Instruction Manual

VACTEST

Vacuum Measurement Equipment
Active Sensor Controller CTR 002/004

Table of Contents

1   Safety

- Read and follow the instructions of this manual.
- Inform yourself regarding hazards, which can be caused by the product or arise in your system.
- Comply with all safety instructions and regulations for accident prevention.
- Check regularly that all safety requirements are being complied with.
- Take account of the ambient conditions when installing your gauge. The protection class is IP 20 (the unit is protected against penetration of foreign bodies).
- Adhere to the applicable regulations and take the necessary precautions for the process media used.
- Consider possible reactions between materials and process media.
- Consider possible reactions of the process media due to the heat generated by the product.
- Before you start working, find out whether any of the vacuum components are contaminated.
- Adhere to the relevant regulations and take the necessary precautions when handling contaminated parts.
- Communicate the safety instructions to other users.

This instruction manual highlights potential hazards where appropriate. Safety notes and warning messages are tagged with one of the keywords DANGER, WARNING, CAUTION, NOTICE and NOTE as follows:

⚠ **DANGER**

… indicates an imminent dangerous situation that will result in death or serious injuries if not prevented.

⚠ **WARNING**

… indicates a potentially dangerous situation that could result in death or serious injuries.

⚠ **CAUTION**

… indicates a potentially dangerous situation that could result in minor injuries.

① **NOTICE**

… indicates a potentially dangerous situation that could result in damage to property.

ⓘ **NOTE**

… indicates helpful tips and recommendations, as well as information for efficient and trouble-free operation.

2 Product Description

The devices are designed to display and control absolute pressure. The Active Sensor Controller CTR 002 is compatible with Busch Digital and 0-10 V Analog Transmitters while the CTR 004 can only be connected to Digital Transmitters.

Up to two (CTR 002) or respectively four (CTR 004) measuring channels can be displayed and controlled simultaneously.

The device can be controlled via USB or RS232.

2.1 Interface Illustration

LCD graphic display

Set key

Menu key

Up/Down key

Mains switch

RS485 connector for digital transmitters

Mains connector 95 ... 265 VAC, 50/60 Hz

RS232 PC interface

Relay contacts (2x for CTR 002) (4x for CTR 004)

USB interface

0 ... 10 V for analog transmitters (channel 1 and 2)
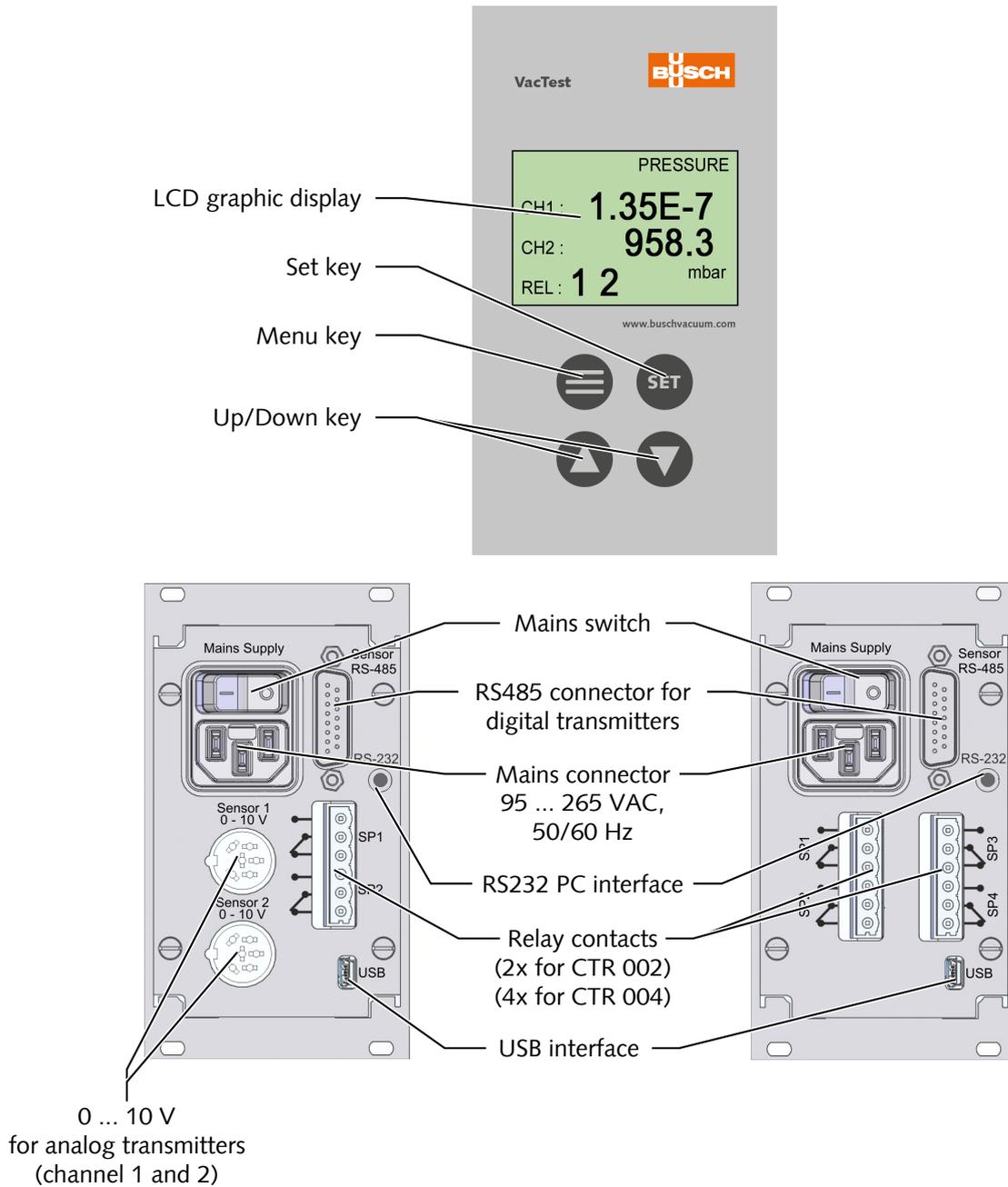
2.2 Product Identification

The product model can be found on the product's nameplate. Technical modifications are reserved without prior notification.

2.3 Delivery Content

Included in the delivery consignment are:

– Active Sensor Controller CTR 002/004
– Mains cable (CEE 7/7 plug)
– Counter plug for relay outputs
– Fasteners for panel installation (19" system)
– Instruction manual

2.4 Proper Use

The device serves exclusively to display and control absolute pressure in combination with Busch Vacuum Transmitters. It may only be connected to components specifically provided for such purpose.

2.5 Improper Use

The use for purposes not mentioned above is regarded as improper, especially:

– Connection to units which are not suitable for this purpose according to their operating instructions.
– Connection to units which have exposed voltage-carrying parts.
– Operation of the devices in areas with ionizing radiation.

No liability or warranty will be accepted for claims arising from improper use.

3 Transport and Storage

• Check the device for transport damage.

> ⚠ **NOTICE**

Devices without external protection.

Risk of damage to the device!

• The device must not come into contact with electrostatically chargeable materials and must not be moved within electrical or high magnetic fields.

If a storage is planned:

• Comply with the storage temperatures, see technical data.
• In rooms with moist or aggressive atmospheres, the device must be airproof shrink-wrapped in a plastic bag together with a bag a desiccant.

4 Installation

⚠ **CAUTION**

Unauthorized modifications.

Risk to injury!

• Modifications or conversions of the gauge are not allowed.

4.1 Installation Conditions

• Make sure that the environment of the device is not potentially explosive.

• Make sure that the ambient conditions comply with the Technical Data [▶ 22].

4.2 Electrical Connection

ⓘ **NOTICE**

Connect transmitters when the controller is powered.

Risk of damage to the device!

• The controller must be switched off before any transmitters are connected.

4.2.1 Mains Connection

The mains connector must be plugged into a mains socket with protective earth conductor. Use three-pole cables, only, with properly wired earth conductor.

4.2.2 Connecting to Digital Transmitters (RS485)

For operation of the gauge with a controller, a suitable connecting cable must be used.
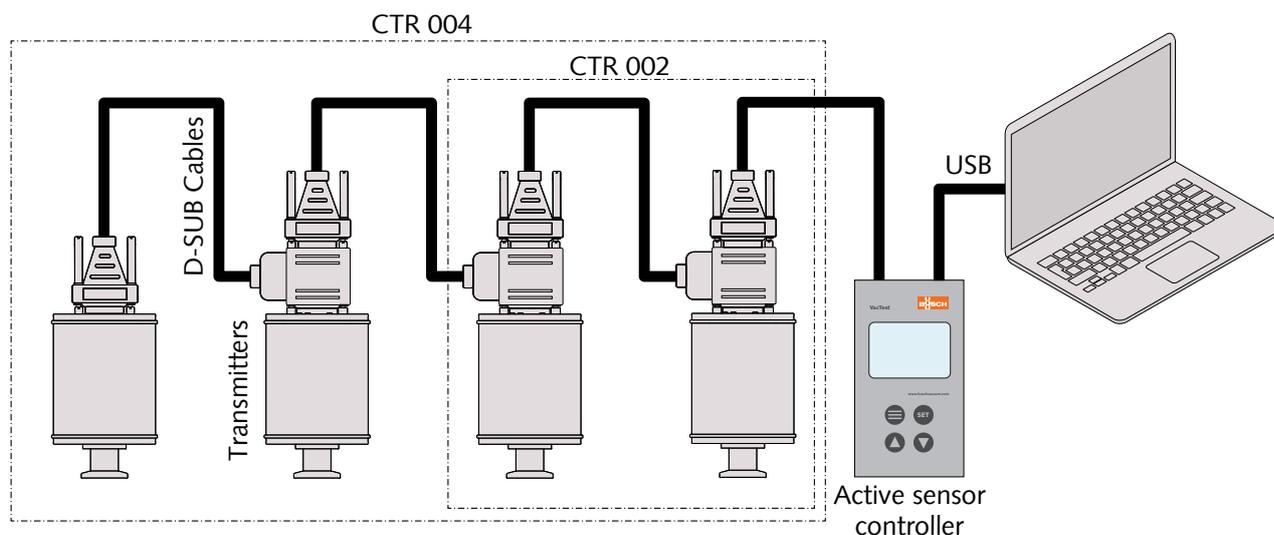
With the controller CTR 002: up to 2 gauges can be connected.
With the controller CTR 004: up to 4 gauges can be connected.

- Set the relevant address at the address selector switch, see Setting RS485 Address (on the gauge instruction manual)
- Connect the D-Sub connector to the gauge and secure it with the screws.
- Connect the controller and secure the D-Sub connector with the screws.

4.2.3 Connecting to Analog Transmitters

For operation of the gauge with a controller, a suitable connecting cable must be used.

Analog transmitters with 0 ... 10 V output signal can be connected to the CTR 002. It automatically detects the transmitter type and provides voltage supply for the transmitters.

Transmitters connected to the analog signal inputs have a fixed assignment to channel 1 or channel 2.

ⓘ NOTE

If an analog transmitter connection is used, the corresponding channel cannot be applied as an address for digital transmitters at the RS485 port!

Examples:

- channel 1: analog ▶ channel 2 can be assigned to RS485
- channel 2: analog ▶ channel 1 can be assigned to RS485
- channel 1, 2: analog ▶ no channels for RS485 available

4.2.4 I/O and Communication Port Schematic

For digital transmitter:

Connector: D-Sub15, 15-pin, female
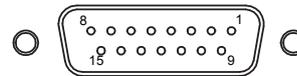
Pin no.	Description	Pin no.	Description
1	Do not connect	2	N/A
3	N/A	4	Voltage Supply 24 VDC
5	Supply GND	6	N/A
7	N/A	8	N/A
9	N/A	10	RS485, D+
11	RS485, D-	12	Ground
13	N/A	14	N/A
15	N/A		

ⓘ NOTE

We recommend to have "Ground" (Pin 12) and supply common (Pin 5) grounded.

For analog transmitter:

Connector: C91E, 6-pin, female, bolted type
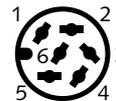
Pin Nr.	Description	Pin Nr.	Description
1	Identification	2	N/A
3	Signal input 1 … 10 V	4	GND
5	24 VDC, max. 8 W	6	AGND

ⓘ NOTICE

Incorrect supply voltage.

Risk of damage to the device!

• Make sure to supply a correct and admissible voltage.

4.2.5 Setpoint Relays

> ℹ **NOTE**
>
> Use enclosed counter plug for electrical connection. Connect only when power is off.
>
> Maximum load for the relays is 2 A / 45 VDC or 4 A / 250 VAC.
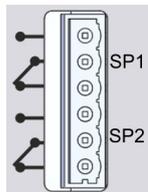
CTR 002   **CTR 004**
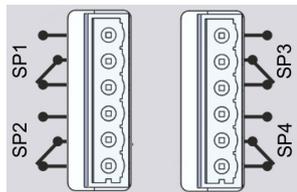
Connector: Phoenix Combicon, 6-pin

The contacts are shown in state-of-rest position, i.e. switching function "off"

For process control this device output provides switching functions by means of 2 or respectively 4 relay switches (switch-over type) SP1 to SP4. The switching outputs can be assigned to one of the measuring channels or set on and off manually.

4.2.6 Serial Interfaces

Connector: 1 = VCC ; +5 V
Mini USB Type B   2 = Data -
                  3 = Data +
                  4 = GND
                  5 = GND
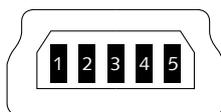
Connector:
RS232 ; Stereo Jack 3.5 mm
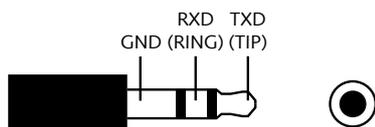
By means of the USB or RS232 interface the controller can be connected to a PC, e.g. for recording measurements or to adjust transmitter parameters in combination with Busch VacTest explorer software.

5   Operation

5.1 Startup

- Connect the transmitters.
- Wire the control lines of the relay outputs.
- Connect the mains.
- Switched on the controller.

ℹ NOTE

Afterwards the device will perform a selt-test and scan for connected vacuum transmitters while the display shows "scan".
Connected transmitters can only be detected during this start procedure!

By default, the controller is operating in display mode / Menu "Pressure".

If the controller is configured to start mode "run" (start-active "on") as described in Start Mode of Relay Control "start active" [▶ 18], the controller actuates the relay switches simultaneously with the display of actual pressure.

Description of keys:

≡	Menu-selection (switch to next Menu)
SET	Confirmation of adjusted values and change to the next input position (flashing inversely)
▲	Increment input value
▼	Decrement input value

5.2 Menu "Pressure" - Pressure Reading

In display mode the controller shows the actual absolute pressure for two or respectively four channels. Reading is numerical above 1 mbar (Torr, …) and exponential below.

Further the display indicates the relay control status (active/inactive) and states of each individual relay (on/off). The state of the switching outputs is indicated by figures 1 and 2 (CTR 002) or 1 to 4 (CTR 004), the figures being enlarged as soon as the corresponding relay is switched on.

Examples:
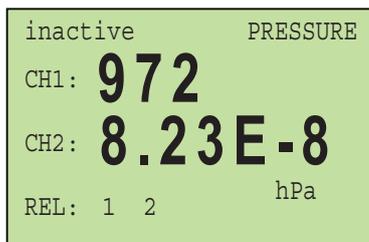
``` inactive PRESSURE CH1: 972 CH2: 8.23E-8 hPa REL: 1 2 ```	2 channels controller CTR 002, relay control inactive, relay 1 and 2 off:
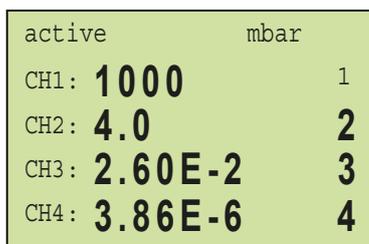
``` active mbar CH1: 1000 1 CH2: 4.0 2 CH3: 2.60E-2 3 CH4: 3.86E-6 4 ```	4 channels controller CTR 004, relay control active, relay 2,3 and 4 on:

SET	• Press the "set" key to activate of deactivate the relay control.
▲ ▼	CTR 004 with selected 2 channels display: • Toggle between channel numbers CH1/2 or CH3/4, see Channel Display Selection "display mode" [▶ 18].

5.3 Menu "Channel" - Parameters and Functions

The menu "Channel" shows channel number, transmitter type and the associated parameters and functions which directly affects pressure reading.

```
                  CHANNEL MENU
ch:  2

type:  DPH 400
gas:   N2/O2/CO/Air
corr:  1.00PI   1.00BA
adjust:
```

ch: Channel

type: Transmitter type (cannot be edited)

gas: Gas type

corr: Gas type correction factor

adjust: Transmitter readjustment

5.3.1 Channel Selection "ch"

SET	• Press "Set" key to enter in the channel selection (flashing inversely).
▲ ▼	• Select the channel.
SET	• Confirm changes and switch to the next parameter (flashing inversely).

5.3.2 Transmitter Type "type"

The system recognizes automatically the connected gauge type.

5.3.3 Set Gas Type Correction Factor "gas" and "corr"

For transmitters whose measurement depends on the type of gas, you can enter a correction factor for compensation below 0.1 mbar. Appropriate correction factors are found in the instruction manual of the transmitter or suitable technical literature. The range of the gas type correction factor is 0.20 to 8.00.

For transmitters with combination sensors separate factors for both sensors can be entered.

Acronym	Sensor type
PI	Pirani
CC	Cold cathode
BA	Bayard-Alpert (Hot cathode)

Pre-defined gas selection "gas":

SET	• Press the "set" key several times until the cursor is flashing line "gas".
▲ ▼	• Select the appropriate gas from the list.
SET	• Confirm with "set".

User-defined correction factor "corr":

SET	• Press the "set" key several times until the cursor is flashing in the line "corr".
▲ ▼	• Adjust the required values.
SET	• Confirm with "set".

5.3.4 Transmitter Readjustment "adjust"

> **ℹ NOTE**
>
> For transmitters DPC and DPH with combination sensors the adjustment does only affect the Pirani sensor. Hot and cold cathode sensors are not readjusted.

- Please refer to the corresponding gauge manual for transmitter readjustment specifications.

SET	For adjustment: • Press the "set" key several times until the cursor is flashing line "adjust".
▲ **▼**	For adjustment at atmosphere pressure: • Press the "up" key, afterwards the display will show "Hi" or an editable reference pressure depending on sensor type. For adjustment of zero pressure: • Press the "down" key, the display will show "Lo".
SET	• Confirm with "set".

5.4 Menu "Sensor" - Parameters and Functions

The menu "Sensor" shows channel number, transmitter type and the associated parameters and functions which control sensor operation of each transmitter.

```
                SENSOR MENU
ch:  2

type:  DPH 400
HCSens: On
trMode: trans_hi
degas:  Off
```

ch: Channel

type: Transmitter type

HCSens/CCSens: Ionization sensor On/Off

trMode: Transition mode

degas: Degas-function

SET	• Confirm changes and switch to the next parameter (flashing inversely)
▲ **▼**	• Adjust input value by means of the up/down keys.

5.4.1 Enable/Disable Ionization Sensor "HCSens" or "CCSens"

These functions are applicable for high vacuum transmitters with combination sensors operating an ionization sensor (hot or cold cathode).

For certain vacuum processes it may be necessary to disable the ionization sensor, which is automatically controlled by the transmitter electronics.

- – "off" ▶ ionization sensor disabled.
- – "on" ▶ automatic control of the ionization sensor.

With disabled ionization sensor transmitters DPC and DPH behave like a Pirani transmitter with range 1000 … 1×10^{-4} mbar. In this case, the output "ur" means that actual pressure is below 1×10^{-4} mbar.

ⓘ NOTE

Settings made under HCSens/CCSens are only temporarily saved in the transmitter memory. After mains supply is switched off or disconnected, the transmitter will always be start in mode "ionization sensor enabled" !

5.4.2 Select Transition Mode "trMode"

For transmitters with combination sensors you can select whether a hard switch-over ("switch") or a continuous transition ("trans" or "trans_hi"/"trans_lo") between the two sensors should be performed in the overlap range.

Detailed information about each mode can be found in the instruction manual of the transmitter.

5.4.3 Degas-function for Hot Cathode Sensor "degas"

ⓘ NOTE

The degas function cannot be started if the hot cathode is disabled (fil "off").

- • Please refer to the corresponding gauge manual for transmitter degas-function specifications.

5.5 Menu "Relay" - Switching Outputs

In the menu "Relay" you can assign the switching outputs and set relay parameters.

```
                   RELAY MENU
rel: 1

ch/mode: ch1      press
    on: 10         mbar
   off: 13         mbar

rel: 1  2
```

rel: Relay number

ch/mode: Relay assignment / switching mode

on/off: Ionization sensor On/Off

SET	• Confirm changes and switch to the next parameter (flashing inversely).
▲ ▼	• Adjust input value by means of the up/down keys.

5.5.1 Relay Selection "rel"

• Select the relay number.

5.5.2 Set Relay Assignment "ch/mode"

Each relay can be assigned to a measuring channel "ch1" to "ch4" and to various switching modes.

Switching modes:

– **press:** Relay switches according to switch-on and switch-off pressure

– **err / !err:** Relay switches in case of a sensor failure

– **ur / !ur:** Relay switches in case of pressure under-range

– **or / !or:** Relay switches in case of pressure over-range

Setting "on" becomes effective as soon as controlling is started.

5.5.3 Adjust Setpoints "on/off"

The setpoints are adjustable over the whole measuring range.

ⓘ NOTICE

Setpoints on/off are set too close.

May result in flickering and damage of the relay!

• Refer to the measurement uncertainty of the gauge (technical data) to set the value.

The relays are controlled by two or four setpoints SP1 to SP4.
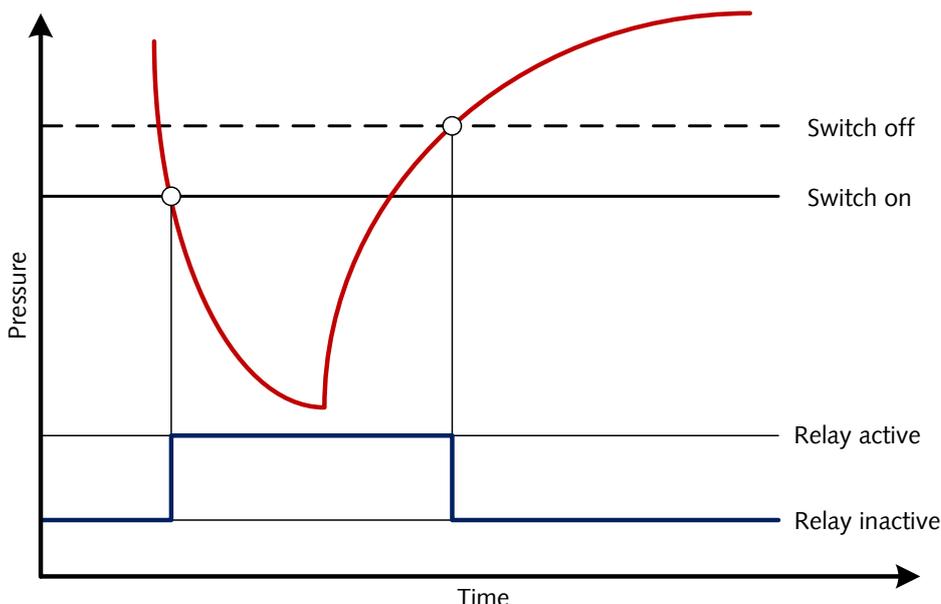
ℹ NOTE

If both relays are assigned to one measuring channel a three-state-control can be achieved by appropriate adjustment of the setpoints.

5.6 Menu "Common" - Display Settings

In the menu "Common" settings for pressure display and the start mode of pressure control are selected.

```
                    COMMON MENU

pressure unit:  mbar
backlight:  On
start active: On
display mode: 4 ch
```

pressure unit: Display unit slection
backlight: Background illumination
start active: Pressure control mode
display mode: Channel display (CTR 004 only)

SET	• Confirm changes and switch to the next parameter (flashing inversely).
▲ ▼	• Adjust input value by means of the up/down keys.

5.6.1 Unit Selection "pressure unit"

• Select the unit that you want to display.

Available units: mbar (default), bar, mTorr, Torr, Pa or hPa

5.6.2 Set Background Illumination "backlight"

– "on" ► backlight is activated.

– "off" ► backlight is deactivate.

– autoff ► backlight is switched off automatically after 20 seconds when no key is pressed

5.6.3 Start Mode of Relay Control "start active"

– "on" ► relay control is start-active, i.e. the relays are activated on as soon as the device has finished its self-test procedure.

– "off" ► after the device is switched on, the relay control has to be activated and deactivated manually.

> ### ℹ NOTE
>
> Independently from these settings relay control can be activated and deactivated by software command via serial interface.

5.6.4 Channel Display Selection "display mode"

The channel display is only available for CTR 004.

– "2 ch" ► 2 channels display

– "4 ch" ► 4 channels display

6 Communication

> ## ⓘ NOTE
>
> The Busch communication protocol is available separately on request.
>
> **Ask your Busch representative to get the document.**

6.1 Device Serial Interface

The controller is equipped with serial interfaces RS232 and USB.

The settings of the CTR 002 / CTR 004 can be changed via the device address 100. Device addresses 1 to 4 enable direct access to the connected transmitters and their parameters.

Interface-Parameter:

9,6 kBd, 8 data bits, 1 Stopbit, no parity

6.2 Commande Overview

Code	Description
TD	Displays the device type.
PN	Displays the product name.
VD	Displays the device's hardware version.
VF	Displays the device's firmware version.
VB	Displays the device's bootloader version.
DR	Make a device reset.
DU	Display and set the pressure unit used for the LCD display of the controller. Value range: mbar (default), bar, mTorr, Torr, Pa or hPa.
PS	Display and set the panel Status
CS	Display and set control status for the controller relays
R1 … R4	Relay 1 … 4

6.2.1 Keylock

Panel Status (PS):
The parameter is used to activate or lock the keyboard.

Settings	Meaning
0 (Default)	Keyboard active
1	Keyboard locked

6.2.2 Relay Control

Control Status (CS):
The parameter is used to activate or deactivate the control function.

Settings	Meaning
0 (Default)	Control function off
1	Control function active

6.2.3 Setpoints

The CTR 002 and CTR 004 provide respectively two and four independent dry contacts. These are available as change-over switches at the connector according to the pin assignment described in I/O and Communication Port Schematic [▶ 7].

Relay R1, R2, R3, R4:

The relays can be independently configured for various switching modes. The Parameter is used to query and set these switching modes.

Settings:

Settings	Meaning
$T[p_1]$ $F[p_2]$	2 pressure thresholds $T[p_1]$ (true) und $F[p_2]$ (false) are transmitted. $T[p_1]<F[p_2]$ Relay closes below p_1 and opens above p_2 $T[p_1]>F[p_2]$ Relay opens below p_2 and closes above p_1
E	Relay closes in case of a device error.
!E	Relay opens in case of a device error.
U	Relay closes in case of pressure under-range.
!U	Relay opens in case of pressure under-range.
O	Relay closes in case of pressure over-range.
!O	Relay opens in case of pressure over-range.
C	Relay closes when cathode is switched on.
!C	Relay opens when cathode is switched on.
T0	Open relay by software command (off).
T1	Close relay by software command (on).

> ### ⚠ NOTICE
>
> Setting $T[p_1] = F[p_2]$ is forbidden!
>
> **Risk of damage to the relay!**
>
> • A gap between the thresholds being too small will result in flickering of the relay

6.3 VacTest Explorer Software

VacTest explorer software has been especially developed for use with Busch vacuum gauges and is available for Windows and Android operating systems.
VacTest explorer features plotting and saving of measurement data as well as a comfortable way of configuring all device parameters.

Download VacTest explorer software on the Busch website www.buschvacuum.com.

Features example:

- Plot, analyze and save measurement curves.
- Compare multiple plots.
- Export measurement data for MS Excel.
- Automatic calculation of leak rates by rate-of-rise measurements.
- Easy configuration of all device parameters.
- Scaling wizard with graphic support for adjusting the voltage output characteristic.
- The voltage output curve can be modified through the VacTest explorer software and can directly replace gauges of other brands.

7 Maintenance and Service

⚠ **WARNING**

Units contaminated with hazardous material.

Risk of poisoning!

Risk of infection!

If the unit is contaminated with hazardous material:

• Wear appropriate personal protective equipment.

The device requires no maintenance. External dirt and soiling can be removed by a damp cloth.

Should a defect or damage occur on the device, please send the unit to us for repair and fulfil the declaration of decontamination downloadable from www.buschvacuum.com.
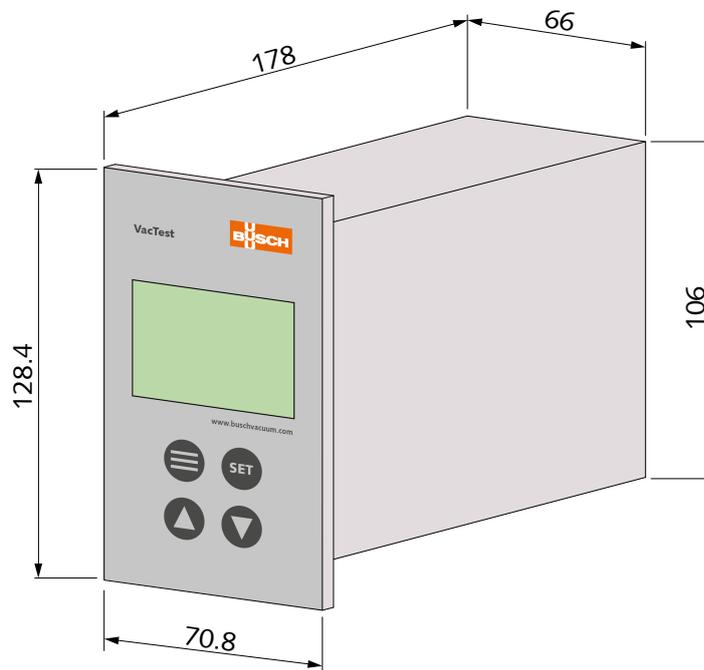
ⓘ **NOTE**

Malfunction of the unit, which is caused by contamination or wear and tear is not covered by warranty.

8 Troubleshooting

Problem	Possible Cause	Remedy
Error message "Err".	Defective pressure transmitter.	• Send transmitter for repair.
Error message "notr".	Connection to transmitter interrupted.	• Check transmitter, connectors and cables.
Error message "ur".	Measurement under range.	• Check pressure range of the transmitter.
Error message "or".	Measurement over range.	• Check pressure range of the transmitter.
Error message "off".	Channel not in use, no transmitter connected.	• If appropriate check transmitter, connectors and cables.
"d" is displayed behind the pressure reading.	VSH is in degas mode	• Wait until the end of the degas procedure.

9 Technical Data

		Controller CTR 002	Controller CTR 004
Materials exposed to vacuum		2	4
Compatibility		All digital transmitters and 0 … 10 V analog transmitters	All digital transmitters
Display		LCD graphic display, background illumination	
Display refresh rate	Hz	2	
Measurement unit		mbar, bar, mTorr, Torr, Pa, hPa	
Inputs		0 … 10 V, RS485	RS485
Sample rate	Hz	RS485: 12.5 0 … 10V: 50	RS485: 12.5
Serial Interface		USB type B	
Power supply	VAC	95 … 265 (50/60 Hz)	
Electrical Connection		IEC-320 C14	
Max. power consumption	W	25	45
Setpoint relay		2 dry contacts, Phoenix strip terminal 6-pole, lifetime ► 300.000 cycles	4 dry contacts, Phoenix strip terminal 6-pole, lifetime ► 300.000 cycles
Relay contact rating		4 A, 250 VAC / 2 A, 45 VDC	
Operating Temperature		+5 ... +50	
Storage temperature		-20 ... +60	
Protection Class		IP 20	
Approximate weight	g	750	800

10 EU Declaration of Conformity

This Declaration of Conformity and the CE-mark affixed to the nameplate are valid for the gauge within the Busch scope of delivery. This Declaration of Conformity is issued under the sole responsibility of the manufacturer.

The manufacturer   **Busch Produktions GmbH**
                Schauinslandstr. 1
                DE-79689 Maulburg

declare that the gauge VacTest CTR 002 / CTR 004

has been manufactured in accordance with the European Directives:

– 'Electromagnetic Compatibility (EMS) ' 2014/30/EU
– 'RoHS' 2011/65/EU, restriction of the use of certain hazardous substances in electrical and electronic equipment

and following the standards.

Standard	Title of the Standard
EN 61326-1:2013 Group 1 / Class B	Electrical equipment for measurement, control and laboratory use. EMC requirements. General requirements
EN 50581:2012	Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances

Person authorised to compile the technical file: Gerd Rohweder
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Maulburg, 24.08.2017

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