

# COBRA PLUS

Dry Screw Vacuum Pumps  
DX 2000 A PLUS Air-Cooled Version (ACV)

## 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 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* [→ 11].

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



### 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.



### NOTE

Illustrations.

In this instruction manual, some machine illustrations are of the COBRA DX 2000 A PLUS without cabinet. Although they differ from the machine with cabinet, the principles and operation are similar.



### NOTE

Illustrations.

In this instruction manual, some maintenance illustrations are those of the COBRA NX 0950 A. Although not shown in the COBRA DX 2000 A PLUS configuration, the principles are similar.



### NOTE

DX 2000 A PLUS configuration.

The COBRA NX 0950 A machine at the top of the configuration is the "pilot" (vacuum pump number 1).

The COBRA NX 0950 A machine at the bottom is the "follower" (vacuum pump number 2).

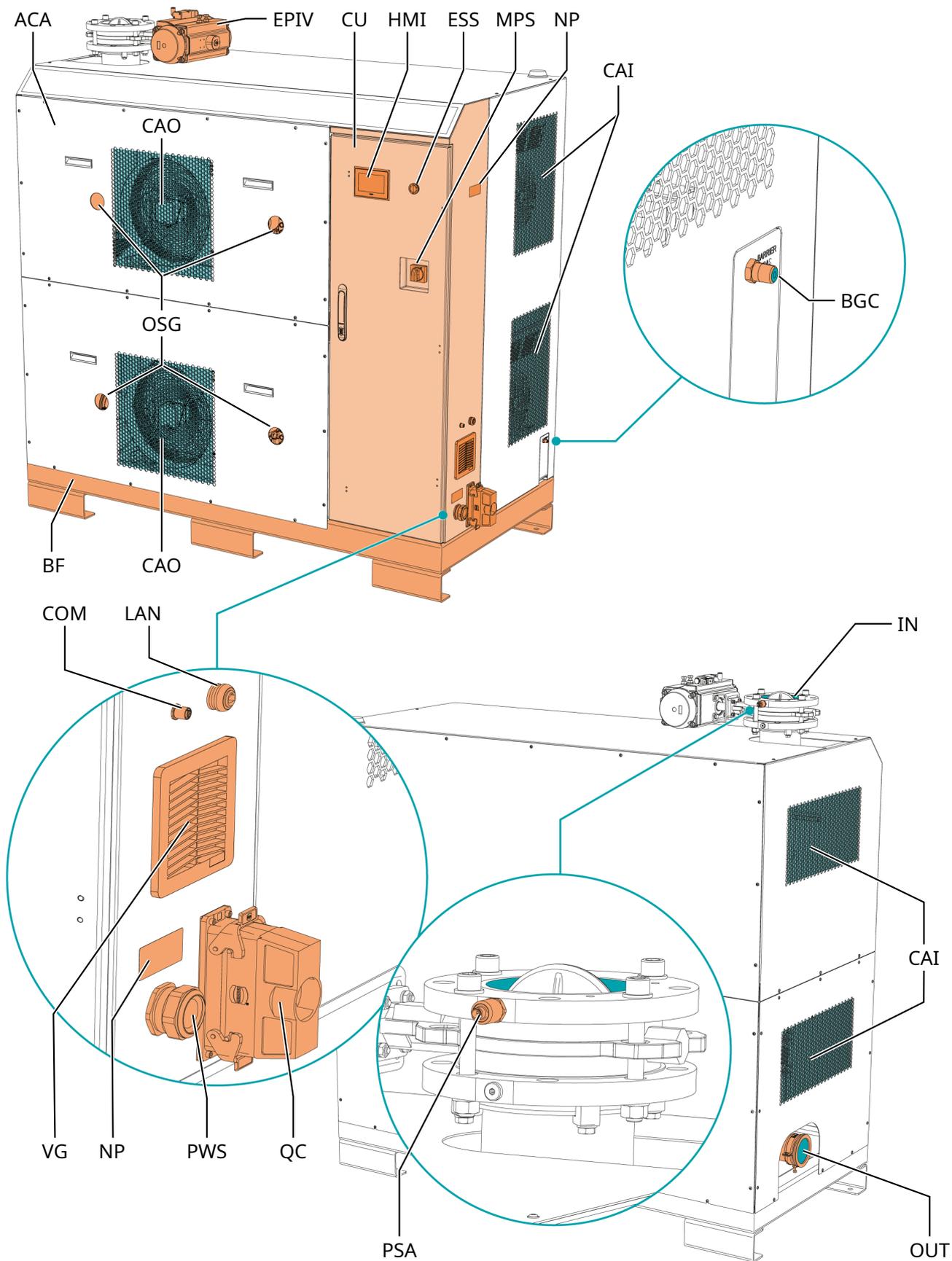
- Specific information about the "pilot" vacuum pump is displayed without superscript digit on the touch screen (HMI).
- Specific information about the "follower" vacuum pump is displayed with superscript digit <sup>2</sup> on the touch screen (HMI).
- See *Description of User Interface Functions* [→ 40].



### WARNING

Each of the two machines has a differently programmed variable speed drive and cannot therefore be exchanged without the intervention of Busch representatives!

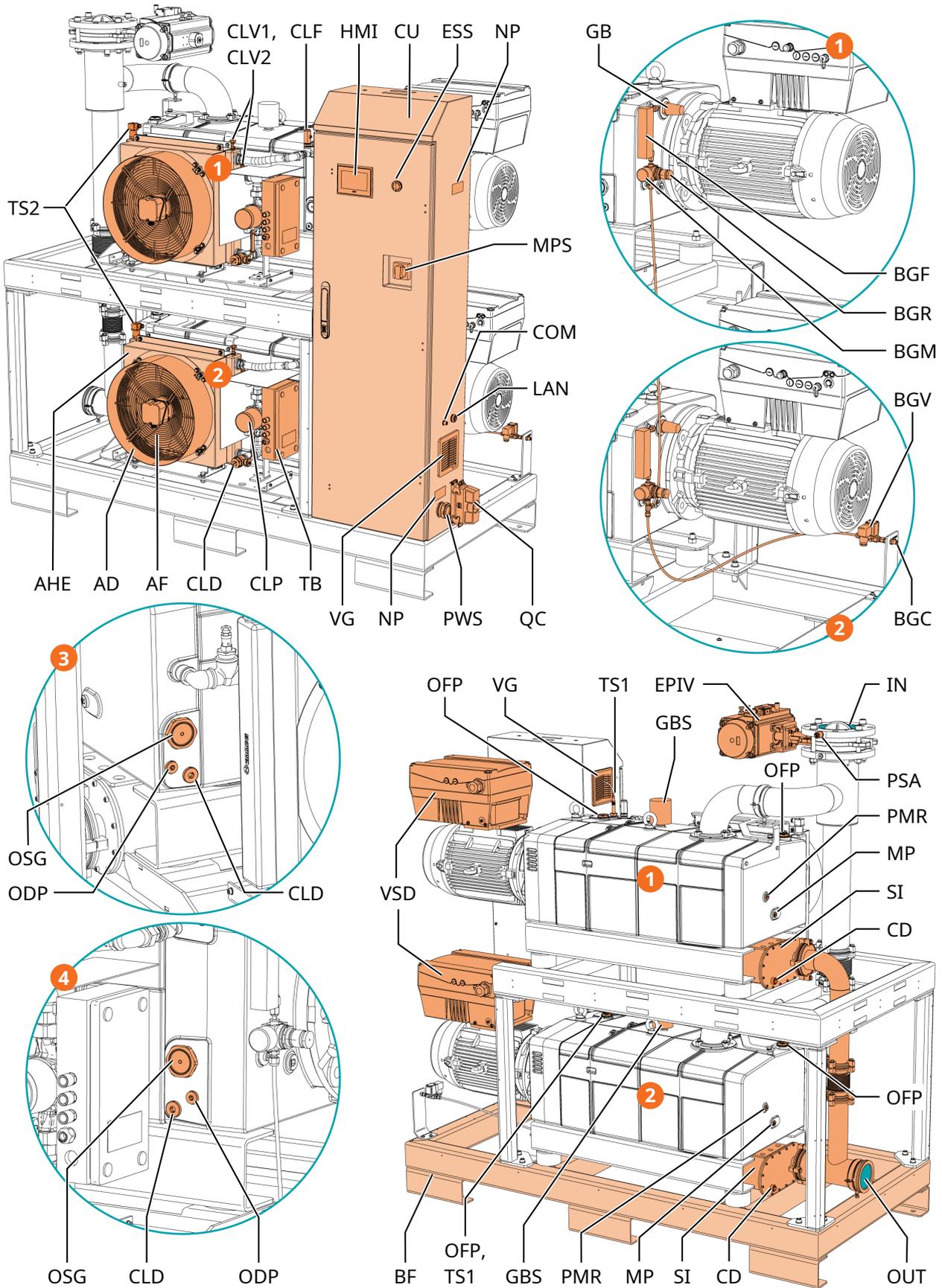
### COBRA DX 2000 A PLUS with cabinet (Option)



Description			
IN	Suction connection (Inlet)	OUT	Discharge connection (Outlet)
ACA	Acoustic cabinet - option	BF	Base frame
BGC	Barrier gas connection - option*	CAI	Cooling air inlet
CAO	Cooling air outlet	COM	Communication I/O port - option
CU	Control unit	EPIV	Electro-pneumatic inlet valve - option
ESS	Emergency stop switch	HMI	User interface (human-machine)
LAN	LAN Communication port (Modbus TCP/IP) - option	MPS	Main power switch - option
NP	Nameplate	OSG	Oil sight glass
PSA	Pressure transmitter (Inlet gas pressure)	PWS	Power supply (cable gland)
QC	Industrial quick connector - option	VG	Ventilation grid

\* See *Barrier Gas System Connection (Optional)* [→ 26]

### Interior of the COBRA DX 2000 A PLUS with optional cabinet removed



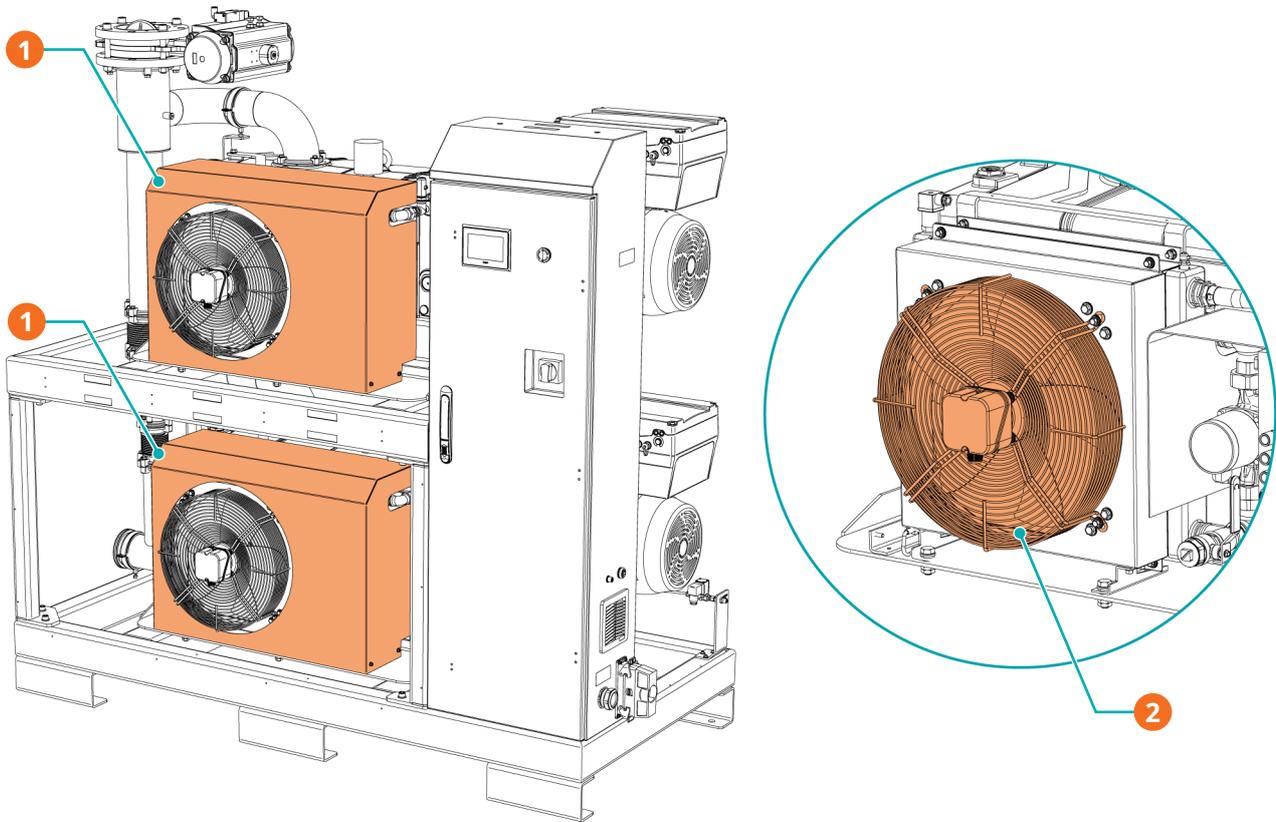
Description			
1	"Pilot" vacuum pump (Pump #1)	2	"Follower" vacuum pump (Pump #2)
3	On each vacuum pump (Suction side)	4	On each vacuum pump (Motor side)

Description			
IN	Suction connection (Inlet)	OUT	Discharge connection (Outlet)
AD	Air deflector (DX 2000 A PLUS with cabinet only)	AHE	Air-water heat exchanger
AF	Axial fan	BF	Base frame
BGC	Barrier gas connection - option*	BGF	Barrier gas flow meter (FME) - option*
BGM	Barrier gas manometer (MAN) - option*	BGR	Barrier gas pressure regulator (PRV) - option*
BGV	Solenoid valve (MV - Barrier gas) - option*	CD	Condensate drain
COM	Communication I/O port - option	CU	Control unit
CLD	Cooling liquid drain plug	CLF	Cooling liquid fill plug
CLP	Cooling liquid pump	CLV1	Cooling liquid vent valve (Heat exchanger)
CLV2	Cooling liquid vent plug (Machine)	EPIV	Electro-pneumatic inlet valve - option
ESS	Emergency stop switch	GB	Gas ballast valve - option
GBS	Gas ballast silencer - option	HMI	User interface (human-machine)
LAN	LAN Communication port (Modbus TCP/IP) - option	MP	Magnetic plug
MPS	Main power switch - option	NP	Nameplate
ODP	Oil drain plug	OFP	Oil fill plug
OSG	Oil sight glass	PMR	Plug for manual rotation of rotors
PSA	Pressure transmitter (Inlet gas pressure)	PWS	Power supply (cable gland)
QC	Industrial quick connector - option	SI	Silencer - option
TB	Terminal box (Cooling system)	TS1	Temperature switch (Machine)
TS2	Temperature switch (Cooling system)	VG	Ventilation grid
VSD	Variable speed drive		

\* See *Barrier Gas System Connection (Optional)* [→ 26]

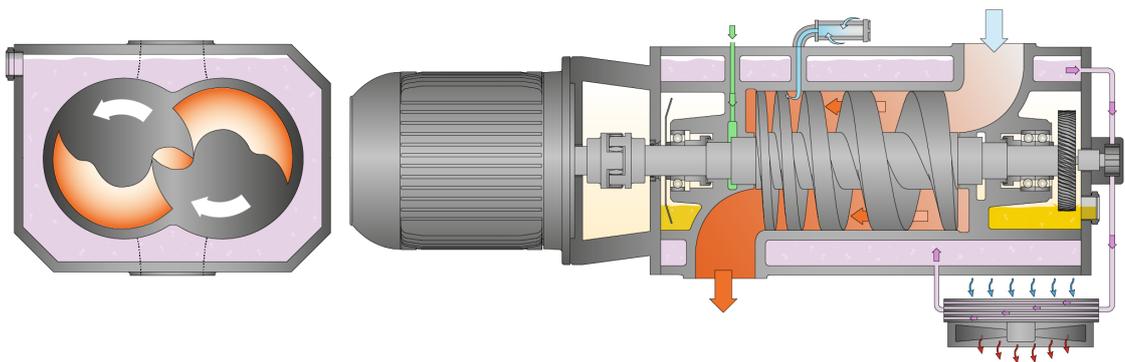
### COBRA DX 2000 A PLUS without cabinet (Standard)

Accessories for the DX 2000 A PLUS without cabinet are the same as for the interior of the DX 2000 A PLUS with optional cabinet, except that the air deflectors (AD) are replaced by the cooling system covers shown below.



Description	
1	Cooling system cover
2	Axial fan (AF) on each vacuum pump

## 2.1 Operating Principle



The machine works on a two-stage twin-screw pump principle.

### Twin-screw pump principle

Two screw rotors rotate inside the cylinder. The pumped medium is trapped between the cylinder and screw chambers, compressed, and transported to the gas outlet. During the compression process, the two screw rotors do not come into contact with each other or with the cylinder. There is no need for a lubrication or an operating fluid in the compression chamber.

## 2.2 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 and other dry, non-aggressive, non-toxic, non-ignitable and non-explosive gases.

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 indoor placement in a non-potentially explosive environment.

The machine is designed for indoor installations. For outdoor installations, consult your Busch representative for special precautions.

The machine is capable of maintaining ultimate pressure, see Technical Data.

The machine is suitable for continuous operation.

Permitted environmental conditions, see Technical Data.



### NOTICE

**Chemical compatibility of the process gases with the machine component materials.**

**Risk of corrosion inside the compression chamber which can reduce performance and its lifetime!**

- Check if the process gases are compatible with those following materials:
  - Cast iron
  - Steel
  - Fluor elastomer (FKM/FPM)
- In doubt, please contact your Busch representative.

## 2.3 Start Controls

The machine is equipped with two Variable Speed Drives (VSD) including a PLC and a Touch Screen.

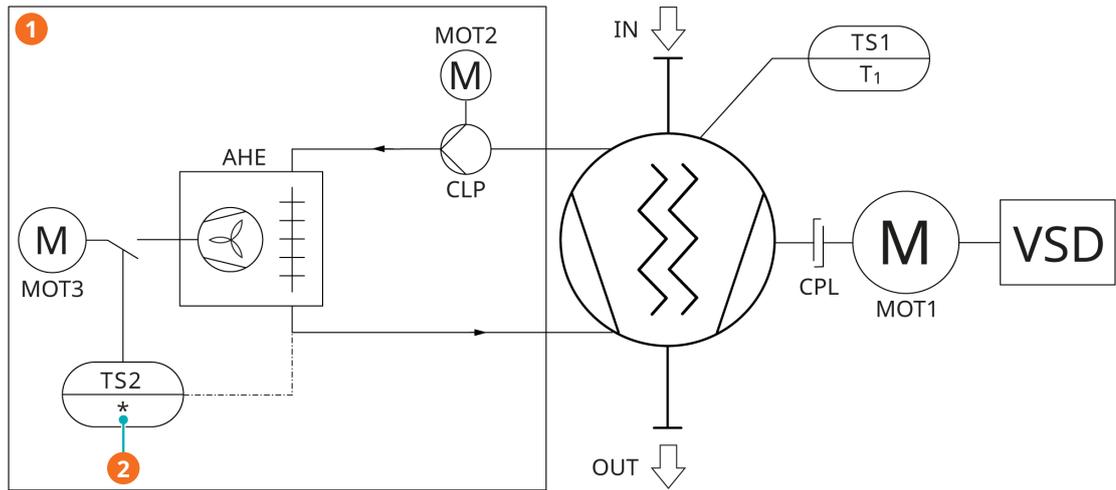
## 2.4 Standard Features

### 2.4.1 Air Cooling

The machine is cooled by a cooling liquid circuit in the cylinder cover and cylinder.

The cooling liquid pump (CLP) allows a recirculating flow in the cooling liquid chamber.

The cooling liquid is cooled by an air-water heat exchanger (AHE).



Description			
1	COBRA NX 0950 A air cooling system (Valid for each COBRA NX 0950 A machine inside the DX 2000 A PLUS)	2	* T cooling liquid

Description			
IN	Suction connection (Inlet)	OUT	Discharge connection (Outlet)
AHE	Air-water heat exchanger	CLP	Cooling liquid pump
CPL	Coupling	MOT1	Motor (Machine)
MOT2	Motor (Cooling liquid pump)	MOT3	Motor (Air-water heat exchanger)
TS1	Temperature switch (Machine)	TS2	Temperature switch (Cooling system)
VSD	Variable Speed Drive		

### 2.4.2 Temperature Switch

The temperature switch monitors the cooling water temperature of the machine.

The temperature switch has one switch point:

- Switch point  $T_1$  (TS1) = 90°C. Trip, the machine must be stopped.

### 2.4.3 Sealing Systems

The machine is equipped with labyrinth seals on the motor side and suction side.

Sealing systems prevent the process gas going to the bearings chambers.

Depending on the application, the sealing systems efficiency can be improved with a barrier gas system, see *Barrier Gas System* [→ 13].

## 2.5 Optional Accessories

### 2.5.1 Gas Ballast Valve

The gas ballast valve mixes the process gas with a limited quantity of ambient air to counteract the condensation of vapor inside the machine.

The gas ballast valve has an influence on the ultimate pressure of the machine, see Technical Data.

### 2.5.2 Silencer

A silencer at the discharge connection (OUT) can be provided to reduce the exhaust gas noise.

- Interface DN 100 ISO-K

If this option is selected, a silencer will be fitted to each pump inside the DX 2000 A PLUS.

## 2.5.3 Barrier Gas System

The barrier gas system allows the supply of compressed air or nitrogen into the motor side shaft seals to improve the sealing efficiency.

## 2.5.4 Electro-pneumatic Inlet Valve



### WARNING

**Maximum permissible inlet weight (suction connection).**

**The maximum permissible inlet weight is 100 kg.**

- Do not exceed the maximum permissible weight!



### CAUTION

**Electro-pneumatic inlet valve pressure.**

**Risk of injuries!**

**Risk of damage to the machine!**

- Busch recommends the installation of a pressure sensor with the following range and accuracy values.

#### Pressure sensor range and accuracy

Range: 0-1000 mbar

Accuracy: +/- 7.0 mbar



### NOTE

**To actuate the valve, compressed air or nitrogen must be supplied.**

Default position of the valve: "normally closed".

Connection size:

- DN160 ISO-K

The electro-pneumatic inlet valve is pilot operated and opens automatically when the machine starts and closes when it stops.

The opening and closing of the valve can be delayed by the Warm-up & Cool-down\* modes of the machine (\*Shutdown/Drying).

## 2.5.5 OTTO IoT Box



The machine can be equipped with the OTTO IoT Box.

It allows the vacuum pump to be connected to the Busch Cloud and collect live measured data during its operation.

The IoT system consists in:

- The IoT Box
- A GSM antenna
- Sensors (Pressure sensor, resistance thermometer, vibration sensor)

For the activation and setup of this optional function, please contact your Busch representative.

For any additional information, refer to the specific document "OTTO IoT Box User's Manual, art. no. 08702236702" or contact your Busch representative.

The information available via the IoT Box is as follows:

- Vibration (mG),
- Ambient temperature (°C/F),
- Inlet pressure (hPa/Torr),
- Temperature of machines 1 and 2 (°C/F),
- Cylinder vibration of machines 1 and 2 (mG),
- Operating time (Hours),
- Total power consumption DX 2000 A PLUS (kW),
- Total amperage DX 2000 A PLUS (A),
- Speed of machines 1 and 2,
- VSD Status for machines 1 and 2,
- VSD Temperature for machines 1 and 2 (°C/F),
- VSD Application error code for machines 1 and 2,
- VSD Power error code for machines 1 and 2.

## 2.5.6 I/O and Communication Port

If the "Remote package control" option is selected:

The control unit (CU) is equipped with a M12 I/O port and a RJ45 communication port (MODBUS) that can allow remote control and monitoring of the machine.

By using the cable supplied with the machine and making the bridges described below in the customer's electrical installation, it is possible to operate the machine in one of three following modes:

- Setup I/O port,
- Power supply,
- Machine remote start.

### Setup I/O port

Connector type: M12 12p female A coded (connection cable included in the scope of supply).



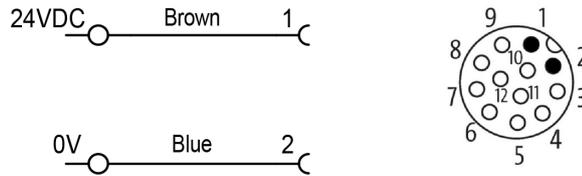
## NOTICE

**Wiring diagrams.**

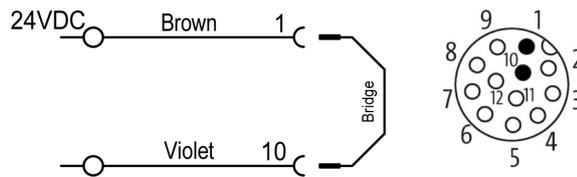
**For more information on all the wiring diagrams below, please refer to the electrical wiring diagram inside the control unit (CU).**

## Power Supply

- 24VDC power supply - Max 1.5A



## Remote Pump Start



It allows the machine to be started by an external signal.

If pins 1 and 10 are bridged, the machine will start according to the settings of the HMI.



### NOTE

**In case of a remote-control start, the machine must be integrated in the user's safety chain (signal warning the user to stop the machine in case of problem or emergency stop).**

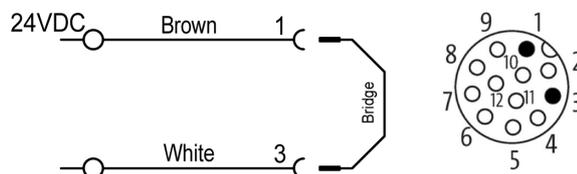


### NOTE

**According to the standard factory setting, there is a bridge on the terminals inside the control unit (CU).**

- Remove the bridge and connect to "Remote pump start" according to the wiring diagram inside the control unit (CU).

## Emergency Start



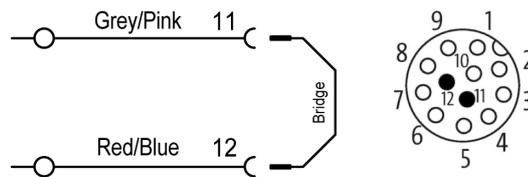
In case of HMI failure, refer to the electrical wiring diagram inside the control unit (CU). The machine then operates at 100% speed and the inlet valve is open.



### NOTE

**No more settings are possible, but the safety chain and the dry contact remain functional.**

## External Safety Switch



It allows to add an external safety element.

Remove the bridge and put a dry contact instead.



### NOTE

The bridge is mandatory in case of a remote-control use.



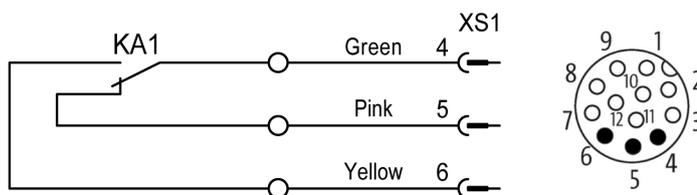
### NOTE

According to the standard factory setting, there is a bridge on the terminals inside the control unit (CU).

- Remove the bridge and connect to "Remote safety contact" according to the wiring diagram inside the control unit (CU).

## External Contact (Pump Status)

- M12 connector Max 30VAC/DC 1.5A
- On terminal Max 250VAC/DC 10A



### NOTE

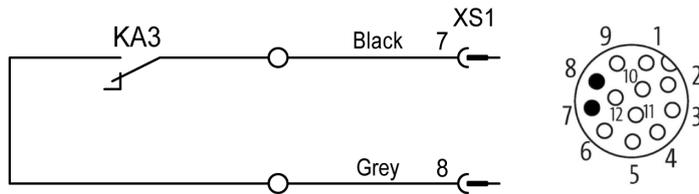
System error, chain safety, EMO.

This contact gives information about the status of the machine and changes its status if an event such as an error, a thermal fault or an emergency stop occurs.

- Status:
  - Normal run: Pin 4-6 OFF / Pin 4-5 ON
  - In case of error: Pin 4-6 ON / Pin 4-5 OFF

## Dry Contact

- M12 connector: Max 30VAC/DC 1.5A
- On terminal: Max 250VAC/DC 10A



- Activation according to the settings of the HMI.

### Modbus Control

For more information:

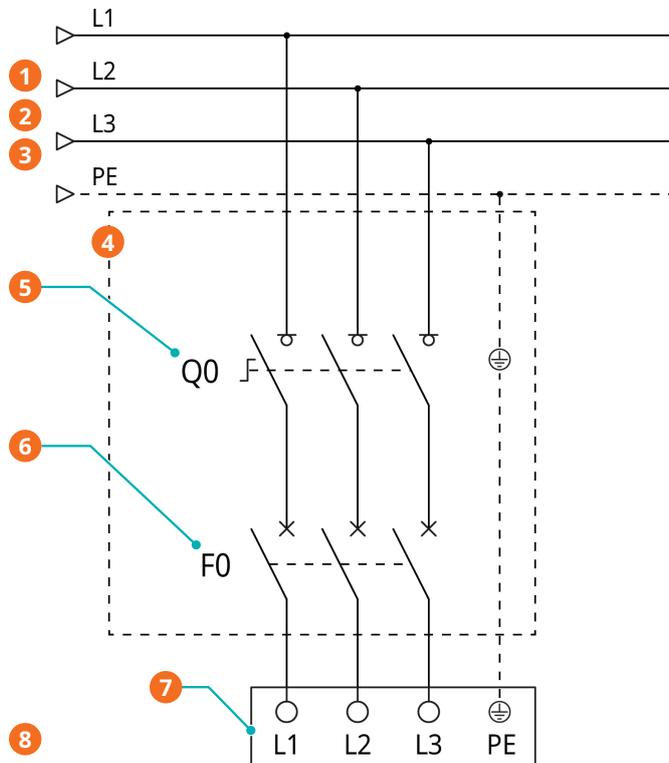
- See *Modbus Control and Ethernet Settings* [→ 37].

## 2.5.7 Main Power Switch / Breaker

The machine can be equipped with a power switch to turn it on and off.

In case this power switch is not installed, an equivalent device must be installed in the customer's system.

### Customer power supply



Description			
1	Power supply Standard Control Unit: 3L+PE 380-440V +/-10% (50/60Hz)	2	Power supply Optional Control Unit: 3L+PE 380-460V +/-10% (50/60Hz)
3	Wire gauge according to EN 60204-1	4	Must be provided by the customer
5	Lockable disconnect switch	6	Overload protection*
7	Vacuum pump terminal board (L1, L2, L3, PE to the control unit)	8	The complete wiring diagram of the control unit is placed inside the electrical cabinet.

\* C-curve - 100A

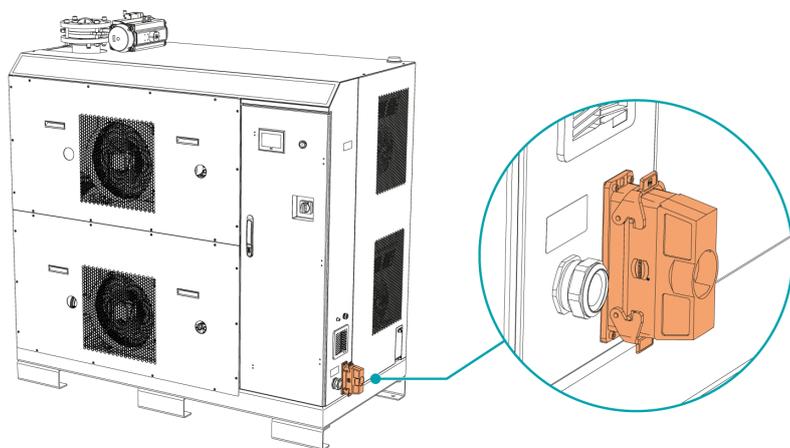
Cable gland size of the power input:

- M50 x 1.5 (cable  $\varnothing$  ► 33 ... 42 mm)

## 2.5.8 Industrial Quick Connector

The standard version of the machine is equipped with a cable gland (PWS).

The machine can be equipped with an industrial quick connector (see *Main Power Supply Connection* [→ 36]).



## 3 Transport



### WARNING

**Transport by truck, train, boat, or plane.**

**Risk of severe injury! Risk of falling! Risk of slipping!**

- When transporting by truck, train, boat, or plane, the pallet must be securely fastened to prevent it from falling or slipping.



### WARNING

**Suspended load.**

**Risk of severe injury!**

- Do not walk, stand, or work under suspended loads.



### WARNING

**Lifting the machine using the motor eye bolt.**

**Risk of severe injury!**

- Do not lift the machine using the eye bolt fitted to the motor. Only lift the machine as shown.



### WARNING

**Standard configuration (machine without cabinet).**

**Risk of severe injury!**

- Do not lift the machine using the lifting eye bolts.
- Always use a forklift as shown in the relevant illustration below.



### WARNING

**Weight of the machine: 2450 kg without cabinet, 2600 kg with cabinet.**

**Risk of severe injury!**

**Handle with care!**

- Due to the weight of the machine, make sure to use a suitable forklift truck.
- Handling access must be from the underneath of the base frame (BF).



### NOTICE

**In case the machine is already filled with oil.**

**Tilting a machine that is already filled with oil can cause large quantities of oil to ingress into the cylinder.**

- Drain the oil prior to every transport or always vertically transport the machine.

## Transport with a forklift



### WARNING

**Weight of the machine: 2450 kg without cabinet, 2600 kg with cabinet.**

**Risk of severe injury!**

**Handle with care!**

- Due to the weight of the machine, make sure to use a suitable forklift truck.
- Handling access must be from the underneath of the base frame (BF).



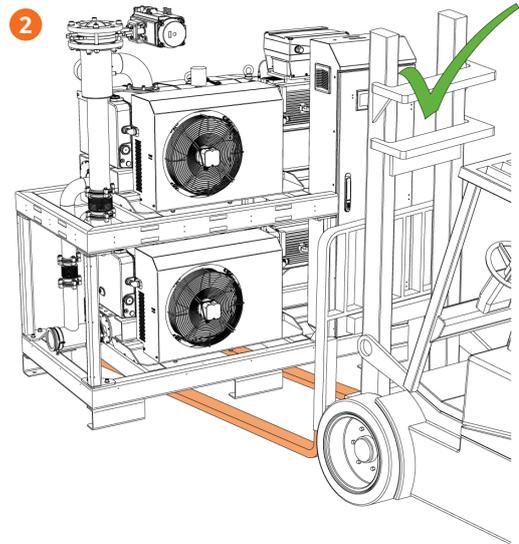
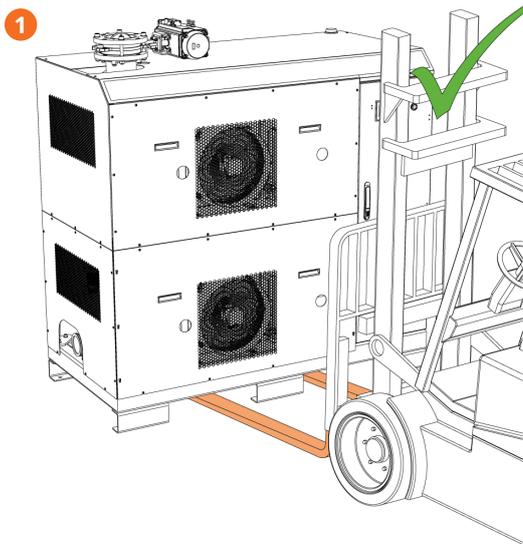
### WARNING

**Machine center of gravity.**

**Risk of severe injury!**

**Handle with care!**

- High risk of tipping due to high center of gravity!
- Always handle the machine horizontally without tilting it!
- Handling access must be from the underneath of the base frame (BF).



#### Description

1	DX 2000 A PLUS with cabinet (Option)	2	DX 2000 A PLUS without cabinet (Standard)
---	--------------------------------------	---	---

- Check the machine for transport damage.

If the machine is secured to a base plate:

- Remove the machine from the base plate.

## 4 Storage

- Seal hermetically all apertures with the caps provided with the machine, or with adhesive tape if the caps are no longer available.
- Store the machine indoors, in a dry place, away from dust and vibrations and if possible, in original packaging, preferably at temperatures between 0 ... 30 °C.

If the machine is to be stored for more than 3 months:

- Seal hermetically all apertures with the caps provided with the machine, or with adhesive tape if the caps are no longer available.
- Wrap the machine in a corrosion inhibitor film.
- Store the machine indoors, in a dry place, away from dust and vibrations and if possible, in original packaging, preferably at temperatures between 0 ... 30 °C.



### NOTICE

**Long storage time.**

**Risk of damage to the machine!**

- Due to a long storage time the capacitors of the variable speed drive can lose efficiency because of electrochemical processes. In the worst case, it can lead to a short-circuit and therefore to a damage to the variable speed drive of the machine.
- Connect the machine every 18 months for 60 minutes to the mains.

# 5 Installation

## 5.1 Installation Conditions

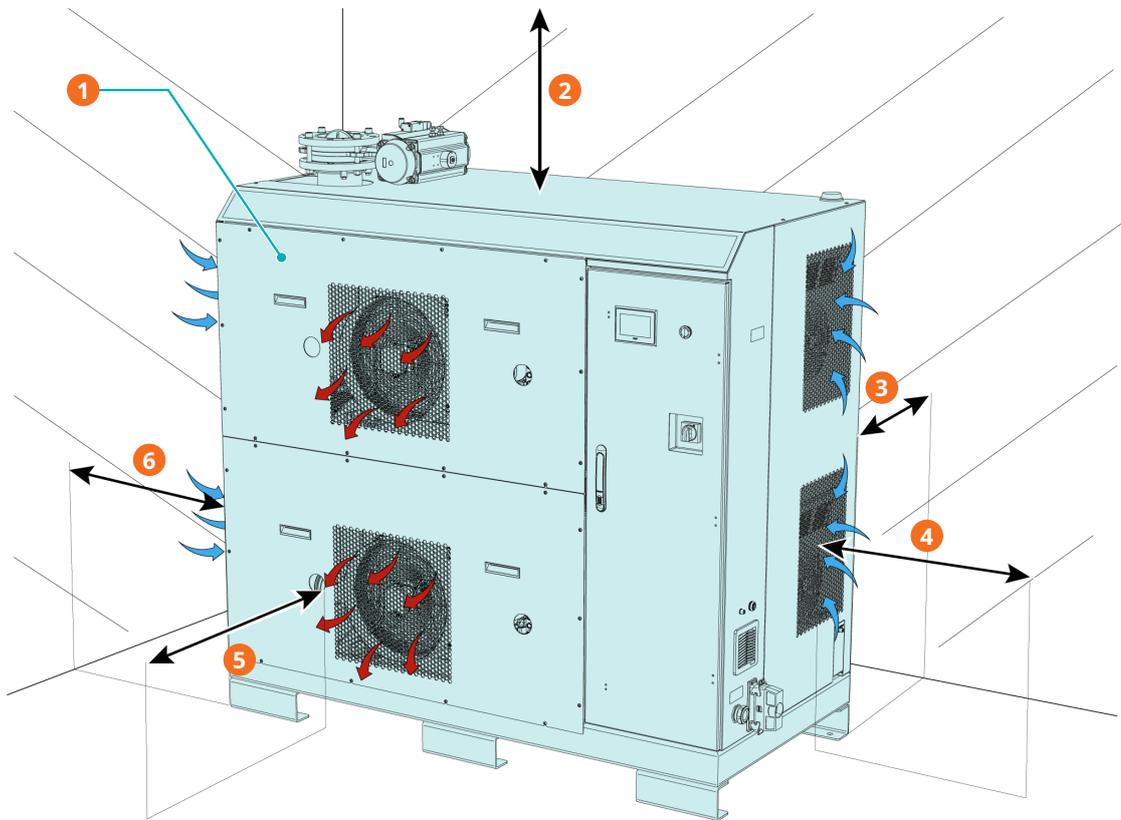
**NOTICE**

Use of the machine outside of the permitted installation conditions.

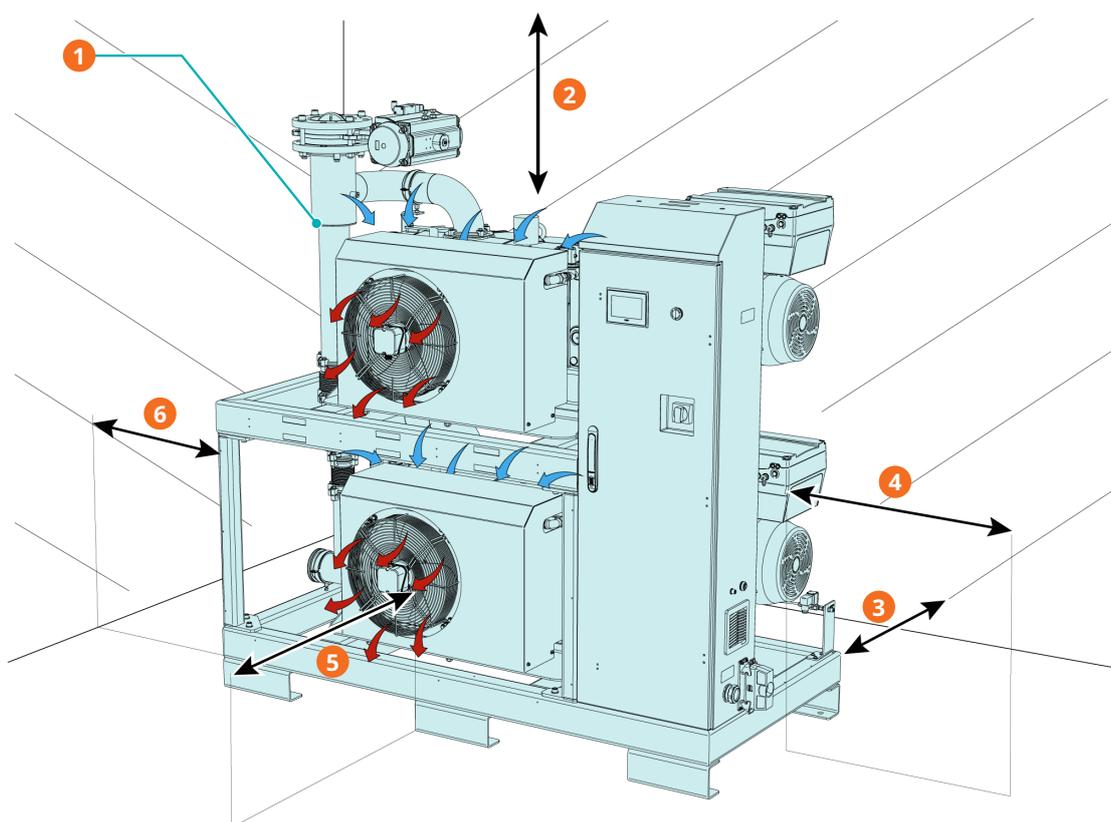
Risk of premature failure!

Loss of efficiency!

- Make sure that the installation conditions are fully respected.



Description			
1	With cabinet (Option)	2	Top side: no requirement
3	Back side: can be installed against a wall, min. 50 mm recommended	4	Right side: min. 1000 mm to allow fresh air intake
5	Front side: min. 1200 mm to allow removal of panels and access to the service side (vacuum pump and electrical cabinet)	6	Left side: min. 1000 mm to allow removal and cleaning of the silencer (option) and warm air exit



Description			
1	Without cabinet (Standard)	2	Top side: no requirement
3	Back side: can be installed against a wall, min. 50 mm recommended	4	Right side: min. 500 mm
5	Front side: min. 500 mm	6	Left side: min. 1200 mm to allow removal and cleaning of the silencer (option) and service

- Make sure that the environment of the machine is not potentially explosive.
- Make sure that the ambient conditions comply with the Technical Data.
- 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 vented such that sufficient cooling of the machine is provided.
- Make sure that cooling air inlets (CAI) and outlets (CAO) are not covered or obstructed and that the cooling air flow is not affected adversely in any other way.
- Make sure that the oil sight glass (OSG) remains easily visible.
- Make sure that enough space remains for maintenance work.
- Make sure that the machine is placed or mounted horizontally, a maximum deviation of 1° in any direction is acceptable.
- Check the oil level, see *Oil Level Inspection* [→ 57].
- Check the cooling liquid level, see *Cooling Liquid Level Inspection* [→ 58].

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 connections of the machine. Therefore, we recommend installing flexible lines on the suction and discharge connections.
- Make sure that the diameter 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 recommended to use larger diameters to avoid a loss of efficiency. In this case, please contact your Busch representative.

### 5.2.1 Suction Connection



#### WARNING

**Unprotected suction connection.**

**Risk of severe injury!**

- Do not put hand or fingers in the suction connection.



#### NOTICE

**Ingress of foreign objects or liquids.**

**Risk of damage to the machine !**

If the inlet gas contains dust or other foreign solid particles:

- Install a suitable filter (5 micron or less) upstream from the machine.

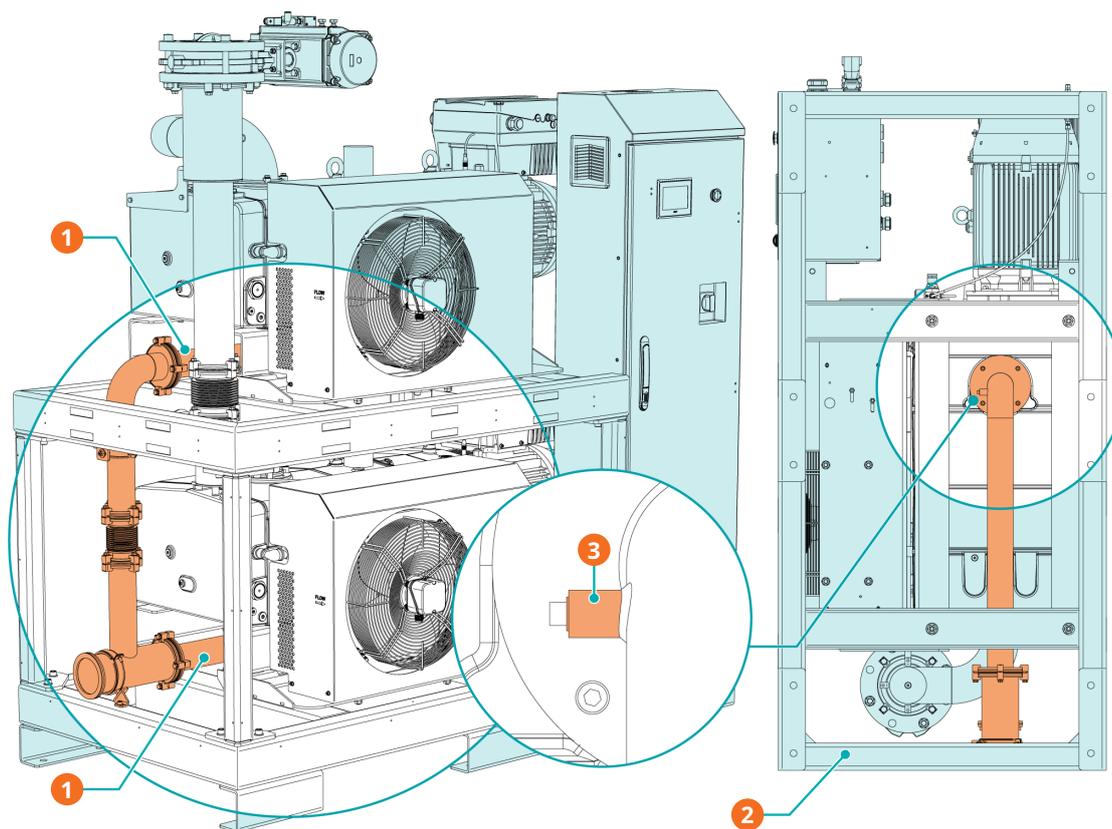
Connection size(s):

- Inlet filter: ISO-K DN160, DIN 28404

If the machine is used as part of a vacuum system:

- Busch recommends the installation of an isolation valve in order to prevent the machine from turning backwards.
- Make sure that the connection lines cause no stress on the connections of the machine. Therefore, we recommend installing flexible lines on the suction and discharge connections.

## 5.2.2 Discharge Connection



Description			
1	Standard exhausts without silencers (SI)	2	Bottom view of the DX 2000 A PLUS
3	Auxiliary port (one on each NX 0950 A)		

### NOTICE

**Discharge gas flow obstructed.**

**Risk of damage to the machine!**

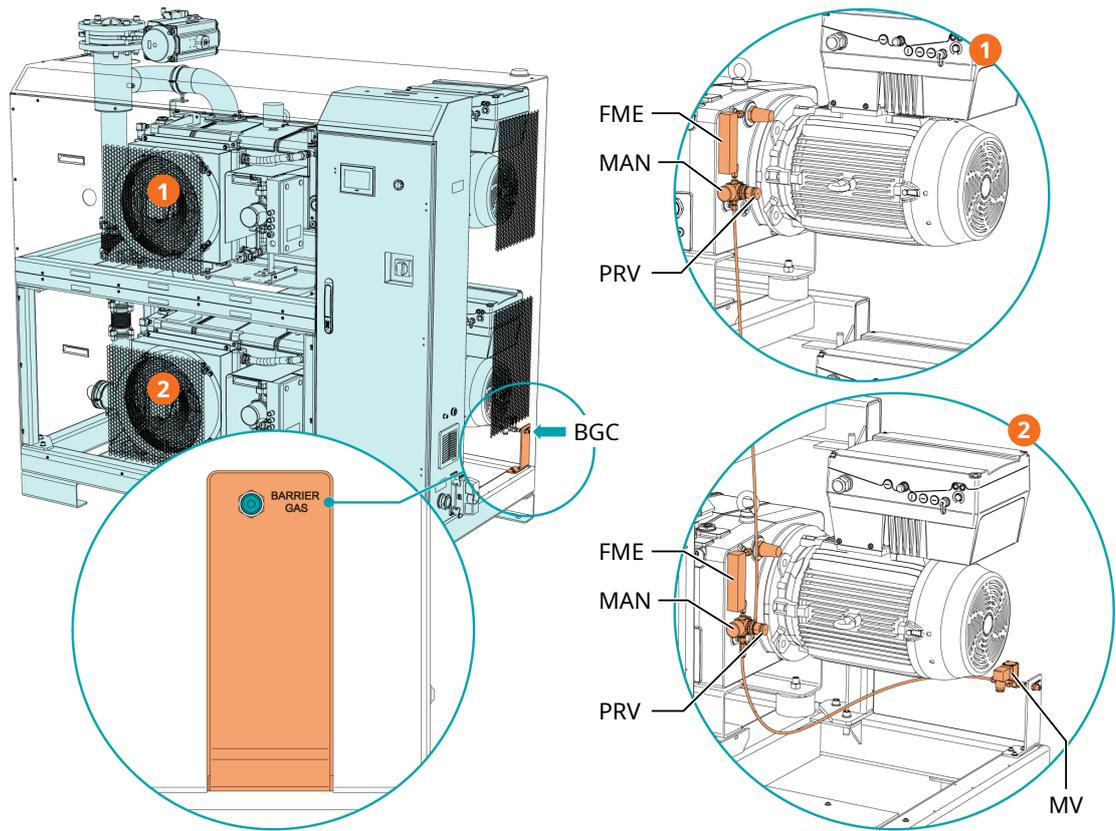
- Make sure that the discharged gas will flow without obstruction. Do not shut off or throttle the discharge line or use it as a pressurized air source.

Connection size(s):

– ISO-K DN100, DIN 28404

- Make sure that the connection lines cause no stress on the connections of the machine. Therefore, we recommend installing flexible lines on the suction and discharge connections.
- Make sure that the counter pressure (also called “back pressure”) at the discharge connection (OUT) does not exceed the maximum allowable discharge pressure, see Technical Data.

### 5.2.3 Barrier Gas System Connection (Optional)



Description			
1	"Pilot" vacuum pump (Pump #1)	2	"Follower" vacuum pump (Pump #2)

Description			
BGC	Barrier gas connection	FME	Flow meter
MAN	Manometer	MV	Solenoid valve
PRV	Pressure regulating valve		

- Connect the barrier gas connection (BGC) to the gas supply.

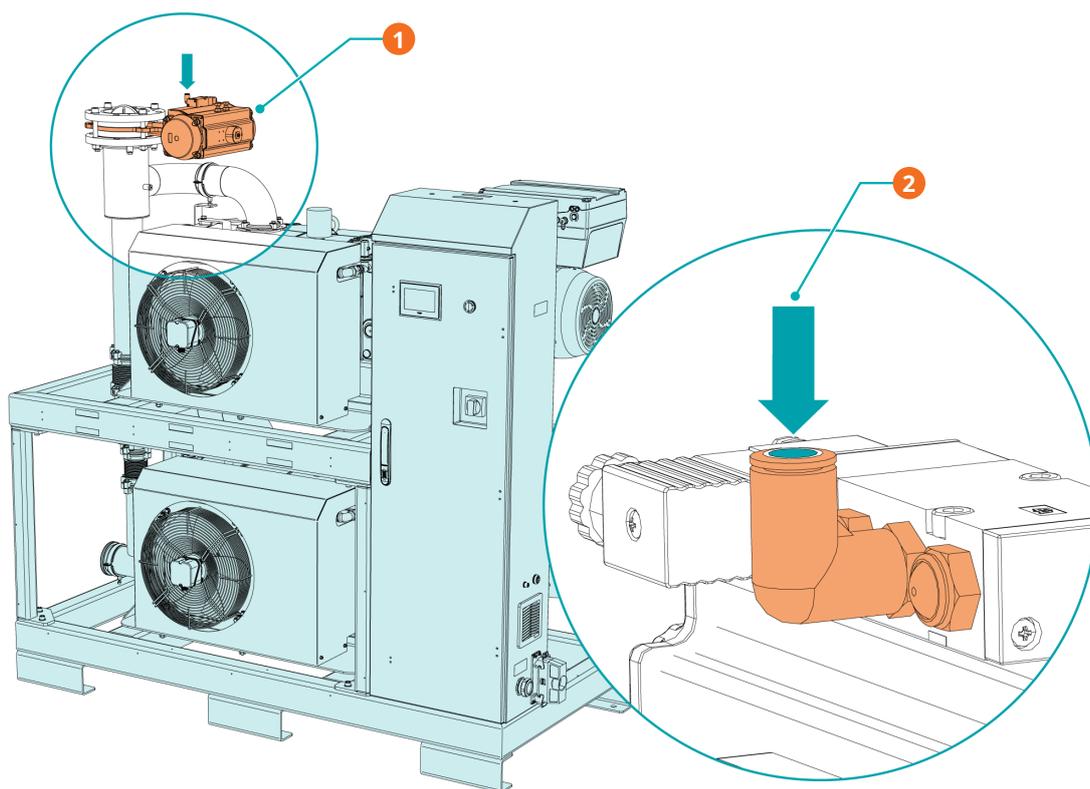
Connection size:

- G1/4", ISO 228-1

- Make sure that the gas complies with the following requirements:

Gas type	Dry nitrogen or air	
Gas temperature	°C	0 ... 60
Maximum gas pressure	bar (g)	13
Recommended pressure setting at the pressure regulating valve (PRV)	bar (g)	3
Filtration	µm	5
Recommended flow rate	SLM (standard liter per minute)	15 ... 20
Air quality (only for air)	Acc. to ISO 8573-1	Class 5.4.4.

## 5.2.4 Electro-Pneumatic Inlet Valve Connection (Optional)



Description			
1	Electro-pneumatic inlet valve (EPIV)	2	Compressed air or nitrogen intake

Connection size:

- DN160 ISO-K

The electro-pneumatic inlet valve (EPIV) must be connected to compressed air or compressed nitrogen gas source.

- Make sure the gas complies with the following requirements:

Gas type	Dry nitrogen or air	
Gas temperature	°C	0 ... 50
Pressure setting for actuation	bar (g)	1.5 ... 8
Actuation mode	Single acting actuator	
	Normally closed by lack of air	

## 5.3 Filling Oil



### WARNING

Oil filling must be performed on each COBRA NX 0950 A machine inside the DX 2000 A PLUS!



### NOTICE

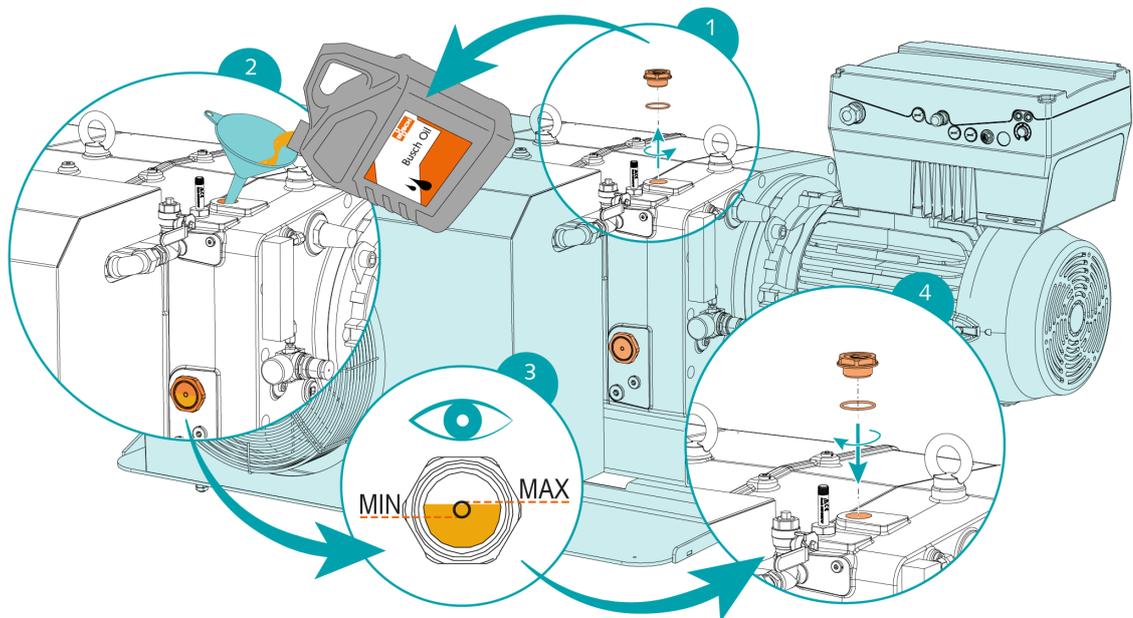
Use of an inappropriate oil.

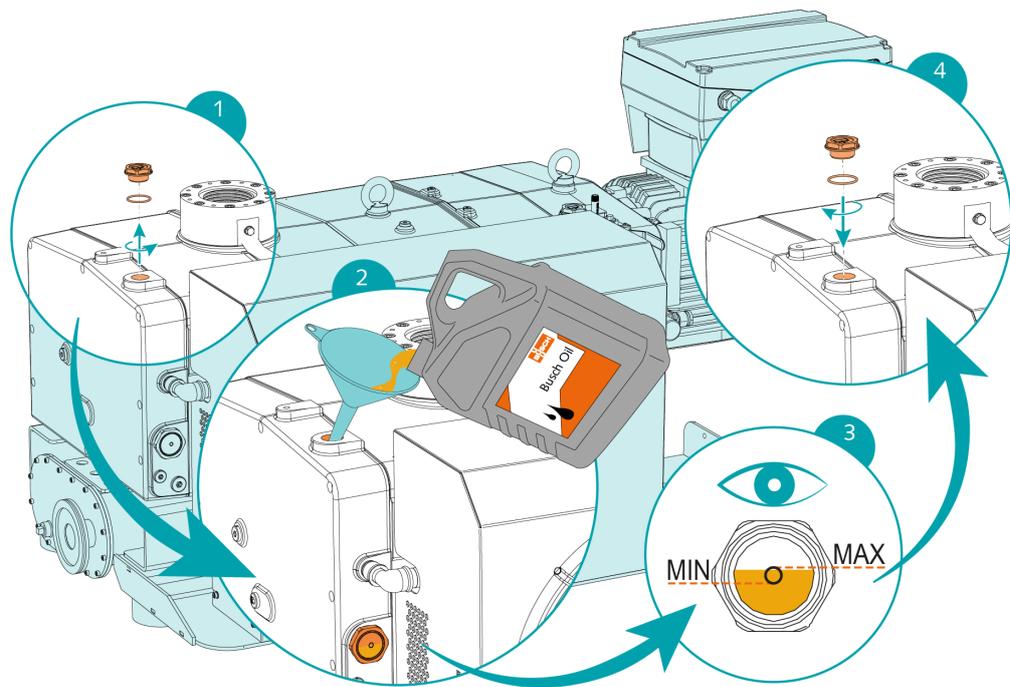
Risk of premature failure!

Loss of efficiency!

- Only use an oil type which has previously been approved and recommended by Busch.

For oil type and oil capacity see Technical Data and *Oil* [→ 75].





When the oil filling is achieved:

- Write down the oil change date on the sticker.



If there is no sticker (part no. 0565 568 959) on the machine:

- Order it from your Busch representative.

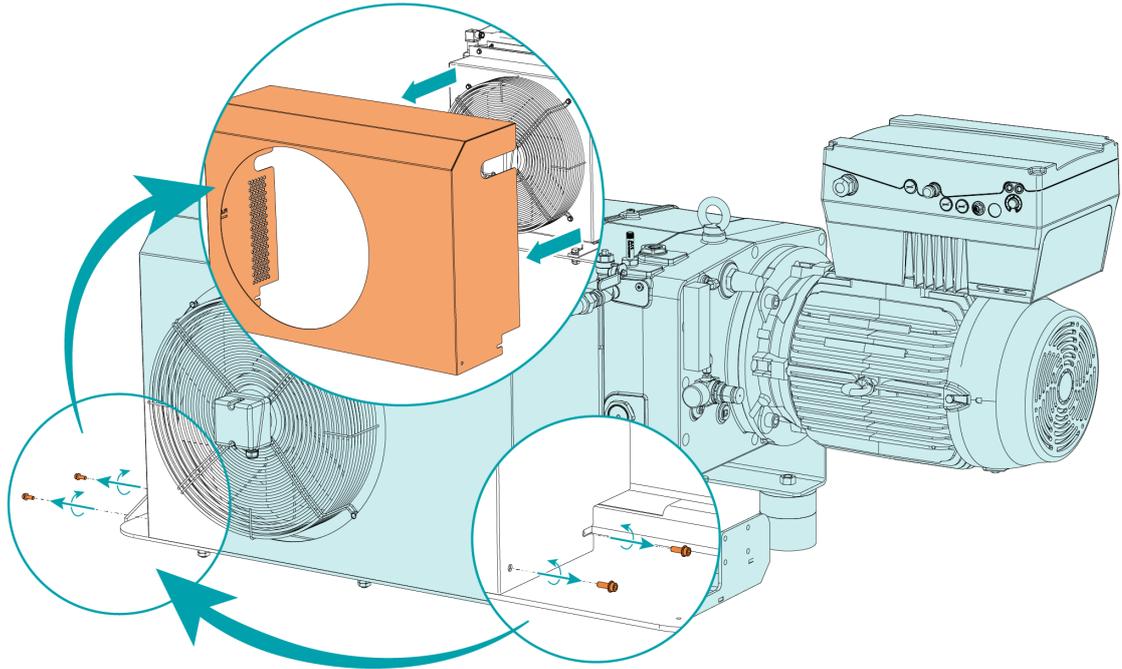
## 5.4 Cooling System Cover Removal



### NOTE

**Before filling or changing the cooling liquid and electrically connecting the cooling system.**

- Remove the cooling system cover.
- The above safety note and the following illustration apply only to the COBRA NX 0950 A machines inside the COBRA DX 2000 A PLUS **without cabinet**.



## 5.5 Filling Cooling Liquid



### WARNING

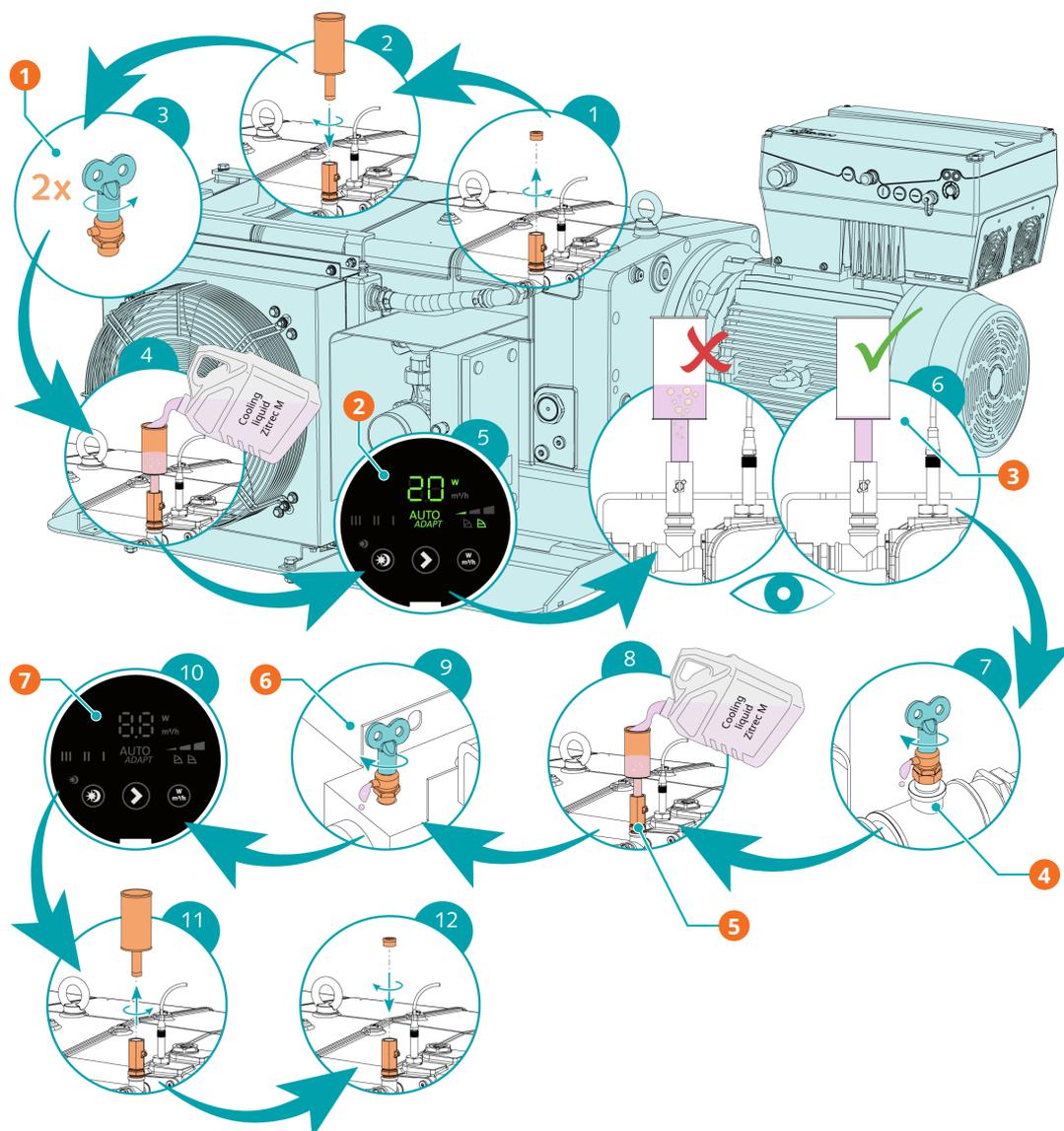
Cooling liquid filling must be performed on each COBRA NX 0950 A machine inside the DX 2000 A PLUS!

The machine is already dispatched with cooling liquid.

If it is not the case:

- Electrically connect the cooling system, see *Electrical Connection of the Cooling System* [→ 38].
- Fill in the machine with cooling liquid according to the following procedure.

For cooling liquid type and cooling liquid capacity see Technical Data and *Cooling Liquid* [→ 76].



Description			
1	Step 3: Open the cooling liquid vent valves (CLV1, CLV2)	2	Step 5: Switch on the cooling liquid pump (CLP)
3	Step 6: Vent air from the cooling system	4	Step 7: Close the cooling liquid vent valve (CLV2) when the cooling liquid is spilling out

Description			
5	Step 8: Resume cooling liquid filling	6	Step 9: Close the cooling liquid vent valve (CLV1) when the cooling liquid is spilling out
7	Step 10: Switch off the cooling liquid pump (CLP)		

## 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 in accordance with EN 60204-1 must be provided by the customers on their 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, 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* [→ 77] or *UK Declaration of Conformity* [→ 78]).

## 6.1 PLUS Machine



### DANGER

**Live wires. Carry out any work on the variable speed drive and motor.**

**Risk of electrical shock!**

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



### DANGER

**Maintenance work without switching-off the power supply to the control unit.**

**Risk of electrical shock!**

- Switch-off the power supply to the control unit with a lockable disconnect switch before attempting any work on it. High voltages are present at the terminals and within the variable speed drive for up to 10 minutes after disconnection of the electrical supply.
- Always ensure by using a suitable multimeter that no voltage is present on any drive power terminals prior to commencing any work.



### DANGER

**Maintenance work without disconnecting the variable speed drive.**

**Risk of electrical shock!**

- Disconnect and isolate the variable speed drive before attempting any work on it. High voltages are present at the terminals and within the variable speed drive for up to 10 minutes after disconnection of the electrical supply.
- Always ensure by using a suitable multimeter that no voltage is present on any drive power terminals prior to commencing any work.
- Make sure that the power supply is compatible with the data on the nameplate of the control unit.
- 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 control unit is not equipped with a lockable disconnect switch, provide it on the power line so that the machine is completely secured during maintenance tasks, or in case of an emergency.
- Provide an overload protection according to EN 60204-1.
  - Busch recommends installing a C-curve circuit breaker.
- Connect the protective earth conductor.
- Electrically connect the machine to the main power supply.
  - See *Main Power Supply Connection* [→ 36].

 **NOTICE**

**The admissible motor speed exceeds the recommendation.**

**Risk of damage to the machine!**

- Check the admissible motor speed range, see Technical Data.
- 

 **NOTICE**

**The motor frequency is below 20 Hz.**

**Risk of damage to the machine!**

- The motor nominal speed must always be higher than 1200 min<sup>-1</sup> (20 Hz).
- 

 **NOTICE**

**Incorrect connection.**

**Risk of damage to the control unit!**

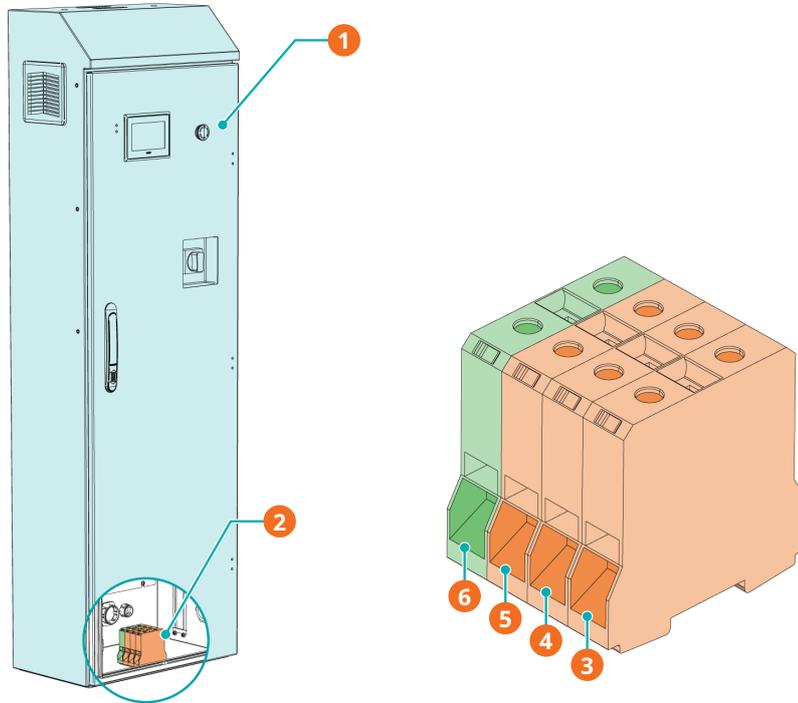
- The wiring diagrams given below are typical. Check the inside of the control unit for connection instructions/diagrams.
-

## 6.2 Main Power Supply Connection

Cable gland size of the power input:

- M50 x 1.5 (cable  $\varnothing$  ► 33 ... 42 mm)

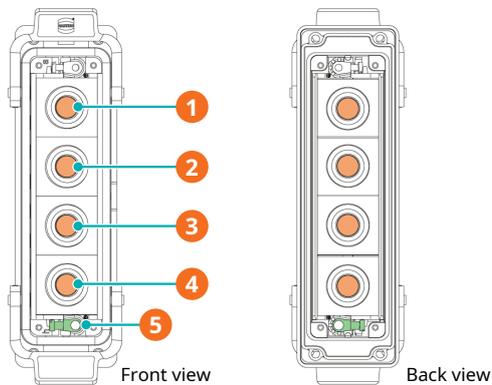
### Standard Connector



Description			
1	Control unit (CU)	2	Main power supply connection
3	L1	4	L2
5	L3	6	PE

### Optional Industrial Quick Connector [→ 18]

- Pin configuration (380-460VAC)



Description			
1	L1	2	L2
3	L3	4	PE
5	PE (Connector housing)		

Plug	
Maximum current	200A @ 40°C
Maximum voltage	480V
Square cable	sq 25... 40 mm <sup>2</sup>
AWG gauge	AWG 3 ... 1
Cable entry	M50 x 1.5mm

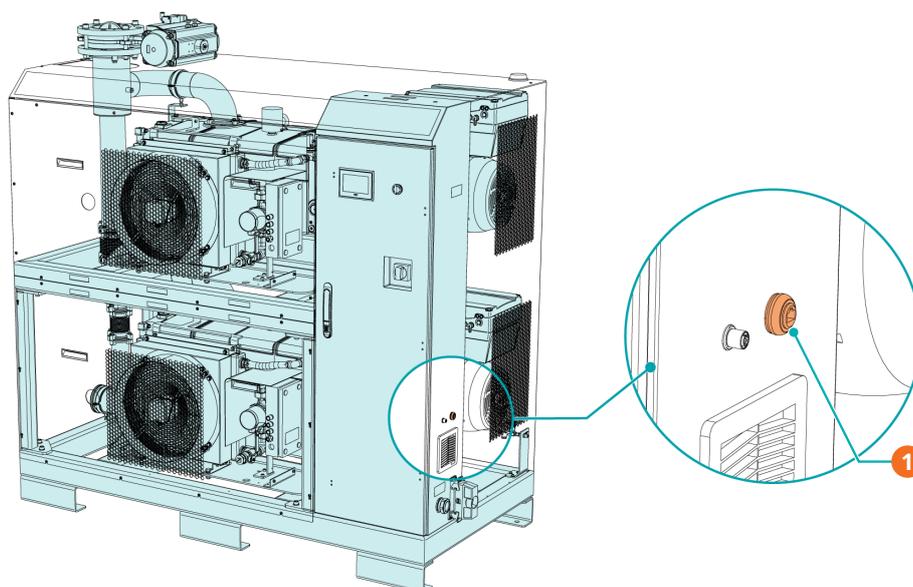
## 6.3 Modbus Control and Ethernet Settings

The user interface (HMI) works in Modbus with "Holding Registers", readable and writable, 16 bits. The default ethernet settings are the following:

Description	Default value
IP address	192.168.0.100
Subnet mask	255.255.255.0
Gateway	192.168.0.1
Port no.	502 (cannot be changed)
Slave ID no.	1-255 (all are functioning)

To control the machine via Modbus TCP/IP:

- Select the control mode "Remote/Modbus control".
- Connect your system to the ethernet RJ45 port located on the right side of the control unit.



Description	
1	LAN Communication port (Modbus TCP/IP)

- Configure the *Ethernet Settings* [→ 52].

### NOTE

**Monitoring via Modbus.**

**Do not activate Remote/Modbus for sole monitoring purpose.**

**This mode is only activated if the machine is fully controlled via Modbus.**

## 6.4 Electrical Connection of the Cooling System



### DANGER

Live wires.

Risk of electrical shock!

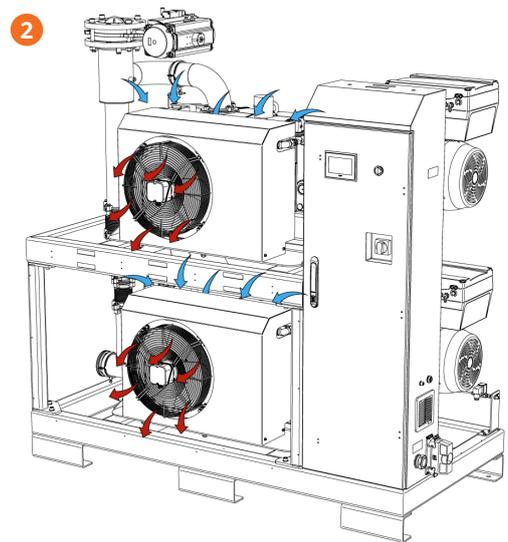
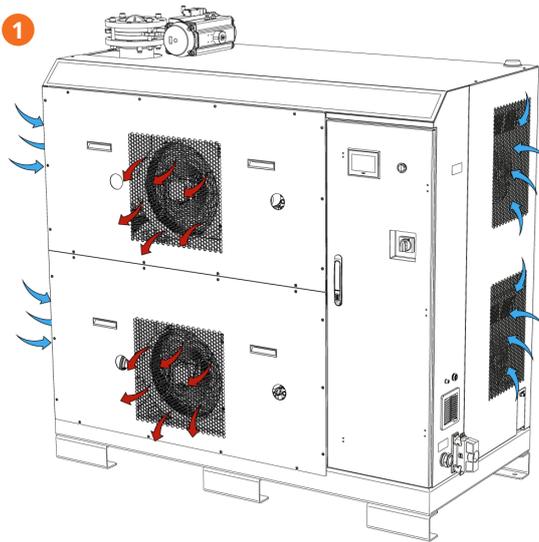
- Electrical installation work must only be executed by qualified personnel.



### NOTE

No additional wiring is required to connect the air-cooling system of the machine. There is only one connection to be made to the main power supply of the machine.

- Make sure that the power supply for the motor is compatible with the data on the nameplate of the motor.
- Make sure that the air flow blows in the right direction according to the following illustration.



Description			
1	DX 2000 A PLUS with cabinet (Option)	2	DX 2000 A PLUS without cabinet (Standard)

## 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.



### CAUTION



**Noise of running machine.**

**Risk of damage to hearing!**

If people are present in the vicinity of a machine that is not insulated from noise for extended periods of time:

- Make sure to wear hearing protection.



### NOTICE

**The machine can be shipped without oil.**

**Operation without oil will ruin the machine in short time!**

- Prior to commissioning, the machine must be filled with oil, see *Filling Oil* [→ 28].



### NOTICE

**Lubricating a dry running machine (compression chamber).**

**Risk of damage to the machine!**

- Do not lubricate the compression chamber of the machine with oil or grease.

- Make sure that the *Installation Conditions* [→ 22] are met.

If the machine is equipped with an electro-pneumatic inlet valve:

- Open the electro-pneumatic inlet valve supply.

If the machine is equipped with a barrier gas system:

- Turn on the barrier gas supply.
- Adjust the barrier gas pressure.
- Make sure that the cooling system is in operation (axial fan (AF) and cooling liquid pump (CLP)). The setting of the cooling liquid pump does not matter. All settings are allowed.
- Switch the machine “on” or “off” at the Touch Screen. The Touch Screen shows the actual machine status and the data of the different sensors and of the variable speed drive (see *Description of User Interface Functions* [→ 40]).
- Make sure that the maximum permissible number of starts does not exceed 6 starts per hour. Those starts should be spread within the hour.
- Make sure that the operating conditions comply with the Technical Data.
- After a few minutes of operation, perform an *Oil Level Inspection* [→ 57].
- After a few minutes of operation, perform a *Cooling Liquid Level Inspection* [→ 58].

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

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

**i NOTE**

**COBRA machines require a certain warm-up time to reach peak performance.**

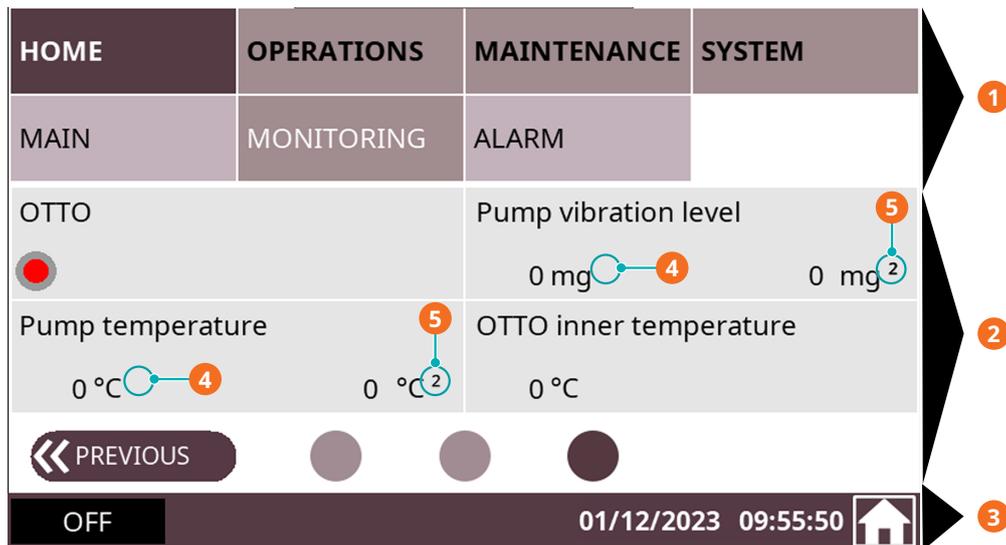
## 7.1 Description of User Interface Functions

The following functions and parameters are available on the TOUCH SCREEN - HMI interface:

- Language selection (English at first step)
- Date and time
- Units such as pressure (mbar, hPa, TORR) and temperature (°C and °F)
- Inlet pressure
- Ethernet settings
- P&ID control settings
- Pressure control settings
- Service indicator such as operating hours, hours to next oil service

### Interface overview

The menu consists of four main tabs (Home, Operations, Maintenance, System) with their own sub-tabs.



Description			
1	Menu tabs and sub-tabs	2	Information panel
3	Bottom bar	4	No superscript digit = Pilot vacuum pump (Pump #1)
5	Superscript digit 2 = Follower vacuum pump (Pump #2)		

## 7.1.1 Roles and Users

Three roles of user rights are predefined in the system.

### Role 1 ► Operator

This role is intended for machine operators to control the machine (limited rights) or monitor operating values. It does not require any password.

### Role 2 ► Installation/Maintenance technician

This role is intended for installation/maintenance technicians to configure the machine according to the application. The password for this role can be found in the separate sheet attached to this instruction manual and allows an access to the following features:

- Change operating mode,
- Reset hours before the next service,
- Set the remote control and monitoring parameters.

### Role 3 ► Busch Service

Only authorized personnel from Busch Service have this level of access rights.

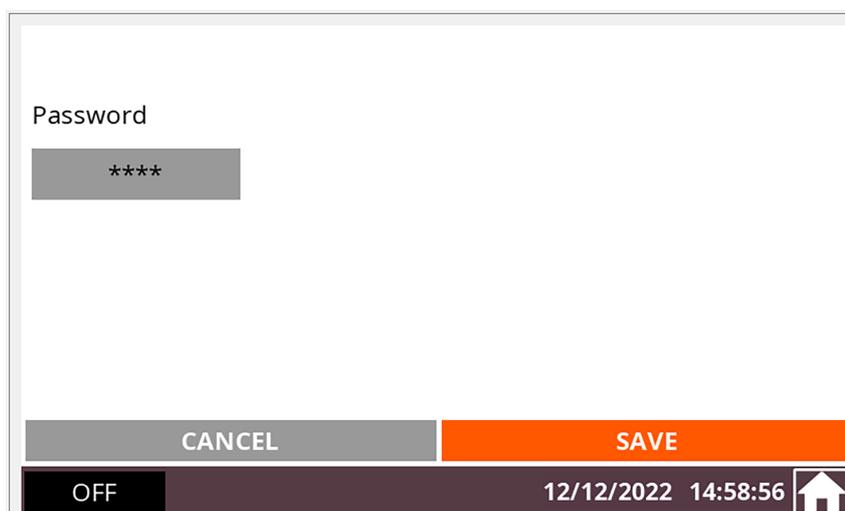


## NOTE

**In case of any questions related to the machine settings:**

- Please contact Busch Service.

When a password is required, the display shows the following screen:



- Press the stars in the password field.
- Enter the correct password in the number pad according to your access right.
- Press "Save".
- From now on, the specific rights are open for a limited period ► delay of 5 minutes.

## 7.1.2 Home

### 7.1.2.1 Main

The display "HOME > MAIN" is the main display.

It is mainly useful for live monitoring.

HOME	OPERATIONS	MAINTENANCE	SYSTEM
MAIN	MONITORING	ALARM	
Inlet pressure 40 mbar		Actual speed 0 %	
<div style="border: 2px solid black; padding: 10px; display: inline-block;">Start</div>			
OFF		01/12/2023 09:36:21 	

### 7.1.2.2 Monitoring (Operating Data)

The display "HOME" > "MONITORING" shows the operating values.

It is divided into three different screens/pages.

#### Screen/Page MONITORING 1

HOME	OPERATIONS	MAINTENANCE	SYSTEM
MAIN	MONITORING	ALARM	
Instant absorbed power 0.00 kW		Running hours total 0 h	
Energy consumption total 3660 kWh		Pump Current 0.0 A	
<div style="display: flex; justify-content: space-around; align-items: center;"> <span>●</span> <span>●</span> <span>●</span> <div style="border: 1px solid black; padding: 5px; border-radius: 10px; display: flex; align-items: center;"> <span>NEXT</span> <span style="font-size: 20px; margin-left: 5px;">&gt;&gt;</span> </div> </div>			
OFF		01/12/2023 09:55:42 	

**Instant absorbed power.** Indicates in kW the total absorbed power in real time.

**Running hours total.** Indicates the total number of operating hours since the first machine commissioning.

**Energy consumption total.** Indicates in kWh the total consumption of energy since the first machine commissioning.

**Pump current.** Indicates in ampere unit (A) the total value of the pump current in real time.

## Screen/Page MONITORING 2

HOME	OPERATIONS	MAINTENANCE	SYSTEM
MAIN	MONITORING	ALARM	
Inlet pressure		Motor frequency	
50 mbar		0 Hz	0 Hz <sup>2</sup>
IGBT temperature		Inner temperature	
0.0 °C	0.0 °C <sup>2</sup>	0.0 °C	0.0 °C <sup>2</sup>
◀ PREVIOUS			NEXT ▶
OFF	01/12/2023 09:55:45		🏠

**Inlet pressure.** Indicates the pressure at the inlet of the pump when the pump is equipped with the inlet valve and when the function is activated.

**Motor frequency.** Indicates in Hz the current drive frequency.

**IGBT temperature.** Indicates the temperature of the insulated-gate bipolar transistor inside the variable speed drive (VSD).

**Inner temperature.** Indicates the temperature of the pump coolant. If the temperature is too high, an alarm occurs.



### NOTE

All values displayed with a superscript 2 are linked to the “follower” vacuum pump (vacuum pump number 2, at the bottom of the configuration).

## Screen/Page MONITORING 3

HOME	OPERATIONS	MAINTENANCE	SYSTEM
MAIN	MONITORING	ALARM	
OTTO		Pump vibration level	
●		0 mg	0 mg <sup>2</sup>
Pump temperature		OTTO inner temperature	
0 °C	0 °C <sup>2</sup>	0 °C	
◀ PREVIOUS			
OFF	01/12/2023 09:55:50		🏠

**OTTO.** Indicates if the IoT function is activated.

**Pump vibration level.** Indicates in mg the level of vibration of the pump.

**Pump temperature.** Indicates the temperature of the pump. If the temperature is too high, an alarm occurs.

**OTTO inner temperature.** Indicates the temperature value of the IoT Box.

**i NOTE**

All values displayed with a superscript 2 are linked to the "follower" vacuum pump (vacuum pump number 2, at the bottom of the configuration).

**7.1.2.3 Alarms**

The display "HOME" > "ALARM" shows the history of the alarms' signals registered by the pump monitoring sensors.

<b>HOME</b>	<b>OPERATIONS</b>	<b>MAINTENANCE</b>	<b>SYSTEM</b>
MAIN	MONITORING	ALARM	
Trigger Date	Trigger Time	Message	  
<b>OFF</b>		01/12/2023 10:11:26	

When an alarm occurs, an audible alarm sounds, and the user must acknowledge the default on the HMI interface.

<b>HOME</b>	<b>OPERATIONS</b>	<b>MAINTENANCE</b>	<b>SYSTEM</b>
MAIN	MONITORING	ALARM	
Trigger Date	Trigger Time	Message	  
2024-02-08	08:50:08	Security chain/Ext fault 1 <sup>2</sup>	
2024-02-08	08:50:08	Power time out <sup>2</sup>	
2024-02-08	08:48:39	OTTO COM loss	
2024-02-08	08:48:05	Power failure <sup>2</sup>	
2024-02-08	08:48:05	Power failure	
<b>OFF</b>		<b>ALARM</b>	08/02/2024 08:51:31

Description			
1	Superscript 2 => alarm concerns "follower" vacuum pump (Pump #2)	2	No superscript digit => alarm concerns "pilot" vacuum pump (Pump #1)

## 7.1.3 Operations

### 7.1.3.1 Operation Modes



#### NOTE

**Synchronous operation.**

**Both COBRA NX 0950 A machines operate in synchronous mode!**

- Make sure that the same operating mode is set on both machines (speed or pressure control).
- Make sure that the same values are set on both machines (speed value in Hz or same pressure target in mbar).

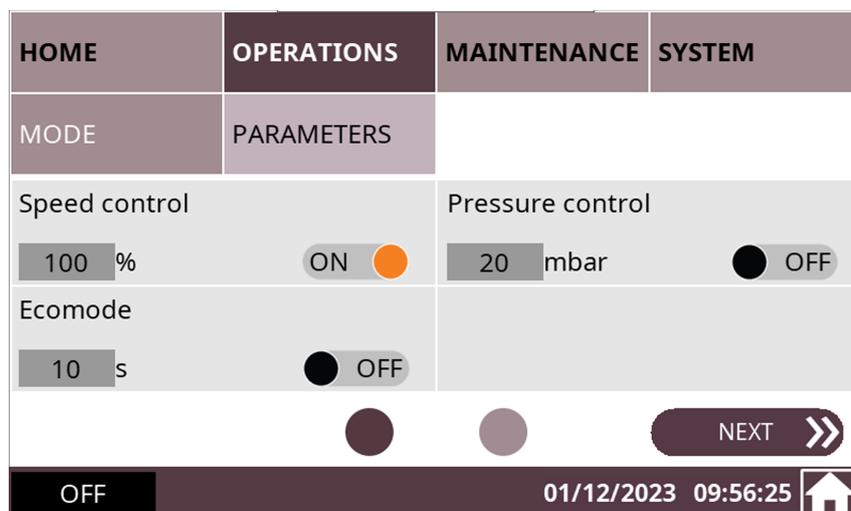
#### NOTE

**All instructions given via HMI and MODBUS will be applied synchronously to both COBRA NX 0950 A machines inside the DX 2000 A PLUS.**

The display "OPERATIONS > MODE" shows the modes of operation.

It allows the control of the machine.

- To access the operating mode menu:
  - Go to "OPERATIONS" > "MODE" and stay on the first screen/page.



**Speed control (Standard).** Configured by default with a vacuum pump speed of 100 %, the speed control mode allows the variation of the motor frequency.

- To change the vacuum pump speed:
  - Press on the speed percentage (password required, see *Roles and Users* [→ 41]).
  - Assign the desired frequency on the keypad and press "Enter".

Parameter	Default value	Adjustment range*
Speed control (target speed)	100 %	1 ... 100 %

\* In percentage of the operating speed range

- For more information on "pumping speed" versus "% speed", refer to the vacuum pump performance curves.

**Pressure control (Option).** The pressure control mode allows to maintain a constant pressure level (target pressure) by automatically adapting the motor frequency.

- To switch from speed control to pressure control:
  - Press on the target pressure value (password required, see *Roles and Users* [→ 41]).
  - Assign the target pressure on the keypad and press “Enter”.
  - Press on the switch button.

Parameter	Default value	Adjustment range
Pressure control (target pressure)	20	0 ... 1000 mbar

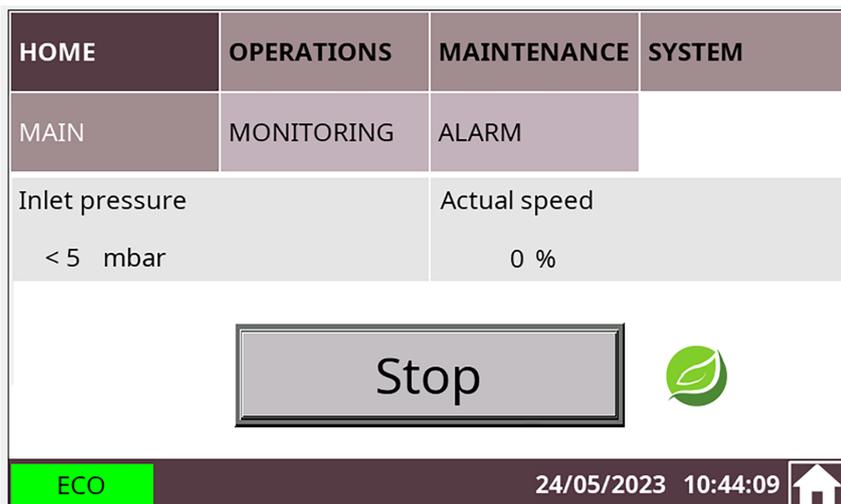
- For smooth process pressure control, it is required to adjust the PID parameters.
- For more information, contact your Busch representative.

**Ecomode (Option - function associated to the Pressure control).**

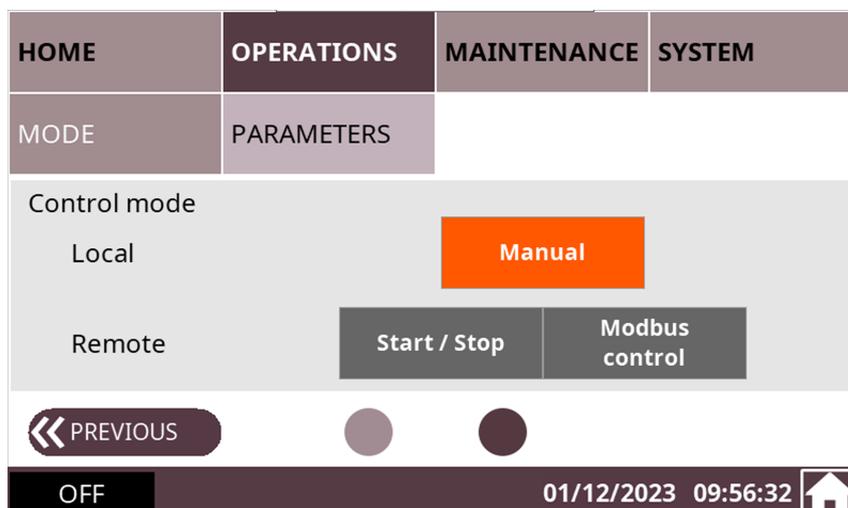
The Ecomode stops the machine when the inlet pressure has reached the preset "ecomode pressure" within a defined time delay and will restart once the inlet pressure exceeds the "restart pressure".

- To activate and set the Ecomode:
  - Press on the Ecomode switch button (password required, see *Roles and Users* [→ 41]).

A green symbol flashes on the HMI as follows indicating that the Ecomode is activated:



The second screen/page of the display “OPERATIONS > MODE” shows the **Control mode** of the machine (**Local > Manual** or **Remote > Start/Stop** or **Modbus control**).



## 7.1.3.2 Operation Parameters



### NOTICE

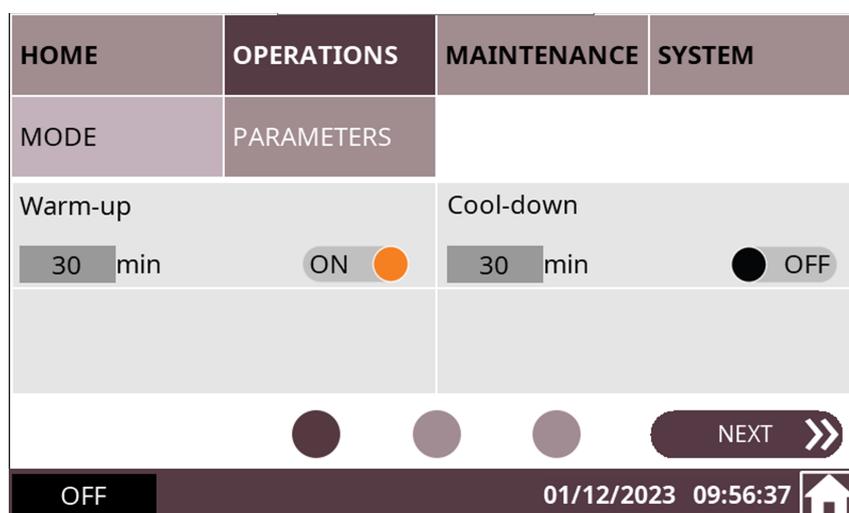
**Change parameter values.**

**Risk of damage to the machine!**

- For all the following functions with parameterization, Busch strongly recommends waiting until the end of a pump cycle before changing any parameter value!

The display “OPERATIONS > PARAMETERS” shows the operation parameters.  
It is divided into three different screens/pages.

#### Screen/Page PARAMETERS 1



#### Warm-up and Cool-down\* modes (\*Shutdown/Drying).

The warm-up mode allows the machine to obtain a suitable operating temperature for the process.

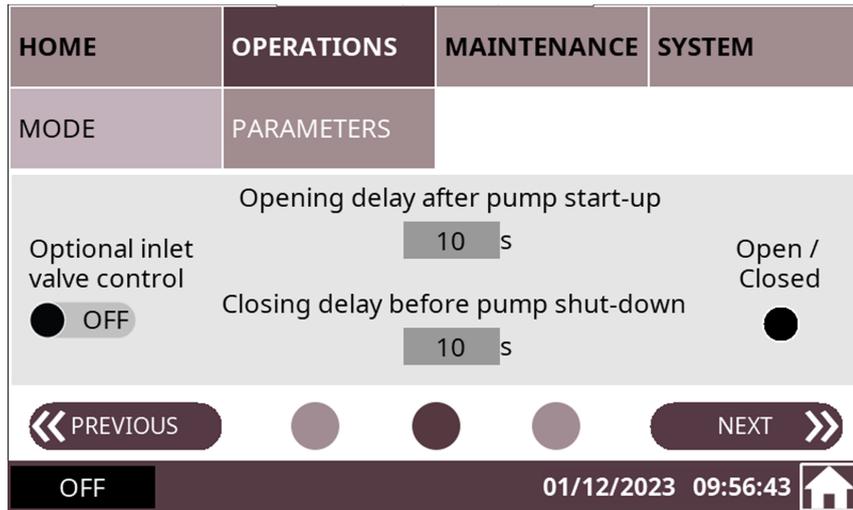
The cool-down\* mode (\*shutdown/drying) allows the evacuation of any condensable vapors, refer to chapter *Conveying Condensable Vapors* [→ 53] for conditions to be met.

During these phases, the machine operates at maximum speed, recommended with the gas ballast valve open to warm up and evacuate a maximum of humidity.

The warm-up mode and the cool-down\* mode (\*shutdown/drying) can both be set with a target time (default value = 30 minutes).

- To activate these two modes:
  - Go to “OPERATIONS” > “PARAMETERS”.
  - Press on warm-up and/or cool-down\* (\*shutdown/drying) switch button (password required, see *Roles and Users* [→ 41]).

### Screen/Page PARAMETERS 2



#### Inlet valve control (Option).

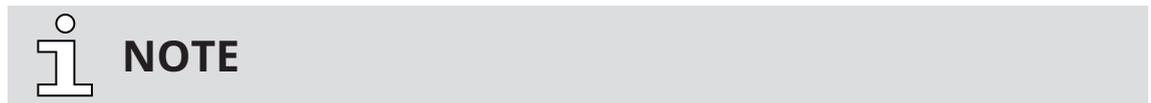
This menu allows the control and setting of the opening parameters of an inlet valve installed at the suction side of the vacuum pump (not included in the scope of delivery of the vacuum pump).

- To activate the optional inlet valve control:
  - Go to “OPERATIONS” > “PARAMETERS”.
  - Go to the second screen/page.
  - Switch the optional inlet valve control on (password required, see *Roles and Users* [→ 41]).

The Opening delay after pump start-up default value is 10 seconds.

- Press to change it.

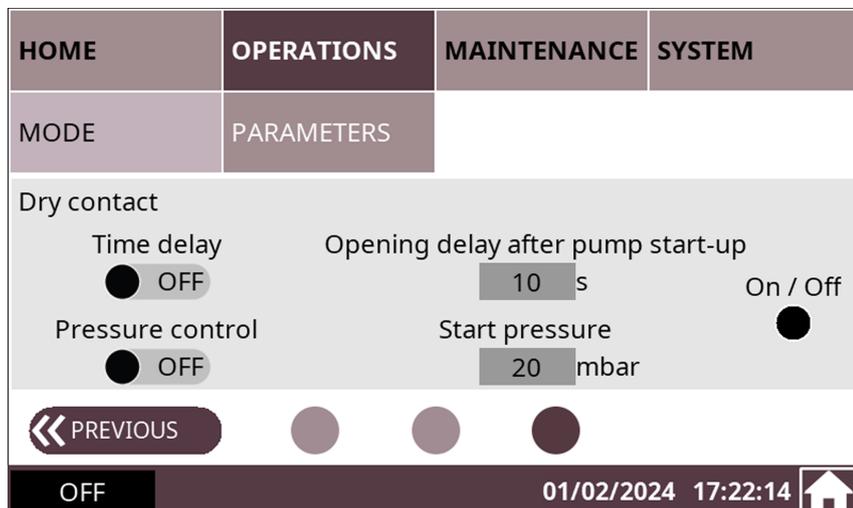
Once the inlet valve control is enabled, the Open/Closed indicator light switches from black to orange.



### NOTE

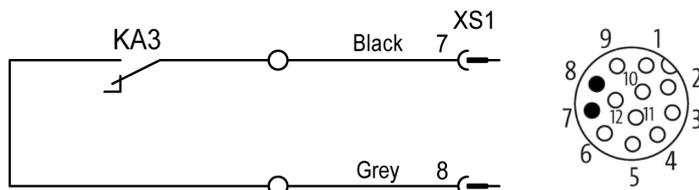
**This function starts at the end of the warm-up phase of the machine.**

### Screen/Page PARAMETERS 3



### Dry Contact

- M12 connector: Max 30VAC/DC 1.5A
- On terminal: Max 250VAC/DC 10A



- Activation according to the settings of the HMI.

## 7.1.4 Maintenance

The display "MAINTENANCE" shows the maintenance and service intervals of the machine.

HOME	OPERATIONS	MAINTENANCE	SYSTEM
Next oil service 8500 h	<input type="button" value="Reset"/>	Oil service interval 8500 h	<input type="button" value="Set"/>
Last service: 27.11.2023	0 Running hours		
Next overhaul 34 month(s)	<input type="button" value="Reset"/>	Overhaul interval 34 month(s)	<input type="button" value="Set"/>
Last service: 27.11.2023			
OFF		27/11/2023 09:57:25	

## 7.1.5 System

### 7.1.5.1 System Settings

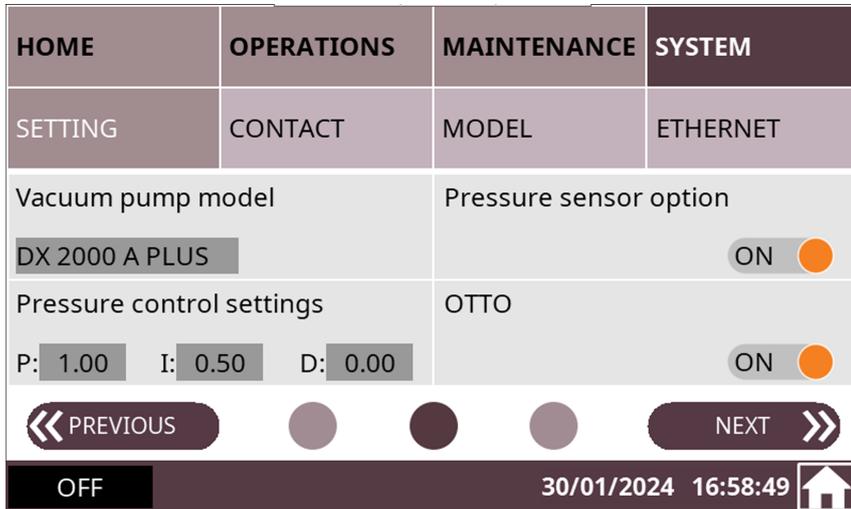
The display "SYSTEM > SETTING" allows to set or change system settings.

#### Screen/Page SETTING 1

HOME	OPERATIONS	MAINTENANCE	SYSTEM
SETTING	CONTACT	MODEL	ETHERNET
Date > 1 / 12 / 2023		Language > English	
Time > 9 : 56		Units > mbar	°C
		<input type="button" value="NEXT"/>	
OFF		01/12/2023 09:56:02	

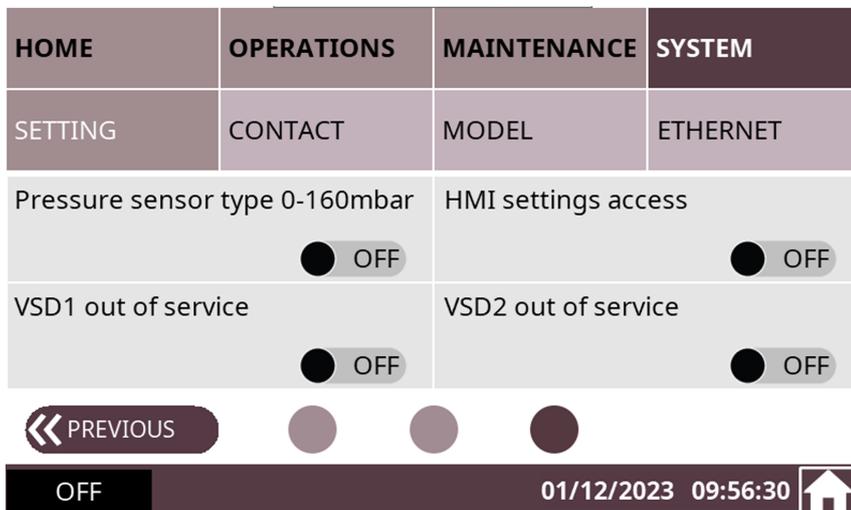
- To edit the system settings such as date, time, language, and units:
  - Go to "SYSTEM" > "SETTINGS".
  - Press on the value to change the selected data.

### Screen/Page SETTING 2



On the second screen/page, it is possible to edit some pump parameters like the pressure control settings (PID) or to activate/deactivate pump functions like the pressure sensor (Option) or OTTO.

### Screen/Page SETTING 3



On the third screen/page, if a pressure sensor is installed, a 0 ... 160 mbar range is displayed:

- Press "ON" to activate the associated function.

It is also possible to:

- Access the internal settings of the HMI by pressing the button for two seconds.
- Disable VSD1 or VSD2 variable speed drive (VSD1 for "pilot" upper vacuum pump, VSD 2 for "follower" lower vacuum pump). For this operation, please contact your Busch representative.

## 7.1.5.2 Model

The "SYSTEM > MODEL" display provides information on the identification of the software and the machine (type and model on screen/page 1, serial number on screen/page 2).

### Screen/Page MODEL 1

HOME	OPERATIONS	MAINTENANCE	SYSTEM
SETTING	CONTACT	MODEL	ETHERNET
Vacuum pump type COBRA PLUS		Vacuum pump model DX 2000 A PLUS	
Software HMI 2.1		Software VSD PLC 1.0	
			NEXT >>
OFF		21/02/2024 16:48:50 	

### Screen/Page MODEL 2

HOME	OPERATIONS	MAINTENANCE	SYSTEM
SETTING	CONTACT	MODEL	ETHERNET
Serial number CHM151654321			
<< PREVIOUS			
OFF		01/12/2023 09:56:50 	

### 7.1.5.3 Ethernet Settings

- To configure the ethernet settings according to your network:
  - Go to "SYSTEM" > "ETHERNET".

HOME	OPERATIONS	MAINTENANCE	SYSTEM
SETTING	CONTACT	MODEL	ETHERNET
Ethernet settings		Change settings	<input type="checkbox"/> OFF
Current IP address		New IP address	
192 . 168 . 0 . 100		192 . 168 . 0 . 100	
Current subnet mask		New subnet mask	
255 . 255 . 255 . 0		255 . 255 . 255 . 0	
Current gateway		New gateway	
192 . 168 . 0 . 1		192 . 168 . 0 . 1	
OFF		01/12/2023 09:56:55 	

- Change the values on the right side of the screen (Change settings).
- Press on the switch button to save the new settings.



#### NOTE

The current Ethernet values are displayed in the left side of the screen (Ethernet settings).

To change these values, it is necessary to fill in all the fields in the right side of the screen (Change settings) before applying the changes by pressing on the switch button:

- New IP address
  - New subnet mask
  - New gateway
- To change the Ethernet settings, it is recommended to connect the vacuum pump with the desired equipment beforehand via the Ethernet port available on the right side of the control cabinet (LAN - see illustration in the chapter "Product Description" of the instruction manual of the vacuum pump).

The default ethernet settings are the following:

Description	Default value
IP address	192.168.0.100
Subnet mask	255.255.255.0
Gateway	192.168.0.1
Port no.	502 (cannot be changed)
Slave ID no.	1-255 (all are functioning)

For more information:

- See *Modbus Control and Ethernet Settings* [→ 37].

## 7.2 Conveying Condensable Vapors

Observe the following when conveying condensable vapors, e.g. water vapors:

### START

- Close the isolation valve\*
- Start the machine
- Warm up the machine for 30 minutes (WARM-UP MODE)
- Open the isolation valve\* and perform the process
- Close the isolation valve\*
- Dry the machine (COOL-DOWN\*\* MODE)
- Wait 30 minutes
- Stop the machine

### END

\* Not included in the scope of delivery.

\*\* (Shutdown/Drying)

- Ensure that the barrier gas system\* (dry compressed air) is connected. Check the volume flow on the barrier gas flow meter (BGF), see *Barrier Gas System Connection (Optional)* [→ 26].

\* option

- Make sure that the air gas ballast\* (GB) is mounted and open. If the gas ballast filter is dirty, it must be cleaned periodically (unscrew and wash out).

\* option

- Make sure that the electro-pneumatic inlet valve\* (dry compressed air) is connected. Reminder: the default position of the electro-pneumatic inlet valve is "normally closed" (no air).

\*option

- Make sure that no liquid can enter the machine via the silencer on the pressure side. Install pipes connected on the outlet side with a gradient away from the vacuum pump. In the case of rising exhaust pipes, provide a condensate trap (e.g. "dead leg") with drain.
- Water vapor within the gas flow is tolerated within certain limits. The conveyance of other vapors shall be agreed upon with Busch.

## 8 Maintenance



### WARNING

Maintenance of the COBRA DX 2000 A PLUS.

We recommend applying the following maintenance procedures to each COBRA NX 0950 A machine inside the DX 2000 A PLUS, simultaneously.



### DANGER

Live wires.

**Risk of electrical shock!**

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



### DANGER

Maintenance work without disconnecting the variable speed drive.

**Risk of electrical shock!**

- Disconnect and isolate the variable speed drive before attempting any work on it. High voltages are present at the terminals and within the variable speed drive for up to 10 minutes after disconnection of the electrical supply.
- Always ensure by using a suitable multimeter that no voltage is present on any drive power terminals prior to commencing any work.



### DANGER

Live wires. Carry out any work on the variable speed drive and motor.

**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

**Failing to properly maintain the machine.**

**Risk of injuries!**

**Risk of premature failure and loss of efficiency!**

- Maintenance work must only be executed by qualified personnel.
- Respect the maintenance intervals or ask your Busch representative for service.



## NOTICE

**Using inappropriate cleaners.**

**Risk of removing safety stickers and protective paint!**

- Do not use incompatible solvents to clean the machine.



## NOTE

**Illustrations.**

**In this instruction manual, some maintenance illustrations are those of the COBRA NX 0950 A. Although not shown in the COBRA DX 2000 A PLUS configuration, the principles are similar.**

- Shut down the machine and lock against inadvertent start up.

If the machine is equipped with an electro-pneumatic inlet valve:

- Close the electro-pneumatic inlet valve supply.

If the machine is equipped with a barrier gas system:

- Close the barrier gas supply.
- Vent the connected lines to atmospheric pressure.

If necessary:

- 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.



### WARNING

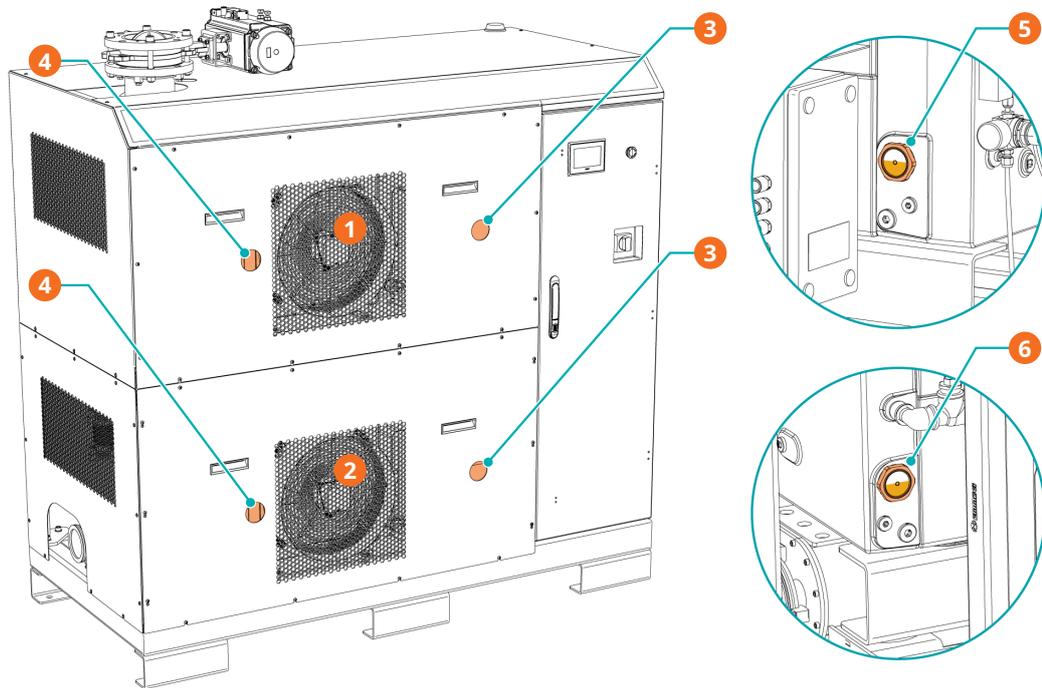
**Maintenance schedule of the COBRA DX 2000 A PLUS.**

**We recommend applying and respecting the maintenance procedures and intervals for each COBRA NX 0950 A machine inside the DX 2000 A PLUS.**

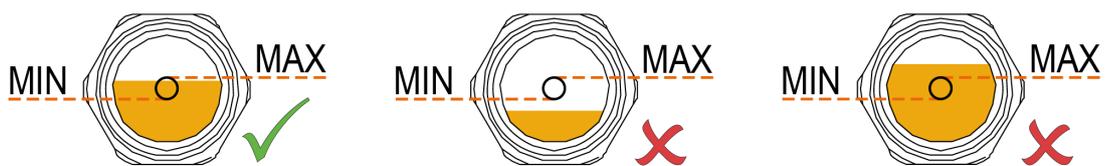
Interval	Maintenance work
Monthly	<ul style="list-style-type: none"> <li>• Check the oil level, see <i>Oil Level Inspection</i> [→ 57].</li> <li>• Check the cooling liquid level, see <i>Cooling Liquid Level Inspection</i> [→ 58].</li> <li>• Check the machine for oil leaks. In case of leaks, have the machine repaired (Contact Busch).</li> </ul>
Yearly	<ul style="list-style-type: none"> <li>• Carry out a visual inspection and clean the machine from dust and dirt.</li> <li>• Check the electrical connections and the monitoring devices.</li> </ul>
Yearly If one or more of these accessories are installed.	<ul style="list-style-type: none"> <li>• Check the filter of the gas ballast valve (GB) and clean it if necessary, see <i>Cleaning the Gas Ballast Filter (Optional)</i> [→ 62].</li> <li>• Check the silencer (SI) and clean it if necessary, see <i>Cleaning the Silencer (Optional)</i> [→ 63].</li> <li>• Check the inlet valve and clean it if necessary.</li> <li>• If the inlet is equipped with a mesh screen, check the condition of the mesh screen, clean or replace if necessary.</li> </ul>
Every 8500 hours or after 1 year	<ul style="list-style-type: none"> <li>• Change the oil of the gear and bearing housings (both sides), see <i>Oil Change</i> [→ 65].</li> <li>• Change the cooling liquid, see <i>Cooling Liquid Change</i> [→ 68].</li> <li>• Clean the magnetic plugs (MP).</li> </ul>
Every 25000 hours or after 4 years	<ul style="list-style-type: none"> <li>• Have a major overhaul on the machine (contact Busch).</li> </ul>

## 8.2 Oil Level Inspection

- Shut down the machine.
- When the machine is stopped, wait 1 minute before checking the oil level.



Description			
1	"Pilot" vacuum pump (Pump #1)	2	"Follower" vacuum pump (Pump #2)
3	Oil sight glass (OSG), Acoustic cabinet (ACA) - Motor side	4	Oil sight glass (OSG), Acoustic cabinet (ACA) - Suction side
5	Oil sight glass (OSG) - Motor side on each vacuum pump	6	Oil sight glass (OSG) - Suction side on each vacuum pump



- Fill up if necessary, see *Oil Filling* [→ 28].

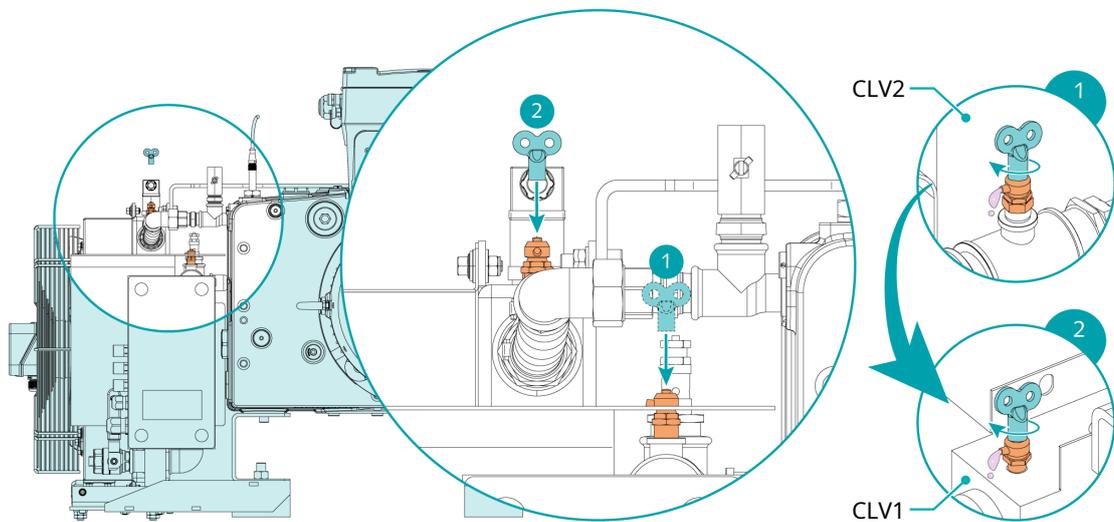
## 8.3 Cooling Liquid Level Inspection



### WARNING

Cooling liquid level inspection must be performed on each COBRA NX 0950 A machine inside the DX 2000 A PLUS!

- Shut down the machine.
- Let the machine cool down.
- Open the cooling liquid vent valves (CLV1 – CLV2).
- Fill up if necessary, see *Filling Cooling Liquid* [→ 31].
- Close the cooling liquid vent valves (CLV1 – CLV2) in the following order when the cooling liquid is spilling out.



## 8.4 Cabinet Openings and Access (Optional)

### Removing the cabinet (ACA) panels

For each side, top and bottom panels can be removed independently or simultaneously.

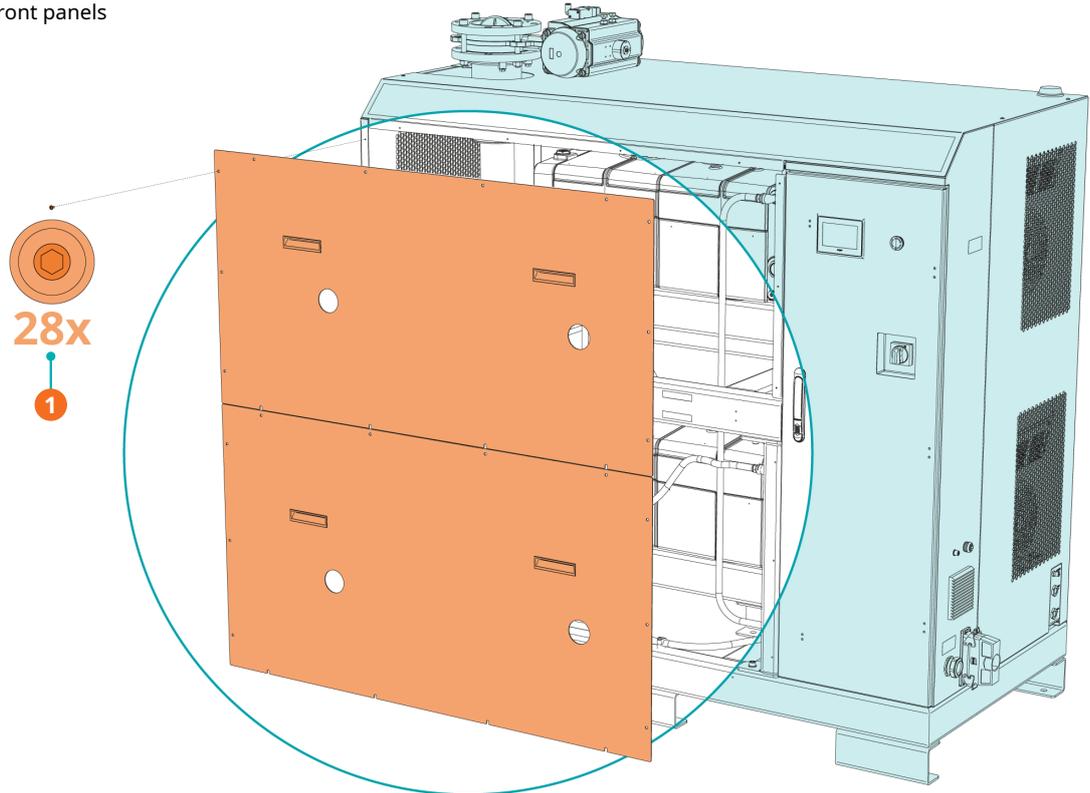


#### NOTE

**Cabinet panels.**

Although the following illustrations refer to the water-cooled version of the COBRA DX 2000 A PLUS, panel disassembly is identical and screw quantities are the same.

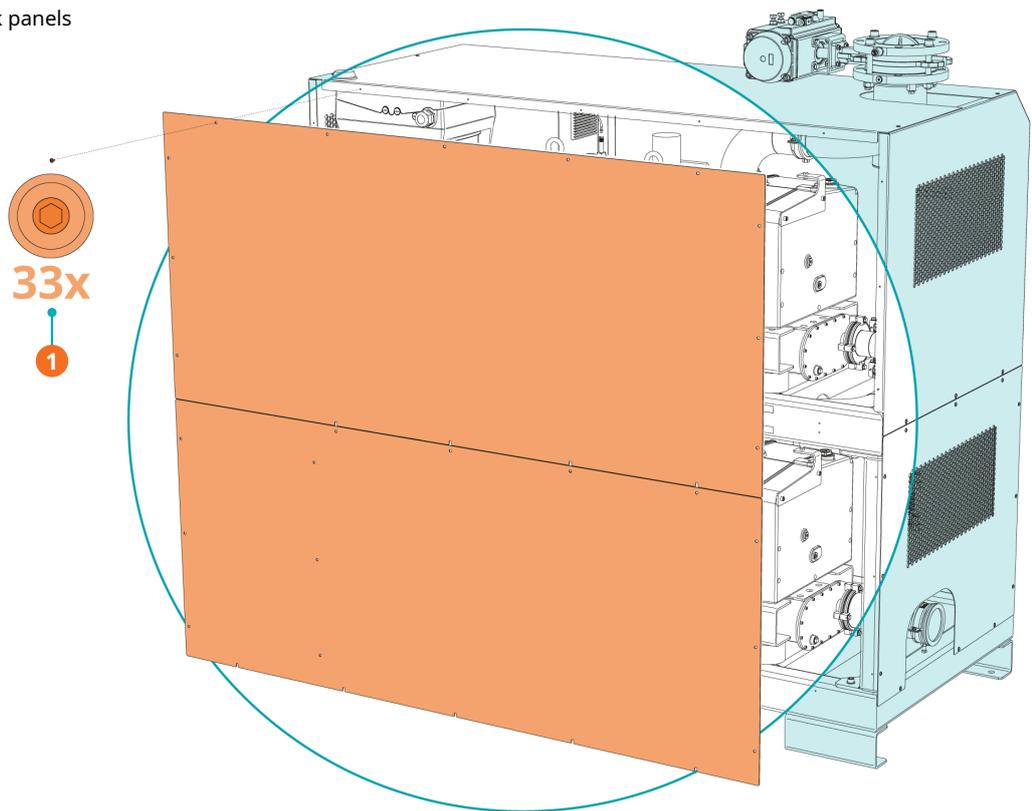
Front panels



#### Description

1	Total number of screws to be removed for both panels		
---	--	--	--

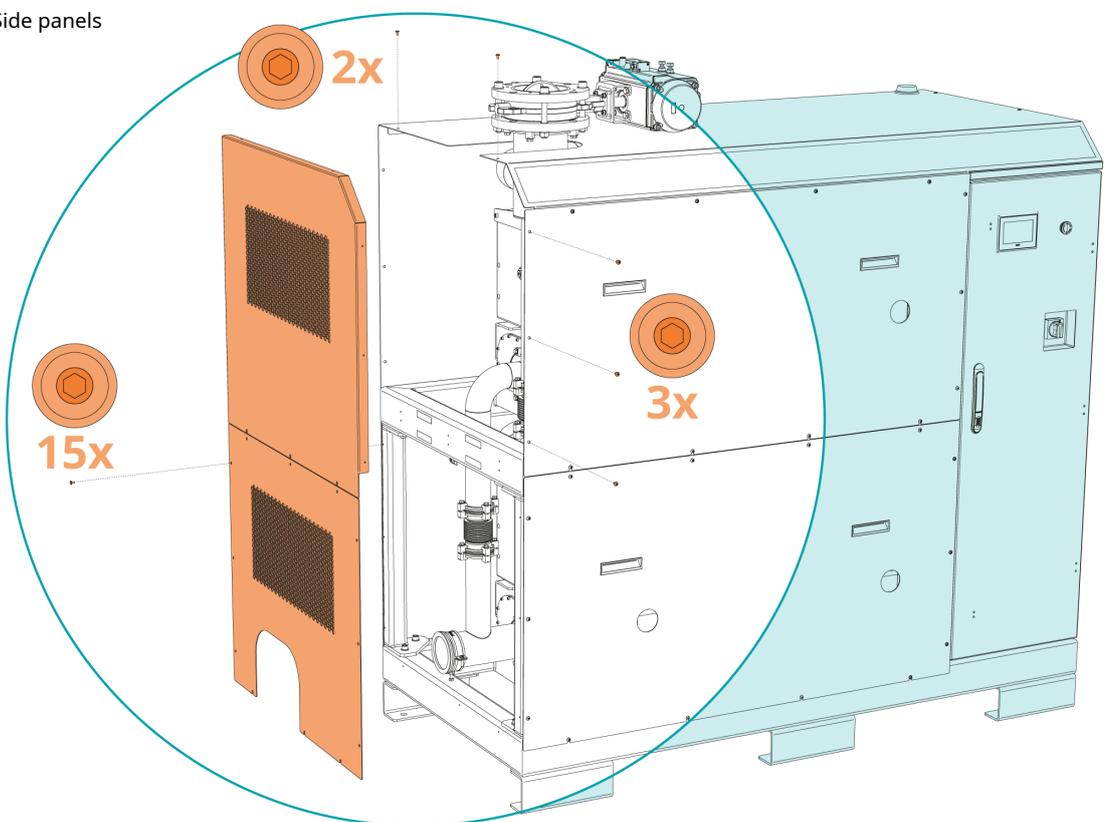
Back panels

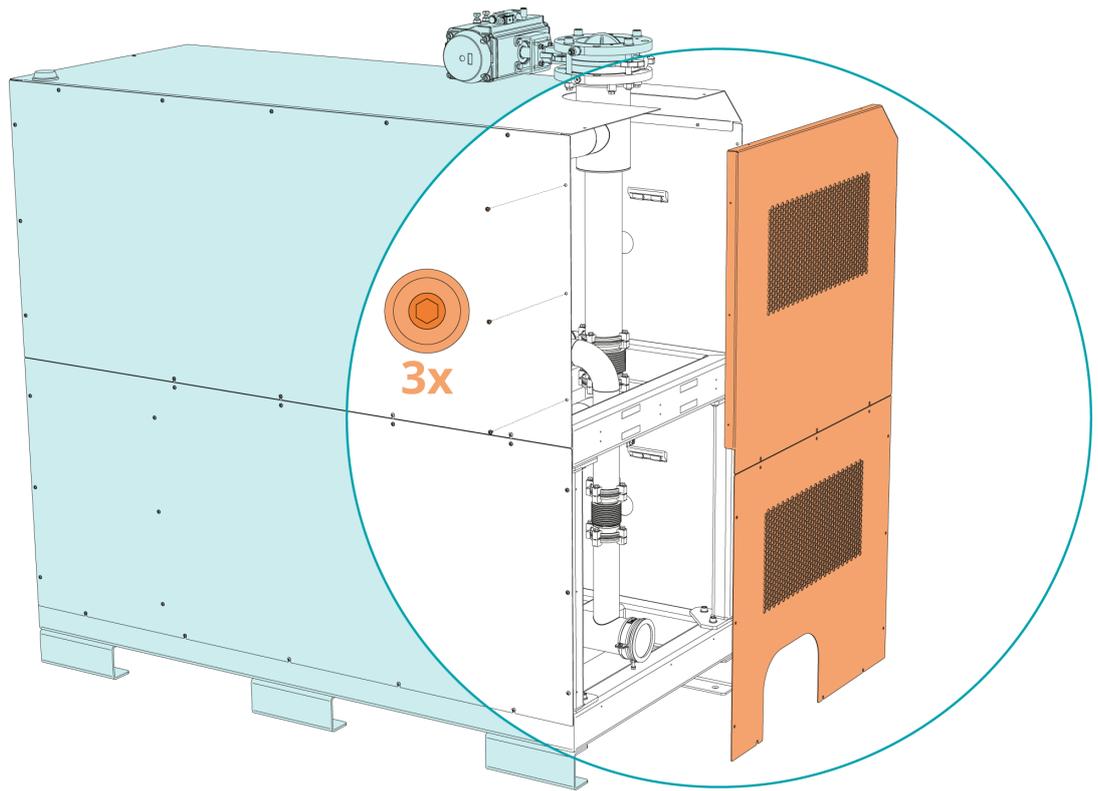


**Description**

1	Total number of screws to be removed for both panels	
---	--	--

Side panels



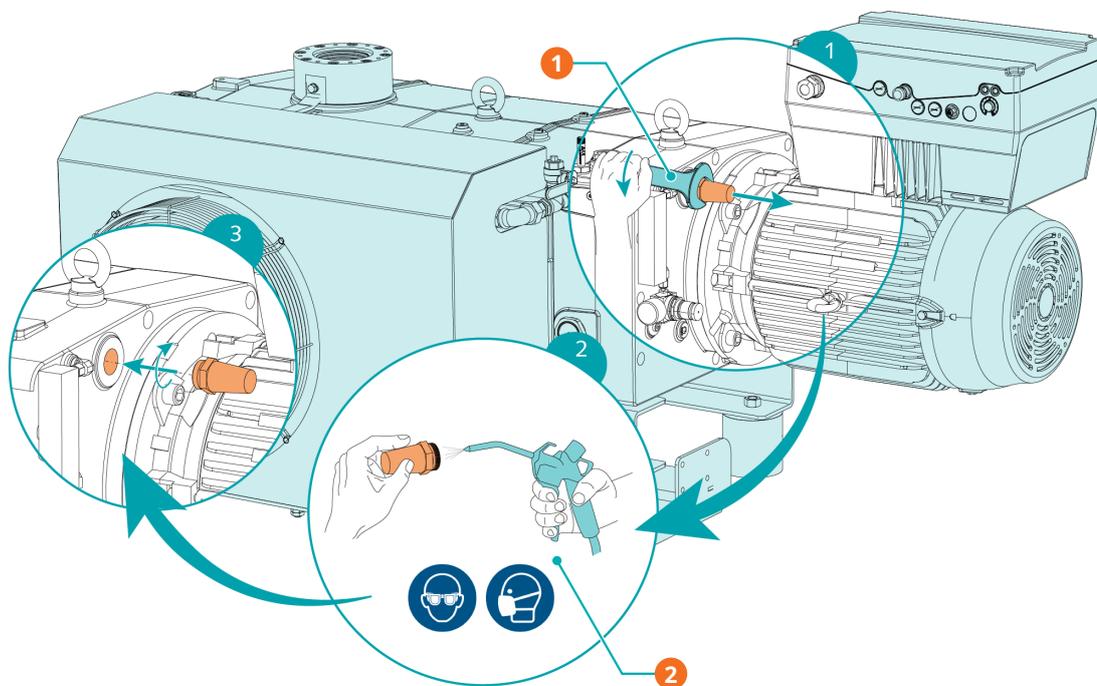


## 8.5 Cleaning the Gas Ballast Filter (Optional)



### WARNING

Cleaning the gas ballast filter must be performed on each COBRA NX 0950 A machine inside the DX 2000 A PLUS!



#### Description

1	Use a 36 mm wrench	2	Use compressed air and wear protective eyewear and mask
---	--------------------	---	---

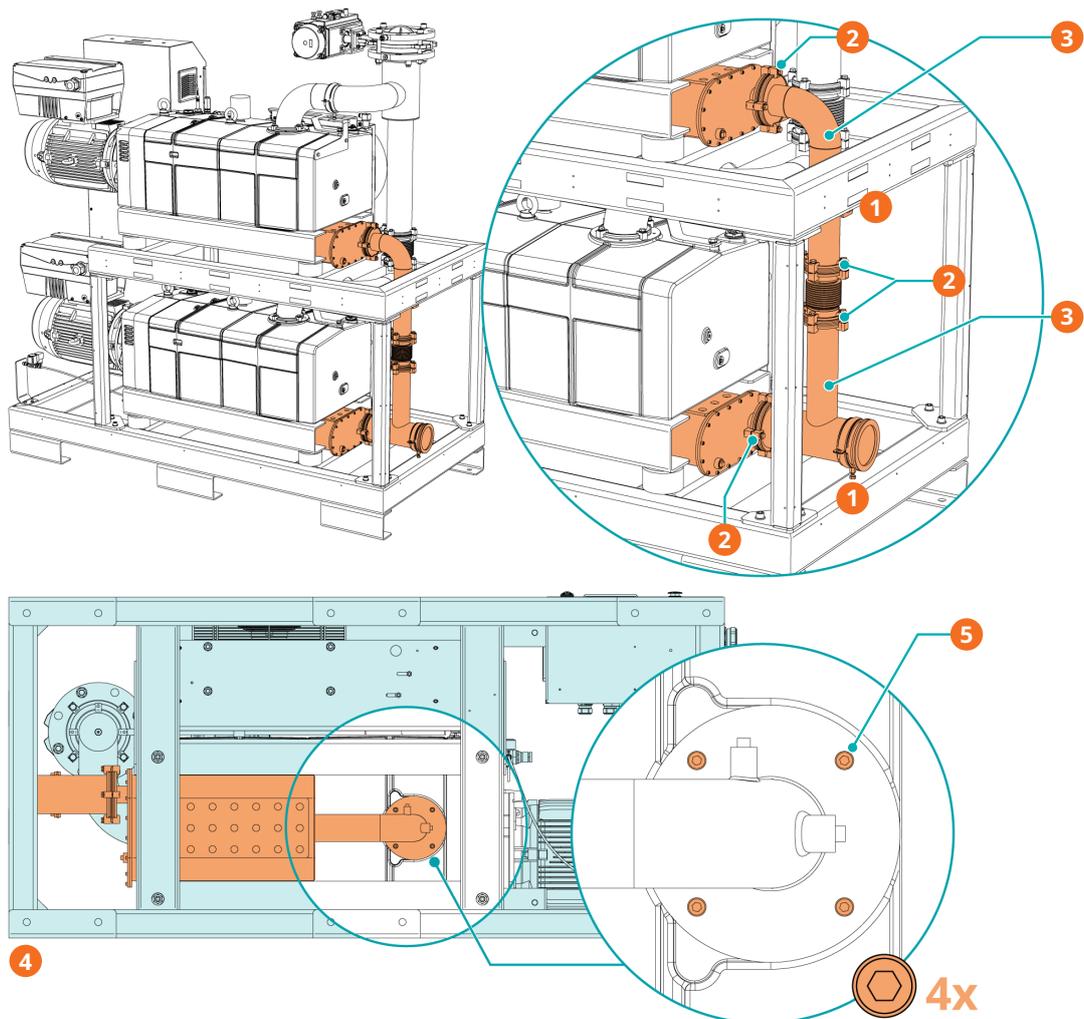
## 8.6 Cleaning the Silencer (Optional)



### WARNING

Cleaning the silencer must be performed on each COBRA NX 0950 A machine inside the DX 2000 A PLUS!

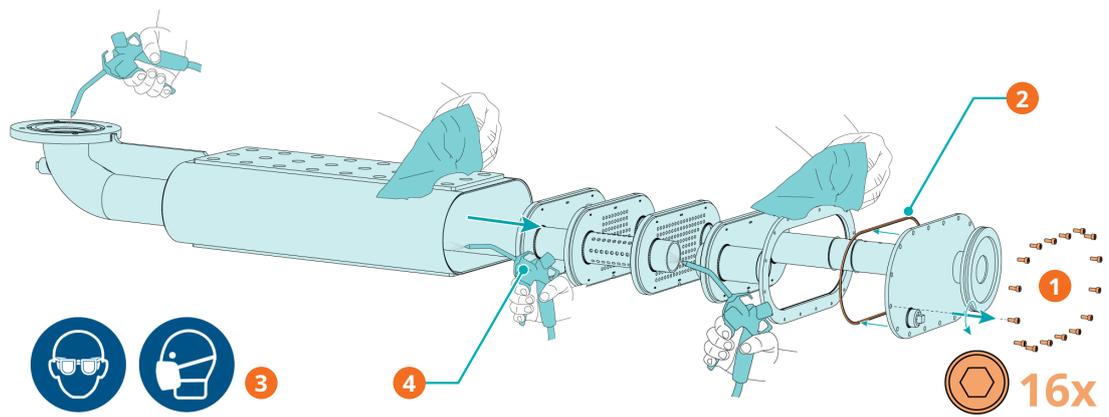
- Make sure to disassemble the exhaust parts in the following order:



#### Description

1	Remove the strappings attached to the frame	2	Dismantle the flanges
3	Remove upper and lower pipings	4	Bottom view of the DX 2000 A PLUS
5	Unscrew the 4 hexagonal screws on each NX 0950 A to remove the silencers		

- Use compressed air and cleaning clothes to clean the inside and outside of pipe parts.



Description			
1	Unscrew the 16 hexagonal screws to disassemble the silencer	2	Be careful with the gasket, clean it with a clean cloth
3	Wear protective eyewear and mask	4	Use compressed air and cleaning clothes to clean the inside and outside of the silencer

## 8.7 Oil Change



### WARNING

Oil change must be performed on each COBRA NX 0950 A machine inside the DX 2000 A PLUS!



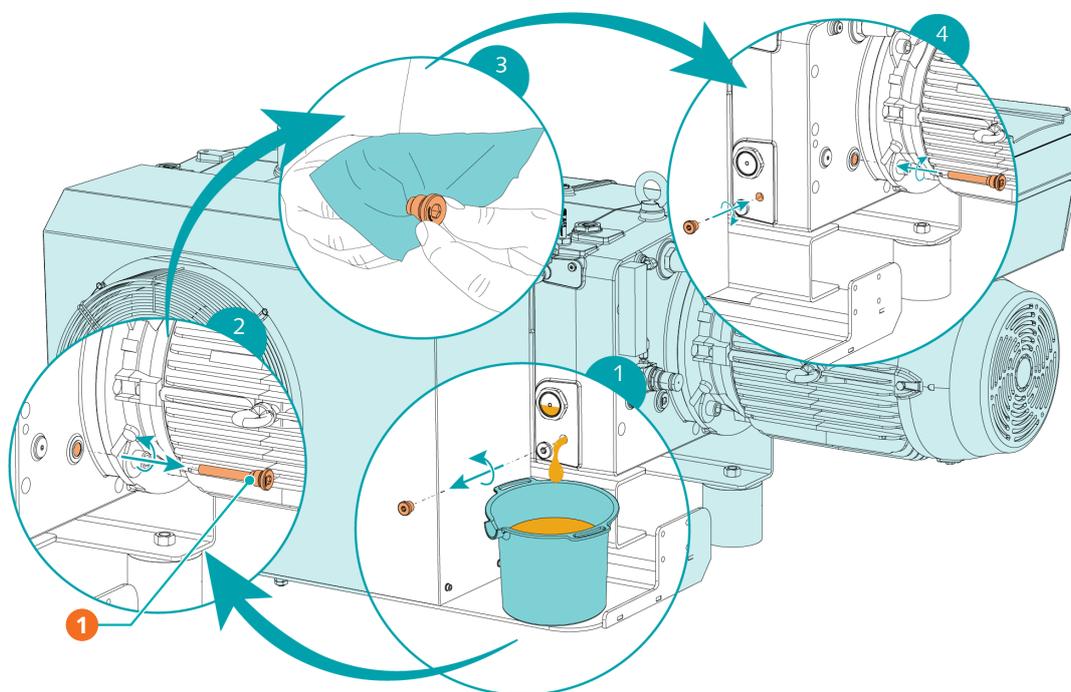
### NOTICE

Use of an inappropriate oil.

Risk of premature failure!

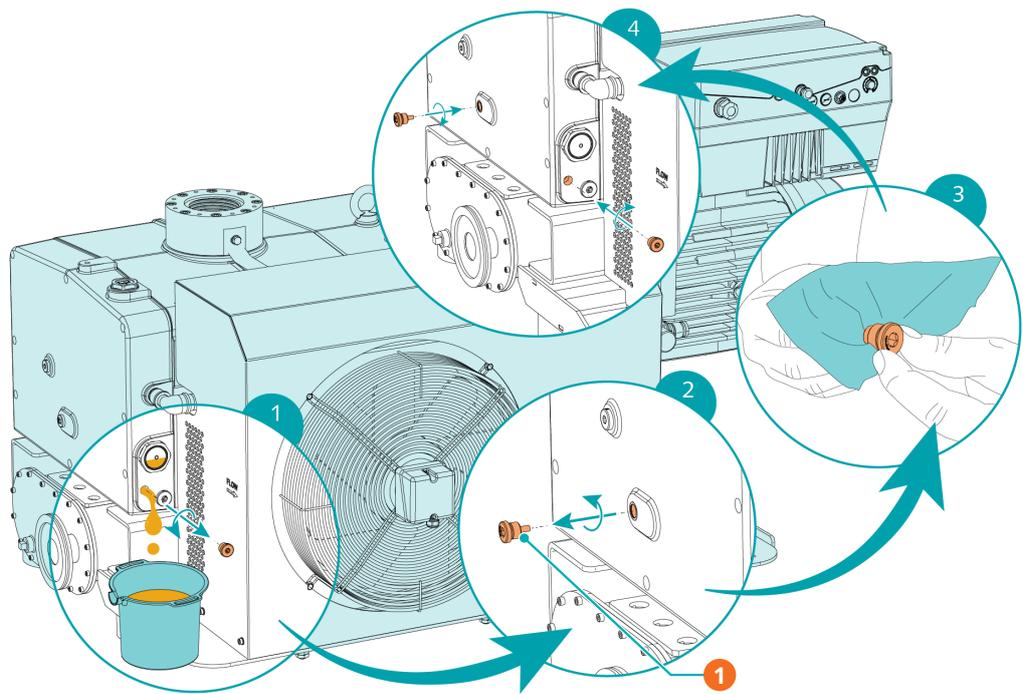
Loss of efficiency!

- Only use an oil type which has previously been approved and recommended by Busch.



#### Description

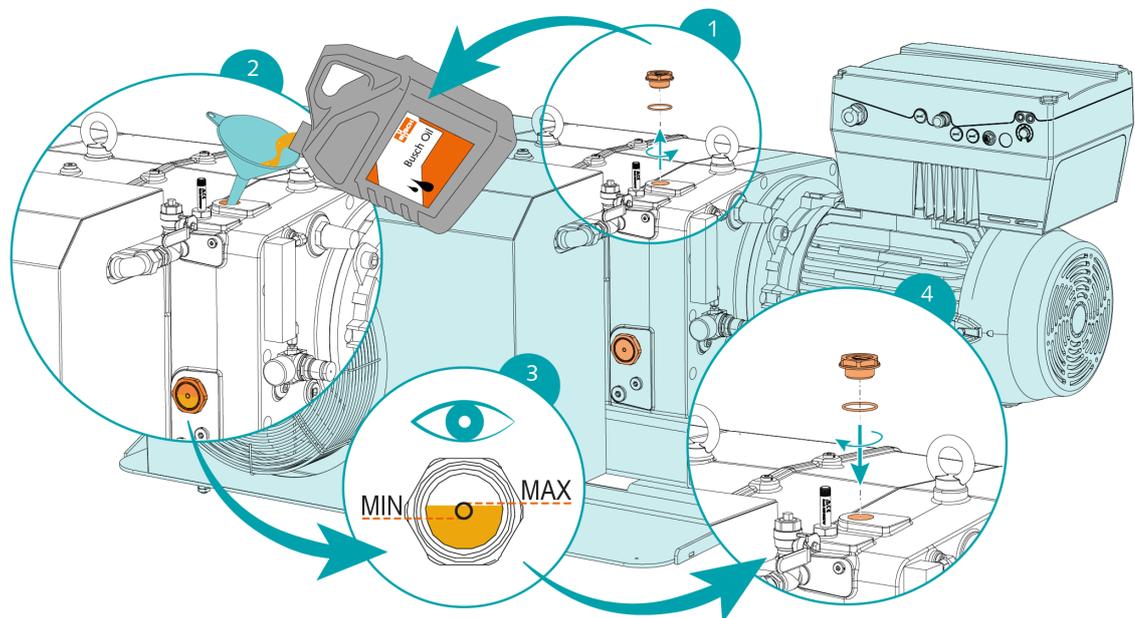
1	Magnetic plug		
---	---------------	--	--

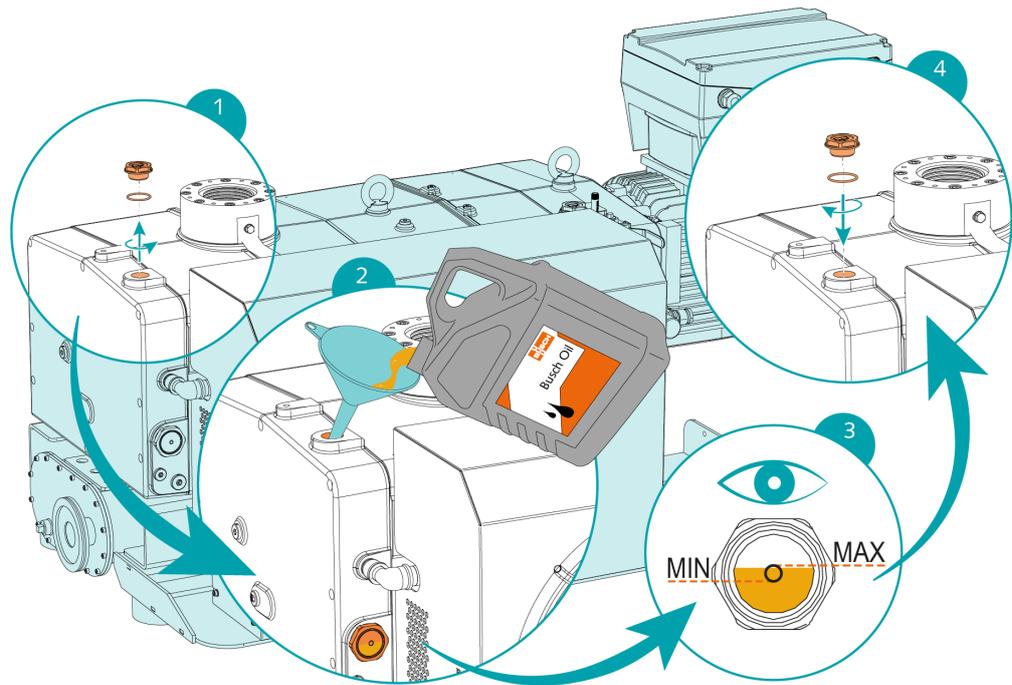


**Description**

1	Magnetic plug
---	---------------

For oil type and oil capacity see Technical Data and Oil [→ 75].





When the oil filling is achieved:

- Write down the oil change date on the sticker.



If there is no sticker (part no. 0565 568 959) on the machine:

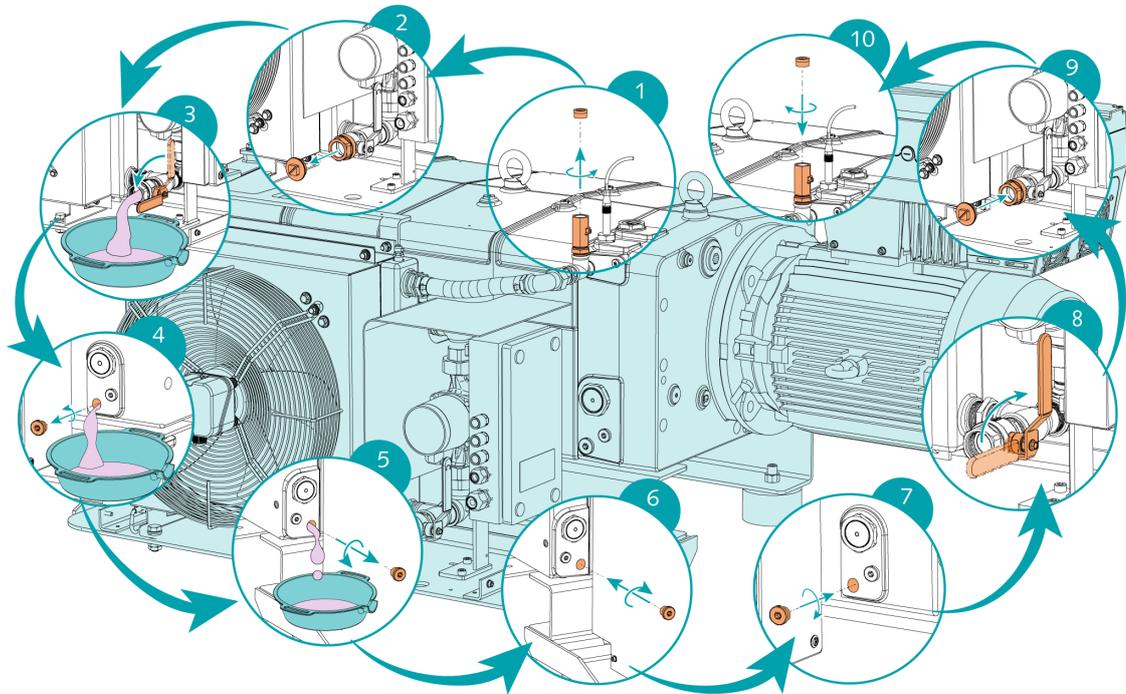
- Order it from your Busch representative.

## 8.8 Cooling Liquid Change

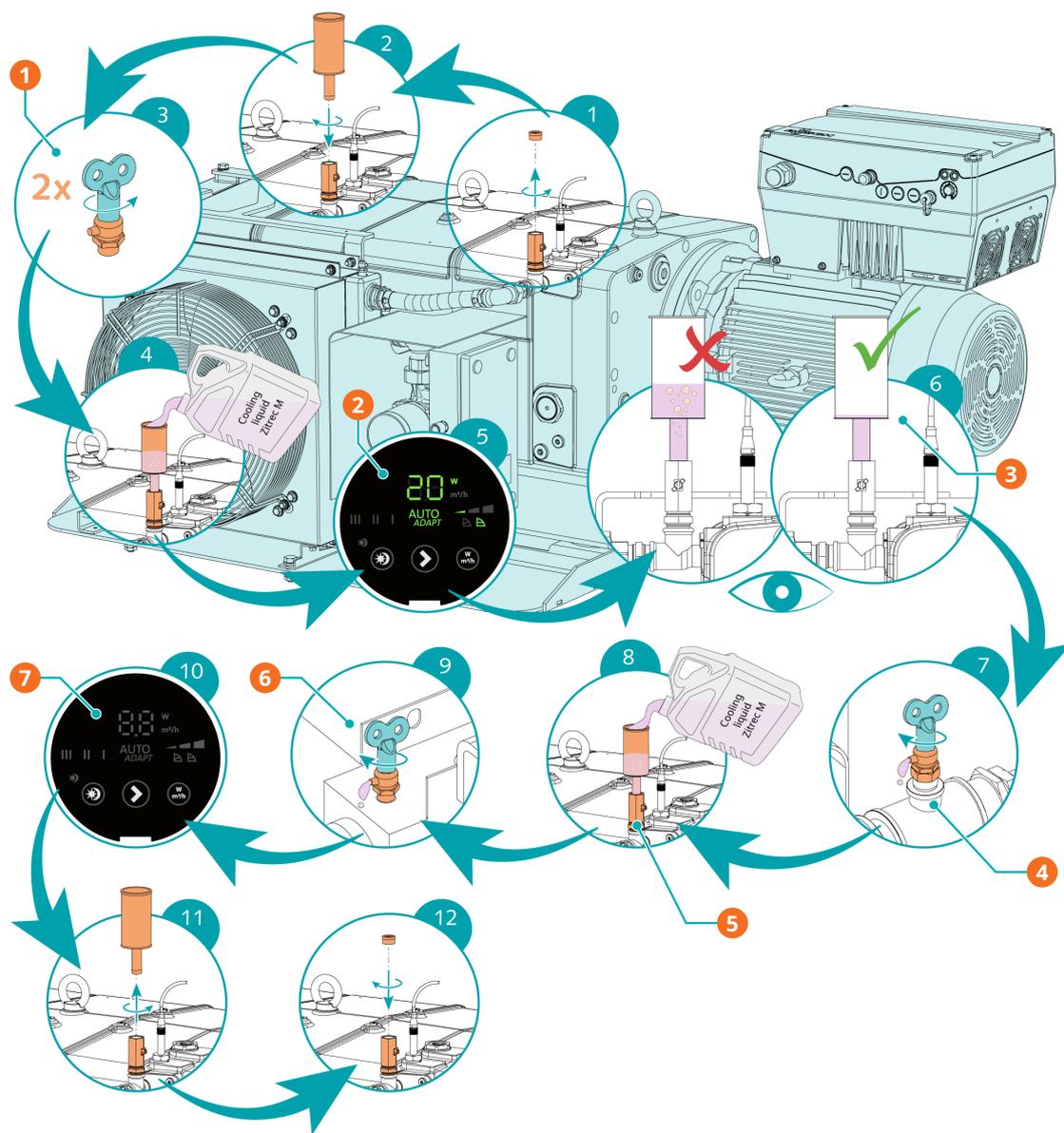


### WARNING

Cooling liquid change must be performed on each COBRA NX 0950 A machine inside the DX 2000 A PLUS!



For cooling liquid type and cooling liquid capacity see Technical Data and *Cooling Liquid* [→ 76].



Description			
1	Step 3: Open the cooling liquid vent valves (CLV1, CLV2)	2	Step 5: Switch on the cooling liquid pump (CLP)
3	Step 6: Vent air from the cooling system	4	Step 7: Close the cooling liquid vent valve (CLV2) when the cooling liquid is spilling out
5	Step 8: Resume cooling liquid filling	6	Step 9: Close the cooling liquid vent valve (CLV1) when the cooling liquid is spilling out
7	Step 10: Switch off the cooling liquid pump (CLP)		

## 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

**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.

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'.

Busch 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](https://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.

- Shut down the machine and lock against inadvertent start up.
- Disconnect the power supply.

If the machine is equipped with an electro-pneumatic inlet valve:

- Close the electro-pneumatic inlet valve supply.

If the machine is equipped with a barrier gas system:

- Close the barrier gas supply.
- Vent the connected lines to atmospheric pressure.
- Disconnect all connections.

If the machine is to be stored:

- See *Storage* [→ 21].

### 10.1 Dismantling and Disposal

- Drain and collect the oil.
- Make sure that no oil drips onto the floor.
- Drain and collect the cooling liquid.
- Make sure that no cooling liquid drips onto the floor.
- Separate special waste from the machine.
- Dispose of special waste in compliance with applicable regulations.
- Dispose of the machine as scrap metal.

# 11 Troubleshooting



## 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.

Problem	Possible Cause	Remedy
Alarm buzzer is on	Alarm from monitoring sensors or electric drive.	<ul style="list-style-type: none"> <li>• Check details of the alarm on the HMI Touch Screen (buttons "Current alarm" and "History alarm", click on the highlighted alarm for more details).</li> </ul>
The machine does not start.	The machine is not supplied with the correct voltage.	<ul style="list-style-type: none"> <li>• Check the power supply.</li> </ul>
	The rotors are jammed or seized.	<ul style="list-style-type: none"> <li>• Rotors inspection or 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> </ul>
	Alarm trip of the monitoring sensors or the variable speed drive.	<ul style="list-style-type: none"> <li>• Let the machine cool down.</li> <li>• Check the alarm notifications on the HMI Touch Screen.</li> </ul>
The machine does not reach the usual pressure on the suction connection.	The motor is defective.	<ul style="list-style-type: none"> <li>• Replace the motor.</li> </ul>
	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 motor runs in the wrong direction.	<ul style="list-style-type: none"> <li>• Check the direction of rotation, see Direction of Rotation.</li> </ul>
The machine runs very noisily.	Internal parts are worn or damaged.	<ul style="list-style-type: none"> <li>• Repair the machine (contact Busch).</li> </ul>
	Wrong oil quantity or unsuitable oil type.	<ul style="list-style-type: none"> <li>• Use one of the recommended oils in the correct quantity, see <i>Oil</i> [→ 75].</li> </ul>
	Defective gears, bearings or coupling element.	<ul style="list-style-type: none"> <li>• Repair machine (contact Busch).</li> </ul>

<b>Problem</b>	<b>Possible Cause</b>	<b>Remedy</b>
The machine runs too hot.	Ambient temperature too high.	<ul style="list-style-type: none"> <li>• Observe the permitted ambient temperature, see Technical Data.</li> </ul>
	Temperature of the process gases at the inlet too high.	<ul style="list-style-type: none"> <li>• Observe the permitted gas inlet temperature, see Technical Data.</li> </ul>
	The cooling liquid pump is defective.	<ul style="list-style-type: none"> <li>• Repair the machine.</li> </ul>
	Oil level too low.	<ul style="list-style-type: none"> <li>• Top up oil.</li> </ul>
	Cooling liquid level too low.	<ul style="list-style-type: none"> <li>• Top up cooling liquid.</li> </ul>
The oil is black.	Oil change intervals are too long.	<ul style="list-style-type: none"> <li>• Drain the oil and fill in new oil, see <i>Oil Change</i> [→ 65].</li> </ul>
	The machine runs too hot.	<ul style="list-style-type: none"> <li>• See problem "The machine runs too hot".</li> </ul>

For resolution of problems not listed in the troubleshooting table, please contact your Busch representative.

# 12 Technical Data

DX 2000 A PLUS		
Pumping speed	m <sup>3</sup> /h	1900
Ultimate pressure without gas ballast	hPa (mbar) abs.	≤ 0.01
Ultimate pressure with gas ballast	hPa (mbar) abs.	≤ 0.05
Nominal motor rating	kW	2 x 18.5
Nominal motor speed (72 Hz)	min <sup>-1</sup>	4320
Sound pressure level (ISO 2151) KpA = 3 dB	dB(A)	≤ 76
Ambient temperature range	°C	5 ... 40
Maximum allowable counter pressure at discharge	hPa (mbar) rel.	200
Maximum allowable gas inlet temperature according to the inlet pressure	°C	≤ 50 hPa (mbar) abs. : 200
		> 50 hPa (mbar) abs. : 70
Ambient relative humidity	at 30°C	90 %
Ambient pressure		Atmospheric pressure
Maximum intensity	A	80
Circuit breaker (MCCB)	A	C-100 (SCCR 10kA @ 400V)
Total Oil capacity - Motor side	l	2 x 1.0
Total Oil capacity - Suction side	l	2 x 1.0
Weight approx. without cabinet	kg	2450
Weight approx. with cabinet	kg	2600
Dimensions (L x W x H) with cabinet – without inlet valve	mm	2035 x 983 x 1950
Gas inlet – Inlet flange		DN 160 ISO-K
Gas outlet – Discharge flange		DN 100 ISO-K

# 13 Oil

VSC 100	
ISO-VG	100
Oil type	Synthetic
Part number 1 L packaging	0831 168 356
Part number 5 L packaging	0831 168 357
Part number 10 L packaging	0831 210 162
Part number 20 L packaging	0831 168 359

## Oil suitability

- **Oil VSC 100:** Suitable for harsh applications.

# 14 Cooling Liquid

Zitrec® M (Ready-to-use)	
Part number 5 L packaging	0831 563 469
Part number 20 L packaging	0831 238 761

**Zitrec® M** coolant (Cooling liquid) is ready-to-use and requires no additional water.

For more information, visit [www.arteco-coolants.com](http://www.arteco-coolants.com).

# 15 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 is determined by the serial number:

Serial number starts with **CHM1...**

**Ateliers Busch S.A.**  
**Zone industrielle**  
**2906 Chevenez**  
**Switzerland**

Serial number starts with **KRM1...**

**Busch Manufacturing Korea, Ltd.**  
**189-51, Soicheon-ro, Majang-myun**  
**Icheon-si, Gyunggi-do, 467-813**  
**Republic of Korea**

declares that the machine: COBRA DX 2000 A PLUS

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

- 'Machinery' 2006/42/EC
- '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:

Standards	Title of the Standard
EN ISO 12100 : 2010	Safety of machinery - Basic concepts, general principles of design
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 2151 : 2008	Acoustics - Noise test code for compressors and vacuum pumps - Engineering method (grade 2)
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

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**

Chevenez, 19.12.2023



**Christian Hoffmann**  
**General Manager**  
**Ateliers Busch S.A.**

Icheon-si, 19.12.2023



**Jeihong Kim**  
**General Manager**  
**Busch Manufacturing Korea, Ltd**

# 16 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 is determined by the serial number:

Serial number starts with **CHM1...**

**Ateliers Busch S.A.**  
**Zone industrielle**  
**2906 Chevenez**  
**Switzerland**

Serial number starts with **KRM1...**

**Busch Manufacturing Korea, Ltd.**  
**189-51, Soicheon-ro, Majang-myun**  
**Icheon-si, Gyunggi-do, 467-813**  
**Republic of Korea**

declares that the machine: COBRA DX 2000 A PLUS

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:

Standards	Title of the Standard
EN ISO 12100 : 2010	Safety of machinery - Basic concepts, general principles of design
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 2151 : 2008	Acoustics - Noise test code for compressors and vacuum pumps - Engineering method (grade 2)
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

Legal person authorized to compile the technical file and importer in the UK (if the manufacturer is not located in the UK): **Busch (UK) Ltd**  
**30 Hortonwood**  
**Telford - UK**

Chevenez, 19.12.2023

Icheon-si, 19.12.2023




**Christian Hoffmann**  
**General Manager**  
**Ateliers Busch S.A.**

**Jaihong Kim**  
**General Manager**  
**Busch Manufacturing Korea, Ltd**

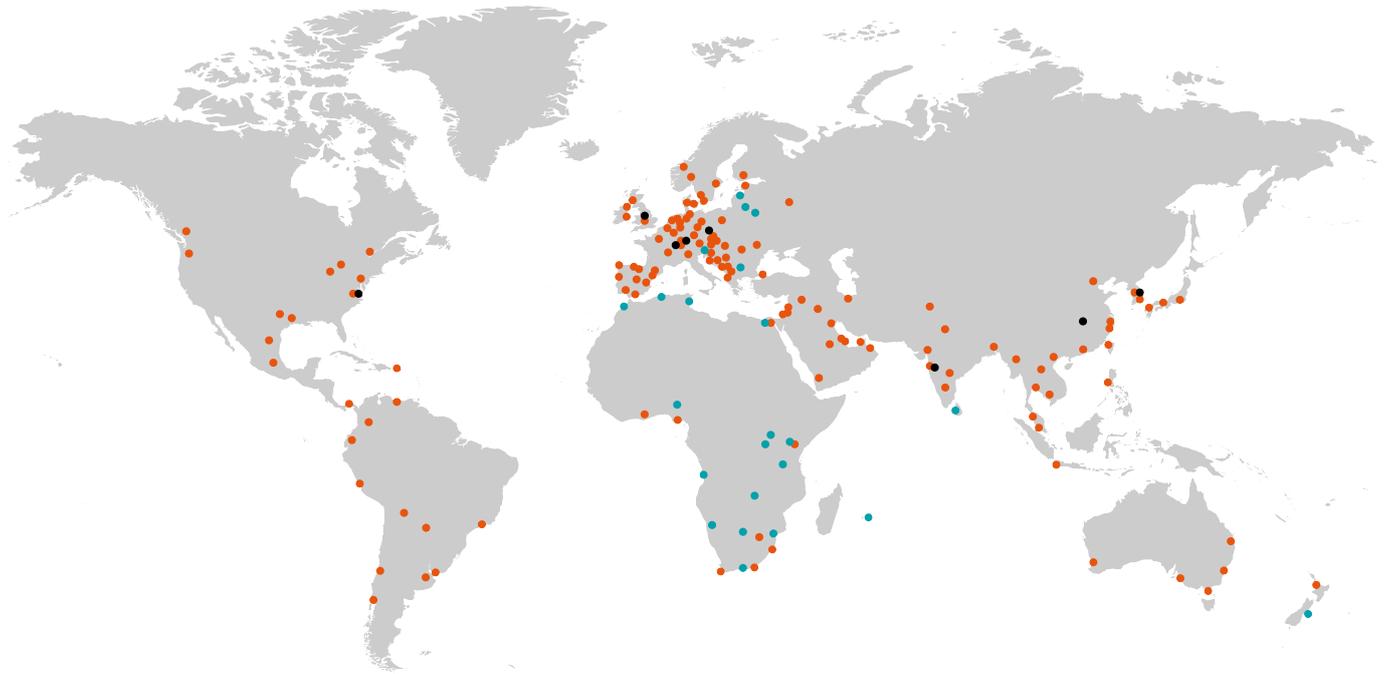
# Notes

A large grid of small dots for taking notes, consisting of approximately 30 columns and 40 rows of dots.

# 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.



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

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