Operating Manual

FTC400

Gas analysis using combined thermal conductivity and infrared measurement

messkonzept
ANALYTICAL TECHNOLOGY

About this manual

Thank you for using the Messkonzept FTC400. It has been designed and manufactured using highest quality standards to give you trouble free and accurate measurements.

All information of technical nature and particulars of the product and its use (including the information in this manual) are given by Messkonzept in good faith. However, it is acknowledged that there may be errors or omissions in this manual. Images and drawings may not be in scale. For the latest revisions to this manual contact Messkonzept or visit www.messkonzept.de
Messkonzept welcomes comments and suggestions relating to the product and this manual.

Please Note! The design of this instrument is subject to continuous development and improvement. Consequently, this instrument may incorporate minor changes in detail from information contained in this manual.
Important! In correspondence concerning this instrument, please specify the type number and serial number as given on the type label on the right side of the instrument.

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This manual applies to: FTC400
Date of Release: March 11, 2021

Quick Installation Guide

For quick installation of the FTC400 we recommend to read the following chapters of this manual:

- Chapter 1 "Operator Safety": Important warnings, saftey instructions and intended use.
- Chapter 3 "Assembly of the Instrument": Mounting, pneumatic and electric connection. Also see Chapter 10 "Appendix: Dimensional Drawing"
- Section 7.1 "Calibration": Recommended calibration intervals, the calibration process and recommended test of functionallity after bringing into service.

Contents

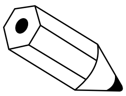
Chapter 1

Operator Safety

This chapter provides information and warnings which must be followed to ensure safe operation and retain the instrument in safe condition. Read this section carefully before beginning to install and use the instrument.

1.1 Notes on Safety Conventions and Icons

This icon draws attention to application errors or actions that can lead to safety risks including the injury to persons or malfunctions, possibly even destruction of the device.



This icon indicates an additional function or hint.

1.2 Warning Notices

⚠

- The manufacturer does not assume liability for inappropriate handling of the device. Malfunctions caused by inappropriate handling may lead to hazards.
- This device is not suited for the operation in areas exposed to explosion hazards!
- Never lead explosive gases or gas mixtures into the device!
- Dependent on the model the device flammable gases may be led in the device. Check item „Glass ball filling" in the device protocol. Flammable gases may be led in devices filled with glass balls. Here, the inside space of the housing is densely filled with glass balls ($\varnothing\sim$ 0.6mm). In the unlikely case that a leakage caused an explosive atmosphere, the small spaces between the glass balls prevent a coincidental ignition caused by a further malfunction of the device from propagating.
- Never open the housing of the FTC400, especially because of the loose glass balls. When the device had been opened it may not work safely with flammable gases.
- Warranty expires if the housing is opened.
- The unit and the cables must be effectively protected against damage and against UV light (protective roof for outdoor installation).

1.3 Safety Instructions

⚠

- For safe operation of the device please pay regard to all instructions and warnings in this manual
- Only put the device into operation after it has been installed properly. A competent and authorised person is required for installation, connection and operation of the device. This person has to read the manual and follow all instructions. Keep this manual to look up questions that can occur later on.
- Defective devices must be disconnected from the process! This applies for apparent damages of the device such as physical damages but also in the case of unclarified malfunctions in the operation. Separate the device from the process pneumatically (both gas inlet and gas outlet) and remove the power supply from the device.
- Make sure that the electric installation protection against accidental contact agree to the applicable safety regulations. The protective earth connection must be made before all other connections. Any interruption in the protective earth can cause danger.
- Pay regard to the local regulations and circumstances regarding electric installations.
- Repairs may only be done by Messkonzept.

1.4 Intended Use

Only gases that are non-corrosive and free of condensate, dust, aerosol or oil mist may be lead in the FTC-series gas analyzer. Flammable gases require appropriate protective measures. Explosive gases may not be lead into the FTC. The Instrument may not be used in hazardous areas. Please contact info@messkonzept.de for detailed information and solutions.

Upon installation the protection class has to be considered. The ambient atmosphere may not be corrosive. OEM-devices with protection class IP00 demand thermal and electric insulation, as well as mechanical protection for operation.

FTC-series gas analyzers do not have a metrology marking in the sense of EU directive 2014/32/EU. They may therefore not be used for example in analyzes in medical and pharmaceutical laboratories or in the manufacture of pharmaceuticals in pharmacies based on a doctor's prescription.

The specifications of the device and its manual have to be observed strictly. Please fill out questionnaire (2.01.1FB180619MPL1) for registration of your measuring task, if your intended use does not comply with intended use described above. Based on the information given in the questionnaire Messkonzept will examine the measuring task and possibly authorize it.

Note: Please keep this manual for future use.

Chapter 2

Principle of Measurement

2.1 Determining Concentrations via Thermal Conductivity

Thermal Conductivity Detectors (TCD) are used in the chemical industry since the 1920s as the first process gas analyzers for the quantitative composition of gas mixtures. Every gas has a typical heat conductivity governed by its molar mass and viscosity. The measurement is based on the principle that the thermal conductivity of a gas mixture is dependent on the thermal conductivities of its gas components and their fractional amounts in the mixture. Thus, the concentrations of different components can be calculated from the thermal conductivity.

The main advantage of the TCD's measurement principle compared with the wide spread infrared analysis technique is, that it is not limited to gases with a permanent dipole moment. It can identify noble gases (He, Ar, Ne, etc.) as well as homonuclear gases such as H_2 and N_2. Furthermore, it is robust and cost effective.
The principle of thermal conductivity measurement works best if the analyzed gas components' thermal conductivities vary greatly. For TC measurement based analysis, one of the following conditions must be met:

- The mixture contains only two different gases (binary mixture), e.g. CO_2 in N_2 or H_2 in N_2
- The thermal conductivity of two or more components is similar, e.g. measuring H_2 or He in a mixture of O_2 and N_2 (quasi binary mixture)
- The mixture contains more than two gases, but all but two components' (or component groups') volumetric fractions are constant over time
- The mixture contains more than two gases, of which all but two components' concentrations can be determined through other measurement principles (as employed in the FTC 400 through cross-sensitivity compensation of IR- and TC-sensor information)

The thermal conductivity of gases rises with temperature and the slope of the increase with temperature is different for different gases. On customer request it can be checked whether the temperature of heat sink and/or source can be changed in order to improve the sensitivity of the measurement or to avoid cross-sensitivity effects.
Cross-sensitivity is the sensitivity of the measurement on other gases than the measured component. Perturbation-sensitivity means the sensitivity of the measurement on other influences than the gas-composition, e.g. the gas pressure.

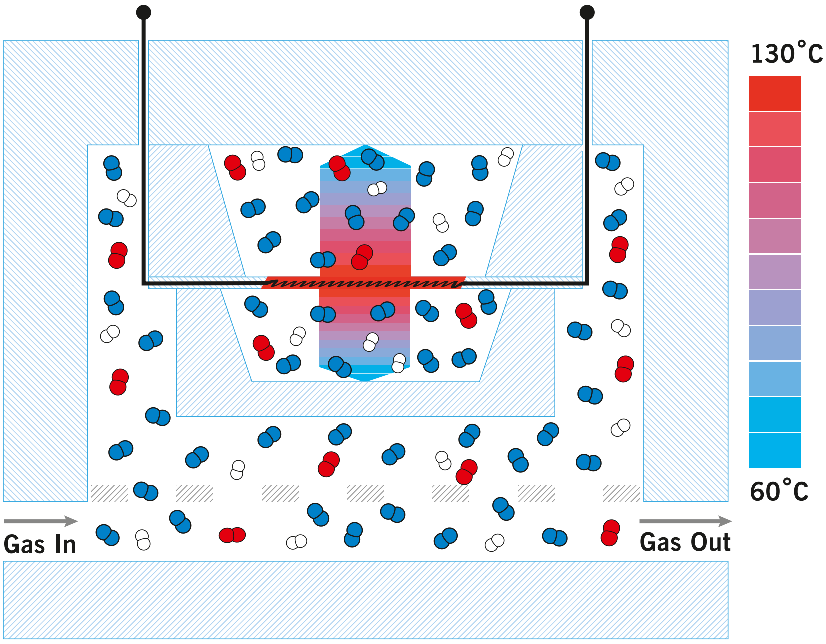


Figure 2.1: Schematic drawing of thermal conductivity measurement. The sensor is comprised in the stainless steel block which is kept at a constant temperature.

The FTC400 contains a thermal conductivity sensor to analyze the quantitative composition of gas mixtures. The measurement is based on the heat transfer between a heat source and a heat sink.

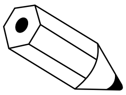
The measuring gas is led through a stainless steel block that is kept at a constant temperature of 63°C (for most applications). The block temperature is stabilized using a control loop - it serves as a heat sink of constant temperature. A micro mechanically manufactured membrane with a thin-film resistor serves as heat source. A control loop stabilizes the membrane temperature at 135°C (for most applications).

Above and below the membrane two small cavities are etched into the silicon. These cavites are filled with measuring gas by diffusion. The surfaces opposite to the membrane are thermally connected with the heat sink. Through maintaining a constant temperature gradient between the two opposite surfaces, the heat flow is dependant of the gas mixture's thermal conductivity alone. Hence the voltage needed to keep the membrane temperature constant is a reliable measure for the thermal conductivity of the mixture and can be used further to determine the gas mixture's composition.

Mea-suring Gas	Carrier Gas	Basic range	Smallest range	Smallest supressed zero range	Multi Gas Mode
H_2	N_2 / air	0% - 100%	0% - 0.5%	98% - 100%	Yes
H_2	Ar	0% - 100%	0% - 0.4%	99% - 100%	Yes
H_2	He	20% - 100%	20% - 40%	85% - 100%	On request
H_2	CH_4	0% - 100%	0% - 0.5%	98% - 100%	On request
H_2	CO_2	0% - 100%	0% - 0.5%	98% - 100%	On request
He	N_2 / air	0% - 100%	0% - 0.8%	97% - 100%	Yes
He	Ar	0% - 100%	0% - 0.5%	98% - 100%	Yes
CO_2	N_2 / air	0% - 100%	0% - 3%	96% - 100%	Yes
CO_2	Ar	0% - 60%	0% - 10%	-	Yes
Ar	N_2 / air	0% - 100%	0% - 3%	96% - 100%	Yes
Ar	CO_2	40% - 100%	-	80% - 100%	Yes
CH_4	N_2 / air	0% - 100%	0% - 2%	96% - 100%	Yes
CH_4	Ar	0% - 100%	0% - 1.5%	97% - 100%	Yes
O_2	N_2	0% - 100%	0% - 15%	85% - 100%	Yes
O_2	Ar	0% - 100%	0% - 2%	97% - 100%	Yes
N_2	Ar	0% - 100%	0% - 3%	97% - 100%	Yes
N_2	CO_2	0% - 100%	0% - 4%	96% - 100%	On request
NH_3	H_2	0% - 100%	0% - 5%	95% - 100%	On request
CO_2	H_2	0% - 100%	0% - 2%	99% - 100%	On request
SF_6	N_2 / air	0% - 100%	0% - 2%	96% - 100%	On request

Table 2.1: Measuring ranges of typical gas compositions for analysis with the FTC400.

⚠ The FTC400 must not be used with explosive gases. Flammable gases such as H_2 and CH_4 may only be used in devices filled with glass balls. A gas mixture of a flammable gas with an inert gas in a mixing ratio such, that it is still inflammable for any amount of air added is called totally inertised. Totally inertised gases can also be used in devices without glass balls.



“Basic range“ is the largest possible measuring range and is set by default. The linearization is performed over the basic range. The smallest measuring ranges at the beginning and the end of the basic range are facilitated through specific calibration. The smallest possible range between the basic range and the smallest ranges at the end beginning and the end of the range can be estimated by linear Interpolation.

The Multi Gas Mode (MGM) is a configuration that allows for the consecutive measurement of different gas pairs. The gas pair can be switched through the control panel or via the RS232-interface. Gas pairs labeled “Yes“ in Table 2.1 are commonly used. Gas mixtures labelled “On request“ can also be implemented upon request.

2.2 Selective measurement of infrared-active gases

Some gas molecules such as CO_2, CH_4, C_2H_6, CO, NO, SO_2 and H_2O absorb infrared radiation in specific wavelenght spectra. The level of absorption is dependent on the concentration of the gas concerned. The FTC400 employs this dependency to perform selective analysis of up to three infrared-active gases in one mixture. This is acchieved through a detector, which tests the absorption using up to three different interference filters, which are selective for specific wavelengths. The selection of interference filters thus determines which gases can be analyzed by your device. As reference, a fourth measurement channel is operated in a wavelength range where no absorption of the analyzed gases occurs. The combination of the IR measurement with the thermal conductivity measurement enables the complete determination of complex gas mixtures in many cases.

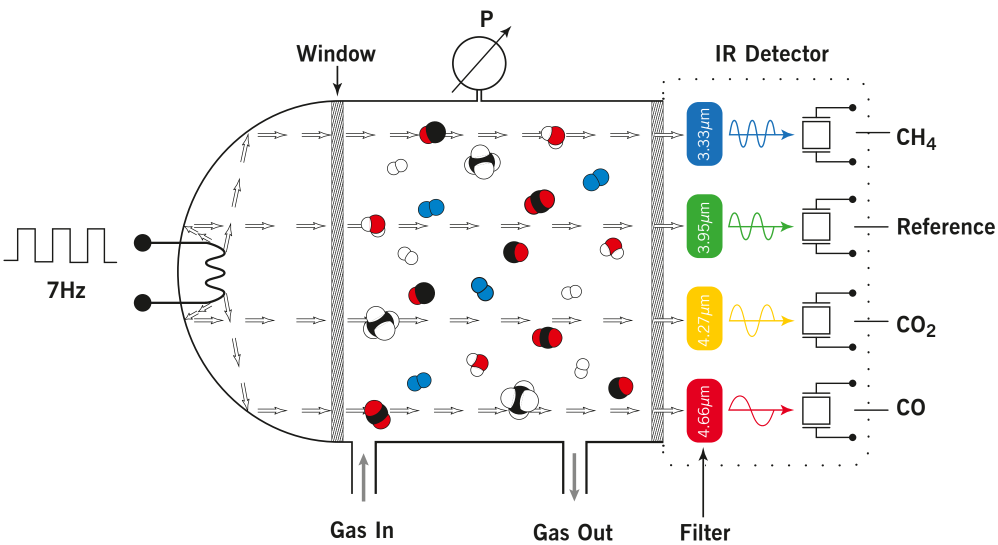


Figure 2.2: Scematic drawing of cuvette for IR measurement

2.3 Analysis of Complex Gas Mixtures

In a (quasi-)binary mixture of gases, knowledge of one physical property of the mixture (such as the thermal conductivity at a given temperature) is in most cases sufficient to determine the mixture’s components’ concentrations. The situation changes for mixtures containing more than two gases: cross

sensitivity effects occur, more sensor information is needed to quantitatively determine the mixture's composition.
The combination of infrared and thermal conductivity measurement enables the complete determination of complex gas mixtures in many cases. The FTC400 comprises both measurements and all necessary compensation calculations in one housing.
This is achieved through a multi-dimensional compensation model that is running on the device's micro-controller. The compensation routine is specifically tailored to your measurement application to provide high precision results over the whole measurement range.

In complex gas mixtures cross sensitivity effects occur, which are compensated through a compensation model. Falty calibration of your IR sensor(s) will negatively influence analysis results also for other gases. When calibrating, perform IR sensor calibration first, only afterwards calibrate for gases primarily determined through TC measurement (see Section 7.2 "Select Signal to Calibrate").

2.4 FTC400 Detector Unit

The FTC400 detector unit consists of a hermetically sealed pressure proof stainless steel block with a gas duct, which is suited for pressures up to 2 bar. Sample gas entering through the gas inlet is guided to the micro-mechanical thermal conductivity sensor and further downstream to the outlet port. In particular the pneumatics are designed to minimize the influence of a changing gas flow. The operating temperature of 63°C is stabilized by a highly accurate PI control loop.
In order to avoid electrical interference on the measuring output the high performance analog adaption circuit is directly mounted on top of the stainless steel block. The piggyback-mounted processor board digitizes the signal in a 24bit A/D converter. The micro-controller performs all calculations, as linearization, calibrations and cross sensitivity compensation directly on the detector unit.

Chapter 3

Assembly of the Instrument

3.1 Installation of the FTC400

The FTC400 is designed for wall fastening. The four mounting holes are shown in Figure 3.1. M4 cylinder head bolts are suitable. Please remember to keep additional space for adequate assembly of gas hoses and cables (see Chapter 10 "Appendix: Dimensional Drawing" for more information).

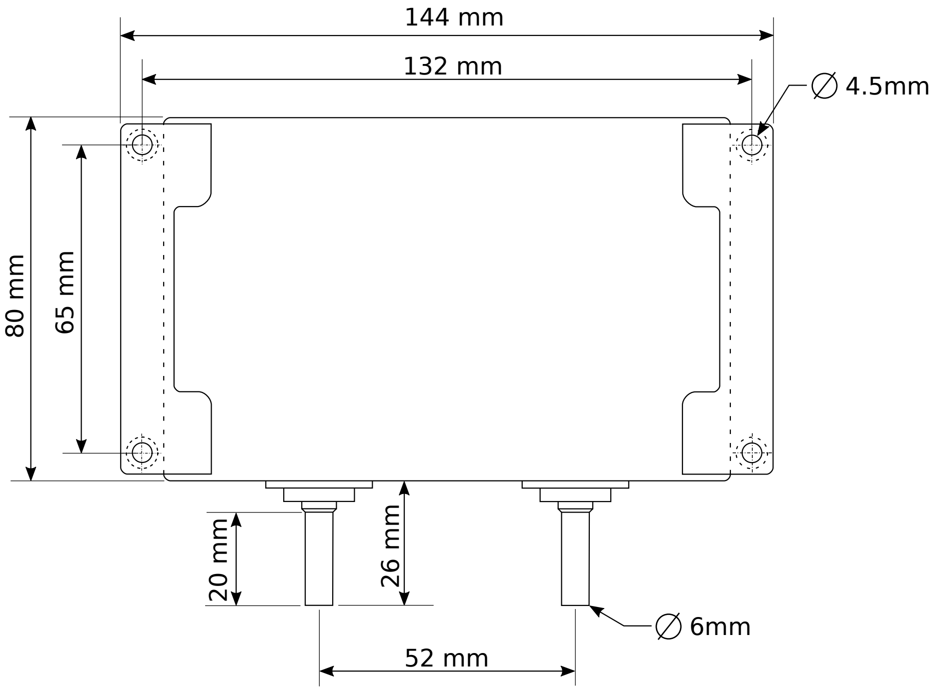


Figure 3.1: Mounting holes shown from the reverse side of the housing

If you are planning to lead flammable or toxic gases into the device, the device must be installed in a well ventilated area. All devices undergo a leakage test during production, nevertheless a limited release of small gas quantities is possible.

3.2 Gas Ports

On the bottom of the FTC400 housing two tubes with 6mm outer diameter for gas connection are located. They are labeled with “GAS IN “ and “GAS OUT“.
For low requirements regarding gas tightness and resistance to pressure the tubes can be used as hose connector. For permanent gas and pressure tightness compression fittings are recommended (e.g. by “Swagelok“©).
After connecting the device a leakage test should be performed (especially when working with flammable and/or toxic gases).

3.3 Electrical Connectors and Ground

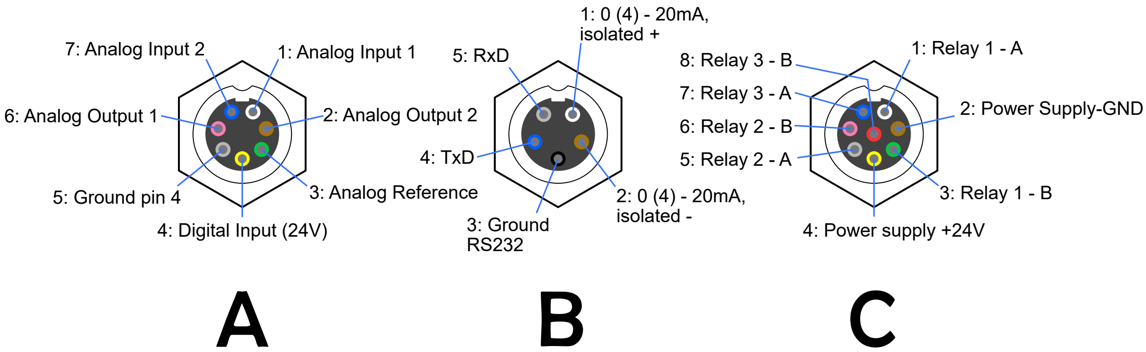


Figure 3.2: Electrical connector pin assignments of the three connectors on the FTC400

The FTC400 has three three plug connectors as shown in Figure 3.2. Further information on the function of each contact is given in Table 3.1. The cables (712, IP67) with molded connector plug and a length of two meters (five meters available on request) are part of the purchased parts package. The cables have open ends. The cross-section of the conductors in cable A and C is 0,14mm^2, for cable B 0,25mm^2. Cable A is shipped with devices set up for analog output.

⚠ The protection class of the device is only effective with all cables attached. In case cable A is not used, connector plug A has to be closed with an end fitting.

Pin No.	Wire colour	Function	Description
Connector A	**(7 pins)**		
1	white	Analog Input 1	0 to 10V, 24 bit resolution
2	brown	Analog Output 2	0 to 10V, 16 bit resolution
3	green	GND	GND for pins 1, 2, 6, 7
4	yellow	Digital Input (DIN)	low: <4.6V; high: >11.4V
5	grey	GND	GND for Pin 4
6	pink	Analog Output 1	0 to 10V, 16 bit resolution
7	blue	Analog Input 2	0 to 10V, 24 bit resolution
Connector B	**(5 pins)**		
1	white	Current Loop +	0 (4) to 20mA, floating isolated $\pm$500V to ground, max. 1000 Ohm burden 16 bit resolution
2	brown	Current Loop -	
3	black	Serial Interface RS232	GND for pin 4, 5
4	blue	Serial Interface RS232	TxD (transmit data)
5	grey	Serial Interface RS232	RxD (receive data)
Connector C	**(8 pins)**		
1	white	Relay 1	isolated contact; max 30V, 0.5A
2	brown	Power supply -	GND
3	green	Relay 1	isolated contact; max. 30V, 0.5A
4	yellow	Power supply +	+ 24V (18V to 30V), max. 700mA
5	grey	Relay 2	isolated contact; max. 30V, 0.5A
6	pink	Relay 2	isolated contact; max. 30V, 0.5A
7	blue	Common Relay 3	isolated contact; max. 30V, 0.5A
8	red	Common Relay 3	isolated contact; max. 30V, 0.5A

Table 3.1: Connecting pin assignment of connectors A, B, C

3.3.1 Requirements for Electrical Connectors

⚠ Before using the device make sure that the power supply is in accordance with the specifications of the device and that all electric connections correspond to the information given in this manual.

The FTC400 is a device of protection class III. For power supply a source with PELV specification (Protective Extra Low Voltage) according to EN 60204-1 must be used. See also Section 3.3.2 "Ground". The potential-free relay contacts must also be monitored with a power supply unit with PELV specification.

3.3.2 Ground

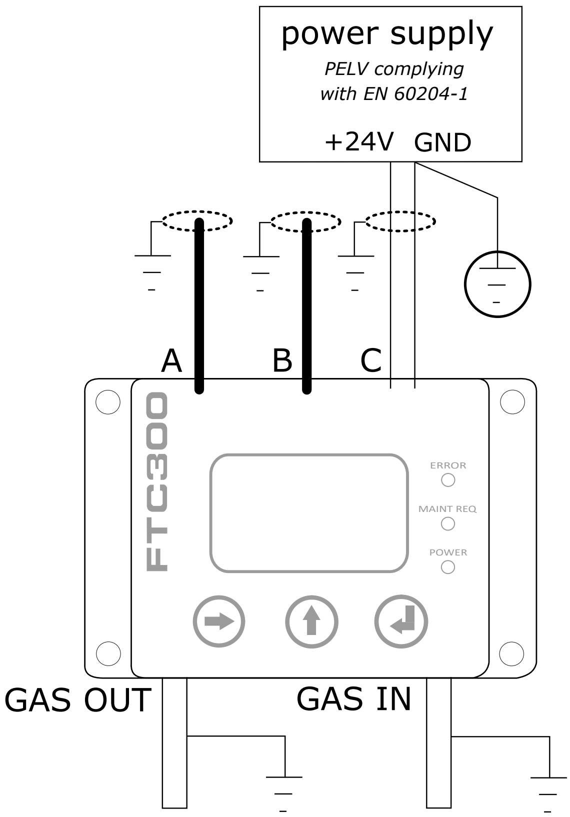


Figure 3.3: Grounding the FTC400

To comply with EN 60204-1 and to ensure your device's function, the device has to be installed such that the power supply (PELV) is connected to protective earth (PE) with its ground conductor, see Figure 3.3. The shielding of cables A, B and C should be connected to functional ground. Dependent on the circumstances, gas inlet and gas outlet can be grounded in addition. Connections to ground should be made with short low-resistant cables of large diameter.

3.3.3 Data exchange via serial interface (RS-232)

The serial interface, often called UART (Universal Asynchronous Receiver Transmitter), is based on the RS-232 standard. The point-to-point data transmission is carried out via the two TxD- (Transmit Data) and RxD- (Receive Data) wires to be crossed with a common ground line (GND) for both devices. This creates a bidirectional bus that allows full-duplex communication. The communication partners can therefore send and receive data simultaneously.

Data transmission via UART is performed with a fixed data frame (UART frame). This frame must be known to both communication partners. It consists of: A start bit, 5-9 data bits, an optional parity bit and one or two stop bits. If a PC is connected to the analyzer, the necessary settings are typically identified automatically. If this is not the case, the parameters can be set manually according to Table 9.2. (see Section 9.1).
Only a few PCs are still delivered with a so-called COM port (serial RS-232 interface). In order to be able to operate and program devices that have an RS-232 interface with computers without this, use of converters from RS232 to USB is advised. The converters often have a 9-pin D-Sub connector as input, but there are also converters with screw terminal connections.

The serial interface allows operation of the instrument and the display and storage of measurement data with the SetApp program. More information and a link to download the software can be found at www.messkonzept.de.

If you plan to develop or use your own software solutions for communication via the RS-232 interface, you may need more detailed information on the available parameters, etc. Please contact Messkonzept in this regard.

Chapter 4

The Front Panel

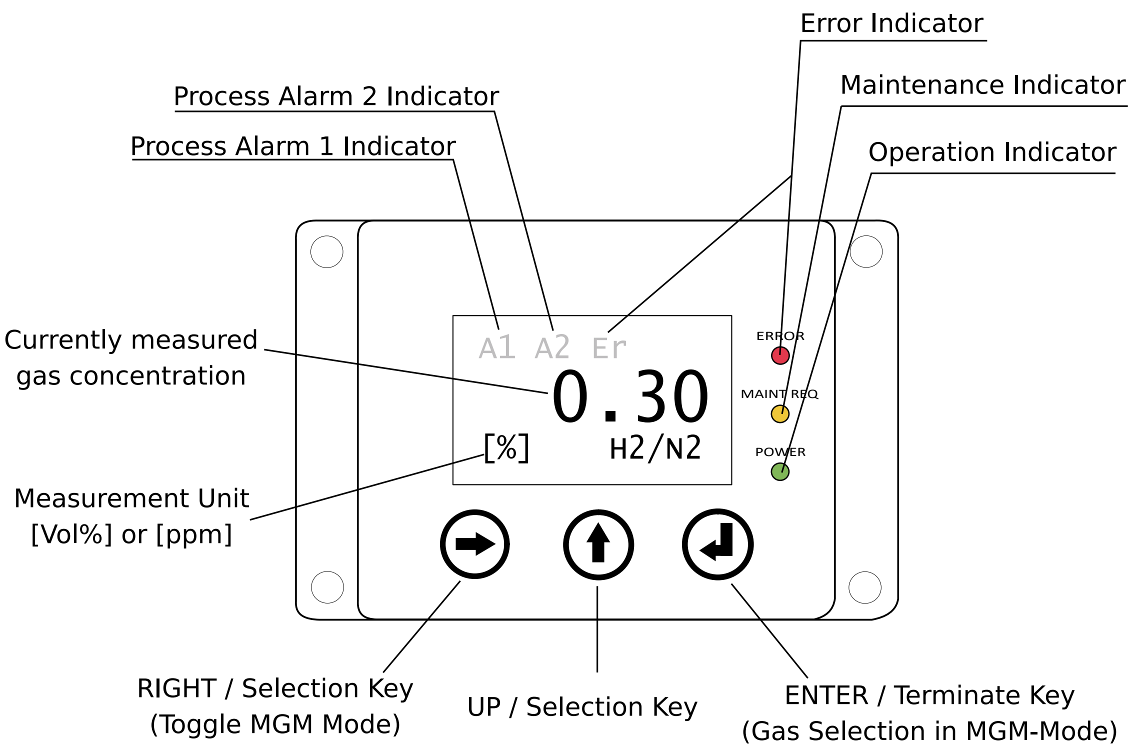
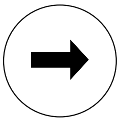


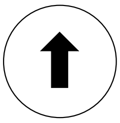
Figure 4.1: Front view schematic of the FTC400 front panel

4.1 Display

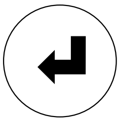
4.2 Keys



RIGHT / Selection Key
On the operation screen, the <RIGHT> key can be used to select one of the measured variables displayed on the work screen. With the <ENTER> key the menu related to the measured parameter can be called up, in which, for example, the calibration routine of the parameter can be accessed.
The <RIGHT> key enables the operator to scroll through the various menu items of menus and submenus. The currently selected menu item is marked by black background and is called with the <ENTER> key.
In submenus requiring numerical inputs, the <RIGHT> key scrolls to the next digit and to "ESC/OK" at the end.



UP / Selection Key
In menus or submenus the <UP> key quits the recent menu and bring you back to the menu above and ultimately to the main menu.
To quit menus with an "ESC/OK" option, select one of these fields with the <RIGHT> key and confirm with <ENTER>.
In submenus requiring numerical inputs, the <UP> key changes the selected digit.



ENTER / Termination Key
The <ENTER> key calls the item that is marked as selected (selection is indicated through black background highlighted text). Menu items are selected by the <RIGHT> key. In submenus with an "ESC/OK" option the <ENTER> key confirms the selection of "ESC" or "OK".

Chapter 5

Instrument display

This chapter describes the device start-up routine. The warm up screen, see Figure 5.1, shows the block temperature while the block warms up. After the warm up, the device switches to the operation screen, see Figure 5.2. From the operation screen the main menu can be opened.

Note: To make device-specific settings on the device, it is necessary to enter an Expert code (preset to 222.0000).

5.1 Warm up Screen

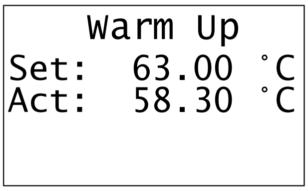


Figure 5.1: warm up screen of the FTC400

The warm up screen shows the current block temperature during warm up in the center of the screen (see Figure above). The target value of the block temperature, 63 °C for the standard version or 70 °C for the high temperature version, is shown in the bottom line of the screen.

Pressing the <UP> key during warm up switches directly to operation screen and activates the current loop. The displayed concentration value will not be precise until the needed block temperature is reached.

5.2 Operation Screen

After warm up the operation screen is shown (see Figure above). Depending on the version of the instrument, either one measured value or several measured values are displayed on the working screen. From the operational screen the main menu can be opened using the <UP> key.

5.2.1 Display of one measured value

```
        0.30
[%]     H2/N2
```

Figure 5.2: FTC400 operation screen (one measured parameter)

In the center of the display the currently measured gas concentration is shown, the associated unit of the measurement (ppm or Vol.%) is indicated in the bottom left corner of the operation screen. The currently measured gas pair, e.g. “H2/N2“ for hydrogen in nitrogen, can be found in the bottom right corner of the display. The display resolution in ppm is 1 ppm, the number of digits displayed in Vol.% indication is adjusted according to your requirements upon shipment (can be changed manually in the Expert mode, see Sections 6.3.1 and 6.5.1).

In the top display line status information may be shown: Alarms are indicated by “A1“ and “A2“, system errors are indicated by “Er“. If the top display line is empty there are no active alarm indications.

5.2.2 Display of several measured values

H_2	2.58	%
CH_4	28.10	%
CO_2	16.87	%
N_2	52.45	%

Figure 5.3: FTC400 operation screen (several measured parameters)

Each line of the display is assigned to a measured variable whose designation is shown on the left side, for example "O2" for oxygen or Pr. for pressure (for devices with pressure sensor). The value of the measured variable is shown next to it on the right. The associated units (Vol. %, ppm, bar, etc.) are displayed on the right side of the display. When displayed in Vol.%, the number of decimal places displayed can be selected (preset according to customer requirements, modification requires Expert Mode, see Section 6.3.1).

Chapter 6

General instrument settings

6.1 Top Level Main Menu

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Diagnosis
Instr. Setup
Output Setup
Expert Setup
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Figure 6.1: main menu of the FTC400

The main menu of the general instrument settings can be accessed from the operation screen (display of measured values) by pressing the <UP> key. Pressing the <UP> key again will take you back to the working screen.

Other submenus are accessible from the main menu. To select the following menu item in the main menu, press the <RIGHT> key. Pressing the <ENTER> button selects the highlighted menu item with a black background and opens the submenu.

The menu paths shown in the following chapters all start from the main menu.

Note: To enter the general device configuration, an Expert Code must be entered, which unlocks the device for one hour. By default, this is 222.0000. The code can be changed in the Expert Setup menu.

6.2 Diagnosis

The FTC400 has several integrated diagnosis and test functions that can be accessed through the diagnosis-menu. The menu provides the following functions:

- A parameter menu in which device-internal parameters/variables can be read out
- An error menu in which pending errors are listed

6.2.1 Parameter Menu

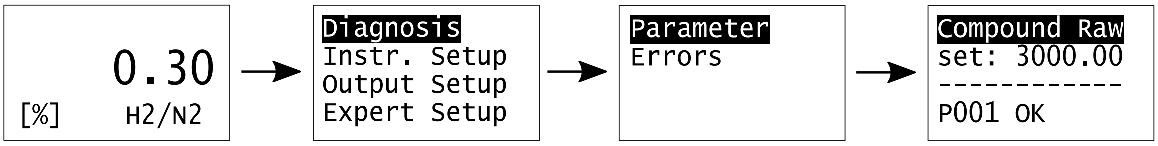


Figure 6.2: parameter menu for advanced diagnosis

The configuration of the FTC400 is defined by a list of internal parameters. The “Parameter“ menu gives read-only access to these parameters. This may help an experienced user to diagnose malfunctions caused by wrong settings. The parameter menu allows you to scroll through the entire parameter list. Contact Messkonzept for detailed information on the listed parameters. The first display line contains the name of the parameter, in the second line the parameter value is shown. The last line shows the parameter index. To move forward in the list, press <ENTER>, to move backwards, press <Up>. To leave the parameter menu mark <OK> by pressing <RIGHT> and confirm with <ENTER>. Some parameters can be changed in the expert setup, see Section 6.5 for more information.

6.2.2 Errors

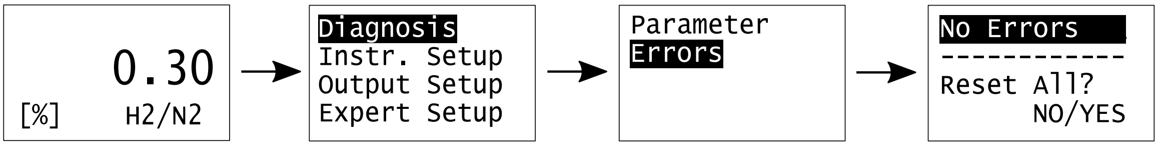


Figure 6.3: error menu

When the device is in the measuring mode or calibrating, several parameters are continuously checked for plausibility. The parameters checked, the list of possible errors and the ranges defining a plausible value can be found in Chapter 8 "Appendix: System Errors".

Errors are indicated by a flashing red light on the front panel. The menu “Errors“ gives access to the list of current errors . “No Errors“ indicates that no error is pending, for pending errors the name of the error is given. Pressing <ENTER> proceeds to the next pending error and <UP> to the previous error. To leave the error menu press <RIGHT> once or twice to select ”NO” or ”YES” and the <ENTER> key to confirm your selection. An error reset will affect maintenance-warnings only - all other errors and warnings are continuously monitored and automatically reset when the error no longer persists.

⚠ Defective devices must be disconnected from the process! This applies for apparent damages of the device such as physical damages but also in the case of unclarified malfunctions in the operation. Separate the device from the process pneumatically (both gas inlet and gas outlet) and remove the power supply from the device.

6.3 Instrument Setup

6.3.1 Display Unit

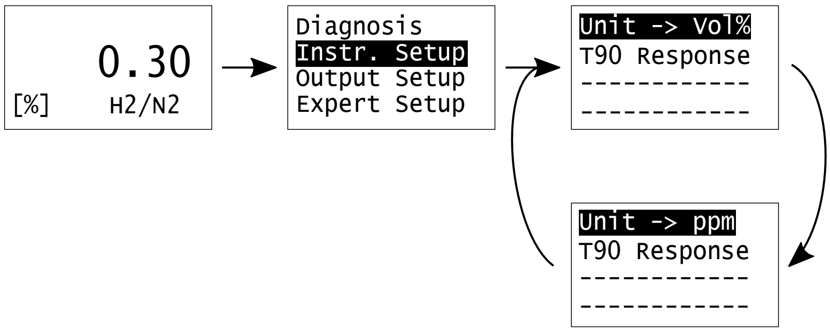


Figure 6.4: changing the displayed unit for gas concentrations

The first item of the instrument setup menu allows selection of the display unit. Pressing <ENTER> alternates the unit between ppm and Vol.%. Quit the menu with the <UP> key. The value of parameter P56 (see Section 6.5.1) sets the number of digits after the decimals point between 1 and 4 when the display unit is set to Vol.%. The resolution in ppm is always 1 ppm. All internal calculations of the FTC400 are done in ppm.Values retrieved through the RS-232 interface will always be in ppm with 1ppm resolution.

6.3.2 Response Time Setup

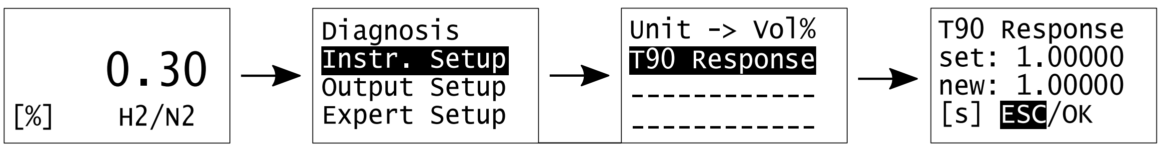


Figure 6.5: T90 response time setup

In the menu "T90 Response" the response time of the exponential filter can be adjusted. The filter reduces the influence of fast variations of the raw signal (signal noise smoothing). The numerical value for the T90 response time is given in the unit of seconds. A range between 0s and 100s is permitted for this value, reasonable values lie between 0.5s to 10s. You can change the numerical value by navigating through the digit position using the <RIGHT> key and changing it using the <UP> key. Confirm by pressing the <UP> key until "OK" is selected. The changed value can be discarded by selecting "ESC" instead. Setting "T90 Response" to 0.0 turns the exponential filter off.

The true response time is influenced by the gas exchange time which depends on the pneumatic installation and the flow rate of measuring gas. A gas flow of 80l/h leads to a gas exchange time of under 0.5s measured from the gas inlet of the device.
Note that the response time in your process depends greatly on the upstream volume before the FTC400. Shorter and/or thinner tubing will benefit response times.

The T90-time is the time, in which a sudden change of the measurand (e.g. the gas concentration) reaches 90% of it's final value.

6.4 Output Setup

Figure 6.6: Analog output setup menu

The FTC400 is equipped with three analog outputs. “Current Loop“ is an isolated current output. “Analog Out 1“ and “Analog Out 2“ are not DC-isolated outputs with an output range from 0 to 10 V. In the ”Output Setup” menu the analog outputs can be configured.

As part of a recent firmware upgrade, the settings of the analog outputs and relays have been restructured. The new menu structure does not yet have a complete user manual. Please contact Messkonzept with your questions about the analog outputs and relay settings.

6.5 Expert Setup

Figure 6.7: Expert Setup menu

The Expert Setup provides a couple of functionalities that should only be used by an advanced user or expert:

- set parameters
- reset to factory settings
- change the “Operator Code“ and the “Expert Code“
- swap between “Normal Mode“ and “Safety Mode“
- simulate alarms and analog outputs

The settings explained here are for advanced users or experts and should not be entered by normal operators. It is in the responsibility of experts to set the parameters properly. The default expert code is “222.000“.

6.5.1 Parameter

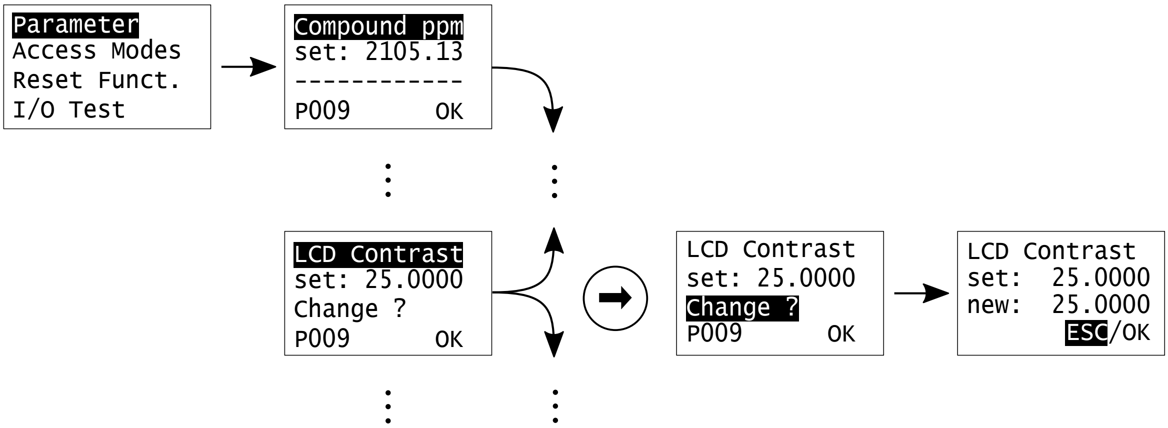


Figure 6.8: Parameter change in expert mode

The configuration of the FTC400 is represented by an internal list of parameters. These parameters govern all settings and functions of the device. In the expert-menu's parameter list press <ENTER> to scroll forward through the list and backwards by pressing <UP>. Some parameters cannot be changed (e.g. sensor information such as "Compound ppm", see Figure above) others can be changed (e.g. "LED Contrast", see Figure above). All changeable parameters are indicated by "Change?" in the third line of the display. Selecting and clicking "Change?" opens a submenu in which a parameter's value can be modified.

⚠ Setting certain parameters to improper values can cause falty measurement results, malfunctions or even permanent physical destruction of the device!

6.5.2 Access Modes

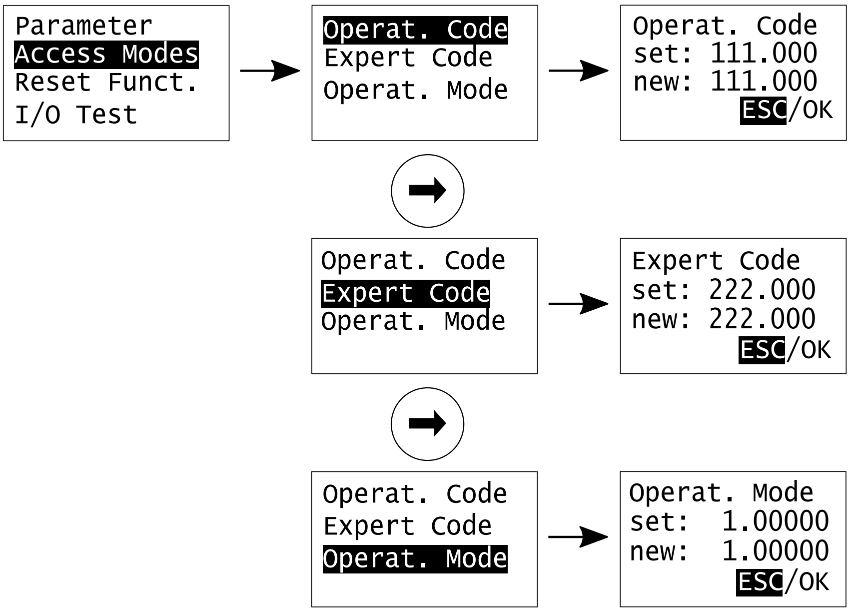


Figure 6.9: Access Mode menu

In this menu the passcodes for the “Operator Mode“ and the “Expert Mode“ can be changed. Further, the device’s mode can be switched between “Safety Mode“ and “Operation Mode“. For the “Operation Mode“ set “1.00000“ in the menu “Mode Set“, for the safe mode enter “3.00000“. In the safe mode, every change of settings requires manual input of the Operator Code.

6.5.3 Reset Functions

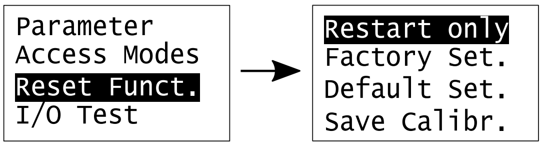


Figure 6.10: Reset Functions menu

This menu provides three reset functions and the possibility to save the current calibration parameters to the Factory Settings:

- “Restart only“: Restart of the software
- “Factory Set.“: Resets all parameters to the factory set values
- “Default Set.“: Resets all parameters to the default set values. CAREFUL: These values are not suited for a properly working device,
- “Save Calibration“: Saves the parameters relevant to calibration. They can be retrieved by “Factory Set.“

If a reset to Factory Settings is performed without saving the calibration parameters beforehand, a new calibration might be necessary.

If the device, against the given warnings, was reset to “Default Settings“ the parameters relevant for the proper operation are overwritten by default values. With these values the device will not work properly. The correct parameters (contact Messkonzept) have to be written to the device again, see Section 6.5.1 or the manual of SetApp which you can find on www.messkonzept.de.

6.5.4 Test of Relays, Analog Outputs and Connections

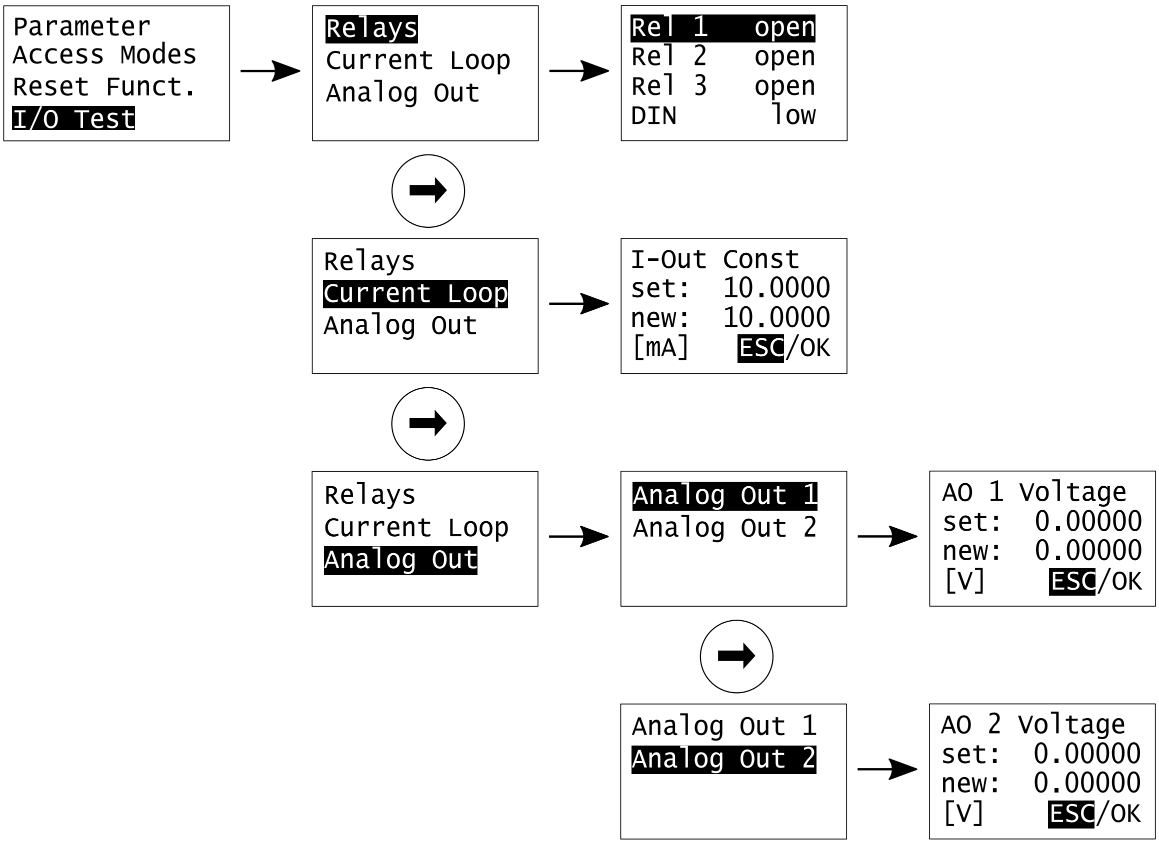


Figure 6.11: I/O Test menu

The “I/O Test“ menu provides the opportunity to set the following properties to a defined status in order to test subsequently connected equipment:

- Relay 1 (Rel 1) (open/closed)
- Relay 2 (Rel 2) (open/closed)
- Common Relay (Rel 3) (open/closed)
- Current of current loop

- Voltage for Analog Out 1
- Voltage for Analog Out 2

The digital input “DIN“ is “low“ for voltages below 4.6V and “high“ above 11.4 V. The output “Current Loop“ can be set to currents between 0 and 22mA. The analog outputs 1 and 2 can be set to supply a voltage between 0V and 10V.

Note! All test signals are permanently on until leaving the “I/O Test“ menu. It is the responsibility of the expert to assure that the I/O test does not interfere with the subsequent connected systems and processes in an unintended way.

Chapter 7

Measurand related settings

For each measured variable, usually given by a gas concentration, measurand related settings can be changed. The settings related to the measured parameter can be accessed from the working screen by selecting the measured parameter with the <RIGHT> key and confirming with the <ENTER> key (see Figure 7.1). The calibration and the alarm setup of the measured parameter can be called up in the parameter-related menu.

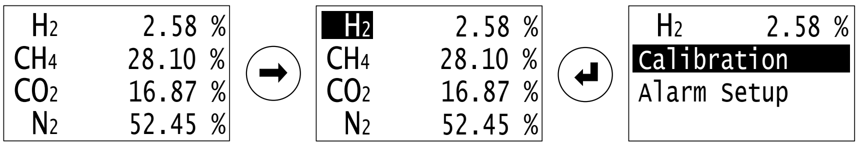


Figure 7.1: Accessing the settings related to the measured parameter

To select the following menu item in the measurand related menu, press the <RIGHT> button. Pressing the <ENTER> button selects the highlighted menu item with a black background and opens the sub-menu.

All inputs of numbers within the menu structure work according to the following principle: With <RIGHT> the respective digit of the number can be selected and with the <UP> key the digit can be changed. Select "OK" with <RIGHT> and confirm with <ENTER> to save the changes and return to the previous menu. Selecting "ESC" interrupts the input and discards changed values.

7.1 Calibration

For devices operated in “safety mode“, the operator code is required to access the calibration menu. By default the operator code is set to 111.000.

We recommend a calibration, resp. a check of the calibration if one of the following criteria is met:

- After bringing the device into service
- On a regular cycle, depending on the precision aimed for. To find out the appropriate time between calibrations, we recommend to begin with a more frequent check of the calibration. The time between calibrations can range between:

  - several month for a measuring task in the Vol.% range
  - days to weeks for a measuring task in the sub-Vol.% range
  - directly before every measurement if highest accuracy is needed

- When the situation of the measurement regarding pressure, temperature or gas flow changes

The goal of the calibration is that the measured concentration is in agreement with the given test gas concentration. To obtain this, two calibration parameters that correspond to the offset/zero and the gain/span of a linear equation are available. A two-point calibration requires two test gases. Both calibration parameters, offset and gain, are adjusted. The concentration of the test gases does not have to meet the beginning and the end of the measuring range, a difference of $\pm 10\%$ is permitted.

The menu sequence is designed such that prior to a gain always an offset calibration has to be done first. For the infrared channels both offset and gain calibration should be performed! For the thermal conductivity signal, determining a new offset value by single point calibration will usually be sufficient to obtain a good calibration result.
In the case of one point calibration, a test gas of any concentration in the measuring range is feasible. For two point calibrations it is preferable to use the gas concentrations at the lower and upper end of your measuring range.

7.1.0.a Calibration gas purities and flooding time

Messkonzept uses gases with the following purities for calibration:

H_2	He	N_2	Ar	O_2	CO_2	CH_4
5.0	5.0	5.0	4.6	4.5	4.5	4.5

Table 7.1: Recommended calibration gas purities

These gas purities are selected such that the devices comply with the specifications for the smallest measuring ranges feasible with the FTC400. Messkonzept recommends gases of same purity for calibration on-site. For differing individual requirements, opt for an appropriate gas purity.
To ensure high precision results after calibration, you have to make sure that the device is well flooded with the calibration gas before starting the calibration sampling. In Messkonzept's internal calibration process for 60 l/h applications this flooding is performed for min. 30 minutes for most gas mixtures (containing H_2, N_2, Ar, O_2, CH_4, ...) and for min. 60 minutes in Helium mixtures. Note that the supply pipe volume needs to be flooded as well. In Messkonzept's calibration process the volume before the device is <100ml. If your calibration setup has a larger volume in front of the device, you might have longer running-in times. Please contact us if you need advice.

7.1.0.b Use of Substitute Gases

Instead of using toxic or explosive gases for calibration, substitute gases may be used. A substitute gas has (at a certain concentration) the same thermal conductivity as the test gas it is substituting, such it can also be used for the calibration instead. Please contact Messkonzept for details on possible substitute gases for your application.

7.2 Select Signal to Calibrate

The FTC400 combines an integrated infrared measurement with thermal conductivity measurement. The measured infrared signal is used for the cross-sensitivity compensation of the thermal conductivity signal. The compensation is active during calibration. For best results we recommend the following order when calibrating or checking the accuracy of the measurement:

- First check the accuracy of all IR measurements. If calibration is necessary, always calibrate both offset and gain (two-point-calibration).
- Only proceed with the test and calibration of gases primarily determined through the thermal conductivity (TC) if IR measurement works correctly. For the TC signal, gain calibration will usually not be necessary, as the measurement is, aside from a small offset drift, very stable over time. If you nevertheless wish to perform a gain calibration, please note that it can only be done after offset calibration.

⚠ Only start thermal conductivity (TC) signal calibration (e.g. "H2 in N2"), when you made sure that your IR signals are calibrated properly! Cross sensitivity compensation is activated during TC signal calibration.

On opening the calibration menu, the item “Calibrate“ is selected. FIRST select the signal you want to calibrate: press the <RIGHT> button three times to select the first line in the display. Press <ENTER> to toggle the signal to calibrate (e.g. "H2 in N2" for TC measurement, "IR2 CO2" for IR measurement, etc.). THEN check if the offset and gain gas concentrations for calibration are correctly set up (lines three and four in the calibration menu). LASTLY, select “Calibrate“ to start the calibration routine. Setting of calibration gas concentrations and the calibration routine will be explained in detail in the following subchapters.

7.2.1 Set Offset Gas Concentration

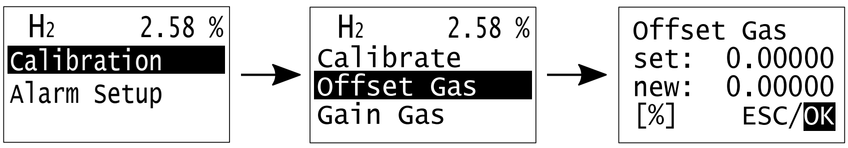


Figure 7.2: offset gas setup menu

Before performing a calibration, the concentrations of the used test gases have to be set. In the submenu “Offset Gas“ the used concentration of the offset gas has to be entered. Select the submenu “Offset Gas“ by pressing the <RIGHT> key and press <ENTER> to open the menu for the numerical entry. Enter the offset calibration gas concentration by changing each digit to the desired value. The position of the cursor in the number is moved by the <RIGHT> key, the value of the digit (0-9 or . for the decimal separator) at the current position of the curser is changed with the <UP> key. When the correct value is set, move the cursor to “OK“ and confirm with <ENTER>.

7.2.2 Set Gain Gas Concentration

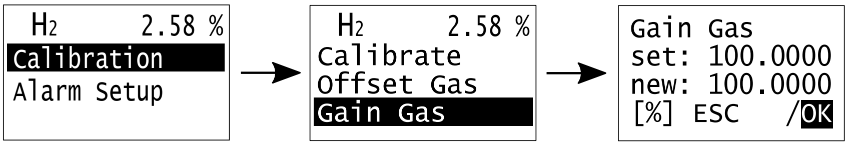


Figure 7.3: gain gas setup menu

Prior to a two point calibration, the gain gas concentration has to be set in the submenu “Gain Gas“. This menu is operated analogously to the “Offset Gas“ menu described in Section 7.2.1.

7.2.3 Offset Calibration

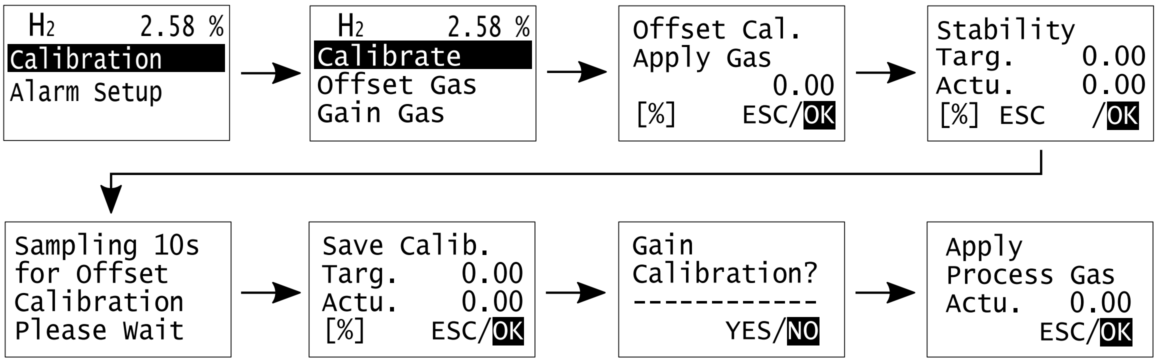


Figure 7.4: menu path if only offset is calibrated

After opening the menu “Calibrate“, you are asked to apply the offset test gas. The third line of the display shows the test gas concentration as set in the “Offset Gas“ menu (see Section 7.2.1). Please calibrate using the same/a similar flow rate as in your process measurement situation. Confirming with “OK“ leads to the menu “Stability“. The second line contains the set test gas concentration (“Targ.“), the third line the measured concentration (“Actu. “) using the current (unchanged) calibration. Before continuing, wait for a sufficient running-in time to evacuate possible disturbing gases from the device. Only continue if the value of the actually measured concentration reaches a final value (you might observe some signal noise around a constant value). To start the calibration sampling, select “OK“ and press <ENTER>. The sampling phase of 10s is started. Based on the average measured concentration, the new offset is determined such that the currently measured (and calibrated) value accords with the given test gas concentration within the specifications of the device. Repeat the calibration in case the measured concentration after calibration is not in agreement with the test gas concentration. By selecting “ESC“ and pressing <ENTER>, the offset calibration is repeated. With “OK“ the calibration is confirmed as correct and the new offset value is saved.

The following menu offers the option to proceed with the gain calibration. Choosing “YES“ leads to the gain calibration menu described below. For the infrared channels always perform gain calibration. For the thermal conductivity signal it is highly recommended to select “NO“ at this point. The TC gain value is very stable over time - imprecise recalibration might worsen your device’s performance! After quitting the calibration, you are asked to apply process gas again, giving you time to restore your typical process measurement environment while error warnings are deactivated and relays stay frozen.

7.2.4 Gain Calibration

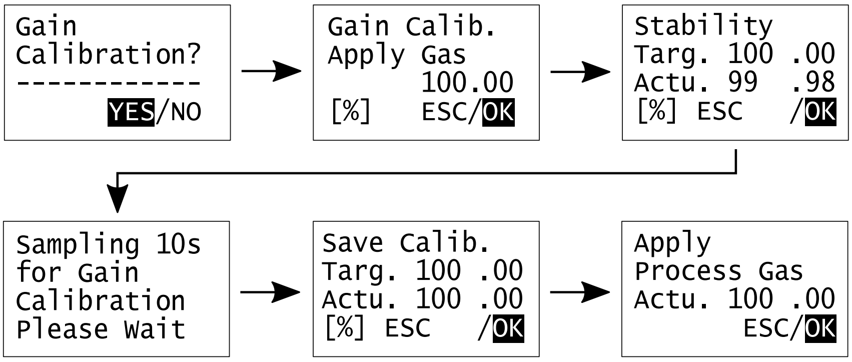


Figure 7.5: menu path of the gain calibration

The menu structure is designed such that the gain calibration procedure is only accessible after an offset calibration. The steps of the gain calibration correspond to the offset calibration described above (of course now using a different gas concentration, as set up in the ”Gain Gas” menu, see Section 7.2.2). Again, please remember to wait for a sufficient running-in time to evacuate possible disturbance gases. The gain calibration can be canceled in any sub-menu by selecting “ESC“. If gain calibration is canceled, the previous slope of your calibration line remains unchanged.

7.3 Alarm Setup

Individual process alarms can be activated and configured for the selected measurand/gas in the alarm setup accessible from the measurand related menu. Limit values and hysteresis can be set. Only one alarm can be set per gas.

A triggered alarm is signaled by a flashing of the measured variable on the display. Alarms can be used to switch relays.

7.3.1 Selection of alarm groups

In the first display line the <ENTER> key can be used to select the alarm group to which the set alarm should belong. The following modes can be selected:

- Alarm 1: The alarm belongs to alarm group 1
- Alarm 2: The alarm belongs to alarm group 2
- Alarm 3: The alarm belongs to alarm group 3
- Alarm OFF: The alarm is switched off.

The setting which alarm groups are to be output via which relay can be made in the relay setup (in the general device configuration). If the alarm is assigned to a group which already contains other gas alarms, the individual traceability to a single gas alarm is lost when a relay is triggered. In the line below, further settings can be made, between which you can switch by pressing the <ENTER> key. The setting options for the respective sub-item can be changed in the line below.

The following settings can be edited:

7.3.1.a Lower Limit

Gives the user the possibility to set the lower limit of the alarm in the unit of measurement used (e.g. Vol % or ppm). When the limit value is exceeded, the alarm is triggered. The selection of the limit value is independent of the measuring range used. With <RIGHT> the digits of the setting value can be selected and edited with <ENTER>.

7.3.1.b Upper Limit

Gives the user the possibility to set the upper limit of the alarm in the measuring unit used (e.g. Vol % or ppm). If the value falls below the limit value, the alarm is triggered. The selection of the limit value is independent of the measuring range used. With <RIGHT> the digits of the setting value can be selected and edited with <ENTER>.

If you only need one of the limit values, you can simply set the other limit value to a sufficiently distant value so that triggering at the limit value not required in your process is no longer possible. Please note that displayed measured values can also become negative under certain circumstances. This is the case for a gas concentration determined by means of thermal conductivity if you feed a gas into the device which has a lower thermal conductivity than the carrier gas for which the device is set up (e.g. if you feed CO2 into a device which is set up for H2 in N2).

7.3.1.c Hysteresis

In order to avoid frequently changing switch-on and switch-off processes of relays at an alarm limit value, a hysteresis value can be set. The setting is made in the measuring unit used (e.g. Vol % or ppm). In the FTC400 the hysteresis is implemented in such a way that an increasing measured value at [Upper Limit] + [Hysteresis] leads to triggering of the alarm at the upper limit and only switches off again when the measured variable has fallen to a value lower than [Upper Limit] - [Hysteresis].

Chapter 8

Appendix: System Errors

In this appendix possible error messages on the FTC400 (see Section 6.2.2) are listed.
In case of an error please check for the description of the error and the actions recommended to remove possible causes. In case this does not lead to a solution, please contact Messkonzept and describe the circumstances that led to this error. Some issues can be resolved through remote maintenance.
If the error persists you might be requested to send the FTC400 back to Messkonzept. Please pay attention to these points when sending the device:

- Close gas ports to keep gas duct clean. Preferably use black rubber caps that came with delivery.
- Put the device in a suitable shockproof packing material. Preferably use the foam box that came with delivery.
- Please attach a short note with a description of the problem or refer to prior mail correspondece on this subject with Messkonzept.

Never open the housing of the FTC400. Warranty is void if the housing was opened, refrain from attempts of repairing the device yourself! Messkonzept may charge more for the repair if the housing was opened. It is more work to check if an attempted repair by the user lead to further damages.

Displayed label	Cause	Default range	corrective measure
EEPROM ERROR	Error reading or writing data to or from internal FLASH-EEPROM	-	Repeat procedure. If the error persists, send the device to Messkonzept with description of error.
CAL GAIN ER	Calibration gain exceeding max. allowed range	0.5-1.5	Check if the used test gas concentration accords with the set concentration. Repeat procedure. If the error persists, send the device to Messkonzept with description of error.
CAL OFFS ER	Calibration offset exceeding max. allowed range	100 mV	*See CAL GAIN ER*
CAL DEV ER	Calibration deviation exceeding max. allowed range	50000 ppm	*See CAL GAIN ER*.
CAL VAR ER	Calibration variation exceeding max. allowed range	1000ppm	Repeat procedure. Check if the measurement is stable before data sampling. Are there sudden fluctioations in relevant process parameters, for example pressure pulses caused by a pump? Has the calibration gas flooded the device properly? Please verify your calibration setup and repeat the calibration. If the error persists, send the device to Messkonzept with description of error.

Displayed label	Cause	Default range	corrective measure
BT MIN ER	Block temperature below specified range	SetTemp-0.6K	The device might still be warming up after start-up or a sudden change of ambient temperature and/or gas flow occured and disturbed the temperature control loop temporarily. Please wait for a couple of minutes and see if the error persists. Another reason for the error might be operation of the device outside the specified ambient temperature or gas temperature range. Consider the device specifications. If the error persists, send the device to Messkonzept with description of error.
BT MAX ER	Block temperature above specified range	SetTemp+0.6K	*See BT MIN ER*.
BU MIN ER	Bridge voltage below specified range	1V	Send the device to Messkonzept with description of error.
BU MAX ER	Bridge voltage above specified range	11V	Send the device to Messkonzept with description of error.
TC MIN ER	TC-signal below specified range	500mV	Send the device to Messkonzept with description of error.
TC MAX ER	TC-signal above specified range	7000mV	Send the device to Messkonzept with description of error.
EXT. ERROR	Error routed from input “DIN“ (0V=no error, +24V=error)	Signal <14V	Check the surveyed external unit.

Table 8.1: Description of System Errors

Chapter 9

Appendix: Specifications

9.1 Specification of Thermal Conductivity Measurement

Attribute	Range / Precision
Linearity	< 1 % of range
Warm up time	Approx. 20 min; up to 1 h for small measuring ranges
Flow rate	10 l/h - 150 l/h, 60 l/h - 80 l/h (recommended)
T90-time	< 1 sec at flow rate higher 60 l/h (or dependant on user selected T-90-filter time)
Noise	< 0.5 % of smallest range
Drift at zero point	< 2 % of smallest range per week
Repeatability	< 1 % of range
Error due to change of ambient temperature	< 1 % of smallest range per 10 K temperature change
Error due to change of flow at 80 l/h	< 1 % of smallest range per 10 l/h
Error due to change of pressure (800 hPa < p < 1200 hPa)	< 1 % of smallest range per 10 hPa

Table 9.1: Specification of TC measurement

9.2 Specification IR Measurement

Coming soon! Please contact us for details: info@messkonzept.de

9.3 Electrical Specifications

Unit / Interface	Feature	Value
Display	128 x 64 dot graphic LCD	
Keypad	3 short-travel keys	
Analog Input 1/2	Voltage range:	0 to 10 V
	Reference potential:	ground
	Input resistance	approx. 50 kΩ
	Resolution	24 bit
Current Loop	Signal Current:	0/4 to 20 mA
	Reference potential:	fully floating, max. ±500 V to ground
	Burden:	max. 800 Ω
	Resolution:	16 bit
Analog Output 1/2	Voltage range:	0 to 10 V
	Reference potential:	ground
	Load resistance:	min. 10 kΩ
	Resolution:	16 bit
Relay 1/2/3	Maximum Voltage:	30 V
	Switching current:	0.5 A (max.)
	Switching capacity:	10 W (max.)
	Reference potential:	fully floating, max. ±500 V to ground
Power Supply	Voltage range:	24±6 V DC
	Max. current:	1 A
	Typical current draw:	500 mA
	Safeguard:	PELV (Protective Extra Low Voltage)
Digital Interface	Type:	RS-232
	Baud rate:	19.2 kbaud
	Data:	8 bit
	Parity:	None
	Stop:	1
	Flow control	None
	Reference potential:	ground

Table 9.2: Electrical Specifications

9.4 Permissible Conditions of the sample to be measured

Pressure (absolute)	Standard version: max. 20 bar abs. with flow measurement: max. 2 bar abs. for flammable gases: max. 3 bar abs.
Gas temperature	At 60 l/h: - max. 80 °C at 25 °C ambient temperature - max. 50 °C at 50 °C ambient temperature
Explosivity	non-explosive, except with special protecting devices
Dust, aerosols, oil mist	to be avoided (e.g. via separator/filter)
corrosive gases	only with corrosion-tolerant variant
Humidity or droplets	no falling below dew point in the measuring path, small quantities tolerable with protective filter against condensate and dust

Table 9.3: Environmental conditions

9.5 Environmental conditions

Operating temperature:	-20 °C to 50 °C (-4 °F to 122 °F) or if casing filled with glass balls: -5 °C to 50 °C (23 °F to 122 °F)
Storage temperature:	-25 °C to 70 °C (-15 °F to 160 °F) (not-condensing)
Protection class	IP 65 (if cables are plugged and/or all unused jacks are sealed using protective caps)

Table 9.4: Environmental conditions

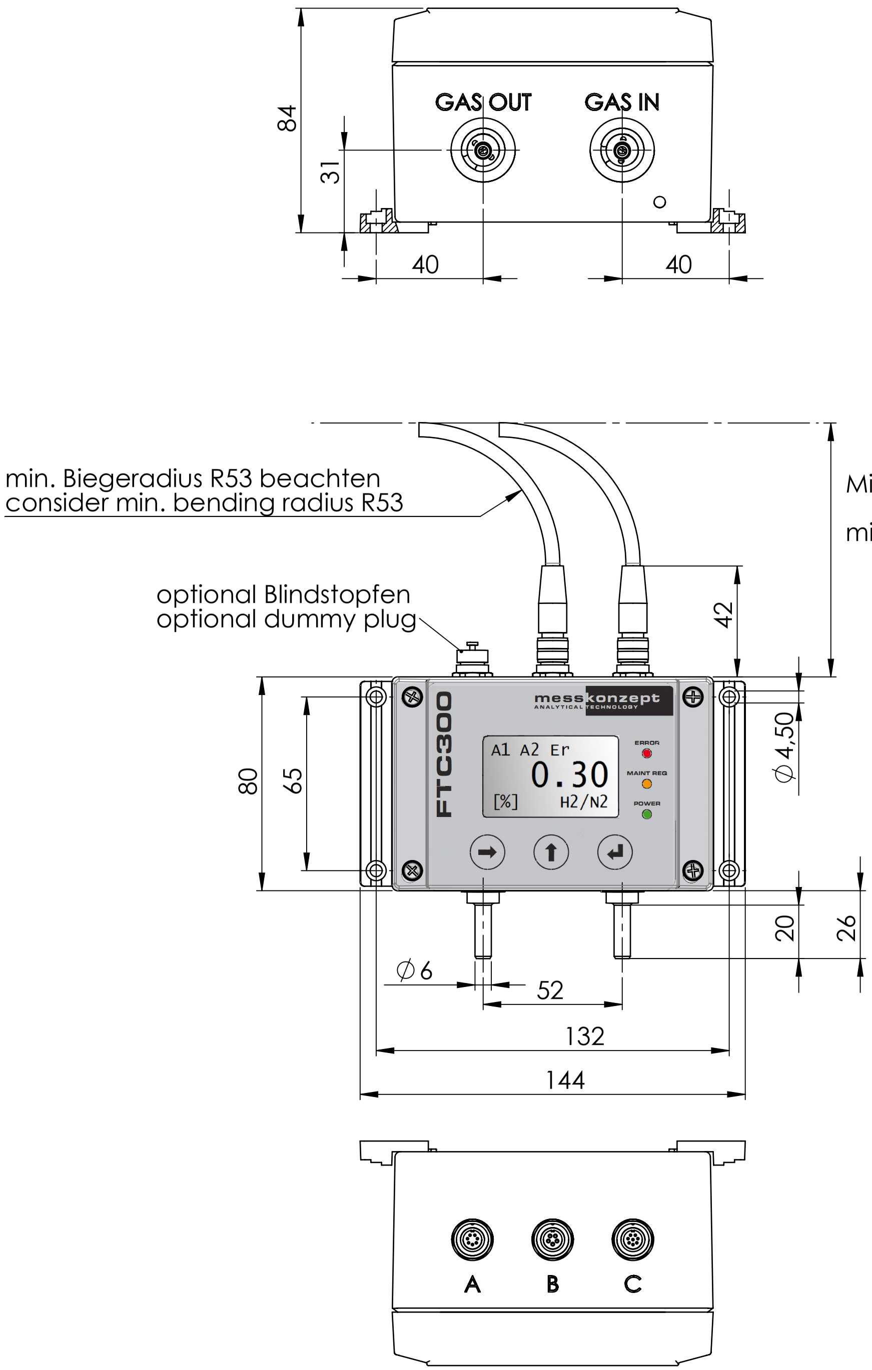
9.6 Dimensions

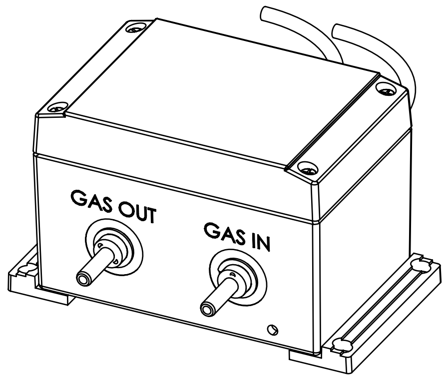
Dimensions:	Depth: 85 mm Width: 144 mm Height: 80 mm without connectors
Weight:	max. 1800 g
Mounting:	Wall mounting

Table 9.5: Dimensions

Chapter 10

Appendix: Dimensional Drawing





Minimaler Freiraum
minimal clearance

95mm bei fixierten Kabeln /
122mm bei losen Kabeln
95mm with cables fixed /
122mm with cables movable

Steckverbindung / plug-and-socket connection
A 7 polig / 7 pins
B 5 polig / 5 pins
C 8 polig / 8 pins

zulässiger Biegeradius: feste Installation R_{min} 53mm
bewegliche Kabel R_{min} 80
tolerable bending radius: fixed installation R_{min} 53mm
flexibel cabel R_{min} 80mm

Obfl.:

DIN ISO 2768-mK		Maßstab	1:2
Datum	28.04.2015	FTC 300	
Name	Ashmore	Massbild	
		A090-X005	Blatt 1 / 1

Zust.	Änderungsnr.	Datum	Name
003		21.11.18	VA
002		15.01.16	VA
01		28.04.15	VA

messkonzept ANALYTICAL TECHNOLOGY

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