POSITAL

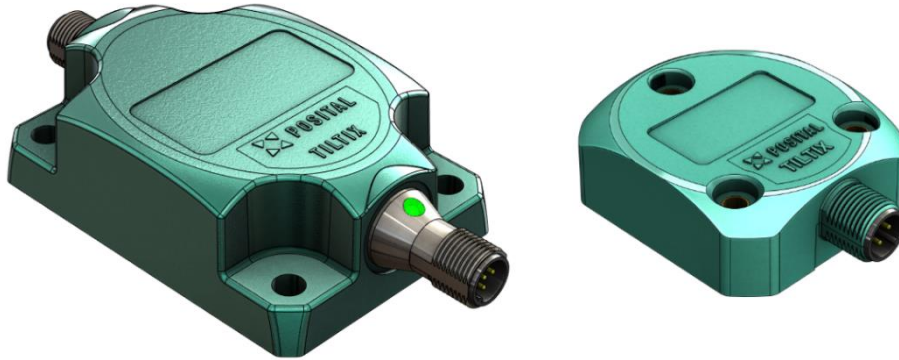## TILTIX MEMS ACS INCLINOMETER
WITH ANALOG INTERFACE

ANALOG

User Manual

POSITAL

TILTIX MEMS ACS INCLINOMETER
WITH ANALOG INTERFACE

1   Content

2   General Safety Advice

2.1   Important Information

Read these instructions carefully, and have a look at the equipment to become familiar with the device before trying to install, operate, or maintain it.

The following special messages may appear throughout this documentation or on the equipment to warn of potential hazards or to call attention towards information that clarifies/simplifies a procedure.

Please Note: Electrical equipment should be serviced only by qualified personnel. No responsibility is assumed by POSITAL for any consequences arising out of the use of this material. This document is not intended as an instruction manual for untrained personnel.

The addition of this symbol to a Danger or Warning safety label indicates that an electrical hazard exists, which will result in personal injury if the instructions are not followed.

This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

3   About this Manual

3.1   Background

This user manual explains how to install and configure the ACS inclinometer with an Analog Interface (Voltage or Current).

3.2   Version Management

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3.3   Imprint

FRABA B.V.

Jan Campertstraat 5,

NL-6416 SG Heerlen

T +49 221-96213-0

info@fraba.com, www.fraba.com

3.4   Copyright

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3.5   User Annotation

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Depending on your region you can reach us by e-mail at the following e-mail addresses. For America info@posital.com, for Asia info@fraba.sg, for Europe info@posital.eu.

3.6   Document History

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4   Introduction

This manual explains how to install and configure the TILTIX ACS inclinometers with an Analog interface, suitable for industrial, military and heavy duty applications.

4.1   TILTIX Inclinomter

TILTIX inclinometers sense and measure the angle of tilt (inclination/slope/elevation) of an object with respect to the force of gravity.

The basic principle behind this TILTIX inclinometer is a Micro-Electro-Mechanical Systems (MEMS) sensor cell that is embedded to a fully molded ASIC.

The angle is measured with the relative change in electrical capacitance in the MEMS cell.

The ACS series of inclinometers are available in 4 variants: a single axis measurement variant with a range of 0 - 360°, a dual axis measurement and Pitch and Roll.

4.2   Analog Interface

The ACS Analog inclinometer is a simple, compact and a very affordable inclination measurement device capable of measuring precise absolute position in both single and dual axes.

It is compatible to most analog measurement devices.

The dual output feature increases the flexibility and compatibility to other digital devices too. Electrically, like all other ACS variants it consists of a highly integrated circuit in SMD technology, temperature compensation, active linearization and the only variation is the analog interface. Customized scaling of analog output is also possible.

All inclinometers are protected against polarity reversal and over-voltage spikes. In addition to that, the heavy duty housing provides a high resistance to shock/ vibration and environmental protection of up to IP69K when used with appropriate connectors.

The ACS Analog sensor comes with bootloaders for easy re-configuration. The setup and configuration guide for the bootloaders is available upon request.

4.3   Typical Applications of TILTIX ACS

- Cranes and Construction Machinery
- Mobile Machinery
- Agriculture Machinery
- Elevated Platforms
- Mobile Lifts and Fire Engines

- Automated Guided Vehicles (AGV)
- Automatic Assembling Machinery
- Boring and Drilling Applications
- Leveling and Flattening
- Robotic applications

TILTIX MEMS ACS INCLINOMETER
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5 Installation

5.1 Accessories

Article No	Article	Description
ACS360/090	Inclinometer	ACS series of Inclinometers
Download	Datasheet1	ACS Datasheet, specifications and drawings
ACS Website	User Manual1	Installation and Configuration User Manual
Download	Leaflet1	Installation Leaflet
10048592	Connecting Cable	Female M12, 8pin A-coded connector with 2m PUR shielded cable
10034547	Connecting Cable	Female M12, 8pin A-coded connector with 5m PUR shielded cable

1) The latest documentation can also be downloaded from our website.

5.2 Pin Assignment

The inclinometer is connected via an 8 pin M12 A-coded round connector or cable exit. (Standard M12, Male side at sensor, Female at connector counterpart or connection cable).

Pin	Cable Exit	ACS-2 axes	ACS-1 axis
1	Red	VS Supply Voltage	VS Supply Voltage
2	Gray	Not Connected	Not Connected
3	Pink	Not Connected	Not Connected
4	Yellow	Ground	Ground
5	Green	X-axis Analog Output	Z -Axis Analog Output
6	Brown	SET1	SET1
7	Blue	Y-axis Analog Output	Not Connected
8	White	Not Connected	Not Connected
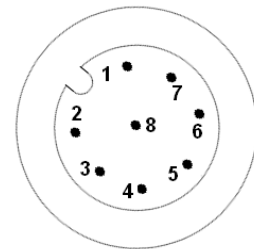
M12 8-Pin Connector Pin Assignment

The function of the analog inputs depends on the configuration

Pin	ACS-2 axes	ACS-1 axis
1	VS Supply Voltage	VS Supply Voltage
2	Y- Axis Analog Output	Not Connected
3	Ground	Ground
4	X -Axis Analog Output	Z -Axis Analog Output
5	Set1	Set1
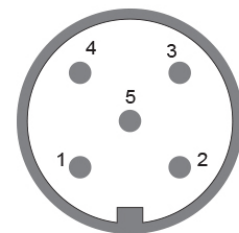
M12 5-Pin Connector Pin Assignment

5.3   Installation Precautions

Warning: Do not remove or mount while the inclinometer is under power!

Avert any modifications to the housing!

Avoid mechanical load!

Prior to installation, please check for all connections and mounting instructions to be complied with. Please also observe the general rules and regulations on operating low voltage technical devices, for safety and sustainability of TILTIX Inclinometers over long period of time.

Please read the installation leaflet for detailed instructions and precautions during mounting and installation.

5.4   Mounting Instructions

TILTIX is a pre-calibrated device which can be put into immediate operation, upon simple and easy installation with a four point mount. The mounting surface must be plane and free of dust and grease. We recommend hex-head screws with M6 or UNCbolts ¼ for the best possible and secure mounting.

Use all four screws for mounting but restrict the tightening torque in the range of 1.5 – 2.5 Nm for the screws. The M12 connectors are to be perfectly aligned and screwed till the end with a tightening torque in the range of 0.4 – 0.6 Nm. Use all four screws for mounting and also note to use the same tightening torque for all the screws.

Prior to installation, please check for all connection and mounting instructions to be complied with. Please do also observe the general rules and regulations on low voltage technical devices

TILTIX MEMS ACS INCLINOMETER
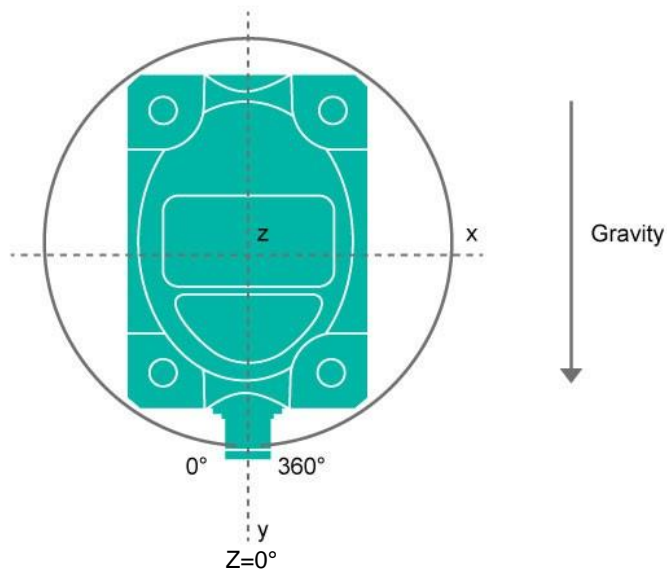## WITH ANALOG INTERFACE

5.5   Measurement Axes

TILTIX ACS -090-2 – Dual Axis Inclinometer

X- and Y-Axis measure the angle position in space. Both axes are limited to ± 90°. The sensor is mounted horizontally. The X- and Y-Axis output 0°, when the inclinometer is flat.
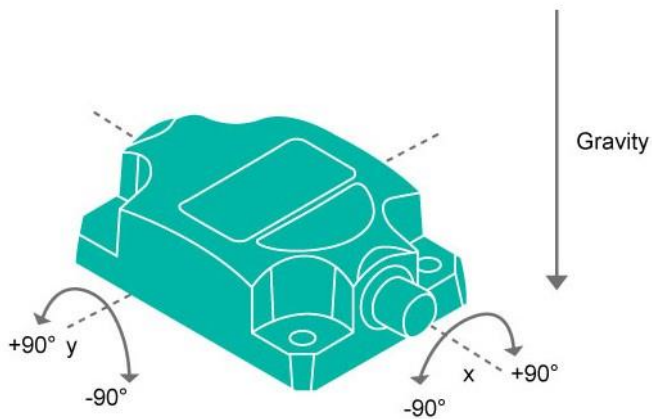
TILTIX ACS -360-1 – Single Axis Inclinometer

The sensor is mounted vertically. A clockwise rotation increases the angle value from 0°-360°. When the male connector is pointing downwards, the output is 0°.
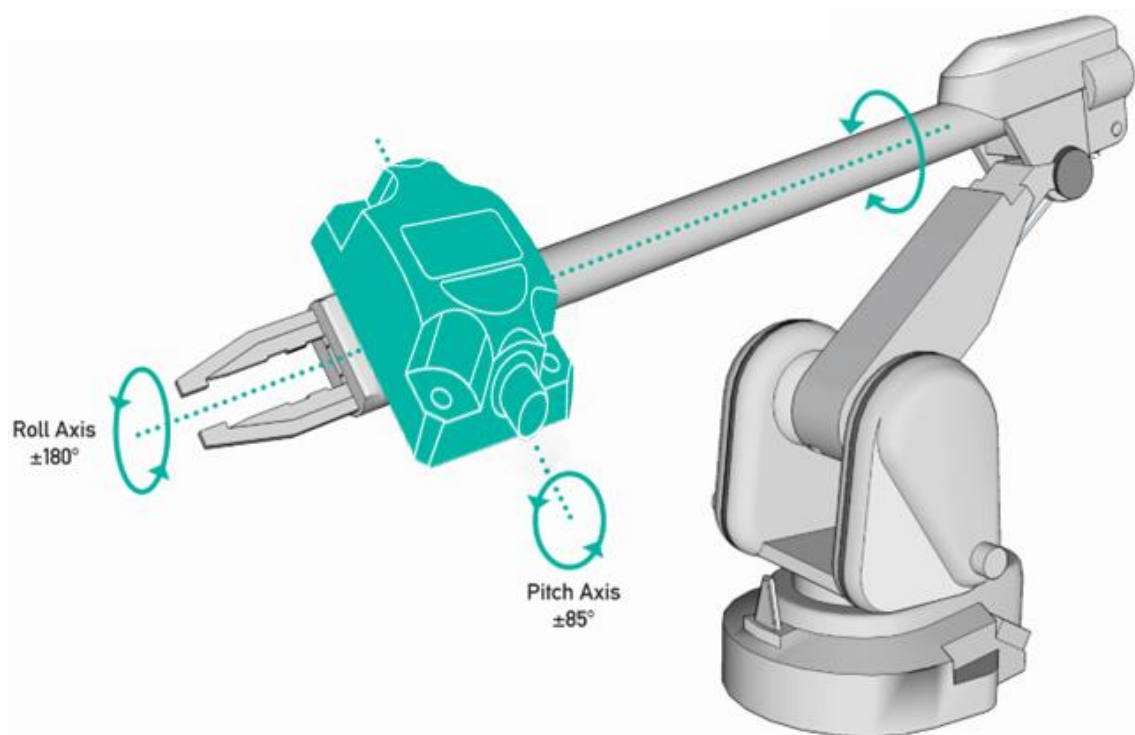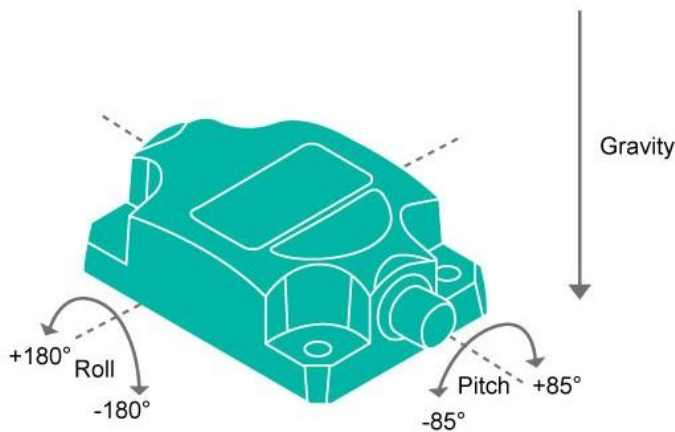
TILTIX ACS -180-E – Pitch and Roll Axis Inclinometer

The Pitch axis monitors the position angle in space, while the Roll axis shows the rotation with respect to the pitch angle.

In case of a robot arm (graphic below), the pitch axis monitors the position angle in space and the roll axis measures the rotation of the robot head around the arm (just like a Singleturn encoder).

The Pitch and Roll version is very usefull for any machine where a part of the application is rotating around another segment.
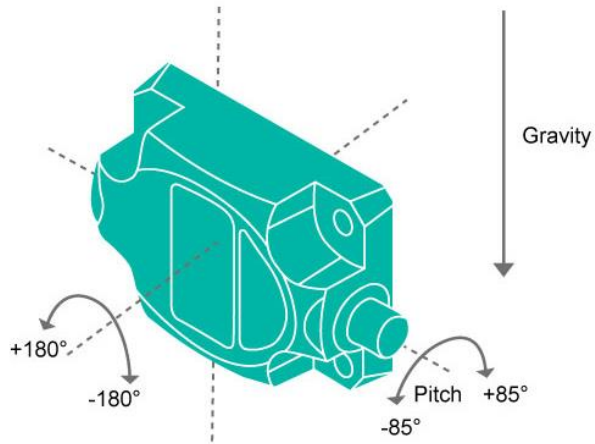
The Pitch axis is limited to ± 85°, while the Roll axis is limited to ± 180°.

TILTIX MEMS ACS INCLINOMETER
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TILTIX ACS-180-F – Pitch and Roll Axis Inclinometer

This version is intended for vertical mounting. Like the ACS-180-E, the Pitch axis monitors the position angle in space, while the Roll axis shows the rotation with respect to the pitch angle.

6   Software Configuration

This chapter succeeds the hardware configuration as in real time. TILTIX is a very flexible device and hence all the parameters are programmable via UBIFAST Configuration Tool. This results in a wide range of configuration options that suit your application.

This chapter is divided into two major parts - one describing the methodology for putting the TILTIX into operation and the other for the UBIFAST programming.

6.1   Default Factory Settings

Description	Value
Supply Voltage	9–32 V DC (absolute maximum ratings)
Resolution	0.01°
Settling Time	min 30 ms; default 200 ms (dependent on filter settings)
Measurement Direction	ACS360: Clockwise ACS090: Standard – see point 5.5
SET 1	Preset/ Factory Reset

Note: The factory settings can be restored at any time. The procedure is explained in point 6.3.

6.2   SET 1 Pin

The inclination sensors are designed to include three functions via the analog input SET1

- Preset of origin - 0° Reference for measurement
- Reset to the Factory Settings
- Programmability via the UBIFAST Configuration Tool[1]

[1]Note: This feature will be available from Q2 2024

To set the preset, apply a high signal (9 V – 32 V) pulse for 2-5 seconds to SET1 input and lock the position. Once the position is locked the ACS resets the current position to the origin position and hence changes the analog output accordingly to either 4 mA or 0V/0.5 V.

Please note that the preset is activated on the rising edge. The Preset function in a dual axis version is applied to both axes at the same time. A separate preset function for each axis can only be set with the UBIFAST Configuration Tool.

6.3   Factory Reset

To reset the sensor to the factory settings, apply a high signal (9 V – 32 V) pulse to SET1 input for at least 10 seconds.

Alternatively, you can reset the sensor to factory settings using the UBIFAST Configuration Tool.

7   Configuration options via UBIFAST Configuration Tool

The following chapter only refer to the configuration using the UBIFAST Configuration Tool, which will only be available from Q2 2024.Please note that we can deliver all settings pre-programmed from the factory.

7.1   Angle Mode / Device Orientation

During production, the sensor is calibrated for all possible device orientations. When using UBIFAST, the sensor can be reprogrammed to the desired angle mode. The following modes are available:

- 090-2 - Dual Axis - X/Y Horizontal Mounting
- 360-1 - Single Axis - Z Vertical Mounting
- 180-E – Dual Axis – Pitch/Roll – Horizontal Mounting
- 180-F - Dual Axis – Pitch/Roll – Vertical Mounting

7.2   Output Range Voltage Version

- 0 - 10 V
- 0.5 – 9.5 V
- 0 - 5V
- 0.5 – 4.5 V
- Custom (Min : 2V /Max . 8V)

7.3   SET1 Pin – Input Mode

- Preset to min[1] - The current position is set to the minimum output value (e.g. 0V / 4mA). Example: The sensor was tilted by 5°, when the preset is set, then the (physical) 5° corresponds to 0V
- Preset to mid[1] - The current position is set to the mid output value (e.g. 2,5V / 12mA). Example: The sensor was tilted by 5°, when the preset is set, then the (physical) 5° corresponds to 2,5V
- Preset to max[1] - The current position is set to the max output value (e.g. 10V / 20mA). Example: The sensor was tilted by 5°, when the preset is set, then the (physical) 5° corresponds to 10V/20mA
- Preset to value[1] - The current position is set to a certain output value (e.g. 2V / 8mA). Example: The sensor was tilted by 5°, when the preset is set, then the (physical) 5° corresponds to 2V / 8mA

1) Applies to both axes

7.4 Measurement Range

Measurement Range x-axis/pitch/z: Customer has to set both (overrides Set Angle Range)

- Angle at min analog output eg. 0V : -60°   /*Display Min/Max depending on Angle Mode*/

- Angle at max analog output eg. 10V : 30° /*Display Min/Max depending on Angle Mode*/

Measurement Range y-axis/roll: Customer has to set both

- Angle at min analog output eg. 0 V   ___   /*Display Min/Max depending on Angle Mode*/

- Angle at max analog output eg. 10 V   ___/*Display Min/Max depending on Angle Mode*/

7.5 Filter

- Disabled - This function switches off all filters

- Moving Average Filter – Available filter length 1-5'000 ms (default 200 ms)

- Butterworth Filter - Cut-off frequency 1 65'535 mHz (default 1'000 mHz)

- Critically Damped Filter - Cut-off frequency 1 65'535 mHz (default 1'000 mHz)

- Kalman Filter – Activates the Kalman Filter. Settings definition:

Parameter	Unit	Minimum value	Maximum value	Default value
Static coefficient	%	0	100	70
Motion threshold	mg	0	1'000	2
Dynamic coefficient	%	0	100	50

Note: The exact description of the respective filters can be found in this document.

Frequently Asked Question

What if the inclinometer doesn't respond after power on?

If the wiring is correct, check the supply voltage.

Unable to set preset?

While setting preset there are a few considerations like resolution and range that have to be taken into consideration. The resolution of the TILTIX set by the user defines the range of the values that can be set. Hence, while setting the preset the user has to be careful to be within range.

What is a moving average filter?

The moving average filter is a kind of simple low pass filter. In TILTIX the moving average is used to dampen the effects due to external influences like vibrations. 0 means that the filter is deactivated. The user can define the array size in the range of 1-5000 ms (default 200 ms). Once the array size is defined the TILTIX takes an average of the position data array for the final position output.

8 Appendix C: Output Graphs

8.1 TILTIX 360-1 Output Values 0-10V
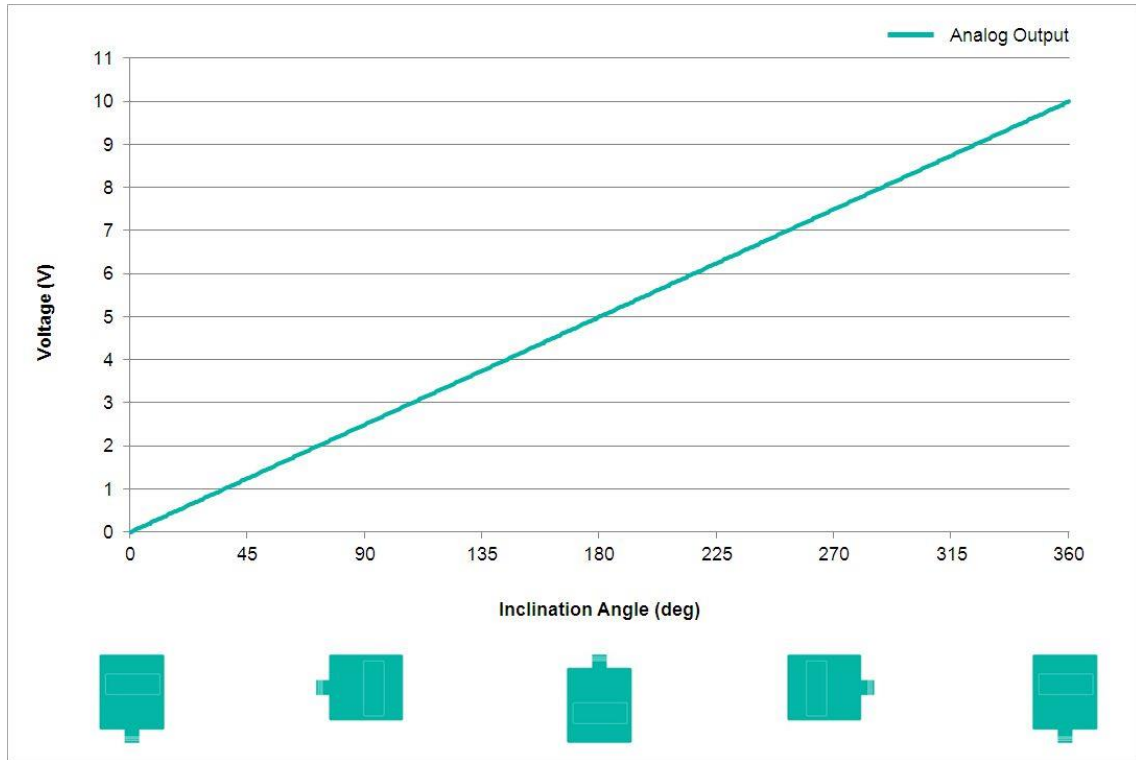
8.2   TITIX 080-2 Output Values 0-10V
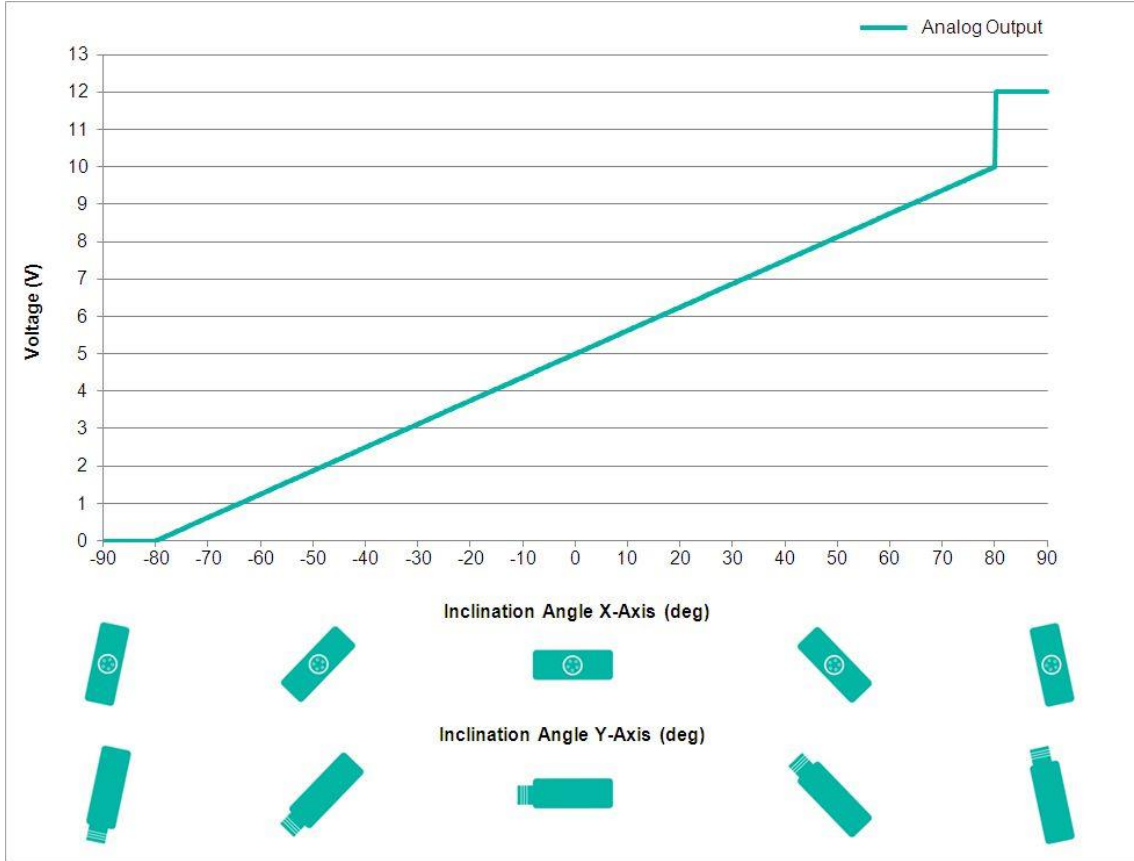
8.3 TILTIX 360-1 Output Values 4-20 mA
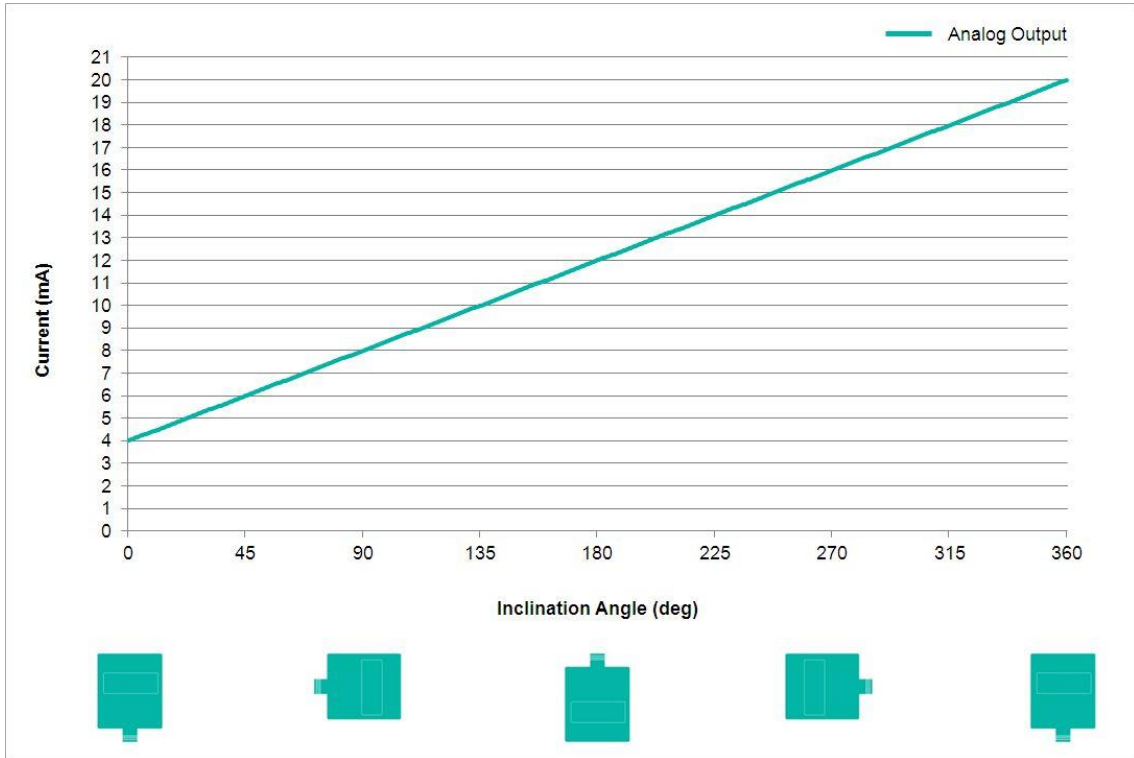
8.4 TILTIX 080-2 Output Values 4-20 mA
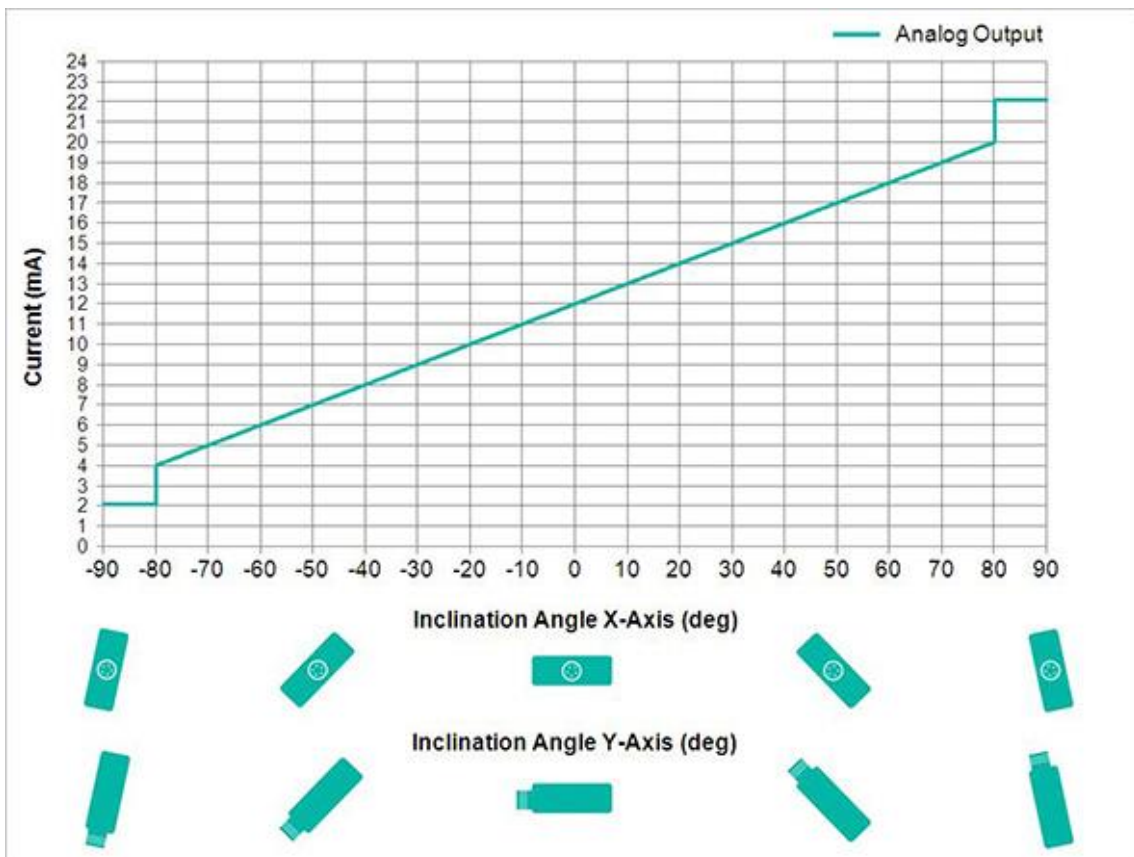
9   Contact

FRABA America

T +1 609 750-8705

▶ info@posital.com

FRABA Europe

T +49 221 96213-0

▶ info@posital.eu

FRABA Asia

T +65 6514 8880

▶ info@posital.sg