Commissioning instructions
FTE
Force/torque sensor system

Superior Clamping and Gripping

SCHUNK®

Imprint

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

Tel. +49-7133-103-2503
Fax +49-7133-103-2189

cmg@de.schunk.com

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

Table of Contents

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 ▸ 1.1.2 [🗋 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.

NOTICE

Material damage!

Information about avoiding material damage.

1.1.2 Applicable documents

- General terms of business *
- Catalog data sheet of the purchased product *
- Assembly and operating manual of the sensor *

The documents labeled with an asterisk (*) can be downloaded from **schunk.com**.

1.2 Warranty

If the product is used as intended, the warranty is valid for 12 months from the ex-works delivery date under the following conditions:

- 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

Depending on the ordered variant, the scope of delivery of the force/torque sensor system FTE includes:

- Force/torque sensor with sensor cable
- ECATOEM or ECATBA (Nano and Mini sizes only)
- Commissioning instructions
- Commissioning CD with calibration certificates
- Accessory pack

2 Basic safety notes

2.1 Intended use

The product is used to record, convert and evaluate analog output signals into electrical signals.

- Appropriate use of the product includes compliance with all instructions in this manual.

2.2 Inappropriate use

The product is not a safety component in accordance with the EC Machine Directive 2006/42/EC and must not be used in safety-relevant parts of machine control units.

2.3 Constructional changes

Implementation of structural changes

By conversions, changes, and reworking, e.g. additional threads, holes, or safety devices can impair the functioning or safety of the product or damage it.

- 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 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.

2.6 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.

2.7 Notes on particular risks

⚠ DANGER

Danger from electric voltage!

Touching live parts may result in death.

- Switch off the power supply before any assembly, adjustment or maintenance work and secure against being switched on again.
- Only qualified electricians may perform electrical installations.
- Check if de-energized, ground it and hot-wire.
- Cover live parts.

NOTICE

Risk of damage to the sensor!

The internal electronics could get damaged.

- Never open Nano, Mini and IP-protected.
- Do not remove any fastening elements.
- Do not drill holes on the sensor.
- Protect internal electronics from contamination.

NOTICE

Risk of damage to the sensor!

Start up the interface before assembly!

- Pay attention to the acting forces and torques during assembly.

3 Technical data

3.1 Basic Data

Designation	ECATOEM PCB	ECATBA
Weight [kg]	0.17	0.455

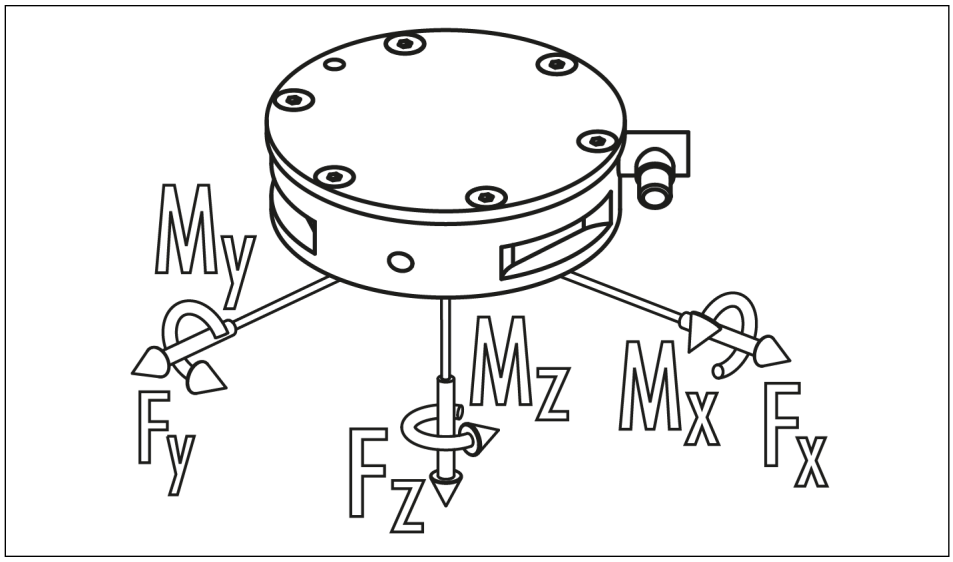
More technical data is included in the catalog data sheet. Whichever is the latest version.

3.2 Force-torque sensor

NOTE

All forces and torques acting on the sensor must be within the specified range of measurement. Exceeding the range of measurement will reduce the maximum number of load cycles and may lead to damage of the sensor.

Information on the range of measurement of each individual force-torque sensor is provided in the catalog data sheet. The latest version is always applicable.



Dimensions and max. loads on the force-torque sensor

Detailed information on the mounting, installation and maintenance of the sensor is provided in the Assembly and Operating Manual for the sensor, ▶ 1.1.2 [🗋 6].

4 Design and description

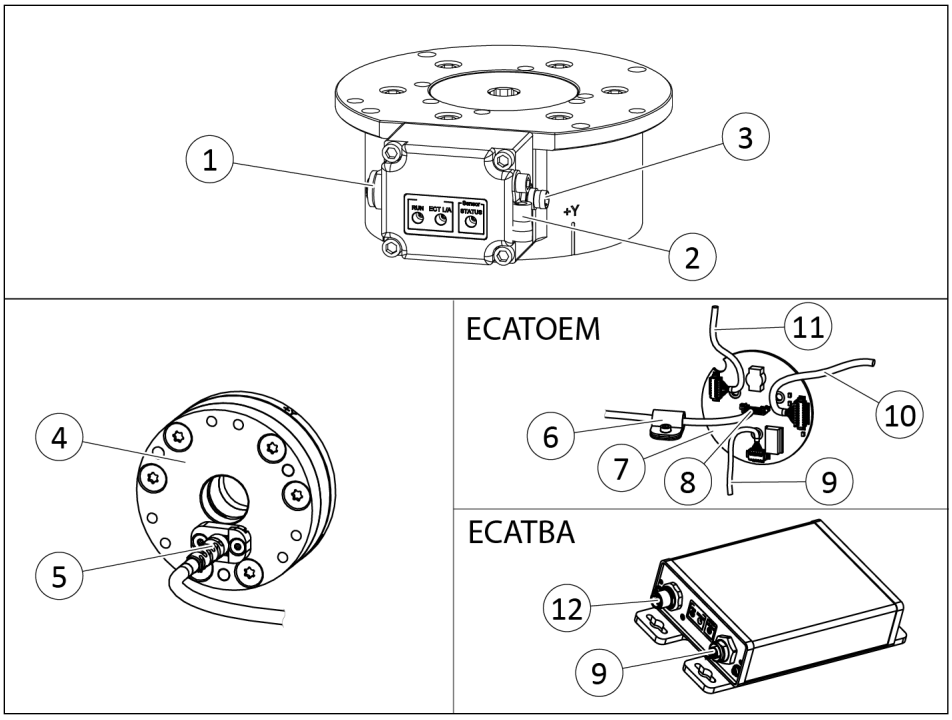
4.1 Design

NOTE

For the sake of clarity, the sizes of the force/torque sensors have been combined into two size groups in some places in this manual:

- FT Nano and FT Mini
- FT Gamma, FT Delta and FT Omega

Force/torque sensor



***Top**: Force/torque sensor with interface electronics (from gamma and larger) /*
***Bottom**: Force/torque sensor with sensor cable (Nano and Mini)*

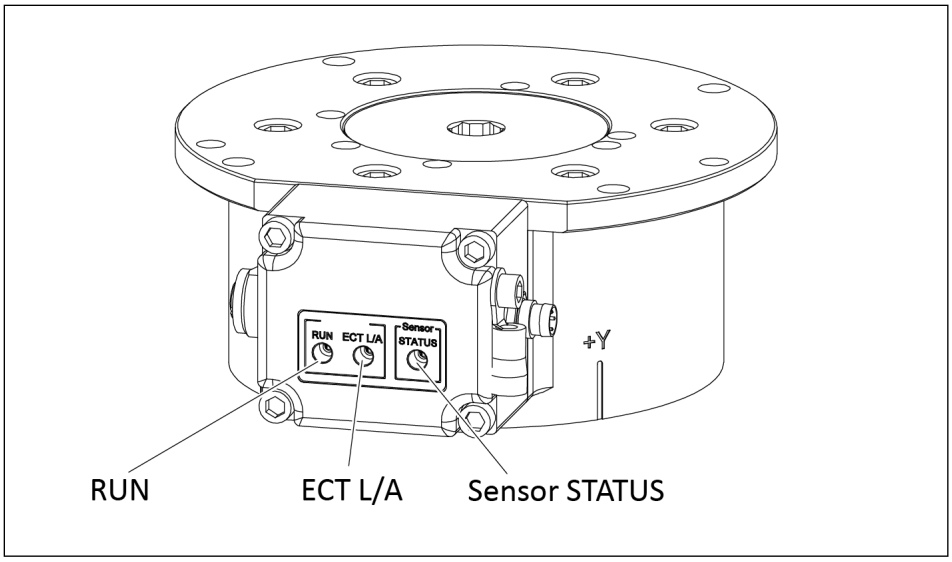
1	Connection for EtherCAT master
2	Ground connection
3	External voltage supply connection
4	FT sensor with EC8 cable
5	Strain relief
6	Strain relief supplied by the customer
7	EtherCat interface card
8	Molex Picoblade connector
9	EtherCAT with optional Mode A PoE
10	Optional external LEDs
11	Optional power supply and monitor signal VDC (20 to 48 V)
12	Power supply

4.2 Description

The force/torque sensor is connected to the system via EtherCAT. The interface is available for all sensors of the Nano and Mini series as well as for selected IP variants of the Gamma, Delta and Omega series.

4.3 Status LEDs

EtherCAT sensor



EtherCAT connection/activity LED

LED status	Connection/ link	Activity	Status
Off	No	No	Connection disabled
Green	Yes	No	Connection available
Flashes green	Yes	Yes	Connection available

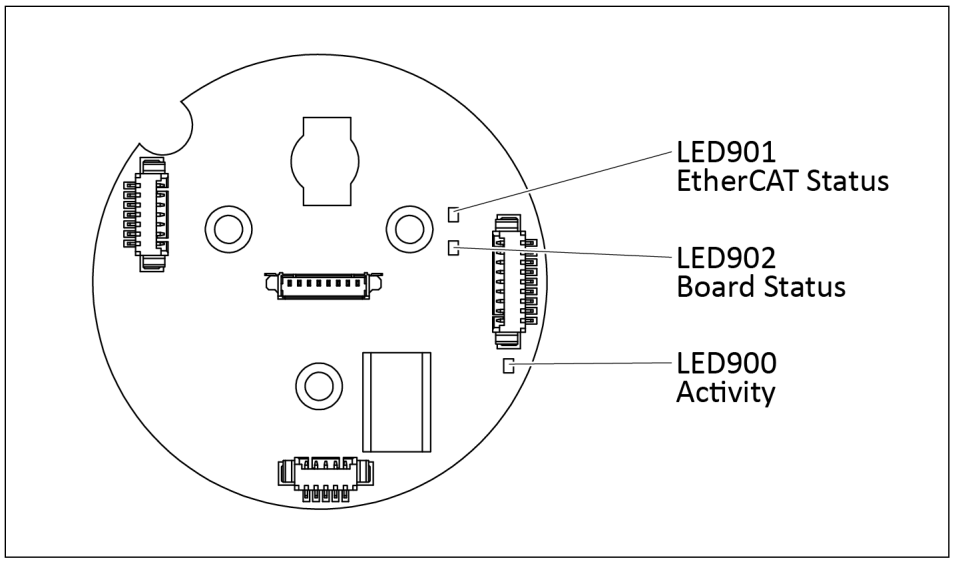
RUN LED

LED status	Description
Off	Device is in INIT state.
Flashes green	Device is in PRE-OPERATIONAL state.
Green	Device is in OPERATIONAL state.

Sensor status LED

LED status	Description
Off	No errors, the status byte is zero
Red	The status byte is not equal to zero. A diagnostic error has occurred or a monitoring limit has been exceeded

ECATOEM



LED900 connection/activity

LED status	Connection/ link	Activity	Status
Off	No	No	Connection disabled
Green	Yes	No	Connection available
Flashes green	Yes	Yes	Connection available

LED901 EtherCAT status

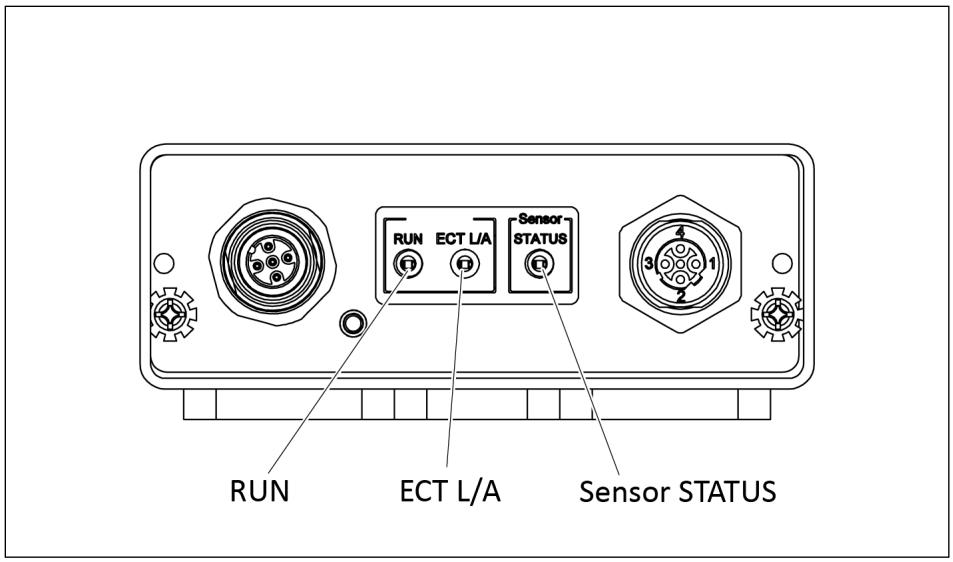
LED status	RUN status	ERROR status	Description
Off	INIT	No	Device is in INIT state.
Flashes green	PRE-OP	No	Device is in PRE-OPERATIONAL state.
Flashes green once	SAFE-OP	No	Device is in SAFE-OPERATIONAL state.
Green	OP	No	Device is in OPERATIONAL state.
Flashes red twice		Process data watchdog timeout	Timeout on connections.

LED status	RUN status	ERROR status	Description
Flashes red once		Local error	The slave device application has changed the EtherCAT state independently due to a local error.
Flashes red		Invalid configuration error	General configuration error.

LED902 board status

LED status	Status / condition	Description
Off	Off	No voltage supply connected.
Green	Everything in order	Fully functional, no defects.
Orange	Saturation	Force/moment sensor is saturated. The input voltage of a resistance strain gauge is too high. The output values are invalid. If available, use less sensitive calibration.
Red	Voltage error	One of the internal diagnostic voltages is outside the acceptable range.
Flashes red (1 Hz)	No calibration loaded	The active calibration slot is empty or has a checksum error.
Flashes red (10 Hz)	Communication error with ECAT ASIC	No or faulty communication between uC and EtherCAT ASIC.
Flashes red (20 Hz)	Transducer saturated	One or more of the sensor's transducers are saturated. Stop force application and wait until the error is corrected. If the error is not corrected, this status indicates possible mechanical damage or power failure.

ECATBA



EtherCAT connection/activity LED

LED status	Connection/ link	Activity	Status
Off	No	No	Connection disabled
Green	Yes	No	Connection available
Flashes green	Yes	Yes	Connection available

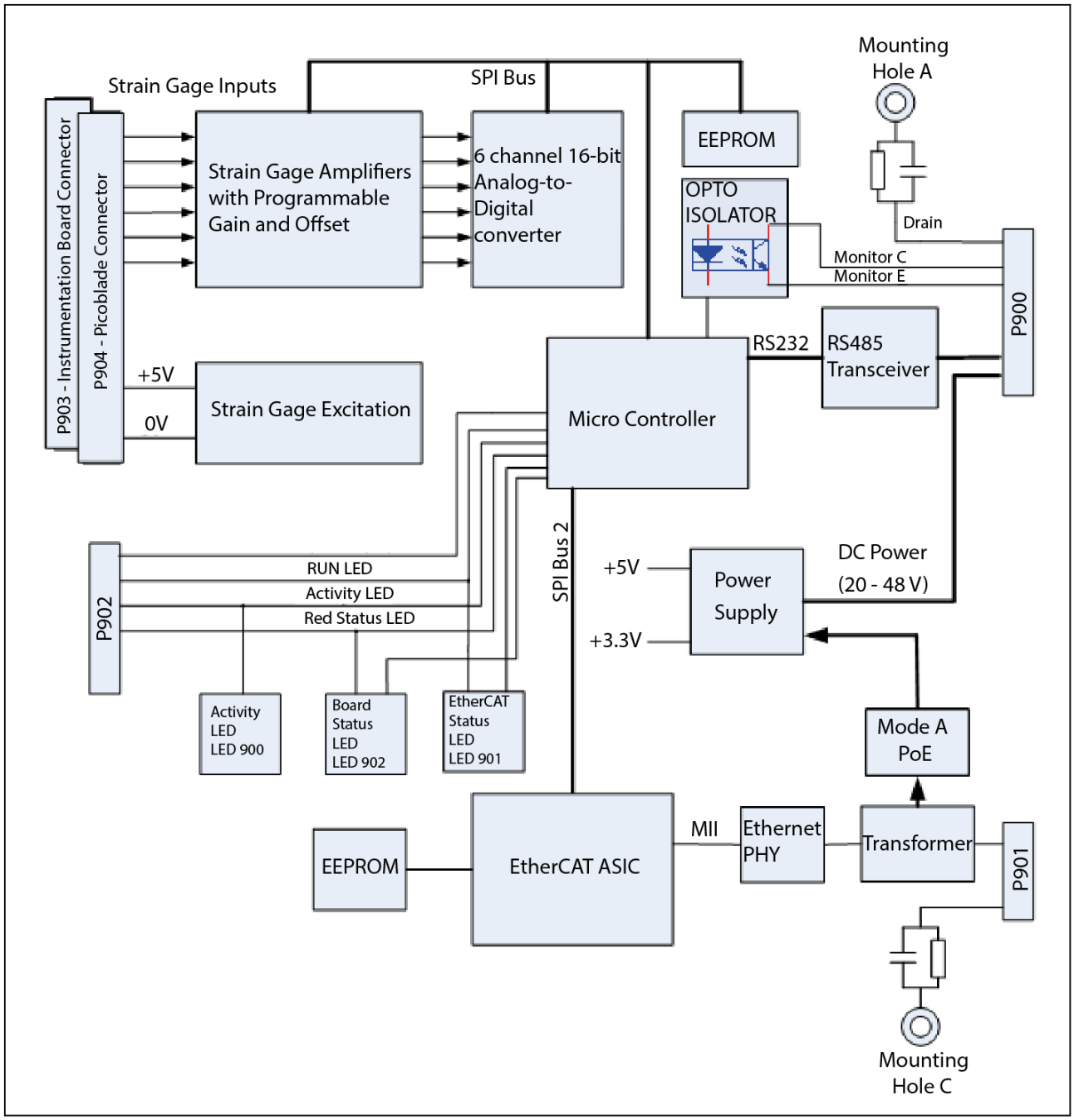
RUN LED

LED status	Description
Off	Device is in INIT state.
Flashes green	Device is in PRE-OPERATIONAL state.
Green	Device is in OPERATIONAL state.

Sensor status LED

LED status	Description
Off	No errors, the status byte is zero
Red	The status byte is not equal to zero. A diagnostic error has occurred or a monitoring limit has been exceeded

4.4 Block diagram ECATOEM



5 Assembly and settings

5.1 Installing and connecting

⚠ DANGER

Danger from electric voltage!

Touching live parts may result in death.

- Switch off the power supply before any assembly, adjustment or maintenance work and secure against being switched on again.
- Only qualified electricians may perform electrical installations.
- Check if de-energized, ground it and hot-wire.
- Cover live parts.

NOTICE

Risk of damage to the electronics!

A faulty connection can cause damage to the internal electronics.

- Observe the PIN allocation of the connecting terminals.
- Make sure that all components are grounded correctly.

1. Connect components of the force-torque sensor system with each other, ▶ 5.2.2 [🗋 17].
2. Optional: Install the software, ▶ 6 [🗋 23].
3. Check for functionality.
4. Mount the force-torque sensor on the robot, see the installation and operating instructions for the sensor.

5.2 Connections

5.2.1 Mechanical connection

NOTICE

Risk of damage to the sensor!

- Do not touch the internal electronics.
- Protect internal electronics from contamination.

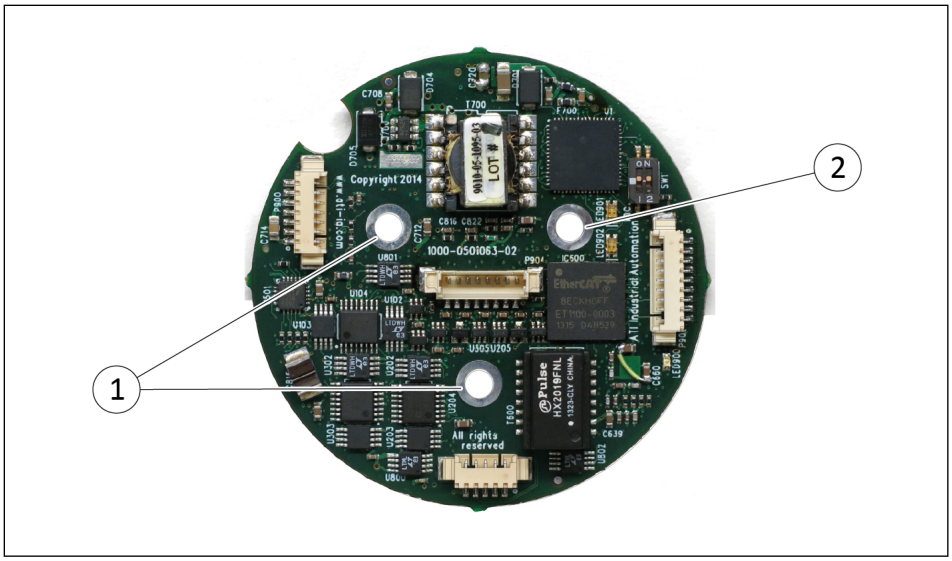
NOTICE

Risk of damage to the contacts!

The sensor has no strain relief.

- Provide suitable strain relief in the end product.

ECATOEM



- Fasten the ECATOEM interface board via the three assembly bores (1+2) using M3 fastening elements. Ensure that the assembly bores (1) are connected to the housing ground.
  CAUTION! Only connect the interface card after assembly and when all conductive tools have been removed!
  IMPORTANT! To minimize vibration of the PCB, all three assembly bores should be used.

5.2.2 Electrical connection

*Power supply requirements **

Type of voltage supply **	Min. voltage [V]	Min. voltage [V]	Max. energy consumption
Power over EtherNet ***	36	57	6
Pwr/CAN	11	25	6

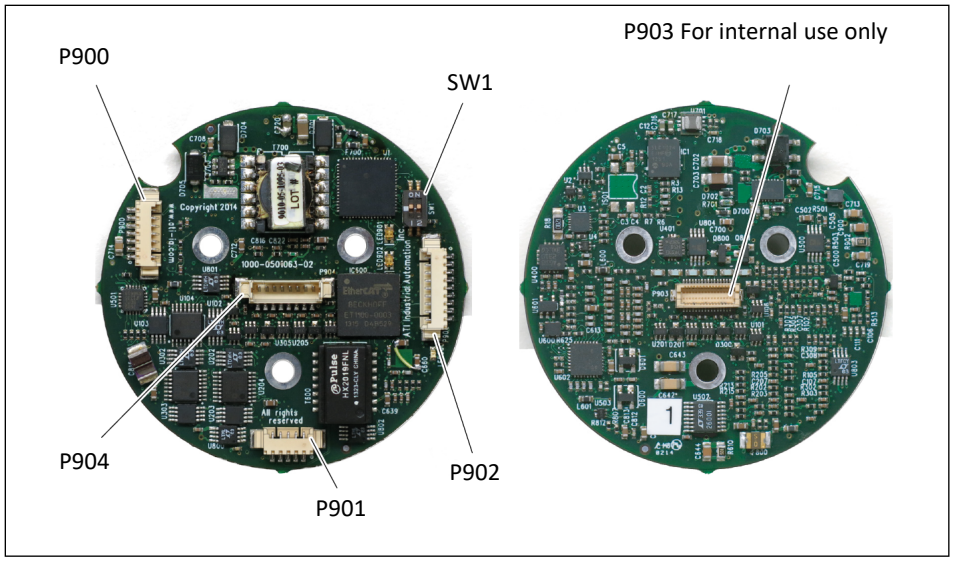
* The FT Gamma and its integrated electronics consumes 2.4 W of system power. Other FT sensors consume less power.

** Power is drawn from only one power source at a time.

*** Complies with IEEE 802.3af, Class 0, supplied with power via data lines. Uses Mode A to receive power. Mode B is not supported.

5.2.2.1 ECATOEM

Connection ECATOEM



Connection ECATOEM

P900 connector for optional DC power supply and monitor signal interface

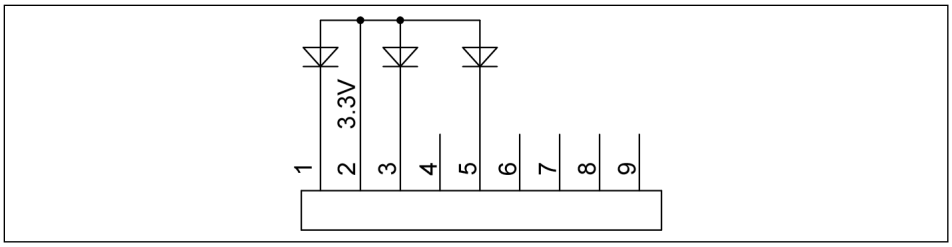
Pin	Signal	Description
1	SL_GND	Voltage supply ground, 20 to 48 VDC
2	RS485-	- Serial interface to the NetBox
3	DRAIN	Serial interface shielding
4	RS485+	+ Serial interface to the NetBox
5	SL_VP	Voltage supply ground positive, 20 to 48 VDC
6	MONITOR_E	Monitoring signal: Emitter contact of the optocoupler
7	MONITOR_C	Monitoring signal: Collector contact of the optocoupler

P901 connector for EtherCAT interfaces

Pin	Signal	Description
1	TX+	EtherNet transmission +
2	TX-	EtherNet transmission -
3	RX+	EtherNet reception +
4	RX-	EtherNet reception -
5	Shield	EtherNet cable shielding

P902 connection for optional external LEDs

Pin	Signal	Description
1	RUN_LED	Connection to the cathode of the optional external EtherCAT RUN LED
2	+3.3V	Connection to the anode of the optional external LEDs
3	ACTIVITY_LED	Connection to the cathode of the optional external ACTIVITY LED
4	+3.3V	Connection to the anode of the optional external LEDs
5	RED_STATUS_ LED	Connection to the cathode of the optional external Board Status LED
6	Reserved	For uC programming
7	Reserved	For uC programming
8	Reserved	For uC programming
9	DGND	Ground for +3.3 V; used for uC programming



P902 LED circuit diagram

P904 connection for strain gauge signals from force/torque sensor

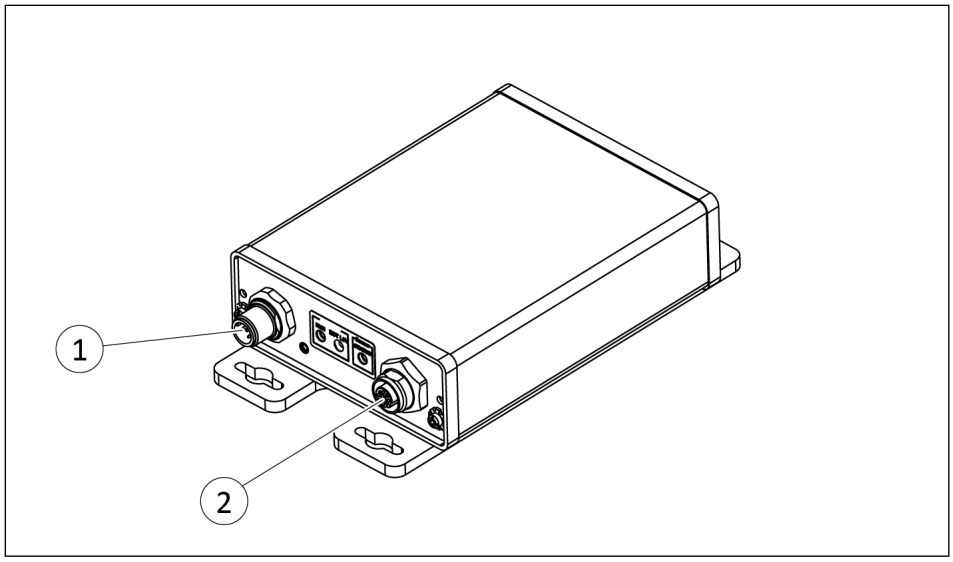
Pin	Signal	Description
1	+VSG	5V, supply voltage of the positive strain gauge bridge
2	-VSG	0V, Negative strain gauge bridge supply voltage
3	G0	Strain gauge 0 clampings
4	G1	Strain gauge 1 clamping
5	G2	Strain gauge 2 clampings
6	G3	Strain gauge 3 clampings
7	G4	Strain gauge 4 clampings
8	G5	Strain gauge 5 clampings

DIP switch SW1

Position	ON/OFF	Description
1	ON	Do not use
	OFF	Default settings OFF
2	ON	Do not use
	OFF	Default settings OFF

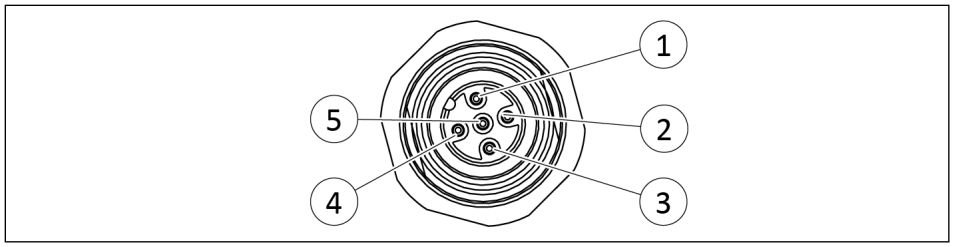
IMPORTANT! Leave dip switch in default settings. Changing the dip switch settings may have a negative effect on the functionality of the EtherCAT card.

5.2.2.2 ECATBA



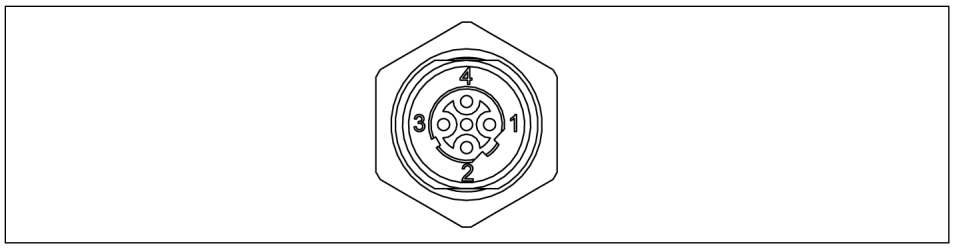
Connection ECATBA

1	Power supply
2	EtherCAT with optional Mode A PoE



M12 connector, 5-pin

Pin	Signal
1	N/C
2	V+
3	GND
4	N/C
5	N/C



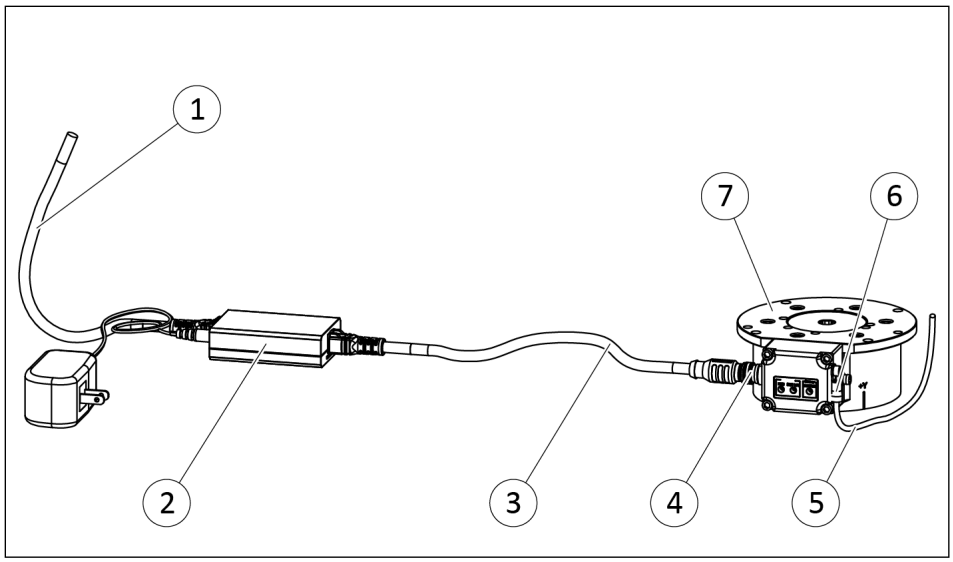
Socket Eurofast connector, 4-pin

Pin	Signal
1	TX+
2	RX+
3	TX-
4	RX-

5.2.2.3 EtherCAT

IMPORTANT! The sensor can be operated via PoE (Power over EtherNet) or via a DC power source with an output voltage range of 20 to 48 V.

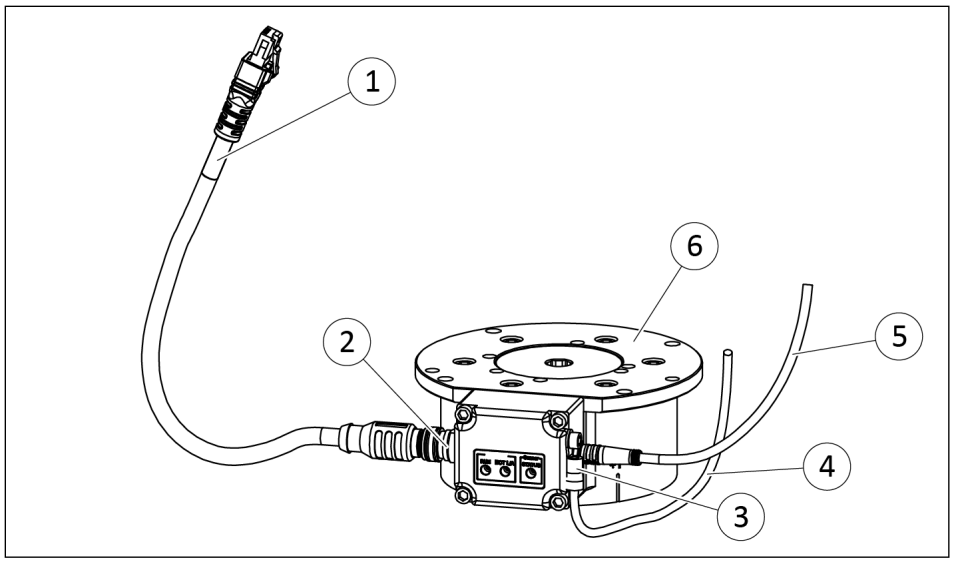
Connection via PoE



Connection for EtherCAT master

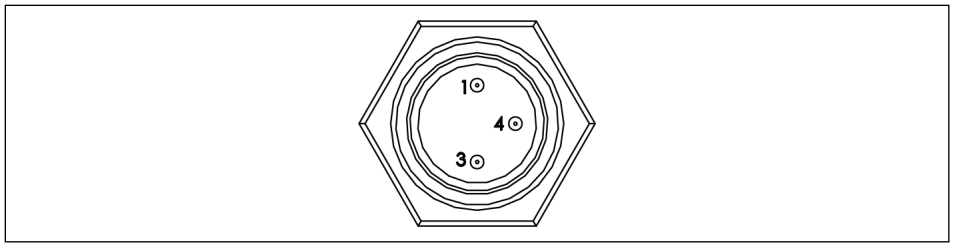
1. Connect the external AC power supply of the PoE injector (2).
2. Connect EtherCAT cable (1) to PoE injector (2).
3. Connect PoE injector with the EtherCAT cable (3).
4. Connect the EtherCAT cable (3) to the EtherCAT sensor (4).

Connection via external power supply



Connection for EtherCAT master

1. Connect the EtherCAT cable (1) to the M12 connector (2) on the EtherCAT sensor (6).
2. Connect external power cable (5) to the 3-pin M8 connector on the EtherCAT sensor (6).
3. Connect the grounding cable (4) to the ground connection (3).



Socket power connector, M8 3-pin

Pin	Signal
1	V+ (20 V to 48 VDC)
3	GND
4	-

6 Start-up

6.1 EtherCAT bus interface

The EtherCAT bus interface allows users to perform the following actions:

- Determine which calibration is active
- Selection of an active calibration
- Reading the active calibration information matrix, serial number, etc.
- Reading the firmware revision of the ECATOEM
- Reading the data about forces/torque
- Reading the strain gauge data and status information
- Configuring the tool transformation
- Setting the monitoring conditions
- Setting the low-pass filter cutoff frequency
- Put the sensor under initial tension

6.1.1 PDO interface

The PDO interface exchanges data with the F/T sensor at high speed.

- TxPDO Map / Output Data
  The TxPDO combines Object 0x6000: Read Data, Object 0x6010: Status Code and Object 0x6020: Sample Counter.
- RxPDO Map / Input Data
  The RxPDO Map consists of Object 0x7010: Control Codes.

6.1.2 EtherCAT Dictionary Objects (SDO data)

The SDO data configures the sensor and reads the date of manufacture and calibration. This section lists special dictionary objects for the EtherCAT F/T sensor application; it does not list objects that are a required part of the EtherCAT standard.

6.1.2.1 Object 0x2020: Tool conversion

This writable object contains the following 32-bit signed integer fields:

Sub index	Name	Description
0x01	Rx	The rotation around the X axis, in units of 0.1 degrees, e.g. an Rx value of 900 = 90 degrees.
0x02	Ry	The rotation around the Y axis, in units of 0.1 degrees.

Sub index	Name	Description
0x03	Rz	The rotation around the Z axis, in units of 0.1 degrees.
0x04	Dx	The displacement along the X axis, in units of 0.01 calibration length units. For example, if the distance component of the torque is meters, a Dx value of 100 = 1 meter.
0x05	Dy	The displacement along the Y axis, in units of 0.01 calibration length units.
0x06	Dz	The displacement along the Z axis, in units of 0.01 calibration length units.

6.1.2.2 Object 0x2040: Calibration

This read-only object contains information about the currently active calibration selected in the "Calibration Selection" field Object 0x7010: Control Codes. It contains the following fields:

Sub index	Name	Type	Description
0x01	FT Serial	STRING(8)	FT Serial number, e.g. "FT01234"
0x02	Calibration Part Number	STRING(30)	Calibration e.g. "SI-120-95"
0x03	Calibration family	STRING(8)	Is always "ECAT"
0x04	Calibration time	STRING(30)	Sensor calibration date

Sub index	Name	Type	Description
0x05	Matrix FxG0	DINT	These 36 elements contain the used scaled "working" matrix for this calibration. This does not necessarily match the calibration matrix in the calibration file, since the calibration matrix must be scaled accordingly to large integers before it can be used by the sensor.
0x06	Matrix FxG1		
0x07	Matrix FxG2		
0x08	Matrix FxG3		
0x09	Matrix FxG4		
0x0a	Matrix FxG5		
0x0b	Matrix FyG0		
0x0c	Matrix FyG1		
0x0d	Matrix FyG2		
0x0e	Matrix FyG3		
0x0f	Matrix FyG4		
0x10	Matrix FyG5		
0x11	Matrix FzG0		
0x12	Matrix FzG1		
0x13	Matrix FzG2		
0x14	Matrix FzG3		
0x15	Matrix FzG4		
0x16	Matrix FzG5		
0x17	Matrix TxG0		
0x18	Matrix TxG1		
0x19	Matrix TxG2		
0x1a	Matrix TxG3		
0x1b	Matrix TxG4		
0x1c	Matrix TxG5		
0x1d	Matrix TyG0		
0x1e	Matrix TyG1		
0x1f	Matrix TyG2		
0x20	Matrix TyG3		
0x21	Matrix TyG4		
0x22	Matrix TyG5		
0x23	Matrix TzG0		
0x24	Matrix TzG1		
0x25	Matrix TzG2		
0x26	Matrix TzG3		
0x27	Matrix TzG4		
0x28	Matrix TzG5		

Sub index	Name	Type	Description	
0x29	Force Units	USINT	**Value**	**Unit**
			1	Lbf
			2	N
			3	Klbf
			4	Kn
			5	Kg
0x2a	Torque Units	USINT	**Value**	**Unit**
			1	Lbf in
			2	Lbf ft
			3	N-m
			4	N-mm
			5	Kg-cm
			6	kN-m
0x2b	Max Fx Counts	DINT	Maximum value for this axis in counts	
0x2c	Max Fy Counts			
0x2d	Max Fz Counts			
0x2e	Max Tx Counts			
0x2f	Max Ty Counts			
0x30	Max Tz Counts			
0x31	Counts per force	DINT	Calibration counts per unit of force	
0x32	Counts per torque	DINT	Calibration counts per torque unit	
0x33	Gain G0	UINT16	The code for programming the gain potentiometer	
0x34	Gain G1			
0x35	Gain G2			
0x36	Gain G3			
0x37	Gain G4			
0x38	Gain G5			
0x39	Offset G0	UINT16	The code for programming the offset DAC	
0x3a	Offset G1			
0x3b	Offset G2			
0x3c	Offset G3			
0x3d	Offset G4			
0x3e	Offset G5			

6.1.2.3 Object 0x2060: Monitor Condition

This user writable object allows you to configure an axis, threshold, and direction that are continuously evaluated against the current force/torque data. When an activated condition becomes true, the monitor output becomes active and remains active until it is reset by setting the "Reset Monitor Condition" bit, which is also mapped in the TxPDO data.

The following fields are available in the monitoring condition:

Sub index	Name	Type	Description	
0x01	Threshold value	DINT	The threshold value which is used for comparison, in counts.	
0x02	Axis	USINT	**Value**	**Axis**
			0x03	Fx
			1	Fy
			2	Fz
			3	Tx
			4	Ty
			5	Tz
0x03	CompareGreaterThan	BOOL	If TRUE, the monitoring condition is true if the selected axis is greater than the selected threshold. If FALSE, the monitoring condition is true if the selected axis is greater than the selected threshold.	

6.1.2.4 Object 0x2080: Diagnostic Readings

This read-only object allows access to diagnostic values. These values can be useful when troubleshooting the system. All diagnostic voltages are filtered with the filter coefficient set to "8". The following are available in the diagnostic readings object:

Sub index	Name	Type	Description	Thresholds	Sampling rate
0x01	6V Supply Sense	UINT16	The 6V supply ADC reading.	2568 to 3970 counts	½ strain gauge sampling rate
0x02	Thermistor	UINT16	The thermistor ADC reading.	None, for information only	½ strain gauge sampling rate
0x03	VBridge Volts	INT16	The excitation voltage ADC reading.	17050 to 17750 counts	Strain gauge sampling rate
0x04	VBridge Current	INT16	The excitation current ADC reading.	500 to 6554 counts	Strain gauge sampling rate

Note:
The force/torque data output from the sensor to the EtherCAT interface is given in count values. The user must convert the value of count values into units for the strain gauge sampling rate.

6.1.2.5 Object 0x2090: Version

This read-only object provides information about the firmware version. The following fields are available in the version object:

Sub index	Name	Type	Description
0x01	Major	UNIT16	Major version
0x02	Minor	UNIT16	Minor version
0x03	Revision	UNIT16	Revision

6.1.2.6 Object 0x6000: Read data

This read-only object represents the current force or current torque or the measuring strip data that is included in the TxPDO input data. The following fields are present in the following read data:

Sub index	Name	Type	Description
0x01	Fx/Gage0	DINT	If the "Gage Data" bit is set in Object 0x7010: Control Codes [🗋 33] , these fields contain the 16-bit data of the encoder. When the "Gage Data" bit is cleared, these fields contain the 32-bit force/ torque result data in counts.
0x02	Fy/Gage1		
0x03	Fz/Gage2		
0x04	Tx/Gage3		
0x05	Ty/Gage4		
0x06	Tz/Gage5		

Conversion of force/torque values into units

The data in the register for this object are given in counts. Therefore, the force/torque values must be converted to a value in units.

Perform the following steps to convert the SDO counts to units:

1. Read SDO register Counts per Force (Object 0x2040: Calibration Subindex 0x31 [🗋 24]).
2. Read SDO register Counts per Torque (Object 0x2040: Calibration Subindex 0x32 [🗋 24]).
3. Check force units (Object 0x2040: Calibration Subindex 0x29 [🗋 24]).
4. Check torque units (Object 0x2040: Calibration Subindex 0x2a [🗋 24]).
5. Read force/torque numbers for the force (Object 0x6000: Read data [🗋 29]).
6. Read force/torque count values for torque (Object 0x6000: Read data [🗋 29]).

7. Convert the meter readings to units.
   – For the force, divide the register from step 5 by the register from step 1.
   – For the torque, divide the register from step 6 by the register from step 2.

Example: A user wants the values for Fx and Tx in units. First, the user reads the registers for the corresponding SDO subindices and finds the following:

Example of registers for SDO subindices

SDO	Sub index	Register	Description
0x2040	0x31	1,000,000	Counts per force
0x2040	0x32	1,000,000	Counts per torque
0x2040	0x29	2	The units of force are N.
0x2040	0x2a	3	The torque units are Nm.
0x6000	0x01	5,214,777	Fx data in raw counts
0x6000	0x04	4,214,777	Tx data in raw counts

Then the user converts the counts into units for Fx and Tx.
For Fx: 5,214,777 counts ÷ 1,000,000 N/counts = 5.21 N
For Tx: 4,214,777 counts ÷ 1,000,000 Nm/counts = 4.21 Nm

6.1.2.7 Object 0x6010: Status Code

This object contains a single DINT value (at subindex 0) with the following bitmap:

Bit number	Description	Indicates an error?
0	Monitoring condition triggered. This bit becomes active when an active monitor condition becomes true and remains set until it is cleared with the "Reset Monitor Conditions" bit in. Object 0x7010: Control codes.	No
1	Supply outside the range. This bit becomes active when the supply sensor reading (Object 0x2080: Diagnostic Readings [🗋 28]) is outside the expected range. This bit remains set until the device is switched on. It may indicate a system error.	Yes
2	Occupied.	
3	VBridge voltages out of range. This bit becomes active when the excitation voltage (Object 0x2080: Diagnostic Readings [🗋 28]) is outside the expected range. This bit remains set until switch-on. It may indicate a system error.	Yes
4	VBridge current out of range. This bit becomes active when the excitation current (Object 0x2080: Diagnostic Readings [🗋 28]) is outside the expected range. This bit remains set until switch-on. It may indicate a system error.	Yes
5	DPOT error. This bit is set when there is an error reading back the value that was written to a DPOT. It remains set until the switch-on cycle.	Yes
6	EEPROM error. This bit is set when there is an error reading back the value that was written to a EEPROM. It remains set until the switch-on cycle.	Yes

Bit number	Description	Indicates an error?
7	DAC error. This bit is set when an error is detected during communication with the DAC. The used DAC (LTC2600) does not support readback but daisy chaining. The firmware detects an error by prepending a known value to all commands and searching for an echo of this known value at the SPI input after the command is sent. It remains set until the power is turned off.	Yes
6-27	Occupied.	
28	Simulated error. This bit reflects the "Simulated Error Control" bit (Object 0x7010: Control-Codes [🗋 33]). It can be used to test the user's error handling.	No, but it can be used to test the handling of user errors if they are treated as such.
29	Calibration Checksum Error. This bit is set if the active calibration has an invalid checksum.	Yes
30	Saturation. This bit is set whenever a strain gauge sample is saturated and remains high for 32 samples after the last saturated sample to allow the effect of the saturated sample on the filtered data to decay.	Yes
31	Error: This bit is set when a status code bit indicating an error is set.	Yes

6.1.2.8 Object 0x6020: Sample Counter

This object contains a single 32-bit unsigned integer at subindex 0 that increments by one each time an F/T sample is read (a complete set of measurement data).

This number changes from 4 294 967 295 (232-1) to 0 without reporting an error. The sample counter is reset to zero when the instrument is switched on.

6.1.2.9 Object 0x7010: Control Codes

This object is included in the RxPDO for real-time control of the F/T system. It contains the following fields:

Sub index	Name	Type	Description	
0x01	Control 1	DINT	**Bit**	**Function**
			0	1 = Set bias current against current load 0 = Use the last set bias current.
			1	1 = Select strain gauge output 0 = Select force/torque output in counts.
			2	1 = set test error 0 = clear test error
			3	1 = Clear monitor status 2 = Leave monitor status unchanged
			4-7	Filter selection
			8-11	Calibration selection
			12-31	Occupied
0x02	Control 2	DINT	**Bit**	**Function**
			0-15	Activate monitor status check 0
			16-19	Tool transformation index selection
			20-30	Occupied
			31	Simulated error control

6.2 Tool conversion

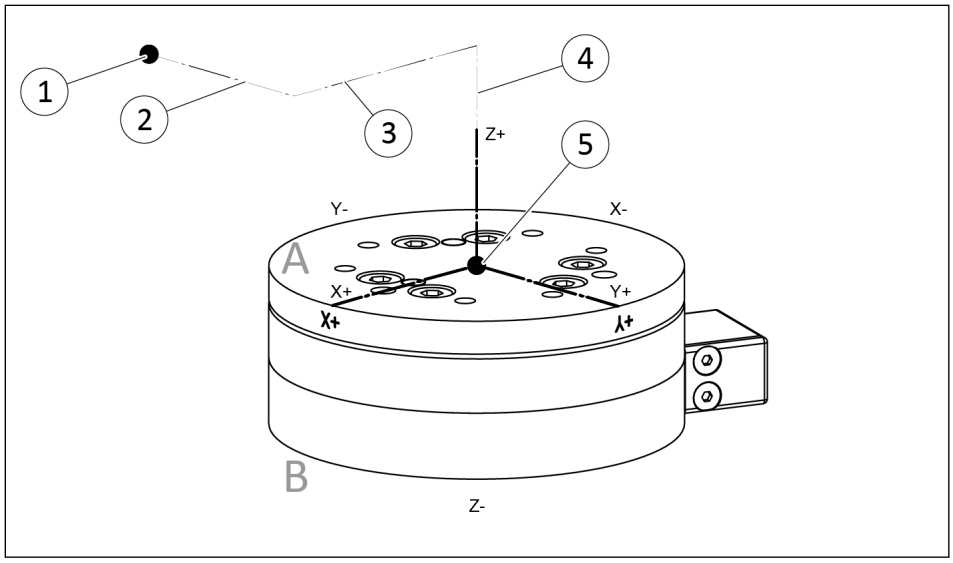
from Gamma and larger

To activate a tool transformation, write down corresponding transformation coefficients from Object 0x2020: Tool transformation [🗋 23]. Set bits "Tool Transform Index Selection" in Object 0x7010: Control Codes [🗋 33] to enable the condition. The software supports a tool transformation.

The tool transformation allows the input of a series of tool transformations to measure the forces and torques acting at a point other than the origin of the sensor. The tool transformations are applied in the order in which they are entered, so you can determine, for example, whether rotations occur before displacements by entering a tool transformation with only rotations before the rotation with displacements. When specifying both rotations and displacements within a given tool transformation, displacements are executed first in the order DX, DY, DZ, and then rotations are executed in the order RX, RY, RZ.

- Displacement DX, DY and DZ: Displacement along each axis is measured in the distance component and component of the torque units of calibration. Thus, if the sensor has been calibrated to use Newton meters as the torque unit, the displacement will be measured in meters.
- Rotations RX, RY and RZ: The rotation around each axis in radians.

Displacement allows the customer to move the origin of the scanning reference frame along the X, Y and Z axes. The displacement should be calculated and the values should be entered before the rotation. The displacement is measured in the set unit, in Nm or in lbs.



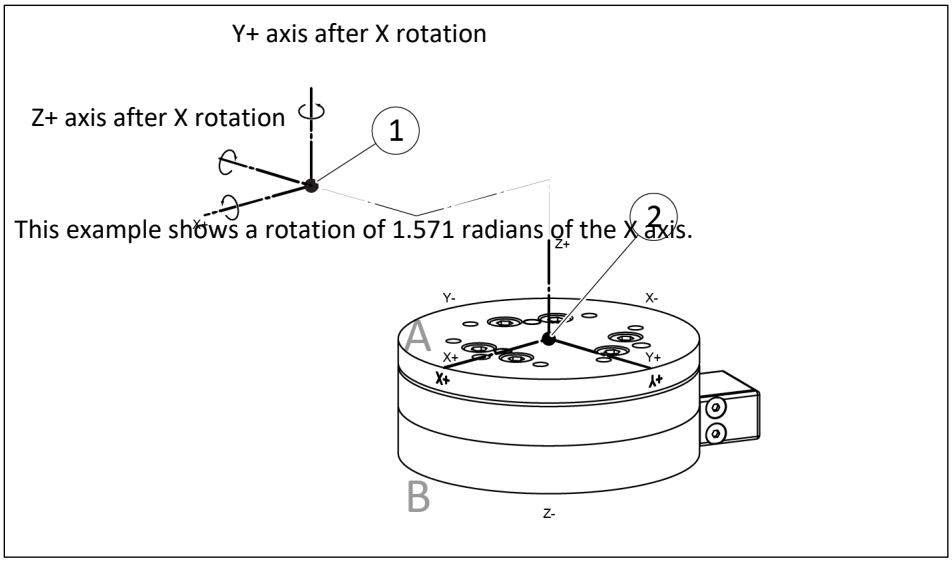
Shifting the origin of the acquisition reference frame

A	Tool side
B	Robot side
1	Origin of the scanning reference frame (applied by the customer)
2	Movement of the origin along the Y axis
3	Movement of the origin along the X axis
4	Movement of the origin along the Z axis
5	Origin of the scanning reference frame (factory settings)

The rotation allows the customer to rotate the axes while maintaining the origin of the frame. The rotation is measured in radians.

If a value is entered for RX, RY or RZ, the following results:

- The RX value rotates Y and Z by X in the direction shown.
- The RY value rotates X and Z by Y in the direction shown.
- The RZ value rotates X and Y by Z in the direction shown.



Rotating reference frame, direction of rotation

A	Tool side
B	Robot side
1	Origin of the scanning reference frame (applied by the customer)
2	Origin of the scanning reference frame (factory settings)

7 Troubleshooting

7.1 Saturation

Possible cause	Corrective action
Force-torque sensor or data acquisition hardware is subject to a load or signal that is outside the range of measurement	Pause force application on force-torque sensor until the error disappears. If the error does not disappear, the overload value was exceeded or the power supply was disconnected.

7.2 Signal noise

Possible cause	Corrective action
Signal noise is caused by mechanical vibrations or electrical interference.	Ensure that the system is properly grounded and isolated from external electrical interference.
A component in the system has failed.	

7.3 Measurement data deviation / drift

Possible cause	Corrective action
Measured values are not completely reset after loading and unloading.	Drift is caused, for example, by rapid temperature changes. Have the force-torque sensor adjusted to the ambient temperature before measuring again. Operate all components separately. Thoroughly clean the sensor body and adapter plate of contamination.
There is an internal error in the entire system.	

7.4 Hysteresis

Possible cause	Corrective action
Measured values are not completely reset after loading and unloading.	Operate all components separately. Thoroughly clean the sensor body and adapter plate of contamination.

8 EU Declaration of Conformity

Manufacturer/ Distributor	SCHUNK GmbH & Co. KG Clamping and gripping technology 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 system FTE This declaration of conformity is valid for all variants mentioned in the appendix.

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

Applied harmonized standards, especially:

EN 61326-2-3:2013	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 61326-2-3:2012)
EN ISO 12100:2010	Safety of machinery - General principles for design - Risk assessment and risk reduction

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 GmbH & Co. KG

Lauffen/Neckar, November 2022

Signature: see original declaration

Dr.-Ing. Manuel Baumeister,
Technology & Innovation

9 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 system FTE
ID number	

- **Electromagnetic Compatibility Regulations 2016**

Applied harmonized standards, especially:

EN 61326-2-3:2013	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 61326-2-3:2012)
EN ISO 12100:2010	Safety of machinery - General principles for design - Risk assessment and risk reduction

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

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

Lauffen/Neckar, November 2022

Dr.-Ing. Manuel Baumeister,
Technology & Innovation

10 Appendix to the declaration of conformity

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

FTD-interface

FTD-Nano-17 SI-12-0.12
FTD-Nano-17 SI-25-0.25
FTD-Nano-17 SI-50-0.5
FTD-Nano-17-T SI-8-0.05
FTD-Nano-17-T SI-16-0.1
FTD-Nano-17-T SI-32-0.2
FTD-Nano-25 SI-125-3
FTD-Nano-25 SI-250-6
FTD-Nano-43 SI-9-0.125
FTD-Nano-43 SI-18-0.25
FTD-Nano-43 SI-36-0.5
FTD-Mini-40 SI-20-1
FTD-Mini-40 SI-40-2
FTD-Mini-40 SI-80-4
FTD-Mini 43 SI-62-0.75
FTD-Mini 43 SI-125-1.5
FTD-Mini 43 SI-250-3
FTD-Mini-45 SI-145-5
FTD-Mini-45 SI-290-10
FTD-Mini-45 SI-580-20
FTD-Mini-58 SI-700-30
FTD-Mini-58 SI-1400-60
FTD-Mini-58 SI-2800-120
FTD-Mini-85 SI-475-20
FTD-Mini-85 SI-950-40
FTD-Mini-85 SI-1900-80
FTD-Gamma SI-32-2.5
FTD-Gamma SI-65-5
FTD-Gamma SI-130-10
FTD-Delta SI-165-15
FTD-Delta SI-330-30
FTD-Delta SI-660-60
FTD-Theta SI-1000-120
FTD-Theta SI-1500-240
FTD-Theta SI-2500-400
FTD-Omega85 SI-475-20

FTD-Omega85 SI-950-40
FTD-Omega85 SI-1900-80
FTD-Omega-160 SI-1000-120
FTD-Omega-160 SI-1500-240
FTD-Omega-160 SI-2500-400
FTD-Omega-191 SI-1800-350
FTD-Omega-191 SI-3600-700
FTD-Omega-191 SI-7200-1400
FTD-Omega-250 SI 4000 500
FTD-Omega-250 SI 8000 1000
FTD-Omega-250 SI-16000-2000
FTD-Omega-331 SI-10000-1500
FTD-Omega-331 SI-20000-3000
FTD-Omega-331 SI-40000-6000

FTN-interface

FTN-Nano-17 SI-12-0.12
FTN-Nano-17 SI-25-0.25
FTN-Nano-17 SI-50-0.5
FTN-Nano-17-T SI-8-0.05
FTN-Nano-17-T SI-16-0.1
FTN-Nano-17-T SI-32-0.2
FTN-Nano-25 SI-125-3
FTN-Nano-25 SI-250-6
FTN-Nano-43 SI-9-0.125
FTN-Nano-43 SI-18-0.25
FTN-Nano-43 SI-36-0.5
FTN-Mini-40 SI-20-1
FTN-Mini-40 SI-40-2
FTN-Mini-40 SI-80-4
FTN-Mini 43 SI-62-0.75
FTN-Mini 43 SI-125-1.5
FTN-Mini 43 SI-250-3
FTN-Mini-45 SI-145-5
FTN-Mini-45 SI-290-10
FTN-Mini-45 SI-580-20
FTN-Mini-58 SI-700-30
FTN-Mini-58 SI-1400-60
FTN-Mini-58 SI-2800-120
FTN-Mini-85 SI-475-20
FTN-Mini-85 SI-950-40

FTN-Mini-85 SI-1900-80
FTN-Gamma SI-32-2.5
FTN-Gamma SI-65-5
FTN-Gamma SI-130-10
FTN-Delta SI-165-15
FTN-Delta SI-330-30
FTN-Delta SI-660-60
FTN-Theta SI-1000-120
FTN-Theta SI-1500-240
FTN-Theta SI-2500-400
FTN-Omega85 SI-475-20
FTN-Omega85 SI-950-40
FTN-Omega85 SI-1900-80
FTN-Omega 160 SI 1000 120
FTN-Omega-160 SI-1500-240
FTN-Omega 160 SI 2500 400
FTN-Omega-191 SI-1800-350
FTN-Omega-191 SI-3600-700
FTN-Omega-191 SI-7200-1400
FTN-Omega-250 SI-4000-500
FTN-Omega 250 SI-8000-1000
FTN-Omega 250 SI 16000 2000
FTN-Omega-331 SI-10000-1500
FTN-Omega-331 SI-20000-3000
FTN-Omega 331 SI-40000-6000

FTE-interface

FTE-Nano-17 SI-12-0.12
FTE-Nano-17 SI-25-0.25
FTE-Nano-17 SI-50-0.5
FTE-Nano-17-T SI-8-0.05
FTE-Nano-17-T SI-16-0.1
FTE-Nano-17-T SI-32-0.2
FTE-Nano-25 SI-125-3
FTE-Nano-25 SI-250-6
FTE-Nano-43 SI-9-0.125
FTE-Nano-43 SI-18-0.25
FTE-Nano-43 SI-36-0.5
FTE-Mini-40 SI-20-1
FTE-Mini-40 SI-40-2
FTE-Mini-40 SI-80-4

FTE-Mini 43 SI-62-0.75
FTE-Mini 43 SI-125-1.5
FTE-Mini 43 SI-250-3
FTE-Mini-45 SI-145-5
FTE-Mini-45 SI-290-10
FTE-Mini-45 SI-580-20
FTE-Mini-58 SI-700-30
FTE-Mini-58 SI-1400-60
FTE-Mini-58 SI-2800-120
FTE-Mini-85 SI-475-20
FTE-Mini-85 SI-950-40
FTE-Mini-85 SI-1900-80
FTE-Gamma IP65 SI-32-2.5
FTE-Gamma IP65 SI-65-5
FTE-Gamma-IP65 SI-130-10
FTE-Delta-IP60 SI-165-15
FTE-Delta-IP65 SI-165-15
FTE-Delta-IP60 SI-330-30
FTE-Delta-IP65 SI-330-30
FTE-Delta-IP60 SI-660-60
FTE-Delta IP65 SI-660-60
FTE-Omega 160-IP60 SI 1000-120
FTE-Omega 160-IP65 SI 1000-120
FTE-Omega 160-IP60 SI 1500-240
FTE-Omega 160-IP65 SI 1500-240
FTE-Omega 160-IP60 SI 2500-400
FTE-Omega 160-IP65 SI 2500-400
FTE-Omega 250 IP60 SI 4000 500
FTE-Omega 250-IP60 SI-8000-1000
FTE-Omega 250-IP60 SI-16000-2000

SCHUNK GmbH & Co. KG
Clamping and gripping technology

Bahnhofstr. 106 - 134
D-74348 Lauffen/Neckar
Tel. +49-7133-103-0
Fax +49-7133-103-2399
info@de.schunk.com
schunk.com

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