Installation and Operating Instructions

Vacuum Pumps
Enivac RE 0016 B / RE 0040 B / RE 0063 B

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Preface

Congratulations on your purchase of the Busch vacuum pump. With watchful observation of the field’s requirements, innovation and steady development Busch delivers modern vacuum and pressure solutions worldwide.

These operating instructions contain information for

- product description,
- safety,
- transport,
- storage,
- installation and commissioning,
- maintenance,
- overhaul,
- troubleshooting and
- spare parts

of the vacuum pump.

The ATEX-drive motor is subject to a separate instruction manual.

For the purpose of these instructions, “handling” the vacuum pump means the transport, storage, installation, commissioning, influence on operating conditions, maintenance, troubleshooting and overhaul of the vacuum pump.

Prior to handling the vacuum pump these operating instructions shall be read and understood. If anything remains to be clarified please contact your Busch representative!

Keep these operating instructions and, if applicable, other pertinent operating instructions available on site.
Product Description

Use

The vacuum pump is intended for

- the suction

of

- explosionsfähigen trockenen, nicht aggressiven und nicht giftigen Gasgemischen gemäß Baumusterprüfbescheinigung

Conveying media with a lower or higher density than air leads to an increased thermal and/or mechanical load on the vacuum pump and is permissible only after prior consultation with Busch.

Permissible temperature range of the inlet gas: see "Technical Data"

According to the directive 2014/34/EU the vacuum pump is made for the intended use in potentially explosive areas.

According to this directive the vacuum pump is inside a category 1 device (suitable for connection to tubings the inside of which is classified as zone 0). Outside the vacuum pump is approved as category 2 device (for use in zone 1).

According to the EC-Type Examination Certificate issued by the German "Physikalisch-Technische Bundesanstalt" (PTB) the vacuum pump may be used for the conveyance of explosive atmospheres consisting of a mixture with air of flammable substances in the form of gas, provided that the material belongs to the temperature classes T1 to T4 according to EN 13463–1 and to the explosion groups IIA to IIB3 according to E. Brandes, W. Möller “Sicherheitstechnische Kenngrößen, Band 1: Brennbare Flüssigkeiten und Gase”, ISBN 3–89701–745–8 (or equivalent source).

The vacuum pump is suitable for placement in an environment where potentially explosive gas/air mixtures of flammable material with temperature class T1 to T3 or T4 (depending on the classification of the drive motor) are likely to occur in normal operation occasionally (zone 1).

In case Busch delivered the vacuum pump without drive motor or a replacement motor is to be mounted or for economic reasons the vacuum pump was equipped with a simpler motor, the following must be observed:

In case the classifications of the vacuum pump and of the drive motor are different the inferior classification is relevant. This means also that the vacuum pump is suitable for the placement in a potentially explosive environment only if both the vacuum pump, the coupling and the drive motor are approved to the required extent for use in potentially explosive areas.

In case the vacuum pump is equipped with a gas ballast (optional) water vapour within the gas flow can be tolerated within certain limits (➔ page 10: Conveying Condensable Vapours). The conveyance of other vapours shall be agreed upon with Busch.

The vacuum pump is thermally suitable for continuous operation (100 percent duty).

The vacuum pump is ultimate pressure proof.

The approval for use in potentially explosive atmospheres is valid for the vacuum pump together with the described measurement and safety equipment. The approval is void if the system is altered or if the scheduled maintenance is not complied with. Maintenance must be performed by specifically instructed personnel only.

Safety Concept

The safety concept for the vacuum pumps Enivac RE 0016 B / RE 0040 B / RE 0063 B for use in potentially explosive atmosphere
as a category 1 device (inside) and category 2 device (outside) is based on two safety principles being independent from each other.

1. Avoidance of ignition caused by an electric or non-electric ignition source inside or outside the vacuum pump.

In order to avoid an ignition inside as well as outside the vacuum pump a sight glass (n) (optionally a level switch (u)) and two different electric switches are used, all of which must be checked for allowed operating parameters prior to start and continuously during operation. In case of an illegal operating parameter the vacuum pump must not start or must be shut down immediately respectively (page 32: Flow Chart Safety Tests).

Electrical equipment with ATEX-approval is being used (where applicable).

- Version without level switch (u): The sight glass (n) must be read every day prior to the start of the vacuum pump, in case of continuous operation again in intervals of max. 24 hours.
- Version with level switch (u) (optional): The level switch must safely inhibit the operation of the vacuum pump if the level is below minimum.
- The pressure switch/indicator (a) gives a warning at switching point S1 (550 hPa#g (=mbar)) and must safely shut down the vacuum pump at switching point S2 (600 hPa#g (=mbar)). The digital display gives an indication to the operator about the degree of soiling and therefore necessary maintenance of the exhaust filter or the discharge/pressure side flame arrester.
- The temperature switch must safely inhibit the operation of the vacuum pump if the temperature limit (120 °C) is exceeded.

2. Avoidance of hazards to persons and goods from the effects of an explosion that might happen inside the vacuum pump despite the mentioned safety precautions.

- Pressure proof design of the vacuum pump, capable of resisting a pressure up to 18 barg without bursting.
- The suction connection and the gas discharge feature flame arrester(s) (j), preventing flashbacks into the suction side and discharge side of the system.
- Flame arrester (j) on the suction side of the vacuum pump with slip-stream interruption.

**Operational Options / Use of Optionally Available Equipment**

Operation with varying speed, i.e. with a frequency inverter is permitted, provided that the drive motor is approved for frequency inverter operation. The minimum speed shall not drop below 700 rpm. The maximum speed is the one for which the drive motor is intended without frequency inverter operation (i.e. the frequency inverter must not be used to increase the speed), but no more than 1800 rpm.

The system control must be designed such that no speed outside the permissible range can be set.

Operation with gas ballast, e.g. in order to avoid condensates, is permitted.

The return of separated oil from the oil separator into the suction connection (required for continuous operation at intake pressures higher than 300 hPa#mbar abs; standard for RE 0016 B, optional for RE 0040 B and RE 0063 B) is permitted.

Operation with an additional temperature switch (optional for RE 0040 B and RE 0063 B) which starts the vacuum pump, if the oil sump temperature falls below 0 °C, is permitted.

Operation with an ATEX-level switch (u) (optional) in order to monitor the oil level is permitted.

Operation with a nickel-plated oil separator (optional) (e) is permitted.

**Principle of Operation**

The vacuum pump works on the rotating vane principle.

A circular rotor (t) is positioned centrically on the shaft of the vacuum pump. The shaft of the vacuum pump is driven by the drive motor shaft by means of a flexible coupling.

The rotor (t) rotates in an also circular, fixed cylinder, the centreline of which is offset from the centreline of the rotor such that the rotor and the inner wall of the cylinder almost touch along a line. Vanes (s), sliding in slots in the rotor, separate the space between the rotor and the cylinder into chambers. At any time gas is sucked in and at almost any time ejected. Therefore the vacuum pump works almost pulsation free.

In order to avoid reverse rotation after switching off, the vacuum pump is equipped with a non-return valve.

**Note:** This valve shall not be used as a non-return valve or shut-off valve to the vacuum system and is no reliable means to prevent suction of oil into the vacuum system while the vacuum pump is shut down.

In case the vacuum pump is equipped with a gas ballast (optional):

Through the gas ballast a small amount of ambient air is sucked into the pump chamber and compressed together with the process gas. This counteracts the accumulation of condensates from the process gas inside the vacuum pump (page 10: Conveying Condensable Vapours).

The gas ballast line is equipped with a sinter metal filter.

In order to improve the operating characteristics the outlet of the pump chamber is equipped with a spring loaded valve (p).

**Oil Circulation**

The vacuum pump requires oil to seal the gaps, to lubricate the vanes (s) and to carry away compression heat.

The oil reservoir is located on the pressure side of the vacuum pump (i.e. high pressure) at the bottom of the bottom chamber of the oil separator (e).

The feed openings are located on the suction side of the vacuum pump (i.e. low pressure).

Forced by the pressure difference between pressure side and suction side oil is being drawn from the oil separator (e) through the oil supply lines and injected on the suction side.

Together with the sucked gas the injected oil gets conveyed through the vacuum pump and ejected into the oil separator (e) as oil mist. Oil that separates before the exhaust filter (p) accumulates at the bottom of the bottom chamber of the oil separator (e).

Oil that is separated by the exhaust filter (p) accumulates at the bottom of the upper chamber of the oil separator (e).

The flow resistance of the exhaust filters (p) causes the inside of the exhaust filters (which is connected to the bottom chamber of the oil separator) to be on a higher pressure level than the outside of the exhaust filters (i.e. the upper chamber of the oil separator). Because of the higher pressure in the bottom chamber it is not possible to let oil that drips off the exhaust filters simply flow down to the bottom chamber.

Version with oil return line to the suction connection:

Therefore the oil that accumulates in the upper chamber is sucked through the oil return line right to the suction connection.

Version with oil return line to the B-cover:

Therefore the oil that accumulates in the upper chamber is sucked through the oil return line right to the cylinder chamber.

**Cooling**

The vacuum pump/ compressor is cooled by

- radiation of heat from the surface of the vacuum pump incl. oil separator (e)
- the air flow from the fan wheel of the drive motor
Start Controls
The vacuum pump comes without start controls. The control of the vacuum pump is to be provided in the course of installation.

Safety

Intended Use
Definition: For the purpose of these instructions, “handling” the vacuum pump means the transport, storage, installation, commissioning, influence on operating conditions, maintenance, troubleshooting and overhaul of the vacuum pump.

The vacuum pump is intended for industrial use. It shall be handled only by qualified personnel.

The allowed media and operational limits ➔ page 3: Product Description) and the installation prerequisites ➔ page 6: Installation Prerequisites) of the vacuum pump shall be observed both by the manufacturer of the machinery into which the vacuum pump is to be incorporated and by the operator.

In particular the intended use in potentially explosive areas, i.e. either inside the vacuum pump or in its adjacency potentially explosive atmosphere can occur, requires that the vacuum pump is equipped accordingly and carries the Ex-mark and that the associated documentation acc. to the directive 2014/34/EU is available.

The maintenance instructions shall be observed.

Prior to handling the vacuum pump these installation and operating instructions shall be read and understood. If anything remains to be clarified please contact your Busch representative!

Safety Notes
The vacuum pump has been designed and manufactured according to state-of-the-art methods. Nevertheless, residual risks may remain. These operating instructions highlight potential hazards where appropriate. Safety notes are tagged with one of the keywords DANGER, WARNING and CAUTION as follows:

DANGER
Disregard of this safety note will always lead to accidents with fatal or serious injuries.

WARNING
Disregard of this safety note may lead to accidents with fatal or serious injuries.

CAUTION
Disregard of this safety note may lead to accidents with minor injuries or property damage.

Emission of Oil Mist
The oil in the process gas is separated to the greatest possible extent, but not perfectly.

Note: The possibly sensible smell is not caused by droplets of oil, though, but either by gaseous process components or by readily volatile and thus gaseous components of the oil (particularly additives).

Noise Emission
For the sound pressure level in free field according to EN ISO 2151 ➔ page 45: Technical Data

Transport
Note: Also a vacuum pump, that is not topped up with oil contains residues of oil (from the test run). Always transport and store the vacuum pump in upright position. Do not put the vacuum pump on its side nor put it upside down.

Transport in Packaging
Packed on a pallet the vacuum pump is to be transported with a forklift.

Transport without Packaging
In case the vacuum pump is packed in a cardboard box with inflated cushions:
♦ Remove the inflated cushions from the box

In case the vacuum pump is packed in a cardboard box cushioned with rolled corrugated cardboard:
♦ Remove the corrugated cardboard from the box

In case the vacuum pump is laid in foam:
♦ Remove the foam

In case the vacuum pump is bolted to a pallet or a base plate:
♦ Remove the bolting between the vacuum pump and the pallet/base plate

In case the vacuum pump was bolted to a pallet or a base plate:
♦ Remove the stud bolts from the rubber feet

DANGER
Disregard of this safety note will always lead to accidents with fatal or serious injuries.

WARNING
Disregard of this safety note may lead to accidents with fatal or serious injuries.

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

• Make sure that the eyebolt is in faultless condition (replace a damaged, e.g. bent eyebolt with a new one)
• Make sure that the eyebolt is fully screwed in and tightened by hand
• Attach lifting gear securely to the eyebolt on the oil separator
• Attach the lifting gear to a crane hook with safety latch
• Lift the vacuum pump with a crane

In case the vacuum pump was bolted to a pallet or a base plate:
♦ Remove the stud bolts from the rubber feet
Prior to every transport make sure that the operating fluid is drained.

Storage

Short-term Storage

Version with gas ballast with ball-valve:

♦ Close the sinter metal filter of the gas ballast device with adhesive tape
♦ Make sure that the suction connection and the gas discharge are closed (leave the provided plugs in)
♦ Store the vacuum pump
  − if possible in original packaging,
  − indoors,
  − dry,
  − dust free and
  − vibration free.

Version with gas ballast without ball-valve, with sinter metal filter:

♦ Close the sinter metal filter of the gas ballast device with adhesive tape

Conservation

In case of adverse ambient conditions (e.g. aggressive atmosphere, frequent temperature changes) conserve the vacuum pump immediately. In case of favourable ambient conditions conserve the vacuum pump if a storage of more than 3 months is scheduled.

During the test run in the factory the inside of the vacuum pump was completely wetted with oil. Under normal conditions a treatment with conservation oil is therefore not required. In case it is advisable to treat the vacuum pump with conservation oil because of very adverse storage conditions, seek advice from your Busch representative!

Version with gas ballast without ball-valve, with sinter metal filter:

♦ Close the sinter metal filter of the gas ballast device with adhesive tape
♦ Make sure that all ports are firmly closed; seal all ports that are not sealed with PTFE-tape, gaskets or o-rings with adhesive tape

Note: VCI stands for "volatile corrosion inhibitor". VCI-products (film, paper, cardboard, foam) evaporate a substance that condenses in molecular thickness on the packed good and by its electro-chemical properties effectively suppresses corrosion on metallic surfaces. However, VCI-products may attack the surfaces of plastics and elastomers. Seek advice from your local packaging dealer! Busch uses CORTEC VCI 126 R film for the overseas packaging of large equipment.

♦ Wrap the vacuum pump in VCI film
♦ Store the vacuum pump
  − if possible in original packaging,

Installation and Commissioning

Installation Prerequisites

CAUTION

Tilting a vacuum pump that is already filled with operating fluid can cause large quantities of operating fluid to ingress into the cylinder.

Starting the vacuum pump with excessive quantities of operating fluid in the cylinder immediately will break the vanes (s) and ruin the vacuum pump.

Once the vacuum pump is filled with operating fluid it shall not be lifted anymore.

− indoors,
− dry,
− dust free and
− vibration free.

For commissioning after conservation:

− Make sure that all remains of adhesive tape are removed from the ports
− Commission the vacuum pump as described in the chapter Installation and Commissioning (➔ page 6)

Mounting Position and Space

− Make sure that the following ambient conditions will be complied with:
  − ambient temperature: see "Technical Data"
    If the vacuum pump is installed in a colder environment than allowed with the oil used:
    ♦ Fit the vacuum pump with a temperature switch and control the vacuum pump such that it will start automatically when the oil sump temperature falls below the allowed temperature
  − ambient pressure: atmospheric
  − Make sure that the environmental conditions comply with the protection class of the drive motor (according to the nameplate)
  − Make sure that the vacuum pump can neither inadvertently nor intentionally be stepped on and cannot be used as a support for heavy objects
  − Make sure that the vacuum pump cannot be hit by falling objects
  − Make sure that the vacuum pump will be placed or mounted horizontally
  − Make sure that the base for placement / mounting base is even
  − Make sure that in order to warrant a sufficient cooling there will be a clearance of minimum 0.1 m between the vacuum pump and nearby walls
CAUTION
During operation the surface of the vacuum pump may reach temperatures of more than 70 °C.
Risk of burns!

Make sure that the vacuum pump will not be touched inadvertently during operation, provide a guard if appropriate

Make sure that the sight glass (n) will remain easily accessible

If the oil change is meant to be performed on location:
- Make sure that the drain port (o) and the filling port (c) will remain easily accessible
- Make sure that enough space will remain for the removal and the reinsertion of the exhaust filter (p)

Suction Connection

CAUTION
Intruding foreign objects or liquids can destroy the vacuum pump

In case the inlet gas can contain dust or other foreign solid particles:
- Make sure that a suitable filter (5 micron or less) is installed upstream the vacuum pump
- Make sure that the filter is sufficiently ATEX-qualified (electrically conductive, with equipotential bonding etc.; also for non-combustible dusts!)
- Make sure that the suction line fits to the suction connection (i) of the vacuum pump
- Make sure that the pipe will cause no stress on the vacuum pump’s connection, if necessary use an expansion joint
- Make sure that the line size of the suction line over the entire length is at least as large as the suction connection (i) of the vacuum pump

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

If two or more vacuum pumps work on the same suction line, if the volume of the vacuum system is large enough to suck back oil or if the vacuum shall be maintained after switching off the vacuum pump:
- Provide a manual or automatic operated valve (= non-return valve) in the suction line
  (the standard non-return valve that is installed inside the suction connection is not meant to be used for this purpose!)

If the vacuum pump is planned to be used for the suction of gas that contains limited quantities of condensable vapour:
- Provide a shut-off valve, a drip-leg and a drain cock in the suction line, so that condensates can be drained from the suction line
- Make sure that the suction line does not contain foreign objects, e.g. welding scales

Gas Discharge

The discharged gas must flow without obstruction. It is not permitted to shut off or throttle the discharge line or to use it as a pressurised air source.

WARNING
The vacuum pump is intended to convey potentially explosive gases/gas mixtures.
Risk of explosion in the discharge area!
The process gas/gas mixture must be disposed of such that no potentially explosive gas mixtures can accumulate in the discharge area.

CAUTION
The discharged gas contains small quantities of vacuum oil.

Staying in vacuum oil contaminated air bears a risk of damage to health.
If air is discharged into rooms where persons stay, sufficient ventilation must be provided for.

- Make sure that the discharge line fits to the gas discharge (l) of the vacuum pump
- Make sure that the pipe will cause no stress on the vacuum pump’s connection, if necessary use an expansion joint
- Make sure that the line size of the discharge line over the entire length is at least as large as the gas discharge of the vacuum pump

In case the length of the discharge line exceeds 2 m it is prudent to use larger line sizes in order to avoid a loss of efficiency and an overload of the vacuum pump. Seek advice from your Busch representative!

- Make sure that the discharge line either slopes away from the vacuum pump or provide a liquid separator or a drip leg with a drain cock, so that no liquids can back up into the vacuum pump

WARNING
Discharge lines made from non-conductive material can build up static charge.
Static discharge can cause explosion of potentially existing oil mist.
The discharge line must be made of conductive material or provisions must be made against static discharge.

Electrical Connection / Controls

- Make sure that installation instructions for the ATEX-drive motor (separate leaflet) are available
- Observe the instructions given in the installation instructions manual for the ATEX-drive motor
- Make sure that the stipulations acc. to the EMC-Directive 2004/108/EC and Low-Voltage-Directive 2006/95/EC as well as the EN-standards, electrical and occupational safety directives and the local or national regulations, respectively, are complied with (this is the responsibility of the designer of the machinery into which the vacuum pump is to be incorporated; ⇒ page 24: note in the EC-Declaration of Conformity).
• Make sure that the power supply for the drive motor is compatible with the data on the nameplate of the drive motor
• Make sure that an overload protection according to EN 60204-1 is provided for the drive motor
• Make sure that the drive of the vacuum pump will not be affected by electric or electromagnetic disturbance from the mains; if necessary seek advice from the Busch service

In case of mobile installation:
♦ Provide the electrical connection with grommets that serve as strain-relief
♦ Execute the interfaces for the switches for
  - pressure inside the oil separator
  - temperature inside the oil separator
  - level monitoring (level switch (u); optional)
  in the system control according to the safety concept (page 3: Safety Concept) and according to the Equipment Documentation Measurement and Safety Instrumentation (page 30)
♦ Make sure that an earth point is available for connection to the earthing connection of the vacuum pump

Electrical circuits in zone 1 (outside) shall be executed intrinsically safe in protection class ib acc. to EN 60079-11.

All signal lines shall be executed with shielded cables according to EN 60079-14 or EN 61241-14 or the equivalent national or local regulations.

Installation

Mounting
• Make sure that the installation prerequisites (page 6) are complied with
• Set down or mount the vacuum pump at its location

Connecting Electrically

![WARNING]

**WARNING**
Risk of electrical shock, risk of damage to equipment.

Electrical installation work must only be executed by qualified personnel that knows and observes the following regulations:
- IEC 364 or CENELEC HD 384 or DIN VDE 0100, respectively,
- IEC-Report 664 or DIN VDE 0110,
- BGV A2 (VBG 4) or corresponding national accident prevention regulations.

• Connect the drive motor according to the installation instructions for the drive motor (separate leaflet)
• Electrically connect the drive motor
• Connect the protective earthing conductor

![CAUTION]

**CAUTION**
Operation in the wrong direction of rotation can destroy the vacuum pump in short time.
Risk of explosion!
Prior to starting-up it must be made sure that the vacuum pump is operated in the proper direction (clockwise rotating field).

Version with three-phase motor:
♦ Determine the intended direction of rotation with the arrow (stuck on or cast)

♦ “Bump” the drive motor
♦ Watch the fan wheel of the drive motor and determine the direction of rotation just before the fan wheel stops

If the rotation must be changed:
♦ Switch any two of the drive motor wires

![WARNING]

**WARNING**
The proper integration of measurement and safety equipment into the system control is decisive for the explosion safety of the vacuum pump.
Risk of explosion!
The vacuum pump may be operated in areas with potentially explosive atmosphere only with completely installed and checked measurement and safety equipment.

• Connect the switches for
  - pressure inside the oil separator
  - temperature inside the oil separator
  - level monitoring (optional)
to the system control (page 30: Equipment Documentation Measurement and Safety Instrumentation)
• After connecting the cable to the temperature switch make sure that the gasket is inserted between the front and the rear part of the housing, the housing is firmly closed and the grommet is tightened
• Connect the earthing connection of the vacuum pump to the earth point with an earth cable

Connecting Lines/Pipes
In case the suction line is equipped with a shut-off valve:
♦ Connect the suction line

**Note:** During the functional check of the measurement and safety instrumentation in the course of the test run with inert gas it is necessary to throttle the gas discharge, which will require the discharge line to be disconnected from the vacuum pump

• Connect the discharge line

Installation without discharge line:
♦ Make sure that the gas discharge (l) is open
• Make sure that all provided covers, guards, hoods etc. are mounted
• 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

Filling Oil
In case the vacuum pump was treated with conservation oil:
♦ Drain the remainders of conservation oil

![CAUTION]

**CAUTION**
The vacuum pump is shipped without oil.
Operation without oil will ruin the vacuum pump in short time.
Prior to commissioning it must be made positively sure that oil is filled in.

The vacuum pump is delivered without oil (oil specification page 23: Oil).

• Keep approx. 1.0 litre (RE 0016 B) or 2.0 litres (RE 0040 B / RE 0063 B) oil acc. to the table Oil (page 23) ready

RE 0016 B / RE 0040 B / RE 0063 B
Note: The amount given in these operating instructions is a guide. The sight glass (n) indicates the actual amount to be filled in.

Version with level switch (u):
- Make sure that the level switch (u) reports "low level"
- Switch on the vacuum pump
- Make sure that the vacuum pump does not start!

**CAUTION**
Filling oil through the suction connection (i) will result in breakage of the vanes (s) and destruction of the vacuum pump.
Oil may be filled through the filling port (c) only.

**CAUTION**
During operation the oil separator is filled with hot, pressurised oil mist.
Risk of injury from hot oil mist with open filling port.
Risk of injury if a loosely inserted filling plug (c) is ejected.
Remove the filling plug (c) only if the vacuum pump is stopped.
The vacuum pump must only be operated with the filling plug (c) firmly inserted.

- Remove the filling plug (c)
- Fill in approx. 1.0 litre (RE 0016 B) or 2.0 litres (RE 0040 B / RE 0063 B) of oil
- Make sure that the level is between the MIN and the MAX-markings of the sight glass (n)

Version with level switch (u):
- Make sure the level switch (u) reports correct level
- Make sure that the seal ring is inserted into the filling plug (c) and undamaged, replace if necessary
- Firmly reinsert the filling plug (c) together with the seal ring

**Note:** Starting the vacuum pump with cold oil is made easier when at this very moment the suction line is neither closed nor covered with a rubber mat.

- Switch on the vacuum pump

In case the suction line is equipped with a shut-off valve:
- Close the shut-off valve

In case the suction line is not equipped with a shut-off valve:
- Cover the suction connection (i) with a piece of rubber mat
- Let the vacuum pump run for a few minutes

Version with level switch (u):
- Check that the level switch (u) reports correct level
- Shut down the vacuum pump and wait a few minutes
- Check that the level is between the MIN and the MAX-markings of the sight glass (n)

In case the level has dropped below the MIN-marking:
In case the level switch (u) has reported low level:
- Top-up oil

In case the suction line is equipped with a shut-off valve:
- Open the shut-off valve

In case the suction line is not equipped with a shut-off valve:
- Remove the piece of rubber mat and connect the suction line

**Checking the Function of the Measurement and Safety Instrumentation**

**WARNING**
Risk of electrical shock, risk of damage to equipment.
Electrical installation work must only be executed by qualified personnel that knows and observes the following regulations:
- IEC 364 or CENELEC HD 384 or DIN VDE 0100, respectively
- IEC-Report 664 or DIN VDE 0110
- BGV A2 (VBG 4) or corresponding national accident prevention regulation.

- Make sure that the vacuum pump aspirates inert gases and that there are no potentially explosive atmospheres in the environment
- Disconnect the discharge line from the vacuum pump
- Connect a throttle valve to the gas discharge (i)
- Switch on the vacuum pump
- Interrupt the electrical circuit of the temperature switch by pulling a connector from the temperature switch
- Make sure that an alarm is released in the system control and the vacuum pump is shut down automatically
- Push the connector back on the temperature switch
- Make sure that the alarm persists
- Make sure that the vacuum pump does not start self-acting
- Switch on the vacuum pump again
- Throttle the gas discharge until the display on the pressure switch/indicator (a) shows 550 hPag (=mbarg)
- Make sure that a warning is released in the system control
- Relieve the throttling of the gas discharge
- Make sure that the warning persists
- Throttle the gas discharge further until the display on the pressure switch/indicator (a) shows 600 hPag (=mbarg)
- Make sure that an alarm is released in the system control, the vacuum pump is shut down automatically and remains shut down
- Remove the throttle valve and connect the discharge line
- Make sure that on the temperature switch the gasket is inserted between the housing cover and the housing bottom, firmly close the housing and tighten the cable gland

**Recording of Operational Parameters**
As soon as the vacuum pump is operated under normal operating conditions:
- Measure the drive motor current and record it as reference for future maintenance and troubleshooting work
- Read the display on the pressure switch/indicator (a) and record it as reference for future maintenance and troubleshooting work (➔ page 13: Checks during Operation)
Operation Notes

Use

**WARNING**

The vacuum pump is designed for operation under the conditions described below.

In case of disregard risk of explosion!

The vacuum pump must only be operated under the conditions described below.

**WARNING**

Operating a faulty vacuum pump puts the explosion safety at risk.

Risk of explosion!

The vacuum pump must only be operated in faultless condition. A faulty vacuum pump must immediately be removed from service.

The vacuum pump is intended for

- the suction
- explosionsfähigen trockenen, nicht aggressiven und nicht giftigen Gasgemischen gemäß Baumusterprüfungbeantragung

Conveying media with a lower or higher density than air leads to an increased thermal and/or mechanical load on the vacuum pump and is permissible only after prior consultation with Busch.

Permissible temperature range of the inlet gas: see "Technical Data"

According to the directive 2014/34/EU the vacuum pump is made for the intended use in potentially explosive areas.

According to this directive the vacuum pump is inside a category 2 device (suitable for connection to tubings the inside of which is classified as zone 0). Outside the vacuum pump is approved as category 2 device (for use in zone 1).

According to the EC-Type Examination Certificate issued by the German "Physikalisch-Technische Bundesanstalt" (PTB) the vacuum pump may be used for the conveyance of explosive atmospheres consisting of a mixture with air of flammable substances in the form of gas, provided that the material belongs to the temperature classes T1 to T4 according to EN 13463–1 and to the explosion groups IIA to IIB3 according to E. Brandes, W. Möller "Sicherheitstechnische Kenngrößen, Band 1: Brennbare Flüssigkeiten und Gase", ISBN 3–89701–745–8 (or equivalent source).

The vacuum pump is approved for use in potentially explosive atmospheres provided that the material belongs to the temperature classes T1 to T4 according to EN 13463–1 and to the explosion groups IIA to IIB3 (zone 1).

In case of disregard risk of explosion!

The vacuum pump shall be protected against contact during operation, it shall cool down prior to a required contact or heat protection gloves shall be worn.

Permissible temperature range of the inlet gas: see "Technical Data"

According to the directive 2014/34/EU the vacuum pump is made for the intended use in potentially explosive areas.

According to this directive the vacuum pump is inside a category 2 device (suitable for connection to tubings the inside of which is classified as zone 0). Outside the vacuum pump is approved as category 2 device (for use in zone 1).

According to the EC-Type Examination Certificate issued by the German "Physikalisch-Technische Bundesanstalt" (PTB) the vacuum pump may be used for the conveyance of explosive atmospheres consisting of a mixture with air of flammable substances in the form of gas, provided that the material belongs to the temperature classes T1 to T4 according to EN 13463–1 and to the explosion groups IIA to IIB3 according to E. Brandes, W. Möller "Sicherheitstechnische Kenngrößen, Band 1: Brennbare Flüssigkeiten und Gase", ISBN 3–89701–745–8 (or equivalent source).

The vacuum pump is approved for use in potentially explosive atmospheres provided that the material belongs to the temperature classes T1 to T4 according to EN 13463–1 and to the explosion groups IIA to IIB3 (zone 1).

In case of disregard risk of explosion!

The vacuum pump shall be protected against contact during operation, it shall cool down prior to a required contact or heat protection gloves shall be worn.

**CAUTION**

During operation the surface of the vacuum pump may reach temperatures of more than 70 °C.

Risk of burns!

The vacuum pump shall be protected against contact during operation, it shall cool down prior to a required contact or heat protection gloves shall be worn.

**CAUTION**

The gas conveyed by the vacuum pump contains remainders of oil.

Aspiration of process gas over extended periods can be harmful.

The room into which the process gas is discharged must be sufficiently vented.

- Make sure that all provided covers, guards, hoods etc. remain mounted
- Make sure that protective devices will not be disabled
- Make sure that cooling air inlets and outlets will not be covered or obstructed and that the cooling air flow will not be affected adversely in any other way
- Make sure that the installation prerequisites (page 6: Installation Prerequisites) are complied with and will remain complied with, particularly that a sufficient cooling will be ensured

Conveying Condensable Vapours

**CAUTION**

Residual condensates dilute the oil, deteriorate its lubricating properties and can cause a seizure of the rotor.

Apply a suitable operating method to make sure that no condensates remain in the vacuum pump.

In order to use the vacuum pump for the conveyance of condensable vapours, the vacuum pump must be equipped with a shut-off valve in the suction line and with a gas ballast.

- Close the shut-off valve in the suction line
- Operate the vacuum pump with the suction line shut off for approx. half an hour, so that the operating temperature rises to approx. 75 °C

At process start:

- Open the shut-off valve in the suction line

At the process end:
Maintenance

WARNING

The approval of the vacuum pump for use in potentially explosive areas remains valid only if the maintenance is conducted regularly according to the maintenance schedule below and genuine spare parts and consumables, approved for use in potentially explosive areas by Busch, are used exclusively.

Maintenance work must be executed by qualified personnel, specially instructed in the maintenance of this type of vacuum pump by Busch.

DANGER

In case the vacuum pump conveyed gas that was contaminated with foreign materials which are dangerous to health, harmful material can reside in filters.

Danger to health during inspection, cleaning or replacement of filters.

Danger to the environment.

Personal protective equipment must be worn during the handling of contaminated filters.

Contaminated filters are special waste and must be disposed of separately in compliance with applicable regulations.

CAUTION

During operation the surface of the vacuum pump may reach temperatures of more than 70 °C.

Risk of burns!

• Prior to action that requires touching of the vacuum pump, let the vacuum pump cool down, however, if the oil is to be drained, for no more than 20 minutes (the oil shall still be warm when being drained)
• Prior to disconnecting connections make sure that the connected pipes/lines are vented to atmospheric pressure

Maintenance Schedule

Note: The maintenance intervals depend very much on the individual operating conditions. The intervals given below are upper limits that must not be exceeded.

Particularly heavy duty operation, such like high dust loads in the environment or in the process gas, other contaminations or ingress of process material, can make it necessary to shorten the maintenance intervals significantly.

Daily:

Version without level switch (u):

♦ Check the level and the colour of the oil (➔ page 12: Checking the Oil)

Weekly:

Version with level switch (u):

♦ Check that the filling plug (c) and the drain plug (o) are firmly seated
♦ Check the vacuum pump for oil leaks – in case of leaks immediately remove the vacuum pump from service and have it repaired (Busch service)

Monthly:

• Check that the filling plug (c) and the drain plug (o) are firmly seated
• Check the vacuum pump for oil leaks – in case of leaks immediately remove the vacuum pump from service and have it repaired (Busch service)

Every 6 Months:

• Make sure that the housing is free from dust and dirt, clean if necessary
• Make sure that the vacuum pump is shut down and locked against inadvertent start up

Note: Any kind of deposit on the vacuum pump compromises the explosion safety of the vacuum pump.

• Clean the fan cowlings, fan wheels, the ventilation grilles and cooling fins

Version with BoWex-coupling:

♦ Undo the screws of the drive motor
♦ Remove the drive motor
♦ Check the coupling element for wear (➔ page 43: Excerpt from Operating- / Assembly Instructions of the BoWex-coupling)
♦ Mount the drive motor on the vacuum pump

• Service the flame arrestors (j) (k) – in case of discolouration or deformation consult Busch or the manufacturer of the flame arrestor in any case
• Check the electrical connection
• Make sure that the electrical connection of the temperature monitoring is undamaged
• Make sure that the electrical connection of the pressure monitoring is undamaged

Version with level switch (u):

♦ Make sure that the electrical connection of the level switch is undamaged
♦ Make sure that the earth cable (cable between earth connection of the vacuum pump and earth point) is undamaged (resistance check)

WARNING

The proper assembly of flame arrestors is essential for their safe function.

Risk of explosion in case of faulty assembly!

Flame arrestors must only be serviced by personnel that have received specific training for this purpose either by Busch or by the manufacturer of the flame arrestors.
Every Year:
- Make sure that the vacuum pump is shut down and locked against inadvertent start up
- Replace the exhaust filter (p) (⇒ page 13: Exhaust Filter)

Version with Sure-Flex-coupling:
- Undo the screws of the drive motor
- Remove the drive motor
- Check the coupling element for wear, replace if necessary
- Mount the drive motor on the vacuum pump

In case an inlet air filter is installed:
- Replace the inlet air filter

In case an inlet screen is installed:
- Check the inlet screen, clean if necessary

Version with gas ballast with sinter metal filter:
- Clean the sinter metal filter (compressed air)
- Check the function of the measurement and safety instrumentation (⇒ page 14: Functional Check of the Measurement and Safety Instrumentation)

Every 500 – 2000 Operating Hours:
(⇒ page 12: Oil Life):
- Change the oil (⇒ page 13: Oil Change)

Alle 16000 Betriebsstunden, spätestens nach 4 Jahren:
- Have a major overhaul on the vacuum pump (Busch service)

Checking the Oil

Checking the Level
- Make sure that the vacuum pump is shut down and the oil has collected at the bottom of the oil separator (e)
- Read the level on the sight glass (n)

In case the level has dropped underneath the MIN-marking:
In case the level switch (u) (optional) has reported low level:
- Top up oil (⇒ page 12: Topping up Oil)

In case the level exceeds the MAX-marking:
- Excessive dilution with condensates – change the oil and check the process
- If appropriate retrofit a gas ballast (Busch Service) and observe the chapter Conveying Condensable Vapours (⇒ page 10)

In case the level exceeds the MAX-marking despite proper use of the gas ballast:
- Clean the sinter metal filter (compressed air)

Topping up Oil

Note: Under normal conditions there should be no need to top up oil during the recommended oil change intervals. A significant level drop indicates a malfunction (⇒ page 16: Troubleshooting).

Note: During operation the exhaust filter gets saturated with oil. It is therefore normal that the oil level will drop slightly after replacement of the exhaust filter.

---

**CAUTION**
Filling oil through the suction connection (i) will result in breakage of the vanes (s) and destruction of the vacuum pump.

Oil may be filled through the filling port (c) only.

**CAUTION**
During operation the oil separator is filled with hot, pressurised oil mist.
Risk of injury from hot oil mist with open filling port.
Risk of injury if a loosely inserted filling plug (c) is ejected.
Remove the filling plug (c) only if the vacuum pump is stopped.
The vacuum pump must only be operated with the filling plug (c) firmly inserted.

- Make sure that the vacuum pump is shut down and locked against inadvertent start up
- Remove the filling plug (c)
- Top up oil until the level reaches the middle of the sight glass (n)

Version with level switch (u):
- Make sure the level switch (u) reports correct level
- Make sure that the seal ring is inserted into the filling plug (c) and undamaged, replace if necessary
- Firmly reinsert the filling plug (c) together with the seal ring

Checking the Colour of the Oil

Note: The oil should be light, either transparent, a little foamy or a little tarnished. A milky discolouration that does not vanish after sedimentation of the oil indicates contamination with foreign material. Oil that is either contaminated with foreign material or burnt must be changed (⇒ page 13: Oil Change).

In case of burnt oil:
- Check the function of the temperature monitoring (⇒ page 14: Functional Check of the Measurement and Safety Instrumentation)

In case the oil appears to be contaminated with water or other condensates despite proper use of the gas ballast:
- Clean the sinter metal filter (compressed air)

Oil Life

The oil life depends very much on the operating conditions. A clean and dry air stream and operating temperatures below 100 °C are ideal. Under these conditions the oil shall be changed every 500 to 2000 operating hours or after half a year.

Under very unfavourable operating conditions the oil life can be less than 500 operating hours. Extremely short life times indicate malfunctions (⇒ page 16: Troubleshooting) or unsuitable operating conditions, though.

Choosing a synthetic oil instead of a mineral oil can extend the oil life.
Oil Change

Draining Used Oil

Note: After switching off the vacuum pump at normal operating temperature wait no more than 20 minutes before the oil is drained (the oil shall still be warm when being drained).

- Make sure that the vacuum pump is shut down and locked against inadvertent start up
- Make sure that the vacuum pump is vented to atmospheric pressure
- Put a drain tray underneath the drain port (o)
- Remove the drain plug (o) and drain the oil

When the oil stream dwindles:

- Reinsert the drain plug (o)
- If applicable, bridge the level switch (u)
- Switch the vacuum pump on for a few seconds
- Make sure that the vacuum pump is shut down and locked against inadvertent start up
- Remove the drain plug (o) again and drain the remaining oil
- Make sure that the seal ring is inserted into the drain plug (o) and undamaged, replace if necessary
- Firmly reinsert the drain plug (o) together with the seal ring
- Dispose of the used oil in compliance with applicable regulations

Flushing the Vacuum Pump

- Fill in the flushing agent
- Firmly reinsert the filling plug (c)
- Close the suction line
- Run the vacuum pump for at least half an hour
- Drain the flushing agent and dispose of it in compliance with applicable regulations

Note: Due to the use of paraffin and even more in case of using diesel fuel/fuel oil, an unpleasant odour can occur after recommissioning. If this is a problem, diesel fuel/fuel oil should be avoided and the vacuum pump be run at idle in a suitable place until the unpleasant odour vanishes.

Filling in Fresh Oil

- Keep 1 litres (RE 0016 B) or 2 litres (RE 0040 B / RE 0063 B) oil acc. to the table Oil (➔ page 23) ready

Note: The amount given in these operating instructions is a guide. The sight glass (n) indicates the actual amount to be filled in.

Version with level switch (n):
- Make sure that the level switch (u) reports "low level"
- Switch on the vacuum pump
- Make sure that the vacuum pump does not start!
- Make sure that the drain plug (o) is firmly inserted

- Remove the filling plug (c)
- Fill in approx. 1 litre (RE 0016 B) or 2 litres (RE 0040 B / RE 0063 B) of oil
- Make sure that the seal ring is inserted into the filling plug (c) and undamaged, replace if necessary
- Firmly reinsert the filling plug (c) together with the seal ring

Exhaust Filter

Check during Operation

- Remove the suction line from the suction connection (i) (unrestricted suction!)
- Check that the reading on the display of the pressure switch/indicator (a) is close to the value recorded at the end of the installation
- Reconnect the suction line to the suction connection (i)
- Check that the discharged gas is free from oil

Assessment

If the pressure switch/indicator (a) indicates a higher pressure than usual, then the exhaust filter (p) is clogged and must be replaced.

Note: Exhaust filters cannot be cleaned successfully. Clogged exhaust filters must be replaced with new ones.
If the pressure switch/indicator (a) indicates a lower pressure than usual, then the exhaust filter (p) is broken through and must be replaced.

If the discharged gas contains oil, the exhaust filter (p) can either be clogged or broken through and, if applicable, must be replaced.

**WARNING**

The proper assembly of flame arrestors is essential for their safe function.

Risk of explosion in case of faulty assembly!

Risk of eye injury.

Flame arrestors must only be serviced by personnel that have received specific training for this purpose either by Busch or by the manufacturer of the flame arrestors.

If the pressure switch/indicator (a) continues to read a higher pressure than usual after the replacement of the exhaust filter, the flame arrestor (k) on the discharge/pressure side can be soiled:

- Service the flame arrestors (j) (k) – in case of discoloration or deformation consult Busch or the manufacturer of the flame arrestor in any case

**Change of the Exhaust Filter**

In case the vacuum pump conveyed gas that was contaminated with harmful foreign material the exhaust filter will be contaminated with harmful material.

Danger to health during the changing of the contaminated exhaust filter.

Danger to the environment.

Wear personal protective equipment during the changing of the contaminated exhaust filter.

Used exhaust filters are special waste and must be disposed of separately in compliance with applicable regulations.

**Removing the Exhaust Filter**

- Make sure that the vacuum pump is shut down and locked against inadvertent start up
- Prior to disconnecting pipes/lines make sure that the connected pipes/lines are vented to atmospheric pressure
- Remove the discharge line, if necessary
- Remove the exhaust cover (k) from the oil separator (e)
- Loosen the screw in the centre of the exhaust filter retaining spring, but do not remove it at this time
- Press the screw in the centre of the exhaust filter retaining spring, but do not remove it at this time
- Make sure that the new exhaust filter (p) is equipped with a new o-ring
- Insert the exhaust filter (p) such that its port is properly seated in its receptacle in the oil separator (e)
- Make sure that the tip of the screw in the centre of the exhaust filter retaining spring protrudes the retaining spring by about 2 – 5 revolutions
- Make sure that the seal under the exhaust cover (k) is clean and undamaged, if necessary replace with a new seal
- Mount the exhaust cover (k) together with the seal and hex head screws on the oil separator (e)
- If necessary connect the discharge line

**WARNING**

Risk of explosion in case of faulty assembly!

Risk of eye injury.

Eye protection goggles must be worn while handling filter springs.

**Inserting the Exhaust Filter**

- Pull the exhaust filter (p) out of the oil separator (e)
- Make sure that the new exhaust filter (p) is equipped with a new o-ring
- Insert the exhaust filter (p) such that its port is properly seated in its receptacle in the oil separator (e)
- Make sure that the tip of the screw in the centre of the exhaust filter retaining spring protrudes the retaining spring by about 2 – 5 revolutions
- Insert the exhaust filter retaining spring such that its ends are secured in their receptacles in the oil separator (e) by the protrusions and that the tip of the screw snaps into the indent of the exhaust filter (p)
- Tighten the screw in the exhaust filter retaining spring such that the screw head touches the spring steel sheet
- Make sure that the seal under the exhaust cover (k) is clean and undamaged, if necessary replace with a new seal
- Make sure that the alarm persists

**Check the Function of the Measurement and Safety Instrumentation**

- Make sure that the vacuum pump aspirates inert gases and that there are no potentially explosive atmospheres in the environment
- Disconnect the discharge line from the vacuum pump
- Connect a throttle valve to the gas discharge (l)
- Switch on the vacuum pump
- Interrupt the electrical circuit of the temperature switch by pulling a connector from the temperature switch
- Make sure that an alarm is released in the system control and the vacuum pump is shut down automatically
- Push the connector back on the temperature switch
- Make sure that the alarm persists
- Make sure that the vacuum pump does not start self-acting
- Switch on the vacuum pump again
- Throttle the gas discharge until the display on the pressure switch/indicator (a) shows 550 hPagg (=mbarg)
- Make sure that a warning is released in the system control
- Relieve the throttling of the gas discharge
- Make sure that the warning persists

---

**Maintenance**

RE 0016 B / RE 0040 B / RE 0063 B
• Throttle the gas discharge further until the display on the pressure switch/indicator (a) shows 600 hPa (=mbarg)
• Make sure that an alarm is released in the system control, the vacuum pump is shut down automatically and remains shut down
• Remove the throttle valve and connect the discharge line
• Make sure that on the temperature switch the gasket is inserted between the housing cover and the housing bottom, firmly close the housing and tighten the cable gland

Overhaul

DANGER
Improper work on the vacuum pump puts the operating safety at risk.
Risk of explosion!
Approval for operation will be void!

Any dismantling of the vacuum pump that is beyond of what is described in this manual must be done by specially trained Busch service personnel only.

DANGER
In case the vacuum pump conveyed gas that was contaminated with harmful foreign material the oil and the exhaust filter(s) will be contaminated with harmful material.

Harmful material can reside in pores, gaps and internal spaces of the vacuum pump.

Danger to health during dismantling of the vacuum pump.

Danger to the environment.

Prior to shipping the vacuum pump shall be decontaminated as good as possible and the contamination status shall be stated in a “Declaration of Contamination” (form downloadable from www.busch–vacuum.com).

Overhaul

Dismantling and Disposal

DANGER
In case the vacuum pump conveyed gas that was contaminated with harmful foreign material the oil and the exhaust filter(s) will be contaminated with harmful material.

Harmful material can reside in pores, gaps and internal spaces of the vacuum pump.

Danger to health during dismantling of the vacuum pump.

Danger to the environment.

During dismantling of the vacuum pump personal protective equipment must be worn.

The vacuum pump must be decontaminated prior to disposal.

Oil and exhaust filters must be disposed of separately in compliance with applicable regulations.

CAUTION
Used oil and used exhaust filters are special waste and must be disposed of in compliance with applicable regulations.

CAUTION
The filter spring can fly out of the exhaust port during removal.
Risk of eye injury.
Eye protection goggles must be worn while handling filter springs.

Removal from Service

Temporary Removal from Service
• Prior to disconnecting pipes/lines make sure that all pipes/lines are vented to atmospheric pressure

Recommissioning

CAUTION
Vanes (s) can stick after a long period of standstill.
Risk of vane breakage if the vacuum pump is started with the drive motor.

After longer periods of standstill the vacuum pump shall be turned by hand.

After longer periods of standstill:

• Make sure that the vacuum pump is locked against inadvertent start up
• Remove the cover around the fan of the drive motor
• Slowly rotate the fan wheel by hand several revolutions in the intended direction of rotation (see stuck on or cast arrow
• Mount the cover around the fan wheel of the drive motor

If deposits could have gathered in the vacuum pump

• Flush the vacuum pump (→ page 11: Maintenance)

• Observe the chapter Installation and Commissioning (→ page 6)
## Troubleshooting

### WARNING

**Vacuum pump for use in potentially explosive atmospheres.**

The vacuum pump must only be operated in faultless condition.

**Risk of explosion in case of operation of faulty equipment!**

A faulty vacuum pump must immediately be removed from service.

In case of faults the cause of which cannot be determined the Busch service must be contacted.

### WARNING

**Risk of electrical shock, risk of damage to equipment.**

Electrical installation work must only be executed by qualified personnel that knows and observes the following regulations:
- IEC 364 or CENELEC HD 384 or DIN VDE 0100, respectively,
- IEC-Report 664 or DIN VDE 0110,
- BGV A2 (VBG 4) or equivalent national accident prevention regulation.

### CAUTION

During operation the surface of the vacuum pump may reach temperatures of more than 70 °C.

**Risk of burns!**

Let the vacuum pump cool down prior to a required contact or wear heat protection gloves.

<table>
<thead>
<tr>
<th>Problem</th>
<th>Possible Cause</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>The vacuum pump does not reach the usual pressure</td>
<td>The vacuum system or suction line is not leak-tight</td>
<td>Check the hose or pipe connections for possible leak</td>
</tr>
<tr>
<td>The drive motor draws a too high current (compare with initial value after commissioning)</td>
<td>Contaminated oil (the most common cause)</td>
<td>Change the oil (➔ page 11: Maintenance)</td>
</tr>
<tr>
<td>Evacuation of the system takes too long</td>
<td>No or not enough oil in the reservoir</td>
<td>Top up oil (➔ page 11: Maintenance)</td>
</tr>
<tr>
<td></td>
<td>The exhaust filter (p) is partially clogged</td>
<td>Replace the exhaust filter (p) (➔ page 11: Maintenance)</td>
</tr>
<tr>
<td></td>
<td>One or more flame arrestors (j) (k) are partially clogged</td>
<td>Warning: Risk of explosion in case of faulty assembly! Flame arrestors must only be serviced by personnel that have received specific training for this purpose either by Busch or by the manufacturer of the flame arrestors. Clean the flame arrestors (j) (k)</td>
</tr>
<tr>
<td></td>
<td>In case a screen is installed in the suction connection (i):</td>
<td>Clean the screen</td>
</tr>
<tr>
<td></td>
<td>The screen in the suction connection (i) is partially clogged</td>
<td>If cleaning is required too frequently install a filter upstream</td>
</tr>
</tbody>
</table>
In case a filter is installed on the suction connection (i):

<table>
<thead>
<tr>
<th>Condition</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>The filter on the suction connection (i) is partially clogged</td>
<td>Clean or replace the inlet air filter, respectively</td>
</tr>
</tbody>
</table>

Partial clogging in the suction, discharge or pressure line | Remove the clogging |
Long suction, discharge or pressure line with too small diameter | Use larger diameter |
The valve disk of the inlet non-return valve is stuck in closed or partially open position | Disassemble the inlet, clean the screen and the valve as required and reassemble |
The oil tubing is defective or leaking | Repair the oil tubing (Busch service) |
The oil return line is broken | Replace the shaft seal ring (Busch service) |
A shaft seal is leaking | |
An exhaust valve (p) is not properly seated or stuck in partially open position | Disassemble and reassemble the exhaust valve(s) (p) (Busch service) |
A vane (s) is blocked in the rotor or otherwise damaged | Free the vanes (s) or replace with new ones (Busch service) |
The radial clearance between the rotor (t) and the cylinder is no longer adequate | Readjust the vacuum pump (Busch service) |
Internal parts are worn or damaged | Repair the vacuum pump (Busch service) |

Version with oil return line to the suction connection:

The oil return line starts in an area vented to atmospheric pressure. Particularly on small model pumps, a fairly large amount of air is sucked through the oil return line, which may prevent the ultimate pressure from reaching 20 mbar abs.

In order to exclude this possible cause:
squirt oil through the gas discharge (l) into the oil return line. While oil is being sucked in, the ultimate pressure is not affected by the air normally sucked through the oil return line.

The gas conveyed by the vacuum pump smells displeasing | Process components evaporating under vacuum
|
| Readily volatile and thus gaseous components of the oil, e.g. additives, particularly right after an oil change.
| **Note:** This is no indication of a malfunction of the oil separator. The oil separator is able to retain droplets of oil, however no gaseous components of it. |
| Check the process, if applicable |
| Use a different type of oil, if applicable |

There is an indication on the control panel / in the control room that the switching point S1 or the switching point S2 have been reached at the pressure switch/indicator (a) | Excessive pressure in the oil separator, possible causes:
- the exhaust filter (p) is partially clogged,
- throttling of the discharge line,
- the flame arrestor (k) on the discharge side is partially clogged |
| Replace the exhaust filter (p) |
| Check the discharge line for throttling |
| **Warning:** Risk of explosion in case of faulty assembly! Flame arrestors must only be serviced by personnel that have received specific training for this purpose either by Busch or by the manufacturer of the flame arrestors. |
| Clean the flame arrestor (k) on the pressure/discharge side |

There is an indication on the control panel / in the control room that the oil level has dropped below the minimum level | Oil level too low |
| Top up oil |

The vacuum pump is shut down | The drive motor is not supplied with the correct voltage or is overloaded |
<p>| Supply the drive motor with the correct voltage |
| The drive motor starter overload protection is too small or trip level is too low |
| Compare the trip level of the drive motor starter overload protection with the data on the nameplate, correct if necessary |
| One of the fuses has blown |
| Check the fuses |</p>
<table>
<thead>
<tr>
<th>Version with alternating current motor:</th>
<th>Repair the drive (Busch service)</th>
</tr>
</thead>
<tbody>
<tr>
<td>The drive motor capacitor is defective</td>
<td>Use sufficiently dimensioned cable</td>
</tr>
<tr>
<td>The connection cable is too small or too long causing a voltage drop at the vacuum pump</td>
<td></td>
</tr>
<tr>
<td>The vacuum pump or the drive motor is blocked</td>
<td>Make sure the drive motor is disconnected from the power supply Remove the fan cover Try to turn the drive motor with the vacuum pump by hand If the vacuum pump is blocked: Repair the vacuum pump (Busch service)</td>
</tr>
<tr>
<td>The drive motor is defective</td>
<td>Replace the drive motor (Busch service) Replace the coupling element (in order not to compromise the explosion safety of the vacuum pump the coupling must be adjusted and measured according to a precisely defined procedure; therefore the coupling element must be replaced by the Busch service only)</td>
</tr>
<tr>
<td>The vacuum pump is blocked</td>
<td>Repair the vacuum pump (Busch service) Make sure the suction line is equipped with a screen If necessary additionally provide a filter Corrosion in the vacuum pump from remaining condensate Repair the vacuum pump (Busch service) Check the process Observe the chapter Conveying Condensable Vapours (➔ page 10)</td>
</tr>
<tr>
<td>Version with three-phase motor:</td>
<td>Repair the vacuum pump (Busch service) When connecting the vacuum pump make sure the vacuum pump will run in the correct direction (➔ page 8 Installation)</td>
</tr>
<tr>
<td>The vacuum pump was run in the wrong direction</td>
<td></td>
</tr>
<tr>
<td>After shutting down the vacuum pump the vacuum system exerted underpressure onto the pump chamber Which sucked back excessive oil from the oil separator into the pump chamber When the vacuum pump was restarted too much oil was enclosed between the vanes (s) Oil could not be compressed and thus broke a vane (s)</td>
<td>Repair the vacuum pump (Busch service) Make sure the vacuum system will not exert underpressure onto the shut-down vacuum pump, if necessary provide an additional shut-off valve or non-return valve</td>
</tr>
<tr>
<td>After shutting down the vacuum pump condensate ran into the pump chamber When the vacuum pump was restarted too much condensate was enclosed between the vanes (s) Condensate could not be compressed and thus broke a vane (s)</td>
<td>Repair the vacuum pump (Busch service) Make sure no condensate will enter the vacuum pump, if necessary provide a drip leg and a drain cock Drain condensate regularly</td>
</tr>
<tr>
<td>The drive motor is running, but the vacuum pump stands still</td>
<td>Replace the coupling element (in order not to compromise the explosion safety of the vacuum pump the coupling must be adjusted and measured according to a precisely defined procedure; therefore the coupling element must be replaced by the Busch service only)</td>
</tr>
<tr>
<td>The coupling between the drive motor and the vacuum pump is defective</td>
<td></td>
</tr>
<tr>
<td>The vacuum pump starts, but labours or runs noisily or rattles</td>
<td>Loose connection(s) in the drive motor terminal box</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>The drive motor draws a too high current (compare with initial value after commissioning)</td>
<td>Version with three-phase-motor: Not all drive motor coils are properly connected</td>
</tr>
<tr>
<td></td>
<td>The drive motor operates on two phases only</td>
</tr>
<tr>
<td></td>
<td>Version with three-phase-motor: The vacuum pump runs in the wrong direction</td>
</tr>
<tr>
<td>Standstill over several weeks or months</td>
<td>Let the vacuum pump run warm with inlet closed</td>
</tr>
<tr>
<td>Improper oil quantity, unsuitable oil type</td>
<td>Use the proper quantity of one of the recommended oils (→ page 23: Oil, Oil change: → page 11: Maintenance)</td>
</tr>
<tr>
<td>No oil change over extended period of time</td>
<td>Perform oil change incl. flushing (→ page 11: Maintenance)</td>
</tr>
<tr>
<td>The exhaust filter (p) is clogged and appears black from burnt oil</td>
<td>Flush the vacuum pump</td>
</tr>
<tr>
<td></td>
<td>Replace the exhaust filter (p)</td>
</tr>
<tr>
<td></td>
<td>Fill in new oil (→ page 11: Maintenance)</td>
</tr>
<tr>
<td></td>
<td>In case the oil life is too short: use oil with better heat resistance (→ page 23: Oil) or retrofit cooling</td>
</tr>
<tr>
<td>Foreign objects in the vacuum pump</td>
<td>Repair the vacuum pump (Busch service)</td>
</tr>
<tr>
<td>Broken vanes (s)</td>
<td></td>
</tr>
<tr>
<td>Stuck bearings</td>
<td></td>
</tr>
<tr>
<td>The vacuum pump runs very noisily</td>
<td>Defective bearings</td>
</tr>
<tr>
<td>Worn coupling element</td>
<td>Replace the coupling element (in order not to compromise the explosion safety of the vacuum pump the coupling must be adjusted and measured according to a precisely defined procedure. Therefore the coupling element must be replaced by Busch service only)</td>
</tr>
<tr>
<td>Stuck vanes (s)</td>
<td>Repair the vacuum pump (Busch service)</td>
</tr>
<tr>
<td>There is an indication on the control panel / in the control room that the temperature monitoring has tripped (permissible temperature at the outlet of the stage has been exceeded)</td>
<td>Insufficient air ventilation</td>
</tr>
<tr>
<td>The vacuum pump is shut down</td>
<td>Clean the fan cowlings, the fan wheels, the ventilation grilles and the cooling fins</td>
</tr>
<tr>
<td></td>
<td>Install the vacuum pump in a narrow space only if sufficient ventilation is ensured</td>
</tr>
<tr>
<td></td>
<td>On a vacuum pump with oil-cooler: clean the intermediate spaces of the finned tube</td>
</tr>
<tr>
<td>Ambient temperature too high</td>
<td>Observe the permitted ambient temperatures</td>
</tr>
<tr>
<td>Temperature of the inlet gas too high</td>
<td>Observe the permitted temperatures for the inlet gas</td>
</tr>
<tr>
<td>The exhaust filter (p) is partially clogged</td>
<td>Replace the exhaust filter (p)</td>
</tr>
<tr>
<td>Not enough oil in the reservoir</td>
<td>Top up oil</td>
</tr>
<tr>
<td>Problem</td>
<td>Solution</td>
</tr>
<tr>
<td>------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Oil burnt from overheating</td>
<td>Flush the vacuum pump&lt;br&gt;Replace the exhaust filter (p)&lt;br&gt;Fill in new oil&lt;br&gt;(➔ page 11: Maintenance&lt;br&gt;In case the oil life is too short: use oil with better heat resistance (➔ page 23: Oil) or retrofit cooling</td>
</tr>
<tr>
<td>Mains frequency or voltage outside tolerance range</td>
<td>Provide a more stable power supply</td>
</tr>
<tr>
<td>Partial clogging of filters or screens</td>
<td>Remove the clogging</td>
</tr>
<tr>
<td>Long suction, discharge or pressure line with too small diameter</td>
<td>Use larger diameter</td>
</tr>
<tr>
<td>The vacuum pump fumes or expels oil droplets through the gas discharge</td>
<td>The exhaust filter (p) is not properly seated&lt;br&gt;Check the proper position of the exhaust filter (p), if necessary insert properly (➔ page 11: Maintenance)</td>
</tr>
<tr>
<td>The oil level drops</td>
<td>The o-ring is missing or damaged&lt;br&gt;Add or replace resp. the o-ring (➔ page 11: Maintenance)</td>
</tr>
<tr>
<td>The exhaust filter (p) shows cracks</td>
<td>Replace the exhaust filter (p) (➔ page 11: Maintenance)</td>
</tr>
<tr>
<td>The exhaust filter (p) is clogged with foreign matter</td>
<td>Replace the exhaust filter (p) (➔ page 11: Maintenance)</td>
</tr>
<tr>
<td>Note: The saturation of the exhaust filter with oil is no fault and does not impair the function of the exhaust filter! Oil dropping down from the exhaust filter is returned to the oil circulation.</td>
<td></td>
</tr>
<tr>
<td>The oil return line is clogged or broken</td>
<td>Repair the oil tubing (Busch service)</td>
</tr>
<tr>
<td>The oil is black</td>
<td>Oil change intervals are too long&lt;br&gt;The oil was overheated&lt;br&gt;Flush the vacuum pump&lt;br&gt;Replace the exhaust filter (p)&lt;br&gt;Fill in new oil&lt;br&gt;(➔ page 11: Maintenance&lt;br&gt;In case the oil life is too short: use oil with better heat resistance (➔ page 23: Oil) or retrofit cooling</td>
</tr>
<tr>
<td>The oil is watery and coloured white</td>
<td>The vacuum pump aspirated water or significant amounts of humidity&lt;br&gt;Version with gas ballast:&lt;br&gt;The filter of the gas ballast is clogged&lt;br&gt;Flush the vacuum pump&lt;br&gt;Replace the exhaust filter (p)&lt;br&gt;Fill in new oil&lt;br&gt;(➔ page 11: Maintenance&lt;br&gt;In case the oil life is too short: use oil with better heat resistance (➔ page 23: Oil) or retrofit cooling&lt;br&gt;Version with gas ballast with sinter metal filter: Clean the sinter metal filter of the gas ballast (compressed air)</td>
</tr>
<tr>
<td>The oil is resinous and/or sticky</td>
<td>Improper oil type, perhaps in confusion&lt;br&gt;Topping up of incompatible oil&lt;br&gt;Flush the vacuum pump&lt;br&gt;Replace the exhaust filter (p)&lt;br&gt;Fill in new oil&lt;br&gt;(➔ page 11: Maintenance&lt;br&gt;Make sure the proper oil is used for changing and topping up</td>
</tr>
</tbody>
</table>
| The oil foams | Mixing of incompatible oils | Flush the vacuum pump  
Replace the exhaust filter (p)  
Fill in new oil  
(➔ page 11: Maintenance  
Make sure the proper oil is used for changing and topping up |
Spare Parts

Note: When ordering spare parts or accessories acc. to the table below please always quote the type („Type”) and the serial no. („No”) of the vacuum pump. This will allow Busch service to check if the vacuum pump is compatible with a modified or improved part.

The approval of the vacuum pump for use in potentially explosive areas remains valid only if genuine spare parts and consumables, which are approved for use in potentially explosive areas by Busch, are used exclusively.

Your point of contact for service and spare parts in the United Kingdom:
Busch (UK) Ltd.
Hortonwood 30-35
Telford
Shropshire
TF1 7YB
Tel: 01952 677 432
Fax: 01952 677 423

Your point of contact for service and spare parts in Ireland:
Busch Ireland Ltd.
A10-11 Howth Junction Business Centre
Kilbarrack, Dublin 5
Tel: +353 (0)1 8321466
Fax: +353 (0)1 8321470

Your point of contact for service and spare parts in the USA:
Busch Inc.
516-B Viking Drive
Virginia Beach, VA 23452
Tel: 1-800-USA-PUMP (872-7867)

Your point of contact for service and spare parts in Canada:
Busch Vacuum Technics Inc.
1740, Boulevard Lionel Bertrand
Boisbriand (Montréal)
Québec J7H 1N7
Tel: 450 435 6899
Fax: 450 430 5132

Your point of contact for service and spare parts in Australia:
Busch Australia Pty. Ltd.
30 Lakeside Drive
Broadmeadows, Vic. 3047
Tel: (03) 93 55 06 00
Fax: (03) 93 55 06 99

Your point of contact for service and spare parts in New Zealand:
Busch New Zealand Ltd.
Unit D, Arrenway Drive
Albany, Auckland 1311
P O Box 302696
North Harbour, Auckland 1330
Tel: 0-9-414 7782
Fax: 0-9-414 7783

Find the list of Busch companies all over the world (by the time of the publication of these installation and operating instructions) on ➔ page 46 (rear cover page).

Find the up-to-date list of Busch companies and agencies all over the world on the internet at www.busch-vacuum.com.

<table>
<thead>
<tr>
<th>Spare Parts Lists</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spare Parts List</td>
</tr>
<tr>
<td>Service kit</td>
</tr>
<tr>
<td>Wartungssatz</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Accessories</th>
<th>Part no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil return line to suction connection (RE 0040/0063 B)</td>
<td>0946 124 018</td>
</tr>
<tr>
<td>Gas ballast, complete (RE 0016 B)</td>
<td>0916 101 562</td>
</tr>
<tr>
<td>Gas ballast, complete (RE 0040 B / RE 0063 B)</td>
<td>0916 128 516</td>
</tr>
<tr>
<td>Level switch</td>
<td>0652 125 885</td>
</tr>
</tbody>
</table>
## Oil

<table>
<thead>
<tr>
<th>Denomination</th>
<th>VM 100</th>
<th>VE 101</th>
<th>VSL 100</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISO-VG</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Base</td>
<td>Mineral oil</td>
<td>Diester</td>
<td>PAO</td>
</tr>
<tr>
<td>Density [g/cm³]</td>
<td>0.888</td>
<td>0.96</td>
<td>0.84</td>
</tr>
<tr>
<td>Ambient temperature area [°C]</td>
<td>12 … 30</td>
<td>0 ... 40</td>
<td>0 ... 40</td>
</tr>
<tr>
<td>Kinematic viscosity at 40 °C [mm²/s]</td>
<td>110</td>
<td>95</td>
<td>96</td>
</tr>
<tr>
<td>Kinematic viscosity at bei 100 °C [mm²/s]</td>
<td>11.5</td>
<td>9.5</td>
<td>13</td>
</tr>
<tr>
<td>Flashpoint [°C]</td>
<td>260</td>
<td>255</td>
<td>240</td>
</tr>
<tr>
<td>Pourpoint [°C]</td>
<td>-15</td>
<td>-30</td>
<td>-50</td>
</tr>
<tr>
<td>Part no. 1 l packaging</td>
<td>0831 000 060</td>
<td>0831 000 099</td>
<td>0831 122 573</td>
</tr>
<tr>
<td>Part no. 5 l packaging</td>
<td>0831 000 059</td>
<td>0831 000 100</td>
<td>0831 122 572</td>
</tr>
<tr>
<td>Remark</td>
<td>Food applications (NSF H1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Filling quantity, approx. [l]</td>
<td>RE 0016 B: 1</td>
<td>RE 0040 B / RE 0063 B: 2</td>
<td></td>
</tr>
</tbody>
</table>
EC-Declaration of Conformity

**Note:** 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.

We

Busch Produktions GmbH  
Schaunislandstr. 1  
79689 Maulburg  
Germany

Declare that the vacuum pumps RE 'ATEX' 0016, 0040, 0063 B  
Type Examination Certificate PTB 03 ATEX 4043 X  
Audit: CE 0637

with a serial number from D1601... to D1752...

has (have) been manufactured in accordance with the European Directives:

- 'Machinery' 2006/42/EC
- 'ATEX Directive' 94/9/EC (up to 19th April 2016) or 2014/34/EU (from 20th April 2016) for use in potentially explosive areas according to classification written on the machine nameplate
- 'Electromagnetic Compatibility' 2014/30/EU
- 'RoHS’ 2011/65/EU, restriction of the use of certain hazardous substances in electrical and electronic equipment

and following the standards.

<table>
<thead>
<tr>
<th>Standard</th>
<th>Title of the Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>EN ISO 12100: 2010</td>
<td>Safety of machinery – Basic concepts, General principles for design –Risk assessment and risk reduction</td>
</tr>
<tr>
<td>EN ISO 13857: 2008</td>
<td>Safety of machinery - Safety distances to prevent hazard zones being reached by the upper and lower limbs</td>
</tr>
<tr>
<td>EN ISO 2151: 2008</td>
<td>Acoustics - Noise test code for compressors and vacuum pumps - Engineering method (grade 2)</td>
</tr>
<tr>
<td>EN 60204-1: 2006</td>
<td>Safety of machinery - Electrical equipment of machines - Part 1: General requirements</td>
</tr>
<tr>
<td>EN 61000-6-2: 2005</td>
<td>Electromagnetic compatibility (EMC) - Generic immunity standards. Immunity for industrial environments</td>
</tr>
<tr>
<td>EN ISO 13849-1: 2015 (1)</td>
<td>Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design</td>
</tr>
<tr>
<td>EN ISO 13463-1: 2009</td>
<td>Non-electrical equipment for potentially explosive atmospheres - Part 1: Basic methodology and requirements</td>
</tr>
<tr>
<td>EN ISO 1127-1: 2011</td>
<td>Explosive atmospheres - Explosion prevention and protection - Part 1: Basic concepts and methodology</td>
</tr>
</tbody>
</table>

Manufacturer  

Dr.-Ing. Karl Busch  
General Director

Person authorized to compile the technical file

Andrej Riwe  
Technical writer

Maulburg, 04.04.2016
Physikalisch-Technische Bundesanstalt
Braunschweig und Berlin

EC-TYPE-EXAMINATION CERTIFICATE
(Translation)


(3) EC-type-examination Certificate Number:

PTB 03 ATEX 4043 X

(4) Equipment: Vacuum pump Typ Enivac RE 0016 B, RE 0040 B, RE 0063 B

(5) Manufacturer: Vakuumpumpen und Systeme Busch Produktions GmbH

(6) Address: Schaunislandstraße 1, D-79689 Maulburg

(7) This equipment and any acceptable variation thereto are specified in the schedule to this certificate and the documents therein referred to.

(8) The Physikalisch-Technische Bundesanstalt, notified body No. 0102 in accordance with Article 9 of the Council Directive 94/9/EC of 23 March 1994, certifies that this equipment has been found to comply with the Essential Health and Safety Requirements relating to the design and construction of equipment and protective systems intended for use in potentially explosive atmospheres, given in Annex II to the Directive.

The examination and test results are recorded in the confidential report PTB Ex 03-43068.

(9) Compliance with the Essential Health and Safety Requirements has been assured by compliance with:

EN 13463-1 \hspace{0.5cm} EN 12874 \hspace{0.5cm} EN 50014

EN 50020

(10) If the sign "X" is placed after the certificate number, it indicates that the equipment is subject to special conditions for safe use specified in the schedule to this certificate.

(11) This EC-type-examination Certificate relates only to the design, examination and tests of the specified equipment in accordance to the Directive 94/9/EC. Further requirements of the Directive apply to the manufacturing process and supply of this equipment. These are not covered by this certificate.

(12) The marking of the equipment shall include the following:

\[\begin{array}{c}
\text{II 1/2 G IIB3 T4} \\
\end{array}\]

Zertifizierungsstelle Explosionsschutz

By order:

Dr. H. Förster
Regierungsdirektor

Braunschweig, 2003-10-23

EC-type-examination Certificates without signature and official stamp shall not be valid. The certificates may be circulated only without alteration. Extracts or alterations are subject to approval by the Physikalisch-Technische Bundesanstalt.

In case of dispute, the German text shall prevail.

Physikalisch-Technische Bundesanstalt • Bundesallee 100 • D-38116 Braunschweig
Physikalisch-Technische Bundesanstalt
Braunschweig und Berlin

(13) SCHEDULE

(14) EC-TYPE-EXAMINATION CERTIFICATE PTB 03 ATEX 4043 X

(15) Description of equipment

Vacuum pumps type Enivac RE 0016 B, RE 0040 B and RE 0063 B work on the rotating vane principle. A circular rotor is positioned centrically on the shaft of the vacuum pump. The rotor rotates in an also circular, fixed cylinder, the centreline of which is offset from the centreline of the rotor such that the rotor and the inner wall of the cylinder almost touch along a line. Vanes, gliding in slots in the rotor, separate the space between the rotor and the cylinder into chambers. During the first half of a revolution the free volume increases and vanishes to almost zero during the second half of a revolution. This causes the conveyed gas to be sucked in, compressed and ejected. The pumps are lubricated with oil, which seals the gap between the sliding vanes and the cylinder while also providing a lubricating film between the vanes and the cylinder.

Vacuum pumps type Enivac RE 0016 B, RE 0040 B and RE 0063 B feature one flame arrester each on the suction side and on the pressure side. The crimped ribbon type flame arrester elements inside the flame arrester consist of one crimped and one flat ribbon each made of stainless steel. The ribbons, each 10 mm wide and 0.15 mm thick are spirally wound in tight layers. This forms passages of triangular shape, which pass vapour-air mixtures, but shall prevent the transmission of flames. Two flame arrester elements are used in each flame arrester. The triangle heights of the ribbons are 0.5 mm on the suction side and 0.3 mm on the pressure side.

The vacuum pumps can optionally be fitted with an explosion-proof oil sump heater.

Several monitoring devices shall make sure that

1. the oil level will not drop below the minimum level,
2. impermissibly high temperatures inside the pump as well as at gas outlet connection will not occur and
3. impermissibly high pressure inside the oil separator and inside the flame arrester on the pressure side will not occur.

The design, materials and dimensions are specified in drawings, part lists and data sheets as listed in the test report PTB EX 03-43068.

Requirements for explosion protection

Interior of inlet and outlet pipe: requirements according to category 1
Vacuum pump environment: requirements according to category 2

(16) Test report PTB Ex Ex 03-43068 (consisting of 10 pages, 126 drawings, 21 parts lists, 17 drawings and parts lists of the flame arresters, installation and operating instructions, hazard analysis and risk assessment, list of variety of types, 5 test reports, data sheets and test protocols with calibration data)
Physikalisch-Technische Bundesanstalt
Braunschweig und Berlin

SCHEDULE TO EC-TYPE-EXAMINATION CERTIFICATE PTB 03 ATEX 4043 X

Result: the type complies with the requirements of directive 94/9/EC for equipment group II, (subdivision IIA and IIB according to EN 50014), temperature class T4 according to EN 50014 and – as specified under (15) in the requirements for explosion protection – category 1 in one part and category 2 in the other part.

(17) Special conditions for safe use
- The housing of the vacuum pumps type Enivac RE 0016 B, RE 0040 B and RE 0063 B shall be tested for leak tightness and strength with a static pressure of 15 bar.
- For the operation of the vacuum pumps type Enivac RE 0016 B, RE 0040 B and RE 0063 B all mounted devices, components and parts (coupling, drive motor etc.) shall be suitable for the respective zone. This includes that the requirements according to equipment group II (subdivision IIA, IIB), category 2G, temperature class T4 (according to EN 50014) are complied with.
- The drive motor must not exceed the allowed power and speed as specified in the operating instructions of the pump.
- Prior to commissioning of the pump a comprehensive equipotential bonding of the entire system shall be applied in accordance with EN 50014:2000, chapter 15 and other applicable EN-, IEC- and ISO-standards.
- The operator shall observe the temperature limits for the oil, the ambient temperature and the conveyed gas and the pressure values on the suction and the pressure side as stipulated in the operating instructions.
- The operator is allowed to commission the pump only when the monitoring devices (as mentioned in the operating instructions) have been properly installed and the prescribed switching conditions have been implemented into the controls.
- Only oils as mentioned in the operating instruction or equivalent oils are allowed to be used.
- The oil separator may alternatively be nickel-plated.
- The optionally available oil sump heater must comply with the requirements acc. to equipment group II (subdivision IIA, IIB), category 2G, temperature class T4 (according to EN 50014).
- The temperature switch may only be operated in an intrinsically safe electrical circuit according to EN 50020, annex A.
- The vacuum pumps may alternatively be fitted with a gas ballast.

The manufacturer of the rotating vane vacuum pump Enivac RE 0016 B, RE 0040 B and RE 0063 B is required to transmit the above conditions to the user in a suitable form, and the user is required to duly fulfill and observe them.

(18) Essential health and safety requirements

Zertifizierungsstelle Explosionsschutz
By order:

Dr. H. Förster
Regierungsdirektor

Braunschweig, 2003-10-23

sheet 3/3

EC-type-examination Certificates without signature and official stamp shall not be valid. The certificates may be circulated only without alteration. Extracts or alterations are subject to approval by the Physikalisch-Technische Bundesanstalt. In case of dispute, the German text shall prevail.

Physikalisch-Technische Bundesanstalt • Bundesallee 100 • D-38116 Braunschweig
Physikalisch-Technische Bundesanstalt
Braunschweig und Berlin

2nd SUPPLEMENT
according to Directive 94/9/EC Annex III.6
to EC-TYPE-EXAMINATION CERTIFICATE PTB 03 ATEX 4043 X

(Translation)

Equipment: Vacuum pump, types Enivac RE 0016 B, RE 0040 B, RE 0063 B
Marking: \(\text{Ex} \ II\ 1/2\ G\ IIB3\ T4\) and \(\text{Ex} \ II\ 1/2\ G\ IIA\ T4\)
Manufacturer: Vacuum pumps and systems
Busch Produktions GmbH
Address: Schauinslandstraße 1
79689 Maulburg, Germany

Description of supplements and modifications
The vacuum pumps, types Enivac RE 0016 B, RE 0040 B and RE 0063 B, have been modified in a number of respects.
The vacuum pumps, types Enivac RE 0040 B and RE 0063 B, are alternatively to be equipped with
RMG-Gaselan flame arrestors.
The vacuum pumps, types Enivac RE 0040 B and RE 0063 B, are alternatively to be equipped with
RMG-Gaselan flame arrestors with a different height of the triangular gap to be able to convey
potentially-explosive explosion-group IIA mixtures.

Test report: PTB Ex 07-47013
Result: The structural modifications do not affect the explosion protection features of types Enivac RE
0016B, RE 0040B, RE 0063B vacuum pumps. The relationship between explosion group and height
of triangular gap of the flame arrester used must be observed. The Special Conditions specified in
(17) remain unaffected.

Zertifizierungsstelle Explosionsschutz
By order:

Dr. H. Bothe
Direktor und Professor

Braunschweig, 14 August 2007

Sheet 1/1

EC-type-examination Certificates without signature and official stamp shall not be valid. The certificates may be circulated only without alteration. Extracts or alterations are subject to approval by the Physikalisch-Technische Bundesanstalt. In case of dispute, the German text shall prevail.

Physikalisch-Technische Bundesanstalt • Bundesallee 100 • 38116 Braunschweig, Germany
3. SUPPLEMENT
according to Directive 94/9/EC Annex III.6

To EC-TYPE-EXAMINATION CERTIFICATE PTB 03 ATEX 4043 X

(Translation)

Equipment: Vacuum pump, type Enivac RE 0016 B, RE 0040 B, RE 0063 B

Marking: Ex II 1/2 G c IIB3 T4 and II 1/2 G C IIA T4

Manufacturer: Busch Produktions GmbH

Address: Schauinslandstraße 1, 79689 Maulburg, Germany

Description of supplements and modifications
The assessment for the Enivac RE 0016 B, RE 0040 B and RE 0063 B vacuum pumps has been adapted to the current status of standards.

The gas ballast can also be operated when an external gas supply system is connected.

Applied standards
EN 13463-1, EN 13463-5, EN 16852

Test report: PTB Ex 13-43008

Result:
The modifications that have been made do not affect the safety against explosion of the Enivac RE 0016B, RE 0040 B and RE 0063 B vacuum pumps. The Special Conditions mentioned in No. 17 of EC Type Examination Certificate PTB 03 ATEX 4043 X remain unaffected.

Zertifizierungssektor Explosionsschutz
On behalf of PTB:

Dr.-Ing. D.-H. Frohse
Oberregierungsrat

Braunschweig, August 19, 2013
Temperature Switch

<table>
<thead>
<tr>
<th>Type</th>
<th>201020-R28-120 05 J ø TR 105+-5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marking</td>
<td>03EN A 120°C .... * VDE T150</td>
</tr>
<tr>
<td></td>
<td>(* = code for date of manufacture)</td>
</tr>
<tr>
<td>Interface</td>
<td>Connection for two cable shoes 6.3 x 0.8 mm</td>
</tr>
<tr>
<td></td>
<td>Cable gland for cable diameter 3.5 … 7 mm</td>
</tr>
</tbody>
</table>

Arrangement of contacts

- Opening at temperature rise (i.e. excessive temperature interrupts the electrical circuit)

Switching points

- Open: 120 °C ± 5 K
- Close: 105 °C ± 5 K

Transition resistance

- < 30 mΩ

Nominal voltage

- 250 V AC
- 125 V AC
- 30 V AC

Nominal current

- 250 V AC 10 A
- 125 V AC 15 A
- 30 V DC 4 A

Nominal temperature range

- -20 … +150 °C

More installation notes:

The temperature switch is intended for use in an intrinsically safe circuit acc. to EN 60079-11, annex A, i.e. for connection to an isolation values for intrinsically safe circuits. The temperature switch is a simple apparatus in terms of EN 60079-11, annex A, i.e. for connection to an isolation values for intrinsically safe circuits! The temperature switch is intended for use in an intrinsically safe circuit acc. to EN 60079-11, annex A, i.e. for connection to an isolation values for intrinsically safe circuits. The temperature switch is intended for use in an intrinsically safe circuit acc. to EN 60079-11, annex A, i.e. for connection to an isolation values for intrinsically safe circuits. The temperature switch is intended for use in an intrinsically safe circuit acc. to EN 60079-11, annex A, i.e. for connection to an isolation values for intrinsically safe circuits. The temperature switch is intended for use in an intrinsically safe circuit acc. to EN 60079-11, annex A, i.e. for connection to an isolation values for intrinsically safe circuits. The temperature switch is intended for use in an intrinsically safe circuit acc. to EN 60079-11, annex A, i.e. for connection to an isolation values for intrinsically safe circuits. The temperature switch is intended for use in an intrinsically safe circuit acc. to EN 60079-11, annex A, i.e. for connection to an isolation values for intrinsically safe circuits. The temperature switch is intended for use in an intrinsically safe circuit acc. to EN 60079-11, annex A, i.e. for connection to an isolation values for intrinsically safe circuits.

Pressing the button on the temperature switch must automatically shut down the vacuum pump. Closing of the electrical circuit after cooling down of the temperature switch must not start the vacuum pump self-acting. The restart of the vacuum pump is permitted only by action from the operating personnel after remedy of the cause of the excessive temperature.

For the functional check in the course of the test run of the vacuum pump with inert gas interrupt the electrical circuit by pulling a connector from the temperature switch. Make sure that an alarm is released in the system control and the vacuum pump is shut down automatically. Push the pulled connector back on the temperature switch. Make sure that the alarm persists and the vacuum pump remains shut down.

After reconnection of the cable to the temperature switch make sure that the gasket is inserted between the housing cover and the housing bottom, the housing is firmly closed and the cable gland is tightened.

Pressure Switch/Indicator

Type/Marking

- ExS10-0AVA0811R2SB
  or
  ExS10-0AVA0811R2SB2

Brief description:

The device is fed with a voltage between 14.5 and 45 V DC (between 14.5 and 27.3 V DC in intrinsically safe circuits). The positive pole of the supply is connected to pin 1, the negative pole to pin 3.

Depending on the pressure signal the current between pin 3 and the negative pole of the supply varies between 4 mA (corresponding to 0 hPa (=mbar)) and 20 mA (corresponding to 1600 hPa (=mbar)). 1600 hPa are not reached in practice, though, as the vacuum pump must be shut down at 600 hPa (corresponding to 10 mA).

Under normal operating conditions the voltage between the pins 4 and 3 is the supply voltage minus 2 V. The LED S1 is lit. When the switching point S1 is reached the voltage falls to zero and the LED S1 goes out.

Under normal operating conditions the voltage between the pins 2 and 3 is the supply voltage minus 2 V. The LED S2 is lit. When the switching point S2 is reached the voltage falls to zero and the LED S2 goes out.

More installation notes:

- Upon delivery the pressure switch/indicator is set as listed below.
  Version ExS10-0AVA0811R2SB:
  The parameters are programmed as «customer specific adjustments». Restoration in case of inadvertent misadjustment ➔ page 42 of these Installation and Operating Instructions.
  Version ExS10-0AVA0811R2SB2:
  The parameters are programmed into the firmware as «factory values». Restoration in case of inadvertent misadjustment ➔ page 42 of these Installation and Operating Instructions ➔ Factory reset - read the factory values».

- Lower pressure signal with signal applied (liquid adjustment) not to be set
- Zero signal without applied signal (dry adjustment) 0.000
- Upper pressure signal with signal applied (liquid adjustment) not to be set
- Span signal without applied signal (dry adjustment) 1.600
- Decimal places dp0 (corresponds to indication 8888., i.e. indication in hPa (mbar))
- Zero scaling 0000
- Endpoint-scaling 1600
- Damping 6 (corresponds to 2 seconds delay)
- Limit value switch point 1 0550
- Hysteresis switch point 1 0015
- Operating mode switch point 1 n.c. (quiescent principle)
- Function switch point 1 norF
<table>
<thead>
<tr>
<th>Limit value switch point 2</th>
<th>0600</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hysteresis switch point 2</td>
<td>0015</td>
</tr>
<tr>
<td>Operating mode switch point 2</td>
<td>n.c. (quiescent principle)</td>
</tr>
<tr>
<td>Fast adjustment</td>
<td>oFF</td>
</tr>
<tr>
<td>Behaviour of signal output</td>
<td>oFF</td>
</tr>
</tbody>
</table>

More installation notes:

Observe the excerpt from Installation and Operating Instructions BA0710 (➔ page37 ff.); the complete documentation is available from www.acs-controlsystem.de).

A matching coupling for the connection of a cable to the pressure switch/indicator (a) is included in the scope of delivery of the vacuum pump.

The direct connection of switching relays to the pins 2 and 4 can cause the current on pin 1 to exceed the limit for intrinsically safe circuits. In order not to exceed the allowed current either only the 4...20 mA signal is to be evaluated with a suitable transmitter supply (e.g. Pepperl+Fuchs KF__-CRG-Ex1.D; not in the Busch scope of delivery), set to the switch points 9.5 and 10 mA, corresponding to 550 and 600 hPaG (=mbarg), or isolation switch amplifiers (e.g. Pepperl+Fuchs KF__-SR2-Ex1.W; not in the Busch scope of delivery) are to be switched between the pins 1, 2 and 4 of the pressure switch/indicator (a) on the one side and the switching relays on the other. Alternatively the evaluation of the 4...20 mA signal, after isolation by means of a suitable transmitter supply (e.g. ACS <-> ExTVA500, Pepperl+Fuchs KFD2-STC4-Ex1) can be performed by a non-Ex-system control or SPS respectively. ➔ Page36, Connection Examples Precont S in Ex-areas.

The pressure switch/indicator (a) is to be integrated into the system control such that 550 hPaG (=mbarg) will release a warning, which must be acknowledged by the operating personnel. 600 hPaG (=mbarg) must automatically shut down the vacuum pump. The restart of the vacuum pump is permitted only by action from the operating personnel after remedy of the cause of the excessive pressure.

For the functional check in the course of the test run of the vacuum pump with inert gas throttle the gas discharge until the display on the pressure switch/indicator (a) reads 550 hPa. Make sure that a warning is released in the system control. Relieve the throttling of the gas discharge, so that the indicated pressure drops below 550 hPa. Make sure that the warning persists. Throttle the gas discharge further until the display on the pressure switch/indicator (a) reads 600 hPa. Make sure that an alarm is released in the system control, the vacuum pump is shut down automatically and remains shut down.

---

**Level Switch (u) (Optional)**

<table>
<thead>
<tr>
<th>Type/Marking</th>
<th>FTL50-GGR2AA6G4A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interface</td>
<td>Electronic insert FEL 56: for separate switching unit (isolation switch amplifier not in the Busch scope of delivery); Signal transmission L-H edge 0.6...1.0 / 2.1...2.8 mA to EN 60947 (NAMUR) along two-wire cabling</td>
</tr>
<tr>
<td>Human interface</td>
<td>2 switches for fail-safe mode and density change, green LED flashes to indicate power on, red LED to indicate switching status, flashes on damage by corrosion on sensor or with defective electronics</td>
</tr>
</tbody>
</table>

More installation notes:

Installation and operation acc. to operating instructions of the level switch (separate leaflet); the complete documentation is available from www.endress.com).
Flow Chart Safety Tests

1. Start test sequence
2. Level in the oil separator ok?
   - yes: Do not switch on pump
   - no: Visual inspection of oil level by means of sight glass on the oil separator
3. Temperature switch closed?
   - yes: Back pressure inside oil separator < S1?
     - yes: Back pressure inside oil separator < S2?
       - yes: Switch on pump
       - no: Operation halted with fault indication
     - no: Operation halted with fault indication
   - no: Temperature monitoring inside the oil separator; pump to be switched off by interruption of the circuit
4. Back pressure inside oil separator < S1?
   - yes: Back pressure monitoring; alarm starts at S1; check exhaust filter
   - no: Alarm, pressure > S1
5. Back pressure inside oil separator < S2?
   - yes: Switch off pump
   - no: Switch off pump
6. Pump already running?
   - yes: Operation halted with fault indication
   - no: Start-up button, pump operation pressed?
7. Stop-button, pump operation pressed?
   - yes: Operation halted with fault indication
   - no: Switch on pump
Connection with switching output
Precont ExS10-0AVA0811R2SB

Connection with switching output
Precont ExS10-0AVA0811R2SB

Connection without switching output
Precont ExS10-0AVA0811R2SB

Connection without switching output
Precont ExS10-0AVA0811R2SB

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Precont S

Pressure transmitter
for continuous measuring and surveillance of pressures in gases, vapors, liquids and dusts

Pressure ranges 0...0,1 bar to 0...100 bar / -0,1...0/+0,1 bar / -1...0/+1 bar
Ceramic or metallic membrane with various process connections
Suitable for wide process temperature range from – 40 °C to +370 °C
Various usability, especially for hygienic applications
ATEX II 1/2 G EEx ia IIC T4 resp. ATEX II 1/2 D Ex ia II 2A/2B T6°C/T6°C/T6°C
Certification for the use in explosion hazardous areas
Excellent accuracy up to 0,1%
Programmable evaluation electronic with high brightness LED-display
- in 2-wire-technology with current signal 4...20 mA or
- in 3-wire-technology with voltage signal 0...10 V
- with two PNP switching outputs

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Application description

The devices of the series Precont S with integrated digital evaluation electronics are compact pressure transmitter for continuous monitoring and surveillance of pressures from -1 up to 1000 bar within gases, vapors, liquids and dusts within closed container or pipelines, also in explosive hazardous areas, at process temperatures from -40°C to +370°C.

The use of a capacitive measuring sensor with ceramic membrane or of a strain gauge with metallic membrane, by use of various, also front flush process connections resp. process diaphragm seals, allows the use in nearly all fields of industry, especially also in hygienic applications.

Function

The device is used for pressure measurement.

Characteristics of the ceramic measuring membrane – Precont S10 / S40 / S70

The system pressure is applied to the ceramic membrane and causes there a variation of the capacity at the back side of the membrane.

A pressure transmitting liquid is not used.

The ceramic membrane offers excellent characteristics like highest pressure and pressure blow strength up to forty times the nominal pressure, vacuum resistance, very high resistance against chemicals, corrosion and abrasion as well as very good insensitivity against temperature shocks, highest accuracy and reproducibility, good long term stability and a very low temperature influence.

Characteristics of the metallic measuring membrane – Precont S20 / S30 / S70

The system pressure is applied to the metallic membrane and causes there a detection of the strain gauge at the back side of the membrane.

A pressure transmitting liquid is only used at pressure ranges lower than 0...25 bar.

The metallic membrane offers excellent characteristics like high pressure and pressure blow strength up to six times the nominal pressure, vacuum resistance, good reproducibility and hysteresis and also good long term stability and a low temperature influence.

Characteristics of the process diaphragm seal – Precont S70

The system pressure is applied to the metallic process of the process diaphragm seal and is transmitted by a pressure transmitting liquid to the respective ceramic or metallic measuring membrane that is placed behind.

This leads among others to a extension of the permissible medium temperature up to +370°C and to an essential increase of the temperature stability of the device.

Signal processing

The pressure dependent variation of capacity resp. the variation of the strain gauge output voltage is recorded in high resolution by a processor, adjusted acc. to the settings and converted in high resolution into an output signal of 4...20mA or 0...10V.

According to the resp. settings the PNP switching outputs are driven. The switching state of the two PNP switching output are indicated by each an LED.

By 3 keys and the four digit LED display all settings for the display, the analogue output as well as the PNP switching outputs can be set resp. adjusted.

A transmitter fast adjustment per key combinations is also possible.

Safety notes

Each person that is engaged with installation and operation of this device, must have read and understood this technical manual and especially the safety notes.

Installation, electrical connection installation and operation of the device must be made by a qualified employee according to the informations in this technical manual and the relevant standards and rules.

The device may only be used within the permitted operation limits that are listed in this technical manual. Every use besides these limits as agreed can lead to serious dangers.

The materials of the device must be chosen resp. checked for suitability by the respective application requirements (contacting substances, process temperature). An unsuitable material can lead to damage, abnormal behavior or destruction of the device and to the resulting dangers.

The device may not be used as sole device for prevention of dangerous conditions in machines and plants.

This device meets article 3 (3) of the EC directive 97/23/EC (pressure equipment directive) and is designed and produced in good engineer practice.

The device meets the legal requirements of all relevant EC directives.

Safety notes for electrical operating supplies for explosive hazardous areas

If a device is installed and operated in explosive hazardous areas, the general Ex construction standards (EN/IEC 60079-14, EN/IEC 529-14, VDE 0195), this safety notes and the enclosed EC conformity certificate incl. supplements must be observed.

The installation of explosive hazardous systems must be carried out principally by specialist staff.

The device meets the classification

- T2
- T2D
- II 3 G Ex ia IIC T6
- II 2 G Ex ia IIC T4
- II 2 D Ex ib IIC T4
- II 2 G Ex ib IIC T4
- II 2 D Ex ib IIC T4

The highest surface temperature is determined inside the housing at complete fill up, that means thermal isolation. The power at the sensor is negligible.

The devices are conceived for measuring of pressures in explosive hazardous areas.

The measured medium may also be combustible gases, vapors, liquids and dusts.

This permitted operating temperatures and pressures are type and variant dependent and can be found in this technical manual.

For applications, which require devices of category 1/2 or category 1, the process pressure and temperature range of the medium has to be between 0.8 bar and 1.1 bar and between -20°C and 60°C.

The permissible maximum values for Ui, li and Pi are equal for variants A/B/C/D/E/F/G/H. To this there must be paid especially attention in the case of combining more intrinsically safe circuits at the variants with voltage output 0...10V (variants E/F/G/H) and at the variants with PNP switching outputs (variants A/E). The rules for combination of intrinsically safe circuits must be observed.

The PA terminal inside the connection housing resp. the process connection must be connected to the potential compensation of the explosive hazardous area.

At variants of the devices with chargeable plastic parts (e.g. cable resp. connection housing), a warning marking points out to the safety measures, that must be applied because of the electrostatic charging in operation and especially in the case of maintenance activities.

- avoid friction - no dry cleaning - no assembling in pneumatic conveyance stream.
**Installation**

The installation of the device at a position, where high pressure pulses can occur, should be avoided. Adjustment and function control can be made easier, if the device is mounted behind a stop fitting.

The installation of the device must be made as close to the pressure source as possible to ensure a reliable measurement result. In the case of fitting a hot liquid into a cold system, care must be taken to avoid the formation of dew points and condensation on the inner surfaces of the pipes.

**Maintenance**

The device is free of maintenance. Special substances can lead to solid deposits on the membrane. Such deposits can lead to faulty measurement results of the device. In the case of silt forming liquids the membrane must be regularly cleaned e.g. with clear water. Don’t use sharp tools or aggressive chemicals for cleaning.

**Repair**

A repair may only be carried out by the manufacturer. If the device must be sent back for repair, the following information must be enclosed:

- An exact description of the application.
- The chemical and physical characteristics of the product.
- A short description of the occurred error.

Before returning the device for repair, the following measures must be proceeded:

- All attack points must be removed. This is especially important if the product is unhealthy, e.g. caustic, toxic, carcinogenic, radioactive etc.
- A returning must be refrained, if it is not possible by 100% to remove the unhealthily product completely, because e.g. it is penetrate into cracks or is diffused through plastic.

**Precont S**

**Electrical connection**

The electrical connection of the device must be carried out according to the respective country specific standards. Incorrect installation or adjustment could cause application-related risks.

Use only twisted shielded signal and measurement wires and install these wires separately from other signal and power wiring. Connect the cable shield only at one side to earth, ideally at the installation place of the device. Metallic parts of the device with connection housing plug - type S resp. cable - type K are electrically connected with the earthing connection screw. At the variant with connection housing terminal box - type A all metallic parts are connected with terminal 1 - PE/shield.

The device must be grounded, e.g. by the earth terminal screw or by the process connection. At the housing variant with terminal box, the terminals for wire cross-section from 0.5...2.5mm² for the connection of a cable are placed below the electronic module. This is plugged in and can be pushed easily. After the connection of the cable, the module must be correctly inserted again.

The cable gland is suitable for cable diameter from 4.5 to 10 mm. After the installation of the cable the cable gland must be firmly screwed to ensure the tightness of the connection housing. The same is valid for the screw cap of the housing.

The voltage applied to the terminal contacts may not exceed 45 V to avoid damage of the electronic. All connections are polarity protected.

The minimum resp. maximum supply voltage depends on the respective variant:

<table>
<thead>
<tr>
<th>Variant</th>
<th>not Ex</th>
<th>Ex</th>
</tr>
</thead>
<tbody>
<tr>
<td>type A/B/F/G/H</td>
<td>14.5...45V DC</td>
<td>14.5...30V DC</td>
</tr>
<tr>
<td>type C/D</td>
<td>10.5...45V DC</td>
<td>10.5...30V DC</td>
</tr>
</tbody>
</table>

A load, e.g. the measuring shunt of an evaluation device, in series with a sensor of the variant A/B/C/D with 4...20mA current signal in 2-wire-technology reduces the supply voltage available at the sensor. Depending on version resp. minimum supply voltage, it results in a maximum value for this resistor, where a correct function is still possible.

The maximum load at signal current 20mA can be calculated by the equation:

$$ R_{L\ max} = (V_{S\ max} - V_{S\ min}) / 20\ mA $$

with $V_{S\ min}$ = applying supply voltage and $V_{S\ max}$ = minimum supply voltage.

The following graph shows the characteristics for the resistor values at 21 V and 45 V.

Inductive loads at the PNP switching outputs, e.g. relays or contactors may only be used with a free-wheeling diode or a RC protection circuit to avoid high voltage peaks.

The load at the PNP switching output will be connected to the terminal + terminal of the supply voltage by a semiconductor switch contactless and by this bounce-free. At an activated switching state a positive signal near supply voltage is fed to the output. At deactivated switching state at failure of supply voltage the semiconductor switch is shut off. The PNP switching output is current limited to 0.2...0.5 A and is overload and short circuit protected.
Operation and display elements

Display window 4-digit
Switching state indicator S1 and S2
Indication of the active switching output by the respective red LED, only at variants A/F.
Control key "Change" Also used for switch over the function of the control key: "+/-".

Function modes

run mode
The pressure transmitter records the applied system pressure and performs the chosen functions according to the set parameters. The measuring value is displayed in the display window.

The analogue output and the switching outputs are driven. A switched-on switching output is signaled by the corresponding red LED.

The overriding of the frame specifications, abnormal behavior conditions or also device malfunctions are displayed by the display values "EEEBea".

By pushing the control key "+/-", the software version will be displayed.

Programming mode
To access the adjustment menu push the control key "OK" and enter the password 3009.

Fast adjustment mode
By pushing key combinations in the run mode the transmitter can be operated without using the adjustment menu.

Zero value adjustment with applied pressure signal:
Short pushing the key "Change" and "OK" in succession and hold approx. 5 seconds.
The output signal 4mA / 10V is generated that can be varied by +/-. Repressing "Change" and +/-.
By pushing the key "OK", the current pressure value is captured as lower pressure reference value, assigned to the previously adjusted output signal and the changed settings are stored lost protected (duration approx. 3 s).

End value adjustment with applied pressure signal:
Short pushing the key "+/-" and "OK" in succession and hold approx. 6 seconds.
The output signal 20mA / 10V is generated that can be varied by +/-. Repressing "Change" and +/-.
By pushing the key "OK", the current pressure value is captured as upper pressure reference value, assigned to the previously adjusted output signal and the changed settings are stored lost protected (duration approx. 3 s).

Damping adjustment:
Short pushing the key "Change" and +/-. Repressing "Change" and +/-.
The damping value can now be varied. This value can be varied arbitrarily by +/-. Repressing "Change" and +/-.
From 0 to 60 seconds in 10 steps of each 0,06 seconds, at variants G / G from 0 to 6 seconds in 10 steps of each 0,6 seconds. By pushing the key "OK", the value is captured and stored lost protected.

A jump back to the run mode is carried out.

Reset to factory values:
At devices of variants G / G, a reset to factory values will be carried out by pushing the key "OK" for approx. 5 seconds at a restart after removing the supply voltage. All customer specific adjustment values will be lost.

Attention:
If the lower pressure reference value (zero) is adjusted higher than the upper pressure reference value (span), the output signal fails below 3,8mA resp. 0V. The display shows "EEEBea" as long as the key "OK" is pushed.

An adjustment has to be done correctly (zero < span).
Damping

The damping influences the reaction speed of display, output signal and switching output at a change of the pressure.
The behaviour of display and output signal follows an exponential characteristic with the damping time constant \( t \).
Within the time period \( t \) the output signal increases respectively by 63\% of the existing deviation.
Within 99\%, the end value is nearly achieved after 5 \( t \).

The damping can be adjusted from 0 to 60 \% in steps of 10 \%, whereby one step equals 0\,6 \%. 

The set time (value \( x \) 0.6 \%) equals 5 \( t \).

The set time (value \( x \) 0.6 \%) equals 5 \( t \).
Technical data

**Auxiliary supply**
- Reversal polarity protected
- Permitted supply voltage: Variant A/B, F/G/H: 14.5...45 V DC, Ex 14.5...30 V DC
- Ripple voltage: 2 V\textsubscript{rms} within the permitted supply voltage range
- Supply current:
  - 2-wire 4...20 mA: 22 mA
  - 3-wire 0...10 V: 10 mA

**Analog output 4...20 mA**
- Signal range: Linear characteristic from 3.8 mA resp. 21 mA, error 3.8 mA / 22 mA
- Inverted output characteristic: 20...4 mA only possible by manufacturer's permission
- Permitted load: \( R_L = \max\left(\frac{V_{OL,\min} - V_{OL,\max}}{20 \text{ mA}}\right) \)
- Resolution: 1 mA
- Minimum delay time: 316 ms (typ. 260 ms)
- Influence of supply voltage: 0.02% FS\(^2\) / 10 V

**Analog output 0...10 V**
- Signal range: Linear characteristic from 0.07...10.5 V, error 0.07 V / 11.25 V
- Inverted output characteristic: 10...0 V only possible by manufacturer's permission
- Permitted load: \( R_L = 2000 \text{ W} \) equates 5 mA at signal 10 V, current limited
- Resolution: 0.5 mV
- Minimum delay time: 316 ms (typ. 260 ms)
- Influence of supply voltage: 0.02% FS\(^2\) / 10 V

**PNP switching output**
- Function: PNP switching to +Vs
- Output voltage: \( V_{OL,\max} = +Vs - 2 \text{ V} \)
- Output current: 25 mA, min. 200 mA
- Rise up time: 70 ms
- Delay time: 336 ms (typ. 280 ms)
- Switching cycles: 100,000,000

**Measuring accuracy**

<table>
<thead>
<tr>
<th>Characteristic deviation</th>
<th>Membrane ceramic</th>
<th>Membrane metallic</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1% / 0.2% FS(^2)</td>
<td>0.2% FS(^2)</td>
<td>1.0% FS(^2) at pressure range 0.1 / 0.25 bar</td>
</tr>
</tbody>
</table>

**Nonlinearity**
- Membrane ceramic: 0.1% FS\(^2\)
- Membrane metallic: 0.3% FS\(^2\)

**Hysteresis**
- Membrane ceramic: negligible
- Membrane metallic: 0.1% FS\(^2\)

**Long term drift**
- Membrane ceramic: 0.1% FS\(^2\) / year not cumulative
- Membrane metallic: 0.15% FS\(^2\) / year not cumulative

**Temperature deviation**
- Membrane ceramic:
  - Zero: 0.10% FS\(^2\) / 10 K
  - Temperature coefficient: 0.75% FS\(^2\) / (20...+80°C)
  - Spans: 0.10% FS\(^2\) / 10 K
  - Max. 0.5% FS\(^2\) / (20...+80°C)
  - Max. 0.8% FS\(^2\) / (20...+80°C)
- Membrane metallic:
  - Zero: 0.20% FS\(^2\) / 10 K
  - Temperature coefficient: 0.20% FS\(^2\) / 10 K
  - Spans: 0.20% FS\(^2\) / 10 K
  - Max. 1.3% FS\(^2\) / (20...+80°C)
  - besides +40...-100°C with factor 2 for \( T_c \)

**Mounting position**

<table>
<thead>
<tr>
<th>Maximum deviation</th>
<th>Precont S10 / S40</th>
<th>Precont S20 / S30</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1 mbar</td>
<td>Process correction G (I) / G (II)</td>
<td>4 mbar Process correction G (I)</td>
</tr>
</tbody>
</table>

**Precont S70**
A change in temperature produces a change of the volume of the pressure transmitting liquid and thus results in an additional zero value shift, whose amount depends on the style of the process diaphragm seal. The influence of the temperature can be minimized by a process diaphragm seal with a wider membrane diameter.

**Precont S70**
At versions with process diaphragm seal the deadweight of the membrane and of the pressure transmitting liquid produces an additional zero value shift, whose amount depends on the style of the process diaphragm seal.

---

\(^{1)}\) Referring to nominal measuring span resp. full scale (FS) 

\(^{2)}\) Nonlinearity + Hysteresis + Reproducibility 

\(^{3)}\) Limit value adjustment 

\(^{4)}\) Specification valid, if adjusted measuring range = nominal measuring range, i.e. for \( T_c = 1 \) 

\(^{5)}\) Turn-Down \( T_c \) = nominal measuring range / adjusted measuring range 

\(^{6)}\) Device tested by 100% process correction test 

\(^{7)}\) Higher values for special measuring range
<table>
<thead>
<tr>
<th>Precont S Environmental conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Materials</strong></td>
</tr>
<tr>
<td>Membrane:</td>
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<td>Membrane:</td>
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<td>Membrane:</td>
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<td>Membrane:</td>
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</tbody>
</table>
Dimension drawings Precont S10

Order code overview Precont S10

Digital pressure transmitter with inside placed ceramic capacitive membrane from -1 to 60 bar

Type:
- S10: Standard
- EXS10: ATEX II 2 G Ex ia IIC T4
- EXS10: ATEX II 2 D Ex ia IIC T4

Process connection:
- G 1/2" A: G 3/4" A
- G 1/2" B: G 3/4" B

Electrical output:
- 2-10 mA
- 0-20 mA
- 4-20 mA

Material process connection (medium contact):
- Stainless steel 1.4404 (AISI 316L) / 1.4571 (X5CrNi1810)
- Not for electrical connection type A / K

Material connection housing:
- PP - polypropylene
- PE - polyethylene
- CFPM - phenolic

Measuring range:
- 0.1 bar
- 0.25 bar
- 0.5 bar
- 1 bar
- 2 bar
- 5 bar
- 10 bar
- 20 bar
- 30 bar
- 50 bar
- 100 bar
- 150 bar
- 250 bar
- 500 bar
- 1000 bar

Gaskets (medium contact):
- 1: FPM - fluorocarbon (Viton®)
- 2: CR - nitrile rubber (Hypalon®)
- 3: EPDM - ethylene propylene diene monomer
- 4: FFKM - fluoroelastomer high density (Kalrez®)
- 5: FFKM - perfluoroelastomer high density (Kalrez®)

Process temperature:
- Standard: -40°C to +125°C
- Extended: -40°C to +125°C

Pressure type:
- R: Inflated pressure
- A: Absolute pressure

Accuracy measuring system:
- Material measuring membrane (medium contact):
- Ceramic Al₂O₃: 96%
- Ceramic Al₂O₃: 99.99% (highly clean)
- Linearization protocol: 0.1% (highly clean)

Electrical connection:
- Plug M12 x 1
- Cable 2m
- Terminal box

Higher values for special measuring range
5.2 Control Intervals for Couplings in Hazardous Areas

<table>
<thead>
<tr>
<th>Explosion group</th>
<th>Control intervals</th>
</tr>
</thead>
<tbody>
<tr>
<td>3G 3D</td>
<td>A checking of the circumferential backlash and a visual check of the flexible sleeve must be effected after 3,000 operating hours for the first time, after 6 months at the latest. Except for centered, stiff connecting flanges (e.g., bellhousings). If you note an unacceptable or no wear at the sleeve after this first inspection, the further inspections can be effected, in case of the same operating parameters, respectively after 6,000 operating hours or after 18 months at the latest. If you note a considerable wear during the first inspection, so that a change of the sleeve would be recommended, please find out the cause according to the table „Breakdows“, as far as possible. The maintenance intervals must be adjusted according to the changed operating parameters.</td>
</tr>
<tr>
<td>II 2GD c IEB T4, T5, T6</td>
<td>A checking of the circumferential backlash and a visual check of the flexible sleeve must be effected after 2,000 operating hours for the first time, after 3 months at the latest. Except for centered, stiff connecting flanges (e.g., bellhousings). If you note an unacceptable or no wear at the sleeve after this first inspection, the further inspections can be effected, in case of the same operating parameters, respectively after 6,000 operating hours or after 12 months at the latest. If you note a considerable wear during the first inspection, so that a change of the sleeve would be recommended, please find out the cause according to the table „Breakdows“, as far as possible. The maintenance intervals must be adjusted according to the changed operating parameters.</td>
</tr>
</tbody>
</table>

CAUTION!
To check the torsional backlash the turned off drive aggregate must be secured against unintended turning on.

Drive end
* Turn the hub in opposite direction to the direction of drive.

CAUTION!
Here the sleeve may not be axially displaced from its wear position.

Mark sleeve and hub (see picture 13).
* Turn the hub in the direction of drive and measure the torsional backlash -S<sub>max</sub>.
* When reaching the torsional backlash -S<sub>max</sub> the nylon sleeve must be exchanged.

Driven end
* Turn the hub in the direction of drive.

CAUTION!
Here the sleeve may not be axially displaced from its wear position.

Mark sleeve and hub (see picture 13).
* Turn the hub in opposite direction to the direction of drive and measure the torsional backlash -S<sub>max</sub>.
* When reaching the torsional backlash -S<sub>max</sub> the nylon sleeve must be exchanged.
5.4 Approximate Values of Wear

If the torsional backlash is $S_{\text{max}} \text{ [mm]} / \text{friction } X_{\text{max}} \text{ [mm]}$, the nylon sleeves must be exchanged.

The reaching of the exchange values depends on the operating conditions and the existing operating parameters.

**CAUTION!**
In order to ensure a long lifetime of the coupling and to avoid dangers regarding the use in hazardous areas, the shaft ends must be accurately aligned.

Please absolutely observe the displacement figures indicated (see tables 5 and 6). If the figures are exceeded, the coupling is damaged.

Table 7:

<table>
<thead>
<tr>
<th>BoWex® size</th>
<th>limits of wear each hub</th>
<th>BoWex® size</th>
<th>limits of wear each hub</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>friction $X_{\text{max}}$ [mm]</td>
<td>torsional backlash $-S_{\text{max}}$ [mm]</td>
<td>friction $X_{\text{max}}$ [mm]</td>
</tr>
<tr>
<td>14</td>
<td>0.8</td>
<td>1.3</td>
<td>45</td>
</tr>
<tr>
<td>19</td>
<td>0.8</td>
<td>1.4</td>
<td>48</td>
</tr>
<tr>
<td>24</td>
<td>1.0</td>
<td>1.5</td>
<td>60</td>
</tr>
<tr>
<td>28</td>
<td>1.0</td>
<td>1.8</td>
<td>80</td>
</tr>
<tr>
<td>32</td>
<td>1.0</td>
<td>1.7</td>
<td>100</td>
</tr>
<tr>
<td>38</td>
<td>1.0</td>
<td>1.7</td>
<td>128</td>
</tr>
<tr>
<td>42</td>
<td>1.0</td>
<td>1.7</td>
<td></td>
</tr>
</tbody>
</table>

5.5 Permissible Coupling Materials in the Hazardous Area

<table>
<thead>
<tr>
<th>explosion group</th>
<th>permitted coupling materials / size</th>
</tr>
</thead>
<tbody>
<tr>
<td>IIB</td>
<td>BoWex® M14 to M25 with sleeve material PA (light)</td>
</tr>
<tr>
<td></td>
<td>BoWex® M14 to M19 with sleeve material PA (light)</td>
</tr>
<tr>
<td></td>
<td>BoWex® M14 to M25 with sleeve material PA12CF15 (black)</td>
</tr>
<tr>
<td>IIC</td>
<td></td>
</tr>
</tbody>
</table>

In the Explosion Groups IIB and IIC the following materials may be combined:

- steel
- stainless steel
## Technical Data

For motor connection parameters see nameplate

<table>
<thead>
<tr>
<th>General Technical Data</th>
<th>RE 0016 B</th>
<th>RE 0040 B</th>
<th>RE 0063 B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal suction capacity m³/h</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50 Hz</td>
<td>13</td>
<td>40</td>
<td>63</td>
</tr>
<tr>
<td>60 Hz</td>
<td>15</td>
<td>48</td>
<td>75</td>
</tr>
<tr>
<td>Ultimate pressure hPa abs. (mbar abs.)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>with oil return line to B-cover</td>
<td>-</td>
<td>0,5</td>
<td></td>
</tr>
<tr>
<td>with oil return line to suction connection</td>
<td></td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Motor nominal rating kW</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50 Hz</td>
<td>0.37</td>
<td>1.5</td>
<td>2.2</td>
</tr>
<tr>
<td>60 Hz</td>
<td>0.55</td>
<td>2.2</td>
<td>2.2</td>
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<tr>
<td>Max. allowed nominal motor rating kW</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50 Hz</td>
<td>0.37</td>
<td>1.5</td>
<td>2.2</td>
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<tr>
<td>60 Hz</td>
<td>0.55</td>
<td>2.2</td>
<td>3.0</td>
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<tr>
<td>Motor nominal speed min⁻¹</td>
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<tr>
<td>50 Hz</td>
<td>1500</td>
<td></td>
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<tr>
<td>60 Hz</td>
<td>1800</td>
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<tr>
<td>Sound pressure level (DIN EN ISO 2151) db(A)</td>
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<tr>
<td>50 Hz</td>
<td>60</td>
<td>63</td>
<td>64</td>
</tr>
<tr>
<td>60 Hz</td>
<td>63</td>
<td>66</td>
<td>68</td>
</tr>
<tr>
<td>Ambient temperature / temperature of inlet gas °C</td>
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<tr>
<td>with oil Busch VE 101</td>
<td>0 … 40</td>
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<tr>
<td>with oil Busch VSL 100</td>
<td>0 … 40</td>
<td></td>
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<tr>
<td>with oil Busch VM 100</td>
<td>12 … 30</td>
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<td>Oil quantity l</td>
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<td>Weight kg</td>
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<td>~39</td>
<td>~87</td>
<td>~91</td>
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**Explosion protection data**

Category w.r.t. process gas (i) 1

Category w.r.t. environment (o) 2

Explosion group  IIIB3

Temperature class w.r.t. process gas (i) T4

Temperature class w.r.t. environment (o) T4*

Temperature switch switching point °C 120

Pressure switch switching point S1 hPag (mbarg) 550

Pressure switch switching point S2 hPag (mbarg) 600

* only if also the drive motor is approved for temperature class T4, else downgrading of the entire vacuum pump to the temperature class of the drive motor