VACUUM SOLUTIONS

R5 PLUS

Oil-Lubricated Rotary Vane Vacuum Pumps
RA 0840 A PLUS without cabinet

Instruction Manual

Get technical data, instruction manuals, service kits

VACUUM APP

0870242418 | -0001_en-US | Original instructions

2/22/2023

Table of Contents

1 Safety

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

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

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

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

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

The machine has been designed and manufactured according to state-of-the-art methods. Nevertheless, residual risks may remain, as described in the following chapters and in accordance with the chapter *Intended Use* [➔ 6]. 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.

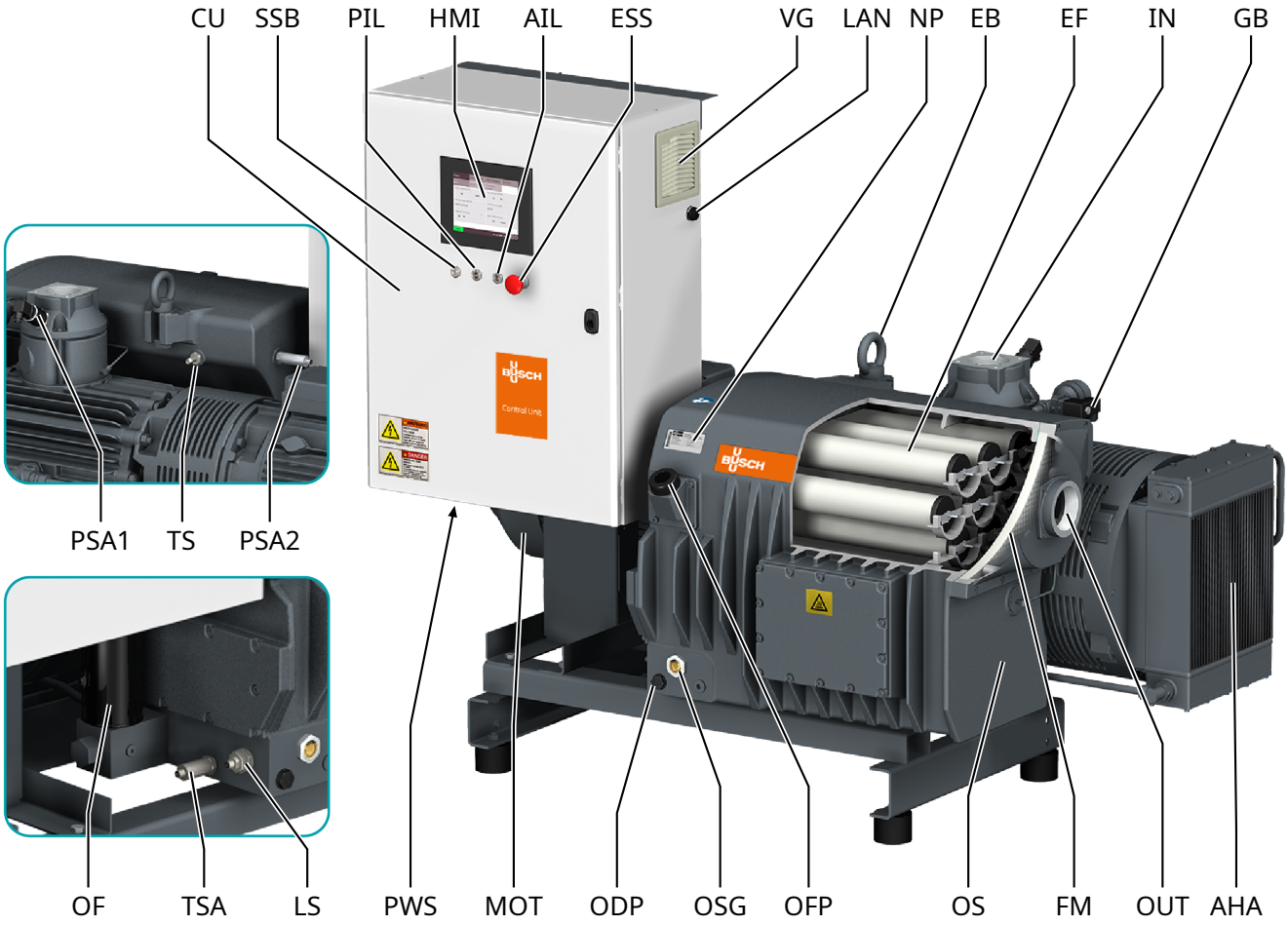
NOTICE

... 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	Suction connection (Inlet)	OUT	Discharge connection (Outlet)
AHE	Air-oil heat exchanger	AIL	Alarm indicator light
CU	Control unit	EB	Eye bolt
EF	Exhaust filter	ESS	Emergency stop switch
FM	Filter material	GB	Gas ballast valve
HMI	User interface (Human-Machine)	LAN	LAN Communication port (Modbus TCP/IP)
LS	Level switch (Oil level)	MOT	Motor (Pump drive)
NP	Nameplate	ODP	Oil drain plug
OF	Oil filter	OFP	Oil fill plug
OS	Oil separator	OSG	Oil sight glass
PIL	Power indicator light	PSA1	Pressure transmitter (Inlet gas pressure)
PSA2	Pressure transmitter (Exhaust gas pressure in the oil separator)	PWS	Power supply (Cable gland)
SSB	Start/Stop button	TSA	Resistance thermometer (Oil temperature)
VG	Ventilation grid		

NOTE

Technical term.

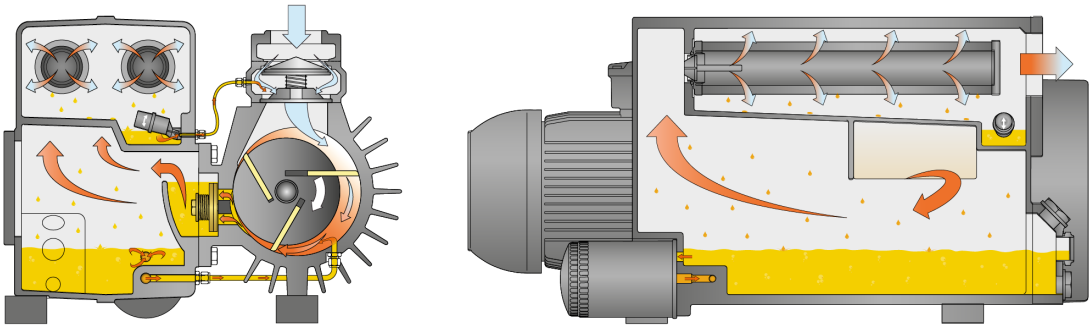
In this instruction manual, we consider that the term ‘machine’ refers to the ‘vacuum pump’.

NOTE

Illustrations

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

2.1 Operating Principle



The machine works on the rotary vane principle.

The oil seals the gaps, lubricates the vanes and takes away compression heat.

The oil filter cleans the circulating oil.

Exhaust filters separate the oil from the discharged gas.

2.2 Intended Use

WARNING

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

Risk of injuries!

Risk of damages to the machine!

Risk of damages to the environment!

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

The machine is intended for the suction of air and other dry, non-aggressive, non-toxic 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 the placement in a non-potentially explosive environment.

The machine is designed for indoor installation, in case of outdoor installation, ask your Busch representative in order to take specific 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.

2.3 Standard Features

2.3.1 User Interface

A user interface, also termed human-machine interface (HMI), allows the control, monitoring and configuration of the machine via a 7.5” touchscreen.

Further information in the chapter *Description of User Interface Functions* [➔ 9].

2.3.2 Control Unit

The control unit is an electrical cabinet where a variable speed drive, a PLC and other electrical components are integrated.

The power supply must be connected to it, see *Electrical Connection* [➔ 27].

2.3.3 Monitoring Devices

The machine is equipped with several monitoring devices to visualise the operating values, machine conditions and to protect the machine from any severe damage.

The oil temperature, oil level, inlet gas pressure and counter pressure at the discharge can be displayed when the machine is running, see *Monitoring* [➔ 46].

Two signal levels are transmitted, a warning and an alarm/trip, see *Dysfunction* [➔ 51].

2.3.4 I/O and Communication Port

The control unit (CU) is equipped with a RJ45 (Modbus) communication port that can allow remote control and monitoring of the machine.

- Refer to the specific document “Pump Control Instructions, art. no.: 0870213261” for more details or contact your Busch representative.

2.3.5 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.

2.4 Optional Accessories

2.4.1 Inlet Filter

The inlet filter protects the machine against dust and other solids in the process gas. The inlet filter is available with a cartridge.

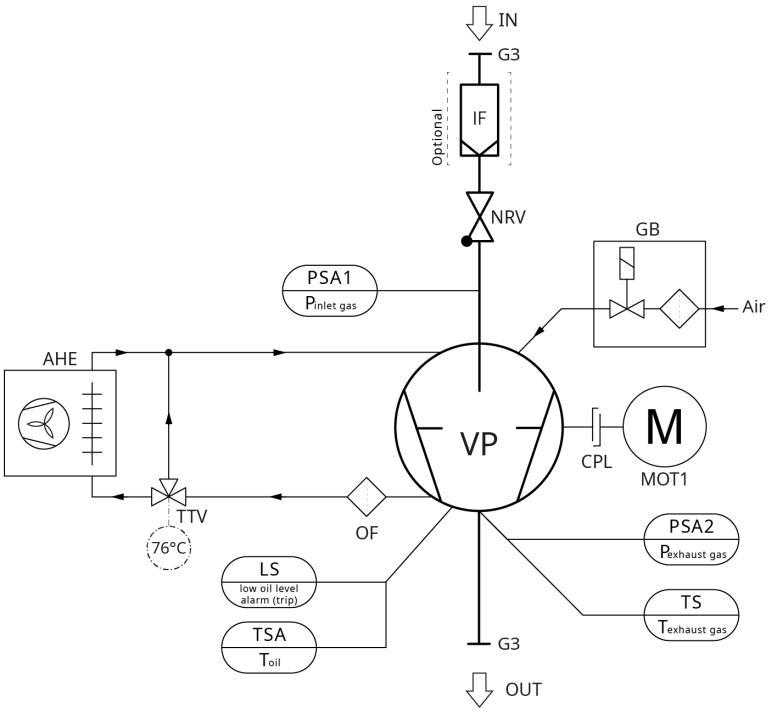
2.4.2 Inlet Filter Condition Monitoring Kit

The Inlet filter condition monitoring kit monitors the pressure differential in the inlet filter cartridge, to detect when replacement is required. The inlet filter cartridge must be replaced when the pressure differential reaches a certain value, which depends on the application and operating pressure. This pressure differential threshold must be set in the control unit, so that a warning is displayed when replacing the cartridge is recommended, refer to the specific document "Pump Control Instructions, art. no.: 0870213261".

2.4.3 Water-Oil Heat Recovery Unit

For heat recovery purpose or in case of unfavorable ambient conditions, a water-oil heat exchanger can be provided. See *Cooling Water Connection (Optional)* [➔ 22].

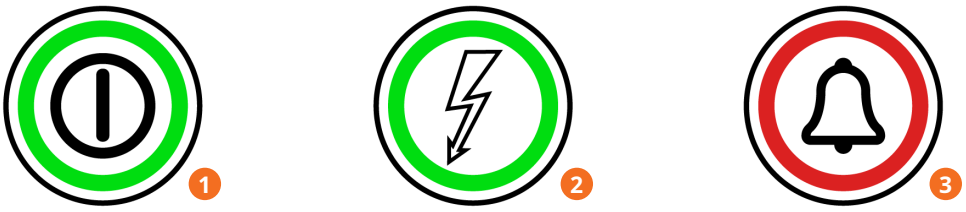
2.5 P&ID "Piping and Instrumentation Diagram"



Description			
AHE	Air-oil heat exchanger (Fan driven by the pump shaft)	CPL	Coupling
GB	Gas ballast	IF	Inlet filter (Optional)
IN	Suction connection (Inlet)	LS	Level switch "alarm/trip" (Oil level)
MOT1	Motor (Pump drive)	NRV	Non-return valve (Not used as an isolation valve)
OF	Oil filter	OUT	Discharge connection (Outlet)
PSA1	Pressure transmitter (Inlet gas pressure)	PSA2	Pressure transmitter (Counter pression in the oil separator)
TSA	Resistance thermometer (Oil temperature)	TS	Temperature switch (Exhaust gas temperature)
TTV	Three-way thermostatic valve	VP	Vacuum pump

2.6 LED Indicators

Next to the user interface, there are three LEDs giving a visual indication of the state of machine.

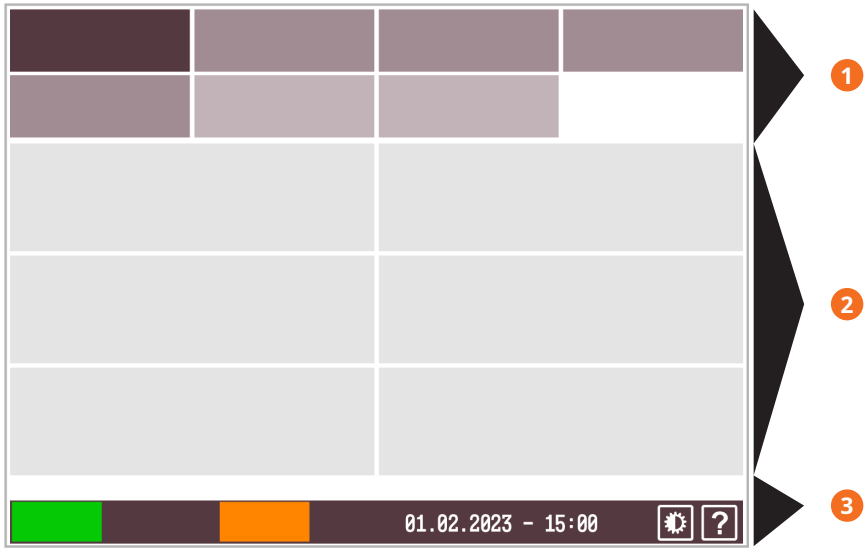


Description			
1	Start/stop button (SSB): The LED is green when the machine is running.	2	Power indicator light (PIL): The LED is green when the machine is powered.

Description			
3	Alarm indicator light (AIL): The LED flashes in red when a warning occurred. The LED is continuously red when an alarm occurred.		

2.7 Description of User Interface Functions

The display is divided into three distinct parts.

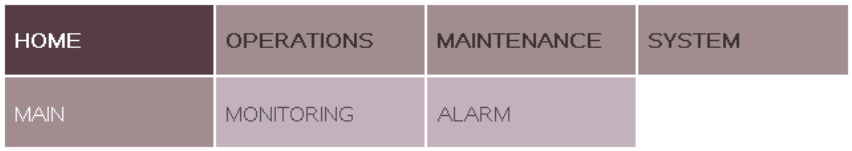


Description			
1	Menu tabs and sub-tabs	2	Information panel
3	Bottom bar		

2.7.1 Menu Overview

The menu consists of four main tabs with their own sub-tabs:

- The "HOME" tab is the main display and is mainly useful for live monitoring.



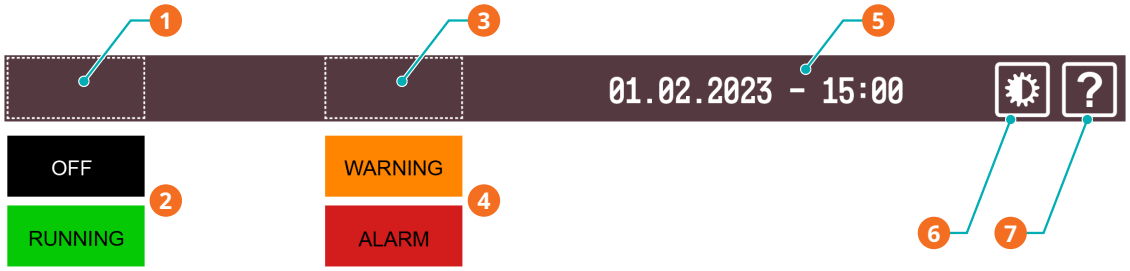
- The “OPERATIONS” tab displays the operating parameters/modes and allows the control of the machine.

- The “MAINTENANCE” tab displays the history of malfunctions, maintenance intervals and operating curves.

- The “SYSTEM” tab allows to set or change settings and provides information about the product and its distributor.

2.7.2 Bottom Bar

The bottom bar provides different pieces of information, in particular the machine state and warning/alarm status.



Description			
1	Machine state	2	Machine state: "OFF" or "RUNNING"
3	Warnings and alarms status	4	Status: "WARNING" or "ALARM"
5	Date and hour	6	Screen brightness
7	Help		

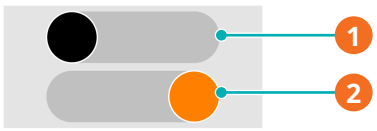
2.7.3 Navigation

When several screens/pages are available in the information panel, dots representing the different screens/pages and “PREVIOUS/NEXT” buttons are displayed above the bottom bar.

- Press either on a dot or “PREVIOUS/NEXT” button to pass from a screen/page to another.

The switch button is black when deactivated and orange when activated.

- Press on the switch button to change its state.



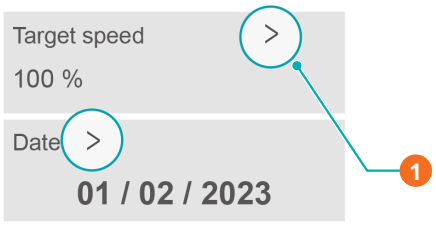
Description			
1	Deactivated (Off)	2	Activated (On)

If a password is required:

- Enter the password, see the chapter *Roles and Users* [➔ 11].

When the character ">" is displayed in a cell of the information panel, that means a step further is available. For example: a redirect link to another view or to open a specific editing view.

- Press in the cell to open the next dialog windows.



Description			
1	Step further available, press to access the next dialog window.		

If a password is required:

- Enter the password, see the chapter *Roles and Users* [➔ 11].

2.7.4 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, refer to the specific document "Pump Control Instructions, art. no.: 0870213261".

Role 3 ► Busch Service

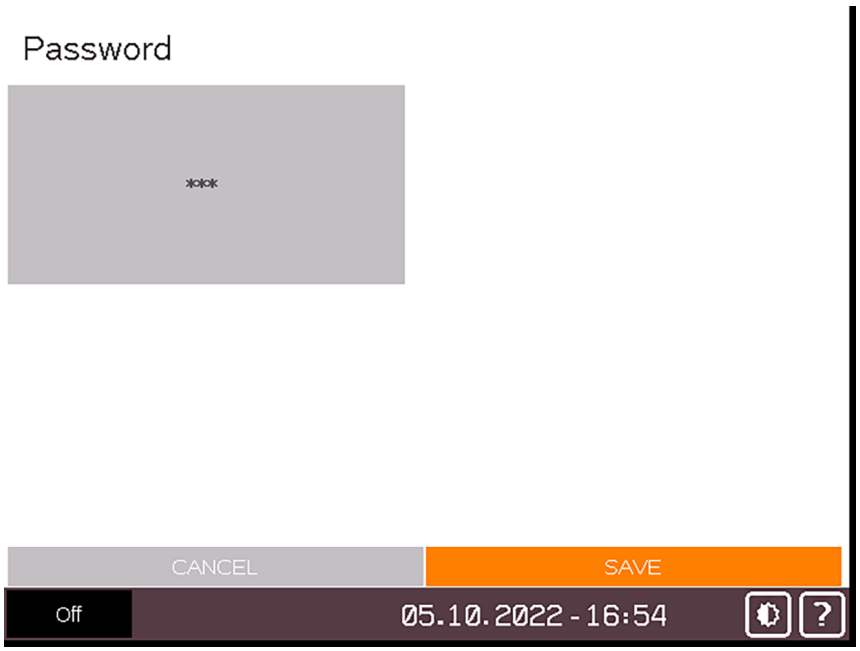
Only authorized personnel from Busch Service have this level of access rights.

NOTE

In case of any questions related to the machine settings:

- Please contact Busch Service.

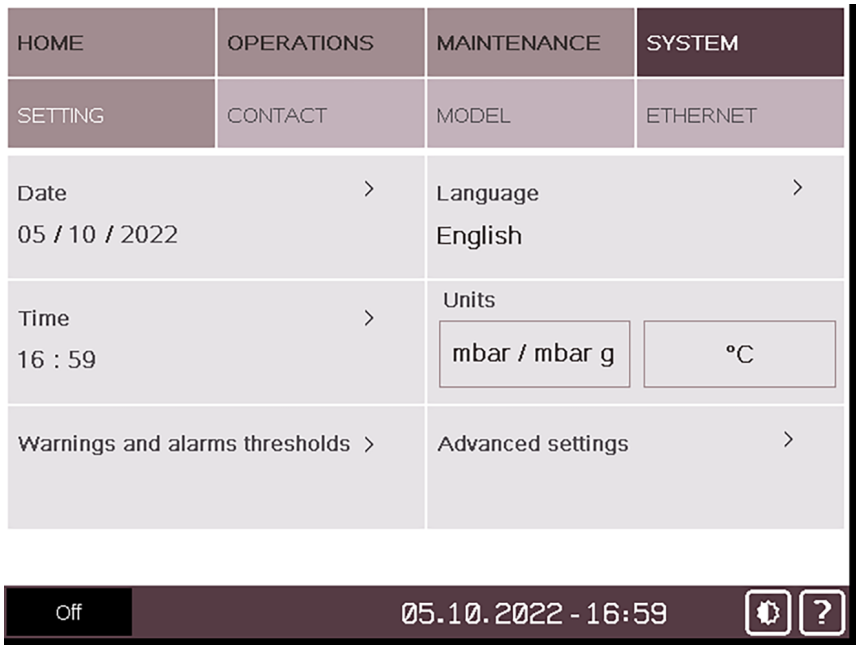
When a password is required, the display shows the following screen:



- Press on the three stars.
- 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.

2.7.5 System Settings

- 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.



NOTE

Warnings and alarms thresholds

Thresholds can only be changed by Busch Service “Role 3”, see the predefined factory settings in the chapter *Warnings and Alarms Thresholds* [➔ 51].

NOTE

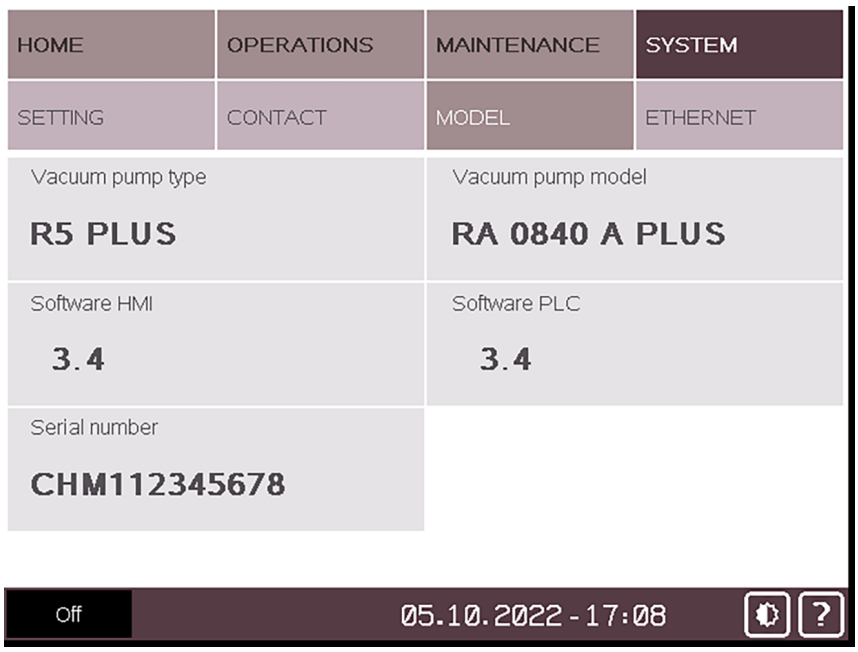
Advanced settings

Advanced settings can only be changed by Busch Service “Role 3”, refer to the specific document "Pump Control Instructions, art. no.: 0870213261".

2.7.6 Machine and Software Identification

To display the machine and software identification:

- Go to “SYSTEM” > “MODEL”.



2.7.7 Ethernet Settings

- To configure the ethernet settings according to your network:
  - Go to “SYSTEM” > “ETHERNET”.
  - Make sure that the Ethernet port (COM) on the right side of the control unit (CU) of the machine is connected to a computer or to the company network.
  - Change the values on the right side of the screen (Change settings), password required ▶ Role 2, see *Roles and Users* [➔ 11].
  - Press on the switch button to save the new settings.

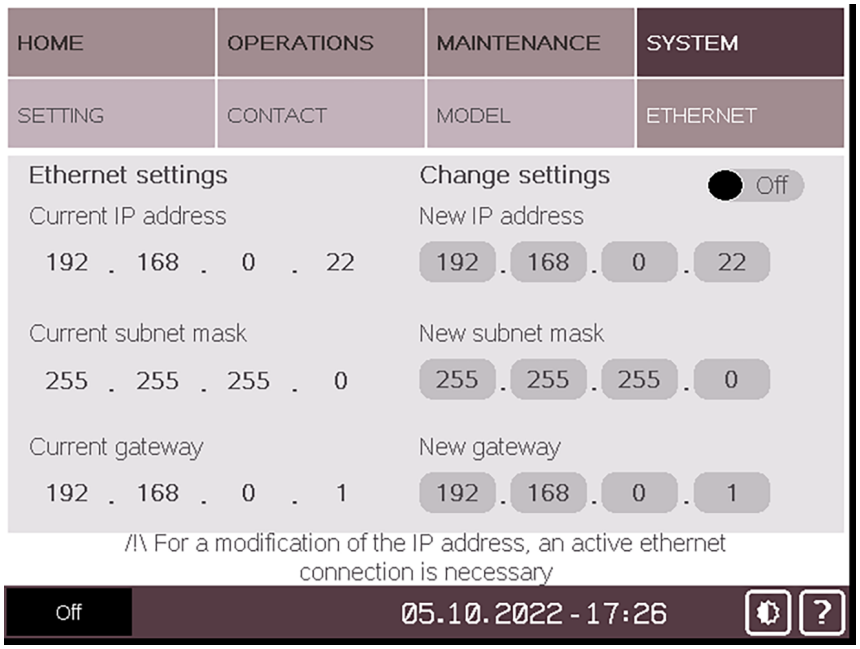
NOTE

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).



Description	Default value
IP address	192.168.0.22
Subnet mask	255.255.255.0
Gateway	192.168.0.1
PLC port (0-65535)	502 *(cannot be changed)*
PLC Slave no.	247 (F7) *(cannot be changed)*

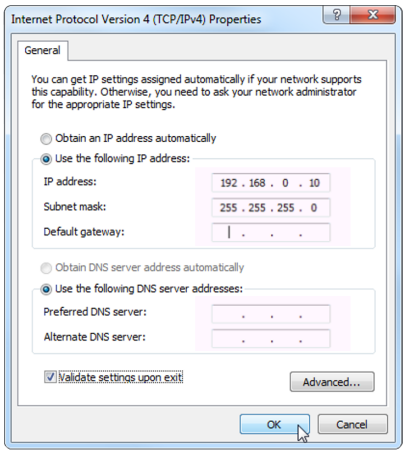
2.8 Web Visualization

Each machine has a built-in Web visualization interface, which allows remote monitoring of the main operating parameters from a computer (via a LAN connection or via an optional WIFI connection), a tablet or a smartphone (via an optional WIFI connection).

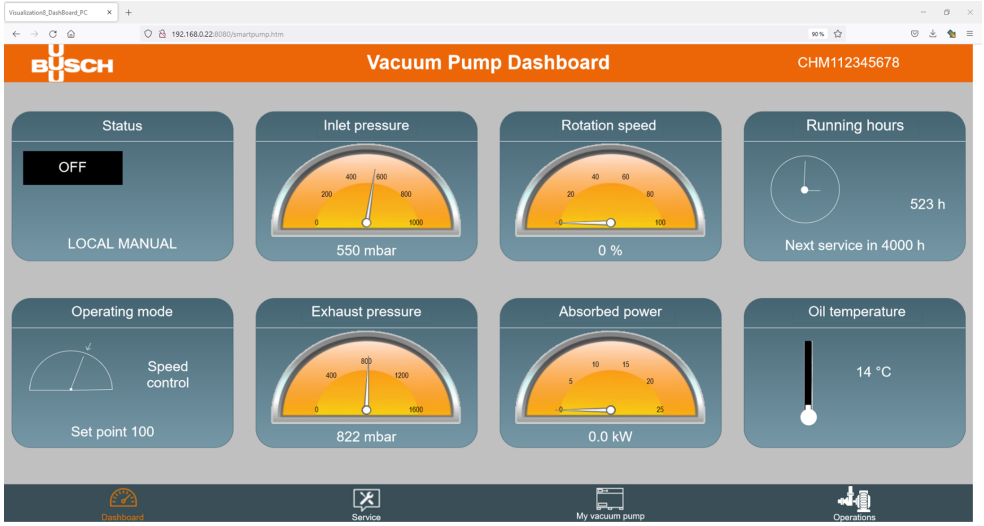
To use the Web visualization interface via a LAN connection:

- Connect an Ethernet cable to the Ethernet port (COM) on the right side of the control unit (CU) of the machine.
- Connect the Ethernet cable to the company network or to the computer. To connect the Ethernet cable to the computer, use a USB/LAN adapter or connect it directly to the Ethernet port of the computer and use the internal network card (administrator access required).

- Check the ethernet settings of the machine in the “Ethernet Settings” menu of the User Interface Display (HMI), see *Ethernet Settings* [➔ 13]. By default, the ethernet settings are:
  - IP address: 192.168.0.22
  - Subnet mask: 255.255.255.0
  - Gateway: 192.168.0.1
- Check the ethernet settings of the computer network (Internet Protocol Version 4 (TCP/IPv4) Properties). The Subnet mask and the first 3 bytes of the IP address must be the same as on the PLUS machine.



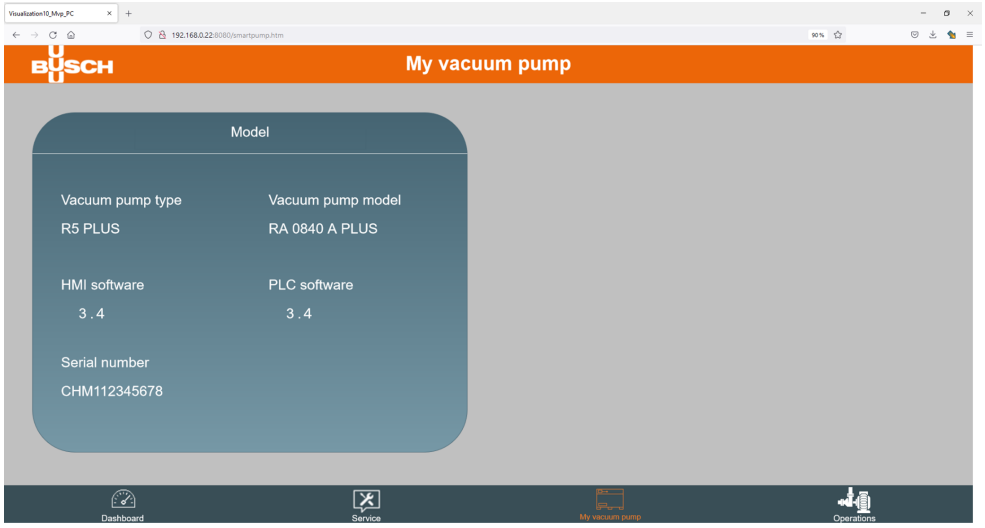
- Open your web browser (full screen window) and type the IP address of the machine to monitor in the address bar, followed by: *:8080/smartpump.htm*. By default, the whole address to be typed in the web browser is: *192.168.0.22:8080/smartpump.htm*
- When the Web visualization interface opens, select “Computer” as monitoring device.
- The main screen, “**Dashboard**”, shows the main operating parameters and settings of the machine (machine status, operating mode, running hours, inlet pressure...).



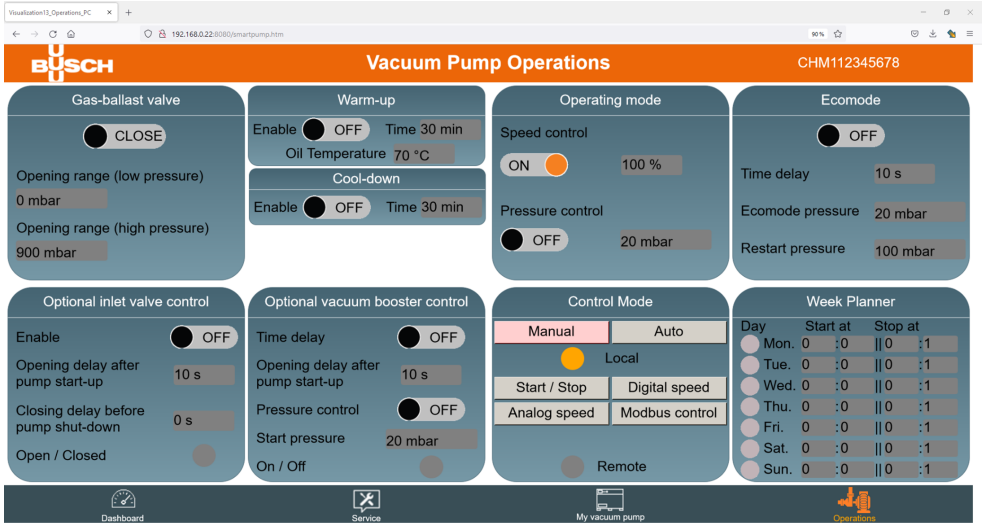
- Use the icons in the bottom bar to navigate in the Web visualization interface.

- The second page “**Service**” shows the service table of the machine and Busch service contact information.

- The third page **“My vacuum pump**” gives general information about the machine.



- The fourth page "**Operations**" gives remote access to the basic settings of the vacuum pump: Control mode, Operating mode, Ecomode, Week planner, Warm-up and Cool-down, Gas ballast valve control, Optional inlet valve control, Optional vacuum booster control.



For more information about these settings, see chapter *In Operation* [➔ 33].

NOTE

Remote start/stop.

Remote start/stop of the vacuum pump is not possible via the Web Visualization interface.

NOTE

- Contact Busch:
  - ➔ If the Ethernet port of the machine (COM) is already used for remote control / monitoring purpose.
    OR
  - ➔ In order to use the Web visualization function via a WIFI connection (requires an optional WIFI module).
- The Web visualization interface is optimized for Google Chrome.
- To change the IP address of the machine (in the event it is already used by another machine for instance), go to the “Ethernet Settings” menu of the User Interface Display (HMI) on the machine, see *Ethernet Settings* [➔ 13].

3 Transport

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.

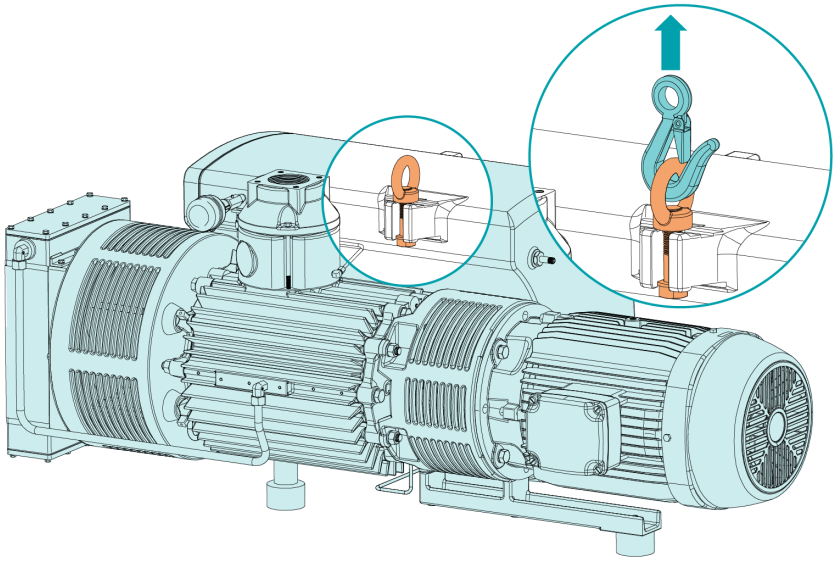
NOTICE

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. Starting the machine with excessive quantities of oil in the cylinder will immediately break the vanes and ruin the machine!

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

- To find out the weight of the machine, refer to the chapter Technical Data or the nameplate (NP).
- Make sure that the eye bolt(s) (EB) is/are in faultless condition, fully screwed in and tightened by hand.



- 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 all apertures with adhesive tape or reuse provided caps.

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

- Wrap the machine in a corrosion inhibiting film.
- Store the machine indoors, dry, dust free and if possible in original packaging preferably at temperatures between 0 ... 30 °C.

5 Installation

5.1 Installation Conditions

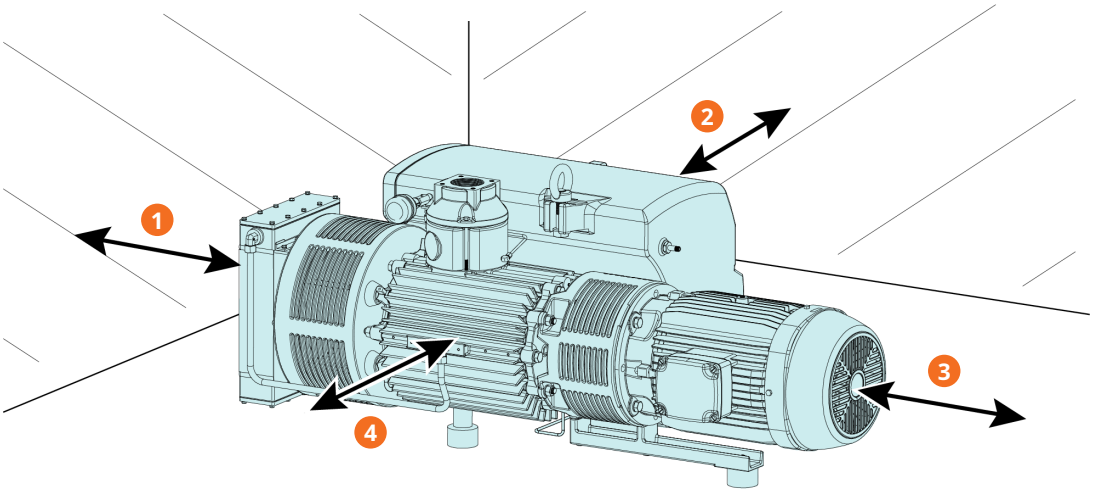
NOTICE

Use of the machine outside of the permitted installation conditions.

Risk of premature failure!

Loss of efficiency!

- Take care that the installation conditions are fully complied with.



Description			
1	~100 cm	2	~50 cm
3	~100 cm	4	~50 cm

- 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 IP54.
- 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 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, a maximum deviation of 1° in any direction is acceptable.
- Check the oil level, see Oil Level Inspection.
- Make sure that all provided covers, guards, hoods, etc. are mounted.

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 connection of the machine; if necessary use flexible joints.
- Make sure that the line size of the connection lines over the entire length is at least as large as the connections of the machine.

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

- Make sure that the connection flanges are fitted with the appropriate gaskets.

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.
- The machine is not suitable for liquid suction.

Connection size(s):

– G3”

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

- Busch recommends the installation of an isolation valve in order to prevent the oil from flowing back to the vacuum system.

5.2.2 Discharge Connection

CAUTION

The discharge gas contains small quantities of oil.

Risk to health!

If air is discharged into rooms where persons are present:

- Make sure that sufficient ventilation is provided.

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):

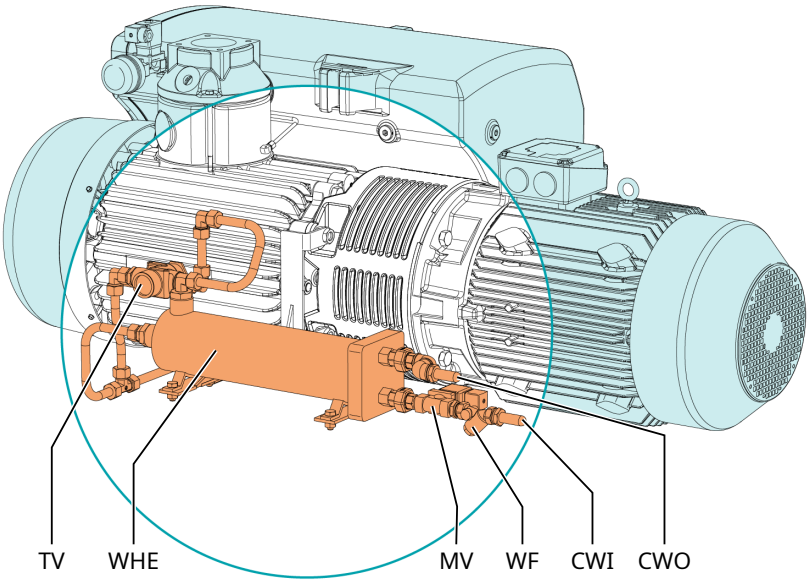
– G3"

Unless the aspirated air is discharged to the environment right at the machine:

- Make sure that the discharge line either slopes away from the machine or provide a liquid separator or a siphon with a drain cock, so that no liquids can flow back into the machine.
- Make sure that the counter pressure (also termed back pressure) at the discharge connection (OUT) does not exceed the maximum allowable discharge pressure, see Technical Data.

5.2.3 Cooling Water Connection (Optional)

Water-oil heat exchanger with inlet and outlet connection



Description			
CWI	Cooling water inlet	CWO	Cooling water outlet
MV	Solenoid valve	TV	Thermostatic valve
WF	Water filter	WHE	Water-oil heat exchanger

The thermostatic valve (TV) is used to control the oil flow in order to keep a stable machine temperature.

The factory adjustment of the thermostatic valve (TV) is approx. 55°C-70°C oil temperature.

The solenoid valve (MV) is used to stop the cooling water circulation when the machine is not running or when the oil temperature is lower than 60°C.

- Connect the cooling water connections (CWI / CWO) to the water supply.

Connection size:

– 19 mm hose (CWI / CWO)

- In case of retrofit of a Water-oil Heat recovery unit:
  - Electrically connect the solenoid valve (MV) to the control unit (CU): see wiring diagram in the control unit cabinet.
  - Change the cooling system type in the “Advanced settings” menu of the User Interface, refer to the specific document "Pump Control Instructions, art. no.: 0870213261". This parameter is only available for “Role 3” users, see *Roles and Users* [➔ 11].
- Make sure that the cooling water complies with the following requirements:

Min. supply capacity	l/min	5
Water pressure	bar	2 ... 6
Supply temperature	°C	+5 ... +35
Required pressure differential across supply and return	bar	≥ 1

- To reduce the maintenance effort and ensure a long product lifetime we recommend the following cooling water quality:

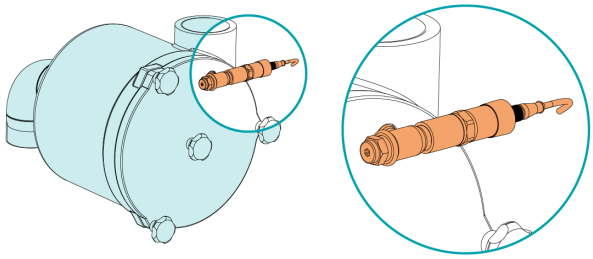
Hardness	mg/l (ppm)	< 90
Properties	Clean & clear	
PH value		7 ... 8
Particle size	µm	< 200
Chloride	mg/l	< 100
Electrical conductivity	µS/cm	≤ 100
Free chloride	mg/l	< 0.3
Materials in contact with the cooling water	Stainless steel, copper and cast iron	

NOTE

Water hardness unit conversion.

1 mg/l (ppm) = 0.056 °dh (german degree) = 0.07 °e (english degree) = 0.1 °fH (french degree)

5.2.4 Inlet Filter Condition Monitoring Kit



- To install the Inlet filter condition monitoring kit:
  - Remove the R1/4 screw plug from the inlet filter cover
  - Mechanically fit the pressure sensor on the body of the inlet filter.
  - Electrically connect the Inlet filter condition monitoring kit to the control unit (CU): See wiring diagram in the control unit cabinet.
  - Enable the Inlet filter condition monitoring function in the “Advanced settings” menu of the User Interface and set the Inlet filter pressure differential warning threshold in the “Warnings and Alarms thresholds” menu, refer to the specific document "Pump Control Instructions, art. no.: 0870213261". This parameter is only available for “Role 3” users, see *Roles and Users* [➔ 11].

NOTE

- Use an ECM cable gland.
- Connect the cable shielding according to the state of the art (refer to the instructions of the cable gland manufacturer).
- It is not possible to install the Inlet filter condition monitoring kit if an external inlet pressure sensor is already connected to the Control Unit of the machine

5.2.5 External Inlet Pressure Sensor

An external inlet pressure sensor can be connected to the Control Unit. To control the machine with an external sensor:

- Mechanically fit the pressure sensor at the desired location upstream of the vacuum pump inlet (on a vacuum vessel or in the vacuum chamber for instance).
- Electrically connect the external pressure sensor to the control unit (CU): See wiring diagram in the control unit cabinet.
- Set the sensor parameters and enable the External inlet pressure sensor control in the “Advanced settings” menu of the User Interface, refer to the specific document "Pump Control Instructions, art. no.: 0870213261". This parameter is only available for “Role 3” users, see *Roles and Users* [➔ 11].

NOTE

- Use an ECM cable gland and a shielded cable.
- Connect the cable shielding according to the state of the art (refer to the instructions of the cable gland manufacturer).
- It is not possible to install the Inlet filter condition monitoring kit if an external inlet pressure sensor is already connected to the Control Unit of the machine.

5.3 Filling Oil

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.

NOTICE

Change oil from mineral to synthetic or the other way around.

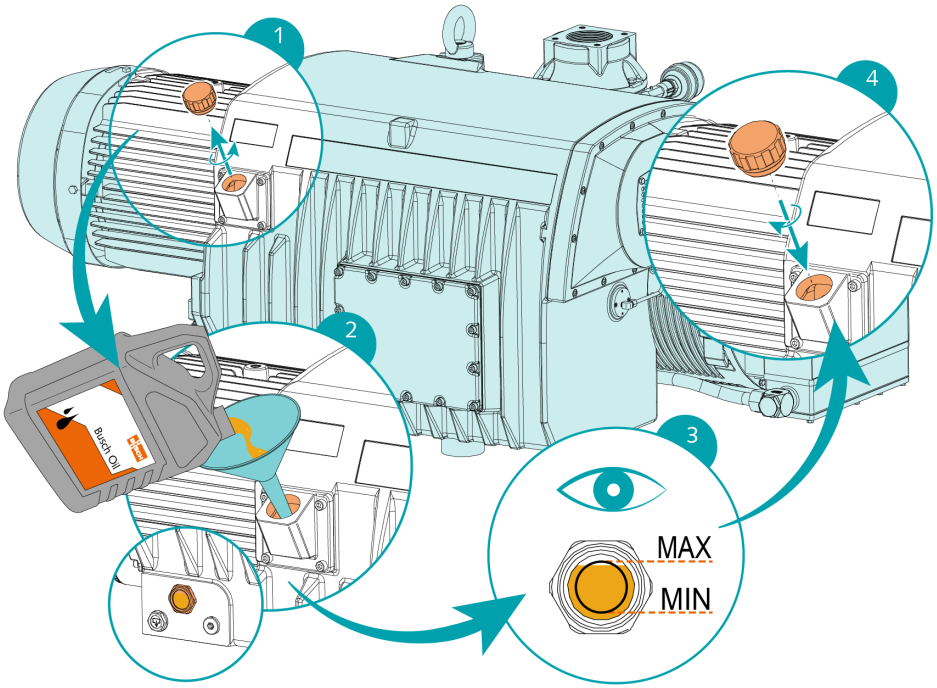
Risk of using a deteriorated oil!

Risk of premature failure!

By default, the oil temperature thresholds (warning/alarm) and the service intervals are configured according to the oil type (mineral or synthetic) written on the nameplate (NP).
In case of oil type change:

- Contact your Busch representative to adapt the thresholds and service intervals accordingly.

For oil type and oil capacity see Technical Data and *Oil* [➔ 70].

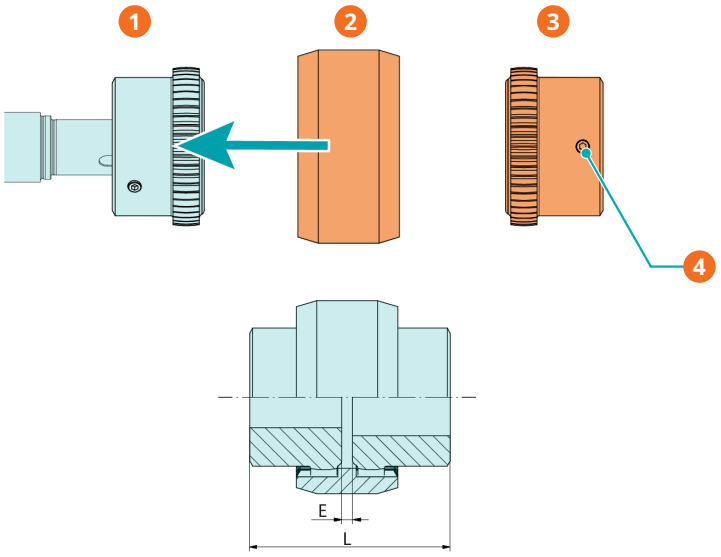


5.4 Fitting the Coupling

NOTE

Radial screw.

For trouble-free operation, use thread locking glue to secure the radial screw.



Description			
1	Coupling hub (machine side)	2	Coupling sleeve
3	Coupling hub (motor side)	4	Radial screw / max. admissible torque: 17Nm

Coupling size	Value “E” (mm)	Value “L” (mm)
BoWex® M-65	4	114

In case of a machine delivery without motor:

- Fit the second coupling hub on the motor shaft (separately delivered).
- Axially adjust the sleeve in such a way until value "E" (or “L”) is reached.
- When the coupling adjustment is done, lock the coupling hub by tightening the radial screw.
- Mount the motor on the machine by including the coupling sleeve.

For further coupling information, go to *www.ktr.com* and download the instruction manual of the BoWex® coupling.

English	German	French
Instruction Manual - English	*Instruction Manual - German*	*Instruction Manual - French*

6 Electrical Connection

DANGER

Live wires.

Risk of electrical shock.

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

CURRENT PROTECTION OF THE CUSTOMER INSTALLATION:

DANGER

Missing current protection.

Risk of electrical shock.

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

NOTICE

Electromagnetic compatibility.

- Make sure that the motor of the machine will not be affected by electric or 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* [➔ 71] or *UK Declaration of Conformity* [➔ 72]).

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.

- 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.
- 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 control unit (CU), see *Wiring Diagram Control Unit* [➔ 29].

NOTICE

The admissible motor speed exceeds the recommendation.

Risk of damage to the machine!

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

NOTICE

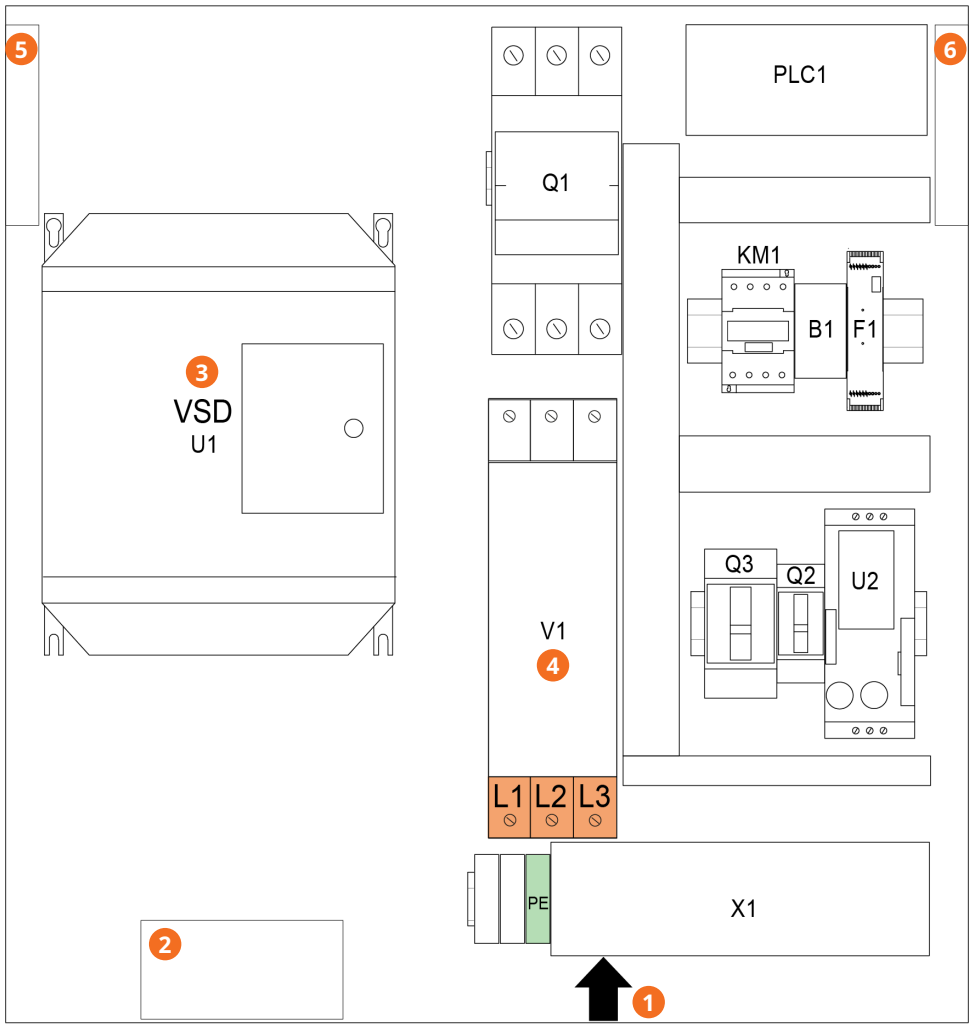
Incorrect connection.

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.

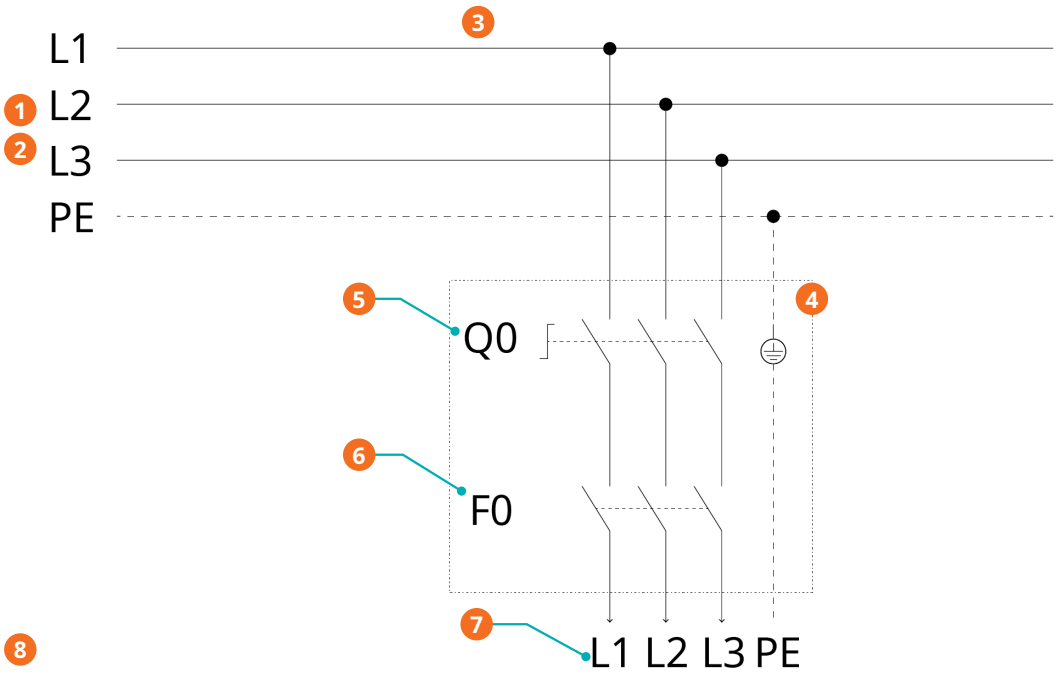
6.2 Wiring Diagram Control Unit

Internal view of the control unit



Description			
1	Power input	2	Box fan
3	VSD: Variable Speed Drive	4	Filter
5	Box filter	6	Box filter

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: C-curve - 80A without DCR / C-curve - 50A with DCR
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.

Cable gland size of the power input:

– M40 x 1.5 (cable ⌀ ►20 ... 33 mm)

7 Commissioning

7.1 Prerequisites Before Use

- Make sure that the *Installation Conditions* [➔ 20] are met.
- Power the machine, the power indicator light (PIL) must be lit in green.
- Fill in the system settings (such as date/time, language and units), see chapter *System Settings* [➔ 12].

Once these steps are completed, the machine is ready to start with default settings:

- Speed control mode at 100 %

For all other operating settings:

- Consult the chapter *Configuration* [➔ 31].

7.2 Configuration

NOTICE

Configuration.

Incorrect configuration can lead to malfunctions!

- The configuration must only be performed by authorized personnel.

The configuration of the machine has to be according to the process type and only performed by “Role 2” users, see *Roles and Users* [➔ 11].

Different machine parameters can be configured, such as:

- *Control Mode* [➔ 33] ▶ Local/Manual (default), Local/Auto (week planner) or Remote/Auto,
- *Operating Mode* [➔ 36] ▶ Speed control (default) or Pressure control,
- *Ecomode* [➔ 38],
- *Gas Ballast Valve Control* [➔ 39],
- *Warm-up / Cool-down Modes* [➔ 40],
- *Optional Inlet Valve Control* [➔ 42],
- *Optional Vacuum Booster Control* [➔ 44].

Do not hesitate to contact Busch to get any further information about the configuration of your machine.

- Click on the “Help” icon in the bottom bar to get the contact information of your Busch representative, see *Bottom Bar* [➔ 10].

7.3 Start Up

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.

To start the machine:

- Press and hold the start/stop button (SSB) for at least 3 seconds.
- Monitor the operating values (*Monitoring* [➔ 46]) and make sure that they always comply with the operating conditions, see Technical Data.

As soon as a warning/alarm signal occurred:

- Investigate the cause of the signal, see *Dysfunction* [➔ 51].

NOTE

Activated oil level signal.

The machine is generally shipped without oil, therefore an alarm signal occurs during the first start-up.

- As soon as the machine has been filled with oil, acknowledge the alarm signal by following the *Warning/Alarm Acknowledgment Procedure* [➔ 53].

NOTE

Control mode “Remote/Auto“.

The machine cannot be started manually if the control mode is set to “Remote/Auto”.

8 In Operation

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.

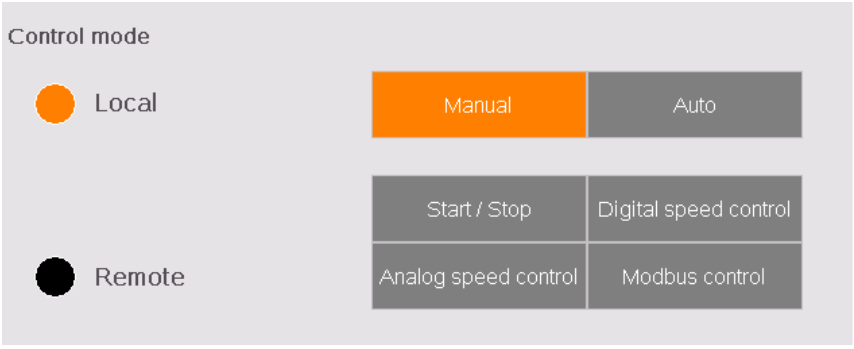
8.1 Control Mode

To access the control mode menu:

- Go to “OPERATIONS” > “MODE”.
- Go to the third screen/page.

8.1.1 Local/Manual

Configured by default, this mode allows to control manually the machine directly from the user interface (HMI).

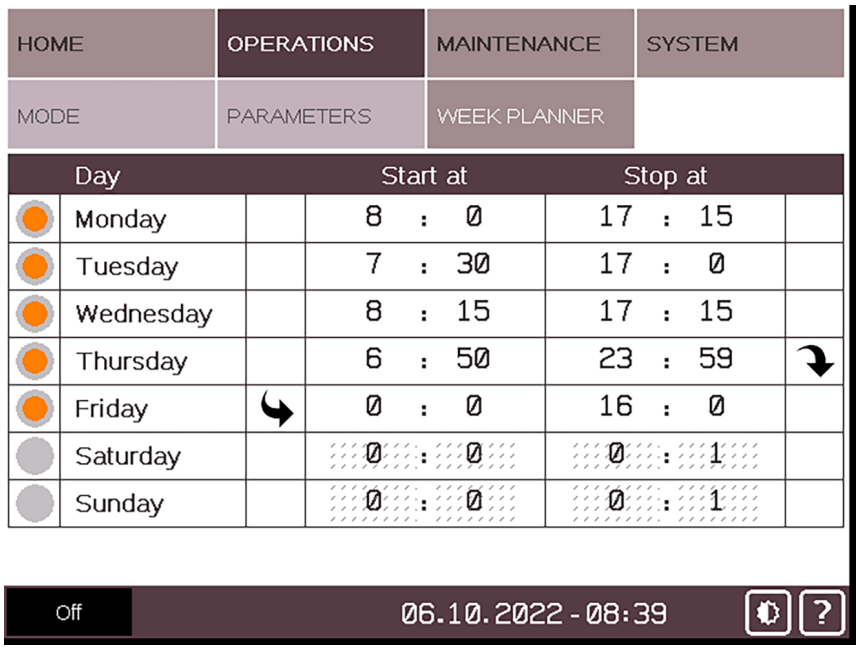


8.1.2 Local/Auto "Week Planner"

The "week planner" function allows definition of a weekly schedule for starting or stopping the machine automatically using the current local settings. A single start and stop a day is possible.

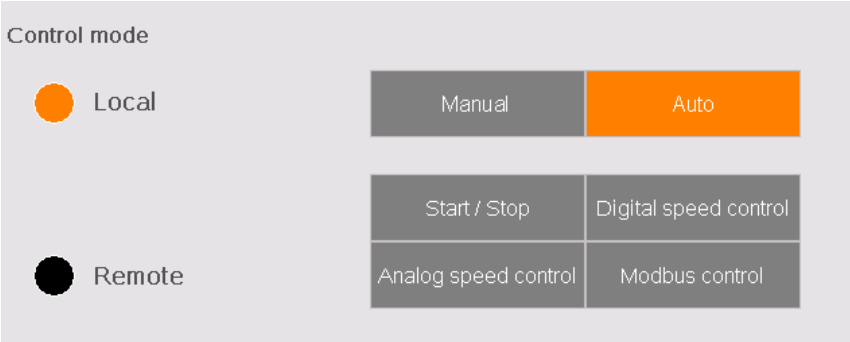
To configure the weekly schedule:

- Go to “OPERATIONS” > “WEEK PLANNER”.
- Press on the days when automatic start and stop are required.
- Set up the start and stop times.



As soon as the schedule is filled in, the control mode “Local/Auto” has to be activated (by “Role 2” users only, see *Roles and Users* [➔ 11]):

- Go to the control mode menu, see *Control Mode* [➔ 33].
- Select the mode “AUTO” in the “LOCAL” field (password required).



WARNING

The machine may start without notice.

Risk of severe injury!

As soon as the mode “Local/Auto” is activated:

- Make sure the machine is fully operational when the programmed schedule begins.

NOTE

To allow the machine to operate non-stop from one day to the next one, select 23:59 as the stop time on the first day and 00:00 as the start time on the second day. Arrows appear in the weekly schedule table to show that the machine will continuously run between the two days.

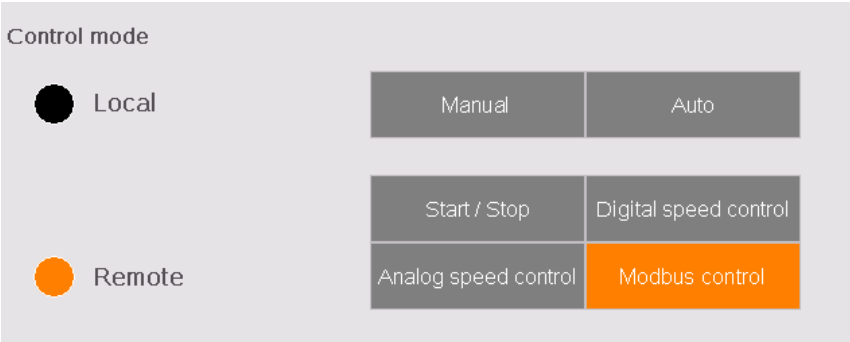
NOTE

Manual starts and stops.

The week planner still allows manual starts and stops.

8.1.3 Remote/Auto

The remote control mode is only available for “Role 2” users, this mode allows remote control of the machine via an analog, digital or Modbus input.



- Refer to the specific document “Pump Control Instructions, art. no.: 0870213261” for more details or contact your Busch representative.

WARNING

The machine may start without notice.

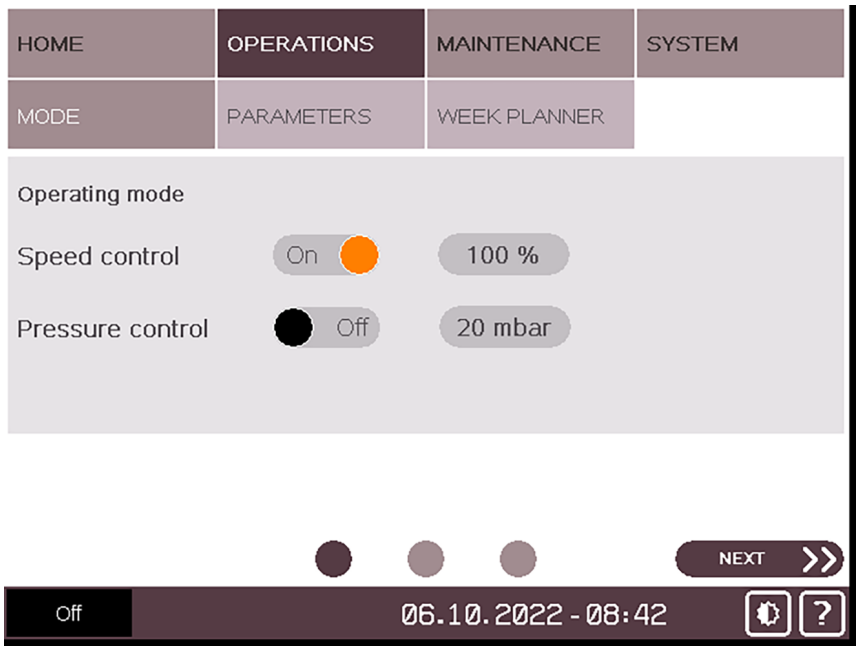
Risk of severe injury!

As soon as the “Remote” mode is activated:

- Make sure the machine is fully operational.

8.2 Operating Mode

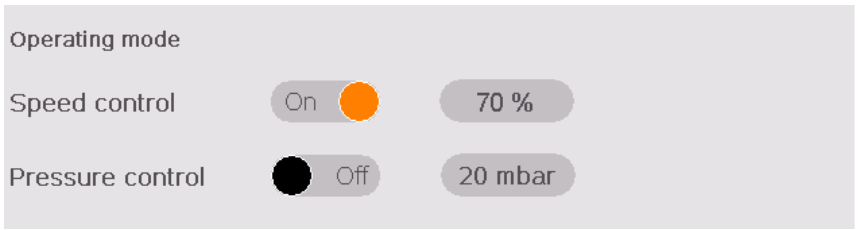
- To access the operating mode menu:
  - Go to “OPERATIONS” > “MODE” and stay on the first screen/page.



8.2.1 Speed Control

Configured by default with a vacuum pump speed of 100 %, the speed control mode allows the variation of the motor frequency. This mode is only available for “Role 2” users, see *Roles and Users* [➔ 11].

- To change the vacuum pump speed:
  - Press on the speed percentage (password required, see *Roles and Users* [➔ 11]).
  - Assign the desired frequency on the keypad and press “Enter”.



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

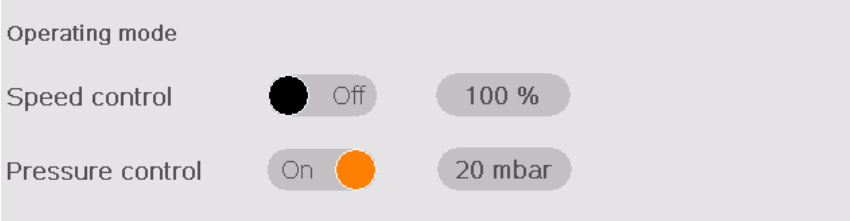
* In percentage of the operating speed range

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

8.2.2 Pressure Control

The pressure control mode allows to maintain a constant pressure level (target pressure) by automatically adapting the motor frequency. This mode is only available for “Role 2” users, see *Roles and Users* [➔ 11].

- To switch from speed control to pressure control:
  - Press on the target pressure value (password required, see *Roles and Users* [➔ 11]).
  - 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	<5 ... 400 mbar

- For smooth process pressure control, it is required to adjust the PID parameters.
- Refer to the specific document “Pump Control Instructions, art. no.: 0870213261” for more details or contact your Busch representative.

NOTE

Display of the ultimate pressure.

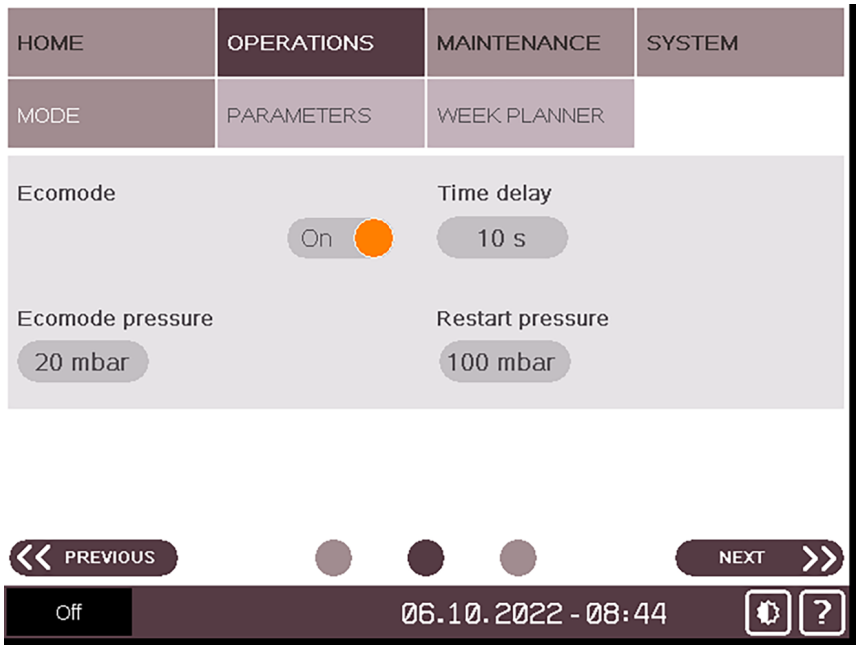
Due to sensor accuracy, the minimum displayed value of the ultimate pressure is 5 mbar preceded by the symbol "<", which means that the actual value is lower than displayed.
The ultimate pressure of the machine is indicated on the nameplate (NP).

8.3 Ecomode

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".

This mode is only available for “Role 2” users, see *Roles and Users* [➔ 11].

- To activate and set the Ecomode:
  - Go to “OPERATIONS” > “MODE”.
  - Go to the second screen/page.
  - Press on the Ecomode switch button (password required, see *Roles and Users* [➔ 11]).



- Press a value to change it.

Parameter	Default value	Adjustment range
Ecomode pressure	20 mbar	5 ... 400 mbar
Restart pressure	100 mbar	5 ... 1000 mbar
Time delay	10 s	1 ... 999 s

NOTE

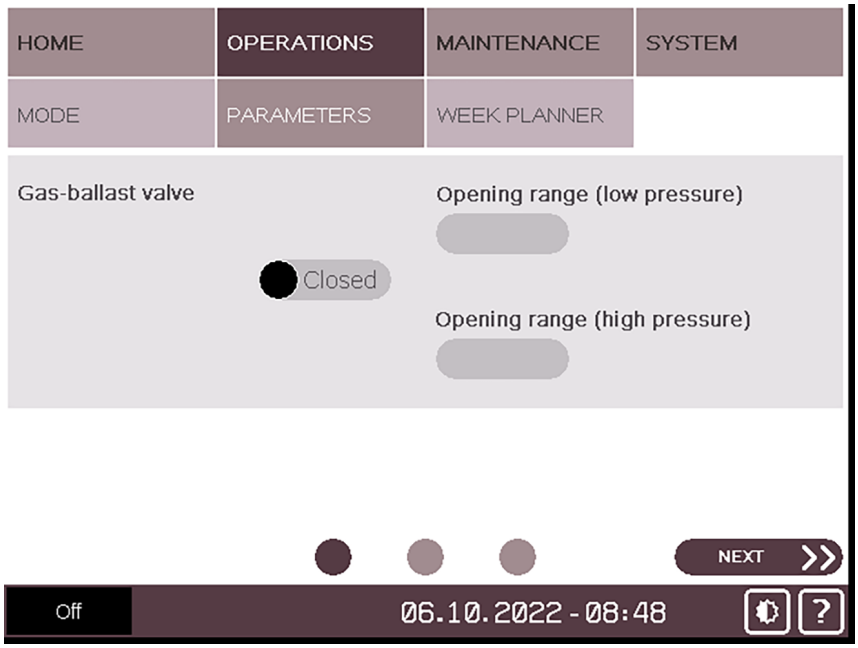
The control unit of the vacuum pump may send a signal to pilot an isolation valve (see *Optional Inlet Valve Control* [➔ 42]) or to control a vacuum booster (see *Optional Vacuum Booster Control* [➔ 44]).

8.4 Gas Ballast Valve Control

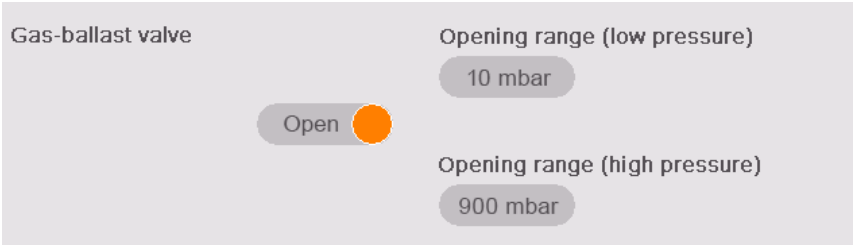
The gas ballast valve can be controlled (open/closed position) via a simple switch button. This operation is only available for “Role 2” users.

To change the state of the gas ballast valve:

- Go to “OPERATIONS” > “PARAMETERS”.
- Stay on the first screen/page.
- Press on the switch button (password required).



- Define an opening pressure range (low and high pressure).



Parameter	Default value	Adjustment range
Opening range (low pressure)	0 mbar	0 ... 899 mbar
Opening range (high pressure)	900 mbar	1 ... 900 mbar

8.5 Warm-up / Cool-down Modes

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

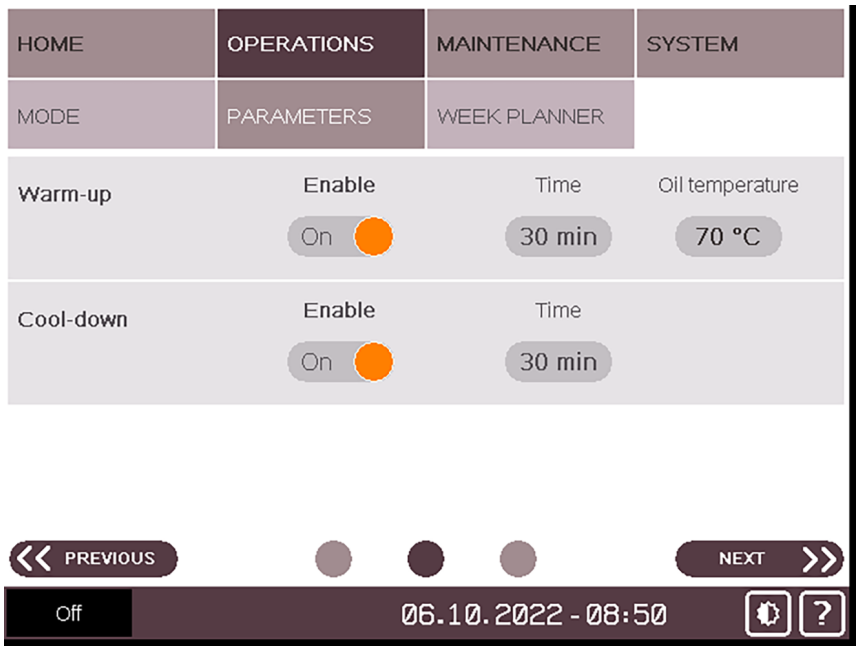
The cool-down mode allows the evacuation of any condensable vapors, refer to chapter *Conveying Condensable Vapors* [➔ 41] for conditions to be met.

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

- The warm-up mode can be set either with a target time or with a target oil temperature. In the second case, the warm-up phase will stop as soon as the oil temperature reaches the target value.
- The cool-down mode can only be set with a target time.

They are only available for “Role 2” users, see *Roles and Users* [➔ 11].

- To activate these two modes:
  - Go to “OPERATIONS” > “PARAMETERS”.
  - Go to the second screen/page.
  - Press on warm-up and/or cool-down switch button (password required, see *Roles and Users* [➔ 11]).



- Press a value to change it.

Parameter	Default value
Warm-up time	30 min
Warm-up temperature	70 °C
Cool-down time	30 min

NOTE

When the warm-up and cool-down modes are activated, an isolation valve (not included in the scope of delivery of the vacuum pump) must be closed to allow the vacuum pump to operate at ultimate vacuum.

The isolation valve can be automatically controlled by the pump during the warm-up and cool-down phases, see *Optional Inlet Valve Control* [➔ 42].

In this case, the valve will open and close according to the diagram available in the chapter *Conveying Condensable Vapors* [➔ 41].

8.5.1 Conveying Condensable Vapors

Water vapor within the gas flow is tolerated within certain limits. The conveyance of other vapors shall be agreed upon with Busch.

If condensable vapors are to be conveyed:

START

- Close the isolation valve*
- Warm up the machine (WARM-UP MODE)
- Wait 30 minutes or wait for the temperature to reach 70° C
- Open the isolation valve* and perform the process
- Close the isolation valve*
- Cool-down the machine (COOL-DOWN MODE)
- Wait 30 minutes

END

* Not included in the scope of delivery

8.6 Optional Inlet Valve Control

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

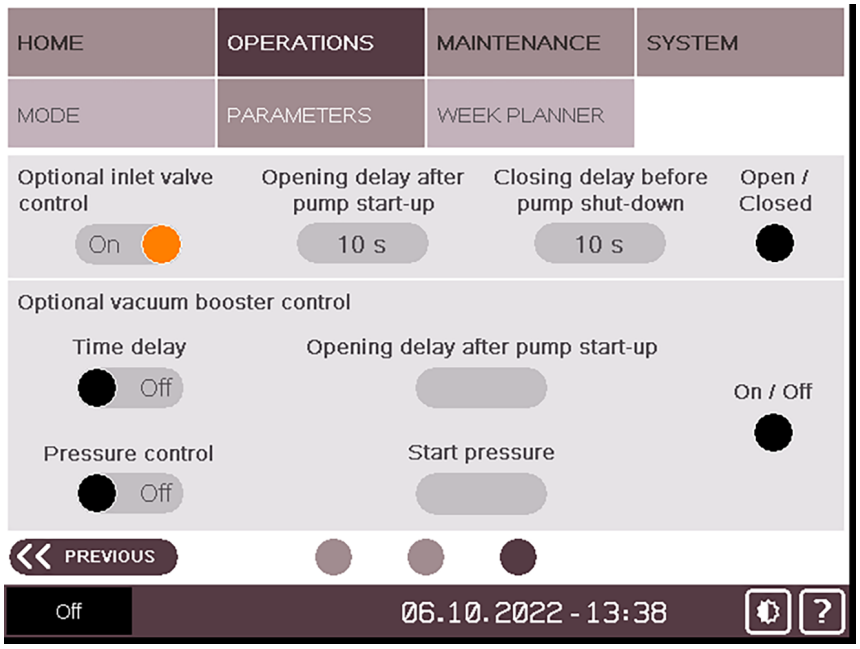
This parameter is only available for “Role 2” users, see *Roles and Users* [➔ 11].

- To activate the optional inlet valve control:
  - Go to “OPERATIONS” > “PARAMETERS”.
  - Go to the third screen/page.
  - Switch the optional inlet valve control on (password required, see *Roles and Users* [➔ 11]).

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

- Press to change it.

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



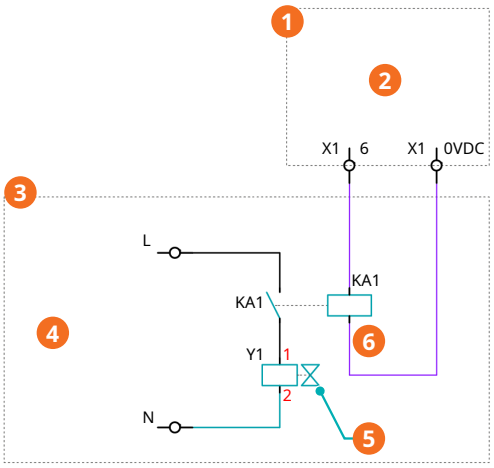
The system allows a time delay between the opening of the valve and the start-up of the vacuum pump (Default value 10s).

START

- Wait 10 seconds
- Open the inlet valve* and perform the process

* Not included in the scope of delivery

The isolation valve control signal must be physically connected to the vacuum pump's control cabinet for the control to operate (See pump wiring diagram in the control unit cabinet).



Inlet Valve Wiring Diagram

Description			
1	PLUS Pump control unit	2	Inlet Valve command line (24VDC from PLUS Pump - Max 1A)
3	Customer side	4	Power line from customer with appropriate protection
5	Customer Inlet valve	6	Customer relay

NOTE

The installation of an isolation valve at the vacuum pump inlet also requires the installation of an external pressure sensor to control the vacuum pump, see *External Inlet Pressure Sensor* [➔ 24].

8.7 Optional Vacuum Booster Control

This menu allows the control and setting of the start-up parameters of a vacuum booster installed at the suction side of the vacuum pump (not included in the scope of delivery of the vacuum pump).

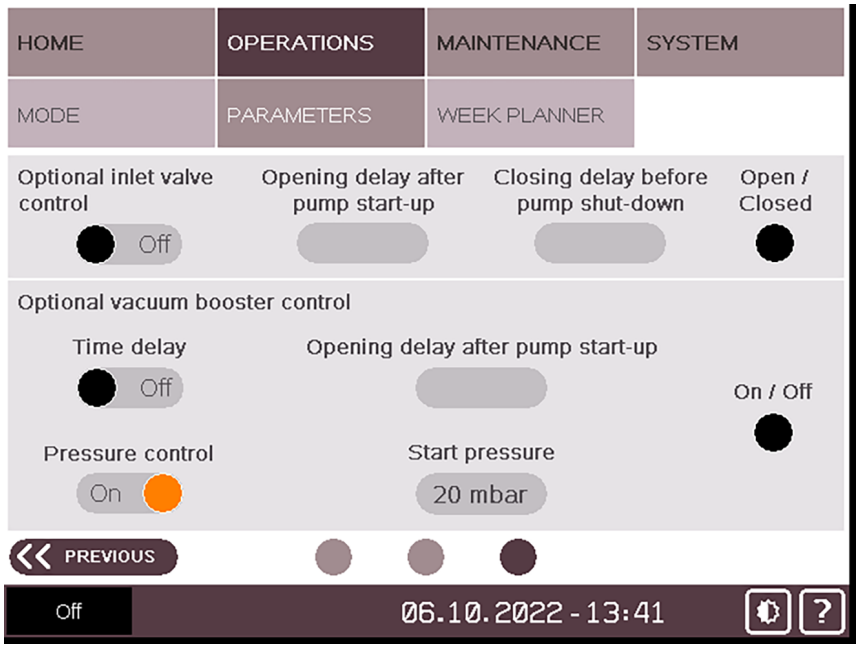
This parameter is only available for “Role 2” users, see *Roles and Users* [➔ 11].

- To activate the optional vacuum booster control:
  - Go to “OPERATIONS” > “PARAMETERS”.
  - Go to the third screen/page.
  - Switch the optional vacuum booster control on (password required, see *Roles and Users* [➔ 11]).

The Start pressure default value is 20 mbar.

- Press to change it.

Once the optional vacuum booster control is enabled, the On/Off indicator light switches from black to orange.



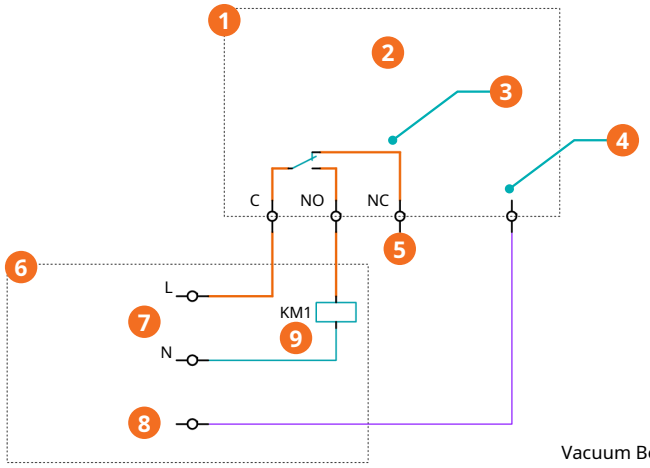
The booster start signal is given by the PLUS pump when the pressure reaches a set value (Default value 20 mbar).

START

- The pressure reaches the set value
- Start vacuum booster*

* Not included in the scope of delivery

The vacuum booster control signal must be physically connected to the vacuum pump's control cabinet for the control to operate (See pump wiring diagram in the control unit cabinet).



Vacuum Booster Wiring Diagram

Description			
1	PLUS Pump control unit	2	Vacuum Booster start
3	Dry contact Max 250VAC 6A	4	Dry contact status 24VDC Max 1A
5	Not used	6	Customer side
7	Customer Booster command	8	Vacuum Booster PLC
9	Customer motor start		

NOTE

For detailed information, see wiring diagram in the control unit cabinet.

NOTICE

Vacuum booster compatibility.

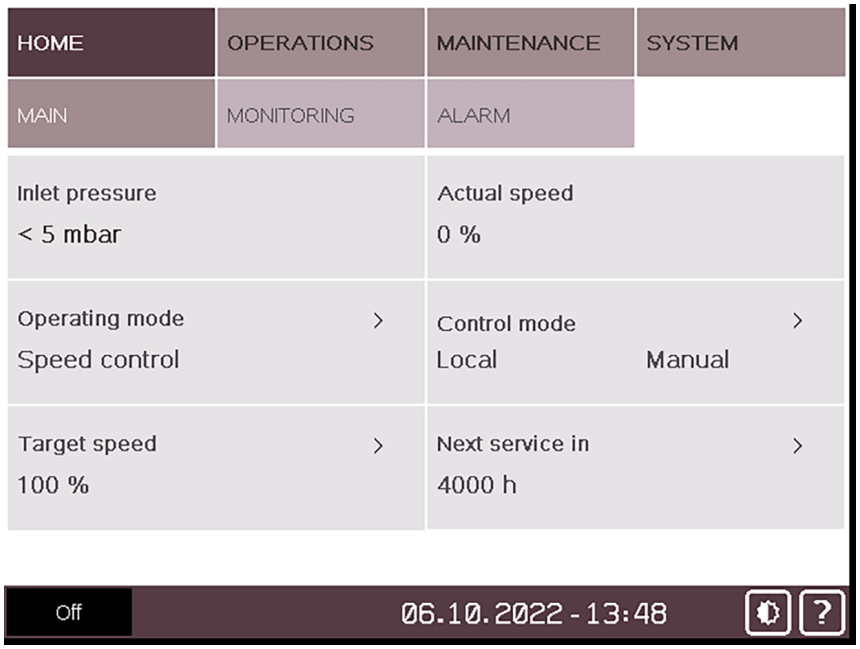
Risk of damage to the machine!

- Contact Busch to check the compatibility of the vacuum booster with the vacuum pump and the recommended starting pressure.

8.8 Monitoring

8.8.1 Operating Information

This display “HOME” > “MAIN” corresponds to the principal menu and is automatically loaded when the machine is started. It displays the principal operating information.



Inlet pressure: Indicates the operating pressure at the suction connection (IN) according to the selected unit. To change the unit, see *System Settings* [➔ 12].

NOTE

Display of the ultimate pressure.

Due to sensor accuracy, the minimum displayed value of the ultimate pressure is 5 mbar preceded by the symbol "<", which means that the actual value is lower than displayed.
The ultimate pressure of the machine is indicated on the nameplate (NP).

Actual speed: Indicates the operating speed of the machine in percentage based on the variable speed drive speed range (1% -> minimum speed ; 100% -> maximum speed).

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

Operating mode: Indicates which operating mode is selected, either “Speed control” or “Pressure control”, see *Operating Mode* [➔ 36].

Control mode: Indicates which control mode is selected, “Local/Manual”, “Local/Auto” or “Remote/Auto”, see *Control Mode* [➔ 33].

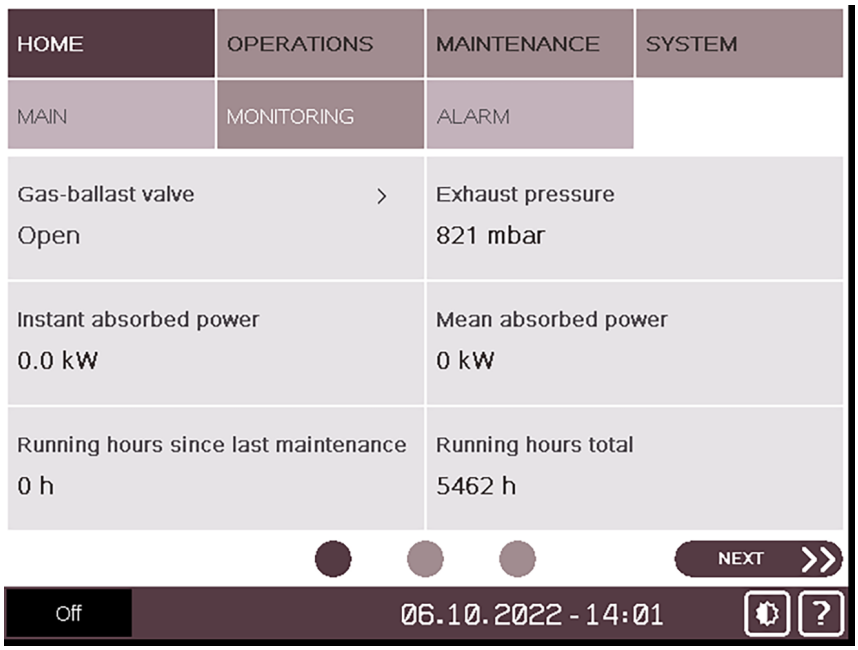
Target speed or target pressure: Depending on the selected operating mode it indicates the target speed (in percentage of the operating speed range) or the target pressure, see *Operating Mode* [➔ 36].

Next service in: Indicates the number of operating hours remaining before the next maintenance, see *Maintenance Schedule* [➔ 56].

8.8.2 Operating Data

This display “HOME” > “MONITORING” displays operating values, it is divided into three different screens/pages.

Screen/Page 1



Gas-ballast valve: Indicates the state of the gas ballast valve ▶ “Open” or “Closed”, see *Gas Ballast Valve Control* [➔ 39].

Exhaust pressure: Indicates the counter pressure value at the exhaust of the machine according to the selected unit. To change the unit, see *System Settings* [➔ 12].

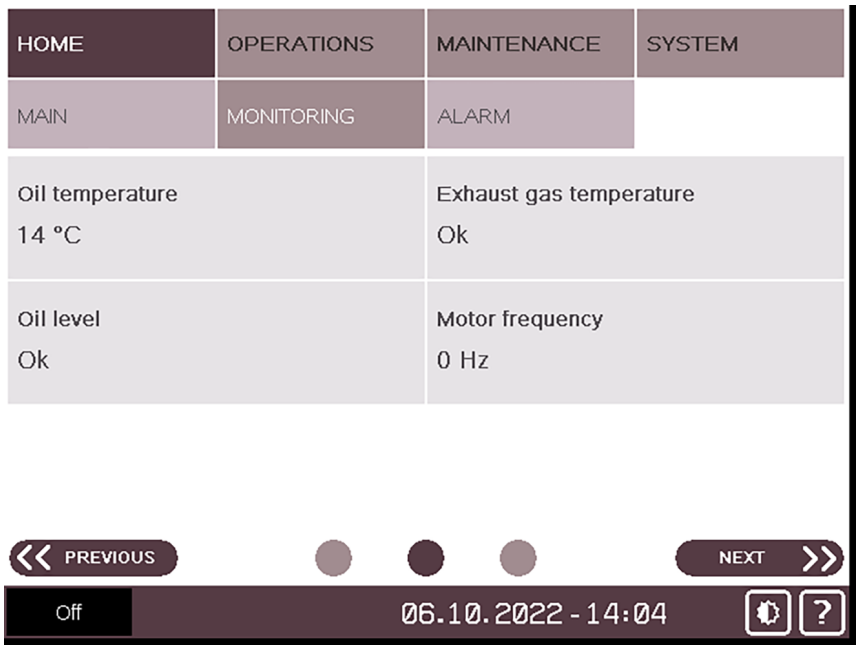
Instant absorbed power: Indicates the absorbed power (in kW) in real time.

Mean absorbed power: Indicates the average of the absorbed power (in kW) since the last reset.

Running hours since last maintenance: Indicates the number of operating hours of the machine since the last maintenance.

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

Screen/Page 2



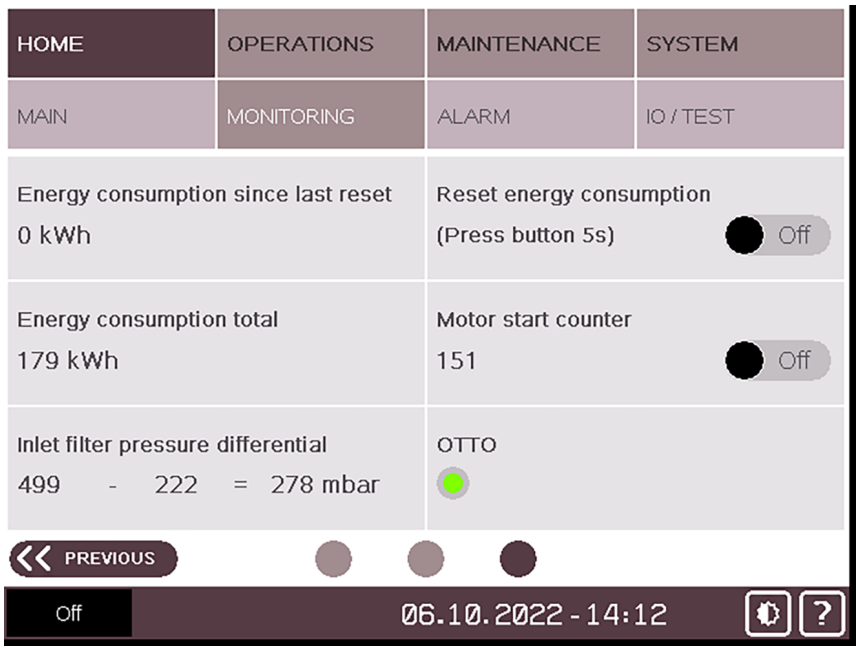
Oil temperature: Indicates the oil temperature, in case of a too high temperature a warning or an alarm occurs, see *Dysfunction* [➔ 51].

Exhaust gas temperature: Indicates the exhaust gas temperature, in case of a too high temperature a warning or an alarm occurs, see *Dysfunction* [➔ 51].

Oil level: Indicates the oil level state in the oil separator (OS) ► "Ok" or "Not Ok", in case of a low oil level an alarm occurs, see *Dysfunction* [➔ 51].

Motor Frequency: Indicates the current drive frequency (in Hz).

Screen/Page 3



Energy consumption since last reset: Indicates the energy consumption in kWh since the last reset.

Reset energy consumption: Allows the resetting of the energy consumption reading by pressing the switch button for 5 seconds.

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

Motor start counter: Indicates the number of starts since the first machine commissioning.

Inlet filter pressure differential: Indicates the pressure differential in the inlet filter cartridge (only if the inlet filter condition monitoring kit is installed).

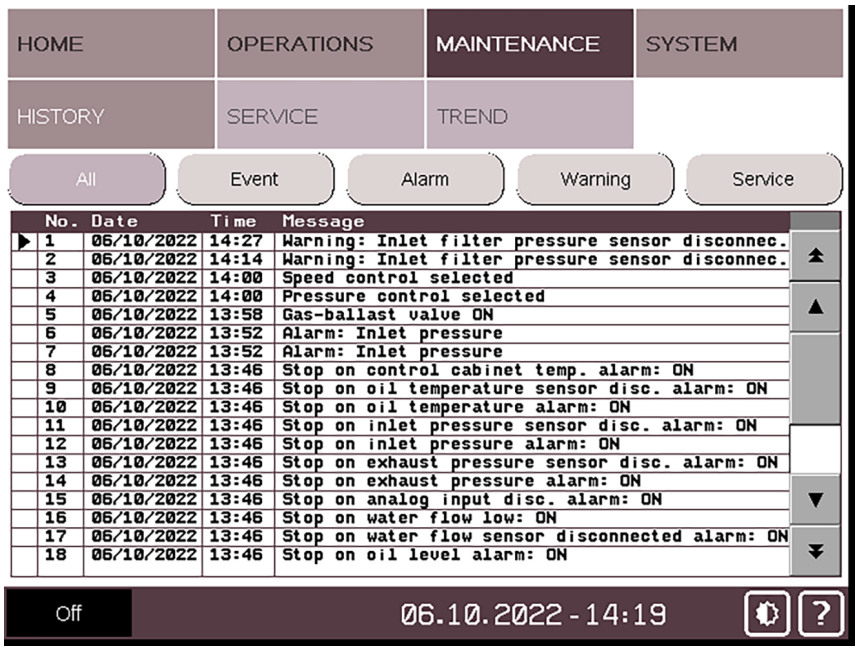
OTTO: Indicates that OTTO (optional) is enabled and connected to the cloud (data transfer).

8.8.3 History

This display “MAINTENANCE” > “HISTORY” shows the history of:

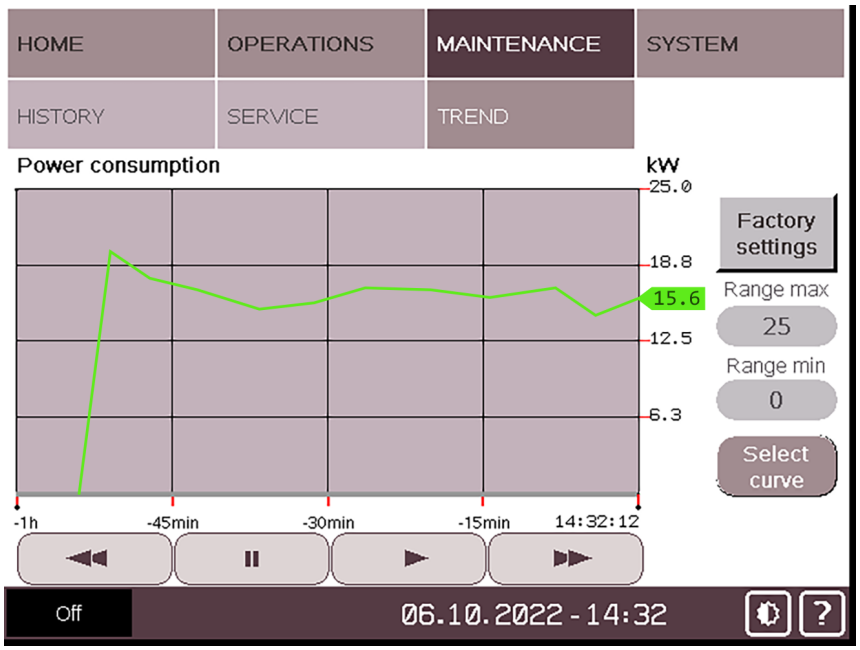
- Events ▶ Parameter changes, function activation, etc....
- Alarms ▶ Alarm signals from sensors
- Warnings ▶ Warning signals from sensors
- Service ▶ Service tasks completed

It is possible to filter the type of message by selecting a specific tab.



8.8.4 Operating Curves

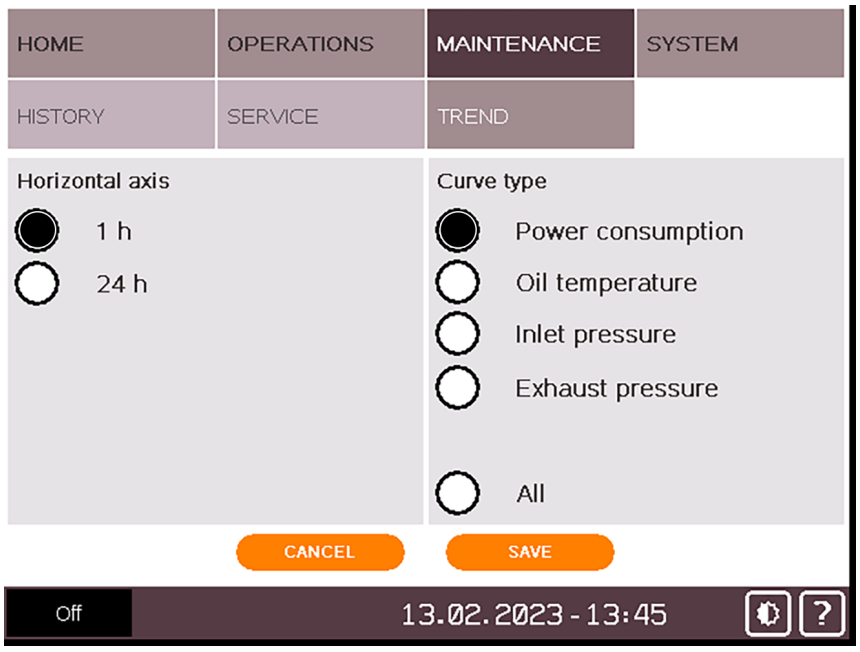
The “MAINTENANCE” > “TREND” display shows the trend curve of one or more operating values.



It offers the possibility to change the time lapse and the curve of 4 different operating values or all at the same time.

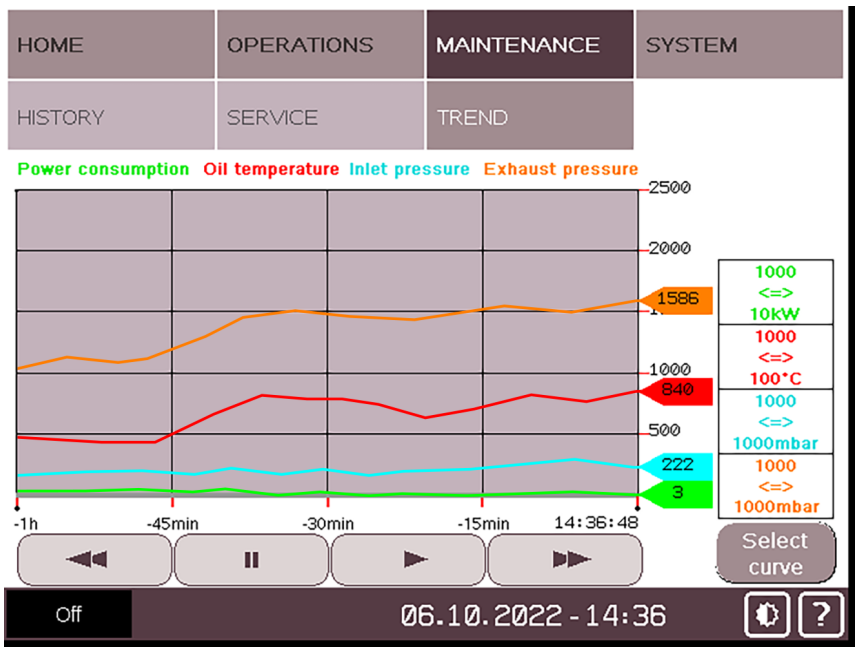
To change the curve type:

- Press on “Select curve”



- Select the desired time lapse (Horizontal axis) and the curve types of the operating value. Different curve types can be selected simultaneously.
- Once the choice is made, press on “SAVE” button.

If more than one type of curve is selected, a corresponding scale appears to the right of the graph.



8.9 Dysfunction

8.9.1 Warnings and Alarms Thresholds

When the machine has reached the limit threshold of an operating value, which is predefined in the system, a signal is sent and visible in the bottom bar.

There are two signal levels:

- Level 1, an orange signal “WARNING” appears, it informs that a value has reached a certain limit. The machine is still working, in the meantime, investigate the source of the dysfunction before the machine reaches the level 2.

- Level 2, a red signal “ALARM” appears, it informs that a value has reached the maximum permitted limit. The machine must stop immediately, investigate the source of the dysfunction.

NOTE

By default, the machine stops when an alarm signal is sent. However, it may be possible that the settings have been voluntary changed to leave the machine running even after an alarm signal.

In any case, you must investigate the source of the dysfunction.

NOTE

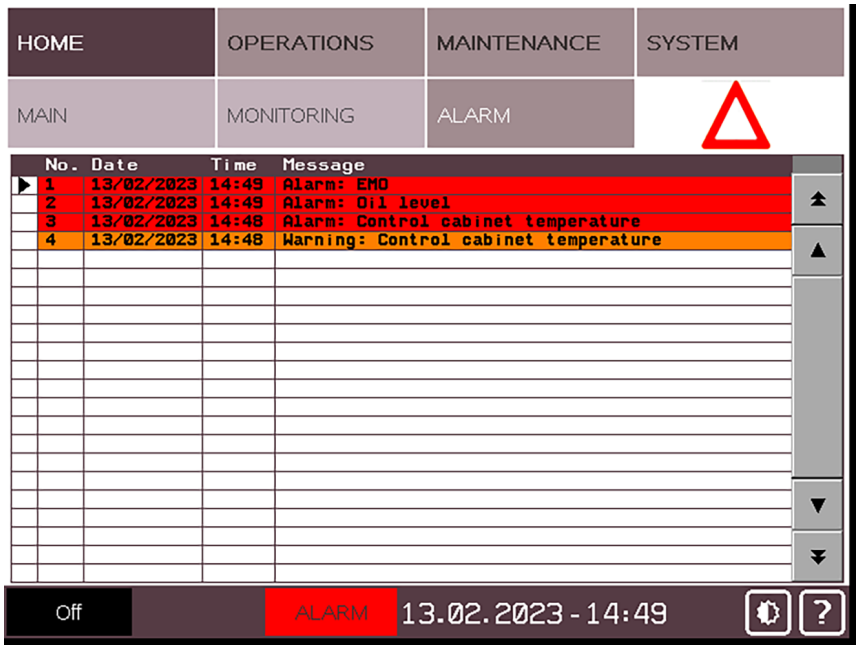
Bottom bar Warning & Alarm signals.

Warning and Alarm signals in the bottom bar are provided with a direct link to the Alarm display.

- Press on the signal to directly access the Alarm display or proceed as follows.

As soon as a signal is sent, the system collects all active dysfunctions in a list:

- Go to “HOME” > “WARNING/ALARM”.
- Consult the list of dysfunctions to identify the problem.



- Investigate why this signal occurred using the *Troubleshooting* [➔ 65] tables.
- Follow the *Warning/Alarm Acknowledgment Procedure* [➔ 53] when the problem has been rectified.

Below, the default warnings and alarms thresholds:

Signal type	Warning (level 1)	Alarm (level 2)
Exhaust gas temperature	n/a	>110°C
Inlet pressure	>800 hPa (mbar) for 15 minutes	>800 hPa (mbar) for 30 minutes
Oil temperature	>90°C with mineral oil >110°C with synthetic oil	>110°C with mineral oil >130°C with synthetic oil
Exhaust pressure	>1400 hPa (mbar) abs.	>1500 hPa (mbar) abs.
Electrical cabinet temperature	>50°C for 30 seconds	>50°C for 60 seconds

NOTE

Threshold values are preset with the factory settings. However, depending on the application, it is possible to adjust the threshold values only after Busch approval. Threshold changes are only available for "Role 3" users.

8.9.2 Warning/Alarm Acknowledgment Procedure

An acknowledgment must be performed once the problem is rectified and when a warning/alarm signal is no longer valid:

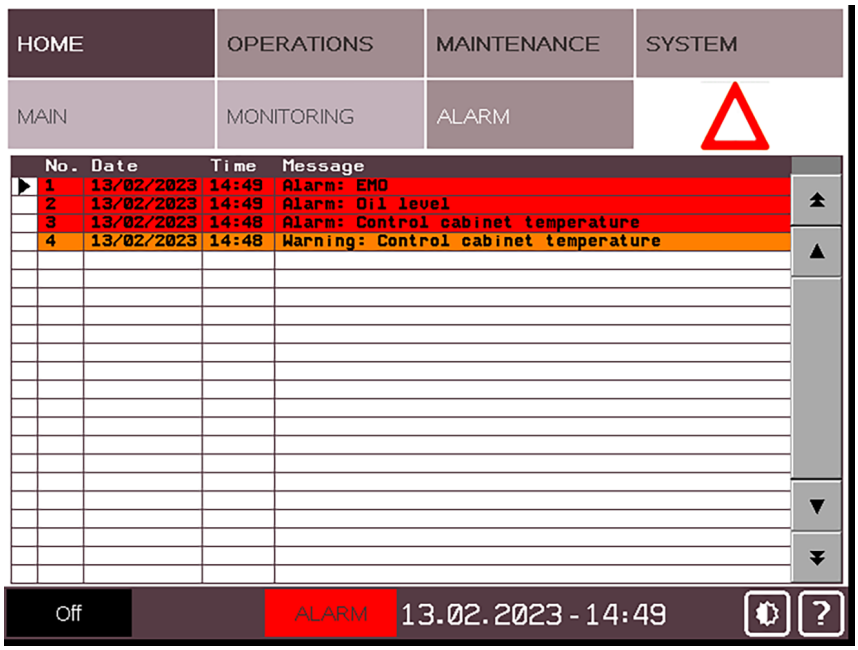
NOTE

Bottom bar Warning & Alarm signals.

Warning and Alarm signals in the bottom bar are provided with a direct link to the Alarm display.

- Press on the signal to directly access the Alarm display or proceed as follows.

- Go to “HOME” > “WARNING/ALARM”.
- Select the line of the respective problem via the scroll buttons (indicated by the symbol “▶”).
- Press on the red triangle to acknowledge the problem.



When the warning/alarm message is no longer active the machine is ready to be restarted. However, if the message remains, this means that the problem is still pending. In this case, refer again to the *Troubleshooting* [➔ 65] or ask your Busch representative for help.

- Press on the Stop/Start button (SSB) to restart the machine.

8.10 Stop the Machine

To stop the machine:

- Press and hold the start/stop button (SSB) for at least 3 seconds.

In case of emergency stop:

- Push the emergency stop switch (ESS).

As long as the power indicator light (PIL) is green, the machine is still powered.

NOTE

Control mode “Remote/Auto”.

The machine cannot be stopped with the start/stop button (SSB) when the machine is remotely controlled.

9 Maintenance

DANGER

Live wires.

Risk of electrical shock.

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

WARNING

The machine may start without notice.

Risk of severe injury!

If the machine is remotely controlled or using auto mode (week planner):

- Make sure that the lockable disconnect switch is activated and protects the machine against inadvertent start up.
- The power indicator light (PIL) must be turned off.

WARNING

Machines contaminated with hazardous material.

Risk of poisoning!

Risk of infection!

If the machine is contaminated with hazardous material:

- Wear appropriate personal protective equipment.

CAUTION

Hot surface.

Risk of burns!

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

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.

9.1 Maintenance Schedule

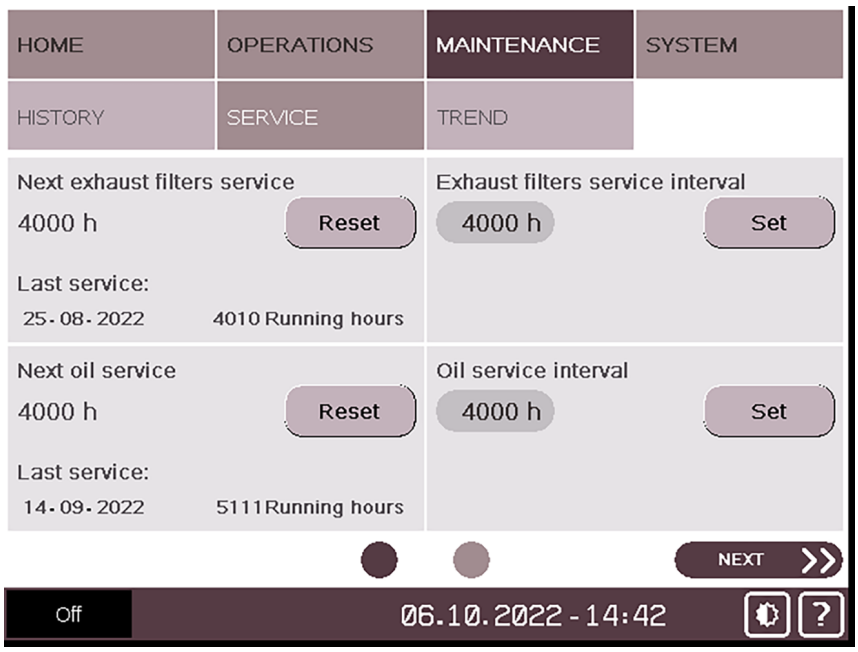
The maintenance intervals depend very much on the individual operating conditions. The intervals given below are considered as starting values which should be shortened or extended as appropriate. Particularly harsh applications or heavy duty operation, such as high dust loads in the environment or in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

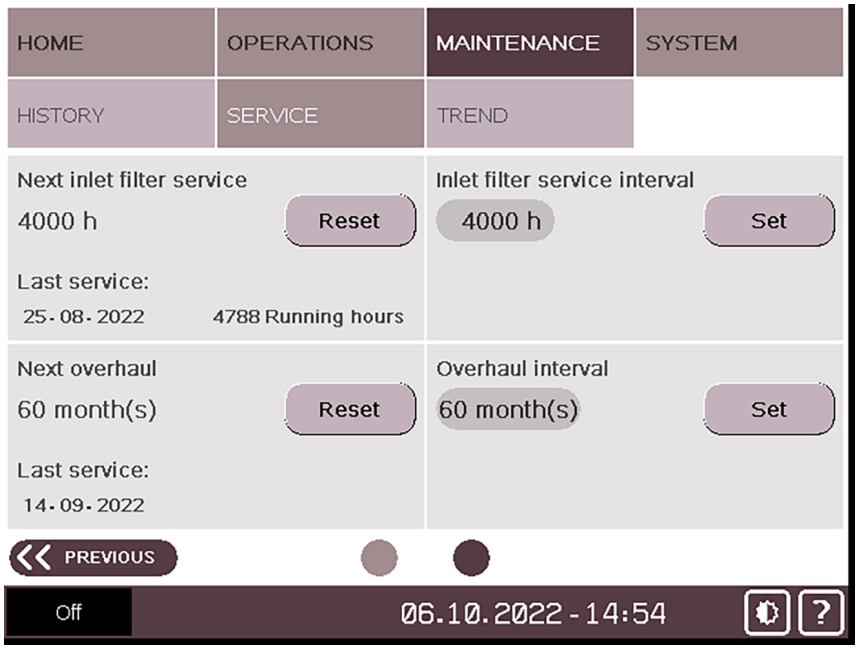
Maintenance work	Interval	
	Normal application	Harsh application
• Check the oil level, see *Oil Level Inspection* [➔ 58].	Weekly	
• Change the oil*, the oil filter* (OF) and the exhaust filters (EF). See *Oil and Oil Filter Change* [➔ 58] and *Exhaust Filter Change* [➔ 60].	Max. after 4000 hours or after 1 year	Max. after 2000 hours or after 6 months
• Clean the machine from dust and dirt, especially the air-oil heat exchanger (AHE), see *Air Heat Exchanger Cleaning* [➔ 61]. • Air-cooled vacuum pump: clean the cooling air inlet and outlet (CAI/CAO), see Machine Cleaning. • Water-cooled vacuum pump: check the water filter (WF), clean if necessary If an inlet filter is installed: • Check the inlet filter cartridge, change it if necessary, see Inlet Filter Cartridge Change. • Check and clean the filters of the inlet/outlet ventilation grids (VG) of the Control Unit (CU) cabinet, see *Troubleshooting* [➔ 65]. Change them if necessary.	Every 6 months	

* Service interval for synthetic oil, shorten the interval when using mineral oil, contact Busch Service

To visualize information about remaining hours:

- Go to “MAINTENANCE” > “SERVICE”.
- Check when the maintenance tasks must be performed and how long the machine has operated since the first commissioning or last maintenance task.





NOTE

RESET can only be done by “Role 2” users.

A reset must be done after the completion of the following tasks:
- *Oil and Oil Filter Change* [➔ 58]
- *Exhaust Filter Change* [➔ 60]
- Inlet Filter Cartridge Change

9.2 Oil Level Inspection

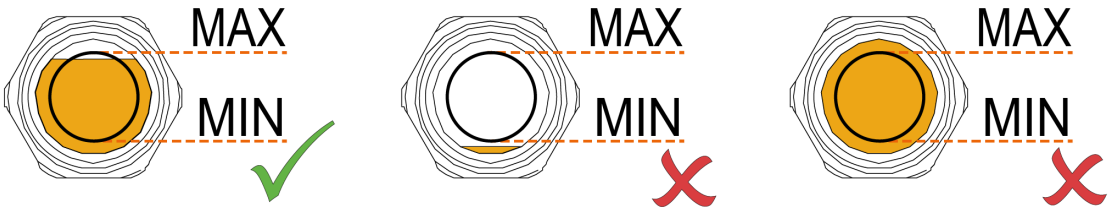
If the oil level is too low, an alarm signal will be sent by the monitoring system.

To check the oil level status:

- Go to “HOME” > “MONITORING”.
- In the cell “Oil level”, “OK” must always be written.

To perform a visual control of the oil level:

- Check the oil sight glass (OSG).



9.3 Oil and Oil Filter Change

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.

NOTICE

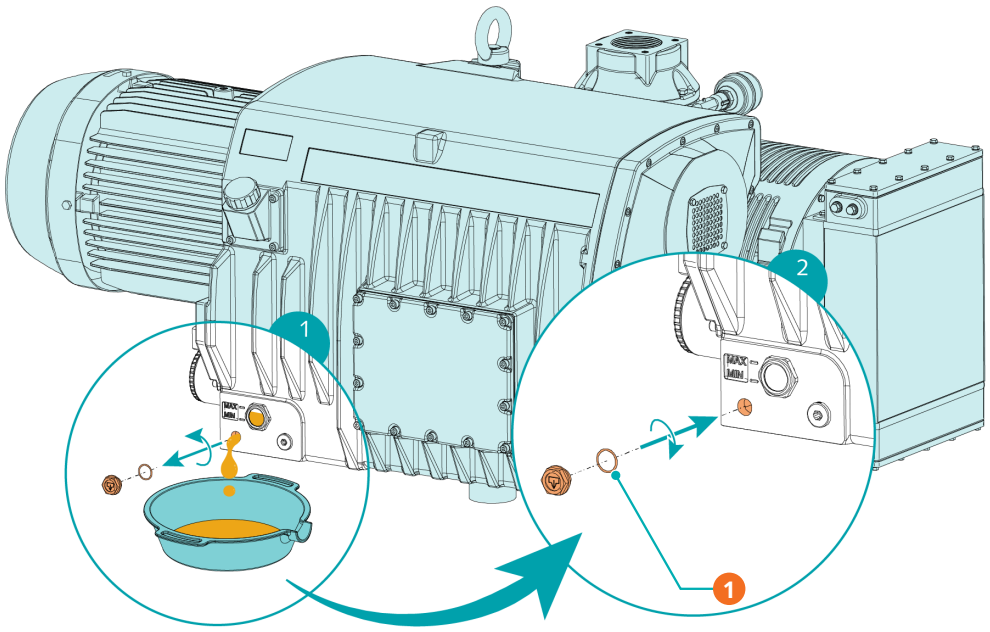
Change oil from mineral to synthetic or the other way around.

Risk of using a deteriorated oil!

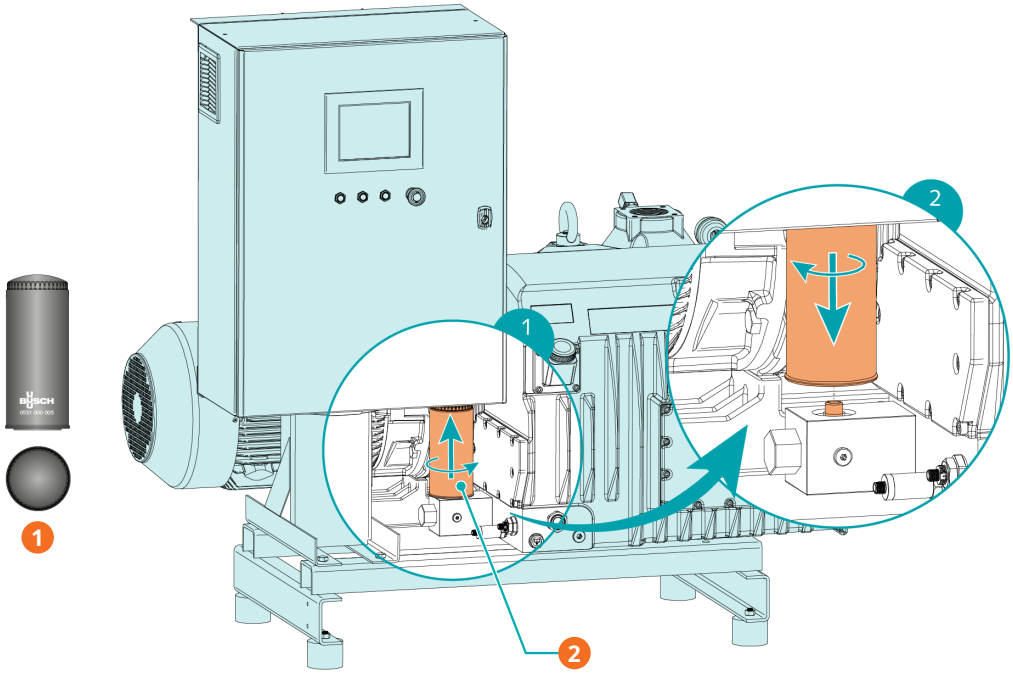
Risk of premature failure!

By default, the oil temperature thresholds (warning/alarm) and the service intervals are configured according to the oil type (mineral or synthetic) written on the nameplate (NP).
In case of oil type change:

- Contact your Busch representative to adapt the thresholds and service intervals accordingly.

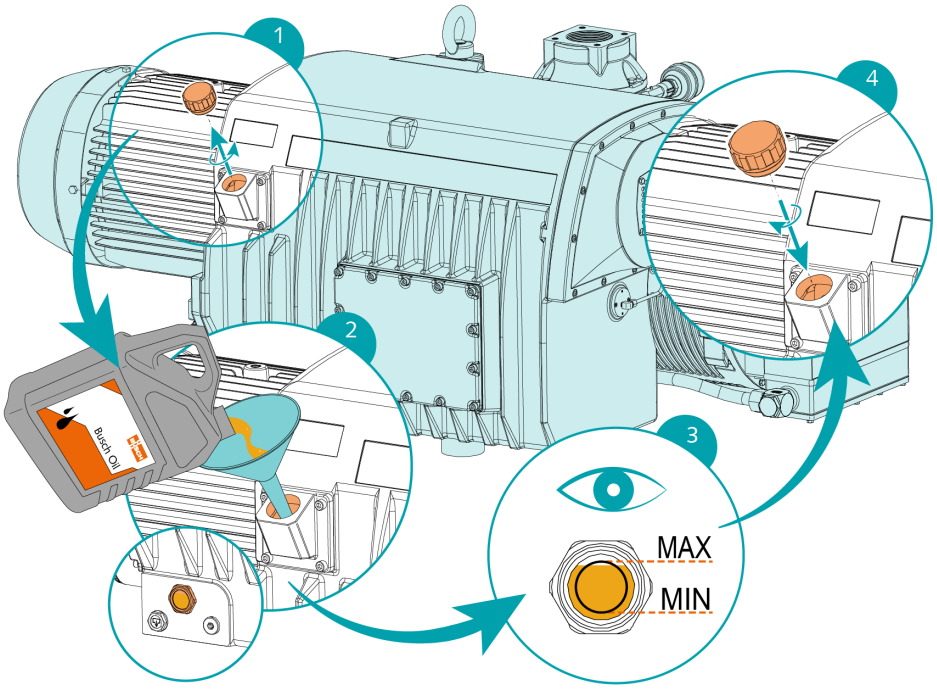


Description			
1	1x O-ring - Part No. 0486 000 505		

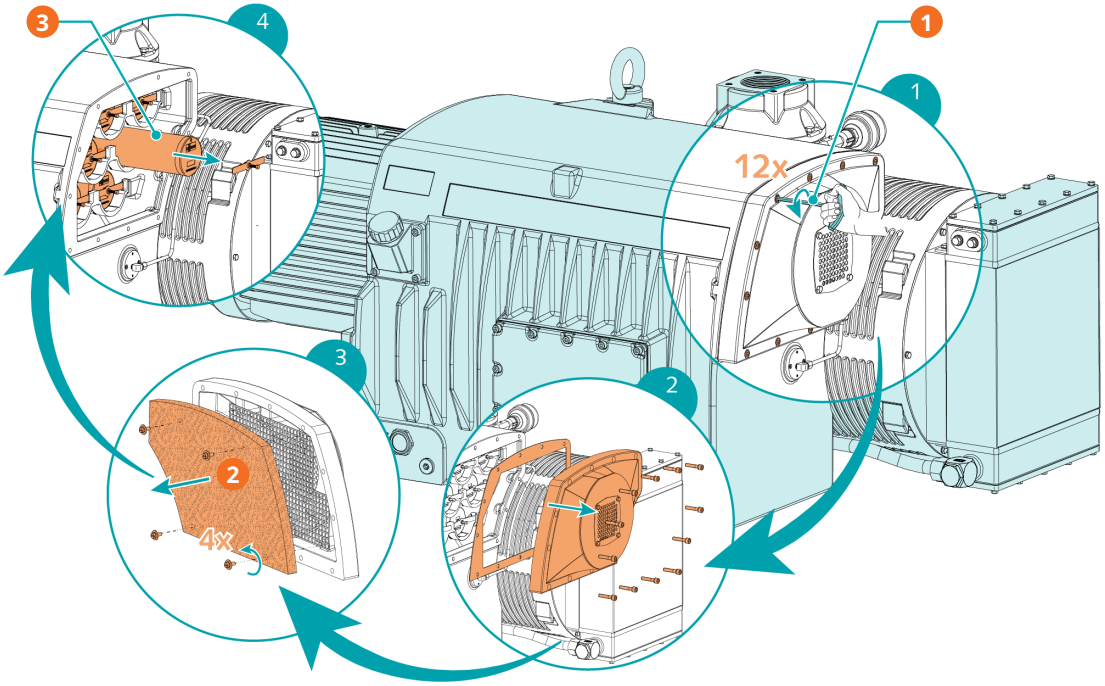


Description			
1	1x oil filter (OF) - Part No. 0531 000 005 (Busch genuine spare part)	2	Unscrew the oil filter. If necessary use an oil filter wrench.

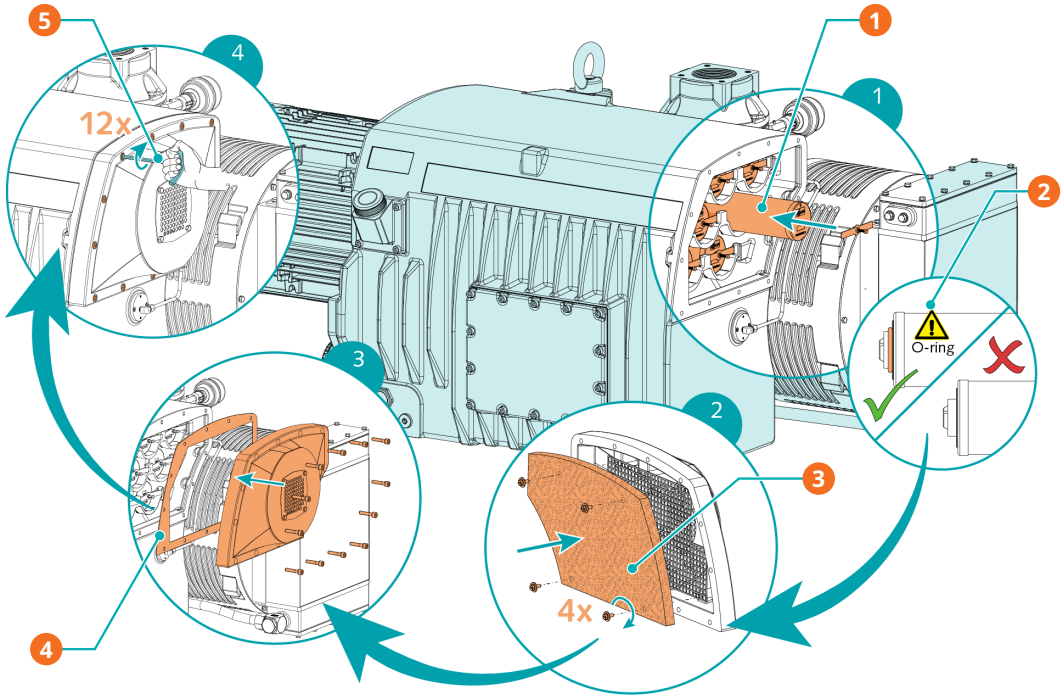
For oil type and oil capacity see Technical Data and *Oil* [➔ 70].



9.4 Exhaust Filter Change



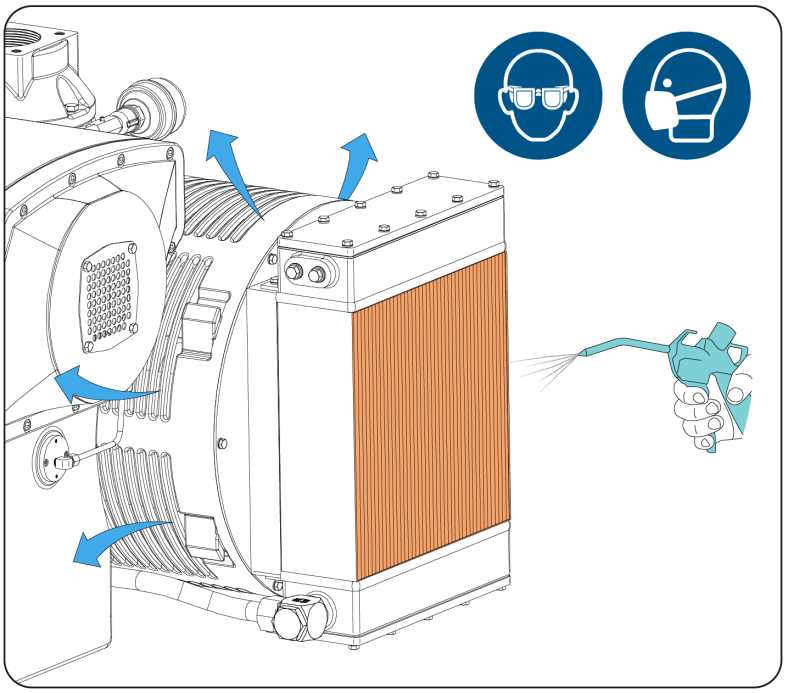
Description			
1	6 mm hex key	2	Extract filter material (FM)
3	8x exhaust filter (EF)		



Description			
1	8x exhaust filter (EF) - Part No. 0532 140 160 (Busch genuine spare part)	2	Make sure the O-ring is in place before refitting the exhaust filter
3	1x filter material (FM) - Part No. 0537 000 042	4	1x flat gasket - Part No. 0480 000 131
5	6 mm hex key / max. admissible torque: 21Nm		

9.5 Air Heat Exchanger Cleaning

- Use compressed air and wear protective eyewear and mask.



10 Overhaul

WARNING

Machines contaminated with hazardous material.

Risk of poisoning!

Risk of infection!

If the machine is contaminated with hazardous material:

- Wear appropriate personal protective equipment.

NOTICE

Improper assembly.

Risk of premature failure!

Loss of efficiency!

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

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

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

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

11 Decommissioning

DANGER

Live wires.

Risk of electrical shock.

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

CAUTION

Hot surface.

Risk of burns!

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

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

If the machine is going to be stored:

- See *Storage* [➔ 19].

11.1 Dismantling and Disposal

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

12 Spare Parts

NOTICE

Use of non-Busch genuine spare parts.

Risk of premature failure!

Loss of efficiency!

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

Spare parts kit	Description	Part no.
Service kit	Includes parts necessary for maintenance	0992 214 839
Spare parts kit	**Description**	**Part no.**
Service kit for PLUS Control Unit	Includes the filters for the ventilation grids of the PLUS Control Unit.	0992 241 181

If other parts are required:

- Contact your Busch representative.

13 Troubleshooting

DANGER

Carry out any work on the control unit and motor.

Risk of electrical shock!

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

CAUTION

Hot surface.

Risk of burns!

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

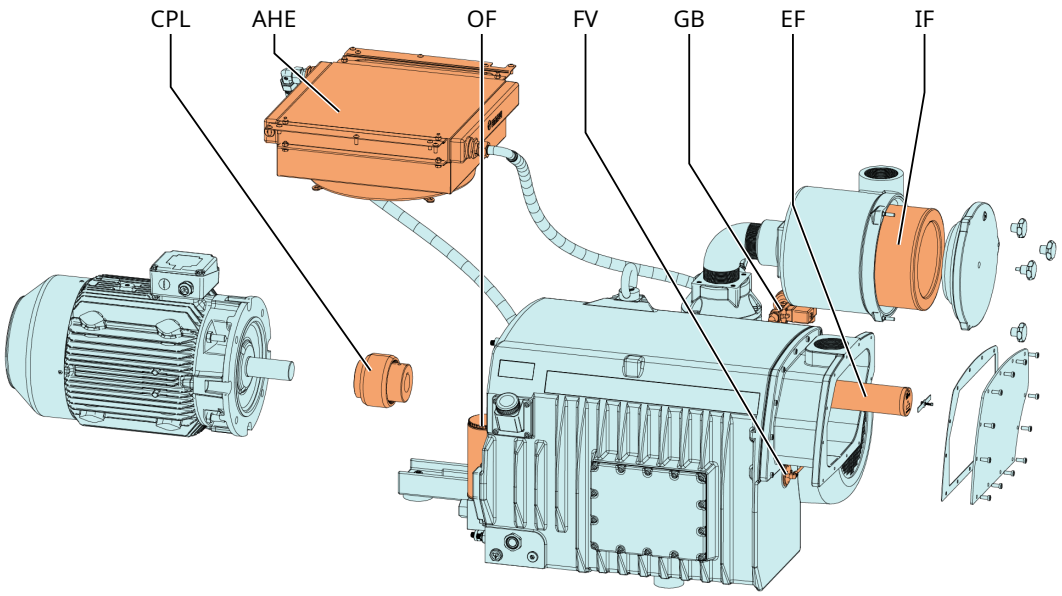
NOTICE

Variable speed drive maintenance.

Risk of damage to the variable speed drive!

- Maintenance and adjustment must only be executed by qualified personnel.

Illustration showing parts that may be involved during troubleshooting:



NOTE

AHE only available for the RA 0840 A PLUS with cabinet.

The first troubleshooting table describes general problems while the second table describes the meaning of occurrences visible from the user interface in the menu "HOME" > "WARNINGS/ ALARMS".

Table 1

Problem	Possible Cause	Remedy
The machine does not start.	The power indicator light (PIL) is not activated. No power signal. The machine is not supplied with the correct voltage.	• Check the power supply connection.
	The machine is powered on but the touchscreen or the PLC does not run.	• Check the 24 V power supply.
	The machine has reached a limit operating value.	• Identify and solve the problem listed in the menu “HOME” > “WARNING/ ALARM”, see *Warnings and Alarms Thresholds* [➔ 51]. • Look up the related problem in the troubleshooting table 2.
	The motor is defective.	• Replace the motor.
	The coupling (CPL) is defective.	• Replace the coupling (CPL).
The machine does not reach the usual pressure on the suction connection.	Oil level too low.	• Top up oil, see *Filling Oil* [➔ 25].
	The inlet filter cartridge (IF) is partially clogged.	• Replace the inlet filter cartridge (IF).
	Internal parts are worn or damaged.	• Repair the machine (contact Busch).
The machine runs very noisily.	Worn coupling (CPL).	• Replace the coupling (CPL).
	Stuck vanes.	• Repair the machine (contact Busch).
	Defective bearings.	• Repair the machine (contact Busch).
The machine runs too hot.	Insufficient cooling.	• Remove dust and dirt from the machine. • Standard air-cooled vacuum pump: check the heat exchanger (AHE). • Water-cooled vacuum pump: check the water heat exchanger (WHE) and the water filter (WF).
	Ambient temperature too high.	• Observe the permitted ambient temperature.
	Oil level too low.	• Top up oil, see *Filling Oil* [➔ 25].
	The exhaust filters (EF) are partially clogged.	• Replace the exhaust filters (EF), see *Exhaust Filter Change* [➔ 60].

Table 1 Problem	Possible Cause	Remedy
The machine fumes or expels oil droplets through the gas discharge.	The exhaust filters (EF) are partially clogged.	• Replace the exhaust filters (EF).
	An exhaust filter (EF) with o-ring is not fitted properly.	• Ensure the correct position of the exhaust filters (EF) and the o-rings.
	The float valve (FV) does not work properly.	• Check the float valve and the oil return line, repair if necessary (contact Busch).
Abnormal oil consumption.	Oil leaks.	• Replace seals (contact Busch).
	The float valve (FV) does not work properly.	• Check float valve and the oil return line, repair it if necessary (contact Busch).
	The machine runs at atmospheric pressure for a long period.	• Make sure that the machine operates under vacuum.
The oil is black.	Oil change intervals are too long.	• Drain the oil and fill in new oil, see Oil Change.
	The machine runs too hot.	• See problem "The machine runs too hot".
The oil is emulsified.	The machine sucked in liquids or significant amounts of vapor.	• Flush the machine (contact Busch). • Clean the filter of the gas ballast valve (GB). • Modify the operational mode (see *Conveying Condensable Vapors* [➔ 41]).
The machine does not reach the target pressure (pressure control mode only).	The machine is over or undersized for the application. Leaks or pressure drops in the pipework upstream the suction connection.	• Check the system pipework. • Ask Busch for advice.
Communication problems when the machine is remotely controlled.	A wire is broken or not connected. The connection is not properly made. Wrong settings between the machine and network.	• Check the wiring between the machine and the network. • Check remote control parameters, refer to the specific document “Pump Control Instructions, art. no.: 0870213261”.
The machine cannot be controlled via the User Interface.	The machine is in Automatic or in Remote control mode.	• Switch the control to Local / Manual mode.

Table 2 Message	Possible Cause	Remedy
Oil level (alarm)	Oil level too low.	• Top up oil, see *Filling Oil* [➔ 25].
Oil temperature (warning + alarm)	Oil temperature too high.	• See problem "The machine runs too hot".

Table 2 Message	Possible Cause	Remedy
Exhaust gas pressure (warning + alarm)	Exhaust gas pressure in the oil separator (OS) too high.	• Replace the exhaust filters (EF), see *Exhaust Filter Change* [➔ 60].
Inlet pressure (warning + alarm)	Inlet pressure too high. The machine has operated for too long at a high inlet pressure.	• Reduce the inlet pressure. • Limit the operating time at a high inlet pressure.
Exhaust gas temperature (warning + alarm)	Exhaust gas temperature too high.	• See problem "The machine runs too hot".
Differential pressure high (warning – if inlet filter condition monitoring kit installed).	The inlet filter cartridge is clogged by dust or particles.	• Replace the inlet filter cartridge.
Electrical cabinet temperature (alarm)	Temperature in the control unit too high. Insufficient cooling. Ambient temperature too high.	• Check and clean the filters of the inlet/outlet ventilation grids (VG) of the Control Unit (CU) cabinet. Change them if necessary. • Check the heat exchanger. • Observe the permitted ambient temperature.
Sensor disconnected (alarm)	At least one of the analog sensors has been disconnected.	• Check the electrical connection of the sensors.
Inverter (VSD) (alarm)	Variable Speed Drive (VSD) default.	• Have the variable speed drive checked by an electrician. • Repair the variable speed drive (contact Busch).
EMO	The emergency stop has been actuated.	• Clarify the reason of the emergency. • Solve the problem and follow the *Warning/Alarm Acknowledgment Procedure* [➔ 53].
Low battery (alarm)	The PLC battery is low.	• Replace the PLC battery (contact Busch).
Fan breaker (alarm)	The circuit breaker of the cooling fan has tripped.	• Refer to schematic and reset the breaker.
VSD breaker (alarm)	The circuit breaker of the variable speed drive has tripped.	• Refer to schematic and reset the breaker.
Analog input module disconnected	The analog input module is not connected or has been disconnected.	• Refer to schematic and reconnect the analog input module.

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

14 Technical Data

			RA 0840 A PLUS	
Pumping speed		m^3/h	400 / 840	
Ultimate pressure		hPa (mbar) abs.	0.1	
Nominal motor rating		kW	18.5	
Permitted motor speed range		min^{-1}	700 ... 1400 (factory setting ► speed control mode at max speed)	
Power supply frequency		Hz	50 / 60	
Power supply voltage (50/60 Hz)		V	3L+PE 380-440V +/-10% (1)	3L+PE 380-460V +/-10% (2)
Circuit breaker (MCCB)	With DC Reactor	A	50 (SCCR 20 kA)	50 (SCCR 20 kA)
	Without DC Reactor	A	80 (SCCR 20 kA)	n/a
Power consumption at 100 mbar (min./max. speed)		kW	8.2 / 14.5	
Power consumption at ultimate pressure (min./max. speed)		kW	4.6 / 7.9	
Noise level (ISO 2151)		dB(A)	<80	
Water vapor tolerance max. (with gas ballast valve)		hPa (mbar)	40	
Water vapor capacity (with gas ballast valve) (value at max speed)		kg / h	22	
Max. allowable gas inlet temperature		°C	≤50 hPa (mbar) abs. ► 150	
			>50 hPa (mbar) abs. ► 80	
Ambient temperature range (air-cooled vacuum pump)		°C	Mineral oil: 5 ... 30 Synthetic oil: 5 ... 40	
Ambient temperature range (water-cooled vacuum pump)		°C	5 ... 46	
Ambient pressure			Atmospheric pressure	
Relative humidity		at 30°C	80%	
Oil capacity		l	17.0	
Weight approx.		kg	800	

(1) Standard Control Unit

(2) 3~ 460V Control Unit with lockable main switch

15 Oil

	VM 100	VSC 100	VSB 100
ISO-VG	100	100	100
Oil type	Mineral oil	Synthetic oil	Synthetic oil
Part number 1 L packaging	0831 000 060	0831 168 356	0831 168 351
Part number 5 L packaging	0831 000 059	0831 168 357	0831 168 352
Part number 10 L packaging	-	0831 210 162	-
Part number 20 L packaging	0831 166 905	0831 168 359	0831 168 353

In case of unfavorable ambient temperature, other oil viscosities may be used. Please consult your Busch representative for more details.

To know which oil has been filled in the machine, please refer to the nameplate (NP).

NOTE

Oil VM 100 suitable for standard applications up to 90°C.

NOTE

Oil VSC 100 suitable for harsh applications.

NOTE

Oil VSB 100 suitable for food applications (H1).

16 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

Ateliers Busch S.A.
Zone Industrielle
CH-2906 Chevenez

declares that the machine: R5 RA 0840 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 ISO 13857 : 2019	Safety of machinery - Safety distances to prevent hazard zones being reached by the upper and lower limbs
EN 1012-2 : 1996 + A1 : 2009	Vacuum pumps - Safety requirements - Part 2
EN ISO 2151 : 2008	Acoustics - Noise test code for compressors and vacuum pumps - Engineering method (grade 2)
EN 60204-1 : 2018	Safety of machinery - Electrical equipment of machines - Part 1: General requirements
EN IEC 61000-6-2 : 2019	Electromagnetic compatibility (EMC) - Generic standards. Immunity for industrial environments
EN IEC 61000-6-4 : 2019	Electromagnetic compatibility (EMC) - Generic standards. Emission standard for industrial environments

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, 25.01.2022

Christian Hoffmann, General Director

17 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

Ateliers Busch S.A.
Zone Industrielle
CH-2906 Chevenez

declares that the machine: R5 RA 0840 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 2021

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

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

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

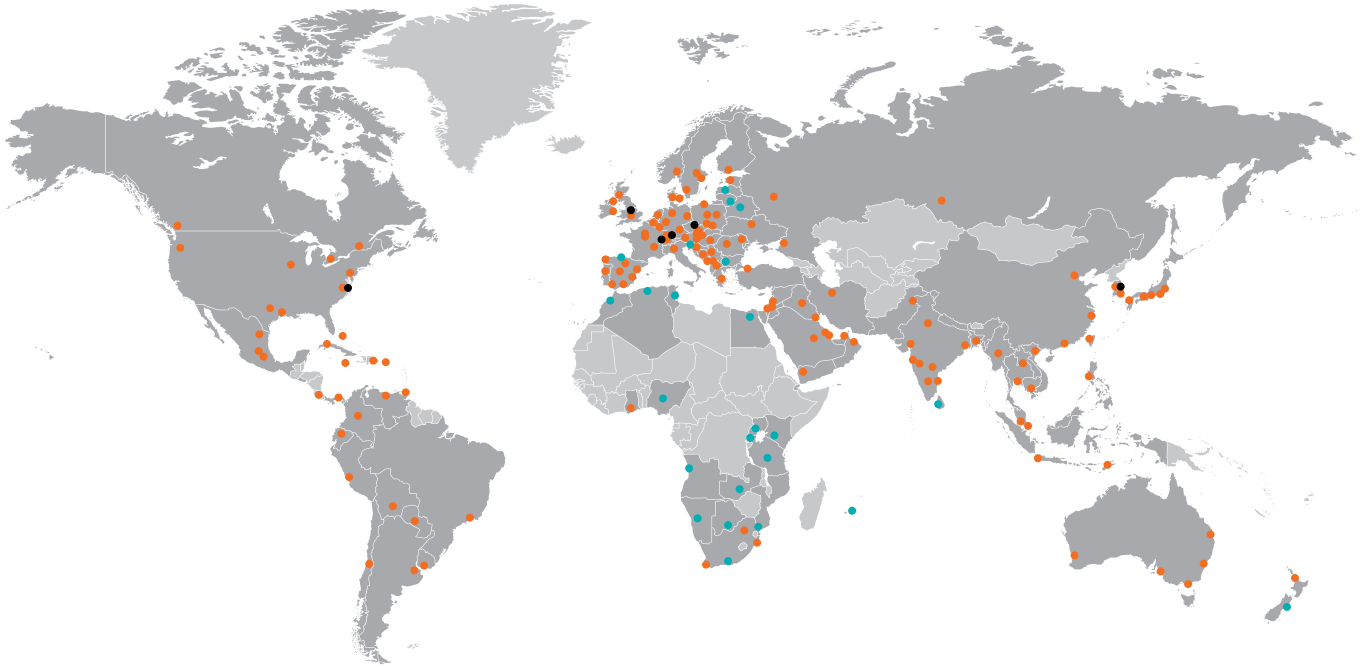
Chevenez, 25.01.2022

Christian Hoffmann, General Director

Notes

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

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