Force-torque Sensor
Type FTC / FTCL
Assembly and Operating Manual

Dear Customer,

Congratulations on choosing a SCHUNK product. By choosing SCHUNK, you have opted for the highest precision, top quality and best service.

You are going to increase the process reliability of your production and achieve best machining results – to the customer's complete satisfaction.

SCHUNK products are inspiring.

Our detailed assembly and operation manual will support you.

Do you have further questions? You may contact us at any time – even after purchase. You can reach us directly at the mentioned addresses in the last chapter of these instructions.

Mit freundlichen Grüßen

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Table of contents

1 About this manual

1.1 Purpose/validity

This manual is part of the module and describes the safe and proper use during all phases of operation.

This manual is valid only for the module specified on the front page.

1.2 Target groups

Target group	Task
Manufacturer, operator	➔ Keep this manual available for the personnel at all times. ➔ Require personnel to read and observe this manual and the applicable documents, especially the safety notes and warnings.
Skilled personnel, fitter	➔ Read, observe and follow this manual and the applicable documents, especially the safety notes and warnings.

Tab. 1

1.3 Applicable documents

You can find the following documents on our homepage:

Document	Purpose
Catalog	Technical data or application parameters of the module and information on accessories. The last version is always valid.
General terms of business	Including notes on the warranty.

Tab. 2

1.4 Symbols in this manual

To give you quick access to information, the following symbols will be used in this guide::

Symbol	Meaning
⚠**DANGER**	Dangers for persons. Nonobservance will cause death or serious injuries.
⚠ **WARNING**	Dangers for persons. Nonobservance can cause death or serious injuries.
⚠ **CAUTION**	Dangers for persons. Nonobservance can cause slight injuries.
❗ **NOTICE**	Information on avoiding material damage.
✓	Prerequisite for a handling instruction.
➔	Handling instruction, also measures in a warning or note.
1. 2. 3. ...	. Step-by-step handling instruction. ➔ Observe the order.
(10)	Reference in the text or in a handling instruction to a part that is represented in a graphic.

Tab. 3

2 Basic safety notes

2.1 Intended use

The module was designed for compensation for the work-piece's or tool's tolerances and positioning inaccuracy

The module is intended for installation in a machine. The requirements of the applicable guidelines must be observed and complied with.

The module may be used only in the context of its defined application parameters.

Any other use or use exceeding that specified is an in-fringement of use for intended purpose. The manufacturer bears no liability for damage resulting from such use.

2.2 Ambient conditions and operating conditions

➔ Use the module only in the context of its defined application parameters (see chapter 5, page 12, and catalog).

➔ Make sure, that the module is dimensioned according to the application

➔ Make sure, that the environment is clean and the environmental temperature is according to the data in the catalog.

➔ Make sure that the environment is free from splash water and vapors as well as from abrasion or processing dust. Excepted are modules that are designed specially for contaminated environments.

2.3 Controlled production

The module represents the state of the art and the recognized safety rules at the time of delivery. However, it can present risks if, for example:

- The module is not used in accordance with its intended purpose.
- The module is not installed or maintained properly.
- The EC Machinery Directive, the VDE directives, the safety and accident-prevention regulations valid at the usage site, or the safety and installation notes are not observed.

2.3.1 Protective equipment

➔ Provide protective equipment per EC Machinery Directive.

2.3.2 Constructional changes, attachments, or conversions

Additional drill holes, threads, or attachments that are not offered as accessories by SCHUNK may be attached only with permission of SCHUNK.

2.4 Personnel qualification

The assembly, initial commissioning, maintenance, and repair of the module may be performed only by trained specialist personnel.

Every person called upon by the operator to work on the module must have read and understood the complete Assembly and Operating Manual, especially the chapter 2 "Basic safety notes". This applies particularly to occasional personnel such as maintenance personnel.

2.5 Safety-conscious working

➔ Avoid any manner of working that may interfere with the function and operational safety of the module.

➔ Observe the safety and accident-prevention regulations valid at the usage site.

2.6 Notes on particular risks

Risk of injury from objects falling and being ejected

➔ Provide protective equipment to prevent objects from falling or being ejected, such as processed workpieces, tools, chips, fragments, rejects.

Risk of injury when the machine/system moves unexpectedly

➔ Do not move parts by hand when the energy supply is connected.

➔ Do not reach into the open mechanism or the movement area of the module.

➔ Remove the energy supplies before installation, modification, maintenance, or adjustment work.

➔ Perform maintenance, modifications, and additions outside the danger zone.

➔ For all work, secure the module against accidental operation.

Risk of injury from spring forces!

Modules that clamp with spring force are under spring tension.

➔ The disassembly of the module may be performed only by trained specialist personnel.

3 Warranty

The warranty is valid for 24 months from the delivery date to the production facility under the following conditions:

- Intended use in 1-shift operation
- Observation of the ambient conditions and operating conditions (see chapter 2.2, page 8)

Parts touching the workpiece and wearing parts are not part of the warranty. Also observe our general terms of business.

4 Scope of delivery

The scope of delivery includes:

- Force-torque Sensor Type FTC / FTCL in the ordered model:
- Software for PC-Connection
- Mounting plug
- Assembly- and Operating manual

➔ For additional accessories, see catalog.

5 Technical Data

Further technical data can be found in our catalog. The most recent version applies.

5.1 FTC

Type	FTC-050-80	FTC-050-80-V	FTC-050-40	FTC-050-40-V
Deadweight [kg]	1,56	2,56	1,56	2,56
Permissible operating temperature [°C]	+5 to +55			
Interfaces, robot-side	ISO 9409-1-A50			
Interfaces, tool-side	ISO 9409-1-A50; for Gripper PZN 64			
Movement area, translatory (X,Y,Z) [mm]	+/- 1.4			
Movement area, rotary (α,β,γ) [°]	+/- 1.4			
Measuring range translatory (X,Y,Z) [mm]	+/- 1.0			
Measuring range rotary (α,β,γ) [°]	+/- 1.0			
Max. tensile loading F_x and F_y [N]	400	400	200	200
Max. tensile loading F_z [N]	350	350	180	180
Max. Torque M_x and M_y [Nm]	14	14	8	8
Max. Torque M_z [Nm]	25	25	13	13
Measuring frequency [kHz]	1			
Power supply [VDC]	10 to 26			
Max. Power consumption [W]	1.8			
Electrical interfaces	RS232 (RS485 on request)			
	CAN (DeviceNET on request)			

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5.2 FTCL

Bezeichnung	**FTCL-050-80 / FTCL-050-40**
Deadweight [kg]	0,96
Permissible operating temperature [°C]	+5 to +55
Interfaces, robot-side	ISO 9409-1-A50
Interfaces, tool-side	ISO 9409-1-A50 and for Gripper PZN 64
Movement area, translatory (X,Y,Z) [mm]	+/- 1,4
Movement area, rotary (α,β,γ) [°]	+/- 1,4
Measuring range translatory (X,Y,Z) [mm]	+/- 1,0
Measuring range rotary (α,β,γ) [°]	+/- 1,0
Measuring frequency [kHz]	1
Power supply [VDC]	10 to 26
Max. Power consumption [W]	1.8
Electrical interfaces	RS232 (RS485 on request)
	CAN (DeviceNET on request)

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6 Assembly

6.1 Mechanical connection

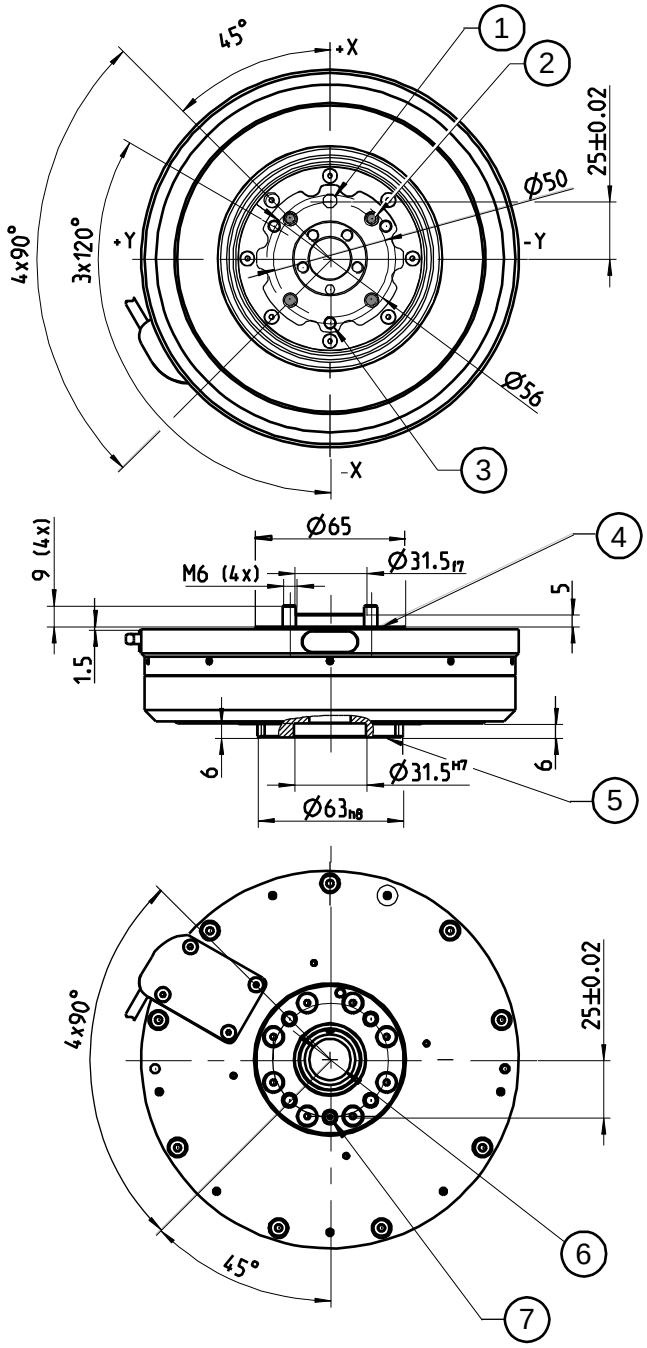
⚠ WARNING
Risk of injury when the machine/system moves unexpectedly! ➔ Switch off energy supply.

Without locking

➔ Module with pre-assembled 4 x M6 cheese-head screws, fasten to robot.

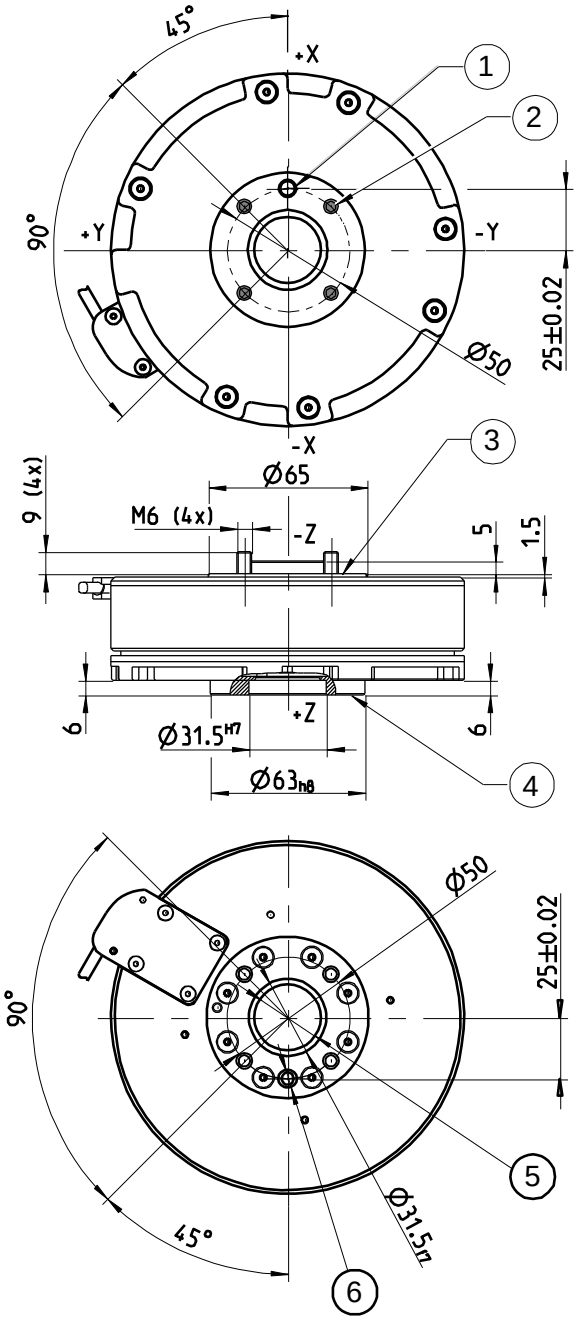
With locking

1. Locking unit with 4 x M6 cheese-head screws, fasten to robot.
2. Sensor unit with pre-assembled 4 x M6 cheese-head screws, fasten to locking unit..



1	Centering pin Ø 6 ^{H7} / 13	5	Mounting surface (tool-side) with ISO 9409-1-A50 interface
2	M6 / 11 (4x)	6	Ø 18 Fully through
3	M5 / 11 (3x) for direct mounting on PZN 64	7	Centering pin Ø 6 ^{H7} / 12.5
4	Mounting surface (robot-side) with ISO 9409-1-A50 interface		

Fig. 1 FTC flange pattern



1	Centering pin Ø 6 ^{H7} / 7	4	Mounting surface (tool-side) with ISO 9409-1-A50 interface
2	M6 / 7 (4x)	5	Ø 26 Fully through
3	Mounting surface (robot-side) with ISO 9409-1-A50 interface	6	Centering pin Ø 6.5 $_{0}^{+0.2}$ / 8.5

Fig. 2 FTCL flange pattern

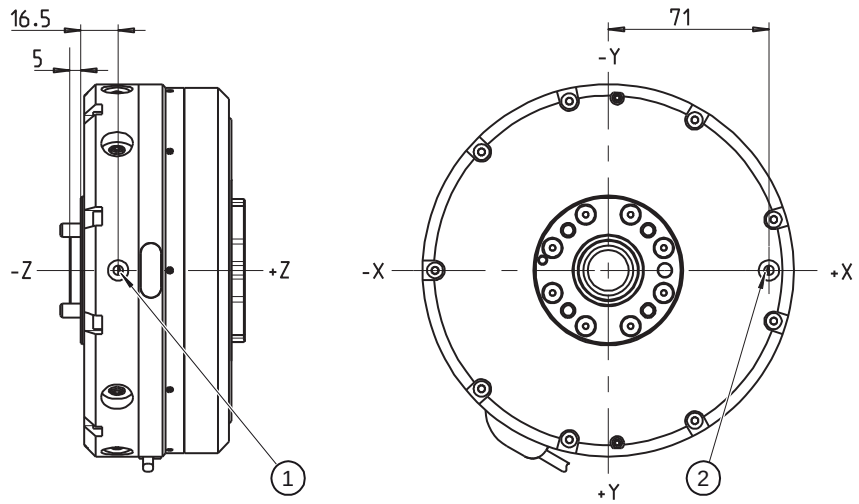
6.2 Air connection

Only for modules with locking
(FTC-050-80-V / FTC-050-40-V)

⚠WARNING

Risk of injury when the machine/system moves unexpectedly!

➔ Switch off energy supply



1 Air connection, outer side 2 Air connection , tool-side

Fig. 3

Connection thread	M5 / 5
Operating pressure	6 bar

Tab. 6

3. Establish air connection at the outer side (1) or the tool-side (2).
4. Close unused connection with a blind plug.

6.3 Electrical connection (data interface)

Standard interfaces:

- RS 232
- RS 485 (on request)
- CANbus
- DEVNet (on request)

6.3.1 RS 232

Settings

Parity	none
Baudrate	Default 9600 can be set via software
Handshake	none
Data bits	8
Stop bits	1

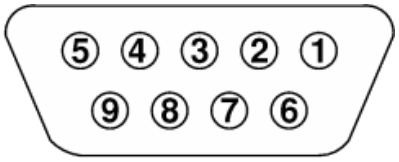
Tab. 7

Pin assignments

- Possible sensor plugs
- Binder plug
- SubD

1	12..24V	6	RS232:Rx
2	GND	7	RS485:A
3	Can_H	8	RS485:B
4	Can_L	Housing	Shielding
5	RS232:Tx		

Fig. 4 Binding plug at sensor



2	RS232:Tx	Housing	Shielding
3	RS232:Rx		
5	GND		

Additionally bridged in plug:

7 and 8 (RTS to CTS)

4 and 6 (DTR to DSR)

Fig. 5 SubD plug at sensor

Cable lengths Maximum cable length depends on the cable used and the Baudrate. Standard: at 9600 Baud max. 30 Meters.

6.3.2 CANbus

Pin assignments

1	12..24V	6	RS232:Rx
2	GND	7	RS485:A
3	Can_H	8	RS485:B
4	Can_L	Housing	Shielding
5	RS232:Tx		

Fig. 6 Binding plug at sensor

Lead-out conductors

Connection to a CAN bus is done using a self-built cable**.**

white	+12..24V
brown	GND
green	CAN_High
yellow	CAN_LOW
Shielding	Shielding

Tab. 8

If necessary, a termination resistor (usually 120 Ohm) may need to be connected at the transmitter end.

Information on transmitting and receiving data and the programming commands is provided in Chapter 8, page 25.

6.4 Setting the DIP switch

NOTICE

ESD-sensitive components are located under the connection plate!
Danger of damage to electronic components.

➔ Suitable protective measures must be taken (e.g. wear an ESD armband)

The DIP switch is located on the bottom of the housing. The connection plate must be removed to set the DIP switch.

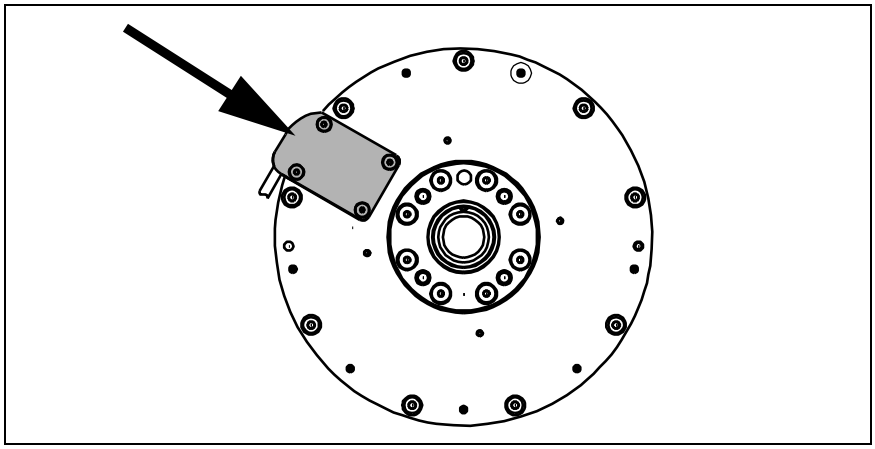
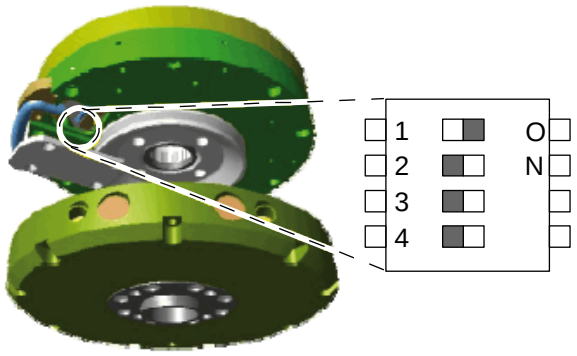


Fig. 7 Connection plate position

1. For modules with locking (FTC-050-80-V / FTC-050-40-V) the locking unit must first be removed in order to remove the connection plate.
2. Remove the connection plate using a 2 mm hexagon socket wrench.

Basic properties can be set at the DIP switch of the force torque sensor. These settings must be made once only before commissioning.



1 CAN termination resistor
2 Reserved
3 Activate flash mode
4 Default boot (=boot with default values)

Fig.8 DIP switch jumpers

CAN termination resistor

Switch the CAN termination resistor (120 Ohm) on / off. If this is the last CAN bus device then this termination resistor must be activated.

Default setting: ON (termination resistor activated)

Activate flash mode

The force torque sensor is switched to flash mode. This setting is only required if the force torque sensor cannot be switched to flash mode via the software. (forgotten password, power failure during a previous software update)

Defaultboot

With a default boot all EEPROM settings are restored to their default values. This is necessary if communication with the force torque sensor is not longer possible due to an incorrectly set Baudrate.

Interfaces	CAN and RS232 activated
Serial Baudrate	9600
CAN Baudrate :	500
CAN ID	5
Cycle time [ms]	1000 (as of firmware Ver. 1.30a)
Position Limit	+/- max/min Position measuring range
Force Limit	+/- max/min Force measuring range
DEVNet (optional) Producer Size	28

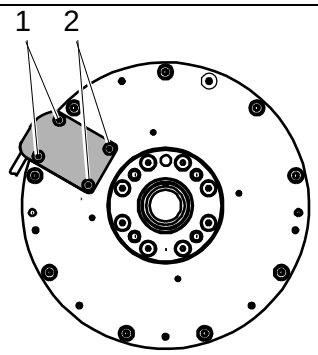
Tab. 9 Default EEPROM values after a default boot

Assembly

NOTICE

Destruction of the force torque sensor when the wrong screws are used!

➔ When mounting the connection plate, make sure that the long and short fastening screws are screwed into the correct positions.



1 Screws long

2 Screws short

Fig.9 Connection screws on the cover plate

7 Operating display

The operating display (LED) is located near to the cable feed

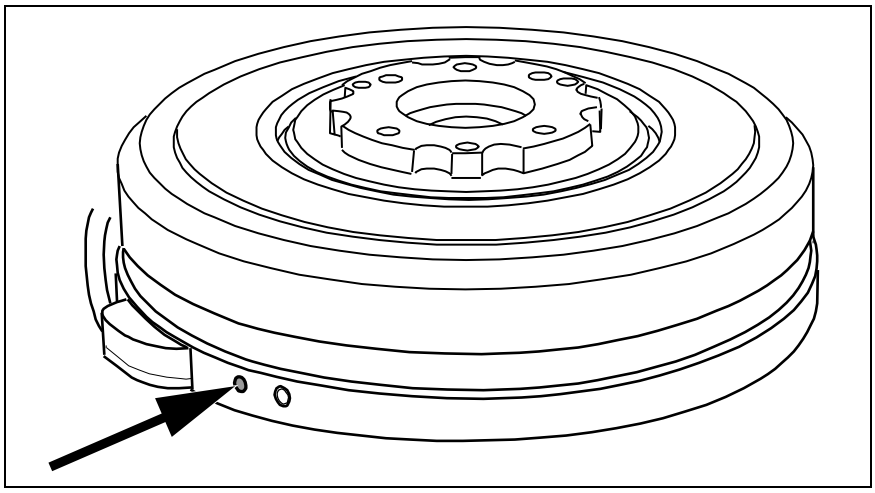


Fig. 10

The operating display can display the following states:

Green	Sensor is ready for operation
Red	A fault exists. This is output to all interfaces.
Rhythmic blinking green-red	One of the two interfaces is not working properly
Irregular blinking red-green	Defective firmware in sensor
Green irregular blinking	Data is being transferred
No display	Sensor is switched off or in FLASH mode

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8 Controlling / Programming

8.1 Introduction

4 sensor command areas

The sensor commands are divided into four areas:

- **Data - commands**
  (sensor is requested to provide data.)
  The command sent to the sensor is immediately incremented by 1 (Command: F, Response: G) and sent back, followed by the requested data.
- **Information - commands** (sensor is requested to provide information.)
  The command sent to the sensor is immediately incremented by 1 and sent back, followed by the number of subsequent bytes as a 16 bit value, and then the requested data.
- **Settings - commands**
  (the sensor settings are changed)
  The command sent to the sensor is immediately incremented by 1 and sent back, followed by the number of expected bytes as a 16 bit value. The sensor then waits for external input until the expected number of bytes have been received. A successful analysis of the parameters is acknowledged with "OK" (0x4B4F or 19279), an unsuccessful analysis with "WP" (0x5057 or 20567).
  Note
  The sensor is blocked for a maximum of 30 seconds while waiting for input of a settings command and cannot process any commands over the other interface during this time.
- **Other commands**

Most commands can be sent over the serial interface using a terminal program for test purposes

8.2 Commands

8.2.1 Data - Commands

Forces & torques (FLOAT)

	DEC	HEX	ASCII
Command	68	0x44	‚D‘
Answer	69	0x45	‚E‘
	6x32 bit (FLOAT) values according to IEEE754 Fx,Fy,Fz,Mx,My,Mz 1x16 bit statusword		
Note	Forces & torques are represented in N and Nm		

Tab. 11

Forces & torques (INT)

	DEC	HEX	ASCII
Command	76	0x4C	‚L‘
Answer	77	0x4D	‚M‘
	6x16 bit values (INT16) Fx,Fy,Fz,Mx,My,Mz 1x16 bit statusword		
Note	Conversion INT → [N] : /32 Conversion INT → [Nm] : /1024		

Tab. 12

Forces (INT)

	DEC	HEX	ASCII
Command	72	0x48	‚H‘
Answer	73	0x49	‚I‘
	3x16 bit values (INT16) Fx,Fy,Fz Seriell : 1x16 bit statusword CAN : 1x8 bit statusword		
Note	In a transmission by CAN the statusword is shortened that all data can be transmitted in one message Conversion INT → [N] : /32		

Tab. 13

Torques (INT)

	DEC	HEX	ASCII
Command	74	0x4A	‚J‘
Answer	75	0x4B	‚K‘
	3x16 bit values (INT16) Mx,My,Mz Serial : 1x16 bit statusword CAN: 1x8 bit statusword		
Note	In a transmission by CAN the statusword is shortened that all data can be transmitted in one message Conversion INT → [Nm] : /1024		

Tab. 14

Digital Forces

	DEC	HEX	ASCII
Command	88	0x58	‚X‘
Answer	89	0x59	‚Y‘
	1x16 bit value (INT16) bits 0-5: the force-range was exceeded bits 8 – 13: the force-range was fallen short Order : bit 0 / 8 = Fx bit 1 / 9 = Fy bit 2 / 10 = Fz bit 3 / 11 = Mx bit 4 / 12 = My bit 5 / 13 = Mz bit 6 / 14 reserved bit 7 / 15 reserved 1x16 bit statusword		
Note			

Tab. 15

Positionen & Rotationen (FLOAT)

	DEC	HEX	ASCII
Command	80	0x50	‚P‘
Answer	81	0x51	‚Q‘
	6x32 bit values (FLOAT) nach IEEE754 X,Y,Z,A,B,C 1x16 bit statusword		
Note	Positions and rotations are represented in the units [mm] and [°]		

Tab. 16

Positions & rotations (INT)

	DEC	HEX	ASCII
Command	86	0x56	‚V‘
Answer	87	0x57	‚W‘
	6x16 bit values (INT16) X,Y,Z,A,B,C 1x16 bit statusword		
Note	Conversion INT → [mm] : /4096 Conversion INT → [°] : *(180/π/65536)		

Tab. 17

Positions (INT)

	DEC	HEX	ASCII
Command	82	0x52	‚R‘
Answer	83	0x53	‚S‘
	3x16 bit values (INT16) X,Y,Z Serial : 1x16 bit statusword CAN : 1x8 bit statusword		
Note	In a transmission by CAN the statusword is shortened that all data can be transmitted in one message Conversion INT → [mm] : /4096		

Tab. 18

Rotations (INT)

	DEC	HEX	ASCII
Command	84	0x54	‚T‘
Answer	85	0x55	‚U‘
	3x16 bit values (INT16) A,B,C Serial : 1x16 bit statusword CAN : 1x8 bit statusword		
Note	In a transmission by CAN the statusword is shortened that all data can be transmitted in one message Conversion INT → [°] : *(180/π/65536)		

Tab. 19

Digital positions

	DEC	HEX	ASCII
Command	90	0x5A	‚Z‘
Answer	91	0x5B	‚[‘
	1x16 bit value (INT16) Bit 0-5 the position-range was exceeded, bit 8-13 the position-range was fallen short Order: bit 0 / 8 = X bit 1 / 9 = Y bit 2 / 10 = Z bit 3 / 11 = A bit 4 / 12 = B bit 5 / 13 = C bit 6 / 14 reserved bit 7 / 15 reserved 1x16 bit statusword		
Note			

Tab. 20

Testdata (FLOAT)

	DEC	HEX	ASCII
Command	70	0x46	‚F‘
Answer	71	0x47	‚G‘
	6x32 bit (FLOAT) values according to IEEE754 100.0/-100.0 / 1.235678 / 1.2345678 / -1.2345678 / 12.345678 / 0.0 1x16 bit statusword = 0x0001		
Note	For testing the own drivers		

Tab. 21

Testdata (INT)

	DEC	HEX	ASCII
Command	78	0x4E	‚N‘
Answer	79	0x4F	‚O‘
	6x16 bit values (INT16) –1 / 0 / -1024 / 255 / 511 / 256 1x16 bit statusword = 0xFE00		
Note	For testing the own drivers		

Tab. 22

Acceleration (FLOAT) (optional)

	DEC	HEX	ASCII
Command	54	0x36	‚6‘
Answer	55	0x37	‚7‘
	6x32 bit (FLOAT) values as per IEEE754 AccX, AccY, AccZ, AccA, AccB, AccC in [m/sec^2] or [°/sec^2] 1x16 bit Status : below 8bit = measuring range exceeded		
Note	As of Firmware 2.00a + measuring cells with acceleration sensors (optional) If this command does not work despite an installed acceleration sensor (Unknown command), then at least one acceleration sensor is faulty.		

Tab. 23

Acceleration (INT) (optional)

	DEC	HEX	ASCII
Command	56	0x38	‚8‘
Answer	57	0x39	‚9‘
	6x16 bit values (INT16) : AccX, AccY, AccZ, AccA, AccB, AccC 1x16 bit below 8 bit = measuring range exceeded		
Note	As of Firmware 2.00a + measuring cells with acceleration sensors (optional) If this command does not work despite an installed acceleration sensor (Unknown command), then at least one acceleration sensor is faulty. Conversion INT → [m/sec^2]: *128.0 Conversion INT → [°/sec^2]: /14.324		

Tab. 24

Acceleration Translatory (INT) (optional)

	DEC	HEX	ASCII
Command	58	0x3A	‚:‘
Answer	59	0x3B	‚;‘
	3x16 bit values (INT16) : AccX, AccY, AccZ 1x16 bit below 8 bit = measuring range exceeded		
Note	As of Firmware 2.00a + measuring cells with acceleration sensors (optional) If this command does not work despite an installed acceleration sensor (Unknown command), then at least one acceleration sensor is faulty. When transferring over CAN, the last 16 bits are shortened to 8 bits so that all data fits into a single CAN message. Conversion INT → Acceleration values [m/sec^2] *128.0		

Tab. 25

Acceleration Rotary (INT) (optional)

	DEC	HEX	ASCII
Command	60	0x3C	‚<‘
Answer	61	0x3D	‚=‘
	3x16 bit values (INT16) : AccA, AccB, AccC 1x16 bit below 8 bit = measuring range exceeded		
Note	As of Firmware 2.00a + measuring cells with acceleration sensors (optional) If this command does not work despite an installed acceleration sensor (Unknown command), then at least one acceleration sensor is faulty. When transferring over CAN, the last 16 bits are shortened to 8 bits so that all data fits into a single CAN message. Conversion INT → Acceleration values [m/sec^2] /14.324		

Tab. 26

8.2.2 Settings functions

Interfaces Set parameter

	DEC	HEX	ASCII
Command	110	0x6E	‚n‘
Answer	111	0x6F	‚o‘
	1x16 bit (INT16) value: number of expected bytes When successfully executed 19279 0x4B4F else 20567 0x5057		
Note	The operating mode of the communication can be set using this. Valid values : • "RS 232","RS 485" (as of HW 3.2), • “CAN[SPACE][SPACE][SPACE]“, • “ DEVNet" (optional, must be enabled)		

Tab. 27

To set the serial Baudrate

	DEC	HEX	ASCII
Command	118	0x76	‚v‘
Answer	119	0x77	‚w‘
	1x16 bit (INT16) value: number of expected bytes If transmission is successful 19279 0x4B4F else 20567 0x5057		
Note	Baudrate is transmitted by 6 char; valid values in Baud: 001200, 002400, 009600, 019200, 038400, 057600, 115200, 230400, 460800, 921600 If the transmission is successful the sensor will reboot with the new adjustments Default: 9600.		

Tab. 28

To set the CAN (DEVNet) Baudrate

	DEC	HEX	ASCII
Command	114	0x72	‚r‘
Answer	115	0x73	‚s‘
	1x16 bit (INT16) value: number of expected Bytes If transmission is successful 19279 0x4B4F , OK‘ sensor will reboot else 20567 0x5057 ‚WP‘		
Note	Baudrate is transmitted by 4 char; valid values in kBaud: 0010, 0025, 0050, 0100, 0125, 0250, 0500, 0800, 1000 If the transmission is successful the sensor will reboot with the new adjustments Default: 500 [kBaud].		

Tab. 29

To set the CAN (DEVNet) ID

	DEC	HEX	ASCII
Command	116	0x74	‚t‘
Answer	117	0x75	‚u‘
	1x16 bit (INT16) value: number of expected Bytes if transmission is successful 19279 0x4B4F ‚OK‘ sensor will reboot else 20567 0x5057 ‚WP‘		
Note	ID is transmitted by 2 char valid values : 00 - 63 Set the CAN-ID of the sensor. If the transmission is successful the sensor will reboot with the new adjustments. Default: 5. **Note** This value must be converted to HEX in the identifier!!		

Tab. 30

DEVNet Set Producer Size

	DEC	HEX	ASCII
Command	116	0x6A	‚j‘
Answer	117	0x6B	‚k‘
	1x16 bit (INT16) value: number of expected Bytes If transmission is successful 19279 0x4B4F else 20567 0x5057		
Note	Producer Size is transmitted by 3 Char valid Values : 000 – 028 If DEVNet is present and activated then the Producer Size can be set using this.		

Tab. 31

Limit of digital forces or rather positions

	DEC	HEX	ASCII
Command	92	0x5C	,\‘
Answer	93	0x5D	,]‘
	1x16 bit (INT16) value = number of expected Bytes If transmission is successful 19279 0x4B4F ,OK‘ else 20567 0x5057 ,WP‘		
Note	you must transmit 16 Char **At positions and rotations** (X,Y,Z,A,B,C): Char1 gives the range, which has to be changed. Valid values are: “X“,“Y“,“Z“,“A“,“B“,“C“ Char 2-7 float Wert (Low Limit) with 1 place before the decimal point and 3 decimal places incl. sign => Char 4 = ,.‘ Char 8-13 float Wert (High. Limit with 1 place before the decimal point and 3 decimal places incl. sign => Char 10 = ,.‘ Char 14-16 all will be ignored For example: The range of the position should be adjusted in rotation B on the values –0.56[°] to +1.783[°].. the command ”set position limit” to the sensor Wait for the answer: 0x93 (acknowledge) + 0x07 (number of expected Bytes) Send ”B-0.56+1.783xxx” to the sensor The sensor should answer with ”OK” The new positionlimit was adjusted successfully and is active now.		

	At forces and torques (Fx,Fy,Fz,Mx,My,Mz): Char1 and 2 gives the range, which has to be changed. Valid values are: „Fx“,“Fy“,“Fz“,“Mx“,“My“,“Mz“ Char 3-9 gives the low limit with 3 places before the decimal point and 2 decimal places incl. sign => Char 7 = ‚.‘ Char 10-16 gives the high limit with 3 places before the decimal point and 2 decimal places incl. sign => Char 14 = ‚.‘ Example: The range of the force should be adjusted in Fy on the values –12[N] to +20.34[N]. Send the command ”set position limit” to the sensor Wait for the answer: 0x93 (acknowledge) + 0x07 (valid of expected bytes) Send ”Fy-012.00 + 020.34” to the sensor The sensor should answer with ”ok” The new position limit was adjusted successfully and is active now.

Tab. 32

To teach the limit of digital forces and positions

	DEC	HEX	ASCII
Command	120	0x78	‚x‘
Answer	121	0x79	‚y‘
	1x16 bit (INT16) value = number of expected Bytes If transmission is successful 19279 0x4B4F ‚OK‘ else 20567 0x5057 ‚WP‘		
Note	you must transmit 2 char Char1 gives the range, which has to be teached. Valid values are: ”X”,”Y”,”Z”,”A”,”B”,”C” Char2 gives the high or low limit, which has to be saved. Valid values are:”+”, ”-” (High, Low) Position and force limit must be taught together. It isn’t possible to teach them separately. If you have to teach different limits of forces and positions, you must work with ”set position limit”. Example: The high position range of ”rotation B” or rather the ”torque My” should be adjusted on the current value of the sensor position Send the command ”to teach set position / force limit” (0x78) to the sensor Wait for an answer. 0x79 (acknowledge) + 0x02 (number of expected bytes) send ”B+” to the sensor. The sensor should answer with ”OK” => the new position limit was adjusted successfully and is active now. Only available in software version 1.10a or later		

Tab. 33

To set the sensor to zero

	DEC	HEX	ASCII
Command	122	0x7A	‚z‘
Answer	123	0x7B	‚{‘
	19279 0x4B4F ‚OK‘ 1x16 bit statusword		
Note			

Tab. 34

Set Data transfer time

	DEC	HEX	ASCII
Command	38	0x26	‚&‘
Answer	39	0x27	‚‘‘
	1x16 bit (INT16) value: number of expected Bytes If transmission is successful 19279 0x4B4F ‚OK‘ else 20567 0x5057 ‚WP‘		
Note	cycle – time in [ms] is transmitted with 5 Char Valid values are: 00001 ..... 65767 After receiving START cyclic operation the last command set is cyclically processed. STOP cyclic operation stops the cyclic operation The set value is stored in EEPROM. **Caution!** If the last command to one of the sensors was a "Settings command" then this can lead to unpredictable results. This function is available as of Firmware Version 1.30a		

Tab. 35

8.2.3 Commands for information

Information of the force

	DEC	HEX	ASCII
Command	100	100	100
Answer	101	101	101
	1x16 bit (INT16) value: Number of the following bytes		
Note	Answer appears in uncoded text (bytes=ASCII code) The maximum force range is read from the sensor and the programmed values are displayed Fx +800.00-800.00 | +10.00-06.916[N] Maximum forcerange | adjusted value		

Tab. 36

Information of the position

	DEC	HEX	ASCII
Command	104	0x68	‚h‘
Answer	105	0x69	‚i‘
	1x16 bit (INT16) value: Number of the following Bytes		
Note	Answer appears in uncoded text (bytes=ASCII code) The maximum force range is read from the sensor and the programmed values are displayed X +01.500 –01.500 | +01.000 -00.916 [mm] Maximum force range | adjusted value		

Tab. 37

Information of the interface

	DEC	HEX	ASCII
Command	108	0x6C	‚l‘
Answer	109	0x6D	‚m‘
	1x16 bit (INT16) value Number of the following bytes		
Note	Answer appears in uncoded text (bytes = ASCII Code). All parameter of the interface concerned. (CAN/DEVNet + Baudrate, CAN ID, RS232/RS485 + Baudrate) As of Firmware Ver. 1.30a additional cycle time for cyclic operation		

Tab. 38

Information of the sensor

	DEC	HEX	ASCII
Command	98	0x62	‚b‘
Answer	99	0x63	‚c‘
	1x16 bit (INT16) value: Number of the following bytes		
Note	Answer appears in uncoded text (bytes = ASCII Code). All important sensor information (hardware version, software version, number of compliant elements, built in DSPs, number of successful executed boot events)		

Tab. 39

8.2.4 Other functions

cyclic Data output START

	DEC	HEX	ASCII
Command	50	0x32	‚2‘
Answer			
Note	the last command set is cyclically processed **Caution!** If the last command to one of the sensors was a "Settings command" then this can lead to unpredictable results.. As of Firmware Ver. 1.30a		

Tab. 40

cyclic Data output STOP

	DEC	HEX	ASCII
Command	52	0x34	‚2‘
Answer			
Note	Sensor stops cyclic operation As of Firmware Ver. 1.30a		

Tab. 41

Reset

	DEC	HEX	ASCII
Command	48	0x30	‚0‘
Answer	49	0x31	‚1‘
	19279	0x4B4F	‚OK‘
Note	Sensor is executed a complete reset and will reboot. In a case of an error the function will be executed too.		

Tab. 42

Flash

	DEC	HEX	ASCII
Command	102	0x66	‚f‘
Answer	103	0x67	‚g‘
	1x16 bit (INT16) value: number of expected Bytes If the password is correct 19279 0x4B4F ‚OK‘ else 20567 0x5057 ‚WP‘		
Note	If you have input the correct password (and a short waiting time of 2 sec.), the bootloader will be active. Now, you can update the new firmware over the serial interface. You have to use the flash tool of T1. After the update was successful you have to disconnect the sensor from the supply voltage for a minimum of 25sec. After that the sensor will be operating. All adjustments like baudrate, ID, position limit and force limit will be kept.		

Tab. 43

SYNC

	DEC	HEX	
Command	144	0x90	
Answer			
	The response of the sensor will be the same as it was at the last command		
Note	Only relevant for the usage of CAN. Hereby, all sensors connected to the bus will respond with the command, which was set at last. **Caution!** If the last command to one of the sensors was a "Settings command" then this can lead to unpredictable results.		

Tab. 44

Statusword

With all data functions a status word is also provided, coded as follows:

bits 0-7 are set if the voltage at PSD 0-7 is above or below the set voltage values (EEPROM).

bits 8–15 are set if the current at PSD 8-15 is higher than the set value (EEPROM). (If the current is lower than the set value then a hardware defect exists)

The following applies for the user: If the status word <> 0 then the measured value output is no longer reliable.

Note
With Get Force INT / Get Torque INT / Get Position INT / Get Rotation INT the status word is shortened for CAN requests. ((bit 0-3 OR bit 4-7) + (bit 8-11 OR bit 12-15))
This means that an assignment of which PSD has caused an error is only partially possible!

9 Options

9.1 Acceleration sensors

When the measuring cells are replaced, in addition to measuring the forces the yielding force torque sensor can also be used to measure acceleration in all 6 degrees of freedom.

A sensor with acceleration sensors can be recognized via an "A" in the Hardware Version (Sensor Info HW: 3.xx A)

This option can be retrofitted to all sensors.

Commands for reading the acceleration are implemented as of Firmware 2.00a.

If an acceleration sensor is defective then commands for reading acceleration can no longer be sent.

10 Error messages

Every error message begins with the following character

DEC	HEX	ASCII
33	0x21	‚!‘

Tab. 45

This is followed by a 16 bit (INT16) value containing an exact error description.
Error messages are output to all interfaces.

The error messages are subdivided into:

- Warnings
- Correctable errors
- Serious errors

10.1 Warnings

10.1.1 Unknown command

Error code	DEC	HEX	ASCII
	8481	0x2121	‚!!‘
Possible cause		**Corrective action**	
When the "Acceleration sensor" option is installed, at least one acceleration sensor is defective when attempting to execute one of the commands below. Command: • Acceleration (FLOAT) • Acceleration (INT) • Acceleration, translatory • Acceleration, rotary		➔ Replace acceleration sensor	

Tab. 46

10.1.2 Wrong Parameter

Error code	DEC	HEX	ASCII
	20567	0x5057	‚WP‘
Possible cause		**Corrective action**	
The wrong parameter or password was sent to the sensor		➔ Send the correct parameter or ➔ send the correct password	

Tab. 47

10.2 Correctable errors

Operating display lights continuously **RED**. The sensor stops working but the error can be corrected by the user

Operating display alternates between **RED** and **GREEN**. One of the two interfaces (Serial/CAN) is not working correctly.

10.2.1 Cecksum1 in EEPROM is not correct

Error code	**DEC**	**HEX**	**ASCII**
	12613	0x3145	‚E1‘
Possible cause		**Corrective action**	
Cecksum1 in EEPROM is not correct		➔ Set Default boot (see Chapter 6.4, Page 21). If this does not correct the error then the EEPROM is defective.	

Tab. 48

10.2.2 EEPROM Part A deleted

Error code	**DEC**	**HEX**	**ASCII**
	12645	0x3165	‚e1‘
Possible cause		**Corrective action**	
Part A of the EEPROM has been deleted.		➔ Set Default boot (see Chapter 6.4, Page 21). If this does not correct the error then the EEPROM is defective.	

Tab. 49

10.2.3 Invalid serial Baudrate

Error code	DEC	HEX	ASCII
	17011	0x4273	‚sB‘
Possible cause		**Corrective action**	
Serial Baudrate is invalid		➔ Set a valid Baudrate or ➔ Set Default boot (see Chapter 6.4, Page 21): Serial Baudrate is set to 9600 Baud.	

Tab. 50

10.2.4 Serial Timeout

Error code	DEC	HEX	ASCII
	21619	0x5473	‚sT‘
Possible cause		**Corrective action**	
CAN Timeout An excessive delay occurred while transferring parameters		➔ Repeat the command	

Tab. 51

10.2.5 Serial defective

Error code	DEC	HEX	ASCII
		0xXX73	‚Xs‘
Possible cause		**Corrective action**	
Serial interface has a problem		➔ The sensor attempts to independently solve the problem. If this error message occurs frequently then the sensor serial interface is defective.	

Tab. 52

10.2.6 Invalid CAN Baudrate

Error code	**DEC**	**HEX**	**ASCII**
	17251	0x4263	‚cB‘
Possible cause		**Corrective action**	
CAN Baudrate is invalid		➔ Set a valid Baudrate or ➔ Set Default boot (see Chapter 6.4, Page 21): CAN Baudrate is set to 500 kbit	

Tab. 53

10.2.7 Invalid MAC ID

Error code	**DEC**	**HEX**	**ASCII**
	18787	0x4963	‚cI‘
Possible cause		**Corrective action**	
Invalid MAC ID		➔ Set a valid MAC ID or ➔ Set Default boot (see Chapter 6.4, Page 21): MAC ID set to 5, valid	

Tab. 54

10.2.8 CAN Timeout

Error code	DEC	HEX	ASCII
	21603	0x5463	‚cT‘
Possible cause		**Corrective action**	
Excessive delay during parameter transfer.		➔ Repeat the command ➔ With an active DEVNet the sensor performs a DUP MAC ID CHECK. As soon as this process is successfully completed the error message is removed.	

Tab. 55

10.2.9 CAN Communication

Error code	DEC	HEX	ASCII
	25443	0x6363	‚cc‘
Possible cause		**Corrective action**	
CAN communication is not functioning correctly.		➔ Check cable and settings	

Tab. 56

10.2.10 DEVNet Size

Error code	DEC	HEX	ASCII
	21347	0x5363	‚cS‘
Possible cause		**Corrective action**	
DEVNet Producer Size is too small		➔ Adjust the DEVNet Producer Size or switch to CAN operation. or ➔ Send the command via the serial interface	

Tab. 57

10.2.11 Input voltage too high

Error code	**DEC**	**HEX**	**ASCII**
	18518	0x4856	‚VH‘
Possible cause		**Corrective action**	
Input voltage too high LED lights RED continuously!		➔ Reduce input voltage to 11..26 V!	

Tab. 58

10.2.12 Input voltage too low

Error code	**DEC**	**HEX**	**ASCII**
	19542	0x4C56	‚VL‘
Possible cause		**Corrective action**	
Input voltage too low LED lights RED continuously!		➔ Increase input voltage to 11..26 V!	

Tab. 59

10.3 Serious errors

Operating display continually lights **RED**. Sensor is defective and must checked by Customer Service.

10.3.1 Curent fault

Error code	DEC	HEX	ASCII
		0x3043 – 0x3843	‚C0' – ‚C7'
Possible cause		**Corrective action**	
Current fault in measuring cell 0-7 Determined when the sensor is started up: **The measuring cell is defective**		➔ Send the FCT Force torque sensor to SCHUNK	

Tab. 60

10.3.2 Voltage error

Error code	DEC	HEX	ASCII
		0x3056 – 0x3856	‚V0' – ‚V7'
Possible cause		**Corrective action**	
Current fault in measuring cell 0-7 Determined when the sensor is started up: **The measuring cell is defective**		➔ Send the FCT Force torque sensor to SCHUNK	

Tab. 61

10.3.3 Broken spring

Error code	DEC	HEX	ASCII
	83	0x0053	‚S'
Possible cause		**Corrective action**	
Defective elastic element in sensor.		➔ Send the FCT Force torque sensor to SCHUNK	

Tab. 62

10.3.4 Ground short in spring

Error code	**DEC**	**HEX**	**ASCII**
	19283	0x4B53	‚SK‘
Possible cause		**Corrective action**	
An elastic element is causing a short to ground => A defective element can no longer be recognized.		➔ Send the Force torque sensor to SCHUNK	

Tab. 63

10.3.5 EEPROM Checksum2

Error code	**DEC**	**HEX**	**ASCII**
	12869	0x3245	‚E2‘
Possible cause		**Corrective action**	
Checksum2 in EEPROM is incorrect • The sensor-specific parameters are invalid • The EEPROM has been manipulated or is defective.		➔ Send the Force torque sensor to SCHUNK	

Tab. 64

10.3.6 EEPROM Part B deleted

Error code	**DEC**	**HEX**	**ASCII**
	12901	0x3265	‚e2‘
Possible cause		**Corrective action**	
EEPROM Part B has been deleted The EEPROM has been manipulated or is defective.		➔ Send the Force torque sensor to SCHUNK	

Tab. 65

10.3.7 EEPROM TIMEOUT

Error code	DEC	HEX	ASCII
	21573	0x5445	‚ET‘
Possible cause		**Corrective action**	
EEPROM could not be written. The EEPROM is defective.		➔ Send the Force torque sensor to SCHUNK	

Tab. 66

10.3.8 Horizontal current fault

Error code	DEC	HEX	ASCII
	18499	0x4843	‚CH‘
Possible cause		**Corrective action**	
Current fault in the horizontal measuring system The current in the horizontal measuring system is too low => a measuring cell is defective		➔ Send the Force torque sensor to SCHUNK	

Tab. 67

10.3.9 Vertical current fault

Error code	**DEC**	**HEX**	**ASCII**
	22083	0x5643	‚CV‘
Possible cause		**Corrective action**	
Current fault in the vertical measuring system The current in the vertical measuring system is too low => a measuring cell is defective		➔ Send the Force torque sensor to SCHUNK	

Tab. 68

10.3.10 CAN controller defective

Error code	**DEC**	**HEX**	**ASCII**
	17251	0x4363	‚cC‘
Possible cause		**Corrective action**	
CAN controller defective The sensor can only be operated via the serial interface.		➔ Replace the CAN controller	

Tab. 69

11 Test software

A terminal program is required for operating the Force torque sensor.

Terminal program settings

Parity	none
Baudrate	Baudrate programmed into sensor (default 9600)
Handshake	none
Data bit	8
Stop bit	1

Tab. 70

All settings functions and information functions can be performed using this.

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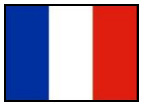

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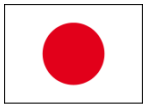

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