

Instruction Manual

R5 PLUS

Oil-Lubricated Rotary Vane Vacuum Pumps
RA 1000-1600 A PLUS



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1 Safety

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

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

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

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

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

The machine has been designed and manufactured according to state-of-the-art methods. Nevertheless, residual risks may remain. 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.

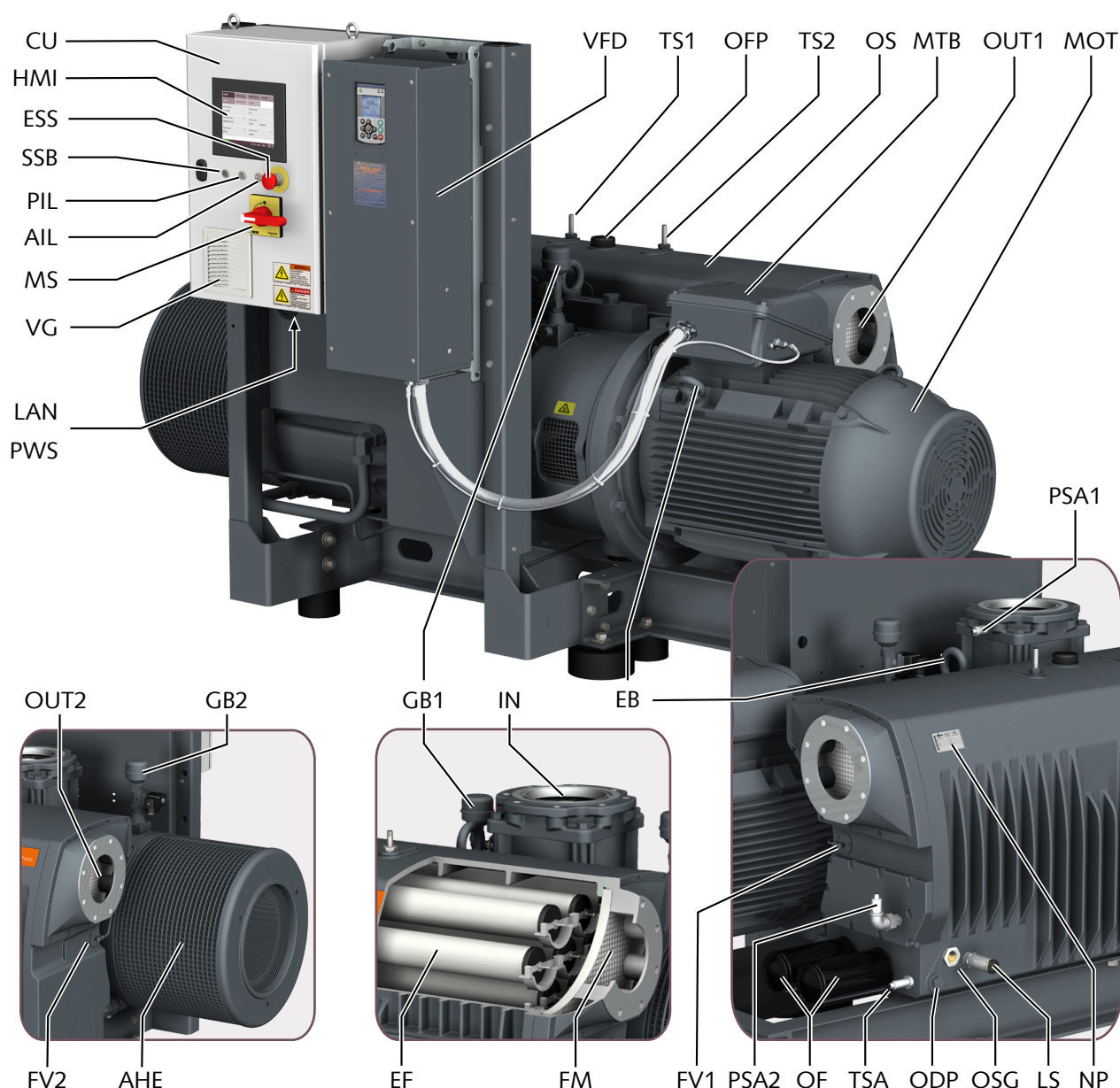
NOTICE

... 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



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	FV	Float Valve
GB	Gas ballast valve	HMI	User interface (human-machine)
IN	Suction connection	LAN	LAN Communication port (Modbus TCP/IP)
LS	Level switch (oil level)	MOT	Motor (pump drive)
MS	Main switch	MTB	Motor terminal box
NP	Nameplate	ODP	Oil drain plug
OF	Oil filter	OFF	Oil fill plug
OS	Oil separator	OSG	Oil sight glass
OUT	Discharge connection	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)

TS Temperature switch

VFD Variable Frequency Drive

SSB Start/Stop button

TSA Resistance thermometer (oil temp.)

VG Ventilation grid

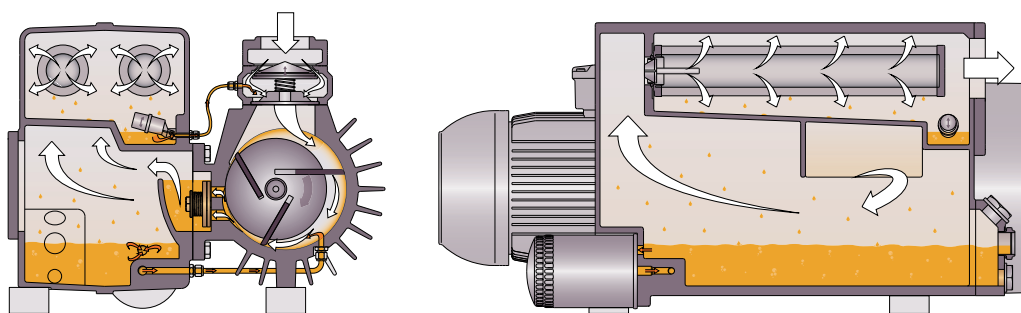
i NOTE**Technical term.**

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

i 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 Application

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 [► 62].

The machine is suitable for continuous operation.

Permitted environmental conditions, see Technical Data [► 62].

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-frequency drive, a PLC and other electrical components are integrated.

The power supply must be connected to it, see Electrical Connection.

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 [► 40].

Two signal levels are transmitted, a warning and an alarm/trip, see Dysfunction [► 47].

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 vapour inside the machine.

The gas ballast valve has an influence on the ultimate pressure of the machine, see Technical Data [► 62].

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.

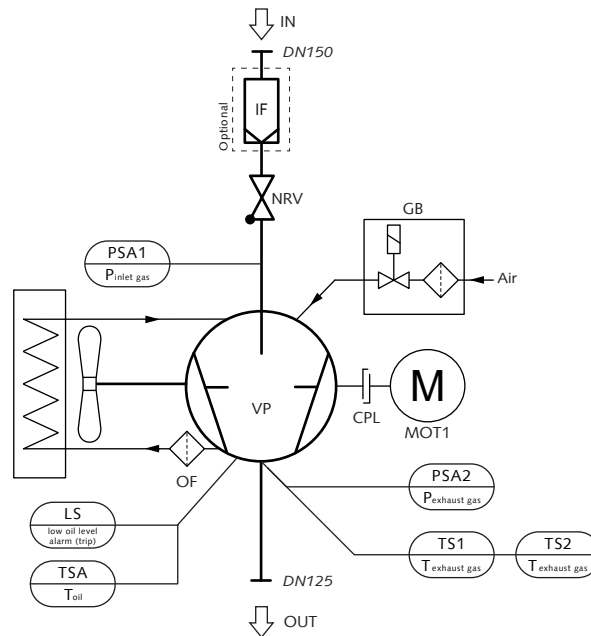
2.4.2 Inlet Filter Condition Monitoring Kit

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) [► 20].

2.5 P&ID "Piping and Instrumentation Diagram"



AHE	Air-oil heat exchanger (fan driven by the pump shaft)	CPL	Coupling
GB	Gas ballast	IF	Inlet filter (Optional)
IN	Suction connection	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
PSA1	Pressure transmitter (inlet gas pressure)	PSA2	Pressure transmitter (counter pressure in the oil separator)
TSA	Resistance thermometer (oil temp.)	TS	Temperature switch (exhaust gas temp.)
TTV	Three-way thermostatic valve	VP	Vacuum pump

2.6 LED Indicators

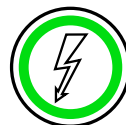
Next to the user interface, there are three LED's which give a visual indication of the machine state.

Start/stop button (SSB)



The LED is green when the machine is running

Power indicator light (PIL)



The LED is green when the machine is powered

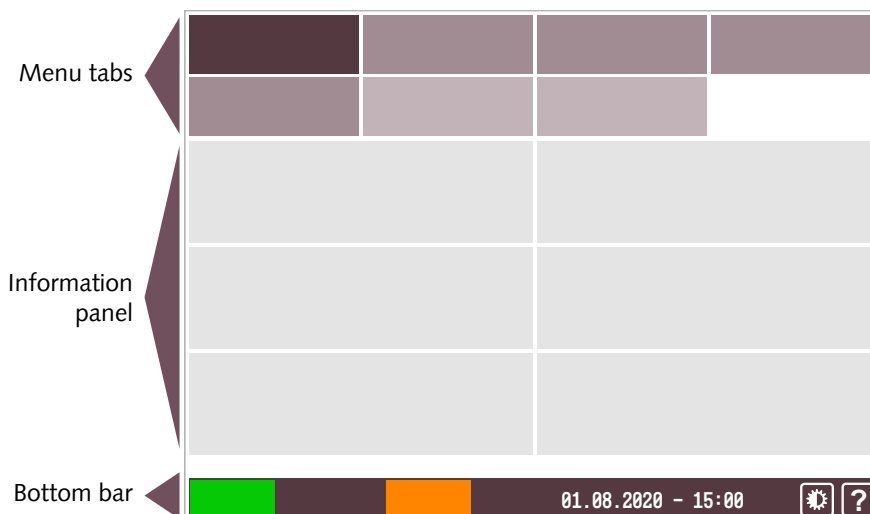
Alarm indicator light (AIL)



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.



2.7.1 Menu Overview

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

- The tab “HOME”, which is the principal display, is mainly useful for live monitoring.

HOME	OPERATIONS	MAINTENANCE	SYSTEM
MAIN	MONITORING	ALARM	

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

HOME	OPERATIONS	MAINTENANCE	SYSTEM
MODE	PARAMETERS	WEEK PLANNER	

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

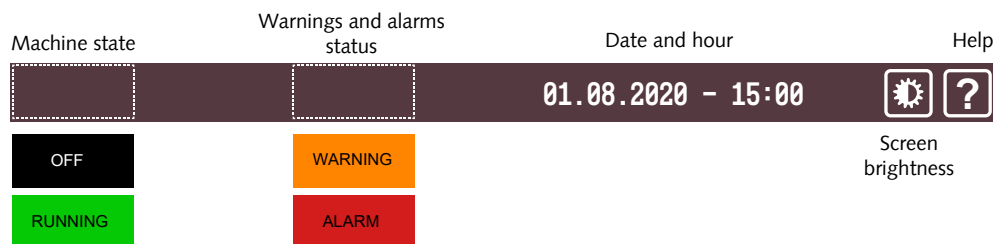
HOME	OPERATIONS	MAINTENANCE	SYSTEM
HISTORY	SERVICE	TREND	

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

HOME	OPERATIONS	MAINTENANCE	SYSTEM
SETTINGS	CONTACT	MODEL	ETHERNET

2.7.2 Bottom Bar

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



2.7.3 Navigation

When several screens are available in the information panel, dots and "PREVIOUS/NEXT" buttons are displayed above the bottom bar.

- Press either on a dot or "PREVIOUS/NEXT" button to pass from a screen to another one.



The switch button is black when it is disabled and orange when it is enabled.

- Press on the switch button to change its state.

If a password is required:

- Enter the password, see the chapter Role and User [► 11].

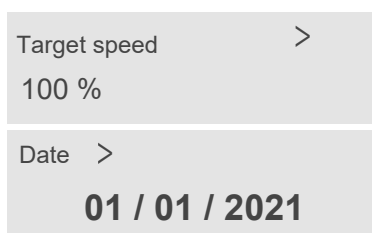


When the character ">" is displayed in a cell of the information panel, that means a step further is available. For example: a redirect link to another view or to open a specific editing view.

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

If a password is required:

- Enter the password, see the chapter Role and User [► 11].



2.7.4 Role and User

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 this screen:



- Press on the three stars.
- Fill the correct password in the number pad according to your access right.
- Save it.
- 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 data.

HOME	OPERATIONS	MAINTENANCE	SYSTEM
SETTINGS	CONTACT	MODEL	ETHERNET
Date > 01 / 07 / 2021		Language > English	
Time > 13 : 48		Units mbar / mbar g °C	
Warnings and alarms thresholds >		Advanced settings >	

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 [► 47].

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".

HOME	OPERATIONS	MAINTENANCE	SYSTEM
SETTINGS	CONTACT	MODEL	ETHERNET
Vacuum pump type R5 PLUS		Vacuum pump model RA 1600 A PLUS	
Software HMI 3.0		Software PLC 3.0	
Serial number CHM120400012			

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 Role and User [► 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 necessary to connect the PLUS 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).

HOME	OPERATIONS	MAINTENANCE	SYSTEM
SETTINGS	CONTACT	MODEL	ETHERNET
Ethernet settings Current IP address 192 . 168 . 0 . 22 Current subnet mask 255 . 255 . 255 . 0 Current gateway 192 . 168 . 0 . 1		Change settings ☐ Off New IP address 0 . 0 . 0 . 0 New subnet mask 0 . 0 . 0 . 0 New gateway 0 . 0 . 0 . 0	
/\ For a modification of the IP address, an active Ethernet connection is necessary.			

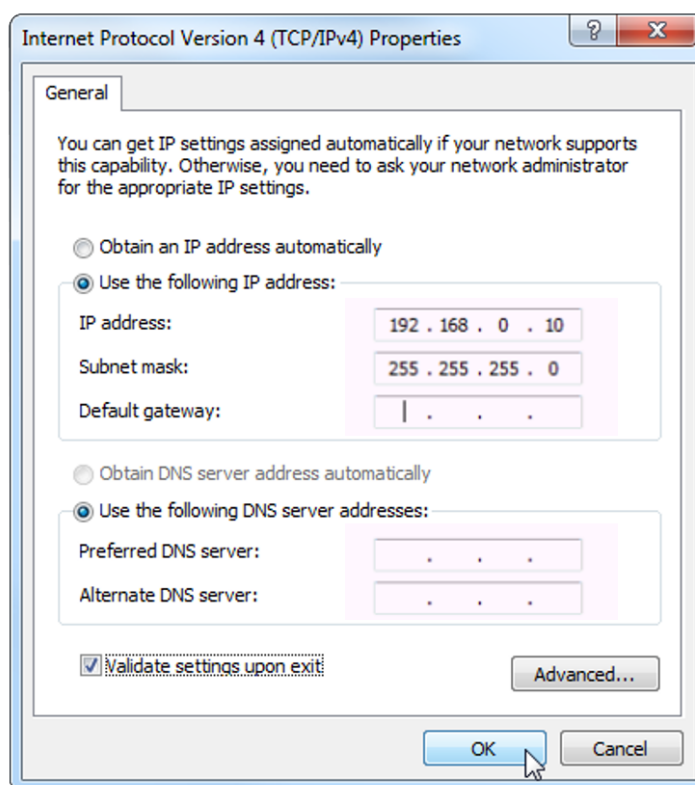
Description	Default value
IP address	192.168.0.22
Subnet mask	255.255.255.0
Gateway	192.168.0.1
PLC port (0-65535)	502 (cannot be changed)
PLC Slave no.	247 (F7) (cannot be changed)

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.

NOTE

The following illustrations are taken from the web visualization of the "R5 RA 0760 A PLUS" vacuum pump.

- The main screen, "**Dashboard**", shows the main operating parameters and settings of the machine (machine status, operating mode, running hours, inlet pressure,...).

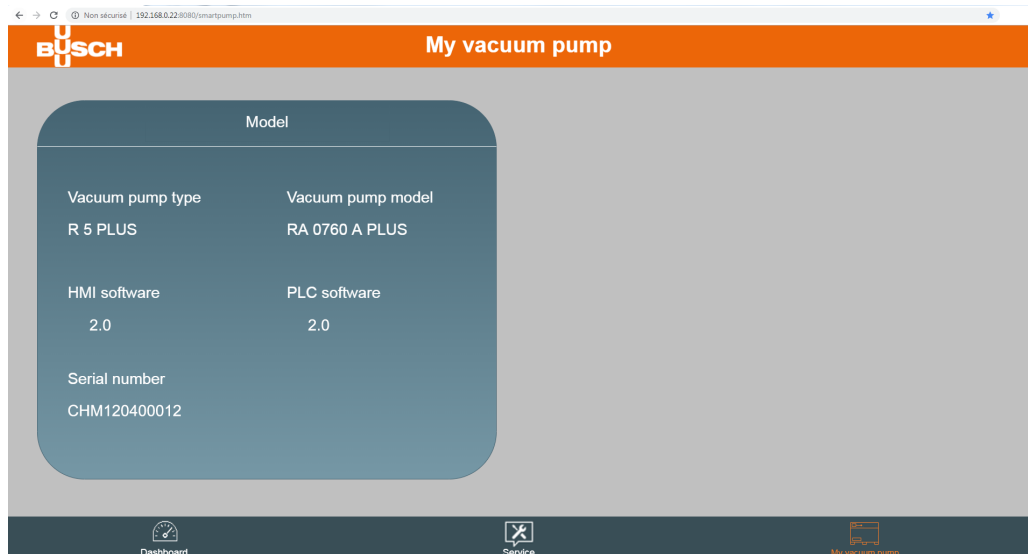


- Use the icons in the bottom bar to navigate in the Web visualization interface.

- 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.



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

Transport and lifting.

Risk of severe injury!

- Lift the machine from underneath with care to prevent the load from tipping over.
- Do not use straps, ropes or other lifting means.

WARNING

Lifting the machine using the motor eye bolt.

Risk of severe injury!

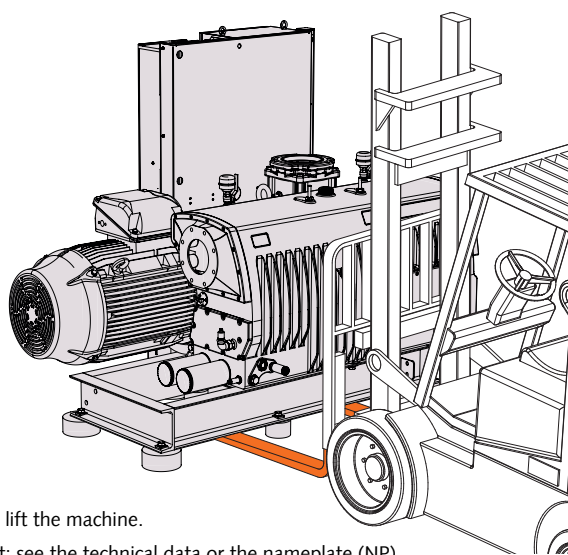
- Do not lift the machine using the eye bolt fitted to the motor. Only lift the machine as shown.

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.



Use a forklift to lift the machine.

Machine weight: see the technical data or the nameplate (NP)

- 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.

! NOTICE

Long storage time.

Risk of damage to the machine!

- Due to a long storage time the capacitors of the variable-frequency 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-frequency drive of the machine.
- Connect the machine every 18 months for 60 minutes to the mains.

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

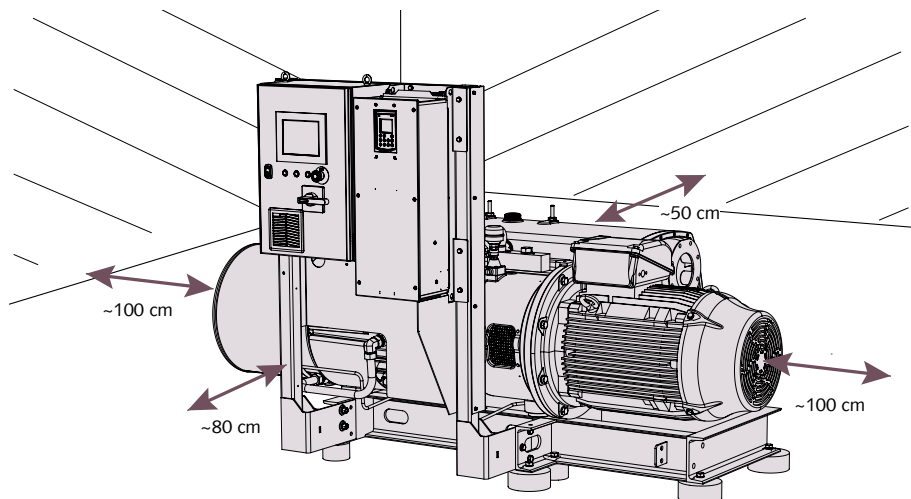
! NOTICE

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.



- Make sure that the environment of the machine is not potentially explosive.
- Make sure that the ambient conditions comply with the Technical Data [► 62].
- Make sure that the environmental conditions comply with the protection class IP54.
- 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 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 machine's connection; if necessary use flexible joints.
- Make sure that the line size of the connection lines over the entire length is at least as large as the connections of the machine.

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

- 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):

- DN150 PN16, EN 1092-1

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.

Connection size(s):

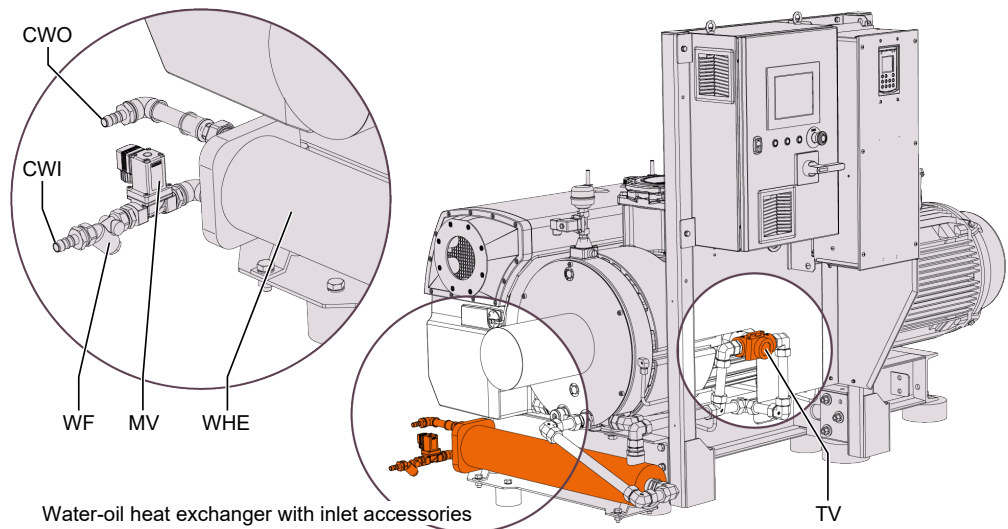
- DN125 PN16, EN 1092-1

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

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 [► 62].

5.2.3 Cooling Water Connection (Optional)



CWI Cooling water inlet

MV Solenoid valve

WF Water filter

CWO Cooling water outlet

TV Thermostatic valve

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): connection terminals X1-5, X1-0V and X1-PE (see wiring diagram T511232067 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 Role and User [► 11].
- Make sure that the cooling water complies with the following requirements:

Min. supply capacity	l/min	8
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:

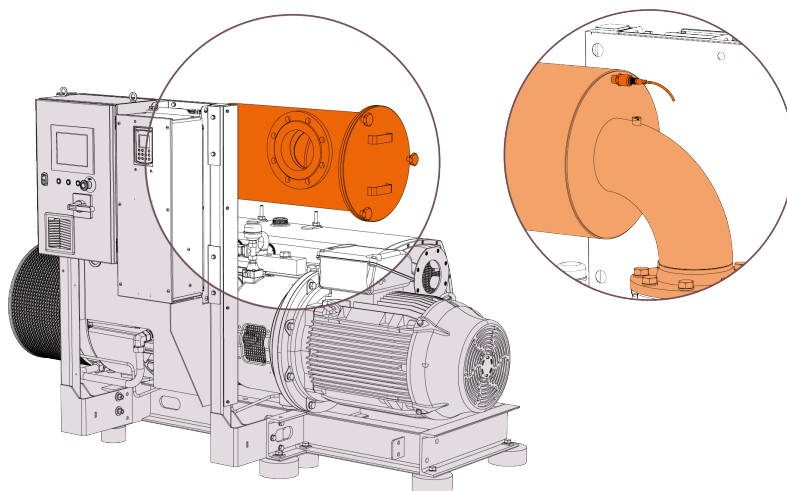
Hardness	mg/l (ppm)	< 90
Properties	Clean & clear	
PH value		7 ... 8
Particle size	µm	< 200
Chloride	mg/l	< 100
Electrical conductivity	µS/cm	≤ 100
Free chloride	mg/l	< 0.3
Materials in contact with the cooling water	Stainless steel, copper and cast iron	

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): connection terminals X1-24V and X1-34 (see wiring diagram T511232067 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 Role and User [► 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): connection terminals X1-24V and X1-34 for 4 – 20 mA signal (see wiring diagram T511232067 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 Role and User [► 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!

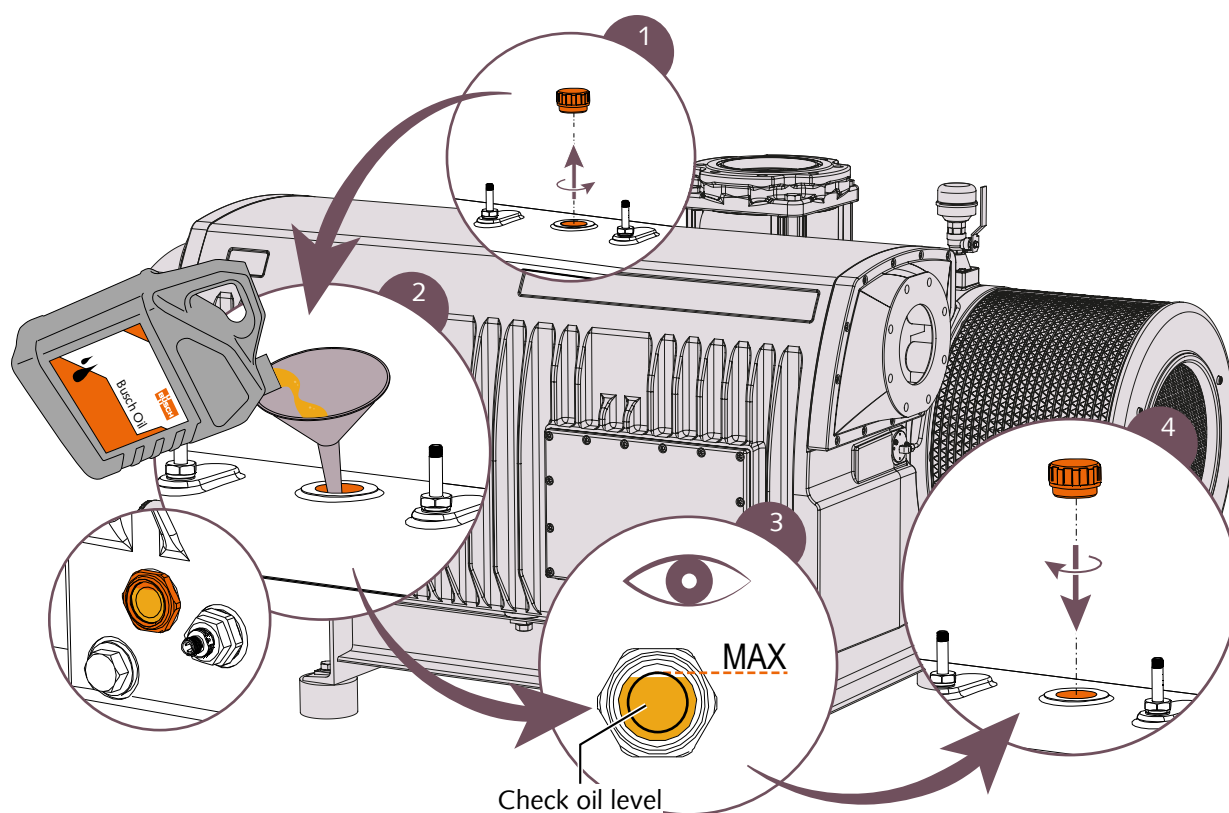
Risk of premature failure!

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).

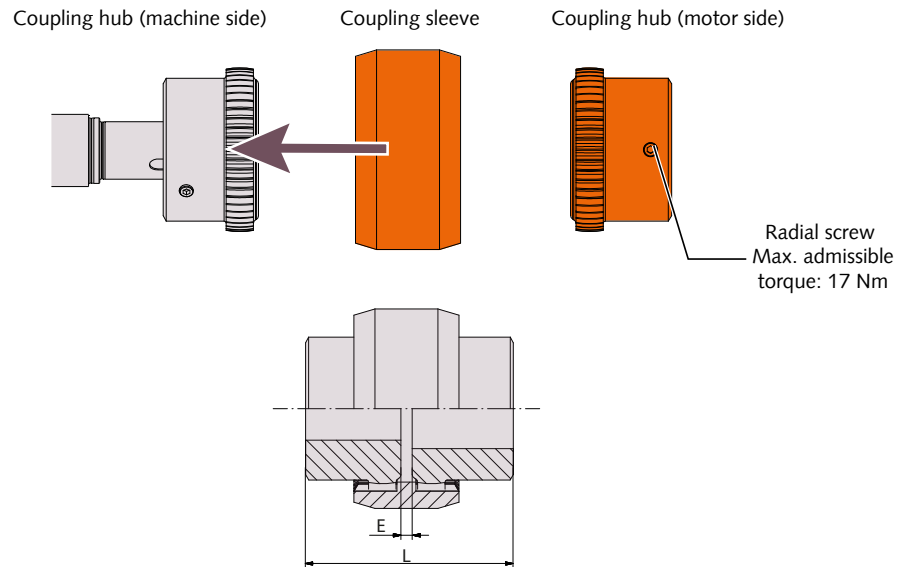
In case of oil type change:

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

For oil type and oil capacity see Technical Data [► 62] and Oil [► 63].



5.4 Fitting the Coupling



Machine type	Coupling size	Value "E" (mm)	Value "L" (mm)
RA 1000 A PLUS	BoWex® I-80	6	186
RA 1600 A PLUS			

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® or POLY PKZ coupling.

5.5 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 has to be insured by customer on its installation.
- The electrical installation must comply with 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 [► 64] or UK Declaration of Conformity [► 65]).

5.5.1 PLUS Machine

DANGER

Live wires. Carry out any work on the variable-frequency 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-frequency 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 isolation default.
 - Busch recommends installing a type B residual protective device and adapted to 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 [► 26].

! NOTICE

The admissible motor speed exceeds the recommendation.

Risk of damage to the machine!

- Check the admissible motor speed range, see Technical Data [► 62].

! NOTICE

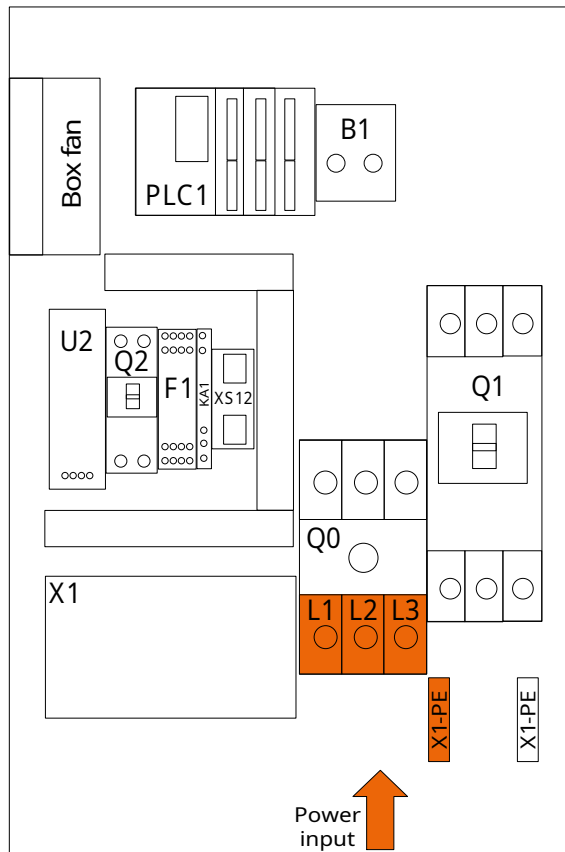
Incorrect connection.

Risk of damage to the control unit!

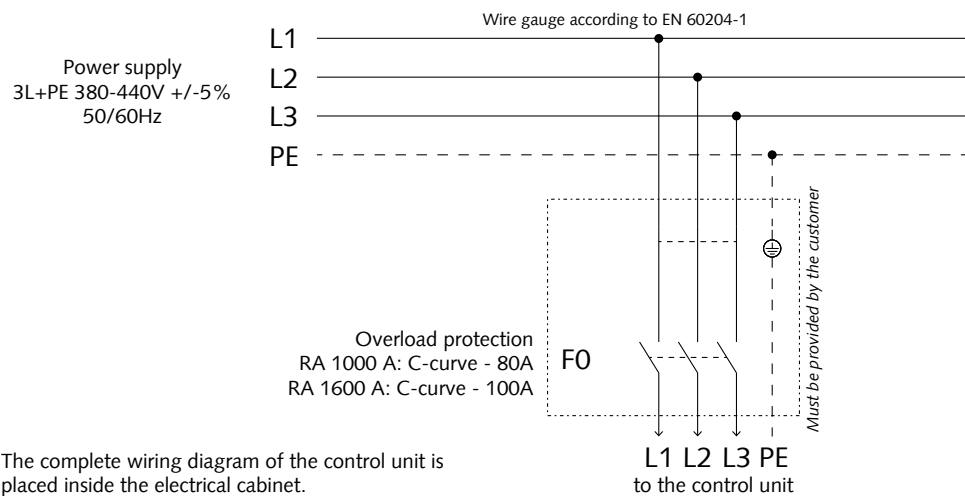
- The wiring diagrams given below are typical. Check the inside of the control unit for connection instructions/diagrams.

5.5.2 Wiring Diagram Control Unit

Internal view of the control unit:



Customer power supply:



Cable gland size of the power input:

- M40 x 1.5 (cable $\varnothing$ ► 24 ... 33 mm)

6 Commissioning

6.1 Prerequisites Before Use

- Make sure that the installation conditions (see Installation Conditions [► 18]) 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 [► 27].

6.2 Configuration

NOTICE

Configuration.

Wrong configuration may occur dysfunctions!

- 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 Role and User [► 11].

Different machine parameters can be configured, such as:

- Control Mode [► 29] ► Local/Manual (default), Local/Auto (week planner) or Remote/Auto,
- Operating Mode [► 31] ► Speed control (default) or Pressure control,
- Ecomode [► 33],
- Gas Ballast Valve Control [► 34],
- Warm-up / Cool-down Modes [► 34],
- Optional Inlet Valve Control [► 36],
- Optional Vacuum Booster Control [► 37].

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].

6.3 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 persons are present in the vicinity of a non noise insulated machine over extended periods:

- Make sure that ear protection is being used.

To start the machine:

- Press and hold the start/stop button (SSB) for at least 3 seconds.
- Monitor the operating values (Monitoring [► 40]) and make sure that they always comply with the operating conditions, see Technical Data [► 62].

As soon as a warning/alarm signal occurred:

- Investigate the cause of the signal, see Dysfunction [► 47].

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 [► 48].

NOTE

Control mode "Remote/Auto".

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

7 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!

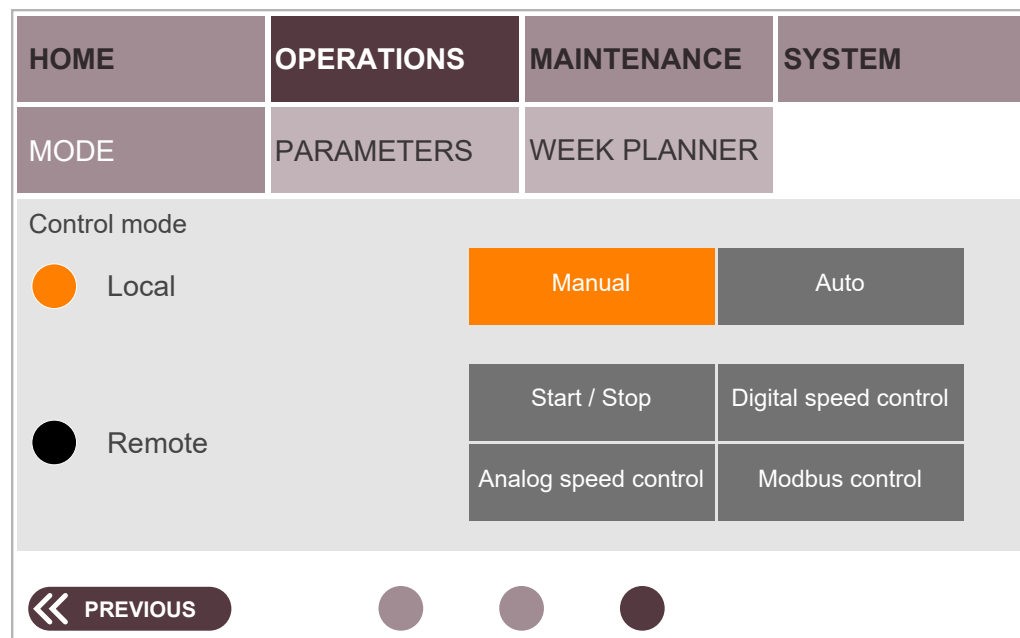
If persons are present in the vicinity of a non noise insulated machine over extended periods:

- Make sure that ear protection is being used.

7.1 Control Mode

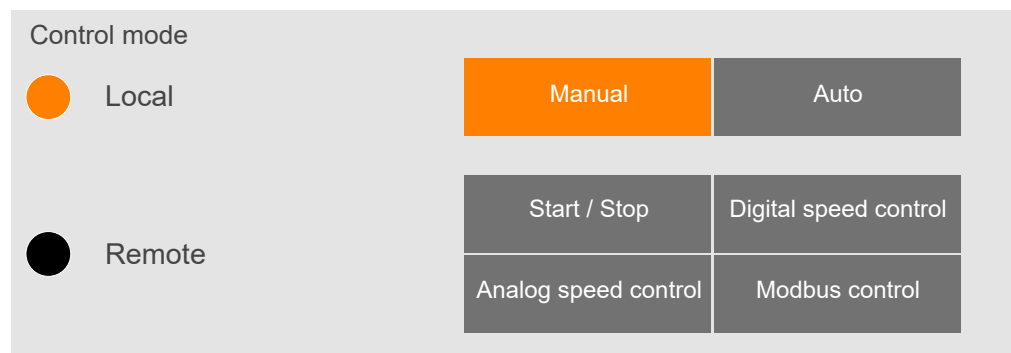
To access the control mode menu:

- Go to "OPERATIONS" > "MODE".
- Access to the third screen.



7.1.1 Local/Manual

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



7.1.2 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 starting and stopping times.

HOME		OPERATIONS		MAINTENANCE		SYSTEM	
MODE		PARAMETERS		WEEK PLANNER			
Day		Start at			Stop at		
	Monday	8 : 0			17 : 15		
	Tuesday	7 : 30			17 : 0		
	Wednesday	8 : 15			17 : 15		
	Thursday	6 : 50			23 : 59 ↗		
	Friday	↳	0 : 0		16 : 0		
	Saturday						
	Sunday						

As soon as the schedule is filled in, the control mode "Local/Auto" has to be activated (by "Role 2" users only, see Role and User [► 11]):

- Go to the control mode screen, see Control Mode [► 29].
- Select the mode "AUTO" in the "LOCAL" field (password required).

Control mode

☒ Local

☐ Remote

Manual

Auto

Start / Stop

Digital speed control

Analog speed control

Modbus control

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.

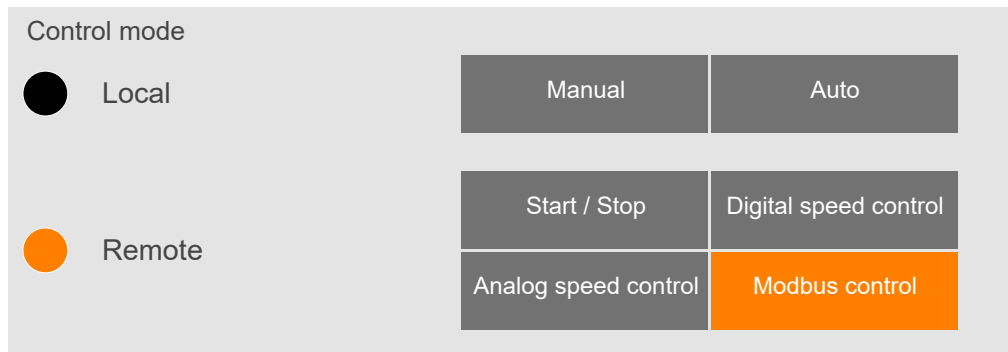
NOTE

Manual starts and stops.

The week planner still allows manual starts and stops.

7.1.3 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!

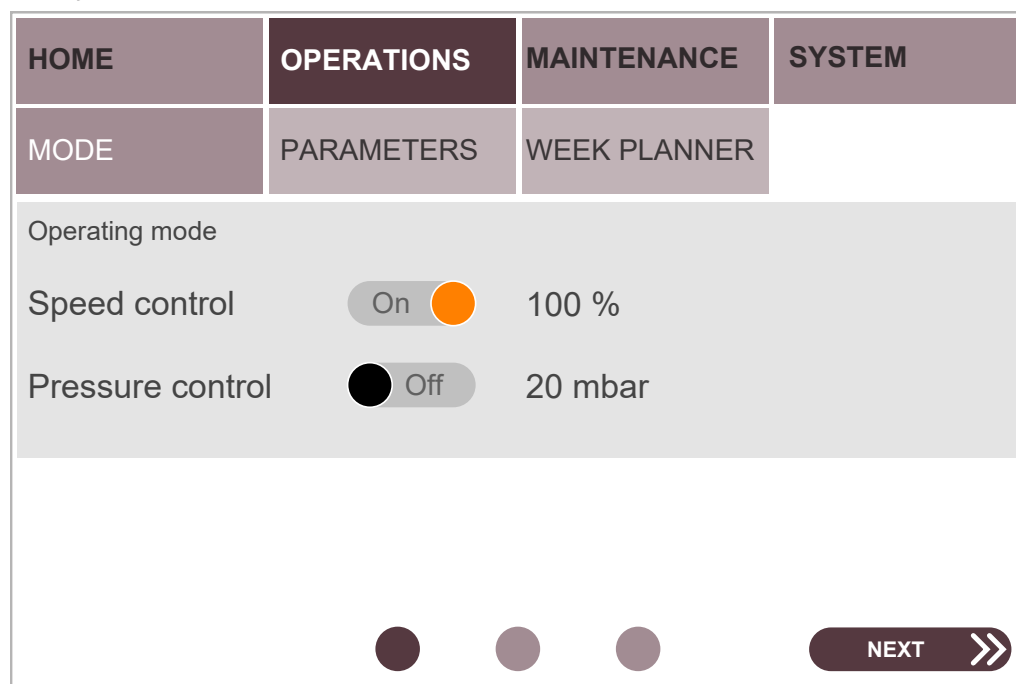
As soon as the “Remote” mode is activated:

- Make sure the machine is fully operational.

7.2 Operating Mode

To access the operating mode menu:

- Go to “OPERATIONS” > “MODE”
- Stay on the first screen.



7.2.1 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 Role and User [► 11].

To change the vacuum pump speed:

- Press on the speed percentage (password required).
- Assign the desired frequency in the keypad and press "Enter".

Operating mode

Speed control ☒ On 70 %

Pressure control ☐ Off 20 mbar

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.

7.2.2 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 Role and User [► 11].

To switch from speed control to pressure control:

- Press on the target pressure value (password required).
- Assign the target pressure in the keypad and press "Enter".
- Press on the switch button.

Operating mode

Speed control ☐ Off 100 %

Pressure control ☒ On 20 mbar

Parameter	Default value	Adjustment range
Pressure control (target pressure)	20	<5 ... 200 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).

7.3 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 Role and User [► 11].

To active and set the Ecomode:

- Go to "OPERATIONS" > "MODE".
- Access to the second screen.
- Press on Ecomode switch button (password required).

HOME	OPERATIONS	MAINTENANCE	SYSTEM
MODE	PARAMETERS	WEEK PLANNER	

Ecomode

Time delay

On 

10 s

Ecomode pressure

Restart pressure

20 mbar

100 mbar

◀ PREVIOUS



NEXT ▶

- Press a value to change it.

Parameter	Default value	Adjustment range
Ecomode pressure	20 mbar	5 ... 200 mbar
Restart pressure	100 mbar	5 ... 1000 mbar
Time delay	10 s	1 ... 999 s

NOTE

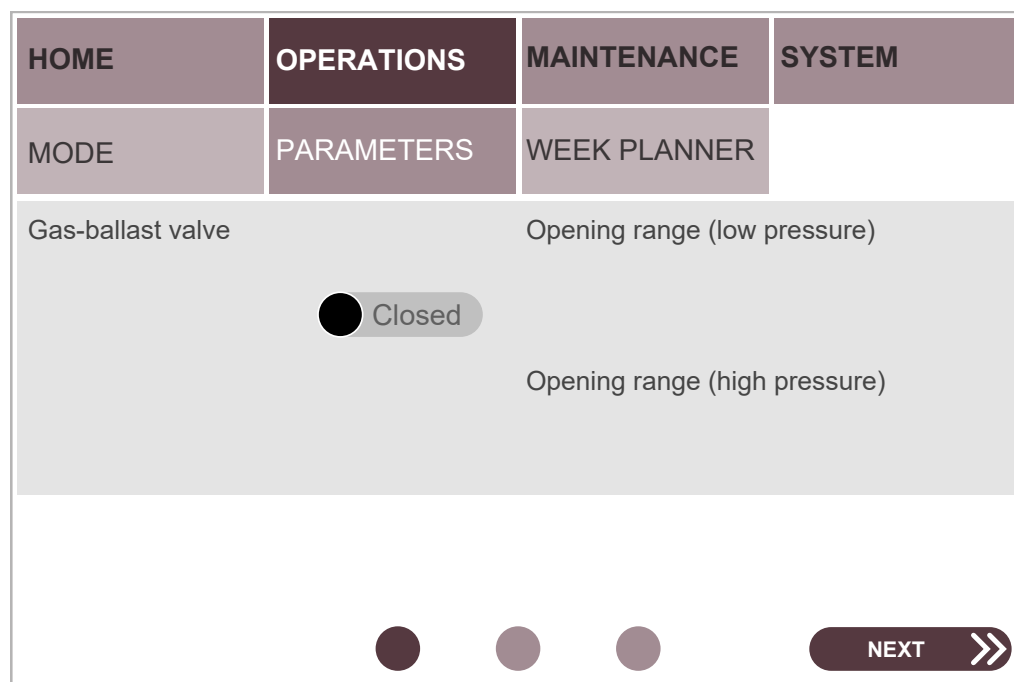
The control unit of the vacuum pump may send a signal to pilot an isolation valve (see Optional Inlet Valve Control [► 36]) or to control a vacuum booster (see Optional Vacuum Booster Control [► 37]).

7.4 Gas Ballast Valve Control

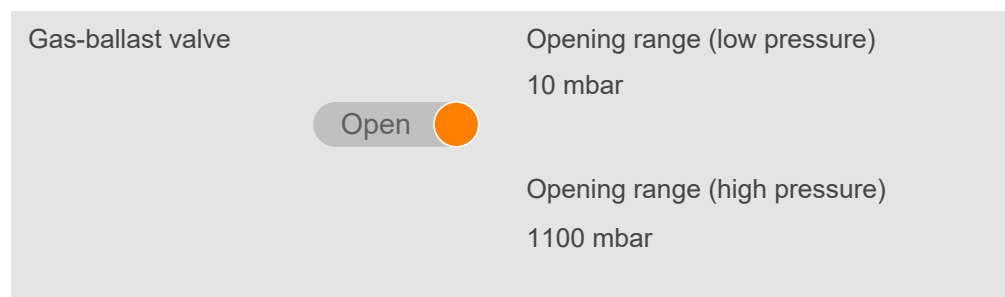
The gas ballast valve can be controlled (open/closed position) via a simple switch button. This operation is only available for “Role 2” users.

To change the state of the gas ballast valve:

- Go to “OPERATIONS” > “PARAMETERS”.
- Stay on the first screen.
- 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 ... 1199 mbar
Opening range (high pressure)	1000 mbar	1 ... 1200 mbar

7.5 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 vapours, see Conveying Condensable Vapours [► 35].

During these phases, the pump operates at maximum speed, with the gas ballast valve open, in order 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 Role and User [► 11].

To activate these two modes:

- Go to “OPERATIONS” > “PARAMETERS”.
- Access to the second screen.
- Press on warm-up and/or cool-down switch button (password required).

HOME	OPERATIONS	MAINTENANCE	SYSTEM
MODE	PARAMETERS	WEEK PLANNER	
Warm-up	Enable On 	Time 30 min	Oil temperature 70 °C
Cool down	Enable On 	Time 30 min	
    			

- 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 in order to allow the vacuum pump to operate at ultimate vacuum.

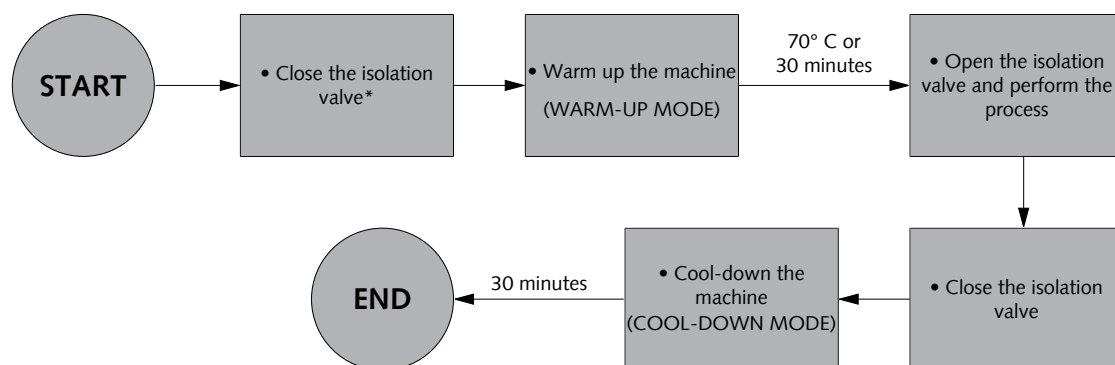
The isolation valve can be automatically controlled by the pump during the warm-up and cool-down phases, see Optional Inlet Valve Control [► 36].

In this case, the valve will open and close according to the diagram available in the chapter Conveying Condensable Vapours [► 35].

7.5.1 Conveying Condensable Vapours

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

If condensable vapours are to be conveyed:



* not included in the scope of delivery

7.6 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 Role and User [► 11].

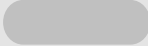
To activate the optional inlet valve control:

- Go to "OPERATIONS" > "PARAMETERS".
- Access to the third screen.
- Switch the optional inlet valve control on (password required).

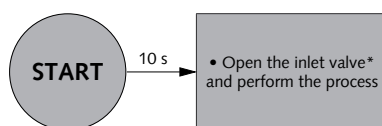
The Opening delay after pump start-up default value is 10 seconds.

- Press to change it.

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

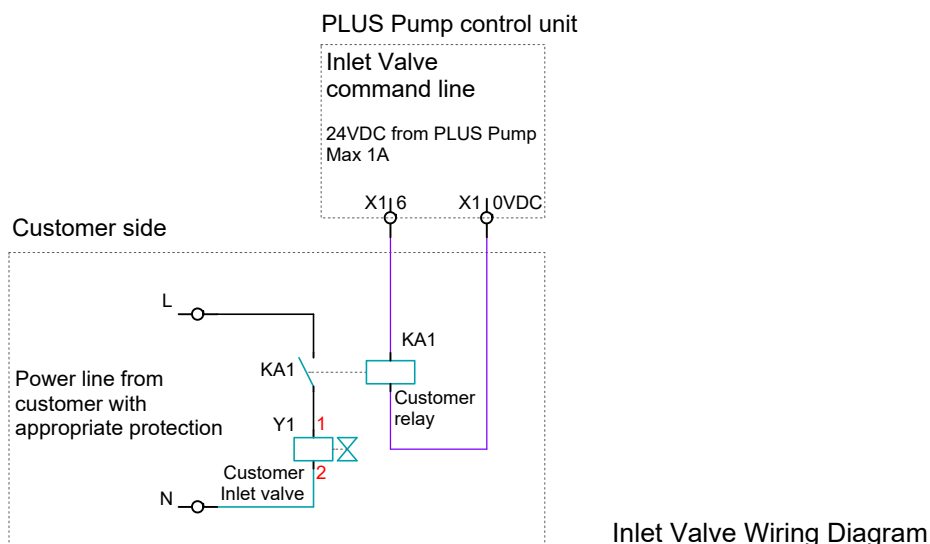
HOME	OPERATIONS	MAINTENANCE	SYSTEM
MODE	PARAMETERS	WEEK PLANNER	
Optional inlet valve control			
On 		Opening delay after pump start-up 10 s	Open / Closed 
Optional vacuum booster control			
 Off		Start pressure 	On / Off 
 PREVIOUS   			

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



* 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 T511232067 in the control unit cabinet).



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 [► 22].

7.7 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 Role and User [► 11].

To activate the optional vacuum booster control:

- Go to “OPERATIONS” > “PARAMETERS”.
- Access to the third screen.
- Switch the optional vacuum booster control on (password required).

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.

HOME

OPERATIONS

MAINTENANCE

SYSTEM

MODE

PARAMETERS

WEEK PLANNER

Optional inlet valve control

Opening delay after pump start-up

Open / Closed

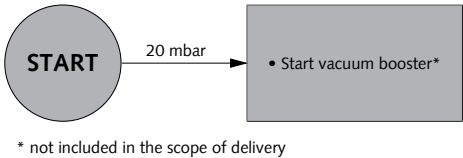
Optional vacuum booster control

Start pressure

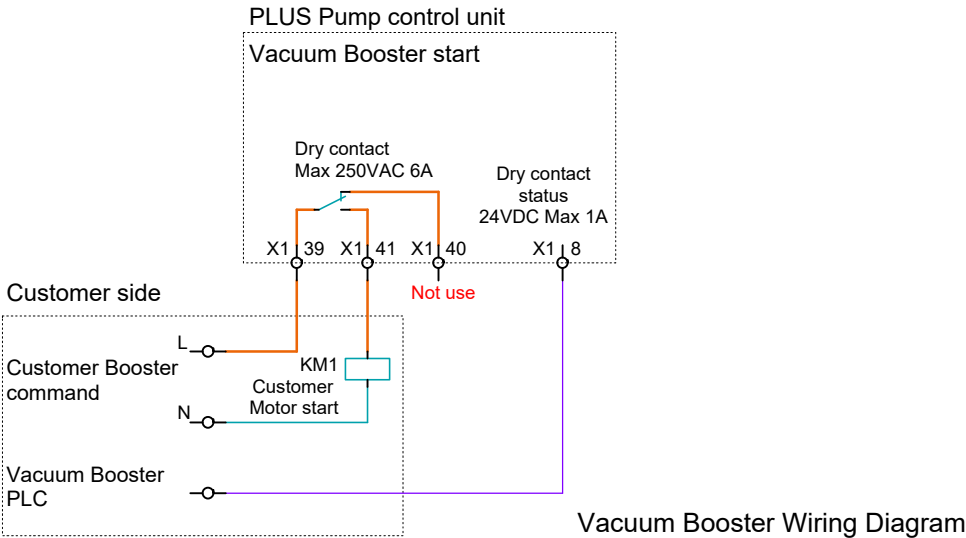
On / Off

PREVIOUS

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



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 T511232067 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.

7.8 Monitoring

7.8.1 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.

HOME	OPERATIONS	MAINTENANCE	SYSTEM
MAIN	MONITORING	ALARM	
Inlet pressure < 5 mbar		Actual speed 0 %	
Operating mode Speed control >		Control mode Local Manual	
Target speed 100 % >		Next service in 4000 h >	

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-frequency 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 [► 31].

Control mode: Indicates which control mode is selected, "Local/Manual", "Local/Auto" or "Remote/Auto", see Control Mode [► 29].

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 [► 31].

Next service in: Indicates the number of operating hours remaining before the next maintenance, see Maintenance Schedule [► 50].

7.8.2 Operating Data

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

Screen 1

HOME	OPERATIONS	MAINTENANCE	SYSTEM
MAIN	MONITORING	ALARM	
Gas-ballast valve > Open		Exhaust pressure 960 mbar	
Instant absorbed power 11.5 kW		Mean absorbed power 10.2 kW	
Running hours since last maintenance 452 h		Running hours total 5462 h	
NEXT >>			

Gas-ballast valve: Indicates the state of the gas ballast valve ► “Open” or “Closed”, see Gas Ballast Valve Control [► 34].

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 2

HOME	OPERATIONS	MAINTENANCE	SYSTEM
MAIN	MONITORING	ALARM	
Oil temperature 82 °C		Exhaust gas temperature Ok	
Oil level Ok			
<< PREVIOUS NEXT >>			

Oil temperature: Indicates the oil temperature, in case of a too high temperature a warning or an alarm occurs, see Dysfunction [► 47].

Exhaust gas temperature: Indicates the exhaust gas temperature, in case of a too high temperature a warning or an alarm occurs, see Dysfunction [► 47].

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 [► 47].

Screen 3

HOME	OPERATIONS	MAINTENANCE	SYSTEM
MAIN	MONITORING	ALARM	
Energy consumption since last reset 921 kWh		Reset energy consumption (Press button 5s) ☐ OFF	
Energy consumption total 5412 kWh		Motor start counter, press 5s to reset 151 ☐ OFF	
Inlet filter pressure differential 100 - 99 = 1 mbar			
PREVIOUS			

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).

7.8.3 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

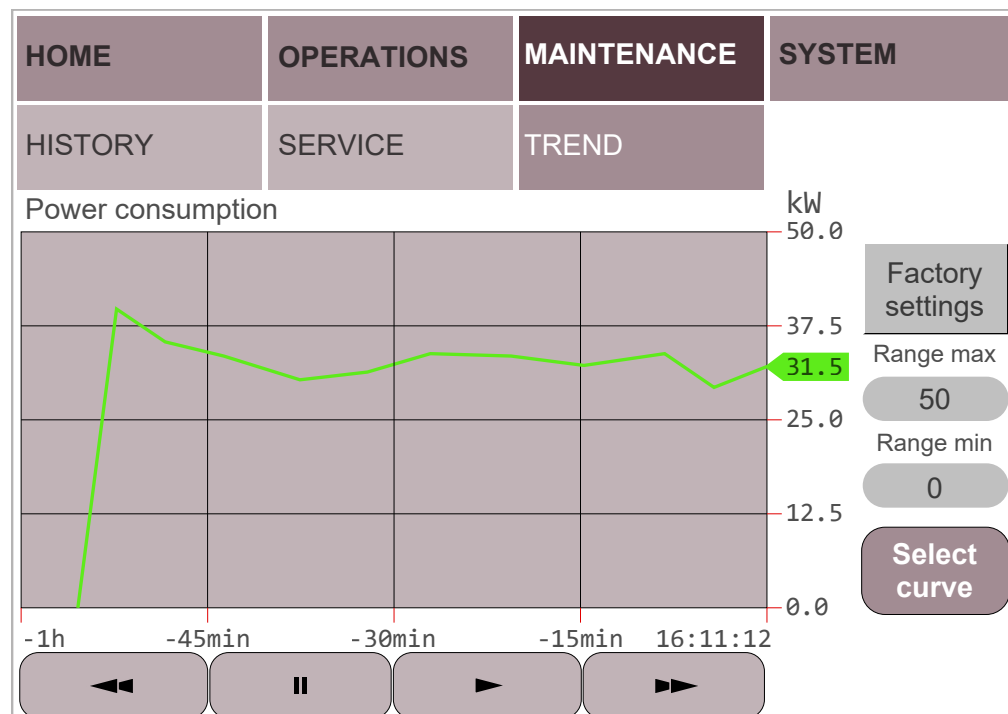
It is possible to filter the type of message by selecting a specific tab.

HOME		OPERATIONS		MAINTENANCE		SYSTEM	
HISTORY		SERVICE		TREND			
All		Event		Alarm		Warning	
						Service	
No.	Date	Time	Message				
▶ 1	02/02/2019	06:47	Alarm: Oil Level				▲
2	04/02/2019	10:28	Warning: Control cabinet temperature				
3	04/02/2019	11:07	Alarm: Exhaust Gas Temperature				▲
4	10/02/2019	08:02	Alarm: Oil Level				
5	14/02/2019	18:45	Ecomode ON				
6	14/02/2019	20:10	Ecomode OFF				
7	21/12/2018	15:12	Exhaust Filter Service				
8	07/11/2018	06:28	Alarm: EMO				
							▼
							▼
							▼

7.8.4 Operating Curves

This display "MAINTENANCE" > "TREND" shows the trend curve of certain 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:

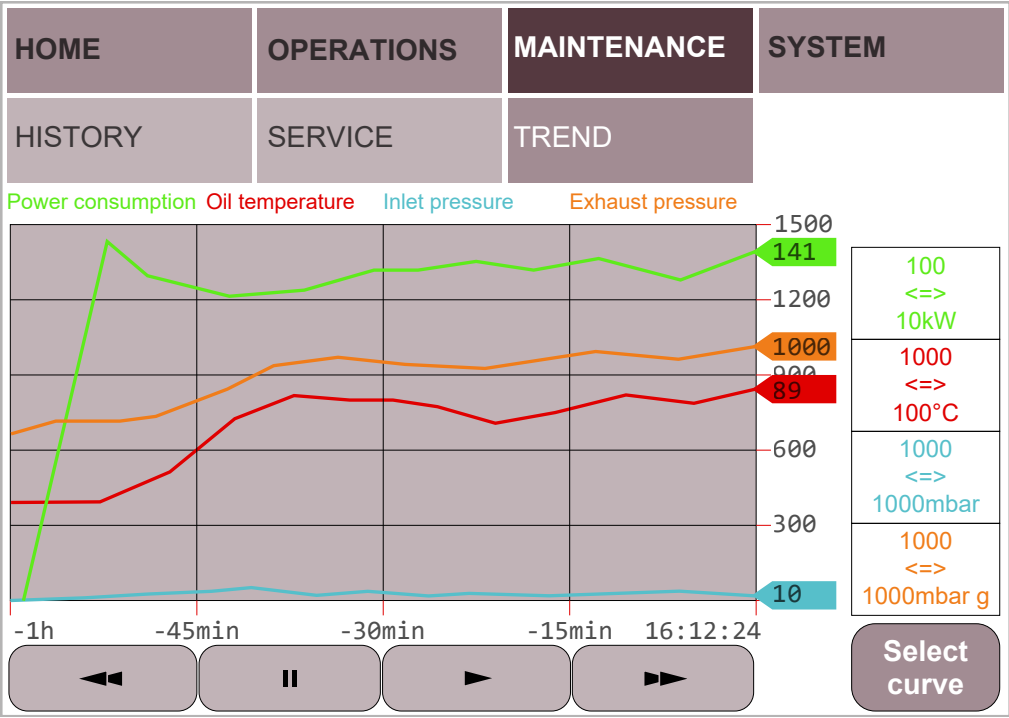
- Press on "Select curve"
- Select the desired time lapse (Horizontal axis) and the curve types of the operating value, different curve types can be selected simultaneously.

MAINTENANCE > TREND > CURVES

Horizontal axis ☒ 1 h ☐ 24 h	Curve type ☒ Power consumption ☐ Oil temperature ☐ Inlet pressure ☐ Exhaust pressure ☐ All
CANCEL SAVE	

- Once the choice is made, press on "SAVE" button.

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



7.9 Dysfunction

7.9.1 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 voluntarily changed to leave the machine running even after an alarm signal.

In anycase, 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.

	No.	Date	Time	Message
▶	1	14/02/2019	18:45	Alarm: EMO
	2	10/02/2019	08:02	Alarm: Oil Level
	3	04/02/2019	08:07	Alarm: Control cabinet temperature
	4	04/02/2019	10:28	Warning: Control cabinet temperature

- Investigate why this signal occurred using the Troubleshooting [► 58] tables.
- Follow the Warning/Alarm Acknowledgment Procedure [► 48] when the problem has been rectified.

Below, the default warnings and alarms thresholds:

NOTE

Mineral oil available only with water-cooling for RA 1600 A PLUS.

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 >120°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.

7.9.2 Warning/Alarm Acknowledgment Procedure

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

NOTE

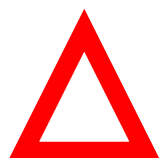
Bottom bar Warning & Alarm signals.

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 "►").

No.	Date	Time	Message
► 1	14/02/2019	18:45	Alarm: EMO
2	10/02/2019	08:02	Alarm: Oil Level
3	04/02/2019	08:07	Alarm: Control cabinet temperature
4	04/02/2019	10:28	Warning: Control cabinet temperature

- Press on the triangle icon 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, that means the problem is still pending. In this case, go back to the Troubleshooting [► 58] or ask your Busch representative for help.

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

7.10 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.

8 Maintenance



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.

! NOTICE

Using inappropriate cleaners.

Risk of removing safety stickers and protective paint!

- Do not use incompatible solvents to clean the machine.

! CAUTION

Failing to properly maintain the machine.

Risk of injuries!

Risk of premature failure and loss of efficiency!

- Respect the maintenance intervals or ask your Busch representative for service.

8.1 Maintenance Schedule

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

Maintenance work	Interval	
	Normal application	Harsh application
• Check the oil level, see Oil Level Inspection [► 52].	Weekly	
• Change the oil*, the oil filter* (OF) and the exhaust filters (EF). See Oil and Oil Filter Change [► 52] and Exhaust Filter Change [► 54].	Max. after 4000 hours, at the latest after 1 year	Max. after 2000 hours, at the latest after 6 months
• Clean the machine from dust and dirt, especially the air-oil heat exchanger (AHE), see Air Heat Exchanger Cleaning [► 55]. • 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 [► 58]. Change them if necessary.	Every 6 months	

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

To visualise information about remaining hours:

- Go to "MAINTENANCE" > "SERVICE".

- Check when the maintenance tasks have to be performed and how long the machine has operated since the first commissioning or last maintenance task.

HOME	OPERATIONS	MAINTENANCE	SYSTEM
HISTORY	SERVICE	TREND	
Next exhaust filters service 3993 h Last service: 00.00.0000		Exhaust filters service interval 4000 h	
0 Running hour(s)		Set	
Next oil service 3993 h Last service: 00.00.0000		Oil service interval 4000 h	
0 Running hour(s)		Set	
			

HOME	OPERATIONS	MAINTENANCE	SYSTEM
HISTORY	SERVICE	TREND	
Next inlet filter service 3993 h Last service: 00.00.0000		Inlet filter service interval 4000 h	
0 Running hour(s)		Set	
Next overhaul 57 month(s) Last service: 00.00.0000		Overhaul interval 60 month(s)	
Set		Set	
			

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 [► 52]
- Exhaust Filter Change [► 54]
- Inlet Filter Cartridge Change

8.2 Oil Level Inspection

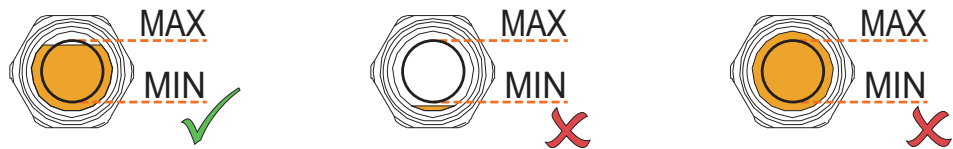
If the oil level is too low, an alarm signal will be sent by the monitoring system.

To check the oil level status:

- Go to "HOME" > "MONITORING".
- In the cell "Oil level" it must always be written "OK".

To perform a visual control of the oil level:

- Check the oil sight glass (OSG).



8.3 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.

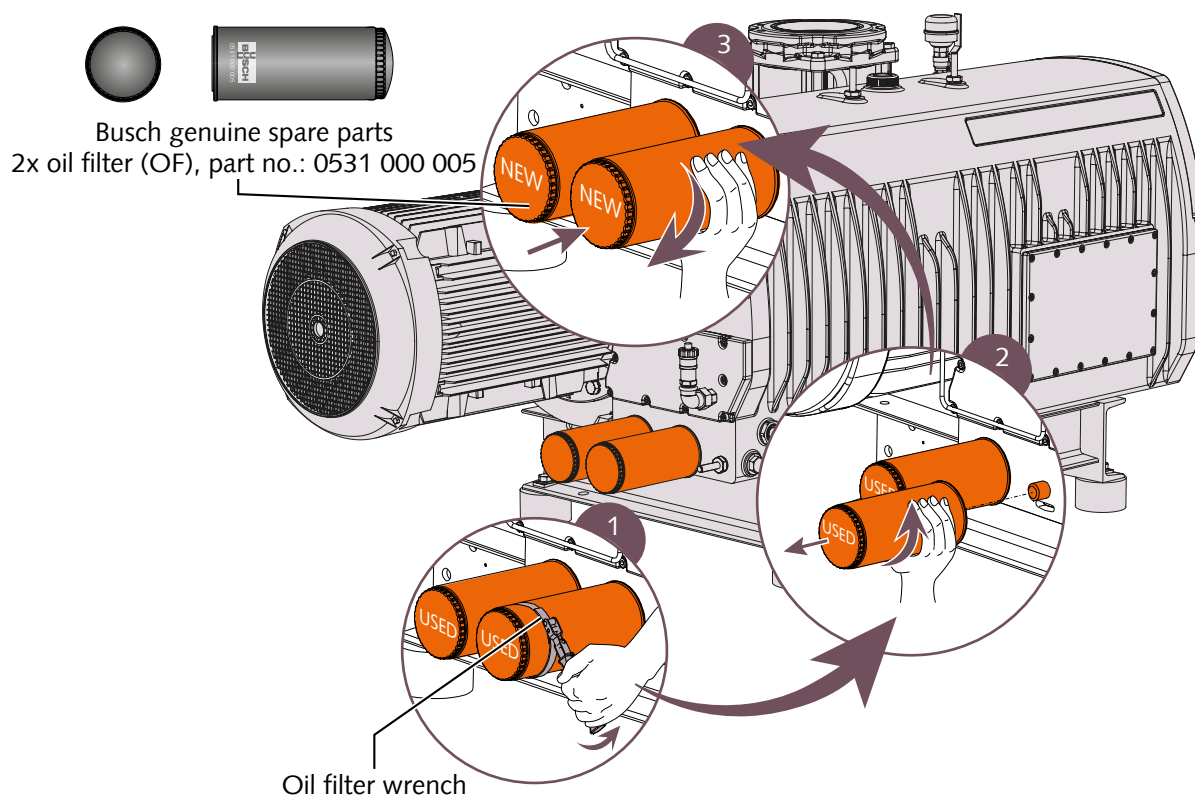
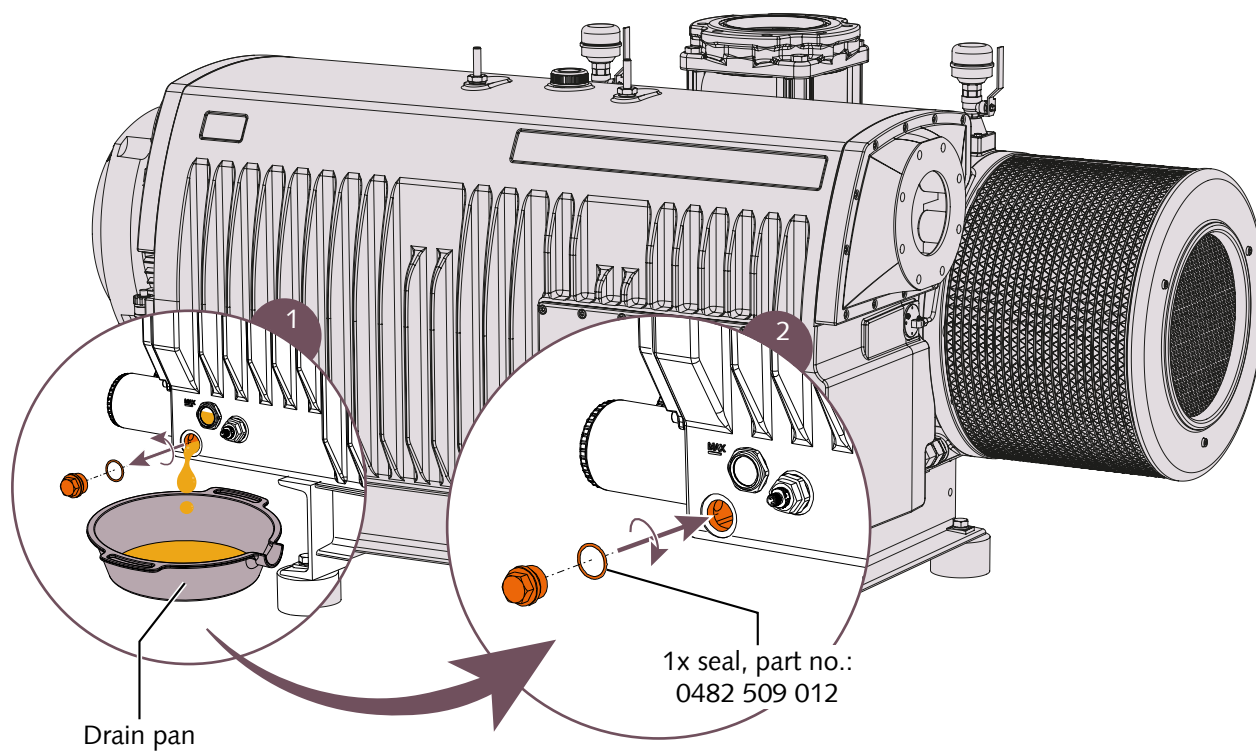
Risk of using a deteriorated oil!

Risk of premature failure!

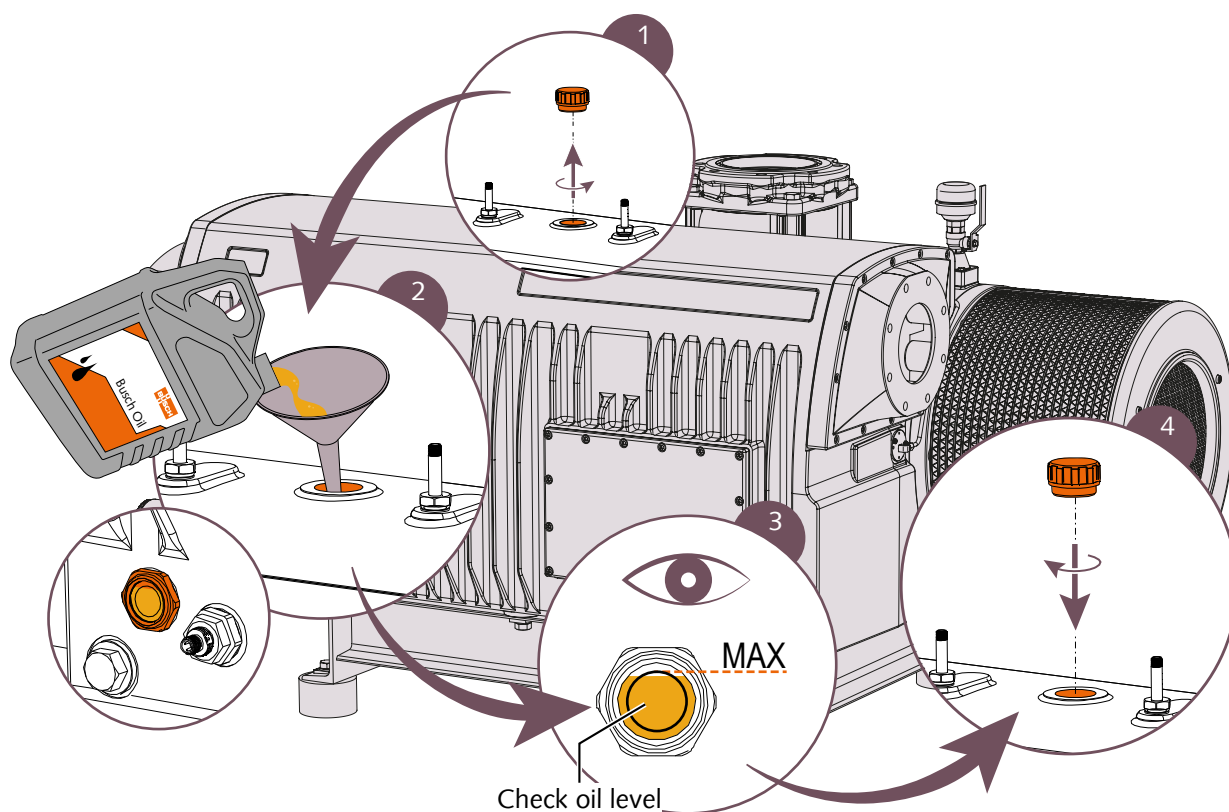
By default, the oil temperature thresholds (warning/alarm) and the service intervals are configured according to the oil type (mineral or synthetic) written on the nameplate (NP).

In case of oil type change:

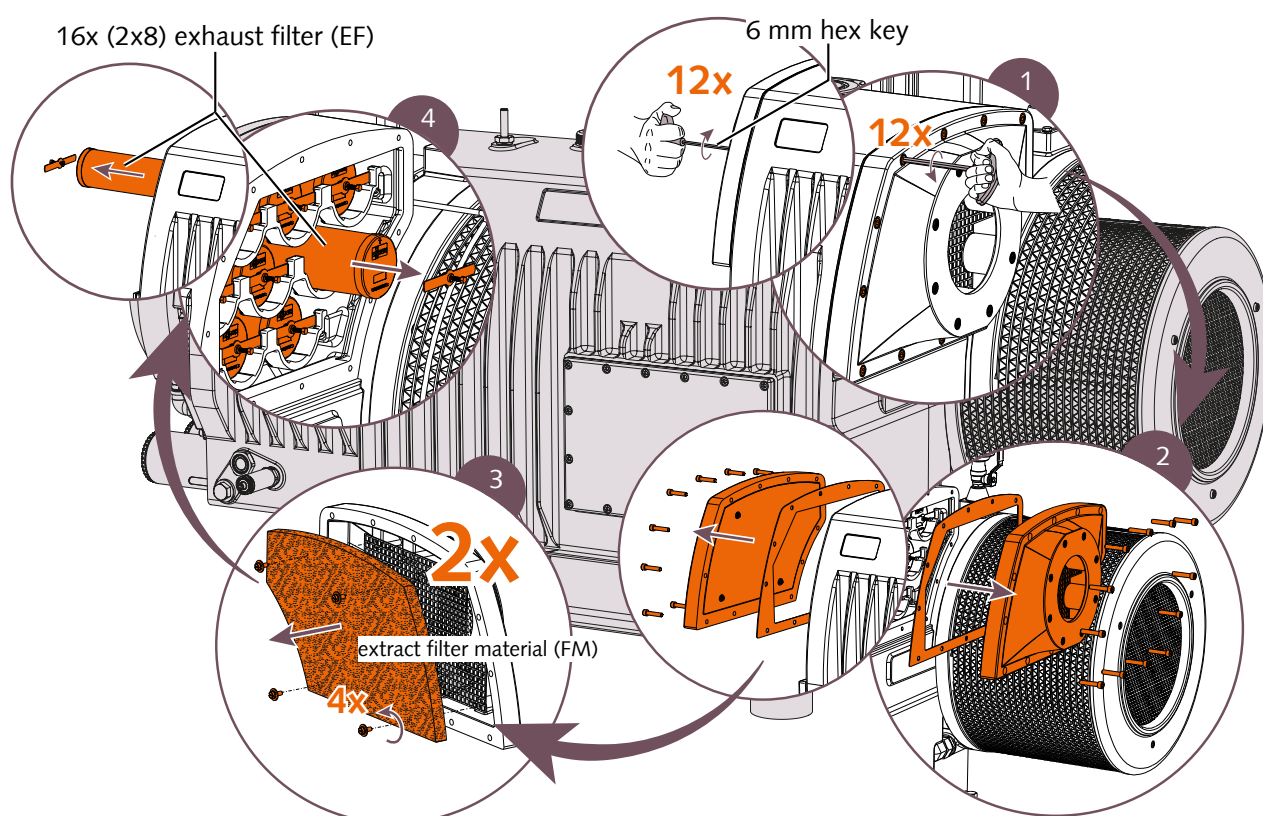
- Contact your Busch representative to adapt the thresholds and service intervals accordingly.

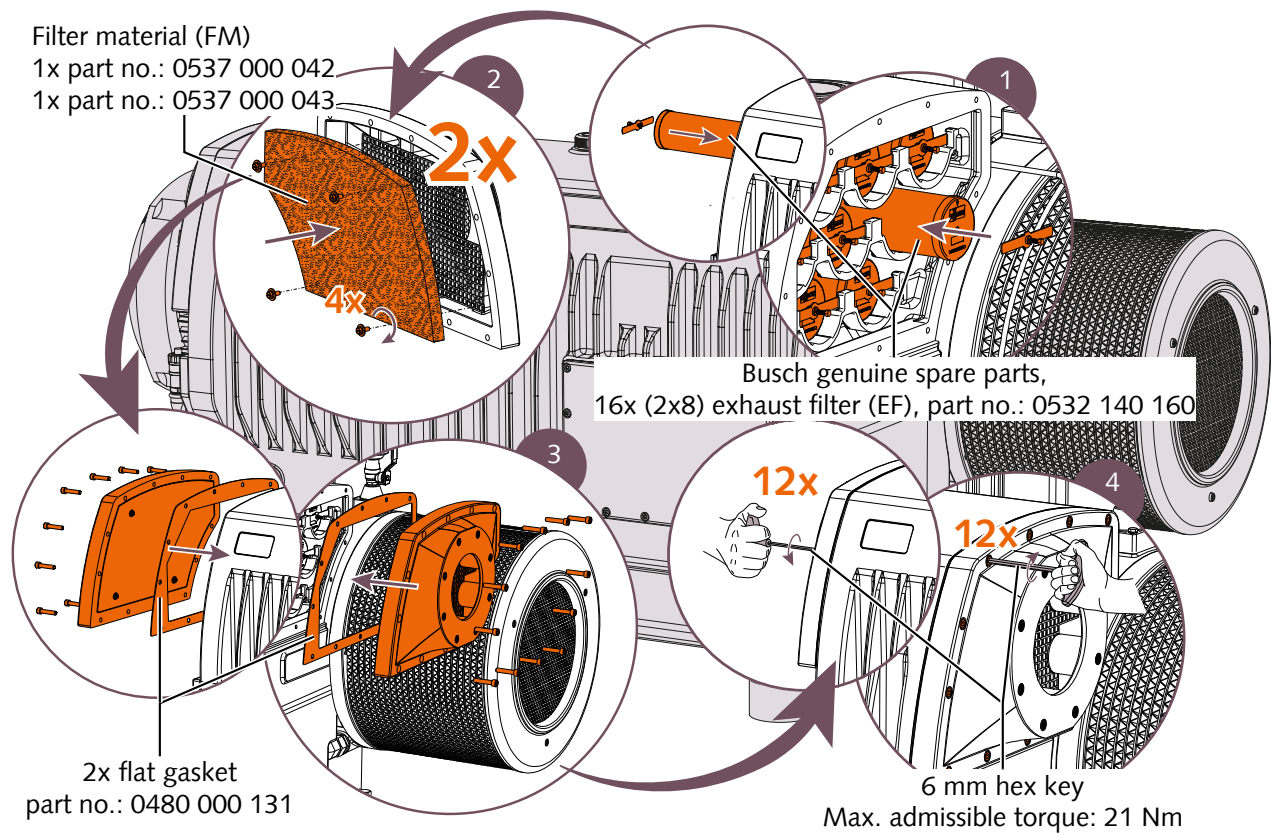


For oil type and oil capacity see Technical Data [► 62] and Oil [► 63].

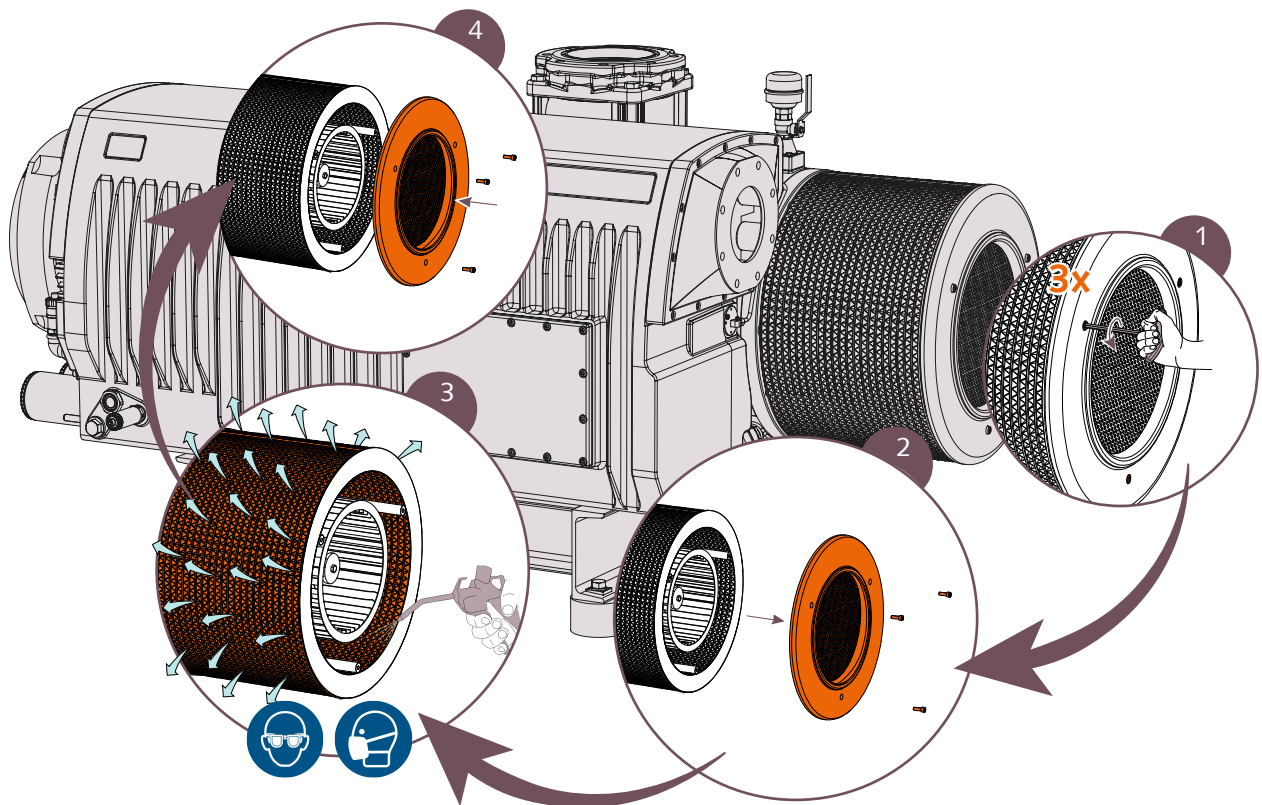


8.4 Exhaust Filter Change





8.5 Air Heat Exchanger Cleaning



9 Overhaul



WARNING

Machines contaminated with hazardous material.

Risk of poisoning!

Risk of infection!

If the machine is contaminated with hazardous material:

- Wear appropriate personal protective equipment.

NOTICE

Improper assembly.

Risk of premature failure!

Loss of efficiency!

- It is highly recommended that any dismantling of the machine that goes beyond anything that is described in this manual should be done through Busch.

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).

10 Decommissioning

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

If the machine is going to be stored:

- See Storage [► 18].

10.1 Dismantling and Disposal

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

11 Spare Parts

NOTICE

Use of non-Busch genuine spare parts.

Risk of premature failure!

Loss of efficiency!

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

Spare parts kit	Description	Part no.
Service kit	Includes all the necessary parts for maintenance.	0992 000 010
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.

12 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.

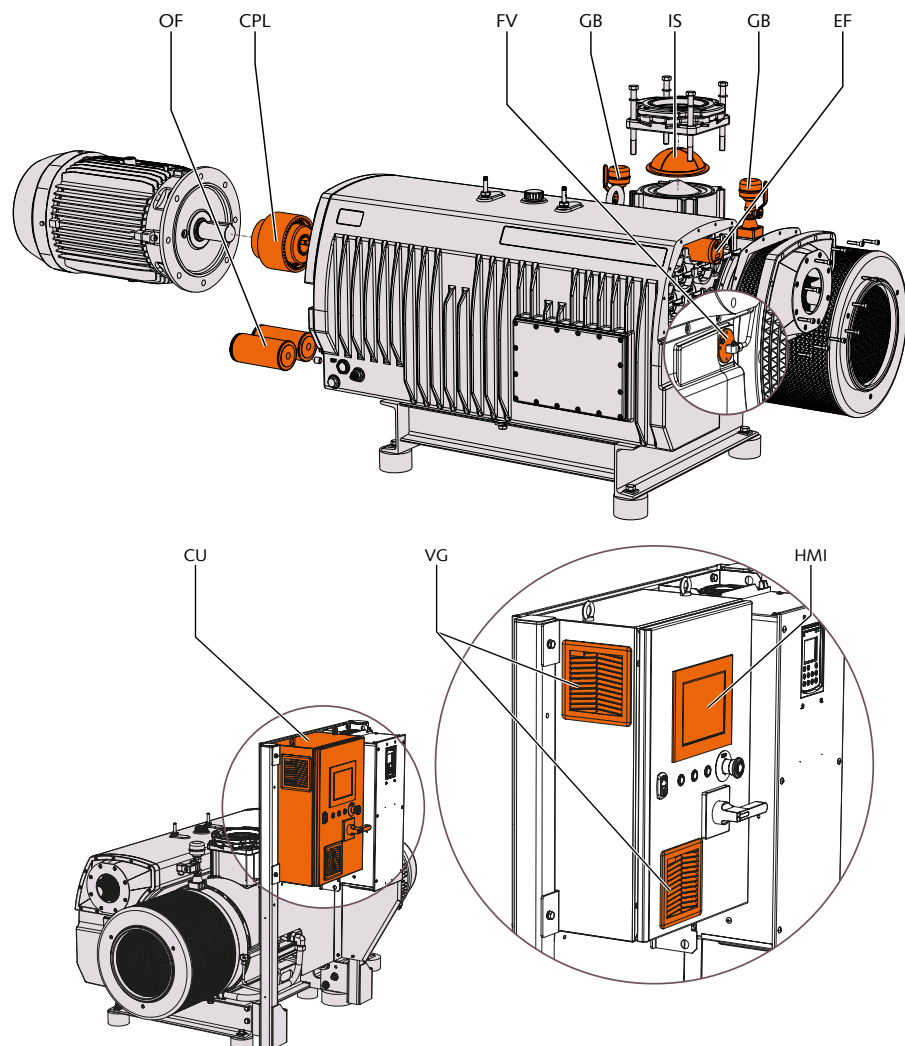
NOTICE

Variable-frequency drive maintenance.

Risk of damage to the variable-frequency drive!

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

Illustration showing parts that may be involved during troubleshooting:



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 [► 47]. - 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 [► 23].
	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 [► 23].
	The exhaust filters (EF) are partially clogged.	Replace the exhaust filters (EF), see Exhaust Filter Change [► 54].

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 float valve and the oil return line, repair it 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 vapour.	• Flush the machine (contact Busch). • Clean the filter of the gas ballast valve (GB). • Modify the operational mode (see Conveying Condensable Vapours [► 35]).
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 [► 23].
Oil temperature (warning + alarm)	Oil temperature too high.	• See problem "The machine runs too hot".
Exhaust gas pressure (warning + alarm)	Exhaust gas pressure in the oil separator (OS) too high.	• Replace the exhaust filters (EF), see Exhaust Filter Change [► 54].

Table 2		
Message	Possible Cause	Remedy
Inlet pressure (warning + alarm)	Inlet pressure too high. The machine has operated for too long at a high inlet pressure.	• Reduce the 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 (VFD) (alarm)	Variable-frequency drive (VFD) default.	• Check the variable-frequency drive by an electrician. • Repair the variable-frequency 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 [► 48].
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.
VFD breaker (alarm)	The circuit breaker of the variable frequency 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.

13 Technical Data

		RA 1000 A PLUS	RA 1600 A PLUS
Nominal pumping speed	m ³ /h	480 / 1200	600 / 1800
Ultimate pressure (without gas ballast valve)	hPa (mbar) abs.	0.3 ... 0.5 ► see nameplate (NP)	
Ultimate pressure (with gas ballast valve)	hPa (mbar) abs.	0.5 ... 1.0	
Nominal motor rating	kW	30.0	37.0
Permitted motor speed range	min ⁻¹	500 ... 1200	
Power supply voltage	V	3~ 380-460 ±10%	
Power supply frequency	Hz	50 / 60	
Max. intensity	A	56	72
Circuit breaker (MCCB)	A	C-80 (ICC 10kA @ 400V)	C-100 (ICC 10kA @ 400V)
Power consumption at 100 mbar (min./max. speed)	kW	8.6 / 22.3	12.8 / 35.9
Power consumption at ultimate pressure (min./max. speed)	kW	5.4 / 12.5	6.9 / 19.0
Noise level (EN ISO 2151) (min./max. speed)	dB(A)	78 / 80	80 / 82
Water vapour tolerance max. (with gas ballast valve) (min./max. speed)	hPa (mbar)	40	
Water vapour capacity (with gas ballast valve) (min./max. speed)	kg / h	45	
Max. allowable pressure in the oil mist separator	hPa (mbar) abs.	1600	
Max. allowable gas inlet temperature	°C	≤50 hPa (mbar) ► 150	
		>50 hPa (mbar) ► 80	
Ambient temperature range	°C	5 ... 40	
Ambient pressure		Atmospheric pressure	
Oil capacity	l	First filling: 35.0	
		Oil change: 30.0	
Weight approx. without Control Unit (CU) and Variable Frequency Drive (VFD)	kg	1230	1580
Protection of electrical devices		IP54	

14 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 168 359	0831 168 353

NOTE

Mineral oil available only with water-cooling for RA 1600 A PLUS.

In case of unfavourable 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).

15 EU Declaration of Conformity

This Declaration of Conformity and the CE-mark 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-mark.

The manufacturer

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

declares that the machine(s) **R5 RA 1000-1600 A PLUS**

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

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

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

Standard	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 1012-1 : 2010 EN 1012-2 : 1996 + A1 : 2009	Compressors and vacuum pumps - Safety requirements - Part 1 and 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
EN ISO 13849-1 : 2015 ⁽¹⁾	Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design

⁽¹⁾ In case control systems are integrated.

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, 14.05.2021



Christian Hoffmann, General Director

16 UK Declaration of Conformity

This Declaration of Conformity and the UKCA-mark 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-mark.

The manufacturer

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

declares that the machine(s) **R5 RA 1000-1600 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 fulfil those provisions:

Standard	Title of the Standard
BS EN ISO 12100 : 2010	Safety of machinery. Basic concepts, general principles of design. Risk assessment and risk reduction.
BS EN ISO 13857 : 2019	Safety of machinery - Safety distances to prevent hazard zones being reached by the upper and lower limbs.
BS EN 1012-1 : 2010 BS EN 1012-2 : 1996 + A1 : 2009	Compressors and vacuum pumps. Safety requirements. Air compressors and vacuum pumps.
BS EN ISO 2151 : 2008	Acoustics - Noise test code for compressors and vacuum pumps - Engineering method (grade 2)
BS EN 60204-1 : 2018	Safety of machinery. Electrical equipment of machines. General requirements.
BS EN IEC 61000-6-2 : 2019	Electromagnetic compatibility (EMC) - Generic standards. Immunity standard for industrial environments.
BS EN IEC 61000-6-4 : 2019	Electromagnetic compatibility (EMC) - Generic standards. Emission standard for industrial environments.
BS EN ISO 13849-1 : 2015 ⁽¹⁾	Safety of machinery. Safety-related parts of control systems. General principles for design.

⁽¹⁾ In case control systems are integrated.

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, 14.05.2021



Christian Hoffmann, General Director

Note

Busch

Vacuum Solutions

We shape vacuum for you.

Argentina

info@busch.com.ar

Australia

sales@busch.com.au

Austria

busch@busch.at

Bangladesh

sales@busch.com.bd

Belgium

info@busch.be

Brazil

vendas@buschdobrasil.com.br

Canada

info@busch.ca

Chile

info@busch.cl

China

info@busch-china.com

Colombia

info@buschvacuum.co

Czech Republic

info@buschvacuum.cz

Denmark

info@busch.dk

Finland

info@busch.fi

France

busch@busch.fr

Germany

info@busch.de

Hungary

busch@buschvacuum.hu

India

sales@buschindia.com

Ireland

sales@busch.ie

Israel

service_sales@busch.co.il

Italy

info@busch.it

Japan

info@busch.co.jp

Korea

busch@busch.co.kr

Malaysia

busch@busch.com.my

Mexico

info@busch.com.mx

Netherlands

info@busch.nl

New Zealand

sales@busch.co.nz

Norway

post@busch.no

Peru

info@busch.com.pe

Poland

busch@busch.com.pl

Portugal

busch@busch.pt

Romania

office@buschromania.ro

Russia

info@busch.ru

Singapore

sales@busch.com.sg

South Africa

info@busch.co.za

Spain

contacto@buschiberica.es

Sweden

info@busch.se

Switzerland

info@buschag.ch

Taiwan

service@busch.com.tw

Thailand

info@busch.co.th

Turkey

vakutek@ttmail.com

United Arab Emirates

sales@busch.ae

United Kingdom

sales@busch.co.uk

USA

info@buschusa.com