

**Inclinometer**

CANopen®, 2 5-pin M12 Connectors

P/N: AX06025X

**Features:**

- 1 or 2 axis inclination or slope sensors
- 2 axis (-80°...80°), functional up to  $\pm 90^\circ$
- 1 axis, vertically positioned (-180° ... 180° or 0...360°)
- High resolution and accuracy
- Option: Three 0-5VDC outputs for direct connection to an analog monitoring control
- Option: RS232 output
- CANopen® (SAE J1939 models also available)
- 12V, 24VDC nominal
- Aluminum enclosure with 2 integral M12 5-pin connector(s)
- IP67 protection (Option: D version for underwater applications)
- .EDS provided to interface to standard CANopen® tools for user programmability

**Applications:**

- Industrial Automation, Cranes, Hoists, Utility Vehicles, Off-highway, Ag, and Forestry Equipment

**Ordering Part Numbers:****Inclinometers:****AX060250 (D)** – Inclinometer, CANopen®, 2 5-pin M12 Connectors*(For a model with 1 Deutsch IPD DT15-4P connector, refer to TDAX06045X.)***AX060251 (D)** – Inclinometer, CANopen®, 3 Analog Outputs, 2 5-pin M12 Connectors**AX060252 (D)** – Inclinometer, CANopen®, 1 RS-232, 2 5-pin M12 Connectors*Note: (D) refers to a version for underwater applications. Please add D to the p/n to order this version.***Accessories:****AX070114** - A mating plug with CAN termination, P/N: AX070114, can be ordered to plug the 2nd connector for applications requiring only one CAN and Power connection as well as requiring a termination of the CAN network.

Mating cables are not supplied.

**Documentation:**

EDS File

User Manual UMAX06025X-45X.

**Description:** The inclinometer is designed to accurately measure inclination angles in two directions X and Y in the range of  $\pm 80^\circ$ . The CANopen® device profile for inclinometers [DS-410], defines the X-axis as the longitudinal measurement, and the Y-axis as the lateral measurement. For both axes, the range of measurement is up to  $\pm 90^\circ$ . If vertically installed, the sensor can also measure an inclination angle in one sensing direction in the  $\pm 180^\circ$  (0-360°) range. The angles are measured by a two-axis MEMS sensor, which senses acceleration caused by the gravity force in two orthogonal directions. The sensor provides two output signals corresponding to each sensing direction. The output signals from the MEMS sensor are normalized and processed by a powerful microcontroller to receive inclination angles. The resolved angles can be then sent to the CAN bus, RS232 port (AX060252 only) or output as voltages (AX060251 only).

The inclinometer also support a variety of extra features that makes it a more versatile sensor. Several of the optional Communication objects outlined in DS-301 are supported by the Inclinometer beyond those referenced in the device profile DS-410. The unit has user programmable functionality using SDO object access, per CiA DS-301. An .EDS file is provided to interface to standard CANopen® tools.

The standard inclinometer is IP67 rated and is packaged in a cast Aluminum housing with 2 M12 5-pin connectors.

Note: CANopen® is a registered community trade mark of CAN in Automation e.V.

## Other Functions

Using standard CANopen tools, the inclinometer can be reprogrammed for another function. Besides using CAN to output angles, the inclinometer can work as a CAN bus reader, presenting CAN input signals as voltages at any of the inclinometer signal voltage outputs. It can also send CAN input signals as text messages using the inclinometer RS-232 port. In a tilt sensor application, an out-of-range state (signal) can be transmitted at one of its voltage outputs in the AX060251 model.

## Standard Functionality

There are two identical functional blocks: Sensor X and Sensor Y presenting angular data from two orthogonal sensing directions X and Y of the inclinometer sensor.

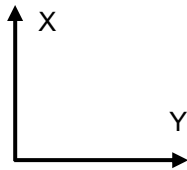


Figure 1.0 Sensing Direction Vectors

## Longitudinal (X) Axis Measuring

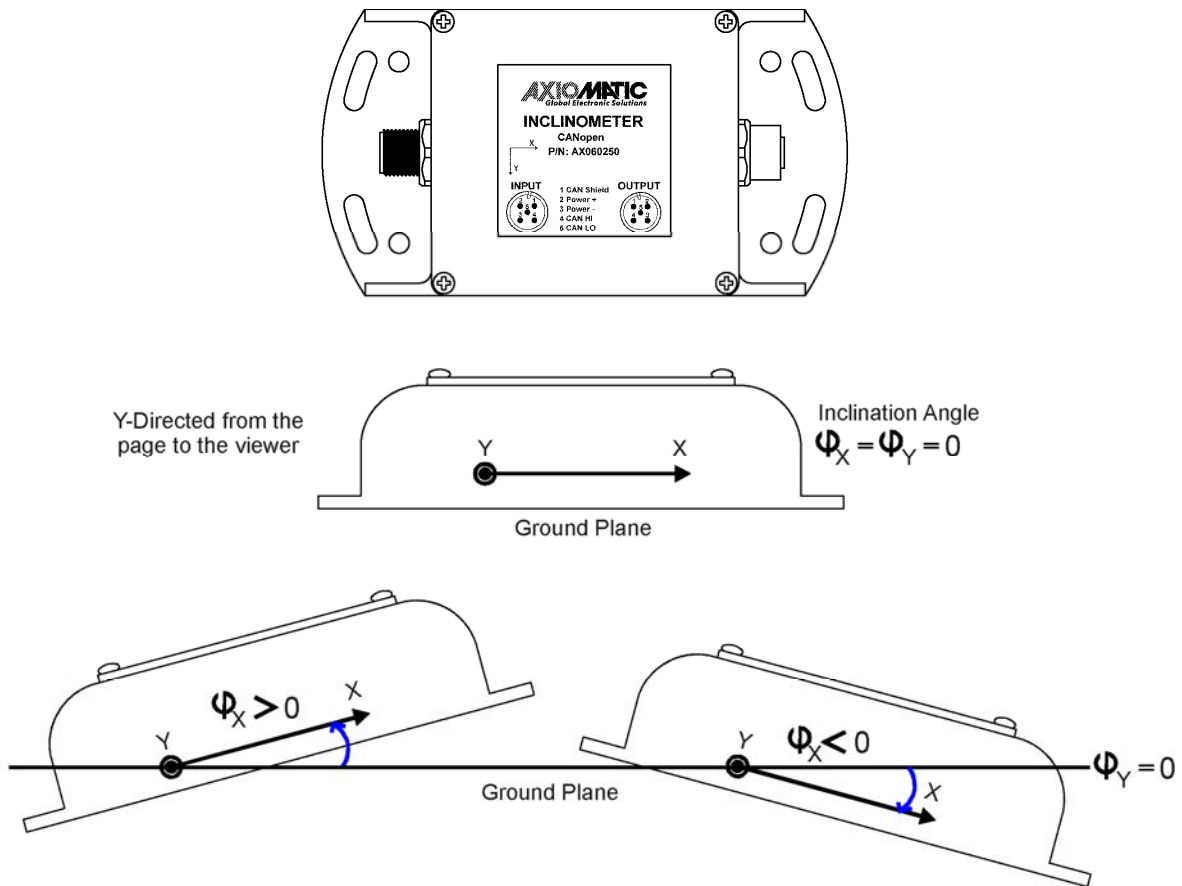


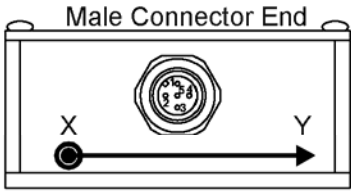
Figure 2 – X-Axis Mounting

The inclinometer measures angles between the sensing directions and the ground plane (relative to gravity). Normally, the sensor is mounted horizontally, with the sensing direction vectors being in parallel with the ground plane. This initial sensor position corresponds to the zero degree inclination on both axes. The zeroed value may be set after the sensor has been mounted by writing to object 6012h for the X-axis (longitudinal) or 6022h for the Y-axis (lateral). When a sensing direction vector points up, out of the ground plane, the inclination angle is considered to be positive, and when the sensing direction vector points down, into the ground plane, it is negative, as shown in Figures 2 and 3.

Lateral (Y) Axis Measuring



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Ground Plane

Inclination Angle  
 $\psi_X = \psi_Y = 0$

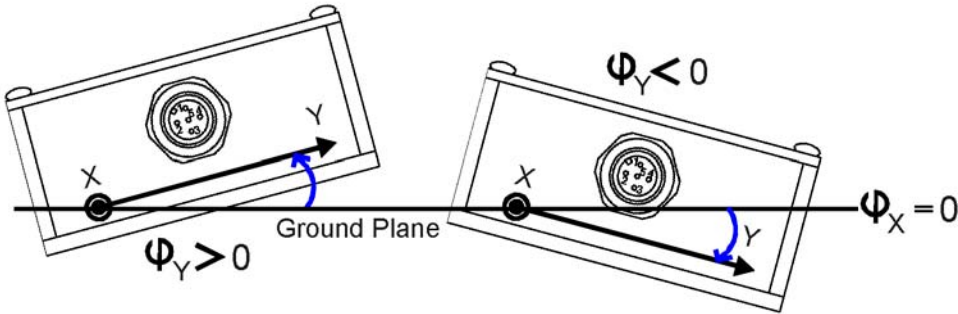


Figure 3 – Y-Axis Mounting

### Vertical Mount (360°) Measuring

This functional block is used only when the inclinometer is mounted vertically, i.e. orthogonally (at 90°) to the ground plane. In this position, if kept vertical, the inclinometer can measure an inclination angle in one direction in the whole  $\pm 180^\circ$  (0-360°) degree range.

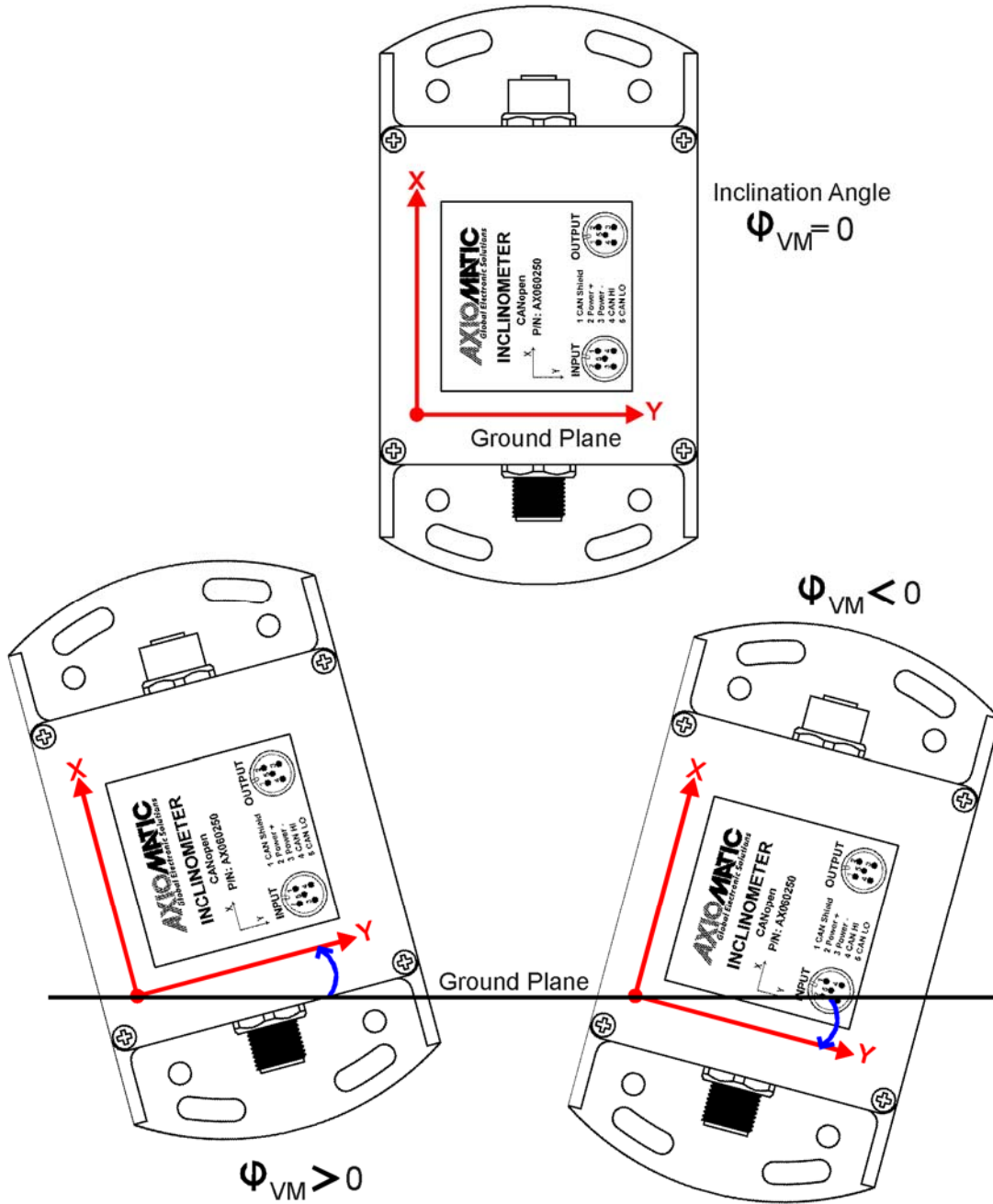


Figure 4 – Vertical Mounting

The sensing direction of the vertically mounted sensor is the same as the Y sensing direction of the regularly (horizontally) mounted sensor. When the X sensing direction points up and the Y sensing direction points to the right, and is in parallel with the ground plane, the inclination angle is zero. The counterclockwise rotation of the sensor produces positive angles and the clockwise, correspondingly, negative, as shown in Figure 4.

## Technical Specifications:

### Input

Power Supply Input	12V, 24V nominal (9...43 VDC power supply range)
Supply Current	40 mA at 12 V Typical 22 mA at 24 V Typical
Protection	Reverse polarity and transient protection is provided.

### Outputs

Operation Modes	Dual Axis or Single Axis
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Single Axis – Angle Range	Single Axis: -180°...180° (0...360°)	Vertical position of the inclinometer should be maintained within the maximum displacement angle ( $\pm 20^\circ$ , by default)
Resolution	$\pm 0.05^\circ$ Maximum	
Initial Accuracy	$\pm 0.25^\circ$ Maximum, at 25°C	
Repeatability	$\pm 0.05^\circ$ Maximum	
Nonlinearity	$\pm 0.1^\circ$ Typical	

Dual Axis – Angle Range	Dual Axis: -80°...80°	Functional up to $\pm 90^\circ$
Dual Axis Measurement Range	Low-angle range -30°...30°	High-angle range -80°...-30° 30°...80°
Resolution	$\pm 0.05^\circ$ Maximum	$\pm 0.2^\circ$ Maximum
Initial Accuracy	$\pm 0.25^\circ$ Maximum, at 25°C	$\pm 0.5^\circ$ Maximum, at 25°C
Repeatability	$\pm 0.05^\circ$ Maximum	$\pm 0.2^\circ$ Maximum
Temperature Drift	$\pm 0.0015$ °/°C Typical, at 0° over the full temperature range -40...85°C	-
Nonlinearity	$\pm 0.1^\circ$ Typical	$\pm 0.25^\circ$ Typical
Cross-Axis Sensitivity	0.5% Typical	

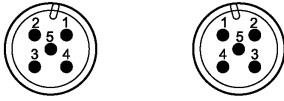

Cut-off frequency, Fc	5 Hz (default) 1...20 Hz (User configurable)
Settling Time	0.3 sec. Typical at Fc $\geq$ 5Hz from 0 to 95% of the static output value



CAN	1 CAN port CANopen® By default, the inclinometer transmits longitudinal and lateral angles (objects 6010h and 6020h) on TPDO1 to the CAN network, according to CiA Standard DS-410.
Protection	Short circuit to ground Connection to the power supply (24V maximum)

Output Voltages	In P/N: AX060251: 3 Analog (0-5V)
Voltage Output 1: Sensor X Angle (default)	Dual-axis mode -90° → 0 V (default, user configurable) 90° → 5 V (default, user configurable)
Voltage Output 2: Sensor Y Angle (default)	
Voltage Output 3: Vertical Mount Sensor Angle (default)	Axis direction is the same as the Y-axis in the dual-axis mode -180° → 0 V (default, user configurable) 180° → 5 V (default, user configurable)
Maximum Output Current	5mA per channel
Resolution	1 mV
Initial Accuracy	$\leq 0.15\%$ @25°C
Temperature Drift	$\leq 30$ ppm/°C over the full temperature range -40...85°C
Protection	Overcurrent (short circuit) Current is limited at $\approx 11.5$ mA Connection to the power supply. Connection to a reverse polarity voltage source (24V maximum)

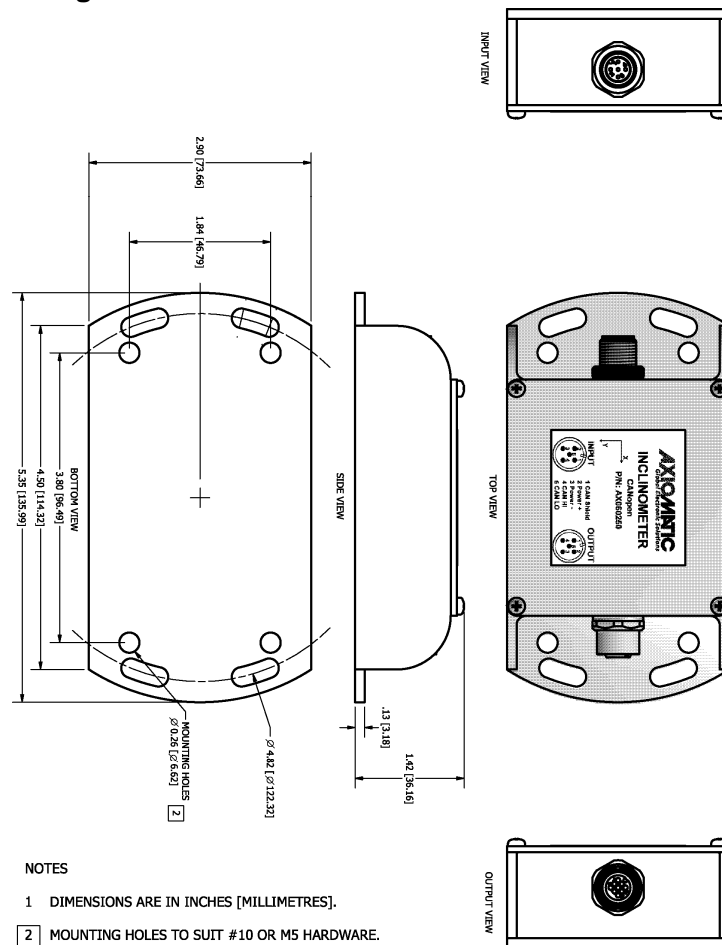
RS-232	In P/N: AX060252: 1 RS-232 Text Format 115200 Baud Rate Data – 8 bit, Parity – None, Stop – 1 bit. Flow Control – No. Short circuit protection to ground.
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### General Specifications

Microprocessor	32-bit, 128 KByte flash program memory
Sensor	Dual axis MEMS acceleration sensor
Control Logic	User programmable functionality using SDO object access, per CiA DS-301 Refer to UMAX06025X-45X for details.
Node ID and Baudrate	By default, the inclinometer ships factory programmed with a Node ID = 127 (0x7F) and with Baudrate = 125 kbps. These parameters are user programmable.
User Interface	.EDS provided to interface to standard CANopen® tools
Operating Conditions	-40 to 85 °C (-40 to 185 °F)
Packaging	Cast Aluminum enclosure 2 Round M12 5-pin A-coded integral connector(s) CONEC P/N: 43-02079 (M12 FEMALE) CONEC P/N: CONEC 43-02080 (M12 MALE) Encapsulated, Lid Gasket Dimensions: 2.90 x 5.35 x 1.42 inches 73.66 x 135.99 x 36.16 mm (L x W x H)
Protection	IP65 (IP67 on request for underwater applications)
Weight	0.85 lbs, 0.39 kg
Vibration	MIL-STD-202G, Test 204D and 214A (Sine and Random) 10 g peak (Sine) 7.86 Grms peak (Random)
Shock	MIL-STD-202G, Test 213B 50g
Approvals	CE marking
Electrical Connections Model AX060250	<p>P/N: AX060250 (CANopen)</p> <p>INPUT CONNECTOR      OUTPUT CONNECTOR</p>  <p>M12 Male FRONT VIEW      M12 female FRONT VIEW</p> <p>1. CAN SHIELD      1. CAN SHIELD 2. Power +      2. Power + 3. Power -      3. Power - 4. CAN HI      4. CAN HI 5. CAN LO      5. CAN LO</p> <p>A mating plug with CAN termination, P/N: AX070114, can be ordered to plug the 2nd connector for applications requiring only one CAN and Power connection as well as requiring a termination of the CAN network.</p>
Electrical Connections Model AX060251	<p>P/N: AX060251 (3 Analog Outputs, CANopen)</p> <p>INPUT CONNECTOR      OUTPUT CONNECTOR</p>  <p>M12 Male FRONT VIEW      M12 female FRONT VIEW</p> <p>1. CAN SHIELD      1. Voltage Output 1 (0-5V, Sensor X Angle Default) 2. Power +      2. Voltage Output 2 (0-5V, Sensor Y Angle Default) 3. Power -      3. Voltage Output 3 (0-5V, Vertical Mount Sensor Angle Default) 4. CAN HI      4. NOT USED 5. CAN LO      5. ANALOG GND</p>

<p>Electrical Connections Model AX060252</p>	<p>P/N: AX060252 (RS-232, CANopen)</p> <p>INPUT CONNECTOR      OUTPUT CONNECTOR</p> <div style="display: flex; justify-content: space-around;"> <div style="text-align: center;">  <p>M12 Male FRONT VIEW</p> </div> <div style="text-align: center;">  <p>M12 female FRONT VIEW</p> </div> </div> <div style="display: flex; justify-content: space-around;"> <div style="width: 45%;"> <ol style="list-style-type: none"> <li>1. CAN SHIELD</li> <li>2. Power +</li> <li>3. Power -</li> <li>4. CAN HI</li> <li>5. CAN LO</li> </ol> </div> <div style="width: 45%;"> <ol style="list-style-type: none"> <li>1. NOT USED</li> <li>2. RS-232 TXD</li> <li>3. RS-232 RXD</li> <li>4. NOT USED</li> <li>5. RS-232 GND</li> </ol> </div> </div>
<p>Installation</p>	<p>Mounting holes accept #10 or M5 screws. The thickness of the mounting flange is 0.13 inch or 3.18 mm.</p> <p>The CAN wiring is considered intrinsically safe. All field wiring should be suitable for the operating temperature range of the module.</p> <p>All chassis grounding should go to a single ground point designated for the machine and all related equipment.</p>
<p>Network Termination</p>	<p>The CAN port is electrically isolated from all other circuits. Refer to the CAN 2.0B specification for more information.</p> <p>It is necessary to terminate the network; therefore an external CAN termination is required. No more than two network terminators should be used on any one single network. A terminator is a 121Ω, 0.25 W, 1% metal film resistor placed between CAN_H and CAN_L terminals at the end two nodes on a network.</p>

## Dimensional Drawing



Specifications are indicative and subject to change. Actual performance will vary depending on the application and operating conditions. Users should satisfy themselves that the product is suitable for use in the intended application. All our products carry a limited warranty against defects in material and workmanship. Please refer to our Warranty, Application Approvals/Limitations and Return Materials Process as described on [www.axiomatic.com/service.html](http://www.axiomatic.com/service.html).

Form: TDAX06025X-08/21/15