OPERATING INSTRUCTIONS

TMS/TMM88, TMS/TMM55

Inclination sensors with current / voltage interface

Sensor Intelligence.

Described product

1- and 2-dimensional inclination sensors:

TMS88A

TMM88A

TMS88B

TMM88B

TMM55E

Manufacturer

SICK AG
Erwin-Sick-Str. 1
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Germany

Legal information

Original document

This document is an original document of SICK AG.

Contents

1 About this document

1.1 Function of this document

These operating instructions are intended to give technical personnel working for the machine manufacturer or machine operator instructions on the mounting, electrical installation, commissioning, and operation of the TMM55, TMS88 and TMM88 inclination sensors.

These operating instructions do not provide information on operating the machine in which an inclination sensor is integrated. For information about this, refer to the operating instructions of the particular machine.

1.2 Explanation of symbols

Warnings in these operating instructions are labeled with symbols. The warnings are introduced by signal words that indicate the extent of the danger. These warnings must be observed at all times and care must be taken to avoid accidents, personal injury, and material damage.

DANGER
... indicates a situation of imminent danger, which will lead to a fatality or serious injuries if not prevented.

WARNING
... indicates a potentially dangerous situation, which may lead to a fatality or serious injuries if not prevented.

CAUTION
... indicates a potentially dangerous situation, which may lead to minor/slight injuries if not prevented.

NOTICE
... indicates a potentially harmful situation, which may lead to material damage if not prevented.

NOTE
... highlights useful tips and recommendations as well as information for efficient and trouble-free operation.

2 Safety information

2.1 Intended use

The TMS/TMM inclination sensors are measuring devices consisting of an electronic sensor and integrated evaluation electronics. The tasks for which the measuring device is designed include recording inclinations in solar thermal energy, photovoltaics or heavy-duty vehicle applications.

SICK AG assumes no liability for losses or damage arising from the use of the product, either directly or indirectly. This applies in particular to use of the product that does not conform to its intended purpose and is not described in this documentation.

2.2 Incorrect use

The inclination sensors do not constitute safety components according to the EC Machinery Directive (2006/42/EC). The inclination sensors must not be used in explosion-hazardous areas. Any other use that is not described as intended use is prohibited. Any use of accessories not specifically approved by SICK AG is at your own risk.

WARNING
Danger due to improper use!

Any incorrect use can result in dangerous situations.

Therefore, take note of the following information:

- Use only in accordance with the intended use.
- All information in these operating instructions must be strictly complied with.

2.3 Requirements for the qualification of personnel

The personnel who work on and with the device must be suitably authorized, trained, and sufficiently qualified. Skilled personnel refers to the following:

- A member of staff who has received specialist training, which is backed up by additional knowledge and experience.
- A member of staff who knows the relevant technical terms and regulations.
- A member of staff who can appraise the work assigned to them, recognize potential hazards, and take suitable safety precautions.

Table 1: Skilled personnel qualifications

Task	Qualification
Mounting	• Technical training • Knowledge of current workplace safety regulations
Electrical installation	• Electrotechnical training • Knowledge of the current electrotechnical workplace safety regulations • Knowledge of the operation and control of the sensor in the particular application
Commissioning, configuration, and operation	• Technical training • Knowledge of the operation and control of the sensor in the particular application

3 Overview

Properties of TMS/TMM88

- Inclination sensors with measuring range: 360°/ ±90° (X/Y)
- High accuracy up to 0.02°
- Compensated cross sensitivity
- Configurable vibration suppression
- Freely configurable current / voltage interface (via PGT-12-Pro)
- Functions:
  - Teach input for zero-point setting when installed
  - Limiting of final value
  - Counting direction and axis assignment of outputs can be configured
  - Digital filter (critically damped (default) or Butterworth low pass, 8th order)
- Suitable for industrial use:
  - Temperature range: -40 °C to +80 °C
  - Enclosure rating: IP65/67

TMS88 1-dimensional inclination sensors are used to measure inclinations in the 360° range. TMM88 2-dimensional inclination sensors are used to measure inclinations in 2 ranges (X/Y) of ±90°. To ensure high levels of accuracy, the sensors are calibrated at the factory.

A compact and rugged design makes the sensors an ideal solution for measuring angles in harsh environments. They are compatible for use in all manner of applications in industry and automotive engineering.

Properties of TMM55E

- Inclination sensors with measuring range: ±10° / ±45° / ±60° (X/Y)
- Sinusoidal output, high accuracy
- Fixed set current / voltage interface
- Rugged impact-resistant small plastic housing
- Suitable for industrial use:
  - Temperature range: -40 °C to +80 °C
  - Enclosure rating: IP65/67

TMM55 2-dimensional inclination sensors are used to measure inclinations in 2 ranges (X/Y) of ±10°, ±45°, and ±60°. To ensure high levels of accuracy, the sensors are calibrated at the factory.

A compact and rugged design makes the sensor an ideal solution for measuring angles in harsh environments. It is compatible for use in all manner of applications in industry and automotive engineering.

Areas of application

- Agricultural and forestry machinery
- Construction machinery and special-purpose vehicles
- Solar thermal energy and photovoltaics
- Automated guided systems
- Crane and lifting technology

4 Technical data

Note

NOTE
This chapter contains an extract of the technical data. For full details, see the TMM55, TMS/TMM88 (8019180) and TMS/TMM88 Dynamic (8023359) product information

4.1 Technical data for TMS88A-PKC360 + TMM88A-PKC090

Table 2: Technical data for TMx88A-PKCxxx

General parameters[1]	**TMS88A-PKC360**			**TMM88A-PKC090**		
Number of measuring axes	1			2		
Measuring range	360°			±90°		
Resolution	0.01°			0.01°		
Accuracy	Range 0...360°	Typical ±0.04°	Maximum ±0.12°	Range up to ±60° up to ±70° up to ±80° up to ±85°	Typical ±0.02° ±0.04° ±0.08° ±0.16°	Maximum ±0.06° ±0.12° ±0.24° ±0.48°
Cross sensitivity (compensated)	-			Typ. ±0.09° (±0.10%FS) Max. ±0.45° (±0.50%FS)		
Temperature coefficient (zero point)	Typ. +0.0088 °/K, -0.0102 °/K					
Sampling rate	100 Hz					
Limit frequency	Typ. 20 Hz, 2nd order (no digital filter) / 0.1 ... 25 Hz, 8th order (with digital filter)					
Operating temperature	-40 °C to +80 °C					
Properties						
Current interface	Freely configurable output in the range 0...20.48 mA (factory setting: 4...20 mA) Freely configurable angle range 0...360° / ±90°					
Functions	Teach input for zero-point setting when installed Limitation of final value, counting direction, and axis assignment of outputs can be configured Digital filter (critically damped (default) or Butterworth low pass, 8th order)					
Electrical parameters						
Supply voltage	17 ... 35 VDC					
Current consumption	40 mA @ 24 V + I_{loop}					
Outputs (short-circuit protected)	Inductive load less than 1 H, load dependent on input voltage (see "Load resistances", page 24)					
Mechanical parameters						
Connection	5-pin M12 sensor plug connector (male connector)					
Enclosure rating	IP65/67					

General parameters[1]	TMS88A-PKC360	TMM88A-PKC090
Dimensions / Weight	Plastic housing: 66 mm x 90 mm x 36 mm / approx. 200 g	

1 All specified angular accuracies apply after a run-in time of 10 min at 25 °C, limit frequency 0.3 Hz, absolute calibration accuracy (at 25 °C): ±0.05°

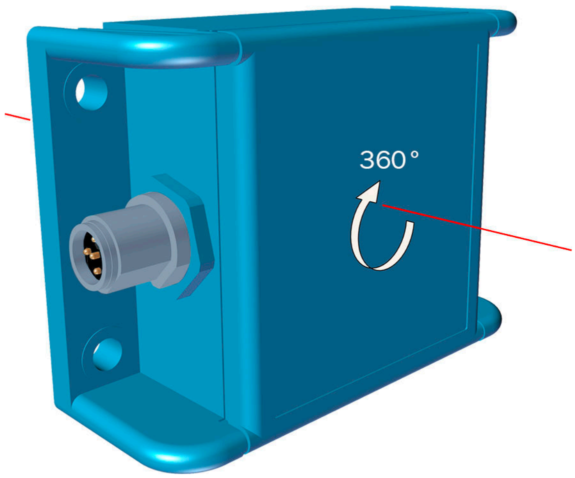

Figure 1: TMS88A measuring axis (large plastic housing)

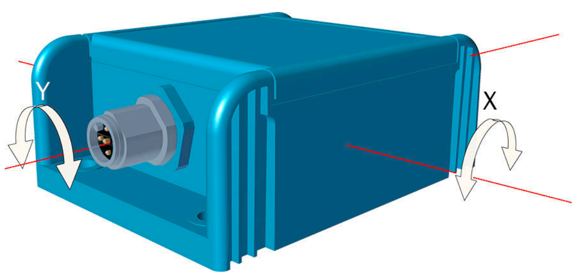

Figure 2: TMS88A measuring axes (large plastic housing)

4.2 Technical data for TMS88A-PLC360 + TMM88A-PLC090

Table 3: Technical data for TMx88A-PLCxxx

General parameters[1]	TMS88A-PLC360			TMM88A-PLC090		
Number of measuring axes	1			2		
Measuring range	360°			±90°		
Resolution	0.01°			0.01°		
Accuracy	Range 0...360°	Typical ±0.04°	Maximum ±0.12°	Range up to ±60° up to ±70° up to ±80° up to ±85°	Typical ±0.02° ±0.04° ±0.08° ±0.16°	Maximum ±0.06° ±0.12° ±0.24° ±0.48°
Cross sensitivity (compensated)	-			Typ. ±0.09° (±0.10%FS) Max. ±0.45° (±0.50%FS)		
Temperature coefficient (zero point)	Typ. ±0.0083 °/K					
Sampling rate	100 Hz					

General parameters[1]	TMS88A-PLC360	TMM88A-PLC090
Limit frequency	Typ. 20 Hz, 2nd order (no digital filter) / 0.1 ... 25 Hz, 8th order (with digital filter)	
Operating temperature	-40 °C to +80 °C	
Properties		
Voltage interface	Freely configurable output in the range -10.48...10.48 V (factory setting: 0...10 V) Freely configurable angle range 0...360° / ±90°	
Functions	Teach input for zero-point setting when installed Limitation of final value, counting direction, and axis assignment of outputs can be configured Digital filter (critically damped (default) or Butterworth low pass, 8th order)	
Electrical parameters		
Supply voltage	10 ... 35 VDC	
Current consumption	55 mA @ 24 V	
Outputs (short-circuit protected)	Capacitive load less than 1.2 µF, resistance greater than 2 kΩ	
Mechanical parameters		
Connection	5-pin M12 sensor plug connector (male connector)	
Enclosure rating	IP65/67	
Dimensions / Weight	Plastic housing: 66 mm x 90 mm x 36 mm / approx. 200 g	

1 All specified angular accuracies apply after a run-in time of 10 min at 25 °C, limit frequency 0.3 Hz, absolute calibration accuracy (at 25 °C): ±0.05°

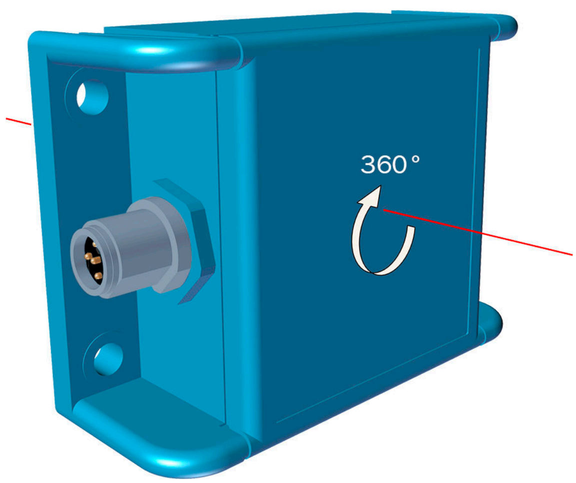

Figure 3: TMS88A measuring axis (large plastic housing)

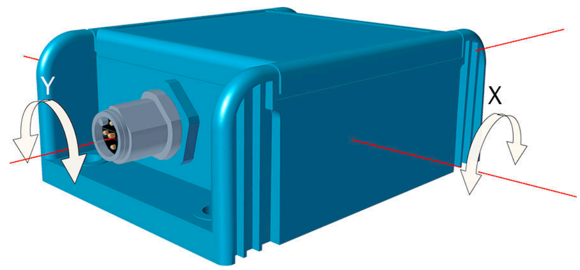

Figure 4: TMS88A measuring axes (large plastic housing)

4.3 Technical data for TMS88B-AKC360 + TMM88B-AKC090

Table 4: Technical data for TMx88B-AKCxxx

General parameters[1]	TMS88B-AKC360			TMM88B-AKC090		
Number of measuring axes	1			2		
Measuring range	360°			±90°		
Resolution	0.01°			0.01°		
Accuracy	Range 0...360°	Typical ±0.15°	Maximum ±0.25°	Range up to ±60° up to ±80°	Typical ±0.10° ±0.20°	Maximum ±0.20° ±0.40°
Cross sensitivity (compensated)	-			Typ. ±0.10° (±0.11%FS) Max. ±0.20° (±0.22%FS)		
Temperature coefficient (zero point)	Typ. ±0.01°/K					
Sampling rate	80 Hz					
Limit frequency	Typ. 20 Hz, 2nd order (no digital filter) / 0.1 ... 25 Hz, 8th order (with digital filter)					
Operating temperature	-40 °C to +80 °C					
Properties						
Current interface	Freely configurable output in the range 4...20 mA (factory setting: 4...20 mA) Freely configurable angle range 0...360° / ±90°					
Functions	Teach input for zero-point setting when installed Limitation of final value, counting direction, and axis assignment of outputs can be configured Digital filter (critically damped (default) or Butterworth low pass, 8th order)					
Electrical parameters						
Supply voltage	16 ... 35 VDC					
Current consumption	35 mA @ 24 V + I_{loop}					
Outputs (short-circuit protected)	Inductive load less than 50 mH, permissible load dependent on input voltage (see "Load resistances", page 24)					
Mechanical parameters						
Connection	5-pin M12 sensor plug connector (male connector)					
Enclosure rating	IP65/67					

General parameters[1]	TMS88B-AKC360	TMM88B-AKC090
Dimensions / Weight	Aluminum housing: 58 mm x 90 mm x 31 mm / approx. 200 g	

1 All specified angular accuracies apply after a run-in time of 10 min at 25 °C, limit frequency 0.3 Hz, absolute calibration accuracy (at 25 °C): ±0.05°

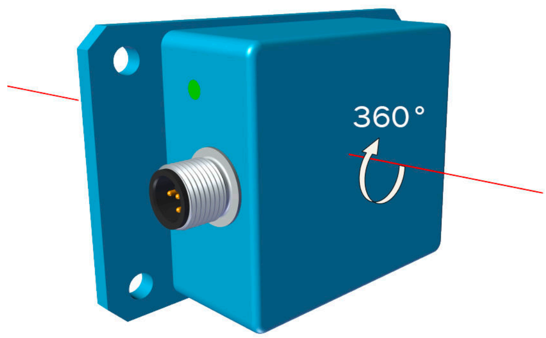

Figure 5: TMS88B measuring axis (aluminum housing)

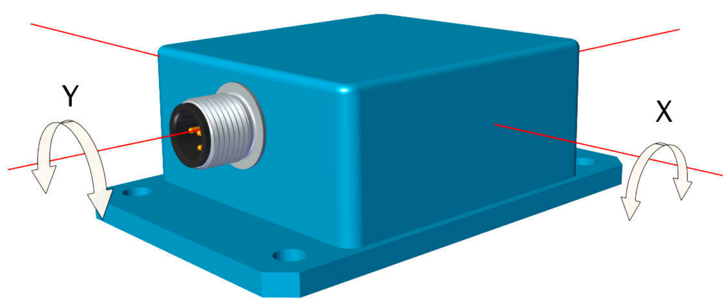

Figure 6: TMM88B measuring axes (aluminum housing)

4.4 Technical data for TMS88B-ALC360 + TMM88B-ALC090

Table 5: Technical data for TMx88B-ALCxxx

General parameters[1]	TMS88B-ALC360	TMM88B-ALC090
Number of measuring axes	1	2

<table>
<tr><th>General parameters[1]</th><th colspan="3">TMS88B-ALC360</th><th colspan="3">TMM88B-ALC090</th></tr>
<tr><td>Measuring range</td><td colspan="3">360°</td><td colspan="3">±90°</td></tr>
<tr><td>Resolution</td><td colspan="3">0.01°</td><td colspan="3">0.01°</td></tr>
<tr><td>Accuracy</td><td>Range
0...360°</td><td>Typical
±0.15°</td><td>Maximum
±0.25°</td><td>Range
up to ±60°
up to ±80°</td><td>Typical
±0.10°
±0.20°</td><td>Maximum
±0.20°
±0.40°</td></tr>
<tr><td>Cross sensitivity (compensated)</td><td colspan="3">-</td><td colspan="3">Typ. ±0.10° (±0.11%FS)
Max. ±0.20° (±0.22%FS)</td></tr>
<tr><td>Temperature coefficient (zero point)</td><td colspan="6">Typ. ±0.01°/K</td></tr>
<tr><td>Sampling rate</td><td colspan="6">80 Hz</td></tr>
<tr><td>Limit frequency</td><td colspan="6">Typ. 20 Hz, 2nd order (no digital filter) / 0.1 ... 25 Hz, 8th order (with digital filter)</td></tr>
<tr><td>Operating temperature</td><td colspan="6">-40 °C to +80 °C</td></tr>
<tr><td colspan="7">Properties</td></tr>
<tr><td>Voltage interface</td><td colspan="6">Freely configurable output in the range 0...10.48 V (factory setting: 0...10 V)
Freely configurable angle range 0...360° / ±90°</td></tr>
<tr><td>Functions</td><td colspan="6">Teach input for zero-point setting when installed
Limitation of final value, counting direction, and axis assignment of outputs can be configured
Digital filter (critically damped (default) or Butterworth low pass, 8th order)</td></tr>
<tr><td colspan="7">Electrical parameters</td></tr>
<tr><td>Supply voltage</td><td colspan="6">16 ... 35 VDC</td></tr>
<tr><td>Current consumption</td><td colspan="6">35 mA @ 24 V</td></tr>
<tr><td>Outputs (short-circuit protected)</td><td colspan="6">Capacitive load less than 1 µF, resistance greater than 1 kΩ</td></tr>
<tr><td colspan="7">Mechanical parameters</td></tr>
<tr><td>Connection</td><td colspan="6">5-pin M12 sensor plug connector (male connector)</td></tr>
<tr><td>Enclosure rating</td><td colspan="6">IP65/67</td></tr>
<tr><td>Dimensions / Weight</td><td colspan="6">Aluminum housing: 58 mm x 90 mm x 31 mm / approx. 200 g</td></tr>
</table>

1 All specified angular accuracies apply after a run-in time of 10 min at 25 °C, limit frequency 0.3 Hz, absolute calibration accuracy (at 25 °C): ±0.05°

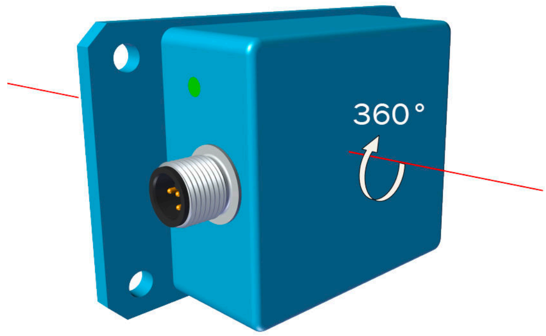

Figure 7: TMS88B measuring axis (aluminum housing)

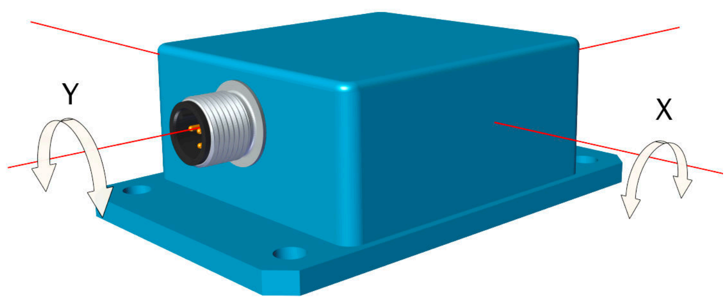

Figure 8: TMM88B measuring axes (aluminum housing)

4.5 Technical data for TMS88B-PKC360 + TMM88B-PKC090

Table 6: Technical data for TMx88B-PKCxxx

General parameters[1]	TMS88B-PKC360			TMM88B-PKC090		
Number of measuring axes	1			2		
Measuring range	360°			±90°		
Resolution	0.01°			0.01°		
Accuracy	Range 0...360°	Typical ±0.15°	Maximum ±0.25°	Range up to ±60° up to ±80°	Typical ±0.10° ±0.20°	Maximum ±0.20° ±0.40°
Cross sensitivity (compensated)	-			Typ. ±0.10° (±0.11%FS) Max. ±0.20° (±0.22%FS)		

General parameters[1]	TMS88B-PKC360	TMM88B-PKC090
Temperature coefficient (zero point)	Typ. ±0.01°/K	
Sampling rate	80 Hz	
Limit frequency	Typ. 20 Hz, 2nd order (no digital filter) / 0.1 ... 25 Hz, 8th order (with digital filter)	
Operating temperature	-40 °C to +80 °C	
Properties		
Current interface	Freely configurable output in the range 4...20 mA (factory setting: 4...20 mA) Freely configurable angle range 0...360° / ±90°	
Functions	Teach input for zero-point setting when installed Limitation of final value, counting direction, and axis assignment of outputs can be configured Digital filter (critically damped (default) or Butterworth low pass, 8th order)	
Electrical parameters		
Supply voltage	16 ... 35 VDC	
Current consumption	35 mA @ 24 V + I_{loop}	
Outputs (short-circuit protected)	Inductive load less than 50 mH, load 500 Ω (standard) Permissible load dependent on input voltage (see "Load resistances", page 24)	
Mechanical parameters		
Connection	5-pin M12 sensor plug connector (male connector)	
Enclosure rating	IP65/67	
Dimensions / Weight	Plastic housing: 66 mm x 90 mm x 36 mm / approx. 200 g	

1 All specified angular accuracies apply after a run-in time of 10 min at 25 °C, limit frequency 0.3 Hz, absolute calibration accuracy (at 25 °C): ±0.05°

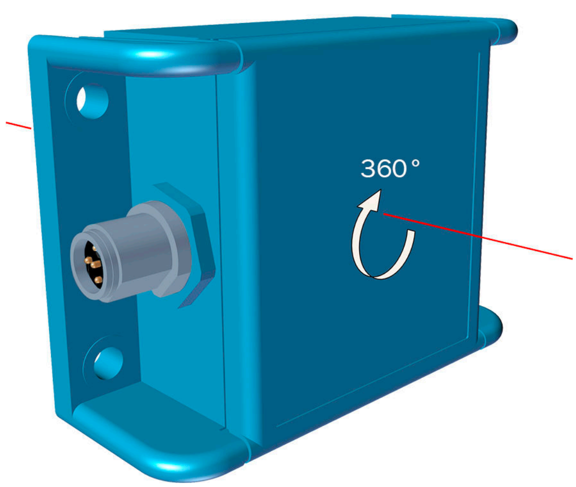

Figure 9: TMS88B measuring axis (large plastic housing)

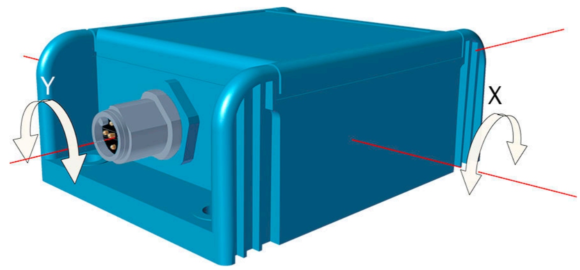

Figure 10: TMS88B measuring axes (large plastic housing)

4.6 Technical data for TMM88B-PLC360 + TMS88B-PLC090

Table 7: Technical data for TMx88B-PLCxxx

General parameters[1]	TMM88B-PLC360			TMS88B-PLC090		
Number of measuring axes	1			2		
Measuring range	360°			±90°		
Resolution	0.01°			0.01°		
Accuracy	Range 0...360°	Typical ±0.15°	Maximum ±0.25°	Range up to ±60° up to ±80°	Typical ±0.10° ±0.20°	Maximum ±0.20° ±0.40°
Cross sensitivity (compensated)	-			Typ. ±0.10° (±0.11%FS) Max. ±0.20° (±0.22%FS)		
Temperature coefficient (zero point)	Typ. ±0.01°/K					
Sampling rate	80 Hz					
Limit frequency	Typ. 20 Hz, 2nd order (no digital filter) / 0.1 ... 25 Hz, 8th order (with digital filter)					
Operating temperature	-40 °C to +80 °C					
Properties						
Voltage interface	Freely configurable output in the range 0...10.48 V (factory setting: 0...10 V) Freely configurable angle range 0...360° / ±90°					
Functions	Teach input for zero-point setting when installed Limitation of final value, counting direction, and axis assignment of outputs can be configured Digital filter (critically damped (default) or Butterworth low pass, 8th order)					
Electrical parameters						
Supply voltage	16 ... 35 VDC					
Current consumption	35 mA @ 24 V					
Outputs (short-circuit protected)	Capacitive load less than 1 µF, resistance greater than 1 kΩ					
Mechanical parameters						
Connection	5-pin M12 sensor plug connector (male connector)					
Enclosure rating	IP65/67					

General parameters[1]	TMM88B-PLC360	TMS88B-PLC090
Dimensions / Weight	Plastic housing: 66 mm x 90 mm x 36 mm / approx. 200 g	

1 All specified angular accuracies apply after a run-in time of 10 min at 25 °C, limit frequency 0.3 Hz, absolute calibration accuracy (at 25 °C): ±0.05°

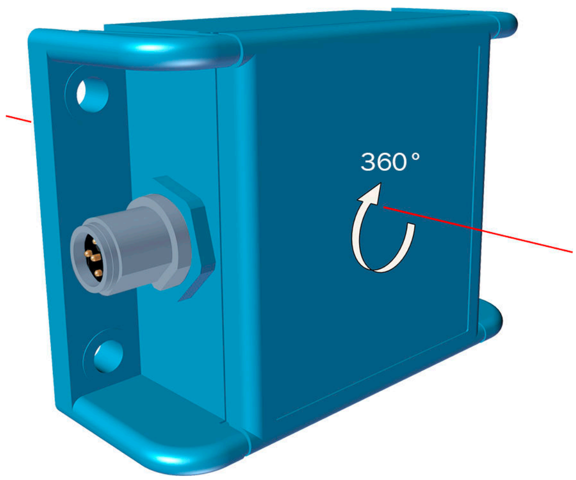

Figure 11: TMM88B measuring axis (large plastic housing)

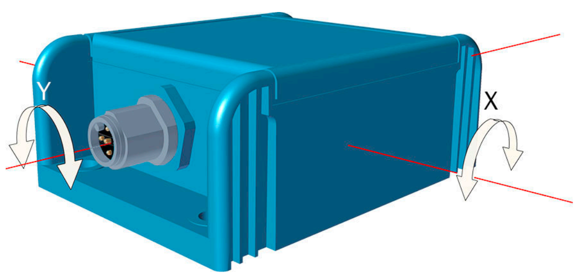

Figure 12: TMM88B measuring axes (large plastic housing)

4.7 Technical data for TMM55E-PMHxxx

Table 8: Technical data for TMM55E-PMHxxx

General parameters[1]	TMM55E-PMH010	TMM55E-PMH045	TMM55E-PMH060
Number of measuring axes	2	2	2
Measuring range	±10°	±45°	±60°
Resolution (zero point)	0.01°	0.05°	0.06°
Angle deviations, max. (in measuring range)	±0.15°	±0.30°	±0.50°
Cross sensitivity	Typ. ±0.25° (±2.5%FS) Max. ±0.5° (±5%FS)	Typ. ±0.9° (±2.0%FS) Max. ±1.8° (±4.0%FS)	Typ. ±1.2° (±2.0%FS) Max. ±2.4° (±4.0%FS)
Temperature coefficient (zero point)	Max. ±0.009 °/K (in relation to the reference temperature 25 °C)		
Limit frequency	Typ. 18 Hz		

General parameters[1]	TMM55E-PMH010	TMM55E-PMH045	TMM55E-PMH060
Operating temperature	-40 °C to +80 °C		
Properties			
Interface	Current output: 4...20 mA, sinusoidal Max. load resistance at U = 11 V: 250 Ω		
Calculation formula Angle value [°]	$\alpha = \arcsin\left[\frac{I_{out} - 12mA}{8mA} * \sin(maxvalue)\right]$		
Electrical parameters			
Supply voltage	11 ... 30 VDC		
Current consumption	15 mA .. 45 mA		
Mechanical parameters			
Connection	0.2 m PUR cable 5 x 0.34 mm^2 with 5-pin sensor-actuator male connector (M12), IEC 61076-2-101, IEC 60947-2, min. tightening torque 0.9 Nm		
Enclosure rating	IP65/67		
Dimensions	Small plastic housing (ABS): 65 mm x 35 mm x 20 mm		
Weight	Approx. 55 g with cable		

1 All specified angular accuracies apply after a run-in time of 10 min at 25 °C

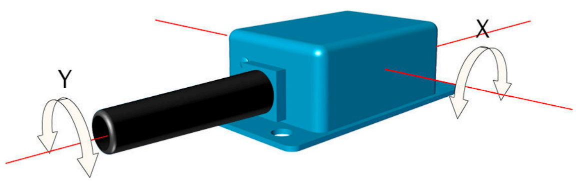

Figure 13: Measuring axes TMM55E

4.8 Technical data for TMM55E-POHxxx

Table 9: Technical data for TMM55E-POHxxx

General parameters 1)	TMM55E-POH010	TMM55E-POH045	TMM55E-POH060
Number of measuring axes	2	2	2
Measuring range	±10°	±45°	±60°
Resolution (zero point)	0.01°	0.05°	0.06°
Angle deviations, max. (in measuring range)	±0.15°	±0.30°	±0.50°
Cross sensitivity	Typ. ±0.25° (±2.5%FS) Max. ±0.5° (±5%FS)	Typ. ±0.9° (±2.0%FS) Max. ±1.8° (±4.0%FS)	Typ. ±1.2° (±2.0%FS) Max. ±2.4° (±4.0%FS)
Temperature coefficient (zero point)	Max. ±0.009 °/K (in relation to the reference temperature 25 °C)		
Limit frequency	Typ. 18 Hz		
Operating temperature	-40 °C to +80 °C		
Properties			

General parameters [1]	TMM55E-POH010	TMM55E-POH045	TMM55E-POH060
Interface	Voltage output 0 V ... 10 V, sinusoidal		
Calculation formula for angle value [°]	$\alpha = \arcsin\left[\frac{U_{out} - 5V}{5V} * \sin(maxvalue)\right]$		
Electrical parameters			
Supply voltage	11 ... 30 VDC		
Current consumption	15 mA .. 25 mA		
Mechanical parameters			
Connection	0.2 m PUR cable 5 x 0.34 mm^2 with 5-pin sensor-actuator male connector (M12), IEC 61076-2-101, IEC 60947-2, min. tightening torque 0.9 Nm		
Enclosure rating	IP65/67		
Dimensions	Small plastic housing (ABS): 65 mm x 35 mm x 20 mm		
Weight	Approx. 55 g with cable		

[1] All specified angular accuracies apply after a run-in time of 10 min at 25 °C

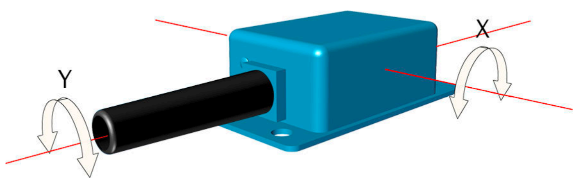

Figure 14: Measuring axes TMM55E

5 Transport and storage

5.1 Transport

For your own safety, please read and observe the following notes:

NOTE
Damage to the device due to improper transport.

- The device must be packaged for transport with protection against shock and damp.
- Recommendation: Use the original packaging as it provides the best protection.
- Transport should be performed by trained specialist staff only.
- The utmost care and attention is required at all times during unloading and transportation on company premises.
- Note the symbols on the packaging.
- Do not remove packaging until immediately before you start mounting.

5.2 Transport inspection

Immediately upon receipt in Goods-in, check the delivery for completeness and for any damage that may have occurred in transit. In the case of transit damage that is visible externally, proceed as follows:

- Do not accept the delivery or only do so conditionally.
- Note the scope of damage on the transport documents or on the transport company's delivery note.
- File a complaint.

NOTE
Complaints regarding defects should be filed as soon as these are detected. Damage claims are only valid before the applicable complaint deadlines.

5.3 Storage

Store the device under the following conditions:

- Recommendation: Use the original packaging.
- Do not store outdoors.
- Store in a dry area that is protected from dust.
- So that any residual damp can evaporate, do not package in airtight containers.
- Do not expose to any aggressive substances.
- Protect from sunlight.
- Avoid mechanical shocks.
- For storage periods of longer than 3 months, check the general condition of all components and packaging on a regular basis.

6 Mounting

6.1 Layout of the fixing holes

In the case of both the plastic (figure 16, figure 15) and the aluminum (figure 17) housing, the four holes for screw-mounting the sensor are located in the baseplate of the inclination sensor.

(Dimensions in mm)

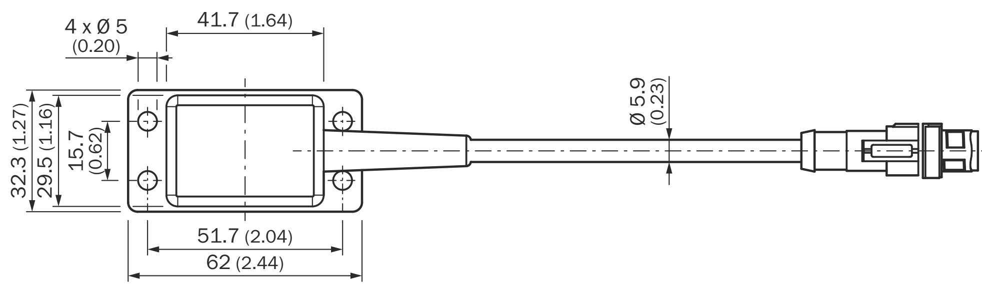

Figure 15: Dimensional drawing TMx55E

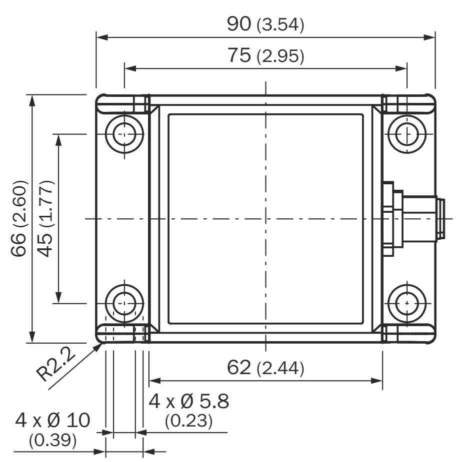

Figure 16: Dimensional drawing TMx88 (plastic housing)

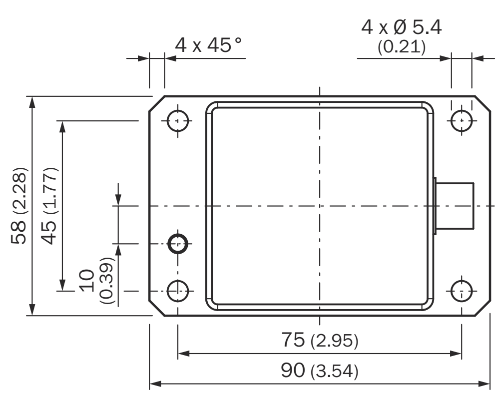

Figure 17: Dimensional drawing TMx88 (aluminum housing)

7 Connection

7.1 Pin assignment

TMx88

TMx88 inclination sensors are equipped with a standard 5-pin M12 round male connector (A-coded).

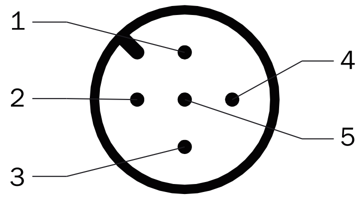

Table 10: M12 male connector pin assignment for TMx88

Pin	Signal	Pin assignment
1	V+	Supply voltage (+24 V)
2	B-OUT (standard Y)	Sensor output B
3	V- / GND	Supply voltage ground / sensor ground
4	A-OUT (standard X)	Sensor output A
5	TEACH	Input for zero-point setting

TMM55E

TMM55E inclination sensors are equipped with a 20 cm long cable that features a standard 5-pin M12 round male connector (A-coded).

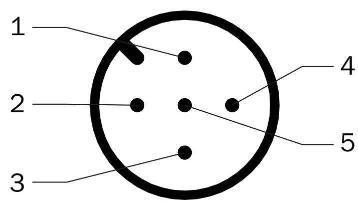

Table 11: M12 male connector pin assignment for TMM55E

Pin	Wire color	Pin assignment
1	Brown	Supply voltage
2	White	Sensor signal Y axis (Y-OUT)
3	Blue	GND supply (V- / GND)
4	Black	Sensor signal X axis (X-OUT)
5	Green/yellow	Signal GND (connected to GND internally)

7.2 Connection diagrams

Connection diagram for the TMx88

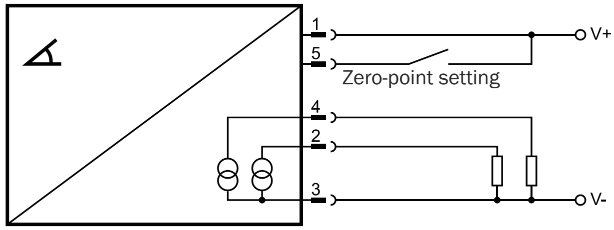

Figure 18: Current output connection diagram for the TMx88

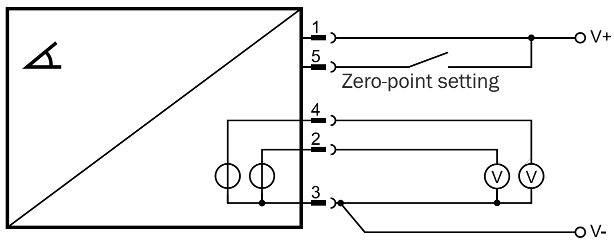

Figure 19: Voltage output connection diagram for the TMx88

Connection diagram for the TMM55

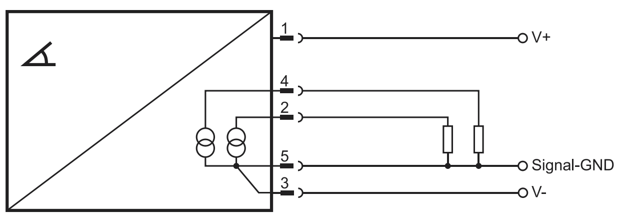

Figure 20: Current output connection diagram for the TMM55

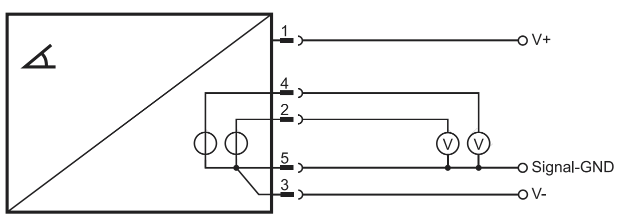

Figure 21: Voltage output connection diagram for the TMM55

7.3 Length of cable and supply voltage for current output

For sensors with current output, the required supply voltage increases by the voltage dip on the connected cable. The most significant voltage dip on the cable occurs when the maximum current of 20 mA is flowing, caused by the resistance of the cable (R_L). The partial resistances of the go and return line must also be taken into account.

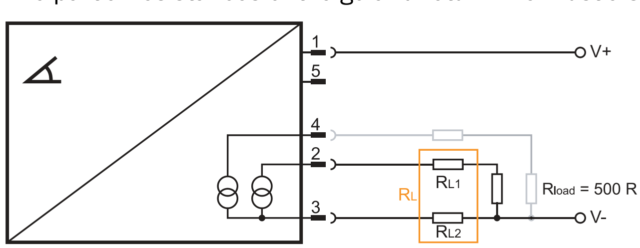

Figure 22: Length of cable for current output

The table lists example possible lengths of cables based on minimum operating voltage and corresponding cable cross-section. The table is based on cable resistances calculated to VDE 0295 and a load (R_{load}) of 500 Ω.

Table 12: Lengths of cable with min. supply voltage and different cable cross-sections

Minimum supply voltage in V	Cable resistance in Ω	Maximum length of cable in m with cable cross-section of:				
		0.14 mm²	0.25 mm²	0.34 mm²	0.50 mm²	0.75 mm²
17	10	35	60	84	124	187
18	50	176	304	423	623	936
20	150	528	914	1271	1870	2808
22	250	880	1524	2118	3117	4681
24	350	1232	2134	2966	4364	6554
26	450	1584	2743	3813	5610	8426
28	550	1936	3353	4661	6857	10299
30	650	2288	3963	5508	8104	12172

7.4 Load resistances

The set load resistance essentially determines the power loss in the sensor, based on the supply voltage. To keep the power loss low and to avoid the sensor overheating, a load resistor appropriate for the supply voltage should be used. The following tables and diagrams illustrate the relationship between supply voltage and permissible load resistance for various operating temperatures.

The minimum and maximum load resistances specified below should always be understood as the total resistance at the output. This total resistance comprises the load resistance and the resistance of the cable.

7.4.1 Load resistance TMx88A

In the figure (see figure 23), the permissible load resistance based on the input voltage for the operating range up to 80 °C is shown in blue. Within a restricted operating range up to 65 °C, combinations of input voltage and load resistance from the area shown in gray are also permitted.

Table 13: Minimum, typical, and maximum load resistances TMx88A

U_{dd} [V]	R_L min. [Ω] @ Ta_{max} = 65 °C	R_L min. [Ω] @ Ta_{max} = 80 °C	R_L max. [Ω]
17	0	230	500
24	130	660	850
28	390	900	1050
35	830	1330	1410

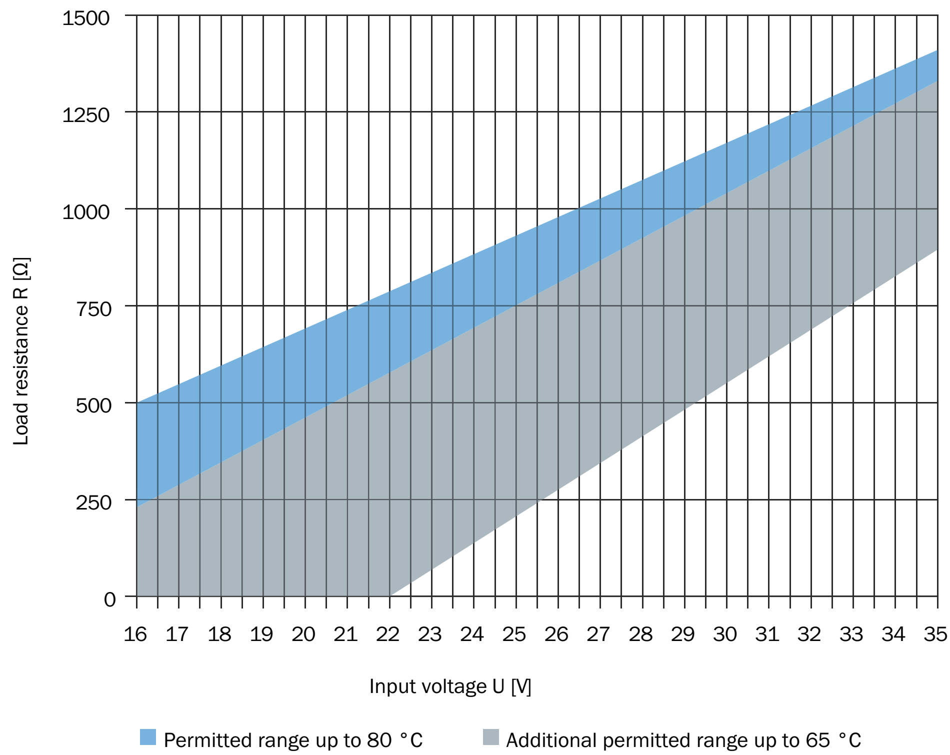

Figure 23: Permissible load resistances TMx88A

7.4.2 Load resistance TMx88B

In the figure (see figure 24), the permissible load resistance based on the input voltage for the operating range up to 80 °C is shown in blue. Within a restricted operating range up to 65 °C, combinations of input voltage and load resistance from the area shown in gray are also permitted.

Table 14: Minimum, typical, and maximum load resistances TMx88A

U_{dd} [V]	R_L min. [Ω] @ Ta_{max} = 65 °C	R_L min. [Ω] @ Ta_{max} = 80 °C	R_L max. [Ω]
16	0	280	450
24	270	740	850
28	510	970	1050
35	930	1370	1400

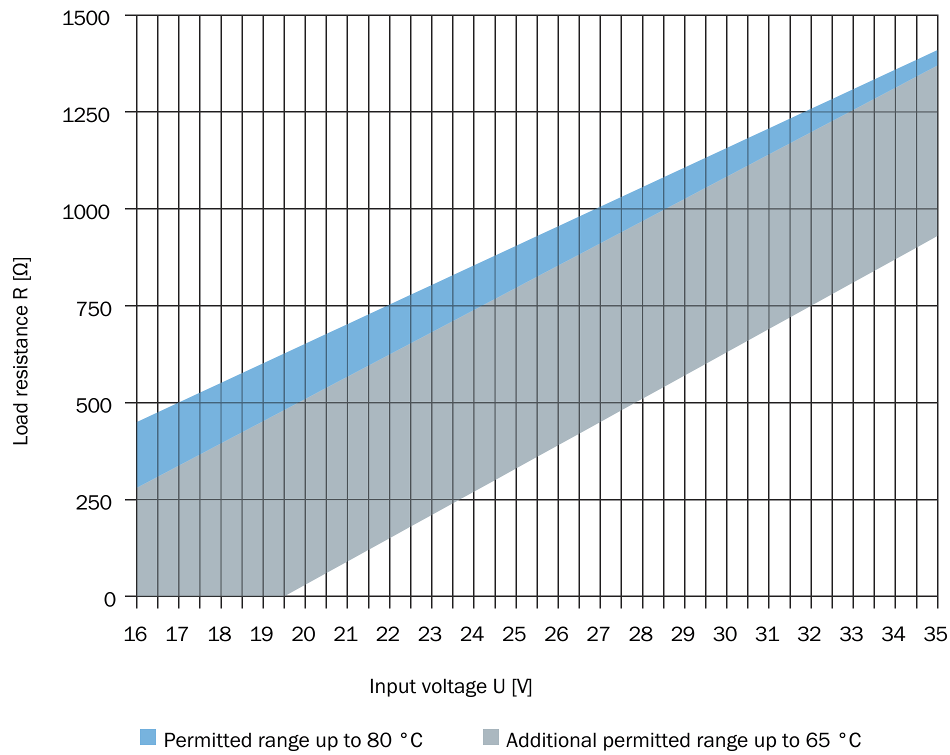

Figure 24: Permissible load resistances TMx88B

7.4.3 Load resistance TMx55E

In the figure (see figure 25), the permissible load resistance based on the input voltage for the operating range up to 80 °C is shown in blue. Within a restricted operating range up to 65 °C, combinations of input voltage and load resistance from the area shown in gray are also permitted.

NOTE

For safety reasons, the sensor has an internal temperature shutdown feature. This switches off both of the sensor outputs as soon as the temperature in the sensor reaches a critical point because power loss is too high. Once the sensor has cooled down, both outputs switch back on automatically. If the cause of the increased power loss (usually an impermissible combination of supply voltage and load resistance) is not removed, the outputs will shut down again a short time later.

Table 15: Minimum, typical, and maximum load resistances TMx55E

U_{dd} [V]	R_L min. [Ω] @ Ta_{max} = 65 °C	R_L min. [Ω] @ Ta_{max} = 80 °C	R_L max. [Ω]
11	0	150	290
12	0	200	330
24	600	800	930
30	900	1100	1230

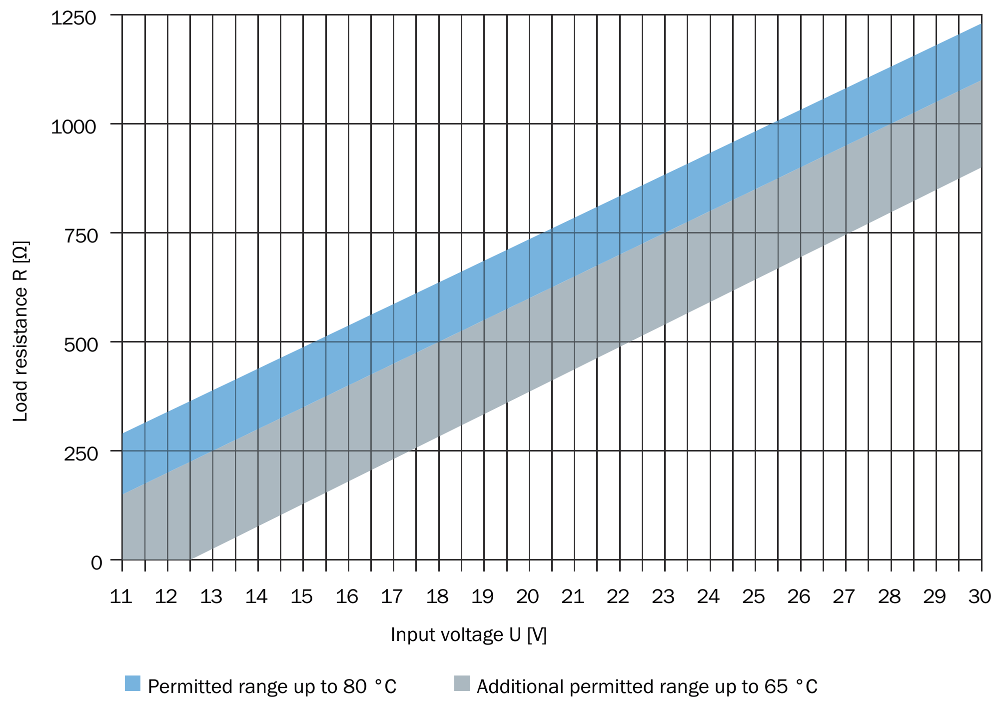

Figure 25: Permissible load resistances TMx55E

8 Description of operation TMS/TMM88

8.1 Axis assignment/Reversal of counting direction

All inclination sensors with current or voltage output have 2 analog outputs A and B. These outputs can be assigned at will to the inclination axes X and Y for the 2-dimensional inclination sensor and to the axis of rotation in the case of the 1-dimensional inclination sensor (the axes are available in the hardware). Both inputs can even be assigned to the same axis. Since the direction can be reversed, any conceivable output assignment is possible. This is done by swapping the output values for current or voltage.

8.2 Zero-point setting

The zero point can be configured for all inclination sensors with current or voltage output. This means that it is possible to specify the zero position when the sensor is installed. The setting can be made either with the PGT-12-Pro hand-held programming tool or using the teach input. The teach input must be connected to the supply voltage (V+, pin 1) for at least one second if you wish to use it to set the zero point. The current angle of the inclination sensor is then set to 0 angular degrees for both outputs. The sensor acknowledges the setting of the zero point by switching off the status LED, also for one second. To reset the zero point to the factory setting, the teach input must be connected to the supply voltage for a further three seconds. The sensor acknowledges the reset by switching off the status LED, also for three seconds.

8.3 Digital filters

TMx88 inclination sensors support an option to make the angle value more insensitive to external vibration interference. Oscillation/vibration interference up to 0.1 Hz can be suppressed with the configurable 8th order low-pass filter. The sensor has two digital filters which can be selected according to the area of application in which the sensor is being used.

Table 16: Filter selection

Filter	Configurable frequency range	Areas of application
Butterworth	0.1 Hz ... 25 Hz	Static inclination measurement with high damping against vibrations
Critically damped	0.1 Hz ... 8 Hz	Inclination measurement for applications subject to specific dynamics, without overshoot in the event of changes in angle combined with good damping

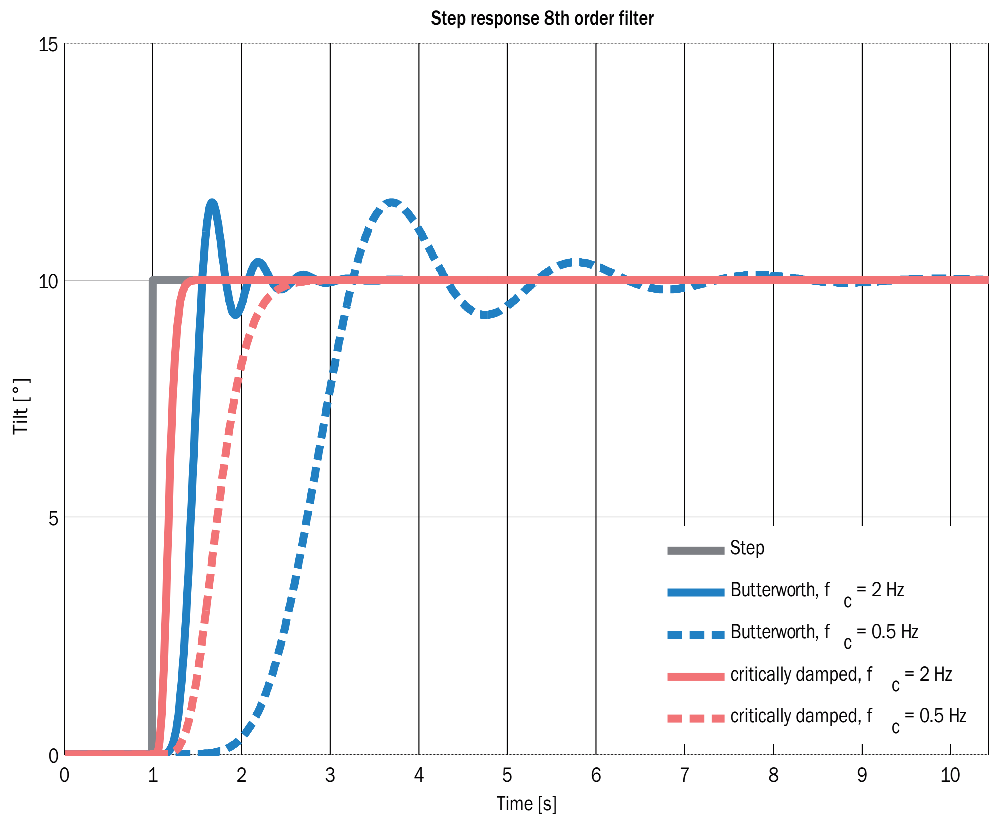

Figure 26: Pulse response of both filters

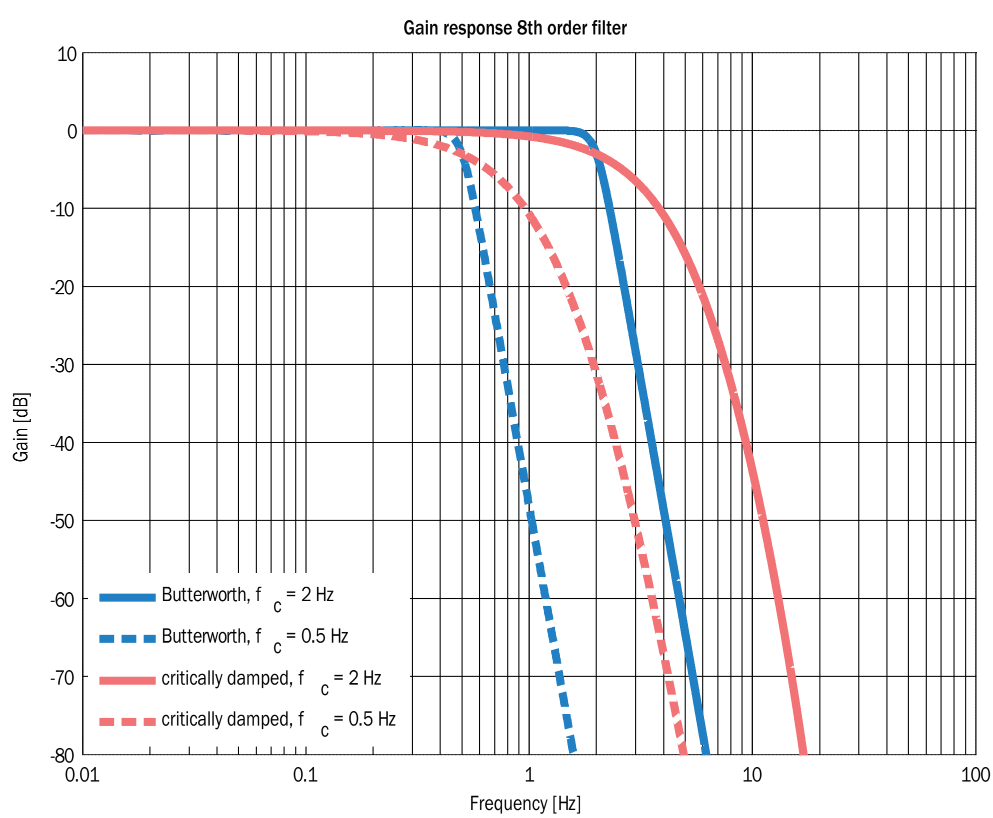

Figure 27: Amplitude characteristic of both filters

8.4 Status LED

The integrated status LED indicates the current status of the device. The statuses listed in the following table can be identified based on the color of the associated LEDs.

Table 17: Status and error information indicated by the status LED

Status LED	Description
Off	No power supply available or teach confirmation
Green	The device is in the normal operating status
Red	Current interface: one or both inputs in the idle state (no load) or connected incorrectly Voltage interface: one or both inputs short-circuited or connected incorrectly

9 Description of operation TMM55

9.1 Output diagrams

TMM55D-PxH010

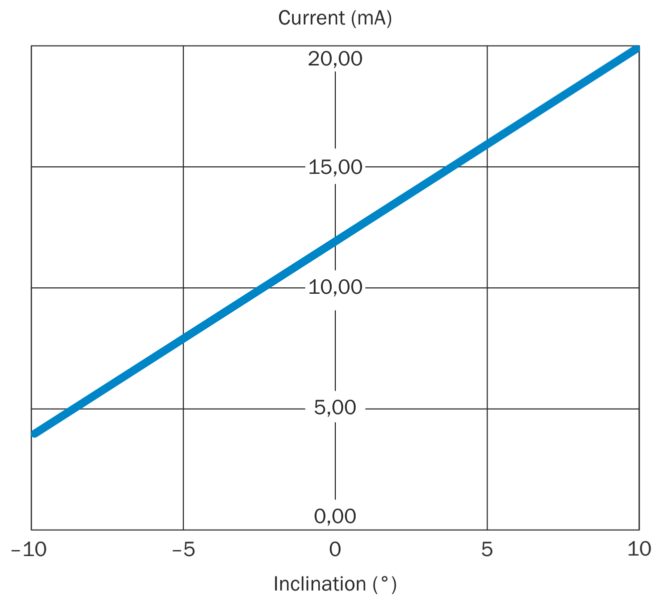

Figure 28: Current output signal

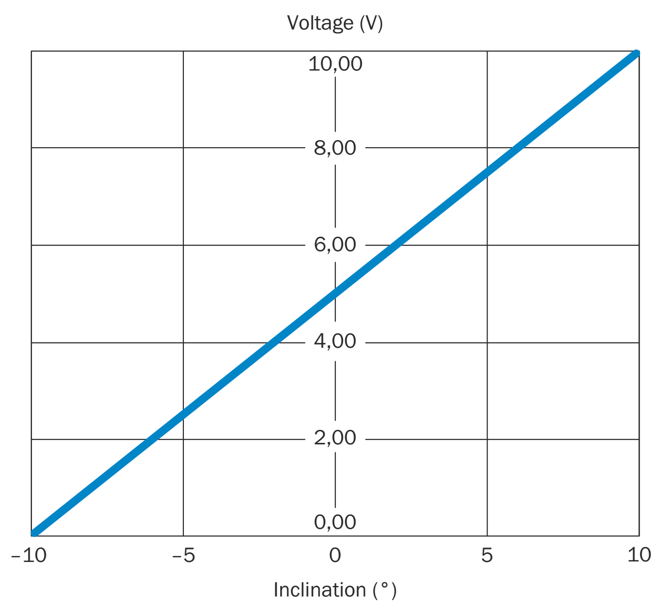

Figure 29: Voltage output signal

TMM55D-PxH045

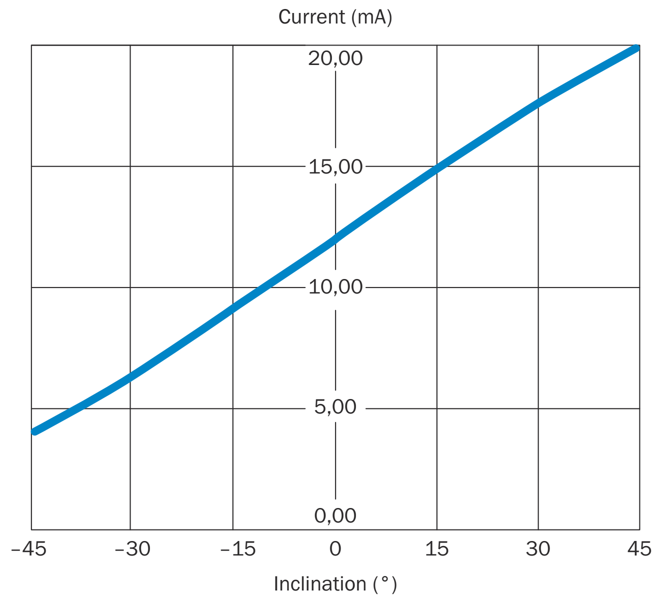

Figure 30: Current output signal

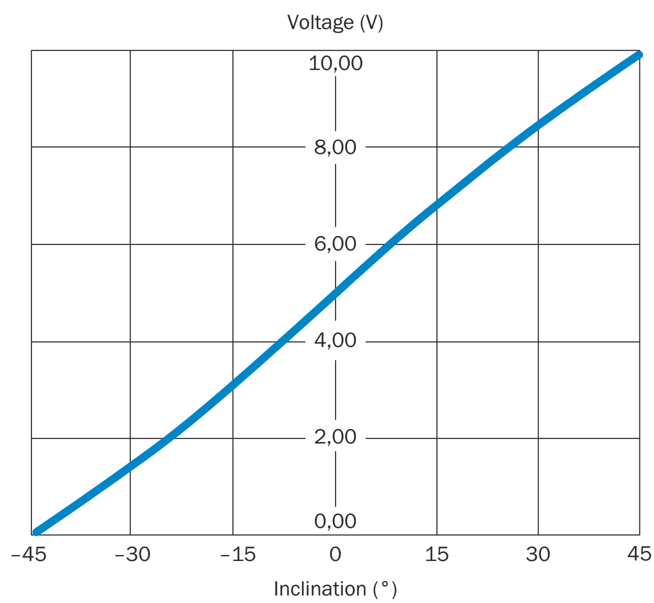

Figure 31: Voltage output signal

TMM55D-PxH060

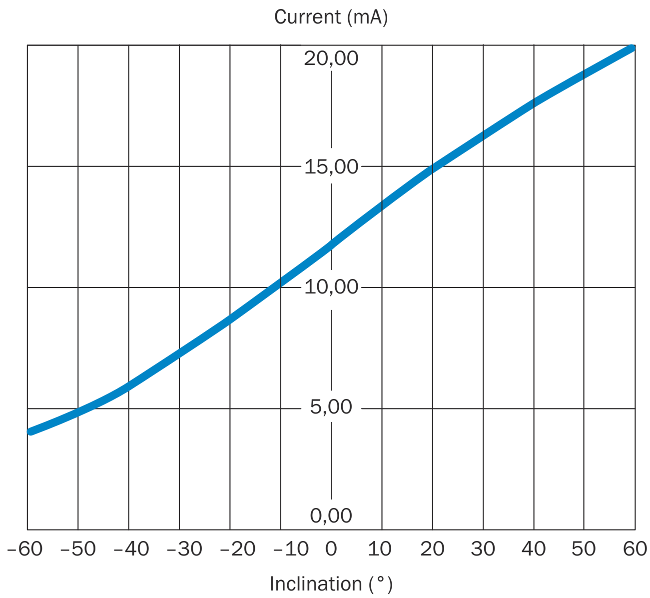

Figure 32: Current output signal

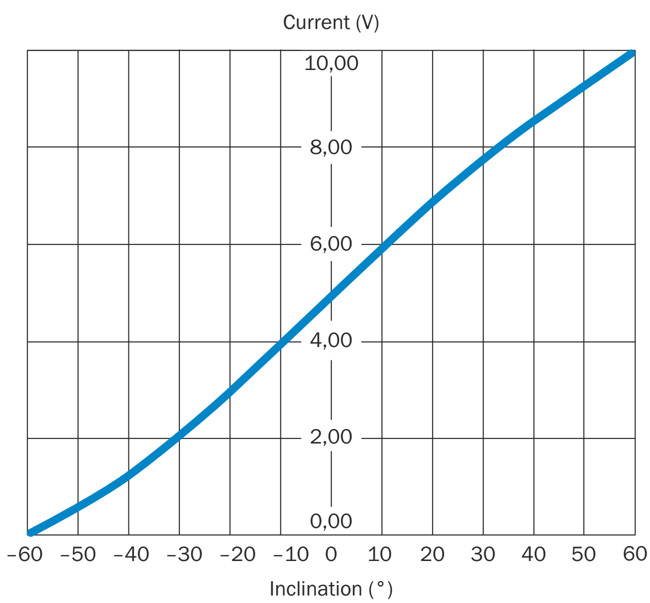

Figure 33: Voltage output signal

9.2 Calculating the inclination angle for TMM55E

Depending on type, TMM55E inclination sensors output an analog signal via the voltage interface or the current interface. The analog signal is sinusoidal. It is not linearized. Therefore, the angle value calculated by the sensor cannot be interpolated linear to the output signal. The actual inclination signal must be calculated separately in the controller. The following formulas are applied:

$$\alpha = \arcsin\left[\frac{I_{out} - 12\,mA}{8\,mA} * \sin(maxvalue)\right]$$

$$\alpha = \arcsin\left[\frac{U_{out} - 5\,V}{5\,V} * \sin(maxvalue)\right]$$

Example calculation

Sensor: TMM55E-PMH060

- Interface: 4 mA ... 20 mA, sinusoidal
- Measuring range: ±60°

$$\alpha = \arcsin\left[\frac{I_{out} - 12mA}{8mA} * \sin(maxvalue)\right]$$

Assumption: I_{out} = 18 mA

Inclination angle: α

$$\alpha = \arcsin\left[\frac{18mA - 12mA}{8mA} * \sin 60°\right]$$

$$\alpha = \arcsin\left[\frac{6mA}{8mA} * 0,866\right]$$

$$\alpha = \arcsin(0,6495)$$

$$\alpha = 40,51°$$

10 Annex

10.1 Conformities and certificates

You can obtain declarations of conformity, certificates, and the current operating instructions for the product at www.sick.com. To do so, enter the product part number in the search field (part number: see the entry in the “P/N” or “Ident. no.” field on the type label).

10.2 Compliance with EU directives

EU declaration of conformity (extract)

The undersigned, representing the manufacturer, herewith declares that the product is in conformity with the provisions of the following EU directive(s) (including all applicable amendments), and that the standards and/or technical specifications stated in the EU declaration of conformity have been used as a basis for this.

10.3 Compliance with UK statutory instruments

UK declaration of conformity (extract)

The undersigned, representing the following manufacturer herewith declares that this declaration of conformity is issued under the sole responsibility of the manufacturer. The product of this declaration is in conformity with the provisions of the following relevant UK Statutory Instruments (including all applicable amendments), and the respective standards and/or technical specifications have been used as a basis.

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