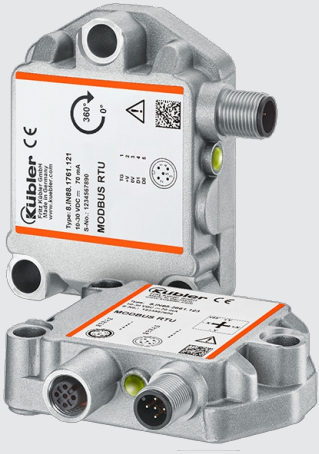
R67910.0002 - 2



Manual

Inclinometer IN88 Modbus

pulses for automation

Table of Contents

1 Document

This document is the English translation of the original German version.

Publisher	Kübler Group, Fritz Kübler GmbH Schubertstraße 47 78054 Villingen-Schwenningen Germany www.kuebler.com
Issue date	05/2021
Language version	German is the original language
Copyright	© 2021, Kübler Group, Fritz Kübler GmbH

Legal Notices

2 General Information

Please read this document carefully before working with the product, mounting it or starting it up.

2.1 Target Group

The device may only be planned, mounted, commissioned and serviced by persons having the following qualifications and fulfilling the following conditions:

- Technical training.
- Briefing in the relevant safety guidelines.
- Constant access to this documentation.
- In case of electrical equipment for potentially explosive atmospheres, the specialized personnel needs knowledge about the ignition protection category concept.
- For facilities in potentially explosive atmospheres, the authorized person must comply with the applicable country-specific regulations.

2.2 Symbols used / Classification of the Warnings and Safety instructions

⚠ DANGER	**Classification:** This symbol, together with the signal word **DANGER**, warns against immediately imminent threat to life and health of persons. The non-compliance with this safety instruction will lead to death or severe adverse health effects.
⚠ WARNING	**Classification:** This symbol, together with the signal word **WARNING**, warns against a potential danger to life and health of persons. The non-compliance with this safety instruction may lead to death or severe adverse health effects.
⚠ CAUTION	**Classification:** This symbol, together with the signal word **CAUTION**, warns against a potential danger for the health of persons. The non-compliance with this safety instruction may lead to slight or minor adverse health effects.

ATTENTION	**Classification:** The non-compliance with the **ATTENTION** note may lead to material damage.
NOTICE	**Classification:** Additional information relating to the operation of the product, and hints and recommendations for efficient and trouble-free operation.

3 Product Description

3.1 Technical Data

Operating, storage and transport temperature range	-40 °C … +85 °C
Supply Voltage and Current Consumption	10 … 30 VDC 70 mA at 10 VDC 30 mA at 24 VDC 6 mA at 30 VDC
2-axes sensor Measuring range per axis	±85.00°
1-axes sensor: Measuring range	0 … 359.99°
Internal process data cycle	20 ms
Function display	Triple LED (red/green/blue)
Bus connection	1 x M12 or 2 x M12
Sensor	MEMS system interface
Resolution	14 bits
Standard scale factor	Scaling off

Output	Modbus protocol RTU
Communication parameters	9600 … 115200 bauds 8 data bits no parity 1 stop bit
Interface	RS485 for Modbus

3.2 Supported Standards and Protocols

- MODBUS APPLICATION PROTOCOL SPECIFICATION V1.1b3
- MODBUS over Serial Line Specification and Implementation Guide V1.02

The Modbus inclinometer supports the current MODBUS APPLICATION PROTOCOL SPECIFICATION V1.1b3. In addition, device-specific registers are available.

The additional services integrated allow performing node number allocation and Modbus bit rate configuration directly via the Modbus.

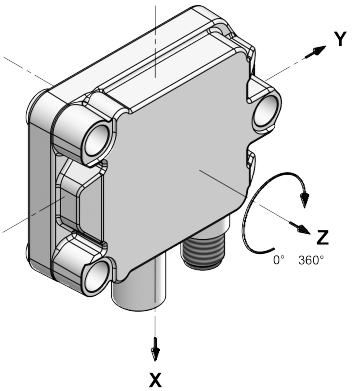
4 Installation

4.1 Mechanical Installation

4.1.1 Axes Orientation

1 dimensional - Rotation angle

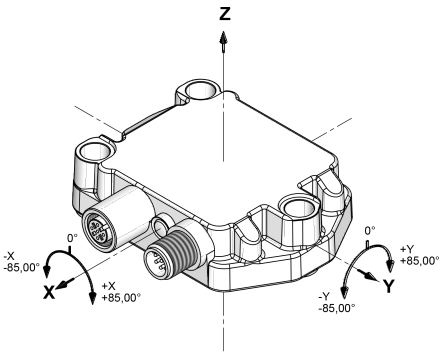
Z axis: Longitudinal (long) 0 … 360°



2 dimensional - Orientation angle

X axis: Longitudinal (long) ±85°

Y axis: Lateral (lat) ±85°



4.2 Electrical Installation

4.2.1 General Information for the Connection

ATTENTION	**Destruction of the device**
	Before connecting or disconnecting the signal cable, always disconnect the power supply and secure it against switching on again.
NOTICE	**General safety instructions**
	Make sure that the whole plant remains switched off during the electrical installation. Make sure that the operating voltage is switched on or off simultaneously for the device and the downstream device.

NOTICE	**Traction relief** Always mount all cables with traction relief.

NOTICE	**Interference susceptibility** Proceed as follows: • Connect the shield to the device housing. • Comply with the maximum cable length for stub lines and for the total length of the bus network. • Check the maximum supply voltage on the device.

4.2.2 Information for EMC-Compliant Installation

Requirements for cables

- Use exclusively shielded twisted-pair cables to connect the device.
- Comply with the maximum permissible connection cables length.

EMC acc. to EN 61326-1	Criterion A The device operates trouble-free, user data transmission proceeds without disturbance, internally stored data and configurations remain preserved	Criterion B During a failure, a disturbed transmission of the user data is allowed, internally stored data and configurations remain preserved
Interference immunity	Is achieved with a shielded line	Is not achieved with a shielded line
	Class A Industrial environment The device has a radiation according to Class A	Class B Living area The device has a radiation according to Class B
Radiation	Is not achieved with a shielded line	Is achieved with a shielded line

Shielding and equipotential bonding

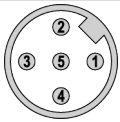
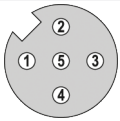
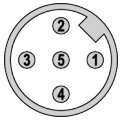
- Apply the cable shield on a large contact area - ideally 360°. Use e. g. a shield terminal to this purpose.
- Pay attention to proper cable shield fastening.
- Preferably connect the shield on both sides with low impedance to the protective earth (PE), e.g.on the device and/or on the evaluation unit. In the event of potential differences, the shield must only be applied on one side.
- If shielding is not possible, appropriate filtering measures must be taken.
- If the protective earth should be connected to the shield on one side only, it must be made sure that no short-time overvoltages can appear on the signal and supply voltage lines.

Kübler offers a wide range of connection cables in various versions and lengths, see www.kuebler.com/connection technology.

Kübler offers various solutions for EMC-compliant installation, e.g. shield terminals for the electrical cabinet, see www.kuebler.com/accessories.

4.2.3 Terminal Assignment

NOTICE	**Designation of signals D0 and D1**
	With Modbus, D0 and D1 can also be designated as A and B ►D0 = A and D1 = B.

Inter-face	**Type of connec-tion**	**1 x M12 connector, 5-pin**					**Pin arrange-ment**
6	1		Bus IN				
		Signal	+V	0V	D0	D1	TG
		Pin	2	3	5	4	1
Inter-face	Type of connec-tion	2 x M12 connector, 5-pin					Pin arrange-ment
6	3		Bus OUT				
		Signal	+V	0V	D0	D1	TG
		Pin	2	3	5	4	1
6	3		Bus IN				
		Signal	+V	0V	D0	D1	TG
		Pin	2	3	5	4	1

+V: Supply voltage +V DC
0V: Ground GND (0V)
D0: Non-inverted signal (A)
D1: Inverted signal (B)
TG: Terminal Ground

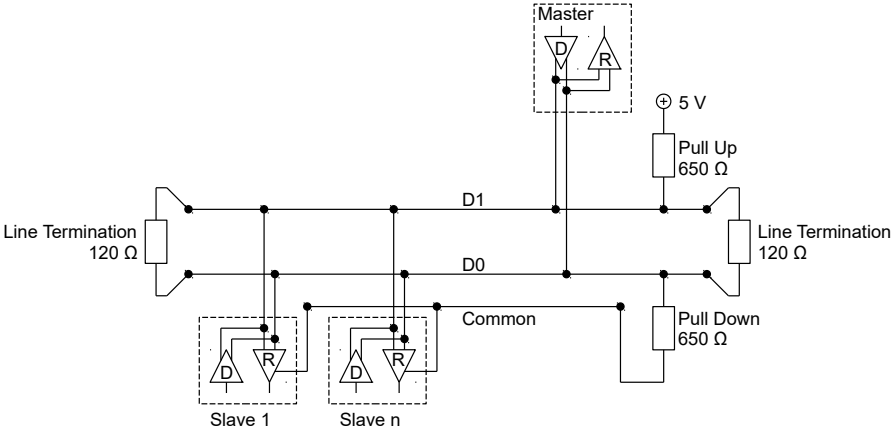
4.2.4 Network topology

Modbus is a 2-wire bus system in which all participants are connected in parallel (that is to say with short stub lines up to 30 cm). MODBUS uses serial lines based on an electrical "two-wire" interface. It is oriented on the EIA/TIA-RS485 standard.

The special RS485 transceiver can control up to 63 nodes with a transmission rate reaching 19.2 kBd. The address range (theoretical maximal number of network participants) is 0 … 247.

In order to prevent reflections, the bus must be terminated at each end with a 120 (or 121) ohm terminating resistor. This is necessary even in case of very short line lengths.

Termination at both ends of the main line:



IMG-ID: 58511243

NOTICE	**Bus termination by means of register** Bus termination can be configured by means of a register. A 120 ohm resistor can be connected to this purpose.

NOTICE	**Comply with the maximum cable length for stub lines and for the total length of the Modbus.** Check the maximum supply voltage on the device.

4.2.5 Electrical Features

Display	LEDs
Interface	RS485 for Modbus
Bus connection	1x or 2x M12
Supply voltage	10 … 30 VDC max. 20 mA

5 Commissioning and Operation

5.1 Function and Status LED

The device is equipped with a triple LED for displaying status and error messages.

Green	=	Modbus bus status
Red	=	Modbus ERR display
Blue	=	= Calibration mode in combination with Green and Red

Display	LED	Meaning	Error cause	Troubleshooting
LED off		No connection to the master	Data line interruption Wrong baud rate Interchanged data line No voltage	Observe the combination with the RED LED If the RED LED is also off, please check the voltage supply
Red off		Device operates error-free		Observe the combination with the green LED
Green Flashing about 250 ms		Device ready for operation		Communication is active
Green flashing Blue flashing		Modbus transmission active	Combination with Green status	GREEN LED flashing green Transmission running
Red flashing 300 ms		Failure	Modbus signaled a system error	
Blue flashing 300 ms		Calibration mode Device is neither 6-point calibrated nor temperature-compensated		Perform 6-point calibration Perform temperature calibration Adjust 30 VDC at the power supply
Blue and Red flashing alternatingly		Calibration mode Device is 6-point calibrated, but not temperature-compensated yet		Perform temperature calibration Adjust 30 VDC at the power supply

5.2 Quick Start Guide

5.2.1 Default Settings

Function code 16 (0x10) allows modifying the parameters.
The default values are listed in the following table:

Reg. [dec]	Reg. [hex]	Format	Parameter name	Default
0261	105	U16	Delay for the transmission	1
0300	12C	U16	Baud rate	2 = 19200 bauds
0301	12D	U16	Parity	1 = none
0302	12E	U16	Stop bit	1 = 1 stop bit
0304	130	U16	Node address	0x3F (63d)
0305	131	U16	Termination	2 = On
0306	132	U16	Digital filter active	1 = On
0307	133	F32	Digital filter coefficient	5.0
0310	136	U16	Axis resolution	10
0311	137	U16	Slope long16 operating parameter	0
0312	138	I16	Slope long16 preset value	0
0313	139	I16	Slope long16 offset	0
0314	13A	I16	Differential offset Slope long 16	0
0315	13B	U16	Slope lateral 16 operating parameter	0
0316	13C	I16	Slope lateral 16 preset value	0
0317	13D	I16	Slope lateral 16 offset	0
0318	13E	I16	Differential offset Slope lateral 16	0
0320	140	U16	Preset Euler axis (only 0)	0
0360	168	U16	Save all application parameters	0x1010
0361	169	U16	Load all parameters (factory setting)	0x1011

5.2.2 Changing the parameters

Modifying and reading device-specific parameters requires commands that are (can be) generated by means of the following function codes:

Function code (dec)	Function code (hex)	Name	Meaning
03	0x03	Read Holding Register	Reads the binary content of the holding registers (4XXXX references)
16	0x10	Preset Multiple Registers	Writes the binary content of the holding registers (4XXXX references)
17	0x11	Report Slave ID	Returns a description and device-specific information

The function codes can be sent to the device via a control or a parameterization software.

5.2.3 Operating modes

The available operating modes are the single or cyclic query of the data - Polled Mode. Moreover, scaling, preset values and many other additional parameters can be programmed via the Modbus. When switching the appliance on, all parameters are loaded from a flash memory. These parameters have previously been stored in a zero-voltage secure manner. The output values can combine in a very variable way e. g. the angle of the measurement axes, the temperature and the position as read-holding registers.

5.2.4 Not supported Modbus function codes

Code Decimal	Code Hexadecimal	Name
01	(0x01)	Read Coil Status
02	(0x02)	Read Input Status
04	(0x04)	Read Input Registers
05	(0x05)	Force Single Coil
06	(0x06)	Preset Single Register
07	(0x07)	Read Exception Status
11	(0x0B)	Fetch Comm Event Ctr
12	(0x0C)	Fetch Comm Event Log
15	(0x0F)	Force Multiple Coils
20	(0x14)	Read General Reference
21	(0x15)	Write General Reference
22	(0x16)	Mask Write 4X Register
23	(0x17)	Read/Write 4X Registers
24	(0x18)	Read FIFO Queue

5.3 Protocol Features

5.3.1 Structure of the Modbus RTU frames

To carry out settings in the device, the respective Modbus registers must be addressed through the telegram. The basic structure of a Modbus telegram is shown below:

Start	Address	Function	Data	CRC	Stop
3.5 bytes	1 byte	1 byte	N x 8 bits	2 bytes	3.5 bytes

The data range has a different structure depending on whether the telegram is a query or a response and on the used function code.

In RTU mode, the messages start with silent interval of at least 3.5 characters. According to the baud rate set in the network, this interval is easiest implemented as a multiple of the duration of a character.

The first field subsequently transmitted is the device address in the range of 01…0xF7 (247) (248-255 are reserved for Modbus). Characters permissible for all fields: hexadecimal 0–9, A–F.

The networked devices constantly monitor the network bus - also during the "silent" intervals. When the first field (address field) is received, the sensor decodes it to determine whether the message is directed to it.

After the last transmitted character, an identical interval of at least 3.5 characters indicates the end of the message. A new message can start after this interval.

The complete message frame must be transmitted as a continuous data stream. In the event of a silent interval of more than 1.5 characters before the end of the frame, the receiver device erases the message and assumes that the following byte is the address field of a new message.

Likewise, if a new message starts before the end of the silent interval of 3.5 characters, the receiver device considers this new message as the continuation of the previous message. This will trigger a fault, as the value in the final CRC field will not be valid for the combined messages.

5.3.2 Function codes

Read holding register (function code 0x03)

Query

	Address	Function	Data		CRC
Byte	1 byte	1 byte	2 bytes	2 bytes	2 bytes
Description	Slave address (sensor)	Function code (Read holding register)	Address of the first requested register (e.g. register 40002)	Number of requested registers (e.g. 40002 to 40003)	For error detection
Example	0x3F	0x03	0x0001	0x0002	

Response

	Address	Function	Data			CRC
Byte	1 byte	1 byte	1 byte	2 bytes	2 bytes	2 bytes
Description	Slave address (sensor)	Function code (read holding register)	Number of the following data bytes (2 registers with each 2 bytes = 4 bytes)	Content of the register (e.g. register 40002)	Content of the register (e.g. 40002 to 40003)	For error detection
Example	0x3F	0x03	0x02			

Preset multiple registers (function code 0x10)

Query

	Address	Function	Data				CRC
Byte	1 byte	1 byte	2 bytes	2 bytes	1 bytes	2 bytes	2 bytes
Description	Slave address (sensor)	Function code (preset multiple registers)	Address of the first register to be written (e.g. register 40269)	Number of registers to be written	Number of the following data bytes (1 register with 2 bytes = 2 bytes)	Value for the register (e.g. register 40269)	For error detection
Example	0x3F	0x10	0x010C	0x0001	0x02		

Response

	Address	Function	Data		CRC
Byte	1 byte	1 byte	2 bytes	2 bytes	2 bytes
Description	Slave address (sensor)	Function code (read holding register)	Address of the first register to be written (e.g.register 40269)	Number of registers written	For error detection
Example	0x3F	0x10	0x010C	0x0001	

Report Slave ID (function code 0x11)

NOTICE	**Slave ID**
	Slave ID does not mean the node address of the sensor. In this case, the Slave ID identifies the sensor type. Function code 17 - Query of Device-Specific Information

Query

	Address	Function	CRC
Byte	1 byte	1 byte	2 bytes
Description	Slave address (sensor)	Function code (preset multiple registers)	For error detection
Example	0x3F	0x11	

Response

	Address	Function	Data					CRC
Byte	1 byte [1]	1 byte [2]	1 byte [3]	1 byte [4]	1 byte [5]	23 bytes [6]	2 bytes [7]	2 bytes [8]
Example	0x3F	0x11	0x1A	0x02	0xFF	0x46353836384D544B75656 26C657256322E3034525455		

[1] Slave address (Sensor)

[2] Function code (read holding register)

[3] Number of the following data bytes (generally 26 bytes)

[4] Sensor slave ID

[5] Status (e.g. ready for operation)

[6] Slave version in the ASCII format (e.g. "F5868MTKueblerV2.04RTU")

[7] Errors counter

[8] For error detection

5.3.3 LRC check

In ASCII mode, the messages are subjected to an error check based on a longitudinal redundancy check.

The check calculation (LRC) follows the content of the message without the initial "colon" and the two final CRLF characters. The LRC check takes place regardless of the parity check method used.

The LRC field has a one-byte length and contains a 8-bit binary value. The LRC value is calculated by the transmitter and attached to the message. On receipt of the message, the receiver calculates a LRC and compares this calculated value with the value contained in the LRC field. If both values are not equal, an error is triggered.

The LRC is formed by adding successive 8-bit blocks of the message. Possible carries are ignored. Then the two's complement of the result is formed. The calculation is performed with the bytes of the message, prior to the coding of every byte in the two ASCII characters that correspond to the hexadecimal representation of every nibble (group of 4 bits). It considers neither the "colon" at the beginning of the message nor the two CRLF characters at its end.

5.3.4 Data Addresses

Modbus bases its data model on a series of tables with characteristic features. The four primary tables are:

Main tables	Object type	Type	Description
Discrete input	Single bit	Read-only	This data type can be provided by an I/O system
Coils	Single bit	Read-write	This data type can be modified by an application
Input register	16-bit word	Read-only	This data type can be provided by an I/O system
Read holding register	16-bit word	Read-write	This data type can be modified by an application

The distinctions between inputs and outputs and between bit-addressable and word-addressable data elements have no influence on the behavior of the application.

All data addresses in Modbus messages are zero-based.

- Holding register 40001 is addressed as Register 0001 in the data address field of the message. The function code field already defines a 'holding register' operation.
  Therefore reference '4XXXX' is implied.
- Holding register 40014 is addressed as register 0x0D (14 decimal).

5.4 Function code 03 - Reading the Holding Register

Read Holding Registers function code 03 (0x03)

Reads the binary content of the holding registers (4XXXX references) in the slave inclinometer.
Broadcast is not supported

Reg [dec]	Reg [hex]	Format	Parameter name	Value	Default
0001	1	I16	ORIENTATION ANGLE X AXIS (long)	Inclination angle in 0.01°	-85.00 ... +85.00
0002	2	I16	ORIENTATION ANGLE Y AXIS (lat)	Inclination angle in 0.01°	-85.00 … +85.00
0003	3	I16	TILTING ANGLE Z AXIS	Tilting angle (1-dimensional)	0 … 179.99°
0004	4	U16	ROTATION ANGLE Z AXIS (long)	Rotation angle in 0.01° (1 axis)	0 … 359.99°
0007	7	U16	POWER SUPPLY VCC	VCC in 0.1 VDC	240
0008	8	U16	TEMPERATURE IN 0.1 °C	Temp. in 0.1 °C	210
0016	10	U16	SIDEVIEW	Rear = 0, Front = 1	0
0023	17	U16	SYSTEM STATE	No error = 0	0
0140	8C	U16	BAUD RATE	Current baud rate	19200 bauds (2)
0144	90	U16	NODE ID	Current node address	63
0145	91	U16	TERMINATION	Termination on/off	2 (on)
0146	92	U16	FILTER ACTIVATION	Filter on/off	1 (on)
0147	93	F32	FILTER SETTING	Filter value in HZ	5.0
0148	94	U32	SERIAL NUMBER	Serial number	16DDDNNNNN
0149	95	U32	PRODUCT CODE	Device type	0x88616100
0150	96	U16	RESOLUTION	Resolution X/Y axis	0.01 ° (10)
0151	97	U16	OPERATING PARAMETER	Setting X axis	0
0152	98	U16	PRESET X AXIS	Preset X axis	0
0153	99	U16	OFFSET X AXIS	Offset X axis	0
0154	9A	U16	DIFF.OFFSET X AXIS	Differential offset	0
0155	9B	U16	OPERATING PARAMETER	Setting Y axis	0
0156	9C	U16	PRESET Y AXIS	Preset Y axis	0
0157	9D	U16	OFFSET Y AXIS	Offset Y axis	0
0158	9E	U16	DIFF.OFFSET Y AXIS	Differential offset	0
0159	9F	U16	OFFSET ROTATION ANGLE	Offset after preset	0

Query

The query message contains the starting register and the number of registers to be read.

The registers are addressed as from 0.

Registers 1–16 are addressed as 0–15.

Example of a read query for registers 40108–40110 of the slave device:

QUERY

Field Name	Example (Hex)
Slave Address	11
Function	03
Starting Address Hi	00
Starting Address Lo	6B
No. of Points Hi	00
No. of Points Lo	03
Error Check (LRC or CRC)	—

IMG-ID: 59652619

Response

The response message contains the register data, two bytes per register. The binary content is right-justified in every byte. In every register, the first byte contains the high-order bits and the second byte the low-order bits. The response is transmitted when the data is fully compiled.

RESPONSE

Field Name	Example (Hex)
Slave Address	11
Function	03
Byte Count	06
Data Hi (Register 40108)	02
Data Lo (Register 40108)	2B
Data Hi (Register 40109)	00
Data Lo (Register 40109)	00
Data Hi (Register 40110)	00
Data Lo (Register 40110)	64
Error Check (LRC or CRC)	—

IMG-ID: 59654539

Orientation angle X axis value query Register 40001 (16-bit access)

Position values depending on the scale factor set.

Orientation angle X axis resolution 0.01°

-85.00 … +85.00

Deterministic position delay:	40 µs
Position jitter:	+/- 1 µs
Total response delay for position values:	40 µs + response frame processing time
Estimated response delay for the position:	10 µs
Minimum cycle time for position update:	20 ms (timeout t3.5 + 300 µs)

Orientation angle Y axis value query Register 40002 (16-bit access)

Position values depending on the scale factor set.

Orientation angle Y axis resolution 0.01°

-85.00 … +85.00

Deterministic position delay:	40 µs
Position jitter:	+/- 1 µs
Total response delay for position values:	40 µs + response frame processing time
Estimated response delay for the position:	10 µs
Minimum cycle time for position update:	20 ms (timeout t3.5 + 300 µs)

Tilting angle Z axis value query Register 40003 (16-bit access)

Position values depending on the scale factor set.

Tilting angle resolution 0.01°

0… 180.0°

ROTATION ANGLE Z axis value query Register 40004 (16-bit access)

Position values depending on the scale factor set.

Rotation angle resolution 0.01°

0… 359.9°

Deterministic position delay:	40 µs
Position jitter:	+/- 1 µs
Total response delay for position values:	40 µs + response frame processing time
Estimated response delay for the position:	100 µs
Minimum cycle time for position update:	

Current VCC voltage query Register 40007:

20 ms (timeout t3.5 + 300 µs)

Value in 0.1 VDC steps

Current VCC value

Example

Value = 245

VCC = 24.5 VDC

Current sensor temperature query Register 40008

Sensor temperature values:	in 0.1 °C
Default:	25 °C (ambient temperature)
Temperature range:	-40 °C … +100 °C
Critical temperature threshold:	90 °C
Update rate:	60 sec.

Example

Value = 332

Temperature = 33.2 °C

Current system status query Register 40023

Default:

No error = 0x0000

Others*

see details in the table

ERRORFREE = 0

INIT_ERR = 1,

SENSOR_ERR = 2,

EPS_INIT_ERR = 3,

EPS_FUNC_ERR = 4

Current baud rate status query Register 40140

Saved values: Current result from the internal baud rate table

Note for the corresponding baud rate:

for all baud rates, general cycle time at least 20 ms

Current node ID status query Register 40144

Node ID value: 0x3F (63) default

Current bus termination status query Register 40145

Bus termination off = 1

12. Bus termination on = 2

Current digital filter status query Register 40146

Filter active 1 default

Filter off 0 Update rate: immediately

Current filter parameter Register 40137 (32-bit access Butterworth)

Filter coefficient values: 0.1 ….10.0

Default: 5.0 default

Update rate: immediately

Serial number Register 40148 (32-bit access)

Permitted values: current serial number in the following format:

0xYYDDDNNNNN

0xYY year (2 last figures)

0xDDD day of the year (1...365)

Low word serial number 0xNNNNN consecutive number 1…65535

Product code Register 40149 (32-bit access)

Permitted values: current product code in the following format:

0xTTDD

0x88266100

0xTT

Product code

0xDD

Interface 61= Modbus

Low word number

0x6100

Modbus standard

5.5 Function Code 16 - Writing the Holding Register

Write Holding Register function code 16 (0x10)

Description

Writing of the values in a sequence of holding registers (references 4XXXX). In the case of a broadcast, this function sets the same register references in all connected slave inclinometers.

NOTICE	**This function takes precedence over the inclinometer memory protection state.**
	The programmed values remain valid in the registers during the whole duty cycle and some functions are immediately taken over.
	The register values are saved in a non-volatile memory, regardless of whether they are programmed in the PLC logic or not.

Reg [dec]	Reg [hex]	Format	Parameter name	Possible values	Default
0261	105	U16	Delay time for the transmission [▶ 27]	(Register 261 Delay Time for the Transmission [▶ 27])	1
0300	12C	U16	Baud rate [▶ 28]	1 = 9600 2 = 19200 3 = 38400 4 = 57600 5 = 115200	2
0301	12D	U16	Parity [▶ 28]	1 = none 2 = even 3 = odd	1
0302	12E	U16	Stop bit [▶ 29]	1 = 1 stop bit, 3 = 2 stop bits	1
0304	130	U16	Node address [▶ 29]	1 … 247 = 1 … 0xF7	0x3F (63d)
0305	131	U16	Termination [▶ 29]	1 = Off 2 = On	2
0306	132	U16	Low-pass filter [▶ 30]	0 = Off 1 = On	1
0307	133	F32	Filter coefficient [▶ 30]	**(**Register 307 Filter Coefficient [▶ 30]**)**	**5.0**
0310	136	U16	Resolution [▶ 30]	1 = 0.001° 10 = 0.01° 100 = 0.1° 1000 = 1.0°	10
0311	137	U16	Operating parameter X axis [▶ 31]	0 = inversion off, scaling off 1 = inversion on and scaling off 2 = inversion off and scaling on (3 inversion on, scaling on) – Not permitted	0
0312	138	I16	Preset X axis [▶ 32]	0 … +/- 85°	0
0313	139	I16	Offset X axis [▶ 32]	0 … +/- 180°	0
0314	13A	I16	Differential offset X axis [▶ 33]	0 … +/- 85°	0
0315	13B	U16	Operating parameter Y axis [▶ 33]	0 = inversion off, scaling off 1 = inversion on and scaling off 2 = inversion off and scaling on (3 inversion on, scaling on) – Not permitted	0
0316	13C	I16	Preset Y axis [▶ 34]	0 … +/- 85°	0
0317	13D	I16	Offset Y axis [▶ 35]	0 … +/- 180°	0

Reg [dec]	Reg [hex]	Format	Parameter name	Possible values	Default
0318	13E	I16	Differential offset Y axis [▶ 35]	0 … +/- 85°	0
0320	140	U16	Preset Z axis [▶ 35]	0 … 360°	0
0360	168	U16	Saving the parameters [▶ 36]	0x1010	-
0361	169	U16	Loading the default parameters (factory setting) [▶ 36]	0x1011	-

Query

The query message contains the references of the registers to be set. The registers are addressed as from 0. Register 1 is addressed as 0.

Example of a query to set two registers beginning with 40002 in slave device 17 (0x11) to 00 0A and 01 02 hex:

QUERY

Field Name	Example (Hex)
Slave Address	11
Function	10
Starting Address Hi	00
Starting Address Lo	01
No. of Registers Hi	00
No. of Registers Lo	02
Byte Count	04
Data Hi	00
Data Lo	0A
Data Hi	01
Data Lo	02
Error Check (LRC or CRC)	—

IMG-ID: 58867851

Response

The normal response contains the slave address, the function code, the starting address and the number of registers set.

Example of a response to the above query:

RESPONSE

Field Name	Example (Hex)
Slave Address	11
Function	10
Starting Address Hi	00
Starting Address Lo	01
No. of Registers Hi	00
No. of Registers Lo	02
Error Check (LRC or CRC)	—

IMG-ID: 58869771

5.6 Function code 17 - Query of Device-Specific Information

Report slave ID function code 17

NOTICE	Slave ID
	Slave ID DOES NOT mean the node address of the sensor. In this case, slave ID means the sensor type.

Description

Returns a description of the type (at the slave address) and other device-specific information.

NOTICE	Broadcast function
	Broadcast is not supported.

Example

The ID and the status of the device with node ID 20 (0X14) are queried:

Command: 14 11 CE BC

QUERY

Field Name	Example (Hex)
Slave Address	11
Function	11
Error Check (LRC or CRC)	—

IMG-ID: 58521099

Response

The format of a response is represented below. The data content depends on the respective sensor type. The data is represented below and refers, in the example, to an encoder.

RESPONSE	
Field Name	Contents
Slave Address	Echo of Slave Address
Function	11
Byte Count	Device Specific
Slave ID	Device Specific
Run Indicator Status	00 = OFF, FF = ON
Additional Data	Device Specific
. . .	
Error Check (LRC or CRC)	—

IMG-ID: 58523019

Summary of the slave IDs:

1 = singleturn encoder

2 = multiturn encoder

Slave ID codes returned by the Kübler encoders in the first byte of the data field.

The Modbus encoder returns 31 bytes as described below:

Byte contents:	
1	Slave address
2	Function code
3	Byte length
4	Slave ID
5	Running indication status (0 = Modbus OFFline (diagnosis), 0xFF = Modbus ready for operation)
6 - 27	System information inclinometer type, company name, SW version (ASCII format)
	Example:
	For inclinometers: 02,FF, “IN88_MB_V103 IN88_V1.28”
	For encoders: „F5868MTKueblerV2.02MB“, or „F5868STKueblerV2.02MB“
28, 29	Errors counter
30, 31	CRC

5.7 Description of the Registers

5.7.1 Register 261 Delay Time for the Transmission

This register allows modifying by software a time delay applied by the transmitter after receiving a message. As a standard, this value is set to 1. The value is therefore multiplied by n.

Example: Input 5 Baud rate = 19200 Delay = 5* 2.2,2ms = 11ms

Value	Baud rate in Kbit/s	Standard delay time
1	9600	5.0 ms
2	19200	2.2 ms
3	38400	1.9 ms
4	57600	1.9 ms
5	115200	1.8 ms

The new delay time is taken into consideration immediately after input / Saving is possible via **Register 360**.

5.7.2 Register 300 Baud Rate

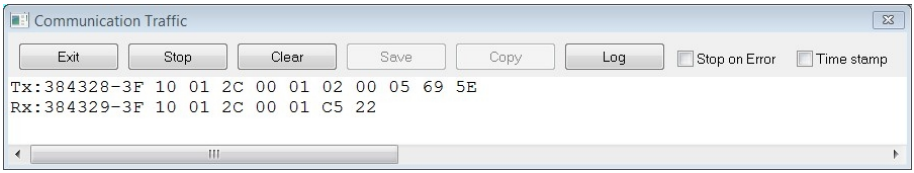
The baud rate can be modified with a Modbus software on Register 300.

Value	Baud rate in Kbit/s
1	9600
2	19200
3	38400
4	57600
5	115200

NOTICE	**Consider the cycle time for the corresponding baud rate.**
	For all baud rates, general cycle time at least 20 ms

A new baud rate is only taken into consideration at the following booting (Reset/Power-on) of the device. All other settings in the register table remain retained.

Example: node ID 3F change baud rate to 115200



5.7.3 Register 301 Parity Setting

This register allows modifying the parity setting by software. As a standard, this value is set to 1 (no parity). If the value is set to 2 (even parity) or to 3 (odd parity) and the parameter is saved using Register 360 Save All Bus Parameters, the device will boot with the modified parity setting at the following powering or Reset Node.

Value	Definition
1	No parity
2	Even parity
3	Odd parity

5.7.4 Register 302 Stop Bit

This register allows modifying the stop bit setting by software. As a standard, this value is set to 1 (1 stop bit). If the value is set to 2 and the parameter is saved using Register 360 Save All Bus Parameters, the device will boot with the modified stop bit setting at the following powering or Reset Node.

Value	Definition
1	1 stop bit
2	2 stop bits

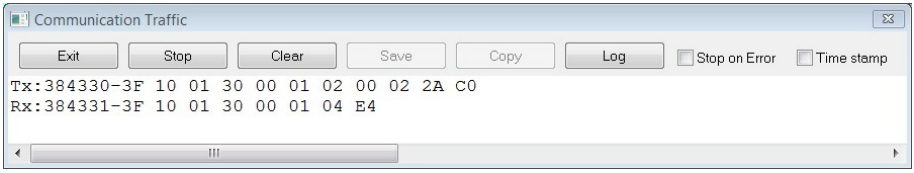
5.7.5 Register 304 Node Address

The node number can also be modified with a Modbus software on Register 304. Node number 00 is reserved for broadcast messages and shall not be used by any node.

The resulting node numbers are in the range 1...7Fh hexadecimal (1...127 decimal). As a standard, the value is set to 0x3Fh, i.e. node ID= 0x3F. If the value is saved using Register 360 Save All Bus Parameters, the device will boot with the modified node address at the following powering or Reset Node. All other settings in the register table remain retained.

Node number 0 is reserved and shall not be used by any node.

Example: node ID 3F change node address to 02



IMG-ID: 58871691

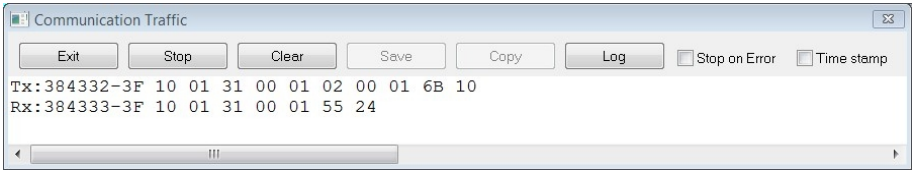
5.7.6 Register 305 Termination

This register allows switching the bus termination on by software. As a standard, this value is set to 2, i.e. the termination is switched on.

The termination can also be modified with a Modbus software on Register 305.

Value	Definition
1	Terminating resistor off
2	Terminating resistor on

Example: node ID 3F switch termination off (01)



IMG-ID: 58885131

5.7.7 Register 306 Low-Pass Filter

Register 306 allows switching the low-pass filter of the sensor on and off.

Value	Definition
0	Low-pass filter off
1	Low-pass filter on

5.7.8 Register 307 Filter Coefficient

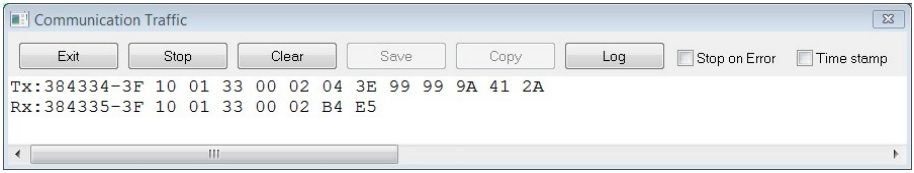
Possible settings:

0.1, 0.3, 0.5, 1.0, 2.0, 5.0, 10.0 Hz

Other values are set by default to 5.0 Hz.

Value	Hexadecimal value
0.1	3D CC CC CD
0.3	3E 99 99 9A
0.5	3F 00 00 00
1.0	3F 80 00 00
2.0	40 00 00 00
5.0	40 A0 00 00
10.0	41 20 00 00

Example: node ID 3F change filter setting to 0.3 Hz



IMG-ID: 58873611

5.7.9 Register 310 Resolution

Register 310 allows setting the resolution of the sensor.

Value	Definition
1d (01h)	0.001° not supported
10d (0Ah)	0.01°
100d (64h)	0.1°
1000d (3E8h)	1.0°
others	not supported

NOTICE	**Measuring axes**
	Parameter 310 Resolution influences the measuring axes long16 and lateral16.

5.7.10 Register 311 Operating Parameter X Axis

This register allows switching on and off the scaling with Offset/Preset of registers Register 312 Preset X Axis [▶ 32], Register 313 Offset X Axis [▶ 32] and the measurement value inversion of the X axis.

Field	Bit	Value	Definition
I (inversion)	0	0	Inversion off
I (inversion)	0	1	Inversion on
S (scaling)	1	0	Scaling off
S (scaling)	1	1	Scaling on

NOTICE	**Inversion and scaling cannot be activated both together.**
	The simultaneous activation of inversion and scaling is not permitted! Register content 3 is not accepted in the Modbus command.

Scaling

If scaling is enabled, the measured value is calculated as follows:

$$Slope\ long16 = \text{physically measured angle} + Differential\ slope\ long16\ offset + Slope\ long16\ offset$$

IMG-ID: 58926091

If scaling is disabled, the measured value corresponds to the physically measured value.

Inversion

If inversion is switched on, the measured value is output inverted.

5.7.11 Register 312 Preset X Axis

Register 312 allows setting the measured value to a desired angle value (PRESET). The desired angle value is transmitted as a signed 16-bit value, taking into consideration the resolution set previously.

The differential offset is included in the Preset calculation.

The angle offset calculated by the Preset value can be read or modified via register 313.

NOTICE	**Consider the resolution**
	The input must be adapted to the selected resolution in register 310.

Angle offset calculation

Slope long16 offset = *Slope long16 preset value* at t_{acc} – slope physical measured at t_{acc} – *Differential slope long16 offset*

t_{acc} = *time when accessing object* 6012_h

IMG-ID: 58929931

Measured value calculation

Slope long16 = physically measured angle + *Differential slope long16 offset* + *Slope long16 offset*

IMG-ID: 58928011

Example

The measured value is to be set to + 45.00 °.

The resolution in register 300 is set to 0.01° = 10d:

Values range: 0 ... ±85.00° . Example: + 45.00° = 4500 (SIGNED16)

5.7.12 Register 313 Offset X Axis

Register 313 allows transferring directly an angle offset that will be used with the measured value in the calculation. The angle offset is transferred with a signed 16 bit value, depending on the resolution set in register 310.

NOTICE	**Observe the validity of the offset**
	The input must be adapted to the resolution selected in register 310.
	The offset is only used in the calculation if the scaling is enabled, see Register 311 Operating Parameter X Axis [▶ 31]

Values range

2 axes sensor

Values range 0 … ±180.00°. Example: + 45.00° = 4500 (SIGNED16)

Angle calculation

Slope long16 = physically measured angle + *Differential slope long16 offset* + *Slope long16 offset*

IMG-ID: 58931851

5.7.13 Register 314 Differential Offset X Axis

Register 314 allows shifting the measuring range with an offset regardless of registers 312 Preset and 313 Offset. Differential means that the offset relates to the preset and not to the physically measured angle, provided a preset hes been set.

To that purpose, a signed 16-bit angular value, depending on the resolution set in register 310, can be transferred in register 314.

NOTICE	**Observe the validity of the offset**
	The input must be adapted to the resolution selected in register 310.
	The offset is only used in the calculation if the scaling is enabled, see Register Operating parameter.

Values range 0 … ±85.00° . Example: + 45.00° = 4500 (SIGNED16)

Angle calculation

Slope long16 = physically measured angle + *Differential slope long16 offset* + *Slope long16 offset*

IMG-ID: 58933771

5.7.14 Register 315 Operating Parameter Y Axis

This register allows switching on and off the scaling with Offset/Preset of registers Register 315 Operating Parameter Y Axis [▶ 33], Register 316 Preset Y Axis [▶ 34] and the measurement value inversion of the Y axis.

Field	Bit	Value	Definition
I (inversion)	0	0	Inversion off
I (inversion)	0	1	Inversion on
S (scaling)	1	0	Scaling off
S (scaling)	1	1	Scaling on

NOTICE	**Inversion and scaling cannot be activated both together.**
	The simultaneous activation of inversion and scaling is not permitted! Register content 3 is not accepted in the Modbus command.

Scaling

If scaling is switched on, the measured value is calculated as follows:

Slope long16 = physically measured angle + *Differential slope long16 offset* + *Slope long16 offset*

IMG-ID: 58933771

If scaling is disabled, the measured value corresponds to the physically measured value.

Inversion

If inversion is switched on, the measured value is output inverted.

5.7.15 Register 316 Preset Y Axis

Register 316 allows setting the measured value to a desired angle value (PRESET). The desired angle value is transmitted as a signed 16-bit value, taking into consideration the resolution set previously.

The differential offset of register 318 is included in the Preset calculation.

The angle offset calculated by the Preset value in 316 can be read or modified via register 313.

Angle offset calculation

Slope long16 offset = *Slope long16 preset value* at t_{acc} – slope physical measured at t_{acc} – *Differential slope long16 offset*

t_{acc} = *time when accessing object* 6012_h

IMG-ID: 58939531

Measured value calculation

Slope long16 = physically measured angle + *Differential slope long16 offset* + *Slope long16 offset*

IMG-ID: 58937611

Example

The measured value is to be set to + 45.00 °.

The resolution in register 300 is set to 0.01° = 10d.

Values range: 0 ... ±85.00°. Example: + 45.00° = 4500 (SIGNED16)

NOTICE	**Consider the resolution**
	The input must be adapted to the resolution selected in register 310.

5.7.16 Register 317 Offset Y Axis

Register 317 allows transferring directly an angle offset that will be used with the measured value in the calculation. The angle offset is transferred with a signed 16 bit value, depending on the resolution set in register 300.

NOTICE	**Observe the validity of the offset**
	The input must be adapted to the resolution selected in register 310.
	The offset is only used in the calculation if the scaling is enabled, see Register 315 Operating Parameter Y Axis [▶ 33]

Values range 0 … ±180.00°. Example: + 45.00° = 4500 (SIGNED16)

Angle calculation

Slope lateral16 = physically measured angle + *Differential slope lateral16 offset* + *Slope lateral16 offset*

IMG-ID: 58941451

5.7.17 Register 318 Differential Offset Y Axis

Register 318 allows transferring directly a differential angle offset that will be used with the measured value in the calculation. Differential means that the offset relates to the preset and not to the physically measured angle, provided a preset hes been set.

The angle offset is transferred with a signed 16 bit value, depending on the resolution set in register 300.

NOTICE	**Observe the validity of the offset**
	The input must be adapted to the resolution selected in register 310.
	The offset is only used in the calculation if the scaling is enabled, see Register Operating parameter.

Values range: 0 … ±85.00°. Example: + 45.00° = 4500 (SIGNED16)

Angle calculation

Slope lateral16 = physically measured angle + *Differential slope lateral16 offset* + *Slope lateral16 offset*

IMG-ID: 58943371

5.7.18 Register 320 Preset Z Axis

Register 320 allows inputting a zero setting position (PRESET).

Example

The measured value is 60°. After a preset, the value is set to 0°.

1-axis sensor:

Values range: Only value 0 is accepted.

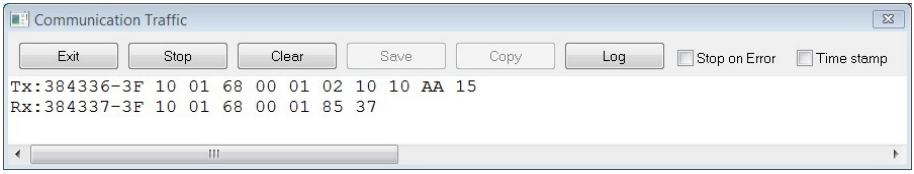
5.7.19 Register 360 Saving the Parameters

This parameter (Register 360) saves all Modbus parameters permanently in the Flash memory. This register serves as an additional protection against accidental changes of the baud rate and node address. Only targeted saving with parameter "save“ (hexadecimal 0x1010) will save permanently all Modbus parameters and bus parameters such as baud rate, node address and termination.

Values range: "save" in hexadecimal 0x1010

NOTICE	**Updating the parameters**
	The new values are only taken over after a power off/on sequence.

Example: node ID 3F: save all parameters



IMG-ID: 58883211

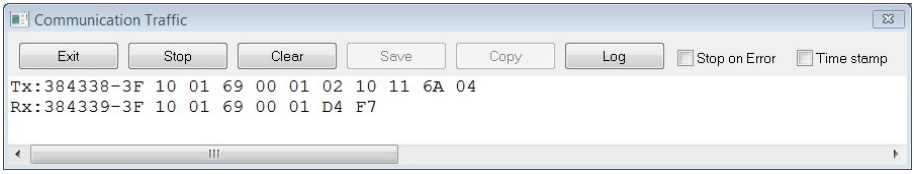
5.7.20 Register 361 Loading the Default Parameters

This parameter loads the standard bus parameters permanently in the Flash memory.

Only targeted loading with parameter "load" (hexadecimal 0x1011) will load the comprehensive standard Modbus parameters and simultaneously save them as default.

Values range: "load" in hexadecimal 0x1011

Example node ID 3F load the default parameters



IMG-ID: 58565387

5.8 Modbus Exception Codes

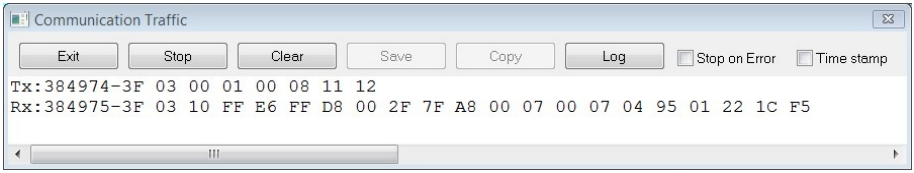
Number	Code Name	Meaning
01	Illegal Function	The function code contained in the query does not correspond to a permitted action for the slave. If a Poll Program Complete command has been issued, this code indicates that this command has not been preceded by a program function.
02	Illegal Data Address	The data address contained in the query does not correspond to a permitted address for the slave.
03	Illegal Data Value	A value contained in the data field of the query is not permitted for the slave.
04	Slave Device Failure	Unrecoverable error while the slave tried to perform the required action.
05	Acknowledge	The slave accepted the query and is processing it, but it will require much time for this. This answer is intended to prevent a timeout error in the master. The master can then send a Poll Program Complete message to determine whether processing is finished.
06	Slave Device Busy	The slave is processing a program command that requires much time. The master must re-send the message later, when the slave will be free.
07	Negative Acknowledge	The slave cannot perform the programming functions. The master should request diagnosis or error information from the slave.
08	Memory Parity Error	The slave detected a parity error in the memory. The master can repeat the request. Servicing may however be necessary for the slave device.
10	Gateway Path Unavailable	Specialized for Modbus gateways. Indicates a wrong gateway configuration.
11	Gateway Target Device Failed to Respond	Specialized for Modbus gateways. Is sent when the slave does not answer.

5.9 Examples

5.9.1 Parameterizing a Specific Application

1. Reading the current sensor values
2. Changing the baud rate
3. Changing the node address
4. Switching the termination off
5. Changing the filter settings
6. Saving all parameters

Node ID 3F Read 8 registers starting with register 1 up to register 8 (temperature)



IMG-ID: 58567307

Orientation angle X axis = FF E6

Orientation angle Y axis = FF D8

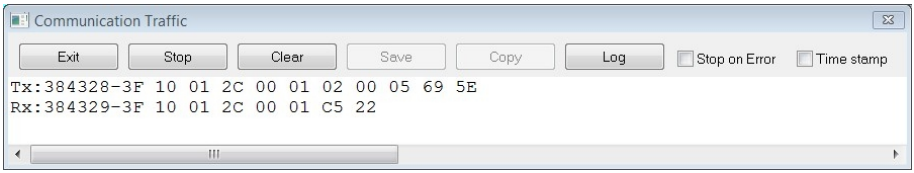
Euler angle X axis = 00 2F

Euler angle Y axis = 7F A8

Voltage VCC = 04 95

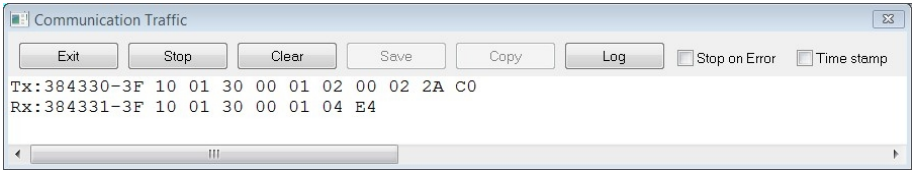
Temperature in 0.1° = 01 22

Node ID 3F Change baud rate to 115200



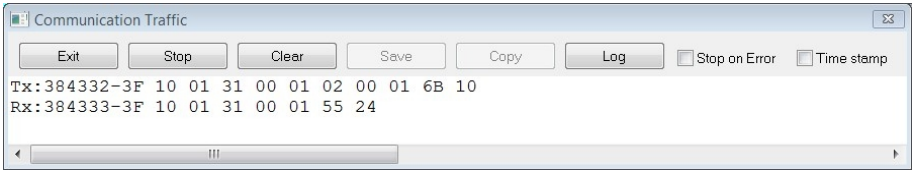
IMG-ID: 58563467

Node ID 3F Change node address to 02



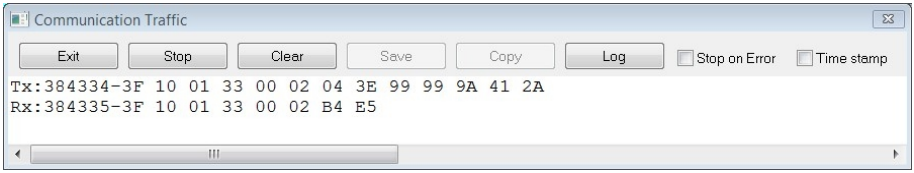
IMG-ID: 58559627

Node ID 3F Switch termination off (01)



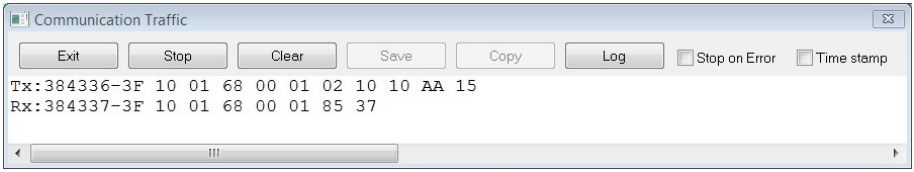
IMG-ID: 58571147

Node ID 3F Change filter setting to 0.3 Hz



IMG-ID: 58561547

Node ID 3F Save all parameters



IMG-ID: 58569227

6 Disposal

6.1 Disposal

Always dispose of unusable or irreparable devices in an environmentally sound manner, according to the country-specific provisions and in compliance with the waste disposal regulations in force. We will be glad to help you dispose of the devices.

See chapter Contact [▶ 46].

NOTICE	**Environmental damage in case of incorrect disposal**
	Electrical waste, electronic components, lubricants and other auxiliary materials are subject to hazardous waste treatment. Problem substances may only be disposed of by licensed specialist companies.

Dispose of disassembled device components as follows:

- Metal components in the scrap metal.
- Electronic components in the electrical waste.
- Plastic parts in a recycling center.
- Sort and dispose of the other components depending on the material type.

Also refer to

Contact [▶ 46]

7 Annex

7.1 Sensor filter

Filter description 1st order

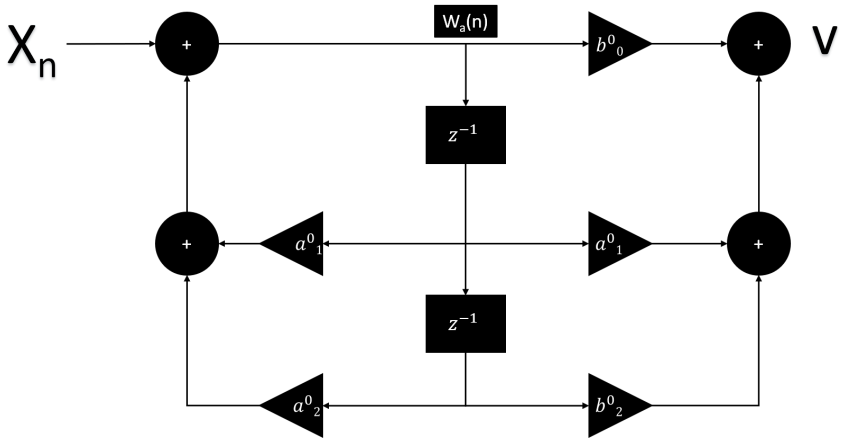
In electronics, low-pass filters are filters that let pass signal portions with frequencies lower than their limit frequency almost without attenuation and attenuate signal portions with higher frequencies.
Setting possibilities: Filter on/off
Filter operating frequency b: defines the starting point of the stop band (range 0.1 … 10.0 Hz)

Filter description 2nd order

An IIRfilter is generally realized with the help of 2nd order subsystems in direct form.
The following picture shows the corresponding block diagram. A subsystem consists of 2 delay elements or memory elements that contain the intermediate values w0(n) as well as of the two coefficients a^0_1, a^0_2 in the recursive portion and the three coefficients b^0_0, b^0_1 and b^0_2.

Functioning

The second index (j) is used for differentiation in case of several subsystems. A subsystem is described by equations, see below. The device uses 4 2nd order subsystems, resulting in an 8th order Butterworth filter.
x_n is here the input signal, y_n is the filter output and simultaneously the input of another subsystem.



IMG-ID: 151303947

$$w_0(n) = x(n) + a^0_1 \times w_0(n-1) + a^0_2 \times w_0(n-2)$$

$$y_0(n) = b^0_0 \times w_0(n) + b^0_1 \times w_0(n-1) + b^0_2 \times w_0(n-2)$$

7.2 Angle calculation

7.2.1 2-axes inclinometer

Orientation angles

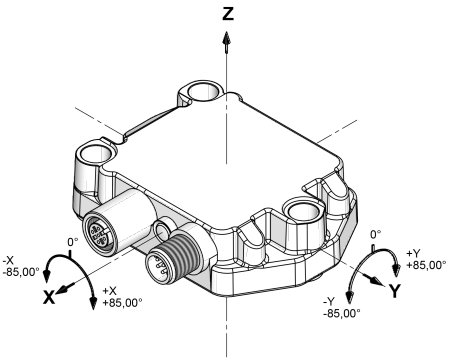
Indicating the two orientation angles describes the inclination of the coordinate system of the sensor with respect to the gravitational direction.

The first value output corresponds to a rotation around the Y axis of the sensor and is called "Orientation angle Y". This value corresponds to the angle [°] formed by the gravity vector with the YZ plane of the sensor.

The second value output corresponds to a rotation around the X axis of the sensor and is called "Orientation angle X". This value corresponds to the angle [°] formed by the gravity vector with the XZ plane of the sensor.

X axis: Longitudinal (long)

Y axis: Lateral (lat)



IMG-ID: 9007199377711755

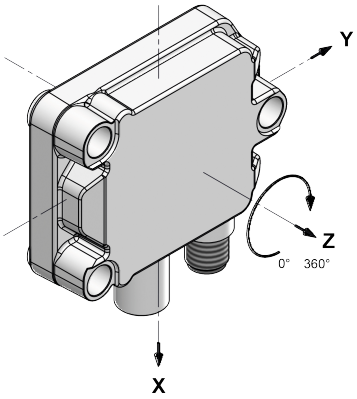
7.2.2 1-axis inclinometer

Rotation angle

In this setting, the output angle value is to be interpreted as a rotation angle. The "Rotation angle Z" corresponds to the angle [°] by which the sensor has been rotated around the Z axis.

NOTICE	**Comply with the maximum Z axis deflection.**
	The sensor also outputs the angle around the Z axis if the Z axis, which normally is at 90° with respect to the gravity vector, is deflected with respect to the gravity vector. However, this is only possible up to the horizontal sensor position. In horizontal position, the Z rotation angle cannot be determined.

Z axis: Longitudinal (long)



IMG-ID: 9007199377709835

7.3 Decimal / Hexadecimal conversion table

Dec	Hex	Dec	Hex	Dec	Hex	Dec	Hex	Dec	Hex
0	*0*	51	*33*	102	*66*	153	*99*	204	*CC*
1	*1*	52	*34*	103	*67*	154	*9A*	205	*CD*
2	*2*	53	*35*	104	*68*	155	*9B*	206	*CE*
3	*3*	54	*36*	105	*69*	156	*9C*	207	*CF*
4	*4*	55	*37*	106	*6A*	157	*9D*	208	*D0*
5	*5*	56	*38*	107	*6B*	158	*9E*	209	*D1*
6	*6*	57	*39*	108	*6C*	159	*9F*	210	*D2*
7	*7*	58	*3A*	109	*6D*	160	*A0*	211	*D3*
8	*8*	59	*3B*	110	*6E*	161	*A1*	212	*D4*
9	*9*	60	*3C*	111	*6F*	162	*A2*	213	*D5*
10	*0A*	61	*3D*	112	*70*	163	*A3*	214	*D6*
11	*0B*	62	*3E*	113	*71*	164	*A4*	215	*D7*
12	*0C*	63	*3F*	114	*72*	165	*A5*	216	*D8*
13	*0D*	64	*40*	115	*73*	166	*A6*	217	*D9*
14	*0E*	65	*41*	116	*74*	167	*A7*	218	*DA*
15	*0F*	66	*42*	117	*75*	168	*A8*	219	*DB*
16	*10*	67	*43*	118	*76*	169	*A9*	220	*DC*
17	*11*	68	*44*	119	*77*	170	*AA*	221	*DD*
18	*12*	69	*45*	120	*78*	171	*AB*	222	*DE*
19	*13*	70	*46*	121	*79*	172	*AC*	223	*DF*
20	*14*	71	*47*	122	*7A*	173	*AD*	224	*E0*
21	*15*	72	*48*	123	*7B*	174	*AE*	225	*E1*
22	*16*	73	*49*	124	*7C*	175	*AF*	226	*E2*
23	*17*	74	*4A*	125	*7D*	176	*B0*	227	*E3*
24	*18*	75	*4B*	126	*7E*	177	*B1*	228	*E4*
25	*19*	76	*4C*	127	*7F*	178	*B2*	229	*E5*
26	*1A*	77	*4D*	128	*80*	179	*B3*	230	*E6*
27	*1B*	78	*4E*	129	*81*	180	*B4*	231	*E7*
28	*1C*	79	*4F*	130	*82*	181	*B5*	232	*E8*
29	*1D*	80	*50*	131	*83*	182	*B6*	233	*E9*
30	*1E*	81	*51*	132	*84*	183	*B7*	234	*EA*

Dec	Hex	Dec	Hex	Dec	Hex	Dec	Hex	Dec	Hex
31	*1F*	82	*52*	133	*85*	184	*B8*	235	*EB*
32	*20*	83	*53*	134	*86*	185	*B9*	236	*EC*
33	*21*	84	*54*	135	*87*	186	*BA*	237	*ED*
34	*22*	85	*55*	136	*88*	187	*BB*	238	*EE*
35	*23*	86	*56*	137	*89*	188	*BC*	239	*EF*
36	*24*	87	*57*	138	*8A*	189	*BD*	240	*F0*
37	*25*	88	*58*	139	*8B*	190	*BE*	241	*F1*
38	*26*	89	*59*	140	*8C*	191	*BF*	242	*F2*
39	*27*	90	*5A*	141	*8D*	192	*C0*	243	*F3*
40	*28*	91	*5B*	142	*8E*	193	*C1*	244	*F4*
41	*29*	92	*5C*	143	*8F*	194	*C2*	245	*F5*
42	*2A*	93	*5D*	144	*90*	195	*C3*	246	*F6*
43	*2B*	94	*5E*	145	*91*	196	*C4*	247	*F7*
44	*2C*	95	*5F*	146	*92*	197	*C5*	248	*F8*
45	*2D*	96	*60*	147	*93*	198	*C6*	249	*F9*
46	*2E*	97	*61*	148	*94*	199	*C7*	250	*FA*
47	*2F*	98	*62*	149	*95*	200	*C8*	251	*FB*
48	*30*	99	*63*	150	*96*	201	*C9*	252	*FC*
49	*31*	100	*64*	151	*97*	202	*CA*	253	*FD*
50	*32*	101	*65*	152	*98*	203	*CB*	254	*FE*
								255	*FF*

8 Contact

You want to contact us:

Technical advice

Kübler's worldwide applications team is available on site all over the world for technical advice, analysis or installation support.

International support (English-speaking)

+49 7720 3903 952

support@kuebler.com

Kübler Germany +49 7720 3903 849

Kübler France +33 3 89 53 45 45

Kübler Italy +39 0 26 42 33 45

Kübler Austria +43 3322 43723 12

Kübler Poland +48 6 18 49 99 02

Kübler Turkey +90 216 999 9791

Kübler China +86 10 8471 0818

Kübler India +91 8600 147 280

Kübler USA +1 855 583 2537

Repair service / RMA form

In case of returns, please package the product sufficiently and attach the completed "Returns form".

www.kuebler.com/rma

Please send your return to the address below.

Kübler Group

Fritz Kübler GmbH

Schubertstraße 47

D-78054 Villingen-Schwenningen

Germany

Phone +49 7720 3903 0

Fax +49 7720 21564

info@kuebler.com

www.kuebler.com

Glossary

ASCII

American Standard Code for Information Interchange. 7-bit coding

CRC

Cyclic Redundancy Check

CRLF

Carriage Return - Line Feed

ERR

Error

HEX

Hexadecimal

IIR

Infinite Impulse Response (filter)

LRC

Longitudinal Redundancy Check

PDU

Protocol Data Unit

RTU

Remote Terminal Unit

VCC

Voltage Common Collector - Designates the higher voltage potential with respect to the ground or to the reference potential

Kübler Group
Fritz Kübler GmbH
Schubertstr. 47
D-78054 Villingen-Schwenningen
Germany
Phone +49 7720 3903-0
Fax +49 7720 21564
info@kuebler.com
www.kuebler.com