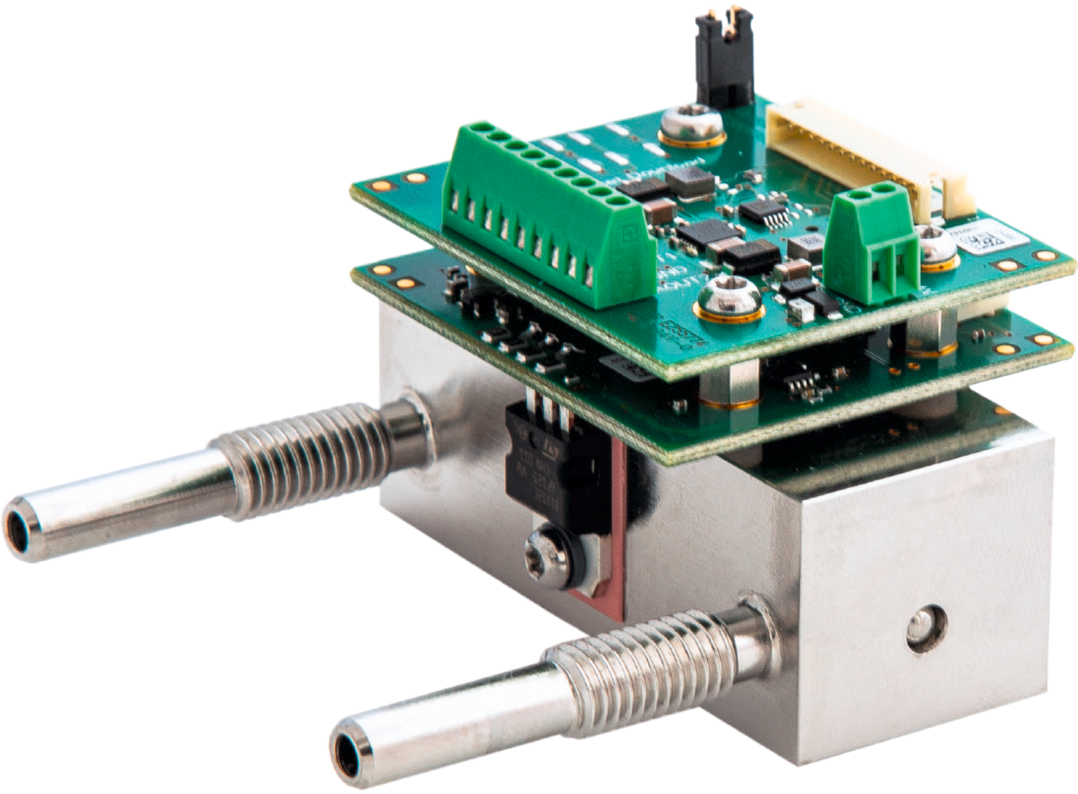
Operating Manual

FTC320-OEM

Gas analysis using thermal conductivity measurement



messkonzept
ANALYTICAL TECHNOLOGY

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.

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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: FTC320-OEM

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Part I

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 Notes on Safety Conventions and Icons

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

Note!
"Note" indicates an additional function or hint.

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 lead 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.

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 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 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.

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 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 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] 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.

Part II

Principle of Measurement

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 other gases than the measured component.

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

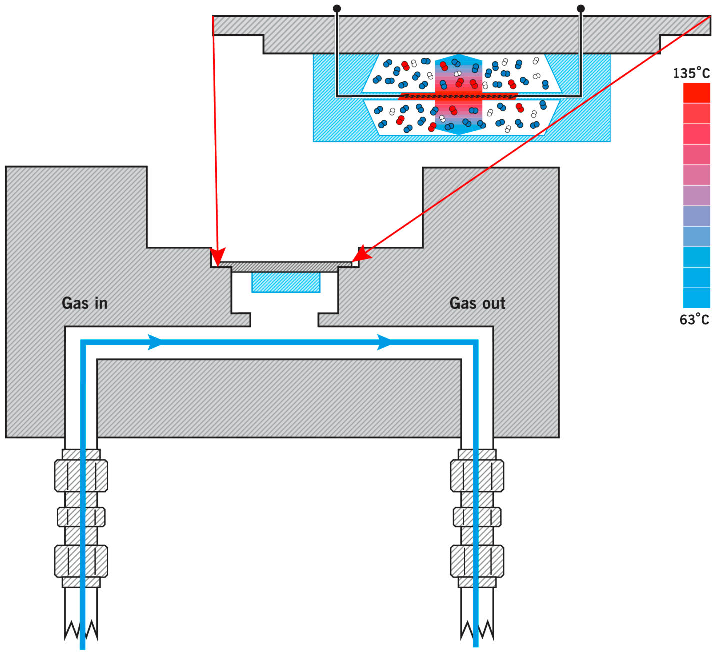

Figure 1: Schematic drawing of thermal conductivity measurement. The sensor is mounted in the stainless steel block that is kept at a constant temperature.

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.

"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. They can be estimated by linear Interpolation.

Table 1 lists typical gas pairs and their measuring ranges.

Measuring Gas	Carrier Gas	Basic range	Smallest range	Smallest suppressed zero range
H2	He	20% - 100%	20% - 40%	85% - 100%
H2	CH4	0% - 100%	0% - 0.5%	98% - 100%
H2	N2 or air	0% - 100%	0% - 0.5%	98% - 100%
H2	Ar	0% - 100%	0% - 0.4%	99% - 100%
H2	CO2	0% - 100%	0% - 0.5%	98% - 100%
He	N2 or air	0% - 100%	0% - 0.8%	97% - 100%
He	Ar	0% - 100%	0% - 0.5%	98% - 100%
CH4	N2 or air	0% - 100%	0% - 2%	96% - 100%
CH4	Ar	0% - 100%	0% - 1.5%	97% - 100%
O2	N2	0% - 100%	0% - 15%	85% - 100%
O2	Ar	0% - 100%	0% - 2%	97% - 100%
NH3	H2	0% - 100%	0% - 5%	95% - 100%
N2	Ar	0% - 100%	0% - 3%	97% - 100%
N2	CO2	0% - 100%	0% - 4%	96% - 100%
CO	H2	0% - 100%	0% - 2%	99% - 100%
Ar	N2 or air	0% - 100%	0% - 3%	96% - 100%
Ar	CO2	0% - 100%	-	80% - 100%
CO2	N2 or air	0% - 100%	0% - 3%	96% - 100%
CO2	Ar	0% - 100%	0% - 10%	-
SF6	N2 or air	0% - 100%	0% - 2%	96% - 100%

Table 1: The measuring ranges of typical gas compositions for analysis with the FTC320-OEM.

2 FTC320-OEM Detector Unit

2.1 Description

The FTC320-OEM is a highly precise and stable Thermal Conductivity Detector (TCD) that is designed for the use as an OEM detector. The unit consists of a hermetically sealed pressure proof stainless steel block with a gas duct, which is suited for pressures up to 20 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 Processor board digitizes the signal in a 24bit A/D converter. The micro-controller performs all calculations, such as linearization, calibrations and cross sensitivity compensation directly on the detector unit.

For indication of the signal, a 0 to 10V analog output is provided. For internal calibration, configuration and digital indication of the signal a TTL-level RS232 or USB communication [2] is required. For these features and for testing purposes (e.g. plotting and logging the signals), Messkonzept offers a Microsoft Windows software and/or a terminal program in order to perform Offset and Gain calibration on a PC. For more information, see part V.

[2] depends, among others, on the place and way of installing the device

2.2 EMC

The product FTC320-OEM does not meet EMC (Electromagnetic Compatibility) requirements, since the device is not shielded. Proper shielding and ingress protection (IP) might be required.

Part III

Assembly of the Instrument

1 Mounting

Warning!
The FTC320-OEM unit must be thermally isolated from the environment!

The bottom view of the FTC320-OEM shows four M3 thread holes which can be used for the fixation of the detector (see Figure 2). Use insulating spacers (min. 4mm) and stainless-steel screws in order to minimize heat flow from the 60°C hot detector body. For water-tight bulkhead mounting, two spacer and two M8 nuts are available upon request.

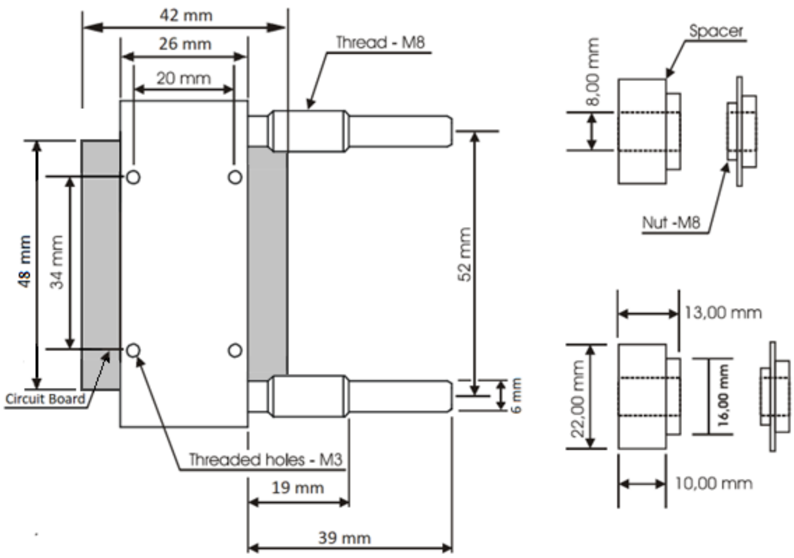

Figure 2: Dimensions of the FTC320-OEM. The M3 thread holes on the back of the detector are shown in the illustration on the left.

2 Pneumatic Connection

For the pneumatic connection, it is important to know the direction of the gas flow, i.e. differentiate between the gas inlet and outlet. Looking at the FTC320-OEM with the electronic boards facing upwards, the gas inlet is on the right-hand side (see figure 3).

Gas inlet and outlet tubes - as well as the body - are stainless steel (1.4571/1.4404). The outer diameters of the 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 connections must be used in order to avoid condensation. With proper heated lines and connections, a dew point up to 50°C is permissible.

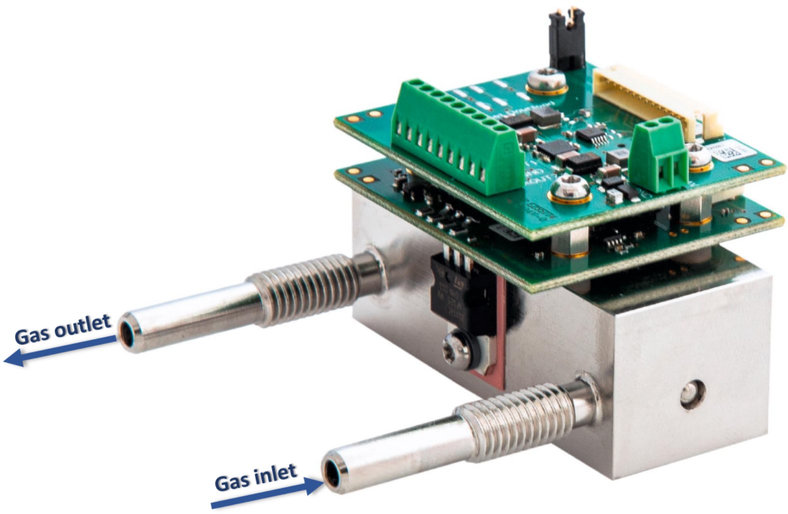

Figure 3: The gas in- and outlet of the FTC320-OEM.

Warning!
The gas led into the device cannot contain any dust, condensate and potentially condensing matter unless the FTC unit 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 Electrical Connection

Figure 4 illustrates the available electrical connections of the FTC320-OEM.

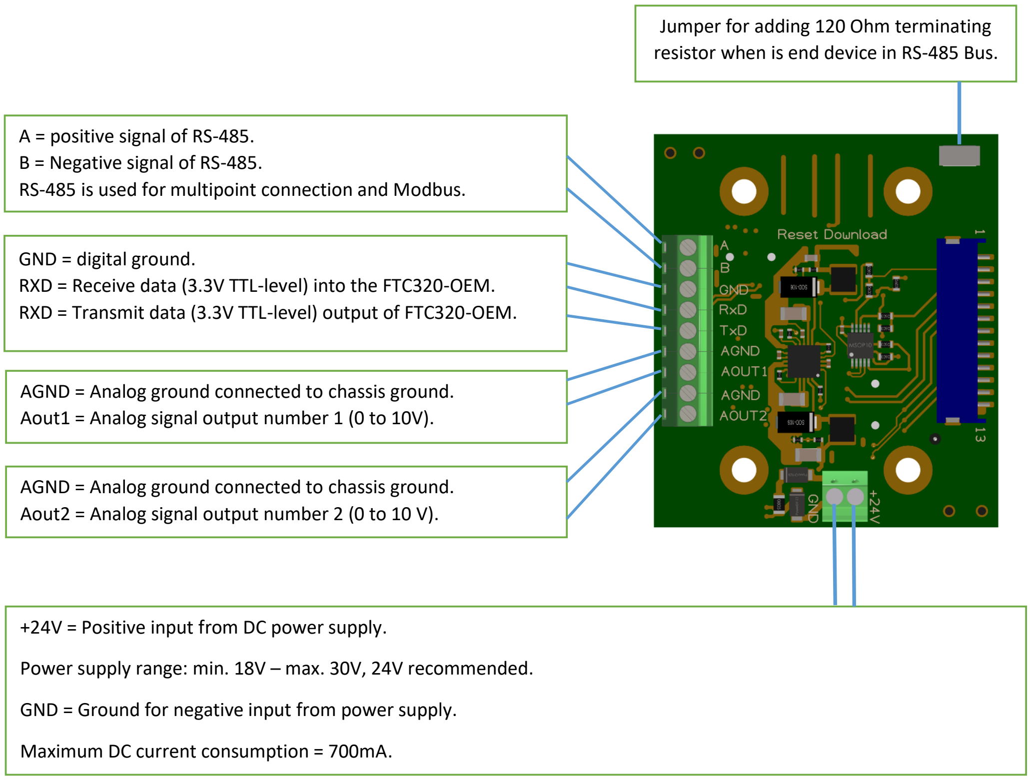

Figure 4: The electrical connections to and from the FTC320-OEM.

Part IV

Output of the Instrument

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 1V-9V, so that minor outside influences like pressure- and flow fluctuations or minor drifts will not cause the signal to exceed the span of 0V-10V.

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-9V. The gas percental concentration can, then, be calculated from the voltage output with the following formula:

$$\text{Gas Concentration (Analog Output)} = \frac{\text{Analog Output} - 1\text{V}}{9\text{V} - 1\text{V}} \cdot (100\ \text{Vol. \%} - 10\ \text{Vol.\%}) \quad (1)$$

Part V

Communication with FTC320-OEM

1 Remote Control via Serial Communication

The FTC320-OEM is equipped with an RS232-Low-Voltage-TTL (LVTTL)-interface (see Figure 5). Low-voltage TTL (LVTTL) is a special form of transistor-transistor logic (logic family) in which the supply voltage is reduced from 5 V to 3.3 V[3]. In addition, an RS485 connection that is used for Modbus communication will be soon offered by Messkonzept.

A dedicated manual for explaining the remote control is available and can be provided upon request. Please contact Messkonzept if you wish to get a copy of the manual.

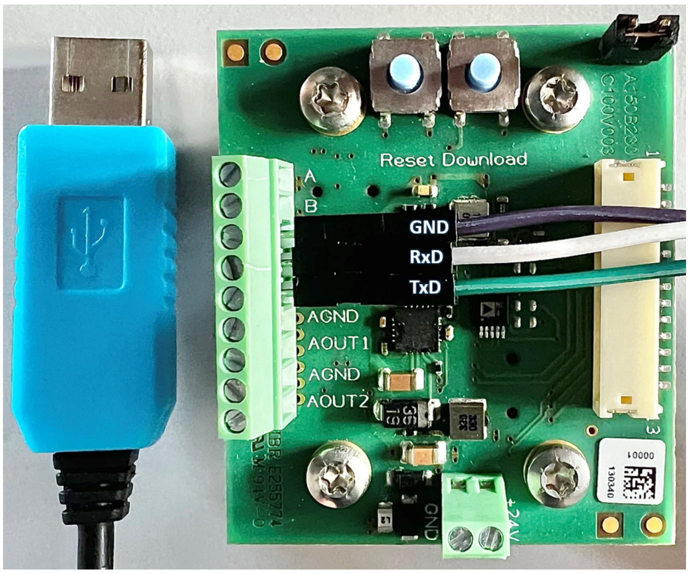

Figure 5: Connecting the Low-voltage TTL (LVTTL) with the board.

2 SetApp 3.0

Starting in February 2023, Messkonzept will offer a software for the operation of the FTC320 series. It enables monitoring of measured values and adjusting the settings of the FTC devices. This is especially important for the OEM series, since SetApp3.0 will make processes such as calibration, setting thresholds, and routing measurements to the analog outputs, among many others, much easier. The SetApp3.0 will be available for download in April, 2023 on our website in the Download section.

[3]When choosing a LVTTL adapter, please make sure that it is compatible with Windows 10 and/or 11.

Part VI

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
Flow rate	Normal flow: 60 l/h, low flow: 15-30 l/h
T90-time	<1sec (at proper flow rate)
Noise	<1% 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°C
Error due to change of flow at 80l/h	<1% of smallest range per 10l/h
Gas pressure (absolute)	80kPa (0.8 bar) to 2000kPa (20bar)[4]
Error due to change of pressure (above 800hPa)	<1% of smallest range per 10hPa

Table 2: 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.

Part VII

Scope of Delivery

- FTC320-OEM TC-Detector.
- Optional: RS232-TTL-converter and PC tools for calibration.

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

Part VIII

Drawings

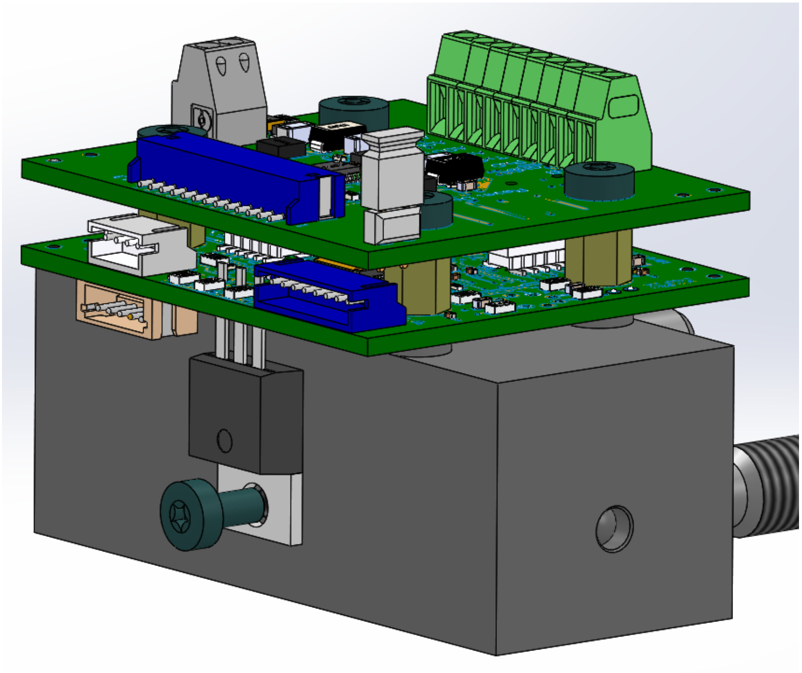

Figure 6: 3D-model of the FTC320-OEM from the upper left side.

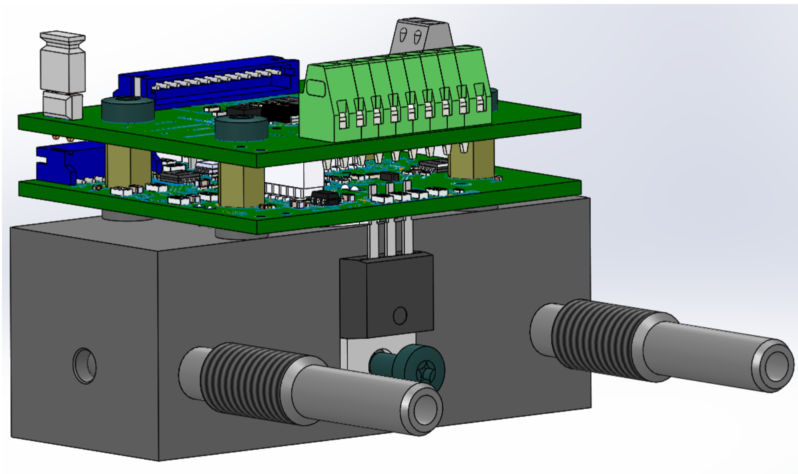

Figure 7: 3D-model of the FTC320-OEM from the bottom left side.

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