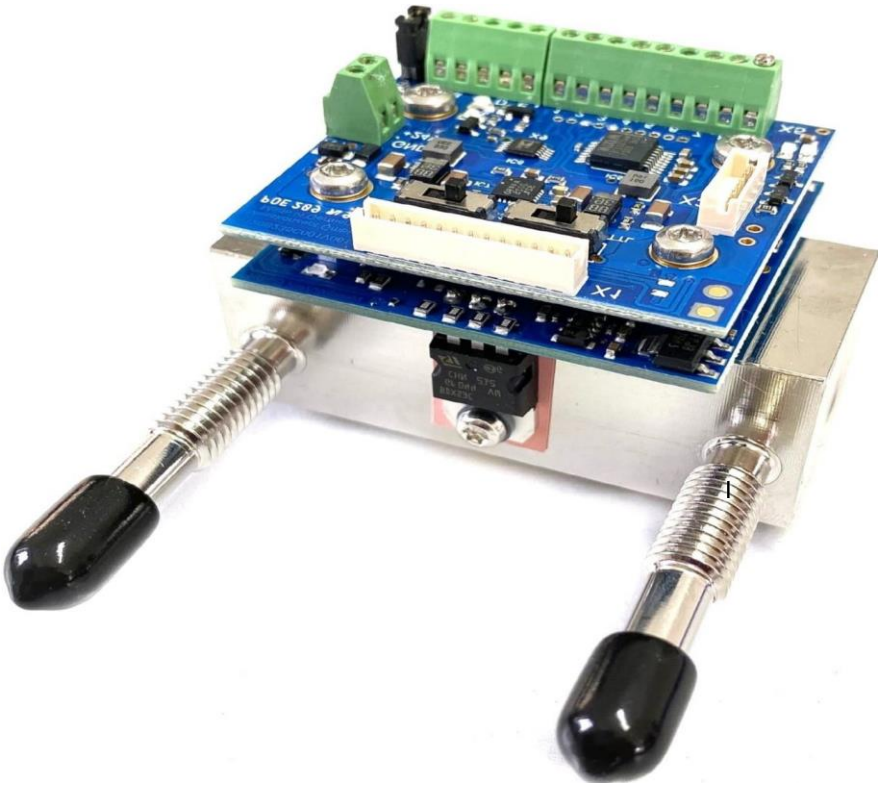
# Operating Manual

# FTC320-OEM

Gas analysis using thermal conductivity measurement



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# About this manual

Thank you for using the Messkonzept FTC320-OEM. 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 with careful studies. 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.

All correspondence should be addressed to:

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# Contents

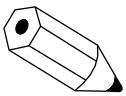
# Chapter 1

# Operator Safety

This section provides information and warnings which must be followed to ensure safe operation and retain the instrument in safe condition. Read this section carefully before installing and using the software.

## 1.1 Notes on Safety Instructions 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

**Warning!**

- 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 put explosive gases or gas mixtures into the device!
- Warranty expires if any element of the device is removed or replaced without the consultation of Messkonzept.
- The unit and the cables must be effectively protected against damage and UV light.

## 1.3 Safety Instructions

**Warning!**

- For the 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 authorized person is required for installation, connection and operation of the device. Please read and follow this manual for the installation.
- Defective devices must be disconnected from the process! This applies for ap parent 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 gaseously (both gas inlet and gas outlet) and remove the power supply from the device.
- Make sure that the electric installation protection against accidental contact adheres to the applicable safety regulations. The device must be connected to protective earth before all other connections. Any interruption in the protective earth connection can cause danger.
  Repairs should only be carried out by Messkonzept.
- Beware of the hot surface (up to 80°C) of the metallic body of the device.
- Improper equipments must be used when handling handling the the metallic part of the device to avoid skin burns.

## 1.4 Intended Use

The FTC-series of gas analyzers offer high-precision measurement and detection of non-corrosive, dust-, condensate-, aerosol and oil mist-free gases [1] . Explosive gases should not be put into the FTC. The Instrument should not be used in hazardous areas [2]. Please contact info@messkonzept.de for detailed information and solutions.

Upon installation, the protection class has to be considered. The ambient atmosphere should 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 can, therefore, not be used in e.g. medical or pharmaceutical laboratory analyses 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.**

[1] Condensate and corrosive tolerant variants on request

[2] Messkonzept also offers, upon request, other models of the FTC-series analyzers that can monitor, additionally to the aforementioned, flammable or explosive gases. For more information in this regard, do not hesitate to contact us.

# Chapter 2

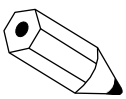
# Principle of Measurement

## 2.1 Determining Concentrations via Thermal Conductivity

Thermal Conductivity Detectors (TCD) have been 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 unique heat conductivity that is 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 conductivity of its gas components and their fractional amounts in the mixture. Thus, the concentrations of different components of a gas mixture 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 conductivity 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 but different than that of the measuring gas, 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 and the volumetric fractions of all but two components (or component groups) 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 FTC400 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. Upon request, it can be checked whether the temperature of heat sink and/or source should be changed in order to improve the accuracy or to avoid cross-sensitivity effects.

*Cross-sensitivity* is the sensitivity of the measurement on different gases than the measured component.

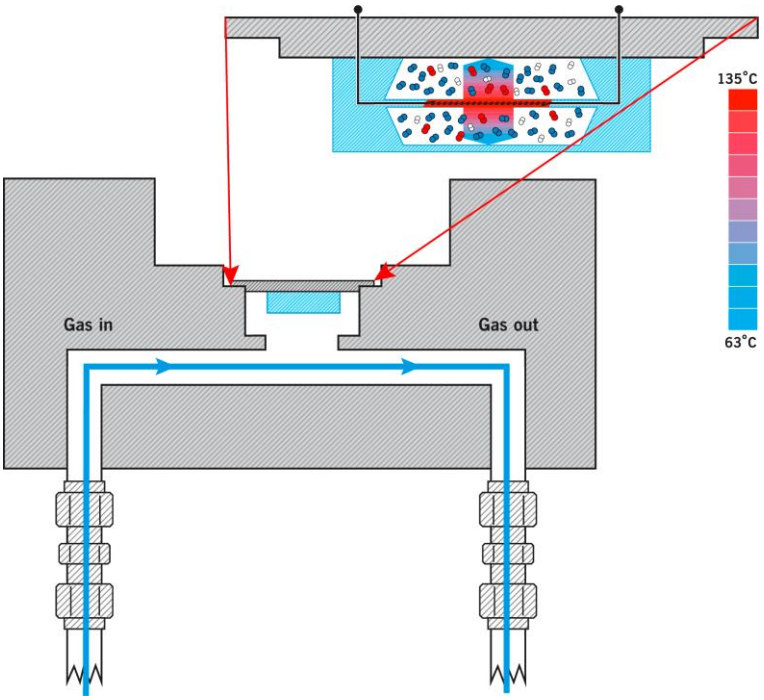



Figure 2.1: Schematic drawing of thermal conductivity measurement. The sensor is mounted in the stainless steel block that is kept at a constant temperature.

The FTC320-OEM contains a TC sensor that analyzes the quantitative composition of gas mixtures. The measurement is based on the heat transfer between a heat source and a heat sink.

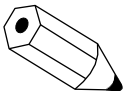
The measuring gas is led through a stainless steel block that is kept at a constant temperature of 63°C (for most applications). The block temperature is stabilized using a control loop - it serves as a heat sink of constant temperature. A micro mechanically manufactured membrane with a thin-film resistor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

Table 2.1 lists typical gas pairs and their measuring ranges.

| Measuring Gas | Carrier Gas | Basic range | Smallest range | Smallest range at end |
|---|---|---|---|---|
| H2 | He | 20% - 100% | 20% - 40% | 85% - 100% |
| H2 | $CH_4$ | 0% - 100% | 0% - 0.5% | 98% - 100% |
| H2 | $N_2$ or air | 0% - 100% | 0% - 0.5% | 98% - 100% |
| H2 | Ar | 0% - 100% | 0% - 0.4% | 99% - 100% |
| H2 | $CO_2$ | 0% - 100% | 0% - 0.5% | 98% - 100% |
| He | $N_2$ or air | 0% - 100% | 0% - 0.8% | 97% - 100% |
| He | Ar | 0% - 100% | 0% - 0.5% | 98% - 100% |
| CH4 | $N_2$ or air | 0% - 100% | 0% - 2% | 96% - 100% |
| CH4 | Ar | 0% - 100% | 0% - 1.5% | 97% - 100% |
| O2 | $N_2$ | 0% - 100% | 0% - 15% | 85% - 100% |
| O2 | Ar | 0% - 100% | 0% - 2% | 97% - 100% |
| NH3 | $H_2$ | 0% - 100% | 0% - 5% | 95% - 100% |
| N2 | Ar | 0% - 100% | 0% - 3% | 97% - 100% |
| N2 | $CO_2$ | 0% - 100% | 0% - 3% | 97% - 100% |
| CO | $H_2$ | 0% - 100% | 0% - 2% | 99% - 100% |
| Ar | $N_2$ or air | 0% - 100% | 0% - 3% | 97% - 100% |
| Ar | CO2 | 0% - 100% | 0% - 50% | 80% - 100% |
| CO2 | $N_2$ or air | 0% - 100% | 0% - 3% | 96% - 100% |
| CO2 | Ar | 0% - 100% | 0% - 20% | 50% - 100% |
| SF6 | $N_2$ or air | 0% - 100% | 0% - 2% | 96% - 100% |

Table 2.1: The measuring ranges of typical gas compositions for analysis with the FTC320-OEM given in Vol. %.



The “basic range“ is the largest possible measuring range and is set as standard. Linearization is carried out over the basic range. The smallest measuring ranges at the beginning and end of the basic range are made possible by a separate calibration.

# Chapter 3

# Installation of the Instrument

## 3.1 Mounting

The bottom view of the FTC320-OEM shows four M3 thread holes which can be used for the fixation of the detector (see Figure 3.1). Do not mount directly on surface. Use insulating spacers (min. 4mm thick) and stainless-steel screws, to minimize the heat flow from the 63°C hot detector body. For bulkhead mounting, two spacer and two M8 nuts are available upon request.

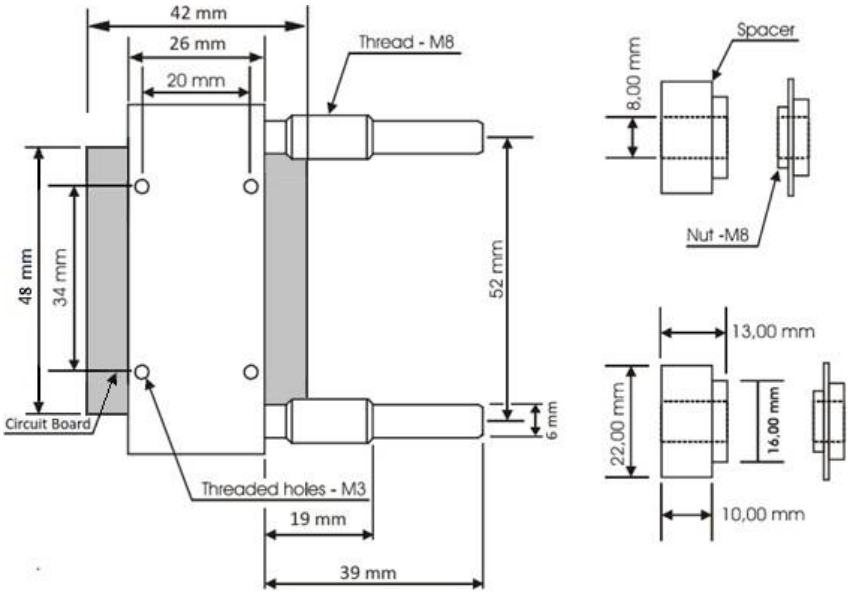



Figure 3.1: Dimensions of the FTC320-OEM and fixation points.

**Warning!**
-Beware of the hot surface (up to 80°C) of the metallic body of the device.
-Improper equipments must be used when handling handling the the metallic part of the device to avoid skin burns.

## 3.2 Housing and insulation

**Thermal insulation and Electromagnetic protection**

The installation of the FTC320-OEM in a customer-specific housing is mandatory. It must not be exposed to any air flow, e.g. from fans. The use of additional insulation is optional, but may be necessary for ambient temperatures below 0°C. Do not use flammable material for insulation. It should be temperature-resistant up to 120°C. The circuit boards must not be covered by the insulation. The appliance is equipped with a thermal fuse that interrupts the current at 110°C. Please consider the waste heat from other appliances in the vicinity as these must not cause a temperature rise above 50°C.

The product FTC320-OEM does not meet Electromagnetic Compatibility (EMC) requirements with- out proper shielding and housing. EMC measures must be implemented by the customer.

## 3.3 Gaseous Connection

Gas inlet and outlet tubes - as well as the body - are stainless steel (1.4571/1.4404) and are shown in figure 3.2. The outer diameters of the gas inlet and outlet tubes are 6mm. The inner gas duct is heated up to 63°C (versions with higher temperatures available on demand). In case condensation may occur in the sample gas lines and connections at ambient temperatures, heated lines and con- nections must be used in order to avoid condensation. With proper heated lines and connections, a dew point up to 50°C is permissible.

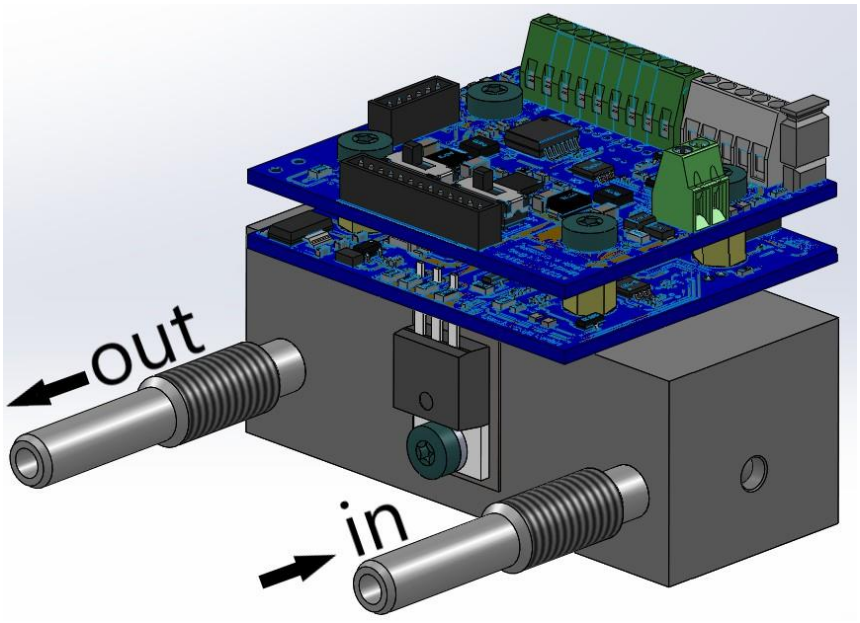


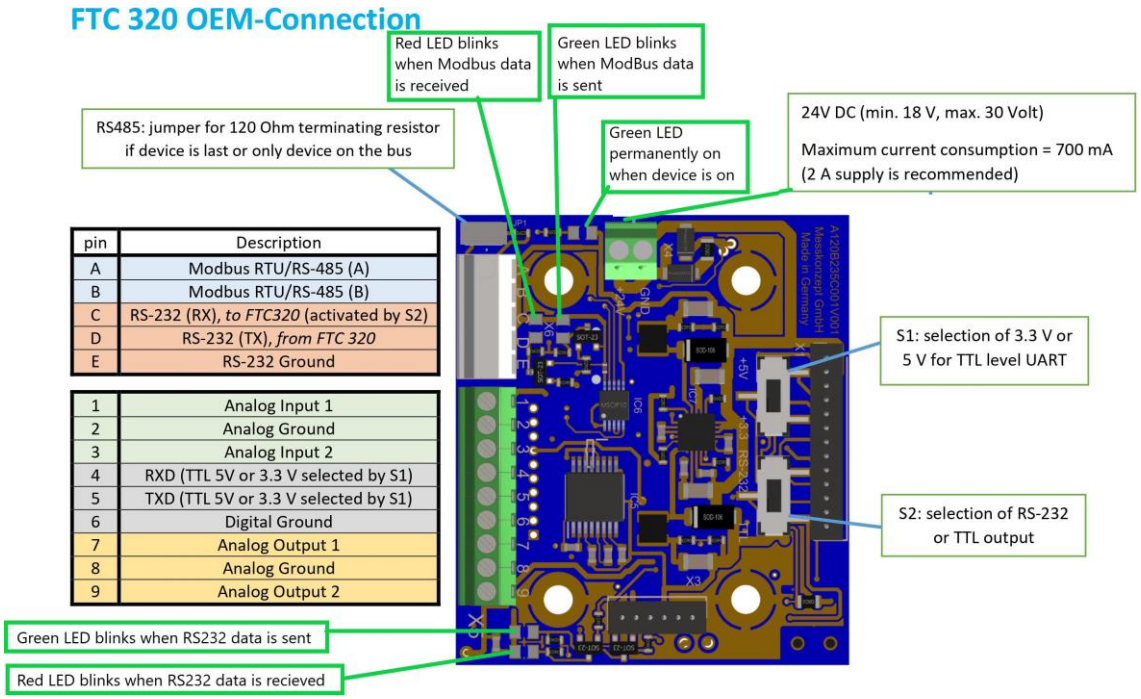

Figure 3.2: The gas in- and outlet of the FTC320-OEM .

**Warning!**

The gas placed into the device cannot contain any dust, condensate and potentially condensing matter unless the FTC unit is equipped with a filter membrane protecting against condensate and dust. Liquid droplets or dust will immediately destroy the sensor element upon contact. If your gas sample may not be dust-, condensate- or corrosion-free, please state this in your request and we will provide you with a suitable FTC320-OEM unit.

## 3.4 Electrical Connection

Figure 3.3 illustrates the available electrical connections of the FTC320-OEM .




| pin | Description |
|---|---|
| A | Modbus RTU/RS-485 (A) |
| B | Modbus RTU/RS-485 (B) |
| C | RS-232 (RX), *to FTC320* (activated by S2) |
| D | RS-232 (TX), *from FTC 320* |
| E | RS-232 Ground |

| | |
|---|---|
| 1 | Analog Input 1 |
| 2 | Analog Ground |
| 3 | Analog Input 2 |
| 4 | RXD (TTL 5V or 3.3 V selected by S1) |
| 5 | TXD (TTL 5V or 3.3 V selected by S1) |
| 6 | Digital Ground |
| 7 | Analog Output 1 |
| 8 | Analog Ground |
| 9 | Analog Output 2 |

Figure 3.3: The electrical connections to and from the FTC320-OEM .

Three green LEDs are located on the PCB (see figure 3.3). One should be permanently on when the device is correctly on, this is found left to the power supply.

The second green LED is blinking when RS232 data is sent successfully (bottom left on figure 3.3). A red LED can also be found next to the RS232 transfer LED, and blinks red when data is successfully recieved.

The third green LED blinks when data is successsfully transfered via ModBus, it can be found below the power supply to the right of pins C and D (see figure 3.3). The red LED next to it, also blinks red when data is successfully recieved via ModBus connection.

If the red or green RS232/RS485 LED is permanently on, there is a communication error, please contact Messkonzept.

# Chapter 4

# Output

The gas concentration is mapped onto the voltage output of the device. The mapping can be freely chosen, with the maximum possible voltage being 10 Volt. The recommended span of the voltage output is 0-10V, so that minor outside influences like pressure- and flow fluctuations or minor drifts will not cause the signal to exceed the physically possible range of 0-10.5V.

Here is an example of a typical mapping of voltage to gas concentration: assume the measuring range is 10-100 Vol.% and the voltage output is set to 1V-10V. The gas percentage concentration can, be calculated from the voltage output with the following formula:

$$\text{Gas Concentration (Analog Output)} = \frac{\text{Analog Output} - 1\text{V}}{10\text{V} - 1\text{V}} \cdot (100\ \text{Vol. \%} - 10\ \text{Vol.\%}) \qquad (4.1)$$

# Chapter 5

# Digital Communication with FTC320-OEM

## 5.1 Remote Control via RS232 Communication

The device provides 3 voltage levels for serial RS232 communication. These can be achieved by various switch combinations of S1 and S2 (see figure 3.3). The following table explains what the switch combination does, the orientation reference would be attained by placing the terminals on the left hand side as in figure 3.3:

| Switch combinations | | |
|---|---|---|
| Voltage levels | Position of switch S1 | Position of switch S2 |
| Full RS232 | - | RS232 (up) |
| TTL 0-5V | 5V (up) | TTL (down) |
| LVTTL 0-3.3V | 3.3V (down) | TTL (down) |

Table 5.1: Possible switch combinations, for desired voltage in- and output.

### 5.1.1 SetApp 3.0

Messkonzept offers a software for the operating of the FTC320 series. It enables via RS232 monitoring of measured values and adjusting the settings of the FTC devices. The configuration is stored in about 400 different parameters. The SetApp3.0 is available for download on our website in the Download section. The manual for SetApp3.0 is available upon request.

## 5.2 ModBus communication

Another form of communication is via **RS485 connection for ModBus RTU**, which allows the user to connect and address multiple FTC devices. The pins are A and B in figure 3.3.

Within the SetApp3.0, parameter 0 (P0) has the serial number of the device which identifies each FTC320-OEM . Parameter 16 (P16) is responsible for the respective ModBus address. The default

address is set to 1 and it is found under group "01 System". To readdress simply select the field in P16, name[1] the address and click "Set".

[1]Note: Each address must be unique, if issues arise contact Messkonzept

# Chapter 6

# Specifications

| | |
|---|---|
| Dimensions with connectors | L=74mm, W=65.9mm, H=44.5mm |
| Weight | 326g |
| Power supply | 21-30V, recommended: 24V, max. 0.8A |
| RS232 - Baudrate / Data | 19.2 kBaud/s, 8N1 |
| RS485 (Modbus RTU) | Default: 19.2 kBaud/s, 8N1 (1.2 - 115.2 kBaud/s configurable) |
| Ambient temperature range | As high as 50°C, and as low as -20°C with proper insulation |
| Linearity | <1% of range |
| Warm up time | Approx. 20min; 1h for small ranges |
| T90-time | <1s sec (at proper flow rate) |
| Noise | <1% of smallest range |
| Drift at zero point | <2% of smallest range per week |
| Repeatability | <1% of range |
| Voltage output | Voltage range: 0 to 10 V[1], load resistance: min. 50 kΩ, resolution: 16 bit |
| Analog input ½ | Voltage range: 0 to 10V[1], Input resistance: approx. 50kΩ, Resolution 24 bit |
| Error due to change of ambient temperature | <1% of smallest range per 10°C |
| Error due to change in pressure (above 80kPa=800mbar) | <1% of smallest range per 1kPa (10mbar) |
| Gas pressure (absolute) | 80kPa (0.8 bar) to 1000kPa (10bar)[2] |

Table 6.1: Specifications of the TC-analyzer FTC320-OEM. The values given above refer to $H_2$ in $N_2$, they may vary for other gas pairs.

| Article No.: | Calibration | Protection | Flow at Atmospheric Pressure |
|---|---|---|---|
| A070B900 | calibrated at 60 l/h | Without protection | recommended value 60/h<br>recommended range 40 l/h -80 l/h<br>permissible range 10 l/h – 120 l/h |
| A070B901 | calibrated at 60 l/h | Protection against **corrosion** | |
| A070B902 | calibrated at 60 l/h | Protection against **condensate** and **dust** | recommended value 60/h recommended range 40 l/h – 150 l/h<br>permissible range 10 l/h – 300 l/h |
| A070B903 | calibrated at 60 l/h | Protection against **corrosion**, **condensate** and **dust** | |
| A070B907 | calibrated at 10 l/h | Protection against **condensate** and **dust** for **low sample gas flow** | recommended value 10/h recommended range 3 l/h – 20 l/h<br>permissible range 1 l/h – 60 l/h |
| A070B907 | calibrated at 30 l/h | Protection against **condensate** and **dust** for **low sample gas flow** | recommended value 30/h recommended range 20 l/h – 40 l/h<br>permissible range 1 l/h – 60 l/h |
| A070B908 | calibrated at 10 l/h | Protection against **corrosion**, **condensate** and **dust for low sample gas flow** | recommended value 10/h recommended range 3 l/h – 20 l/h<br>permissible range 1 l/h – 60 l/h |

Table 6.2: Variants Different Specifications

[1]Reference potential: earth

[2]Messkonzept also offers devices with higher pressure tolerance upon request.

# Chapter 7

# Views of the device

The 3D STEP model is available on the website on request

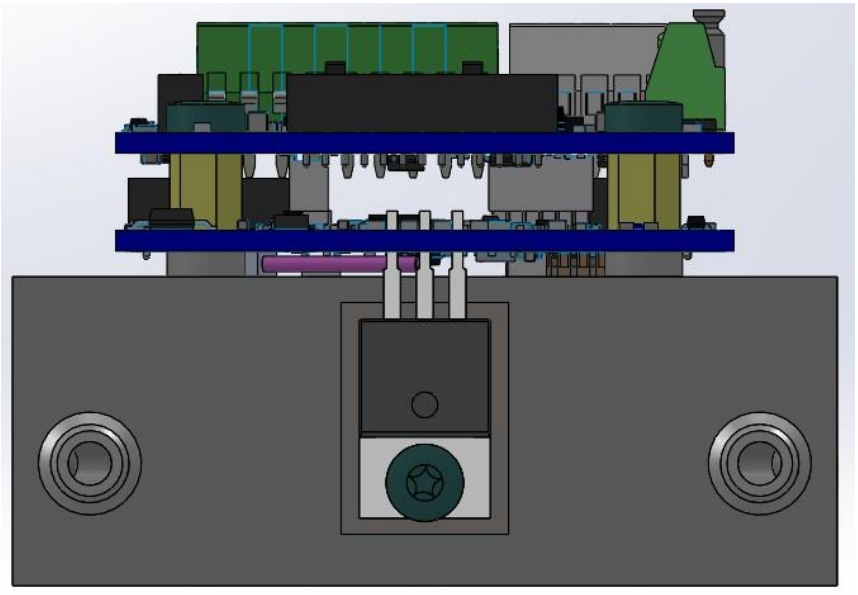


Figure 7.1: View of the FTC320-OEM from the front side.

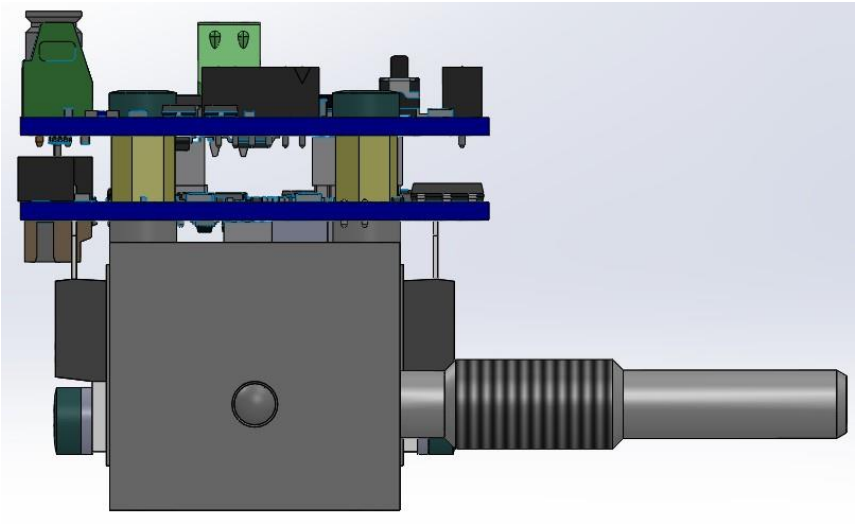


Figure 7.2: View of the FTC320-OEM from the left side.

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