MICRO-EPSILON

Operating Instructions

inertialSENSOR INC5701

INC5701S
INC5701D

1-axis inclination sensor

MICRO-EPSILON Eltrotec GmbH
Manfred-Wörner-Straße 101

73037 Göppingen / Germany

Tel. +49 (0) 7161 / 98872-300
Fax +49 (0) 7161 / 98872-303
eltrotec@micro-epsilon.com
www.micro-epsilon.com

Contents

1. Safety 5
1.1 Symbols Used 5
1.2 Warnings 5
1.3 Notes on CE Marking 6
1.4 Intended Use 6
1.5 Proper Environment 6

2. Functional Principle, Technical Data 7
2.1 Functional Principle 7
2.2 Structure and Electrical Connection 7
2.3 Technical Data 8
2.4 Low-pass Filter 9
2.5 SensorFUSION Filter 10

3. Delivery 11
3.1 Unpacking, Included in Delivery 11
3.2 Storage 11

4. Installation and Assembly 12
4.1 Sensor Cable 12
4.2 Sensor 13
4.3 Pin Assignment 15
4.4 Current and Voltage Output 16
4.4.1 Continuous Operation Mode 16
4.4.2 Switching Operation Mode 17
4.5 Digital Output RS485 19

5. Operation 20

6. Limitation of Liability 21

7. Service, Repair 22

8. Decommissioning, Disposal 22

Appendix

A 1 Accessories 23

A 2 Factory Settings 24

A 3 sensorTOOL 25
A 3.1 Configure Baudrate 26
A 3.2 Measurement Menu 27
A 3.2.1 Start / Stop 28
A 3.2.2 Signal Processing 29
A 3.2.3 CSV Output 30
A 3.3 Single Value Menu 32
A 3.4 Settings Menu 33
A 3.5 Info Menu 36

A 4 Digital Interface RS485 37
A 4.1 Hardware Interface 37
A 4.2 Protocol 37
A 4.2.1 Reading Measurement Data 38
A 4.2.2 Example Transmission of a Measurement Value 41

1. Safety

System operation assumes knowledge of the operating instructions.

1.1 Symbols Used

The following symbols are used in these operating instructions:

⚠ CAUTION	Indicates a hazardous situation which, if not avoided, may result in minor or moderate injury.
NOTICE	Indicates a situation that may result in property damage if not avoided.
➪	Indicates a user action.
i	Indicates a tip for users.

1.2 Warnings

⚠ CAUTION

Connect the power supply and the display/output device according to the safety regulations for electrical equipment.
> Risk of injury

> Damage to or destruction of the sensor

NOTICE

The supply voltage must not exceed the specified limits.
> Damage to or destruction of the sensor

No sharp or heavy objects should be allowed to affect the cables. Avoid folding the cables. Do not bend more tightly than the minimum bending radius of the cables.
> Damage or destruction of the cable, failure of the measuring device

Do not crush the cable. Protect the sensor cable against damage.
> Damage or destruction of the cable, failure of the measuring device, data loss

Ensure that the coupling nuts of the connectors are firmly tightened.
> Damage or destruction of the cable, failure of the measuring device

1.3 Notes on CE Marking

The following apply to the INC5701:
- EU Directive 2014/30/EU
- EU Directive 2011/65/EU

Products which carry the CE mark satisfy the requirements of the EU directives cited and the relevant applicable harmonized European standards (EN). The measuring system is designed for use in industrial environments.

The EU Declaration of Conformity and the technical documentation are available to the responsible authorities according to the EU Directives.

1.4 Intended Use

The INC5701 is designed for use in industrial applications. It is used for
- measuring angles
- determination of orientation
- measuring the position of manoeuvrable components

- The system must only be operated within the limits specified in the technical data, see 2.3.
- The sensor must be used in such a way that no persons are endangered or machines and other material goods are damaged in the event of malfunction or total failure of the sensor.
- Take additional precautions for safety and damage prevention in case of safety-related applications.

1.5 Proper Environment

- Protection class: [1] IP67
- Temperature range:
  - Operation: -40 ... +85 °C (-40 ... +185 °F)
  - Storage: -40 ... +85 °C (-40 ... +185 °F)
- Ambient pressure: Atmospheric pressure

1) with M12 connector

2. Functional Principle, Technical Data

2.1 Functional Principle

With the inclination principle, inertial or gravitational forces are measured depending on the position of the sensor and transformed to an absolute angular value.

Therefore the sensor is mounted on the manoeuvrable component to be measured. The change of inclination is output as an absolute value relative the environment.

2.2 Structure and Electrical Connection

Two variants of the sensor are offered. INC5701S [1] with a low-pass filter and INC5701D [2] using SensorFUSION with an additional dynamic extension.

Both versions are available with analog output (current, voltage and switching output) as well as RS485 for configuration of the sensor using the software sensorTOOL.

Power supply and signal output are effected through a 8-contact (M12) connector on the sensors housing.

1) = Standard
2) = Dynamic/SensorFUSION

2.3 Technical Data

Model		INC5701S	INC5701D
Number of measuring axes		1	
Adjustable filters		Low-pass (0.3 … 4 Hz)	Low-pass (0.3 … 4 Hz), SensorFUSION
Measuring range		1° … 360° [1]	
Resolution	Digital	0.001°	
	Analog	Current: 0.0069°, voltage: 0.0083°	
Accuracy [2]	Digital	≤ ±0.04°	
	Analog	≤ ±0.12°	
Sensitivity analog output		≤ 16 mA/° or ≤ 4 V/° [1]	
Measuring rate		250 Hz	
Temperature stability	Digital	0.0013°/ K	
	Analog	0.0083°/ K	
Supply voltage		5 … 32 VDC	
Power consumption		< 1 W	
Digital interface		RS485 / Ethernet [3] / PROFINET [3] / EtherNet/IP [3]	
Analog output		4 … 20 mA (max. 390 Ω) and 0.5 … 4,5 V (min. 1 kΩ) (configurable)	
Switching output		0 / 5 V (min. 1 kΩ)	
Connection		Supply snd signal: 8-pin M12 plug See accessories for connection cable	
Installation		Wall mounting; screw connection via mounting holes (M4)	
Temperature range	Operating	-40 … +85 °C (-40 ... +185 °F)	
	Storage	-40 … +85 °C (-40 ... +185 °F)	
Shock (DIN EN 60068-2-27)		(1500 g, 0.5 ms, half-sine shock, 3 x in each direction)	
Protection class (DIN EN 60529)		IP67 (connected)	
Material		Aluminum die-cast	
Weight		250 g	

All specifications are typical for +25 °C, unless otherwise stated.
1) In order to achieve maximum sensitivity, continuous adjustment of the measuring range is possible.
(Examples: measuring range 1° ⇨ sensitivity 16 mA/° or 4 V/°; measuring range 360° ⇨ sensitivity 0.044 mA/° or 0.011 V/°)
2) Accuracy based on full measuring range of 360 ° without inclination of sensor
3) In combination with the Micro-Epsilon interface modules IF1032 (Ethernet) and IF2030 (PROFINET, EtherNet/IP), see A 1.

Article designation

INC	5701	S	-360	-SA	-U/I

-U/I: Output
U = voltage 0.5 ... 4.5 V,
I = current 4 ... 20 mA,
switching output 0 / 5 V

-SA: Connection: SA = Connector axial

-360: Measuring range in °

S: Model: S = Standard, D = Dynamic (SensorFUSION)

5701: High Performance inclination sensor

2.4 Low-pass Filter

Both sensor variants operate with a low-pass filter which can be freely adjusted from 0.3 Hz to 4 Hz. Depending on the chosen cut-off frequency, the sensor signal is stabilized against undesired, short-term mechanical interferences like shocks or vibration. The lower the cut-off frequency is chosen, the more stable the signal but the higher the signal delay.

The filter has influence to the analog output as well as to the digital output.

2.5 SensorFUSION Filter

For the dynamic variant (INC5701D) an additional filter can be chosen. The combination of the low-pass filter with the additional dynamic extension is known as SensorFUSION. The SensorFUSION technology enables these sensors to be used even in vibrating environments, while providing reliable and accurate measurement results. The advantage of the SensorFUSION in comparison to the low-pass filter is shown in Figure below, see Fig. 1.

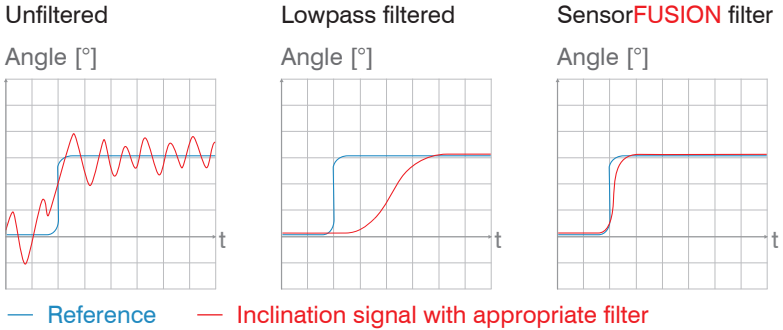


Fig. 1 Advantage of the SensorFUSION filter in comparison to the low-pass filter

3. Delivery

3.1 Unpacking, Included in Delivery

1 Sensor INC5701
1 Operating Instructions
1 Measurement protocol of the final test

- Carefully remove the components of the measuring system from the packaging and ensure that the goods are forwarded in such a way that no damage can occur.
- Check the delivery for completeness and shipping damage immediately after unpacking.
- If there is damage or parts are missing, immediately contact the manufacturer or supplier.

Optional accessories are available in the appendix, see A 1.

3.2 Storage

Storage temperature:	-40 ... +85 °C (-40 ... +185 °F)
Humidity:	5 - 95 % (non-condensing)

4. Installation and Assembly

4.1 Sensor Cable

NOTICE

No sharp or heavy objects should be allowed to affect the cables. Avoid folding the cables. Do not bend more tightly than the minimum bending radius of the cables.
> Damage or destruction of the cable, failure of the measuring device

Do not crush the cable. Protect the sensor cable against damage.
> Damage or destruction of the cable, failure of the measuring device

Ensure that the coupling nuts of the connectors are firmly tightened.
> Damage or destruction of the cable, failure of the measuring device

4.2 Sensor

The sensor is fixed with two M4 screws. After the sensor has been attached to the component, the zero position (angular value = 0°) is freely adjustable with the software tool of Micro-Epsilon, see 5, see A 3.

From the zero position the sensor measures an angle of up to ±180° in each direction of rotation (clockwise and counterclockwise).

i For precise measurements, position the sensor without tilting, see Fig. 2.
The measuring axis must not be tilted during a measurement.

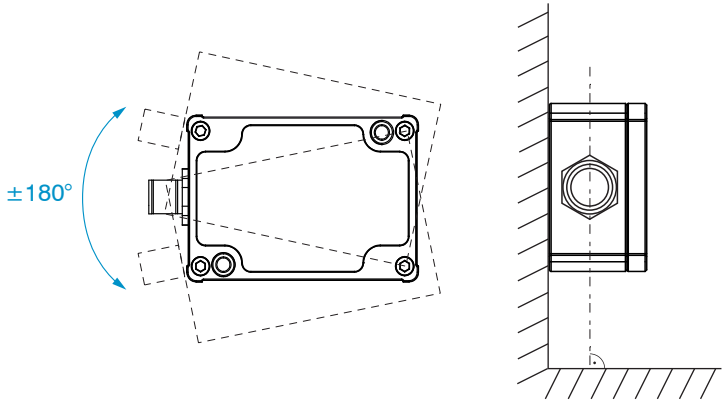


Fig. 2 Zero position (angle value 0°); measuring angle ±180°

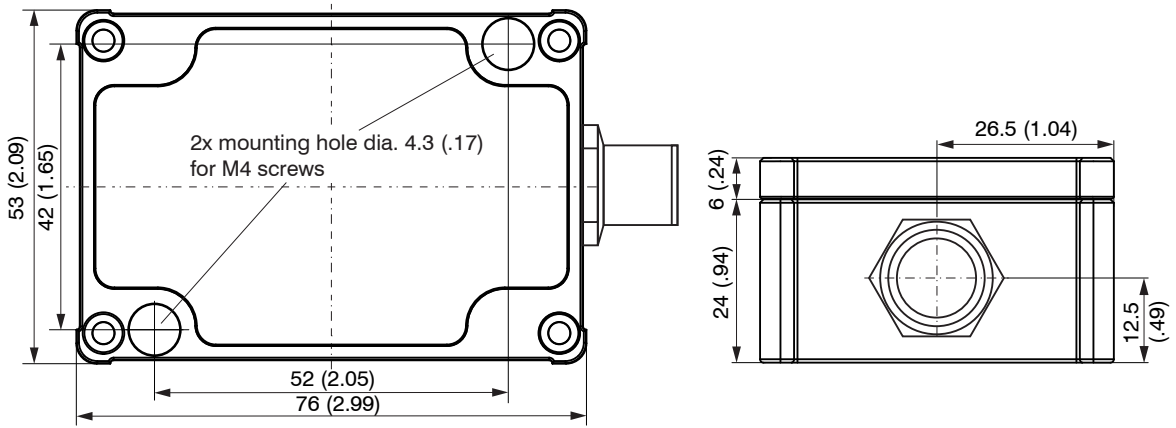
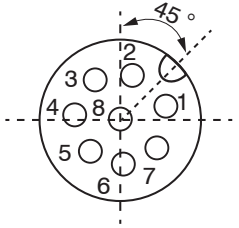


Fig. 3 Dimensional drawing, dimensions in mm (inches)

4.3 Pin Assignment

Connect the open cable end in accordance with the color coding, see Fig. 4.

Pin [1]	Color [2]	Description
1	White	Voltage output (angle)
2	Brown	GND (current output)
3	Green	Current output (angle)
4	Yellow	RS485+
5	Gray	GND (signal voltage output)
6	Black/pink	GND (supply)
7	Blue	RS485-
8	Red	Supply +



View of solder pin side, 8-pin, A-coded, female connector

Fig. 4 Pin assignment of the 8-pin, A-coded, female connector

1) - SA - Connector
2) PCx/8-M12 power supply and output cable, see A 1.

4.4 Current and Voltage Output

The sensor makes the angular value available as analog output variable either as current or voltage value on separate pins, depending on the configuration of the sensor using the software tool of Micro-Epsilon.

4.4.1 Continuous Operation Mode

In this process, the symmetrical measurement range in the unit angular degrees is scaled to the respective analogue range.

i The sensitivity increases with decreasing measurement range as only a small angular rang is scaled to the same output range.

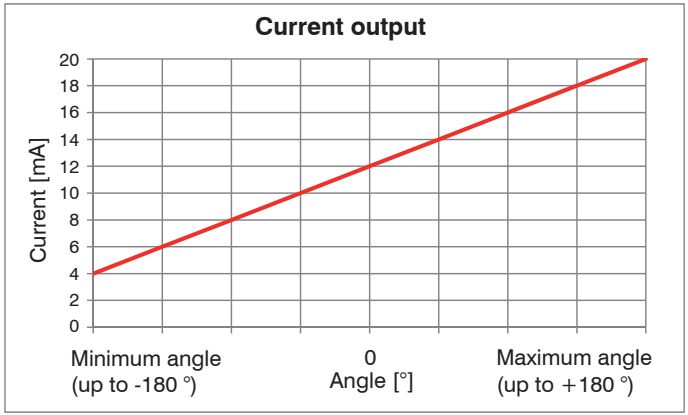


Fig. 5 Scaling of the angular measurement range to analog output variable current

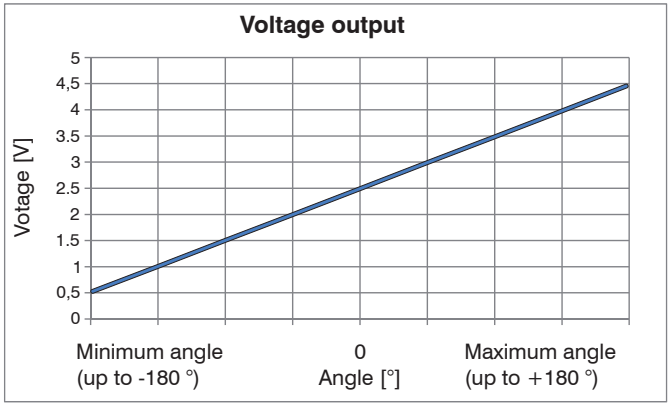


Fig. 6 Scaling of the angular measurement range to analog output variable voltage

4.4.2 Switching Operation Mode

The switching mode, configurable via Software, switches the analog voltage output to 5 V when the inclination value reaches the trigger-level “on-level“ and switches back to 0 V when the inclination value falls below the “off-level“, see Fig. 7.

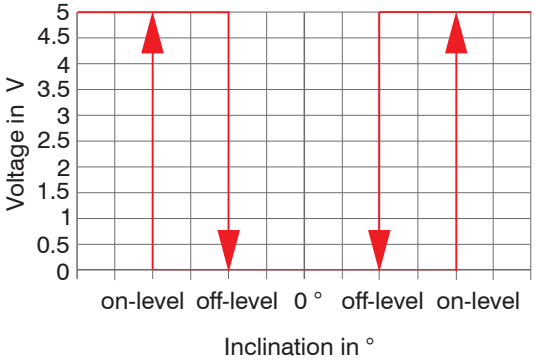


Fig. 7 Hysteresis of the trigger-levels in switching operation

That functionality can be used, for example, as safety feature which switches off a machine if a certain inclination angle is exceeded. The duration of the rising and falling edge is t < 10 µs, see Fig. 8.

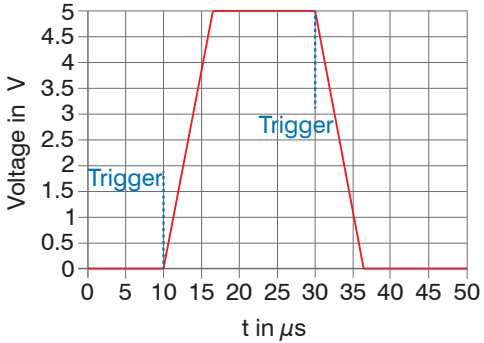


Fig. 8 Rising and falling edge of the voltage output in switching mode, t < 10 µs

Two different modes are selectable:

- Edge triggered, i.e. immediate switching when reaching the trigger-level.
- Edge triggered with delay, i.e. switching after specified time during which the trigger-level is reached permanently (debouncing).

The output values at the digital interface in switching mode are either zero or equal to the “on-level” as long as the trigger condition is met, see Fig. 9.

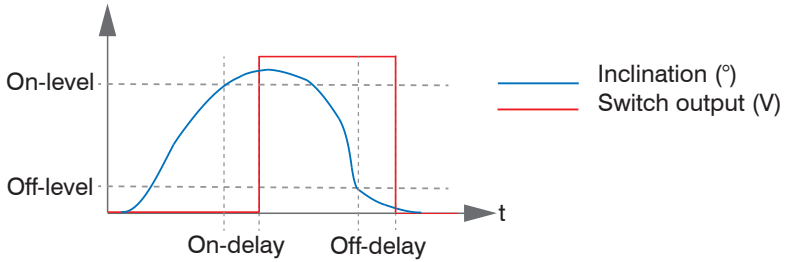


Fig. 9 Edge-triggered with delay (debouncing)

The debouncing (switching delay) can be adjusted in a wide range independently for the rising edge and the falling edge by the parameters “on-delay” and “off-delay”. The switch output will change only if the trigger level is reached or exceeded permanently during the delay duration. That ensures that the switch output will change only in stable signal conditions and will prevent undesired frequent switching in case of signal fluctuations or vibrations, see Fig. 10.

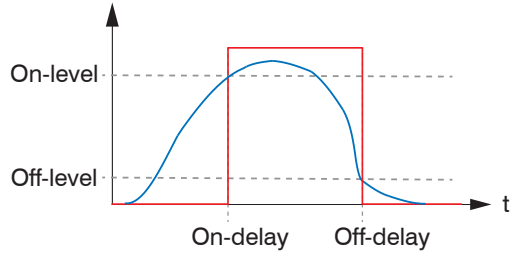


Fig. 10 Edge-triggered (immediate switching)

4.5 Digital Output RS485

You can read out the measured data in digital form using the RS485 interface. The PC software sensorTOOL, see A 3, permits configuration of the sensor and the visualization of the measured data.

The bus protocol required to read out the measured data in your own applications is described, see A 4.

Additionally, you can use the IF1032/ETH interface converter, see A 1, by MICRO-EPSILON MESSTECHNIK GmbH & Co. KG, to read out the measured data via Ethernet.

5. Operation

The measurement device is already calibrated when delivered. Calibration by the user is not necessary. After connection to the supply voltage, the sensor is immediately ready for operation and independently initiates the measurement.

Additionally, the digital RS485 interface is ready to react to enquiries by the master (periodic retrieval of measured data).

For sensor configuration please use the power supply and output cable with USB/RS485 converter, see A 1, as well as the software of MICRO-EPSILON.

i For reproducible measurement results, the sensor requires a warm-up time of approx. 10 minutes after connection to the voltage supply.
The zero position (angle value 0°) is freely configurable via the sensorTOOL program.

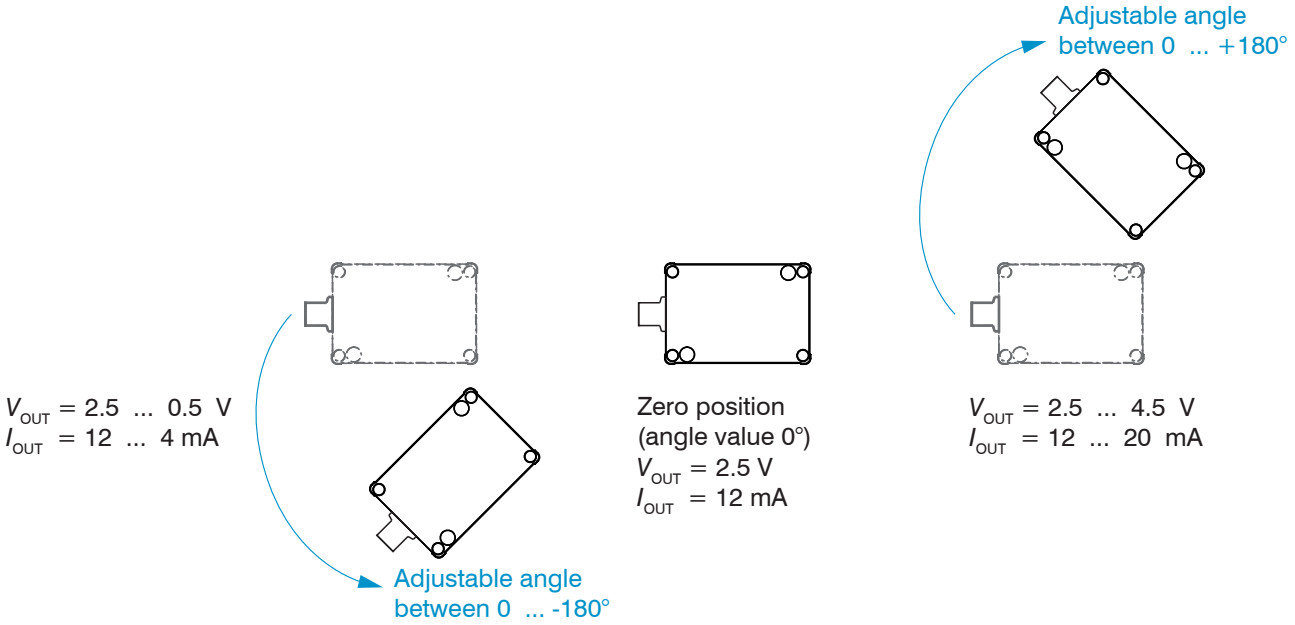


Fig. 11 Analog output depending on the direction of rotation

6. Limitation of Liability

All components of the device have been checked and tested for functionality by MICRO-EPSILON MESSTECHNIK. However, should any defects occur despite careful quality control, these shall be reported immediately to MICRO-EPSILON MESSTECHNIK or to your distributor / reseller.

MICRO-EPSILON MESSTECHNIK undertakes no liability whatsoever for damage, loss or costs caused by or related in any way to the product, e.g. due to

- non-observance of the Operating Instructions / Quick Manual / Assembly Instructions,
- improper use or improper handling (in particular improper installation, - commissioning, - operation and - maintenance) of the product,
- repairs or modifications by third parties,
- the use of force or other handling by unqualified persons on the product.

This limitation of liability also applies to defects resulting from normal wear and tear (e.g. on wearing parts) and non-compliance with the specified maintenance intervals (if applicable).

MICRO-EPSILON MESSTECHNIK is exclusively responsible for repairs. It is not permitted to make unauthorized structural and / or technical modifications or alterations to the product. In the interest of further development, MICRO-EPSILON MESSTECHNIK reserves the right to modify the design.

In addition, the General Terms and Conditions of MICRO-EPSILON MESSTECHNIK shall apply, which can be accessed under Legal details | Micro-Epsilon https://www.micro-epsilon.com/impressum/

For translations into other languages, the German version shall prevail.

7. Service, Repair

If the sensor is defective, please send us the affected parts for repair or exchange.

If the cause of a fault cannot be clearly identified, please send the entire measuring system to:

MICRO-EPSILON Eltrotec GmbH
Manfred-Wörner-Straße 101

73037 Göppingen / Germany

Tel. +49 (0) 7161 / 98872-300
Fax +49 (0) 7161 / 98872-303
eltrotec@micro-epsilon.com
www.micro-epsilon.com

8. Decommissioning, Disposal

➡ Remove the power and output cable from the sensor.

Incorrect disposal may cause harm to the environment.

➡ Dispose of the device, its components and accessories, as well as the packaging materials in compliance with the applicable country-specific waste treatment and disposal regulations of the region of use.

Appendix

A 1 Accessories

Designation	Description	
PC3/8-M12	Power supply and output cable, 3 m long	
PC5/8-M12	Power supply and output cable, 5 m long	
PC10/8-M12	Power supply and output cable, 10 m long	
PC10/8-M12	Power supply and output cable, drag chain suitable, 10 m long	
PC15/8-M12	Power supply and output cable, 15 m long	
PC2/8-Sub-D	Power supply and output cable with USB/RS485 converter, 2.8 m long	
IF1032/ETH		Multi-channel analog/Ethernet-EtherCAT converter
IF2030/ENETIP IF2030/PNET		Interface module for PROFINET connection or EtherNet connection of a Micro-Epsilon sensor with RS485 or RS422 interface, suitable for PC2/8-Sub-D cable, DIN rail housing, incl. GSML file for software integration in the PLC

A 2 Factory Settings

Low-pass filter: 0.7 Hz

Gyro-effect: 63 %

Current measurement range: 360 °

Current measurement start: -180 °

Output signal: 4 ... 20 mA

Analog Output Signal: Signal 2 (SensorFUSION)

Zero position (angle value 0°), see Fig. 12

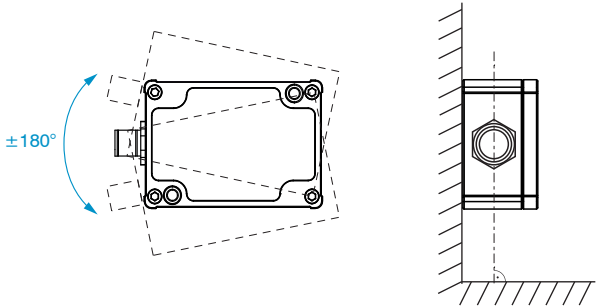


Fig. 12 Zero position (angle value O°); measuring angle ±180°

A 3 sensorTOOL

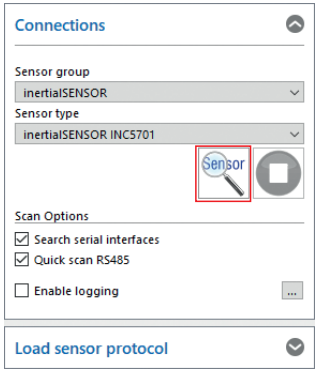
➡ Connect the sensor via the USB interface to a PC/notebook.

The supply voltage is supplied via the USB interface.

➡ Start the program `sensorTOOL`.

You can find this program online at

https://www.micro-epsilon.de/download/software/sensorTOOL.exe.



➡ Select the connected sensor.

➡ Click the `Sensor` button with the magnifier symbol.

The program will now search for connected sensors on the available interfaces.

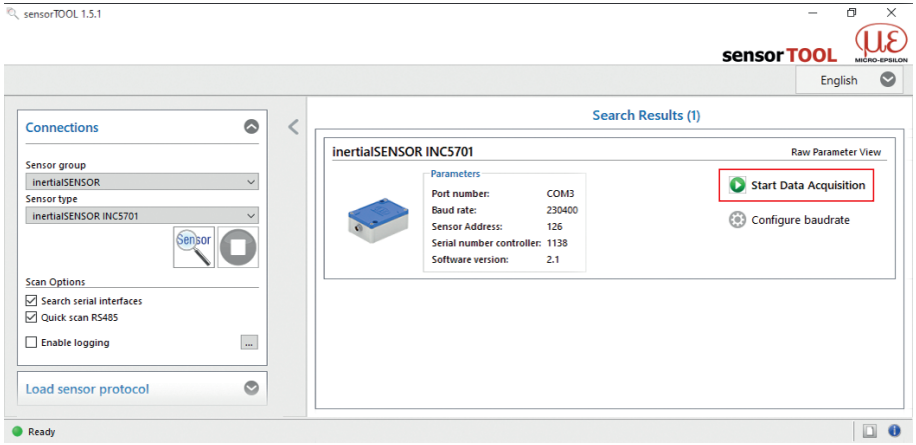


Fig. 13 First interactive site after calling the sensorTOOL

You need an HTML5-compatible web browser on a PC/notebook.

➡ Select a desired sensor.

➡ Click the `Start Data Acquisition`, see A 3.2 or `Configure baudrate` button, see A 3.1.

A 3.1 Configure Baudrate

Choose the `Configure baudrate` button to set the basic settings for the serial interface.

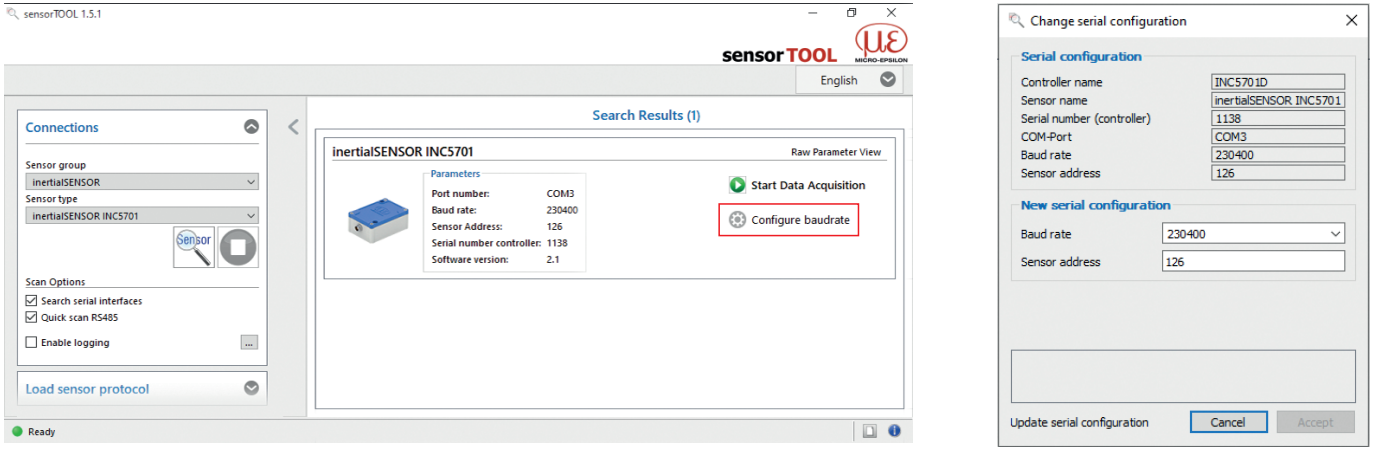


Fig. 14 Settings for serial interface

A 3.2 Measurement Menu

Start the data acquisition by clicking on `Start Data Acquisition` or on the sensor picture.

The following window appears.

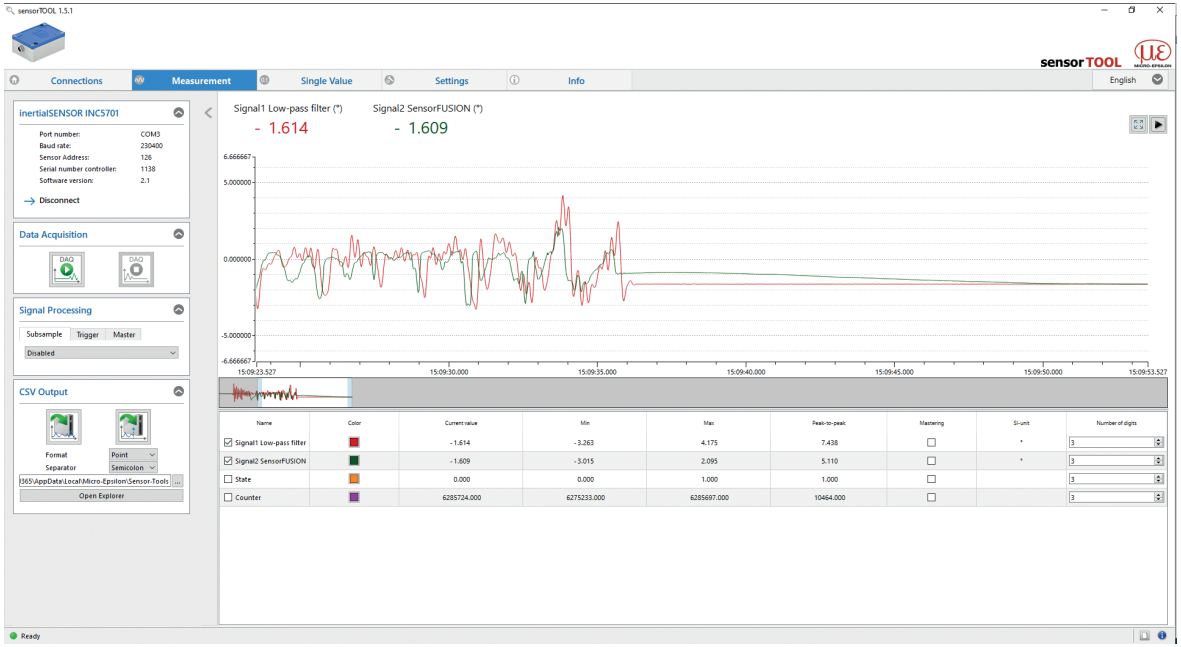


Fig. 15 View data acquisition menu

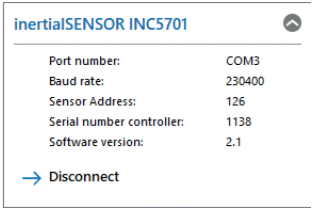


Fig. 16 View `Disconnect`

By clicking the `Disconnect` button you return to the sensor search, see Fig. 16.

	➡ Click the `Reset scale` button to reset the Y-scale to initial settings (e.g. after zooming).
	➡ Click the `Jump to Head` button to display the current signal course.

A 3.2.1 Start / Stop

➡ Start the data acquisition by clicking the `Start` button, see Fig. 17.

The acquisition is completely restarted and the record stopped before is deleted.

➡ Stop the data acquisition by clicking the `Stop` button, see Fig. 18.

Fig. 17 Start *Fig. 18 Stop*

A 3.2.2 Signal Processing

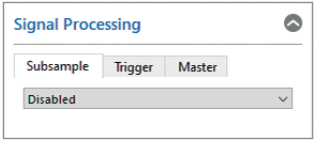


Fig. 19 View `Signal Processing`

You can select the following options for signal processing:

Measurement	Signal Processing	*Subsample*	*Disabled*	*Deactivated; basic settings*
			Sample-based	*Number of samples is adjustable, every xth measurement is recorded.*
			Time-based	*Time-based; time can be set in milliseconds* [1]
		Trigger	*Disabled*	*Deactivated; basic settings*
			Continuous	*Manual trigger*
			One-shot (sample-based)	*Sample can be set; records the signal course according to the set samples; the more samples, the longer the course.*
			One-shot (time-based)	*Milliseconds can be set; records the signal course according to the time set.*
		Master	*Master now*	*Sets the master*, see Fig. 22.
			Reset	*Resets the master.*

1) For example every 5000 ms: The signal course displayed after this period has elapsed.

Gray shaded fields require a selection.

Value Dark-bordered fields require you to specify a value

A 3.2.3 CSV Output

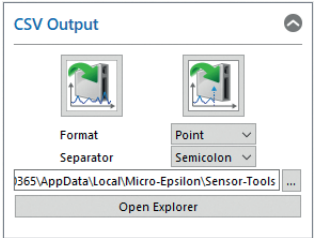


Fig. 20 View `CSV output`

	Click this button to start acquiring the measurement data.
	Click this button to safe the currently selected measurement value.

Measurement	CSV Output	*Format*	*Point / Comma*
		Separator	*Comma / Semicolon / Tabulator*

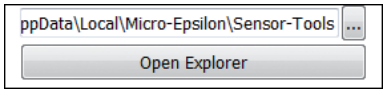
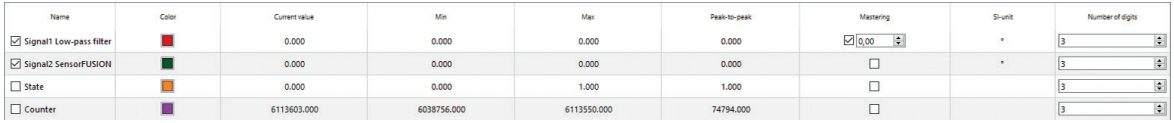


Fig. 21 View `Open Explorer`

Gray shaded fields require a selection.

Value Dark-bordered fields require you to specify a value



Name	Show or hide signal curves of the sensors used.
Color	Change the color settings of the single signal cources.
Mastering	By activating the `Mastering` checkbox you can manually enter the master value. `Master now` in the `Data Acquisition > Signal Processing` menu in the `Master` tab menu sets the master value, see Fig. 19.

Fig. 22 Depiction and description of data acquisition table

A 3.3 Single Value Menu

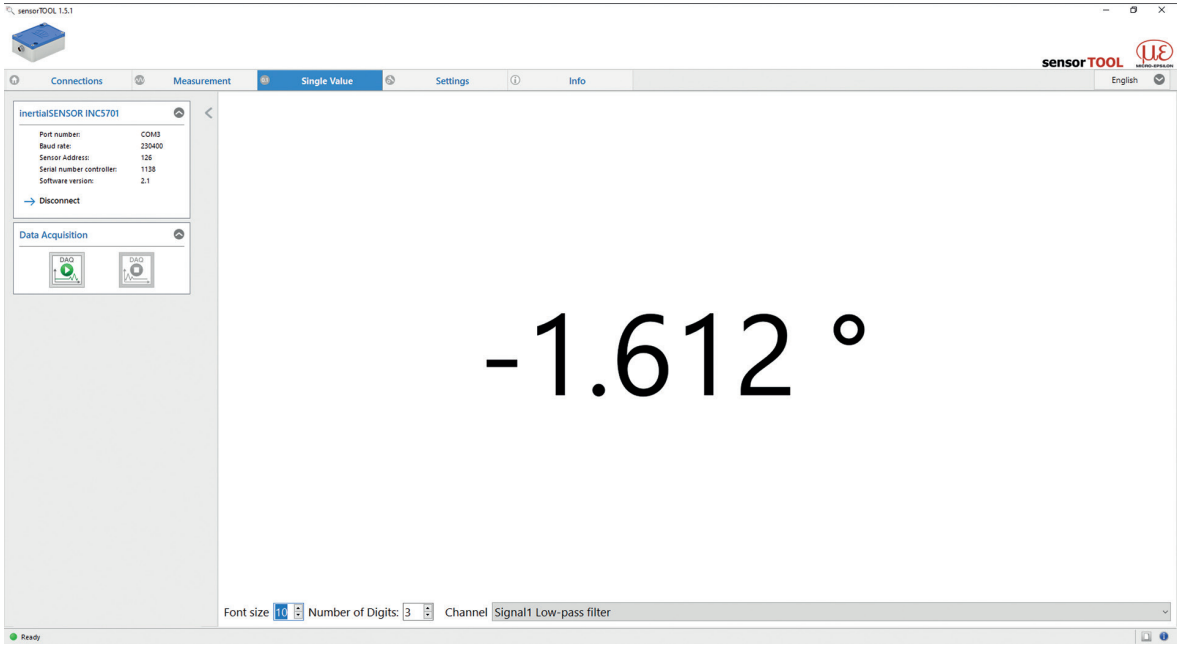


Fig. 23 Single value menu

Single value	Font	*1 ... 30*	-
	Number of digits	*0 ... 6*	-
	Channel	*Signal 1 Low-pass filter*	*Selection of the output to be displayed. The outputs are set before in the `Settings` menu under `Output`.*
		Signal 2 sensorFUSION [1]	
		State	-
		Counter	-

1) Only applies for INC5701D

A 3.4 Settings Menu

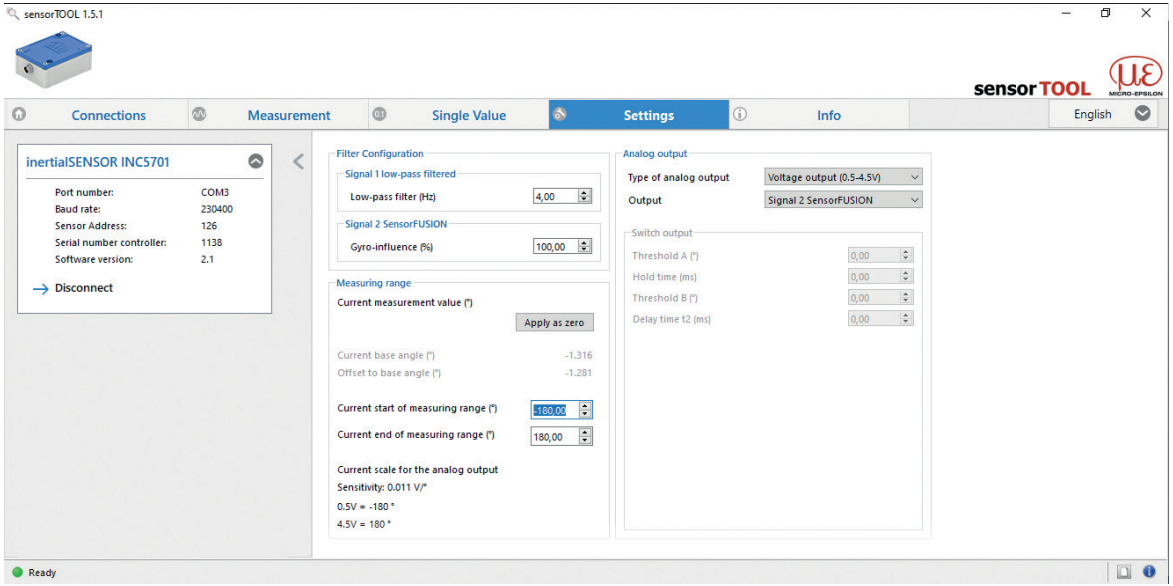


Fig. 24 View `Settings` menu

Filter Configuration	Signal 1 low-pass filtered Low-pass filter (Hz)	*0.30 ... 4.00*	*Select lowpass frequency between 0.3 and 4 Hz.*
	Signal 2 SensorFUSION Gyro-influence (%)	*0 ... 100*	*Choose the weighting of the gyro sensor between 0 and 100 %.*

Gray shaded fields require a selection.

Value Dark-bordered fields require you to specify a value

Measurement range	Current measurement value	Apply as zero	*Press, to set the current reading to zero.*
	Current start of measuring range	*-180 ° ... 0 °*	*Start of measuring range*
	Current end of measuring range	*-180 ° ... 180 °*	*End of measuring range*
	Current scale of the analog output	Sensitivity: 0.011 V/° ... 4 V/° 0.044 mA/° ...16 mA/°	*Scales the analog output range onto the desired measuring range*

➡ Click `Apply as zero` in order to set the current measurement value to zero.

Analog output	Type of analog output	*Output off*	
		Current output (4 ... 20 mA)	
		Voltage output (0.5 ... 4.5 V)	
		Switch output	
	Output	*Signal 1 Low-pass filtered*	*1) Only applies for INC5701D*
		Signal 2 SensorFUSION [1]	

Low-pass frequency

Small low-pass filter frequency (0.3 Hz)	- Smooth waveform - Large time delay of the measuring signal	Application: inclination measurement with noncritical reaction time, e. g. alignment of solar panels
High low-pass frequency (4 Hz)	- Fast measurement - Increased signal noise	Application: inclination measurement with critical response time, leveling of mobile cranes

Gray shaded fields require a selection.

Value Dark-bordered fields require you to specify a value

Switching output

Threshold A	0.00 ... 99.99	Adjustable threshold. Triggering of the active switching event when the threshold value is exceeded. No threshold exceeded (not active) ➪ low Threshold exceeded (active) high ➪ high
Hold time t1 (ms)	0.00 ... 99.99	Adjustable time for which the active switching event is at least held.
Threshold B	0.00 ... 99.99	Adjustable threshold. Ending the active switching event is at least held.
Delay time t2 (ms)	0.00 ... 99.99	Adjustable period for which the value has to be continuously below the threshold B for a switching event (active) is ended.

➪ Set the start of the measuring range between -180 ° and 0 ° and the end of the measuring range between -180 ° und 180 °.

The end of the measuring range cannot be set smaller than the start of the measuring range.

➪ Click `Apply as zero` in order to set the current measurement value to zero.

A 3.5 Info Menu

This window provides the current overview of the sensor/diagnostic information.

Using the various function buttons, you can also reset to factory settings here, save information and settings for the selected sensor to the clipboard and/or save settings to a `*.csv` file, and import settings from a `*.csv`– file.

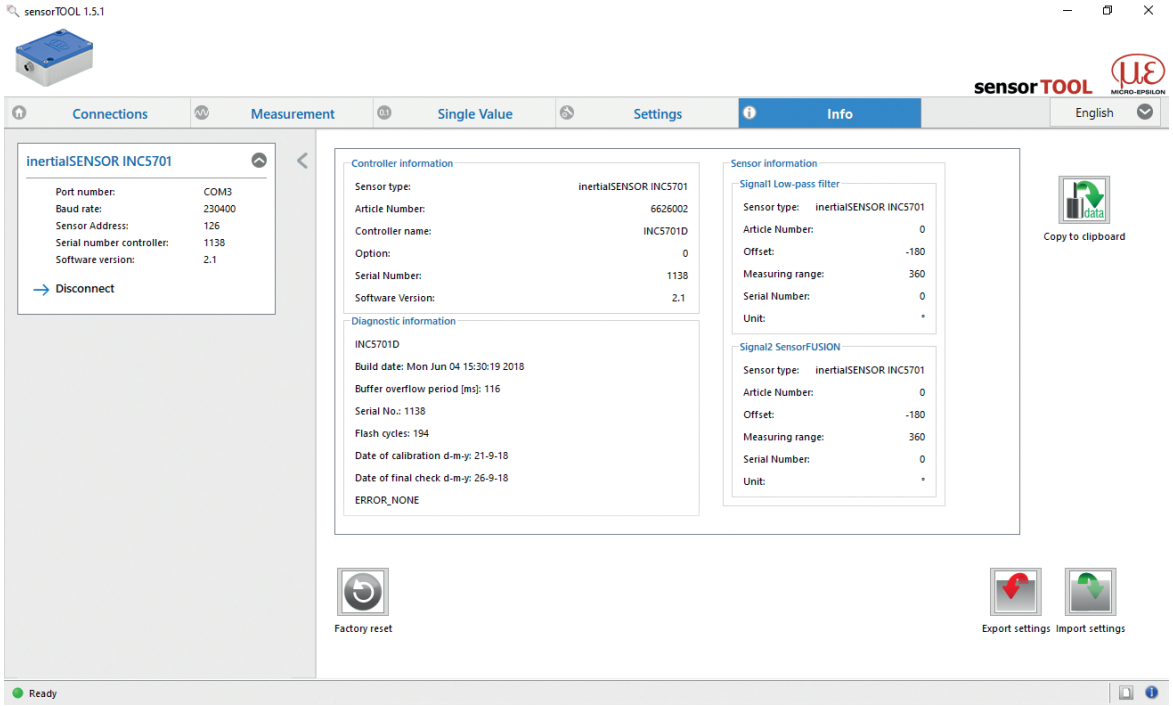


Fig. 25 Info menu view

A 4 Digital Interface RS485

A 4.1 Hardware Interface

The interface is a half-duplex RS485 interface, which means that one cable pair is jointly used for sending and receiving.

Baud rate	230400 b/s
Data format	1 start bit, 8 data bits, 1 parity bit even, 1 stop bit
Bus address	126

Fig. 26 Settings of the RS485 interface

A terminating resistance of 120 Ω is required between the A- and B-line of the RS485 interface at the beginning and the end of the RS485 bus. A terminating resistor of the RS485 line is not incorporated in the sensor. It is therefore allowed to connect several sensors to one bus cable.

A 4.2 Protocol

INC5701 acts as RS485 slave. As the system uses a half-duplex protocol, only the master can initiate communication. Each device at the RS485 bus requires its own address. The master sends an enquiry with the destination address to the bus and only the slave with this address answers accordingly. At any given moment, the digital output signal of INC5701D contains the output values of the low-pass filter and the SensorFUSION filter, independent of the filter configuration. The user can therefore directly compare both filter principles at any time. The configuration merely switches the analog output to the respective filter type.

A 4.2.1 Reading Measurement Data

Master: Request data						
Byte:	SD	DA	SA	FC	FCS	ED
Value:	0x10	x	x	0x4C	x	0x16
		FCS				

Slave: Response data										
Byte:	SD	LE	LE rep	SD rep	DA	SA	FC	Data[]	FCS	ED
Value:	0x68	x	x	0x68	x	x	0x08	x	x	0x16

Designations	
SD	Start Delimiter (0x10: datagram without data, 0x68: datagram with variable length)
LE	Length (number of bytes without SD, LE, LE rep, SD rep, FCS, ED)
LE rep	LE repeated
SD rep	SD repeated
DA	Destination Address (default 0x7E = 126)
SA	Source Address (e. g. 0x01)
FC	Function Code
FCS	Checksum (sum of all bytes without SD, LE, LE rep, SD rep, FCS, ED, overflow at 256)
ED	End Delimiter
Data[]	Measurement data, variable number, little endian

i A measured value is represented as 4-byte float data type in the unit angular degrees [°].

The measurement data consists of one status byte, one measured values counter, number of measured values, and the measured data. The measured values counter increases continuously with each sampled value. It represents the number of measured values buffered in the sensor since the last enquiry by the master and therefore represents the number of the measured values transmitted in this package (floats).

The internal sampling at 250 Hz generates a new measured value every 4 ms. The maximum number of measured values which can be held within the sensor is

- 58 for INC5701S and
- 29 for INC5701D (contains SensorFUSION and low-pass filter).

Therefore, an enquiry by the master must reach the sensor within
58 * 4 ms = 232 ms or 29 * 4 ms = 116 ms, respectively, in order to read the content from the internal memory and ensure uninterrupted sampling (periodic enquiry). If the enquiries are not made in time, error flag 0x01 is set in the status byte.

This error flag is deleted automatically as soon as the master resumes its periodic enquiries. The analog output remains unaffected by this. The first measurement value in the Data[] package is the oldest measured value.

Byte	Meaning	Data format
Data[0]	Status byte (contains error flags, normally 0x00)	8 bit
Data[1]	Long term values counter [bit 0:7]	Uint 32 bit
Data[2]	Long term values counter [bit 8:15]	
Data[3]	Long term values counter [bit 16:23]	
Data[4]	Long term values counter [bit 24:31]	
Data[5]	Number of measured values in this package	8 bit
Data[6]	Padding byte	8 bit
Data[7]	Padding byte	8 bit
Data[8]	Measured value 1 [bit 0:7]	Float 32 bit
Data[9]	Measured value 1 [bit 8:15]	
Data[10]	Measured value 1 [bit 16:23]	
Data[11]	Measured value 1 [bit 24:31]	
Data[12]	Measured value 2 [bit 0:7]	Float 32 bit
Data[13]	Measured value 2 [bit 8:15]	
Data[14]	Measured value 2 [bit 16:23]	
Data[15]	Measured value 2 [bit 24:31]	

Fig. 27 Encoding of Measured Data in the Transmission Protocol, INC5701S

Byte	Meaning	Data format
Data[0]	Status byte (contains error flags, normally 0x00)	8 bit
Data[1]	Long term values counter [bit 0:7]	Uint 32 bit
Data[2]	Long term values counter [bit 8:15]	
Data[3]	Long term values counter [bit 16:23]	
Data[4]	Long term values counter [bit 24:31]	
Data[5]	Number of measured values in this package	8 bit
Data[6]	Padding byte	8 bit
Data[7]	Padding byte	8 bit
Data[8]	Measured value 1 LP [1] [bit 0:7]	Float 32 bit
Data[9]	Measured value 1 LP [1] [bit 8:15]	
Data[10]	Measured value 1 LP [1] [bit 16:23]	
Data[11]	Measured value 1 LP [1] [bit 24:31]	
Data[12]	Measured value 2 LP [1] [bit 0:7]	Float 32 bit
Data[13]	Measured value 2 LP [1] [bit 8:15]	
Data[14]	Measured value 2 LP [1] [bit 16:23]	
Data[15]	Measured value 2 LP [1] [bit 24:31]	
...	...	...
Data[n] =8+(4*Data [5])	Measured value 1 SF [2] [bit 0:7]	Float 32 bit
Data[n + 1]	Measured value 1 SF [2] [bit 8:15]	
Data[n + 2]	Measured value 1 SF [2] [bit 16:23]	
Data[n + 3]	Measured value 1 SF [2] [bit 24:31]	
Data[n + 4]	Measured value 2 SF [2] [bit 24:31]	Float 32 bit
Data[n + 5]	Measured value 2 SF [2] [bit 24:31]	
...	...	

Fig. 28 Encoding of Measured Data in the Transmission Protocol, INC5701D

1) LP = Low pass filter 2) SF = SensorFUSION Filter

A 4.2.2 Example Transmission of a Measurement Value

Master: Request data						
Byte:	SD	DA	SA	FC	FCS	ED
Value:	0x10	0x7E	0x01	0x4C	0xCB	0x16
		FCS				

DA = Destination Address = 0x7E = 126 (Slave)

SA = Source Address = 0x01 (Master)

FCS = Checksum = 0x7E + 0x01 + 0x4C = 0xCB

= 126 + 1 + 76 = 203 (no overflow)

Slave: Response data										
Byte:	SD	LE	LE rep	SD rep	DA	SA	FC	Data[]	FCS	ED
Value:	0x68	1B	1B	0x68	0x01	0x7E	0x08	x	0x67	0x16
					FCS					

4 measured values = 4 x float = 4 x 4 bytes = 16 data bytes

LE = Length = 16 data bytes + 11 bytes (DA, SA, FC, 1xstatus, 4xstatus, 4xcounter, 1xnumber, 2xpadding byte) = 0x1B =27

DA = Destination Address = 0x01 (Master)

SA = Source Address = 0x7E = 126 (Slave)

FCS = Checksum = 0x01 + 0x7E + 0x08 + 0x00 (status) + 0x04 (counter) ... = 0x67 (note overflow at 256 each time = reset sum to zero)

MICRO-EPSILON Eltrotec GmbH
Manfred-Wörner-Straße 101 · 73037 Göppingen / Germany
Tel. +49 (0) 7161 / 98872-300 · Fax +49 (0) 7161 / 98872-303
eltrotec@micro-epsilon.com · www.micro-epsilon.com
Your local contact: www.micro-epsilon.com/contact/worldwide/

X9751391-A032123HDR