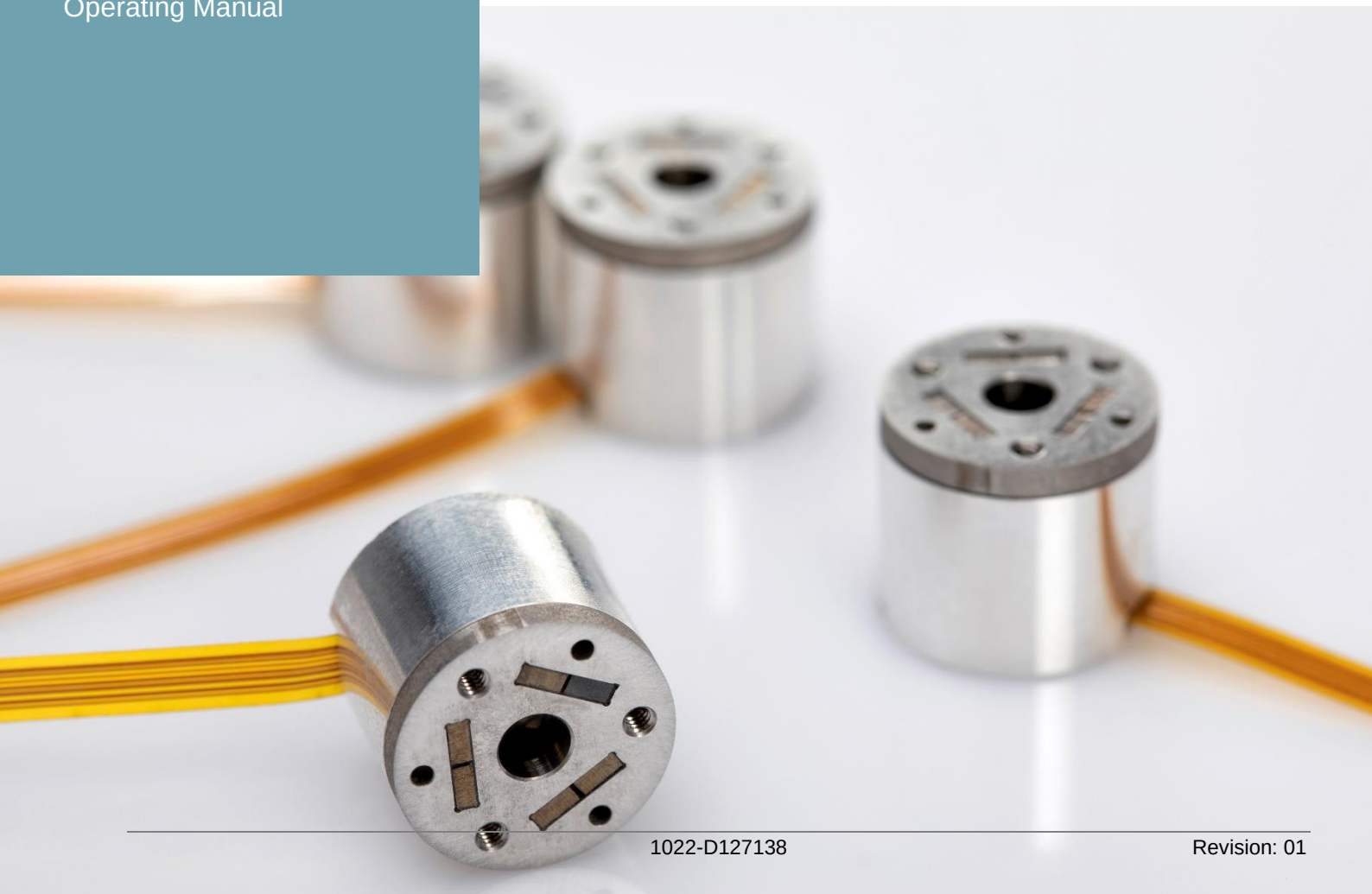
WITTENSTEIN

# Functional Model
# 6-Axis Force Torque Sensor with Evaluation Electronics

Operating Manual



## Revision history

| Revision | Date | Comment | Chapter |
|---|---|---|---|
| 01 | 14-06-2020 | New version | All |

## Technical support

If there are any questions about customer service or repairs service, please contact us.

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## Copyright

# Contents

# 1 About this manual

This operating manual contains necessary information to safely operate the **functional model 6-axis force torque with evaluation electronics**, in the following **functional model F/T sensor**.
The operator must ensure that all persons assigned to install and operate the functional model F/T sensor have read and understood these instructions in full.
Store these instructions within reach of the functional model F/T sensor.
The original was prepared in German, all other language versions are translations of the original instructions.

## 1.1 Signal words

The following signal words are used to indicate hazards, things that are forbidden and important information:

| | |
|---|---|
| | **⚠ DANGER**<br>**This signal word indicates an imminent danger that will cause serious injuries or even death.** |
| | **⚠ WARNING**<br>**This signal word indicates a potential hazard that could cause serious injuries and even death.** |
| | **⚠ CAUTION**<br>**This signal word indicates a potential hazard that could cause minor or serious injuries.** |
| | ***NOTICE***<br>**This signal word indicates a potential hazard that could lead to material damage.** |
| | **A note without a signal word indicates application hints or especially important information for working with the functional model F/T sensor.** |

## 1.2 Safety symbols

The following safety symbols are used to indicate possible hazards, prohibitions, and important information:

| | | | |
|---|---|---|---|
|  |  |  | |
| General danger | Electric voltage | Suspended loads | |

## 1.3 Design of the safety instructions

The safety instructions of these instructions are designed according to the following pattern:

**⚠ CAUTION**

**Explanatory text shows the consequences of disregarding this information.**

- Instructive text uses direct address to indicate what to do.

## 1.4 Information symbols

The following information symbols are used:

- Indicates an action to be performed

➲ Indicates the results of an action

ⓘ Provides additional handling information

# 2 Safety

This operating manual, especially the safety instructions and the rules and regulations valid for the operating site, must be observed by all persons working with the functional model F/T sensor. In addition to the safety instructions in this manual, also observe any (legal and otherwise) applicable environmental and accident prevention rules and regulations (e.g. personal safety equipment).

## 2.1 EU Low Voltage Directive

Since the functional model F/T sensor is in functional model status, EC conformity cannot be certified. Accordingly, the functional model F/T sensor is not provided with a CE mark.
The electrical installation is to be carried out in accordance with the relevant provisions (e.g. wire cross-sections, protection).
Compliance with the requirements for the entire system is the responsibility of the manufacturer of this system.

## 2.2 Dangers

To avoid danger to the operator or damage to the machine, the functional model F/T sensor may be put to use only for its intended usage (see chapter 2.4 "Intended use") and in a technically flawless and safe state.
Read the general safety instructions before beginning work (see chapter 2.7 "General safety instructions").

## 2.3 Personnel

Only technicians who have read and understood this operating manual may perform work on the functional model F/T sensor. Based on their training and experience, technicians must be able to evaluate the tasks assigned to them, in order to recognize and avoid risks.

## 2.4 Intended use

The functional model is only used for verifying the functional principle, the measurement of forces and torques in the three spatial directions. Further it is only intended for laboratory and test operation and is not suitable for long-term testing. The functional samples may neither be placed on the market nor sold to third parties.

- The functional model F/T sensor must not be used in applications with special environmental conditions e.g. vacuum, potentially explosive atmospheres, clean room or areas with radioactive contamination.
- It must be ensured that the functional model F/T sensor is only used up to its specified nominal load.

**⚠ WARNING**

**Under continuous load, the component may break and damage the operating equipment. There is a risk of injury if parts fall off.**

- The functional model F/T sensor has not been subjected to an endurance test. Information on the fatigue strength of the functional model F/T sensor is not available at the time of delivery.

## 2.5 Reasonably foreseeable misuse

Any use that deviates from the approved technical data (e.g. nominal force, nominal torque, temperature) is not use as intended and is therefore not permitted.

## 2.6 Guarantee and liability

Guarantee and liability claims are excluded for personal injury and material damage in case of
- Ignoring the information on transport and storage
- Improper use (misuse)
- Improper or neglected maintenance and repair
- Modifications or reconstructions that have been carried out without the approval of **WITTENSTEIN SE**.

The warranty claims for functional models become time-barred within 12 months after the transfer of risk as detailed in section 5 of the general sales and delivery condition.

## 2.7 General safety instructions

**⚠ WARNING**

**Faulty electrical connections or not approved, current-carrying components can cause serious injuries and even death.**
- Have all electrical connection work performed by qualified technicians only.
- Immediately replace damaged cables or plugs.

**NOTICE**

**Loose or overloaded screw connections can damage the functional model F/T sensor.**
- Always use a calibrated torque wrench to tighten and check all screw connections for which a tightening torque has been specified.

# 3 Product description functional model F/T sensor

The functional model F/T sensor consists of the following components:

- 6-axis F/T sensor,
- Electronics box,
- Application software *F/T Explorer*.

## 3.1 Sensor

The 6-axis force/torque sensor is a compact sensor which can measure forces and torques in the three spatial directions. Strain gauges are used as resistive measurement elements to convert the sensor deformation into electric voltage signals.

Figure 3.1: 6-axis F/T sensors in two available frame sizes

### 3.1.1 3D geometry

The sensor 3D geometry of the available frame sizes is displayed in the followig figure.

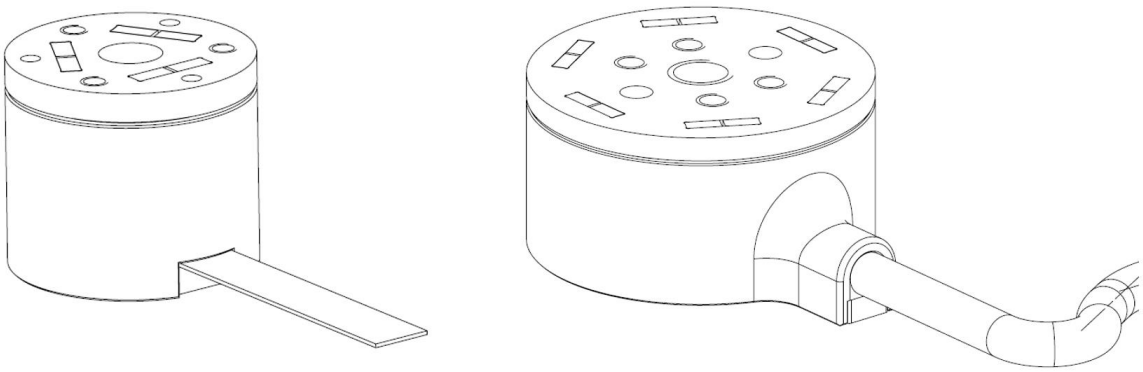


Figure 3.2: 3D geometry of the sensors HEX12 (left) and HEX21 (right)

### 3.1.2 Application interface

The dimensions of the top and bottom cover as application interface for the two available sensor versions HEX12 and HEX21 can be found in chapter 9.1 „Application interface“.

### 3.1.3 Name plate

The name plate is attached to the housing of the electronics.

| | | Despriction |
|---|---|---|
| WITTENSTEIN SE A<br>Walter-Wittenstein-Straße 1, D-97999 Igersheim<br>Sensor kit: Force/torque sensor and electronics board B<br>Type: HEX210S-060S-1 C \| Date: 10-09-2020 D<br>Functional model E<br>Protection class: IP 20 F \| Voltage $U_0$ (V): 3.3 V G<br>Temperature range: 0 – 50 °C H<br>Logo Customer I<br>Customer address, customer city | A | Manufacturer information |
| | B | Product description |
| | C | Ordering code |
| | D | Date of manufacturing |
| | E | Product maturity level |
| | F | IP protection class |
| | G | Supply voltage |
| | H | Operating temperature |
| | I | Customer information |

Tabelle 1: Typenschild 6-Achs-F/T-Sensor

### 3.1.4 Performance data

The maximum permissible forces and torques please see in chapter 9.2 „Technical data“.

## 3.2 Electronics box

The functional model F/T sensor contains the sensor itself as well as the corresponding evaluation electronics. The electronics digitizes the analog voltage signals of the strain gauges and calculates the prevailing forces and torques with the aid of a calibration matrix. This data is then transferred to the computer and visualized by the application software.

Figure 3.3: Electronics box with HEX 21 F/T sensor

## 3.3 Application software *F/T Explorer*

The functional model F/T-Sensor also includes a software application. This visualizes the force and torque values as time series on the computer. Available functions are described in chapter 6.5.

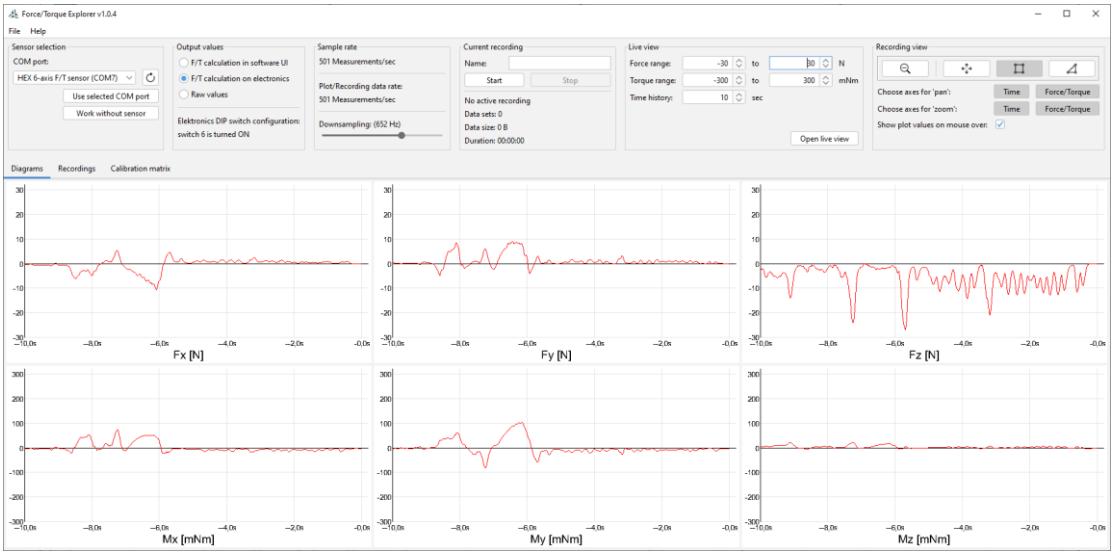


Figure 3.4: Application software *F/T Explorer*

# 4 Transport and storage

## 4.1 Scope of delivery

- Check the completeness of the delivery against the delivery note.
  ⓘ Missing parts or damage must be notified immediately in writing to the carrier, the insurance company or **WITTENSTEIN SE**.

## 4.2 Packaging

The functional model F/T sensor is delivered packed in foil or cardboard boxes.

- Dispose of the packaging materials at the recycling sites intended for this purpose. Observe the applicable national regulations concerning disposal.

## 4.3 Transport

**NOTICE**

**Hard knocks, because of falling or hard dropping, can damage the functional model F/T sensor.**

- Only use hoisting equipment and lifting capacities with sufficient capacity.
- Never exceed the maximum permissible load for hoisting equipment.
- Lower the functional model F/T sensor slowly.

**⚠ WARNING**

**Suspended loads can fall and can cause serious injuries and even death.**

- Do not stand under suspended loads.

## 4.4 Storage

Store the functional model F/T sensor in dry surroundings at a temperature of 0° C to + 30° C in the original packaging. Make sure that the sensor is always stored in an unloaded state to avoid damage and deformation of the sensor.

# 5 Assembly

- Read the general safety instructions before beginning work (see Chapter 2.7 "General safety instructions").

## 5.1 Preparations

**NOTICE**

**Pressurized air can damage the functional model F/T sensor.**

- Do not use pressurized air to clean the functional model F/T sensor.

- Clean/de-grease the output shaft /output flange of the servo actuator with a clean, lint-free cloth moistened with a suitable grease-dissolving but non-aggressive cleaning agent.
- Dry all fitting surfaces to neighboring components in order to achieve the proper friction values of the screw connections.
- Check the fitting surfaces additionally for damage and impurities.

**⚠ DANGER**

**Electrical work in humid conditions can result in electric shocks that can cause serious injury or death.**

- Therefore, clean the sensor and the associated electronics only when switched off and with the power supply deactivated.

## 5.2 Install the functional model F/T sensor in the application

The F/T sensor itself must be installed in the application according to the existing drilling pattern.

- Pay attention to the tapped holes and any existing fits.
- The dimensions can be found in the customer drawing / customer-specific performance data.
- Do not mount the sensor on plastic bodies, as this can lead to signal creep.

**NOTICE**

**Tightening the fastening screws too firmly can damage the functional model F/T sensor.**

- When tightening the screws, make sure that the tightening torques do not exceed the nominal torque of the sensor.
- Example: The tightening torque for M4 screws is 2.64 Nm and nominal torque of the HEX 21 is only 0.5 Nm.

**NOTICE**

**Too much screwing of the fastening screws into the cover structure can damage the functional model F/T sensor.**

- When screwing in the screws, please note that they must not protrude more than 3 mm into the sensor structure.

## 5.3 Elektrische Anschlüsse installieren

**⚠ DANGER**

**Electrically live components may result in electric shocks if touched and can cause serious injuries and even death.**

- Observe the five safety rules of electrical engineering before starting electrical installation work:
  - Disconnect.
  - Secure against being switched on again.
  - Check that there is no voltage.
  - Ground and short-circuit.
  - Cover neighboring and electrified parts.
- Check that protective caps are on the plugs. If protective caps are missing, check the plugs for damage and soiling.

**⚠ DANGER**

**Electric operation in moist areas may result in electric shocks and can cause serious injuries and even death.**

- Carry out the electrical assembly only in dry areas.

The cables of all functional models F/T sensor need to be laid out in such a way that a minimum bending radius 10 x diameter is kept. The cables may be twisted by a maximum of ± 30° over a length of 1 m.
Torsional load of the cables should be avoided.

# 6 Startup and operation

## 6.1 Safety instructions and operating conditions

- Read the general safety instructions before beginning work (see chapter 2.7 "General safety instructions").

**Improper use can cause damage to the functional model F/T sensor.**

- The functional model F/T sensor may only be operated in the laboratory.
- Make sure that the ambient temperature is within the permissible range (see chapter 9.2 „Technical data")
- Use the functional model F/T sensor only up to its maximum limit values (see chapter 9.2 „Technical data"). For other application conditions, please contact our sales department. Always quote the serial number.
- Operate the functional model F/T sensor only if it is permanently mounted.
- Make sure that the sensor housing is grounded during commissioning.

## 6.2 Data for the electrical setup

- There are no voltages higher than 10 V (low voltage range).
- The functional model F/T sensor does not have a 230 V mains plug.

| | |
|---|---|
|  | The cables of all functional models F/T sensor need to be laid out in such a way that a minimum bending radius 10 x diameter is kept. The cables may be twisted by a maximum of ± 30° over a length of 1 m. Torsional load of the cables should be avoided. |

## 6.3 Coordinate axes definition of the sensor

The coordinate axes of the sensor are defined as follows:

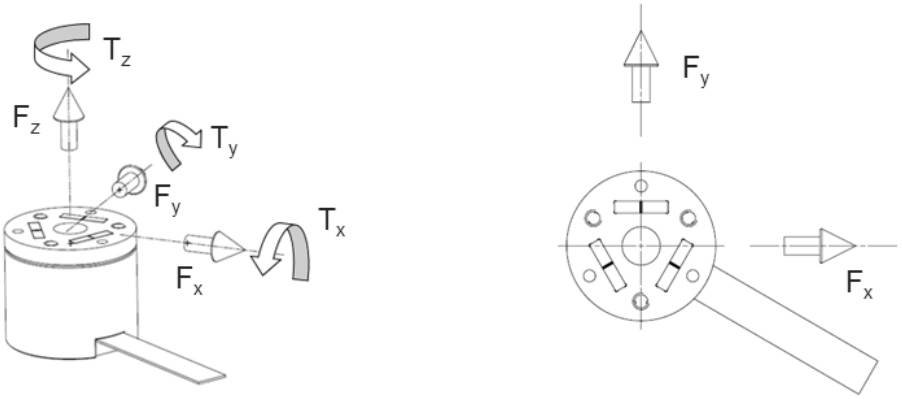



Figure 6.1: Coordinate axes definition of **HEX12** F/T sensor

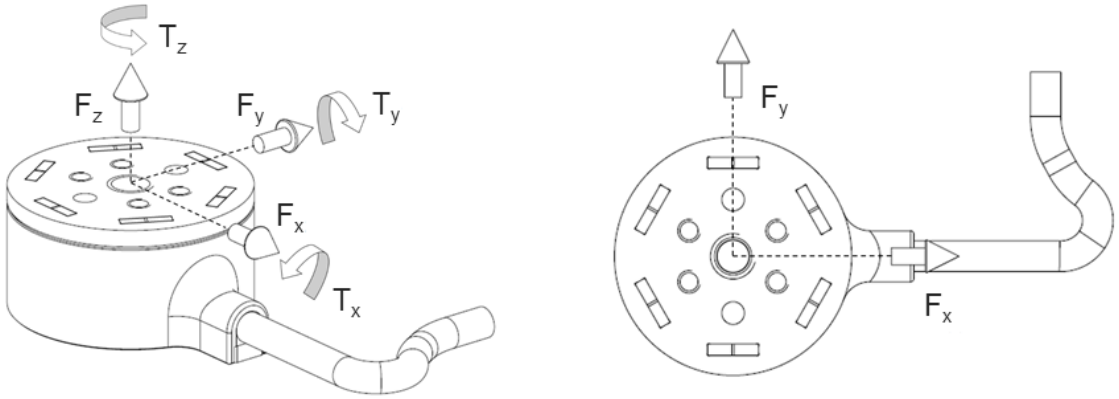
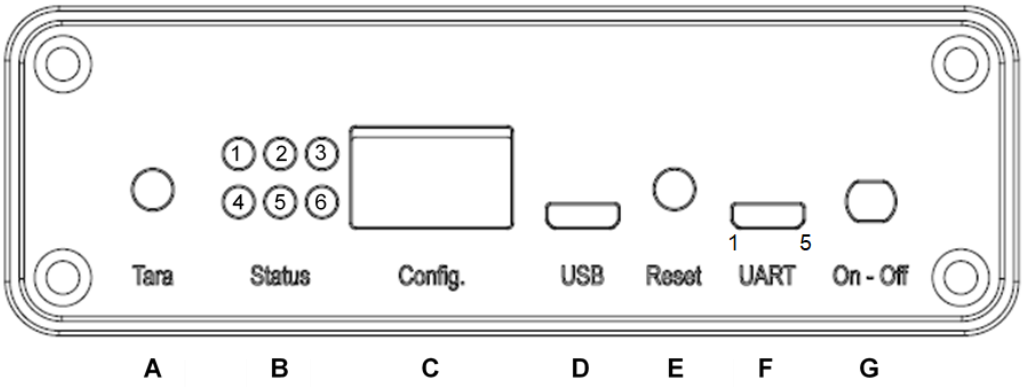



Figure 6.2: Coordinate axes definition for **HEX10**, **HEX21** and **HEX32** F/T sensor

## 6.4 Operation and configuration of the electronics box

Please refer to the following figures and tables for the key assignment and further functional description of the electronics.

### 6.4.1 Description of the control panel




| ID | Function | Description |
|---|---|---|
| A | Tara | This function sets the currently recorded values to zero. |
| B | Status | 1 Flashing light (red) when the tara function is running.<br>2 *No function.*<br>3 *No function.*<br>4 Flashing light (green) when the data transfer is working normally.<br>5 *No function.*<br>6 Power LED: Permanent light (green) when the electronics board is powered on.<br>1 Port error: Permanent light (red) when no data is sent.<br>1-3 Error: Flashing light (red) when an error has occurred. |
| C | Config. | The DIP switch is used to configure the electronics board.<br>The respective pin assignment is shown below (6.3.2). |
| D | USB | The native micro USB interface from the internal STM32 micro controller is used to connect the electronics board with the desktop PC (12 MBit). The electronic is supplied by the 5 volt from the USB interface. |
| E | Reset | This function resets the microcontroller. |
| F | UART | The UART interface is used to communicate with an external micro controller.<br>The respective pin assignment is shown below (6.3.3). |
| G | On - Off | This toggle switch is used to power on and off the electronics board.<br>• Switch – left:<br>Power off.<br>• Switch – middle:<br>Power off.<br>• Switch – right:<br>Power on. |

Table 2: Description of the electronics‘ control panel functions

### 6.4.2 DIP switch configurations

The configurations of the electronics are made by means of the DIP switches. The assignment of the switches is shown in the following table.

| | **Config. [C]** | | | | | |
|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** |
| **Function** | Sample rate | Moving average filter | *Trigger mode* | Sample rate | *Not connected* | Output values |
| **OFF** | *See below* | Off | Off | *See below* | - | Raw values |
| **ON** | | On | On | | | Force / Torque values |

Table 3: DIP switch configuration

| | **Config. [C]** | |
|---|---|---|
| | **1** | **4** |
| **Sample rate** | | |
| 1 kHz | **OFF** | **OFF** |
| 1 kHz | **OFF** | **ON** |
| 500 Hz | **ON** | **OFF** |
| 100 Hz | **ON** | **ON** |

Table 4: DIP switch configuration for sample rate

### 6.4.3 UART interface

The configurations of the UART interface is shwon in the following tables.

| **1** | **2** | **3** | **4** | **5** |
|---|---|---|---|---|
| 5 V | TX 3.3 V | RX (3.3 V) | *Not connected.* | Ground |

Table 5: UART pin configurations

| **Baud rate** | **Word length** | **Paraty** | **Stop** |
|---|---|---|---|
| 2,000,000 bit/s | 8 bit | None | 1 bit |

Table 6: UART interface configurations

### 6.4.4 Data format of the serial interface

The electronics sends data via a serial interface via USB to the COM port of the PC or via the UART interface. First the three force and then three torque values are sent before the temperature value follows. These are 32-bit floating point numbers (float32).

| F_x | F_y | F_z | M_x | M_y | M_z | Temp |
|---|---|---|---|---|---|---|
| 4 Bytes | 4 Bytes | 4 Bytes | 4 Bytes | 4 Bytes | 4 Bytes | 4 Bytes |

Table 7: Datenformat der seriellen Schnittstelle

PLease see a simple Python example to convert the byte stream to floating point numbers below:

[CH2, CH1, CH4, CH3, CH6, CH5, temp] = struct.unpack('fffffff', serial_line[0:28]).

### 6.4.5 Sub-D-HD connector pin assignment

Figure 6.3 shows the pin assignment of the Sub-D-HD connector.

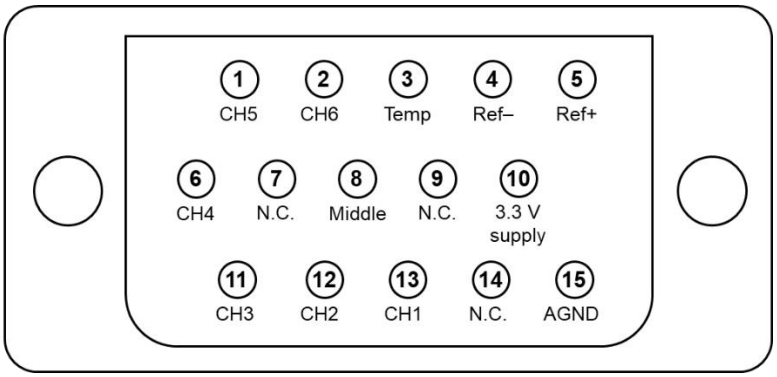



Figure 6.3: Sub-D-HD connector pin assignment

## 6.5 Operation and functions of the application software

The supplied Force/Torque Explorer software is used to display, record and save sensor measurement values.

### 6.5.1 Software installation and start

With the delivery of your sensor you will receive the software application as a compressed archive in ZIP format on a USB stick. You unpack the data on your Windows or Linux computer with 64bit processor architecture. Other operating systems and 32bit environments are not supported.

In a Windows environment start the application by double-clicking the executable file ForceTorqueExplorer.exe. A Java environment is required and is included in the delivery.

After starting the software the serial port where your sensor is connected is automatically selected (HEX 6-axis F/T sensor). The user interface of the *Force/Torque Explorer* is shown in figure 6.1.

### 6.5.2 Software function overview

Please refer to the following table for available functions of the software application.

| ID | Funktion | Beschreibung |
|---|---|---|
| A | Live view | After starting the software, the live view appears. This can be opened at any time using the "Open Live View" button in the upper "Live View" control panel. Here the received sensor data is displayed live. The value ranges of the diagrams can be set in the upper control panel "Live view". |
| B | Sample rate | By default the software receives and processes all data sent by the electronics. The frequency can be adjusted in the upper control panel "Sample rate" and down-sampling can be realized. |
| C | Start/stop recordings | In the upper control panel "Recording" a new recording can be started with the button "Start". Before that a name can be assigned. With the button "Stop" in the same control panel the recording is stopped. |
| D | View/edit/export recordings | In the tab "Recordings" all previous recordings are listed. These can be viewed, renamed, deleted and exported using the available control panels. Furthermore, previously exported recordings can be imported (supported file formats see chapter 6.5.3). When viewing recordings, the diagram can be moved with the left mouse button pressed down and zoomed with the mouse wheel. |
| E1 | Calibration matrix | In the tab "Calibration matrix" the calibration matrix for the conversion of raw values into force/torque values can be imported, exported, transposed and edited. You will receive the calibration matrix for your sensor with the delivery. |
| E2 | Calibration matrix further information | The calibration matrix is also implemented on the sensor electronics. The matrix calculation can be done both in the electronics and in the software application.<br>**Attention:** If the matrix calculation is activated twice, wrong values of force and torque are displayed.<br>Default assignment:<br>- Electronics: DIP switch config. 6: ***OFF = Raw values***<br>- Software-Appl.: Activate Matrix: ***ON = F/T values*** |

Table 8: Function overview of the software application *F/T Explorer*

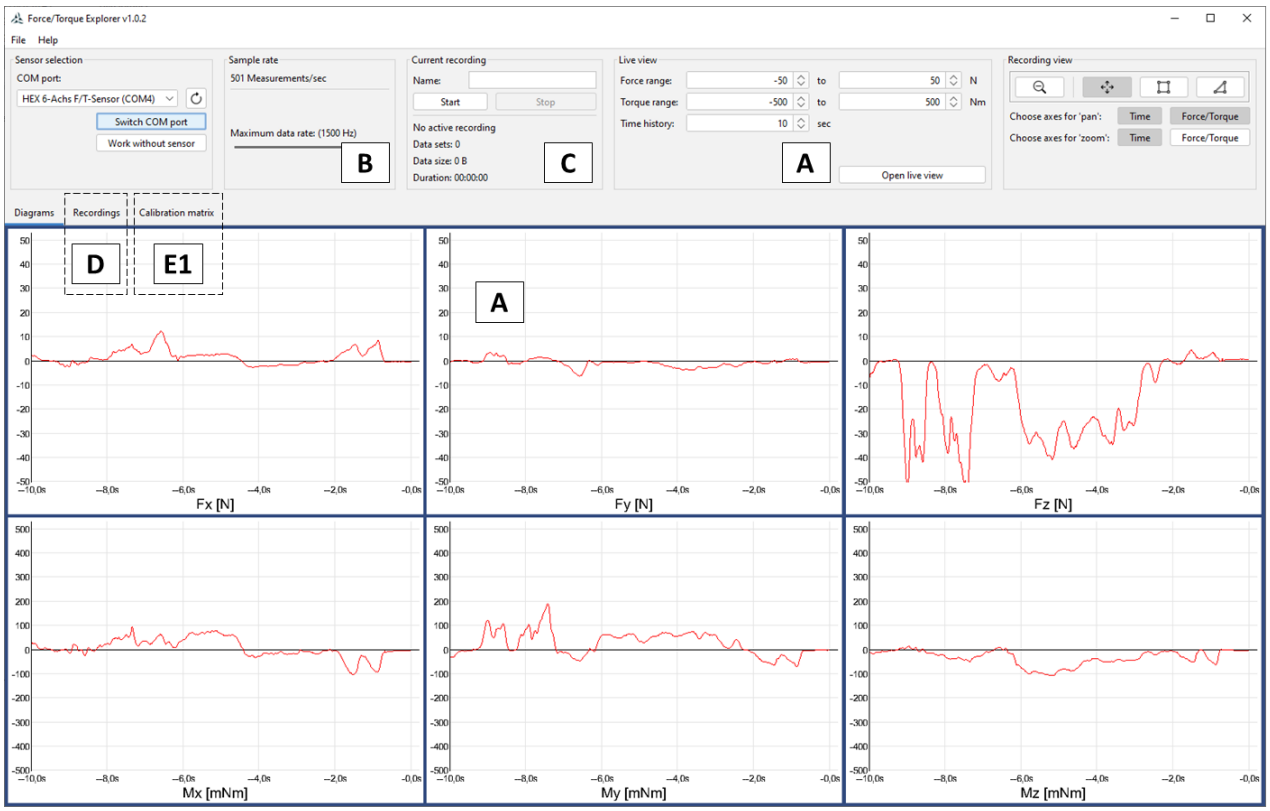



Figure 6.4: Function overview of the *F/T Explorer*

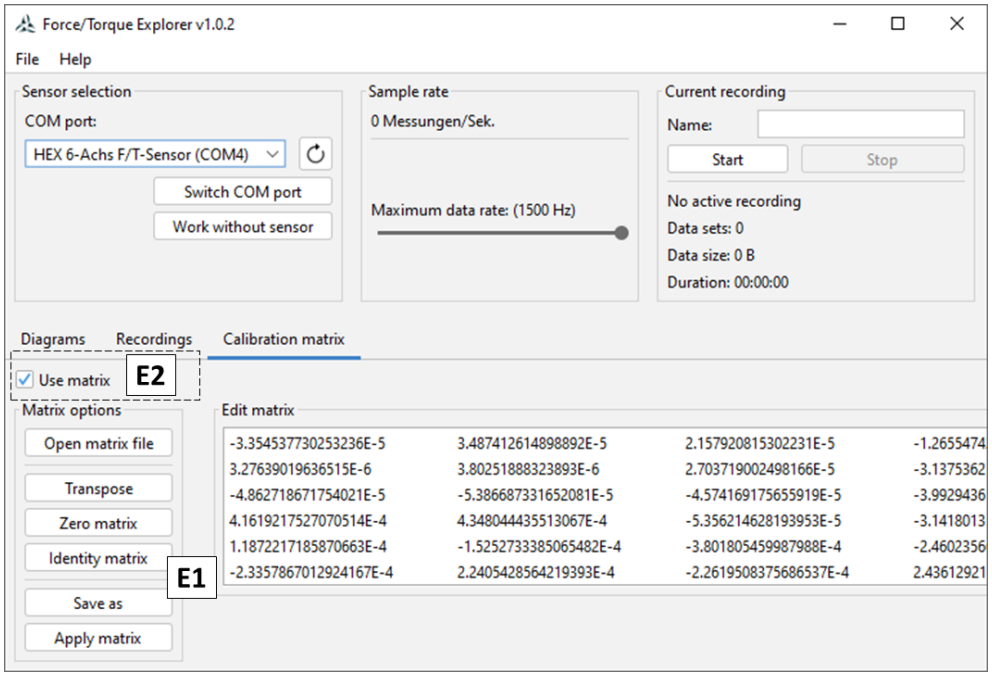



Figure 6.5: How to use the calibration matrix in *F/T Explorer*

### 6.5.3 Supported file formats for recordings

The interface allows data to be recorded and exported in various file formats for further processing. Due to the small data size, we recommend exporting in binary format. Further available file formats are listed in the following table.

| Format | | Note | F/T Explorer supports | |
|---|---|---|---|---|
| | | | Import | Export |
| Binary file | .dat | Recommended file format. Smallest file size. | X | X |
| JavaScript Object Notation | .json | Import not supported. File size reduced to minimum. | | X |
| Comma Separated Values | .csv | Standard CSV with separator [ , ] and decimal mark [ . ]. Further format for directly importing into Excel with separator [ ; ] and decimal mark [ , ]. | X[a)] | X |
| Python Pickle | .pkl | Binary format for import into Python. Sample script provided in the "Scripts" folder in the program directory. | X | X |

a) Import is only supported for the standard format, not for the Excel format.

# 7 Maintenance and disposal

- Read the general safety instructions before beginning work (see chapter 2.7 "General safety instructions").

## 7.1 Maintenance work

### 7.1.1 Visual inspection

- Check the entire functional model F/T sensor and all cables for exterior damage.

### 7.1.2 Checking the tightening torques

- Check the tightening torque of the fastening screws on the functional model F/T sensor before you start the measuring process.
- When tighthening the screws, make sure that the tightening torques do not exceed the nominal torque of the sensor.

### 7.1.3 Cleaning

**NOTICE**

**Pressurized air can damage the servo actuator seals.**

- Do not use pressurized air to clean the functional model F/T sensor.

- Clean the functional model F/T sensor using a clean, lint-free cloth.
- If necessary, use a suitable fat dissolving but non-aggressive cleaning agent.
- Dry all contact surfaces to adjacent components to obtain the correct coefficients of friction of the screw connections.
- Additionally check the contact surfaces for damage and foreign bodies.

## 7.2 Maintenance

Perform a visual inspection of the functional model F/T sensor before each commissioning.

- Check the sensor for obvious damage.
- Check the sensor for dirt and remove it if necessary according to the cleaning instructions in chapter 7.1.3 "Cleaning".
- Check the cables for damages.
- Check the evaluation electronics for obvious damages.
- Check the evaluation electronics for soiling and remove it if necessary according to the cleaning instructions in chapter 7.1.3 "Cleaning".

**⚠ DANGER**

**Touching live parts or damaged cables can result in electric shock that can cause serious injury or death.**

- Check the functional model F/T sensor for damaged cables and plugs before each use.
- Also check the evaluation electronics for damage before each comissioning.

## 7.3 Disposal

Consult our customer service department for supplementary information on disassembly and disposal of the functional model F/T sensor.

ⓘ Dispose of the functional model F/T sensor at the recycling sites intended for this purpose.
ⓘ Observe the locally valid regulations for disposals.

# 8 Malfunctions

***NOTICE***

**Changed operational behavior can be an indication of existing damage or cause damage to the functional model F/T sensor.**

- Do not put the functional model F/T sensor back into operation until the cause of the malfunction has been rectified.

Rectifying of malfunctions may only be done by specially trained technicians.

| Fault | Possible cause | Solution |
|---|---|---|
| **No measurement are displayed** | Sensor plug not plugged into electronics | Insert the sensor plug into the evaluation electronics. |
| | Electronics switched off | Switch on the evaluation electronics using the power switch. |
| | Electronics not connected to power supply | Connect the evaluation electronics to the power supply via the USB plug. |

| | | |
|---|---|---|
| | Cable break | Please contact our customer service. |
| **Displaying incorrect measured values** | Incorrect calibration | Please contact our customer service. |
| | Overload of the sensor and plastic deformation of the elementary cells | In case of plastic deformation of the elementary cells, the sensor was irreparably damaged due to improper loading or overloading. |
| | Overload of the sensor and breakage of the bond or the elementary cells | In case of breakage of the adhesive bond or the elementary cells, the sensor was irreparably damaged due to improper loading or overloading. |
| | Sensor not zeroed correctly | Zero the sensor by means of the „Tara“ function. |
| | Double activation of matrix calculation in electronics and software application | Matrix calculation is activated only once.<br><br>Default assignment:<br>- Electronics: DIP switch config. 6: ***OFF = Raw values***<br>- Software-Appl.: Activate Matrix: ***ON = F/T values*** |
| | Sensor signals creep strongly | Mount the sensor on a rigid base (steel, no polymers) and fix it with steel screws. |
| **Sporadic failure** | Cable break | Please contact our customer service. |

Table 9: Malfunctions

# 9 Appendix

## 9.1 Application interface

The dimensions of the top and bottom cover which serve as the application interface for the two available sensor versions HEX12 and HEX21 can be found in the following.

### 9.1.1 Application interface – HEX 12

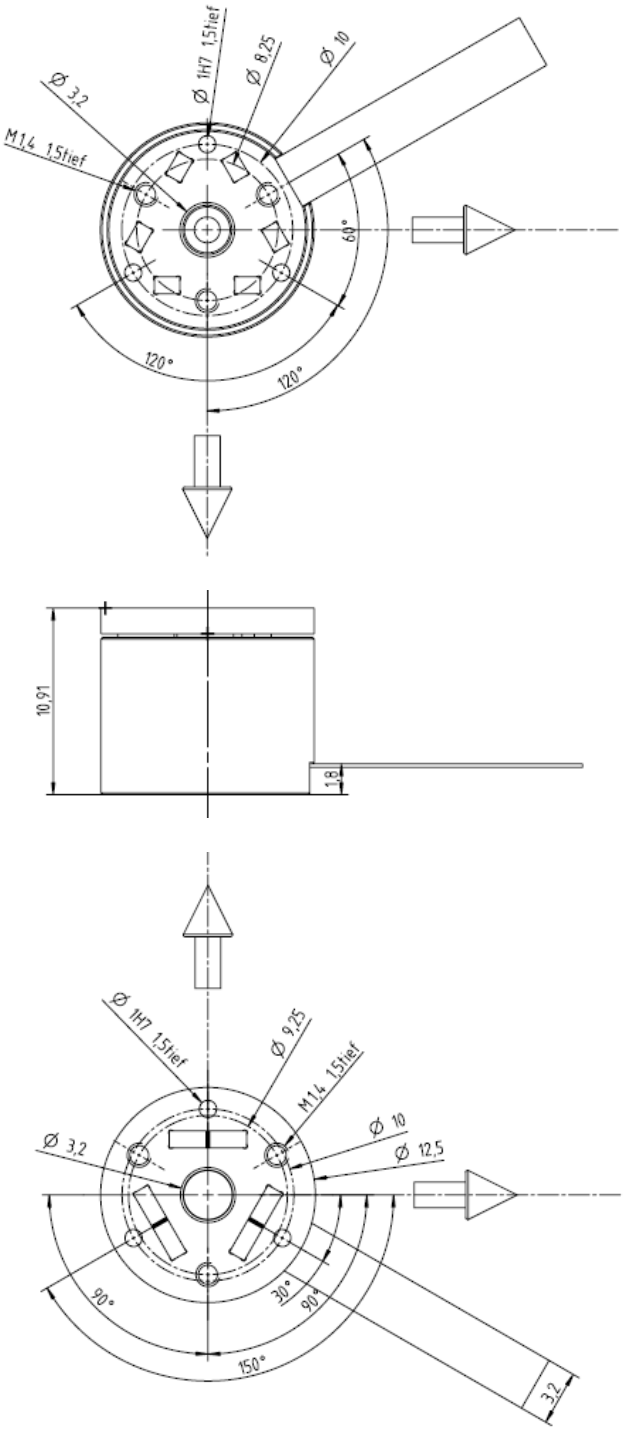



Figure 9.1: Dimensions of the HEX 12 top and bottom cover as application interface (same bore hole pattern at the top and bottom)

### 9.1.2 Application interface – HEX 21

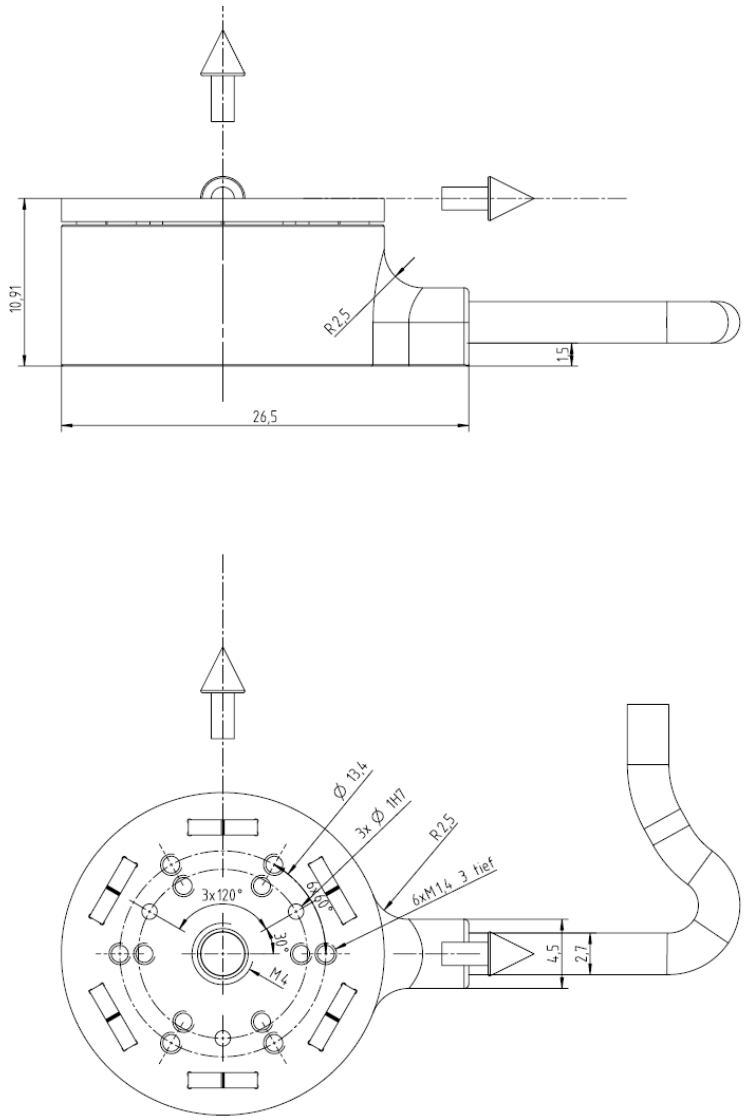



Figure 9.2: Dimensions of the HEX 21 top and bottom cover as application interface (same bore hole pattern at the top and bottom)

## 9.2 Technical data

Please note that in exceptional cases the functional model F/T sensor may deviate from the given technical data.

### 9.2.1 Technical data – HEX 12

| **SENSOR** | |
|---|---|
| Ordering code | HEX125S-020S-1R1-1 |
| **Dimensions** | |
| Diameter [a)] | 12.5 mm |
| Height | 11.0 mm |
| Weight | < 10 g |
| **Nominal measurement range** | |
| $F_x$, $F_y$, $M_z$ | ± 25 N |
| $M_x$, $M_y$, $M_z$ | ± 125 mNm |

| Technical specifications | |
|---|---|
| Accuracy [b] | 1 % |
| Crosstalk | 3 % |
| Overload capacity | 300 % |
| **Product features** | |
| Material | Titanium Grade 5, Aluminium |
| Protection class | IP20 |
| Temperature range | 0 – 50 °C |
| Technology | Foil strain gauges |
| Cable | Flex cable with axial/radial cable outlet and Sub-D-HD connector |

a) The diameter excludes any connector or cable features.

b) The accuracy is the difference between the applied and the actually measured load.
The maximum measurement accuracy in percent refers to the full scale value of the sensor.

### 9.2.2 Technical data – HEX 21

| SENSOR | |
|---|---|
| Ordering code | HEX210S-060S-1R1-1 |
| **Dimensions** | |
| Diameter [a] | 21.0 mm |
| Height | 11.0 mm |
| Weight | < 10 g |
| **Nominal measurement range** | |
| $F_x$, $F_y$, $F_z$ | ± 50 N |
| $M_x$, $M_y$, $M_z$ | ± 0.5 Nm |
| **Technical specifications** | |
| Accuracy [b] | 1 % |
| Crosstalk | 3 % |
| Overload capacity | 300 % |
| **Product features** | |
| Material | Titanium Grade 5, Aluminium |
| Protection class | IP20 |
| Temperature range | 0 – 50 °C |
| Technology | Foil strain gauges |
| Cable | Round cable with radial cable outlet and Sub-D-HD connector |

a) The diameter excludes any connector or cable features.

b) The accuracy is the difference between the applied and the actually measured load.
The maximum measurement accuracy in percent refers to the full scale value of the sensor.

### 9.2.3 Technical data – Evaluation electronics

| **ELECTRONICS BOX** | |
|---|---|
| Ordering code | EVAL100S-06-1 |
| **Product features** | |
| Dimensions | 100 x 86 x 34 mm |
| Supply voltage | 5 V |
| Interface | USB, UART |
| Sample rate | 100 Hz, 500 Hz, 1 kHz |
| Resolution | 10 bit (true), 3 $\sigma$ |
| Temperature range | 0 °C – 50 °C |

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