Using Advanced Sensors in Smart Industry Applications

Matteo Fusi

STMicroelectronics

AME MEMS Product Marketing

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Technology Tour 2019

Anaheim, CA | March 26

Agenda

→ Smart Industry

→ Smart Industry & Predictive Maintenance

→ Sensors for Smart Industry

→ Smart Connections from Sensor to Cloud: Technologies & Tools

→ Q & A

What is Smart Industry

The 4th industrial (r)evolution → value emerging after the initial hype

Flexibility Industry 4.0 Productivity

Safety **Efficiency** Reliability

Environment Quality IIOT

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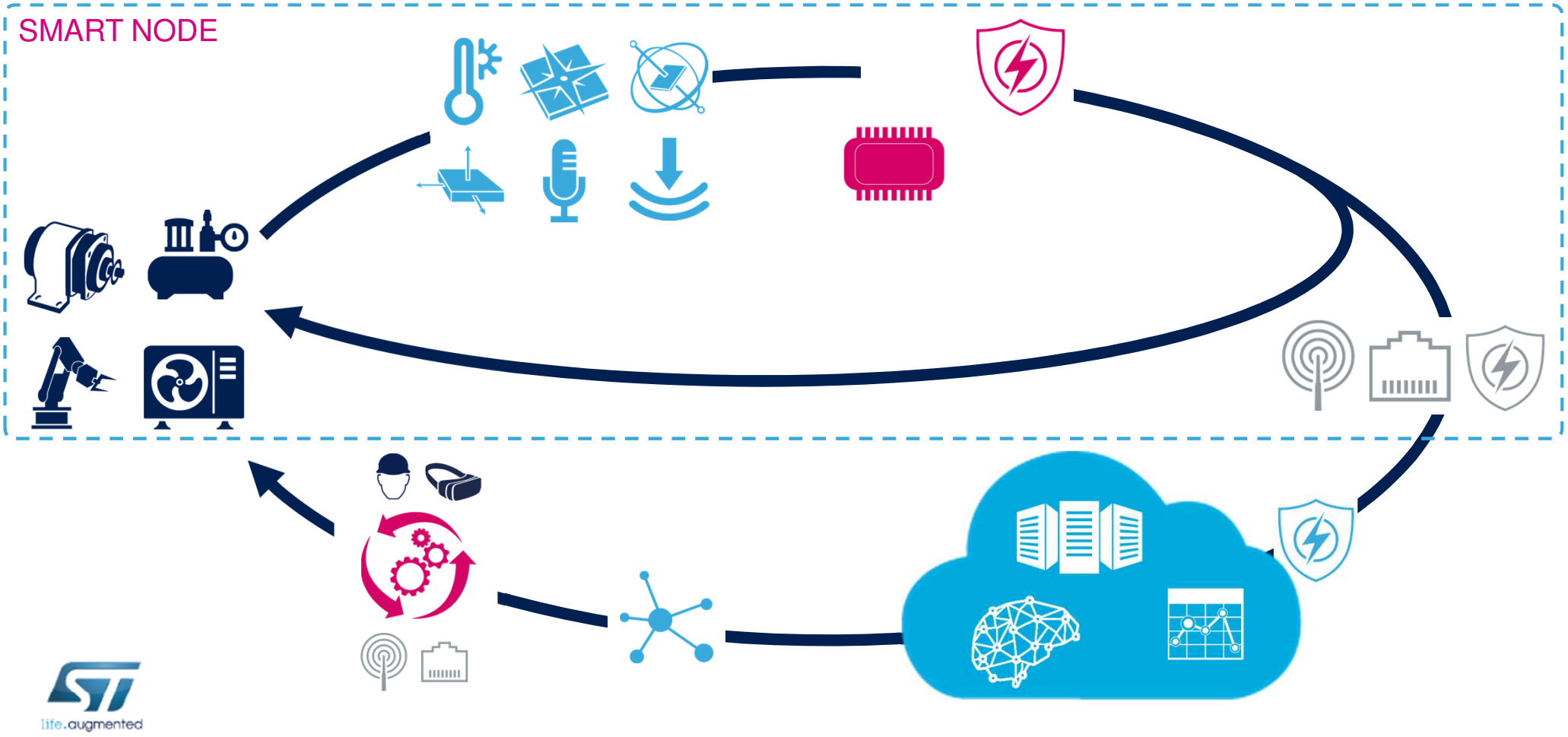
Smart Industry: Critical Building Blocks



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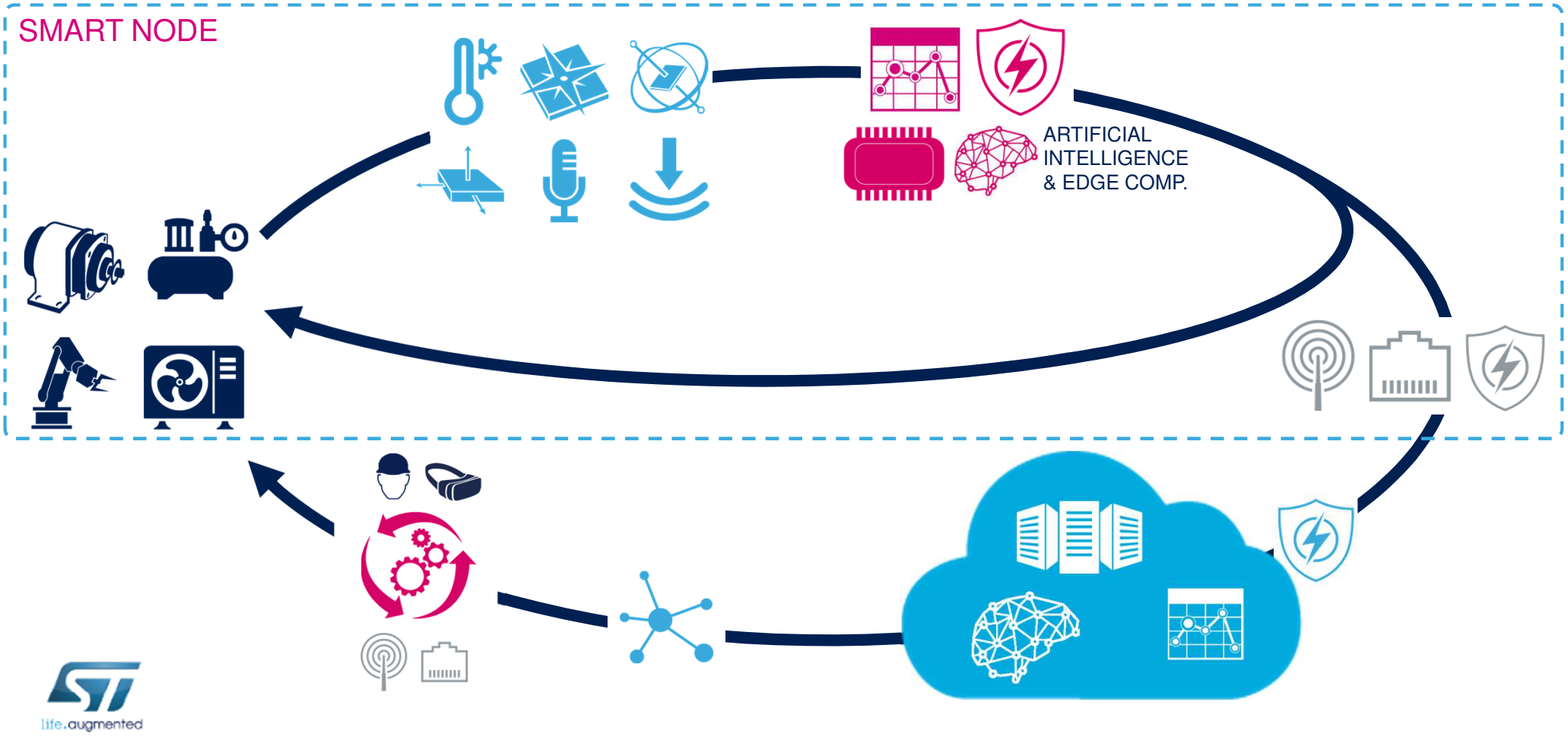
Smart Industry: Trends and Enablers



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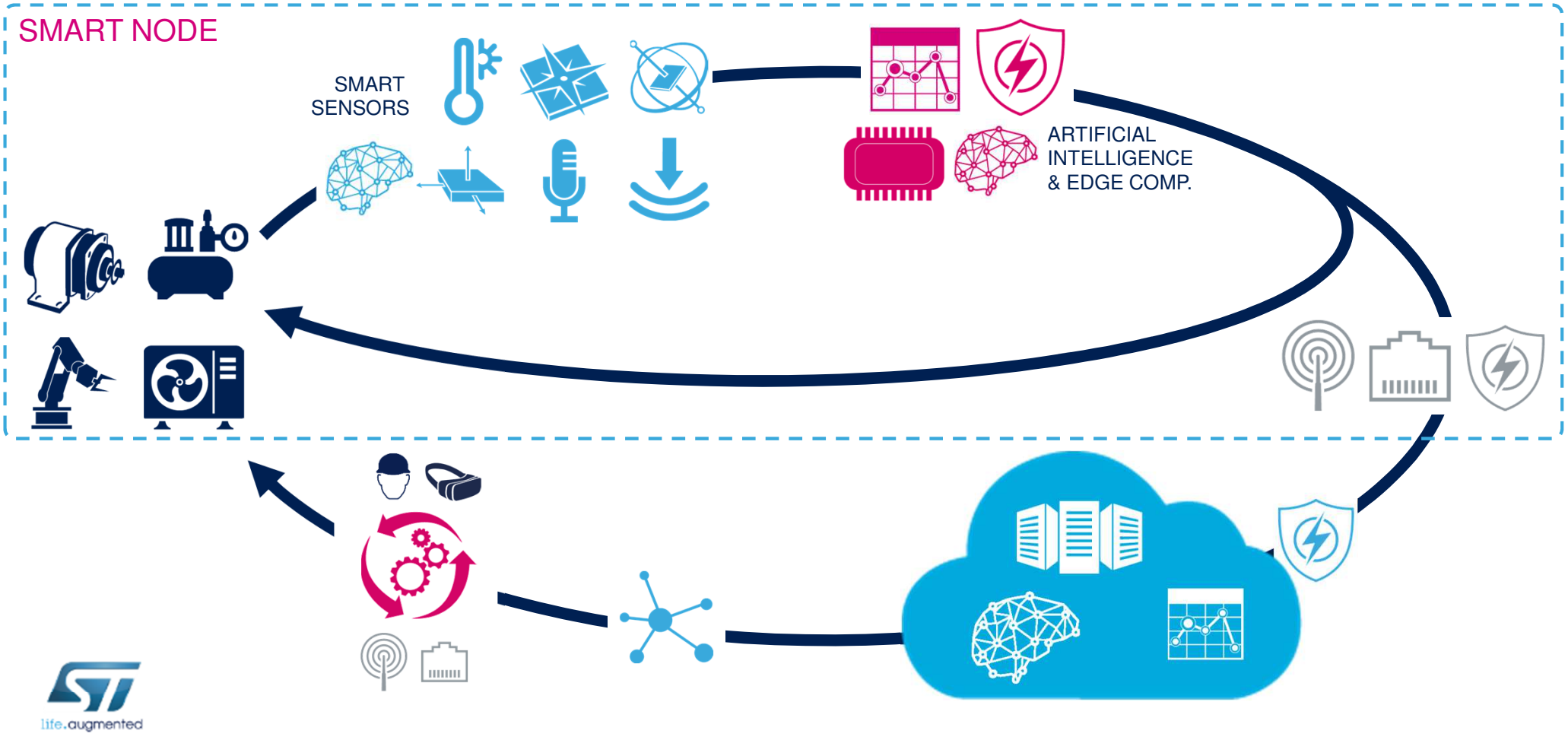
Smart Industry: Trends and Enablers



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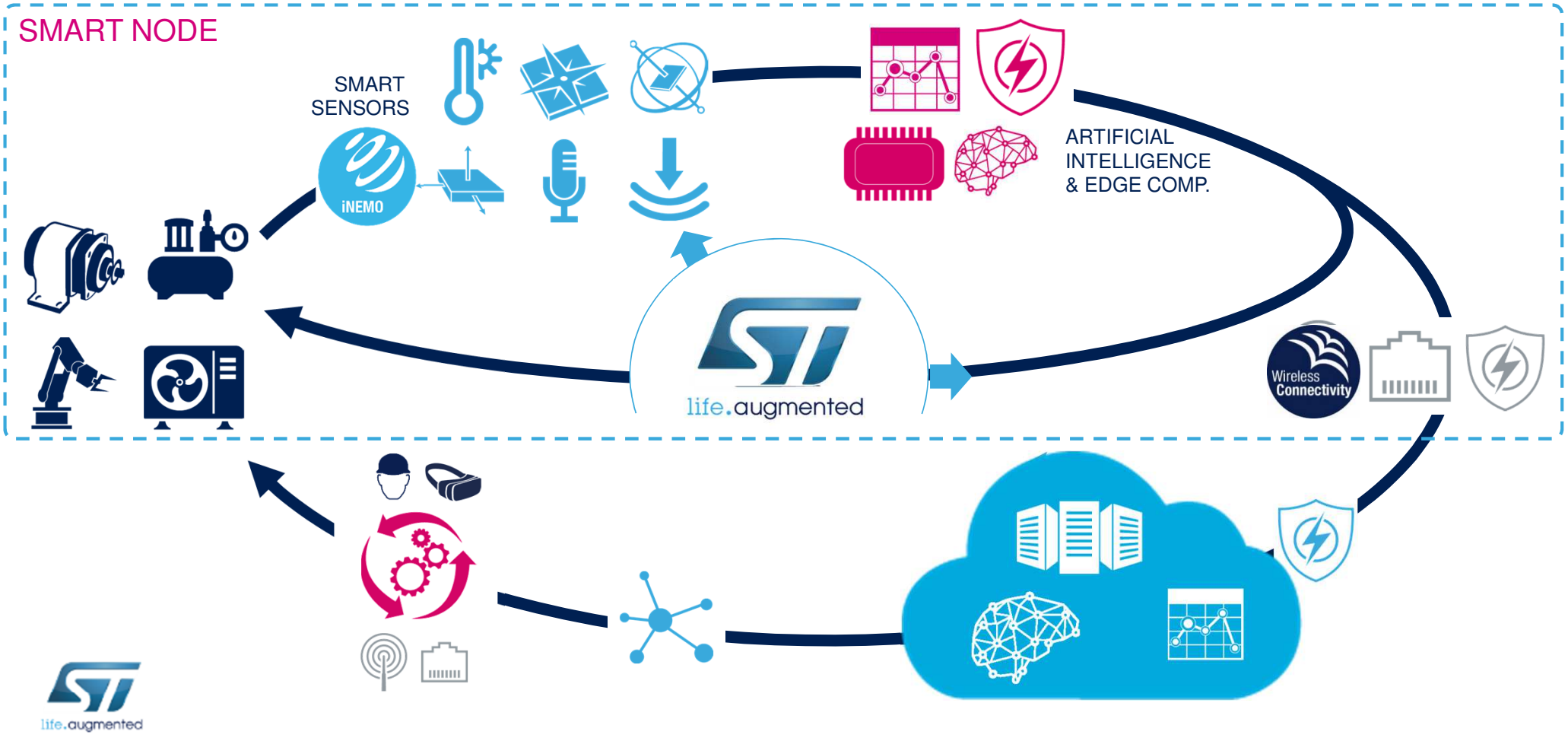
Smart Industry: Trends and Enablers



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ST Industrial Sensors

10-Year Product Longevity

Benefits

- 10-YEAR LONGEVITY FROM PRODUCT INTRODUCTION DATE
- DESIGN AND MANUFACTURING FOR HIGHER ROBUSTNESS & PERFORMANCES
- CALIBRATION & TESTING FOR HIGHER ACCURACY & QUALITY
- EXTENDED TEMPERATURE RANGE AND ENDURANCE TO SHOCK AND VIBRATION

Growing Product Family

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Sensors in Industrial Applications

- Predictive maintenance and automation
- Asset tracking & supply chain
- Structural Health Monitoring
- Shock detection Anti-tampering
- Metering and Pressure Monitoring
- Real-time monitoring & calibration

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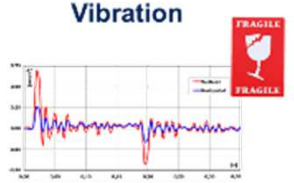
Asset tracking & supply chain

Free Fall Detection

Vibration



Accelerometer	**IIS2DLPC / LIS2DTW12**	Vibration Orientation Shipping Environment	**Ultra low power digital accelerometer** • Ultra low current consumption <1.0uA in LPM • Smart functions & FIFO • LGA 12L 2.0 x 2.0 x 0.7mm
Temperature, Humidity sensor	**STTS22H HTS2**	Shipping Environment Goods Status	**Ultra low power high accuracy temperature sensors** • Accuracy ±0.5°C (Max) • Temperature range: -40ºC / +125°C • Ultra low current consumption 1.75uA • One shot mode
Pressure sensor	**LPS22HH**	Take off and landing detection	**Ultra low-power humidity and temp sensor** • Integrated temperature and humidity sensor • T accuracy ±0.5°C ; RH accuracy ±3.5°C • Current consumption 3.5uA @ 1Hz ODR

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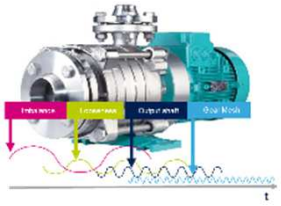
Real Time Condition Monitoring



Vibrometer

IIS3DWB

Vibration
Orientation
Free Fall detection
Shipping Environment
Goods Status

Ultra Wide Bandwidth, Low Noise, digital accelerometer for vibration monitoring

- From ±2g up to ±16g Full Scale
- 5KHz Bandwidth
- Ultra low noise (90 µg/√Hz)
- Package LGA 2.5x3x0.83

Inclinometer

IIS3DHHC
IIS2ICLH

Platform Leveling
Antenna Pointing
Structural Health Monitoring
Smart Installation

Ultra Accurate, Ultra high resolution Digital Inclinometer

- High resolution, High Accuracy (<0.5° over Temp. and Time)
- Operating range -40 to 105C
- High End Ceramic Package 5x5x1.7 CLGA 16Lead

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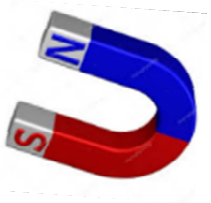
Electric Smart Meter

Anti-Tampering Sensor Solutions



Accelerometer	**IIS2DH or IIS2DLPC**	Vibration Impact Detection Orientation Detection
Magnetometer, eCompass	**IIS2MDC** **ISM303DAC**	Magnetic and/or orientation Disturbances, Intrusion Detection

Precise anti-tampering solutions based on accelerometers and/or magnetic sensor in discrete or integrated solutions

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Gas Meter

Sensors Solutions to create Value

Accelerometer	**IIS2DH** **IIS2DLPC**	Vibration detection	Earthquake detection using an accelerometer to switch off GAS supply when dangerous
Magnetometer eCompass	**IIS2MDC** **ISM303DAC**	Magnetic and/or orientation Disturbances, Intrusion Detection	Precise Anti-tampering solutions based on an accelerometer and/or a magnetic sensor in discrete or integrated solution
Pressure sensor	**LPS33HW**	Precision pressure sensing	Pressure sensor can be used for GAS ultrasound *metering compensation* to achieve precise metering accuracy and to detect *gas leakage*
Microphone	**MP23ABS1**	Ultrasonic Sensing	MEMS Microphone with Ultrasound bandwidth for gas leakage detection

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Water Level Monitoring / Alarm

with Pressure Sensor

Pressure sensor	**LPS22HH**	Indirect or ambient Pressure sensing
Waterproof Pressure sensor	**LPS33HW**	Direct Contact water level sensing

Pressure sensor used for measure Water Level in **SMART Water Level monitoring / Alarm**

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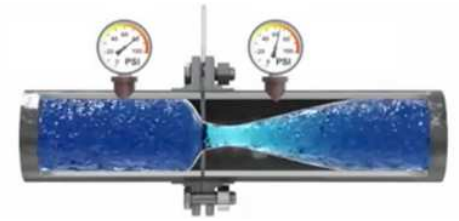
Pressure Sensor for Flow Metering
in Industrial Market



Robust Pressure sensor

LPS33HW

*Flow meters based on **Orifice/Venturi** and **Ultrasonic** methodologies*

Robustness to harsh environment (chemical compounds)
High Accuracy for precise measurement

Dual Sensor
for Differential Flow Methodology

One pressure sensor needed for compensation of flow meter for Ultrasonic methodology

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Machine Condition Monitoring

Accelerometer		**IIS2DH** **IIS2DLPC**	Vibration Orientation Free Fall detection	Accelerometer monitoring • loose connection of the overall structure • Severe mechanical stresses of transformer structure an windings caused high fault currents
Temperature & Microphone		**STTS751** **IMP34DT05**	Shipping Environment Goods Status	Temperature and Vibration monitoring; Audio-activated functions; Predictive maintenance • Fan integrity • Electrical overloading • Ultrasonic analysis (component failure, high frequency sources) (MP23ABS1) • Electrical leakages • magnetic circuit hot spot

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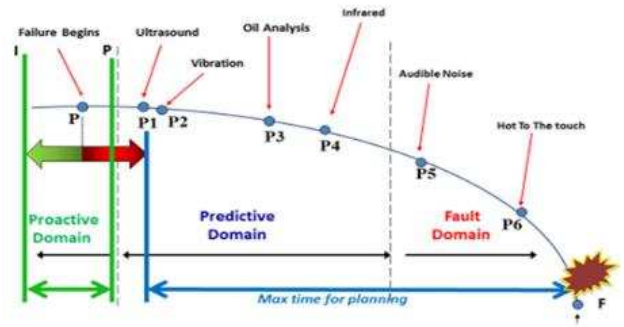
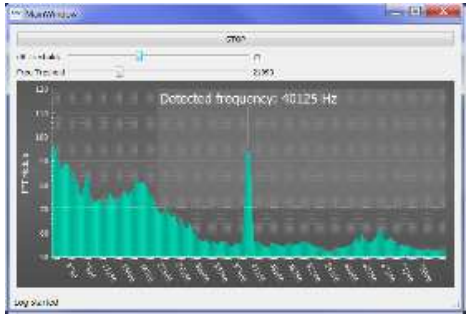
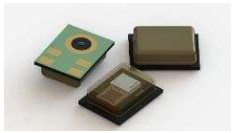
Predictive maintenance and automation





Microphone

MP23ABS1



Wide Acoustic Bandwidth
Up to 80KHz allows for
Ultrasonic monitoring
Prior to any vibrational
characteristics

- Compressed fluid leaks
- Vacuum leaks
- Steam trap failures
- Bearing condition monitoring
- Electrical arcing/tracking
- Fan and motor unbalance

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Shock Detection & Anti-Tempering

High-g Accelerometers

Accelerometer

H3LIS331DL

Vibration
Orientation
Free Fall detection

High-g, 3-axis digital accelerometer

Ultra low power: 10uA in LP mode

Max full scale: ±400g

Wake up function

Bandwidth: 0.5kHz

TFLGA 16L 3.0 x 3.0 x 1.0mm

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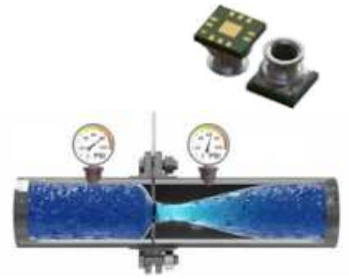
New High Accuracy MEMS
designed for Industrial Applications

PRESSURE
LPS33HW
FLOW METERING

Robustness to harsh environment
Accuracy measurement



6-AXIS IMU
ISM330DLC
SMART FARMING

Power Consumption / Noise
Dedicated signal path for stabilization control loop

HIGH PRECISION INCLINOMETER
IIS3DHHC
BUILDING MONITORING

Ultra low noise
Stability over temperature and time

WIDE BAND ACCELEROMETER
IIS2DLPC
VIBRATION ANALYSIS

Versatility: low power and high ODR/wide bandwidth operating modes

TEMPERATURE & ACCELEROMETER
LIS2DWT12
ASSET TRACKING

Low Noise
Ultra Low power consumption

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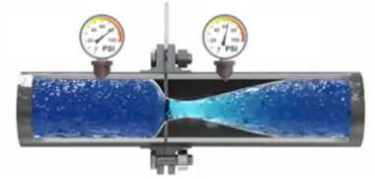
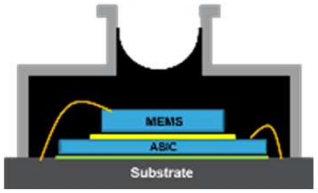
LPS33HW

WP Pressure Sensor for Harsh Environment & High Pressure Resistant



A look inside



Features

- 260 to 1260 mbar absolute pressure
- RMS noise 0.8Pa with Low resolution mode
- Absolute accuracy 2.5hPa @ 0 ~ 65'C
- Relative Pressure accuracy 0.1hPa
- ODR from 1 Hz to 75 Hz
- Low power consumption: 4 µA
- Embedded FIFO for Pressure and Temperature data
- Water resistant up to 10Bar
- Cylindrical Water proof package 3.3x3.3x2.9mm
- Potting GEL protects electrical components.

3.3 x 3.3 x 2.9mm

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ISM330DHC

New iNEMO 6-axis Inertial Module for Industry 4.0

Temperature Features

Extended Temp. Range: up to **+105°C**

Axel Performance

Typ. Noise Density: **60 µg/√Hz**

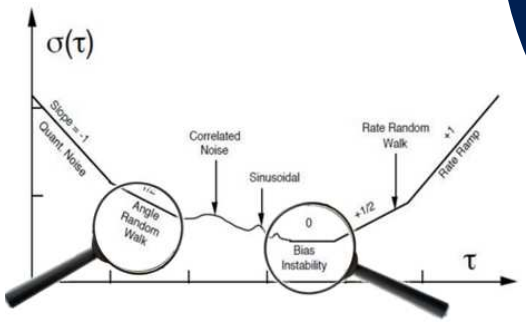
ODR: **up to 6.6KHz / BW up to ODR/2**

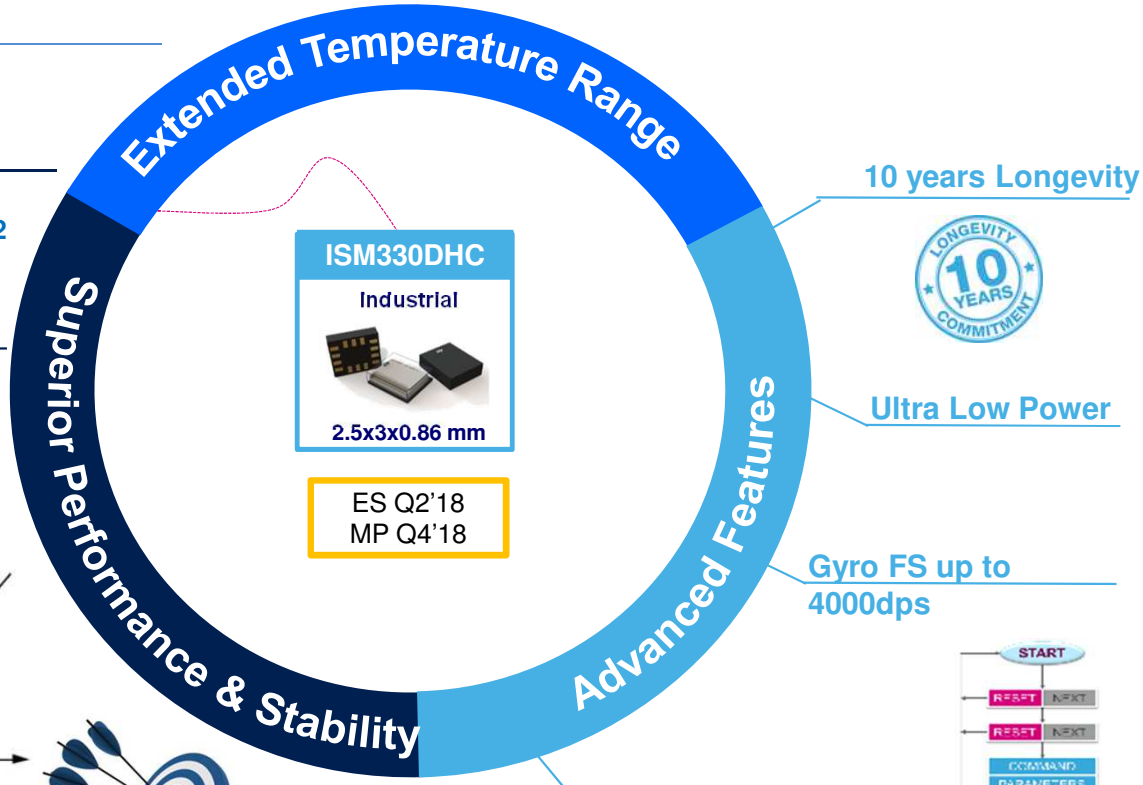
Gyro Stability Features

Typ. ARW: **0.21 deg/√h**

Typ. BI: **3°/hr (High accuracy)**

Stability: **Over time & Temperature**





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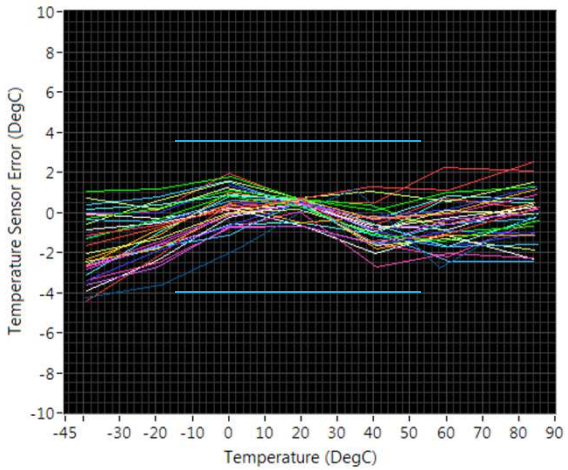
LIS2DTW12

Ultra Low power/noise accelerometer with temperature sensor



Features

- Up to16g full scale, ODR from 1.6Hz up to 1.6kHz
- Ultra low power / noise : < 0.4uA / 90 ug/SQRT(Hz)
- High speed I2C (3.4MHz), standard SPI (10MHz)
- FIFO, LP and HP filters, Self-Test
- Embedded features : Enhanced Tap / Double Tap, Wake up, Free fall, 6D / 4D orientation, Activity / Inactivity detection, Offset management, single data conversion on demand

- A temperature sensor calibrated at room temperature
  - 12-bit temperature data output
  - Temperature accuracy
    - +/- 2.5 °C on 0 / +90°C temperature range suitable for applications requiring absolute temperature measurement with fair accuracy (asset tracking…)
    - +/- 4 °C on -20 / +60°C temperature range suitable for applications requiring absolute temperature measurement with fair accuracy (asset tracking…)

2.0 x 2.0 x 0.7mm

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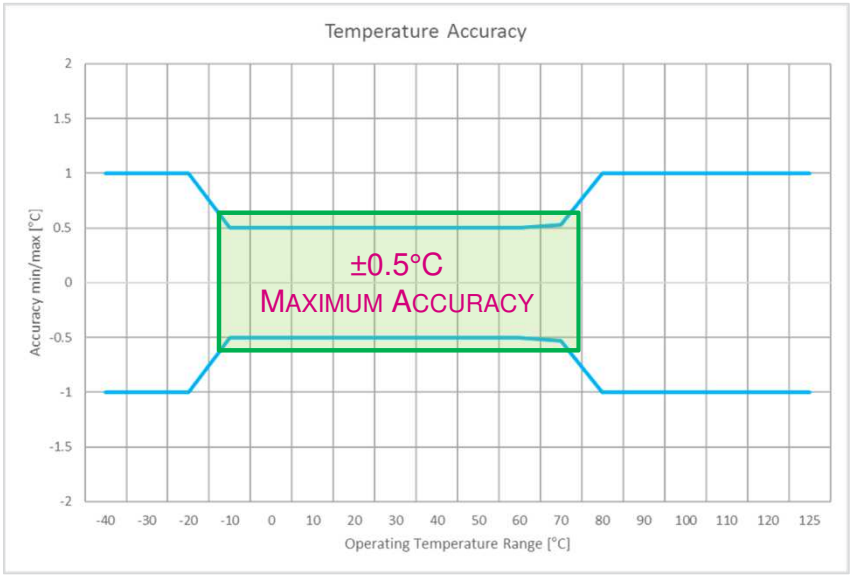
STTS22H

High Accuracy standalone Temperature Sensor



Features

- Supply voltage: **1.5V – 3.6V**
- Current consumption: **1.7uA** in one shot mode
- Output interface: I2C / **SMBus 3.0**
- Programmable **interrupt**
- SMBus **ALERT support**
- 2 Programmable I2C address
- Accuracy: **±0.5°C (max) [-10°C – 60°C]**
- **Selectable ODR** (down to 1Hz)
- **One shot reading mode**
- Package: UDFN-6L 2.0 x 2.0 x 0.5mm with **exposed pad down** for better temperature matching with external environment.

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IIS3DWB

Ultra-wide bandwidth, low-noise 3-axis digital accelerometer for industrial applications

LGA-14L
(2.5 x 3 x 0.83 mm) typ.

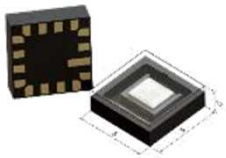
The IIS3DWB is a system-in-package featuring a 3-axis digital accelerometer with low noise over an ultra-wide and flat frequency range.
The wide bandwidth, low noise, very stable and repeatable sensitivity, together with the capability of operating over an extended temperature range (up to +105 °C), make the device particularly suitable for vibration monitoring in industrial applications.

Features

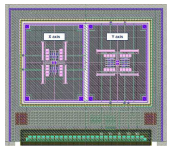
- User-selectable full-scale: ±2/±4/±8/±16 *g*
- Ultra-wide and flat frequency response range: from dc to 5 kHz (±3 dB point)
- Ultra-low noise density: down to 90 µg/√Hz in 3-axis mode / 65 µ*g*/√Hz in single axis mode
- High stability of the sensitivity over temperature and against mechanical shock
- Extended temperature range from -40 to +105 °C
- Low power: 1.1 mA with all 3 axes delivering full performance
- SPI serial interface
- Low-pass or high-pass filter with selectable cut-off frequency
- Interrupts for wake-up / vibration - no vibration / FIFO thresholds
- Embedded FIFO: 3 kB
- Embedded temperature sensor
- Embedded self-test
- Supply voltage: 2.1 V to 3.6 V
- Compact package: LGA 2.5 x 3 x 0.83 mm 14-lead
- ECOPACK®, RoHS and “Green” compliant

IIS2ICLH

2-Axes Ultra Accurate, Ultra low Power Digital Inclinometer



CLGA-16 5x5mm2



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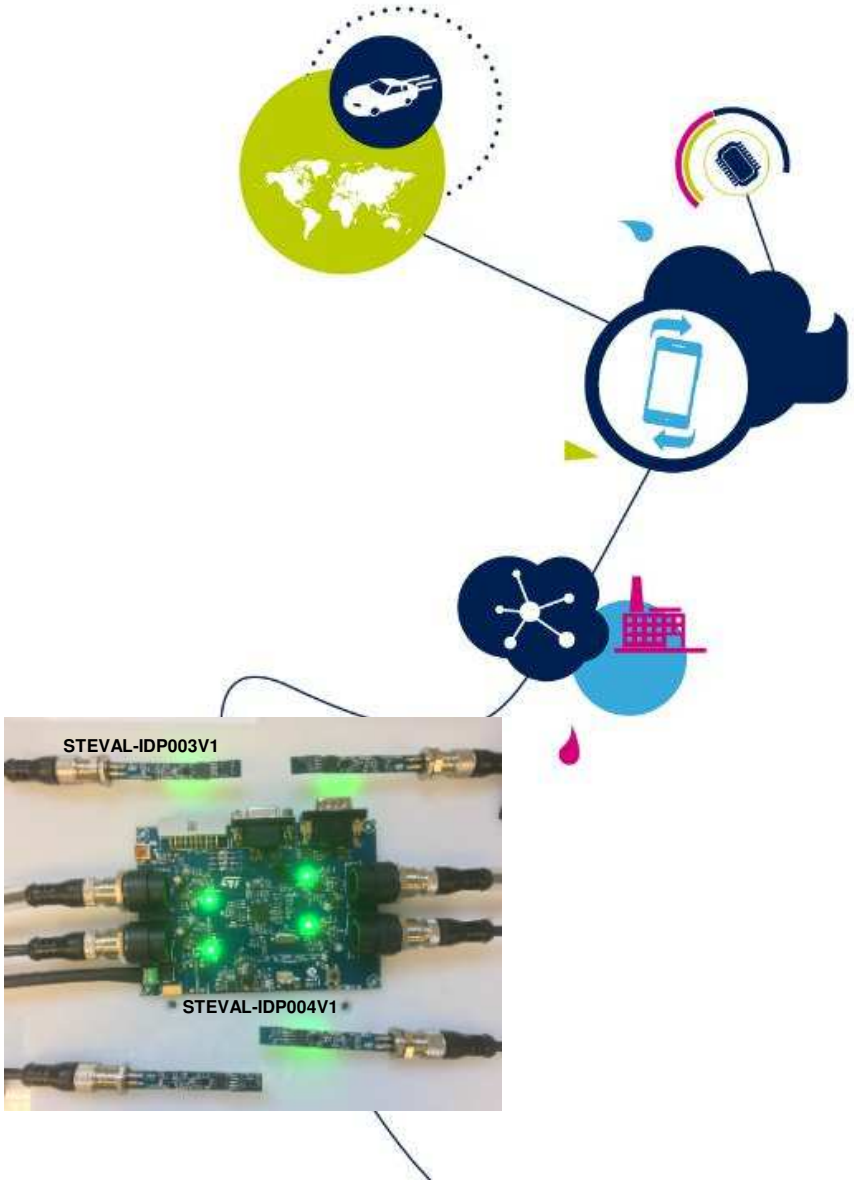
Features

- 2 Axis Digital, High Resolution, Ultra Low Power Accelerometer
- High Accuracy (<0.5° over Temp. and Time)
- Noise Density: 20 µg/√Hz
- Offset change vs Temp. 0.05 mg/°C
- Ultra Low Current consumption: 400 uA
- Bandwidth: 25, 50, 200 Hz
- Digital SPI Output
- -40 to +105C Operating Temp

Smart Connections from Sensor to Cloud:

Technologies & Tools



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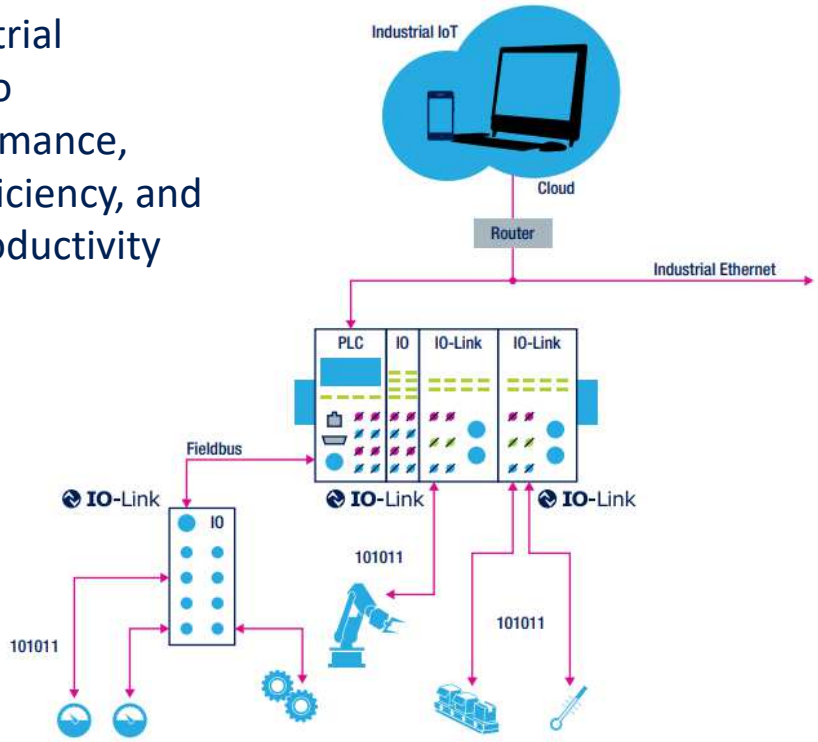
IO-Link Technology

IO-Link provide a platform for condition monitoring in industrial application.

Intelligent industrial networks Lead to

- ➔ Better performance,
- ➔ Increased efficiency, and
- ➔ Improved productivity



Long-term investment
IO-Link corresponds to the international standard IEC 61131-9.

Innovative
IO-Link offers digital data communication to the last meter between field devices and the machine control

Economical
IO-Link is „Plug & Play"-compatible with existing machinery and systems

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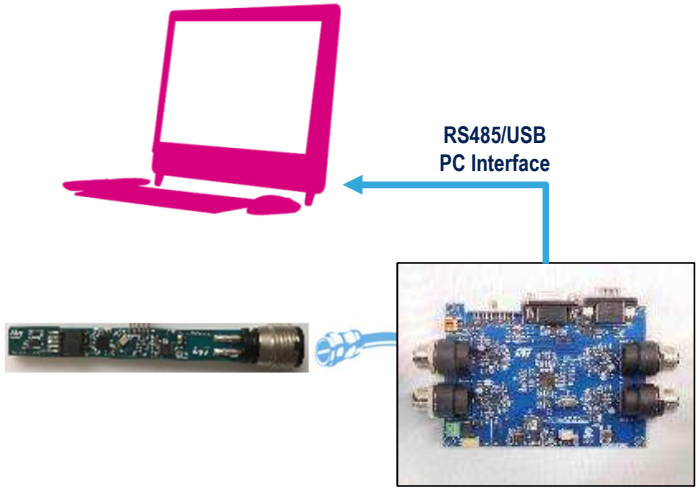
IO-Link Kit solution

IO-Link Kit based on STM32

Hardware	STEVAL-IDP004V1	STEVAL-IDP003V1  VL6180X  STEVAL-IDP003V1P IIS2DH  STEVAL-IDP003V1V STTS751  STEVAL-IDP003V1T IIS328DQ  STEVAL-IDP003V1A STEVAL-IDP004V1 
Software	STSW-IO-LINK	



Description:
This solution has been designed to provide a platform for condition monitoring in industrial application.
The main board **STEVAL-IDP004V1** powered by a STM32F205RBT7, hosts four L6360 IO-Link master transceivers, managing PHY to support IO-Link Communication standard.
The multi sensor board **STEVAL-IDP003V1** powered by a STM32L071CZ hosts the L6362A IO-Link Device transceiver, managing PHY layer to support IO-Link Communication Standard. Sensor form factor, facilitate the assembly inside a M12 industrial connector.
Daughter sensor board are based on:

- TOF **VL6180X** proximity sensor
- **IIS2DH** accelerometer MEMS sensor
- **STTS751** temperature sensor
- **IIS328DQ** accelerometer MEMS sensor.

Sensor board data exchange and main board configuration can be handle with a set of command addressable through PC Terminal interface.

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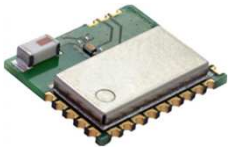
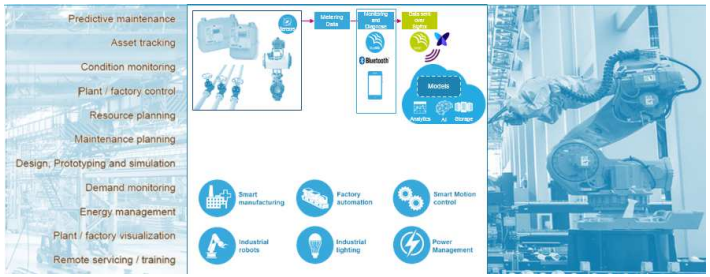
Low-Power RF for Smart Industry

ST Provide RF IC's and Modules for Smart Industry

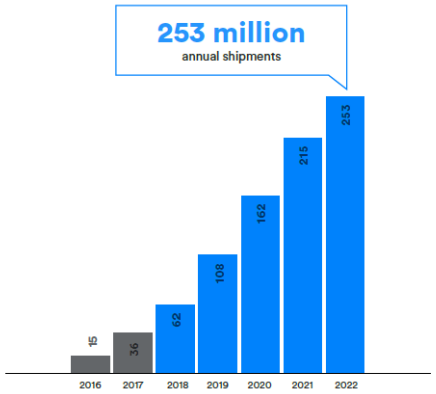




BlueNRG SoC:
BlueNRG-MS
BlueNRG-1
BlueNRG-2

BlueNRG Modules:
BLUENRG-M0A
BLUENRG-M0L
SPBTLE-1S
BLUENRG-M2SP
BLUENRG-M2SA

SubGHz ICs:
SPIRIT1
S2-LP



Bluetooth Device Shipments
Numbers in Mu
Source: Bluetooth.com

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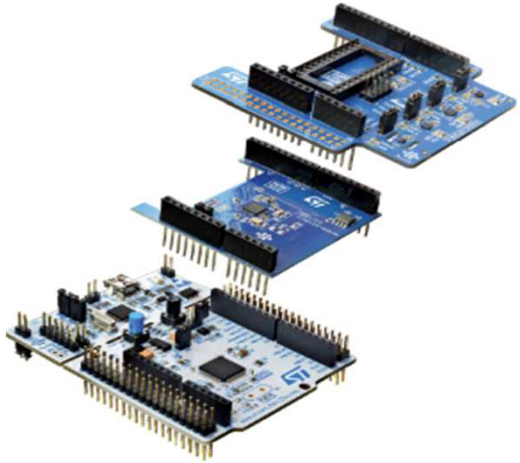
BlueNRG based Dev. Tools

BlueNRG Hardware Tools Support

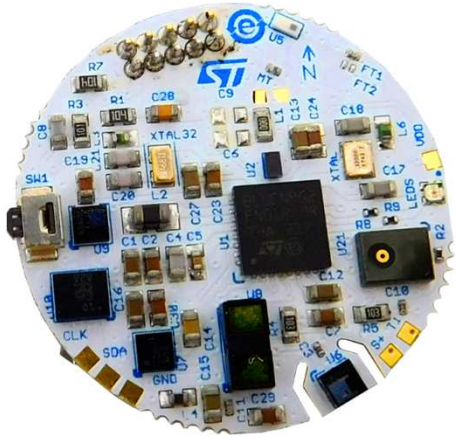
STEVAL-IDB007V2
BlueNRG-1

STEVAL-IDB008V2
BlueNRG-2

STEVAL-IDB009V1
BlueNRG-2



Nucleo-L152RE & X-Nucleo-IDB05A1
BlueNRG-MS + STM32L152



STEVAL-BCN002V1B
BlueNRG-2

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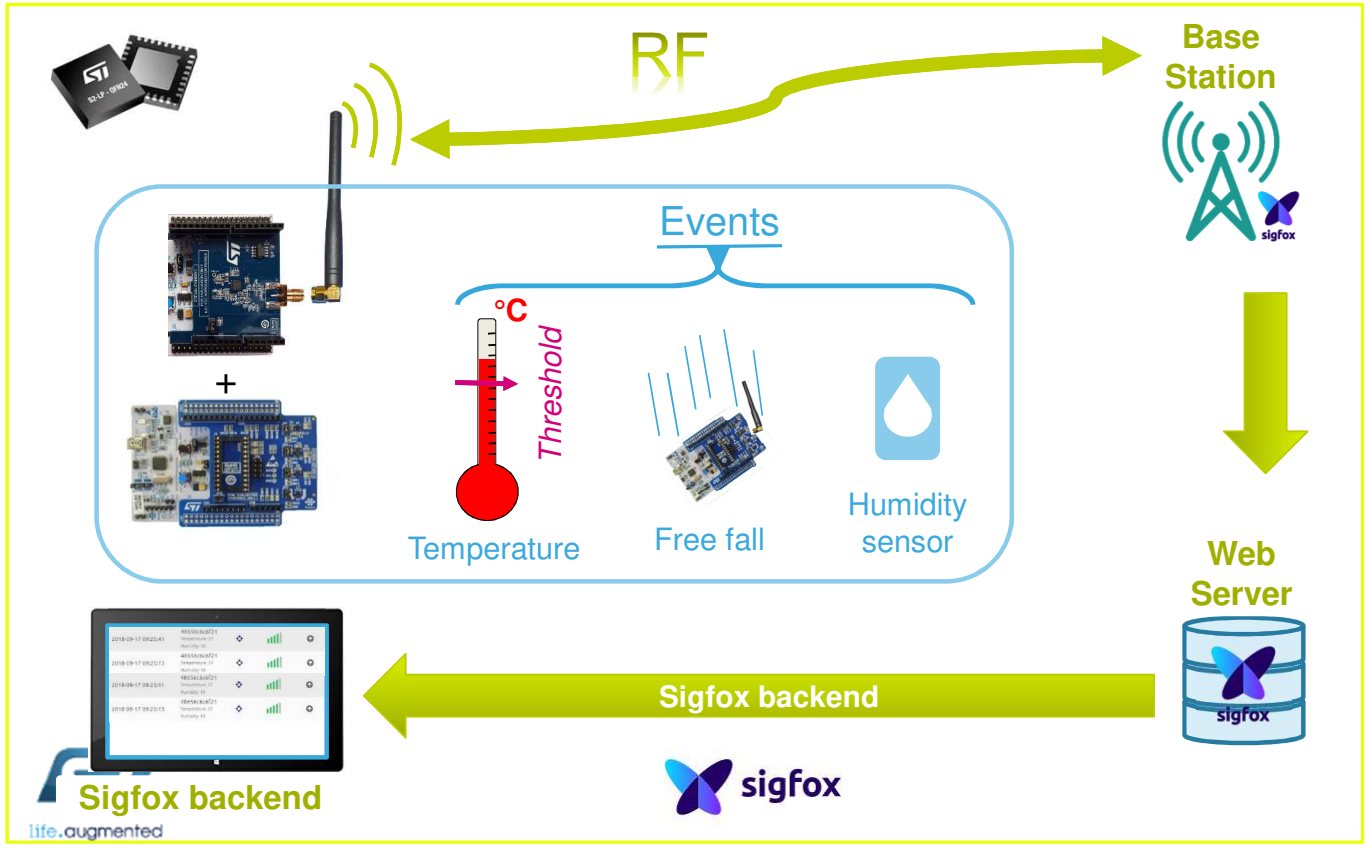
STM32+S2-LP+MEMS SW package

SIGFOX asset tracking application

Low Power SIGFOX - ASSET TRACKING



Data are sent to sigfox backend when one of these events occurred

- **STM32** microcontroller
- **S2-LP** Sub-GHz transceiver
- **MEMS** board

SIGFOX frame content:
- Raw payload
- Parsing on backend

Sigfox backend displays: Simple parsing of the raw SIGFOX payload.

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IoT Discovery Kit

All-in-One IoT Development Platform

- Motion sensors
- Environmental sensors
- MEMS Microphones
- Proximity sensor
- Dynamic NFC Tag
- Low Power MCU
- Sensors Fusion
- Bluetooth Low Energy
- Sub 1GHz
- Wi-Fi

B-L475E-IOT01A

STM32 L4

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IoT Discovery Cloud Providers

ST Provides Device Kit and FW package for the major Cloud providers

- Amazon AWS IoT
  - X-CUBE-AWS
  - FP-CLD-AWS and Web Dashboard
  - Amazon FreeRTOS
- Microsoft Azure IoT
  - FP-CLD-AZURE1
  - STM32ODE IoT Web Dashboard
  - X-CUBE-AZURE
- Google Cloud IoT Platform
  - X-CUBE-GCP
- IBM Watson IoT
  - X-CUBE-WATSON
  - FP-CLD-WATSON1

Summary of Products & Tools

More info is available on www.st.com

- Accelerometers : IIS2DLPC, LIS2DTW12, IIS2DH, H3LIS331DL, LIS3XXXX (High-g)
- Vibrometer : IIS3DWB
- Inclinometer : IIS3DHHC, IIS2ICLH
- Inertial Modules : LSM6DSO, ISM330DHC
- Temperature Sensor: STTS22H, STTS751
- Humidity & Temp. Module : HTS2
- MEMS Microphones : MP23ABS1, IMP34DT05
- Pressure Sensors : LPS33HW
- Magnetometers & Compass Modules: IIS2MDC, ISM303DAC
- BlueNRG SoC: BlueNRG-MS, BlueNRG-1, BlueNRG-2
- BlueNRG Modules: BLUENRG-M0A, BLUENRG-M0L, SPBTLE-1S, BLUENRG-M2SP, BLUENRG-M2SA
- SubGHz ICs: SPIRIT1, S2-LP
- IO-Link: STEVAL-IDP004V1 & STEVAL-IDP003V1
- IO-Link: P-NUCLEO-IOM01M1, P-NUCLEO-IOD01A1
- IO-Link: P-NUCLEO-IOD01A1
- SIGFOX: NUCLEO-FL053R8, X-NUCLEO-S2868A1, X-NUCLEO-IKS01A2
- BlueNRG-MESH SDK: STEVAL-IDB007V2, STEVAL-IDB008V2, Nucleo-L152RE & X-Nucleo-IDB05A1, STEVAL-BC002V1

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ST Community – Product and Technical Support

Product and Technical Support: **https://community.st.com/s/**

For more information on sensors: **www.st.com/sensors**

Information on longevity: **10yr Longevity Program**

Android / Linux / Open Drivers: **Drivers for MEMS**

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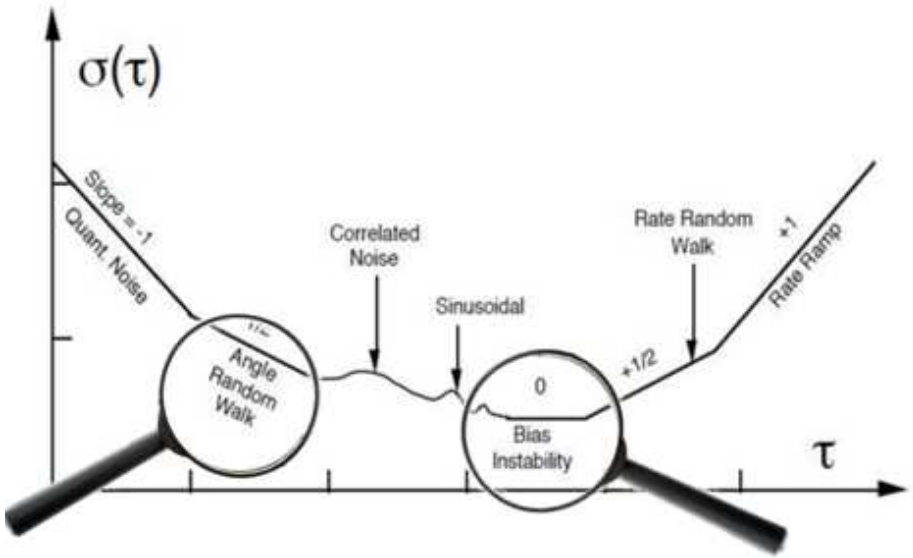
Thank You!

ISM330DHC

New iNEMO 6-axis Inertial Module for Industry 4.0



Features

AXL Performance

- Typ. Noise Density: 60 µg/√Hz
- ODR: up to 6.6KHz / BW up to ODR/2

2.5x3x0.86 mm

Gyro Stability Features

- Typ. ARW: 0.21 deg/√hr
- Typ. BI: 3°/hr (High accuracy)
- Stability: Over time & Temperature

Gyro FS up to 4000 dps

4KB FIFO

Programmable Finite State Machine (FSM)

Extended Temp. Range: up to +105°C

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