

**VICOTEC410**  
**CO and Visibility Measuring Device**



**Installation**  
**Operation**  
**Maintenance**



## Document Information

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### Described Product:

Product name: VICOTEC410

Variants:

### Document ID

Title: Operating Instructions VICOTEC410

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### Manufacturer

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### Original Documents

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Please contact the manufacturer or your local representative in case of doubt.

### Legal information

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## Glossary

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**Skilled persons:** Persons who, based on their technical training and knowledge as well as knowledge of the relevant regulations, can assess the tasks given and recognize the dangers involved.

**Competent person:** Persons who, based on their technical training on, and knowledge concerning the specific device, as well as knowledge of the relevant regulations, can assess the tasks given and recognize the dangers involved.

**Instructed person:** Persons properly instructed on the tasks assigned, possible risks and necessary protective measures.

## Warning Symbols

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Hazard (general)



Hazard by voltage

## Warning levels / Signal words

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### **DANGER**

Risk or hazardous situation which *will* result in severe personal injury or death.

### **WARNING**

Risk or hazardous situation which *could* result in severe personal injury or death.

### **CAUTION**

Hazard or unsafe practice which *could* result in personal injury or property damage.

### **NOTICE**

Hazard which *could* result in property damage.

## Information Symbols

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Important technical information for this product



Important information on electric or electronic functions



Nice to know



Supplementary information



Link to information at another place

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# VICOTEC410

## 1 Important Information

Main safety information

Main operating information

Intended use

Own responsibility

## 1.1 Main safety information

### 1.1.1 Authorized personnel

Persons responsible for safety must ensure the following:

- All work on device parts is carried out by qualified personnel only. Qualified persons are those who, based on their training, experience or instruction as well as their knowledge of relevant standards, regulations, accident prevention rules and plant conditions, are authorized by those responsible for safety for personnel and the plant to carry out such work. It is decisive that these persons can recognize and avoid possible hazards in a timely manner.
- Skilled persons are persons according to DIN VDE 0105 or IEC 364 or directly comparable standards such as DIN 0832.
- These persons have adequate knowledge through training
- These skilled persons have the delivered Operating Instructions as well as the associated system documentation available during all work, and observe these documents with regard to avoiding hazards and damage.

Contact the manufacturer before using this measuring device for other purposes where the device functionality cannot be judged properly within such applications.

### 1.1.2 Intended use

- The VICOTEC410 measuring system and its system components are only to be used for measuring visibility and/or CO concentrations in road tunnels.

### 1.1.3 Prerequisite

All planning, assembly, installation, start-up, maintenance and repair work must be carried out by adequately instructed personnel only and checked by the responsible skilled persons.

### 1.1.4 Correct handling

- Use the system in accordance with the technical data and specifications regarding permissible usage, assembly, connection, ambient, and operating conditions (refer to the order documents, device user information (type plates etc.), as well as the documentation supplied with the system).
- Persons carrying out the work must be aware of, and observe general assembly and safety regulations,
- Act according to local, system-specific conditions and risks arising from technical operating and regulations, in particular local road safety regulations.
- Ensure proper use of tools and hoist and transport equipment.
- Provide sufficient protection devices and personal safety equipment and ensure that these are used by the personnel.
- Secure system components delivered without a degree of protection with effective protection devices on-site.
- Observe all measures necessary for conservation of value, e.g. during transport and storage and/or maintenance and inspection.

1.1.5 **Avoiding consequential damage arising from device malfunctions**

In order to avoid malfunctions that can lead to direct or indirect person or property damage, the operator must ensure:

- Personnel responsible for maintenance can be informed at any time and as quickly as possible.
- Maintenance personnel are trained to be able to respond to malfunctions on the VICOTEC410 and to react correctly to related operational malfunctions.
- Defective operating resources are switched off immediately in case of doubt.
- That switching off does not lead directly to subsequent malfunctions.
- Switching outputs “Data valid” for CO and VIS are wired correctly and are processed in the control station without having to close the tunnel.

	<p><b>NOTICE: Procedure when cleaning the tunnel</b></p> <ul style="list-style-type: none"> <li>▶ Switch the VICOTEC system to operating mode “Maintenance”</li> <li>▶ Be sure to cover sensor tubes with closure caps</li> <li>▶ Never touch sensors directly with washing brushes (risk of modifying optical alignment which can cause a device malfunction)</li> <li>▶ After cleaning, check the optical interfaces of the sensors for contamination; when necessary, clean the optical interfaces in accordance with maintenance regulations, see p. 62, § 7.2.1.</li> </ul>
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1.1.6 **Environmentally acceptable behavior and disposal**

- Observe applicable waste disposal regulations to protect the environment.
- Sensor subassemblies are easy to dismantle and disposed of as waste.
- Sensor outer housing, optics chassis and brackets are made of aluminium and can be recycled.

	<p><b>NOTICE: Suitable disposal!</b></p> <ul style="list-style-type: none"> <li>▶ Do not dispose of electronic components from VISOTEC410 system components as household waste. Dispose of these components in a suitable facility.</li> </ul>
---	--

1.2 **Intended use**

1.2.1 **Purpose of the device**

Operate the VISOTEC410 visibility/CO measuring device as specified by the manufacturer, i.e. only use the VICOTEC410 measuring system and its system components to measure visibility and/or CO concentrations in road tunnels.

1.2.2 **Installation location**

The opto-electronic VICOTEC410 measuring device supports continuous, delay-free measurement of visibility and CO concentrations in road tunnels. The sturdy, compact sensors are designed as contact-free, direct in-situ measuring devices.

Subject to change without notice

### 1.3 **Responsibility of user**

These Operating Instructions serve understanding the function, and explain assembly, installation and maintenance work as well as how to operate the VICOTEC410. Other documents may contain more detailed information but can never replace these Operating Instructions.

#### **Target groups of this document**

- SICK Service technicians or trained customer personnel; qualified technicians/engineers - with excellent device knowledge
- Operators, customer installation personnel, technicians for measurement and control technology, electric, electronics - with basic device knowledge

#### **Correct use**

- ▶ Only use the device as described in these Operating Instructions (--> page 44). The manufacturer bears no responsibility for any other use.
- ▶ Carry out the specified maintenance work.
- ⊗ Do not remove, add or change any components in or on the device unless such changes are officially allowed and specified by the manufacturer. Otherwise any warranty by the manufacturer becomes void.



Read the Operating Instructions before starting the work! Observe all warning information exactly!

#### **Special local conditions**

- ▶ Follow all local laws, regulations and company-internal operating directives applicable at the installation location.

#### **Keeping documents**

These Operating Instructions:

- ▶ Must be available for reference.
- ▶ Must be passed on to new owners.

### 1.4 **Additional documentation/information.**

- ▶ Check the contents of the CD delivered with the product (PN:2058621).

# VICOTEC410

## 2 Product Description

Product identification

Functional principle

Characteristics

Variants

## 2.1 Product identification

Product name:	VICOTEC410
Product variants:	VICOTEC411 (VIC411), VICOTEC412 (VIC412), VICOTEC414 (VIC414)
Firmware version:	Program RCU410 (9054915 Version 0362)
Manufacturer:	SICK AG Erwin-Sick-Str. 1 · 79183 Waldkirch · Germany

The type plate is located

- Sender or reflector/receiver unit: On the back of the housing.
- RCU410: On the right outer side of the housing.

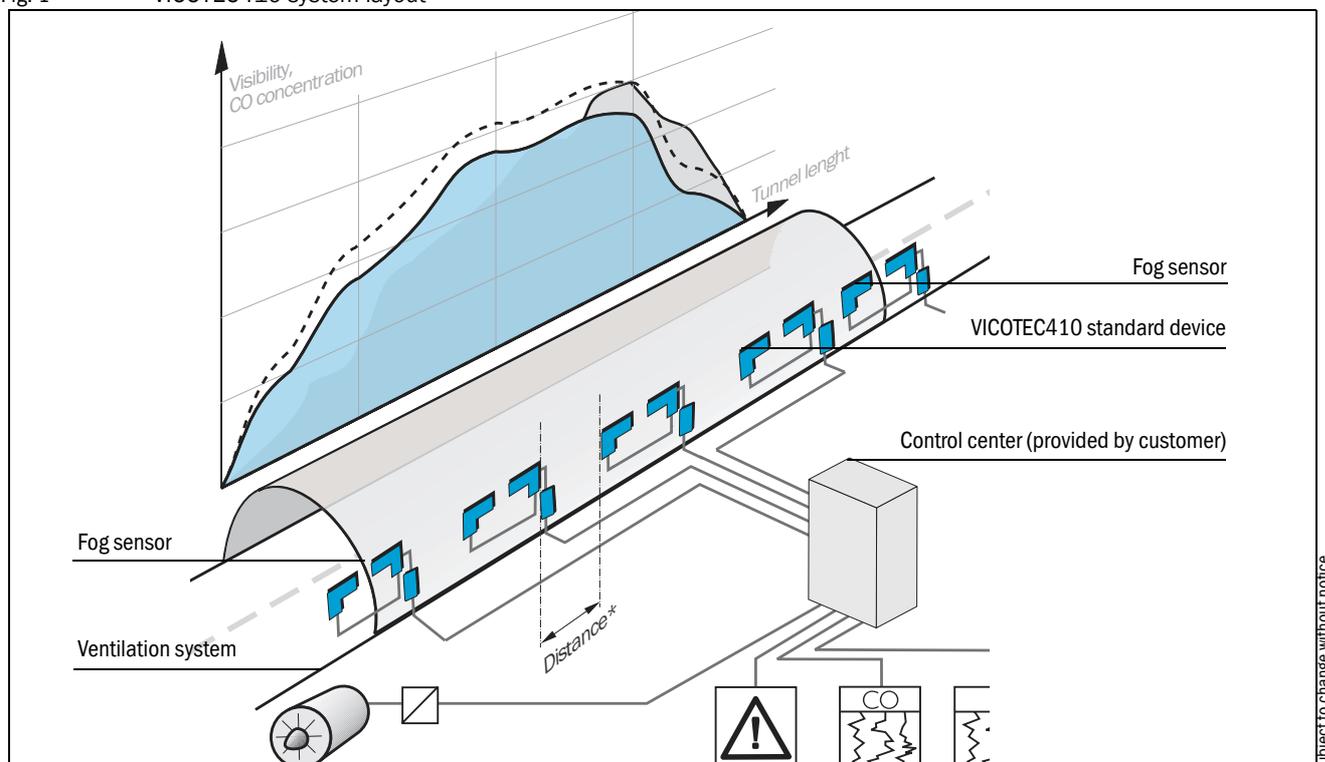
## 2.2 Features of the VICOTEC410

- ▶ Simultaneous and single visibility and CO concentration measurement
- ▶ Comfortable operation via a menu-controlled graphic display on the evaluation unit
- ▶ Automatic adjustment function (*AutoAdjust*) for simple start-up
- ▶ Minimum effort for installation, start-up and maintenance.

The option of simultaneous as well as single visibility and CO concentration measurement opens up flexible application possibilities for the VICOTEC410, such as:

- Monitoring short tunnel sections or underpasses with one measuring point
- Monitoring longer tunnel sections
- Integrating a fog sensor for each tunnel portal (max. 2 fog sensors)

Fig. 1 VICOTEC410 system layout



2.2.1 **Method of operation**

The VICOTEC410 operates independently.

- The measuring principles used support extensive options for excellent self-monitoring
- When a *malfunction* occurs, the VICOTEC410 switches automatically to “Malfunction” mode. The analog outputs are set to the parameter value set for malfunctions, “Live zero”, or the last valid value.

Operating states are signaled by status signals and entered in a logbook.

Each sensor pair of a measuring point has one or two opto-electronic measuring devices that deliver, independent of each other, visibility and/or CO concentration measured values. The CO measuring unit (IR unit) comprises an infrared sender and an infrared receiver. The visibility measuring unit (VIS unit) is arranged in parallel and comprises a sender/receiver unit and a triple reflector.

2.3 **Device variants**

2.3.1 **Standard components**

- Sensor pair (sensor “left”, “right”)
- Control unit RCU410
- 2 mounting brackets
- Extension cable, 12 m, 6 pole; plug and socket C16-1
- Connection cable, 2 m for sensor - control unit connection

Fig. 2

Device versions

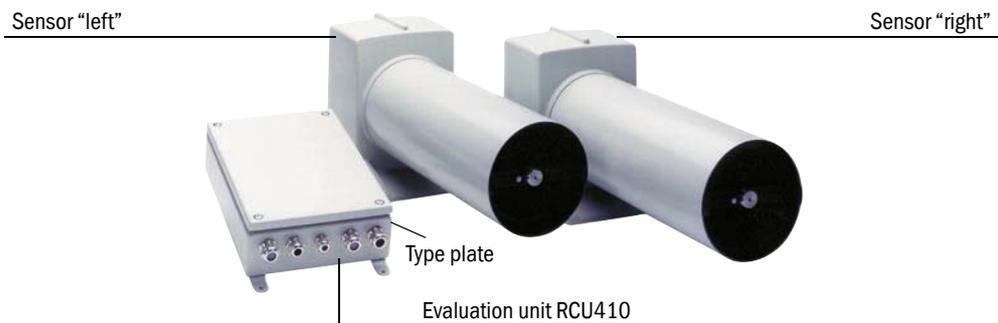


Table 1

Device variants	Measuring task
VICOTEC411	Single visibility measurement
VICOTEC412	Single CO concentration measurement
VICOTEC414	Simultaneous visibility and CO concentration measurement

### 2.3.2 Optional equipment

The VICOTEC410 can also be configured with

- 1 terminal box, "sensor left"
- 1 terminal box, "sensor right"
- Connection unit with separate voltage supply (230 V AC); allows locating the RCU410 up to 1000 m away (CAN bus)
- Repeater for RS422
- Additional prefabricated connection cables:
  - 1 connection cable, 1 m for sensor - evaluation unit connection
  - 1 extension cable, 24 m, 6 pole; plug and socket; C16-1, to connect both sensors
- 2 mounting brackets incl. fixing accessories in material 1.4529 or 1.4571
- Plastic separator plate for using the stainless steel consoles
- Surge protection elements

### 2.4 Functional principle/measuring principle

- Visibility measuring principle: Transmission measurement (NDIR), auto-collimation method
- CO concentration measuring principle: Negative gas correlation

### 2.5 Special features

- Sturdy design proven in hundreds of tunnels
- Long optical measuring distance (2 x 10 m) for exact measured value recording and simple installation, even in curves, as well as easy alignment
- Automatic contamination compensation on visibility and CO measuring channel
- Simple and fast check of all measured variables possible using closed gas cells (CO) or neutral density glasses (visibility)
- Early alarm for maintenance request (contamination) for optimized maintenance cycle planning
- Effective dust protection tubes, heated reflector and thermal insulation allow typical maintenance intervals of 1 year

#### 2.5.1 Special device version

The VIC412 (Individual measurement of CO-concentration) is also available in a 20 m version. The measuring distance can be adjusted from 19,5 to 20,5 m.

There is no difference to the standard device with regards the optical alignment and operation of the device.

*Device type: VIC412-22S07 material-no. 1054383*



The 20 m - measuring distance is only available for the version VIC412 .

## 2.6 Device components

### 2.6.1 VICOTEC410 sensors

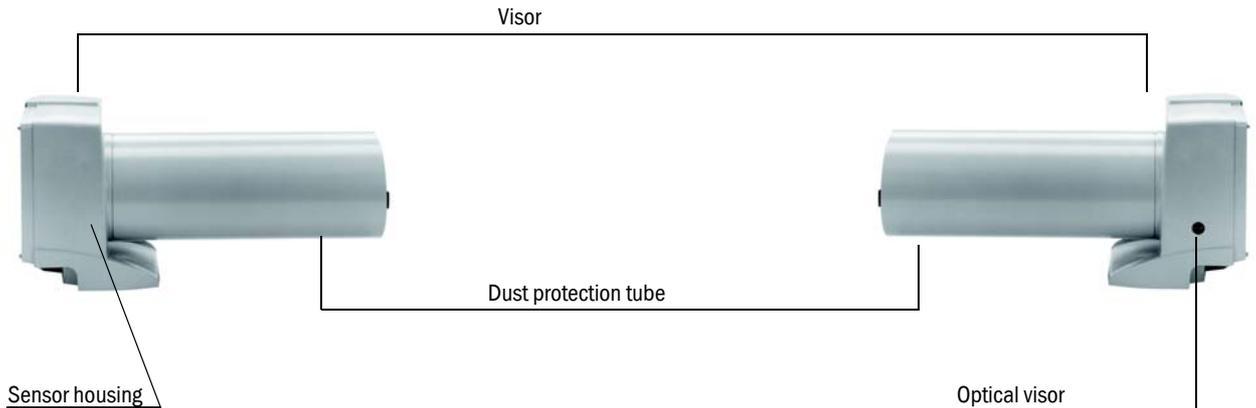
Fig. 3 Sensor versions

#### Sensor "left"

- VICOTEC 411: VIS reflector
- VICOTEC 412: CO sender
- VICOTEC 414: VIS reflector/CO sender

#### Sensor "right"

- VICOTEC 411: VIS sensor
- VICOTEC 412: CO receiver
- VICOTEC 414: VIS sensor/CO receiver



### 2.6.2 Evaluation unit RCU410

Each measuring device has an evaluation unit (Remote Control Unit), the RCU410. The RCU410 provides the recorded measured data as analog and digital signals and performs the following functions:

- Measuring system operation
- Measuring and status signals evaluation and output
- Sensor voltage supply

## 2.7 RCU interfaces

### 2.7.1 RCU interfaces- standard version

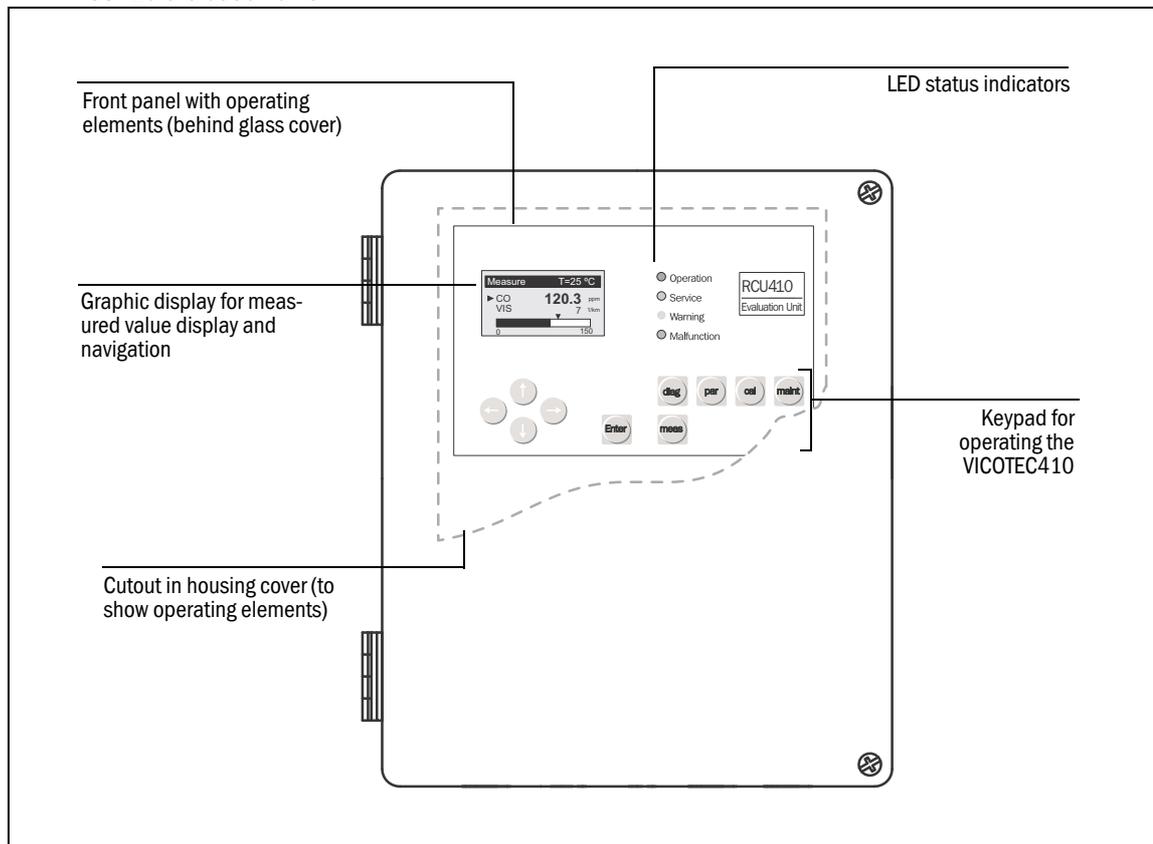
- 3 relays:
  - VIS malfunction
  - CO malfunction
  - Service/Dust/Warning
- 2 analog outputs
  - VIS: 0 ... 20 mA; Live-Zero: 4 mA
  - CO: 0 ... 20 mA; Live-Zero: 4 mA
- 1 digital input
  - Service switch

The RCU410 also has an RS422 interface (electrically isolated) on which all measured data are made available with status messages.

### 2.7.2 RCU410 interfaces – Profibus

- 1 digital input
  - Service switch
- Interfaces
  - PROFIBUS interface
  - RS422 interface

Fig. 4 RCU410 evaluation unit



### 2.8 Fog correction via the RCU410

VICOTEC411s are installed just as fog sensors at a maximum distance of 10 m from the portals. These are connected to the VICOTEC4xx measuring points (tunnel sensors) via an RS422 bus circuit. An RCU410 declared as Master then corrects the measured values of the tunnel sensors when fog exists so that no fog is suctioned in. Details on parameter settings, see p. 45, §4.5.2.

### 2.9 Screening out fog on measuring points close to the portals

Apart from the possibility of detecting fog and taking appropriate measures, SICK also offers a device that does not record fog as visibility factor (e.g. VISOTEC450). This device is used preferably at those measuring points closer than 300 m from a portal. This prevents fog being assessed as visibility factor and initially avoids erroneous switching to suction in fresh air.

## 2.10

**Fog correction via control technology before the portals**

If visibility distance measuring devices (e.g. VISIC620 from SICK) are used before the portals, it is recommended to design ventilation control so that fresh air is only suctioned into the tunnel when it can be expected that this will improve visibility or when necessary to maintain other limit values (NO<sub>2</sub>, CO,...). An improvement in the visibility distance can then be expected when the visibility in the tunnel (heat transmission coefficient - HTC) is much worse than the heat transmission coefficient to be expected when suctioning in fog. In this case, it is important to observe that a larger volume of condensation crystals is inside the tunnel than outside the tunnel which thickens any fog suctioned into the tunnel. This effect cannot be calculated beforehand so it is recommended modeling this in the control with an adjustable variable (referred to here as "Delta heat transmission coefficient") so that it can be adapted during the tunnel operation test phase. The following Table provides assistance for converting visibility distance into a heat transmission coefficient in stages without having to use a complex mathematic formula. Detailed consultation can be requested from the

Table 2 Visibility distance to heat transmission coefficient conversion Table

Visibility distance	As HTC converted visibility distances	Delta HTC (only as an example here)	HTC expected in the tunnel
900 m	3.3/km	2/km	5.3/km
800 m	3.75/km	2/km	5.75/km
700 m	4.3/km	2/km	6.3/km
600 m	5/km	2/km	7/km
500 m	6/km	2/km	8/km
450 m	6.7/km	2/km	8.7/km
400 m	7.5/km	2/km	9.5/km
350 m	8.6/km	2/km	10.6/km
300 m	10/km	2/km	12/km
250 m	12/km	2/km	14/km

local SICK contact person.

This fog correction method has the advantage that measured values in the tunnel always reflect the actual visibility. This ensures a warning or closure when visibility is poor.



# VICOTEC410

## 3 Installation

Project planning  
Transport  
Setup  
Installation  
Initial start-up

### 3.1 Project planning

### 3.2 Safety information

The following symbols are used in these installation instructions for important safety information for the user. The symbols are located exactly where required within the Sections. Safety information, especially warnings, must be observed and followed.

#### 3.2.1 Protection devices/protective measures



**DANGER: Hazards through electrical equipment**

VICOTEC410 system components are operating resources for use in industrial high-voltage systems. These operating resources have parts that are dangerous, live and possibly not insulated during installation, start-up and operation. Unauthorized removal of required covers, incorrect usage or operation or inadequate maintenance of system components referred to above can cause severe health or material damage.



**WARNING: Preventive measures for operating safety**

If the VICOTEC410 is used as a sensor in combination with a control system, the operator must ensure that a failure or device malfunction on the VICOTEC410 cannot cause unallowed damage or hazardous operating states, or states that can endanger or obstruct traffic.

### 3.3 Material required

Table 3 Materials and Part Nos. for assembly

Material required	Part No.
Assembly kit for mounting brackets for VICOTEC32x, 41x, dowels and screws made of stainless steel 1.4571	2045457
Assembly kit for mounting brackets for VICOTEC32x, 41x, dowels and screws made of stainless steel 1.4529	2045458
Insertion tool for stainless steel dowel, M12	5601225

### 3.4 Preparing the installation location

- ▶ Secure the place of work
- ▶ Provide adequate light, power and a jack lift at the place of work
- ▶ Provide fixing accessories, suitable drills and tips, circuits, socket wrench set, torque wrench, marking material, measuring tools, spirit level.



#### Selection criteria

▶ **Define the measuring path:**

Comply with the measuring path when possible. Record small deviations in the Assembly protocol.

▶ **Select fixing accessories:**

The tunnel atmosphere is usually highly corrosive. Use only suitable, non-corrosive or protected fixing accessories.

▶ **Define the tilt angle:**

Always align the mounting brackets at the same tilt angle to the tunnel wall. Different tilt positions to the tunnel profile make the following sensor alignment difficult. Insert washers under the wall holder when necessary.

▶ **Fit the mounting brackets on a sufficiently solid foundation (e.g. concrete  $\geq$  BE5) for exact sensor alignment.**

3.4.1

### Overview of installation work

- Check device scope of delivery
- Check mounting bracket alignment for the sensors and adjust when necessary
- Install the sensors
- Install the terminal boxes (option) and connection unit with separate voltage supply (option)
- Install the evaluation unit
- Connect the VICOTEC410 components
- Electrical connections on the evaluation unit

Note: Fitting the mounting brackets is described in detail in the Project Planning Information Section, see p. 21, §3.6.1.

3.5

### Scope of delivery

Check the scope of delivery against the order and delivery documents.

Standard delivery includes the components: See p. 12, 2.3.1

Optional components: See p. 13, 2.3.2

3.6

### Assembly

#### Procedure

- 1 Determine the installation location for mounting brackets according to project planning.
- 2 Drill holes for wall holder. Drill holes according to the selected expanding dowels or wall ties, see Fig. 5, page 22.
- 3 Insert dowels or wall ties according to the manufacturer's assembly specifications.
- 4 Screw the consoles on provisionally at first. Align with visual control.  
Tighten screws according to the manufacturer's assembly specifications, use a torque wrench when necessary.
- 5 Check rough alignment of consoles visually, correct as necessary.



Wall plate and mounting bracket can be fitted slightly tilted when the cross-section profiles are tilted or rounded. Leave sufficient clearance for removing the tube and device cover.

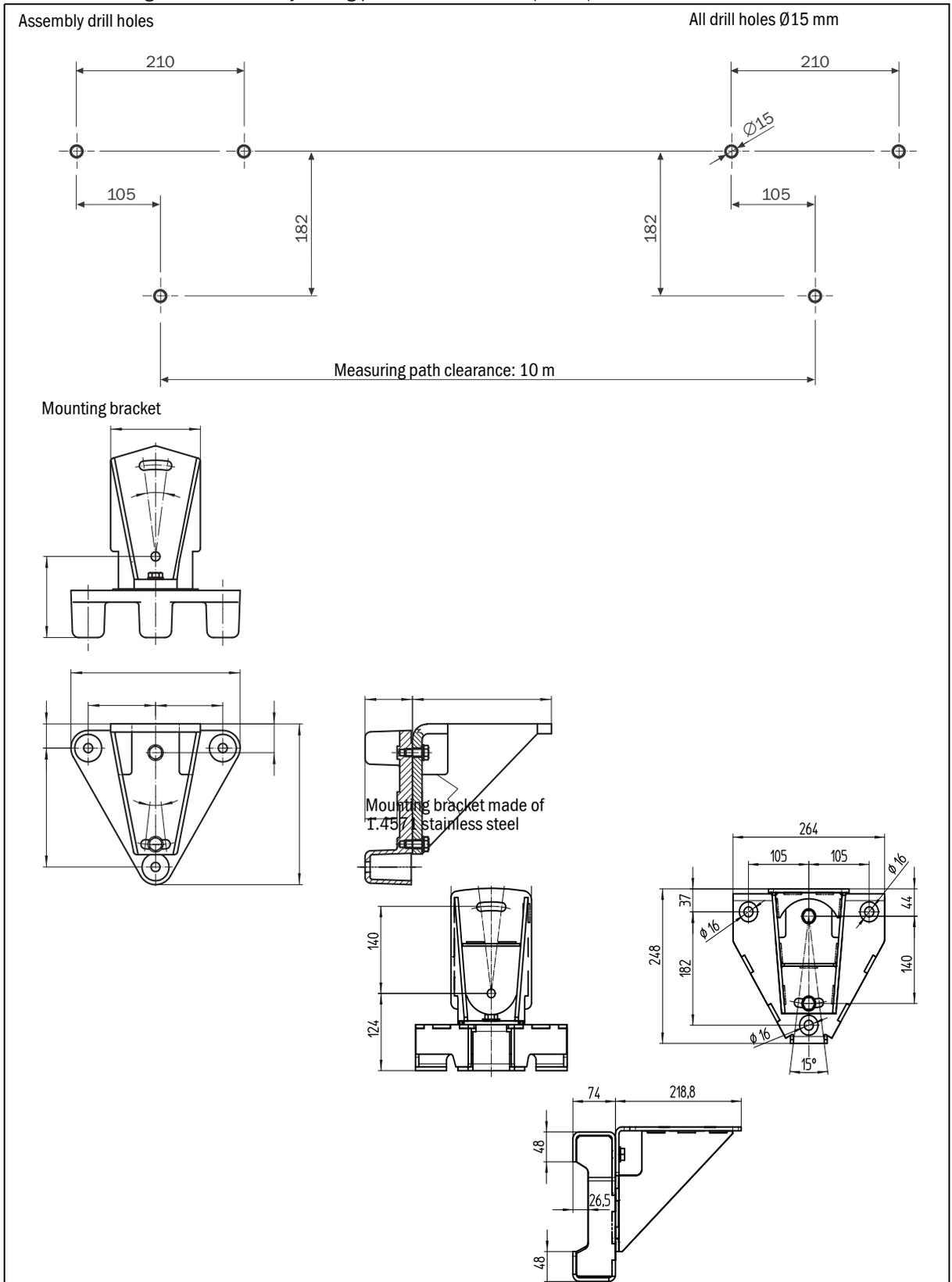
### 3.6.1 Fitting the mounting brackets

The mounting brackets comprise 2 parts:

- Wall holder for direct assembly on the wall
- Angle bracket to fix the sensor.

Two screws fasten the wall holder and the mounting bracket together. The mounting bracket can be swiveled up to 15° to compensate any assembly unevenness.

Fig. 5 Mounting bracket assembly drilling plan and dimensions (in mm)



Subject to change without notice

### 3.6.2 Installing the sensors

#### Procedure

- 1 First check the sensor serial numbers on the type plates. Only fit sensors with matching serial numbers as pairs.

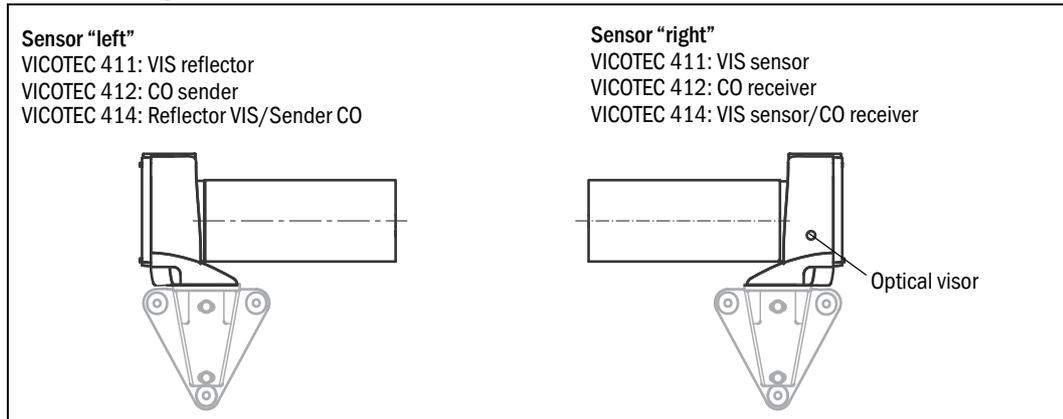


Make sure "Sensor right" is actually fitted on the right otherwise the optical visor cannot be accessed.

- 2 Sensor arrangement:

Fig. 6

Sensor arrangement on tunnel wall

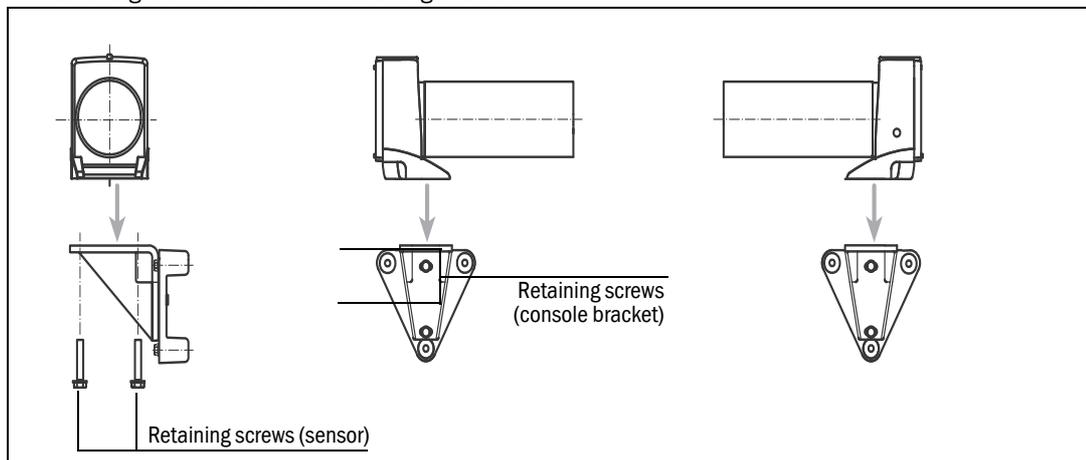


For simplification, sensor "VIS reflector/CO sender" is referred to as sensor "left" and sensor "VIS sensor/CO receiver" as sensor "right" in this document.

- 3 Fitting the sensors

Fig. 7

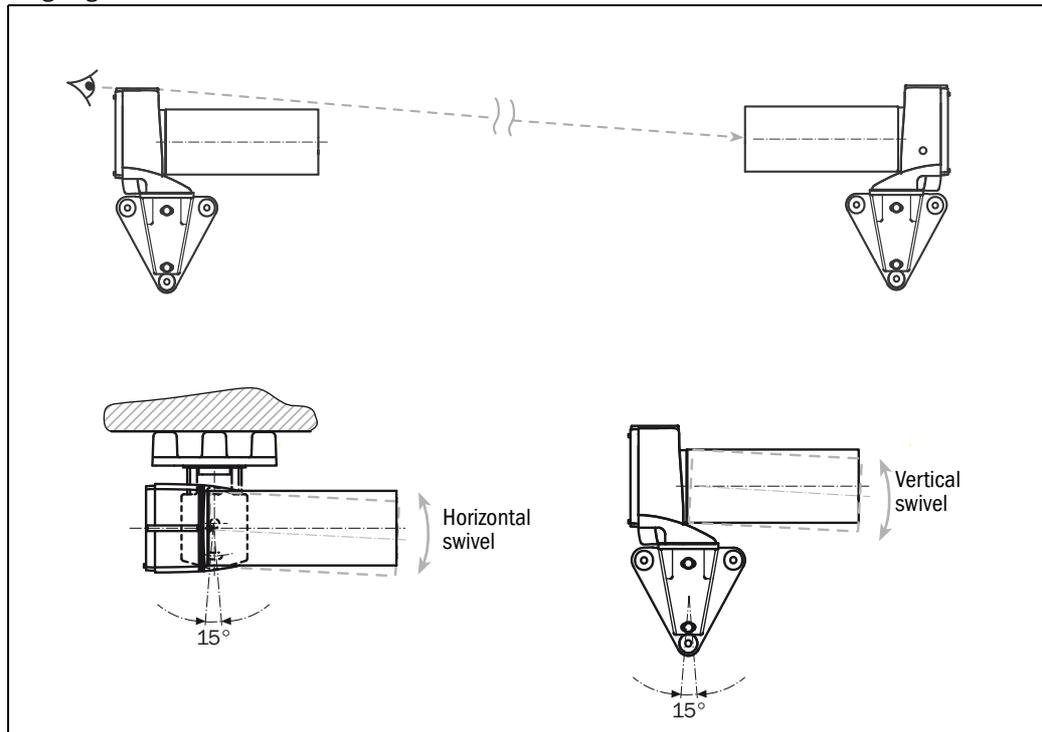
Fastening the sensors to the mounting brackets



- ▶ When using stainless steel consoles, fit the plastic separator plate on the angle bracket so that the sensors have no direct contact with the consoles.
  - ▶ Position the sensor on the mounting bracket and screw the sensor "hand-tight" with the 2 retaining screws provided.
  - ▶ Insert the plastic sleeves in the fastening drill holes of the sensor. (See Fig. 6)
  - ▶ Loosen the 2 retaining screws of the console bracket so that it can be swiveled slightly with the sensor.
- 4 Align the sensors using the visor opening.

Fig. 8

Aligning the sensors



- ▶ Position to the center of the other sensor through the visor opening on top of the sensor.
- ▶ Tighten at least one of the retaining screws when alignment is correct.

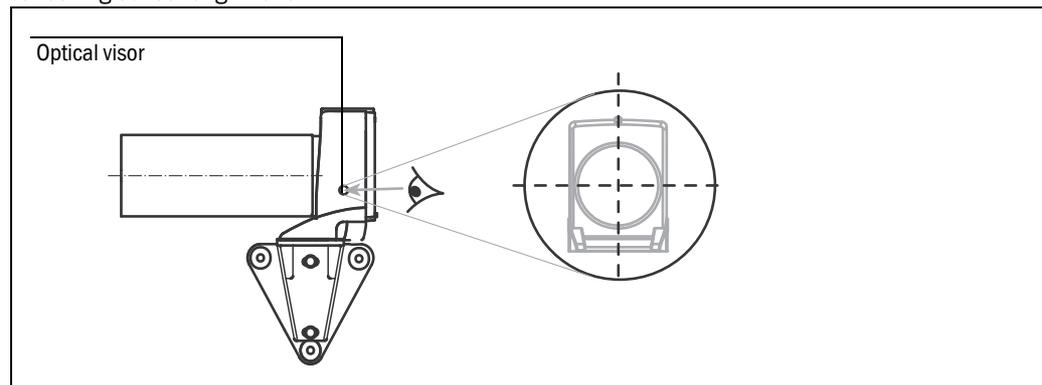


**NOTICE:** Align the sender first - then the receiver

- 5 Aligning the sensors using the optical visor.

Fig. 9

Checking sensor alignment



- 6 Check the alignment
  - ▶ Look through the optical visor of the “right” sensor (see p. 24, Fig. 9) and check that the other sensor appears centered.
  - ▶ Adjust the sensor as necessary.
  - ▶ Tighten all retaining screws when alignment is correct.
- 7 VICOTEC410 “not in operation”
  - ▶ Close the dust protection tubes of the sensors with the covers provided until start-up.

### 3.7 Installing the terminal boxes and connection unit

The terminal boxes (option) and connection unit come with separate voltage supply.

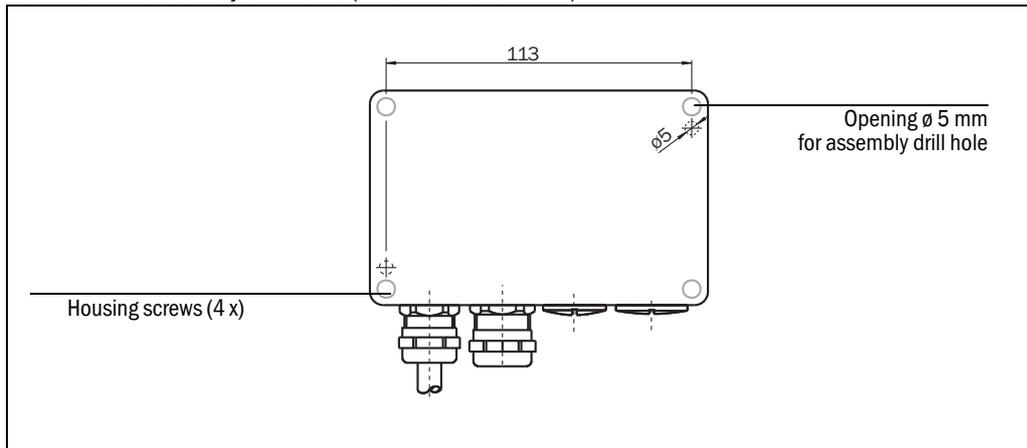
#### 3.7.1 Fitting the terminal boxes (option)



Fit the terminal boxes close to the respective sensor. Check cable lengths, the supply line delivered already fitted to the terminal box is 1 meter long.

Fig. 10

Terminal box assembly drill holes (measurement in mm)



- ▶ Open and remove the terminal box cover
- ▶ Fasten the housing to the tunnel wall with 2 x M4 assembly screws
- ▶ Reassemble the terminal box.

#### 3.7.2 Fitting the connection unit to distant evaluation unit

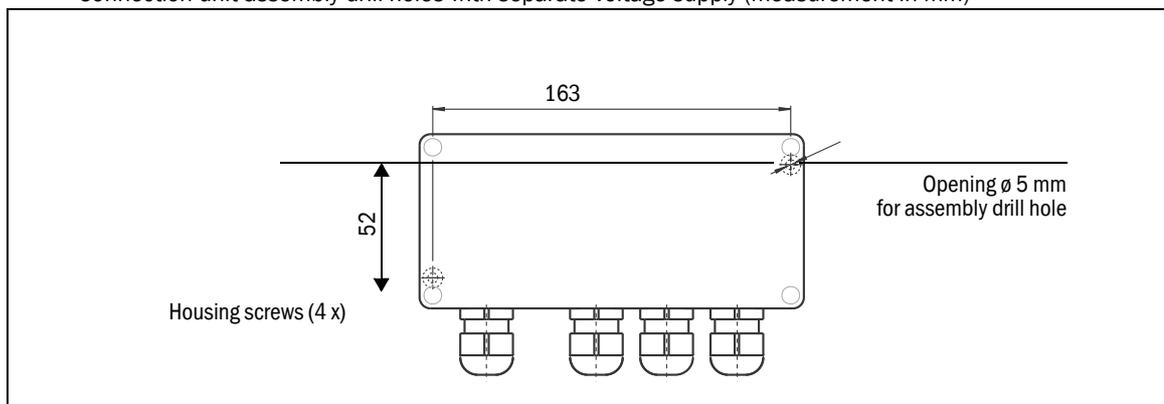
Fitting the connection unit with separate voltage supply when the evaluation unit is up to 1000 m away



Fit this connection unit so that the cable length to the connector contact of sensor "right" does not exceed 2 meters

Fig. 11

Connection unit assembly drill holes with separate voltage supply (measurement in mm)



- ▶ Open and remove the connection unit cover
- ▶ Fasten the housing to the tunnel wall with 2 x M4 assembly screws
- ▶ Reassemble the connection unit.

### 3.8 Installing the evaluation unit

	<b>NOTICE:</b> Consider maximum cable lengths when selecting the RCU410 fitting location
---	---

Table 4 Maximum cable lengths between VICOTEC sensor and evaluation unit

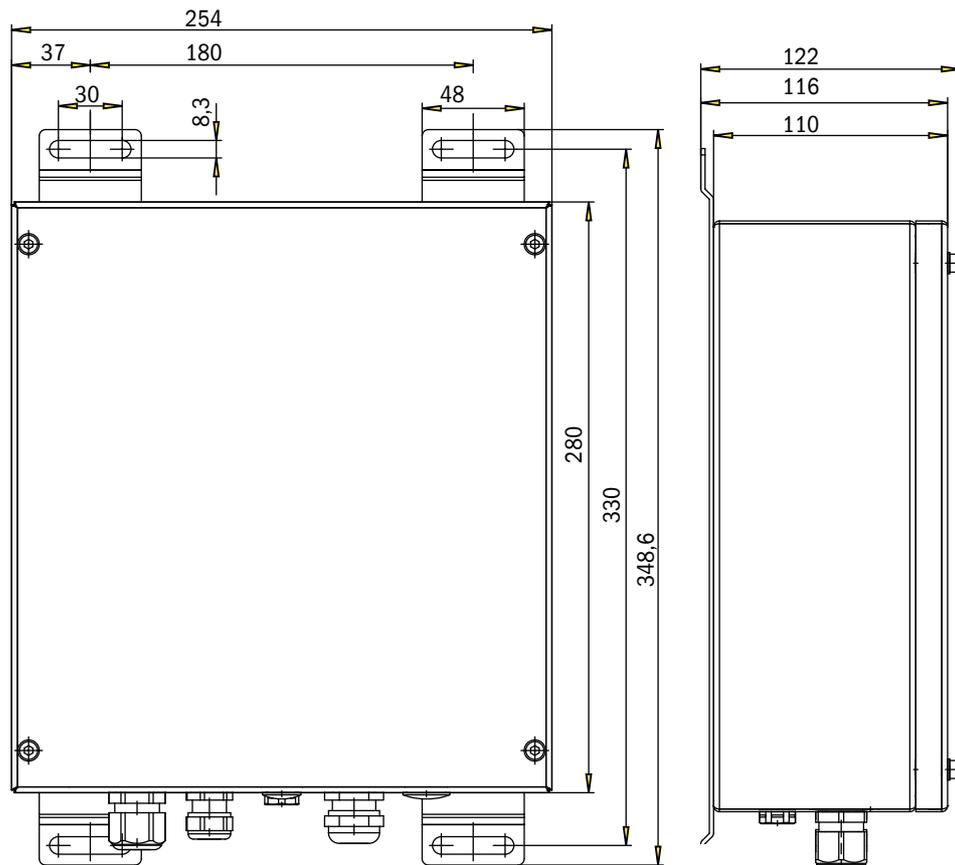
Evaluation unit	VICOTEC411	VICOTEC412/414	Additionally required
Distance	Max. 14 m connection cable (1 m, 2 m or 2+12 m)		
	50 m cable		<ul style="list-style-type: none"> <li>● Terminal box</li> </ul>
	1000 m cable		<ul style="list-style-type: none"> <li>● Terminal box</li> <li>● Connection unit</li> </ul>

	Further information, see p. 19, §3.1 Cable routing diagram.
---	---

#### Procedure

Check the delivered connection cable (1 m, 2 m or terminal box as well as connection unit with separate voltage supply).

Fig. 12 Connection unit assembly drill holes with separate voltage supply (dimensions in mm)



- ▶ Install the evaluation unit on an easily accessible, flat, vertical surface
- ▶ Fit the housing on the 4 fastening clips provided

## Electrical installation



### CAUTION: General hazards through electric voltages

- ▶ Observe relevant safety regulations during all installation work! Take suitable protective measures against possible local risks or those arising from the system!
- ▶ If it is necessary to open the device for setting or repair: Disconnect the device from all power sources before starting work.
- ▶ If the open device must be live during work: This work must be performed by skilled persons who are familiar with potential hazards. If it is necessary to remove or open internal components, live parts could be exposed.
- ▶ If liquid has penetrated electrical device components: Shut the device down immediately and disconnect mains voltage at external source (e.g. disconnect the mains cable). Then contact the manufacturer's customer service or request suitably trained skilled persons to repair the device.
- ▶ If safe operation of the device is no longer possible: Shut the device down and secure it against unauthorized start-up.
- ▶ Never interrupt the protective conductor connections inside or outside the device. Otherwise the device can become dangerous.

#### 1 Connect the evaluation unit:

- Lead the end of the connection cable through the PG screw fitting on the EvU and connect it to the CAN bus terminal
- Connect the socket of the prefabricated connection cable "evaluation unit" to the plug of the "VIS sender" and turn tight

#### 2 Connect the sensors:

- Connect the plug to the socket of the "Sensor right" and turn tight
- Connect the socket of the "Sensors" connection cable to the plug of the "Sensor left" and turn tight;



Extending the 1 m and 2 m cable with "evaluation unit" connection cable is possible at any time.

### 3.9.1 Connecting VICOTEC410 cabling variants

Various cabling variants are available depending on the device configuration selected and the cable length required. See the overview on the following pages.



Please note the maximum cable lengths listed in the following Table

Table 5 VICOTEC410 cabling variants

Line	Cores and cross section			Max. length in meters		End 1			End 2			Provided by	
	3 x 2 x 0.75 mm <sup>2</sup>	2 x 2 x 0.75 mm	3 x 1.5 mm <sup>2</sup>	VICOTEC411	VICOTEC412/414	Plug	Wiring	Connection terminal	Plug	Wiring	Connection terminal	Customer	SICK
W-C1	•			20				•			•	•	
W-C2 a,b	•			50	12			•			•	•	
W-C3		•		1000				•			•	•	
W-C4	•			50	12			•			•	•	
W-C5			•					•			•	•	
W-S1	•			12 or 24		•			•				•
W-S2	•			2 or 1		•					•		•
W-S2a	•			12		•			•				•
W-S3	•			1		•				•			•
W-S4 a,b	•			1		•				•			•
W-S5	•			1		•				•			•

Fig. 13 Variant 1: Connection cable between sensor "right" - RCU up to 14 m (standard cabling)

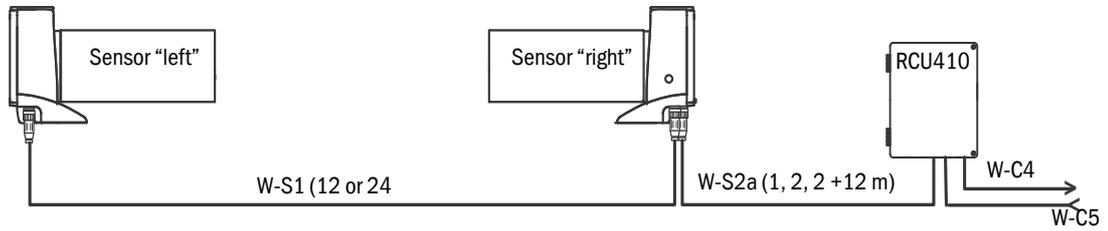


Fig. 14 Variant 2: Terminal boxes on both sensors

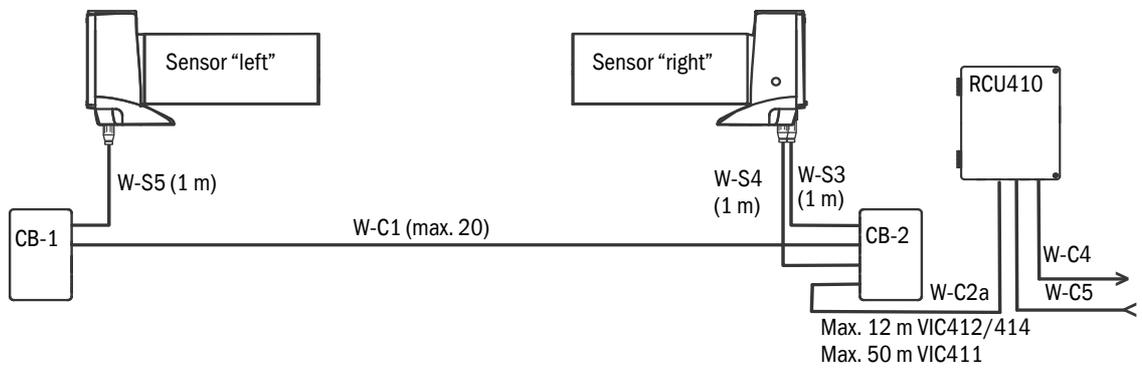
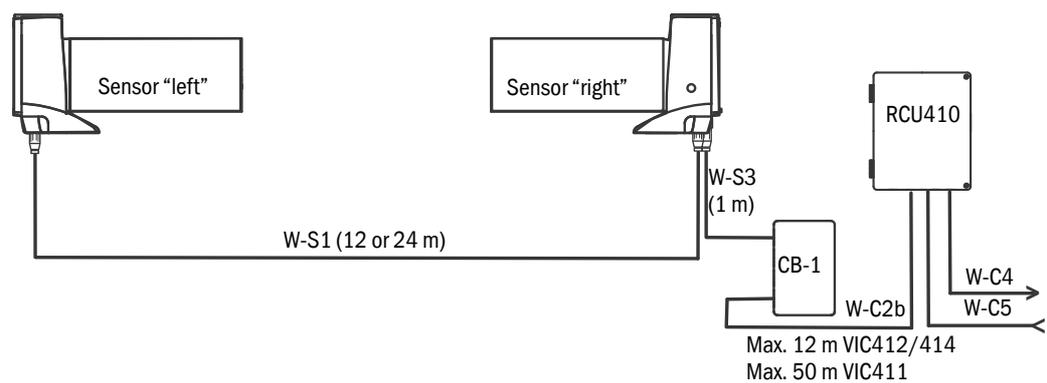


Fig. 15 Variant 3: Terminal box on sensor "right"



Subject to change without notice

Table 6 VICOTEC410 cabling variants

Line	Cores and cross section			Max. length in meters		End 1			End 2			Provided by	
	3 x 2 x 0.75 mm <sup>2</sup>	2 x 2 x 0.75 mm	3 x 1.5 mm <sup>2</sup>	VICOTEC411	VICOTEC412/414	Plug	Wiring	Connection terminal	Plug	Wiring	Connection terminal	Customer	SICK
W-C1	•			20				•			•	•	
W-C2 a,b	•			50	12			•			•	•	
W-C3		•		1000				•			•	•	
W-C4	•			50	12			•			•	•	
W-C5			•					•			•	•	
W-S1	•			12 or 24		•			•				•
W-S2	•			2 or 1		•					•		•
W-S2a	•			12		•			•				•
W-S3	•			1		•				•			•
W-S4 a,b	•			1		•				•			•
W-S5	•			1		•				•			•

Fig. 16 Variant 4: Additional power supply on sensor "right"

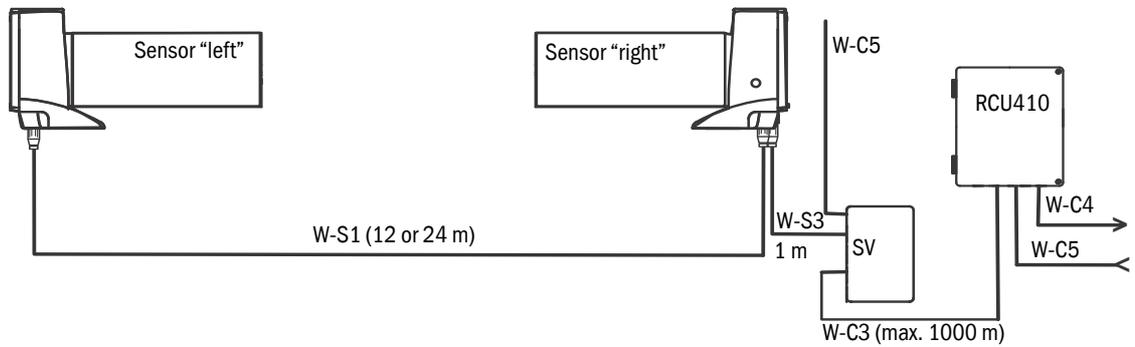


Fig. 17 Variant 5 Additional power supply on terminal boxes on both sensors

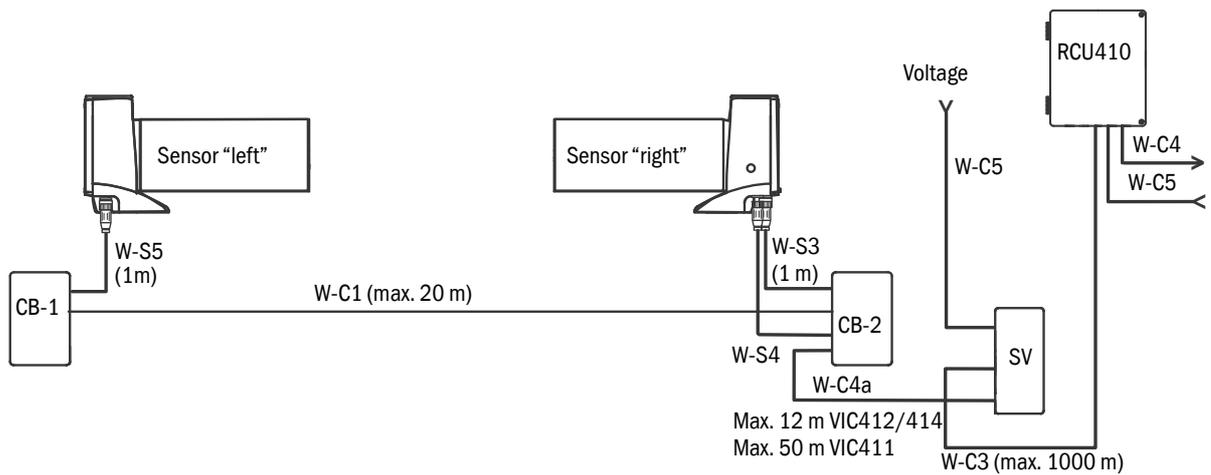
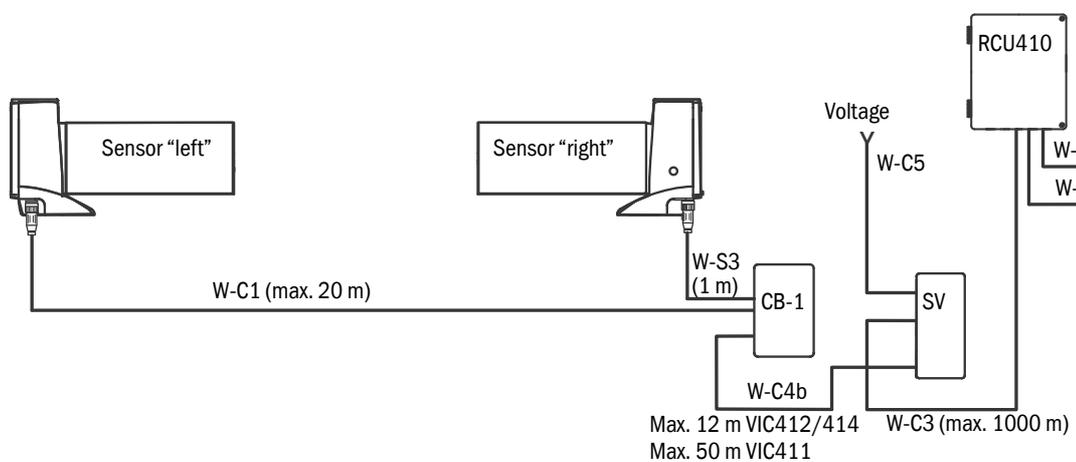


Fig. 18 Variant 6: Additional power supply on terminal box on sensor "right"



Subject to change without notice

### 3.9.2 Connecting the VICOTEC410 sensors

- Carry out all work with the mains disconnected and potential-free
- Connect plug connections and turn tight until engaged
- All cables led through cable glands must be clean at the sealing point and inserted with the outer coat into the sealing point of the cable gland. Otherwise the degree of protection cannot be ensured.
- Tighten the cable glands again after the cables have been led through so that sealing is ensured.

Wire the cables, when present (depending on the cabling variant), in accordance with the following terminal diagrams.

Fig. 19 VICOTEC41x and RCU410 terminal connections

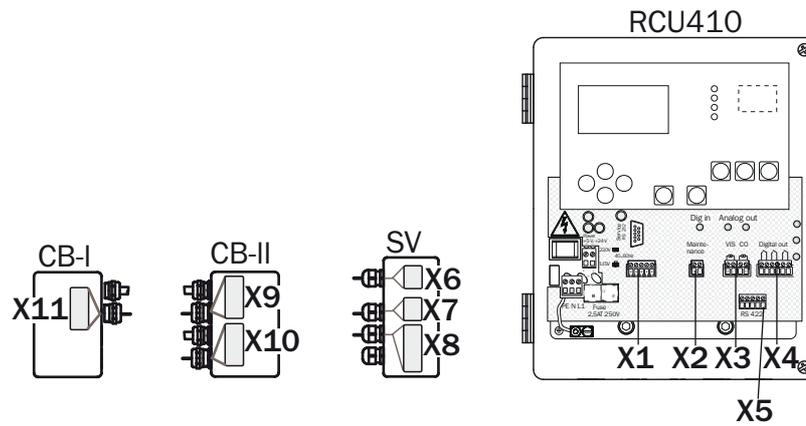
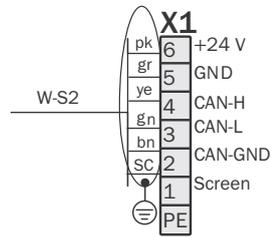
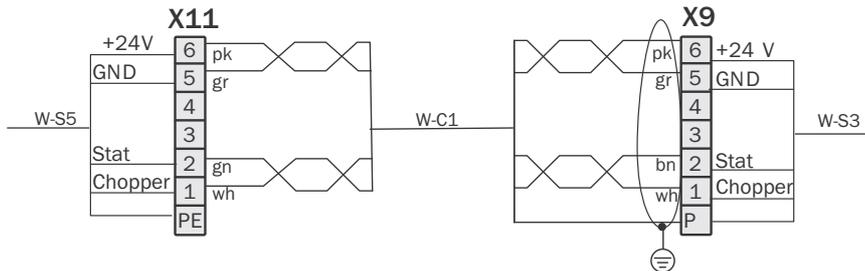


Fig. 20 Terminal diagrams for different cabling variants

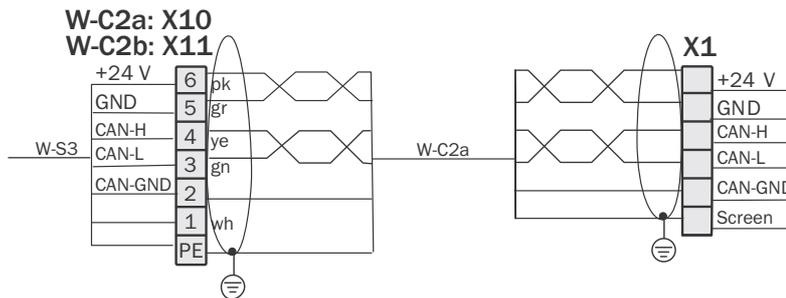
**Leitung W-S2**



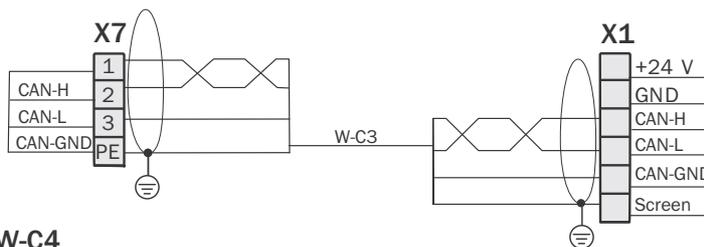
**Leitung W-C1**



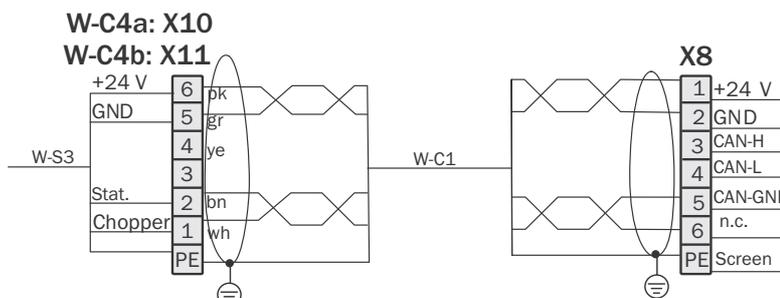
**Leitung W-C2**



**Leitung W-C3**



**Leitung W-C4**



### 3.10 Evaluation unit connections

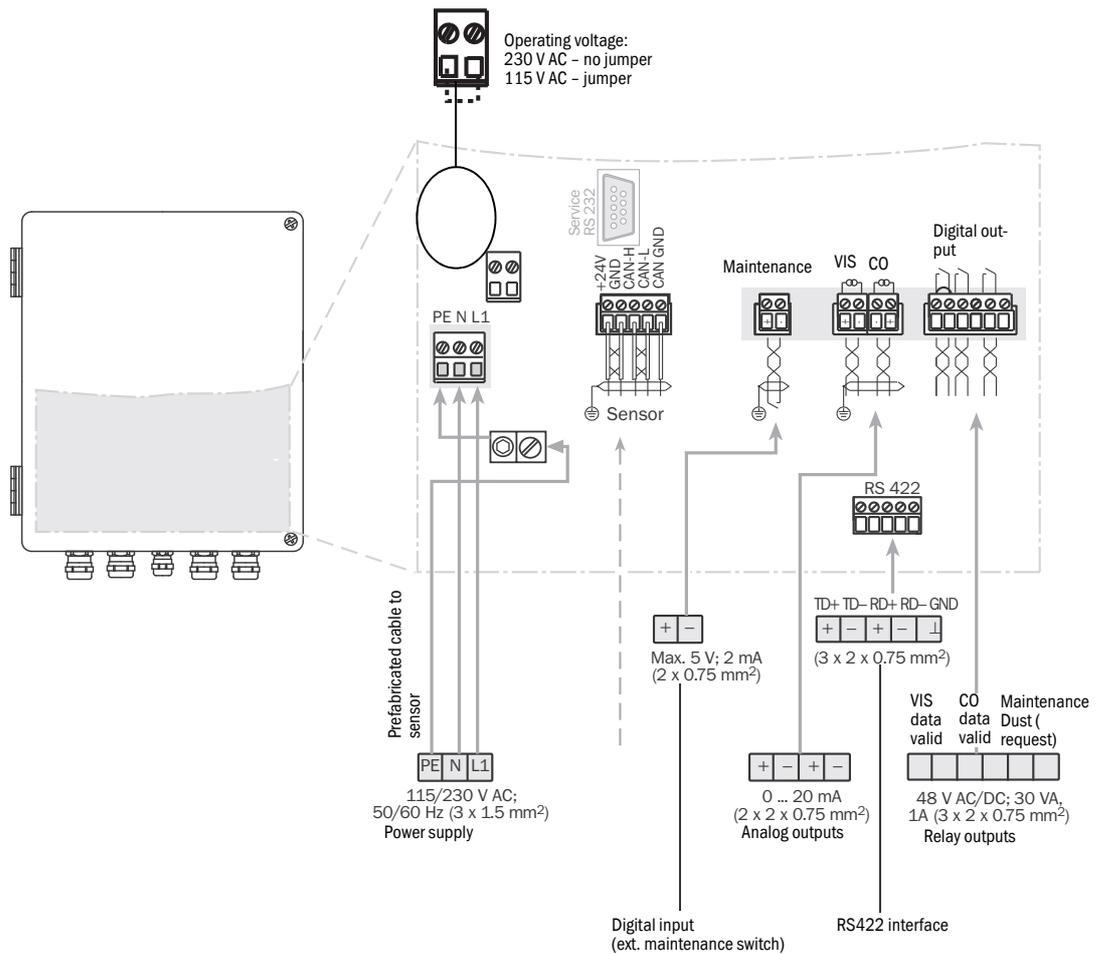
#### 3.10.1 Evaluation unit as standard version

Connect the evaluation unit to the VICOTEC410 system components in accordance with the previous Section.

Available for communication with the control system:

- 3 relay outputs for status messages
- 2 analog output for measured value output
- 1 digital input to connect an external maintenance switch

Fig. 21 Evaluation unit connections - standard version



#### Procedure

- Lead the power supply cable through the PG screw fittings and connect in accordance with Fig. 18



**CAUTION: With 115 V supply! With 115 V supply, wire an insulated wire jumper to the terminal marked "Power"!**

**WARNING: Connecting the wrong supply voltage damages the device!**



**Procedure**

- ▶ Lead the power supply cable through the PG screw fitting and connect in accordance with Fig. p. 80, Fig. 32.
- ▶ Lead the PROFIBUS cable through the PG screw fitting and connect in accordance with Fig. p. 80, Fig. 32..



**CAUTION: With 115 V supply!**

- ▶ With 115 V supply, wire an insulated wire jumper to the terminal marked "Power"!

**WARNING:** Connecting the wrong supply voltage damages the device!



# VICOTEC410

## 4 Start-up / Switching on

Preparations  
Switch-on procedure  
Starting start-up

#### 4.1 **Necessary technical knowledge for start-up**

(see p. §1.1.1)

#### 4.2 **Safety information on start-up**

The measuring point in the tunnel must be accessible and secured in accordance with the road traffic safety regulations for tunnels.

#### 4.3 **Preparing for start-up**

- ▶ Check optical alignment of the fitted sensors, readjust when necessary, see p. 24, Fig. 9
- ▶ Check connections of sensors and evaluation unit
  - Check all connections on sensors and terminal boxes.
  - Check connections and signal assignment on evaluation unit
  - Check power supply on evaluation unit and, as necessary, connection unit with separate voltage supply
- ▶ Initial start-up steps, see p. 20, §3.4.1
  - 1 *Step:* Power supply ON
  - 2 *Step:* Set parameters
  - 3 *Step:* Adjustment

##### **Information for operator or customer**

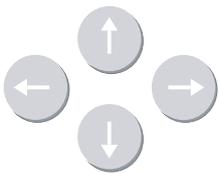
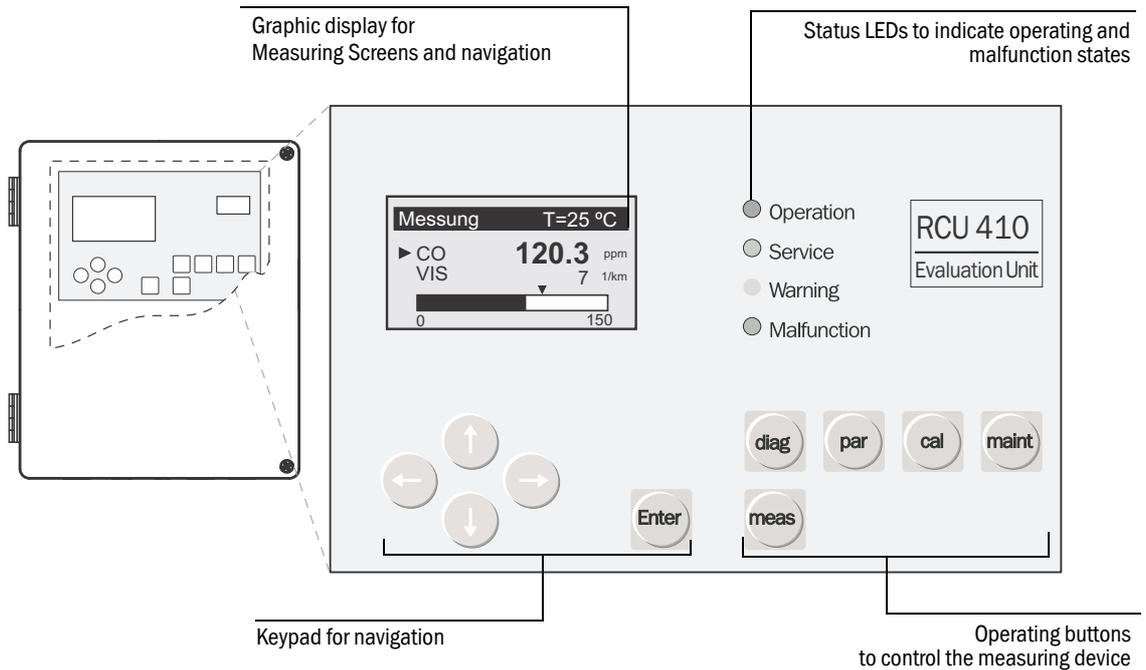
Arrange the following measures/prerequisites before the date agreed for start-up:

- Safe access to the measuring points as well as installation location for the evaluation unit
- Provide a lifting platform/ladders at the measuring points
- Adequate lighting at the measuring points
- Provide documentation from the operator and SICK (Operating Instructions, order-specific documents, when available)
- Availability of a competent person familiar with the location who has been informed on the onsite preparations and localities
- Specifications at date of start-up at the latest:
  - Language to be used on the evaluation unit display (German, English, French)
  - Type (fog, CO or VIS/CO sensor). number and configuration of sensors

#### 4.4 **Operating elements**

The evaluation unit of the VICOTEC410 is responsible for all settings, display and control functions. The operator panel with the display, status indicators and key pad is accessible when the evaluation unit cover is opened.

Fig. 23 Display and operating elements on the RCU 410 evaluation unit



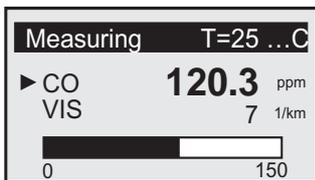
*Arrow buttons*

Navigate, select, scroll or edit menu items, variables, units or digits.



*Enter*

Execute the selected menu contents or commands.



*Display in Measuring mode*

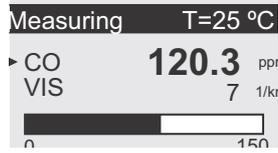
Display all current measured values, e.g. CO concentration (CO) and visibility (VIS) of the combined VICOTEC 414 sensor as well as ambient temperature; details on measuring range-start and end values

**LEDs**

- Operation
- Service
- Warning
- Malfunction

- Measuring operation
- Maintenance or Service mode
- Warning messages, see Diagnosis mode (*diag*)
- Device malfunction, error message, see Diagnosis mode (*diag*)

#### 4.4.1 Function buttons and menu overview



T=25 °C      current temperature measured value  
 CO 120.3 ppm      current CO measured value  
 VIS 7 1/km      current visibility measured value (VIS) per km

- ▶ Selected measured variable
- ▶ 0 or 150 measuring range start or end value (MRE) of the measured variable shown in capitals (e.g. CO)



Diagnosis

- Error messages (plain-text)
- Warning messages (plain-text)
- Display sensor-internal raw values or logbook entries for error diagnosis



Parameter

- Parameter setting
- Identification
- Service

Set/display device data and enter installation altitude (sea level)

Display serial numbers (system, device components)  
 Display calibration data



Calibration

- Zero adjust
- Span test

Zero point determination

Control point check using test cells for CO and glass filters for VIS



Maintenance

- System start
- Maintenance mode
- Tests
- Reset Parameter

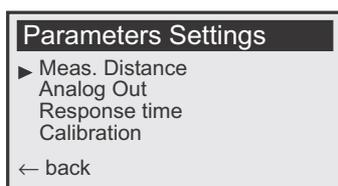
Trigger VICOTEC410 system start

Activate Maintenance mode

Test analog outputs, relay outputs, PROFIBUS and RS422

Reset parameters to basic setting (factory settings)

#### Display screens



- The black bar shows the selected operating mode (e.g. parameter settings) or the menu items just selected during navigation.
- Four lines for submenus, plain-text messages or fixed settings (values)

Function bar:

← back

← Return to higher menu level with the *arrow* button

edit: *Enter*

Activate menu item or confirm input with *Enter*

select  
1234

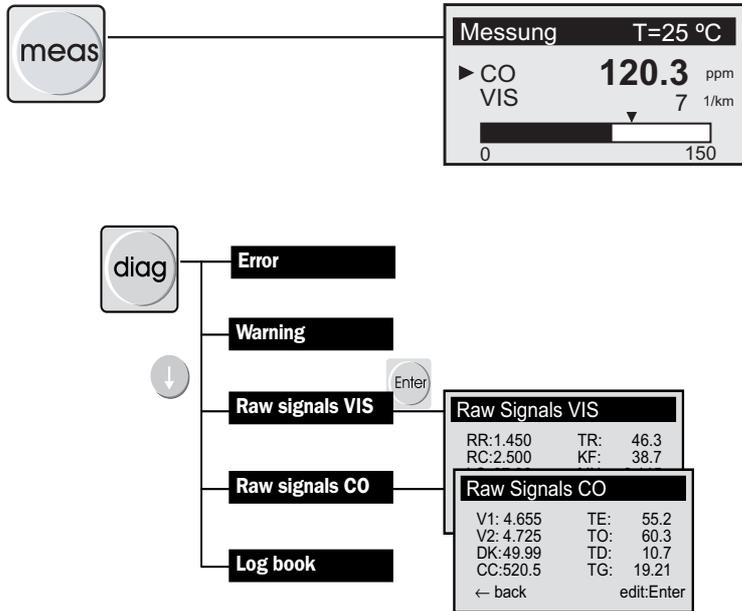
Select variable with button *Enter*

Set values per digit (increment) when selecting a variable requiring numeric input using buttons *Arrow* ↑ (↓)

Password

Enter the password as 1 2 3 4 using the *Arrow* buttons ↑ (↓)

### 4.4.2 Menu structure



#### Measuring operation

#### Diagnosis

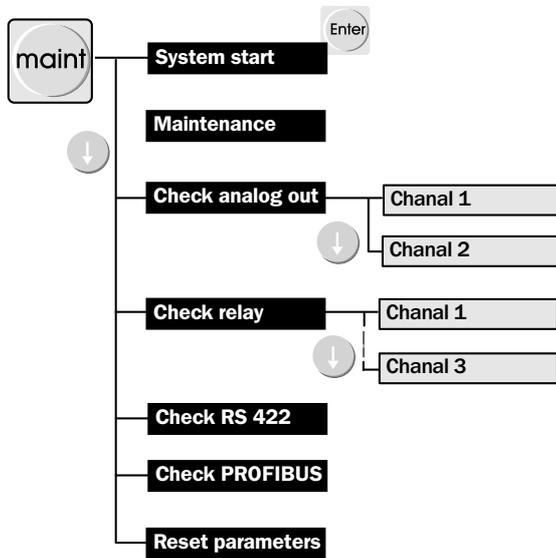
Plain-text messages, see trouble-shooting and fault clearance

Plain-text message, see warnings

Explanation on VIS sensor raw signals

Explanation on CO sensor raw signals

#### Calibration



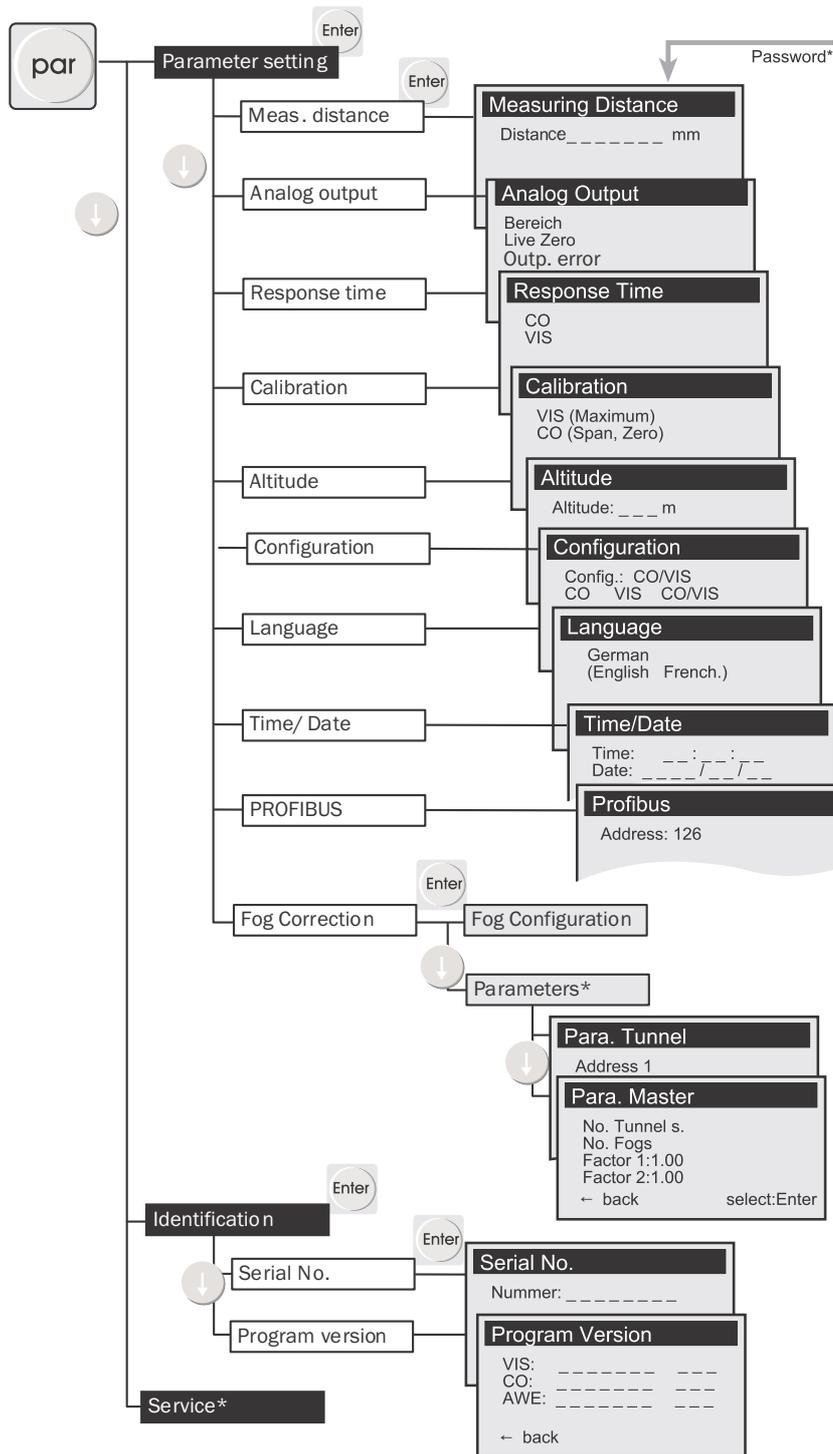
**Maintenance**

System start?  
Yes/No

Maintenance mode?  
Yes/No  
20 mA, 4 mA

On/Off

Use test plug and measuring device (oscilloscope)!  
Test PROFIBUS interface: Cold Start: Initialize PROFIBUS hardware; Warm Start: PROFIBUS module restart  
Reset; Default setting active



Subject to change without notice

## 4.5 Commencing start-up

### 4.5.1 1st step: Power supply ON

- ▶ Switch the power supply (provided by the customer) for the VICOTEC410 on.
- The evaluation unit shows the text “SICK” on the display for about 20 seconds to signal that the sensors are being started.
- Relays 1 and 2 show when the sensors are ready for operation.
- The display switches to displaying the measured values (measuring operation).
- The measuring sensors are heated up for about 30 minutes (at 20 °C ambient temperature). The *Warning* LED is on during the warm-up phase.
- Parameters can be set at the same time (*2nd step*).
- Zero adjust (*3rd step*) to determine usable reference values is performed after the warm-up phase.

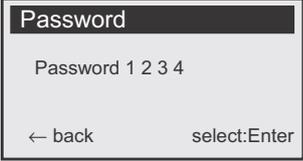
### 4.5.2 2nd step: Setting VICOTEC410 parameters

- Basic setting (default) as from the factory or by performing the “Reset Parameter” command. Check for the respective VICOTEC410 application or measuring task during initial start-up and adapt as necessary.

#### Operating example

- The steps involved in selecting the display language serve as detailed example on how to use the elements on the evaluation unit.
- The following Sections in these instructions are not as detailed, apart from settings where details on actual display contents appear useful.

Table 7 Setting VISOTEC410 parameters

Action	Instruction
	Determine display language: English, German, French ► Activate Parameter mode
 	► Select settings ► Navigate to menu item <i>Language</i> and select
 <p>    </p>	Acknowledge the password prompt as follows:  Use the Arrow buttons to enter the code <i>1 2 3 4</i> and acknowledge. Language selection German, English or French is now possible. Further settings for parameters are also accessible.
 <p>      </p>	The display shows the active language <i>English</i> (1st line).  ► Use the arrow buttons to select a language, e.g. <i>German</i> and confirm. All further dialogs are now shown in this language ► Back to main menu

**Checking/adapting the basic setting**

Table 8 Parameter settings: Basic setting and setting ranges

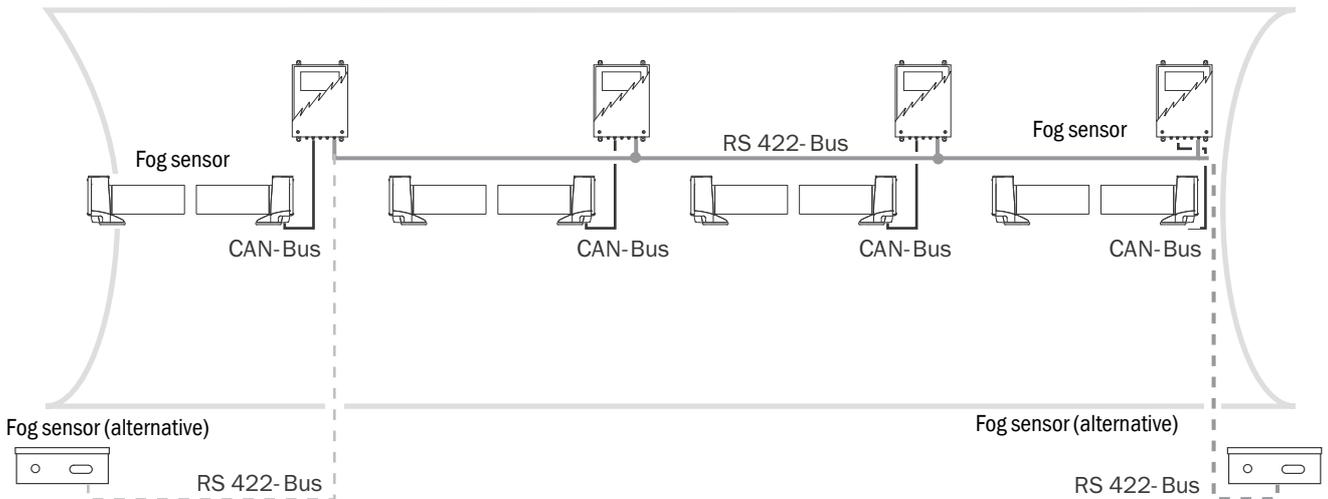
Parameter	Factory setting (default)			Setting range	Remark
	VIC411	VIC412	VIC414		
Set the measuring distance <sup>1, 2</sup> parameter!	10000 mm			9500 ... 10500 mm	Measure sensor distance again and enter when necessary
Analog outputs range	VIS: 15 1/km	CO: 300 ppm	VIS: 15 1/km; CO: 300 ppm	VIS: 1...99 1/km CO: 1...500 ppm	Visibility measuring range CO concentration measuring range
Live Zero	4 mA			0, 2, 4 mA	Zero point of measurement
Output for error	Live Zero			Retain Live Zero or measured value	Zero point of measurement
Smoothing	VIS: 60 s	CO: 60 s	VIS/CO: 60 s	VIS/CO: 5...300 s	Averaging over preset time
Calibration	VIS: 3.145	CO span: 1.00 CO zero: 0	VIS: 3.145 CO span: 1.00 CO zero: 0	VIS: 1.470...4.880 CO span test: 0.50...1.99 CO zero: -999...999	Serves as information (Service)
Altitude <sup>2</sup> parameter!	-	0 m		0 ... 5000 m	Installation altitude (sea level)
Language	English			German, English, French	Language for displays/dialogs on evaluation unit display
Time/date <sup>2</sup> parameter!	00:00:00 (local time, battery buffered) 000/01/01			00:00:00 000/01/01	Setting/time and date format of measuring system
1) Always check!		2) Always set parameter!			

## 4.5.3

**Fog correction with additional VICOTEC411 measuring point close to portal**

VICOTEC411s are installed just as fog sensors at a maximum distance of 10 m from the portals. These are connected to the VICOTEC4xx measuring points (tunnel sensors) via an RS422 bus circuit. An RCU410 declared as Master then corrects the measured values of the tunnel sensors when fog exists so that no fog is suctioned in. Details on parameter settings, see p. 45, §4.5.2.

Fig. 24 Fog correction using the VICOTEC410 and fog sensor



Define one of the sensors in the tunnel as Master. This reads the fog sensor values and corrects the visibility measured values of all tunnel sensors (its own as well) depending on the measured values from the fog sensors, the “Factor 1” and “Factor 2” parameters of each tunnel sensor and the “Fog threshold” parameter of the Master. The individual parameters have the following significance: - Fog threshold : This is a limit defining the fog intensity (measured in transmission on the fog sensors) as from which the fog correction program is actually started. The following reference values can generally be used:

Table 9 Fog threshold reference values

Fog threshold	Approximate visibility distance before the portal as from which fog correction is started	Converted to heat transmission coefficient
0,80	250	12/km
0,85	300	10/km
0,90	500	6/km
0,95	1100	2.7/km
1,00	Free view	

-Factor 1 (Factor 2): This is used as weighting factor for fog sensor 1 (fog sensor 2) measured values by the measured value correction of the tunnel sensor. Correction is performed in the measuring point transmission and not in the heat transmission coefficient. The following mathematical equation is used:

$$T_{korr} = \min(100\%; T_{mess} - \max(\text{Faktor 1} \cdot (\text{Nebelschw} - T_{Nebel1}); \text{Faktor 2} \cdot (\text{Nebelschw} - T_{Nebel2})))$$

$T_{mess}$  = Transmission of tunnel sensor measured

$T_{Korr}$  = Corrected transmission of tunnel sensor from which visibility is calculated

$T_{Nebel 1}$  = Transmission measured on fog measuring point 1

$T_{Nebel 2}$  = Transmission measured on fog measuring point 2

Table 10 Parameter settings for fog correction: Basic setting and setting range

Parameter	Factory setting (default)			Setting range	Remark
	VIC411	VIC412	VIC414		
Set the measuring distance <sup>1, 2</sup> parameter!	10000 mm			9500 ... 10500 mm	Measure sensor distance again and enter when necessary
Fog correction configuration	Tunnel			Tunnel Master Fog 1 Fog 2	This setting determines the function of the respective fog sensor.. If "Fog 1" or "Fog 2" has been selected here, no further settings are necessary, otherwise see following Table rows.
Tunnel parameter					
Address	9			1 ... 8	Each address must be unique.
Factor 1	1.00			0.00 ... 2.00	
Factor 2	1.00			0.00 ... 2.00	
Master parameter					Parameter explanation, see p. 45, §4.5.2.
Number of tunnels	0 1			0 ... 8 1 or 2	
Number of fog sensors	1.00			0.00 ... 2.00	
Factor 1	1.00			0.00 ... 2.00	
Factor 2	0.80			0.00 ... 1.00	
Fog threshold					
1) Always check!			2) Always set parameter!		

Table 11 Auxiliary Table for better estimation of parameters

Factor 1/2	Fog threshold	Significance
0.00	1.00	No fog correction at this measuring point
1.00	1.00	Transmission measured value of tunnel sensor corrected exactly to the fog sensor measured value
2.00	1.00	Transmission measured value of tunnel sensor corrected to twice the fog sensor measured value.
0.00	0.90	No fog correction at this measuring point
1.00	0.90	Transmission measured value of tunnel sensor increased by '90% transmission measured value of fog sensor'.
2.00	0.90	Transmission measured value of tunnel sensor increased by twice '90% transmission measured value of fog sensor'.

#### 4.5.4 Connecting the PROFIBUS during start-up

PROFIBUS connects the process control level e.g. central computer, host, control room) to the analyzer. Measured values, status states and error messages are queried cyclically via the PROFIBUS. The VICOTEC410 supports PROFIBUS-DP-V1 with transfer rates between 9.6 - 187 kBit/s. A device master file (GSBD) is available on the evaluation unit to define the interface. This contains specifications on device manufacturer, identification number, transfer rates available, etc. This GSD (Profile GSD) of the device can be easily used during project planning for the PROFIBUS.

A unique 7 bit device address (1-127) serves to identify PROFIBUS participants and can be entered when setting evaluation unit parameters. Addresses 126 and 127 are reserved and must not be used.



**NOTICE:**

A terminator (terminating resistor) must be plugged to the final device. See p. 71, Fig. 29

#### Measured values provided

Measured values provided by the VICOTEC410 are defined in the device master file (GSD as 2 input channels for the process control level (2 AI). The following Table shows the measured variables, each with the respective measurement unit, according to the definition sequence in the GSD.

Table 12 Units of measure

Measured variable	VIS	CO
Unit	K • 10 <sup>-3</sup> m <sup>-1</sup>	ppm

Each measured value has an own status byte. Significance of the status bytes is shown in the Table below.

Table 13 Status byte significance

Operating state	APRO identifier	Code (hexadecimal)	Code (binary)
Initialization or Warming-up phase	APRO_ST_UNCERTAIN_INITAIL_VALUE	0x4C	0100 1100
Zero adjust (Zero Adjust)	APRO_ST_UNCERTAIN_SENSOR_CALIBRATION	0x64	0110 0100
Maintenance	APRO_ST_UNCERTAIN_LAST_USABLE_VALUE	0x44	0100 0100

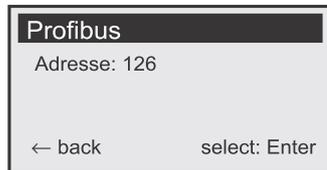
Subject to change without notice

Operating state	APRO identifier	Code (hexadecimal)	Code (binary)
Error	APRO_ST_BAD_SENSOR_FAILURE	0x10	0001 0000
Contamination	APRO_ST_GOOD_NC_MAINTENANCE_REQUIRED	0xA4	1010 0100
Measuring (no error)	APRO_ST_GOOD_NC_OK	0x80	1000 0000
Initialization of the Profibus interface not fully completed yet	APRO_ST_BAD_OUT_OF_SERVICE + APRO_ISS_CONSTANT	0x1F	0001 1111

#### 4.5.5 Call up Parameter mode in the Profibus



▶ Activate Parameter mode (*par*)



▶ Call up menu Profibus and select address  
 ▶ Use the arrow buttons to enter the corresponding 7 bit address and acknowledge.



▶ Activate Maintenance mode (*maint*) and call up the menu Profibus



▶ Perform menu item Cold Start  
 This initializes the PROFIBUS software with the new addresses. The device master file (GSD) can now be configured via the PROFIBUS Master for VICOTEC410 operation.



- ▶ Figure for LEDs and PROFIBUS communication and terminator connection location, see p. 71, Fig. 29
- ▶ Figure for terminal connections of evaluation unit, see p. 35, Fig. 22

#### 4.5.6 Zero adjust

During zero adjust, the VICOTEC410 performs adjustment for the

- CO unit
- VIS unit (visibility)



*Warm-up phase:* A zero adjust should not be carried out during the warm-up phase, e.g. after switching the power supply on. This is signaled by a LED warning.

*Error during adjustment:* If the message “Error during adjustment” appears, call up the error message(s) in Diagnosis mode and clear the malfunction, see p. 60, §7.

Table 14

Action	Instruction
	Carry out zero adjust. Call up <b>Calibration mode</b>
<div style="border: 1px solid black; padding: 5px;"> <p><b>Zero Adjust CO</b></p> <p>Do you want to start the adjust procedure?</p> <p style="text-align: center;"> <input type="button" value="Yes"/> <input type="button" value="No"/> </p> <p style="text-align: center;"> <input type="button" value="← back"/> <span style="float: right;">select:Enter</span> </p> </div>	<ul style="list-style-type: none"> <li>▶ Select <b>Zero Adjust</b> and acknowledge the password prompt with <b>1 2 3 4</b>.</li> <li>▶ Acknowledge prompt to perform Zero Adjust of the CO unit with <b>“Enter”</b>.</li> </ul> <p>The Zero Adjust now starts on the CO unit and takes a few minutes, <b>“Please wait!”</b> appears on the display. Amplification settings AMP1 and AMP2 for CO-free path are shown on the display for about 1 minute</p> <p>Adjustment coefficients C1, C1-Var and C2 are typical raw values for a CO-free measuring path.</p>
<div style="border: 1px solid black; padding: 5px;"> <p><b>Zero Adjust CO</b></p> <p>C1 : +0.98            C1-VAR: +0.005            C2 : 0.97</p> <p style="text-align: center;"> <input type="button" value="← back"/> <span style="float: right;">save: Enter</span> </p> </div>	<p>Save adjustment results with <b>“Enter”</b></p>

4.6

### Function test

- Control functions, analog output signals, see menu structure on page 48
- Display and switching functions, see menu structure on page 48
- Measured value function test:
  - Test set with 3 neutral density filters: Part No. 2031447
  - Test set with CO cells and 3 neutral density filters: 2021529

Fig. 25

Test cells



# VICOTEC410

## 5 Operation

Access  
Operation  
Status messages

5.1 **Authorized persons/access protection**

- SICK Service technicians
- Trained personnel

5.1.1 **Recognizing an unsafe operating state**

Fig. 26 Recognizing an unsafe operating state

Display		Measure
Smoke	escaping from the housing	1 Shut the device down immediately. 2 Have the device serviced.
Humidity	penetrating the device	1 Shut the device down immediately. 2 Localize and stop liquid source. 3 Have the device serviced.
	Or moisture condensation on electrical connections	1 Shut the device down. 2 Dry connections.
Electrical circuits	Damaged or broken	1 Shut the device down. 2 Have damage repaired.
Interface	Damaged or deformed	Shut the device down. Have repairs carried out. <i>If occurring due to heat from inside the device:</i> Shut the device down immediately. <i>If caused by acute external effects:</i> Localize heat source and protect the device provisionally against the heat effects. <i>Otherwise:</i> Have the device checked immediately by a skilled person.
Noise	Unusual noises can be heard from device	Check malfunction displays and malfunction messages of the device Have device checked by a skilled person.
Smoke	escaping from the housing	Shut the device down immediately. Have the device serviced.



**CAUTION: Danger caused by unsafe operating state**  
*When the device is in an unsafe state or could be:*

- ▶ Shut the device down, disconnect from the mains voltage and signal voltage and secure against unallowed or accidental start-up.

5.2 **Standard procedures**

Following actions are possible during operation after the RCU housing has been opened:



Read off measured value on the display (measuring operation)

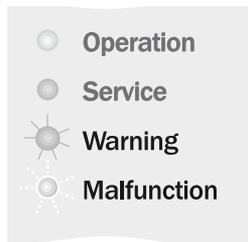


Display warnings and error messages in plain-text



Set device to maintenance or trigger a system start

### 5.2.1 **Checking malfunction displays**



Warning or malfunction



Display warnings and error messages in plain-text

### 5.3 **Menus**

See also p. 56, §5.3 and p. 40, Fig. 23

### 5.4 **Status messages**

See also Table 1666



# VICOTEC410

## 6 Shutdown

Preparations  
Switch-off procedure

## 6.1 Technical knowledge necessary for shutdown

The VICOTEC410 is used for controlling or regulating the tunnel ventilation plants and therefore a shutdown could lead to tunnel closure. Therefore, always coordinate shutdowns with the tunnel operator.

## 6.2 Safety information on shutting down

Have the shutdown performed by trained personnel or a SICK Service technician. Comply with the applicable tunnel safety test.

## 6.3 Shutdown preparations

- ▶ Inform connected locations
- ▶ Passivate/deactivate safety devices
- ▶ Save data
- ▶ Clarify measuring point access (tunnel closure, jack lift ...)

## 6.4 Switch-off procedure

## 6.5 Switching the device off

Disconnect the device from the mains.

## 6.6 Protective measures for the shutdown device

### 6.6.1 Measures for short-term shutdown



#### CAUTION:

CO receiver/cell can be damaged without air-conditioning.

### 6.6.2 Measures for long-term storage



Observe the environmental requirements defined in the specifications.  
Store dry and free from dust.

## 6.7 Transport

- Choose appropriate packing for the optical, electronic measuring devices. Preferably use the delivery cartons.

## 6.8 Disposal

- ▶ The device can be easily dismantled into single components which can then be recycled accordingly as raw materials.



The following subassemblies contain substances that have to be disposed of separately:

- *Electronics*: Condensers, rechargeable batteries, batteries.
- *Display*: Liquid of LC display.

# VICOTEC410

## 7 Maintenance

Maintenance plan  
Maintenance work  
Preventative maintenance  
Recommended spare parts

## 7.1 VICOTEC410 maintenance

### 7.1.1 Maintenance planning

The main task is to check the sensors, in regular intervals, for outer damage and contamination on the optical interfaces.

No general recommendations can be made for the maintenance time frame because the load levels depend on several factors, such as, for example, traffic volumes, dirt and wetness carried into the tunnel, amount of road salt used, air flow relations in the tunnel etc.

#### Maintenance recommendation

The maintenance recommendation is, during the starting period after installation, to check the sensors after 6 weeks and to check the degree of contamination. The maintenance-free cycle can then be extended and planned over a longer term as experience is gained. Cleaning is normally required twice a year at the most.

**NOTICE: Contamination inspection**

For safety reasons, the sensors should be inspected and cleaned at least once a year.

Automatic contamination measurement provides additional safety. The system itself continuously monitors contamination of the sensor optics. If the contamination limit value is exceeded, the evaluation unit issues an early warning that leaves enough time for preparing the maintenance work and that no malfunctions occur.

#### When requesting Customer Service from SICK

Request SICK's Customer Service in writing to the responsible office 4 weeks before the planned maintenance date at the latest. Before this date, the customer must ensure:

- Safe access to, and safeguarding the assembly and workplaces in the tunnel.  
The tunnel/traffic lane should be closed when necessary
- Provision of a jack lift or ladders and adequate lighting at the installation locations
- Availability of a skilled person with knowledge of local conditions.



Inform Service about malfunctions or potential repairs as early as possible. The Service engineer can then have the spare parts and consumables that may be necessary available for the maintenance date and thus avoid unnecessary and expensive multiple journeys.



### 7.3 Spare Parts

#### 7.3.1 Recommended spare parts for 2 years operation

Part No.	Designation
2032123	Cell wheel spare parts set
2020237	Lamp

# VICOTEC410

## 8 Clearing Malfunctions

General malfunctions  
Malfunction messages  
    Display messages  
Measurement errors

## 8.1 VICOTEC410 malfunction handling

### Troubleshooting strategy

The VICOTEC410 continuously registers all impairments or malfunctions on device components. Such impairments/malfunctions are displayed and processed on the evaluation unit as follows

Table 15 Malfunction display

Component/Tool	Signal	Remark
Front panel, Evaluation unit	<i>Warning LED</i> goes on	Functional impairment on system that will not directly lead to corrupt measured values.
	<i>Malfunction LED</i> blinks	Functional impairment on system that can lead to system failure or restricted function. See <i>error memory, logbook</i>
Error memory	Call up menu <i>Error</i>	Use plain-text messages on existing errors to localize and clear the problem (see "Troubleshooting Table").
Warning memory	Call up menu <i>Warning</i>	Plain-text message(s) for pending warnings
Logbook (event storage)	Diagnosis mode Call up menu <i>Logbook</i>	Record of last 20 events
<i>Output</i> for serious problems (malfunction, error message)	Relay 1 inactive 1 for VIS unit defect Relay 2 inactive <sup>[1]</sup> for CO unit defect Relay 3 active for contamination	Group malfunction for VIS unit  Group malfunction for CO unit  Maintenance request

- 1 The relay is active during normal operation (no malfunctions), i.e. the contact is closed.

### Procedure

- 1 Call up menu "Error" to view error messages concerning warning or malfunction signals.
- 2 Localize possible causes and clear the malfunction using the Error Table.

## 8.1.1

**Troubleshooting and clearing malfunctions**

Table 16

Malfunction display/messages

Error indication	Possible cause	Clearance
<p><i>Malfunction LED</i> goes on; (Warning LED possibly blinks)</p> <p>Relay 1: VIS group malfunction</p> <p>Relay 2: CO group malfunction</p> <p>Relay 3</p> <p>Maintenance request</p>	Plain-text error messages indicate possible causes	<p>► Start Diagnosis mode (diag): Call up menu Error (or Warning) Carry out the specified task for clearance</p>
Device not responding	Device components power supply defective	Check power supply on all device components: If necessary, provide power supply on site If necessary, reconnect connections on device components, see p. 27, §3.9
	Incorrect operating voltage	Check operating voltage set on the evaluation unit: If necessary, make appropriate settings, see p. 34, §3.10
	Defective fuse	Check fuse in the evaluation unit: If necessary, replace fuse, fuse position see p. 70, §8.1.3
	No defect localized yet	Uninstall all device components (electrical) and reconnect one after the other, see p. 27, §3.9: Run only the cable from evaluation unit to sensor "right" possibly via the terminal box (or connection unit with separate voltage supply) Sensor "right" possibly via terminal box Cable between sensors possibly via sensor "left" terminal box
	Error occurs again	Replace the component connected beforehand, contact Service
	24 V/5 V supply defective	Check 24 V/5 V supply, replace evaluation unit resp. electronic board module; contact Service
EEPROM parameters	EEPROM parameter set invalid	Reset parameters! Call up <i>Maintenance mode (maint)</i> Trigger menu item <i>Reset Parameters</i> Set parameters again, see p. 45, §4.5.2 Perform zero adjust, see p. 52, §4.5.6
	Evaluation unit defective	If the error message remains even after all measures: Replace evaluation unit or electronic board module; contact Service

Table 16 Malfunction display/messages

Error indication	Possible cause	Clearance
CO: Sensor communication	Communication between sensor and evaluation unit interrupted	Check cable between evaluation unit and sensor "right" and repair when necessary Check connection on the plug-in terminal on the evaluation unit and repair when necessary Check outer or inner plug-in connector on sensor "right" and repair when necessary Check signals with an oscilloscope or contact Service Restart the system (new start) after clearance Call up Maintenance mode (maint) Trigger menu item <i>System start</i>
CO: Sensor amplifier has reached maximum value	Erroneous	Check alignment of sensors and readjust when necessary, see p. 23, §3.6.2
	Light path interrupted	Check measuring distance of sensors whether the light path has been interrupted and clear as necessary
CO Motor fault	CO unit, sensor "right" defective	Contact Service; replace sensor when necessary
CO: Sensor no signal	Contamination too heavy on the optical interfaces	Clean optical interfaces, see p. 62, §7.2.1
	Light path interrupted	Check measuring distance of sensors whether the light path has been interrupted and clear as necessary
	CO unit, sensor "right" defective	Check CO raw signal Trigger <i>Diagnosis mode (diag)</i> Call up and check menu item <i>CO raw signal</i> , contact Service when necessary
CO: Signal too high	CO unit, sensor "right" defective	Check CO raw signal Trigger <i>Diagnosis mode (diag)</i> Call up and check menu item <i>CO raw signal</i> , contact Service when necessary
CO: IR source fault	CO unit, sensor "left" defective	Contact Service; replace sensor when necessary
	IR source defective	
	Sensor "left" power supply defective	
CO: Chopper fault	CO unit, sensor "left" defective	Contact Service; replace sensor when necessary
CO: Device not ready, warming up	Operating temperature not yet reached	Wait for warm-up phase of the device to complete (approx. 30 min.)

Table 16 Malfunction display/messages

Error indication	Possible cause	Clearance
VIS: Sensor communications	Communication between sensor and evaluation unit interrupted	Check cable between evaluation unit and sensor "right" and repair when necessary Check connection on the plug-in terminal on the evaluation unit and repair when necessary Check outer or inner plug-in connector on sensor "right" and repair when necessary Check signals with an oscilloscope, contact Service when necessary Restart the system (new start) after clearance Call up <i>Maintenance mode (maint)</i> Trigger menu item <i>System start</i>
VIS: Sensor malfunction	VIS unit, sensor "right" defective	Contact Service; replace sensor when necessary
VIS: No signal	Incorrect sensor alignment	Check alignment of sensors and readjust when necessary, see p. 23, §3.6.2
	Contamination too heavy on the optical interfaces	Clean optical interfaces, see p. 62, §7.2.1
	Light path interrupted	Check measuring distance of sensors whether the light path has been interrupted and clear as necessary
	VIS unit, sensor "right" defective	Check VIS raw signal Trigger <i>Diagnosis mode (diag)</i> Call up and check menu item <i>VIS raw signal</i> Contact Service
VIS: No valid reference value	No valid reference value for visibility measurement after system start or span test	Reset parameters! Call up Maintenance mode (maint) Trigger menu item <i>Reset Parameters</i> Set parameters again, see p. 45, §4.5.2 Perform zero adjust, see p. 52, §4.5.6
VIS: Sensor amplifier has reached maximum value	Incorrect sensor alignment	Check alignment of sensors and readjust when necessary, see p. 23, §3.6.2 Clean optical interfaces, see p. 62, §7.2.1
	Light path interrupted	Check measuring distance of sensors whether the light path has been interrupted and clear as necessary
VIS: Signal too high	VIS unit, sensor "right" defective	Check VIS raw signal Trigger <i>Diagnosis mode (diag)</i> Call up and check menu item <i>VIS raw signal</i>

## 8.1.2

**Warnings**

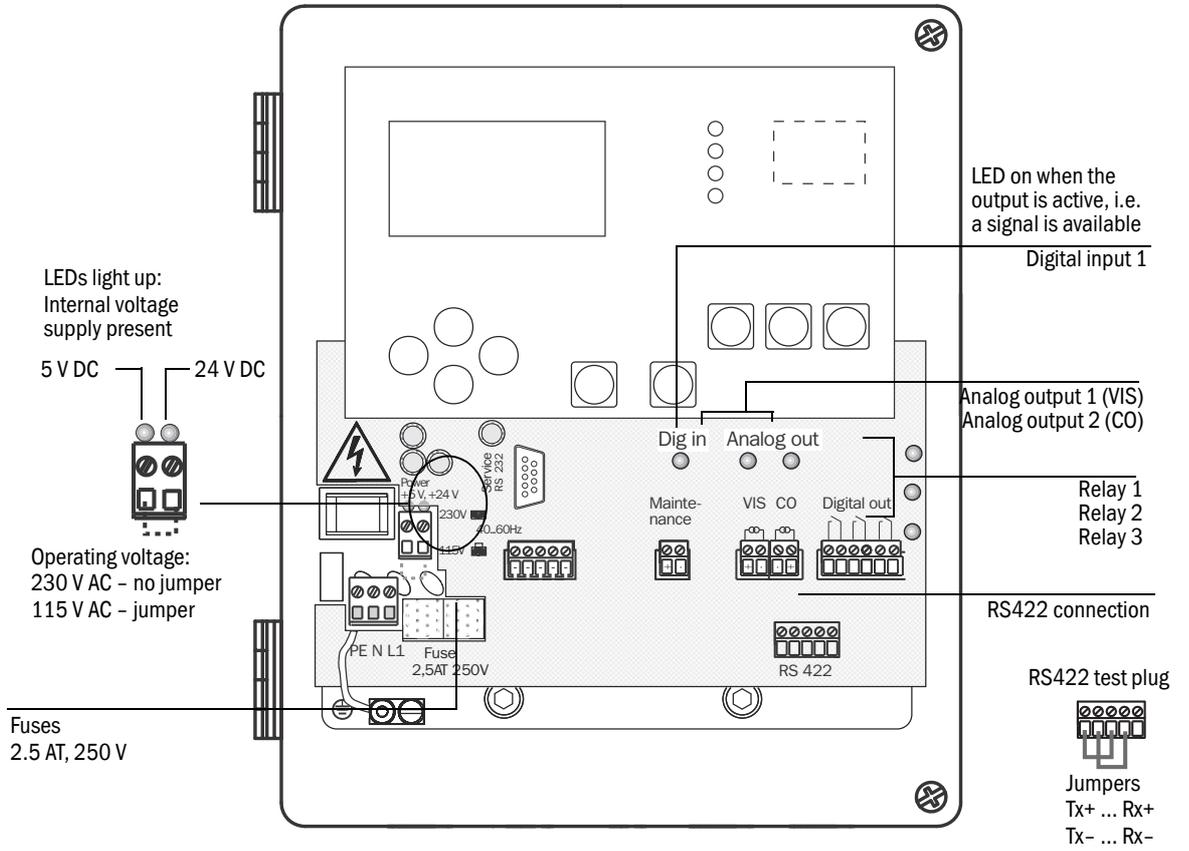
Table 17

Warning messages

Warning message	Possible cause	Clearance
<ul style="list-style-type: none"> <li>● CO: Sensor low signal, contamination</li> <li>● VIS: Sensor low signal, contamination</li> </ul>	Contamination too heavy on the optical interfaces	<ul style="list-style-type: none"> <li>▶ Clean optical interfaces, see p. 62, § 7.2.1/</li> <li>▶ Perform zero adjust after cleaning, see p. 52, § 4.5.6</li> </ul>
<ul style="list-style-type: none"> <li>● CO: Warming up</li> <li>● VIS: Warming up</li> </ul>	Operating temperature not yet reached	Wait for warm-up phase of the device to complete (approx. 30 min.)
VIS: RS422 communication  Error only possible on Master in the fog configuration	RS422 socket on evaluation unit defective	<ul style="list-style-type: none"> <li>▶ Test the RS422 interface               <ul style="list-style-type: none"> <li>– Connect test plug* to RS422 socket</li> <li>– Call up Maintenance mode (maint), trigger menu Test RS422</li> <li>– Check signals with an oscilloscope or contact Service</li> </ul> </li> </ul> Replace the defective interface evaluation unit, contact Service
	Connection to central computer interrupted/defective	Check connection to connected central computer, reestablish when necessary
* Wire the test plug, see p. 70, § 8.1.3		

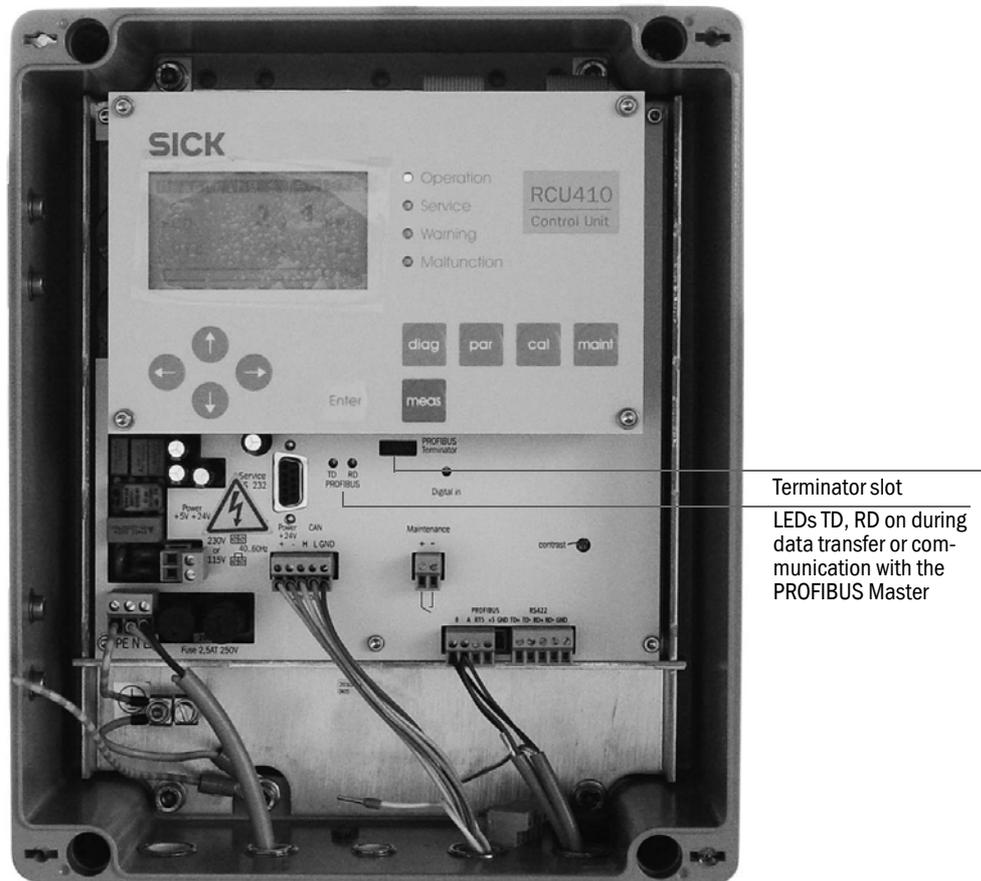
8.1.3 Further tips on troubleshooting  
 Troubleshooting on the evaluation unit - standard version

Fig. 28 LED displays, signals and fuses on the evaluation unit



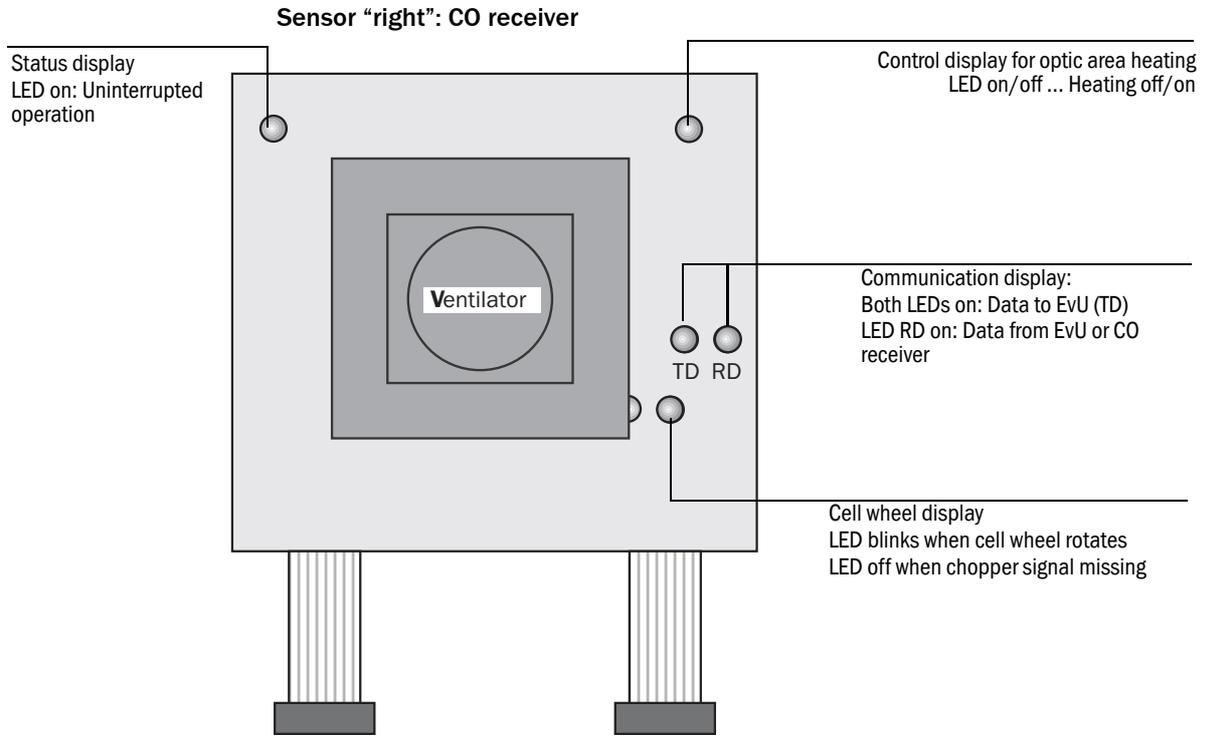
Troubleshooting on the evaluation unit - PROFIBUS version

Fig. 29 LED displays, signals and fuses on the evaluation unit

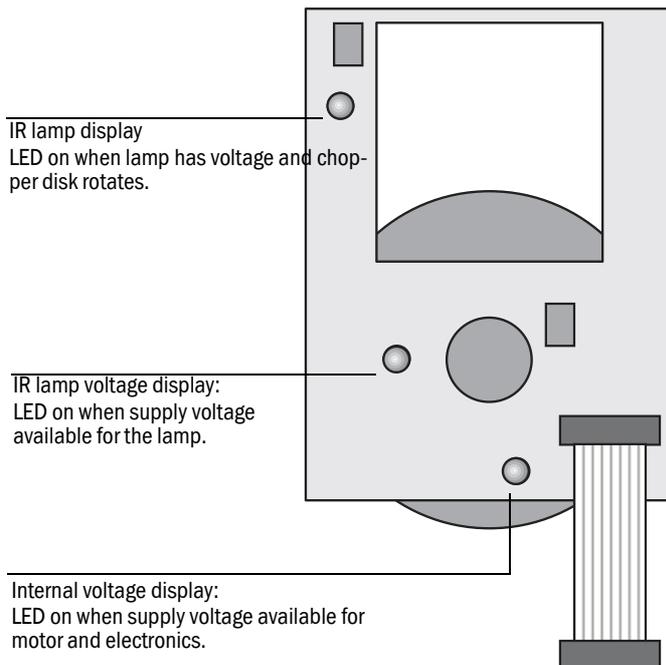


Troubleshooting on the CO unit

Fig. 30 LED displays on the CO unit



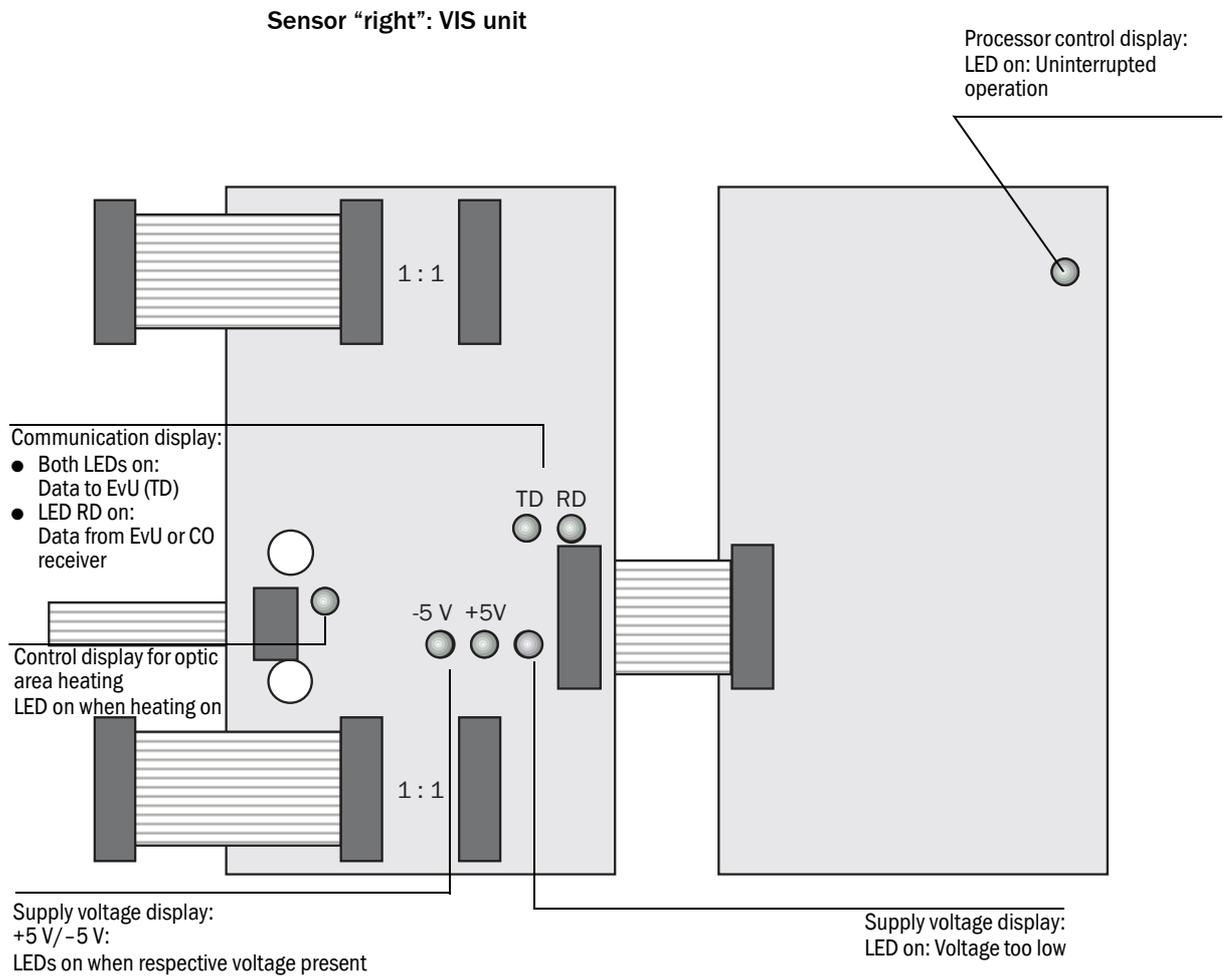
**Sensor "left": CO sender**



Subject to change without notice

Troubleshooting on the VIS unit

Fig. 31 LED displays on the VIS unit



8.1.4 **Sensor values**

The sensor values shown in the Table are valid for uninterrupted, steady state operation within specified limits.

**Retrieving these data**

- Call up Diagnosis mode (diag) and then navigate to and retrieve CO or VIS raw signals.

Table 18 CO unit raw data

Raw value	Description	Typical value range
V1	CO voltage	2.7 ... 3.6
V2	N <sub>2</sub> voltage	3.9 ... 4.9
DK	Zero point correction value	0 ... ~ 250
CC	Peltier current	450 ... 700
TE	Temperature for electronics	50 ... 60
TO	Temperature for optic chamber	59.5 ... 60.5
TD	Temperature for detector	10.4 ... 11.0
TG	Temperature for environment	Measured value

Table 19 VIS unit raw data

Raw value	Description	Typical value
RR	Receiver signal	2.8 ... 4.5 at 25 °C
RC	Control receiver signal	2.495 ... 2.515 at 25 °C
LC	Current LED	15 ... < 40 °C at 25 °C
TS	Temperature for optic chamber	59.5 ... 60.5
TR	Transmission	70 ... 100 %
KF	HTC factor	0 ... 15 1/km
Mx	Free view	3.1 ... 5 V
DM	Visibility, daily maximum	3.1 ... 5 V



# VICOTEC410

## 9 Specifications

Declaration of Conformity

Approvals

Technical data

## 9.1

**Compliances**

The technical version of this device complies with the following EU directives and EN standards:

- EU Directive: LVD (Low Voltage Directive)
- EU Directive: EMC (Electromagnetic Compatibility)



Applied EN standards:

- EN 61010-1, Safety requirements for electrical equipment for measurement, control and laboratory use
- EN 61326, Electrical equipment for measurement, control and laboratory use - EMC requirements

## 9.1.1

**Electrical protection**

- Insulation: Protection class 1 in accordance with EN 61010-1
- Insulation coordination: Measuring category II in accordance with EN61010-1.
- Contamination: The device operates safely in an environment up to contamination level 2 in accordance with EN 61010-1 (usual, non-conductive contamination and temporary conductivity by occasional moisture condensation).
- Electrical energy: The wiring system to the mains supply voltage of the system must be installed and fused according to the relevant regulations.

9.1.2 **Declaration of Conformity**

The CE Declaration of Conformity for the VICOTEC410 has the number 9057802 and can be requested from SICK.

9.1.3 **Laws, standards, guidelines complied with**

- EC Directive 2006/95/EC
  - EC Directive EMC 2004/108/EC
  - EN61010-1
  - EN61326
- and usable in accordance with guidelines and recommendations of the
- RABT (Directive for Construction and Operation of Road Tunnels)
  - ASTRA (Swiss Federal Roads Authority)
  - RVS (Standards and Regulations for Road Traffic)
  - EC Directive 2004/54
  - PIARC (Permanent International Association for Road Construction)

Table 20 Standards and their significance

Short description	Document No
Directive 2006/95/EC	RL 2006/95/EC
EMC Directive/2004/108/EC	RL 2004/108/EC
Safety Requirements Electrical Equipment	EN 61010-1
Electrical Equipment for Measurement	EN61326

## 9.2

**Technical Data**

Table 21

Technical data overview

Technical data	VICOTEC411	VICOTEC412	VICOTEC414
<b>General Data</b>			
Measured variable	Extinction coefficient: Heat transmission coefficient	CO concentration: ppm	Extinction coefficient: Heat transmission coefficient CO concentration: ppm
Measuring principle	Scattered light	Negative gas correlation	VIS: Scattered light CO: Negative gas correlation
Measuring path	10 m ( $\pm 0.5$ m)		
Measuring range	VIS: $K = 0$ to $15 \text{ }^1/\text{km}$	CO: 0 ... 300 ppm	VIS: $K = 0$ ... $15 \text{ }^1/\text{km}$ CO: 0 ... 300 ppm
Repeat accuracy	VIS: $\pm 0.1 \text{ }^1/\text{km}$	CO: $\pm 2$ ppm	VIS: $\pm 0.1 \text{ }^1/\text{km}$ CO: $\pm 2$ ppm
Ambient temperature	-30 to +60 °C		
Storage temperature	-30 to +85 °C		
<b>Connections</b>			
Interfaces	CAN bus, sensors electrically isolated, RS422 electrically isolated, RS 232 PROFIBUS DP		
Analog outputs <sup>1</sup>	2 channels, 0 - 20 mA, Live Zero selectable 0, 2, 4 mA		
Relays <sup>1)</sup>	3 outputs for CO malfunction, visibility malfunction, display maintenance/contamination/warning Switching voltage 125 V AC; max. switching current 60 VA Switching voltage 150 V AC; max. switching current 30 VA		
Digital input	5 V max., 2 mA; External maintenance switch		
<b>Power supply</b>			
Connection unit <sup>2</sup>	190 V to 260 V AC; 50 Hz or 95 V to 130 V AC; 60 Hz		
Evaluation unit	190 V to 260 V AC; 50 Hz or 95 V to 130 V AC; 60 Hz		
Power input for evaluation unit with sensor	Max. 45 VA typical 20 VA	Max. 80 VA typical 45 VA	Max. 90 VA typical 50 VA
<b>Protection class, dimensions</b>			
Protection class	IP65		
Dimensions (W x H x D)			
Sensor	190 x 259 x 541 mm		
Evaluation unit	230 x 110 x 280 mm		

<sup>1</sup> Not for PROFIBUS version

<sup>2</sup> With power supply for sensors

9.2.1 **Dimensions**

9.2.2 **Dimensions, VICOTEC410 sensor and evaluation unit**

Fig. 32 Dimensions, VICOTEC410 sensor

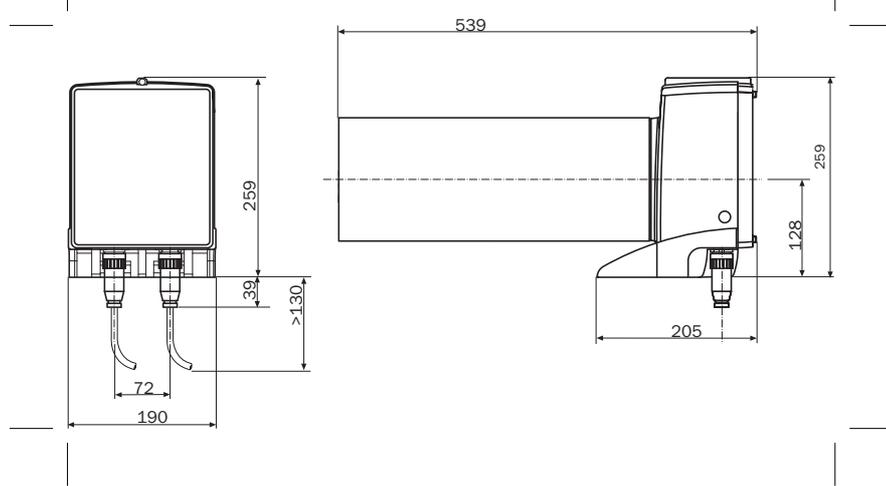
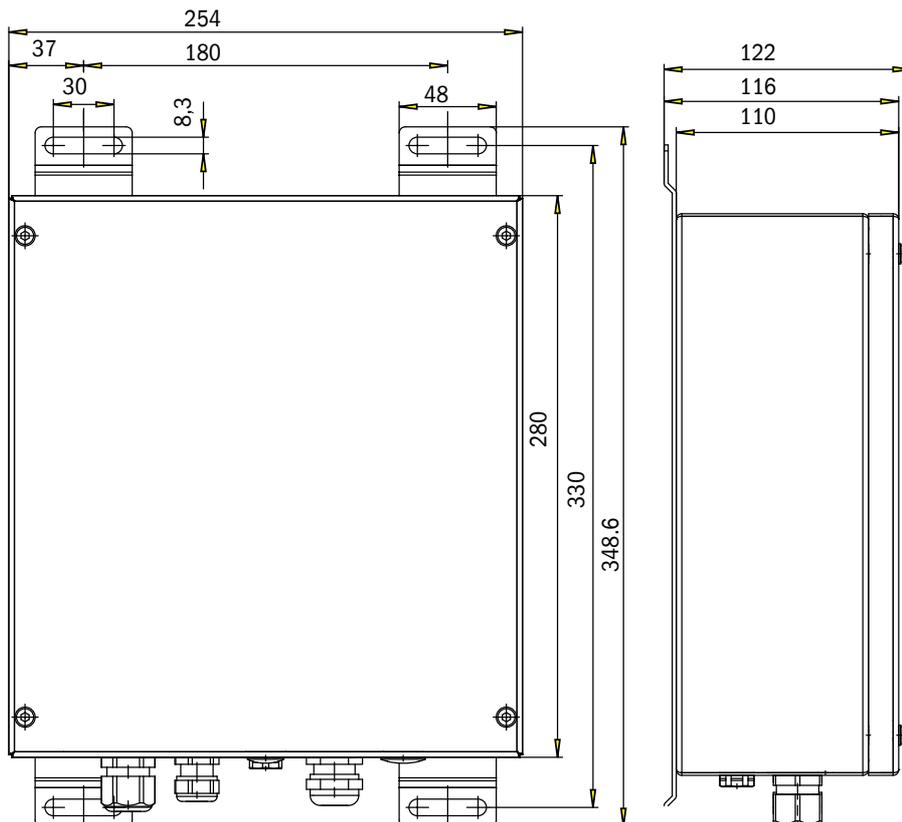


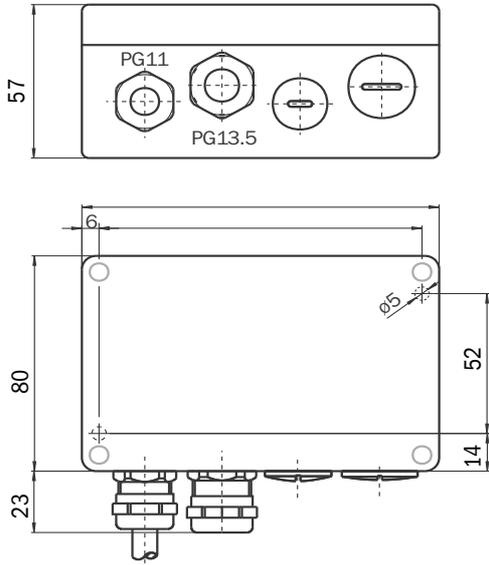
Fig. 33 Dimensions, evaluation unit RCU410 (in mm)



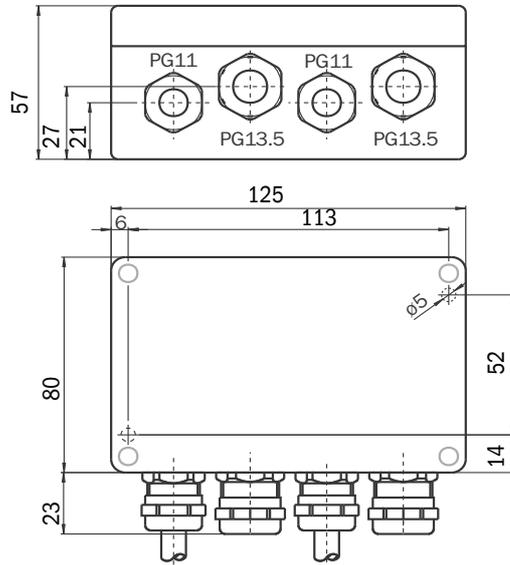
Subject to change without notice

9.2.3 Dimensions, connection unit

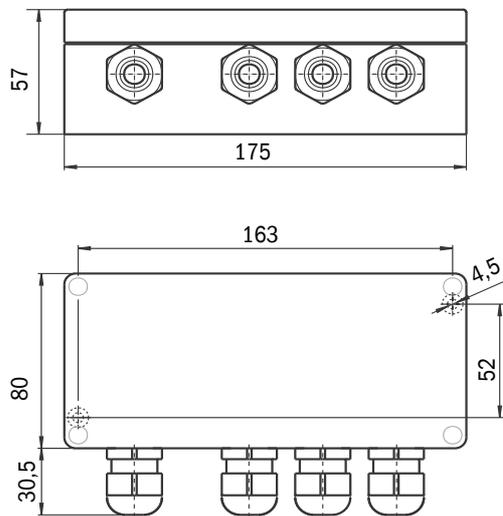
Terminal box "left"



Terminal box "right"



Connection unit with separate voltage supply



# VICOTEC410

## 10 Important Information

Main safety information  
Main operating information  
Intended use  
Own responsibility

## 10.1 Main safety information

### 10.1.1 Authorized personnel

Persons responsible for safety must ensure the following:

- All work on device parts is carried out by qualified personnel only. Qualified persons are those who, based on their training, experience or instruction as well as their knowledge of relevant standards, regulations, accident prevention rules and plant conditions, are authorized by those responsible for safety for personnel and the plant to carry out such work. It is decisive that these persons can recognize and avoid possible hazards in a timely manner.
- Skilled persons are persons according to DIN VDE 0105 or IEC 364 or directly comparable standards such as DIN 0832.
- These persons have adequate knowledge through training
- These skilled persons have the delivered Operating Instructions as well as the associated system documentation available during all work, and observe these documents with regard to avoiding hazards and damage.

Contact the manufacturer before using this measuring device for other purposes where the device functionality cannot be judged properly within such applications.

### 10.1.2 Intended use

- The VICOTEC410 measuring system and its system components are only to be used for measuring visibility and/or CO concentrations in road tunnels.

### 10.1.3 Prerequisite

All planning, assembly, installation, start-up, maintenance and repair work must be carried out by adequately instructed personnel only and checked by the responsible skilled persons.

### 10.1.4 Correct handling

- Use the system in accordance with the technical data and specifications regarding permissible usage, assembly, connection, ambient, and operating conditions (refer to the order documents, device user information (type plates etc.), as well as the documentation supplied with the system).
- Persons carrying out the work must be aware of, and observe general assembly and safety regulations,
- Act according to local, system-specific conditions and risks arising from technical operating and regulations, in particular local road safety regulations.
- Ensure proper use of tools and hoist and transport equipment.
- Provide sufficient protection devices and personal safety equipment and ensure that these are used by the personnel.
- Secure system components delivered without a degree of protection with effective protection devices on-site.
- Observe all measures necessary for conservation of value, e.g. during transport and storage and/or maintenance and inspection.

10.1.5 **Avoiding consequential damage arising from device malfunctions**

In order to avoid malfunctions that can lead to direct or indirect person or property damage, the operator must ensure:

- Personnel responsible for maintenance can be informed at any time and as quickly as possible.
- Maintenance personnel are trained to be able to respond to malfunctions on the VICOTEC410 and to react correctly to related operational malfunctions.
- Defective operating resources are switched off immediately in case of doubt.
- That switching off does not lead directly to subsequent malfunctions.
- Switching outputs “Data valid” for CO and VIS are wired correctly and are processed in the control station without having to close the tunnel.

	<p><b>NOTICE: Procedure when cleaning the tunnel</b></p> <ul style="list-style-type: none"> <li>▶ Switch the VICOTEC system to operating mode “Maintenance”</li> <li>▶ Be sure to cover sensor tubes with closure caps</li> <li>▶ Never touch sensors directly with washing brushes (risk of modifying optical alignment which can cause a device malfunction)</li> <li>▶ After cleaning, check the optical interfaces of the sensors for contamination; when necessary, clean the optical interfaces in accordance with maintenance regulations, see p. 62, § 7.2.1.</li> </ul>
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10.1.6 **Environmentally acceptable behavior and disposal**

- Observe applicable waste disposal regulations to protect the environment.
- Sensor subassemblies are easy to dismantle and disposed of as waste.
- Sensor outer housing, optics chassis and brackets are made of aluminium and can be recycled.

	<p><b>NOTICE: Suitable disposal!</b></p> <ul style="list-style-type: none"> <li>▶ Do not dispose of electronic components from VISOTEC410 system components as household waste. Dispose of these components in a suitable facility.</li> </ul>
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10.2 **Intended use**

10.2.1 **Purpose of the device**

Operate the VISOTEC410 visibility/CO measuring device as specified by the manufacturer, i.e. only use the VICOTEC410 measuring system and its system components to measure visibility and/or CO concentrations in road tunnels.

10.2.2 **Installation location**

The opto-electronic VICOTEC410 measuring device supports continuous, delay-free measurement of visibility and CO concentrations in road tunnels. The sturdy, compact sensors are designed as contact-free, direct in-situ measuring devices.

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### 10.3 **Responsibility of user**

These Operating Instructions serve understanding the function, and explain assembly, installation and maintenance work as well as how to operate the VICOTEC410. Other documents may contain more detailed information but can never replace these Operating Instructions.

#### **Target groups of this document**

- SICK Service technicians or trained customer personnel; qualified technicians/engineers - with excellent device knowledge
- Operators, customer installation personnel, technicians for measurement and control technology, electric, electronics - with basic device knowledge

#### **Correct use**

- ▶ Only use the device as described in these Operating Instructions (--> page 44). The manufacturer bears no responsibility for any other use.
- ▶ Carry out the specified maintenance work.
- ⊗ Do not remove, add or change any components in or on the device unless such changes are officially allowed and specified by the manufacturer. Otherwise any warranty by the manufacturer becomes void.



Read the Operating Instructions before starting the work! Observe all warning information exactly!

#### **Special local conditions**

- ▶ Follow all local laws, regulations and company-internal operating directives applicable at the installation location.

#### **Keeping documents**

These Operating Instructions:

- ▶ Must be available for reference.
- ▶ Must be passed on to new owners.

### 10.4 **Additional documentation/information.**

- ▶ Check the contents of the CD delivered with the product (PN:2058621).

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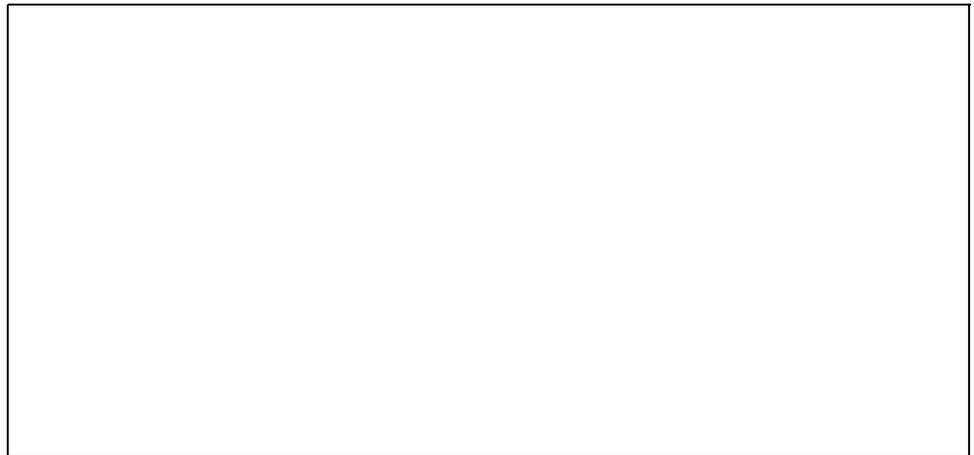
# VICOTEC410

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