

ST Sensors

May 2017

Product Marketing Team EMEA



MEMS & SENSORS

Portfolio overview



- Gyroscope
- Accelerometer
- Magnetometer
- 6-axis & 9-axis inertial module
- Optical image stabilization



- Temperature
- Humidity
- Pressure
- UV index



- Microphone



- Accelerometer
- Hi-g Accelerometer
- Gyroscope
- 6-axis inertial module

WFR Wafer Foundry For Medical

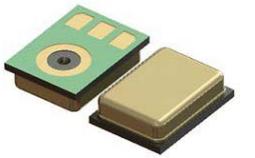


ST MEMS shipped
11
BILLION



NEW TOP SELLING MEMS Products



Accelerometer	6-axis IMU	E-compass	Pressure	Microphone
LIS2DW12	LSM6DSL	LSM303AGR	LPS33HW	MP23AB01DH
				
2x2x0.7 mm	2.5x3x0.86 mm	2x2x1 mm	3.3x3.3x2.9 mm	3.35x2.5x0.98 mm
<ul style="list-style-type: none"> ✓ 10 to 14bit resolution ✓ Noise level flex ✓ <<1µA in LP MODE 	<ul style="list-style-type: none"> ✓ Low Power ✓ Ultra Low Noise A+G ✓ Embedded Algo 	<ul style="list-style-type: none"> ✓ AMR, 50Ga FS ✓ 3mGa noise ✓ Offset cancellation 	<ul style="list-style-type: none"> ✓ Waterproof Apps ✓ Low noise ✓ Temp compensated 	<ul style="list-style-type: none"> ✓ Differential, Analog ✓ 135dB AOP, 65dB SNR ✓ SENS ±1dB

ST MARKET POSITION

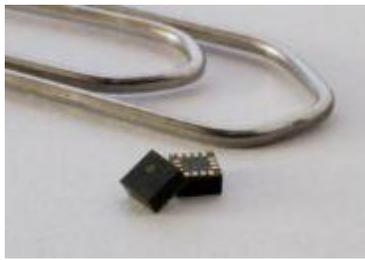
- Lower **POWER**
- Lower **NOISE** & Higher **ACCURACY**
- High level of **FLEXIBILITY** and **EASY** integration
- **SOFTWARE & TOOLS** available



Motion MEMS

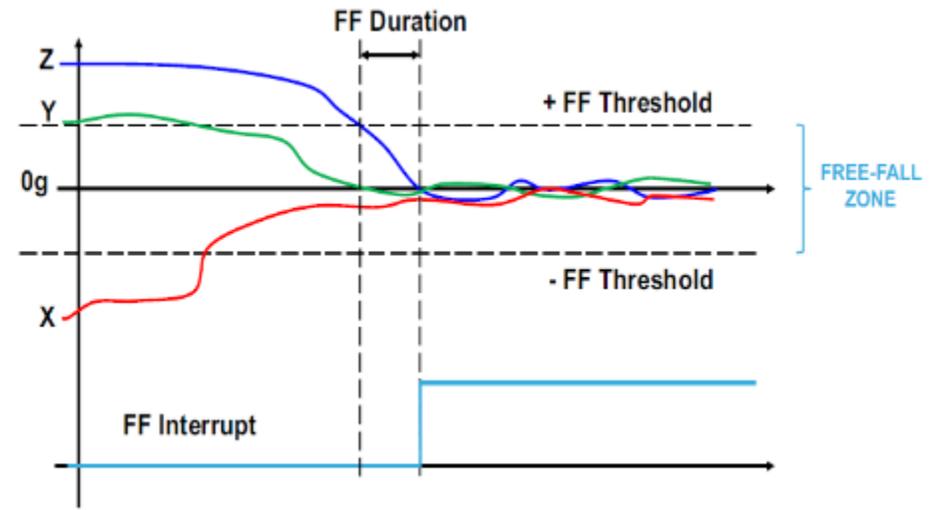


LIS2DE12, LIS2DH12: Accelerometers



• Main Features

- 3-Axis Digital SPI/I2C Accelerometer from ± 2 to $\pm 16g$
- Very low power:
 - **6 μ A/11 μ A** in **LPM/HRM** (@50Hz)
 - **2 μ A** in **HRM** (@1Hz)
- Embedded features (Filters, FIFO, Temperature sensor, Self-Test)
- 2x2 LGA-12, 0.5mm pitch
- LIS2DH12
 - **Up to 12 bit resolution** for Performance and Embedded Functionalities
- LIS2DE12:
 - **8 bit resolution** for Low Power and Cost effective



Free-fall interrupt

Key Features

8 and 12-bit Resolution
P2P and Cost effective
Very low power

LIS2DW12*: Ultra Low Power

- 3-Axis Digital SPI/I2C Accelerometer from ± 2 to ± 16 g
- From **12** to **14 bit** resolution, **Low Power** and **High Performance** Modes, low noise enabled fct
- ODR: single shot and from 1.6 to 1.6KHz, FIFO, Temperature sensor, Self-Test
- **Ultra Low Power:**
 - **0.38 μ A** in **Low Power Mode** @1.6Hz
 - **3 μ A** in **Low Power Mode** @50Hz
 - **90 / 120 μ A** in **HPM** @1.6KHz
 - **50nA** in **PD**
 - Power supply 1.62 – 3.6V
 - 2x2x**0.7mm**, P2P with rest of the family

	High Perf Mode	Low Power Mode 4	Low Power Mode 3	Low Power Mode 2	Low Power Mode 1	
Resolution [bit]	14	14	14	14	12	
ODR [Hz]	12.5 - 1600	1.6 - 200	1.6 - 200	1.6 - 200	1.6 - 200	
BW [Hz]	ODR/2 ODR/4, ODR/10, ODR/20	180 ODR/4, ODR/10, ODR/20	360 ODR/4, ODR/10, ODR/20	720 ODR/4, ODR/10, ODR/20	3200 ODR/4, ODR/10, ODR/20	
Noise Density [μ g/ \sqrt Hz] @ FS=2g, ODR=200Hz	110 / 90	160 / 130	210 / 180	300 / 240	550 / 450	
Current cons [μ A]	ODR=1.6Hz	-	0.65 / 0.7	0.55 / 0.6	0.45 / 0.5	0.38 / 0.4
	ODR=12.5Hz	90 / 120	4 / 5	2.5 / 3	1.6 / 2	1 / 1.1
	ODR=25Hz	90 / 120	8.5 / 10	4.5 / 6	3 / 3.5	1.5 / 2
	ODR=50Hz	90 / 120	16 / 20	9 / 11	5.5 / 7	3 / 3.5
	ODR=100Hz	90 / 120	32 / 39	17.5 / 21.5	10.5 / 13	5 / 6
	ODR=200Hz	90 / 120	63 / 77	34.5 / 42	20.5 / 25	10 / 12
	ODR=400, 1600Hz	90 / 120	-	-	-	-

Low noise disabled /enabled

Key Features
Noise level flexibility
<<1 μ A in LP Mode

*Available for Mass Market in Q2 2017

LIS2DW12 with rest of the family

	LIS2DW12	LIS2DS12	LIS2HH12	LIS2DH12	LIS2DE12
Package (mm)	2x2x0.7 – LGA-12	2x2x.86 – LGA-12	2x2x1 – LGA-12	2x2x1 – LGA-12	2x2x1 – LGA-12
Full scales (g)	±2/±4/±8/±16	±2/±4/±8/±16	±2/±4/±8	±2/±4/±8/±16	±2/±4/±8/±16
Resolution	5 modes: Low power (12 bit), 4x High res (14 bit)	3 modes: Low power (10 bit), Normal (12 bit), High res (14 bit)	3 modes: Low power (8 bit), Normal (10 bit), High res (16 bit)	3 modes: Low power (8 bit), Normal (10 bit), High res (12 bit)	1 mode: Low power (8 bit)
Sensitivity (mg)	0.244	0.244	0.061	1	15.6
Noise Density (±2g, 100Hz)	90µg/sqrt(Hz)	120µg/sqrt(Hz)	140µg/sqrt(Hz)	750µg/sqrt(Hz)	1315µg/sqrt(Hz)
Power cons. in PD Low Power Mode Normal Mode (µA)	0.05 0.38 @1.6Hz, 3 / 16 @50Hz 120 in HPM @50Hz	0.7 2.5 @1Hz, 8 @50Hz, 150 from 12.5 up to 6.4kHz	5µA / - /110µA @ 50Hz 180µA up to 800Hz	0.5 2 @1Hz, 6 @ 50Hz 11 @50Hz	0.5 2 @1Hz, 6 @50Hz no normal mode
0g level offset accuracy (Typ)	±20 mg	±30 mg	±30 mg	±40 mg	±100 mg
0g level change vs. Temp	±0.2 mg/°C	±0.3 mg/°C	±0.25 mg/°C	±0.5 mg/°C	±0.5 mg/°C
ODR	One shot, 1.6Hz- 1.6KHz	1 Hz – 6.4kHz	10Hz-800Hz (HR)	1Hz-5.376 kHz (Low power), 1Hz-1.344 kHz (Normal, HR)	1Hz-5.376 kHz (Low power)
BW	Up to ODR/2	Up to ODR/2	Up to ODR/2	ODR/2 (LPM and NM), ODR/9 (HR)	ODR/2 (Low power)
FIFO	32-level	256 level FIFO (14b), 768 level (if XL module)	32-level	32-level (10bit)	32-level (10bit)
Self-test / Temp sensor	Yes / Yes (1 digit/°C)	Yes / Yes	Yes / 11bit resolution (8 digit/°C)	Yes / Yes	Yes / Yes
Power supply	1.62 to 3.6 V	1.62 to 1.98 V	1.71 to 3.6 V	1.71 to 3.6 V	1.71 to 3.6 V

ST it is also **SPECIFIC** device

High Performance Accelerometer: LIS3DHH



NEW

- 16bit accelerometer
- Supply voltage 1.7 to 3.6V;
- Full -Scale +/-2.5g
- Zero-g noise density : $65\mu\text{g}/\sqrt{\text{Hz}}$ (Max)
- High Stability
 - Zero-g level change vs. temperature $< 2\text{mg}/^\circ\text{C}$
 - Sensitivity change vs. temperature $< 2\%$
- Embedded FIFO 32 Levels
- SPI 4-Wire digital output Interface
- Embedded temperature sensor (12-bit data output)
- Extended operating Temp range (0°C to $+70^\circ\text{C}$)
- Ceramic cavity LGA16 5x5x1.7mm

CERAMIC CAVITY



5 x 5 x 1.7 mm

Key Features

Ultra High Resolution
Low noise
Ceramic cavity

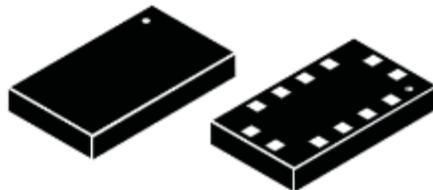
ST it is also **SPECIFIC** devices for **SPECIFIC** application: **LIS2DHT**

Samples ready

LIS2DHT the **Ultra Thin** Accelerometer for Wearable / Smart Textile / Smart card / .. **When thickness is key**

- Main Features (LIS2DH12-like)

- Very thin accelerometer (0.5mm)
- Full scale from ± 2 to $\pm 16g$
- Very low power:
 - **6 μ A/11 μ A** in **LPM/HRM** (@50Hz)
 - **2 μ A** in **HRM** (@1Hz)
- Embedded features (Free-Fall, Wake-up, Tap/double tap, Filters, FIFO, Temperature sensor, Self-Test)
- 2x3.5 LGA-12, 0.6mm pitch



LGA-12L 2x3.5x0.5 mm

Key Features

0.5mm Thickness
Very low power

3-axis Low-power High-G Axel

H3LIS100DL, H3LIS200DL and H3LIS331DL

Features

- 3 axis, High-g Full Scale (100g/200g/400g)
- Low power consumption - 300 μ A in Active mode - 10 μ A in low-power mode
- Programmable interrupt
- Package LGA, 3x3x1 mm³, 16 Leads

Benefits

- Enabler for a broad range of application
- Ideal for battery operated applications
- Enables system level power consumption reduction
- Small footprint and pin to pin compatible with all the H3LISxxxDL

Applications

- Ideal for all space and power-constrained applications requiring precise shock detection
- Concussion detection and monitoring in impact sports
- Car black box (for insurance purpose)
- Augmented sports
- Shock detection in tools, equipment, portable instrument and for asset tracking
- Vibration monitoring for equipment condition monitoring



Accelerometer Roadmap Evolution

Focus Product

Running Business

High Performance

Low Power

LIS344ALH
4x4



LIS2HH12
2x2 LGA 12



LIS3DHH
5x5 LGA 12



LIS3LV02DL
4.4x7.5



H3LIS331DL
H3LIS200
H3LIS100
3x3 LGA 16
100, 200, 400g



LIS2DS12
2x2 LGA 12



LIS2DW12
2x2x.7 LGA 12



ULP
2x2x LGA 12
LGA 12



MP: Q2'17

MP: Q1'18

LIS3DH
3x3 LGA 16



LIS2DH12 / LIS2DE12 / IIS2DH
2x2 LGA 12



LIS2DHT
2x3.5x0.5 LGA 14



MP: Q2'17



2015

2016

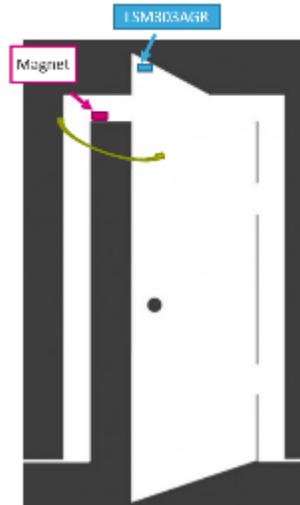
2017

2018



Magnetometer: to detect magnet and rotation

- To detect **Earth Magnetic field** for Compass
- Movement and **Rotation** measurement
- **Anti-tamper** in case of high magnet field
- Companion for **9-axis** high accuracy movement recognition



- Heading = angle between Xb axis and Magnetic North
- Earth's magnetic field H has a horizontal component
- If sensor is horizontal, magnetometer senses Xh and Yh components of H projected on axis;
- Heading = $\arctan(Y_h / X_h)$

New ST AMR technology

Why AMR ?

Allows many different tradeoffs in terms of **Noise, Power, Bandwidth & Dynamic Range**

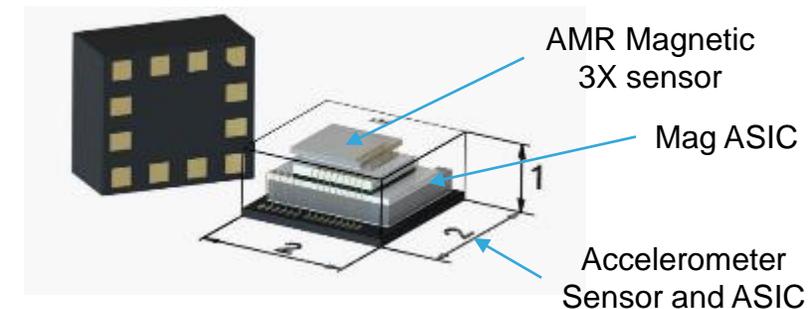
- Very low noise can be achieved for low bandwidth
- Very low power consumption can be achieved for medium noise applications

Internal offset and its thermal drift can be completely cancelled out thanks to embedded set/reset function

- Electrical offset is canceled out combining outputs after SET and RESET pulse
- Even post-soldering and thermal drift of the offset are completely cancelled out
- no need to repeat Hard Iron calibration when temperature changes

Magnetic layer is automatically reset by internal ASIC

- SET/RESET pulse generated
- Current pulse sets the magnetization of the sensing layers
- Highly reliable in case of strong magnetic shock



***ST new fully integrated AMR sensing technology
for magnetometers***

AMR Magnetometer & Digital Compass

LIS2MDL & LSM303AGR

LIS2MDL*

(standalone LSM303AGR magnetometer)

- 3-axis digital magnetometer:
 - $\pm 50\text{Ga}$ FS
 - Typical resolution 2.5mGa RMS
 - ODR on single mode operation from 10 to 100 Hz
 - Self-test embedded
- Embedded magnetic **Offset cancellation** enabling no offset thermal drift
- Power consumption (@ODR=20Hz):
 - $200\mu\text{A}$ in High resolution
 - $50\mu\text{A}$ in Low power & $2\mu\text{A}$ in Power down

Key Features

Standard 2x2 pinout
Self test & High field behavior
Flexibility in resolution vs. consumption

LSM303AGR⁽¹⁾

- 3-axis accelerometer: up to $\pm 16\text{g}$ full-scale, LIS2DH12 based
- 3-axis magnetic sensor: $\pm 50\text{Ga}$ FS
 - Resolution down to 2.5mGa RMS
 - 10, 20, 50, 100 ODR
- Embedded temperature sensor
- Embedded **Self test** for A and M
- Embedded magnetic Offset cancellation
 - **No offset** thermal drift
- LGA-12, 2x2, P2P compatible with LSM303C, LIS2DH12/DE12, LIS2DS12, LIS2DW12

Key Features

High Full Scale Magnetometer
Flexibility resolution vs. power consumption
Magnetic offset cancellation embedded

⁽¹⁾ Note that LSM303AH combines LIS2MDL + LIS2DS12
LSM303AH is not Mass Market Focus

*Mass Production by April 2017

Magnetometer, e-Compass

Evolution

Focus Product

Running Business

Smart eCompass

LSM303C
2x2 LGA 12



LIS2DH12 Features XL



LSM303AGR
2x2 LGA 12



LSM303AH⁽¹⁾
2x2 LGA 12

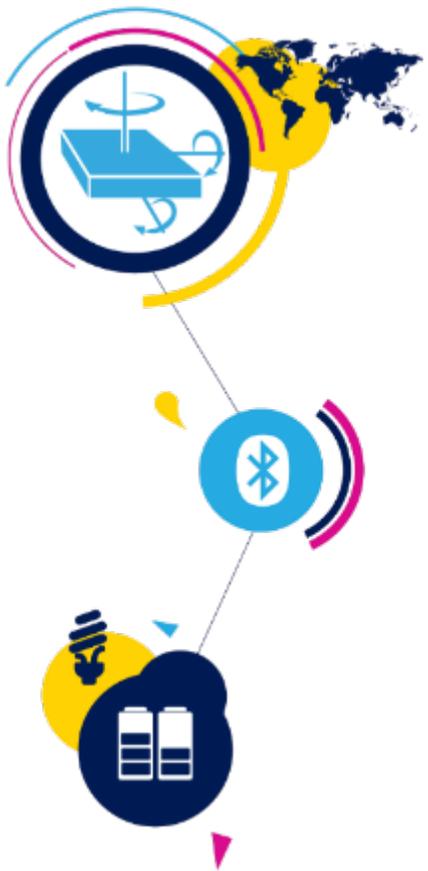


LIS3MDL
2x2 LGA 12



High Performance / Low Power

LIS2MDL
2x2 LGA 12
MP: Q2'17



Continuous improvement LSM6DSL*

Ultra-low-power 6-axis iNEMO® inertial module combines high accuracy with low power



LGA-14L, 2.5 x 3.0 x 0.86
Pin to pin compatible
 with LSM6DS3 &
 LSM6DS3H



Low-Power: DIVIDED by2

- **Always-on experience:**
 - 0.29 mA in **combo** low power mode
 - 0.48 mA in **combo** normal mode
 - 0.65 mA in **combo** high-performance mode
 - 4.5µA in Accelerometer only mode
- Ultra low noise gyro: **4mdps/√Hz***
- $\pm 2/\pm 4/\pm 8/\pm 16$ g AxI Full scale
- $\pm 125/\pm 245/\pm 500/\pm 1000/\pm 2000$ dps Gyro full scale
- **FIFO** up to 4 Kbyte for dynamic data batching
- Accelerometer and Gyro **ODR up to 6.66kHz**
- **I2C/SPI data synchronization feature**
- Hard, soft ironing for external magnetic sensor corrections
- Digital function (Pedo, Tilt, StepMvtDetec)
- Sensor hub

From LSM6DS3 to LSM6DSL*

a continuous improvement

	LSM6DS3	LSM6DS3H	LSM6DSL / DSM
Current Cons XL [μ A]	240 (HP up to ODR1600) 120 (NM@ODR200) 24 (LPM@ODR13)	240 (HP up to ODR1600) 120 (NM@ODR200) 10 (LPM@ODR13)*	160 (HP up to ODR1600) 80 (NM@ODR200) 22 (LPM@ODR50) 4.5 (LPM@ODR1)
Current Cons Combo [mA]	1.25 (HP) 0.9 (NM@ ODR200) 0.5 (LPM@ODR50)	1.1 (HP) 0.85 (NM@ ODR200) 0.45 (LPM@ODR50)	0.65 (HP) 0.48 (NM@ODR200) 0.29 (LPM@ODR50)
Noise Density Gyro [mdps/ \sqrt Hz]	7 (typ, HP)	6 (typ, HP)	4 (6DSL) 3.8 (6DSM)
ODR [Hz]	XL: 13 to 6664 Gyro: 13 to 1666	XL: 13 to 6664 Gyro: 13 to 3332	XL: 1 to 6664 Gyro: 13 to 6664
FIFO depth (bytes)	Up to 8k	Up to 8k	Up to 4k
Sensor data collection	Yes	Yes	Yes
OIS / EIS	No / Yes	Yes / Yes	No / Yes (6DSL) Yes / Yes (6DSM)
Sensor Sync	Yes	Yes	Yes

With LSM6DSL Power consumption \ll 1mA

*LSM6DSM is a LSM6DSL for OIS and very low noise

gildas.henriet@st.com – EMEA – Sensors Presentation

6 & 9-axis IMU Roadmap Evolution



Note

Focus Product

2016 Focus Product

Legacy Product

Business running

LSM6DS0



**3x3x0.86 mm
LGA 16**
Synchronous A, G
Eco power mode

LSM6DS3



**2.5x3x0.83s mm
LGA 14**
Low power (<1mA)
Advanced functionalities

LSM9DS1



**3x3.5x1 mm
LGA 24**
Synchronous A, G
Low magnetization M
Eco power mode

LSM6DSM⁽¹⁾



**2.5x3x0.83 mm
LGA-14**
Very Low power **0.65mA**
Image Stabilization:
EIS - OIS

LSM6DSL



**2.5x3x0.83 mm
LGA-14**
Very Low power **0.65mA**
Embedded Algos
EIS

LSM6DSx



**2.5x3x0.83 mm
LGA-14**
Improved in
power consumption
Compressed FIFO
Lower noise



Industrial Product Family

10 years longevity commitment

Accelerometers

IIS328DQ

12-bit
 $\pm 2/\pm 4/\pm 8g$
 T=-40 to 105 °C

24-lead 4x4x1.8mm QFN package

Introduction date Q1'15

IIS2DH

12-bit
 $\pm 2/\pm 4/\pm 8/\pm 16g$
 T= -40 to 85 °C
 FIFO

12-lead 2x2x1mm LGA package

Introduction date Q1'15

Gyroscopes

I3G4250D

16-bit
 $\pm 245/\pm 500/\pm 2000 dps$
 T= -40 to 85 °C
 FIFO

16-lead 4x4x1mm LGA package

Introduction date Q1'15



Automotive Accelerometers

AIS328DQ

Automotive Inertial Sensor – 3 axes – 2/4/8g full scale – Digital Output – QFPN package

12 bit resolution, low power consumption (<10µA at 10Hz ODR)

- AEC-Q100 - PPAP available
- Temperature Extended range: -40° to 105°C
- QFPN 4x4x1.8 24L package



AIS3624DQ

Automotive Inertial Sensor – 3 axes – 6/12/24g full scale – Digital Output – QFPN package

• 12 bit resolution, low power consumption (<10µA at 10Hz ODR)

- AEC-Q100 - PPAP available
- Temperature Extended range: -40° to 105°C
- QFPN 4x4x1.8 24L package, P2p with AIS328DQ



Key features

AEC-Q100, Flexible FS
-40 to 105°C

Automotive Gyroscope

34

A3G4250D

Automotive – **3** axes – **G**yroscope – **4x4** LGA
16L – **±245**dps full scale – **D**igital Output

- ±245dps full-scale
- 16-bit rate value data output
- Integrated low and high-pass filters with user selectable bandwidth
- Ultra-stable over temperature and time
- AEC-Q100
- Temperature range: -40° to 85°C
- LGA-16 4x4x1.1 mm³



Key features

**AEC-Q100, 245dps
ULTRA STABLE**

Environmental Sensors



Why Environmental Sensors:

- Pressure sensor (mbar)
 - **LPS22HB / LPS33HW** are **barometric** sensors with High accuracy pressure measurement, low power consumption and water resistant / proof Applications
 - Pressure sensor can be used for absolute pressure monitoring, altimeter: It complete a IMU solution to detect floor level changes in outdoor navigation
 - Applications: **Weather station, Smart Watch/Glasses, Altimeter, Vacuum Cleaner**
- Humidity sensor (% RH range)
 - **HTS221** is **humidity** sensor with temperature sensor embedded
 - Humidity sensor help to improve air quality or prevent electronics from water exposure
 - Applications: **Weather station, Smart home, Smart Watch/Glasses, Home Appliances**
- Temperature sensor (°C)
 - **STTS751** can be used if humidity or pressure sensors is not required

LPS22HB, LPS225HB⁽¹⁾, LPS22HD⁽¹⁾: High Accuracy Barometric Sensor

Low noise, High accuracy, Reduced current consumption & High stability vs Temperature

• Key parameters

- 260 to 1260 mbar absolute pressure
- Pressure noise: down to 20 μ bar & **7.5 μ bar (LPF)**
- ODR from 1 to **75Hz**, one shot
- Low power consumption: **12 μ A** (low noise) to **3 μ A** (low power) @1Hz
- **Embedded** Temperature compensation
- 32 samples Embedded FIFO for Pressure **and** Temperature
- SPI and I²C interfaces
- **2x2x0.76 mm package**
- LPS225HB: 2x2.5x0.8mm Package Version
- LPS22HD: one shot mode enabling 200Hz ODR

**<20 cm accuracy
6 cm with OPC**

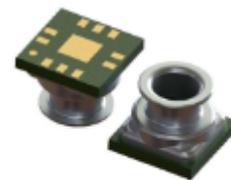
World's smallest
pressure sensor



Samples ready

it is also **SPECIFIC** devices for **SPECIFIC** application: **LPS33HW***

Pressure Sensor for Water Proof App's



CCLGA 10L
3.3 x 3.3 x 2.9 mm

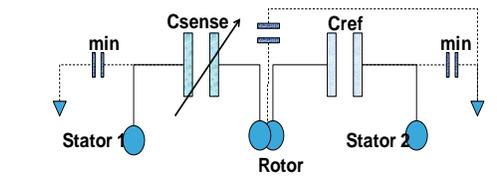
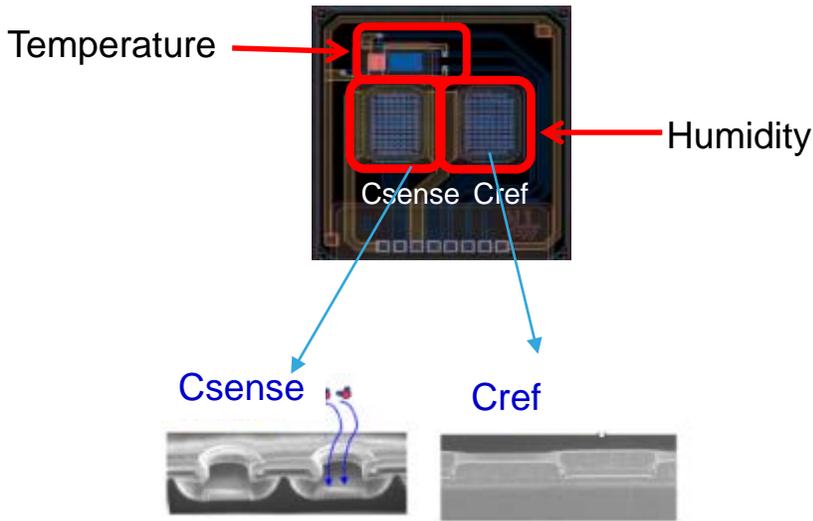
*ISO 22810 Horology Certified
(Water resistant Watches standard)
IEC 60529 (IP Code): IPx7 and IPx8
certified*

• Key Features:

- For Waterproof Applications
- 260 to 1260 mbar absolute pressure
- < 1Pa RMS of noise
- ODR from 1 Hz to 75 Hz
- Low power consumption: 4 μ A
- High shock survivability: > 20,000 g
- SPI and I²C interfaces
- Embedded FIFO



Humidity Sensor HTS221



$$C_{sense} = C_0 + S \cdot \%rH$$

- **Features:**
 - **Humidity (0 to 100% RH) and temperature (-40 to 120 °C) sensor**
 - **Humidity Accuracy (20%RH to 80%RH):**
 - HTS221 $\pm 3.5\%RH$
 - **Low Power Consumption: 2 μA @ 1Hz ODR**
 - **SPI and I²C interfaces**
 - **Self-Test**
 - **Supply voltage: 1.7 to 3.6 V**

Key Features
 $\pm 3.5\%RH$ Accuracy
2x2 Package
Low Power

Analog Temperature Sensors Roadmap

- **STLM20** operates like a **band gap** temperature sensors.
- Very **low current** consumption.
- **Predictable** curvature error
- Suitable for: consumer, portable, industrial and medical applications, home appliances.

STLM20W87F

Temp. range: -55°C / +130°C
SOT323-5L (1.8 x 1.15 x 0.8mm)
Accuracy: ±0.5°C @ 25°C (typ), ±2.5°C @ 130°C (max)



STLM20DD9F

Vcc: 2.4V - 5.5V
Temp. range: -40°C / +85°C
Accuracy: ±0.5°C @ 25°C (typ), ±2.1°C @ 85°C (max)
Iq: 4.8uA
UDFN-4L (1.0 x 1.3 x 0.5mm)



LM135

Temp. range: -55°C / +150°C
Accuracy: ±0.5°C (typ), ±1.5°C (max)



LM235

Temp. range: -40°C / +120°C
Accuracy: ±0.5°C (typ), ±1.5°C (max)



LM335

Temp. range: -40°C / +100°C
Accuracy: ±0.5°C (typ), ±1.0°C (max)
I_R: 450uA to 5mA
To-92 (3.7 x 5.03mm)
SO-8 (4.8 x 3.9 x 1.75mm)



- LMx35 operates like **Zener diode @ breakdown voltage** (directly proportional to the absolute temperature at **10mV/°K**).
- **Accuracy flat** across the whole operating range.
- Up to **200°C** operating temp. (non continuous).
- Suitable for: Industrial applications and home appliances

Digital Temperature sensors

Digital Output

- I2C/SMBus 2.0 output with selectable address (up to 8).
- Programmable temp. conversion rate.
- One shot reading for current saving.
- Pin for interrupt generation with programmable threshold and hysteresis.
- Suitable for: consumer, portable, industrial and medical applications, home appliances.

STTS751

Vcc: 2.25V – 3.6V
Idd: 20uA (typ @ 1 conv/s)
Temp. range: -40°C / +125°C
Accuracy: ±1.0°C @ 25°C (typ), ±2.5°C @ 125°C (max)
Resolution: prg 9 – 12 bit
Conversion time: 14 – 112ms (max)
UDFN-6L (1.0 x 1.3 x 0.5mm)



STTS75

Idd: 75uA (typ)
Resolution: prg 9 – 12 bit
Conversion time: 85 – 680ms (max)



STCN75

Resolution: 9 bit
Conversion time: 85ms (max)



STDS75

Resolution: prg 9 – 12 bit
Conversion time: 150 – 1200ms (max)



STLM75

Vcc: 2.7V - 5.5V
Idd: 125uA (typ)
Temp. range: -55°C / +125°C
Accuracy: ±0.5°C (typ), ±3.0°C (max)
Resolution: 9 bit
Conversion time: 150ms (max)
MSOP-8 (3.0 x 3.0 x 1.1mm)
SO-8 (4.9 x 3.9 x 1.75mm)



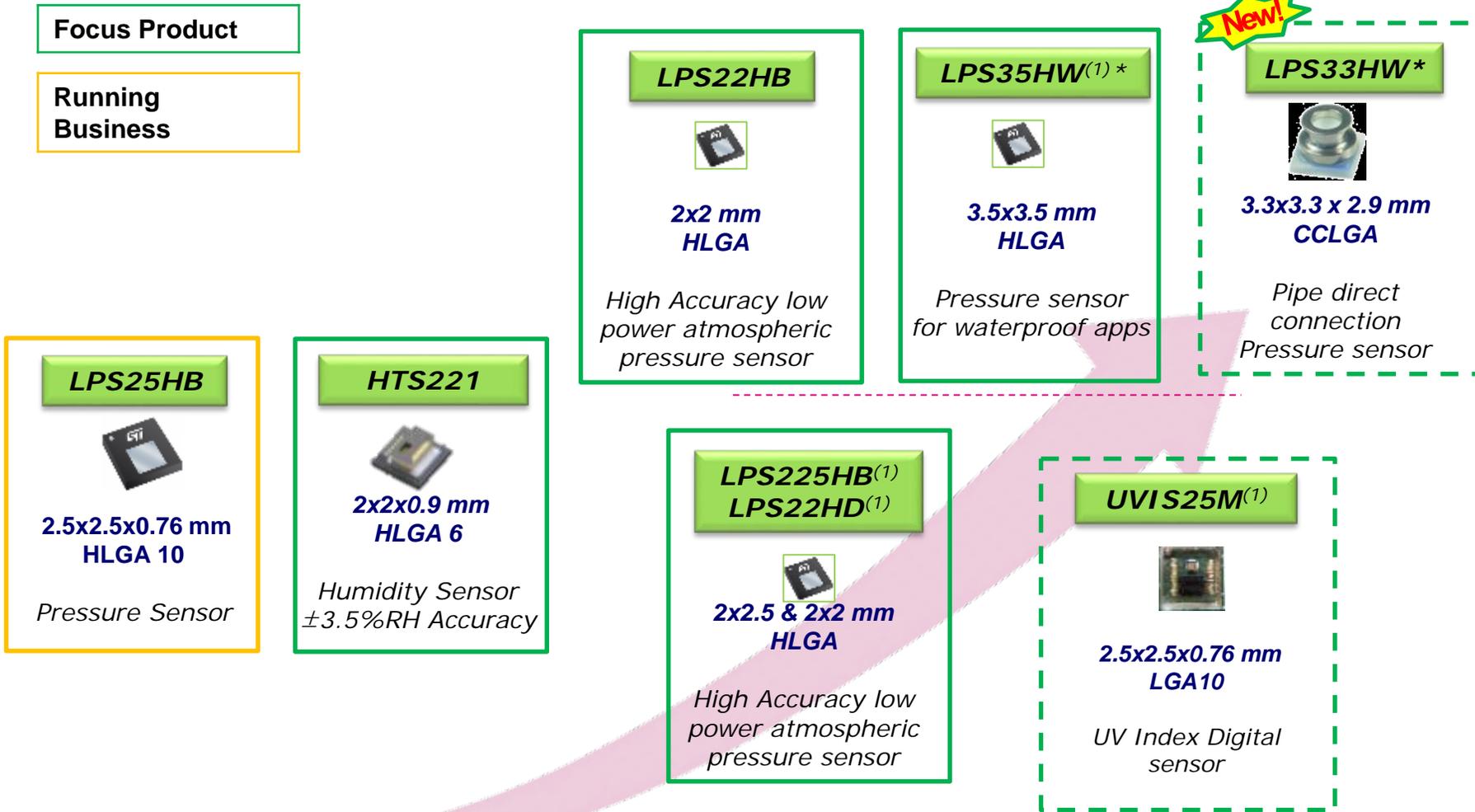
- Accuracy flat (typ) across the whole operating range.
- I2C/SMBus output with selectable address (up to 8).
- One shot reading for current saving.
- Dedicated pin for interrupt or thermostat/comparator function
- Programmable threshold with hysteresis.
- Suitable for: consumer, portable, industrial and medical applications, home appliances.

Environmental Sensors

Roadmap Evolution

Focus Product

Running Business



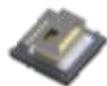
LPS25HB



2.5x2.5x0.76 mm
HLGA 10

Pressure Sensor

HTS221



2x2x0.9 mm
HLGA 6

Humidity Sensor
±3.5%RH Accuracy

LPS22HB



2x2 mm
HLGA

High Accuracy low
power atmospheric
pressure sensor

LPS35HW⁽¹⁾ *



3.5x3.5 mm
HLGA

Pressure sensor
for waterproof apps

LPS33HW*



3.3x3.3 x 2.9 mm
CCLGA

Pipe direct
connection
Pressure sensor

**LPS225HB⁽¹⁾
LPS22HD⁽¹⁾**



2x2.5 & 2x2 mm
HLGA

High Accuracy low
power atmospheric
pressure sensor

UVIS25M⁽¹⁾



2.5x2.5x0.76 mm
LGA10

UV Index Digital
sensor

2015

2016

2017

2018

Microphones



Main Acoustic Parameters

Sensitivity

- Electrical response to a given standard acoustic input (1kHz sine at a 94 dB SPL)
- **The narrower the spread is from part to part, the better it is.**
- Typ spread is ± 3 dB.

SNR

- Ratio of a reference signal to the noise level at the microphone output
- **The Higher, the better**
- Typ 63/64dB

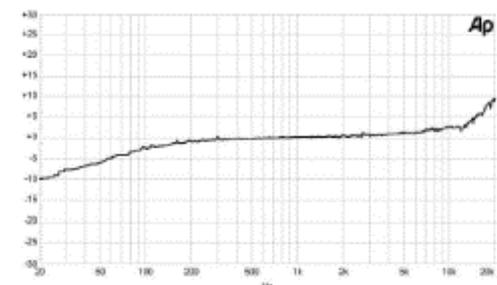
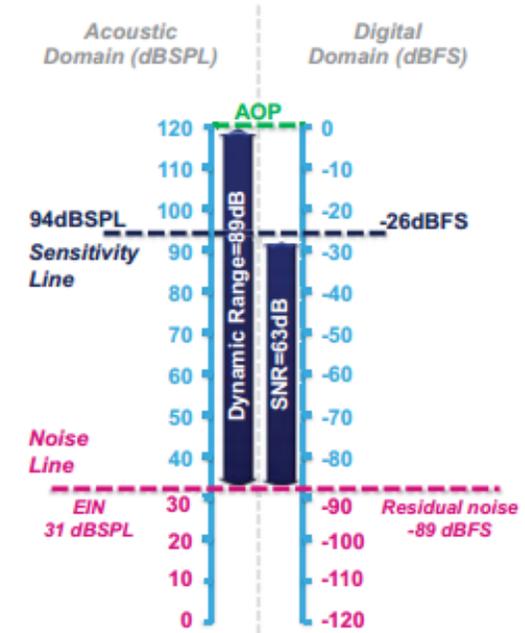
AOP

- **Acoustic Overload Point** is the highest acoustic sound pressure level the microphone can tolerate with a THD <10%
- **The higher, the better**
- Typ 120dB SPL

Frequency response

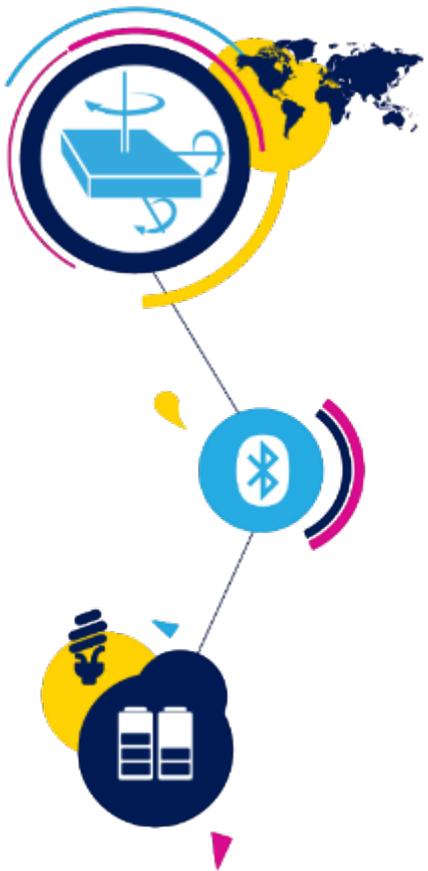
- Is the microphone sensitivity plot in a given frequency range normalized at the sensitivity to a reference signal.
- **Usually, the flatter, the better**

DIGITAL MICROPHONE EXAMPLE

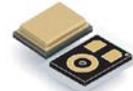


Analog & Digital Microphones

Roadmap Evolution



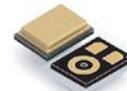
MP23AB02B



2.5x3.35x.98 mm

Bottom Port
SNR 64dB
AOP 125dB
SENS ±3dB

MP23AB01DM



2.5x3.35x.98 mm

Differential
Bottom Port
SNR 64.5dB
AOP 130dB

MP23AB01DH



2.5x3.35x.98 mm

Differential
Bottom Port
SNR 65dB
AOP 135dB
SENS ±1dB

MP34DT01-M



3x4x1 mm

Top Port
SNR 61dB
AOP 120dB
SENS ±3dB

MP34DB02



3x4x1 mm

Bottom Port
SNR 62.6dB
AOP 120dB
SENS ±3dB

**MP34DT04-C1
MP34DT05**



3x4x1 mm

Top Port
SNR 64dB
AOP
120dB/122.5dB
SENS ±3dB

2015

2016

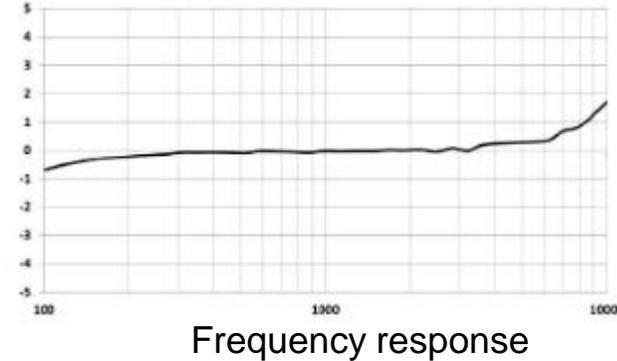
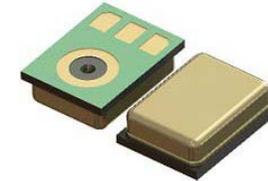
2017

2018

MP23AB01DH

- Bottom Port, Analog Differential microphone:

- **High AOP (135dB)** for better sound fidelity
- Better signal integrity thanks to the fully differential output
- **Narrow Sensitivity: +/- 1dB**
- Ultra-flat bandwidth for noise canceling applica



Parameter	MP23AB01DH		
	Min	Typ	Max
Supply voltage [V]	2.3		3.6
Current consumption [uA] @2.7V		220	
Sensitivity [dBV]	-39	-38	-37
SNR[dB] (20Hz-20kHz, A-Weighted)		65	
Roll-off [Hz]		35	
THD [%] @120dB SPL			2
AoP [10% THD]		135	
PSR (217Hz Sine wave, 100mVpp)		-100	
Output	Analog Differential		

Package Dim	3.35x2.5x0.98mm
Port Hole	0.35mm

Key Features

Analog Differential
65dB SNR, SENS ±1dB



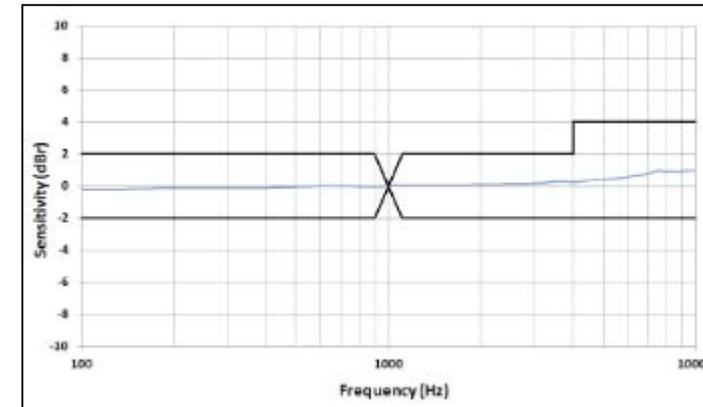
Digital Microphone: MP34DT01-M MP34DT04-C1 MP34DT05 MP34DB02

TOP PORT:

- **MP34DT01-M** - 61dB SNR, Metallic package
- **MP34DT04-C1** - 64dB SNR, LGA package
- **MP34DT05** – 122.5dB AOP , LGA package

BOTTOM PORT:

- **MP34DB02** – 62.6dB SNR, Metallic package
- PDM output
- 120dB SPL Acoustic Overload Point
- Sensitivity = -26dBV \pm 3dB
- Omni-directional sensitivity
- Dimension (mm): 3 x 4 x 1
- Supply voltage V_{cc} = 1.6V – 3.6V
- Supply current I_{dd} = 600 μ A



Key Features

Digital, Top & Bottom Port
61 to 64 dB SNR
P2P

Digital : Performance comparison table

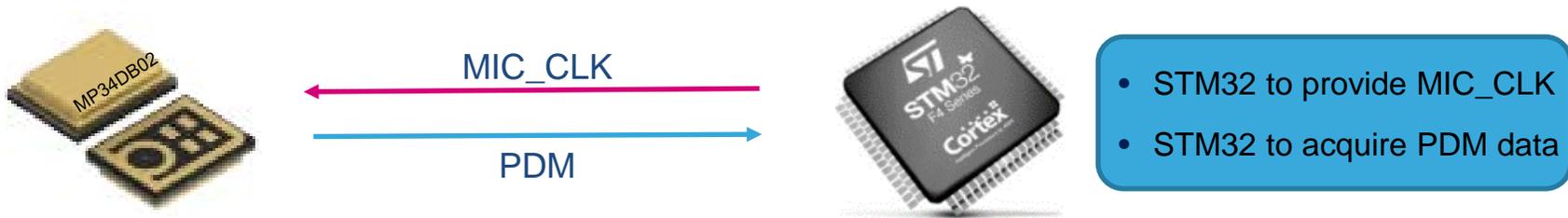
Parameter	MP34DB02			MP34DT01-M			MP34DT04-C1			MP34DT05		
	Bottom Port			Top Port								
	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max
Supply voltage [V]	1.64	1.8	3.6	1.64	1.8	3.6	1.6	1.8	3.6	1.6	1.8	3.6
Supply Current [uA]		650			600			650			650	
Sensitivity [dBFS]	-29	-26	-23	-29	-26	-23	-29	-26	-23	-29	-26	-23
SNR [A-Weighed @ 1kHz 94dB SPL]		62.6			61			64			64	
THD [%] @94dB SPL						0.5			0.5			0.5
THD [%] @100dB SPL			1			1			1			
THD [%] @110dB SPL												1
THD [%] @115dB SPL			5			2		5				
THD [%] @120dB SPL			10			10		10			6	
AoP [10% THD]		120			120			120			122.5	
Roll-off [Hz]		100			<35Hz			< 35Hz			< 35Hz	
Clock [MHz]	1	2.4	3.25	1	2.4	3.25	1	2.4	3.25	1	2.4	3.25

- Test conditions: Vdd = 1.8 V, Clock = 2.4 MHz, T = 25 °C, unless otherwise noted
- AOP and THD better performance on MP34DT05 is due to the new ASICd

Digital MICs to STM32 architecture

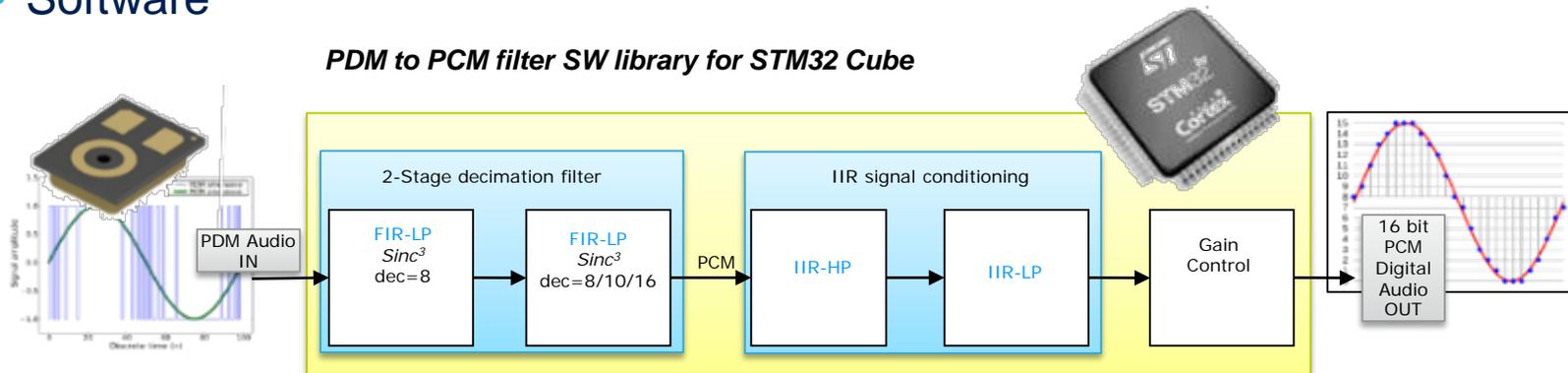
- Hardware :

- Serial: SAI/I2S/SPI: 1 or 2 microphones share CLK and data line
- DFSDM (Digital Filter for Sigma Delta Modulator) dedicated interface
 - only on selected STM32 devices

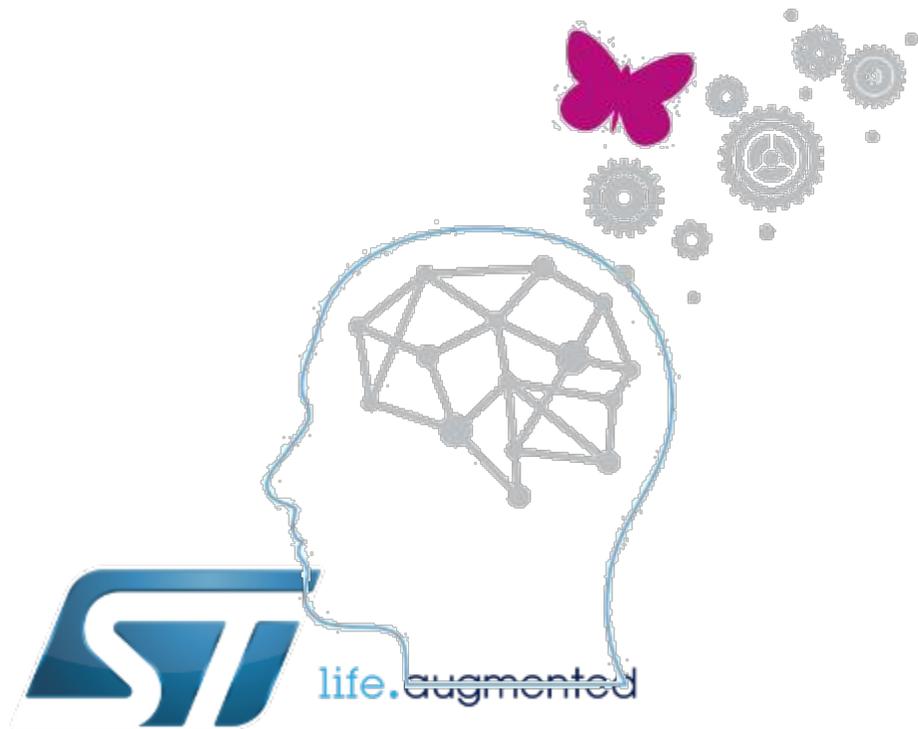


- Software

PDM to PCM filter SW library for STM32 Cube



Tools, SW & Evaluation Kits



STM32 Open Development Environment

The STM32 Open Development Environment consists of a set of **modular developer boards** and a **software environment** designed around the **STM32 microcontroller family**

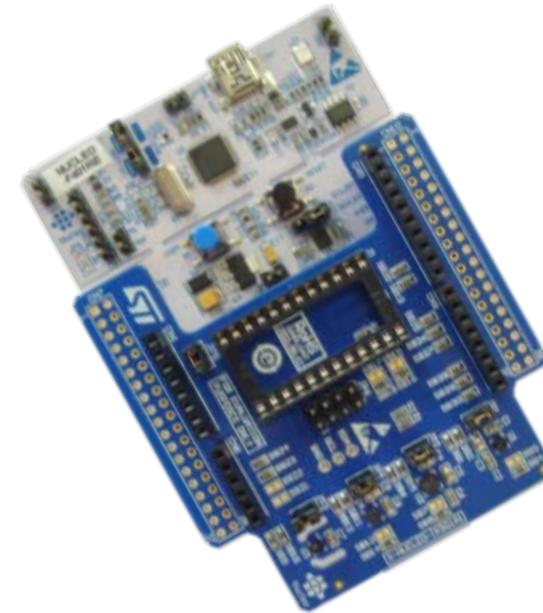
STM32 Nucleo
development boards

STM32Cube
development software

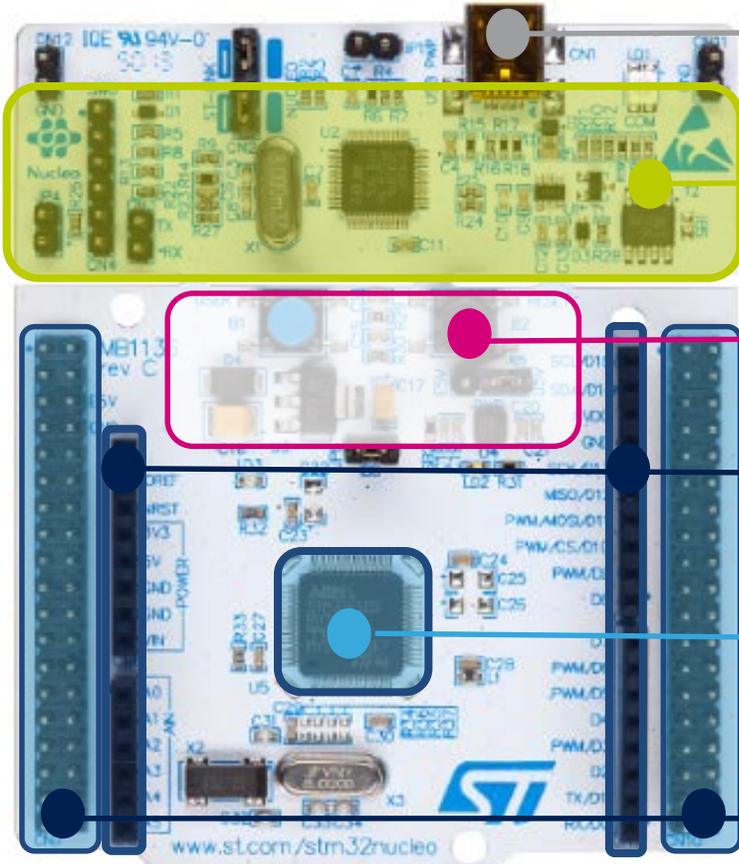
STM32 Nucleo
expansion boards

STM32Cube
expansion software

Compatibility with
multiple development environments



Nucleo / X-Nucleo: Stackable solution



Flexible board power supply :
through USB or external source

Integrated ST-Link/V2-1:
mass storage device flash programming

2 push buttons, 2 color Leds

Arduino extension connectors :
easy access to add-ons

One STM32 MCU flavor with 64

Morpho extension headers :
direct access to all MCU I/Os

STM32 Nucleo features



X-NUCLEO: Available Solution



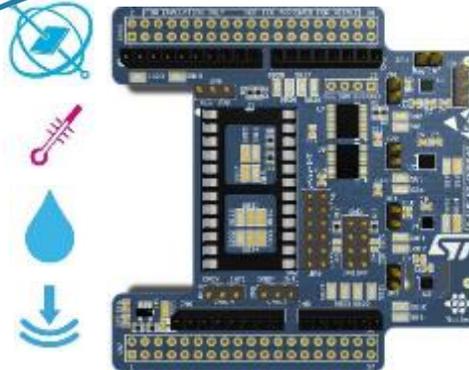
Bluetooth SMART BlueNRG
X-NUCLEO-IDB04A1



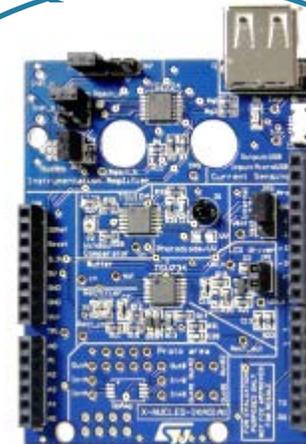
Proximity/ ALS VL6180X
X-NUCLEO-6180XA1



Microphone on 2x MP34DT01-M
X-NUCLEO-CCA02M1



Motion + Environmental Sensors
X-NUCLEO-IKS01A2



ANALOG/ OPAMPS
X-NUCLEO-IKA01A1

TSV734
TSZ124
TSU104

- STM32 X-Nucleo boards allow to add a function to STM32 Nucleo boards
- It is stacked on the STM32 Nucleo

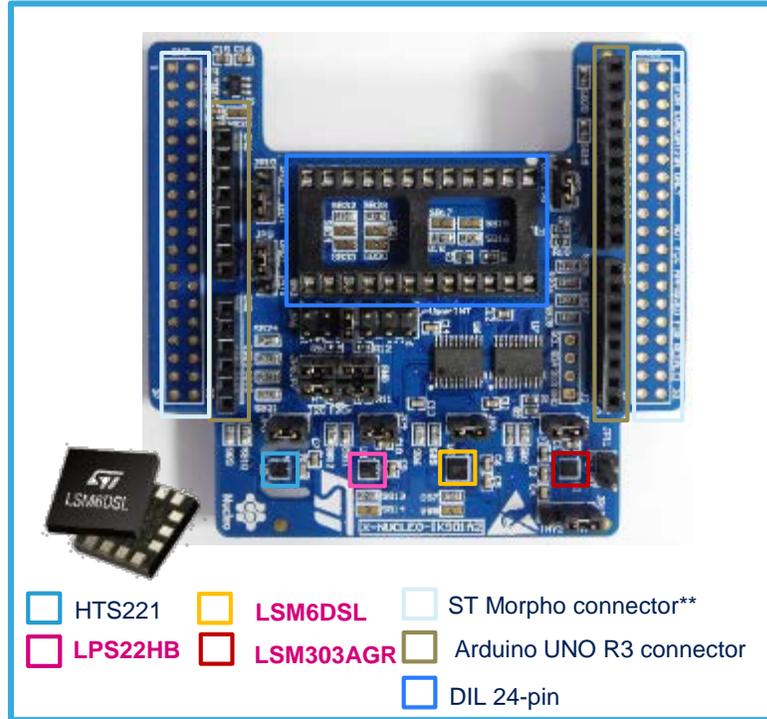
(*) thanks to the electrical compatibility it can be used as a shield for Arduino UNO R3 or similar

Boost your design speed !

Nucleo Sensors Ecosystem: HW + SW

<http://www.st.com/x-nucleo>

Order code: **X-NUCLEO-IKS01A2**



X-CUBE-MEMS1

Low level drivers and SW examples

Open.MEMS Libraries

Sensor fusion

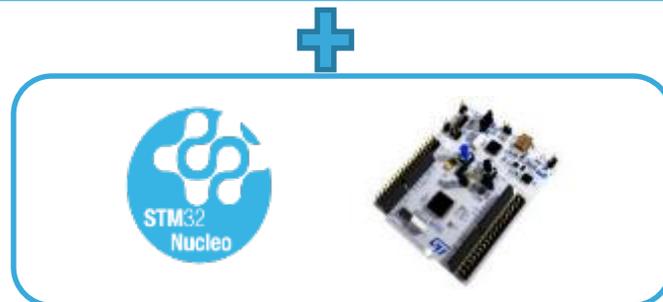
Calibration

Man Activity

Open.Framework Applications

Bluemicrosystem

... Application examples with stacked expansion boards ...

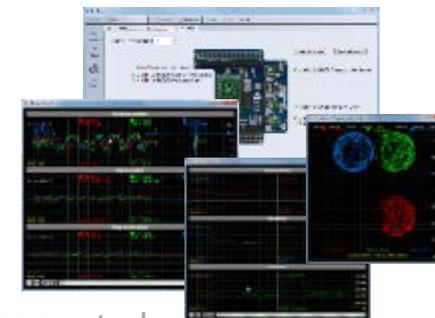


NUCLEO-F401, NUCLEO-L053, NUCLEO-L152 or NUCLEO-L476



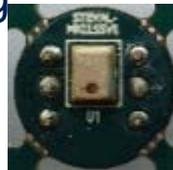
Unicleo-GUI

... sensor register control,
raw data, magnetometer calibration ...

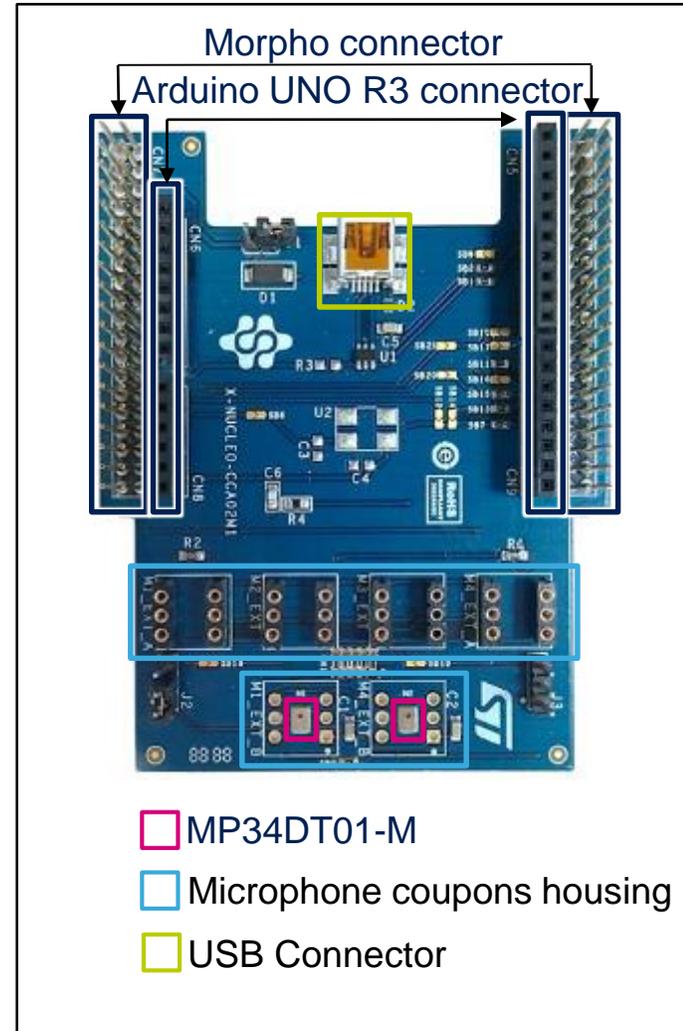


X-NUCLEO-CCA02M1

- MEMS microphone evaluation board
 - STM32Nucleo Expansion, compatible with STM32 ODE
- 2x MP34DT01-M microphones
- 1x miniUSB FS connector:
 - USB audio data streaming
- Up to 4 microphones synchronized acquisition and streaming
- 6x ST MEMS Microphone coupons housing:



STEVAL-MKI129V1
STEVAL-MKI129V2
STEVAL-MKI129V3





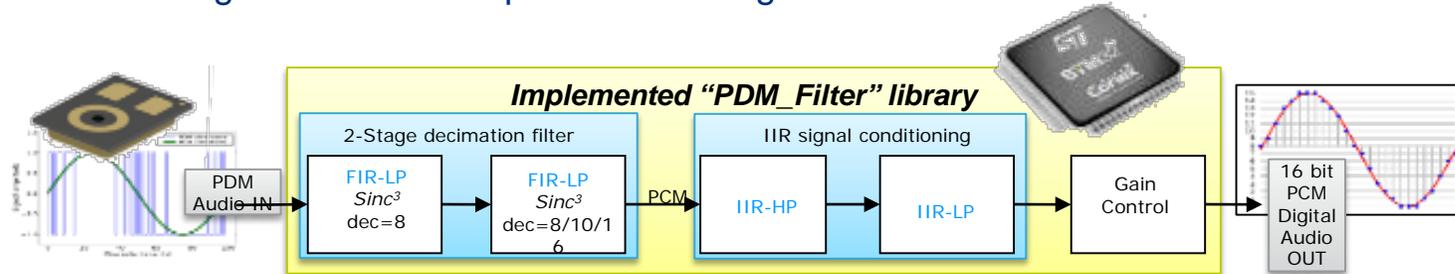
Latest info available at www.st.com/openaudio

MEMS MICs SW libraries 1/2

Open.Audio: set of libraries and processing algorithms for audio capturing systems based on digital MEMS microphones.

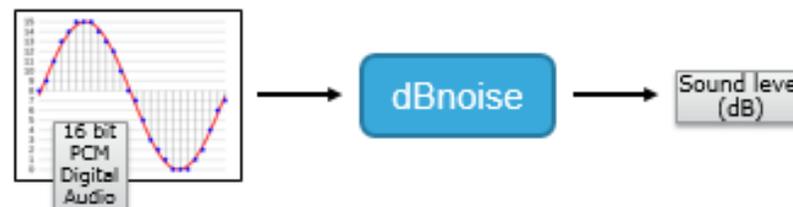
- **PDM to PCM conversion library**

- Converts digital MEMS microphones PDM signal to the PCM format.



- **dBNoise, Sound pressure level (dB)**

- Provide Ambient Sound Pressure level in dB





Latest info available at www.st.com/openaudio

MEMS MICs SW libraries 2/2

- **osxAcousticBF: BEAMFORMING**

- Uses signals from 2 MEMS microphones to create a virtual directional microphone

- **osxAcousticEC: AEC**

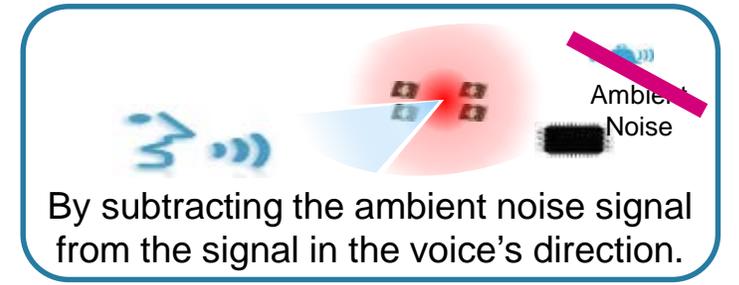
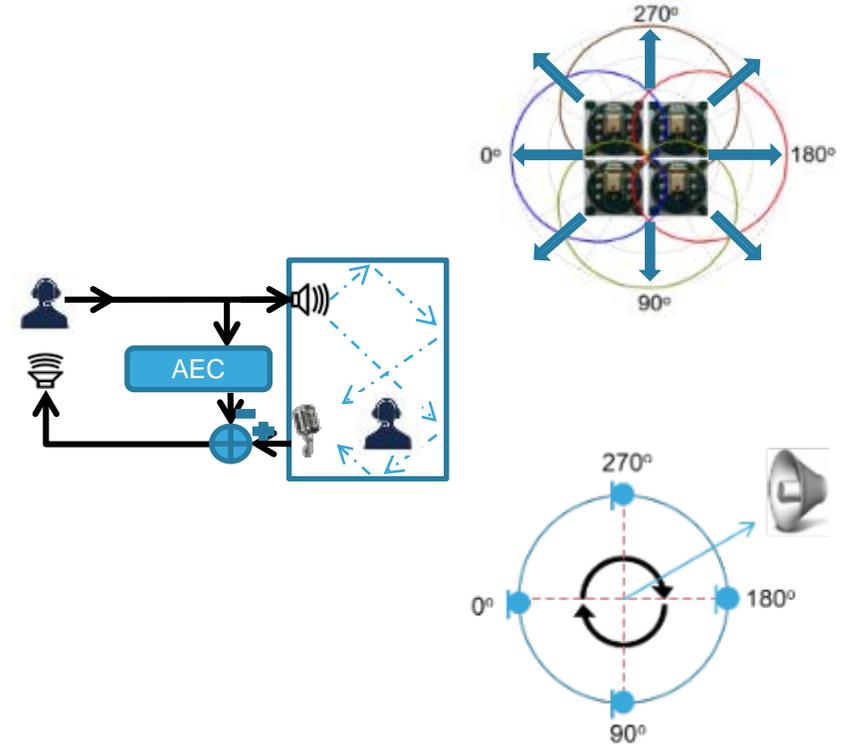
- Acoustic Echo Cancelation
- Cleans microphone input from loudspeakers to avoid echo

- **osxAcousticSL: SOUND SOURCE LOCALIZATION**

- Uses a MEMS microphones array to estimate the direction of the audio signal

- **Active Noise Cancelation (BF+SL)**

- To remove the environmental noise by focusing on the sound source.



ST SOFTWARE Available: Open.MEMS libraries

Latest info available at
www.st.com/openmems

- **Sensor Fusion: osxMotionFX**



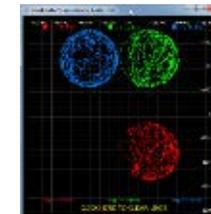
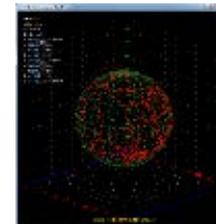
- **Man activity tracking:**

- **osxMotionPM** (Pedometer)
- **osxMotionAR** (Activity recognition for belt and pocket), **osxMotionAW** (Activity recognition for Wrist), **osxMotionGR** (Gesture Recognition), **osxMotionPE** (Pose estimation), **osxMotionID** (Motion Intensity), **osxMotionAR** (Carry position of an object)



- **Calibration: NEW!**

- **osxMotionAC** (Accelerometer Calibration), **osxMotionGC** (Gyroscope Calibration), **osxMotionMC** (Magnetometer Calibration),



ST SOFTWARE Available: Tilt / Inclination measurement

Application

- Alarm (car, home)
- Digital Inclinometer for moving machines, airplanes, construction machines
- Consumer devices, camera (virtual horizon)

How to validate:

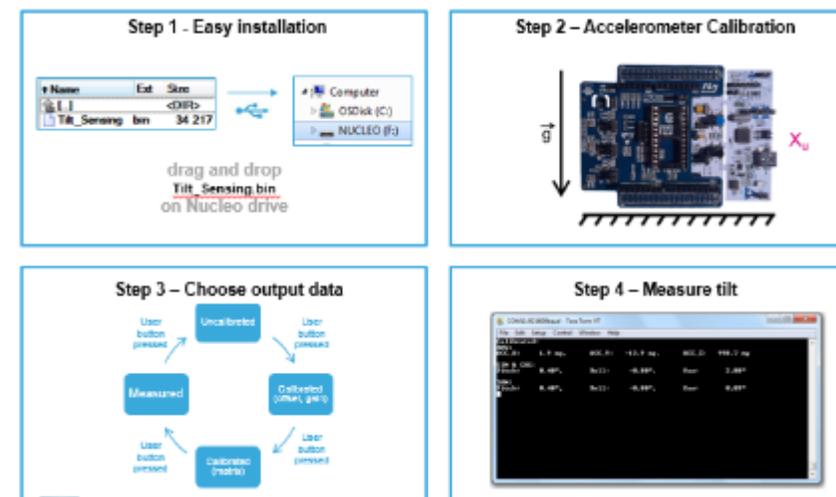
- [AN3182](#) for guidance
- X-Nucleo HW (using embedded LSM6DS0 accelerometer)
- SW for test & validation (includes sensor calibration (Offset, Gain);
- IAR project including source code.

Result:

- **0.2° tilt accuracy with LSM6DS0 accelerometer.** (with calibration procedure)

How to get SW:

- Yr ST Contact or gildas.henriet@st.com



Tilt Error [°]	Uncalibrated			Calibrated - Offset & Gain		
	Pitch	Roll	Yaw	Pitch	Roll	Yaw
Min	-0.87	-0.05	-0.88	0.04	-0.1	0.04
Max	0.3	1.07	1.02	0.21	0.09	0.22
Max-Min	1.17	1.12	1.9	0.17	0.19	0.18

ST SOFTWARE Available: Vibration Analysis

Application

- Appliance real time monitoring
 - White goods low speed motor, Washing machine drum balance,
 - Robot,
 - Slow movement (doors, windows)
- Industrial monitoring for preventive maintenance
 - Compressor, geared motors, windmill
 - Elevator, ...

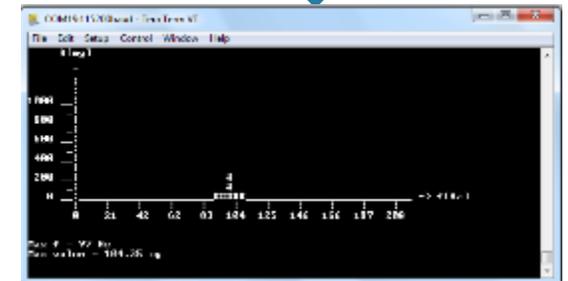
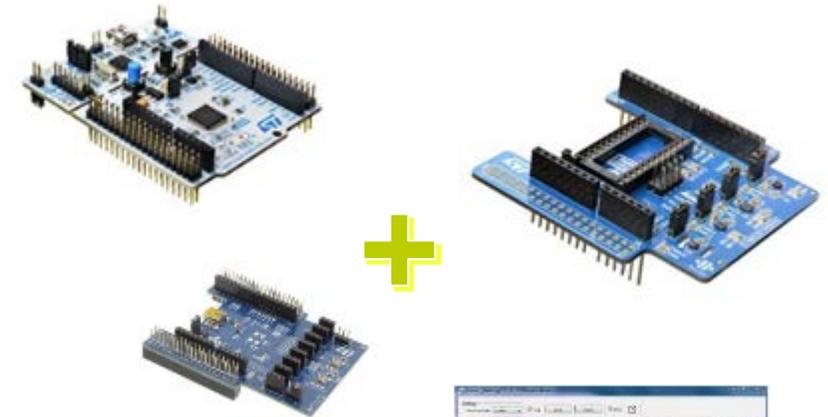
How to validate:

- Sound And Vibration Analysis Toolkit:
- Nucleo Microphone CCA02M1 board + separate microphone adapters
- Accelerometer **IKS01A1** (LSM6DS0/3) + LIS2DS12 DIL adapter
- **FFT SW** for Time to Frequency domain transform for local alerts/limits

Result:

Appliance	BW (Max ODR/2)	Industrial	BW (Max ODR/2)
LIS2DH12	2.56 kHz (8-bit) / 672 Hz (10-bit)	H3LIS331 DL	500 Hz
LIS2HH12	400 Hz (14-bit)	IIS328DQ	500 Hz
LSM6DS3	3.3 kHz (14-bit)	IIS2DH	2.56 kHz (8-bit) / 672 Hz (10-bit)
LIS2DS12	3.2 kHz (12-bit)	LIS2DS12	3.2 kHz (12-bit)

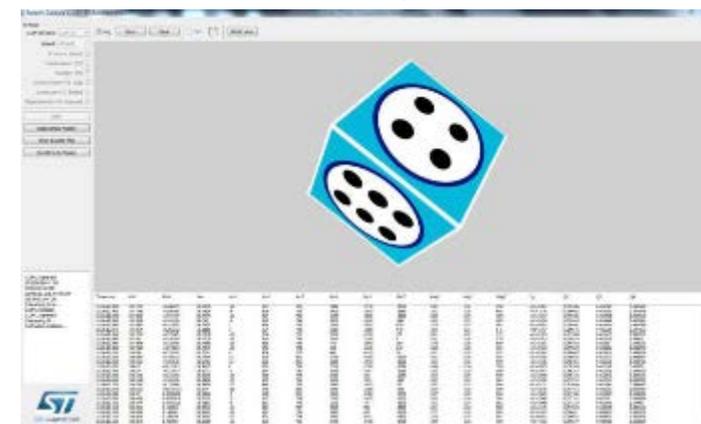
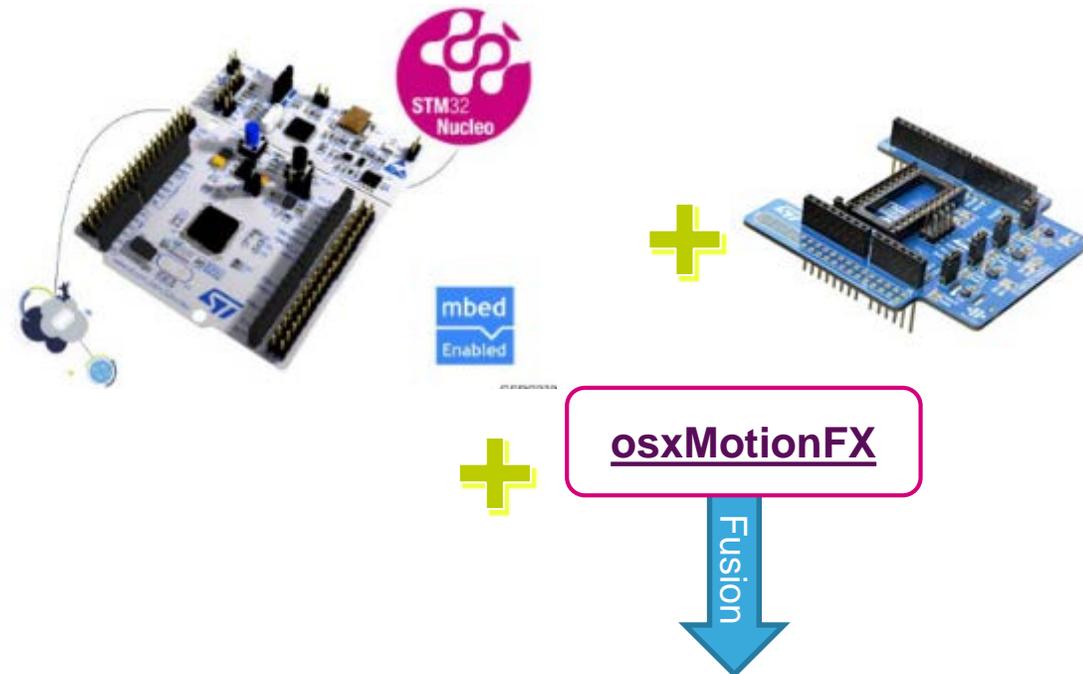
- Yr ST Contact or gildas.henriet@st.com



ST SOFTWARE Available: Gesture Recognition / Analysis

71

- Application
 - IOT, Smart watch
 - IMU Robotics, Robot Cleaner*
- How to validate:
 - Nucleo for HW
 - **OsxMotionFx for SW**
 - **OsxMotionRx for Robot SW**
- Result:
 - Ready to use solution
 - No IP issues
- How to get SW:
 - Available on line: **osxMotionFX**

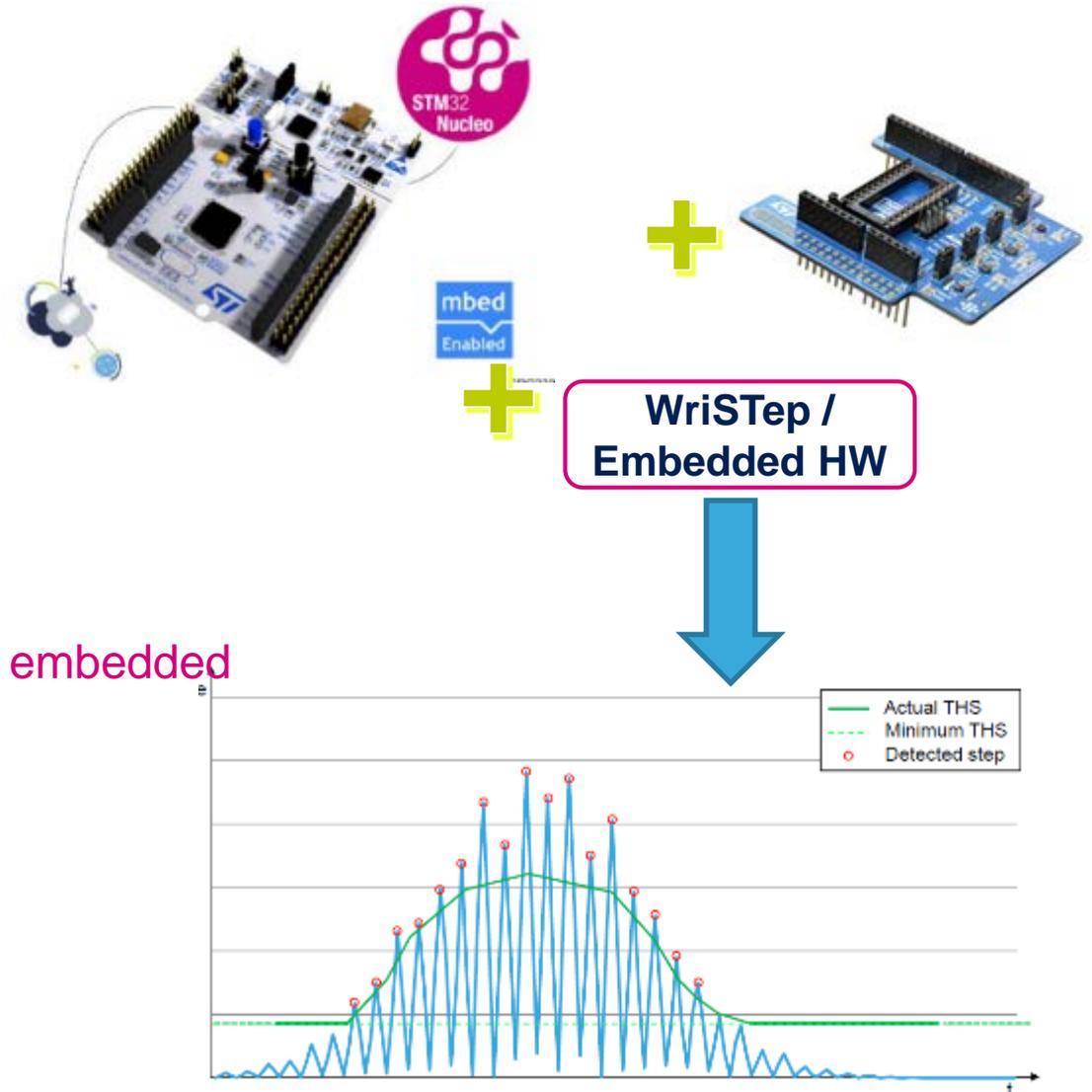


* Custom version for Robot applications

ST SOFTWARE Available: Pedometer

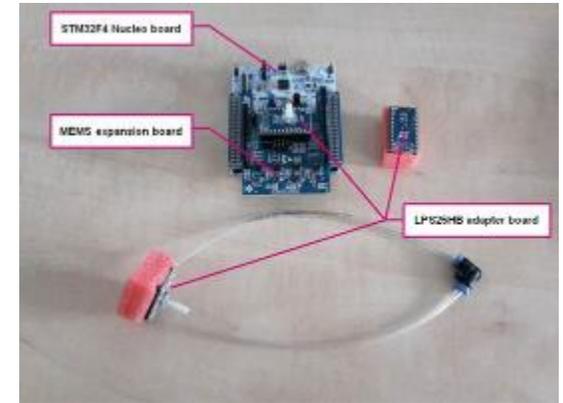
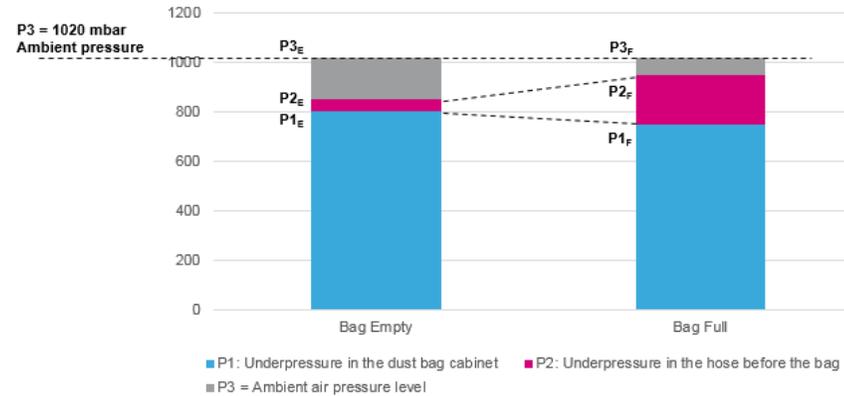
72

- Application
 - IOT, Smart watch
 - Tracking system, pedometer
- How to validate:
 - Nucleo for HW
 - 2 options:
 - **WriStep** library
 - **LSM6DS3/DSL** pedometer HW embedded
- Result:
 - Ready to use solution
 - Available for Wrist or pocket position
- How to get SW:
 - Available on line: [osXMotionPM](#)



ST SOFTWARE Available: UnderPressure / OverPressure

- Application
 - Vacuum Cleaner
 - Water level Detection
- How to validate:
 - Nucleo for HW, LPS25HB
 - IAR project for SW
- Result:
 - Ready to use solution
 - Under and Over Pressures measurable, Customized Threshold
- How to get SW:
 - Your ST Contact or gildas.henriet@st.com



```

PRESS: 989.14 mbar (REF NOT SET)
PRESS: 989.17 mbar (REF NOT SET)

TimeStamp: 0:11:9.64
REF PRESS SET: PRESS: 989.17 mbar

PRESS (REF SET): 0.00 mbar INT_SOURCE: 0x05 HIGH
PRESS (REF SET): 9.67 mbar INT_SOURCE: 0x05 HIGH
PRESS (REF SET): 10.14 mbar INT_SOURCE: 0x05 HIGH
PRESS (REF SET): 1.23 mbar INT_SOURCE: 0x05 HIGH
PRESS (REF SET): 1.14 mbar INT_SOURCE: 0x05 HIGH
PRESS (REF SET): 2.04 mbar INT_SOURCE: 0x05 HIGH
PRESS (REF SET): 1.00 mbar INT_SOURCE: 0x05 HIGH
PRESS (REF SET): -19.03 mbar INT_SOURCE: 0x06 LOW
PRESS (REF SET): -12.42 mbar INT_SOURCE: 0x06 LOW
PRESS (REF SET): -17.56 mbar INT_SOURCE: 0x06 LOW
PRESS (REF SET): -32.46 mbar INT_SOURCE: 0x06 LOW
PRESS (REF SET): -1.07 mbar INT_SOURCE: 0x06 LOW
PRESS (REF SET): 5.38 mbar INT_SOURCE: 0x05 HIGH
PRESS (REF SET): 5.79 mbar INT_SOURCE: 0x05 HIGH
PRESS (REF SET): -17.19 mbar INT_SOURCE: 0x06 LOW
PRESS (REF SET): -15.15 mbar INT_SOURCE: 0x06 LOW
PRESS (REF SET): -18.40 mbar INT_SOURCE: 0x06 LOW
  
```

AUTOZERO,
REF_P
registers are
set

THS_P is set
in this
example to
1mbar

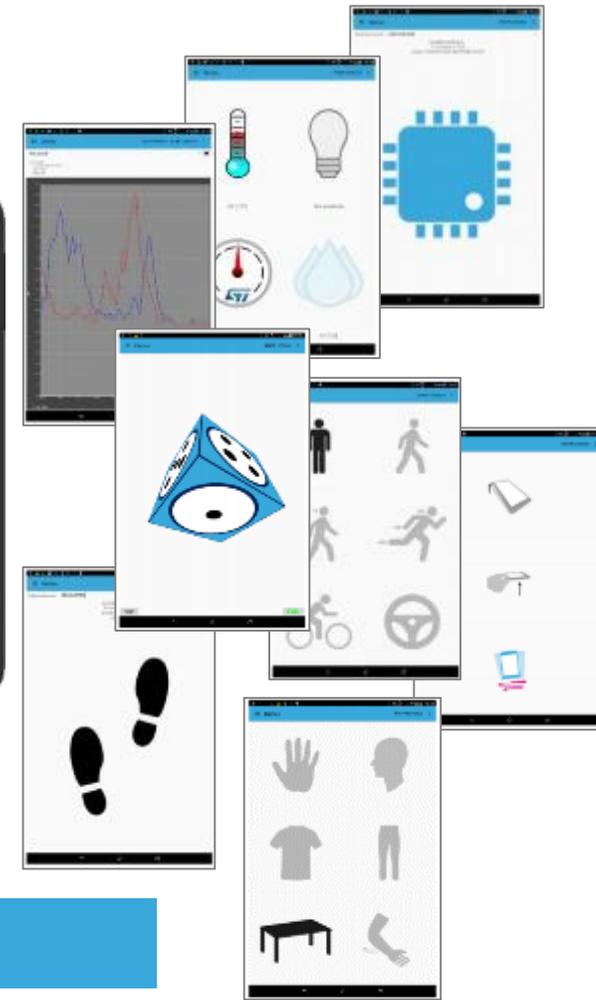
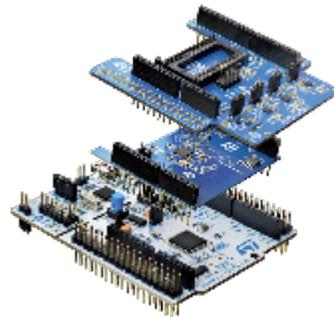
Pressure High or Low interrupt is generated

ST SOFTWARE Available: **BLUEMICROSYSTEM**

Application examples with sensors, RF and Audio



STM32 Open Development Environment



open.AUDIO

open.MEMS

* Simplified libs licensing scheme through BlueMS App = no need to compile source code to run a demo

STM32 OTA Firmware upgrade

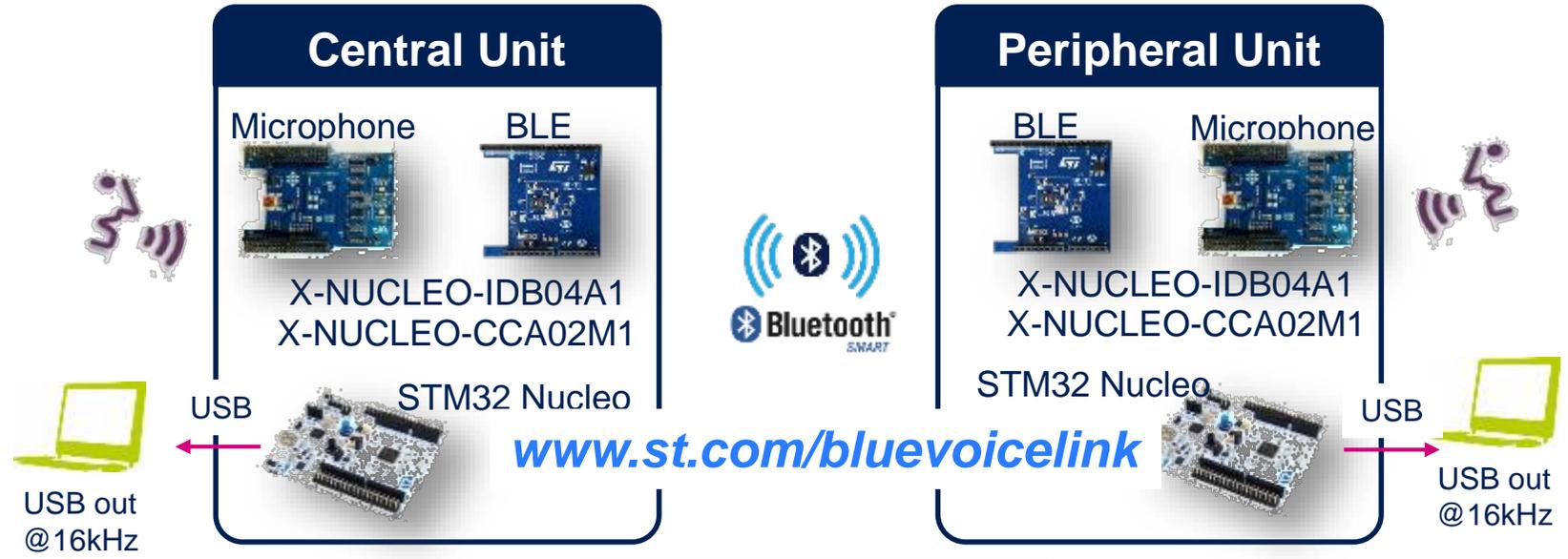
BMS Android and iOS App free download



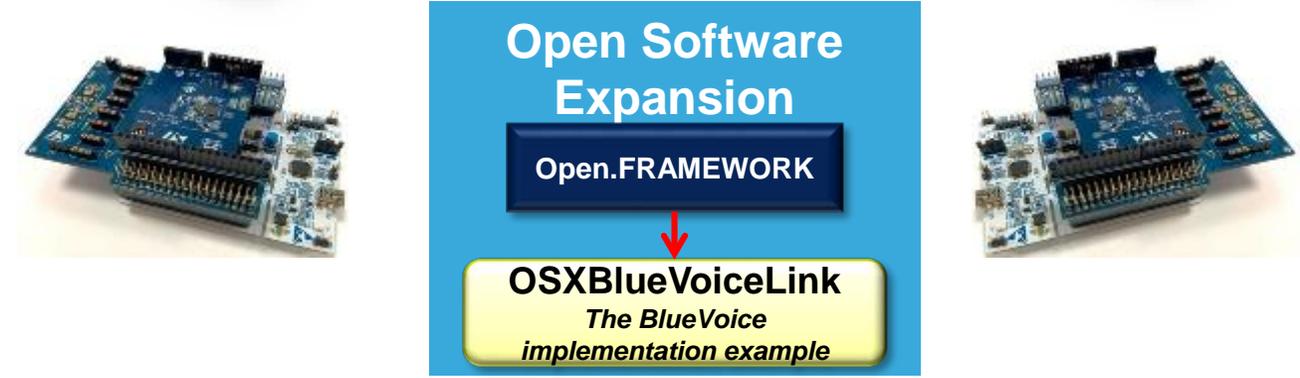
ST SOFTWARE Available:

Voice over BLE Solution - OsxBlueVoice

Half-duplex and Bi-directional audio
@64kbps



www.st.com/bluevoicelink



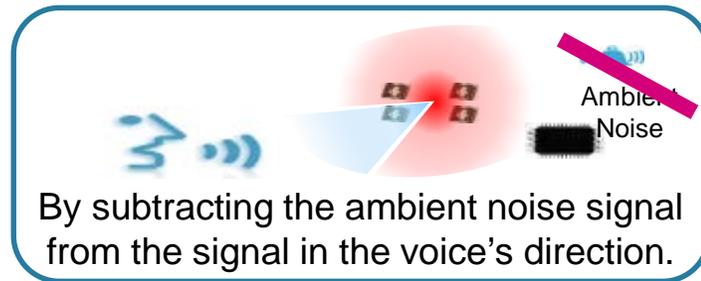
ST SOFTWARE Available: **OPEN.AUDIO**

- Application
 - IOT, High Quality Audio system,
 - Voice Over BLE
 - VOIP and Teleconferencing

- How to validate:

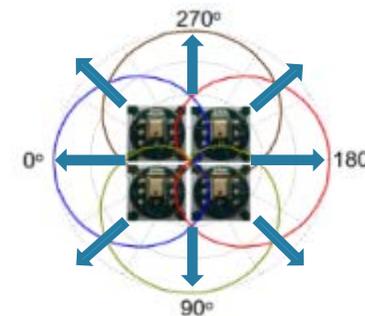
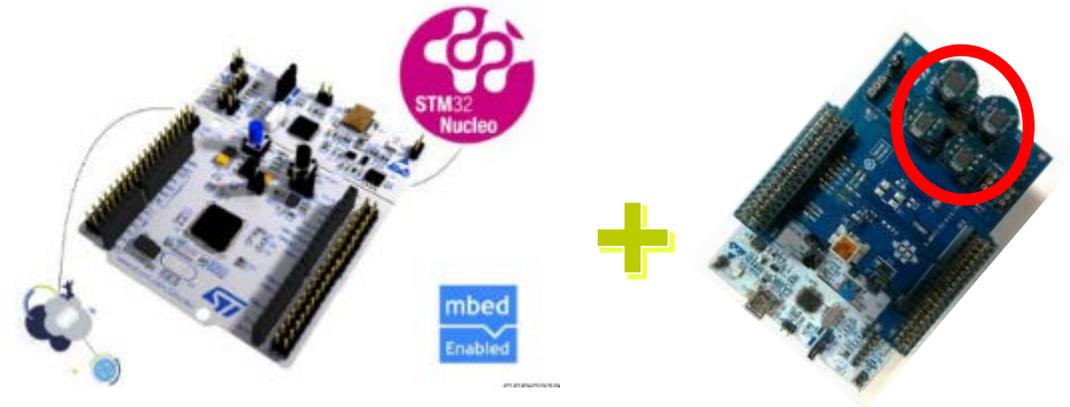
- Nucleo for HW

- Result:

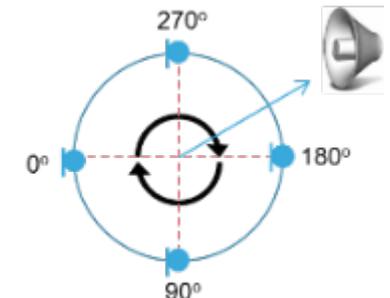


- How to get SW:

- Available on line: [Open.AUDIO](#)



OPEN.AUDIO



STEVAL-WESU1

Wearable Embedded System Unit

Sense



STEVAL-WESU1 is a reference design developed and optimized to help designers implement the latest technologies in wearable and portable applications

Key products on board

LSM6DS3: MEMS 3D accelerometer ($\pm 2/\pm 4/\pm 8/\pm 16$ g) + 3D gyroscope ($\pm 245/\pm 500/\pm 2000$ dps)

LIS3MDL: MEMS 3D magnetometer ($\pm 4/\pm 8/\pm 12/16$ gauss)

LPS25HB: MEMS pressure sensor, 260-1260 hPa absolute digital output barometer

BLUENRG-MS: BLE Network processor

BALF-NRG-01D3 : 50 Ohm / Conjugate match to BlueNRG Balun

STC3115 : Fuel gauge IC

STNS01: Li-Ion linear battery charger

USBULC6-2M6 : Very low capacitance ESD protection

100 mAh Li-Ion battery included



Order code: **STEVAL-WESU1**

Latest info available at
[STEVAL-WESU1](#)

STEVAL-STLKT01V1

SensorTile + Eval kit

Sense

STEVAL-STLCS02V1



13.5 x 13.5 mm



Miniaturized Tile that can be **soldered** or **plugged** on a host board

Key products on board

LSM6DSM: MEMS 3D accelerometer ($\pm 2/\pm 4/\pm 8/\pm 16$ g) + 3D gyroscope ($\pm 245/\pm 500/\pm 2000$ dps) with OIS

LSM303AGR: MEMS 3D magnetometer (± 50 gauss) + 3D accelerometer ($\pm 2/\pm 4/\pm 8$ g / ± 16 g)

LPS22HB: MEMS pressure sensor, 260-1260 hPa absolute digital output barometer

BLUENRG-MS: BLE Network processor

BALF-NRG-01D3 : 50 Ohm / Conjugate match to BlueNRG Balun

MP34DT04 : Digital MEMS microphone

STM32L4 : Microcontroller

100 mAh Li-Ion battery included

OSX
OpenSoftwareX

open.AUDIO

open.MEMS

open.RF



Order code: STEVAL-STLKT01V1
Module only: STEVAL-STLCS02V1 (available NOW)

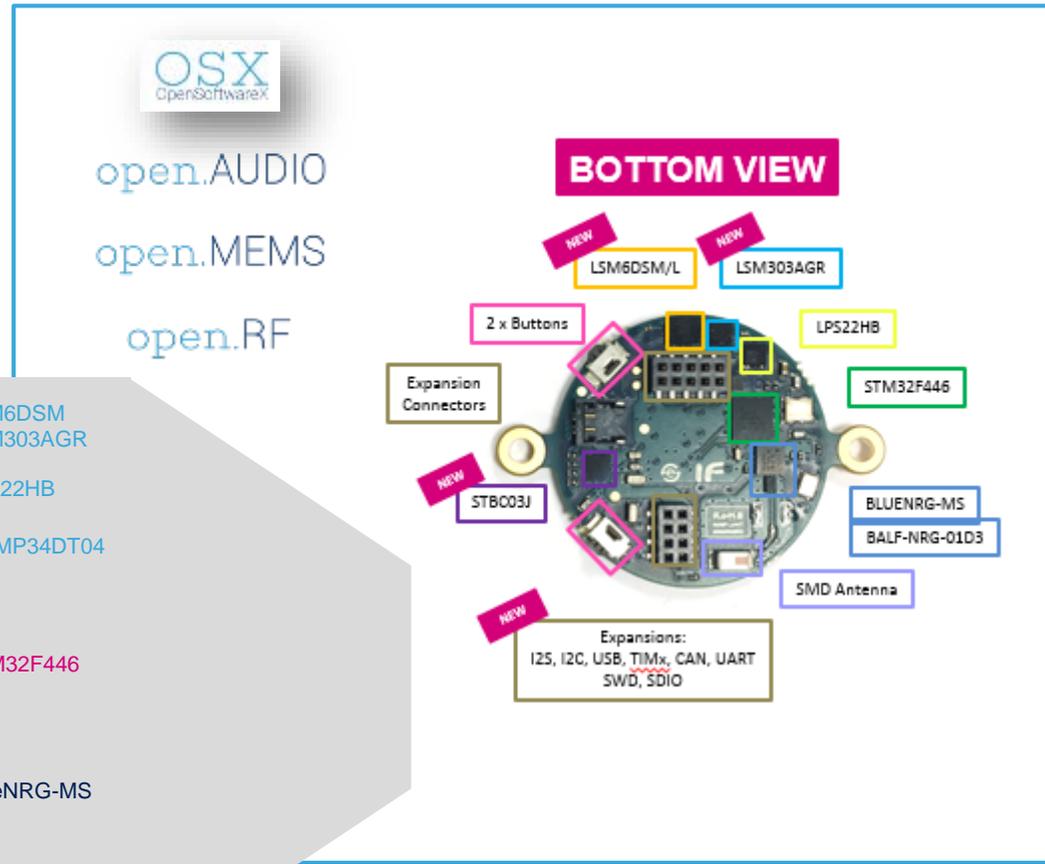
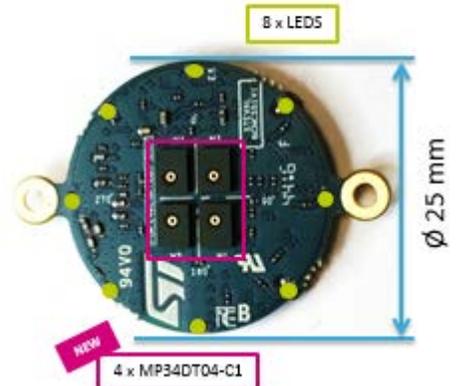
Latest info available at
STEVAL-STLKT01V1

STEVAL-BCNCS01V1*

BlueCoin



TOP VIEW



BOTTOM VIEW

Sensors

Low-Power MCU

Ultra Low Power Connectivity

Power/Battery Management

- Motion MEMS
- Environmental sensors
- MEMS microphone array
- High Performance brain
- Sensor fusion
- Bluetooth Smart
- Li-ion Battery Charger
- LSM6DSM
LSM303AGR
- LPS22HB
- 4 x MP34DT04
- STM32F446
- BlueNRG-MS
- STBC03J

Available soon:
STEVAL-BCNCS01V1

Order code: STEVAL-BCNCS01V1

*Available for Mass Market in 17Q2



Key Messages & Conclusion



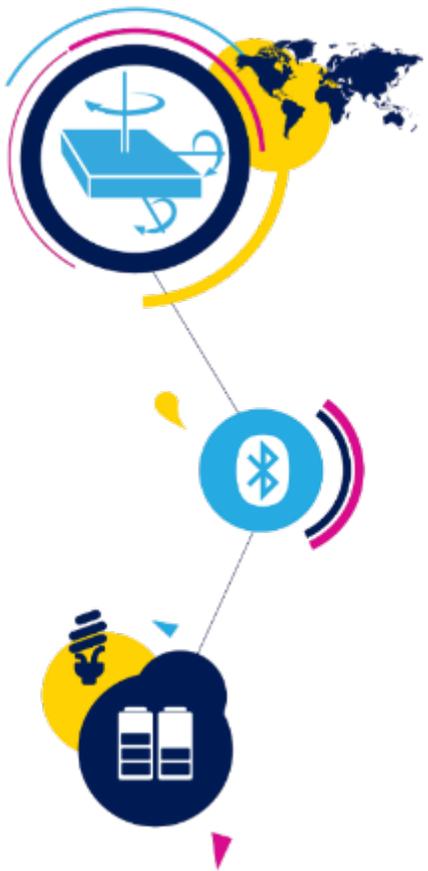
TOP SELLING MEMS Products

Sense

- 3-axis Digital AXL: [LIS2DE12](#) / [LIS2DH12](#) / [LIS2DW12](#)
- 3-axis Digital High-g AXL (up to 400g): [H3LIS100DL](#) / [H3LIS200DL](#) / [H3LIS331DL](#)
- 3-axis Magnetometer and 6-Axis e-Compass: [LSM303AGR](#) / [LIS2MDL*](#)
- 6-axis iNEMO IMU: [LSM6DSL](#)
- Industrial Sensors (10Years longevity committed): [IIS328DQ](#) / [I3G4250D](#) / [IIS2DH](#)
- Automotive Sensors: [AIS328DQ](#) / [AIS3624DQ](#) / [A3G4250D](#)
- Environmental Sensors: [LPS22HB](#) / [LPS33HW*](#) / [HTS221](#)
- Microphones: [MP23AB01DH](#) / [MP34DT01-M](#) / [MP34DB02](#)



WW Manufacturing Leader: EMEA knowhow



ASIC Front-end

FRANCE
(Crolles & Rousset)

Dedicated 8" MEMS FAB

ITALY
(Agrate & Catania)

Dual Sourcing
Capability

Global
Manufacturing

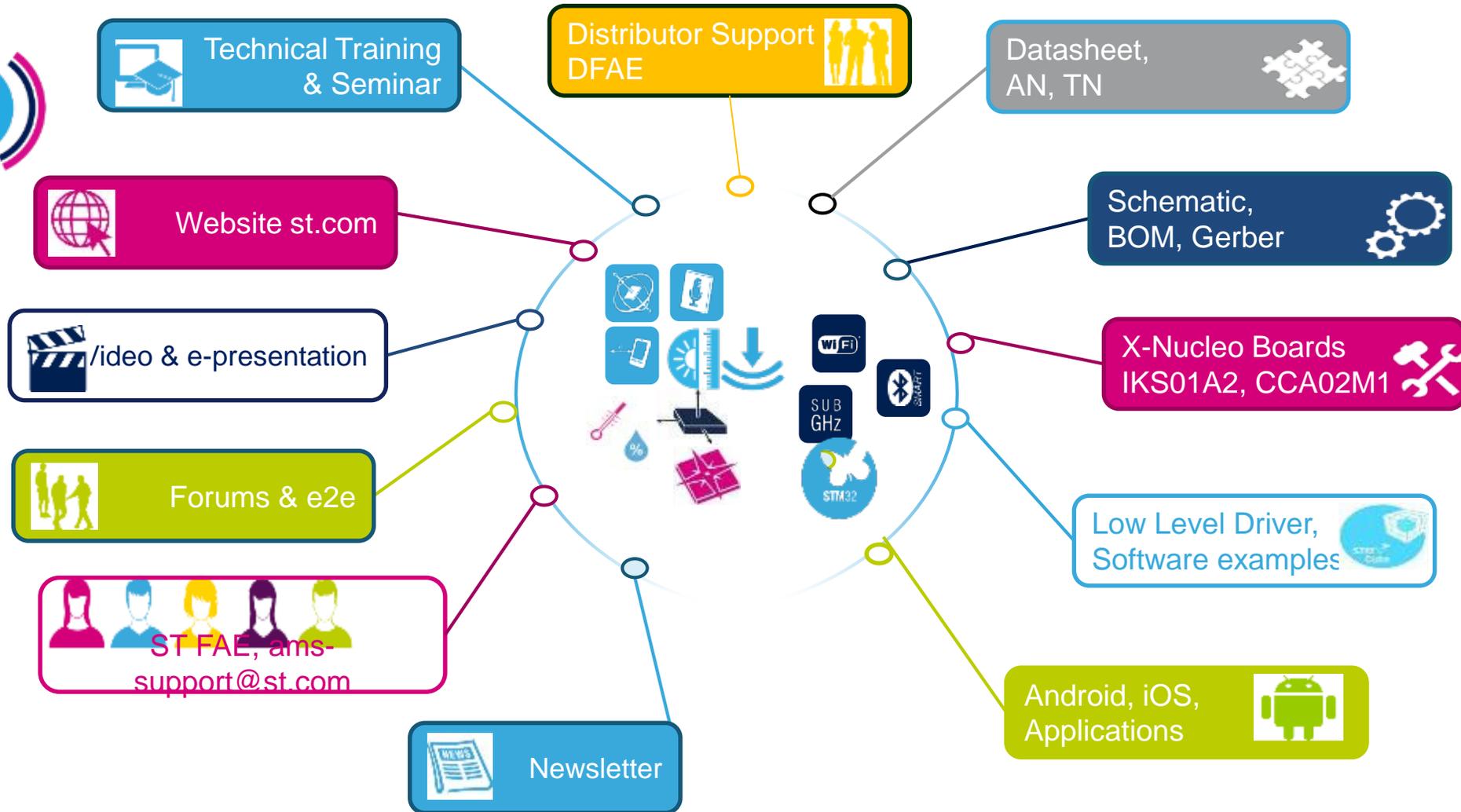


Dedicated Assy & Testing Line

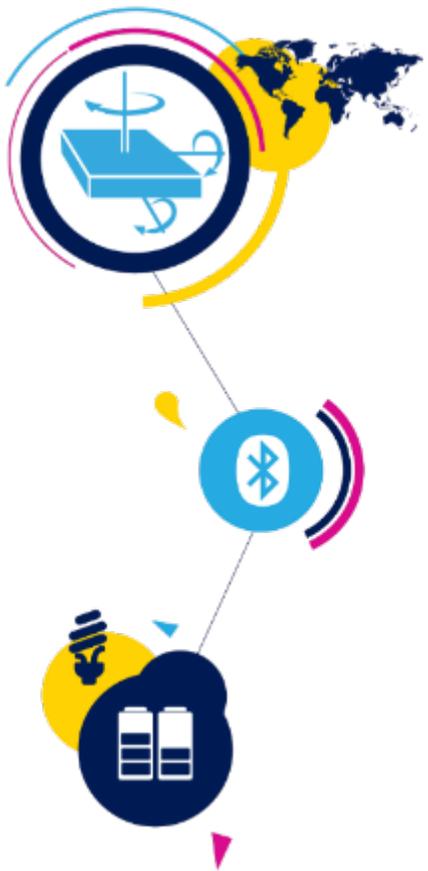
MALTA & CALAMBA

ST Sensors Support for you

Easy-to-use, Customer-oriented



Takeaway: Why Choose ST ?



Our Strengths

ST'S
MARKET-PROVEN
MANUFACTURING
TECHNOLOGY

HIGH-VOLUME
MANUFACTURING
CAPABILITY

EXPERTISE
IN MULTI-AXIS
SENSOR
INTEGRATION

PARTNERSHIP
WITH OEMS
IN PRODUCT
DEVELOPMENT

Paving the Future with Unique Assets and Focused Market Leadership



Menu

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Home > MEMS and Sensors

MEMS and Sensors

ST's sensor portfolio includes MEMS, sensor hubs, environmental and temperature sensors, microphones, touch and proximity sensors.

- A unique sensor portfolio
- High-volume manufacturing capacity
- High performance sensor fusion
- MEMS foundry, assembly and testing lines, with in-house complete dual source

Accelerometers



Automotive sensors



Gyroscopes



e-Compasses



Humidity sensors



iNEMO inertial modules



MEMS microphones



Pressure sensors



Temperature sensors



Touch sensors



UV index sensors



Proximity sensors

