Installation and Operating Instructions

Vacuum Pumps

Mink MM 1104, 1144, 1102, 1142 BV

ATEX-Version, Gas Tight

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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,
- installation and commissioning,
- maintenance,
- overhaul,
- troubleshooting and
- spare parts

of the vacuum pump.

Version with ATEX-drive motor:

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
- mixtures of dry, non-aggressive and non-toxic gases and/or dust according to the identification on the nameplate of the vacuum pump (explanation see below).

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.

Max. allowed temperature of the inlet gas: 40 °C

According to the directive 94/9/EC ("ATEX 95") the vacuum pump is made for the intended use in potentially explosive areas according to the data given on the nameplate of the vacuum pump and on the data given on the nameplate of the drive motor.

This requires a separate consideration of the conveyed gas/air or dust/air mixtures on the one side and the environment of the vacuum pump on the other. On the nameplate of the vacuum pump the classification with regard to the conveyed gas/air or dust/air mixtures is marked with an "inside", while the classification with regard to the environment is marked with an "outside". The classification of the motor always refers to the environment.

In case Busch delivered the vacuum pump/ compressor 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.

Depending on the version the approval is valid only together with certain standard or optional components, or is limited by the use of certain optional components, as described below and in the chapter Operational Options / Use of Optionally Available Equipment (➔ page 4).

The classification on the vacuum pump is to be read as follows (interpretations of equipment categories and zones for information only; the relevant laws, directives and standards are literally binding; for temperature classes and explosion groups see E. Brandes, W. Möller "Sicherheitstechnische Kenngrößen, Band 1: Brennbare Flüssigkeiten und Gase", ISBN 3–89701–745–8 (or equivalent source)):

1 = Execution according to directive 94/9/EC
2 inside = in this line classification for explosive atmosphere inside the vacuum pump
3 II 2G II B3 TX = in the process gas explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas likely to occur in normal operation occasionally; if the process gas contains dust, also if the dust is not combustible, the use of a special ATEX-inlet air filter (with equipotential bonding) is required; temperature monitoring is required (resistance thermometer and temperature-transmitter in standard scope of delivery);
4 II 3G II B3 TX = in the process gas explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas not likely to occur in normal operation but, if it does occur, will persist for a short period only;
if the process gas contains dust, also if the dust is not combustible, the use of a special ATEX-inlet air filter (with equipotential bonding) is required; temperature monitoring is required (resistance thermometer and temperature-transmitter in standard scope of delivery);

4. II 3D TX °C = in the process gas explosive atmosphere in the form of a cloud of combustible dust in air not likely to occur in normal operation but, if it does occur, will persist for a short period only; the use of the special ATEX-inlet air filter (with equipotential bonding) is required;

5. outside = in this line classification for explosive atmosphere in the environment of the vacuum pump

6. II 2G IIB3 TX °C = in the environment explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas, vapour or mist likely to occur in normal operation occasionally; temperature monitoring is required (resistance thermometer and temperature-transmitter in standard scope of delivery); sufficiently qualified ATEX-drive motor is required;

7. II 2D TX °C = in the environment explosive atmosphere in the form of a cloud of combustible dust in air not likely to occur in normal operation but, if it does occur, will persist for a short period only; temperature monitoring is required (resistance thermometer and temperature-transmitter in standard scope of delivery); sufficiently qualified ATEX-drive motor is required;

The vacuum pump is equipped with pressure relief lines (r) between the pump stage and the gas discharge (q). The pressure relief lines and shaft seal rings safeguard that no process gases will escape into the environment of the vacuum pump. The proper function of the vacuum pump requires ambient pressure +/-200 hPa (=mbar) to be present at the gas discharge (q) at any operating point. *unless specified otherwise on the nameplate of the vacuum pump.

The pressure switch/indicator (optional) is to be integrated into the system control such that the maintenance of the permitted pressure range will be monitored. If the pressure gets outside this range the system control must automatically shut down the vacuum pump.

Standard-version:

The gas shall be free from vapours that would condensate under the temperature and pressure conditions inside the vacuum pump.

Version “Aqua”:

The vacuum pump features the corrosion protection coating CPC and is capable of conveying water vapour (page 12: Conveying Condensable Vapours). Conveyance of other vapours shall be agreed upon with Busch. Conveyance of water or other liquids in liquid phase increases the power consumption and shall therefore be avoided (risk of drive overload).

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

Max. permissible number of startings per hour: 12

The vacuum pump is ultimate pressure proof.

The minimum allowed intake pressure is to be read from the nameplate of the vacuum pump. By means of process control it must be made sure that the minimum allowed intake pressure will not be underrun. Under very restricted conditions (page 4: Operation with Vacuum Relief Valve / Ambient Air Valve) the use of a vacuum relief valve (optional) with inlet air filter and equipotential bonding (if required) is permitted.

The vacuum pump is not absolutely gas tight. In case of conveying air in new conditions of the vacuum pump the leakage rate amounts to 0.1 hPa l/s at 250 mbar suction pressure. Due to illegal pressures at the gas connections, worn shaft seal rings or clogged pressure relief lines this leakage rate can rise considerably. Make sure that the installation space or location is vented such that in case of conveying media which are dangerous to health no impermissible accumulation of conveyed media in the environment of the vacuum pump will occur. The installation space or location must be vented sufficiently.

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

Version with temperature monitoring:

The safety concept is based on the prevention of excessive temperatures by means of a gas temperature sensor in the vicinity of the stage gas outlet (=zone of highest temperature) together with various other measures to prevent sparks. The temperature sensor must be integrated into the system control such that operation of the vacuum pump will safely be inhibited if the shutdown temperature (see nameplate) is exceeded.

Version with pressure monitoring at the gas outlet (optional):

In order to ensure the gas tightness the pressure at the gas outlet is monitored. The pressure switch/indicator must be integrated into the system control such that the vacuum pump will be switched off if the pressure gets outside the range from -200 mbar* to +200 mbar.

*unless specified otherwise on the nameplate of the vacuum pump.

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 and the allowed speed range is given on the nameplate of the vacuum pump.

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

Operation with Vacuum Relief Valve / Ambient Air Valve

All vacuum pumps the pressure of which according to the nameplate is 60 hPa (mbar), as well as vacuum pumps type MM 1104 version “Aqua” and MM 1144 version “Aqua” the pressure of which according to the nameplate is 100 hPa (mbar) are ultimate pressure proof, i.e. may be operated against a closed suction connection. For all other vacuum pumps operation without gas transfer would lead to excessive temperatures and is hence not permitted.

In case the pressure control in the suction side of the system cannot be achieved by means of process control or by controlling the drive motor, the pressure needs to be controlled by means of a vacuum relief valve (optional).

For the version “Aqua” it can be necessary to dry the vacuum pump after process end by means of conveying ambient air (page 12: Conveying Condensable Vapours).

However, if vacuum relief valves/ambient air valves are used the following must be observed:
Apart from this:

Aspiration of ambient air from a zone 1 or a zone 2 (potentially explosive gas atmospheres) is permitted only if the vacuum pump is approved for the conveyance of these gases. It is recommended to install an ATEX-air filter (with equipotential bonding) upstream the vacuum relief valve/ambient air valve.

Aspiration of ambient air from a zone 21 or a zone 22 (potentially explosive dust/air atmospheres) is permitted only if an ATEX-air filter (with equipotential bonding) is installed upstream the vacuum relief valve/ambient air valve.

Aspiration of ambient air from areas not classified as potentially explosive is permitted. It is recommended to install an air filter upstream the vacuum relief valve/ambient air valve.

**Principle of Operation**

The vacuum pump works on the claw principle.

The components are dimensioned such, that on the one hand there is never contact between the two claws or between a claw and the cylinder, on the other hand the gaps are small enough to keep the clearance loss between the chambers low.

In order to avoid the suction of solids, the vacuum pump is equipped with a screen in the suction connection.

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

The vacuum pump compresses the inlet gas absolutely oil-free. A lubrication of the pump chamber is neither necessary nor allowed.

**Cooling**

The vacuum pump is cooled by

- radiation of heat from the surface of the vacuum pump
- the air flow from the fan wheel of the drive motor
- the process gas
- the air flow from the fan wheel on the shaft of the vacuum pump

**Start Controls**

The vacuum pump comes without start controls. The control of the vacuum pump is to be provided in the course of installation.

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**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.

The maintenance instructions shall be observed.

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 94/9/EC is available.

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.

**Noise Emission**

For the sound pressure level in free field according to EN ISO 2151 ➔ page 55: Technical Data.

- **CAUTION**
  The vacuum pump emits noise of high intensity in a narrow band.

  Risk of damage to the hearing.

  Persons staying in the vicinity of a non noise insulated vacuum pump over extended periods shall wear ear protection.
Transport

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 is fastened to the pallet by means of tightening straps:
- Remove the tightening straps

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

- Make sure that the eyebolts are in faultless condition (replace damaged, e.g. bent eyebolts with a new ones)
- Make sure that the eyebolts are fully screwed in and tightened by hand
- Attach lifting gear securely to the eyebolts on the synchronising gear (h) and on the drive motor
In case the drive motor comes without an eyebolt or the eyebolt on the drive motor is located at an unfavourable position:
- Loop a belt/rope with suitable length and strength around the flange of the drive motor
- 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

Storage

Short-term Storage
- 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.

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.

- 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,
  - 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)

Installation and Commissioning

Installation prerequisites

CAUTION
In case of non-compliance with the installation prerequisites, particularly in case of insufficient cooling:

Risk of damage or destruction of the vacuum pump and adjoining plant components!
Risk of injury!

The installation prerequisites must be complied with.

- Make sure that the integration of the vacuum pump is carried out such that the essential safety requirements of the Machine Directive 2006/42/EC are complied with (in the responsibility of the designer of the machinery into which the vacuum pump is to be incorporated; ➔ page 54: note in the EC-Declaration of Conformity)

Mounting Position and Space

- Make sure that the following ambient conditions will be complied with:
  - dry and free from corrosion-promoting gases, vapours, mists and dusts
  - ambient temperature: 0 … 40 °C
  - ambient pressure: atmospheric

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• 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 1 m between the vacuum pump and nearby walls
• Make sure that no heat sensitive parts (plastics, wood, cardboard, paper, electronics) will touch the surface of the vacuum pump
• Make sure that the installation space or location is vented such that a sufficient cooling of the vacuum pump is warranted

CAUTION
The vacuum pump is not absolutely gas tight
Risk of damage to health!
Make sure that the installation space or location is vented such that in case of conveying media which are dangerous to health no impermissible accumulation of conveyed media in the environment of the vacuum pump will occur.

• Make sure that the installation space or location is vented such that even in the case of an impaired gas tightness of the vacuum pump (e.g. due to illegal pressures at the gas discharge, worn shaft seal rings or clogged pressure relief lines) no impermissible accumulation of process gas in the environment of the vacuum pump will occur. Closed cooling air circuits are not permitted.

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 (f) of the synchronising gear will remain accessible

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 (included in scope of delivery)
  • 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 (m) of the vacuum pump

Version for the conveyance of explosive atmospheres consisting of a mixture with air of flammable substances in the form of gas:
  • Make sure that the pipe is made from electrically conductive material and equipped with an equipotential bonding connection (execution according to EN 60079-14 or equivalent national or local regulations)

Version for the conveyance of explosive atmospheres in the form of a cloud of combustible dust in air:
  • Make sure that the pipe is made from electrically conductive material and equipped with an equipotential bonding connection (execution according to EN 61241-14 or equivalent national or local regulations)

• 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 (m) 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!

In case the vacuum pump shall be maintained after shutdown of the vacuum pump:
  • Provide a manual or automatic operated valve (= non-return valve) in the suction line

Version “Aqua”, if very humid process gases and/or adverse operating cycles bear the risk, that condensates remain in the vacuum pump:
  • 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 anti-pulsation chamber is equipped with a condensate drain cock (n) (optional); (if the condensate drain cock is missing contact the Busch service)
  • Make sure that the suction line does not contain foreign objects, e.g. welding scales

Gas Discharge

WARNING
In case the vacuum pump is intended to convey potentially explosive gases/gas mixtures (➔ page 3: Product Description):

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.

• Make sure that the discharge line fits to the gas discharge (q) of the vacuum pump

Version for the conveyance of explosive atmospheres consisting of a mixture with air of flammable substances in the form of gas:
  • Make sure that the pipe is made from electrically conductive material and equipped with an equipotential bonding connection (execution according to EN 60079-14 or equivalent national or local regulations)

• Make sure that the pipe will cause no stress on the vacuum pump's connection, if necessary use an expansion joint
• Make sure that ambient pressure +/- 200 hPa (=mbar) will be present at the gas discharge (q) at any operating point unless specified otherwise on the nameplate of the vacuum pump
• 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

Electrical Connection / Controls

Version with ATEX-drive motor:
♦ 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 54: 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

Version with temperature monitoring:
♦ Execute the interfaces for the temperature measurement system in the system control according to the instructions of the manufacturer (→ page 20: Equipment Documentation Measurement and Safety Instrumentation); applicable shutdown temperature → nameplate of the vacuum pump

Version with pressure monitoring at the gas outlet (optional):
♦ Execute the interface for the pressure switch/indicator in the system control according to the safety concept (→ page 5: Safety Concept) and according to the instructions of the manufacturer (→ page 20: Equipment Documentation Measurement and Safety Instrumentation)
• Make sure that an earth point is available for connection to the equipotential bonding rail or the ATEX-inlet air filter resp.

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

Checking Synchronising Gear Oil

The vacuum pump is delivered with oil filled synchronising gear.
The level shall be slightly above the middle of the sight glass (f).
• Check on the sight glass (f) that the proper amount of oil is filled

Connecting Electrically

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.

Version with ATEX-drive motor:
♦ Connect the drive motor according to the installation instructions for the drive motor (separate leaflet)

Version with non-ATEX-drive motor:
♦ Connect the drive motor according to the installation instructions given below

CAUTION
The connection schemes given below are typical. Depending on the specific order or for certain markets deviating connection schemes may apply.

Risk of damage to the drive motor!
The inside of the terminal box shall be checked for drive motor connection instructions/schemes.

• Electrically connect the drive motor
• Connect the protective earth conductor

Delta connection (low voltage):

Star connection (high voltage):

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Double star connection, multi-voltage motor with 9 terminals (low voltage):

![Diagram of double star connection](image)

Star connection, multi-voltage motor with 9 terminals (high voltage):

![Diagram of star connection](image)

Version with ATEX-inlet air filter, without equipotential bonding rail:
- Connect the housing of the inlet air filter to the earth point with an earth cable

**Connecting Lines/Pipes**

- Connect the suction line
- Connect the discharge line

Installation without discharge line:
- Make sure that the gas discharge (q) is open

Version with equipotential bonding rail:
- Connect the equipotential bonding connectors of the pipes to the equipotential bonding rail

Version with ATEX-inlet air filter, without equipotential bonding rail:
- Connect the equipotential bonding connector of the suction line to the earth point
- Make sure that all provided covers, guards, hoods etc. are mounted
- Make sure that the cooling air inlets and outlets are not covered or obstructed and that the cooling air flow is not affected adversely in any other way

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

(version with temperature monitoring only)

![Diagram of checking function](image)

**WARNING**

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.

Version with temperature monitoring:
- Connect the temperature measurement system (part of standard scope of delivery) to the system control

Version with pressure monitoring at the gas outlet (optional):
- Connect the pressure switch/indicator to the system control

Version with equipotential bonding rail:
- Connect the equipotential bonding rail to the earth point with an earth cable

**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
- Open the lid of the temperature measurement system (g)
- Disconnect the white cable from pin 3, the first red cable from pin 5 and the second red cable from pin 6
- In order to simulate the resistance thermometer Pt100 set a variable ohmic resistance to approx. 100 Ω
- Connect the variable ohmic resistance with 3 identical cables to the pins 3, 5 and 6 of the temperature transmitter as shown in the sketch (the cable connected to pin 5 compensates the cable resistance)
- Switch on the vacuum pump

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).

- Determine the intended direction of rotation with the arrow (d) (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**

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.
• Increase the ohmic resistance to the resistance at shutdown temperature according to the Equipment Documentation Measurement and Safety Instrumentation (➔ page 20)
• Make sure that an alarm is released in the system control and the vacuum pump is shut down automatically
• Decrease the ohmic resistance to a value less than the shutdown point
• Make sure that the alarm persists
• Make sure that the vacuum pump does not start self-acting
• Switch on the vacuum pump again
• Interrupt the ohmic resistance
• Make sure that a fault indication is released in the system control and the vacuum pump is shut down automatically
• Reconnect the variable ohmic resistance
• Switch on the vacuum pump again
• Short circuit the variable ohmic resistance
• Make sure that a fault indication is released in the system control and the vacuum pump is shut down automatically
• Remove the short circuit
• Remove the variable ohmic resistance
• Reconnect the resistance thermometer Pt100 to the temperature transmitter (white cable to pin 3, first red cable to pin 5, second red cable to pin 6, ➔ sketch)

![Resistance Thermometer](image)

- white
- red

• Firmly close the temperature measurement system (g) with the lid

### 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

### Operating 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.

---

The vacuum pump is intended for:
- the suction of mixtures of dry, non-aggressive and non-toxic gases and/or dust according to the identification on the nameplate of the vacuum pump (explanation see below).

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.

Max. allowed temperature of the inlet gas: 40 °C

According to the directive 94/9/EC ("ATEX 95") the vacuum pump is made for the intended use in potentially explosive areas according to the data given on the nameplate of the vacuum pump and on the data given on the nameplate of the drive motor.

This requires a separate consideration of the conveyed gas/air or dust/air mixtures on the one side and the environment of the vacuum pump on the other. On the nameplate of the vacuum pump the classification with regard to the conveyed gas/air or dust/air mixtures is marked with an "inside", while the classification with regard to the environment is marked with an "outside". The classification of the motor always refers to the environment.

In case Busch delivered the vacuum pump/ compressor 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.

Depending on the version the approval is valid only together with certain standard or optional components, or is limited by the use of certain optional components, as described below and in the chapter Operational Options / Use of Optionally Available Equipment (➔ page 4).

The classification on the vacuum pump is to be read as follows (interpretations of equipment categories and zones for information only; the relevant laws, directives and standards are literally binding; for temperature classes and explosion groups see E. Brandes, W. Möller “Sicherheitstechnische Kenngrößen, Band 1: Brennbare Flüssigkeiten und Gase”, ISBN 3–89701–745–8 (or equivalent source)):

1. = Execution according to directive 94/9/EC
2. inside = in this line classification for explosive atmosphere inside the vacuum pump

---

**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.
II 2G IIB3 TX = in the process gas explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas not likely to occur in normal operation occasionally; if the process gas contains dust, also if the dust is not combustible, the use of a special ATEX-inlet air filter (with equipotential bonding) is required; temperature monitoring is required (resistance thermometer and temperature-transmitter in standard scope of delivery);

II 3G IIB3 TX = in the process gas explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas not likely to occur in normal operation but, if it does occur, will persist for a short period only; if the process gas contains dust, also if the dust is not combustible, the use of a special ATEX-inlet air filter (with equipotential bonding) is required; temperature monitoring is required (resistance thermometer and temperature-transmitter in standard scope of delivery);

II 3D TX ° C = in the process gas explosive atmosphere in the form of a cloud of combustible dust in air not likely to occur in normal operation but, if it does occur, will persist for a short period only; the use of the special ATEX-inlet air filter (with equipotential bonding) is required;

outside = in this line classification for explosive atmosphere in the environment of the vacuum pump

II 2G IIB3 TX = in the environment explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas, vapour or mist likely to occur in normal operation occasionally; temperature monitoring is required (resistance thermometer and temperature-transmitter in standard scope of delivery); sufficiently qualified ATEX-drive motor is required;

II 3G IIB3 TX ° C = in the environment explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas, vapour or mist not likely to occur in normal operation but, if it does occur, will persist for a short period only; temperature monitoring is required (resistance thermometer and temperature-transmitter in standard scope of delivery); sufficiently qualified ATEX-drive motor is required

II 2D TX ° C = in the environment explosive atmosphere in the form of a cloud of combustible dust in air likely to occur in normal operation occasionally; temperature monitoring is required (resistance thermometer and temperature-transmitter in standard scope of delivery); sufficiently qualified ATEX-drive motor is required;

II 3D TX ° C = in the environment explosive atmosphere in the form of a cloud of combustible dust in air not likely to occur in normal operation but, if it does occur, will persist for a short period only; temperature monitoring is required (resistance thermometer and temperature-transmitter in standard scope of delivery); sufficiently qualified ATEX-drive motor is required

The vacuum pump is equipped with pressure relief lines (r) between the pump stage and the gas discharge (q). The pressure relief lines and shaft seal rings safeguard that no process gases will escape into the environment of the vacuum pump.

The proper function of the vacuum pump requires ambient pressure +/-200° hPa (=mbar) to be present at the gas discharge (q) at any operating point.

*unless specified otherwise on the nameplate of the vacuum pump.

The pressure switch/indicator (optional) is to be integrated into the system control such that the maintenance of the permitted pressure range will be monitored. If the pressure gets outside this range the system control must automatically shut down the vacuum pump.

Standard-version:

The gas shall be free from vapours that would condensate under the temperature and pressure conditions inside the vacuum pump.

Version “Aqua”:

The vacuum pump features the corrosion protection coating CPC and is capable of conveying water vapour (page 12: Conveying Condensable Vapours). Conveyance of other vapours shall be agreed upon with Busch. Conveyance of water or other liquids in liquid phase increases the power consumption and shall therefore be avoided (risk of drive overload).

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

Max. permissible number of startings per hour: 12

The vacuum pump is ultimate pressure proof.

The minimum allowed intake pressure is to be read from the nameplate of the vacuum pump. By means of process control it must be made sure that the minimum allowed intake pressure will not be underrun. Under very restricted conditions (operation with Vacuum Relief Valve / Ambient Air Valve) the use of a vacuum relief valve (optional) with inlet air filter and equipotential bonding (if required) is permitted.

The vacuum pump is not absolutely gas tight. In case of conveying air in new conditions of the vacuum pump the leakage rate amounts to 0.1 hPa l/s at 250 mbar suction pressure. Due to illegal pressures at the gas connections, worn shaft seal rings or clogged pressure relief lines this leakage rate can rise considerably. Make sure that the installation space or location is vented such that in case of conveying media which are dangerous to health no impermissible accumulation of conveyed media in the environment of the vacuum pump will occur. The installation space or location must be vented sufficiently.

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.

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 vacuum pump emits noise of high intensity in a narrow band.

Risk of damage to the hearing.

Persons staying in the vicinity of a non noise insulated vacuum pump over extended periods shall wear ear protection.

• 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
Version “Aqua”:

- Close the shut-off valve in the suction line
- Warm up the vacuum pump for approx. 10 minutes

At process start:
- Open the shut-off valve in the suction line
- Open the ambient air valve
- Operate the vacuum pump for another approx. 10 minutes
- Close the ambient air valve
- Regularly drain condensate from the anti-pulsation chamber (n)

Maintenance Schedule

- Prior to disconnecting connections make sure that the connected pipes/lines are vented to atmospheric pressure

CAUTION

Due to the corrosion protection coating CPC the vacuum pump is capable of conveying water vapour.

Very humid process gases and/or adverse operating cycles can lead to residual condensates, though, which cause corrosion.

If this is the case, it is necessary to counteract residual condensates by warming up the vacuum pump, conveyance of ambient air after process end and regular draining of the anti-pulsation chamber (m).

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.

Monthly

In case of dusty process gases:

- Open the suction connection
- Operate the vacuum pump for approx. 5 minutes with unrestricted suction
- Make sure that the vacuum pump is shut down and locked against inadvertent start up

In case an inlet air filter (l) is installed:
- Check the inlet air filter (l), if necessary replace

In case of operation in a dusty environment:
- Clean as described under ➔ page 13: Every 6 Months

Every 3 Months:

- Make sure that the vacuum pump is shut down and locked against inadvertent start up
- Check the level of the synchronising gear oil

The level shall be slightly above the middle of the sight glass (f).

The level of the synchronising gear should stay constant over the lifetime of the oil. If the level does fall, the gear is leaky and the vacuum pump requires repair (Busch service).

WARNING

Do not open the vacuum pump in potentially explosive atmosphere.

Risk of explosion!

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.
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
- Remove the acoustic enclosure

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

- Remove the protective grid (p) from the cooling air outlet
- Open the inspection port (e) on the cooling air duct
- Clean the cooling air duct (compressed air)

**Note:** Make sure that the foam mats do not get soaked with water

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

**Version with ROTEX-coupling:**

- Remove the drive motor
- Measure the dimension B of the coupling element
- Replace the coupling element if the measured value < \( B_{\text{min}} \)
- Remount the drive motor
- Close the inspection port (e) on the cooling air duct
- Mount the protective grid (p) on the cooling air outlet
- Mount the acoustic enclosure
- Check the electrical connection
- Make sure that the electrical connection of the temperature monitoring is undamaged

**Version with equipotential bonding of the fan cover:**

- Make sure that the earth cable on the fan cover is undamaged (resistance check)

**Version with ATEX-inlet air filter (with equipotential bonding):**

- Make sure that the earth cable on the inlet air filter housing is undamaged (resistance check)

**Version with vacuum relief valve with air filter and equipotential bonding:**

- Make sure that the earthing cable on the air filter housing before the vacuum relief valve is undamaged (resistance check)

**Every Year:**

- Make sure that the vacuum pump is shut down and locked against inadvertent start up

In case an inlet air filter (l) is installed:

- Replace the inlet air filter (l)

**Version with vacuum relief valve with inlet air filter:**

- Check the function of the measurement and safety instrumentation (➔ page 14: Functional Check of the Measurement and Safety Instrumentation)

**Every 5000 Operating Hours, At the Latest after 2 Years**

In case of higher requirements in terms of gas tightness:

- Replace the shaft seal rings (Busch service)

**Every 10000 Operating Hours, At the Latest after 2 Years**

**Version with vacuum relief valve with inlet air filter:**

- Check the inlet screen, clean if necessary

In order to check the pressure relief lines (r):

- Undo the fittings between the collecting line and the gas discharge (q)

**DANGER**

In case the vacuum pump conveyed gas that was contaminated with foreign materials which are dangerous to health, harmful material can reside in the pressure relief lines (r).

Danger to health during blowing out the pressure relief lines.

Danger to the environment.

Wear personal protective equipment while handling contaminated pressure relief lines.

Collect deposits from the pressure relief lines and dispose of them in compliance with applicable regulations.
- Remove the eye bolt (h, 615)
- Remove the lid (424)

**CAUTION**
Pressurised air supply systems supply a too high pressure.
Risk of damage to the vacuum pump.
Adjust the pressurised air to 0.2 barg by means of a pressure regulator.

- Remove the screw plugs of the pressure relief lines and connect the pressurised air lines (➔ illustration)

- Apply 0.2 barg to the pressure relief lines (r)
- Check that both pressure relief lines (r) pass the pressurised air
  In case one or both pressure relief line(s) is/are clogged:
  - Remove the vacuum pump from service and have it repaired (Busch service)
  - Reconnect the collecting line to the gas discharge (q) and to the pressure relief lines
  - Reinsert the screw plugs, remount the lid (424) and the eyebolt (h, 615)

**Every 20000 Operating Hours, At the Latest after 6 Years:**
- Have a major overhaul on the vacuum pump (Busch service)

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**Checking the Function of the Measurement and Safety Instrumentation**
(version with temperature monitoring only)

**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
- Open the lid of the temperature measurement system (g)
- Disconnect the white cable from pin 3, the first red cable from pin 5 and the second red cable from pin 6
- In order to simulate the resistance thermometer Pt100 set a variable ohmic resistance to approx. 100 \( \Omega \)
- Connect the variable ohmic resistance with 3 identical cables to the pins 3, 5 and 6 of the temperature transmitter as shown in the sketch (the cable connected to pin 5 compensates the cable resistance)

- Switch on the vacuum pump
- Increase the ohmic resistance to the resistance at shutdown temperature according to the Equipment Documentation Measurement and Safety Instrumentation (➔ page 20)
- Make sure that an alarm is released in the system control and the vacuum pump is shut down automatically
- Decrease the ohmic resistance to a value less than the shutdown point
- Make sure that the alarm persists
- Make sure that the vacuum pump does not start self-acting
- Switch on the vacuum pump again
- Interrupt the ohmic resistance
- Make sure that a fault indication is released in the system control and the vacuum pump is shut down automatically
- Reconnect the variable ohmic resistance
- Switch on the vacuum pump again
- Short circuit the variable ohmic resistance
- Make sure that a fault indication is released in the system control and the vacuum pump is shut down automatically
- Remove the short circuit
- Remove the variable ohmic resistance
• Reconnect the resistance thermometer Pt100 to the temperature transmitter (white cable to pin 3, first red cable to pin 5, second red cable to pin 6, ➔ sketch)

• Firmly close the temperature measurement system (g) with the lid

**Overhaul**

**WARNING**
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 foreign materials which are dangerous to health, 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).

Busch service will only accept vacuum pumps that come with a completely filled in and legally binding signed “Declaration of Contamination” (form downloadable from www.busch-vacuum.com).

**Removal from Service**

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

**Recommissioning**
• Observe the chapter Installation and Commissioning (➔ page 6)

**Dismantling and Disposal**

• Drain the oil
• Make sure that materials and components to be treated as special waste have been separated from the vacuum pump
• Make sure that the vacuum pump is not contaminated with harmful foreign material

According to the best knowledge at the time of printing of this manual the materials used for the manufacture of the vacuum pump involve no risk.

• Dispose of the used oil in compliance with applicable regulations
• Dispose of the vacuum pump as scrap metal

**WARNING**
Improper work on the vacuum pump puts the operating safety at risk.

**DANGER**
In case the vacuum pump conveyed gas that was contaminated with foreign materials which are dangerous to health, 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.
# 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 corresponding 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</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(compare with initial value after commissioning)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Evacuation of the system takes too long</td>
<td></td>
<td></td>
</tr>
<tr>
<td>In case a vacuum relief valve/regulating system is installed:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The vacuum relief valve/regulating system is misadjusted or defective</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The screen in the suction connection (m) is partially clogged</td>
<td></td>
<td></td>
</tr>
<tr>
<td>In case a filter (l) is installed on the suction connection (m):</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The filter on the suction connection (m) is partially clogged</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Partial clogging in the suction, discharge or pressure line</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Long suction, discharge or pressure line with too small diameter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The valve disk of the inlet non-return valve is stuck in closed or partially open position</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Internal parts are worn or damaged</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The gas conveyed by the vacuum pump smells displeasing</td>
<td>Process components evaporating under vacuum</td>
<td>Check the process, if applicable</td>
</tr>
</tbody>
</table>

**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.

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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>Cause</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>The vacuum pump does not start</td>
<td>The drive motor is not supplied with the correct voltage or is overloaded</td>
<td>Supply the drive motor with the correct voltage</td>
</tr>
<tr>
<td></td>
<td>The drive motor starter overload protection is too small or trip level is too low</td>
<td>Compare the trip level of the drive motor starter overload protection with the data on the nameplate, correct if necessary</td>
</tr>
<tr>
<td></td>
<td>One of the fuses has blown</td>
<td>Check the fuses</td>
</tr>
<tr>
<td></td>
<td>The connection cable is too small or too long causing a voltage drop at the vacuum pump</td>
<td>Use sufficiently dimensioned cable</td>
</tr>
<tr>
<td></td>
<td>The vacuum pump or the drive motor is blocked</td>
<td>Make sure the drive motor is connected from the power supply</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Remove the fan cover</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Try to turn the drive motor with the vacuum pump by hand</td>
</tr>
<tr>
<td></td>
<td></td>
<td>If the vacuum pump is blocked:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Repair the vacuum pump (Busch service)</td>
</tr>
<tr>
<td></td>
<td>The drive motor is defective</td>
<td>Replace the drive motor (Busch service)</td>
</tr>
<tr>
<td></td>
<td>(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>
<td></td>
</tr>
<tr>
<td>The vacuum pump is blocked</td>
<td>Solid foreign matter has entered the vacuum pump</td>
<td>Repair the vacuum pump (Busch service)</td>
</tr>
<tr>
<td></td>
<td>Make sure the suction line is equipped with a screen</td>
<td></td>
</tr>
<tr>
<td></td>
<td>If necessary additionally provide a filter</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Corrosion in the vacuum pump from remaining condensate</td>
<td>Repair the vacuum pump (Busch service)</td>
</tr>
<tr>
<td></td>
<td>Check the process</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Observe the chapter Conveying Condensable Vapours (page 12)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>The vacuum pump was run in the wrong direction</td>
<td>Repair the vacuum pump (Busch service)</td>
</tr>
<tr>
<td></td>
<td>When connecting the vacuum pump make sure the vacuum pump will run in the correct direction (page 6: Installation)</td>
<td></td>
</tr>
<tr>
<td>The drive motor is running, but the vacuum pump stands still</td>
<td>The coupling between the drive motor and the vacuum pump is defective</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 vacuum pump starts, but labours or runs noisily or rattles</td>
<td>Loose connection(s) in the drive motor terminal box</td>
<td>Check the proper connection of the wires against the connection diagram</td>
</tr>
<tr>
<td></td>
<td>Not all drive motors coils are properly connected</td>
<td>(particularly on motors with six coils)</td>
</tr>
<tr>
<td></td>
<td>The drive motor operates on two phases only</td>
<td>Tighten or replace loose connections</td>
</tr>
<tr>
<td></td>
<td>The vacuum pump runs in the wrong direction</td>
<td>Verification and rectification (page 6: Installation and Commissioning)</td>
</tr>
<tr>
<td></td>
<td>Foreign objects in the vacuum pump</td>
<td>Repair the vacuum pump (Busch service)</td>
</tr>
<tr>
<td></td>
<td>Stuck bearings</td>
<td></td>
</tr>
<tr>
<td>Problem</td>
<td>Solution</td>
<td></td>
</tr>
<tr>
<td>------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>The vacuum pump runs very noisily</td>
<td>Defective bearings: Repair the vacuum pump (Busch service)</td>
<td></td>
</tr>
<tr>
<td>Worn coupling element</td>
<td>Replace the coupling element</td>
<td></td>
</tr>
<tr>
<td>(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>
<td></td>
<td></td>
</tr>
<tr>
<td>Low oil level in the synchronising gear</td>
<td>The synchronising gear is leaky</td>
<td></td>
</tr>
<tr>
<td>Synchronising gear damaged due to operation with low oil level</td>
<td>Repair the vacuum pump (Busch service)</td>
<td></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: Make sure that the cooling of the vacuum pump is not impeded by dust/dirt</td>
<td></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>
<td></td>
</tr>
<tr>
<td>Ambient temperature too high</td>
<td>Install the vacuum pump in a narrow space only if sufficient ventilation is ensured</td>
<td></td>
</tr>
<tr>
<td>Temperature of the inlet gas too high</td>
<td>Observe the permitted ambient temperatures</td>
<td></td>
</tr>
<tr>
<td>Mains frequency or voltage outside tolerance range</td>
<td>Observe the permitted temperatures for the inlet gas</td>
<td></td>
</tr>
<tr>
<td>Partial clogging of filters or screens</td>
<td>Provide a more stable power supply</td>
<td></td>
</tr>
<tr>
<td>Partial clogging in the suction, discharge or pressure line</td>
<td>Remove the clogging</td>
<td></td>
</tr>
<tr>
<td>Long suction, discharge or pressure line with too small diameter</td>
<td>Use larger diameter</td>
<td></td>
</tr>
</tbody>
</table>
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 exclusive use of the genuine spare parts and consumables is a prerequisite for the proper function of the vacuum pump and for the granting of warranty, guarantee or goodwill.

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 302896
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 56 (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>Pos.</th>
<th>Part Description</th>
<th>Qty</th>
<th>Part no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td>ATEX-filter cartridge, polyester, for inlet air filter or vacuum relief valve</td>
<td>1</td>
<td>0532 137 988</td>
</tr>
<tr>
<td></td>
<td>WITH equipotential bonding</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-</td>
<td>Filter cartridge, paper, for inlet air filter or vacuum relief valve</td>
<td>1</td>
<td>0532 000 003</td>
</tr>
<tr>
<td></td>
<td>WITHOUT equipotential bonding</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-</td>
<td>Filter cartridge, polyester, for inlet air filter or vacuum relief valve</td>
<td>1</td>
<td>0532 121 863</td>
</tr>
<tr>
<td></td>
<td>WITHOUT equipotential bonding</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-</td>
<td>Inlet flange, lower part, with non-return valve</td>
<td>1</td>
<td>0916 102 518</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-</td>
<td>Screen</td>
<td>1</td>
<td>0534 000 018</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-</td>
<td>ATEX-filter cartridge, paper, for inlet air filter or vacuum relief valve</td>
<td>1</td>
<td>0532 134 778</td>
</tr>
<tr>
<td></td>
<td>WITH equipotential bonding</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MM 1104, 1144, 1102, 1142 B V ATEX-Version, Gas Tight
Equipment Documentation
Measurement and Safety Instrumentation

Overview

Version with Resistance Thermometer, without Transmitter

In case the transmitter is furnished by the system supplier or operator.

<table>
<thead>
<tr>
<th>Scope of delivery</th>
<th>Resistance thermometer with connecting cable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type/Marking</td>
<td>TR40 Pt100/B/3</td>
</tr>
<tr>
<td>Documentation</td>
<td>Operating instructions Resistance thermometers (➔ page 22: Documentation Resistance Thermometer)</td>
</tr>
</tbody>
</table>

Version with Resistance Thermometer and Transmitter

Standard scope of delivery for version with temperature monitoring

<table>
<thead>
<tr>
<th>Scope of delivery</th>
<th>Thermometer system, consisting of: Resistance thermometer with connecting cable, transmitter, junction box</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type/Marking</td>
<td>Resistance thermometer: TR40 Pt100/B/3 Transmitter: TMT181-B Junction box: 15060603</td>
</tr>
</tbody>
</table>

Brief description:
Resistance thermometer with connected temperature transmitter
Temperature resistor with 3-wire connection.
Temperature transmitter with 3-wire electronics for signal 4 ... 20 mA.
Connection of supply voltage to pins + (positive pole) and - (negative pole).

Upper limiting values in supply circuit (certified intrinsically safe electric circuit):

- Temperature 250 °C Resistance 194.074 Ω Current 15.676 mA
- Temperature 270 °C Resistance 201.287 Ω Current 16.541 mA
- Temperature 280 °C Resistance 204.876 Ω Current 16.973 mA
- Temperature 290 °C Resistance 208.453 Ω Current 17.405 mA
- Temperature 300 °C Resistance 212.019 Ω Current 17.838 mA
- Temperature 310 °C Resistance 215.573 Ω Current 18.270 mA
- Temperature 340 °C Resistance 226.166 Ω Current 19.568 mA
- Temperature 350 °C Resistance 229.673 Ω Current 20.000 mA

Summary of temperatures, resistances and currents (presets):

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Resistance</th>
<th>Current</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under measurement range (= sensor short circuit)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Lower measurement range limit</td>
<td>-20 °C</td>
<td>92.160 Ω</td>
</tr>
<tr>
<td>Shutdown temperature (applicable shutdown temperature see nameplate of the vacuum pump)</td>
<td>125 °C</td>
<td>14.944 Ω</td>
</tr>
<tr>
<td></td>
<td>130 °C</td>
<td>149.824 Ω</td>
</tr>
<tr>
<td></td>
<td>150 °C</td>
<td>157.315 Ω</td>
</tr>
<tr>
<td></td>
<td>160 °C</td>
<td>161.043 Ω</td>
</tr>
<tr>
<td></td>
<td>165 °C</td>
<td>162.903 Ω</td>
</tr>
<tr>
<td></td>
<td>170 °C</td>
<td>164.760 Ω</td>
</tr>
<tr>
<td></td>
<td>180 °C</td>
<td>168.465 Ω</td>
</tr>
<tr>
<td></td>
<td>190 °C</td>
<td>172.158 Ω</td>
</tr>
<tr>
<td></td>
<td>220 °C</td>
<td>183.168 Ω</td>
</tr>
<tr>
<td></td>
<td>225 °C</td>
<td>184.993 Ω</td>
</tr>
<tr>
<td></td>
<td>230 °C</td>
<td>186.815 Ω</td>
</tr>
<tr>
<td></td>
<td>240 °C</td>
<td>190.451 Ω</td>
</tr>
<tr>
<td></td>
<td>250 °C</td>
<td>194.074 Ω</td>
</tr>
<tr>
<td></td>
<td>270 °C</td>
<td>201.287 Ω</td>
</tr>
<tr>
<td></td>
<td>280 °C</td>
<td>204.876 Ω</td>
</tr>
<tr>
<td></td>
<td>290 °C</td>
<td>208.453 Ω</td>
</tr>
<tr>
<td></td>
<td>300 °C</td>
<td>212.019 Ω</td>
</tr>
<tr>
<td></td>
<td>310 °C</td>
<td>215.573 Ω</td>
</tr>
<tr>
<td></td>
<td>340 °C</td>
<td>226.166 Ω</td>
</tr>
<tr>
<td></td>
<td>350 °C</td>
<td>229.673 Ω</td>
</tr>
</tbody>
</table>

Upper measurement range limit | 350 °C | 229.673 Ω | 20.000 mA |
Sensor breakage | - | - | 21.0 mA

More installation notes: After connection of the cables to the switchboard/system control make sure that the housing is firmly closed and the cable glands are tightened.

Dokumentation
Operating instructions Resistance thermometers (➔ page 22: Documentation Resistance Thermometer)
Operating Instructions Temperature Transmitter (➔ page 44: Documentation Temperature Transmitter)
Pressure Switch/indicator
(Optional)

<table>
<thead>
<tr>
<th>Type/Marking</th>
<th>ExS10-0AVA1711R2SB4</th>
</tr>
</thead>
</table>

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 -1 barg in factory setting) and 20 mA (corresponding to +1 barg in factory setting).

If required two switching points can be evaluated by means of the pins 4 and 2 and the state of the switches be read on the LEDs S1 and S2.

Technical Data → separate Documentation

Interface
A mating coupling is in the scope of delivery. Cable connection with screw clamps max. 0.75 mm².

Upon delivery the pressure switch/indicator is set to "factory values", except for the limit values of the switch points 1 and 2 and the operating mode of switch point 2. Restoration in case of inadvertent misadjustment → separate Documentation.

Lower pressure signal with signal applied (liquid adjustment) not to be set

Zero signal without applied signal (dry adjustment) -.999 (achieves sufficient accuracy, can be retained)

Upper pressure signal with signal applied (liquid adjustment) not to be set

Span signal without applied signal (dry adjustment) 1.000 (achieves sufficient accuracy, can be retained)

Decimal places dp3 (corresponds to indication 8.888)

Zero scaling -.999

Endpoint-scaling 1.000

Damping 1 (corresponds to 0.3 seconds delay)

Limit value switch point 1 -.200 ("customer specific adjustment")

Hysteresis switch point 0.003

Operating mode switch point 1 n.o. (working principle)

Function switch point 1 norF

Limit value switch point 2 0.200 ("customer specific adjustment")

Hysteresis switch point 2 0.003

Operating mode switch point 2 n.c. (quiescent principle, "customer specific adjustment")

Fast adjustment on

Behaviour of signal output oFF

More installation notes:
The pressure switch/indicator is to be integrated into the system control such that the maintenance of the permitted pressure range* will be monitored. If the pressure gets outside this range the system control must automatically shut down the vacuum pump.

*ambient pressure ±200 hPa (±mbar), unless specified otherwise on the nameplate of the vacuum pump

Observe the separate Documentation.

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

Pin 1 transmits the sum of the currents of the pins 2, 3 and 4. The monitoring circuitry shall be designed such that the current and the voltage allowed for intrinsically safe circuits will not be exceeded on any wire at any time.

Switching options (examples):
1. Use of isolation switch amplifiers (e.g. Pepperl+Fuchs KF__-SR2-Ex1.W; not in the Busch scope of delivery) switched between the pins 1, 2 and 4 of the pressure switch/indicator on the one side and the switching relays on the other.

2. Evaluation of the 4 ... 20 mA signal of the pressure switch/indicator alone, by means of a suitable transmitter supply (e.g. Pepperl+Fuchs KF__-CRG-Ex1.D; not in the Busch scope of delivery).

3. Evaluation of the 4 ... 20 mA signal of the pressure switch/indicator alone, after isolation by means of a suitable transmitter supply (e.g. ACS ExTVA500, Pepperl+Fuchs KFD2- STC4-Ex1; not in the Busch scope of delivery), by means of a non-Ex-system control or SPS respectively.

The pressure switch/indicator is to be integrated into the system control such that the maintenance of the pressure range from -200 mbarg to +200 mbarg (corresponding to a current between 10.4 and 13.6 mA, if the factory set measurement range is retained) will be monitored. If the pressure gets outside this range the system control 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.

MM 1104, 1144, 1102, 1142 B V ATEX-Version, Gas Tight
## Contents

1. General information
2. Safety
3. Specifications
4. Design and function
5. Transport, packaging and storage
6. Commissioning, operation
7. Information on mounting and operation in hazardous area (Europe)
8. Electrical connection values
9. Calculation examples for self-heating at the probe/thermowell tip
10. Maintenance and cleaning
11. Faults
12. Dismounting, return and disposal

Appendix: EC declaration of conformity

Declarations of conformity can be found online at www.wika.com.
1. General information

1. General information
- The instrument described in the operating instructions has been designed and manufactured using state-of-the-art technology. All components are subject to stringent quality and environmental criteria during production. Our management systems are certified to ISO 9001 and ISO 14001.
- These operating instructions contain important information on handling the instrument. Working safely requires that all safety instructions and work instructions are observed.
- Observe the relevant local incident prevention regulations and general safety regulations for the instrument’s range of use.
- The operating instructions are part of the instrument and must be kept in the immediate vicinity of the instrument and readily accessible to skilled personnel at any time.
- Skilled personnel must have carefully read and understood the operating instructions, prior to beginning any work.
- The manufacturer's liability is void in the case of any damage caused by using the product contrary to its intended use, non-compliance with these operating instructions, assignment of insufficiently qualified skilled personnel or unauthorised modifications to the instrument.
- The general terms and conditions, contained in the sales documentation, shall apply.
- Subject to technical modifications.

Further information:
- Internet address: www.wika.de / www.wika.com
- Application consultant: Tel.: +49 5372 132-0
- Fax: +49 5372 132-406
- info@wika.de

Explanation of symbols

WARNING! ...indicates a potentially dangerous situation that can result in serious injury or death, if not avoided.

CAUTION! ...indicates a potentially dangerous situation, which can result in light injuries or damage to equipment or the environment, if not avoided.

Information ...points out useful tips, recommendations and information for efficient and trouble-free operation.

1. General information / 2. Safety

WARNING!
...indicates a potentially dangerous situation in a potentially explosive atmosphere, resulting in serious injury or death, if not avoided.

WARNING!
...indicates a potentially dangerous situation, caused by hot surfaces or liquids, that can result in burns if not avoided.

Abbreviations
RTD  “Resistance Temperature Detector” = Resistance thermometers
TC  “Thermocouple”

2. Safety

WARNING!
Before installation, commissioning and operation, ensure that the appropriate thermometer has been selected in terms of measuring range, design and specific measuring conditions.

Choose the thermowell with regard to the maximum pressure and temperature (e.g. rating chart in DIN 43772).

Non-observance can result in serious injury and/or damage to equipment.

Further important safety instructions can be found in the individual chapters of these operating instructions.

2.1 Intended use
These resistance thermometers and thermocouples are used for temperature measurement in industrial applications, in hazardous areas.

Resistance thermometers are used for measuring temperatures from -200 ... +600 °C. For thermocouples, the possible measuring ranges range from -200 ... +1,200 °C. Thermometers of this design can be installed directly in the process as well as in thermowells. The thermowell designs can be selected as desired, but the operating process data (temperature, pressure, density and flow rate) must be taken into account.
2. Safety

The system operator is responsible for selecting the thermometer or thermowell, and for the selection of their materials, so as to guarantee their safe operation within the system or machine. When preparing a quote, WIKA can only give recommendations which are based on our experience in similar applications.

The thermometer has been designed and built solely for the intended use described here and may only be used accordingly.

The technical specifications contained in these operating instructions must be observed. Improper handling or operation of the instrument outside of its technical specifications requires the instrument to be shut down immediately and inspected by an authorised WIKA service engineer.

If the instrument is transported from a cold into a warm environment, the formation of condensation may result in the instrument malfunctioning. Before putting it back into operation, wait for the instrument temperature and the room temperature to equalise.

The manufacturer shall not be liable for claims of any type based on operation contrary to the intended use.

2.2 Personnel qualification

**WARNING!**
Risk of injury should qualification be insufficient
Improper handling can result in considerable injury and damage to equipment.
- The activities described in these operating instructions may only be carried out by skilled personnel who have the qualifications described below.
- Keep unqualified personnel away from hazardous areas.

Skilled personnel
Skilled personnel are understood to be personnel who, based on their technical training, knowledge of measurement and control technology and on their experience and knowledge of country-specific regulations, current standards and directives, are capable of carrying out the work described and independently recognising potential hazards.

Special operating conditions require further appropriate knowledge, e.g. of aggressive media.

2.3 Additional safety instructions for instruments per ATEX and IECEx

**WARNING!**
Non-observance of these instructions and their contents may result in the loss of explosion protection.

WARNING!
Follow the requirements of the 94/9/EC (ATEX) and IECEx directives.
Follow the respective national regulations concerning Ex-usage (e.g. EN/IEC 60079-10 and EN/IEC 60079-14).

2.4 Special hazards

**WARNING!**
Observe the information given in the applicable type examination certificate and the relevant country-specific regulations for installation and use in potentially explosive atmospheres (e.g. EN/IEC 60079-14, NEC, CEEX). Non-observance can result in serious injury and/or damage to equipment.
For additional important safety instructions for instruments with ATEX/IECEx approval, see chapter 2.3 “Additional safety instructions for instruments per ATEX and IECEx”.

**WARNING!**
For hazardous media such as oxygen, acetylene, flammable or toxic gases or liquids, and refrigeration plants, compressors, etc., in addition to all standard regulations, the appropriate existing codes or regulations must also be followed.

**WARNING!**
Protection from electrostatic discharge (ESD) required. The proper use of grounded work surfaces and personal wrist straps is required when working with exposed circuitry (printed circuit boards), in order to prevent static discharge from damaging sensitive electronic components.
To ensure safe working on the instrument, the operating company must ensure:
- that suitable first-aid equipment is available and aid is provided whenever required.
- that the operating personnel are regularly instructed in all topics regarding work safety, first aid and environmental protection and know the operating instructions and, in particular, the safety instructions contained therein.

**WARNING!**
Residual media in dismantled instruments can result in a risk to persons, the environment and equipment. Take sufficient precautionary measures.
Do not use this instrument in safety or Emergency Stop devices. Incorrect use of the instrument can result in injury.
Should a failure occur, aggressive media with extremely high temperature and under high pressure or vacuum may be present at the instrument.
2. Safety

2.5 Labelling, safety marks

2.5.1 Product labels for resistance thermometers

Model: WIKAI TR10-B-II GZ

- Sensor in accordance with standard:
  - F: Thin-film resistor
  - W: Wire-wound resistor

- Transmitter model (only for design with transmitter):

- Product label for measuring instrument TR10-A

Year of manufacture

- Approval number

3. Specifications

3.1 Resistance thermometer

- Sensor connection method:
  - 2-wire
  - 3-wire
  - 4-wire

- Limiting error of the sensor per DIN EN 60751:
  - Class B
  - Class A
  - Class AA

- The combination of a 2-wire connection with class A or class AA is not permissible, since the lead resistance of the measuring insert negates the higher sensor accuracy.

- Basic values and limiting errors:
  - Basic values and limiting errors for the platinum measurement resistance are laid down in DIN EN 60751.
  - The nominal value of Pt100 sensors is 100 Ω at 0 °C.
  - The temperature coefficient α can be stated simply to be between 0 °C and 100 °C with:
    \[ \alpha = 3.85 \cdot 10^{-3} \text{ °C}^{-1} \]

- The relationship between temperature and electrical resistance is described by polynomials, which are also defined in DIN EN 60751. Moreover, this standard specifies the basic values in °C steps in tabular form.
3. Specifications

<table>
<thead>
<tr>
<th>Class</th>
<th>Temperature range wires (°C)</th>
<th>Thin film (°F)</th>
<th>Limiting error in °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>-196 ... +600 °C</td>
<td>-50 ... +500 °F</td>
<td>±0.30 + 0.0050 °C</td>
</tr>
<tr>
<td>A</td>
<td>-100 ... +550 °C</td>
<td>-30 ... +300 °F</td>
<td>±0.15 + 0.0020 °C</td>
</tr>
<tr>
<td>AA</td>
<td>-50 ... +250 °C</td>
<td>0 ... +150 °F</td>
<td>±0.10 + 0.0017 °C</td>
</tr>
</tbody>
</table>

1) t is the value of the temperature in °C irrespective of the sign.

Bold: standard version

For further technical information, see WIKA data sheet and Technical information IN 06.17
“Usage limitations and accuracies of platinum resistance thermometers per EN 60751: 2008”.

3.2 Thermocouples

3.2.1 Sensor type

<table>
<thead>
<tr>
<th>Model</th>
<th>Recommended max. operating temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>K</td>
<td>1,200 °C</td>
</tr>
<tr>
<td>J</td>
<td>800 °C</td>
</tr>
<tr>
<td>E</td>
<td>800 °C</td>
</tr>
<tr>
<td>T</td>
<td>400 °C</td>
</tr>
<tr>
<td>N</td>
<td>1,200 °C</td>
</tr>
<tr>
<td>S</td>
<td>1,600 °C</td>
</tr>
<tr>
<td>R</td>
<td>1,600 °C</td>
</tr>
<tr>
<td>B</td>
<td>1,700 °C</td>
</tr>
</tbody>
</table>

Tolerance values of the thermocouples per IEC 60584 part 2 | ASTM 14.03 E230 (Reference temperature 0 °C)

<table>
<thead>
<tr>
<th>Type Thermocouple</th>
<th>Tolerance value</th>
<th>Class</th>
<th>Temp. range °C</th>
<th>Tolerance value °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>K NiCr-NiNi</td>
<td>IEC 60584 part 2</td>
<td>1</td>
<td>-40 ... +1,000</td>
<td>±1.5 °C or ±0.005</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>-40 ... +1,000</td>
<td>±2.5 °C or ±0.0075</td>
</tr>
<tr>
<td>N NiCrNi-NiNi</td>
<td>ASTM 14.03 E230</td>
<td>Special</td>
<td>0 ... +1,250</td>
<td>±2.0 °C or ±0.0075</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Standard</td>
<td>0 ... +1,250</td>
<td>±2.0 °C or ±0.075</td>
</tr>
<tr>
<td>J Cu-Ni</td>
<td>IEC 60584 part 2</td>
<td>1</td>
<td>-40 ... +750</td>
<td>±1.1 °C or ±0.035</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>-40 ... +750</td>
<td>±2.1 °C or ±0.065</td>
</tr>
<tr>
<td></td>
<td>ASTM 14.03 E230</td>
<td>Special</td>
<td>0 ... +750</td>
<td>±2.2 °C or ±0.075</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Standard</td>
<td>0 ... +750</td>
<td>±2.2 °C or ±0.075</td>
</tr>
<tr>
<td>E Cu-Ni</td>
<td>IEC 60584 part 2</td>
<td>1</td>
<td>-40 ... +800</td>
<td>±1.1 °C or ±0.040</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>-40 ... +800</td>
<td>±2.1 °C or ±0.040</td>
</tr>
<tr>
<td></td>
<td>ASTM 14.03 E230</td>
<td>Special</td>
<td>0 ... +800</td>
<td>±2.2 °C or ±0.040</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Standard</td>
<td>0 ... +800</td>
<td>±2.2 °C or ±0.040</td>
</tr>
<tr>
<td>T Cu-Ni</td>
<td>IEC 60584 part 2</td>
<td>1</td>
<td>-40 ... +350</td>
<td>±1.0 °C or ±0.035</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>-40 ... +350</td>
<td>±2.0 °C or ±0.075</td>
</tr>
<tr>
<td></td>
<td>ASTM 14.03 E230</td>
<td>Special</td>
<td>0 ... +370</td>
<td>±1.0 °C or ±0.035</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Standard</td>
<td>0 ... +370</td>
<td>±1.0 °C or ±0.075</td>
</tr>
</tbody>
</table>

Wika operating instructions RTD and TC, Intrinsically safe designs (Ex i) 11

GB

GB

3.2.2 Potential measurement uncertainties

Important factors which counteract the long-term stability of thermocouples.

Aging effects/poisoning

- Oxidation processes in thermocouples which are not appropriately protected (“bare” thermocouple wires) result in falsifications of the characteristic curves.
- Foreign atoms (poisoning) that diffuse into the original alloys lead to changes of these original alloys and thus falsify the characteristic curve.
- The influence of hydrogen leads to the embrittlement of the thermocouples.

The Ni leg of the type K thermocouple is often damaged by sulphur, which is contained in exhaust gases, for example. Thermocouple types J and T age slightly, as the pure metal leg oxidises first.

In general, rising temperatures cause accelerated aging effects.

Green rot

If type K thermocouples are used at temperatures from approx. 800 °C to 1,050 °C, considerable changes of the thermoelectric voltage can occur. The cause of this is a chromium depletion or a chromium oxide in the NiCrNi leg (± leg). The precondition for this is a low concentration of oxygen or steam in the immediate environment of the thermocouple. The nickel leg is not affected by it. The consequence of this effect is a drift of the measured value caused by decreasing thermoelectric voltage. This effect is accelerated if there is a shortage of oxygen (reducing atmosphere), since a complete oxide layer, which would protect it from further oxidation of the chromium, cannot be formed on the surface of the thermocouple.

The thermocouple is permanently destroyed by this process. The name green rot is derived from the greenish shimmering colouration on the breaking point of the wire.
3. Specifications

The thermocouple type N has in this regard an advantage due to its silicon content. Here, a protective oxide layer forms on its surface under the same conditions.

K effect
The NiCr leg of a type K thermocouple has an ordered alignment with respect to the alignment in the crystal lattice below approx. 400 °C. If the thermocouple is heated further, a transition to a disordered state occurs in the temperature range between approx. 400 °C and 600 °C. Above 600 °C, an ordered crystal lattice is restored.

If these thermocouples cool too quickly (quicker than approx. 100 °C per hour), the undesirable disordered crystal lattice occurs again during cooling in the range from approx. 600 °C to approx. 400 °C. In the characteristic curve of type K, however, a consistently ordered alignment state is assumed and provided with values. This results in a fault of the thermoelectric voltage of up to approx. 0.8 mV (approx. 8 °C) in this range. The K effect is reversible and is largely eliminated again by annealing above 700 °C, followed by correspondingly slow cooling.

Thin sheathed thermocouples are particularly sensitive in this respect. Cooling in resting air can already lead to deviations of 1 K.

In type N thermocouple, it has been possible to reduce this short-range-order effect by alloying both legs with silicon.

The application range of these thermometers is limited by the permissible maximum temperature of the thermocouple and by the max. temperature of the thermowell material.

Listed models are available both as single or dual thermocouples. The thermocouple will be delivered with an insulated measuring point, unless explicitly specified otherwise.

Tolerance value
For the tolerance value of thermocouples, a cold junction temperature of 0 °C has been taken as the basis. When using a compensating cable or thermocouple cable, an additional measuring error must be considered.

For limiting deviations and further specifications, see the corresponding WIKA data sheet and Technical information IN 09.23, “Application of thermocouples”.

4. Design and function

4.1 Description
These thermometers (resistance thermometers and thermocouples) detect temperatures in processes. Depending on the design, these thermometers are suitable for low, medium and high process requirements in hazardous areas.

Insulated measuring point
The model TRx or model TCx thermometers consist of a welded tube, a mineral-insulated sheathed cable or ceramic-insulated thermal wires (in which the temperature sensor is located, embedded in a ceramic powder), a temperature-resistant sealing compound, cement compound or a thermal transfer paste.

Alternatives:
The measuring insert or the cable probe can also be provided in a tubular form. In this case, the sensor is located in a welded tube and embedded in a ceramic powder, heat-conducting paste or in a sealing compound suitable for this purpose.

The measuring insert for high-temperature thermocouples can also be assembled from thermal wires insulated with ceramic rods or ceramic beads. The ceramic tube is cemented into a metallic support tube using a temperature-resistant cement.

Thermocouples, non-insulated (grounded)
For special applications, e.g., for surface temperature measurements, the sensors are in direct contact with the protective sleeve, or the measuring points of thermocouples are welded to the bottom (see chapter 7.1.1 “Special conditions of use (X conditions”)).

[Diagram of measuring point insulated (ungrounded) and measuring point not insulated (grounded)]

V-Pad version, model TC56-V
Measuring point not insulated

[Diagram of V-Pad version with A22G powder and V-Pad]
4. Design and function / 5. Transport, packaging and storage

Vibration resistance
The thermometers have an impact- and vibration-resistant design. The vibration resistance of the basic model corresponds to DIN EN 60751 (up to 3 g), while for special designs higher loads are possible. The impact resistance of all versions complies with the requirements of EN 60751, with the exception of high-temperature thermocouples assembled from ceramic-insulated thermal wires.

Electrical connection
In terms of connection, the thermometer is equipped with a housing and a connector or bare wire ends. The housing design will contain the terminals or a certified transmitter. Optionally, separately-certified digital displays can be built into the housing.

4.3 Scope of delivery
Cross-check scope of delivery with delivery note.

5. Transport, packaging and storage

5.1 Transport
Check instrument for any damage that may have been caused by transport. Obvious damage must be reported immediately.

5.2 Packaging
Do not remove packaging until just before mounting. Keep the packaging as it will provide optimum protection during transport (e.g. change in installation site, sending for repair).

5.3 Storage
Permissible conditions at the place of storage:
- Storage temperature: Instruments without built-in transmitter: -40 ... +65 °C
- Instruments with built-in transmitter: see operating instructions of the transmitter in question
- Humidity: 35 ... 85 % relative humidity (no condensation)

Avoidance of exposure to the following factors:
- Direct sunlight or proximity to hot objects
- Mechanical vibration, mechanical shock (putting it down hard)
- Soot, vapour, dust and corrosive gases

5. Transport, packaging and storage / 6. Commissioning, operation

Store the instrument in its original packaging in a location that fulfills the conditions listed above. If the original packaging is not available, pack and store the instrument as described below:
1. Wrap the instrument in an antistatic plastic film.
2. Place the instrument, along with shock-absorbent material, in the packaging.
3. If stored for a prolonged period of time (more than 30 days), place a bag containing a desiccant, inside the packaging.

6. Commissioning, operation

WARNING!
Before storing the instrument (following operation), remove any residual media. This is of particular importance if the medium is hazardous to health, e.g. caustic, toxic, carcinogenic, radioactive, etc.

CAUTION!
- Damage to cables and wires, and to connection points, must be avoided
- Provide finely stranded conductor ends with end sleeves (cable assembly)
- Both the internal capacitance and inductance must be considered

For the electrical connections of thermometers (e.g. connection circuit diagrams, tolerance values, etc.), please refer to the appropriate data sheets. If field transmitters or digital displays have been built into the connection housing, these data sheets must also be given proper consideration.
6. Commissioning, operation

6.2 Electrical connection of resistance thermometers
6.2.1 Resistance thermometer with terminal block

[Diagram showing electrical connections for resistance thermometers]

6.2.2 Resistance thermometer with cable or connector
Without connector

[Diagram showing electrical connections for resistance thermometers]

Lemos connector

[Diagram showing Lemos connector details]

WIKI operating instructions RTD and TC, intrinsically safe designs (Ex i)
6. Commissioning, operation

6.3 Electrical connection of thermocouples

6.3.1 Thermocouples with terminal block

The colour coding at the positive connection to the device always decides the connection of polarity and connection terminal.

6.3.2 Thermocouples with cable or connector

Cable
For the marking of the cable ends, see table

Lemo connector, male at the cable

Binder connector, male at the cable
(screwplug-in-connector)

Single thermocouple

Dual thermocouple

Thermal connector

Plus and minus are marked.
For dual thermocouples, two thermal connectors are used.

6.4 Multipoint thermocouples (as per 8.4)
They are usually equipped with a housing in which transmitters or terminal blocks are mounted. The transmitters/digital displays are fastened mechanically (e.g. rail system in housing or holder in connection head) and installed in accordance with EN/IEC 60079-11 and EN/IEC 60079-14.
Optionally, depending on design, the housings can be equipped with or without terminals (e.g. terminal blocks, etc.) in accordance with EN/IEC 60079-11 and EN/IEC 60079-14.

When using several transmitters/digital displays, the housing volume increases as a function of the “heat source”, thus increasing the volume to be heated. This guarantees that the housing surface temperature does not increase significantly.

WARNING!
When using no terminals and line wiring, compliance with the installation regulations in accordance with EN/IEC 60079-11 and EN/IEC 60079-14 must be guaranteed.

6.5 Cable glands
In thermometers equipped with connection heads, the cable glands must be fully sealed in order to ensure that the necessary ingress protection is reached.

Requirements for meeting ingress protection
- Only use cable glands with their indicated clamping range (cable diameter suitable for the cable gland)
- Do not use the lower clamping area with very soft cable types
- Only use circular cross-section cables (if necessary, slightly oval in cross-section)
- Do not twist the cable

9 WKA operating instructions RTD and TC, intrinsically safe designs (Ex i)
6. Commissioning, operation

- Repeated opening/closing is possible; however only if necessary, as it might have a detrimental effect on the protection class.
- For cable with a pronounced cold-flow behaviour the screw connection must be fully tightened.

6.5 Parallel threads

If the thermowell connecting head, extension neck, thermowell or process connection are connected with parallel threads (e.g. G 1/2, M20 x 1.5 –…), these threads must be secured using seals which prevent liquids from penetrating into the thermowell.

As standard, WIKA uses copper profile seals for the connection between the neck tube and the thermowell, and flat paper seals for the connection of the connection head and the extension neck or thermowell.

If the thermowell and the thermowell are already connected, the seals will already be mounted. The plant operator must check whether the seals are suitable for the operating conditions and must replace them, if necessary, with suitable seals.

For thermometers without a thermowell, and/or where these are delivered separately, the seals are not included and must be ordered separately.

Tighten the threads by hand when carrying out the final assembly on the plant. This will correspond to the delivery status of the pre-mounted components. The final tightening torque should be applied using a spanner (half rotation).

The seals must be replaced after dismantling!

The seals can be ordered from WIKA, indicating the WIKA order number and/or the designation (see table).

<table>
<thead>
<tr>
<th>WIKA Order No.</th>
<th>Designation</th>
<th>Suitable for threads</th>
</tr>
</thead>
<tbody>
<tr>
<td>11349981</td>
<td>per DIN 7603 Form C 14 x 18 x 2 - CuF</td>
<td>G 1/2, M14 x 1.5</td>
</tr>
<tr>
<td>11349999</td>
<td>per DIN 7603 Form C 18 x 22 x 2 - CuF</td>
<td>M18 x 1.5, G 1/2</td>
</tr>
<tr>
<td>11350008</td>
<td>per DIN 7603 Form C 21 x 25 x 2 - CuF</td>
<td>G 1/2, M20 x 1.5</td>
</tr>
<tr>
<td>11350016</td>
<td>per DIN 7603 Form C 27 x 33 x 2.5 - CuF</td>
<td>G 1/2, M22 x 2</td>
</tr>
<tr>
<td>11357416</td>
<td>per DIN 7603 Form C 20 x 24 x 2 - CuF</td>
<td>M20 x 1.5</td>
</tr>
<tr>
<td>12492278</td>
<td>per DIN 7603 D21 2 x D25 9 x 1.5 - Al</td>
<td>G 1/2, M20 x 1.5</td>
</tr>
<tr>
<td>3153138</td>
<td>per DIN 7603 Form C D14 2 x D17 9 x 2 - SIFa</td>
<td>G 1/2, M14 x 1.5</td>
</tr>
<tr>
<td>33614185</td>
<td>per DIN 7603 Form C D33 3 x D33 9 x 2.5 - SIFa</td>
<td>G 1</td>
</tr>
</tbody>
</table>

Legend:
- CuF = Copper max. 45 HBP, filled with asbestos-free sealing material
- Al = Aluminium Al99.9, F 11, 32 to 45 HB
- SIFa = Soft iron, 80 to 95 HB, filled with asbestos-free sealing material

WIKA operating instructions RTD and TC, intrinsically safe designs (Ex i)
7. Information on mounting, operation in hazardous area (Europe)

E) When using transmitters and digital displays, the following must be observed:

- The contents of these operating instructions and those of the transmitter.
- The relevant regulations for installation and use of electrical systems.
- The regulations and directives regarding explosion protection. Transmitters and digital displays must have their own approval.

F) When ordering spare parts, the parts that are to be replaced must be specified exactly:

- Ignition protection type (here Ex i)
- Approval No.
- Order No.
- Manufacturing No.
- Order item

7.1.1 Special conditions of use (X conditions)

Versions with $D < 3$ mm or "non-insulated" versions are operationally non-compliant with section 6.3.1.2 of EN/IEC 60079-11. Therefore, from a safety-relevant point of view, these intrinsically safe circuits must be considered galvanically connected to the earth potential, which is why equipotential bonding must be secured for the entire installation of the intrinsically safe circuits. In addition, for the connection, separate conditions in accordance with EN/IEC 60079-14 must be observed.

Electrostatic discharges must be avoided in instruments, that due to their design, do not conform to the electrostatic requirements in accordance with EN/IEC 60079-0.

The transmitters and digital displays used must have their own EN/IEC approval. The installation conditions, electrical connected loads, temperature classes or maximum surface temperatures for use in potentially explosive dust atmospheres and permissible ambient temperatures can be seen from the relevant approvals and must be observed.

Thermal backflow from the process, that exceeds the permissible ambient temperature of the transmitter, must not be allowed to occur. It must be prevented by installing suitable heat insulation or a neck tube of suitable length.

If the wall thickness is below 1 mm, the instruments must not be subjected to ambient stresses that may have an adverse effect on the partition wall. Alternatively, a thermowell of suitable minimum wall thickness may be used.

When using a thermowell/neck tube, the overall instrument must be designed such that it allows installation in a way that results in a sufficiently tight gap (IP 67) or a flameproof gap (EN/IEC 60079-1) towards the less hazardous area.

When housings are used, they must either have their own suitable approval or comply with the minimum requirements. IP protection: at least IP 20 (at least IP 65 for dust), applies to all housings. However, light metal housings must be suitable in accordance with EN/IEC 60079-0 Section 6.1. In addition, non-metallic housings or powder-coated housings must meet the requirements of EN/IEC 60079-0 or have a suitable warning note.

WIKI operating instructions RTD and TC, intrinsically safe designs (Ex i)
7. Information on mounting, operation in hazardous area (Europe)

Use in methane atmospheres
Owing to the higher minimum ignition energy of methane, the instruments can also be used where methane causes a potentially explosive atmosphere. The instrument can be optionally marked with IIC + CH₄.

For applications that require Ex IIB or IIC, instruments with "ia" marking may also be used in measuring circuits of type T6.

7.2 Temperature class classification, ambient temperatures
The permissible ambient temperatures depend on the temperature class, the housing used, and any transmitters and/or digital displays fitted as option.

When a transmitter is connected to a transmitter and/or digital display, the lowest value of either the ambient temperature limits or the highest temperature class will apply. The lower temperature limit is -40 °C; and -50 °C for special designs.

Where there are neither transmitters nor digital displays mounted within the housing, there will also be no additional warming.

With a built-in transmitter (optionally with digital display), heating caused by the operation of the transmitter or digital display may occur.

For applications without transmitters (digital displays) that require Group II instruments (potentially explosive gas atmospheres), the following temperature class classification and ambient temperature ranges apply:

<table>
<thead>
<tr>
<th>Temperature class</th>
<th>Ambient temperature range (Ta)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T6</td>
<td>(-50) ... 40 °C to +60 °C</td>
</tr>
<tr>
<td>T5</td>
<td>(-50) ... 40 °C to +95 °C</td>
</tr>
<tr>
<td>T4, T3</td>
<td>(-50) ... 40 °C to +100 °C</td>
</tr>
</tbody>
</table>

See and observe the permissible ambient temperatures and surface temperatures for third-party products from the relevant approvals and/or data sheets.

Example
For instruments fitted with a DIH10 transmitter and digital display, for example, the following limit for temperature class classification applies:

Temperature class | Ambient temperature range (Ta)
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>T6</td>
<td>-40 °C to +60 °C</td>
</tr>
</tbody>
</table>

For applications that require Group II instruments (potentially explosive gas atmospheres), the following surface temperatures and ambient temperature ranges apply:

<table>
<thead>
<tr>
<th>Power Pi (mW)</th>
<th>Ambient temperature range (Ta)</th>
</tr>
</thead>
<tbody>
<tr>
<td>750</td>
<td>(-50) ... 40 °C to +40 °C</td>
</tr>
<tr>
<td>850</td>
<td>(-50) ... 40 °C to +70 °C</td>
</tr>
<tr>
<td>950</td>
<td>(-50) ... 40 °C to +100 °C</td>
</tr>
</tbody>
</table>

See and observe the permissible ambient temperatures and surface temperatures for third-party products from the relevant approvals and/or data sheets.

WIKA operating instructions RTD and TC, intrinsically safe designs (Ex i)
7. Information on mounting, operation in hazardous area (Europe)

7.3.2 Increasing the separation of the connection components and hot surfaces
The neck distance (N) is defined as the distance between the lower edge of the connection head (or the housing) to the heat-emitting surface. The temperature to be expected at the lower edge of the connection head or housing is, at most, 100 °C. The conditions for built-in transmitters or displays must be observed. If required, the neck length must be increased accordingly.

For thermometers fitted with a connection lead, the temperature at the interface with the connecting cable is restricted. The maximum is 150 °C. To ensure that the permissible temperature is not exceeded, the dimension X must be selected accordingly.

<table>
<thead>
<tr>
<th>Maximum temperature of the medium</th>
<th>Recommendation for dimension N</th>
<th>Recommendation for dimension X</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 °C</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>135 °C</td>
<td>20 mm</td>
<td>20 mm</td>
</tr>
<tr>
<td>200 °C</td>
<td>50 mm</td>
<td>50 mm</td>
</tr>
<tr>
<td>&gt; 200 °C or 450 °C</td>
<td>100 mm</td>
<td>100 mm</td>
</tr>
</tbody>
</table>

**WARNING!**
For reasons of work safety and saving of resources, hot surfaces should be protected against accidental touch and energy loss by means of insulation.

7.4 Mounting examples in hazardous areas

7.4.1 Possible installation methods with the marking II 1G Ex ia IIC T6 Ga or II 1D Ex ia IIC T65 °C Da

**Hazardous area**

Zones 0, 1, 2 or Zones 20, 21, 22

**Safe area**

Associated electrical equipment

- Intrinsically safe supply or suitable barrier

Option with built-in transmitter - t ≥ 710

- Intrinsically safe supply or suitable barrier

Process connection

- Intrinsically safe supply or suitable barrier

Compression fitting

- Intrinsically safe supply or suitable barrier

Thermowell TWxx

- Intrinsically safe supply or suitable barrier

Welded

- Intrinsically safe supply or suitable barrier

Connection head Field housing

- Intrinsically safe supply or suitable barrier
7. Information on mounting, operation in hazardous area (Europe)

The sensor together with housing or connection head is located in Zone 0 (Zone 20). An Ex ia type circuit must be used. Connection heads/cases made of aluminum are not permitted in Zone 0. At this position, WIKA uses connection heads/cases made of stainless steel.

7.4.2 Possible installation methods with the marking II 1/2 Ex ib IIC T6 Ga/Gb or II 1/2 D Ex ib IIC T65 °C Ex/Db

Hazardous area

Safe area

Associated electrical equipment

Intrinsically safe supply or suitable barrier

Zones 0, 1, 2 or Zones 20, 21, 22

Process connector

Compressor fitting

Thermowell, T_TW

Twisted

Welded

Twisted

Twisted

The sensor or thermowell tip protrudes into Zone 0. The housing or connection head is in Zone 1 (Zone 21) or Zone 2 (Zone 22). It is sufficient to use an Ex ib type circuit.

Zone separation is guaranteed if sufficiently tight (IP 67) process connections are used.

Examples of suitable process connections include gas-tight standardised industrial flanges, threaded connections or pipe connections.

The welded parts, process connections, compression fittings, thermowells or housings used must be designed such that they withstand all influencing variables resulting from the process, such as temperature, flow forces, pressure, corrosion, vibration and impacts.

8. Electrical connection values

8.1 Electrical data without built-in transmitter or digital display

For Group II instruments (potentially explosive gas atmospheres), the following maximum connection values apply:

- $U_i = 30\,\text{V}$
- $I_i = 550\,\text{mA}$
- $P_i$ (at the sensor) $= 1.5\,\text{W}$

For Group II instruments (potentially explosive dust atmospheres), the following maximum connection values apply:

- $U_i = 30\,\text{V}$
- $I_i = 550\,\text{mA}$
- $P_i$ (at the sensor) $= 4.2\,\text{W}$

For calculation examples, see chapter 9 "Calculation examples for self-heating at the sensor/thermowell tip:"

1) The permissible power to the sensor depends on the temperature of the medium $T_M$, the temperature class and the thermal resistance $R_{th}$, but shall not be more than 1.5 W. For calculation examples, see chapter 9 "Calculation examples for self-heating at the sensor/thermowell tip:"

2) The permissible power to the sensor depends on the temperature of the medium $T_M$, the maximum allowed surface temperature and the thermal resistance $R_{th}$, but shall not be more than the values from "Table 2" (column 3), see chapter 7.1.2 "Ex marking:"

3) Use in methane atmosphere

Owing to the higher minimum ignition energy of methane, the instruments can also be used where methane causes a potentially explosive atmosphere. The instrument can be optionally marked with IIC + CH4.

The internal inductance ($L_i$) and capacitance ($C_i$) of standard measuring inserts in accordance with DIN 43736 are negligible. The values for cable probes and very long sheathed-cable resistance thermometers can be seen from the rating plate and must be taken into account when connecting them to an intrinsically safe power supply.
8. Electrical connection values

Sensor circuit in Ex ia or ib, IIC intrinsic safety ignition protection
Only for connection to intrinsically safe circuits with the following maximum output values for Group II instruments (potentially explosive gas atmospheres):

\[ U_o = DC 30 \text{ V} \]
\[ I_o = 550 \text{ mA} \]
\[ P_o = 1.5 \text{ W} \]

For Group II instruments (potentially explosive dust atmospheres), the following maximum output values apply to their connection to intrinsically safe circuits:

\[ U_o = DC 30 \text{ V} \]
\[ I_o = 550 \text{ mA} \]
\[ P_o = \text{For the values, see "Table 2" (column 2), chapter 7.1.2 "Ex marking"} \]

8.2 Electrical data for built-in transmitters or digital displays

For the sensor circuit, the values mentioned in 8.1 apply.

Signal circuit in Ex ia or ib, IIC intrinsic safety ignition protection

\[ U_i = \text{depending on the transmitter/digital display} \]
\[ I_i = \text{depending on the transmitter/digital display} \]
\[ P_i = \text{in the housing: depending on the transmitter/digital display} \]
\[ Q_i = \text{depending on the transmitter/digital display} \]
\[ L_i = \text{depending on the transmitter/digital display} \]

The transmitters and digital displays used must have their own certification in accordance with EN/IEC. The installation conditions and electrical connection values can be seen from the relevant approvals and must be observed.

8.3 Electrical data with built-in transmitters in accordance with the FISCO model

The transmitters/digital displays used for the application range in accordance with the FISCO model are considered FISCO field units. The requirements in accordance with EN/IEC 60079-27, and the connection conditions of the approvals in accordance with FISCO, apply.

8.4 TC65/TC95 multipoint thermocouples

Assembly of multipoint thermocouples from individual sheathed cables

For the individual insulated sheathed cable, the values mentioned in 8.1 apply. For operationally grounded multipoint thermocouples, the sum of all the sensors must comply with the above-mentioned values. For applications in dust areas, the values from "Table 2" (column 2) given in chapter 7.1.2 "Ex marking" must be observed.

9. Calculation examples for self-heating at the sensor/thermowell tip

9.1 Calculation example for RTD measuring point with thermowell

Use at the partition wall to Zone 0: Calculate the maximum permissible temperature \( T_{\text{max}} \) at the thermowell tip for the following combination:

RTD measuring insert Ø 6 mm with built-in model T32.1S head-mounted transmitter, fitted into a Design 2F/3 multi-part thermodata. Power supply is, for example, via a Model KFD2-STC4-EX1 transducer power supply (WIKA article No. 2541269).

\[ T_{\text{max}} = 315 \text{ °C} \]

9.2 Calculation examples for self-heating at the sensor/thermowell tip

The self-heating at the sensor tip or thermowell tip depends upon the sensor type (TC/RTD), the probe diameter, the thermowell design and the power supplied to the sensor in the event of a failure. The table below shows the possible combinations. The table shows when a failure occurs, thermocouples produce much less self-heating than resistance thermometers.

<table>
<thead>
<tr>
<th>Sensor type</th>
<th>Probe Ø in mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>without thermowell</td>
<td>2.0, 3.0, 4.0</td>
</tr>
<tr>
<td>with multi-part thermowell</td>
<td>6.0, 8.0, 10.0</td>
</tr>
<tr>
<td>(straight and tapered)</td>
<td>12.0, 15.0, 18.0</td>
</tr>
<tr>
<td>(e.g. TV22, TV25, TV46, TV54, etc.)</td>
<td></td>
</tr>
<tr>
<td>with thermowell - machined from solid</td>
<td>25.0, 30.0, 35.0</td>
</tr>
<tr>
<td>material (straight and tapered)</td>
<td></td>
</tr>
<tr>
<td>(e.g. TV10, TV15, TV20, TV25, TV30, TV50, TV55, TV60, etc.)</td>
<td></td>
</tr>
<tr>
<td>Special thermowell - EN 14587</td>
<td>40.0, 50.0, 60.0</td>
</tr>
<tr>
<td>Tx55 (tubular holder)</td>
<td>75.0, 90.0, 105.0</td>
</tr>
<tr>
<td>Built into a blind bore</td>
<td>120.0, 150.0, 180.0</td>
</tr>
</tbody>
</table>

| (minimum wall thickness 5 mm)               |               |

1) surface-sensitive

When using multiple sensors and simultaneous operation, the sum of the individual powers must not exceed the value of the maximum permissible power. The maximum permissible power must be limited to 1.5 W maximum. This must be guaranteed by the plant operator.

9.3 Calculation example for RTD measuring point with thermowell

Use at the partition wall to Zone 0: Calculate the maximum permissible temperature \( T_{\text{max}} \) at the thermowell tip for the following combination:

RTD measuring insert Ø 6 mm with built-in model T32.1S head-mounted transmitter, fitted into a Design 2F/3 multi-part thermodata. Power supply is, for example, via a Model KFD2-STC4-EX1 transducer power supply (WIKA article No. 2541269).

\[ T_{\text{max}} = 315 \text{ °C} \]

9.4 Calculation example for RTD measuring point with thermowell

Use at the partition wall to Zone 0: Calculate the maximum permissible temperature \( T_{\text{max}} \) at the thermowell tip for the following combination:

RTD measuring insert Ø 6 mm with built-in model T32.1S head-mounted transmitter, fitted into a Design 2F/3 multi-part thermodata. Power supply is, for example, via a Model KFD2-STC4-EX1 transducer power supply (WIKA article No. 2541269).

\[ T_{\text{max}} = 315 \text{ °C} \]
9. Calculation examples for self-heating at the sensor/thermowell tip

Example

Resistance thermometer RTD
Diameter: 6 mm
Temperature of the medium $T_M = 150^\circ C$
Supplied power: $P_0 = 15.2 \text{ mW}$
Temperature Class T3 (200 °C) must not be exceeded

Thermal resistance [Rth] from table = 37 K/W
Self-heating: $0.0152 \times 37 \text{ K/W} = 0.56 \text{ K}$
$T_{\text{max}} = T_M + \text{self-heating: } 150^\circ C + 0.56^\circ C = 150.56^\circ C$

The result shows that in this case self-heating at the thermowell tip is negligible. As safety clearance for type-examined instruments (for T6 to T3), another 5 °C must be subtracted from the 200 °C; hence 195 °C would be permissible. This means that in this case temperature class T3 is not exceeded.

Additional information

Temperature class for T3 = 200 °C
Safety margin for type-examined instruments (T6 to T3) = 5 K
Safety clearance for type-examined instruments (T1 to T2) = 10 K

1) EN 60 079-0: 2009 Section 26.5

Simplified verification of intrinsic safety for the above-mentioned combination

<table>
<thead>
<tr>
<th>Measuring instrument</th>
<th>Power supply</th>
</tr>
</thead>
<tbody>
<tr>
<td>$U_c$: DC 30 V</td>
<td>$U_p$: DC 15 V</td>
</tr>
<tr>
<td>$I_c$: 550 mA</td>
<td>$I_p$: 150 mA</td>
</tr>
<tr>
<td>$R_c$: negligible</td>
<td>$P_c$: 50.2 mW</td>
</tr>
<tr>
<td>$C_c$: negligible</td>
<td>$C_p$: 90 nF</td>
</tr>
<tr>
<td>$L_c$: 305 mH</td>
<td>$L_p$: 100 mH</td>
</tr>
<tr>
<td>$M_c$: 7.5 mH</td>
<td>$M_p$: 2.7 mH</td>
</tr>
</tbody>
</table>

Upon comparing the values, it is obvious that it is permissible to connect these units to one another. However, the operator must also take into account the values for inductance and capacitance of the electrical connection leads.

9.2 Calculation example for a sheathed cable with RTD sensor

Use at the partition wall to Zone 0: Calculate the maximum permissible temperature $T_{\text{max}}$ at the probe tip for the following combination:

Resistance thermometer without thermowell (TR10-H) Ø 6 mm without transmitter, mounted by means of a compression fitting with stainless steel sealing ring. Power supply is, for example, via a model Z954 Zener barrier (WIKA Article No. 3247936), for example.

$T_{\text{max}}$ is obtained by adding the temperature of the medium and the self-heating. The self-heating of the thermowell tip depends on the supplied power $P_0$ of the Zener barrier and the thermal resistance $R_{\text{th}}$.
9. Calculation examples for ... / 10. Maintenance and cleaning

Simplified verification of intrinsic safety for the above-mentioned combination

<table>
<thead>
<tr>
<th>Measuring insert</th>
<th>Zener barrier Z954</th>
<th>Display instrument (non-hazardous area)</th>
</tr>
</thead>
<tbody>
<tr>
<td>U&lt;sub&gt;a&lt;/sub&gt; DC 30 V</td>
<td>U&lt;sub&gt;a&lt;/sub&gt; DC 30 V</td>
<td>U&lt;sub&gt;a&lt;/sub&gt; AC 230 V</td>
</tr>
<tr>
<td>I&lt;sub&gt;a&lt;/sub&gt; 550 mA</td>
<td>I&lt;sub&gt;a&lt;/sub&gt; 510 mA</td>
<td>I&lt;sub&gt;a&lt;/sub&gt; 2A nA</td>
</tr>
<tr>
<td>P&lt;sub&gt;i&lt;/sub&gt; (max) at the sensor: 1.5 W</td>
<td>P&lt;sub&gt;i&lt;/sub&gt; 1150 mW</td>
<td>P&lt;sub&gt;i&lt;/sub&gt; 60 nA</td>
</tr>
<tr>
<td>C&lt;sub&gt;i&lt;/sub&gt; negligible</td>
<td>C&lt;sub&gt;i&lt;/sub&gt; 4.9 µF</td>
<td>C&lt;sub&gt;i&lt;/sub&gt; 4 µF</td>
</tr>
<tr>
<td>I&lt;sub&gt;i&lt;/sub&gt; negligible</td>
<td>I&lt;sub&gt;i&lt;/sub&gt; 6.13 mH</td>
<td>I&lt;sub&gt;i&lt;/sub&gt; 1 nA</td>
</tr>
</tbody>
</table>

Upon comparing the values, it is obvious that it is permissible to connect these units to one another. However, the operator must also take into account the values for inductance and capacitance of the electrical connection leads.

These calculations apply to the Z954 Zener barrier in connection with a resistance thermometer Pt100 in 3-channel mode without grounding, i.e., symmetrical operation of the resistance thermometer in 3-wire circuit on a display or evaluation instrument.

Electrical connection
For sensor connections, terminal, cable or connector assignments, see chapter 6.1 "Electrical connection".

10. Maintenance and cleaning

10.1 Maintenance
These thermometers are maintenance-free.
Repairs must only be carried out by the manufacturer.

10.2 Cleaning

CAUTION!
- Clean the instrument with a moist cloth. This applies in particular to thermometers with a housing made of plastic and cable probes with plastic-insulated connection lead, to ensure that any risk of electrostatic discharge is avoided.
- Electrical connections must not come into contact with moisture.
- Wash or clean the dismantled instrument before returning it, in order to protect staff and the environment from exposure to residual media.
- Residual media in dismantled instruments can result in a risk to persons, the environment and equipment. Take sufficient precautionary measures.

For information on returning the instrument, see chapter 12.2 "Returns".

11. Faults

<table>
<thead>
<tr>
<th>Faults</th>
<th>Causes</th>
<th>Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>No signal</td>
<td>Mechanical load too high or overtemperature</td>
<td>Replace probe or measuring insert with a suitable design</td>
</tr>
<tr>
<td>Error measured values</td>
<td>Sensor drift caused by overtemperature</td>
<td>Replace probe or measuring insert with a suitable design</td>
</tr>
<tr>
<td>Error measured values (too low)</td>
<td>Sensor drift caused by chemical attack</td>
<td>Use a design with thermowell</td>
</tr>
<tr>
<td>Error measured values and response times too long</td>
<td>Entry of moisture into cable or measuring insert</td>
<td>Replace probe or measuring insert with a suitable design</td>
</tr>
<tr>
<td>Error measured values of thermocouples</td>
<td>Wrong mounting geometry, for example mounting depth too deep or heat dissipation too high</td>
<td>Temperature-sensitive area of the sensor must be inside the medium, and surfaces must be isolated.</td>
</tr>
<tr>
<td>Deposits on the sensor or thermowell</td>
<td></td>
<td>Remove deposits</td>
</tr>
<tr>
<td>Error measured values of thermocouples</td>
<td>Parasitic voltages (thermal voltage, galvanic voltage) or wrong calibration line</td>
<td>Use a suitable calibration line</td>
</tr>
<tr>
<td>Indication of the measured value jumps</td>
<td>Cable break in connecting cable or loose contact caused by mechanical overload</td>
<td>Replace probe or measuring insert with a suitable design, for example equipped with a strain relief or a thicker conductor cross-section</td>
</tr>
<tr>
<td>Corrosion</td>
<td>Composition of the medium not as expected or modified or wrong thermowell material selected</td>
<td>Analyse medium and then select a more suitable material or replace thermowell regularly</td>
</tr>
<tr>
<td>Signal interference</td>
<td>Stray currents caused by electric fields or earth loops</td>
<td>Use screened connecting cables, increase the distance to motors and power lines</td>
</tr>
<tr>
<td>Earth circuits</td>
<td>Eliminate potentials, use galvanically isolated transmitter supply isolators or transmitters</td>
<td></td>
</tr>
</tbody>
</table>
12. Dismounting, return and disposal

12.1 Dismounting

**WARNING!**

Residual media in dismounted instruments can result in a risk to persons, the environment and equipment. Take sufficient precautionary measures.

Let the instrument cool down sufficiently before disconnecting it! When disconnecting it, there is a risk that dangerously hot pressure media may escape.

Connections must only be opened when the instrument is depressurised and has cooled down.

The thermometer or the measuring insert can be removed from the thermowell. The thermowell itself should only be removed from the process once it is in a depressurised state. For thermometers without thermowell, the system must have been depressurised, cooled down and be free of hazardous materials.

12.2 Returns

**WARNING!**

Absolutely observe when shipping the instrument:

All instruments delivered to WIKA must be free from any kind of hazardous substances (acids, bases, solutions, etc.).

To return the instrument, use the original packaging or a suitable transport package.

To avoid damage:

1. Wrap the instrument in an antistatic plastic film.
2. Place the instrument, along with the shock-absorbing material, in the packaging.
3. If possible, place a bag containing a desiccant, inside the packaging.
4. Label the shipment as transport of a highly sensitive measuring instrument.

Information on returns can be found under the heading "Service" on our local website.

12.3 Disposal

Incorrect disposal may endanger the environment.

Dispose of instrument components and packaging materials in an environmentally compatible way and in accordance with the country-specific waste disposal regulations.

---

**Appendix: EC declaration of conformity**

**Document No.:** 1157/07/003

**We declare under our sole responsibility that the CE marked products: Type:**

**TR.../ TC...**

**Description:**

**Resistance Thermometers, Thermocouples**

**in conformity with the essential protection requirements of the directive(s):**

2004/108/EC (EMC) *(M) *

**In the declared configuration**

**IEC**

**Marking:**

**IEC**

The devices have been tested according to the following standards:

- EN 61326-1:2006 *(1)*
- EN 61326-2-1:2006 *(1)*
- EN 61326-2-1:2006 *(1)*
- EN 61010-2-030:2008 *(1)*
- EN 61010-2-030:2008 *(1)*
- EN 61010-2-030:2008 *(1)*

(1) Only valid for intrinsically safe WIKA products. (Ex) are not approved by the company.
Translation

EC-Type Examination Certificate

(1) German Equipment and protective systems intended for use in potentially explosive atmospheres: Directive 94/9/EC

(2) Certificate Number: TÜV 10 ATEX 555793 X

(3) for the equipment: Thermometer TR, TC...

(4) of the manufacturer: WIKA Alexander Wiegand SE & Co. KG

(5) Address: Alexander-Wiegand-Straße 30 63911 Pfungstadt Germany

(6) Order number: 000055579301

(7) Date of issue: 2018-05-18

(8) This equipment or protective system and any acceptable variation thereof are specified in the schedule to this certificate and the documents therein referred to.

(9) The TÜV NORD CERT GmbH, notified body No. 0041 in accordance with Article 9 of the Council Directive of the EC of March 23, 1994 (94/9/EC), certifies that this equipment or protective system 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 No. 19 203 555793.

(10) Compliance with the Essential Health and Safety Requirements has been assured by compliance with EN 60079-11:2009 EN 60079-11:2007 EN 60079-28:2007

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

(12) This EC-type examination certificate relates only to the design, examination and testing 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.

(13) SCHEDULE

EC-Type Examination Certificate No. TÜV 10 ATEX 555793 X

(14) Description of equipment

The thermometer type TR (resistance sensor) and TC... (thermocouple element) consists of a welded tubing or a mineral-sheathed cable or a ceramic insulated thermo wire, with the temperature sensor inside which is embedded in a ceramic powder, in a heat resistant casting compound, a cement compound or a thermal conductance paste. For connection purpose the thermometer may equipped with a plug or a free connecting cable. Other components like an enclosure used as a connection box or a thermowell may be used. A certified transmitter resp. a certified current loop indicator may be placed inside the enclosure.

The compliance with the temperature class and the intrinsic safety of the circuit is assured by an intrinsically safe power supply. The maximum surface temperature at the top of the probe resp. the thermowell is to be calculated, depending on the applied power, the ambient temperature resp. medium temperature and the thermal resistance. The required values (R₀) are supplied by the manufacturer as a matrix, depending on the probe diameter and the configuration of the probe (see Table 3).

The permissible ambient temperatures are depending on the marking of the temperature class, the used enclosure and the installation of an optionally used transmitter and/or a digital display. In this case the special conditions for safe use (17) must be considered. The lower temperature limit is -40 °C, for special models the lower temperature limit is -50 °C.

For the connection of a thermometer and a transmitter and/or a digital display the minor values of the ambient temperature limits and the temperature class with the highest figure is valid.

The pressure and temperature range of explosive atmosphere at the connection side must be for applications which require devices of the category 1 resp. category 1/2 between 0.8 to 1.1 bar and -20 °C to 60 °C. If the thermometer is operated outside this atmospheric conditions this EC-Type Examination Certificate for a device for category 1 resp. category 1/2 is only a guide. Additional tests for the special application conditions are recommended.

The thermometer must be suitable for the thermal and mechanical stress within the process. As the case may be a thermowell with a proper minimum wall thickness may be used.

(15) Certification body

TÜV NORD CERT GmbH, Langenmeyeckstrasse 10, 45141 Essen, accredited by the central office of the countries for safety engineering (GL), IECEx, Nr. 3046, legal successor of the TÜV NORD CERT SE & Co. KG ibid., Nr. 0022

The head of the certification body

Schwed

Hanover office, Am TÜV 1, 30519 Hanover, Fax +49 (0) 511 896 1585, Fax +49 (0) 511 896 1590

This certificate may only be reproduced without any changes, schedule included. Requests or clarifications shall be addressed to the TÜV NORD CERT GmbH
Schedule EC-Type Examination Certificate No. TÜV 10 ATEX 555783 X

For applications without transmitter (digital display) which require devices of the group II (explosive gas atmospheres) the following temperature classes divisions and ambient temperature ranges apply:

<table>
<thead>
<tr>
<th>Marking</th>
<th>Temperature class</th>
<th>Ambient temperature range (°C)</th>
<th>Maximum surface temperature (T_{max}) at the tip of the probe or thermowell</th>
</tr>
</thead>
<tbody>
<tr>
<td>II 1 G Ex ia IIC T6 Ga</td>
<td>T6</td>
<td>(-50)°C to +60°C</td>
<td>T_{w} (medium temperature) + self-heating. The special conditions for safe use (17) shall be considered.</td>
</tr>
<tr>
<td>II 1 G Ex ia IIC T6 Ga</td>
<td>T6</td>
<td>(-50)°C to +80°C</td>
<td>T_{w} (medium temperature) + self-heating. The special conditions for safe use (17) shall be considered.</td>
</tr>
<tr>
<td>II 1 G Ex ia IIC T5 Ga</td>
<td>T5</td>
<td>(-50)°C to +60°C</td>
<td>T_{w} (medium temperature) + self-heating. The special conditions for safe use (17) shall be considered.</td>
</tr>
<tr>
<td>II 1 G Ex ia IIC T5 Ga</td>
<td>T5</td>
<td>(-50)°C to +80°C</td>
<td>T_{w} (medium temperature) + self-heating. The special conditions for safe use (17) shall be considered.</td>
</tr>
<tr>
<td>II 1 G Ex ia IIC T4 Ga</td>
<td>T4,T3</td>
<td>(-50)°C to +100°C</td>
<td>T_{w} (medium temperature) + self-heating. The special conditions for safe use (17) shall be considered.</td>
</tr>
<tr>
<td>II 2 G Ex ia IIC T4 Ga</td>
<td>T4,T3</td>
<td>(-50)°C to +100°C</td>
<td>T_{w} (medium temperature) + self-heating. The special conditions for safe use (17) shall be considered.</td>
</tr>
</tbody>
</table>

For the installation of a transmitter and/or a digital display the special conditions for safe use shall be considered (17).

For applications which require devices of the group II (explosive dust atmospheres) the following surface temperatures and ambient temperature ranges apply:

<table>
<thead>
<tr>
<th>Marking</th>
<th>Power P_i (W)</th>
<th>Ambient temperature range (°C)</th>
<th>Maximum surface temperature (T_{max}) at the tip of the probe or thermowell</th>
</tr>
</thead>
<tbody>
<tr>
<td>II 1 D Ex ia IIC T55 °C Da</td>
<td>750 mW</td>
<td>(-50)°C to +40°C</td>
<td>T_{w} (medium temperature) + self-heating. The special conditions for safe use (17) shall be considered.</td>
</tr>
<tr>
<td>II 1 D Ex ia IIC T55 °C Da</td>
<td>650 mW</td>
<td>(-50)°C to +60°C</td>
<td>T_{w} (medium temperature) + self-heating. The special conditions for safe use (17) shall be considered.</td>
</tr>
<tr>
<td>II 1 D Ex ia IIC T55 °C Da</td>
<td>550 mW</td>
<td>(-50)°C to +100°C</td>
<td>T_{w} (medium temperature) + self-heating. The special conditions for safe use (17) shall be considered.</td>
</tr>
</tbody>
</table>

For the installation of a transmitter and/or a digital display the special conditions for safe use shall be considered (17).

1 The values in brackets apply for special models. This probes are manufactured with a special casting compound. Furthermore they are equipped with enclosures made of stainless steel and cable bushings for low temperatures.

Schedule EC-Type Examination Certificate No. TÜV 10 ATEX 555783 X

Technical data

Electrical data without built-in transmitter or digital display

For devices of group II (explosive gas atmospheres) the following maximum connection values apply:

\[ U_i = 30 \text{ V} \]
\[ I_i = 550 \text{ mA} \]
\[ P_i (at the sensor) = 1.5 \text{ W} \]

For devices of group II (explosive dust atmospheres) the following maximum connection values apply:

\[ U_i = 30 \text{ V} \]
\[ I_i = 550 \text{ mA} \]
\[ P_i (at the sensor) = \text{Values from table 2, column 2} \]

The internal inductance (L) and capacitance (C) of standard measuring inserts according to DIN 43735 are negligibly small. The values for cable probes shall be taken from the type label and shall be considered for the connection to an intrinsically safe power supply.

Sensor circuit in type of protection intrinsic safety Ex ia, or ib, IIC

Only to be connected to intrinsically safe circuits with the following output values for devices of group II (explosive gas atmospheres):

\[ U_o = 30 \text{ V} \]
\[ I_o = 550 \text{ mA} \]
\[ P_o = 1.5 \text{ W} \]

Sensor circuit in type of protection intrinsic safety Ex ia, or ib, IIC

Only to be connected to intrinsically safe circuits with the following output values for devices of group II (explosive dust atmospheres):

\[ U_o = 30 \text{ V} \]
\[ I_o = 550 \text{ mA} \]
\[ P_o = \text{Values from table 2, column 2} \]

For the use of multiple sensors and simultaneous operation the summation of all single power dissipation may not exceed the maximum permissible power dissipation. This shall be considered by the end-user in the end-use application.

2 The permissible power for the sensor depends on the medium temperature T_{w}, the temperature class and the thermal resistance R_{th}, maximum, however, the values from table 2, column 2.

3 The permissible power for the sensor depends on the medium temperature T_{w}, the maximum permissible surface temperature and the thermal resistance R_{th}, maximum, however, the values from table 2, column 2.
Schedule EC-Type Examination Certificate No. TUV 10 ATEX 655793 X

Electrical data with built-in transmitter or digital display

For the sensor circuit the above specified values corresponding to the group II apply.

Signal circuit in type of protection intrinsic safety Ex ia, or ib, IIC resp. IIC

U_s = depending on transmitter/digital display
I_s = depending on transmitter/digital display
P_s = inside the enclosure: depending on transmitter/digital display
C_s = depending on transmitter/digital display
I_t = depending on transmitter/digital display

The used transmitter/digital display shall be provided with their own EC-Type Examination Certificate in accordance to EN/IEC. The installation conditions and the electrical connection values shall be taken from the corresponding EC-Type Examination Certificate and shall be considered.

Electrical data with built-in transmitter or digital display according to the FISCO model

The used transmitter/ digital display for operating conditions according to the FISCO model are considered as FISCO field devices. The requirements according to EN/IEC 60079-27 and the conditions for connection of the EC-Type Examination Certificate for FISCO apply.

Multipoint thermometers

Multipoints built up from several shell elements

For the isolated single element the above specified values are valid. For elements which are considered as grounded due to their construction the specified values apply for the sensors in sum. For use in dust atmospheres the values of table 2, column 2 apply.

Coaxial multi-point thermocouples

The circuits of the coaxial element shall be considered as connected due to their construction. For the application a separate examination shall be done resp. for the connection of the coaxial multi-point thermocouple special conditions for safe use shall be considered if applicable. An additionally assessment as an intrinsically safe system shall be done (e.g. connection of several circuits of different transmitters etc.).
Schedule's EC-Type Examination Certificate No. TUV 10 ATEX 95679 X

(17) Special conditions for safe use

1.) For types with \( \Phi \geq 3 \text{ mm} \) or "grounded measuring points" the intrinsically safe circuits shall be considered as galvanically connected to ground potential from a safety-related view. Potential equalization shall exist in the complete course of the erection of the intrinsically safe circuits. Furthermore for the connection the requirements of EN/IEC 60079-14 shall be considered.

2.) For devices that do not comply to the electrostatic requirements of EN/IEC 60079-0 and EN/IEC 60079-20 due to their construction, electrostatic charging shall be avoided.

3.) The used transmitters/digital displays shall be provided with their own EC-Type Examination Certificate in accordance to EN/IEC. The installation conditions, the electrical connection values, the temperature classes resp. the maximum surface temperatures of devices for use in explosive dust atmospheres and the permissible ambient temperature shall be taken from the corresponding EC-Type Examination Certificate and shall be considered.

4.) A reverse heat flow from the process exceeding the permissible ambient temperature of the transmitter, the digital display or the enclosure is not allowed and shall be avoided by a suitable thermal insulation or a suitable neck length of the tubing.

5.) In case of a wall thickness less than 1 mm the device may not be exposed to environmental conditions which may negatively affect the partition wall. A thermowell with a suitable minimum wall thickness can be used alternatively.

6.) Using a thermowell/neck tube the device shall be constructed in a way that allows an installation that results in a sufficient tight joint (IP67) or a flameproof joint (EN/IEC 60079-1) in the direction of the less endangered area.

7.) The circuits of the coaxial multipoint thermocouple shall to be considered as connected due to their construction. For the application a separate examination shall be done resp. for the connection of the coaxial multipoint thermocouple special conditions for safe use must be considered if applicable. An additionally assessment as an intrinsically safe system shall be done (e.g. connection of several circuits of different transmitters etc.).

8.) For the use of enclosures they shall either be provided with their own EC-Type Examination Certificate or they shall comply to the minimum requirements. IP-protection: at least IP20 (at least IP65 for dust) applies for all enclosures. Light metal enclosures, however, shall comply with the corresponding clauses of the applicable standards. Non-metallic enclosures or powder-coated enclosures shall additionally comply with the electrostatic requirements of the applicable standards or have an corresponding warning marking.

(18) Essential Health and Safety Requirements

no additional ones
Compact Instructions

iTEMP® PCP TMT181

- Temperaturkopftransmitter
- Temperature head transmitter
- Transmetteur de température

Endress+Hauser
People for Process Automation

TMT181

Montage

Installation

Raccordement

Verdrahtung auf einen Blick

Wiring overview


**Abmessungen in mm (in)**

**Dimensions in mm (in)**

**Dimensions en mm (in)**

---

**Montage**

- Zulässige Umgebungstemperatur: -40 bis 85 °C (für Ex-Bereich siehe Ex-Zertifikate)
- Einbauort: Feldgehäuse; Sensornachlasskopf Form B nach DIN 43 729
- Einbauweise: keine Einschränkungen
- Sicherheitshinweise: Das Gerät darf nur von einem Netzteil mit energiebegrenztem Stromkreis nach IEC 61010-1 gespeist werden: SELV or Class 2 circuit

**Installation**

- Ambient temperature: -40 to 85 °C [-40 to 185 °F], for Ex-area see Ex-certification
- Installation area: Field housing; connection head Form B accord. to DIN 43 729
- Installation angle: No limit
- Safety notes: The unit must only be powered by a power supply that operates using an IEC 61010-1 compliant energy limited circuits: SELV or Class 2 circuit

---

**Potenzialausgleich**

Bei abgescherter Installation im Feldgehäuse ist zu beachten, dass die Abmessung der Beugeleiste (Ausschaltung 4 bis 20 mA) und Schirmung der Sensorenabschnitt muss das gleiche Potential haben! Bei Einsatz von geerdeten Thermoelementen wird eine Schirrmung der 4-20 mA Ausgangssignale empfohlen. In Anlagen mit großen magnetischen Feldern wird eine Schirmung aller Leitungen mit niedrigerer Anbindung am Einbaugehäuse des Transmitters empfohlen.

**Compensation de potentiel**

Dans le cas d'un montage séparé en boîtier de terrain, prière de noter: Le blindage côté sortie (signal de sortie 4... 20 mA) et le blindage côté capteur doivent être au même potentiel. Lors de l'utilisation de thermocouples mis à la terre, un blindage de la sortie 4-20 mA est recommandé. Pour les installations avec champs magnétiques importants, il est conseillé de procéder au blindage de toutes les lignes avec liaison à basse impédance au boîtier du transmetteur.

---

**Potential levelling**

Please take note when installing the head transmitter remotely in a field housing: The screen on the 4 to 20 mA signal output must have the same potential as the screen at the sensor connections!

When using earthed thermocouples screening of the output 4 to 20 mA cable is recommended. In plants with strong electromagnetic fields screening of all cables with a low ohm connection to the transmitter housing is recommended.
Operation
Head transmitter set-up is done using the ReadWin® 2000 PC software. This is available as an accessory (see page 8).

Note!
When the interface cable is connected (see 'Accessories' on page 8), the technical specifications [e.g. measured error] are not observed. For this reason, during operation disconnect the connection via the interface cable between the head transmitter and PC.

The following table shows the structure of the PC-Configuration software ReadWin® 2000 interactive menu operation:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard settings</td>
<td>- Sensor type</td>
</tr>
<tr>
<td></td>
<td>- Connection mode [2-, 3- or 4-wire connection]</td>
</tr>
<tr>
<td></td>
<td>- Units [°C/°F]</td>
</tr>
<tr>
<td></td>
<td>- Measurement range start [depends on sensor]</td>
</tr>
<tr>
<td></td>
<td>- Measurement range end [depends on sensor]</td>
</tr>
</tbody>
</table>

Expanded settings
- Cold junction compensation [internal/external on TC-connection]
- Compensation resistance [0 to 20 DP on 2-wire connection]
- Fault condition reaction (≤ 3.6 mA or ≥ 21.0 mA > 21.5 mA is guaranteed)
- Output (analog signal/inverse)
- Damping (0 to 8 s)
- Offset (-9.9 to +9.9 K)
- Measurement point identification/TAG

Service functions
- Simulation [on/off]

For detailed ReadWin® 2000 operating instructions please read the on-line documentation contained in the ReadWin® 2000 software.

Zubehör
- Konfigurationskabel für den Temperaturtransmitter (PC-Software ReadWin® 2000 und USB-Schnittstellenkabel):
  - TXU10-0-AA
- ReadWin® 2000 kann kostenlos direkt vom Internet unter folgender Adresse geladen werden:
  - www.endress.com/readwin
- Montagegeräte für Kopftransmitter:
  - 4 Schrauben, 6 Federn, 10 Schutzleisten;
  - Bestell-Nr.: 510 01112
- Adapter für Hutschienenmontage, DIN rail clip nach IEC 60715
  - Bestell-Nr.: 510 00656

Accessoires
- Kit de configuration (le logiciel de configuration PC ReadWin® 2000 et le câble d’interface PC):
  - Référence de commande : TXU10-0-AA
- ReadWin® 2000 peut être chargé gratuitement directement d’Internet à l’adresse suivante:
  - www.endress.com/readwin
- Kit de montage pour transmetteur
  - 4 vis, 6 ressorts, 10 rondelles freins;
  - Référence de commande : 510 01112
- Adaptateurs pour montage sur rail préféré selon IEC 60715
  - Référence de commande : 510 00656

Ergänzende Dokumentation
Weitere technische Daten:
- Technische Information iTEMP® PCP TMT 181
  - [TI070R/09/de] (MM 1104, 1144, 1102, 1142 B V ATEX-Version, Gas Tight)

Supplementary documentation
Further technical data:
- Technical Information iTEMP® PCP TMT 181
  - [TI070R/09/en]

Documentation complémentaire
D’autres données techniques:
- Technical Information iTEMP® PCP TMT 181
  - [TI070R/14]
Safety instructions

Temperature head transmitter

iTTEMP® TMT181, TMT187, TMT188

ATEX II 1G
Safety instructions

**ITEAM® TMT181, TMT187, TMT188**

Temperature head transmitter

For electrical apparatus certified for use in explosive hazardous areas

Designation according to Directive 94/9/EG:

- Equipment Group II
- Equipment Category II
- Area of application: explosive gas-air mixtures (II)

**Areas of application:**

<table>
<thead>
<tr>
<th>Equipment Category</th>
<th>Explosive gas-air mixtures (II)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category 1</td>
<td>Zone 0, 1 or 2</td>
</tr>
<tr>
<td>Category 2</td>
<td>Zone 1 or 2</td>
</tr>
<tr>
<td>Category 3</td>
<td>Zone 2</td>
</tr>
</tbody>
</table>

Designation of explosion protection: Ex in IIC T6/T5/T4

Electrical apparatus with explosion protection to European standard

Type of protection:

- Ex
- in
- IIC
- T6/T5/T4

Apparatus group:

Temperature class:

---

Safety instructions (Intrinsic safety Ex ia)

1. Install in accordance with the manufacturer's specifications and the applicable standards and regulations.

2. Setting up the head transmitter (only TMT187 is possible) is only allowed to be done in a non-hazardous area.

3. Instrumentation used for setting up must not exceed a voltage of U_N = 30 V; this can, for example, be achieved by using battery powered laptops. Setting up with a mains powered PC U_N = 253 V can only be done when using an approved adapter with barrier, e.g., TMT181-VA-VR.

4. When installing the unit note that the housing ingress protection classification IP 20 to EN 60529 is upheld.

**Safety instructions for Zone 1 and 2**

- This device can, according to the manufacturer, be operated in Zone 1 (II 2G) or Zone 2 (II 2G). The current circuit can be set into the Zone 0 (II 1G) area. Conforms to description II 2G.

**Safety instructions for Zone 0**

- These instructions are only valid if the unit is to be installed directly in the Zone 0 area.

- Explosive mixture-air mixtures are only allowed to occur under atmospheric conditions:
  - -50 °C ≤ Ta ≤ +50 °C
  - 0 bar ≤ p ≤ 1.1 bar

- If there is no explosive mixture present or the additional measures according to EN 1127-1 are upheld, the unit can also be operated outside the atmospheric conditions according to the manufacturer's specification.

- The restricted ambient temperatures per EN 1127-1.6.4 must be observed (see following table).

- The power circuits to be supplied must meet the specifications for explosion protection Ex ia IIC EN 60079-14 12.3.

- The devices can only be used in fluids if the process-wetted materials are sufficiently resistant to such fluids.
10. If the entire device is operated in Zone 0, the compatibility of the device materials with the fluids has to be ensured. (Housing: polycarbonate (PC), potting: polyurethane (PUR)).

11. The temperature transmitter must be installed in such a way that electrostatic charge cannot occur, e.g. installation in grounded metallic head or grounded housing.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>H 1G</th>
<th>Ex ia IIC</th>
<th>T3a-T5/T4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power supply set</td>
<td>E_i &lt; 4 V DC</td>
<td>I_o ≤ 500 mA</td>
<td>C_o ≤ 2 mAh</td>
</tr>
<tr>
<td></td>
<td>E_i &lt; 750 mV</td>
<td>I_o ≤ 250 mA</td>
<td>C_o ≤ 1 mAh</td>
</tr>
<tr>
<td>Sense circuit</td>
<td>E_i ≤ 0.2 V DC</td>
<td>I_o ≤ 6.3 mA</td>
<td>C_o ≤ 2.5 nF</td>
</tr>
<tr>
<td></td>
<td>E_i &lt; 0.85 mV</td>
<td>I_o ≤ 0.25 mA</td>
<td>C_o ≤ 25 nF</td>
</tr>
<tr>
<td>Max. connection</td>
<td>Ex ia IIC</td>
<td>Ex ia IIB</td>
<td>C_o ≥ 974 µF</td>
</tr>
<tr>
<td>value</td>
<td>E_i ≤ 4.5 mV</td>
<td>I_o ≤ 0.5 mV</td>
<td>C_o ≥ 999 µF</td>
</tr>
<tr>
<td>Temperature range</td>
<td>June 1.2</td>
<td>June 9</td>
<td></td>
</tr>
<tr>
<td>T3</td>
<td>Ta = -20 °C to +65 °C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T5</td>
<td>Ta = -30 °C to +25 °C</td>
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<td></td>
</tr>
<tr>
<td>T4</td>
<td>Ta = -30 °C to +25 °C</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

www.endress.com/worldwide
EC-TYPE-EXAMINATION CERTIFICATE
(Translation)


2. EC-TYPE-EXAMINATION CERTIFICATE Number:

ZELM 99 ATEX 0019 X

3. Equipment: Headtransmitter TITEM Type TMT 181 resp. Type TMT 187 resp. Type TMT 188

4. Manufacturer: Endress + Hauser Werke GmbH + Co. KG.

5. Address: Obere Wark 1, D-74794 Nesselwang

6. This equipment and any acceptable variation thereof are specified in the schedule to this certificate and the documents therein referred to.

7. The Prüf- und Zertifizierungsstelle ZELM Ex, notified body No. 0820 in accordance with Article 9 of the Council Directive 94/9/EC of 23 March 1994, certified 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 ZELM Ex 0448919026.

8. Compliance with the Essential Health and Safety Requirements has been assured by compliance with:

EN 50 014: 1997
EN 57 020: 1994
EN 50 284: 1999

9. 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.

10. This EC-type-examination Certificate relates only to the design and construction of the specified equipment in accordance with Directive 94/9/EC. Further requirements of this Directive apply to the manufacture and supply of this equipment.

11. The marking of the equipment shall include the following:

II 1 G Ex ia IIC T6


13. Electrical data

Type of protection: intrinsic Safety "Ex ia IIC"

Supply circuit: type of protection intrinsic Safety "Ex ia IIC"

for connection to an intrinsically safe circuit with the following maximum values:

U_i = 30 V
I = 100 mA
P_i = 750 mW

effective internal capacitance and effective internal inductance are negligibly small.

Setup circuit: only for a short-time connection of a standard personal computer via the configuration set: Type TMT 181 A to suitable connections.

Maximum r.m.s. a.c. or d.c. voltage: U_i = 253 V.

EC-type-examination Certificates without signature and stamp are not valid. The certificates may only be circulated without alteration. Excerpts or alterations are subject to approval by the Prüf- und Zertifizierungsstelle ZELM Ex.

In the case of disputes, the German text shall prevail.
Prüf- und Zertifizierungsstelle

ZELM Ex

Schedule to EC-TYPE-EXAMINATION CERTIFICATE ZELM 99 ATEX 0019 X

Sensor circuit (terminals 3, 4, 5 and 6)

type of protection Intrinsically Safe Ex ia IIC resp. Ex ia II B

maxima:

$U_i = 9.5 \, \text{V}$

$I_i = 4.5 \, \text{mA}$

Power:

$P_i = 11 \, \text{mW}$

(linear output characteristic)

IIC resp. II B

effective internal inductance:

$4.5 \, \text{mH}$

$8.5 \, \text{mH}$

effective internal capacitance:

$70 \, \mu \text{F}$

$1300 \, \mu \text{F}$

The supply circuit and the sensor circuit are to be considered in a combined manner to be galvanic with each other. The technical function of isolation remains.

(16) Report No.

ZELM Ex 0449919026

(17) Special conditions for safe use

The configuration via the setup circuit is only permitted in non-hazardous locations. In this case, none of the connections may be laid into the hazardous location.

The head transmitter is to be installed, so that the degree of protection IP 20 for the connectors is guaranteed in accordance with EN 60529.

The head transmitter is to be installed in such a way, that no electrostatic charge is possible.

The instruction manual has to be observed, in particular with regard to the consideration of lesser ambient temperatures during the application in accordance with category 1.

(18) Essential Health and Safety Requirements

met by standards

Zertifizierungsstelle ZELM Ex

Braunschweig, March 30, 2000

Dipl. Ing. Harald Zelm

ZELM Ex

1. Supplement

(Supplement according to EC-Directive 94/9 Annex III letter 6)

to EC-type-examination Certificate

ZELM 99 ATEX 0019 X

(Translation)

Equipment:

Headtransmitter ITMP Type TMT 181 resp. Type TMT 187

resp. Type TMT 188

Manufacturer:

Endress + Hauser Wetzlar GmbH + Co KG

Address:

Obere Wank 1, D-87484 Nesselwang

Description of supplement

Only the head transmitter may be manufactured in future in accordance with the test documents listed in the test report ZELM Ex 0290019054. Therefore the old version of the head transmitter is not more manufactured for avoidance of the confusion of the electrical data.

The different versions and the marking remain unchanged.

Further the ambient temperature range remains unchanged, in particular with regard to the consideration of lesser ambient temperatures during the application in accordance with category 1.

Only the following data are valid for the future:

Data resp. measures for the explosion protection

Electrical data

Supply circuit

(type of protection Intrinsically Safe Ex ia IIC)

for connection to an intrinsically safe circuit with the following maximum values:

$U_i = 30 \, \text{V}$

$I_i = 150 \, \text{mA}$

$P_i = 750 \, \text{mW}$

effective internal inductance and effective internal capacitance are negligibly small.
Prüf- und Zertifizierungsstelle
ZELM Ex

SCHEDULE TO THE 1. SUPPLEMENT OF THE EC-TYPE-EXAMINATION CERTIFICATE
ZELM 99 ATEX 0019 X

Setup circuit
only for a short-time connection of a standard personal computer via the configuration set Type TMT 181 A to suitable connections.
maximum r.m.s. a c. or d.c. voltage $U_{in} = 253 \, \text{V}$.

Sensor circuit
(type of protection intrinsic Safety EEEx ia IIC resp. EEEx ia IIB
maximum values:
$U_{r} = 8.2 \, \text{V}$
$I_{r} = 4.6 \, \text{mA}$
$r_{e} = 9.35 \, \text{mV}$
(linear output characteristic)

IIC resp. IIB
effective signal inductance: 4.5 mH 8.5 mH
effective external capacitance: 974 nF 1900 nF

The supply circuit and the sensor circuit are to be considered in a combined manner to be galvanic with each other. The technical function of isolation remains.

Report No.
ZELM Ex 0290019054

Special conditions for safe use
The special conditions in accordance with EC-type-examination Certificate ZELM 99 ATEX 0019 X are maintained.

Essential Health and Safety Requirements
met by standards

Zertifizierungsstelle ZELM Ex
Braunschweig, October 6, 2000

Dipl.-Ing. Harald Zelm

Sheet 2 / 2

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Prüf- und Zertifizierungsstelle ZELM Ex

2. Supplement
(Supplement according to EC-Directive 94/9 Annex III letter 6)
to EC-type-examination Certificate
ZELM 99 ATEX 0019 X
(Translation)

Equipment: Headtransmitter ITEMP Type TMT 181 resp. Type TMT 187 resp. Type TMT 189
Manufacturer: Endress + Hauser Wetzlar GmbH + Co.KG
Address: Oberer Wark, D-38414 Nesselwang

Description of supplement
The 2. Supplement to the EC-type-examination Certificate was necessary concerning the change of the circuit design due to additional EMC capacitances.
The headtransmitter may be manufactured in future in accordance with the test documents listed in the test report ZELM Ex 0050117058 only. Therefore the old version of the headtransmitter is not more manufactured.
The electrical data, the different versions and the marking remain unchanged.
Further the ambient temperature range remains unchanged, in particular with regard to the consideration of lesser ambient temperatures during the application in accordance with category 1G.

Report No.
ZELM Ex 0050117058

Special conditions for safe use
The special conditions in accordance with EC-type-examination Certificate ZELM 99 ATEX 0019 X are maintained.

Essential Health and Safety Requirements
met by standards

Zertifizierungsstelle ZELM Ex
Braunschweig, May 25, 2001

Dipl.-Ing. Harald Zelm

Sheet 1 / 1
4. Supplement
to EC-type-examination Certificate ZELM 99 ATEX 0019 X

All other technical data and special conditions for safe use remain unchanged and are also valid for the 4. Supplement.

The Headtransmitter iTEMP may be manufactured in future also in accordance with this 4. Supplement.

Report No.
ZELM Ex 2006817864

Essential Health and Safety Requirements
Within the scope of this 4. Supplement the agreement of the device with current standards has been checked.
The essential health and safety requirements are still fulfilled by compliance with following Standards:
EN 60079-0:2006
EN 60079-11:2007
EN 60079-20:2007
EN 1127-1:2007

Braunschweig, January 22, 2009

[Signature]

Zertifizierungsstelle ZELM ex
Dipl.-Ing. Rüdiger Zelm

ZELM ex
Zertifizierungsstelle ZELM ex
Dr.-Ing. Dipl.-Ing. Braunsweg
EC-Declaration of Conformity

Note: This Declaration of Conformity and the CE-mark affixed to the nameplate are valid for the vacuum pump within the Busch-scope of delivery. When this vacuum pump 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 acc. to the Directive Machinery 2006/42/EC for the superordinate machine, issue the Declaration of Conformity for it and affix the CE-mark.

For maintenance of this Declaration of Conformity of vacuum pumps without a drive may only be used a drive with written consent of Busch.

We

Busch Produktions GmbH
Schauinslandstr. 1
79689 Maulburg
Germany

Declare that the vacuum pumps MM 1104, 1144, 1102, 1142 BV ATEX-Version, Gas Tight

Documentation No.: T611141618

In accordance with the European Directives:
– “ATEX” 94/9/EC for use in potentially explosive areas acc. to the nameplate,
– “Machinery” 2006/42/EC,
– “Electromagnetic Compatibility” 2004/108/EC,
– “Restriction of the use of certain hazardous substances in electrical and electronic equipment” (“RoHS”) 2002/95/EC

have been designed and manufactured to the following specifications:

<table>
<thead>
<tr>
<th>Standard</th>
<th>Title of the Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harmonised Standards</td>
<td></td>
</tr>
<tr>
<td>EN ISO 12100</td>
<td>Safety of machinery –General principles for design –Risk assessment and risk reduction</td>
</tr>
<tr>
<td>EN ISO 13857</td>
<td>Safety of machinery - Safety distances to prevent hazard zones being reached by the upper and lower limbs</td>
</tr>
<tr>
<td>EN 1012-1</td>
<td>Compressors and vacuum pumps - Safety requirements - Part 1 and 2</td>
</tr>
<tr>
<td>EN 1012-2</td>
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<tr>
<td>EN ISO 2151</td>
<td>Acoustics - Noise test code for compressors and vacuum pumps - Engineering method (grade 2)</td>
</tr>
<tr>
<td>EN 60204-1</td>
<td>Safety of machinery - Electrical equipment of machines - Part 1: General requirements</td>
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<tr>
<td>EN 61000-6-1</td>
<td>Electromagnetic compatibility (EMC) - Generic immunity standards</td>
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<tr>
<td>EN 61000-6-2</td>
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<tr>
<td>EN 61000-6-3</td>
<td>Electromagnetic compatibility (EMC) - Generic immunity standards</td>
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<td>EN 61000-6-4</td>
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<tr>
<td>EN 13463-1</td>
<td>Non-electrical equipment for potentially explosive atmospheres - Part 1: Basic methodology and requirements</td>
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<tr>
<td>EN 1127-1</td>
<td>Explosives 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, 21.02.2014

MM 1104, 1144, 1102, 1142 BV ATEX-Version, Gas Tight
## Technical Data

Ex-classification, permitted ultimate pressures, shut-off temperatures and motor connection parameters see nameplates

### Version with standard motor (cat. 2 or cat. 3 inside the vacuum pump, no Ex-zone in the environment of the vacuum pump)

<table>
<thead>
<tr>
<th>Type</th>
<th>Frequency [Hz]</th>
<th>Motor nominal rating* [kW]</th>
<th>Nominal speed [min⁻¹]</th>
<th>Nominal suction capacity [m³/h]</th>
<th>Sound pressure level at 400 Pa abs. suction pressure [dB(A)]</th>
<th>Weight [kg]</th>
<th>Ambient temperature range [° C]</th>
<th>Ambient pressure</th>
<th>Synchronising gear oil qty [l]</th>
<th>Synchronising gear oil filled ex-works</th>
</tr>
</thead>
<tbody>
<tr>
<td>MM 1104 BV</td>
<td>50</td>
<td>1.3</td>
<td>1500</td>
<td>62</td>
<td>-185</td>
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<tr>
<td></td>
<td>60</td>
<td>1.7</td>
<td>1800</td>
<td>75</td>
<td>70</td>
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<tr>
<td>MM 1144 BV</td>
<td>50</td>
<td>1.8</td>
<td>1500</td>
<td>78</td>
<td>-190</td>
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<tr>
<td></td>
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<td>1800</td>
<td>96</td>
<td>70</td>
<td>-190</td>
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<td>2.8</td>
<td>3000</td>
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<td>-190</td>
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<td>0 … -40</td>
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<td></td>
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<td>3.0</td>
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<td>3.5</td>
<td>3000</td>
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<td>-195</td>
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<td></td>
<td>60</td>
<td>4.8</td>
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<td>175</td>
<td>79</td>
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<td>3.0</td>
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<td>600-3600</td>
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</table>

### Version with Ex-motor

<table>
<thead>
<tr>
<th>Type</th>
<th>Frequency [Hz]</th>
<th>Motor nominal rating* [kW]</th>
<th>Nominal speed [min⁻¹]</th>
<th>Nominal suction capacity [m³/h]</th>
<th>Sound pressure level at 400 Pa abs. suction pressure [dB(A)]</th>
<th>Weight [kg]</th>
<th>Ambient temperature range [° C]</th>
<th>Ambient pressure</th>
<th>Synchronising gear oil qty [l]</th>
<th>Synchronising gear oil filled ex-works</th>
</tr>
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<tbody>
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<td>2.2</td>
<td>1500</td>
<td>62</td>
<td>-200</td>
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* may vary depending on specific order