



## AXISENSE-G DUAL AXIS GYRO STABILIZED TILT SENSOR

### SPECIFICATIONS

- $\pm 75^\circ$  Dual Axis Tilt Sensor
- Gyro Stabilized for Fast Response
- CAN J1939 Interface
- Packaged for Harsh Environments
- Inherent Shock Suppression
- Simple Mounting Features

### FEATURES

- Multi-axis Gyro and Accelerometer
- Sensitive to Pitch and Roll Movements
- Factory Calibrated and Compensated
- Built-in Diagnostics
- -40 to 85 °C Operating Temperature
- Survives 10,000 g Shock Events
- Cable with 4-pin Superseal™ Connector

### APPLICATIONS

- Stationary and Mobile Cranes and Hoists
- Forklifts and Material Handling Equipment
- Dump Trucks
- Vehicle Chassis Levelling
- Excavation Equipment
- Agricultural Machines
- Road Paving Equipment
- Scissor and Man Lifts

The Model AXISENSE-G is a dual axis tilt sensor that combines signals from a multi-axis accelerometer and multi-axis gyro into an accurate representation of pitch and roll angles. The addition of the gyro improves the reaction time of the sensor and reduces susceptibility to shock and vibration events.

The sensor uses gravity for the reference and reports any positive or negative tilt angle in both the X and Y axes. The static accuracy for these measurements is  $\pm 0.5^\circ$ .

The tilt sensor is packaged in a rugged enclosure with simple mounting features. It's designed to be immune to harsh environments commonly found in automotive and off-road vehicle applications. The IP67 rating makes the sensor suitable for use outdoors.

The sensor is supplied with a 400 mm (15.7") integrated cable and a 4-pin sealed, keyed, latching connector. The wide supply voltage range of 8 – 36 VDC allows the sensor to operate with most electrical systems. A built-in temperature sensor and self-diagnostic features immediately notify the user or system of any problems or malfunctions.

## AXISENSE-G DUAL AXIS GYRO STABILIZED TILT SENSOR

### ABSOLUTE MAXIMUM RATINGS <sup>a)</sup>

| Parameter                     | Symbol             | Min      | Typ | Max    | Unit | Notes/Conditions                            |
|-------------------------------|--------------------|----------|-----|--------|------|---------------------------------------------|
| Supply voltage                | V <sub>CC</sub>    | -40      |     | 40     | V    | Reference to GND                            |
| Operating/storage temperature | T <sub>STO</sub>   | -40      |     | 85     | °C   |                                             |
| Operating humidity            | H <sub>OP</sub>    |          |     | 100    | %RH  | >80% <40% of time                           |
| Storage humidity              | H <sub>STO</sub>   |          |     | 60     | %RH  | Unpowered                                   |
| Shock limit (any axis)        | a <sub>shock</sub> |          |     | 10,000 | g    | Non-repetitive 0.2 ms                       |
| Mounting screw torque         | M <sub>fix</sub>   |          | 10  | 15     | Nm   | M6 size                                     |
| Cable bend radius             |                    | 24<br>48 |     |        | mm   | Static Installation<br>Dynamic Installation |

a) Maximum limits the device will withstand without damage.

### ELECTRICAL SPECIFICATIONS

(Unless otherwise specified, all parameters are measured at 23 °C @ 12 V applied)

| Parameters                          | Symbol           | Min | Typ | Max | Unit | Notes/Conditions           |
|-------------------------------------|------------------|-----|-----|-----|------|----------------------------|
| Supply voltage                      | V <sub>CC</sub>  | 8   | 12  | 36  | Vdc  |                            |
| Supply current                      | I <sub>CC1</sub> | 15  | 20  | 45  | mA   |                            |
| CAN speed                           | f <sub>CAN</sub> |     | 250 |     | kbps |                            |
| CAN transmission rate <sup>1)</sup> |                  | 5   |     | 100 | ms   | Configurable <sup>4)</sup> |

1) Limited by CAN protocol.

### OPERATING SPECIFICATIONS

(Unless otherwise specified, all parameters are measured at 23 °C @ 12 V applied)

| Parameter                                        | Symbol              | Min | Typ   | Max   | Unit | Notes/Conditions                                                   |
|--------------------------------------------------|---------------------|-----|-------|-------|------|--------------------------------------------------------------------|
| Measurement range                                |                     | -75 |       | +75   | deg  | X & Y axes, ref to gravity                                         |
| Installation offset                              | Δ <sub>OFF</sub>    |     |       | ±0.3  | deg  |                                                                    |
| Absolute Accuracy, x/roll angle <sup>2) 7)</sup> | Δ <sub>STAT,x</sub> |     | ±0.50 | ±1.50 | deg  | Static<br>Depends on actual tilt angles, see Figure 1 for details. |
| Absolute Accuracy, y/pitch angle <sup>2)</sup>   | Δ <sub>STAT,y</sub> |     |       | ±0.5  | deg  | Static<br>Whole angular range                                      |
| Mean Accuracy, RMS <sup>6)</sup>                 | Δ <sub>DYN</sub>    |     | ±1.5  |       | deg  | Dynamic<br>Whole angular range                                     |
| Predicted Lifetime Stability                     | Δ <sub>LT</sub>     |     |       | ±0.5  | deg  |                                                                    |
| Settling time <sup>3)</sup>                      | t <sub>SET</sub>    |     | 300   |       | ms   | 90% of final reading                                               |
| Resolution <sup>1)</sup>                         | RES                 |     |       | 0.01  | deg  |                                                                    |
| Orientation Algorithm Update rate <sup>5)</sup>  | f <sub>u</sub>      |     | 100   |       | Hz   |                                                                    |
| Startup time                                     | t <sub>s</sub>      |     |       | 1.0   | s    | V <sub>CC</sub> 0 to 24V transition                                |

2) Absolute accuracy is the worst-case deviation between output angle and actual angle.

Static accuracy is verified by an end of line measurement at different angles after calibration. The sensor module will not be removed from fixture in between. Static implies no movement of the sensor. As the inclinometer is designed to be fixed with M6 screws, there is some mechanical clearance that may lead to a small misalignment and offset in application. For some applications, it may be reasonable to implement an in-application offset correction to attain best overall accuracy.

3) Depends on filter setting.

4) Configurable from 5 ms to 100 ms, see notes on page 10.

5) Gyroscope and accelerometer are sampled at 1 kHz. Signals are carefully filtered and sampled down to 100 Hz

6) Dynamic accuracy is the RMS (root mean square) deviation between output angle and set angle, tested under three different conditions:

- linear acceleration in one sensor axis with 0.3 g for a period of 1 second or
- random vibration with 0.3 g RMS or
- rotational movement of one sensor axis with a rotational velocity of 30 °/s

It is important to note that this error depends very much on the desired application and the strength of vibration and additional acceleration. Testing the sensor in the application is recommended.

7) Due to mathematical properties of the roll/x angle sensor output, the absolute static error depends on the actual pitch/y angle for y values > 50°. See Figure 1 for details.

## AXISENSE-G DUAL AXIS GYRO STABILIZED TILT SENSOR

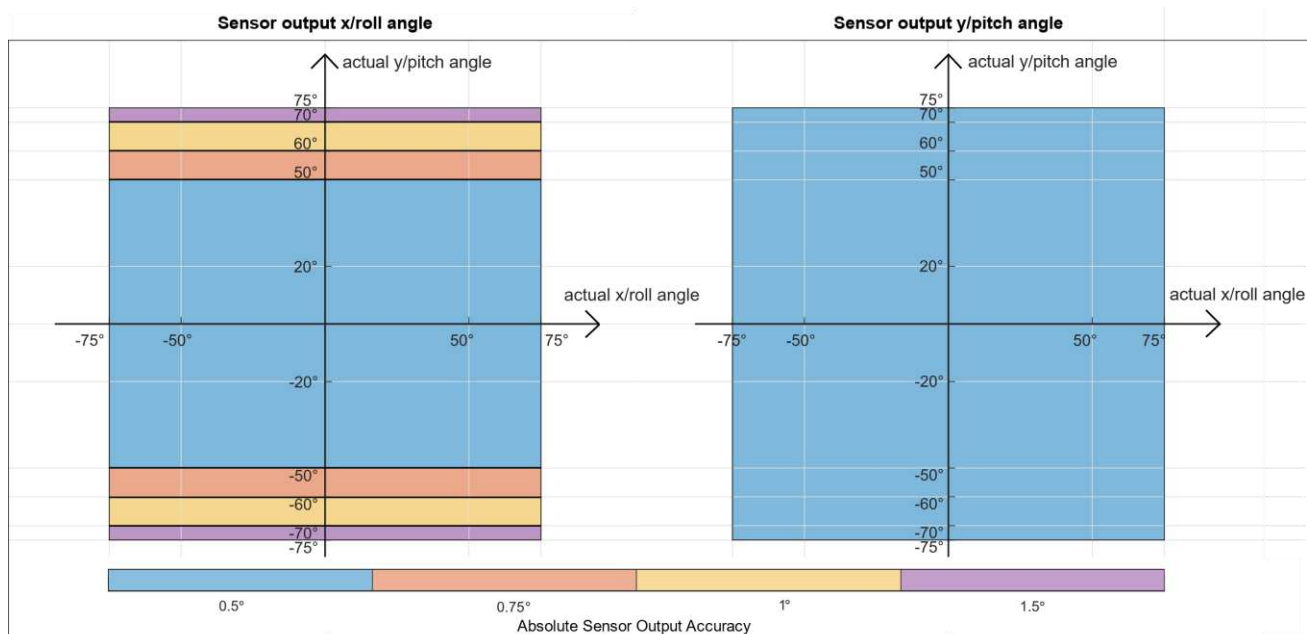


Figure 1: Definition of the absolute sensor output accuracy across the whole measurement range of  $\pm 75^\circ$ . Left: Sensor output x/roll angle. Interval-wise accuracy definition related to the actual y/pitch angle. Right: Sensor output y/pitch angle, constant accuracy throughout the whole measurement range.

### ENVIRONMENTAL SPECIFICATIONS

| Parameter                  | Symbol | Min                                                                      | Typ | Max | Unit  | Notes/Conditions  |
|----------------------------|--------|--------------------------------------------------------------------------|-----|-----|-------|-------------------|
| Operating temperature      |        | -40                                                                      |     | 85  | °C    |                   |
| Storage temperature        |        | -40                                                                      |     | 85  | °C    |                   |
| Operating ambient humidity |        | 0                                                                        |     | 60  | %RH   | >80% <40% of time |
| Ingress protection         | IP67   |                                                                          |     |     |       |                   |
| Media compatibility        |        | External exposed surfaces:<br>Nylon, Polyurethane Resin, Brass, Polyamid |     |     |       |                   |
| Compliance                 |        | RoHS 2 directive 2011/65/EU<br>REACH 1907/2006                           |     |     |       |                   |
| Weight                     |        |                                                                          | 60  |     | grams |                   |

## AXISENSE-G DUAL AXIS GYRO STABILIZED TILT SENSOR

### FUNCTIONAL OPERATION

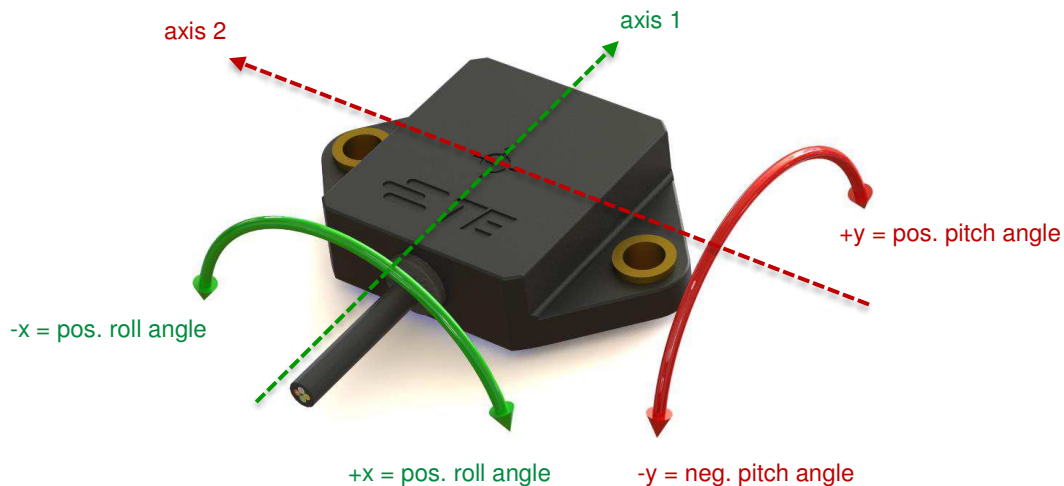


Figure 2: Sensitive Axes Orientation

Angles are defined according to **DIN 70000** and **ISO 8855**:

- Roll measures rotation angle *around* the (local) body x-axis
- Pitch measures rotation angle *around* the (local) body y-axis

### BLOCK DIAGRAM

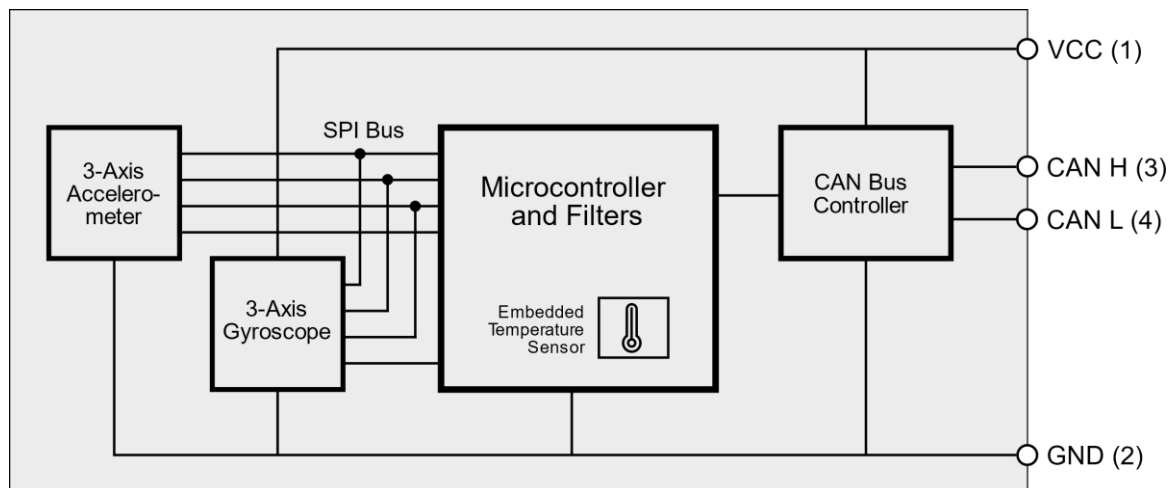


Figure 3: Block Diagram

# AXISENSE-G DUAL AXIS GYRO STABILIZED TILT SENSOR

## OUTLINE DIMENSIONS

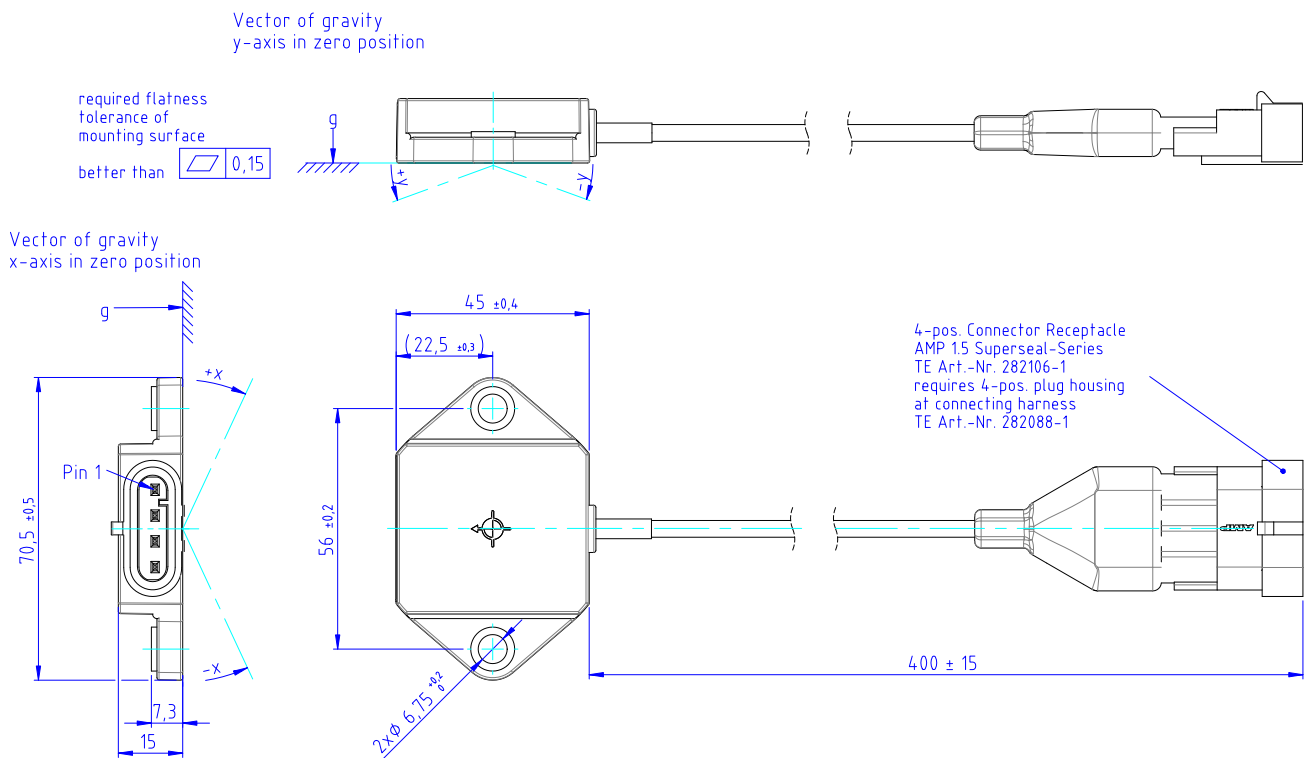


Figure 4: Dimensions

## CONNECTOR DETAIL

The tilt sensor has an AMP Superseal series connector with 4 terminals (TE Connectivity part-no. 282106-1). It mates with TE Connectivity part-no. 282088-1.

| Pin Number | Function                         | Description   | Wire Color | Direction    |
|------------|----------------------------------|---------------|------------|--------------|
| 1          | Supply voltage - V <sub>CC</sub> | 8 – 36 V      | White      | Input        |
| 2          | Ground - GND                     | 0V            | Yellow     | Input        |
| 3          | CAN_H                            | CAN high line | Brown      | Input/output |
| 4          | CAN_L                            | CAN low line  | Green      | Input/output |

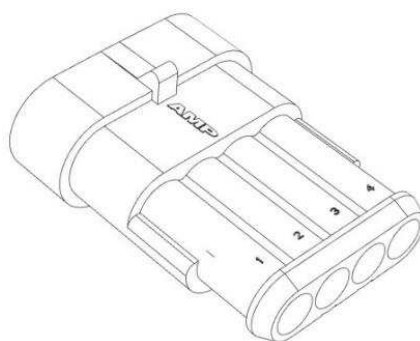


Figure 5: Connector Pinout

## AXISENSE-G DUAL AXIS GYRO STABILIZED TILT SENSOR

### ELECTRICAL INTERFACE

The tilt sensor has a SAE J1939 CAN-compatible interface described in detail in the following section. OEM adaptation is possible.

#### Conventions

The tilt sensor complies with SAE J1939 CAN2.0B and uses a baud rate of 250 kbps. Proprietary A (0xEF) and B (0xFF) portions of SAE J1939 are used. The 29-bit message identifiers can be formulated using the following scheme:

| Bit Position | Description                                                                                                            |
|--------------|------------------------------------------------------------------------------------------------------------------------|
| 28:26        | Message priority (6 is lowest, 0 is highest)                                                                           |
| 25:24        | Future J1939 use. Always 0                                                                                             |
| 23:16        | Data content (PF). Always set to 0xFF for priority B                                                                   |
| 15:8         | Data content (PS). (0x52 = Sensor serial number, 0x53 = Sensor Data, 0x54 = Ground Control Command to the sensor)      |
| 7:0          | Source address (SA). Indicates which device sent the message (0xC0 = SA unassigned, 0x80 – 0xF7 = Chassis Tilt Sensor) |

#### Source Addresses

The tilt sensor sends a onetime address claim message 500 ms after startup and upon request by the host:

| Module           | Source Address                                   |
|------------------|--------------------------------------------------|
| Master (MA)      | Various (except tilt sensor source address)      |
| Tilt sensor (SA) | Uninitialized 0xC0<br>Settable range 0x80...0xF7 |

## Tilt Angle

Priority: 4 Source Address: Tilt sensor  
 Data Content (PF): 0xFF (Proprietary B)  
 Data Content (PS): 0x53 Repetition Rate: 10 ms

| Data | Byte | Function                                               |
|------|------|--------------------------------------------------------|
| X    | 0    | X-Axis (Roll) Tilt Reading x100 (Signed Word, LSB)     |
| X    | 1    | X-Axis (Roll) Tilt Reading x100 (Signed Word, MSB)     |
| X    | 2    | Y-Axis (Pitch) Tilt Reading x100 (Signed Word, LSB)    |
| X    | 3    | Y-Axis (Pitch) Tilt Reading x100 (Signed Word, MSB)    |
| X    | 4    | Internal Temperature (Signed Byte)                     |
| X    | 5    | Software Version (Major, Minor upper and lower nibble) |
| X    | 6    | Data Status and Time Stamp                             |
| X    | 7    | Error Codes x                                          |

### Description of Operation:

The tilt sensor broadcasts this message periodically to update the host module.

#### Data Definition

|                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Data Bytes 0-1 | <p>X-Axis angle reading in hundredths of a degree</p> <p><i>Example:</i></p> <p><i>Data Bytes 0, 1 are 0xD8, 0xDC for -90.00 deg</i></p> <p><i>Data Bytes 0, 1 are 0x64, 0x19 for +65.00 deg</i></p>                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Data Bytes 2-3 | <p>Y-Axis angle reading in hundredths of a degree</p> <p><i>Example:</i></p> <p><i>Data Bytes 2, 3 are 0xB0, 0xB9 for -180.00 deg</i></p> <p><i>Data Bytes 2, 3 are 0x10, 0x27 for +100.00 deg</i></p>                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Data Byte 4    | <p>Internal Temperature in degrees Celsius</p> <p><i>Example:</i></p> <p><i>Data Byte 4 is 0x55 for +85 °C</i></p> <p><i>Data Byte 4 is 0xD8 for -40 °C</i></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Data Byte 5    | <p>Software Version (<i>Major bits 4-7, Minor bits 0-3 in hexadecimal</i>)</p> <p><i>Example:</i></p> <p><i>0x3C for version 3.12 – decimal implied</i></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Data Byte 6    | <p>Data Status → lower nibble, bits 0-3</p> <p>0x0000<sub>b</sub> During power up or when data is invalid</p> <p>0x0001<sub>b</sub> Data available and valid</p> <p>0x0011<sub>b</sub> Error (see Byte 7 error code for definitions)</p> <p>0xXX10<sub>b</sub> Undefined Positional data in Bytes 0-5 are set to 0xFF, if status is invalid or undefined, but may be valid in error per Byte 7</p> <p>Time Stamp → upper nibble, bits 4-7</p> <p>0xFFFF<sub>b</sub> this number is incremented for every transmission to prevent a stagnant transmission, when 0x1111<sub>b</sub> is reached, value rolls over to 0x0000<sub>b</sub></p> |
| Data Byte 7    | <p>Error Codes (bit set = 1 when fault exists; cleared = 0 when no fault present).</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |

**Error Codes**

| Fault Topic                   | Bit | = 0                          | =1                                                                                                                                  |
|-------------------------------|-----|------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|
| EEPROM Error                  | 0   | Checksum Ok                  | Checksum Failure<br>Byte 6 status = 11b<br>Positional and temperature data transmitted                                              |
| Sensor Element Error (X-axis) | 1   | Normal Operation             | Fault detected<br>Byte 6 status = 11b<br>X-axis positional data set = 0xFFFF; remaining positional and temperature data transmitted |
| Sensor Element Error (Y-axis) | 2   | Normal Operation             | Fault detected<br>Byte 6 status = 11b<br>Y-axis positional data set = 0xFFFF; remaining positional and temperature data transmitted |
| Supply Voltage Detection      | 3   | Supply Voltage $\geq$ 8V     | Supply Voltage < 8 V<br>Byte 6 status = 11b<br>Positional and temperature data transmitted                                          |
| Overvoltage Error             | 4   | Supply voltage $\leq$ 36V    | Supply Voltage > 36 V<br>Byte 6 status = 11b<br>Positional and temperature data transmitted                                         |
| Overtemperature Error         | 5   | PCBA temperature $\leq$ 90°C | Temperature > 90 °C<br>Byte 6 status = 11b<br>Positional and temperature data transmitted                                           |
| Not defined                   | 6   | Not defined                  | Not defined                                                                                                                         |
| Not defined                   | 7   | Not defined                  | Not defined                                                                                                                         |

**Tilt Sensor Address Claim**

|                    |      |                  |                                         |
|--------------------|------|------------------|-----------------------------------------|
| Priority:          | 6    | Source Address:  | Tilt Sensor                             |
| Data Content (PF): | 0xEE |                  |                                         |
| Data Content (PS): | 0xFF | Repetition Rate: | Once 500 ms after startup<br>On request |

| Data | Byte | Function                                                         |
|------|------|------------------------------------------------------------------|
| X    | 0    | Serial Number (LSB)                                              |
| X    | 1    | Serial Number                                                    |
| X    | 2    | Serial Number (MSB), Manufacture Code (LSB)                      |
| X    | 3    | Manufacture Code (MSB)                                           |
| 00   | 4    | ECU Instance, Function Instance                                  |
| 88   | 5    | Function                                                         |
| 00   | 6    | Reserved                                                         |
| 30   | 7    | Vehicle System Instance, Industry Group, Arbitrary Address Claim |

### Description of Operation:

The tilt sensor broadcasts this message per J1939-81, 4.2.2.1 with byte definitions as follows:

#### Data Definition

|                       |                                             |
|-----------------------|---------------------------------------------|
| Data Byte 0           | Serial Number, Bits 0 - 7                   |
| Data Byte 1           | Serial Number, Bits 8 - 15                  |
| Data Byte 2, Bits 0-4 | Serial Number, Bits 16 - 20                 |
| Data Byte 2, Bits 5-7 | Manufacturer Code, Bits 0 - 2               |
| Data Byte 3           | Manufacturer Code, Bits 3 - 10              |
| Data Byte 4, Bits 0-2 | ECU Instance = 0                            |
| Data Byte 4, Bits 3-7 | Function Instance = 0                       |
| Data Byte 5           | Function = 136 (Slope Sensor)               |
| Data Byte 6, Bit 0    | Reserved = 0                                |
| Data Byte 6, Bits 1-7 | Vehicle System = 0 (Non-Specific System)    |
| Data Byte 7, Bits 0-3 | Vehicle System Instance = 0                 |
| Data Byte 7, Bits 4-6 | Industry Group = 3 (Construction equipment) |
| Data Byte 7, Bit 7    | Arbitrary Address Claim = 0 (Not Arbitrary) |

### Tilt Sensor Address Claim Request

|                    |             |                  |            |
|--------------------|-------------|------------------|------------|
| Priority:          | 6           | Source Address:  | Master     |
| Data Content (PF): | 0xEA        |                  |            |
| Data Content (PS): | Tilt Sensor | Repetition Rate: | On Request |
| Data               | Byte        | Function         |            |
| 00                 | 0           | PGN (LSB)        |            |
| EA                 | 1           | PGN              |            |
| X                  | 2           | PGN (MSB)        |            |

### Description of Operation:

The tilt sensor broadcasts the "Tilt Sensor Address Claim" message upon receiving this message per J1939-21, 5.4.2 with byte definitions as follows:

#### Data Definition

|                      |                                            |
|----------------------|--------------------------------------------|
| Data Byte 0 PGN      | – Requestor Source Address                 |
| Data Byte 1 PGN (PF) | – 0xEA (Address Claim)                     |
| Data Byte 2 PGN (PS) | – 0XXX (Source Address of the Tilt Sensor) |

**Master Control Commands – Chassis Tilt Sensor**

|                    |                      |                  |                                                |
|--------------------|----------------------|------------------|------------------------------------------------|
| Priority:          | 4                    | Source Address:  | Master                                         |
| Data Content (PF): | 0xFF (Proprietary B) | CAN ID           | 0x10FF54XX<br>XX = Source<br>Address of Master |
| Data Content (PS): | 0x54                 | Repetition Rate: | On request                                     |

| Data Byte | Function                                       |
|-----------|------------------------------------------------|
| 0         | Command Byte                                   |
| 1         | Depends on Command Byte, see explanation below |
| 2         | Depends on Command Byte, see explanation below |
| 3         | Depends on Command Byte, see explanation below |
| 4         | Depends on Command Byte, see explanation below |
| 5         | Depends on Command Byte, see explanation below |
| 6         | Depends on Command Byte, see explanation below |
| 7         | Depends on Command Byte, see explanation below |

**Description of Operation**

The master shall request the unique serial number (S.N.) of the Tilt Sensor. The intent is to assign different source addresses to the Chassis Tilt Sensor so that multiple sensors can operate on one CAN Bus. The first byte is the Command Byte specifying the meaning for the rest of the message. The rest of the data depends on the Command Byte as detailed below.

Request for Sensor S.N.

|            |     |                                                                     |
|------------|-----|---------------------------------------------------------------------|
| Data Byte  | 0   | 0x00 (commands sensor to respond with Sensor Serial Number message) |
| Data Bytes | 1-7 | 0xFF; not used                                                      |

Request for Source Address Change

|            |     |                                                                                                                  |
|------------|-----|------------------------------------------------------------------------------------------------------------------|
| Data Byte  | 0   | 0x01 (commands sensor with specified S.N. to change SA to given value; stored in the sensor non-volatile memory) |
| Data Byte  | 1   | New Source Address in hexadecimal                                                                                |
| Data Bytes | 2-7 | Not used                                                                                                         |

Request for Wait

|            |     |                                                                                                                                               |
|------------|-----|-----------------------------------------------------------------------------------------------------------------------------------------------|
| Data Byte  | 0   | 0x02 (Stop all sensor responses and broadcast. This includes no response to a subsequent request for serial number commands or address claim) |
| Data Bytes | 1-7 | Not used                                                                                                                                      |

Request for Repetitive Transmission of Data

|            |     |                                                                     |
|------------|-----|---------------------------------------------------------------------|
| Data Byte  | 0   | 0x03 (Start sensor data broadcast and enable answering to requests) |
| Data Bytes | 1-7 | Not used                                                            |

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### Request for Transmission Rate Change

|            |     |                                                                  |
|------------|-----|------------------------------------------------------------------|
| Data Byte  | 0   | 0x04 (changes the CAN broadcast transmission rate)               |
| Data Byte  | 1   | New transmission period in hex, see Table 1 for possible options |
| Data Bytes | 2-7 | Serial Number in BCD of target sensor                            |

Table 2: Transmission rate options

| Options | Resulting transmission rate |
|---------|-----------------------------|
| 0x05    | 5 ms                        |
| 0x0A    | 10 ms (default)             |
| 0x0F    | 15 ms                       |
| 0x14    | 20 ms                       |
| 0x3C    | 60 ms                       |

### Request for Return to Uninitialized Source Address

|            |     |                                                                                                                                                      |
|------------|-----|------------------------------------------------------------------------------------------------------------------------------------------------------|
| Data Byte  | 0   | 0x09 (commands sensor with specified SA and S.N. to change its SA currently stored in the sensor non-volatile memory to the uninitialized SA = 0xC0) |
| Data Byte  | 1   | Current Source Address in hexadecimal of target sensor                                                                                               |
| Data Bytes | 2-7 | Serial Number in BCD of target sensor                                                                                                                |

## Sensor Serial Number

Priority: 4

Source Address: Tilt Sensor

Data Content (PF): 0xFF (Proprietary B)

Data Content (PS): 0x52

Repetition Rate: On request

| Data | Byte | Function                                                                                                                        |
|------|------|---------------------------------------------------------------------------------------------------------------------------------|
| X    | 0    | Serial Number in BCD (set = 00); populate extra positions with zero                                                             |
| X    | 1    | Serial Number in BCD (set upper nibble=0; upper digit year of production→lower nibble; year of production; ex. 14 for 2014; AA) |
| X    | 2    | Serial Number in BCD (set upper nibble=0; upper digit year of production→lower nibble; year of production; ex. 14 for 2014; AA) |
| X    | 3    | Serial Number in BCD (lower digit of calendar week→upper nibble; reserved X→lower nibble)                                       |
| X    | 4    | Serial Number in BCD (most significant sequence digits; upper CC)                                                               |
| X    | 5    | Serial Number in BCD (least significant sequence digits; lower CC)                                                              |
| X    | 6    | Software Revision Major Number in BCD                                                                                           |
| X    | 7    | Software Revision Minor Number in BCD                                                                                           |

## AXISENSE-G DUAL AXIS GYRO STABILIZED TILT SENSOR

### Examples

Initial Inclination sensor sources address = 0xC0 (uninitialized), 0xE8 after change and 0xC0 again

Inclination sensor serial number = 174700286

Master source address = 0xC3

| Data packet | Time in ms | Time delta in ms | In/Out | CAN Id   | CAN Data                | Comment                                                                                                                                                                                                                                     |
|-------------|------------|------------------|--------|----------|-------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1           | 0          | 0                | Rx     | 18EEFFC0 | 00 00 20 66 00 88 00 30 | Address claim of inclinometer                                                                                                                                                                                                               |
| 2           | 57         | 57.6             | Rx     | 10FF53C0 | 28 23 94 11 19 13 01 00 | Tilt angle broadcast, sensor SA = 0xC0, X Angle = 0x2328 = 90°, Y Angle = 0x1194 = 45°, Temper. = 0x19 = 25 °C Softw. Ver. = 0x13 = 1.3x Data timest. = 0x0 = 0 Data status = 0x1 = valid Error code = 0x00 = no err transm. period = 10 ms |
| 3           | 67         | 9.9              | Rx     | 10FF53C0 | 28 23 94 11 19 13 11 00 | ...                                                                                                                                                                                                                                         |
| 4           | 77         | 9.9              | Rx     | 10FF53C0 | 28 23 94 11 19 13 21 00 | ...                                                                                                                                                                                                                                         |
| 5           | 87         | 9.8              | Rx     | 10FF53C0 | 28 23 94 11 19 13 31 00 | ...                                                                                                                                                                                                                                         |
| 6           | 97         | 9.9              | Rx     | 10FF53C0 | 28 23 94 11 19 13 41 00 | ...                                                                                                                                                                                                                                         |
| 17          | 205        | 9.9              | Rx     | 10FF53C0 | 28 23 94 11 19 13 F1 00 | Maximum timestamp reached (0xF)                                                                                                                                                                                                             |
| 18          | 215        | 9.8              | Rx     | 10FF53C0 | 28 23 94 11 19 13 01 00 | Timestamp rollover (0x0)                                                                                                                                                                                                                    |
| 19          | 225        | 9.9              | Rx     | 10FF53C0 | 28 23 28 23 19 13 11 00 | Continue with tilt angle broadcast                                                                                                                                                                                                          |
| 2688        | 26577      | 6.2              | Tx     | 10FF54C3 | 00 00 00 00 00 00 00 00 | Serial number command request                                                                                                                                                                                                               |
| 2689        | 26579      | 1.6              | Rx     | 10FF52C0 | 00 01 74 70 02 86 01 36 | Serial number answer in BCD = 174700286, Software Ver = 1.36                                                                                                                                                                                |
| 2690        | 26582      | 2.6              | Rx     | 10FF53C0 | 9A 23 B1 22 19 13 E1 00 | Tilt angle broadcast, X = 0x239A = 91.14°, Y = 0x22B1 = 88.81°                                                                                                                                                                              |
| 2691        | 26591      | 9.9              | Rx     | 10FF53C0 | 9A 23 B1 22 19 13 F1 00 | ...                                                                                                                                                                                                                                         |
| 7957        | 249957     | 2                | Tx     | 10FF54C3 | 01 E8 00 01 74 70 02 86 | Change source address of sensor 174700286 S.N. to 0xE8                                                                                                                                                                                      |
| 7958        | 250148     | 191.2            | Rx     | 10FF53E8 | 92 23 B9 22 1E 13 A1 00 | Tilt angle broadcast, source address has changed!                                                                                                                                                                                           |
| 8872        | 259173     | 9.4              | Tx     | 10FF54C3 | 02 00 00 01 74 70 02 86 | Stop transmission                                                                                                                                                                                                                           |
| 8874        | 262689     | 3515.5           | Tx     | 10FF54C3 | 03 00 00 01 74 70 02 86 | Start transmission again (3.515 seconds no answer)                                                                                                                                                                                          |
| 8875        | 262695     | 5.8              | Rx     | 10FF53E8 | 93 23 B8 22 1E 13 D1 00 | Tilt angle broadcast                                                                                                                                                                                                                        |
| 9247        | 266369     | 9.9              | Tx     | 10FF54C3 | 04 04 00 01 74 70 02 86 | Change transmission period to 0x04 = 40 ms                                                                                                                                                                                                  |
| 9250        | 266602     | 39.9             | Rx     | 10FF53E8 | 91 23 B8 22 1E 13 31 00 | Tilt angle broadcast with 40 ms transmission period                                                                                                                                                                                         |
| 9251        | 266642     | 40               | Rx     | 10FF53E8 | 90 23 B8 22 1E 13 41 00 | ...                                                                                                                                                                                                                                         |
| 9252        | 266682     | 40               | Rx     | 10FF53E8 | 93 23 B8 22 1E 13 51 00 | ...                                                                                                                                                                                                                                         |

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| Data packet | Time in ms | Time delta in ms | In/Out | CAN Id   | CAN Data                | Comment                               |
|-------------|------------|------------------|--------|----------|-------------------------|---------------------------------------|
| 9661        | 283009     | 20.7             | Tx     | 10FF54C3 | 09 E8 00 01 74 70 02 86 | Deinitialize sensor source address    |
| 9662        | 283089     | 80.1             | Rx     | 10FF53C0 | 90 23 BA 22 1E 13 E1 00 | Sensor's source address is 0xC0 again |
| 9663        | 283129     | 39.9             | Rx     | 10FF53C0 | 91 23 BB 22 1E 13 F1 00 | ...                                   |
| 9664        | 283169     | 40               | Rx     | 10FF53C0 | 91 23 BB 22 1E 13 01 00 | ...                                   |
| 9805        | 288789     | 24.2             | Tx     | 10FF54C3 | 00 00 00 00 00 00 00 00 | Serial number command                 |
| 9806        | 288790     | 1.6              | Rx     | 10FF52C0 | 00 01 74 70 02 86 01 36 | it's still 174700286                  |
| 9807        | 288805     | 40               | Rx     | 10FF53C0 | 90 23 BB 22 1E 13 D1 00 | Tilt angle broadcast                  |
| 9808        | 288845     | 40               | Rx     | 10FF53C0 | 90 23 BA 22 1E 13 E1 00 | ...                                   |
| 9809        | 288885     | 40               | Rx     | 10FF53C0 | 90 23 BA 22 1E 13 F1 00 | End of trace                          |

# INSTALLATION AND MOUNTING INSTRUCTIONS

## INTRODUCTION

This specification covers the requirements for mounting of inclination sensor modules from the AXISENSE Series. This series is mainly developed with focus on platform leveling, dynamic engine management, tip-over protection and tilt alarm. When corresponding with personnel, use the terminology provided in this specification to facilitate inquiries for information. Basic terms and features of this product are provided in Figure 6.



Figure 6: Sensor Terminologies

## REFERENCE MATERIAL

### Customer Assistance

Reference Product Type can be found on the label of the sensor starting with “AXISENSE-G”. Use of this name will identify the product type and help you to obtain product information. Such information can be obtained through a local Representative, by visiting our Website at [www.te.com](http://www.te.com).

### Drawings

Customer Drawings for product part numbers are available from the service network. If there is a conflict between the information contained in the Customer Drawings and this specification or with any other technical documentation supplied, the information contained in the Customer Drawings takes priority.

### Specifications

Reference documents which pertain to the products are available via [www.te.com](http://www.te.com) or your personal point of contact at TE Connectivity.

### REQUIREMENTS

The sensor shall always be mounted according the specified mounting direction, which is floor mount (see Figure 7), “g” reflects the vector of gravity in zero position of both movement axes.

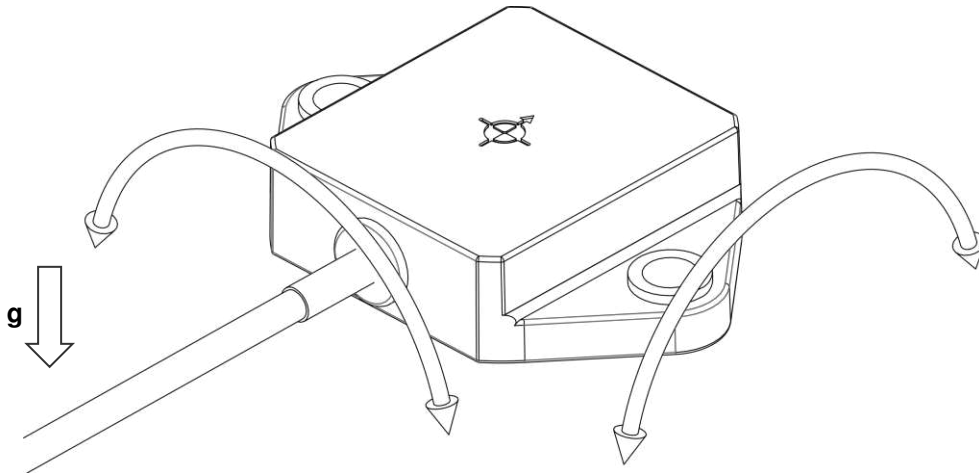


Figure 7: Mounting Reference to Gravity

To obtain the most accurate sensor outputs and prevent accelerated degradation over time, these items should be considered:

- Prevent from direct sunlight
- Avoid high relative humidity
- Avoid extreme temperatures close to the specified operational temperature limits
- Minimize number of temperature changes and temperature shift
- Select location with minimum acceleration from application (vibration, shock, centrifugal etc.)

A flat mounting area with a surface deviation of less than 0.15 mm must be chosen. No welding seams or surface bends should be present in the mounting footprint of the sensor housing. While installing the sensor do not exceed minimum bending radius of cable which (24 mm for static and 48 mm for use in dynamic application).

The recommended mounting torque is 10 Nm, which is also depending on the property class of the used screws (e.g. 6.8 class screw limits torque to 7.5 Nm). The applied mounting torque must not exceed 15 Nm.

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To achieve best accuracy of the output values, the reference edge of the housing, as highlighted in Figure 8, should be used. This edge complies with the alignment of the sensor module during the calibration process in factory. Figure 9 reflects these requirements and recommendations.

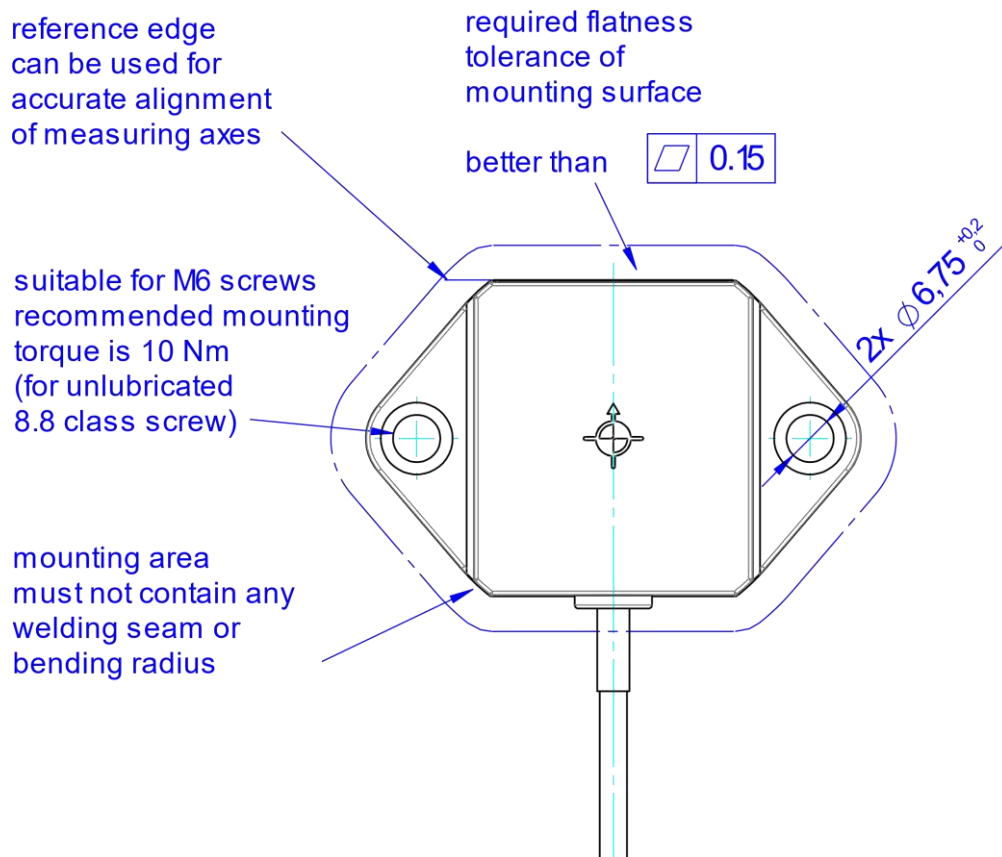


Figure 8: Mounting Detail

The sensor module should be mounted with screws onto a part already containing M6 size threaded holes separated by a distance of  $56 \pm 0.25$  mm. Mounting of the sensor module with M6 hexagon nuts and threaded pins fixed to the part is also recommended as long as the required flatness below the sensor module is guaranteed (see Figure 9). It is advised to use a washer with the screw or hexagon nut in any of those cases.

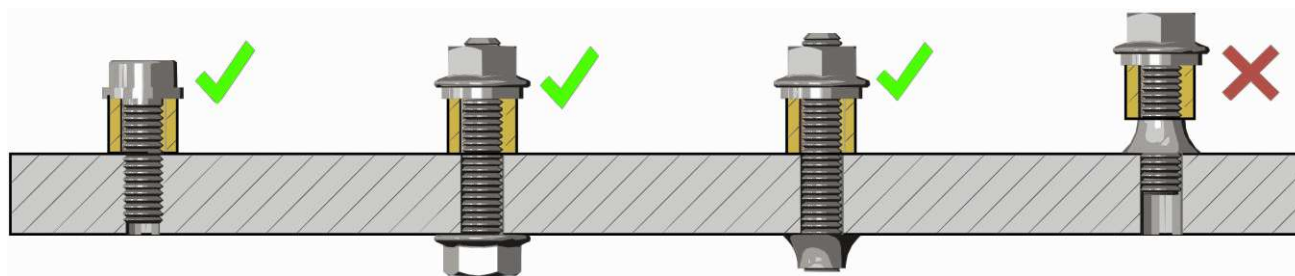


Figure 9: Mounting Screw Detail

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When the counterpart in application contains through holes and the module is mounted with screws and hexagon nuts, it is recommended to use the through hole dimension and distance displayed in Figure 10.

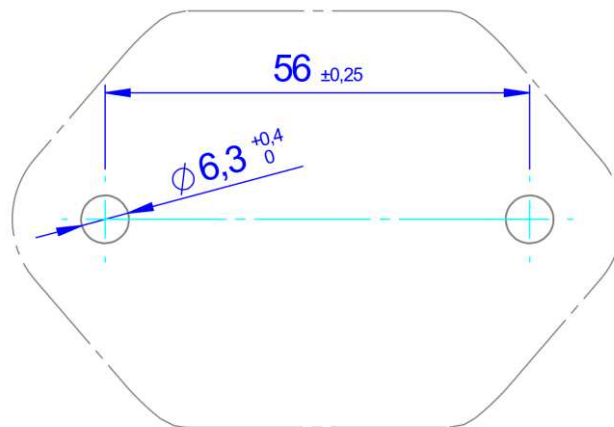


Figure 10: Mounting Hole Detail

In the case of an ideal alignment in application, the sensor axes would match exactly the axes to be measured. Using the minimum diameter for the through holes will reduce the possible deviation of the sensor module axes from ideal alignment. Thus, compared to the use of the maximum diameter, a better system accuracy can be achieved in application.

Beside limiting any undesired rotation, the maximum diameter of the through holes in the part shall be limited for another reason. Limiting the diameter to Ø6.7 mm will assure that the force onto the sensor housing emerged by the mounting torque of the screws applies only to the metal compression limiters of the sensor housing.

This is necessary, because it avoids the influence of mechanical stress caused by the mounting torque on other parts of the sensor module assembly. Otherwise, it would have a negative effect on the performance and accuracy of the system.

### NOTE

*All numerical values are in metric units. Dimensions are in millimeters. Unless otherwise specified, dimensions have a tolerance according to ISO 2768-mK. Figures and illustrations are for identification only and are not drawn to scale.*

## AXISENSE-G DUAL AXIS GYRO STABILIZED TILT SENSOR

### Ordering Information

| Part Number                   | Short Description                                                                                                                                              |
|-------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| AXISENSE-G-700<br>10219046-00 | Dual axis gyro stabilized tilt sensor, shock suppression, fast response, range $\pm 75^\circ$ , Vcc 8-38 VDC, CAN J1939 Interface, customizable source address |



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