

More Precision

inertialSENSOR // Inclination and acceleration sensors



Inclination and acceleration sensors inertialSENSOR

Multi-axis inclination and acceleration measurements

High static and dynamic accuracies

Precise measurements even with sudden movements, shocks and vibrations

Stable measurement signal even with temperature fluctuations

Various analog and digital interfaces



Precise inclination measurement

Industrial inclination measurement is a demanding measurement task in which the angle of inclination of an object relative to the earth's gravity is measured in one or two axes. Sensors from Micro-Epsilon are extremely precise and at the same time extremely robust against interference and fluctuating temperatures. Due to their outstanding angular accuracy and resolution, the inclination sensors can be used in a wide range of measurement tasks in both industry and the laboratory.

Precise acceleration and oscillation measurements

Acceleration measurements are required where technical systems are exposed to stresses either caused by their own movement or by external impacts. Ideally suited to monitoring tasks or predictive system maintenance, the sensor reliably and precisely monitors the acceleration values of sensitive plant components. Standard models are available for all industrial and laboratory applications (ACC570x) and OEM systems for serial integration (ACC530x).





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Typical applications and measured values inertialSENSOR

Micro-Epsilon offers an extensive portfolio of inclination and acceleration sensors. These compact sensors are often used in challenging environments (outdoor areas or integrated in a machine) and are therefore highly resistant to external influences of any kind. They measure angles and acceleration values reliably and precisely, e.g. of entire (mobile) machines or sensitive plant components.

Inertial sensors are particularly suitable for monitoring tasks or for predictive system maintenance.

Depending on the respective measurement task, inclination and acceleration measurements have different requirements. To give you a rough overview and enable you to preselect the right sensor, the most common types of application and measured variables are listed below, along with the appropriate sensor series:

For inclination measurements



1) High precision inclination measurement (1 axis)

For inclination measurements in only one axis, the focus is usually on very high resolution and accuracy. Changes in the angle or position of the object generally occur with little dynamism. INC5701D sensors are ideal for such applications.



2) Dynamically compensated inclination measurement (1/2 axes)

The measurement of dynamic movements focuses on fast angular output. Typical disturbing influences such as centrifugal forces, vibrations or impacts on the sensor must often be optimally compensated for or reduced. The INC5502D has been developed for exactly this purpose.



3) 1-axis or 2-axis static inclination measurement

If the position of a quasi-static object is to be monitored in one or two axes (also in parallel), the INC5502D is used. In this case, the dynamic compensation moves into the background and the signal is filtered using a low-pass filter.

For acceleration measurements



1) Acceleration

Acceleration values are usually measured in one axis and are used to monitor machines or machine parts, e.g. the approach speed of a press ram. An ACC5701 with analog output, for example, is suitable for this purpose.



2) Oscillation

For example, the amplitude and frequency of the lateral vibrations caused by the lateral movements of a wind turbine are detected.

A 2-axis acceleration sensor such as the ACC5702 is often used.



3) Vibration

Measurements of vibrations or oscillations are performed in different axes, intended to detect imbalances, bearing damage or other mechanical issues. The ACC5703 model with digital output is ideally suited for these measurement tasks.

Features inertialSENSOR

Interference compensation

Selection of various types of filters and compensation

Centrifugal force compensation



Examples Swinging an excavator arm Heavy braking on vehicles

Shock compensation



Examples Stone impacts on excavators, setbacks on milling machines

Vibration suppression



Reference curve Uncompensated Low-pass filter sensorFUSION technology

Examples

Compactors on inclines, engine vibration in mobile machinery

Maximum integration flexibility

Various installation positions with regard to measuring axis, measuring range and mounting direction



Extremely wide field of use due to extraordinary robustness

Excellent signal stability:Robust and long-life designsExtremely robust against fluctuating
temperatures ...Image: Competitive of the second stability of the second s

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Dynamic inclination measurement in mobile machines inertial **SENSOR**



The INC5502D precisely measures the inclination position of the bucket and compensates for impact and centrifugal forces that occur during excavation. In addition, a large measuring range of $+\text{-}180^\circ$ / 360° is required, as the bucket can be opened and closed completely.

The INC5502D is used to level the driver's cab in order to detect uneven surfaces during the drive, standstill and operation. The sensor is insensitive to disturbing accelerations such as vibrations, shocks or movements during braking and cornering, i.e. the output signal is not distorted.



Reduced risk of tipping with loading wagons



Alignment of solar and photovoltaic panels

Acceleration measurement in wind turbines inertialSENSOR



Oscillation measurement of the drive train

Wind turbulence causes dynamic loads on the structure and the drive train. To measure these oscillations, high-precision and temperature-stable acceleration sensors from Micro-Epsilon are used.





Monitoring the tower oscillation

Wind turbines are exposed to high stress caused by swaying. In order to avoid damage and downtimes, these tower oscillations are monitored. Inclination and acceleration sensors from Micro-Epsilon detect the tower oscillation with highest precision even with strongly fluctuating temperatures.



Stone chipping with harvesters



Monitoring of floor vibrations

Dynamic and precise inclination sensor inertialSENSOR INC5502D

1-axis or 2-axis inclination measurement

High precision for dynamic measurement tasks up to $\pm 0.3^\circ$

Angle measurement with disturbance compensation

Compact and robust plastic housing (IP67/IP69K)

Maximum signal stability thanks to application-specific parameter sets

Compact & robust - ideal for machine integration

Industrial-grade interfaces for mobile machines

CANOPOR

SAE J1939

Precise inclination measurement in highly dynamic applications The robust INC5502D inclination sensors are used for precise measurement of angles, alignment of machine parts and position detection of moving components. Thanks to the intelligent sensorFUSION algorithm, the measurement signal remains stable and free of overshoots even during sudden movements, e.g. due to shocks or start-up and braking processes. The high signal quality and a very short response time enable extremely accurate measurements during motion.

Depending on the measurement task, different types of angles (Euler or position angle) can be detected and output simultaneously in one or two axes. Other parameters such as accelerations or rotational speeds can also be displayed and output.

Combination with sensorTOOL software

For a quick functional test and to check the measured values, the INC5502D can also be connected to the sensorTOOL software. The sensorTOOL enables you to adjust parameters and to display the measured values immediately.

Compact design, great performance

A slim design and individual alignment options reduce installation effort and facilitate mounting on moving machinery and vehicles (construction machinery, agricultural machinery, forestry machinery), cranes and lifting platforms or ships. Integrated analog and digital interfaces allow direct output of measured values as well as easy setting of sensor parameters.

Solution of special measurement tasks using customized parameter sets

Suitable, application-specific parameter sets for standard applications can be provided on request. These can be easily transferred to the sensor via the sensorTOOL software and optimize the sensor's measurement settings. As a result, the sensor immediately provides very accurate measurement values.

The presets are based on typical parameter combinations that have proven themselves in the specific application.

Model		INC5502D CO/J1939	INC5502D I	INC5502D U		
Number of measuring axes		1 or 2				
Euler angle		longitudinal (roll): $\pm 180^{\circ}$ (switchable to $0^{\circ} \dots 360^{\circ}$) lateral (pitch): $\pm 85^{\circ}$ (switchable to $95^{\circ} \dots 265^{\circ}$) (sign reversible, axis orientation selectable)				
	Position angle	Tilt x and Tilt y: $\pm 90^{\circ}$ (sign reversible, axis orientation selectable)				
Resolution		0.01°				
Repeatability		$\leq \pm 0.05^{\circ}$				
System accuracy [1]		static: $\pm 0.15^{\circ}$ (measuring range $\leq \pm 30^{\circ}$) and $\pm 0.25^{\circ}$ (measuring range $> \pm 30^{\circ}$) dynamic: up to $\pm 0.3^{\circ}$ (typ. $\pm 0.5^{\circ}$)	static: ±0.2° (meas and ±0.25° (meas dynamic: up to :	uring range $\leq \pm 30^{\circ}$) uring range $> \pm 30^{\circ}$) $\pm 0.3^{\circ}$ (typ. $\pm 0.5^{\circ}$)		
Measuring rate			200 Hz			
Temperature stability [2]			±0.008°/ K			
Supply voltage			9 32 VDC			
Max. current consumption		110 mA (12 VDC)	50 mA (24 VDC)			
Digital interface [3]		CANopen, SAE J1939	RS485, Ethernet, EtherCAT, PROFINET, EtherNet/IP			
Analog output		-	420 mA (max. 300 Ω)	010 V / 0.54.5 V (min. 3 kΩ)		
Connection [4]		1 or 2x 5-pin M12 plug connectors (plug socket, daisy-chained) 1 x 8-pin M12 plug connector				
Mounting		Mounting holes Ø 4 mm				
Temperature range	Storage	-40 +85 °C				
lemperature range	Operation	-40 +85 °C				
Shock (DIN EN 60068-2-27)		1:	500g / 0.5 ms in 3 axes (half-sine)			
Protection class (DIN EN 60529	9)		IP67 / IP69K (plugged)			
Material		Glass fiber re	einforced polyamide (housing) PUR (p	otting)		
Weight		approx. 120 g				
Control and indicator elements		bicolor LED for status				
Special features		adjustable filters: sensorFUSION, low-pass filter. On request, predefined, application-specific config files can be provided. We can also set up individual parameter sets for series applications. Output of further measurement parameters (raw values): acceleration x, y, z axes, measuring range ±2 g; angular velocity x, y, z, axes, measuring range ±500°/s				

^[1] All specifications are typical for 25 °C, unless otherwise stated
^[2] Typically in the temperature range -40...+85 °C
^[3] Ethernet, EtherCAT, PROFINET and EtherNet/IP require connection via interface module
^[4] Further connection options on request (e.g. integrated cable, Deutsch plug)

	INC5502D	-360/90	-P	-S	-CO		
					Interface: CO = CANOpen J1939 = SAE J1939 I = RS485, 420 mA, U = RS485, 010 V and 0.54.5 V		
				Connection: $S = 1 \times M12$			
				$OS = 2 \times M12$ one-sided			
				$DS = 2 \times M12$ two-sided			
Housing: P = glass fiber reinforced plastic					glass fiber reinforced plastic		
		Measuri	suring range: Euler angle / position angle				
	Series						

High-precision inclination sensor inertialSENSOR INC5701D

Highest accuracy and resolution for precise measurements

Extremely stable measurement signal even with strongly fluctuating temperatures

High EMC resistance due to robust, die-cast aluminum housing

Digital RS485 interface and freely scalable analog outputs

Ideal for high-precision inclination measurement

The INC5701D is a 1-axis inclination sensor that offers a measuring range up to 360°. The sensor stands out due to its excellent angular accuracy and resolution intended for very accurate and precise measurements. The industrial-grade aluminum die-cast housing enables applications in extremely harsh ambient conditions such as, e.g., in close proximity to electromagnetic fields. In addition, high temperature stability ensures reliable measurements in environments with strongly fluctuating temperatures which makes the sensor ideally suited to outdoor applications.

Fields of application

Excellent angular accuracy and resolution make the inclination sensors ideal for precise measurements in laboratory and industry. In production monitoring, for example, machine components are precisely aligned using the INC5701.

Easy commissioning and configuration

The free sensorTOOL configuration software supports quick and easy commissioning of the inclination sensor. The sensorTOOL enables you to adjust parameters and to display the measured values.

In addition to outputs and filtering, the measuring range can also be infinitely adjusted between 0 and 360°, for example, so that the system sensitivity can be optimally adapted to the respective measurement task.

Model		INC5701D
Number of measuring axes		1
Measuring range [1]		0° 360°
Desclution	Digital	0.001°
Resolution	Analog	Current: 0.0069°, voltage: 0.0083°
Sustam acouracy [2]	Digital	$\leq \pm 0.04^{\circ}$
System accuracy es	Analog	$\leq \pm 0.12^{\circ}$
Sensitivity [1] [3]		\leq 16 mA/° or \leq 4 V/°
Measuring rate		250 Hz
Temperature atability	Digital	0.0013°/ K
Temperature stability	Analog	0.0083°/ K
Supply voltage		5 32 VDC
Power consumption		< 1 W
Digital interface [4]		RS485 / Ethernet / PROFINET / EtherCAT / EtherNet/IP
Analog output		configurable: 4 20 mA (max. 390 $\Omega)$ and 0.5 4.5 V (min. 1 k $\Omega)$
Switching output		0/5 V (min. 1 kΩ)
Connection		1 x 8-pin M12 plug connector
Mounting		Screw connection via mounting holes (M4)
Tomporaturo rango	Storage	-40 +85 °C
lemperature range	Operation	-40 +85 °C
Shock (DIN EN 60068-2-27)		1500g / 0.5 ms in 3 axes (half-sine)
Protection class (DIN EN 60529)		IP67 (plugged)
Material		Aluminum die-cast
Weight		approx. 250 g

[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] All specifications are typical for +25 °C, unless otherwise stated. In relation to the full measuring range of 360° without tilting the sensor
[3] Sensitivity at the analog output
[4] Ethernet, EtherCAT, PROFINET and EtherNet/IP require connection via interface module

INC570	1	D	-360	-SA	-U/I	
					Output: U/I = R and 0.5	S485, 4 20 mA 4.5 V
				Connec	tion: SA =	= Connector axial
			Measuring range in °			
	Model D = Dynamic (SensorFUSION)					
Number of axes						
High-pre	High-precision inclination sensor					

High-precision acceleration sensor inertialSENSOR ACC570x

High accuracy and resolution for precise measurements

Extremely stable measurement signal even with strongly fluctuating temperatures

High interference immunity with increased EMC requirements

Ideal for integration into plant and machinery

Digital RS485 interface and freely scalable analog outputs

Ideal for integration into plant and machinery

The analog ACC570x acceleration sensors are therefore ideal for static

and dynamic acceleration measurements. They detect accelerations

in one, two or three axes. These sensors are often used in applications

The entire electronics is in a sealed aluminum die-cast housing and

designed for ambient temperatures up to 125 °C. The high temperature

stability enables the sensor to achieve high measurement accuracy

even when surrounded by strongly fluctuating ambient temperatures.

The housing offers excellent interference immunity for increased EMC

requiring maximum precision in harsh ambient conditions.

requirements in close proximity to electromagnetic fields.

Fields of application

The high signal-to-noise ratio enables the analog ACC570x sensors to measure even minor accelerations which occur, e.g., with tower oscillations of wind turbines, bearings and also measuring/calibration systems.

Its high EMC resistance makes the sensor ideally suitable for precise condition monitoring of electrical machines such as, e.g., generators. Combined with high temperature stability, the sensor is used in wind turbines to monitor the oscillations and vibrations of drive trains, rotor blades (ice detection) and generators (noise reduction).

Model		ACC570x I ACC5703 U/I			
Number of measuring axes		1, 2 or 3	3		
Measuring range		± 1 g / ± 2 g / ± 4 g / ± 8 g	$\pm 0.1g$ $\pm 8g$ (freely selectable) $^{\scriptscriptstyle [1]}$		
Resolution		20 µg/√Hz	25 µg/√Hz		
Sensitivity		8 mA/g (±1g) / 4 mA/g (±2g) / 2 mA/g (±4g) / 1 mA/g (±8g)	\leq 80 mA/g or \leq 20 V/g $^{[1]}$		
Linearity [2]		0.15%	5 FSO		
Frequency range		0 10	000 Hz		
Measuring rate		-	\leq 4 kHz ^[3]		
Cross axis sensitivity		1 %	FSO		
T	Zero	±30 ppm / °C			
iemperature stability (*)	Sensitivity	±30 ppm / °C			
Supply voltage		12 32 VDC	5 32 VDC		
Power consumption		1 W	1.5 W		
Digital interface [5]		-	RS485, Ethernet, PROFINET, EtherCAT, EtherNet/IP		
Analog output		4 20 mA (max. 500 Ω)	4 20 mA (max. 390 $\Omega);0.5$ 4.5 V (min. 1 k $\Omega)$ (16 bit, freely scalable within the measuring range)		
Switching output		-	max. three outputs: 0/5 V (min. 1 k $\Omega)$		
Connection [6]		1 x 5-pin M12 plug connector	1 x 8-pin M12 plug connector		
Mounting		Screw connection via mounting holes (M4)			
T	Storage	-40 +85 °C [7]			
lemperature range	Operation	-40 +85 °C [^{7]}			
Shock (DIN EN 60068-2-27)		1500g / 0.5 ms in 3 axes (half-sine)			
Protection class (DIN EN 60529)		IP67 (plugged, optional IP68)			
Material		Aluminum die-cast			
Weight		approx. 250 g			

^[1]To achieve maximum sensitivity, the measuring range can be infinitely adjusted (examples: measuring range ±0.1 g sensitivity 80 mA/g or 20 V/g; measuring range ±8 g sensitivity 1 mA/g or 0.25 V/g)

^[2]FSO = Full Scale Output

¹³ The digital interface RS485 is only active up to a sampling rate of 1000 Hz. At higher rates only the analog output is active. The sampling rate and response time depend on the low-pass filter setting.

 $^{[4]}$ Typically in the temperature range -40...+85 $^\circ\mathrm{C}$

^[5] Ethernet, EtherCAT, PROFINET and EtherNet/IP require connection via interface module

^[6] Further connection options on request (e.g. integrated cable, Deutsch plug)

 $^{[7]}\ensuremath{\mathsf{Optionally}}\xspace$ up to 125 °C (customer-specific versions with high-temperature cable)



Acceleration sensor for serial integration & OEM inertialSENSOR ACC530x

Customer-specific designs

Space-saving and robust plastic housing

Easy connection with AMP plug

High shock resistance



The ACC530x acceleration sensor is suitable for both static and dynamic acceleration measurements. The sensor detects accelerations in either one or two axes.

Combined with a compact design, its excellent price/performance ratio enables versatile fields of application in particular with serial applications involving large quantities.

Fields of application

The sensor is used to reliably detect accelerations and vibrations. High shock resistance and high protection class as well as simple and easy installation with an AMP plug make the ACC530x ideally suitable for serial applications, e.g., in mobile machines.

Model		ACC5301-2 ACC5302-2		
Number of measuring axes		1 2		
Measuring range [1]		±2g		
Resolution		100 <i>µ</i> g/√Hz		
Sensitivity		4 mA/g or 1 V/g		
Linearity [2]		< ±1.25 % FSO		
Frequency range [1]		0 100 Hz (-3dB)		
Tomporaturo stability [3]	Zero	±200 p	pm / °C	
Temperature stability (*)	Sensitivity	±40 ppm / °C		
Supply voltage		10.8 30 VDC		
Power consumption		< 1 W		
Analog output		420 mA (max. 300 $\Omega)$ or 0.5 4.5 V (min. 1 k $\Omega)$		
Connection		AMP Superseal 1.5 connector		
Mounting		Screw connection via mounting holes (M4)		
Temperature repai	Storage	-40 +85 °C		
lemperature range	Operation	-40 +85 °C		
Shock (DIN EN 60068-2-27)		1000g / 0.5 ms in 3 axes (half sine)		
Protection class (DIN EN 60529)		IP67 (plugged)		
Material		(glass fiber-reinforced) polyamide		
Weight		approx	<. 40 g	
⁽¹⁾ Customer-specific designs ⁽²⁾ FSO = Full Scale Output				

^[3] Typically in the temperature range -40...+85 °C



Drawings inertial **SENSOR**

INC5502D-360/90-P-OS



INC5502D-360/90-P-DS



INC5502D-360/90-P-S

ACC530x







INC5701D / ACC570x



Pin assignment inertial SENSOR

Pin assignment INC5502 digital

Pin	Assignment	Signal
1	Shield	CAN_SHLD
2	Supply voltage (9 32 VDC)	V+
3	GND / 0 V / V-	V-
4	CAN_H bus cable	CAN_H
5	CAN_L bus cable	CAN_L





Pin assignment INC5502D analog

Pin	Assignment	Signal
1	X-axis inclination	4 20 mA/0.5 4.5 V/0 10 V
2	GND signal	
3	Y-axis inclination	4 20 mA/0.5 4.5 V/0 10 V
4	RS485 bus line	RS485+
5	Teach-In	9 32 VDC, \geq 300 ms (IN)
6	GND / 0 V / V	V_
7	RS485 bus line	RS485-
8	Supply voltage 9 32 VDC	V ₊



pin M12 housing connector ew on pin side, A-coded

Pin assignment INC5701D und ACC5703 U/I

		INC5701D	ACC5703-8-SA-U/I
Pin	Cable color: PCx/8-M12)	Assignment	Assignment
1	White	U (angle)	Output channel 2
2	Brown	GND (current)	GND (Output)
3	Green	I (angle)	Output channel 3
4	Yellow	RS485+	RS485+
5	Gray	GND (voltage)	Output channel 1
6	Black/pink	GND (supply)	GND (supply)
7	Blue	RS485-	RS485-
8	Red	Supply +	Supply +



View connector side

Pin assignment ACC570xI

		ACC5701	ACC5702	ACC5703
Pin	Cable color: PCx/5-M12	Assignment	Assignment	Assignment
1	Brown	12 32 VDC	12 32 VDC	12 32 VDC
2	White	GND	GND	GND
3	Blue	X out	X out	X out
4	Black	n.c.	Y out	Y out
5	Gray	n.c.	n.c.	Z out



View connector side

Pin assignment ACC530x

		ACC5301	ACC5302
Pin	PCx/4-AMP	Assignment	Assignment
1	1	n.c.	Y
2	2	X-á	axis
3	3	G	ND
4	4	V	сс



Accessories and software inertial **SENSOR**

Accessories/cables INC5502D CANopen/SAE J1939

Art. no.	Model	Description
6965007	PC1/5	Parameterization cable for access to the sensorTOOL, 1 m long
29011154	PC5/5-M12 IWT	Supply/output cable, 5 m long

Accessories/cables INC5502D U/I, INC5701D and ACC5703 U/I

Art. no.	Model	Description
6965009	PC1/8	Parameterization cable for access to the sensorTOOL, 1 m long
29011159	PC3/8-M12	Supply/output cable, 3 m long
29011141	PC5/8-M12	Supply/output cable, 5 m long
29011285	PC10/8-M12	Supply/output cable, 10 m long
29011059	PC15/8-M12	Supply/output cable, drag-chain suitable, 15 m long

Accessories/cables ACC570x I

Art. no.	Model	Description
29011154	PC5/5-M12 IWT	Supply/output cable, 5 m long
29011116	PC10/5-M12	Supply/output cable, 10 m long
29011178	PC20/5-M12	Supply and signal cable, 20 m lang
6965005	PC40/5-M12	Supply/output cable, 40 m long
6965006	PC80/5-M12	Supply and signal cable, 80 m long

Accessories/cables ACC530x

Description

Art. no.	Model	Description
6965001	PC4/4-AMP	Supply/output cable, 4 m long
6965002	PC10/4-AMP	Supply/output cable, 10 m long

Free configuration software

The configuration software from Micro-Epsilon offers simple commissioning of the sensors using a digital RS485 interface. The software enables access to many parameter set up and sensor configurations, e.g., measuring ranges and output parameters.

The software is available as a free download at www.micro-epsilon.com/service/download.









Sensors and Systems from Micro-Epsilon



Sensors and systems for displacement, distance and position



Optical micrometers and fiber optics, measuring and test amplifiers



Sensors and measurement devices for non-contact temperature measurement



Color recognition sensors, LED analyzers and inline color spectrometers



Measuring and inspection systems for metal strips, plastics and rubber



3D measurement technology for dimensional testing and surface inspection



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