



Assembly and Operating Manual

FTR-AXIA

Force/torque sensor

Translation of Original Operating
Manual

Hand in hand for tomorrow

Imprint

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Technical changes:

We reserve the right to make alterations for the purpose of technical improvement.

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Dear Customer,

Thank you for trusting our products and our family-owned company, the leading technology supplier of robots and production machines.

Our team is always available to answer any questions on this product and other solutions. Ask us questions and challenge us. We will find a solution!

Best regards,

Your SCHUNK team

Customer Management

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Please read the operating manual in full and keep it close to the product.

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1 General

1.1 About this manual

This manual contains important information for a safe and appropriate use of the product.

This manual is an integral part of the product and must be kept accessible for the personnel at all times.

Before starting work, the personnel must have read and understood this operating manual. Prerequisite for safe working is the observance of all safety instructions in this manual.

In addition to these instructions, the documents listed under ▶ 1.1.5 [6] are applicable.

NOTE: The illustrations in this manual are intended to provide a basic understanding and may deviate from the actual version.

1.1.1 Presentation of Warning Labels

To make risks clear, the following signal words and symbols are used for safety notes.



⚠ DANGER

Dangers for persons!

Non-observance will inevitably cause irreversible injury or death.



⚠ WARNING

Dangers for persons!

Non-observance can lead to irreversible injury and even death.



⚠ CAUTION

Dangers for persons!

Non-observance can cause minor injuries.

CAUTION

Material damage!

Information about avoiding material damage.

1.1.2 Definition of Terms

The term "product" replaces the product name on the title page in this manual.

1.1.3 Variants

This operating manual applies to the following variations:

- Force/torque sensor FTR-AXIA with RS485 interface
 - SI-75-4/SI-150-8
 - SI-200-8/SI-500-20
 - SI-480-20/SI-1200-50

1.1.4 Sizes

This operating manual applies to the following sizes:

- FTR-AXIA 80

1.1.5 Applicable documents

- General terms of business *
- Catalog data sheet of the purchased product *
- Assembly and operating manuals of the accessories *

The documents labeled with an asterisk (*) can be downloaded from [schunk.com/downloads](https://www.schunk.com/downloads).

1.2 Warranty

If the product is used as intended, the warranty is valid for 24 months from the ex-works delivery date under the following conditions:

- Observe the specified maintenance and lubrication intervals
- Observe the ambient conditions and operating conditions

Parts touching the workpiece and wear parts are not included in the warranty.

1.3 Scope of delivery

The scope of delivery includes

- Force/torque sensor in the version ordered
- 5USB connector type A with following characteristics:
 - Sensor cable with M8 socket, 6-pin for connection to product
 - Outlet for 3.5 mm jack cable for synchronization with customer application
- Assembly and Operating Manual
- Accessory pack

1.4 Accessories

A wide range of accessories are available for this product

For information regarding which accessory articles can be used with the corresponding product variants, see catalog data sheet.

2 Basic safety notes

2.1 Intended use

The product is a machine component designed for measuring forces and torques (FT) in six directions. Forces acting mechanically are converted by the product to electrical measured values and transferred to a PC via RS485 protocol.

- The product may only be used within the scope of its technical data, ▶ 3 [13].
- When implementing and operating components in safety-related parts of the control systems, the basic safety principles in accordance with DIN EN ISO 13849-2 apply. The proven safety principles in accordance with DIN EN ISO 13849-2 also apply to categories 1, 2, 3 and 4.
- The product is intended for installation in a machine/ automated system. The applicable guidelines for the machine/ automated system must be observed and complied with.
- The product is intended for industrial and industry-oriented use.
- Appropriate use of the product includes compliance with all instructions in this manual.

2.2 Not intended use

- Any utilization that exceeds or differs from the appropriate use is regarded as misuse.

2.3 Constructional changes

Implementation of structural changes

Modifications, changes or reworking, e.g. additional threads, holes, or safety devices, can damage the product or impair its functionality or safety.

- Structural changes should only be made with the written approval of SCHUNK.

2.4 Spare parts

Use of unauthorized spare parts

Using unauthorized spare parts can endanger personnel and damage the product or cause it to malfunction.

- Use only original spare parts or spares authorized by SCHUNK.

2.5 Ambient conditions and operating conditions

Required ambient conditions and operating conditions

Incorrect ambient and operating conditions can make the product unsafe, leading to the risk of serious injuries, considerable material damage and/or a significant reduction to the product's life span.

- Make sure that the product is used only in the context of its defined application parameters, ▶ 3 [13].

2.6 Personnel qualification

Inadequate qualifications of the personnel

If the personnel working with the product is not sufficiently qualified, the result may be serious injuries and significant property damage.

- All work may only be performed by qualified personnel.
- Before working with the product, the personnel must have read and understood the complete assembly and operating manual.
- Observe the national safety regulations and rules and general safety instructions.

The following personal qualifications are necessary for the various activities related to the product:

Trained electrician

Due to their technical training, knowledge and experience, trained electricians are able to work on electrical systems, recognize and avoid possible dangers and know the relevant standards and regulations.

Qualified personnel

Due to its technical training, knowledge and experience, qualified personnel is able to perform the delegated tasks, recognize and avoid possible dangers and knows the relevant standards and regulations.

Instructed person

Instructed persons were instructed by the operator about the delegated tasks and possible dangers due to improper behaviour.

Service personnel of the manufacturer

Due to its technical training, knowledge and experience, service personnel of the manufacturer is able to perform the delegated tasks and to recognize and avoid possible dangers.

2.7 Personal protective equipment

Use of personal protective equipment

Personal protective equipment serves to protect staff against danger which may interfere with their health or safety at work.

- When working on and with the product, observe the occupational health and safety regulations and wear the required personal protective equipment.
- Observe the valid safety and accident prevention regulations.
- Wear protective gloves to guard against sharp edges and corners or rough surfaces.
- Wear heat-resistant protective gloves when handling hot surfaces.
- Wear protective gloves and safety goggles when handling hazardous substances.
- Wear close-fitting protective clothing and also wear long hair in a hairnet when dealing with moving components.

2.8 Notes on safe operation

Incorrect handling of the personnel

Incorrect handling and assembly may impair the product's safety and cause serious injuries and considerable material damage.

- Avoid any manner of working that may interfere with the function and operational safety of the product.
- Use the product as intended.
- Observe the safety notes and assembly instructions.
- Do not expose the product to any corrosive media. This does not apply to products that are designed for special environments.
- Eliminate any malfunction immediately.
- Observe the care and maintenance instructions.
- Observe the current safety, accident prevention and environmental protection regulations regarding the product's application field.

2.9 Malfunctions

Behavior in case of malfunctions

- Immediately remove the product from operation and report the malfunction to the responsible departments/persons.
- Order appropriately trained personnel to rectify the malfunction.
- Do not recommission the product until the malfunction has been rectified.
- Test the product after a malfunction to establish whether it still functions properly and no increased risks have arisen.

2.10 Disposal

Handling of disposal

The incorrect handling of disposal may impair the product's safety and cause serious injuries as well as considerable material and environmental harm.

- Follow local regulations on dispatching product components for recycling or proper disposal.

2.11 Fundamental dangers

General

- Observe safety distances.
- Never deactivate safety devices.
- Before commissioning the product, take appropriate protective measures to secure the danger zone.
- Disconnect power sources before installation, modification, maintenance, or calibration. Ensure that no residual energy remains in the system.
- If the energy supply is connected, do not move any parts by hand.
- Do not reach into the open mechanism or movement area of the product during operation.

2.11.1 Protection during handling and assembly

Incorrect handling and assembly

Incorrect handling and assembly may impair the product's safety and cause serious injuries and considerable material damage.

- Have all work carried out by appropriately qualified personnel.
- For all work, secure the product against accidental operation.
- Observe the relevant accident prevention rules.
- Use suitable assembly and transport equipment and take precautions to prevent jamming and crushing.

Incorrect lifting of loads

Falling loads may cause serious injuries and even death.

- Stand clear of suspended loads and do not step into their swiveling range.
- Never move loads without supervision.
- Do not leave suspended loads unattended.

2.11.2 Protection during commissioning and operation

Falling or violently ejected components

Falling and violently ejected components can cause serious injuries and even death.

- Take appropriate protective measures to secure the danger zone.
- Never step into the danger zone during operation.

3 Technical data

3.1 Basic data

Designation	Value
Weight [kg]	0.3
Diameter [mm]	82
Height [mm]	25.4
Force overload on axes [N] *	
F_x, F_y	± 2500
F_z	± 4500
Torque overload on axes [Nm] *	
M_x, M_y	± 100
M_z	± 100
Force rigidity (calculative) [N/m]	
X and Y-axis	2.7×10^7
Z-axis	4.1×10^7
Torque rigidity (calculative) [N/rad]	
X and Y-axis	2.4×10^4
Z-axis	4.8×10^4
Natural frequencies [Hz]	
F_x, F_y, M_z	2200
M_x, M_y, F_z	2600

*

Caution: The overload values apply only when loading in one relevant axis direction, not when there is an overlap of forces and torques in several axis directions!

More technical data is included in the catalog data sheet. Whichever is the latest version.

3.2 Ranges of measurement

Each version of the product is calibrated in two force and torque ranges. The ranges of measurement 1 and 2 each refer to the force and torque parameters of the individual axes.

Calibration version

The product can be calibrated differently, depending on the version:

Parameter	F_{XY} [N]	F_z [N]	M_{XYZ} [Nm]
Range of measurement 1	150	470	8
Range of measurement 2	75	235	4

Tab.: Version FTR-AXIA SI-75-4/SI-150-8

Parameter	F_{XY} [N]	F_z [N]	M_{XYZ} [Nm]
Range of measurement 1	500	900	20
Range of measurement 2	200	360	8

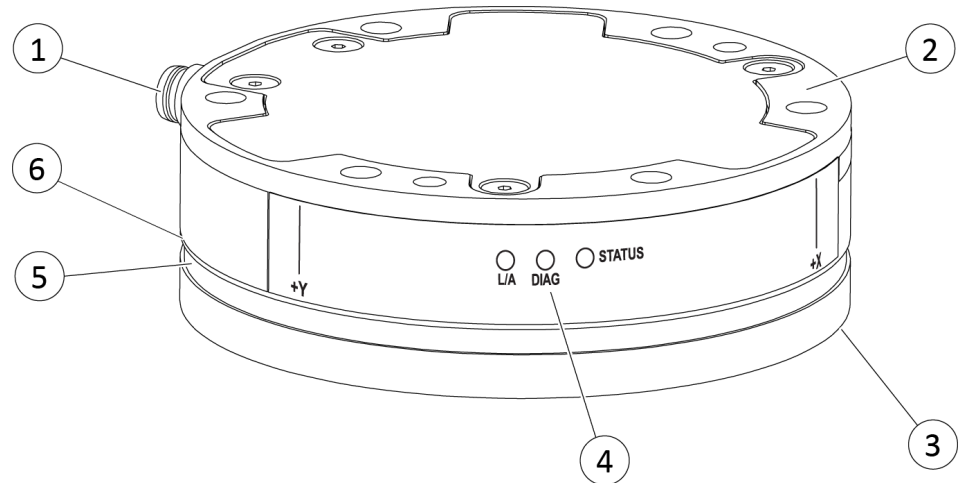
Tab.: Version FTR-AXIA SI-200-8/SI-500-20

Parameter	F_{XY} [N]	F_z [N]	M_{XYZ} [Nm]
Range of measurement 1	1200	2000	50
Range of measurement 2	480	800	20

Tab.: Version FTR-AXIA SI-480-20/SI-1200-50

4 Design and description

4.1 Design



Design

Item	Designation
1	Plug-in connection with fitting for power and signal line, 6-pin, M8
2	Robot side (for adapter plate or robot)
3	Tool side (for customer tool or end effector)
4	LEDs: link/activity, diagnosis, status
5	Seal for protection class IP64
6	Identification groove for identification of product version

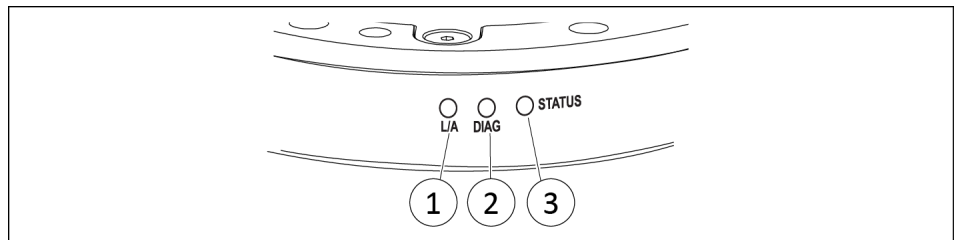
4.2 Description

Application

- Forces and torques are measured via three measuring bridges, each with four silicone strain gauges in six directions $(F_x / F_y / F_z / M_x / M_y / M_z)$
- Acting forces and torques are measured and transferred to a PC as calibrated data.
- Interfering contours are avoided due to the compact housing.
- A very high rigidity ensures the accuracy of measured values and prevents unwanted movement or twisting of the sensor.
- Individual vibration damping due to programmable low-pass filter with limit frequency.
- Dust and splash water protection enable flexible use.

LEDs

Three LEDs on the product indicate the current operating status.



LEDs on the product

Item	LED	Meaning
1	L/A	Link/activity LED lights up green when there is a connection/activity or is switched off when there is no connection or activity.
2	DIAG	Diagnostics LED lights up red in case of error or is switched off, ▶ 6.1 [38].
3	STATUS	Status LED indicates correct or incorrect functioning of the product via a red, green or orange indicator, ▶ 6.1 [38].

4.3 Special features of the FTR-Axia 80

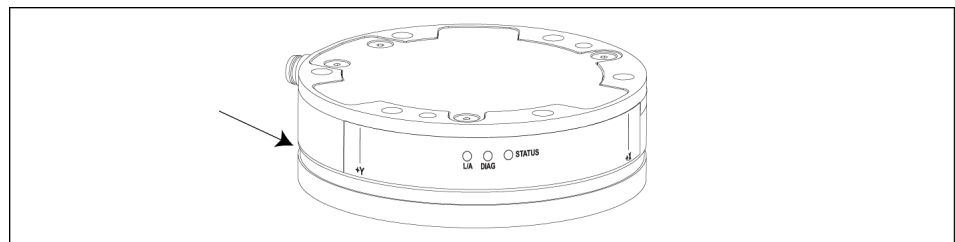
In addition to the LEDs on the product, LEDs on the USB port tell you about the current data flow, USB connector.

Functional principle

The robot side of the housing (2) is screwed onto the robot or adapter plate. The customer tool, such as a gripper or another end effector, is mounted onto the tool side (3). Six screws ensure a secure hold in each case; two alignment pins each guarantee precise torque measurements and serve as additional twist protection.

Product versions

The number of identification grooves in the product indicates which product version it is.

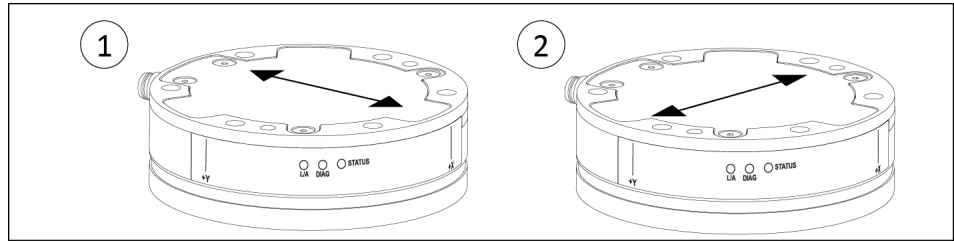


Identification groove

Version	Material	Number of grooves
SI-75-4/SI-150-8	Aluminum	3
SI-200-8/SI-500-20	Aluminum	0
SI-480-20/SI-1200-50	Stainless steel	2

4.4 Measurements

4.4.1 X/Y-axis force measurements

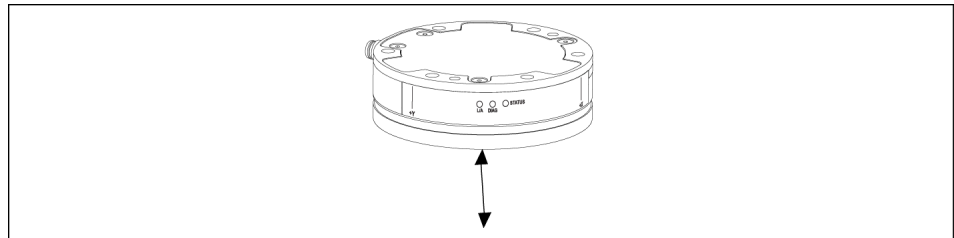


X/Y-axis force measurement

Item	Axis	Measurement
1	X-axis	The tool side is moved in the X-axis direction compared to the robot side.
2	Y-axis	The tool side is moved in the Y-axis direction compared to the robot side.

For the most part, the tool side is moved both in the X and Y directions simultaneously, leading therefore to the result F_{XY} .

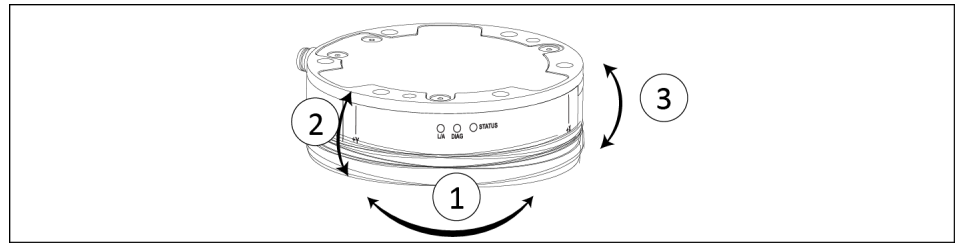
4.4.2 Z-axis force measurement



Z-axis force measurement

When measuring force in the Z-axis direction, the tool side of the product is moved in the Z-axis direction compared to the robot side. This leads to the result F_z .

4.4.3 Torque measurements



Torque measurements

The torques that act on the product around the axes are measured.

Item	Axis	Measurement
1	Z-axis	The tool side is twisted compared to the robot side (M_z).
2	Y-axis	The tool side is tilted in the Y-axis direction compared to the robot side (M_y).
3	X-axis	The tool side is tilted in the X-axis direction compared to the robot side (M_x).

5 Assembly

5.1 Mechanical connection

5.1.1 Fastening elements

Mounting and connection	FTR-AXIA	
	SI-75-4/ SI-150-8	SI-200-8/ SI-500-20
Threadlock adhesive	Loctite ® 242	
Robot side connection (adapter plate or robot)		
Mounting screw (6 Piece)	M5 x 8.5, 12.9	
Tightening torque [Nm]	5.88	8.47
Drilled hole for alignment pin (2 Piece)	Ø 4 H7	
Tool side connection		
Mounting screw (4 Piece)	M5 x 5.2, 12.9	
Tightening torque [Nm]	5.88	8.47
Mounting screw, supplied by the customer (6 Piece)	M5 x 5, 12.9	
Tightening torque [Nm]	5.88	8.47
Drilled hole for alignment pin (2 Piece)	Ø 3 H7	

5.1.2 Requirements for adapter plates

The product is normally mounted between the robot arm and the end effector (customer tool). If required, an adapter plate can be used on both mounting sides to adapt the product to the customer's equipment (robot flange, end effector). Alignment pins allow precise positioning here. Threaded holes allow for secure fastening.

Adapter plate requirements

CAUTION

Risk of material damage caused by incorrect alignment elements!

Using more than two alignment elements may damage the product.

- To align the product to the adapter plate, use an alignment pin and centering collar.
- If necessary, you can order customized adapter plates from SCHUNK on request.

Note the following when configuring the adapter plate:

- The adapter plate must have bore holes for screws and alignment pins for precise positioning on the robot and product. Alignment pins prevent unwanted shifting and twisting. Information about fastening elements on the tool and robot side is provided in the relevant manuals.
- The adapter plate must be thick enough to ensure the required depth of engagement for the fastening screws. The adapter plate must allow for rigid mounting on the product.
- The fastening screws must have the correct length. If the fastening screws are too long, there will be a gap between the adapter plate and the product whereas fastening screws that are too short will not provide a secure connection.
- Two alignment pins prevent twisting. The alignment pins must not protrude further from the surface of the adapter plate than permitted by the corresponding bore hole in the product's housing.

CAUTION

Risk of material damage if alignment pins are too long!

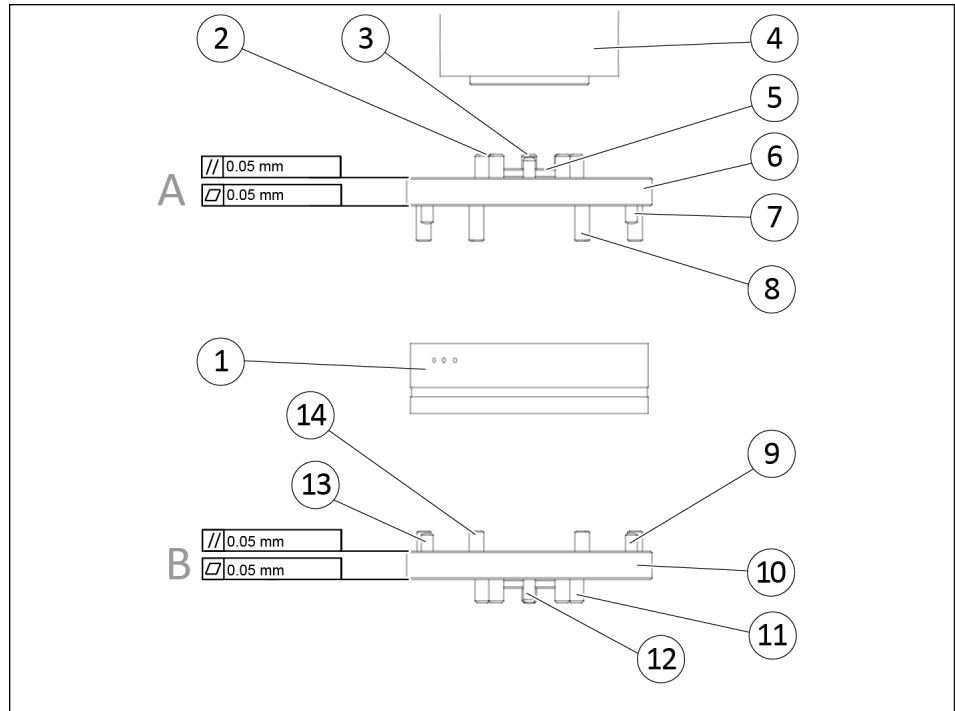
Using alignment pins that are too long creates a gap between the adapter plate and the product and can damage the product.

- Use alignment pins of the correct length.
- Make sure the adapter plate and product are flush.

CAUTION

The customer tool may only touch the tool adapter plate.

If the tool touches another part of the product, the load will not be correctly detected.



Item	Description
1	Product
2	Fastening screw M5 x 8.5
3	Alignment pin 3 mm
4	Robot arm
5	Alignment hub
6	Assembly adapter plate
7	Alignment pin 3 mm
8	Fastening screw M5 x 5.2
9	Alignment pin 4 mm (provided by customer)
10	Tool adapter plate (provided by customer)
11	Fastening screw (provided by customer)
12	Alignment 4 mm (provided by customer)
13	Alignment 3 mm (provided by customer)
14	Fastening screw M5 x 8.5

5.2 Assembling and connecting the product



⚠ WARNING

Risk of injury due to unexpected movements!

If the power supply is switched on or residual energy remains in the system, components can move unexpectedly and cause serious injuries.

- Before starting any work on the product: Switch off the power supply and secure against restarting.
- Make sure, that no residual energy remains in the system.



⚠ WARNING

Risk of injury due to improperly carried out assembly!

Improperly carried out assembly work can lead to severe injuries and property damage.

- Before beginning work, ensure sufficient assembly clearance.
- Secure components from falling down or over.
- Ensure that all work has been carried out in accordance with the specifications in these instructions.
- Observe tightening torques.

CAUTION

Incorrect assembly will cause material damage!

The drilling patterns on the assembly and tool side of the product are identical but the depths of engagement differ! The screws for the assembly side can cause damage to the product on the tool side.

- Take care not to mix up the assembly and tool side of the product.

NOTE

- Secure all screws with Loctite® 242. To do this, apply adhesive to the exposed screw threads.
- Use adhesive only once. Always apply new adhesive if reusing fastening elements.

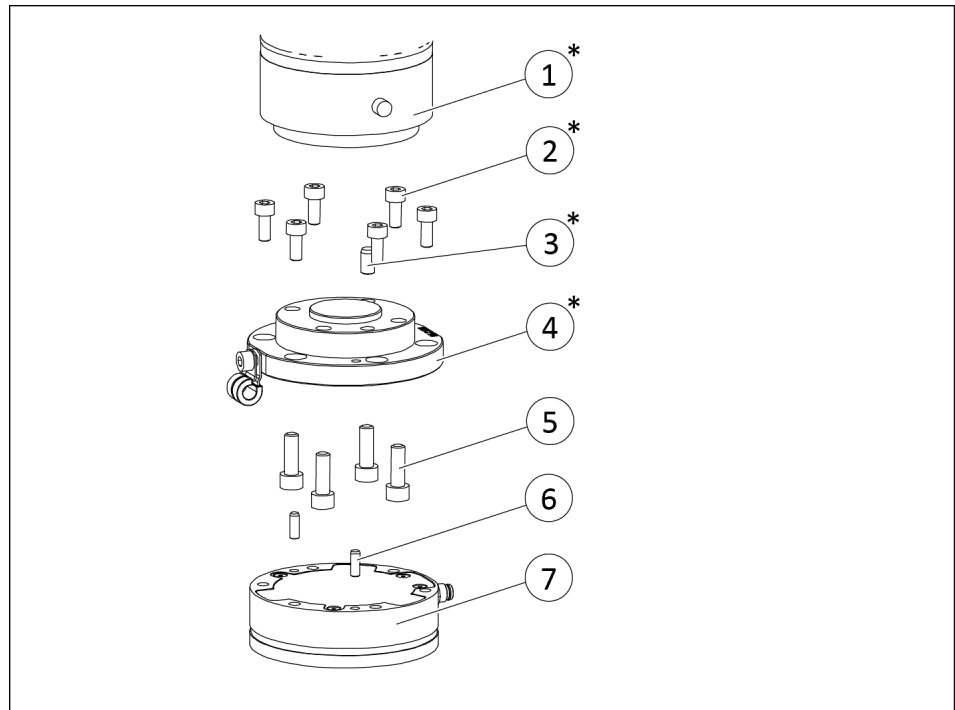
CAUTION

Risk of material damage if alignment pins are too long!

Using alignment pins that are too long creates a gap between the adapter plate and the product and can damage the product.

- Use alignment pins of the correct length.
- Make sure the adapter plate and product are flush.

Mounting the product on the robot arm



Connection via adapter plate to robot arm, schematic diagram

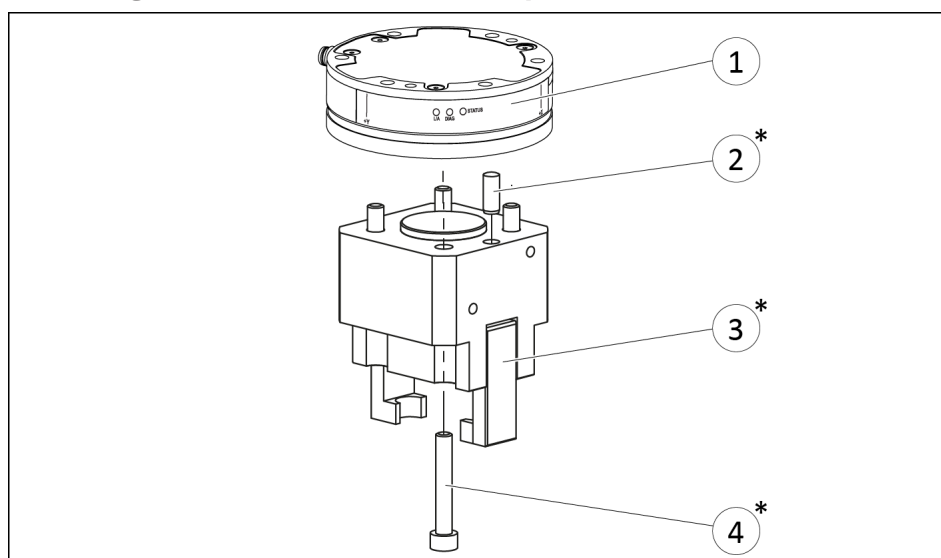
* provided by customer (available from SCHUNK on request)

Item	Designation
1	Robot arm
2	Mounting screw
3	Alignment pin
4	Adapter plate
5	Mounting screw
6	Alignment pin
7	Product

1. Clean the mounting surfaces.
2. Apply threadlocker.
3. If necessary, secure the adapter plate (4) to the robot (1) using the screws (2) and alignment pin (3).

- ⇒ Observe the tightening torque, depth of engagement and strength class, if required.
 - ⇒ Observe the notes on the version of the adapter plate, ▶ 5.1.2 [📄 20].
- 4.** Attach the product (7) to the robot.
- ⇒ Use a hexagon socket wrench for this purpose.
 - ⇒ Tighten the screws (5). Observe the tightening torque, ▶ 5.1 [📄 20].

Mounting the end effector onto the product



Mounting the end effector onto the product

* provided by customer (available from SCHUNK on request)

Item	Designation
1	Product
2	Alignment pin
3	End effector (tool provided by customer)
4	Mounting screw

- 1.** Clean the mounting surfaces.
- 2.** Apply threadlocker.
- 3.** If necessary, secure the adapter plate to the product (1).
 - ⇒ Observe the tightening torque, depth of engagement and strength class, if required.
 - ⇒ Observe the notes on the version of the adapter plate, ▶ 5.1.2 [📄 20].
- 4.** Secure the end effector (3) to the product (1) using the screws (4) and alignment pin (2).
 - ⇒ Observe the tightening torque, depth of engagement and strength class, if required.

CAUTION

Material damage due to incorrect assembly!

- If the plug connection is tightened with a tool, e. g. a wrench, do not exceed the maximum tightening torque of 0.5 Nm.
-

5.2.1 Electrical connection

Power supply requirements

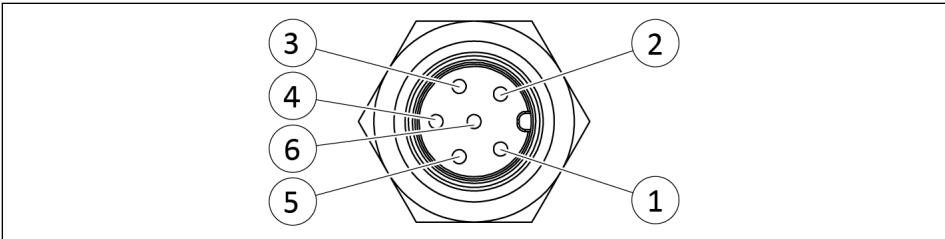
Designation	Sensor
Supply voltage [VDC]	12-30
Max. Power consumption [W]	1.5

Designation	Sensor cable
Nominal voltage [V]	> 30
Nominal power current [A]	> 0.25

5.2.1.1 Pin allocation

Sensor connections

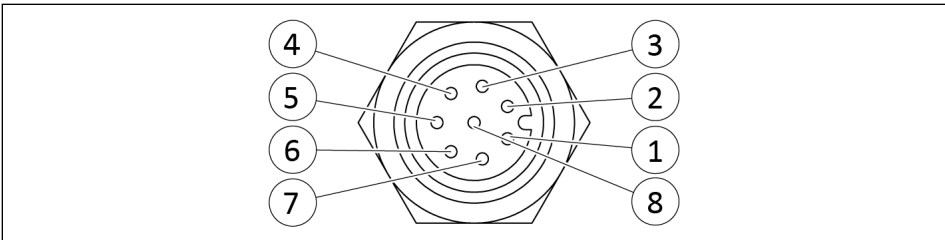
FT-AXIA 80



M8 sensor connector, 6-pin

Pin	Signal
1	TX+
2	TX-
3	RX+
4	RX-
5	V+
6	V- / 0V / Ground
Housing	Shielding

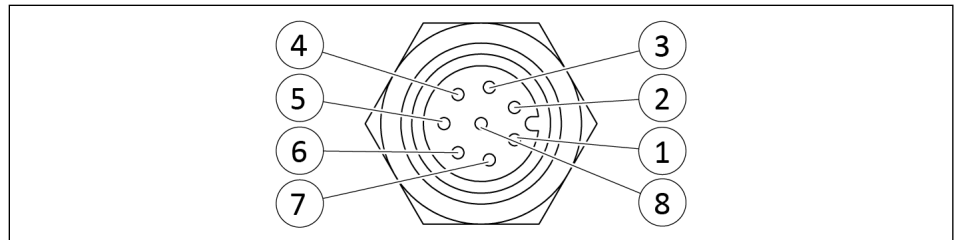
FT-AXIA 90



M8 sensor connector, 8-pin

Pin	Signal
1	Reserved
2	V+
3	V- / 0V / Ground
4	TX-
5	RX+
6	TX+
7	Reserved
8	RX-
Housing	Shielding

FT-AXIA 130

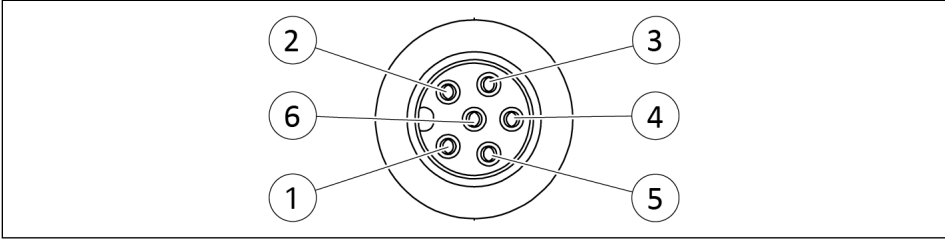


M12 sensor connector, 8-pin

Pin	Signal
1	Reserved
2	V+
3	V- / 0V / Ground
4	TX-
5	RX+
6	X+
7	Reserved
8	RX-
Housing	Shielding

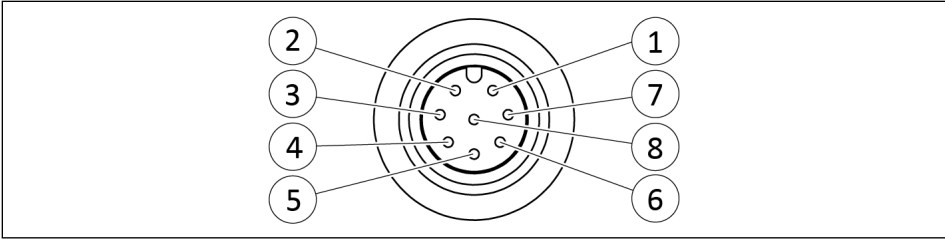
FT-AXIA 80

Sensor cable connections



M8 socket, 6-pin

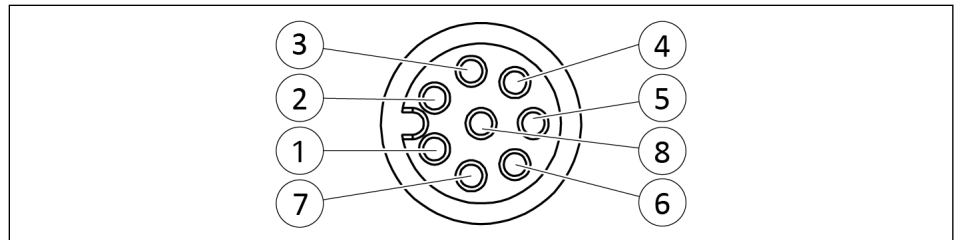
Pin	Signal
1	TX+
2	TX-
3	RX+
4	RX-
5	V+
6	V- / 0V / Ground
Housing	Shielding



M12 connector, 8-pin

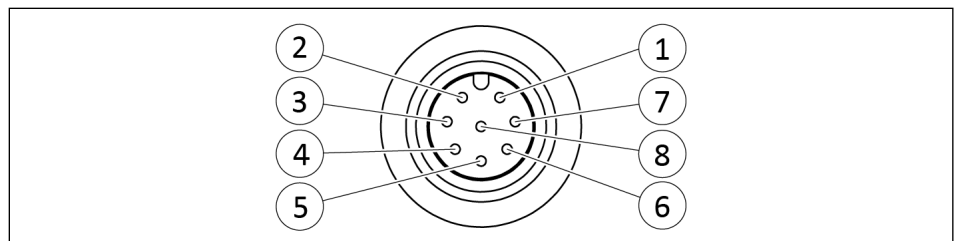
Pin	Signal
1	Reserved
2	V+
3	V- / 0V / Ground
4	TX-
5	RX+
6	TX+
7	Reserved
8	RX-
Housing	Shielding

FT-AXIA 80/90



M8 socket, 8-pin

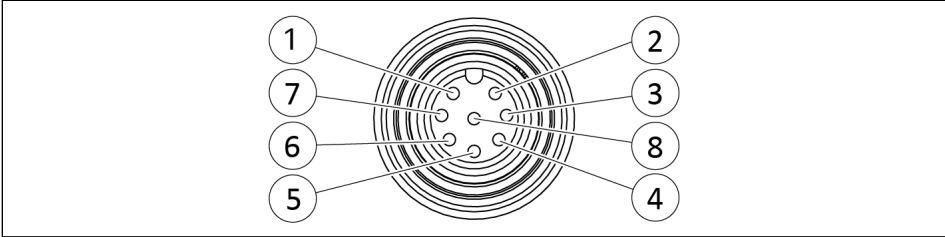
Pin	Signal
1	Reserved
2	V+
3	V- / 0V / Ground
4	TX-
5	RX+
6	TX+
7	Reserved
8	RX-
Housing	Shielding



M12 connector, 8-pin

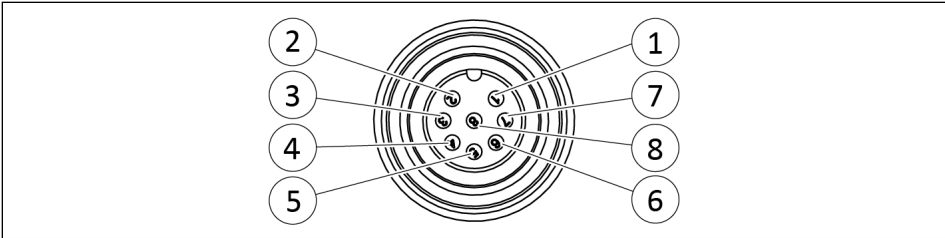
Pin	Signal
1	Reserved
2	V+
3	V- / 0V / Ground
4	TX-
5	RX+
6	TX+
7	Reserved
8	RX-
Housing	Shielding

FT-AXIA 130



M12 socket, 8-pin

Pin	Signal
1	Reserved
2	V+
3	V- / 0V / Ground
4	TX-
5	RX+
6	TX+
7	Reserved
8	RX-
Housing	Shielding



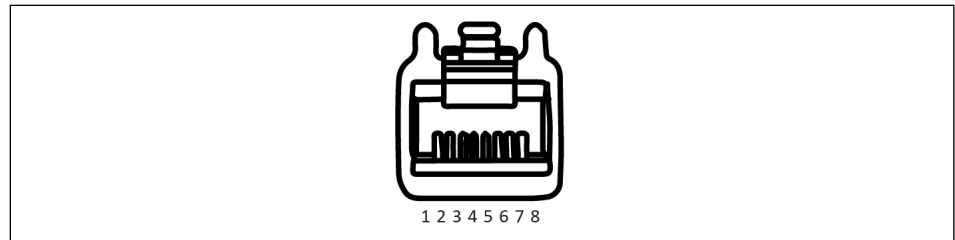
M12 connector, 8-pin

Pin	Signal
1	Reserved
2	V+
3	V- / 0V / Ground
4	TX-
5	RX+
6	TX+
7	Reserved
8	RX-
Housing	Shielding

Non-terminated end

EtherNET cable

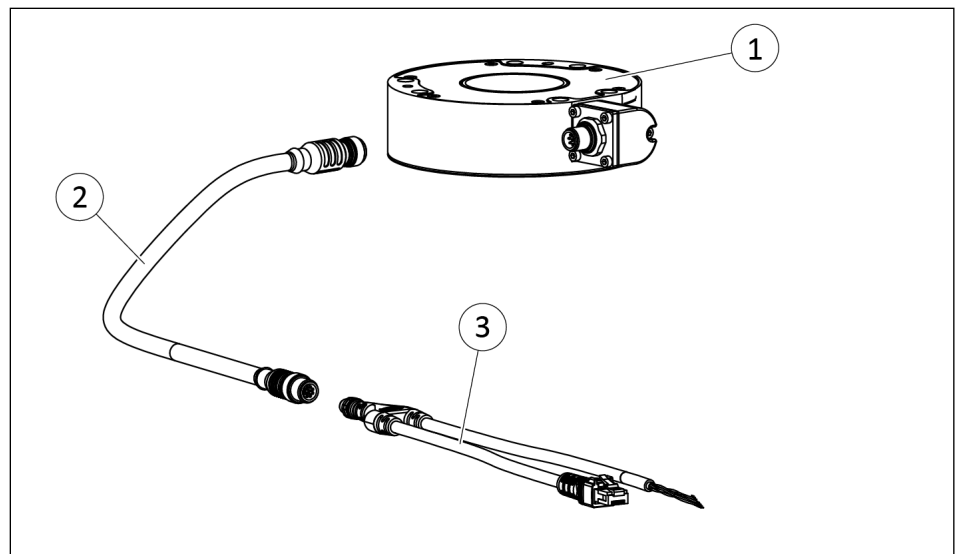
Wire sheath color	Signal
Braided metal shielding	Shielding (connect to ground)
Brown	V+
Brown/White	V- / 0V / Ground
Blue/White (TP1+)	Reserved
Blue (TP1-)	Reserved



EtherNET connector, RJ45, 8-pin, socket

Pin	Color	Signal
1	White/Orange	TX+
2	Orange	TX-
3	White/Green	RX+
4	-	-
5	-	-
6	Green	RX-
7	-	-
8	-	-

5.2.1.2 Connecting the force/torque sensor



Connecting the force/torque sensor (shown on FT-AXIA130 as an example)

1. Connect the supplied sensor cable (2) to the force/torque sensor (1).
2. Connect the supplied control line (3) to the sensor cable (2).
3. Connect the control line (3) to the customer's control system.

5.3 Setting up the product

On connecting the USB connector, the installation of the COM port driver will start automatically. If it does not, the PC and firewall settings must be checked or the driver installed manually.

Windows

An available Internet connection is a prerequisite for the manual installation of the drivers.

1. In the Windows run field, (above the start button), enter the command to open the device manager: `devmgmt.msc`.
2. In the *COM & LPT* area, check whether a COM port has been allocated to the product.
If a device is marked "unknown" here, right-click on this.
3. Select *Update driver software* or *automatically search for current driver software*.

NOTE

Run field not available/no PC access rights

Depending on the PC settings, the *Run* button may not be available. It may appear with the corresponding user rights.

- Right-click with the mouse on a free space in the task bar > Context Menu *Characteristics* > tab *Start Menu* > button *Adapt* > activate the *Run* option.
Or
 - Ask the administrator to set up the driver and product.
-

NOTE

No USB driver

If neither automatic nor manual installation of the USB driver on the PC is possible, the USB interface will have to be set up as a virtual COM port. Appropriate drivers can be found on the Internet, for example on one of the following sites:

- <https://www.virtual-serial-port.org>
⇒ <http://www.ftdichip.com/Drivers/VCP.htm>
 - Ask the administrator to set up the driver and product, if required.
-

Precision test

Following initial assembly and once per year, a precision check of the product will need to be performed, ▶ [maintenance](#) [51].

1. On the tool side, attach a tool with a defined weight.
2. Remove the cable between the assembly and tool side to preclude this from causing erroneous results.

3. Connect the power supply to the product and wait for a warm-up period of approx. 30 minutes.
4. Make sure no nearby external heat sources can falsify the measurement results.
5. Move the robot so that the unloaded product is located in the following positions: Note the outputs here and calculate:

- ⇒ $F_{X, \text{point } n}$ $F_{Y, \text{point } n}$ $F_{Z, \text{point } n}$
- Point 1: in direction Z+
 - Point 2: in direction X+
 - Point 3: in direction Y+
 - Point 4: In direction X-
 - Point 5: In direction Y-
 - Point 6: In direction Z-

6. Calculate the mean values from all six points: determine

$F_{X, \text{mean value}}$, $F_{Y, \text{mean value}}$ and $F_{Z, \text{mean value}}$.

7. Calculate the following for each of the 6 points:

$$F_x = F_{x, \text{point } n} - F_{x, \text{average}}$$

$$F_y = F_{y, \text{point } n} - F_{y, \text{average}}$$

$$F_z = F_{z, \text{point } n} + F_{z, \text{average}}$$

$$\text{Tooling Mass} = \sqrt{F_x^2 + F_y^2 + F_z^2}$$

- ⇒ The calculated weight of the mounted tool has to be less than twice the worst accuracy assessment of the sensor for all six points calculated.
Example: max. (tool masses) – min. (tool masses) < 36 N
- ⇒ In addition, the tool mass must lie within 36 N of the results of this test when performed with a new sensor.
- ⇒ If the product does not pass this test, it will have to be sent to SCHUNK for diagnosis and re-calibration, if necessary.

Example

The rated precision of the product for FTR-AXIA 80 is 2 % on all axes at 500 N permissible force on axes XY (F_{XY}) and 900 N on axis Z (F_Z). In case of 2 % rated precision, the maximum possible inaccuracy is ± 10 N on F_{XY} and ± 18 N on F_Z . If the measured values are outside these tolerance limits, the product must be re-calibrated. Recalibration is recommended once a year. Replace component or send it to SCHUNK for repair.

5.4 Console

For communication via the serial interface with the product, set up a console. As an SSH and telnet client, the free PuTTY software is compatible with Linux and Windows systems and ideal for connection to a local serial interface. Another software may also be used for serial consoles; in this documentation, the connection is described by way of example with the Windows operating system and PuTTY software.

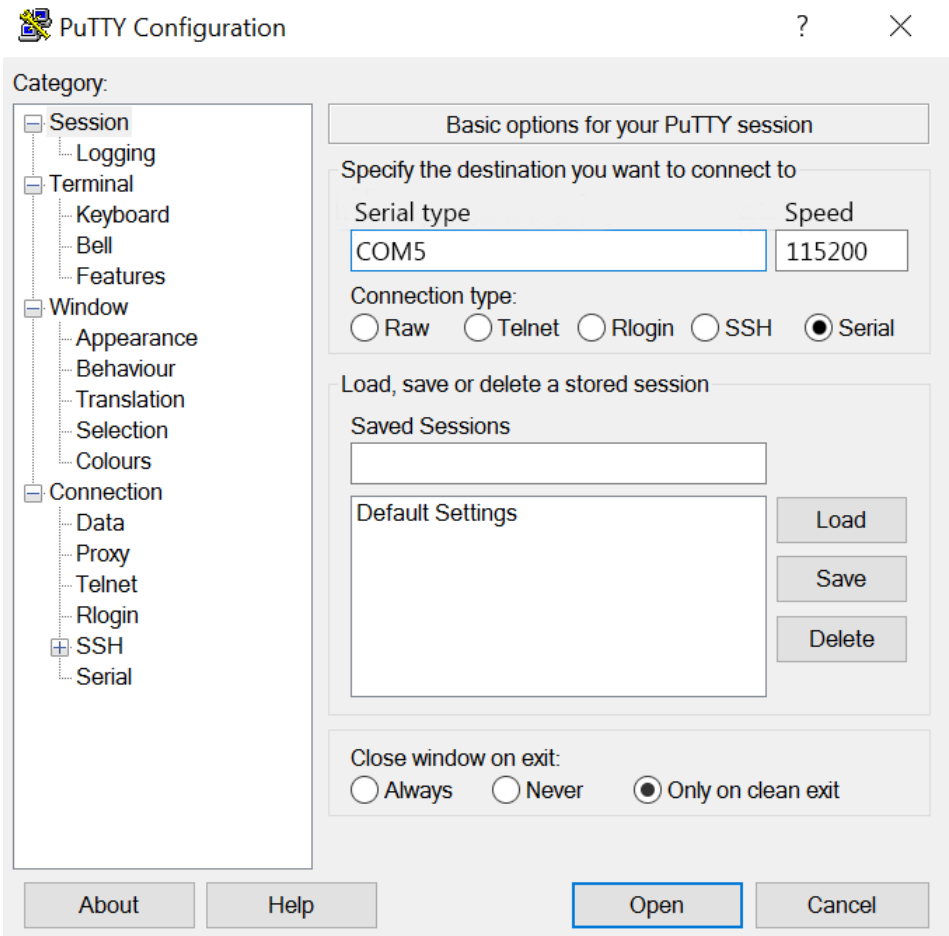
Note: The PuTTY software is a command line editor without a graphical user interface and is only available in English.

Installing PuTTY

1. Download the software (www.putty.org) and store it locally on the PC connected to the product.
2. Start installation by double-clicking on the *.exe file.
3. Follow the instructions for the installation procedure and have the icon generated on the desktop or in the start menu so that you can start the software simply later on.
4. Following successful installation, perform a restart if required.

Starting and setting up PuTTY

1. Start PuTTY (via icon on desktop or in start menu).
2. Make the following configuration settings:



Note: The usual Windows shortcuts Ctrl+C and Ctrl+V will not function in the console window; Ctrl+C even leads to an active process being terminated. In order to copy text in the console window to the clipboard, select this with the mouse. Right-clicking will then insert the text from the clipboard. To avoid error messages due to copied over formatting, tabs or graphics, it is recommended that you only copy unformatted plain text.

Area / command	Setting
Configuration > Session	
Connection type	Select Serial
Configuration > Connection > Serial	
Serial line	Select the COM port previously identified as the connection interface in the device manager.
Speed	Enter 115200 (baud rate)

PuTTY command line commands

The following table contains the most important command line commands for communicating with the product. Detailed information on possible commands, ▶ [PuTTY command line commands](#) [46].

Command	Meaning
h or ?	Open the help page (English)
BIAS [ON OFF <values>]	Define/display/delete maximum measured values
SET	Display/define values for tool conversion, ▶ set command [48]
SAVEALL	Save all parameters set in the permanent memory
STATUS	Print out status report
RESET	Reset controller

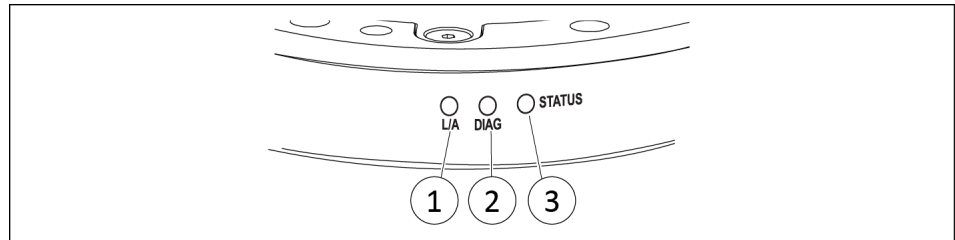
Tips:

1. When inputting text in the console window, upper and lower case is not important.
2. In the console window, select the text to copy it and insert it by right-clicking. To insert text via a context menu rather than directly, the function of the right mouse button can be adapted: To do this, in the configuration of the PuTTY console in the area *Window > Selection* activate the option *Windows [Middle extends, Right brings up menu]*.

6 Operation

6.1 LEDs

LEDs on the product



LEDs on the product

When switched on, the product will perform a self-test, in which the three device LEDs STATUS, DIAG and L/A first light up red and then green one after the other for approx. 1 second each.

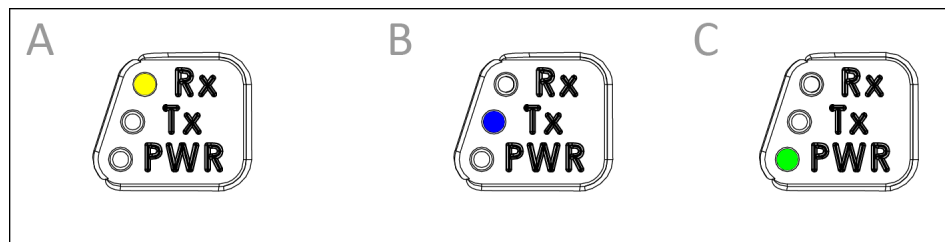
If the self-test is successful, the LEDs will inform you about the current operating state:

LED L/A	Description
Off	No serial connection established.
Green	Normal operation, serial connection established. After a connection has been established, the LED will light up for 5 seconds.

LED DIAG	Description
Off	Serial interface ready for operation.
Red	Error detected during communication, error code entered in the status word.

LED STATUS	Description
Off	Product starts or checks the status.
Red	Indicates an error in the status word.
Green	Normal operation.
Red/Green (Orange)	Measured value of an axis outside the permissible range.

LEDs on USB port



LEDs on USB port

A	LED	Description
LED	Off	No receipt of data via USB port.
Rx	Yellow	Receipt of data via USB port.
B	LED	Description
LED	Off	No data transfer via USB port.
Tx	Blue	Data transfer via USB port.
C	LED	Description
LED	Off	No power supply established.
PWR	Green	Power supply established.

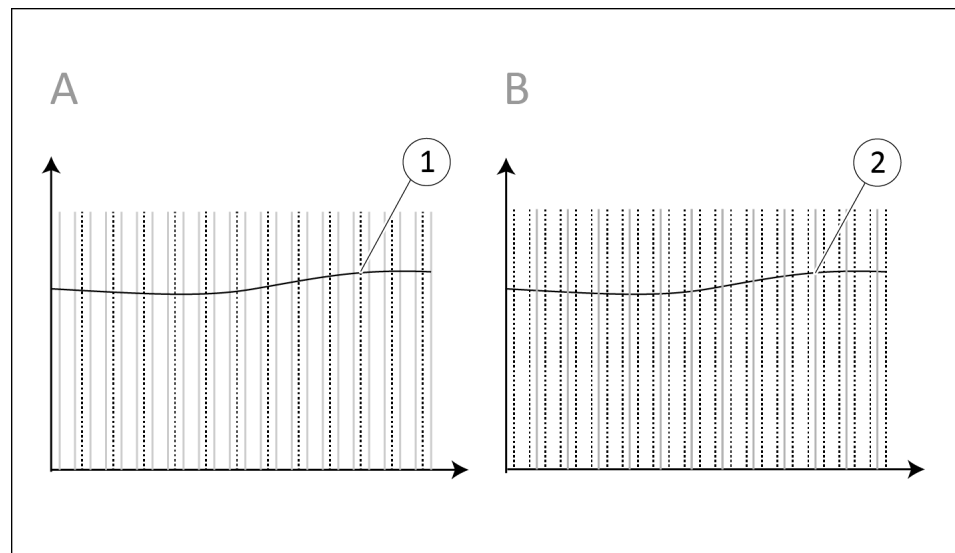
6.2 Measurement and transmission data

Sampling rate

The sampling rate is the frequency at which the product measures, converts and transmits signals. The desired sampling rate is controlled by analog/digital converters, can be saved on the product in the permanent memory and the output values are rounded up or down in hertz or kilohertz (e. g. an exact sampling rate of 7912 Hz is rounded up to the output value of 8 kHz).

Data rate

The data rate indicates how quickly data can be output via the serial interface. This may restrict the sampling rate. If the sampling rate is higher than the data rate, not all data measured will be transferred. If the sampling rate is lower than the data rate, it may happen that no new measurement was taken between two data transmission points in time. In this case the values of the last measurement are transferred again.



(Schematic diagram)

..... Sampling rate

— Data rate

Example A: Data rate is higher than sampling rate, is measured less frequently than it is transferred, individual measured values like e. g. (1) are transferred several times.

Example B: Sampling rate is higher than data rate, is measured more frequently than it is transferred, individual measured values like e. g. (2) are not transferred.

Selecting a data rate that is higher than the sampling rate is recommended if other devices in the network are operated at a higher frequency.

6.3 Filters and dampening

Low-pass filter

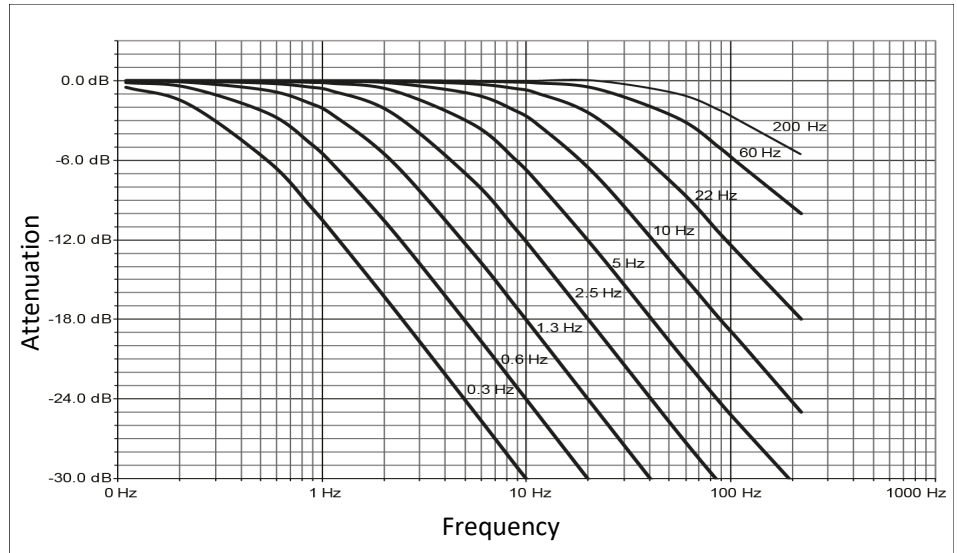
The limit frequency of the filter is the frequency at which the highest value of the output signal is reduced by a factor of 0.7 (i.e. dampening at -3 dB) compared to the output signal of the transmission band.

The limit frequency depends on the selected sampling rate and can be influenced by switching on a low-pass filter in the "filTC" field. The following table shows the influence of filter selection on the limit frequency with different sampling rates.

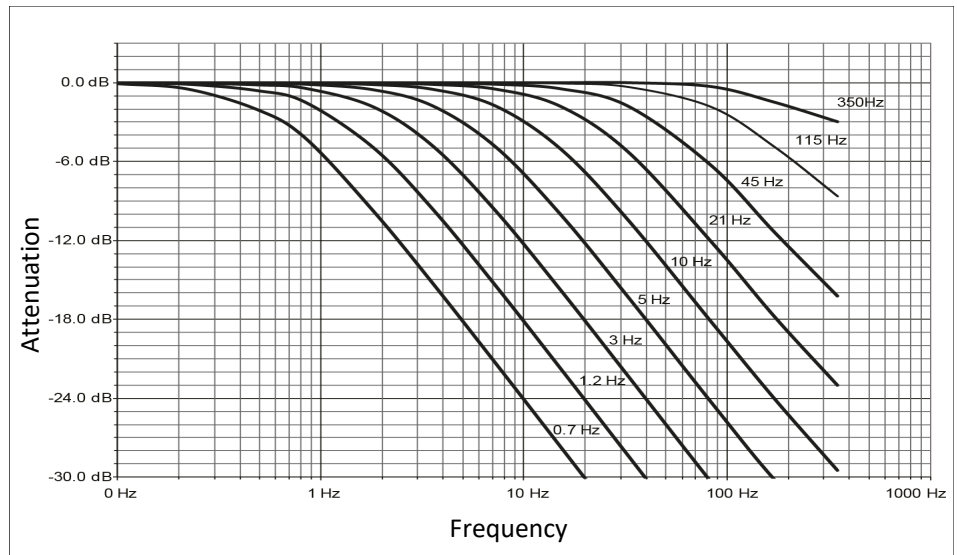
Filter	488 kHz	976 kHz	1953 kHz	3906 kHz	7912 kHz
0	200	350	500	1000	2000
1	58	115	235	460	935.10
2	22	45	90	180	364.04
3	10	21	43	84	169.52
4	5	10	20	40	81.24
5	2.5	5	10	20	39.84
6	1.3	3	5	10	20.31
7	0.6	1.2	2.4	4.7	9.37
8	0.3	0.7	1.4	2.7	5.47

Filter damping

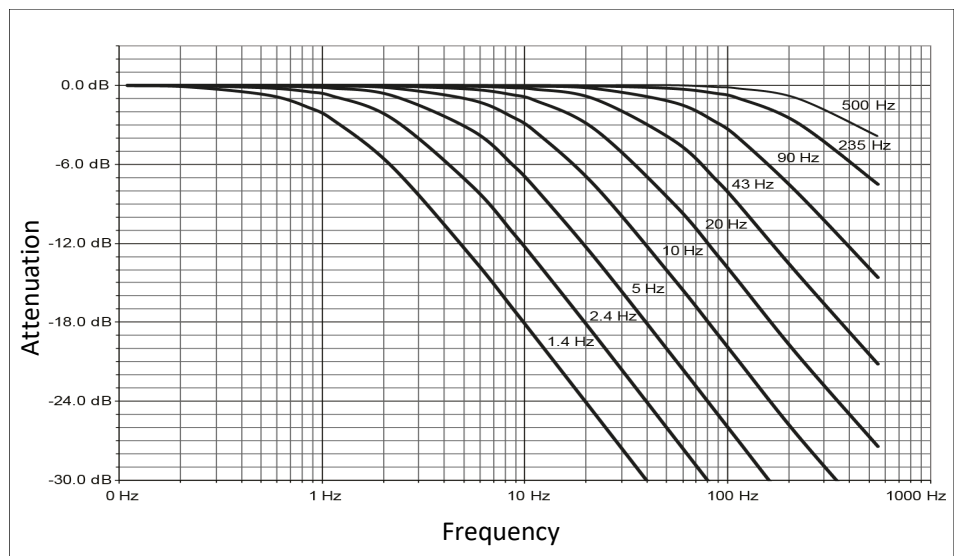
Damping describes the oscillation behavior of the filter. If damping is very low, the filter will oscillate relatively freely. By modifying the damping, the transmission and hence the oscillation behavior will be influenced. Depending on the selected sampling rate, this leads to the following relations between frequency and damping:



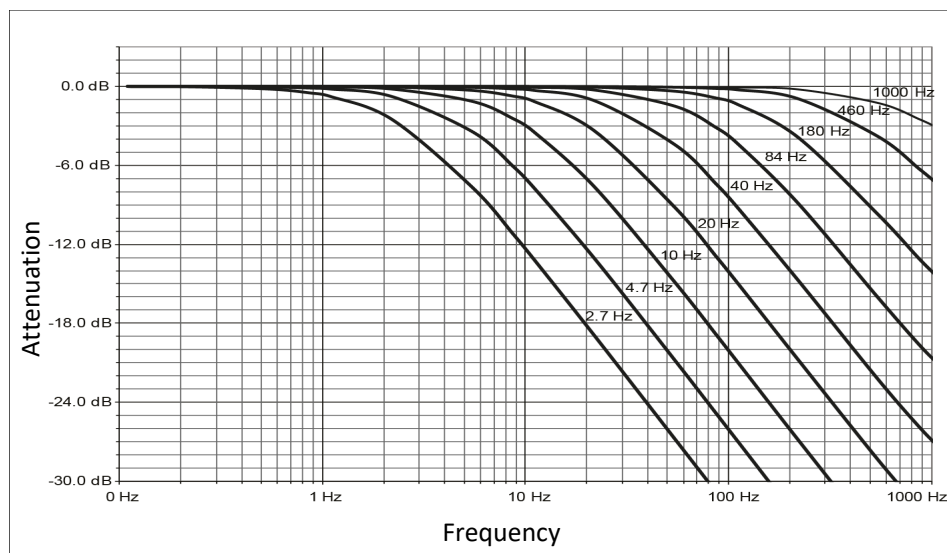
Filter damping at 0.5 kHz sampling rate



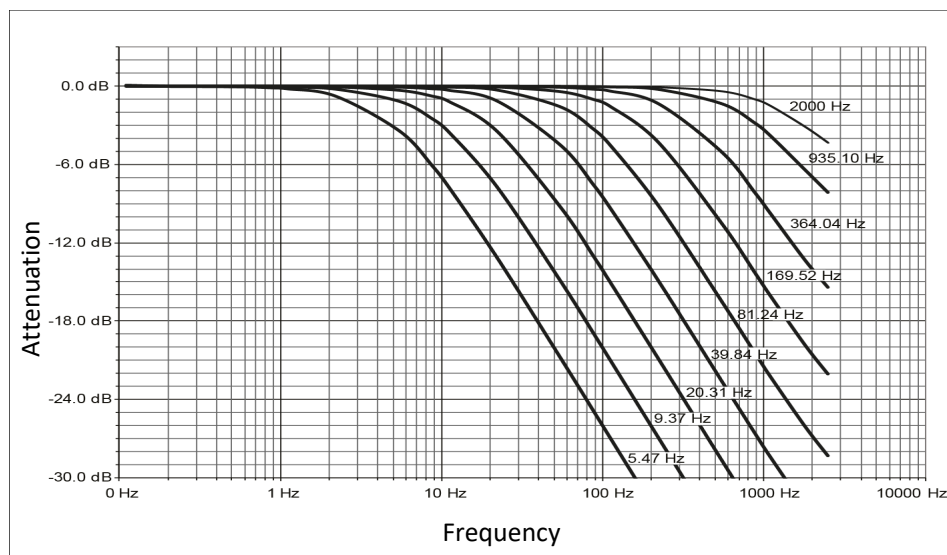
Filter damping at 1 kHz sampling rate



Filter damping at 2 kHz sampling rate



Filter damping at 4 kHz sampling rate



Filter damping at 8 kHz sampling rate

Reducing noise

Fluctuations of forces and torques can lead to noise that can be measured and thus to falsified measurement results. Vibrations caused by movement and electrical interference can also lead to noise. Noise can be reduced by means of the following measures:

- As far as possible, avoid or reduce mechanical vibrations.
- Set a low-pass filter in accordance with requirements and activate this.
- Avoid interference from motors or other electronic devices and ensure sufficient earthing of other devices.
- For all devices, ensure a protection class I power supply (protective conductor and Schuko plug).

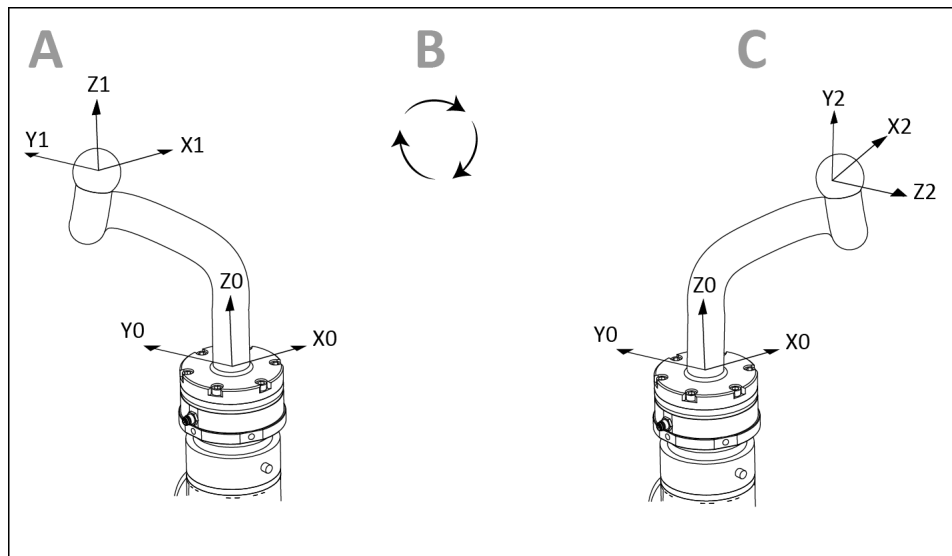
6.4 Measurement deviations

Setting to zero (BIAS)

To prevent external factors such as tool weight and gravity falsifying the measurement results, these are deducted from the measurement results. For this, the software collects forces and torques currently acting on the product and subtracts them as a reference from future measurements. This reference for setting to zero is controlled via the BIAS command.

Tool conversion

Depending on the customer tool used with the product, this may result in the center of gravity being displaced. For this purpose, the offset and rotation of each axis between the initial position and target position are measured ($D_x / D_y / D_z$ and $R_x / R_y / R_z$). The measurement is made at the center of gravity (see drawing). The displacements measured are then entered via the console in order to minimize falsification of the measurement results, ▶ 6.5 [48].



Tool conversion example sketch

With this example, the rotation about the Z-axis results only from the rotations about the X and Y-axis; the tool does not turn about the Z-axis itself in this application.

	A	B	C
Illustration	Initial position	Movement	Target position
Offset	$D_{xyz} = 0^\circ$	(D = "Distance")	$D_x = 100 \text{ mm}$ $D_y = 40 \text{ mm}$ $D_z = 200 \text{ mm}$
Rotation	$R_{xyz} = 0^\circ$	(R = "Rotation")	$R_x = 90^\circ$ $R_y = 180^\circ$ $R_z = 0^\circ$

Tool conversion console commands

Console commands for the conversion example:

$$D_{XYZ} = D_{100/40/200 \text{ mm}} \text{ and } R_{XYZ} = R_{90^\circ/180^\circ/0^\circ}$$

Input	Meaning of tool conversion
set ttdu 2	Set unit for offset to millimeters.
set ttau 0	Set unit for rotation to degrees.
set ttdx 100	Set X-offset to 100 mm.
set ttdy 40	Set Y-offset to 40 mm.
set ttdz 100	Set Z-offset to 200 mm.
set ttrx 90	Set X-rotation to 90°.
set ttry 180	Set Y-rotation to 180°.
set ttrz 0	Set Z-rotation to 0°.

For further information on console commands, ► [6.5 \[45\]](#)

CAUTION

Overload during tool conversion

The forces and torques applied to the travel paths need to be observed to prevent the product getting damaged.

- When entering the rotation and offset, apply the tolerances for measurement deviations so as not to overload the product.

6.5 Command reference

Tips for work in the PuTTY command line editor

CAUTION

Using known keyboard shortcuts

Using familiar keyboard shortcuts does not work in the console as in Windows, the shortcut Ctrl+C for example leads to a process being terminated.

- Observe the following tips when working with the command line editor and only use the specified commands and shortcuts.

1. Selecting the text with the mouse will save this automatically to the clipboard.
2. Right-clicking will insert the text from the clipboard. The command entered is not display but executed directly.
3. Passwords and multi-line texts can also be inserted by selecting (Copy) and right-clicking (Add) in the PuTTY console.

4. Use the cursor keys to display previously input texts and commands and to execute these again.
5. Modify the size of the PuTTY console window if required as with Windows.
6. If the connection is interrupted, close the error message, right-click on the upper frame of the PuTTY console and select the *Restart Session* command to restore it.
7. Always terminate sessions by entering *exit* or *logout*.
8. No distinction is made between upper and lower case in the PuTTY console.
9. Enter commands without brackets.

Tip: The text from the clipboard can be inserted by right-clicking. In doing so the command is inserted directly and executed. To insert text via a context menu rather than directly, the function of the right mouse button can be adapted: To do this, in the configuration of the PuTTY console in the area *Window > Selection* activate the option *Windows [Middle extends, Right brings up menu]*.

Important PuTTY commands

The most important commands for operating the PuTTY command line editor are listed below. The square brackets describe possible parameters (different possibilities are separated by pipe symbols)

Command	Meaning
h or ?	Open the help page (English)
BIAS [ON OFF <values>]	Set to zero on / off, define values
PEAK [C R]	List/delete maximum measured values
CAL	Call up all fields
CAL [field name]	Call up the content of the field named
CAL [field name] [value]	Call up the specified value from the field named
SET	Output all fields
SET [field name]	Output the content of the field named
SET [field name] [value]	Set the field named to the specified value
VIEW [0 1 A]	Calibrations: show 0, 1 or active
DIAG	Diagnostic status overview
SIMERR [ON OFF]	Control of simulated errors

Command	Meaning
SAVEALL	Save all parameters set in the permanent memory
STATUS	Output the status report
RESET	Reset controller

Parameters for individual commands

Command C – continuous mode |

Command S – single mode

The parameters for the commands "C" (continuous mode) and "S" (single mode) can be coupled with one another in any order. Indicators and settings of forces and torques should be coupled with the specification of the axes. To stop command C and end the continuous output of data, press any key.

Parameter	Meaning
[H]	Hexadecimal display of values
[D]	Decimal display of values (default setting)
[1 2 3 4 5 6 7]	Selection of a certain gauge
[F]	Force
[T]	Torque
[XYZ]	Axis
[M]	Magnitude
[C]	Specification of force and torque values as a counter
[U]	Specification of force and torque values with the units defined by the user
>	Illustration of output values formatted as an overview (easily readable, default setting)
<	Compressed illustration of output values without leading zeros and other spaces (less readable, suitable for further machine processing)
s	Display of checksum from cyclic redundancy check
#	Output counter of values output via "C" or "S" command

Parameter	Meaning
@	Read counter of analog/digital converter that is increased by one unit with each conversion.
!	Display of the 32-bit status code.

Command set – change settings

To display and modify settings, enter "set" with the desired parameter. The "set" command needs to be entered individually for each parameter to be set or queried; parameters cannot be coupled here.

Parameter	Meaning	Other parameters
location	Display position of the product	
serNum	Display serial number of the product.	
hwProdCode	Display item number of the hardware.	
hwRev	Display revision number of the hardware.	
ttdu	Define unit for offset with tool conversion.	0 = inch 1 = feet 2 = mm 3 = cm 4 = m
ttau	Define unit for rotation with tool conversion	0 = degrees ° 1 = angle of arc rad
ttdx / ttdy / ttdz	Offset for the tool conversion of the relevant axis, default value 0	
ttrx / ttry / ttrz	Angle of rotation for the tool conversion of the relevant axis, default value 0	
baud	Transfer rate (between 300 Baud and 3 MBaud), default value 115200	
msg	Dealing with inexplicable error messages	0 = do not output 1 = output

Further information can be found in the **PuTTY manual**.

7 Troubleshooting

LED STATUS on the product lights up red continuously (> 20 seconds)

Possible cause	Corrective action
Plug connection faulty.	Check the contact of plug connections.
Connector or cable defective.	Check cable and connector for damage.
Product defective.	Replace component or send it to SCHUNK for repair.

LED L/A on product does not light up or flash

Possible cause	Corrective action
Connection to the control unit faulty.	Check the connector and cable connection.
	Contact the plug connections again.
	Switch off the product and restart it.

Product not sending data

Possible cause	Corrective action
Incorrect assembly.	Make sure that the assembly and tool side of the product have not been mixed up.
	Check LEDs, connectors and cables.
	Check connection and correct functioning of receiver.

Saturation error is displayed in the status code

Saturation occurs when the product's load is above the permissible limits. In this case, the status code will display a saturation error bit.

Possible cause	Corrective action
Load of product above the permissible limits.	Reduce load, perform a precision check and reset the error code.
Electrical malfunction.	Check the plug connection, detach if required and reconnect it.
	Switch off the product and restart it.

Noise

Jumping when reading the force and torque data is known as noise. If this is >0.05 % of the full range values when the product is not loaded, an error is present.

Possible cause	Corrective action
Mechanical vibrations	Reduce vibrations.
Electrical malfunction.	Check the power supply and connections for noise and interference.
	Poor earthing.

Possible cause	Corrective action
Component failure.	Check overall system for failure of a component.

Drift

Drift is when the measured values do not stabilize after the load has been attached or removed. In such cases the values increase or fall further. A certain amount of drift is normal but this must not significantly impair the measurement results.

Possible cause	Corrective action
Change in ambient conditions.	Avoid sudden fluctuations in temperature. Using the Bias command, check the values in Resolved Data Mode for displacement.
Mechanical coupling	Check product and cable; cables may not touch the product.

Hysteresis

Hysteresis is when there is a delayed change in the measured values after the load has been attached or removed. In such cases the values increase or fall further. A certain amount of hysteresis is normal, but this must not significantly impair the measurement results.

Possible cause	Corrective action
Mechanical coupling	Check product and cable; cables may not touch the product.
Internal error	Switch off the product and restart it. Replace component or send it to SCHUNK for repair.

8 Maintenance

8.1 Maintenance intervals

Maintenance interval	Maintenance work
weekly	<p>Clean all parts thoroughly, check for damage and wear, if necessary replace seals and wearing parts</p> <p>Check the wires, plug connections and cables for damage, abrasion and wear.</p> <p>Tighten the connections and wires so that these do not touch the product, thereby leading to falsified measuring results.</p>
annual	<p>Perform a precision test, ▶ 5.3 [33]. If required, send the product back to Schunk for re-calibration.</p>

8.2 Removing the product from the robot arm

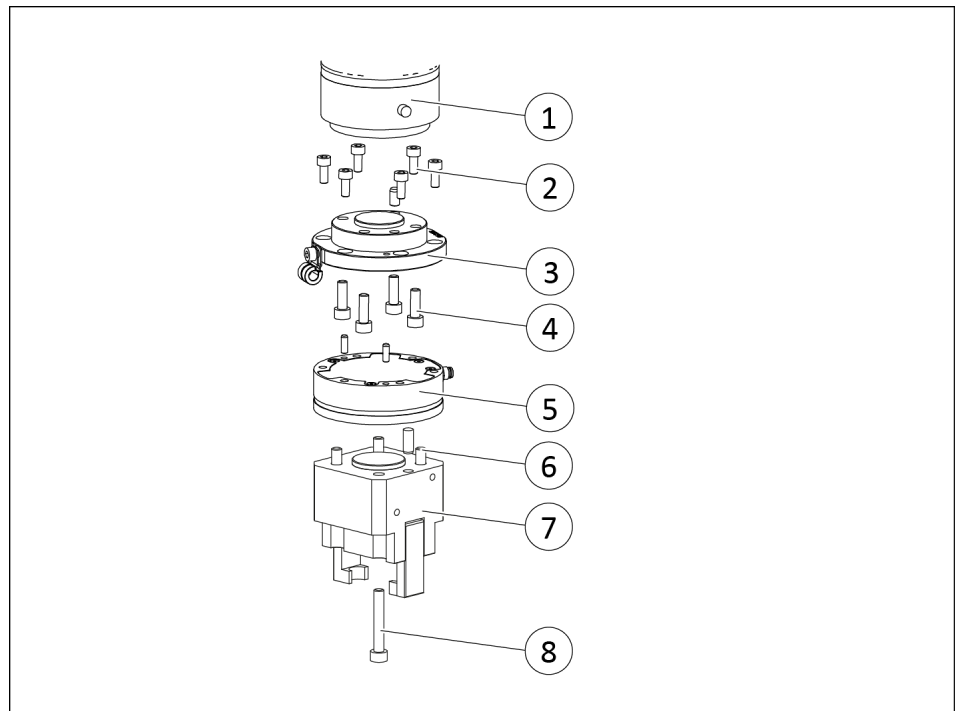


⚠ WARNING

Risk of injury due to sudden movements!

If the energy supply is switched on or if residual energy is still present in the system, this can cause components to move unexpectedly, which may result in serious injuries and material damage.

- Before starting any work on the product: Switch off the energy supply and secure against re-connection.
- Ensure that no residual energy remains in the system.
- Secure components from falling down or over.

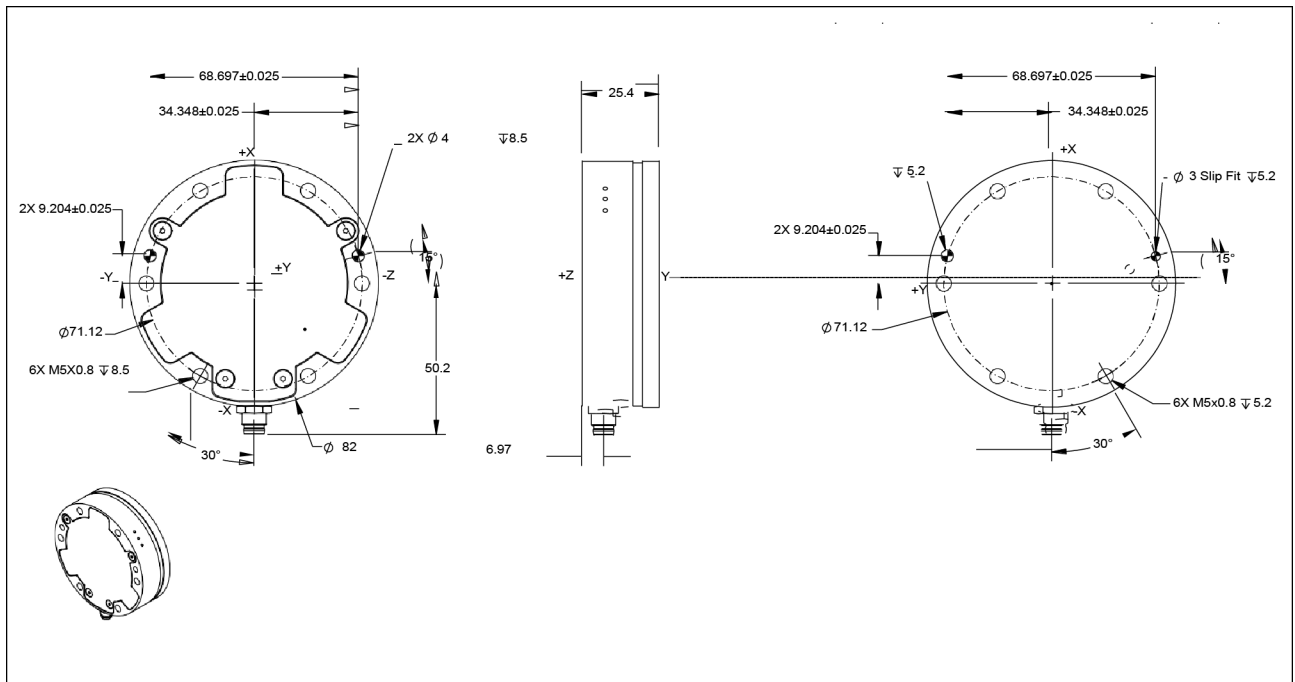


Disassembling the product

- 1.** Switch off and deactivate all activated supply circuits (e. g. electrics, air, water, etc).
- 2.** Loosen the screws (6) and (8) and remove the end effector (7).
- 3.** Loosen the screws (4) and remove the end effector (4).
- 4.** Support the product (5) and use a hexagon socket wrench to loosen the secured screws (2) and (4) that fasten the product to the robot (1) or adapter plate (3).
- 5.** Remove the product (5).

8.3 Drawing

The following figure is an example image.
It serves for illustration and assignment of the spare parts.
Variations are possible depending on size and variant.



Drawing

9 Translation of the original declaration of incorporation

in terms of the Directive 2006/42/EG, Annex II, Part 1 Section B.

Manufacturer/
Distributor SCHUNK SE & Co. KG
Spanntechnik | Greiftechnik | Automatisierungstechnik
Bahnhofstr. 106 – 134
D-74348 Lauffen/Neckar

We hereby declare that the partly completed machine described below

Product designation: Force/torque sensor / FTR-AXIA /electric
ID number 1392581, 1392582, 1392583

meets the following basic occupational health and safety of the Machinery Directive 2006/42/EC:

No. 1.1.1, No. 1.1.2, No. 1.1.3, No. 1.1.5, No. 1.3.2, No. 1.5.1, No. 1.5.2; No. 1.5.4, No. 1.5.6, No. 1.5.8, No. 1.5.10, No. 1.5.11, No. 1.5.13

The partly completed machinery may not be put into operation until it has been confirmed that the machine into which the partly completed machinery is to be installed complies with the provisions of the Machinery Directive (2006/42/EC). The declaration shall be rendered invalid if modifications are made to the product.

Applied harmonized standards, especially:

EN ISO 12100:2010 Safety of machinery – General principles for design –
Risk assessment and risk reduction

The special technical documentation according to Annex VII, Part B, belonging to the partly completed machine, has been created.

Person authorized to compile the technical documentation:
Stefanie Walter, Address: see manufacturer's address

Signature: see original declaration

Lauffen/Neckar, October 2024

Dr.-Ing. Manuel Baumeister,
Head of Systems Engineering,
Technology & Innovation

11 EU Declaration of Conformity

Manufacturer/
Distributor

SCHUNK SE & Co. KG
Spanntechnik | Greiftechnik | Automatisierungstechnik
Bahnhofstr. 106 – 134
D-74348 Lauffen/Neckar

We hereby declare on our sole authority that the product meets the requirements of the following directives at the time of the declaration.

The declaration is rendered invalid if modifications are made to the product.

Product designation: Force/torque sensor FTR-AXIA

This declaration of conformity is valid for all variants mentioned in the appendix.

- **Electromagnetic compatibility (EMC directive) 2014/30/EU**

Applied harmonized standards, especially:

IEC 61326-2:2022 Electrical equipment for measurement, control and laboratory use
– EMC requirements – Part 2-3: Particular requirements – Test configuration, operational conditions and performance criteria for transducers with integrated or remote signal conditioning (IEC 61326-2-3:2020)

All related technical documentation has been prepared in electronic form according to Directive 2014/30/EU and will be made available to national authorities on demand. The signatory is resident at the manufacturer's address and is authorized to compile this documentation.

Signed for and on behalf of: SCHUNK SE & Co. KG

Lauffen/Neckar, October 2024

Signature: see original declaration

Dr.-Ing. Manuel Baumeister,
Technology & Innovation

12 UKCA Declaration of Conformity

Manufacturer/
Distributor SCHUNK Intec Limited
 Clamping and gripping technology
 3 Drakes Mews, Crownhill
 MK8 0ER Milton Keynes

We hereby declare on our sole authority that the product meets the requirements of the following directives at the time of the declaration.

The declaration is rendered invalid if modifications are made to the product.

Product designation: Force/torque sensor FTR-AXIA
ID number 1392581, 1392582, 1392583

- **Electromagnetic Compatibility Regulations 2016**

Applied harmonized standards, especially:

IEC 61326-2:2022 Electrical equipment for measurement, control and laboratory use
 – EMC requirements – Part 2-3: Particular requirements – Test
 configuration, operational conditions and performance criteria for
 transducers with integrated or remote signal conditioning (IEC
 61326-2-3:2020)

Person authorized to compile the technical documentation:
Marcel Machado, address: refer to manufacturer's address

Signed for and on behalf of: SCHUNK SE & Co. KG



Lauffen/Neckar, October 2024

Dr.-Ing. Manuel Baumeister,
Head of Systems Engineering,
Technology & Innovation

13 Information on the RoHS Directive, REACH Regulation and Substances of Very High Concern (SVHC)

RoHS Directive

SCHUNK products are classified as "large-scale stationary installations" or as "large-scale stationary industrial tools" within the meaning of Directive 2011/65/EU and its extension 2015/863/EU "on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS)", or fulfill their intended function only as part of one. Therefore products from SCHUNK do not fall within the scope of the directive at this time.

REACH Regulation

Products from SCHUNK fully comply with the regulations of Regulation (EC) No. 1907/2006 "concerning the Registration, Evaluation, Authorization and Restriction of Chemicals (REACH)" and its amendment 2022/477. SCHUNK attaches great importance to completely avoiding chemicals of concern to humans and the environment wherever possible.

Only in rare exceptional cases do SCHUNK products contain SVHC substances on the candidate list with a mass content above 0.1%. In accordance with Article. 33 (1) of Regulation (EC) No. 1907/2006, SCHUNK complies with its duty to "communicate information on substances in articles" and lists the components concerned and the substances used in an overview that can be viewed at [schunk.com\SVHC](https://www.schunk.com/SVHC).

Signature: see original declaration

Lauffen/Neckar, October 2024

Dr.-Ing. Manuel Baumeister,
Head of Systems Engineering,
Technology & Innovation

14 Appendix to the declaration of conformity

This declaration of conformity is valid for all variants of the force/torque sensor mentioned in this appendix.

FTN-interface

FTN-AXIA80-DUAL SI-75-4/SI-150-8
FTN-AXIA80-DUAL SI-200-8/SI-500-20
FTN-AXIA80-UR-DUAL SI-200-8/SI-500-20
FTN-AXIA80-DUAL SI-480-20/SI-1200-50
FTN-AXIA90-SI-1000-50
FTN-AXIA130-SI-2000-125
FTN-AXIA130-SI-4000-300

FTE-interface

FTE-AXIA80-DUAL SI-75-4/SI-150-8
FTE-AXIA80-DUAL SI-200-8/SI-500-20
FTE-AXIA80-DUAL SI-480-20/SI-1200-50
FTE-AXIA90-SI-1000-50
FTE-AXIA130-SI-2000-125
FTE-AXIA130-SI-4000-300

FTRS-interface

FTR-AXIA80-DUAL SI-75-4/SI-150-8
FTR-AXIA80-DUAL SI-200-8/SI-500-20
FTR-AXIA80-DUAL SI-480-20/SI-1200-50
FTRS422-AXIA90-SI-1000-50
FTRS422-AXIA130-SI-2000-125
FTRS422-AXIA130-SI-4000-300



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