ST industrial inclinometers

Overview of industrial sensors

ST industrial accelerometers portfolio

Tilt sensing with inclinometers and IMUs

Development tools + SW for tilt sensing
ST sensors for industry 4.0
A complete portfolio

- High-g shock accelerometers
- Inclinometers
- Vibration sensors
- 6-axis IMU + Machine Learning
- High performance
- High accuracy
- High reliability
- Pressure sensors
- Humidity sensors
- Temperature sensors

High performance
High accuracy
High reliability
## Industrial accelerometers

<table>
<thead>
<tr>
<th>Accelerometer</th>
<th>Description</th>
<th>Package Size</th>
<th>Key Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>IIS2DH</td>
<td>General purpose</td>
<td>2 x 2 x 1 mm</td>
<td>Low Power, Wide BW (2 kHz)</td>
</tr>
<tr>
<td>IIS2DLPC</td>
<td>Inclinometers</td>
<td>2 x 2 x 0.7 mm</td>
<td>Ultra low power, High versatility: on the fly changes from ultra low power to high resolution/high performance modes</td>
</tr>
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<td>IIS32BDQ</td>
<td>Inclinometers</td>
<td>4 x 4 x 1.8 mm</td>
<td>Extended Top: -40°C+105°C, QFN Package</td>
</tr>
<tr>
<td>IIS32ICLX</td>
<td>Inclinometers</td>
<td>5 x 5 x 1.7 mm</td>
<td>2 axis digital Inclinometer, Cur Cons: 0.42 mA, FS: ± 0.5/1.0/2.0/3.0</td>
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<td>IIS3DHHC</td>
<td>Inclinometers</td>
<td>5 x 5 x 1.7 mm</td>
<td>3 axis digital Inclinometer, High resolution and stability over temperature and time, High End Ceramic Package</td>
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<td>IIS3DWB</td>
<td>Vibration Sensor</td>
<td>2.5 x 3 x 0.86 mm</td>
<td>3-axis Digital axel, Ultra Wide and Flat Bandwidth (&gt;5Khz), Low Noise (75 µg/√Hz), Low power (1.1mA), Extended Top: -40°C +105°C, Ideal for Vibration Monitoring</td>
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Inclinometers measure the angle of an object relying on the projection of the acceleration of gravity on the sensing axes.

Dynamic Inclinometers implement sensor data fusion from accelerometer and gyroscope to measure reliably the angle of an object when it is not in stationary conditions and thus subjected to spurious accelerations.

**Inclinometers**

- **IIS3DHHC**: 3-axis digital Inclinometer
- **IIS2ICLX**: 2-axis digital Inclinometer
- **ISM330DHCX**: 6-axis IMU

**Dynamic Inclinometers**

- Antenna pointing, platform leveling and stabilization
- Robotics and industrial automation
- Industrial vehicles and construction machines
- Installation and monitoring of equipment, solar panels
- Precise leveling instruments
- Building and infrastructure condition monitoring
- Antenna pointing, platform leveling and stabilization
- Robotics
- Industrial vehicles, mining, cranes
- Inclinometers for autonomous vehicles

**Coming soon**

- Robotics and industrial automation
- Installation and monitoring of equipment, solar panels
- Precise leveling instruments
- Building and infrastructure condition monitoring

**Applications**

- Antenna pointing
- Platform leveling and stabilization
- Robotics and industrial automation
- Industrial vehicles and construction machines
- Installation and monitoring of equipment, solar panels
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**Applications**

- Antenna pointing
- Platform leveling and stabilization
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- Inclinometers for autonomous vehicles
Industrial Inclinometers Portfolio

High Accuracy Inclinometer Portfolio

IIS3DHHC
3-axis digital Inclinometer

High accuracy 3-axes Digital Inclinometer

- High-stability over temperature and time
- ±2.5 g Full Scale
- Offset change vs Temp < 0.4 mg/°C
- Low noise (45 µg/√Hz)
- Operating temperature range -40÷85°C

IIS2ICLX
2-axis digital Inclinometer

Ultra high-accuracy, high-resolution, low-power, 2-axis Digital Inclinometer

- High resolution, High Accuracy (<0.5° over Temp. and Time)
- ±0.5g to ±3g Full Scale
- Offset change vs Temp < 0.075 mg/°C
- Ultra low noise (15 µg/√Hz)
- Low power (0.42mA)
- Operating temperature range -40÷105°C
- Programmable Machine Learning Core & Finite State Machines to integrate AI algorithms
Industrial 6-axis IMU

### I3G4250D
- 3 Axis Digital Gyro
- High linearity and stability over temperature and time

**4 x 4 package**

### ISM330DLC
- Dual Channel output
- Low Power
- Smart Features
- Axcel with wide BW (3kHz) and low noise

**2.5 x 3 x 0.86 mm**

- Cur Cons HP: 0.75 mA combo
- FS: gyro up to 2000 dps; axel up to 16 g

### ISM330DHCX
- Enhanced machine Learning Core and FSM
- High Accuracy and stability: (BI : 3°/hr)
- Accelerometer with wide BW (3kHz) and low noise

**2.5 x 3 x 0.86 mm**

- Cur Cons HP: 0.90 mA gyro; 1.2 mA combo
- FS: gyro up to 4000 dps; axel up to 16 g
- Extended Top: -40°C +105°C

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4 x 4 package
2.5 x 3 package
Key Features

- **Configurability**
  - Angular rate range: from ±125dps up to ±4000 dps
  - Axel Full Scale: from ±2g up to ±16g
  - Low power and high-performance modes

- **High Accuracy, Stability and linearity over temperature and time**
  - Gyro Offset vs T ±0.005 dps/°C (typ)
  - Gyro Bias Instability 3°/hr (typ)
  - Rate Noise Density 5 mdps/√Hz (typ)
  - Axel Noise Density 60 µg/√Hz (typ) – ODR up to 6.6kHz

- **Programmability & digital features**
  - Programmable Machine Learning Core & Finite State Machines to integrate AI algorithms
  - 9 kB Embedded FIFO
  - Sensor Hub

- **Extended operating temperature range** from -40 to +105 °C
Quick & modular prototyping

STM32 Nucleo with expansion board, tool and Unicleo GUI

STM32 NUCLEO with X-NUCLEO EXPANSION
X-NUCLEO-IKS02A1
and optional dedicated Adapter Board

Software package:
UNICLEO GUI
with
X-CUBE-MEMS1

Currently Supported Industrial Sensors

- IMU: ISM330DLC, ISM330DHCX
- Accelerometer: IIS2DH, IIS2LPC
- Inclinometer: IIS2ICLX*
- Magnetometer: IIS2MDC, ISM303DAC
- Microphones: IMP34DT05
- Temperature: STTS22H

*Coming soon...on X-NUCLEO-IKS02A1
Software libraries for inclinometers

### Accuracy/Calibration

- **Accelerometer Calibration**
- **Gyroscope Calibration**
- **Sensor Fusion**

### Measuring

- **MotionTL (in X-CUBE-MEMS1)** for 3-axis accelerometers
  - Static Tilt measure: 3 axis inclinometers (Q3/2020 for 2-axes)
  - Accelerometer calibration
  - Tilt angles Pitch & Roll + Gravity inclination

- **MotionDI (in X-CUBE-MEMS1)** for 6-axis IMUs
  - Accelerometer Calibration
  - Gyroscope calibration
  - 6-axis sensor fusion accurate orientation angles in presence of vibrations and motion
  - Tilt angles Pitch & Roll + Yaw & Rotation vector
Deep sensor performance evaluation

For any sensor in the portfolio
A powerful Tool & GUI to capture and process data and assess sensor performance

Professional MEMS motherboard
STEVAL-MKI109V3

Evaluation board (adapter)

Different flavors of DIL24 adapter board
STEVAL-MKI186V1 for IIS3DHHC

Software package:
UNICO-GUI

- Linux → STSW-MKI109L
- Mac OS X → STSW-MKI109M
- Windows → STSW-MKI109W

Professional MEMS motherboard

Different flavors of DIL24 adapter board