

User manual

Inclination Sensors with Current and Voltage Interface

Version: 1.9 Date: 2018-05-22



GEMAC Chemnitz GmbH Zwickauer Straße 227 09116 Chemnitz Germany

classicLINE IS1BP360-I-CL IS2BP090-I-CL IS1BP360-U-CL

IS2BP090-U-CL

basicLINE

IS1MA360-I-BL IS2MA090-I-BL IS1MA360-U-BL IS2MA090-U-BL IS1BP360-I-BL IS2BP090-I-BL IS1BP360-U-BL IS2BP090-U-BL

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Revision History

Date	Revision	Changes
2014-05-30	0	first version
2014-08-14	1	Update ordering information
2015-03-30	2	BasicLine sensors with analog output added
2015-08-12	3	Update permitted load resistance
2015-08-12	4	Designation Table 3 and Table 8 corrected
2015-11-12	5	EMC BasicLine added; Resolution BasicLine corrected
2017-01-25	6	MTTF values and digital filter default values added
2017-10-26	7	housing drawings
2018-05-22	8	Does not exist (conformation to German revision histoy)
2018-05-22	9	Updating CE conformity

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1 Overview

1.1 Characteristics

- Inclination sensors with measurement range: 360° / ±90° (X/Y)
- Linearized output, high accuracy (up to 0.06°)
- Compensated cross sensitivity
- Programmable vibration suppression
- Freely programmable current or voltage interface
- Robust, UV resistant, impact strength plastic housing
- compact, robust aluminum housing
- Suitable for industrial use:
 - Temperature range: -40 °C to +80 °C
 - Degree of protection: IP65/67

The 1-dimensional inclination sensors IS1xx360-I-xL and IS1xx360-U-xL are suitable to measure the inclination in the measurement range of 360°, the 2-dimensional inclination sensors IS2xx090-I-xL and IS2xx090-U-xL are suitable to measure the inclination in 2 dimensions (X/Y) of $\pm 90^{\circ}$. To ensure a high accuracy, the sensors are calibrated at the factory.

The compact and robust design make the sensors a suitable angle measurement device in rough surroundings for different applications in industry and vehicle technology.

1.2 Applications

- Solar thermal and photo-voltaic systems
- Agricultural and forestry machinery
- Construction machinery
- Crane and hoisting technology



2 Technical Data IS1BP360-I-CL + IS2BP090-I-CL

General Parameters ¹	IS1BP360-I-CL		IS2BP090-I-CL				
Measurement range	360°			±90°			
Resolution	0.01°				0.01°		
Accuracy	Range 0360°	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 °/I	<		
Sampling rate	100 Hz						
Cut-off frequency	typ. 20 Hz, 2 nd order (without digital filter) / 0.1 Default digital filter: critically damped						
Operating temperature		-40 °C to +80 °C ²					
Characteristics							
Current interface	freely adjustable output in the range 020.45 mA (factory default: 420 mA) freely adjustable angle in the range 0360° / ±90°				mA)		
Functions	Teach input for zero point adjustment when installed Limit value , Axis direction and assignment of the outputs are adjustable Digital filter (critically damped (default) or Butterworth lowpass, 8 th order)						
Electrical Parameters							
Supply voltage	17 to 35 VI	C					
Current consumption	40 mA @ 2	24 V + I _{loop}					
Outputs (short-circuit proof)	inductive load less than 1 H, permitted load resistance depends on supply voltage, see table 3 and figure 2						
Mechanical Parameters							
Connection	Sensor connector 5-pole M12 (male)						
Degree of protection	IP65/67						
Dimensions / Weight	plastic hou	sing: 66 mm x	90 mm x 36 mm /	about 200 g			
Reliability according EN ISO 13849-1	3						
MTTF	300 years						
MTTFd	559 years						
CE conformity							
EC Directives							
2014/30/EU	EMC directive						
2011/65/EU	RoHS direct	ctive					
Harmonized standards							
DIN EN 61326-1:2013-07	Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1: General requirements						
DIN EN 50581:2013-02	Technical documentation for the assessment of electrical and electronic products with re- spect to the restriction of hazardous substances						

Table 1: Technical Data IS1BP360-I-CL + IS2BP090-I-CL

all indicated angle accuracies are valid after a running time of 10 minutes at 25 °C, Cut-off frequency 0.3 Hz Absolute calibration accuracy (at 25 °C): ±0.05°
 for full temperature range up to 80 °C limited combinations of supply voltage and load resistance are permitted only, see figure 2

for full temperature range up to 80 °C limited combinations of supply voltage and load resistance are permitted only, see figure 2
 This product is a standard product and no safety part in accordance with the machinery directive. The calculation is based on an average environment temperature of 40 °C and a usage of 8760 h/a.



Transient Emissions						
Limit curves broadband and narrowband DIN EN ISO 14982 (agricultural and forestry machinery) respectively DIN EN 13309 (construction machinery) 30 1000 MHz (vertical and horizontal)						
Limits according to CIS	PR 11					
Immunity to Radio Frequency Fields (RF fields)						
DIN EN ISO 14982 (agricultural and forestry machinery) respectively DIN EN 13309 (construction machinery) 20 400 MHz 200 V/m (1 kHz AM)						
Anechoic chamber according to ISO 11452-2 Limits according to DIN EN ISO 14982 (agricultural and forestry machinery) respectively DIN EN 13309 (construction machinery) 200 1000 MHz vertical / 400 1000 MHz horizontal 100 V/m (1 kHz AM) Performance criteria A						
Limits according to EN 61326-1						
Immunity to Conducted Disturbances						
2b +20 V 3a -150 V 3b +150 V 4 -12 V 5a +70 V	Severity level III III III III III III Ri = 1 Ω Ri = 0.5 Ω	Performance criteria C B C A A B A A				
Limits according to EN	61326-1					
Limits according to EN	61326-1					
Limits according to EN 61326-1						
Immunity to Electromagnetic Discharge (ESD)						
Limits according to DIN EN ISO 14982 (agricultural and forestry machinery) respectively DIN EN ISO 13309 (construction machinery) discharge combination 330 pF / 330 Ω Contact discharge 8 kV bipolar (metallic parts) Air discharge 15 kV bipolar Performance criteria A						
	DIN EN ISO 14982 (agr DIN EN 13309 (constru- 30 1000 MHz (vertical Limits according to CIS elds) Limits according to DIN EN ISO 14982 (agr DIN EN 1309 (constru- 200 V/m (1 kHz AM) Performance criteria A Limits according to DIN EN ISO 14982 (agr DIN EN ISO 14982 (agr DIN EN 1309 (constru- 200 1000 MHz vertical 100 V/m (1 kHz AM) Performance criteria A Limits according to EN 0 Limits according to EN 0 Test pulse 1 -450 V 2a +37 V 2b +20 V 3a -150 V 4 -12 V 5a +70 V 5b +36 V Limits according to EN 0 Limits according to EN 0 Limits according to EN 0 DIN EN ISO 14982 (agr DIN EN ISO 1309 (con discharge combination 2 Contact discharge 8 kV Air discharge 15 kV bip	DIN EN ISO 14982 (agricultural and forestry mad DIN EN 13309 (construction machinery) 30 1000 MHz (vertical and horizontal) Limits according to CISPR 11 Idds) Limits according to CISPR 11 Idds Limits according to DIN EN ISO 14982 (agricultural and forestry mad DIN EN 13309 (construction machinery) 20 400 MHz 200 V/m (1 kHz AM) Performance criteria A Limits according to DIN EN ISO 14982 (agricultural and forestry mad DIN EN 13309 (construction machinery) 200 1000 MHz vertical / 400 1000 MHz hori 100 V/m (1 kHz AM) Performance criteria A Limits according to EN 61326-1 Test pulse Severity level 1 -450 V III 2a +37 V III 2b +20 V III 3b +150 V III 3b +150 V III 3b +150 V III 5a +70 V Ri = 1 Ω 5b +36 V Ri = 0.5 Ω Limits according to EN 61326-1 Limits according to EN 61326-1				

Table 2: Electromagnetic Compatibility (EMC) IS1BP360-I-CL + IS2BP090-I-CL



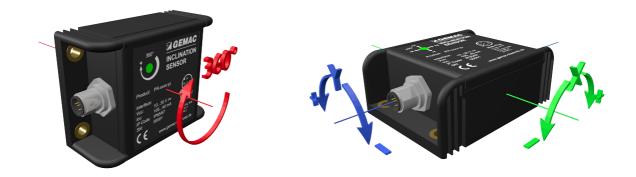


Figure 1: Measurement axes orientation - IS1BP360-I-CL + IS2BP090-I-CL big plastic housing (factory default settings)



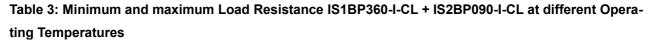
2.1 Load Resistance IS1BP360-I-CL + IS2BP090-I-CL

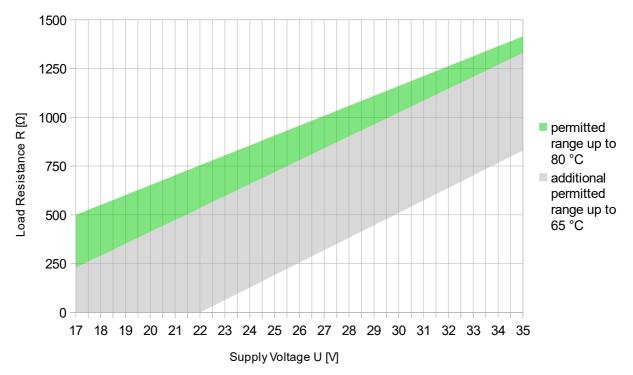
Power dissipation depends on supply voltage and the load resistance. To reduce power dissipation, which may cause overheating, the load resistor should be chosen according to supply voltage. Table 3 and figure 2 show the relation between supply voltage and the permitted load resistance for different temperature ranges.

The green area in figure 2 shows the permitted load resistance depending on supply voltage for operating temperatures up to 80 °C. Combinations of supply voltage and load resistor within the gray colored area are permitted for a limited operating temperature range up to 65°C in addition.

The following values of minimum and maximum load resistance are meant as total resistance as sum of resistance of the load resistor and cable resistance (see 9.3 Cable length and minimum supply voltage for current interface).

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	390	1050
35	830	1330	1410









3 Technical Data IS1BP360-U-CL + IS2BP090-U-CL

General Parameters⁴	IS1BP360-U-CL			IS2BP090-U-CL			
Measurement range	360°		±90°				
Resolution	0.01°				0.01°		
Accuracy	Range 0360°	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)		-			o. ±0.09° (±0.7 k. ±0.45° (±0.8		
Temperature coefficient (zero point)			typ. ±0	.0083 °/K			
Sampling rate			10	0 Hz			
Cut-off frequency typ. 20 Hz, 2 nd order (without digital filter) / 0.1 25 Hz, 8 th order (w Default digital filter: critically damped filter 8 th order at 2			h digital filter) Iz				
Operating temperature			-40 °C	to +80 °C			
Characteristics							
Voltage interface	freely adjustable output in the range -10.4810.48 V (factory default: 010 V) freely adjustable angle in the range 0360° / $\pm90^\circ$						
Functions	Teach input for zero point adjustment when installed Limit value , Axis direction and assignment of the outputs are adjustable Digital filter (critically damped (default) or Butterworth lowpass, 8 th order)						
Electrical Parameters							
Supply voltage	10 to 35 VD	C					
Current consumption	55 mA @ 24	4 V					
Outputs (short-circuit proof)	capacitive load less than 1.2 $\mu F,$ resistive load greater than 2 $k\Omega$						
Mechanical Parameters							
Connection	Sensor connector 5-pole M12 (male)						
Degree of protection	IP65/67						
Dimensions / Weight	plastic housing: 66 mm x 90 mm x 36 mm / about 200 g						
Reliability according EN ISO 13849-1⁵							
MTTF	287 years						
MTTFd	542 years						
CE conformity							
EC Directives							
2014/30/EU	EMC directi	ive					
2011/65/EU	RoHS direc	tive					
Harmonized standards							
	Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1: General requirements						
DIN EN 61326-1:2013-07	Part 1: Gen	eral requireme	ents				

Table 4: Technical Data IS1BP360-U-CL + IS2BP090-U-CL

⁴ all indicated angle accuracies are valid after a running time of 10 minutes at 25 °C, Cut-off frequency 0.3 Hz Absolute calibration accuracy (at 25 °C): $\pm 0.05^{\circ}$ This product is a standard product and no safety part in accordance with the machinery directive. The calculation is based on an

⁵ average environment temperature of 40 °C and a usage of 8760 h/a.



Electromagnetic Compatibility (EMC)						
Transient Emissions						
Radiated disturbance / Radio field strength	Limit curves broadband and narrowband DIN EN ISO 14982 (agricultural and forestry machinery) respectively DIN EN 13309 (construction machinery) 30 1000 MHz (vertical and horizontal)					
	Limits according to CIS	SPR 11				
Immunity to Radio Frequency Fields (RF fields)						
Strip line according to ISO 11452-5	Limits according to DIN EN ISO 14982 (agricultural and forestry machinery) respectively DIN EN 13309 (construction machinery) 20 400 MHz 200 V/m (1 kHz AM) Performance criteria A					
Anechoic chamber according to ISO 11452-2	 Limits according to DIN EN ISO 14982 (agricultural and forestry machinery) respectively DIN EN 13309 (construction machinery) 200 1000 MHz vertical / 400 1000 MHz horizontal 100 V/m (1 kHz AM) Performance criteria A 					
Radio Frequency Fields according to IEC 61000-4-3	Limits according to EN 61326-1					
Immunity to Conducted Disturbances						
Test pulse according to ISO 7637-2 (on-board power supply 24 VDC)	Test pulse 1 -450 V 2a +37 V 2b +20 V 3a -150 V 3b +150 V 4 -12 V 5a +70 V 5b +36 V	Severity level III III III III III III III Ri = 1 Ω Ri = 0.5 Ω	Performance criteria C B C A A B A A			
Burst according to IEC 61000-4-4	Limits according to EN	61326-1				
Surge according to IEC 61000-4-5	Limits according to EN	61326-1				
Conducted HF-Signals according to IEC 61000-4-6	Limits according to EN	61326-1				
Immunity to Electromagnetic Discharge (ESD)						
ESD according to ISO 10605	Limits according to DIN EN ISO 14982 (agricultural and forestry machinery) respectively DIN EN ISO 13309 (construction machinery) discharge combination 330 pF / 330 Ω Contact discharge 8 kV bipolar (metallic parts) Air discharge 15 kV bipolar Performance criteria A					
ESD according to IEC 61000-4-2	Limits according to EN	61326-1				

Table 5: Electromagnetic Compatibility (EMC) IS1BP360-U-CL + IS2BP090-U-CL



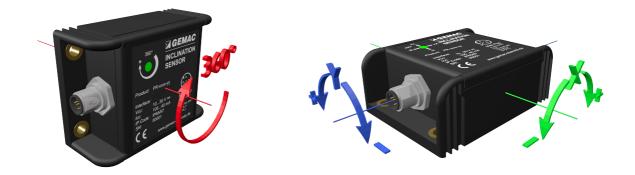


Figure 3: Measurement axes orientation - IS1BP360-U-CL + IS2BP090-U-CL big plastic housing (factory default settings)



4 Technical Data IS1MA360-I-BL + IS2MA090-I-BL

General Parameters ⁶	IS1MA360-I-BL	IS2MA090-I-BL			
Measurement range	360°	±90°			
Resolution	0.01° (0.09° at measurement range 360°)	0.01° (0.045° at measurement range ±90°)			
Accuracy	Rangetypicalmaximum0360°±0.15°±0.25°	$\begin{array}{llllllllllllllllllllllllllllllllllll$			
Cross Sensitivity (compensated)	-	typ. ±0.09° (±0.10 %FS) max. ±0.45° (±0.50 %FS)			
Temperature coefficient (zero point)	typ. ±	:0.01 °/K			
Sampling rate	100 Hz				
Cut-off frequency	typ. 20 Hz, 2 nd order (without digital filter) / 0.1 25 Hz, 8 th order (with digital filter)Defa digital filter: critically damped filter 8 th order at 2 Hz				
Operating temperature	-40 °C t	o +80 °C 7			
Characteristics					
Current interface	freely adjustable output in the range 420 r freely adjustable angle in the range 0360°				
Functions	Teach input for zero point adjustment when installed Limit value , Axis direction and assignment of the outputs are adjustable Digital filter (critically damped (default) or Butterworth lowpass, 8 th order)				
Electrical Parameters					
Supply voltage	16 to 35 VDC				
Current consumption	35 mA @ 24 V + I _{loop}				
Outputs (short-circuit proof)	inductive load less than 50 mH, permitted load resistance depends on supply voltage (see table 8 and figure 5)				
Mechanical Parameters					
Connection	Sensor connector 5-pole M12 (male)				
Degree of protection	IP65/67				
Dimensions / Weight	aluminum housing: 58 mm x 90 mm x 31 m	m / about 200 g			
Reliability according EN ISO 13849-18					
MTTF	302 years				
MTTFd	572 years				
CE conformity					
EC Directives					
2014/30/EU	EMC directive				
2011/65/EU	RoHS directive				
Harmonized standards					
DIN EN 61326-1:2013-07	Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1: General requirements				
DIN EN 50581:2013-02	Technical documentation for the assessment of electrical and electronic products with re- spect to the restriction of hazardous substances				

Table 6: Technical Data IS1MA360-I-BL + IS2MA090-I-BL

all indicated angle accuracies are valid after a running time of 10 minutes at 25 °C, Cut-off frequency 0.3 Hz Absolute calibration accuracy (at 25 °C): ±0.05°
 for full temperature range up to 80 °C limited combinations of supply voltage and load resistance are permitted only, see figure 5

for full temperature range up to 80 °C limited combinations of supply voltage and load resistance are permitted only, see figure 5
 This product is a standard product and no safety part in accordance with the machinery directive. The calculation is based on an average environment temperature of 40 °C and a usage of 8760 h/a.



Tansient Emissions Limit curves broadband and narrowband DIN EN ISO 14982 (agricultural and forestry machinery) respectively DIN EN 13309 (construction machinery) a1000 MHz (vertical and horizontal) Immunity to Radio Frequency Fields (RF Fields according to DIN EN ISO 14982 (agricultural and forestry machinery) respectively DIN EN 13309 (construction machinery) a400 MHz Strip line according to ISO 11452-5 Limits according to DIN EN ISO 14982 (agricultural and forestry machinery) respectively DIN EN 1309 (construction machinery) 20400 MHz 120 V/m (1 kHz AM) Performance criteria A Anechoic chamber according to ISO 11452-2 Limits according to DIN EN ISO 14982 (agricultural and forestry machinery) respectively DIN EN 1309 (construction machinery) 20400 MHz 120 V/m (1 kHz AM) Performance criteria A Anechoic chamber according to ISO 11452-2 Limits according to DIN EN ISO 14982 (agricultural and forestry machinery) respectively DIN EN 13309 (construction machinery) 20400 MHz vertical, 100 V/m (1 kHz AM, 80 %) 8002000 MHz vertical, 100 V/m (1 kHz AM, 80 %) 8002000 MHz vertical, 100 V/m (1 kHz AM, 80 %) 8002000 MHz vertical, 100 V/m (1 kHz AM, 80 %) 8002000 MHz vertical, 100 V/m (1 kHz AM, 80 %) 8002000 MHz vertical, 100 V/m (1 kHz AM, 80 %) 8002000 MHz vertical, 100 V/m (1 kHz AM, 80 %) 8002000 MHz vertical, 100 V/m (1 kHz AM, 80 %) 8002000 MHz vertical, 100 V/m (1 kHz AM, 80 %) 8002000 MHz vertical, 100 V/m (1 kHz AM, 80 %) 8002000 MHz vertical, 100 V/m (1 kHz AM, 80 %) 8002000 MHz vertical, 100 V/m (1 kHz AM, 80 %) 8002000 MHz vertical, 100 V/m (1 kHz AM, 80 %) 8002000 MHz vertical, 100 V/m (1 kHz AM, 80 %) 8002000 MHz vertical, 100 V/m (1 kHz AM, 80 %) 8002000 MHz vertical, 100 V/m (1 kHz AM, 80 %) 8002000 MHz vertical, 100 V/m (1						
DIN EN ISO 14982 (agricultural and forestry machinery) respectively DIN EN 13309 (construction machinery) 30 1000 MHz (vertical and horizontal) Immunity to Radio Frequency Fields (RF field) Strip line according to ISO 11452-5 Limits according to DIN EN ISO 14982 (agricultural and forestry machinery) respectively DIN EN ISO 14982 (agricultural and forestry machinery) Radio Frequency Fields accord						
Immunity to Radio Frequency Fields (RF fields) Strip line according to ISO 11452-5 Limits according to DIN EN ISO 14982 (agricultural and forestry machinery) respectively DIN EN 13309 (construction machinery) 20400 MHz 120 V/m (1 kHz AM) Performance criteria A Anechoic chamber according to ISO 11452-2 Limits according to DIN EN ISO 14982 (agricultural and forestry machinery) respectively DIN EN ISO 14982 (agricultural and forestry machinery) respectively DIN EN ISO 14982 (agricultural and forestry machinery) respectively DIN EN ISO 14982 (agricultural and forestry machinery) respectively DIN EN ISO 14982 (agricultural and forestry machinery) respectively DIN EN I3309 (construction machinery) 200 1000 MHz vertical, 100 V/m (1 kHz AM, 80 %) 800 2000 MHz vertical, 100 V/m (1 kHz AM, 80 %) 800 2000 MHz vertical, 100 V/m (PM, t = 577 µs, period 4600 µs) Performance criteria A Radio Frequency Fields according to IEC 61000-4-3 Limits according to EN 61326-1 Immunity to Conducted Disturbances Test pulse according to ISO 7637-2 Test pulse Severity level Performance criteria						
Strip line according to ISO 11452-5Limits according to DIN EN ISO 14982 (agricultural and forestry machinery) respectively DIN EN I3309 (construction machinery) 20 400 MHz 120 V/m (1 kHz AM) Performance criteria AAnechoic chamber according to ISO 11452-2Limits according to DIN EN ISO 14982 (agricultural and forestry machinery) respectively DIN EN ISO 14982 (agricultural and forestry machinery) respectively DIN EN ISO 14982 (agricultural and forestry machinery) respectively DIN EN 13309 (construction machinery) 200 1000 MHz vertical, 100 V/m (1 kHz AM, 80 %) 800 2000 MHz vertical, 100 V/m (1 kHz AM, 80 %) 800 2000 MHz vertical, 100 V/m (PM, t =577 µs, period 4600 µs) Performance criteria ARadio Frequency Fields according to IEC 61000-4-3Limits according to EN 61326-1Immunity to Conducted DisturbancesTest pulse according to ISO 7637-2Test pulse according to ISO 7637-2Test pulseSeverity levelPerformance criteria						
DIN EN ISO 14982 (agricultural and forestry machinery) respectively DIN EN 13309 (construction machinery) 20 400 MHz 120 V/m (1 kHz AM) Performance criteria AAnechoic chamber according to ISO 11452-2 DIN EN ISO 14982 (agricultural and forestry machinery) respectively DIN EN 13309 (construction machinery) 200 1000 MHz vertical, 100 V/m (1 kHz AM, 80 %) 800 2000 MHz vertical, 100 V/m (1 kHz AM, 80 %) 800 2000 MHz vertical, 100 V/m (PM, t =577 µs, period 4600 µs) Performance criteria ARadio Frequency Fields according to IEC 61000-4-3Limits according to EN 61326-1Immunity to Conducted DisturbancesTest pulse according to ISO 7637-2Test pulse according to ISO 7637-2Test pulseSeverity levelPerformance criteria						
DIN EN ISO 14982 (agricultural and forestry machinery) respectively DIN EN ISO 14982 (agricultural and forestry machinery) DIN EN 13309 (construction machinery) 200 1000 MHz vertical, 100 V/m (1 kHz AM, 80 %) 800 2000 MHz vertical, 100 V/m (PM, t =577 µs, period 4600 µs) Performance criteria A Radio Frequency Fields according to IEC 61000-4-3 Immunity to Conducted Disturbances Test pulse according to ISO 7637-2 Test pulse Severity level Performance criteria						
IEC 61000-4-3 Immunity to Conducted Disturbances Test pulse according to ISO 7637-2 Test pulse Severity level Performance criteria						
Test pulse according to ISO 7637-2 Test pulse Severity level Performance criteria						
$\begin{array}{cccccccccccccccccccccccccccccccccccc$						
Burst according to IEC 61000-4-4 Limits according to EN 61326-1						
Surge according to IEC 61000-4-5 Limits according to EN 61326-1						
Conducted HF-Signals according to Limits according to EN 61326-1 IEC 61000-4-6						
Immunity to Electromagnetic Discharge (ESD)						
ESD according to ISO 10605 Limits according to DIN EN ISO 14982 (agricultural and forestry machinery) respectively DIN EN ISO 13309 (construction machinery) discharge combination 330 pF / 330 Ω Contact discharge 8 kV bipolar (metallic parts)						
Air discharge 15 kV bipolar Performance criteria A						

Table 7: Electromagnetic Compatibility (EMC) IS1MA360-I-BL + IS2MA090-I-BL

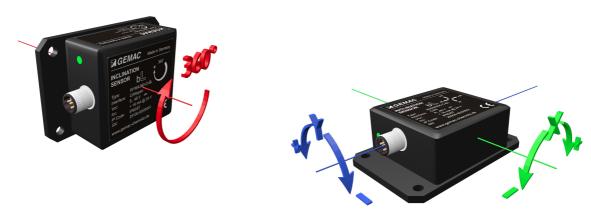


Figure 4: Measurement axes orientation - IS1MA36 ry default setting)





4.1 Load Resistance IS1MA360-I-BL + IS2MA090-I-BL

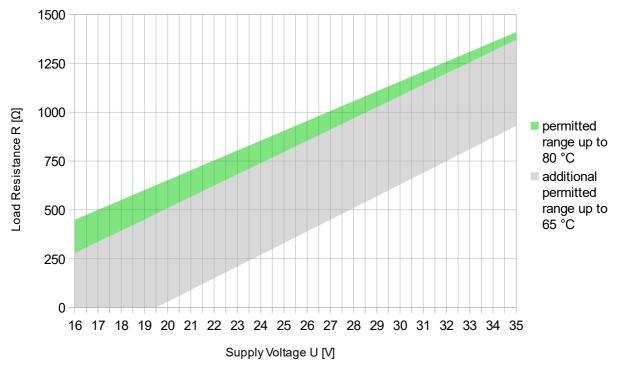
Power dissipation depends on supply voltage and the load resistance. To reduce power dissipation, which may cause overheating, the load resistor should be chosen according to supply voltage. Table 8 and figure 5 show the relation between supply voltage and the permitted load resistance for different temperature ranges.

The green area in figure 5 shows the permitted load resistance depending on supply voltage for operating temperatures up to 80 °C. Combinations of supply voltage and load resistor within the gray colored area are permitted for a limited operating temperature range up to 65°C in addition.

The following values of minimum and maximum load resistance are meant as total resistance as sum of resistance of the load resistor and cable resistance (see 9.3 Cable length and minimum supply voltage for current interface).

U _{dd} [V]	R _L min. [Ω] @ Ta _{max} = 65 °C	R _L min. [Ω] @ Ta _{max} = 80 °C	R _∟ max. [Ω]
16	0	280	450
24	270	740	850
28	510	970	1050
35	930	1370	1400

 Table 8: Minimum and maximum Load Resistance IS1MA360-I-BL + IS2MA090-I-BL at different Operating Temperatures







5 Technical Data IS1MA360-U-BL + IS2MA090-U-BL

General Parameters ⁹	IS1MA360-U-BL	IS2MA090-U-BL			
Measurement range	360°	±90°			
Resolution	0.01° 0.01° (0.09° at measurement range 360°) (0.045° at measurement range				
Accuracy	$\begin{array}{cccc} \mbox{Range} & \mbox{typical} & \mbox{maximum} \\ 0360^\circ & \mbox{\pm}0.15^\circ & \mbox{\pm}0.25^\circ & \mbox{up to } \mbox{\pm}60^\circ & \mbox{\pm}0.10^\circ \\ \mbox{up to } \mbox{\pm}80^\circ & \mbox{\pm}0.20^\circ \end{array}$				
Cross Sensitivity (compensated)	- typ. ±0.09° (±0.10 %FS) max. ±0.45° (±0.50 %FS)				
Temperature coefficient (zero point)	typ. ±	:0.01 °/K			
Sampling rate	10	00 Hz			
Cut-off frequency	typ. 20 Hz, 2 nd order (without digital filter digital filter: critically dar	r) / 0.1 25 Hz, 8^{th} order (with digital filter) nped filter 8^{th} order at 2 Hz			
Operating temperature	-40 °C	to +80 °C			
Characteristics					
Voltage interface	freely adjustable output in the range 010.4 freely adjustable angle in the range 0360°				
Functions	Teach input for zero point adjustment when installed Limit value , Axis direction and assignment of the outputs are adjustable Digital filter (critically damped (default) or Butterworth lowpass, 8 th order)				
Electrical Parameters					
Supply voltage	16 to 35 VDC				
Current consumption	35 mA @ 24 V				
Outputs (short-circuit proof)	capacitive load less than 1 $\mu F_{\text{,}}$ resistive load	l greater than 1 k Ω			
Mechanical Parameters					
Connection	Sensor connector 5-pole M12 (male)				
Degree of protection	IP65/67				
Dimensions / Weight	aluminum housing: 58 mm x 90 mm x 31 m	ım / about 200 g			
Reliability according EN ISO 13849-1 ¹⁰					
MTTF	354 years				
MTTFd	664 years				
CE conformity					
EC Directives					
2014/30/EU	EMC directive				
2011/65/EU	RoHS directive				
Harmonized standards					
Harmonized standards DIN EN 61326-1:2013-07	Electrical equipment for measurement, cont Part 1: General requirements	rol and laboratory use - EMC requirements			

Table 9: Technical Data IS1MA360-U-BL + IS2MA090-U-BL

⁹ all indicated angle accuracies are valid after a running time of 10 minutes at 25 °C, Cut-off frequency 0.3 Hz Absolute calibration accuracy (at 25 °C): ±0.05° This product is a standard product and no safety part in accordance with the machinery directive. The calculation is based on an

¹⁰ average environment temperature of 40 °C and a usage of 8760 h/a.



Electromagnetic Compatibility (EMC)				
Transient Emissions				
Radiated disturbance / Radio field strength	Limit curves broadband and narrowband DIN EN ISO 14982 (agricultural and forestry machinery) respectively DIN EN 13309 (construction machinery) 30 1000 MHz (vertical and horizontal) Limits according to CISPR 11			
Immunity to Radio Frequency Fields (RF fie	lds)			
Strip line according to ISO 11452-5	Limits according to DIN EN ISO 14982 (agricultural and forestry machinery) respectively DIN EN 13309 (construction machinery) 20 400 MHz 120 V/m (1 kHz AM) Performance criteria A			
Anechoic chamber according to ISO 11452-2	Limits according to DIN EN ISO 14982 (agricultural and forestry machinery) respectively DIN EN 13309 (construction machinery) 200 1000 MHz vertical, 100 V/m (1 kHz AM, 80 %) 800 2000 MHz vertical, 100 V/m (PM, t =577 µs, period 4600 µs) Performance criteria A			
Radio Frequency Fields according to IEC 61000-4-3	Limits according to EN	61326-1		
Immunity to Conducted Disturbances				
Test pulse according to ISO 7637-2 (on-board power supply 24 VDC)	Test pulse 1 -450 V 2a +37 V 2b +20 V 3a -150 V 3b +150 V 4 -12 V 5a +70 V 5b +36 V	Severity level III III III III III III Ri = 1 Ω Ri = 0.5 Ω	Performance criteria C B C A A A B B B	
Immunity to Electromagnetic Discharge (ES	SD)			
ESD according to ISO 10605	Limits according to DIN EN ISO 14982 (agricultural and forestry machinery) respectively DIN EN ISO 13309 (construction machinery) discharge combination 330 pF / 330 Ω Contact discharge 8 kV bipolar (metallic parts) Air discharge 15 kV bipolar Performance criteria A			
ESD according to IEC 61000-4-2	Limits according to EN	61326-1		

Table 10: Electromagnetic Compatibility (EMC) IS1MA360-U-BL + IS2MA090-U-BL

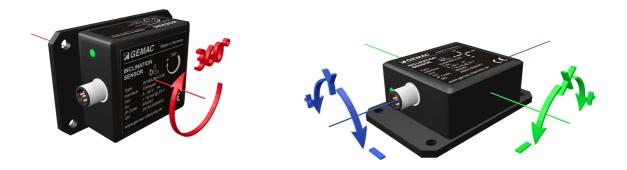


Figure 6: Measurement axes orientation - IS1MA360-U-BL + IS2MA090-U-BL aluminum housing (factory default setting)



6 Technical Data IS1BP360-I-BL + IS2BP090-I-BL

General Parameters ¹¹	IS1BP36	IS2BP090-I-BL			
Measurement range	360	360° ±90°			
Resolution	0.01° 0.045° at measurement range 360°) (0.045° at measurement range ±9				
Accuracy	$\begin{array}{cccccccccccccccccccccccccccccccccccc$				
Cross Sensitivity (compensated)	-			o. ±0.09° (±0. k. ±0.45° (±0.	
Temperature coefficient (zero point)		typ. ±	0.01 °/K		
Sampling rate		10	0 Hz		
Cut-off frequency	typ. 20 Hz, 2 nd order (v	vithout digital filter) / (filter: critically dampe).1 25 Hz, 8 ^t d filter 8 th order	^h order (with o r at 2 Hz	ligital filter)digital
Operating temperature		-40 °C to	• +80 °C 12		
Characteristics					
Current interface	freely adjustable output freely adjustable angle				
Functions	Teach input for zero point adjustment when installed Limit value , Axis direction and assignment of the outputs are adjustable Digital filter (critically damped (default) or Butterworth lowpass, 8 th order)				
Electrical Parameters					
Supply voltage	16 to 35 VDC				
Current consumption	35 mA @ 24 V + I _{loop}				
Outputs (short-circuit proof)	inductive load less than permitted load resistand		/ voltage (see t	able 13 and f	igure 8)
Mechanical Parameters					
Connection	Sensor connector 5-pol	le M12 (male)			
Degree of protection	IP65/67				
Dimensions / Weight	plastic housing: 66 mm	x 90 mm x 36 mm /	about 200 g		
Reliability according EN ISO 13849-1	13				
MTTF	302 years				
MTTFd	572 years				
CE conformity					
EC Directives					
2014/30/EU	EMC directive				
2011/65/EU	RoHS directive				
Harmonized standards					
DIN EN 61326-1:2013-07	Electrical equipment for Part 1: General require		ol and laborate	ory use - EMC	requirements -
DIN EN 50581:2013-02	Technical documentation spect to the restriction of			nd electronic	products with re-

Table 11: Technical Data IS1BP360-I-BL + IS2BP090-I-BL

all indicated angle accuracies are valid after a running time of 10 minutes at 25 °C, Cut-off frequency 0.3 Hz Absolute calibration accuracy (at 25 °C): ±0.05°
 for full temperature range up to 80 °C limited combinations of supply voltage and load resistance are permitted only, see figure 8

 ¹² for full temperature range up to 80 °C limited combinations of supply voltage and load resistance are permitted only, see figure 8
 13 This product is a standard product and no safety part in accordance with the machinery directive. The calculation is based on an average environment temperature of 40 °C and a usage of 8760 h/a.



Electromagnetic Compatibility (EMC)					
Transient Emissions					
Radiated disturbance / Radio field strength	DIN EN ISO 14982 (ag DIN EN 13309 (constru	Limit curves broadband and narrowband DIN EN ISO 14982 (agricultural and forestry machinery) respectively DIN EN 13309 (construction machinery) 30 1000 MHz (vertical and horizontal)			
	Limits according to CISPR 11				
Immunity to Radio Frequency Fields (RF field)	lds)				
Strip line according to ISO 11452-5	Limits according to DIN EN ISO 14982 (agricultural and forestry machinery) respectively DIN EN 13309 (construction machinery) 20 400 MHz 120 V/m (1 kHz AM) Performance criteria A				
Anechoic chamber according to ISO 11452-2	Limits according to DIN EN ISO 14982 (agricultural and forestry machinery) respectively DIN EN 13309 (construction machinery) 200 1000 MHz vertical, 100 V/m (1 kHz AM, 80 %) 800 2000 MHz vertical, 100 V/m (PM, t =577 µs, period 4600 µs) Performance criteria A				
Radio Frequency Fields according to IEC 61000-4-3	Limits according to EN 61326-1				
Immunity to Conducted Disturbances					
Test pulse according to ISO 7637-2 (on-board power supply 24 VDC)	Test pulse 1 -450 V 2a +37 V 2b +20 V 3a -150 V 3b +150 V 4 -12 V 5a +70 V	Severity level III III III III III III III I	Performance criteria C B C A A A A		
Burst according to IEC 61000-4-4	Limits according to EN		A		
Burst according to IEC 61000-4-4 Surge according to IEC 61000-4-5	Limits according to EN Limits according to EN	61326-1	A		
-		61326-1 61326-1	A		
Surge according to IEC 61000-4-5 Conducted HF-Signals according to	Limits according to EN Limits according to EN	61326-1 61326-1	A		
Surge according to IEC 61000-4-5 Conducted HF-Signals according to IEC 61000-4-6	Limits according to EN Limits according to EN SD) Limits according to DIN EN ISO 14982 (ac DIN EN ISO 13309 (cc discharge combination	I 61326-1 I 613			

Table 12: Electromagnetic Compatibility (EMC) IS1BP360-I-BL + IS2BP090-I-BL



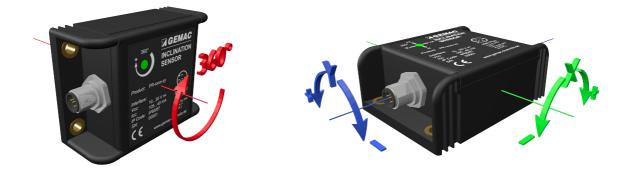


Figure 7: Measurement axes orientation - IS1BP360-I-BL + IS2BP090-I-BL big plastic housing (factory default settings)



6.1 Load Resistance IS1BP360-I-BL + IS2BP090-I-BL

Power dissipation depends on supply voltage and the load resistance. To reduce power dissipation, which may cause overheating, the load resistor should be chosen according to supply voltage. Table 13 and figure 8 show the relation between supply voltage and the permitted load resistance for different temperature ranges.

The green area in figure 8 shows the permitted load resistance depending on supply voltage for operating temperatures up to 80 °C. Combinations of supply voltage and load resistor within the gray colored area are permitted for a limited operating temperature range up to 65°C in addition.

The following values of minimum and maximum load resistance are meant as total resistance as sum of resistance of the load resistor and cable resistance (see 9.3 Cable length and minimum supply voltage for current interface).

U _{dd} [V]	R _L min. [Ω] @ Ta _{max} = 65 °C	R _L min. [Ω] @ Ta _{max} = 80 °C	R _∟ max. [Ω]
16	0	280	450
24	270	740	850
28	510	970	1050
35	930	1370	1400

Table 13: Minimum, typical and maximum Load Resistance IS1BP360-I-BL + IS2BP090-I-BL

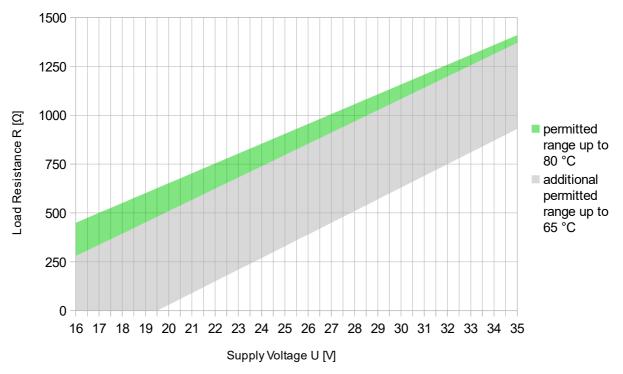


Figure 8: Permitted Load Resistance IS1BP360-I-BL + IS2BP090-I-BL



7 Technical Data IS1BP360-U-BL + IS2BP090-U-BL

General Parameters ¹⁴	IS1BP360-U-BL	IS2BP090-U-BL		
Measurement range	360°	±90°		
Resolution	0.01° 0.01° (0.09° at measurement range 360°) (0.045° at measurement range :			
Accuracy	Rangetypicalmaximum0360°±0.15°±0.25°	$\begin{array}{llllllllllllllllllllllllllllllllllll$		
Cross Sensitivity (compensated)	-	typ. ±0.09° (±0.10 %FS) max. ±0.45° (±0.50 %FS)		
Temperature coefficient (zero point)	typ. ±	:0.01 °/K		
Sampling rate	10	0 Hz		
Cut-off frequency	typ. 20 Hz, 2 nd order (without digital filter) / critically damped f	$0.1 \hdots 25 \mbox{ Hz}, 8^{th} \mbox{ order}$ (with digital filter)filter: îilter 8^{th} order at 2 Hz		
Operating temperature	-40 °C	to +80 °C		
Characteristics				
Voltage interface	freely adjustable output in the range 010.4 freely adjustable angle in the range 0360°			
Functions	Teach input for zero point adjustment when installed Limit value , Axis direction and assignment of the outputs are adjustable Digital filter (critically damped (default) or Butterworth lowpass, 8 th order)			
Electrical Parameters				
Supply voltage	16 to 35 VDC			
Current consumption	35 mA @ 24 V			
Outputs (short-circuit proof)	capacitive load less than 1 $\mu\text{F},$ resistive load	l greater than 1 kΩ		
Mechanical Parameters				
Connection	Sensor connector 5-pole M12 (male)			
Degree of protection	IP65/67			
Dimensions / Weight	plastic housing: 66 mm x 90 mm x 36 mm /	about 200 g		
Reliability according EN ISO 13849-1 ¹⁵				
MTTF	354 years			
MTTFd	664 years			
CE conformity				
EC Directives				
2014/30/EU	EMC directive			
2011/65/EU	RoHS directive			
Harmonized standards				
DIN EN 61326-1:2013-07	Electrical equipment for measurement, cont Part 1: General requirements	rol and laboratory use - EMC requirements -		
DIN EN 50581:2013-02	Part 1: General requirements Technical documentation for the assessment of electrical and electronic products with re- spect to the restriction of hazardous substances			

Table 14: Technical Data IS1BP360-U-BL + IS2BP090-U-BL

¹⁴ All indicated angle accuracies are valid after a running time of 10 minutes at 25 °C, Cut-off frequency 0.3 Hz Absolute calibration accuracy (at 25 °C): ±0.05° This product is a standard product and no safety part in accordance with the machinery directive. The calculation is based on an

¹⁵ average environment temperature of 40 °C and a usage of 8760 h/a.



Transient Emissions Radiated disturbance / Radio field strength Limit curves broadband and narrowband DIN EN ISO 14982 (agricultural and forestry machinery) respectively DIN EN 13309 (construction machinery) 30 1000 MHz (vertical and horizontal) Immunity to Radio Frequency Fields (RF fields continue) Limits according to CISPR 11 Immunity to Radio Frequency Fields (RF fields (RF fields)) DIN EN 1309 (construction machinery) 20 400 MHz Strip line according to ISO 11452-5 DIN EN ISO 14982 (agricultural and forestry machinery) respectively DIN EN 13309 (construction machinery) 20 400 MHz Anechoic chamber according to ISO 11452-2 Limits according to DIN EN ISO 14982 (agricultural and forestry machinery) respectively DIN EN 13309 (construction machinery) 20 400 MHz Anechoic chamber according to ISO 11452-2 Limits according to DIN EN ISO 14982 (agricultural and forestry machinery) respectively DIN EN ISO 14982 (agricultural and forestry machinery) re	Electromagnetic Compatibility (EMC)						
DIN EN ISO 14982 (agricultural and forestry machinery) respectively DIN EN 13309 (construction machinery) 30 1000 MHz (vertical and horizontal) Immunity to Radio Frequency Fields (RF fields) Strip line according to ISO 11452-5 Limits according to DIN EN ISO 14982 (agricultural and forestry machinery) respectively DIN EN ISO 14982 (agricultural and forestry machinery) respectively DIN EN ISO 14982 (agricultural and forestry machinery) respectively DIN EN 1309 (construction machinery) 20 400 MHz 120 V/m (1 KHz AM) Performance criteria A Anechoic chamber according to ISO 11452-2 Limits according to DIN EN ISO 14982 (agricultural and forestry machinery) respectively DIN EN 13309 (construction machinery) 20 400 MHz Anechoic chamber according to ISO 11452-2 Limits according to DIN EN ISO 14982 (agricultural and forestry machinery) respectively DIN EN 13309 (construction machinery) 200 1000 MHz vertical, 100 V/m (1 kHz AM, 80 %) 800 2000 MHz vertical, 100 V/m (1 kHz AM, 80 %) 800 2000 MHz vertical, 100 V/m (PM, t =577 µs, period 4600 µs) Performance criteria A Radio Frequency Fields according to IEC 61000-4-3 Limits according to EN 61326-1 Immunity to Conducted Disturbances Everity level Performance criteria 1450 V	Transient Emissions	Transient Emissions					
Immunity to Radio Frequency Fields (RF fields) Strip line according to ISO 11452-5 Limits according to DIN EN ISO 14982 (agricultural and forestry machinery) respectively DIN EN 13309 (construction machinery) 20 400 MHz 120 V/m (1 kHz AM) Performance criteria A Limits according to ISO 11452-2 Anechoic chamber according to ISO 11452-2 Limits according to DIN EN ISO 14982 (agricultural and forestry machinery) respectively DIN EN ISO 14982 (agricultural and forestry machinery) respectively DIN EN ISO 14982 (agricultural and forestry machinery) respectively DIN EN ISO 14982 (agricultural and forestry machinery) respectively DIN EN ISO 14982 (agricultural and forestry machinery) respectively DIN EN 13309 (construction machinery) 200 1000 MHz vertical, 100 V/m (1 kHz AM, 80 %) 800 2000 MHz vertical, 100 V/m (PM, t =577 µs, period 4600 µs) Performance criteria A Radio Frequency Fields according to IEC 61000-4-3 Immunity to Conducted Disturbances Test pulse according to ISO 7637-2 (on-board power supply 24 VDC) Test pulse Severity level Performance criteria	Radiated disturbance / Radio field strength	DIN EN ISO 14982 (agricultural and forestry machinery) respectively DIN EN 13309 (construction machinery)					
Strip line according to ISO 11452-5 Limits according to DIN EN ISO 14982 (agricultural and forestry machinery) respectively DIN EN 13309 (construction machinery) 20 400 MHz 120 V/m (1 kHz AM) Performance criteria A Anechoic chamber according to ISO 11452-2 Limits according to DIN EN ISO 14982 (agricultural and forestry machinery) respectively DIN EN ISO 14982 (agricultural and forestry machinery) respectively DIN EN ISO 14982 (agricultural and forestry machinery) respectively DIN EN ISO 14982 (agricultural and forestry machinery) respectively DIN EN ISO 14982 (agricultural and forestry machinery) respectively DIN EN 13309 (construction machinery) 200 1000 MHz vertical, 100 V/m (1 kHz AM, 80 %) 800 2000 MHz vertical, 100 V/m (1 kHz AM, 80 %) 800 2000 MHz vertical, 100 V/m (1 kHz AM, 80 %) 800 2000 MHz vertical, 100 V/m (1 kHz AM, 80 %) 800 2000 MHz vertical, 100 V/m (1 kHz AM, 80 %) 800 2000 MHz vertical, 100 V/m (1 kHz AM, 80 %) 800 2000 MHz vertical, 100 V/m (1 kHz AM, 80 %) 800 2000 MHz vertical, 100 V/m (1 kHz AM, 80 %) 800 2000 MHz vertical, 100 V/m (1 kHz AM, 80 %) 800 2000 MHz vertical, 100 V/m (1 kHz AM, 80 %) 800 2000 MHz vertical, 100 V/m (1 kHz AM, 80 %) 800 2000 MHz vertical, 100 V/m (1 kHz AM, 80 %) 800 2000 MHz vertical, 100 V/m (1 kHz AM, 80 %) Radio Frequency Fields according to IEC 61000-4-3 Limits according to EN 61326-1 Immunity to Conducted Disturbances Test pulse according to ISO 7637-2 (on-board power supply 24 VDC) Test pulse Severity level Performance criteria C		Limits according to CISPR 11					
DIN EN ISO 14982 (agricultural and forestry machinery) respectively DIN EN 13309 (construction machinery) 20 400 MHz 120 V/m (1 kHz AM) Performance criteria AAnechoic chamber according to ISO 11452-2 DIN EN ISO 14982 (agricultural and forestry machinery) respectively DIN EN 1309 (construction machinery) 200 1000 MHz vertical, 100 V/m (1 kHz AM, 80 %) 800 2000 MHz vertical, 100 V/m (1 kHz AM, 80 %) 800 2000 MHz vertical, 100 V/m (PM, t =577 μs, period 4600 μs) Performance criteria ARadio Frequency Fields according to IEC 61000-4-3Limits according to EN 61326-1Immunity to Conducted DisturbancesTest pulse according to ISO 7637-2 1 -450 VTest pulse severity level IIIPerformance criteria C	Immunity to Radio Frequency Fields (RF fie	elds)					
DIN EN ISO 14982 (agricultural and forestry machinery) respectively DIN EN 13309 (construction machinery) 200 1000 MHz vertical, 100 V/m (1 kHz AM, 80 %) 800 2000 MHz vertical, 100 V/m (PM, t =577 µs, period 4600 µs) Performance criteria A Radio Frequency Fields according to IEC 61000-4-3 Limits according to EN 61326-1 Immunity to Conducted Disturbances Exercise Severity level Test pulse according to ISO 7637-2 (on-board power supply 24 VDC) Test pulse 1 Severity level Performance criteria C	Strip line according to ISO 11452-5	DIN EN ISO 14982 (agricultural and forestry machinery) respectively DIN EN 13309 (construction machinery) 20 400 MHz 120 V/m (1 kHz AM)					
IEC 61000-4-3 Immunity to Conducted Disturbances Test pulse according to ISO 7637-2 (on-board power supply 24 VDC) Test pulse Severity level Performance criteria C	Anechoic chamber according to ISO 11452-2	DIN EN ISO 14982 (agricultural and forestry machinery) respectively DIN EN 13309 (construction machinery) 200 1000 MHz vertical, 100 V/m (1 kHz AM, 80 %) 800 2000 MHz vertical, 100 V/m (PM, t =577 μs, period 4600 μs)					
Test pulse according to ISO 7637-2 (on-board power supply 24 VDC) Test pulse 1 Severity level 450 V Performance criteria C		Limits according to EN 61326-1					
(on-board power supply 24 VDC) 1 -450 V III C	Immunity to Conducted Disturbances						
$\begin{array}{cccccccccccccccccccccccccccccccccccc$		1 -450 V III C 2a +37 V III B 2b +20 V III C 3a -150 V III A 3b +150 V III A 4 -12 V III A 5a +70 V Ri = 1 Ω B					
Immunity to Electromagnetic Discharge (ESD)	Immunity to Electromagnetic Discharge (ES	SD)					
ESD according to ISO 10605 Limits according to DIN EN ISO 14982 (agricultural and forestry machinery) respectively DIN EN ISO 13309 (construction machinery) discharge combination 330 pF / 330 Ω Contact discharge 6 kV bipolar (metallic parts) Air discharge 8 kV bipolar Performance criteria A	ESD according to ISO 10605	DIN EN ISO 14982 (agricultural and forestry machinery) respectively DIN EN ISO 13309 (construction machinery) discharge combination 330 pF / 330 Ω Contact discharge 6 kV bipolar (metallic parts) Air discharge 8 kV bipolar					
ESD according to IEC 61000-4-2 Limits according to EN 61326-1	ESD according to IEC 61000-4-2	Limits according to EN 61326-1					

Table 15: Electromagnetic Compatibility (EMC) IS1BP360-U-BL + IS2BP090-U-BL

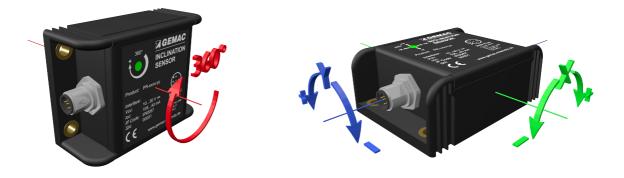


Figure 9: Measurement axes orientation - IS1BP360-U-BL + IS2BP090-U-BL big plastic housing (factory default settings)





8 Mounting

8.1 Position of Drilling Holes

The four drilling holes to mount the sensor are situated in the base plate of the plastic- (Figure 10) or aluminum housing (Figure 11) respectively.

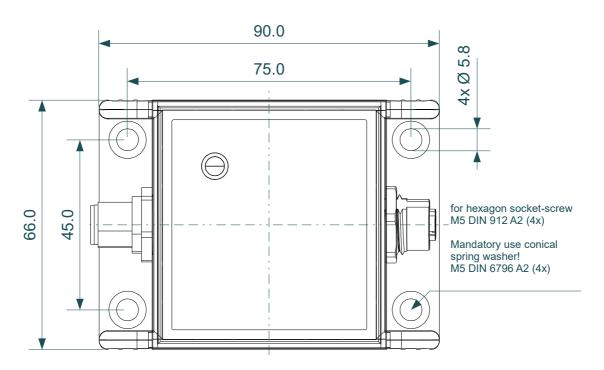
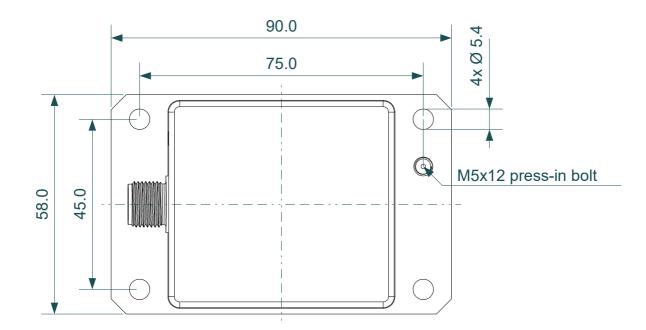


Figure 10: Dimensioned Sketch of big plastic housing (BP) (dimensions in mm)







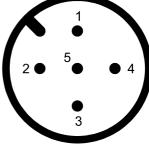
9 Connection

9.1 Connector Pin Out

The inclination sensors ISxxxxx-I-xL and ISxxxxx-U-xL are equipped with a common 5-pole round plug M12 (A-coded).

Pin	Signal	Allocation	
1	V+	Supply voltage (+24 V)	
2	B-OUT (Standard Y)	Sensor output B	
3	V- / GND	Supply voltage ground / Sensor ground	2 🔴
4	A-OUT (Standard X)	Sensor output A	
5	TEACH	Input for zero point adjustment	

Figure 12: Connector Pin Out



(View from the outside)

9.2 Connection diagram

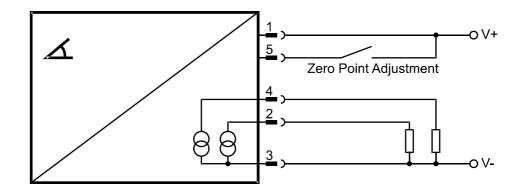


Figure 13: Connection diagram: current interface

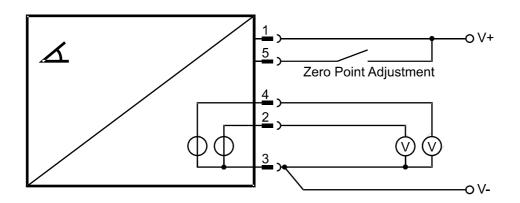


Figure 14: Connection diagram: voltage interface



9.3 Cable length and minimum supply voltage for current interface

At current interface (IS1xx360-I-xL + IS2xx090-I-xL), the required supply voltage is increased by the voltage drop on the connected cable. The highest voltage drop on the cable is produced when the maximum current of 20 mA is flowing through the resistance of the cable (R_L). Here, the resistance of the outgoing and the incoming wire must be taken into account (refer to Figure 15).

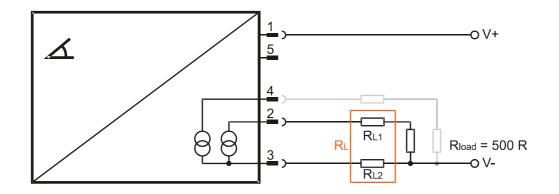


Figure 15: Cable length at current interface

It is necessary to ensure, that the total load resistance as sum of resistance of the load resistor and cable resistance is within the permitted range.

The following table shows examples of the possible cable length at minimum supply voltage and the corresponding wire size (cross section). The table is based on the calculation of the line resistance according to VDE 0295 and a load resistance (Rload) of 500 Ω .

Minimum	Cable	Maximum cable length in m at wire sizes of:					
supply voltage in V	resistance in Ω	0.14 mm ²	0.25 mm²	0.34 mm²	0.50 mm²	0.75 mm²	
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	

 Table 16: Cable length at minimum supply voltage and different wires sizes



10 Functional description

10.1 Axis assignment / Axis direction

All inclination sensors ISxxxxx-I-xL and ISxxxxx-U-xL have two analog outputs A and B that can be assigned to any in hardware available X and Y axes for the 2-dimensional inclination sensor and to the rotation axis in the 1-dimensional inclination sensor. An assignment of both outputs to the same axis is also possible. With the optional inversion of the axis direction, every conceivable constellation of the output assignment is possible. The axis direction can be changed by swapping the upper and lower current or voltage output values.

10.2 Zero Point Adjustment

For all inclination sensors ISxxxxx-I-xL and ISxxxxx-U-xL, the zero point can be adjusted. This allows to set the zero position in the installed state of the sensor. This can either be made via the PC program ISD-Control in combination with the starter-kit ISPA1 (PR-23999-02), by the teach adapter TA1 (PR-23998-00) or by means of the teach input. To set the zero point using the teaching input, it has to be connected for a period of at least one second with the supply voltage (V+, pin 1). The current position of the inclination sensor is then set for each output to zero degree angle. The sensor will confirm this by turning off the Status LED for the duration of one second. To reset the zero point to factory defaults, the teaching input has to be connected for the duration of three additional seconds to the supply voltage. The sensor will indicate this by turning off the Status LED also for three seconds.



10.3 Digital Filter

The inclination sensors ISxxxxx-I-xL und ISxxxxx-U-xL offers the possibility to suppress the influence of external disturbing vibrations. The internal lowpass digital filters (8th order) are programmable down to 0.1 Hz. The sensor has two digital filters that can be selected according to the application of the sensor.

Filter	Adjustable frequency range	Applications
Butterworth	0.1 Hz 25 Hz	Static inclination measurement with high damping to vibration
Critically damped	0.1 Hz 8 Hz	Inclination measurement in applications that requires a certain dynamism, without over- shoot at angle changes with good damping



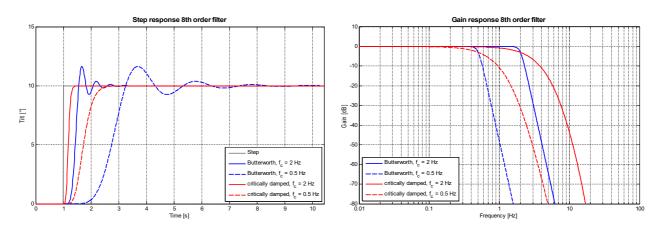


Figure 16: Impulse and amplitude response of the two filters

10.4 Status LED

The integrated two-color Status LED signals the recent device state. The color of the LED distinguish the different device states as shown in Table 18.

Status LED	Description			
Off	No power supply or teach confirmation			
Green	The device is in working condition			
Red	Current interface: one or both outputs in open circuit condition or wrong connected Voltage interface: one or both outputs in short circuit condition or wrong connected			

Table 18: Status and Error Display through Status LED



11 Sensor configuration

11.1 Inclination sensor programming adapter

With the optional inclination sensor programming adapter (starter kit ISPA1 - PR-23999-02) it is possible to adjust all inclination sensors with CAN/CANopen, current or voltage interface. The programming adapter is connected via USB to a PC. The connection of the sensors with the programming adapter is realized through various included adapter cables. The inclination sensor is supplied with power through the adapter. Except for the ISxTKxxx-C-RL there is no additional power supply necessary.

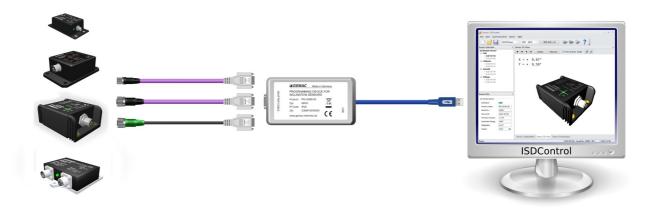


Figure 17: Starter kit



11.2 PC software ISDControl

The parametrization of all possible values is done with the PC software ISDControl, which is included in all starter kits. Each configuration can be stored in a file.

11.2.1 Configuration of all values

For all inclination sensors, the adjustment of the parameters can be done either numerically or graphically. (refer to Figure 18 and 19).

🖌 *Untitled - ISDCo	ntrol					- 0 X
<u>F</u> ile <u>V</u> iew <u>C</u> omr	munication <u>S</u> enso	or <u>H</u> elp				
🗋 🔂 🔒	Current/Voltage	• • 300h 30	01h	>	?	
Sensor Selection	×	Sensor Configuration				×
Inclination Sensor		All Parameters Analog Outputs				
CAN IS2D 90 P20		All Parameters Analog Outputs				
IS1D 00 P20			Document		Sensor	
IS2D 05 P26		Enable Digital Filter:	critical damped 🔹		critical damped	
CANopen IS2D 90 P21		Cut-off Frequency (in mHz):	2000		2000	
■ IS1D 00 P21		Enable Zero Point Adjustment:				
Current		Zero Offset X (in °/100):	0 (off)		0 (off)	Auto
■ IS2D 90 P24 ■ IS1D 00 P24		Zero Point Offset Y (in °/100):	0 (off)		0 (off)	Auto
Voltage						
		Channel A - Output:	X-Axis	Change	X-Axis	
● IS2BP0 	990-U-CL	Channel A - Limitation:	enabled	-	enabled	
L 1510 001 25		Channel A - Lower Inclination Value:	-90,00°		-90,00°	
		Channel A - Upper Indination Value:	90,00°	90,00°	90,00°	
ensor Info	×	Channel A - Lower Voltage Value:	0,000 V		0,000 V	
Connected Sensor —		Channel A - Upper Voltage Value:	10,000 V		10,000 V	
Interface:	VOLTAGE	Sharrad D. Ostanta	Y-Axis		Y-Axis	
Product Code:	PR-23554-00	Channel B - Output:		Change		
Serial No.:	00278	Channel B - Limitation:	enabled		enabled	
Device ID:	IS2D 90 P25	Channel B - Lower Inclination Value:	-90,00°		-90,00°	
		Channel B - Upper Inclination Value:	90,00°		90,00°	
Firmware Version:	v3.51	Channel B - Lower Voltage Value:	0,000 V		0,000 V	
Inclination Range:	±90°	Channel B - Upper Voltage Value:	10,000 V		10,000 V	
Resolution:	0,01°					
Status:	0x01 🥠					
		Construction Construction	C O			
		Sensor Configuration Sensor 3D-View	Sensor Oscilloscope			
eady			IS2D 90 P	25 - Serial No	.: 00278 📼	NUM ,

Figure 18: Numerical configuration of the inclination sensor

11 Sensor configuration



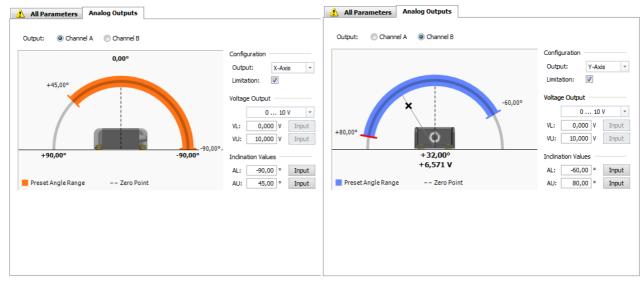


Figure 19: Graphical configuration of the outputs A and B

11.2.2 3D imaging and display of the current angle

Using the programs integrated 3D view, the position of the sensor in space can be visualized.

Eile <u>V</u> iew <u>C</u> ommunication <u>S</u> ensor <u>H</u> e	
Current/Voltage 💌	
ensor Selection	× Sensor 3D-View
Inclination Sensor	← → ↑ ↓ Default Fullscreen ♥ Show Indinat. Values
⊒ - CAN 	
	$X = -0.00^{\circ}$ $\Lambda = \pm 1.005$ V
⊞ IS2D 05 P26	$X = -0,09^{\circ}$ $A = + 4,995 V$ $Y = -0,88^{\circ}$ $B = + 4,951 V$
CANopen IS2D 90 P21	Y = - ⊍,88° B = + 4,951 V
■ IS1D 00 P21	
Current	
- Voltage	
● IS2BP090-U-CL 	
in and a second	×
nsor Info	×
nsor Info	×
nsor Info	×
nsor Info onnected Sensor Interface: VOLTAGE Product Code: PR-23554-00	×
Interface: VOLTAGE Product Code: PR-23554-00	×
ensor Info onnected Sensor Interface: VOLTAGE Product Code: PR-23554-00 Serial No.: 00278	×
imsor Info onnected Sensor Interface: VOLTAGE Product Code: PR-23554-00 Serial No.: 00278 Device ID: IS2D 90 P25 Firmware Version: v3.51	×
ensor Info connected Sensor Interface: VOLTAGE Product Code: PR-23554-00 Serial No.: 00278 Device ID: IS2D 90 P25 Firmware Version: v3.51	
imor Info onnected Sensor Interface: VOLTAGE Product Code: PR-23554-00 Serial No.: 00278 Device ID: IS2D 90 P25 Firmware Version: v3.51 Inclination Range: ±90°	
ensor Info Connected Sensor Interface: VOLTAGE Product Code: PR-23554-00 Serial No.: 00278 Device ID: IS2D 90 P25 Firmware Version: v3.51 Inclination Range: ±90° Resolution: 0,01°	X Sensor Configuration Sensor 3D-View Sensor Oscilloscope

Figure 20: 3D imaging and display of the current angle

11.2.3 Oscilloscope display of the current angle

In the oscilloscope display, the influence of the adjustable digital filter can be controlled directly. Time base of the view, and amplitude and offset can be set analog to the operation of an oscilloscope.

VIntitled - ISDControl								
<u>File View Communication Sensor H</u> elp								
🗋 🚰 🔚 Current/Voltage 🔹 📑 300h 301h								
Sensor Selection × Sensor Oscilloscope ×								
Sensor Selection × Inclination Sensor • • Inclination Sensor • • CAN • • ISD 09 P20 • • ISD 09 P21 • • ISD 00 P21 • • ISD 00 P24 • • ISD 00 P24 • • ISD 00 P24 • • ISD 00 P25 • Product Code: PR-23554-00 Serial No.: 00278 Device ID: ISD 90 P25 Firmware Version: v3.51 Indination Range: ±90° Resolution: 0.01° <th>Parameter Sensor Enable Digital Filter: Cut-off Frequency (in mH 2000 Accept Accept Options Time basis: 1 s/div * Reset View V -Axis Amplitude: 10 °/div * 10 °/div * Offset: 10,0° * Auto -10,0° * Auto Oscilloscope -0,56 ° 0,15 °</th> <th>ng —</th>	Parameter Sensor Enable Digital Filter: Cut-off Frequency (in mH 2000 Accept Accept Options Time basis: 1 s/div * Reset View V -Axis Amplitude: 10 °/div * 10 °/div * Offset: 10,0° * Auto -10,0° * Auto Oscilloscope -0,56 ° 0,15 °	ng —						
Status: 0x01	Sensor Configuration Sensor 3D-View Sensor Oscilloscope							
Ready	IS2D 90 P25 - Serial No.: 00278 🖾 NUM	.::						

Figure 21: Oscilloscope display of the current angle



12 Ordering Information

Article Number	Product Type	Interface (default)	Axes / measurement range	Housing
PR-23450-00	IS1BP360-I-CL	4 20 mA	1-dimensional, 360°	big plastic housing
PR-23454-00	IS2BP090-I-CL	4 20 mA	2-dimensional, ±90°	big plastic housing
PR-23550-00	IS1BP360-U-CL	0 10 V	1-dimensional, 360°	big plastic housing
PR-23554-00	IS2BP090-U-CL	0 10 V	2-dimensional, ±90°	big plastic housing
PR-25400-00	IS1MA360-I-BL	4 20 mA	1-dimensional, 360°	aluminum housing
PR-25404-00	IS2MA090-I-BL	4 20 mA	2-dimensional, ±90°	aluminum housing
PR-25500-00	IS1MA360-U-BL	0 10 V	1-dimensional, 360°	aluminum housing
PR-25504-00	IS2MA090-U-BL	0 10 V	2-dimensional, ±90°	aluminum housing
PR-25450-00	IS1BP360-I-BL	4 20 mA	1-dimensional, 360°	big plastic housing
PR-25454-00	IS2BP090-I-BL	4 20 mA	2-dimensional, ±90°	big plastic housing
PR-25550-00	IS1BP360-U-BL	0 10 V	1-dimensional, 360°	big plastic housing
PR-25554-00	IS2BP090-U-BL	0 10 V	2-dimensional, ±90°	big plastic housing
PR-23998-00	TA1	Teach adapter		
PR-23999-02	ISPA1	Inclination sensor programming adapter (Starter kit including programming adapter, cables and PC software)		

Table 19: Ordering Information