

Datasheet

smartPREDICT-AE RS485/USB

Digital vibration and motion sensor system for IIoT

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Description

The smartPREDICT-AE is a multi-sensor system based on iNDTact's high-bandwidth vibration sensor iMPactXS that enables highly sensitive vibration-based condition monitoring of structures, products and processes. Alongside the high-bandwidth, high-sensitivity vibration sensor, a micro-electromechanical system (MEMS) offers additional motion information (acceleration and angular velocity). The temperature sensor on the bottom of smartPREDICT-AE allows for internal reference temperature measurement next to the iMPactXS.

The smartPREDICT-AE can be used for direct parameter measurement and transmission to machines (PLCs) or edge devices for IIoT via Modbus RTU.

Key Features

- Integrated ultra-low noise acoustic emission sensor with 96 kHz sampling rate
- Integrated acceleration sensor
- Integrated gyroscope sensor
- Integrated temperature sensor
- Autonomous condition monitor with teachable fingerprinting and alarm output
- Output of 11 vibration features (sPR, RMS, etc.) for each Sensors (AE/Acc/Gyro)
- Configurable digital IIR filters for bandwidth and POI control
- Real time raw data streaming*
- Recorder for Raw Data and Spectrum
- GPIOs for digital/analog input or output
- Serial Modbus RTU interface with switchable line termination
- USB interface
- Firmware updates via bootloader for new features or custom analysis
- IP67 protection

Applications (examples)

- Conditional monitoring of machines & processes with direct input for PLC
- Monitoring and trending of vibrational parameters of high value assets
- Shock and vibration monitoring for construction machine/vehicle or agricultural machine/vehicle
- Materials research
- Production control
- Final inspection and testing
- Incoming goods department
- Biological studies
- Structure monitoring

Revision History

Revision	Date	Authors	Description
V20240724	24.07.2024	OR	Added Option MC8 Removed obsolete Option MC6
V20240703	03.07.2024	OR	Added Climatic Compatibility Added Shock and Vibration Immunity Properties
V20240304	04.03.2024	OR	Corrected inconsistent information on bandwidth of ADXL373
V20240125	25.01.2024	OR	Added additional acceleration sensor with 400g range. Updated EMC information. Added revision history. Removed obsolete Options. Added Options MC6 and MC7.
V20221118	18.11.2022	OR	Added new acceleration sensor with 32g range. Updated supply voltage range, GPIO and RS485 electrical properties.
V20210511	11.05.2021	OR	Added more detailed properties, typical performance characteristics, programmable gain stage section and block diagram.
V20191104	04.11.2019	BS	Release

Properties

Sensors

Type	Sensor	Range	Accuracy	Noise	Sampling Rate	Resolution
Vibration	iMPactXS	0.06 Hz to 48 kHz ±0.15 nC ±1.5 nC ±15 nC		< -99 dB	96 kHz	24 Bit
Acceleration XYZ	LSM6DSO32	DC to 3.3 kHz ±4 g ±8 g ±16 g ±32 g	±20 mg	120 µg/√Hz	6.667 kHz	16 Bit
Additional for "MC7 0 x", "MC8 0 x"	ADXL373	DC to 2.56 kHz ±400 g	±10 %	3.5 LSB rms	6.667 kHz	12 Bit
Gyroscope XYZ	LSM6DSO32	DC to 1.4 kHz ±125 °/s ±250 °/s ±500 °/s ±1000 °/s ±2000 °/s	±0.5 °/s	0.0038 °/s/√Hz	6.667 kHz	16 Bit
Temperature	LMT01LPG	-40 to 90 °C	±0.5 °C		10 Hz	16 Bit

Components

Component	Details
CPU	ARM Cortex M7
Flash Memory	34 MByte
RAM	32.5 MByte
Connector Interface	M12, 8-pin, x-coded, female

GPIO Functions

Function	Details
Digital Input/Output	Alert output from Autonomous Condition Monitoring General State and Control Interface*
Analog Input/Output*	Analog-to-Digital converter / Digital-to-Analog-Converter*
Timer Input/Output*	E. g. PWM Input/Output, rotational speed input, ...*
Interrupt Input*	External Interrupt pin for custom functionality*
System Wakeup*	Exit CPU from standby mode*
CAN Interface*	Additional CAN Interface to connect external device / bus*
I2C Interface*	Additional I2C Interface to connect external device / bus*
UART Interface*	Additional UART Interface to connect external device*

* Available with future Firmware Update

Electrical Properties

Parameter	Min	Typical	Max	Unit
Supply Voltage	10	24	36	V
Power Consumption		1	2	W
GPIO Digital Input Voltage			5	V
GPIO Digital Output Voltage			3.3	V
GPIO Analog Input/Output Voltage			3.3	V
GPIO Internal Series Resistance		100		Ω
GPIO Pullup/Pulldown Resistance	30	40	50	kΩ
RS485 Operational Common-Mode Range	-7		12	V
RS485 Differential Input Voltage	-12		12	V
RS485 High Level Input Voltage	2			V
RS485 Low Level Input Voltage			0.8	V
RS485 Unit Load			3/20	
RS485 Bus Loads			213	
RS485 Switchable Line Termination		120		Ω

Environmental & Physical Properties

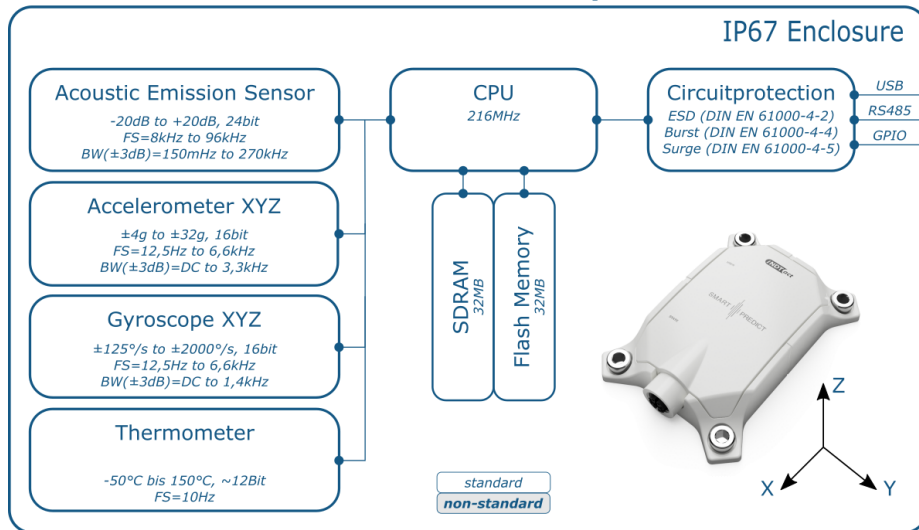
Parameter	Value	Unit
Operating Temperature	-40 to 85	°C
Storage Temperature	-40 to 85	°C
Electromagnetic Compatibility (EMC)	Tested according to DIN EN 61326-1 DIN EN 61326-2-3 DIN EN 50121-1 DIN EN 50121-4 DIN EN 55011 DIN EN 61000-4-2 DIN EN 61000-4-3 DIN EN 61000-4-4 DIN EN 61000-4-5 DIN EN 61000-4-6 DIN EN 61000-4-8	
Shock and Vibration Immunity	Tested according to DIN EN 50125-3:2003 TN-TR50-6776:2018 DIN EN 60068-2-6:2008 DIN EN 60068-2-64:2020 DIN EN 60068-2-27:2010	
Climatic Compatibility	Tested according to DIN EN 60068-2-1:2007 & DIN EN 60068-2-2:2007	
Ingress Protection	IP67	
Dimensions	50 x 89 x 22	mm
Dimension with Mounting Frame	76 x 104 x 22	mm
Weight	98 (+ 18 Mounting Frame)	g
Case Material	Polybutylenterephthalat (PBT)	
Mounting	Adhesive (+ Screw optional)	

Available Options

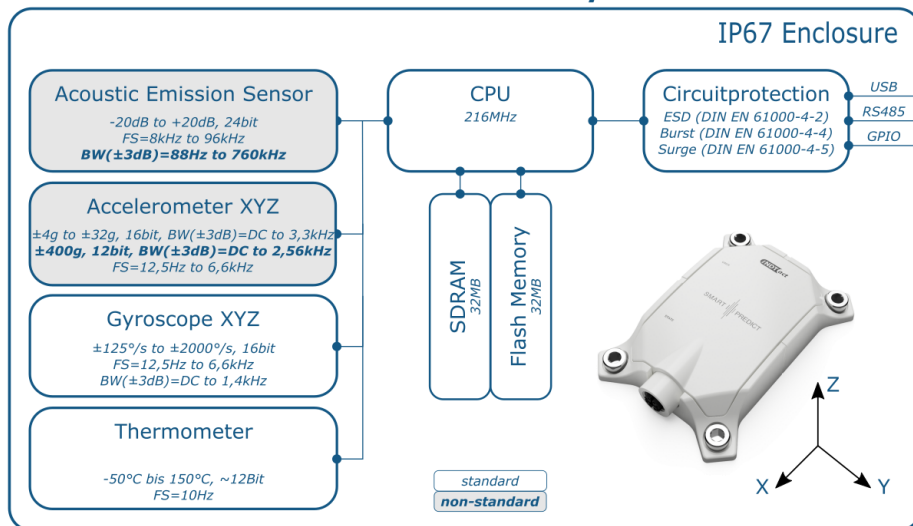
Option	Specification	Part Number
"MC5 0 x"	Standard, C-Prototype	smartPREDICT-AE RS485/USB MC5 0 x
"MC7 0 x"	C-Prototype	smartPREDICT-AE RS485/USB MC7 0 x
"MC8 0 x"	C-Prototype	smartPREDICT-AE RS485/USB MC8 0 x

Block Diagram

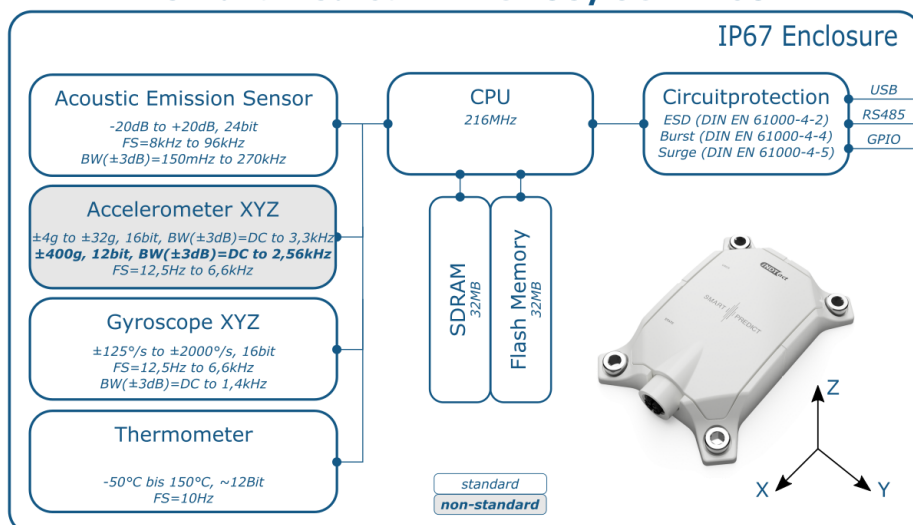
smartPredict-AE RS485/USB MC5



smartPredict-AE RS485/USB MC7



smartPredict-AE RS485/USB MC8



Programmable Gain Stage

The smartPREDICT-AE includes a programmable gain stage for the vibration sensor iMPactXS. Therefore it is possible to adjust the vibration sensor signal in gain and bandwidth for a large variety of applications to obtain an optimal signal to noise ratio. This makes it possible to obtain the desired application information with optimum quality and accuracy and to make precise conclusions about the condition of the machine to be monitored.

The following table gives an overview over the available settings. It is possible to adjust the lower cut off frequency (FREQ) and the transfer gain (GAIN) separately.

Option MC5 & MC8

	FREQ	LOW	MED	HIGH
GAIN				
LOW (-20 dB)		0.07 Hz	0.7 Hz	7 Hz
MED (0 dB)		0.7 Hz	7 Hz	70 Hz
HIGH (20 dB)		7 Hz	70 Hz	700 Hz
MAX (~40 dB)*		~70 Hz	~700 Hz	~7000 Hz

*The gain "Max" setting may be used but the gain nor the related cut-off frequency are guaranteed. Measurements from different devices are expected to have a high spread using this setting.

Option MC7

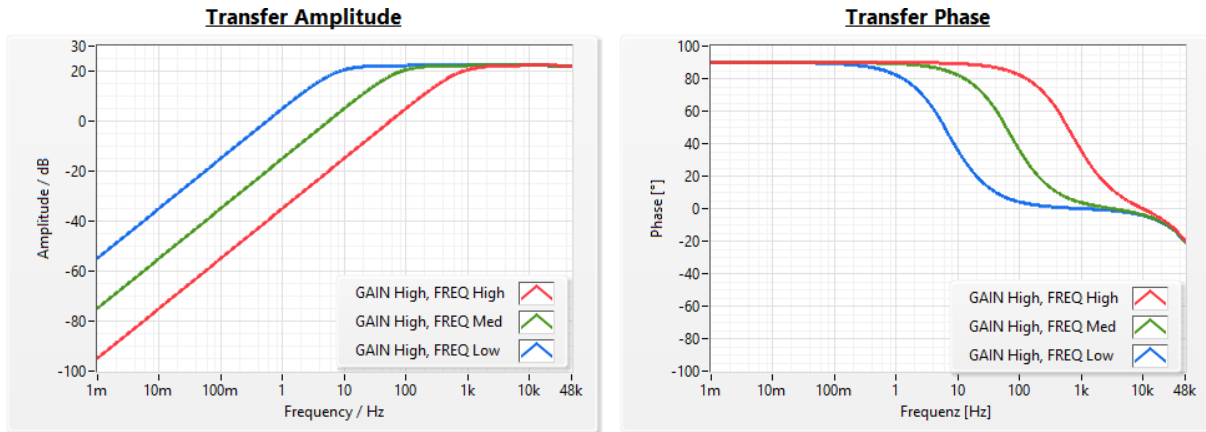
	FREQ	LOW	MED	HIGH
GAIN				
LOW (-20 dB)		88 Hz	880 Hz	8,8 kHz
MED (0 dB)		880 Hz	8,8 kHz	76 kHz
HIGH (20 dB)		8,8 kHz	76 kHz	381 kHz
MAX (~40 dB)*		~76 kHz	~381 kHz	>400 kHz

*The gain "Max" setting may be used but the gain nor the related cut-off frequency are guaranteed. Measurements from different devices are expected to have a high spread using this setting.

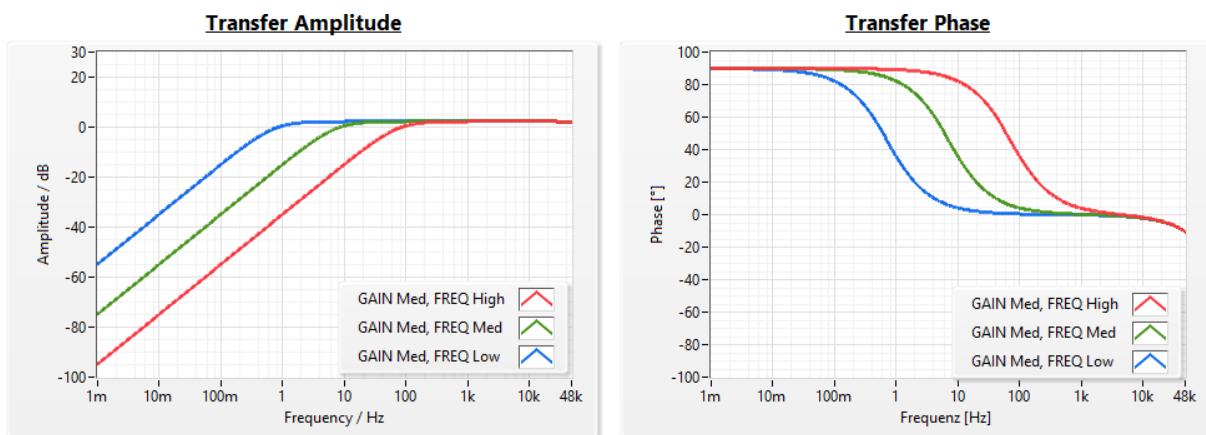
Typical Performance Characteristics

Option MC5 & MC8

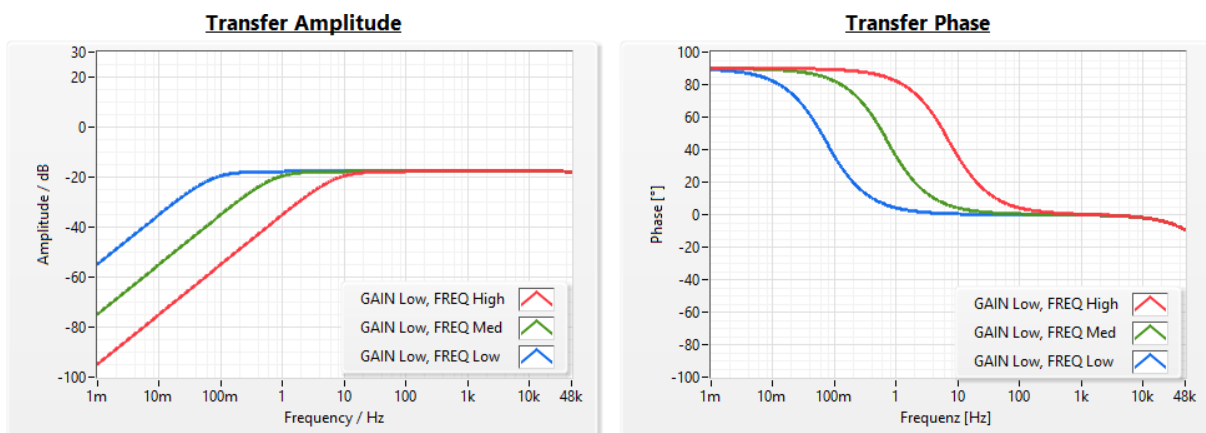
Sensor iMPactXS – Gain Setting „High“



Sensor iMPactXS – Gain Setting „Med“

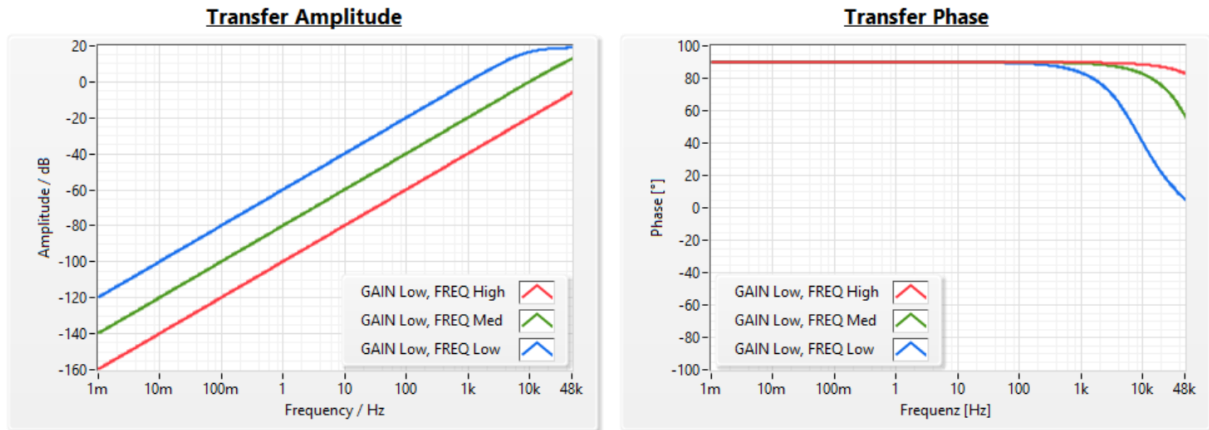


Sensor iMPactXS – Gain Setting „Low“

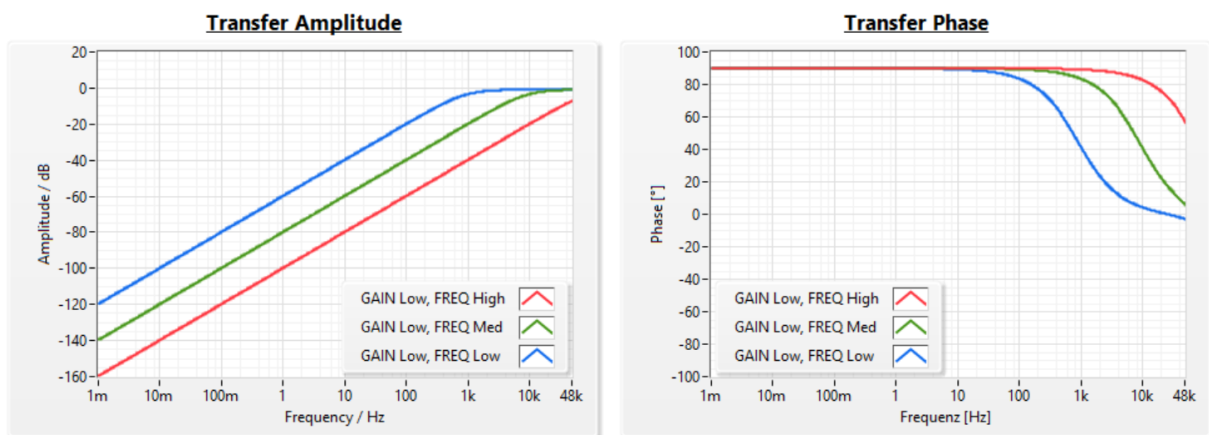


Option MC7

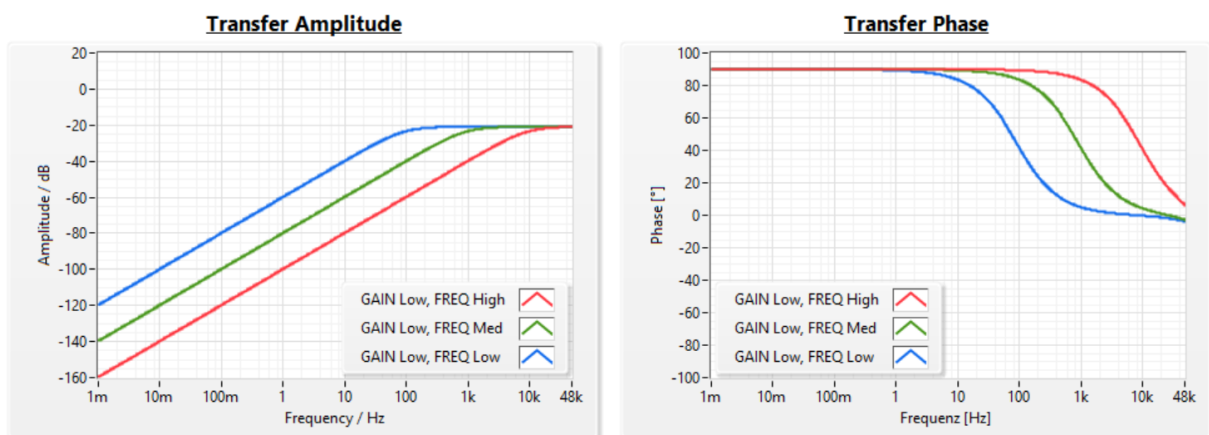
Sensor iMPactXS – Gain Setting „High“



Sensor iMPactXS – Gain Setting „Med“



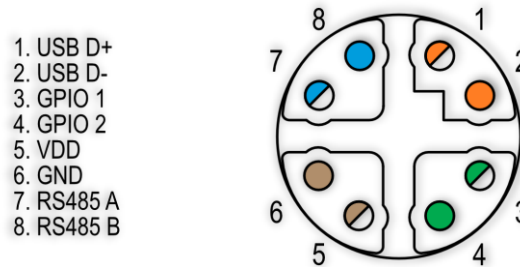
Sensor iMPactXS – Gain Setting „Low“



Connector

Pin Allocation on Device (M12, 8-Pin, X-Coded, Female)

Seen from outside onto the device.

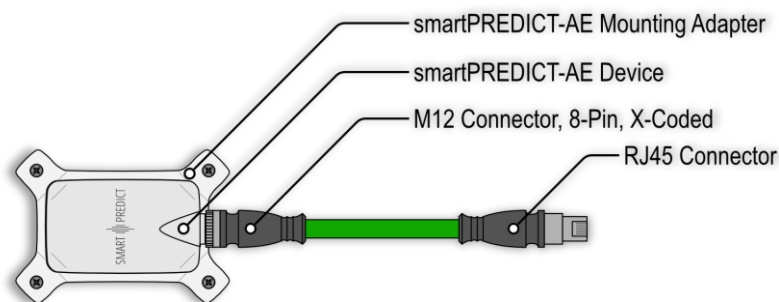


Pin Description

Pin Number	Name	Description
1	USB D+	Non-Inverting Data Line of USB Interface
2	USB D-	Inverting Data Line of USB Interface
3	GPIO 1	Programmable General-Purpose Input/Output for Analog and Digital Signals
4	GPIO 2	Programmable General-Purpose Input/Output for Analog and Digital Signals
5	VDD	Power Supply
6	GND	Ground
7	RS485 A	Inverting Data Line of RS485 Interface*
8	RS485 B	Non-Inverting Data Line of RS485 Interface*

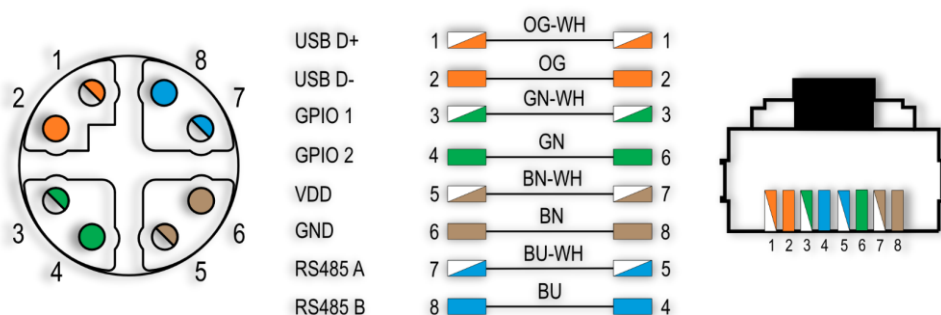
* Incorrect according to Modbus Specification but used by most differential transceiver manufacturers.

Example: Connection via Standard M12 to RJ45 Cable Setup



Pin Allocation of Standard M12 Male to RJ45 Male Cable

Plugs seen from front of connector.

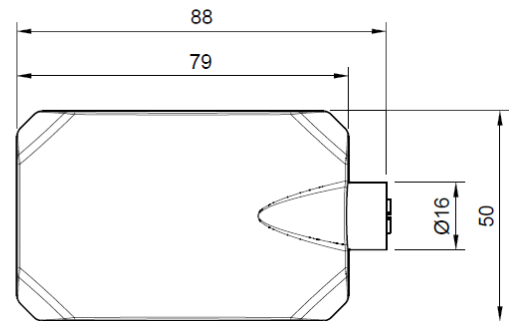
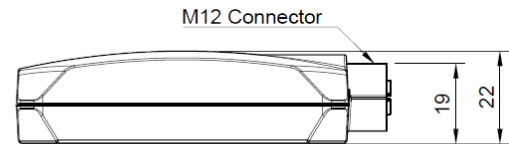
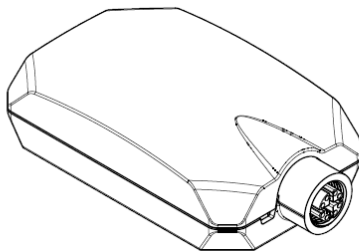


Technical Drawings

Dimensions without Mounting Frame

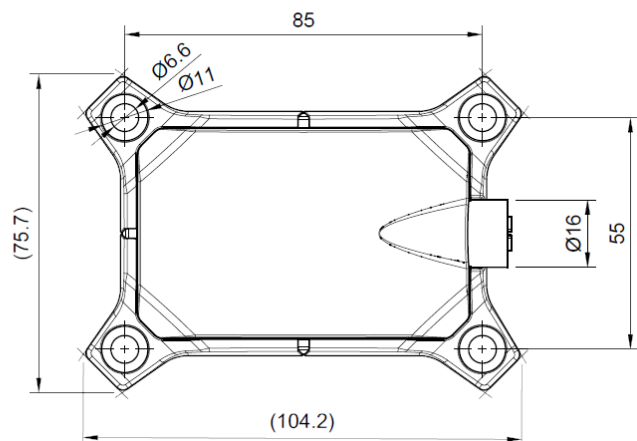
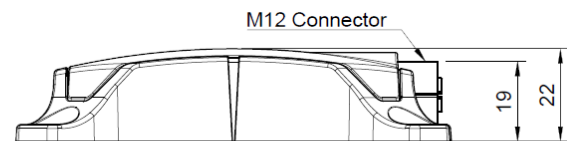
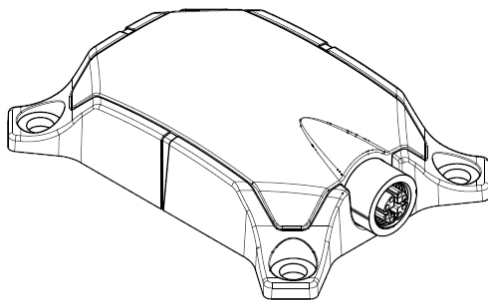
All dimensions in millimeters.

- View without mounting frame
- If used without mounting frame, adhesive is required for coupling to surface

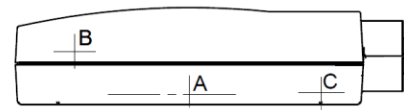
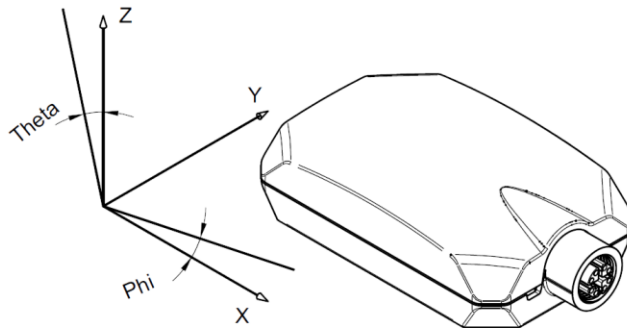


Dimensions with Mounting Frame

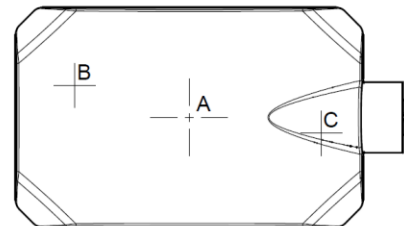
- View with mounting frame
- Mounting frame with 4x Ø 6.6 mm holes
- Coupling with adhesive/adhesive tape possible



Sensor Positions & Orientation



A = AE-Sensor
B = Acc. & Gyro. Sensor
C = Temperature Sensor



Interface Description

Modbus is a serial communications protocol for industrial electronic devices. It enables communication among many devices connected to the same network. The basic architecture is based on a single master device and up to 247 slave devices. Many hardware interfaces and software libraries provide APIs for Modbus communication.

FURTHER INFORMATION:

See Application Note: "smartPREDICT-AE RS485USB Modbus Reference Guide" for detailed configuration instructions of the Modbus communication. Datasheets, User Guides and Application Notes are available on our website www.indtact.de.

Accessories (on request, not included in delivery)

- Cable: CAT 7+, 8-pin, x-coded
- Mounting frame: See technical drawings
- Screws for mounting frame: see technical drawings, max. Ø6 mm
- Glue for coupling of sensor system: contact iNDTact specialists for consultation

Application Information

For reversible sensor application with low accuracy (e. g. for a quick test) at room temperature, the use of hot-melt adhesive or double-sided tape is possible. An effective quick test coupling is achieved when a drop of hot-melt (e. g. via hot-melt gun) is applied onto the sensor and immediately pressed onto the surface of the test object until solidification. Test objects with high heat capacity must be warmed up in advance to approximately 50°C before hot melt glue is applied to avoid a release due to shrinkage mismatch.

WARNING: During the manual application, the use of an insulation layer or thermo gloves is recommended for protection against heat-injuries.

For reversible sensor application with high accuracy (e. g. proof of concept), the use of a special cement glue is recommended (available upon request).

For permanent sensor application with a higher accuracy and a higher temperature performance, the use of approved structural adhesives with appropriate surface pre-treatment is recommended. iNDTact offers such adhesives for common applications on request.

In general, the surfaces of the test specimen and the sensor bottom side must be free of dust, grease and dirt. In case of contamination, a cleaning with solvent like alcohol, isopropanol or acetone might be necessary. For more information, please contact your structural adhesive supplier.

IMPORTANT: Prior to any applications, especially those relevant to security, the adhesive performance in combination with the sensor must be tested and approved according to the requirements of the use case.

Declaration of Conformity

- CE compliant
- RoHS compliant
- 3TG compliant
- REACH compliant

The smartPREDICT-AE is a component, which contains lead zirconium titanate in a proportion of more than 0.1% by weight.

Lead zirconium titanate (abbreviation: PZT, Lead titanium zirconium oxide) has been included in the SVHC list by the European Chemicals Agency (ECHA) (EC No: 235-727-4, CAS No: 12626-81-2).

iNDTact GmbH does not manufacture PZT itself but purchases it in crystalline and insoluble form from suppliers who have registered the substance with the ECHA. If the device is used as intended, no release of PZT can occur at any time. Risks can only occur in the case of inhalation or oral uptake (e.g. in the form of dust after mechanical processing or machining), but these can be ruled out if used as intended.

Legal Disclaimer

Pre-Series Versions (engineering samples)

Herein described is a pre-series version of the smartPREDICT-AE product. These versions are seen as engineering samples and may vary from the valid technical specifications of the product series contained in this data sheet. They are therefore not intended or fit for resale to third parties or for use in end products. Their sole purpose is internal client testing. The testing of an engineering sample may in no way replace the testing of a product series. iNDTact assumes no liability for the use of samples. The purchaser shall indemnify iNDTact from all claims arising from the use of pre-series versions.

Product Use

iNDTact products may only be used within the parameters of this product data sheet. They are not fit for use in life- sustaining or security sensitive systems. Security sensitive systems are those for which a malfunction is expected to lead to bodily harm or significant property damage. The resale and / or use of products are at the purchaser's own risk and his own responsibility. The examination of fitness for the intended use is the sole responsibility of the purchaser. The purchaser shall indemnify iNDTact from all third party claims arising from any product use not covered by the parameters of this product data sheet or not approved by iNDTact and reimburse iNDTact for all costs in connection with such claims. The purchaser must monitor the market for the purchased products, particularly with regard to product safety, and inform iNDTact without delay of all security relevant incidents.

Application Examples

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