ST Sensors

October 2019

Product Marketing Team EMEA

life.augmented

Agenda

life.augmented

Enhancing innovation with ST Sensors

CONSUMER

Key point:
Embedded Features
Wide offer, regular introduction of new products,
Competitive prices

INDUSTRIAL

Key point:
High Accuracy
Dedicated products
10Years Longevity

AUTOMOTIVE

Key point:
AEC-Q100 certification
High performance products
>10Years Longevity

SensorTile.BOX

Ready to use Sensor Node for beginner up to Professional,
LSM6DSOX

Reduced system power consumption & edge computing with MLC* X version

Growing dedicated **offer for Industrial** applications

minimum longevity 10 years

STWIN

Latest Industrial Sensors
IIS3DWB, ISM330DHCX,..

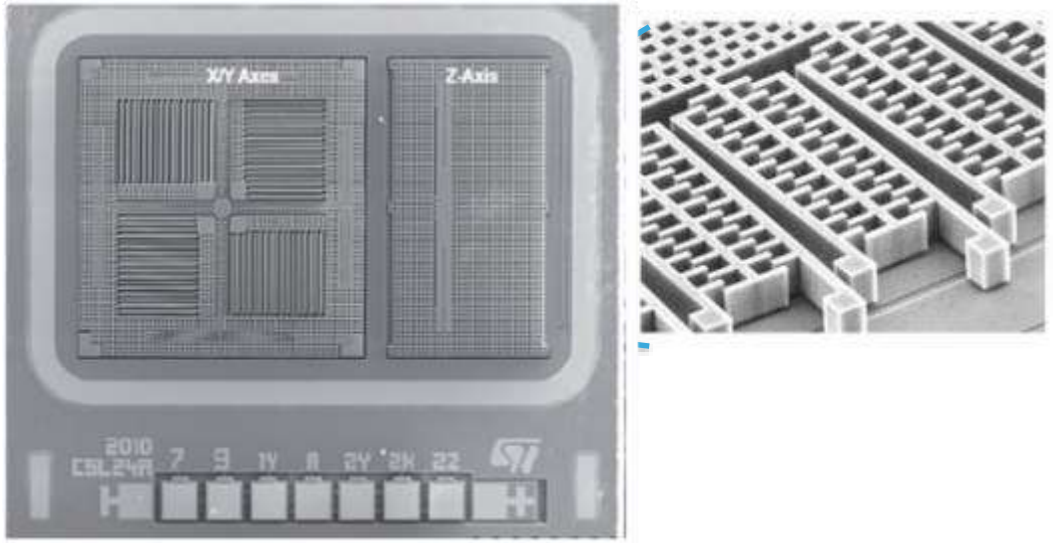
*MLC: Machine learning core

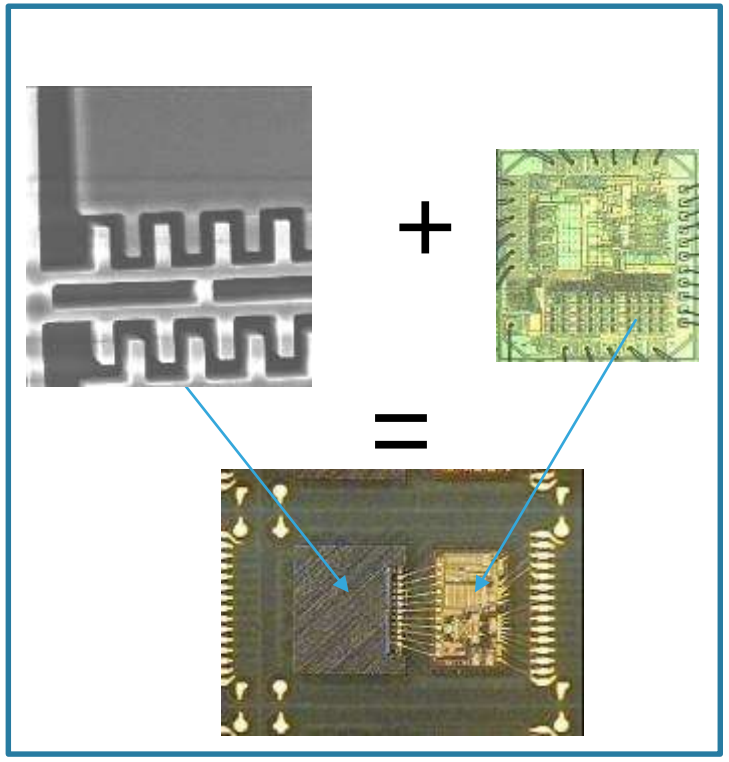
life.augmented

What is a MEMS?

- MEMS means Micro Electro Mechanical System MEMS contain movable 3-D structures
- The Structure moves accordingly to external displacement

- In MEMS not only electrons are moving!





Scanning Electron Microscope pictures of a capacitive micro-machined structure manufactured with THELMA process

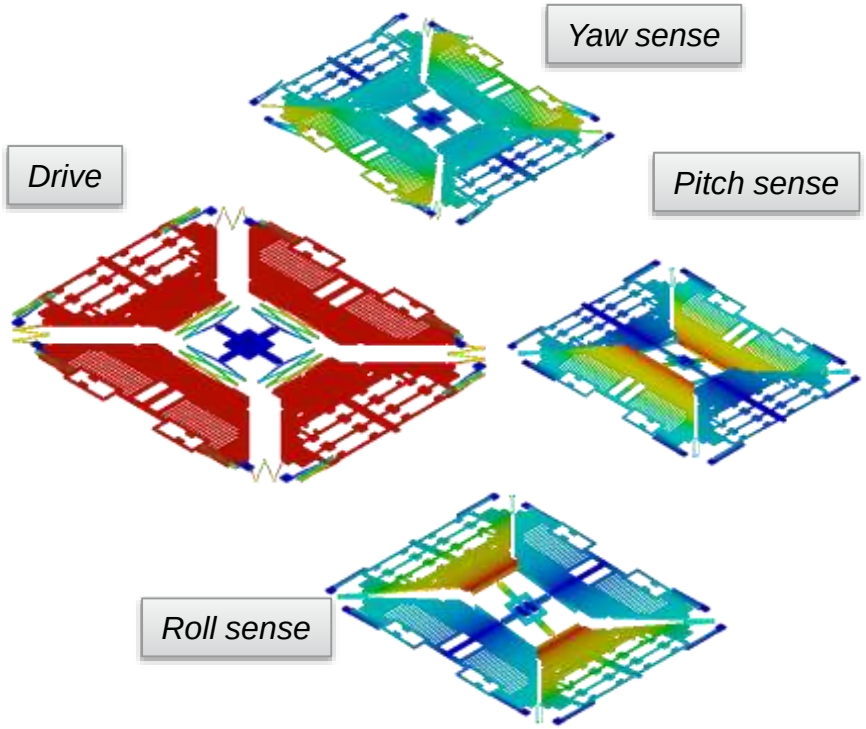
How a gyroscope is working

- *To take advantage of the Coriolis' principle, a movable mass must be kept under continuous movement by means of electrostatic actuation on capacitive driving plates (**drive** circuitry).*
- *As soon as external angular rate is applied, the capacitive sensing interface reads the corresponding displacement of the movable mass.*

- **Yaw** is rotation about the vertical axis (z-Axis)

- **Roll** is rotation around the longitudinal axis, (x-Axis)

- **Pitch** is rotation around the lateral or transverse axis, (y-Axis)



life.augmented

Some ‘g’ references

Passenger car acceleration	0.2 / 0.3g
Earth’s gravity	1g (by definition)
Emergency braking (Formula 1)	1g
Running	<5g (shock at low back level)
Bobsleigh rider in corner	5g
Human unconsciousness	7g
Walking down/up stairs	7.4/8g (shock at ankle level)
Running	8/12g (shock at ankle level)
Car Frontal choc @15Km/h	10/15g
Car Frontal choc high speed	35g (shock at head level, with Airbag)
Car Frontal choc high speed	40g (for the vehicle)
Car Frontal choc high speed	65g (shock at head level, without Airbag)
Tennis ball	500/700g

life.augmented

SENSORS & MOTION MEMS

ST offer

	Products	Applications
CONSUMER	Features Wide offer, intro of new products Competitive price	AXL, 6-axis IMU, Mag, E-compass, Microphone, Pressure, Humidity, Temperature
INDUSTRIAL	High Accuracy Dedicated products 10 Years Longevity	AXL, 6-axis IMU, Mag, E-compass, Microphone, Dedicated AXL
AUTOMOTIVE	AEC-Q100 >10 Years Longevity	AXL, Gyro, 6-axis IMU

IOT
Wearable
Alarm
Smart Home
Remote Control
Voice Assistant

Indus Robot
Positioning
Tracking
Tilt
Vibration

Alarm
E-call
Telematic
Vehicle tracking

SENSORS & MOTION MEMS

	Portfolio	New Products Introduction			
			NEW Products qualified		
CONSUMER IOT Wearable Alarm Smart Home Remote Control Voice Assistant	 AXL  6-axis IMU  Mag, E-compass  Microphone  Pressure, Humidity, Temperature	LPS33W LSM6DSR LSM6DSRX LSM6DSOX	LPS27HHW NEW	LSM6DSO32 NEW MP23DB01HP / KS MP23DB02MM STTS22H NEW	LIS2DU12 NEW HTS2
INDUSTRIAL Indus Robot Positioning Tracking Tilt Vibration	 AXL  6-axis IMU  Mag, E-compass  Microphone  Dedicated AXL	ISM330DHCX		IIS2ICLX IIS3DWB LPS22HH eq.	
AUTOMOTIVE Alarm E-call Telematic Vehicle tracking	 AXL  Gyro  6-axis IMU	ASM330LHH AIS2DW12		ASM330LHHX AIS2IH	
		MP in 19H1	MP in 19Q3	MP in 19Q4	MP in 2020

NEW Product recently introduced

NEW Product recently qualified

life.augmented

SENSORS & MOTION MEMS

References*

CONSUMER

INDUS TRIAL

AUTO MOTIVE

Sensor Type

LIS: Linear Inertial Sensor
LSM: Linear Sensor Module
LPS: Linear Pressure Sensor
HTS: Humidity Temperature Sensor
MP: Microphone

IIS: Industrial Inertial Sensor
ISM: Industrial Sensor Module

AIS: Automotive Inertial Sensor
ASM: Automotive Sensor Module

Output
A: Analog
D: Digital

Packing
(N/A): Tray
TR: Tape & Reel (default delivery)

ISM 330 D H C X TR

Number of Axis or Package size
2: **2**x2 mm package
3: **3**-Axis Accel or Gyro
6: 3-Axis Accel + 3-Axis Gyro

For microphone, pressure sensor:
23: **2**x**3** mm package size

330: **3**-Axis Accel + **3**-Axis Gyro + **0** Magneto
303: **3**-Axis Accel + **0** Gyro + **3**-Axis Magneto

Main characteristics:
H: **H**igh Performance
WB: **W**ide **B**and
ICL: I**CL**inometer
X: Machine Learning Core (MLC)

For Pressure sensor:
W: Waterproof
HB: High precision, **B**astille (water resistant)
For mic:
BS1: Bottom Port High Sensitivity, Version1
B01HP: Bottom Port, V1, **H**igh **P**erformance
T05: Top Port, Version5

** This is a "general rule" – exception always exist*

life.augmented

Today's ST Motion Sensor Offer

Consumer, Industrial, Automotive

MOTION SENSORS	FEATURES	APPLICATIONS	PRODUCTS
Accelerometer Movement, Shock, Vibration, Wakeup, Tilt/Inclination Free fall	Movement detection		❖ Consumer, Movement detection • LIS2DE12, LIS2DH12, LIS2DW12, LIS2DTW12 ❖ Industrial, Tilt, Vibration • IIS2DH, IIS2DLPC, IIS2ICLX*, IIS3DWB* ❖ Automotive, Alarm, shock • AISS328DQ, AISS3624DQ, AIS2DW12*
6-axis IMU Combo gyroscopes and accelerometer sensors	Rotation for high accuracy movement monitoring		❖ Consumer, Movement recognition • LSM6DSO, LSM6DSOX, LSM6DSR ❖ Industrial, Robot • ISM330DLC, ISM330DHCX ❖ Automotive, Telematics • ASM330LHH
Compass Standalone magnetometer for magnetic field measurement, combo with accelerometer	Magnetic field + acceleration		❖ Alarm, E-compass • LIS2MDL, LSM303AGR , LSM303AH ❖ Industrial, Anti-tamper • IIS2MDC, ISM303DAC

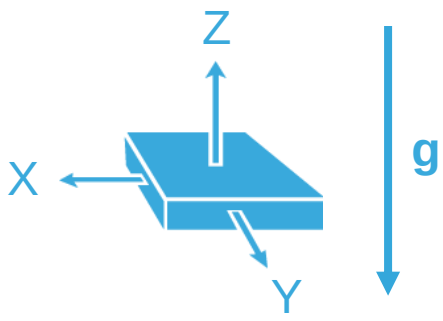
life.augmented

BUT THERE'S MORE THAT CAN BE DONE WITH ST SENSORS…

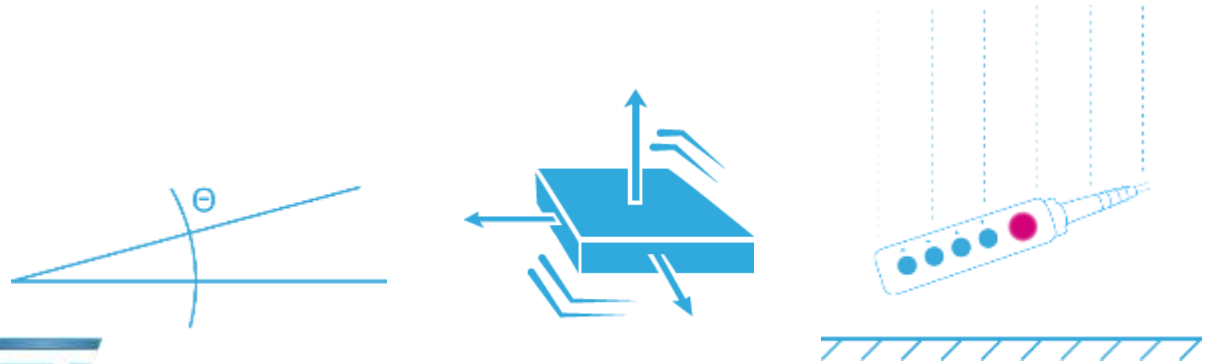
* Available soon

What are the key roles of an **Accelerometer** in applications?

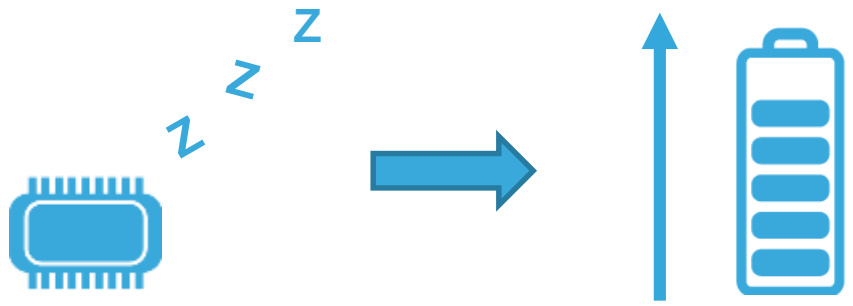
- Acceleration on the 3-axis measurement - mg



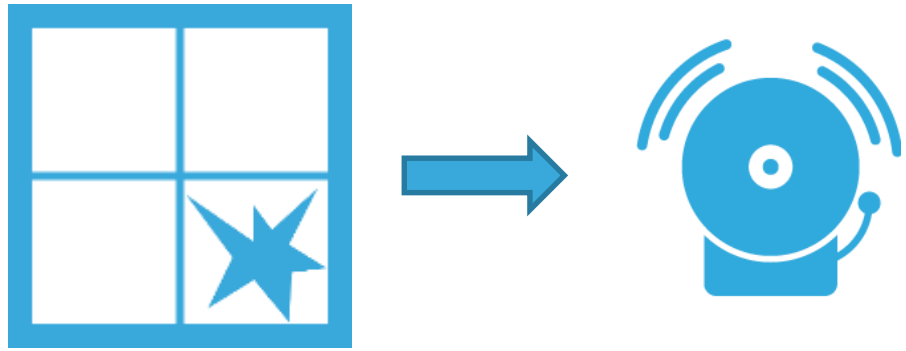
- Measure tilt, vibration, shock and fast acceleration variation (free-fall) in industrial applications for predictive maintenance



- Save power (cost) by using accelerometer for wakeup and standby mode



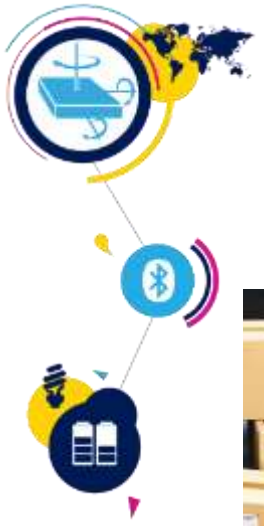
- For alarms, generate interruption to detect unexpected situation



life.augmented

Accelerometer Applications

Consumer, Industrial, Automotive



Asset Tracking
Shock / WakeUp

Alarms
Tilt / WakeUp

Sport
Activity tracking / Pedometer

People monitoring
Freefall / Activity

Predictive maintenance
& Monitoring
Vibration / Tilt

White Goods
Vibration / Tilt

Industrial /Automotive Inclinometer
Positioning / Tilt

Car Alarms / PKE*
Tilt / Movement

And many others….

*Passive Key Entry

What are the key roles of a **IMU** in applications?

- Rotation speed (dps) & angle measurements (degree)

- Determine with accuracy movement for context awareness and Virtual Reality applications

- Control inclination and rotation, monitor condition of equipment (predictive maintenance)

- Stabilize device (drone, camera) and determine its position evolution (robot or vehicle - dead reckoning); **E**lectronic **I**mage **S**tabilization

life.augmented

6-axis **IMU** Applications

Consumer, Industrial, Automotive

IOT / Wearable
Movement tracking & Shock

High precision sport tracker
Activity tracking

Robot / Drone
Positioning / Stabilization

Predictive maintenance
& Monitoring
Vibration / Tilt

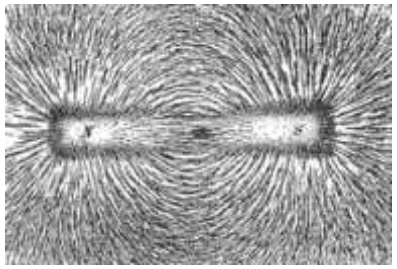
Industrial Robot
Vibration / Tilt / Stabilization

GNSS, Telematics
Rotation / Movement

And many others…

What are the key roles of a **Magnetometer / e-Compass** in applications?

- Magnetic field (vector) measurement – gauss (Tesla)



- Detection of absolute orientation (heading) of an object (e-Compass application) using the Earth magnetic field

E-compass in watch, asset tracking (container, pallet orientation), …

- Detect excessive magnetic field source or Earth magnetic field change

Water meter (magnet attack detection), …

Smart parking (car presence disturbs Earth magnetic field), …

- Relative change of object position, pointing in the right direction

Alarm application (door close / open), …

Antenna orientation, …

life.augmented

Magnetometer / e-Compass Applications

Consumer, Industrial

IOT / Industrial

Movement tracking

Wearable

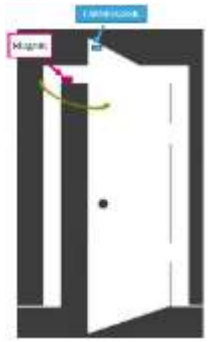
Compass

Robot / Drone

Compass / Navigation

Antena / Object

Orientation



Alarm

Rotation / magnet detection

Smart meter

Anti-tamper

And many others…

Today's ST Environmental Offer

Consumer, Industrial

ENVIRONMENTAL SENSOR	FEATURES	APPLICATIONS	PRODUCTS
Temperature sensor Analog and Digital contact temperature sensors	Local Temperature Monitoring		❖ Temperature Compensation • STML20, STTS751 ❖ Asset Tracking • STTS22H* ❖ Predictive maintenance • STTS22H ❖ H+T Monitoring @ Home • HTS221
Humidity sensor Combo humidity and temperature sensor	Env. Humidity Monitoring		❖ Weather forecast • LPS22HB ❖ Watch, Altitude control • LPS22HH, LPS33HW, LPS27HHW ❖ E-cigarette • LPS33W ❖ Leakage detection • LPS22HH, LPS33HW
Pressure sensor Water resistant / Water proof	Atmospheric Pressure Monitoring		❖ Mass Market • MP34DT05-A, MP34DT06J ❖ Battery powered • MP23DB01HP*, MP23DB02MM* ❖ Industrial, Ultrasound • IMP34DT05, MP23ABS1
MEMS microphone Analog, Digital, top and bottom port solutions	Acoustic Monitoring		

* Available soon

BUT THERE'S MORE THAT CAN BE DONE WITH ST SENSORS…

life.augmented

What are the key roles of a precision **temperature sensor** in applications?

- Ambient Temperature measurement - °C

- Use temperature sensor for temperature impact compensation on application components

e.g. CO gas sensor reading T-compensation

- Save calibration cost during ctm application boards production by using precision absolute temperature sensor

$↓

No need to calibrate T-sensor at different temperatures

- Predictive maintenance (monitoring and avoid system overheating)

$>T_{max}$!

life.augmented

Temperature Sensor Applications

Asset Tracking

Smart Home
& Thermostat

HVAC

Temperature compensation
& protection

Predictive maintenance
& Monitoring

White Goods

Solar Panel &
Power Supply

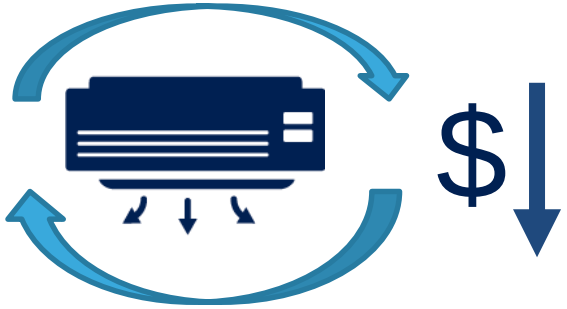
Respiratory Equip.

And many others…

What are the key roles of a **Humidity sensor** in applications?

- Ambient Humidity measurement / control – RH% (temperature always measured)

- Save operating cost by optimizing processes with temperature and humidity sensors.



e.g. optimization of A/C cooling cycles

- People health

e.g. optimize H+T condition at home

- Food safety

e.g. Moisture control

life.augmented

Humidity Sensor Applications

Weather Station

Smart Home
(air quality monitoring)

Heat Index Alert

Smart Agriculture

Respiratory Equipment/
Humidifiers

Incubators

Home Appliances
Dryer, Fridge (Crisper)

Storage/
Goods Tracking

And many others…

What are the key roles of a **Pressure sensor** in applications?

- Ambient Pressure measurement – mbar/hPa (atmospheric pressure sensor – 260-1260mbar)

For weather forecasting

- For application where water-resistant or water-proof is request

e.g. sport watches

- Altimeter for navigation and tracking

Average Sea level pressure = 1013.25 mbar (varies with weather)
Pressure decrease when altitude increases

- Monitoring under / over pressure

e.g. bag / water container content

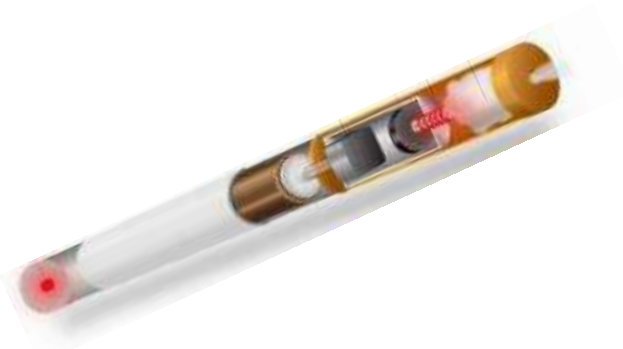
life.augmented

Pressure Sensor Applications
with water proof capability

Vaccum cleaner
Floor type, dust bag content level

Asset tracking
Takeoff/ landing pressure

Gas meter
Leakage detection



E-cigarette
Detect inhalation

Altimeter control
Pressure measurement

Weather station /
Air quality monitoring

Performance
Measurement
Measure pressure variation

Indoor & outdoor
Navigation
Floor level detection

And many others…

life.augmented

What are the key roles of a **Microphone** in applications?

- **Voice, sound and noise capture**

e.g. presence detection

- **To assist people in critical situation**

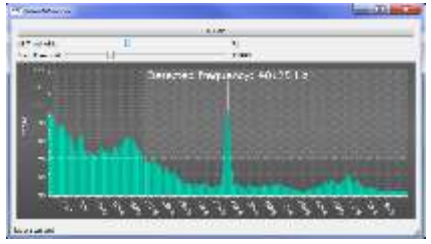
e.g. ecall, elderly people monitoring

- **Voice is convenient for HMI: Simple & Easy**

BoM

e.g. voice activation

- **Failure detection in ultrasonic BW**



e.g. predictive maintenance

life.augmented

Microphone Applications

Remote Control

Hand free kit
/ eCall

Voice assistant

Alarms / Intercom

Headset

Noise quality
environment

Noise measurement
& cancellation

Ultrasonic
measurement

And many others…

Consumer products and roadmap

life.augmented

SENSORS & MOTION MEMS

CONSUMER

Features

Wide offer, intro of new products

Competitive price


AXL


6-axis IMU


Mag, E-compass


Microphone


Pressure, Humidity, Temperature

Latest qualified products		New products for H2 2019	New products for 2020
LPS22HH	LPS33W	LPS27HHW	LSM6DSO32
LSM6DSO	LSM6DSR	LSM6DSRX	
	LSM6DSOX	STTS22H	LIS2DU12
LIS2DTW12		MP23DB01HP /KS	HTS2
MP34DT06J		MP23DB02MM	

- LIS2DTW12: in Mass Production
- NEW LIS2DU12: Mass Production targeted in 20Q1
- NEW **LSM6DSOX: in Mass Production**
- LSM6DSR, **LSM6DSRX**: **in Mass Production**
- NEW LSM6DSO32: Mass Production targeted in 19Q4
- **LPS33W :** in Mass Production
- NEW **LPS27HHW**: **in Mass Production**
- NEW STTS22H : **In Mass Production**
- HTS2 : Mass Production targeted in 20Q2
- MP23DB01HP, MP23DB02MM: Mass Production targeted in 19Q4 (October)

life.augmented

NEW Product recently introduced

NEW Product recently qualified

Sensors for Consumer

Sensor	Main Application	Pruduct Strength
High-performance and low power accelerometer **LIS2DW12 & LIS2DTW12** **LIS2DH12 & LIS2DE12** In Mass Prod	 Wearables, IoT, Tracker	**LIS2DW12 & LIS2DTW12** • Ultra low power • Multiple Noise / Power config for high flexibility • Embedded Temperature sensor **LIS2DH12 & LIS2DE12** • Optimize compromise for resolution, power consumption & cost
High-performance and low power 6-axisIMU **LSM6DSO & LSM6DSOX** **LSM6DSR & LSM6DSRX** In Mass Prod	 Wearables, IoT, Tracker	**LSM6DSOX & LSM6DSRX** • Ultra low power with increased Accuracy, • Improved Noise & temperature behavior • More embedded digital features (Fifo, Algo, FSM, **MLC**)

LIS2DE12, LIS2DH12, LIS2DW12, LIS2DTW12

CONSUMER Accelerometer

LIS2DE12

- **8 bit resolution** for Low Power and Cost effective.
- Power consumption:
  - **6µA** (@50Hz)
  - **2µA** (@1Hz)
- Embedded features (Interrupts, Filters, FIFO, Temperature sensor, Self-Test)

LIS2DH12

- **Up to 12 bit resolution** for Performance and Embedded Functionalities. **LPM** & **HRM** available
- Power consumption:
  - **6µA/11µA** in **LPM/HRM** (@50Hz)
  - **2µA** in **HRM** (@1Hz)
- Embedded features (Interrupts, Filters, FIFO, Temperature sensor, Self-Test)

LIS2DW12 & LIS2DTW12

- From **12 to 14 bit** resolution, Low Power and High Performance Modes, low noise enabled feature
- Ultra Low Power:
  - **0.38µA i**n Low Power Mode @1.6Hz
  - **3µA** in Low Power Mode @50Hz
  - **90** / **120µA** in HPM @1.6kHz
  - **50nA** in PD
- Single shot and ODR from **1.6 to 1.6kHz**
- FIFO, Temperature sensor, Self-Test, Interrupts
- **LIS2DTW12** embed **calibrated temperature sensor (±0.8° in 0-70°C)**

Common Features

3-axis accelerometer, Digital SPI/I2C, from ±2 to ±16 g Full Scale
Same pinout - 2x2 LGA-12 Leads, 0.5mm pitch

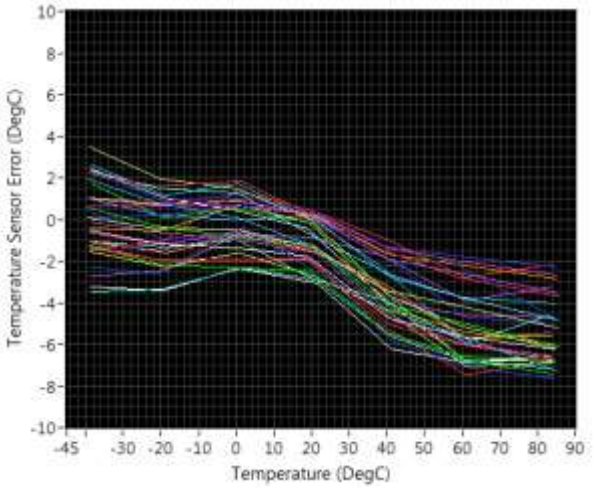
life.augmented

LIS2DW12 & LIS2DTW12

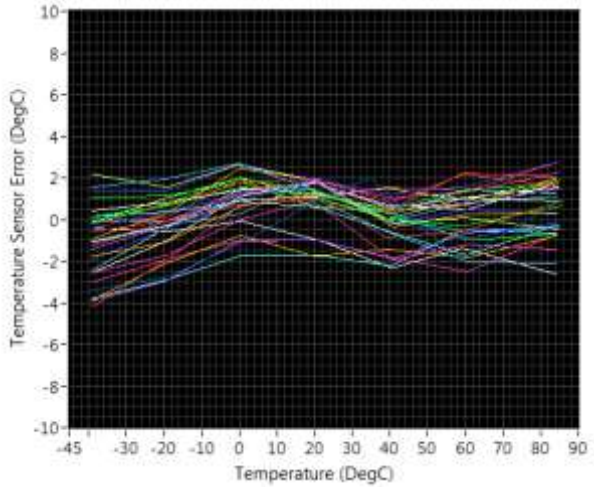
Temperature Sensor Performances With an Additional OPC

33

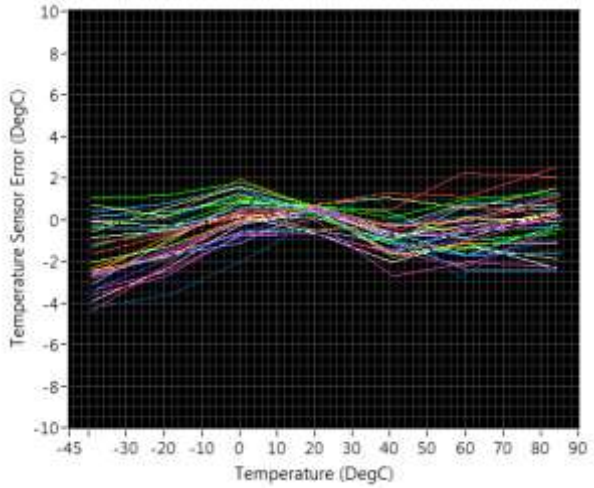
LIS2DW12



LIS2DTW12



LIS2DTW12 + OPC @ 25°C at customer level



- In case a customer is interested to a specific operating temperature or needs an higher accuracy, an additional OPC can performed along the customer production line in order to increase further the temperature sensor performances.
- The final accuracy will depend on the accuracy of the reference sensor and the calibration setup.

life.augmented

The new consumer accelerometer LIS2DU12*

Low power at high ODR

- 12b resolution accelerometer, FS from ±2g to ±16g
- 3 operating Modes:
  - One shot mode
- **Power consumption – 3 operation Modes**(1):
  - Normal mode (with **Anti-Alias Filter**): From **3.2µA @6.25Hz** to **5.8µA @800Hz** ODR
  - **Ultra Low Power** mode (no AAF): from **0.45µA @1.6Hz to 0.67µA @6.25Hz ODR**
  - **One shot mode: 0.2µA & 20nA in Sleep mode @1.8V**
- **Big FIFO** (up to **768** samples of Accel data @ 8 bit of data output)
  - 256 Accel 8 bit samples (x, y, z) or 128 Accel 12 bit (x, y, z) + Temperature samples
- SPI/I2C/I3C digital interfaces
- High stability enabling to reach :
  - Post solder offset: ±20mg (typ)
  - Post solder offset drift vs temperature: ±1mg/°C
- Embedded functions: Free-Fall, Wake Up/Inactivity, 6D/4D, Tap/Double Tap
- LGA 2x2x0.7 **standard package**, p2p with previous generation (LIS2DW12 / LIS2DH12 / LIS2DE12 / …)

(1) Test Condition: VDD=1.8V, FS=+/-8g, BW_{-3dB} = ODR/2, Temp = 25 ˚C

*Contact ST for more info, SOP in 20Q1

life.augmented

LIS2DE12, LIS2DH12, LIS2DU12*, LIS2DW12, LIS2DTW12

with rest of the family

	LIS2DW12/ LIS2DTW12	LIS2DU12*	LIS2DS12	LIS2HH12	LIS2DH12	LIS2DE12
Package (mm)	2x2x0.7 – LGA-12	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/±16	±2/±4/±8	±2/±4/±8/±16	±2/±4/±8/±16
Resolution	5 modes: Low power (12 bit), 4x High res (14 bit)	12 bit, NM (with AAF), ULP (no AAF)	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	0.976	0.244	0.061	1	15.6
Noise Density (±2g, 100Hz)	90µg/sqrt(Hz)	500µg/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	0.02 0.45 @1.6Hz 3.4 @100Hz 5.8 @800Hz	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
0*g* level offset accuracy (Typ)	±20 mg	±40 mg	±30 mg	±30 mg	±40 mg	±100 mg
0g level change vs. Temp	±0.2 m*g*/°C	±1 m*g*/°C	±0.2 mg/°C	±0.25 m*g*/°C	±0.5 m*g*/°C	±0.5 m*g*/°C
ODR	One shot, 1.6Hz-1.6KHz	One shot, 1.6Hz-800Hz	1 Hz – 6.4kHz	10Hz-800Hz (HR)	1Hz-5.376 kHz (LPM), 1Hz-1.344 kHz (NM, HR)	1Hz-5.376 kHz (Low power)
BW	Up to ODR/2	Up to ODR/2	Up to ODR/2	Up to ODR/2	ODR/2 (LPM & NM), ODR/9 (HR)	ODR/2 (Low power)
FIFO	32-level	768-level 128 if AXL & Temp	256 level (14b) 768 level (if XL module)	32-level	32-level (10bit)	32-level (10bit)
Self-test / Temp sensor	Yes / Yes (up to 16 digit/°C) -calibrated on LIS2DTW12	Yes / Yes (12b resolution)	Yes / Yes	Yes / 11bit resolution (8 digit/°C)	Yes / Yes	Yes / Yes
Power supply	1.62 to 3.6 V	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

*Contact ST for more info,

LSM6DSO & LSM6DSR - LSM6DSO**X** & LSM6DSR**X**

6-axis IMU

LSM6DSO
Low Power

- **A**: from ±2 to ±16 g FS, **G**: from ±125 to ±2000dps FS
- Accuracy: **G**: **3.8**mdps/√Hz, **A**: **70**µ*g*/√Hz noise level
- **0.55mA** in HP Mode, **0.35mA** in Normal Mode
- **A**: **4.4µA** @1.6Hz
- **3µA** in Power Down Mode

LSM6DSR
Performance & Stability

- **A:** from ±2 to ±16 g FS, **G**: from ±125 up to **4000dps** FS
- Accuracy improved Bias Instability **5 °/hr**
- High Temperature stability: **±5** mdps/K

FEATURES common to LSM6DSO(X) & LSM6DSR(X)

- **16x Finite State Machine**
  - Recognize custom motion patterns from **A** + **G** + **external sensor** to generate interrupts
- Sensor HUB
- Smart FIFO **up to 9KB** (using compressed mode)
- Pedometer, Step Detector, Step Counter
- Standard Package 2.5x3mm – 14L

MLC for LSM6DSOX & LSM6DSRX

- **8x Machine Learning Core**
- From **1 to 15µA** per MLC
- 10 to 1000 time energy saving by running algo on MLC (vs. AP)*
- No need for algo development
- Based on inductive method, constructed from **measured data**

P2P with LSM6DSL, LSM6DS3, SW compatible

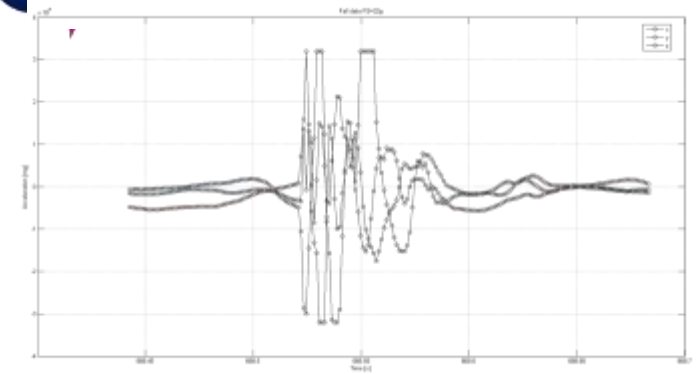
life.augmented

LSM6DSO32

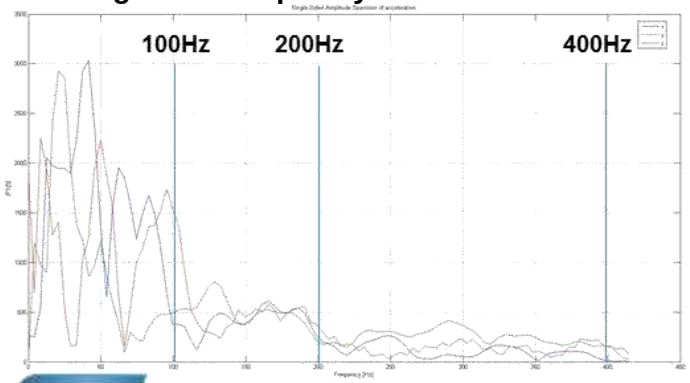
32g Fall & Shock Detector

Analysis shape in time & frequency content

Fall signal vs. time. FS: 32g



Fall signal vs. frequency



32g Accelerometer for Fall/shock Detection

- Accelerometer Full scale: ±4/±8/±16±32 g
- Gyroscope Full scale: ±125/±250/±500/±1000/±2000 dps
- Minimal current consumption (0.55mA in HPM)
- Accelerometer @4.4µA in LPM, ODR@1.6HZ
- 2x programmable Interrupts for motion detection, Data ready, Fifo
- **Pin-2-Pin and SW compatible with LSM6DSO family**
- Digital functions (FIFO, FSM, filtering capabilities) compliant with LSM6DSO

LSM6DSO32

2.5 x 3 x 0.86 mm

life.augmented

*Contact ST for more info, SOP in 19Q4

LSM6DSL, LSM6DSO, LSM6DSO32, LSM6DSR

	LSM6DSL	LSM6DSO	LSM6DSO32	LSM6DSR
Full Scale A (g) / G (dps)	±2, ±4, ±8, ±16 ±125, ±245, ±500, ±1000, ±2000	±2, ±4, ±8, ±16 ±125, ±250, ±500, ±1000, ±2000	±4, ±8, ±16, ±32 ±125, ±250, ±500, ±1000, ±2000	±2, ±4, ±8, ±16 ±125, ±245, ±500, ±1000, ±2000, ±4000
Resolution / Sensitivity A / G	16bit / 16 bit	16bit / 16 bit	16bit / 16 bit	16bit / 16 bit
Noise density - A / G	80 µg/vHz / 4mdps/vHz	70µg/vHz / 3.8mdps/vHz	120µg/vHz / 3.8mdps/vHz	60 µg/vHz / 5mdps/vHz
Noise in NM/LPM – A / G (rms)	1.8mg / 75mdps	1.8mg / 75mdps	3.2mg / 75mdps	1.8mg / 90mdps
Offset - A / G	±40 mg / ±3 dps	±20 mg / ±1 dps	±20 mg / ±0.5dps	±10 mg / ±1 dps
Sensitivity vs Temp A / G	±0.01%/K / ±0.007%/K	±0.01%/K / ±0.007%/K	±0.007%/K / ±0.005%/K	±0.01%/K / ±0.007%/K
Offset vs Temp - A / G	±0.1 mg/K / ±0.015 dps/K	±0.1 mg/K / ±0.01 dps/K	±0.1 mg/K / ±0.01 dps/K	±0.1 mg/K / ±0.005 dps/K
G turn on time	35ms (typ)	35ms (typ)	35ms (typ)	35ms (typ)
Power consumption (µA)	650 (A, G full speed) 160 (A full speed) 4.5 (A @ODR 1.6Hz) ; 3 (PD)	550 (A, G full speed), 350 (normal mode) 170 (A full speed) 4.4 (A @ODR 1.6Hz); 3 (PD)	550 (A, G full speed), 350 (normal mode) 170 (A full speed) 4.4 (A @ODR 1.6Hz) ; 3 (PD)	1200 (A, G full speed) 360 (A full speed) 5.5 (A @ODR 1.6Hz); 3 (PD)
ODR - A / G	1.6 to 6664Hz 12.5 to 6664Hz	1.6 to 6664Hz 12.5 to 6664Hz	1.6 to 6664Hz 12.5 to 6664Hz	1.6 to 6664Hz 12.5 to 6664Hz
Vdd & VddIO ranges	1.71 – 3.6V & 1.62 – 3.6V	1.71 – 3.6V & 1.62 – 3.6V	1.71 – 3.6V & 1.62 – 3.6V	1.71 – 3.6V & 1.62 – 3.6V
Interfaces	I2C (<400kHz) / SPI (10MHz)	I2C (<400kHz) / SPI (10MHz) / I3C	I2C (<400kHz) / SPI (10MHz) / I3C	I2C (<400kHz) / SPI (10MHz) / I3C
FIFO	4KBytes, timestamp and pedometer, A, G, ext sensor, temp.	Up to 9KBytes, timestamp and pedometer, A, G, ext sensor, temp.	Up to 9KBytes, timestamp and pedometer, A, G, ext sensor, temp.	Up to 9KBytes, timestamp and pedometer, A, G, ext sensor, temp.
Temperature sensor	256 lsb/K	256 lsb/K	256 lsb/K	256 lsb/K
Package Size	2.5x3x.83 – LGA-14L	2.5x3x.83 – LGA-14L	2.5x3x.83 – LGA-14L	2.5x3x.83 – LGA-14L
Max external sensors (Hub)	4 external sensors, data synchro with res 25µs	4 external sensors, data synchro	4 external sensors, data synchro	4 external sensors, data synchro
MLC option	N.A.	Yes, LSM6DSOX	No	Yes, LSM6DSRX
Embedded features (* Android based)	SMD, pedometer, tap/double tap, 6D/4D, WakeUp, FF, activity/no activity, tilt* detections	OIS, SMD, pedometer 2.0, step counter, step detection, FF, WU, 6D, click /double click, Activity / Inactivity, 16x **FSM for A+G+Ext sensors**	OIS, SMD, pedometer 2.0, step counter, step detection, FF, WU, 6D, click /double click, Activity / Inactivity, 16x **FSM for A+G+Ext sensors**	OIS, SMD, pedometer 2.0, step counter, step detection, FF, WU, 6D, click /double click, Activity / Inactivity, Activity recognition, 16x **FSM for A+G+Ext sensors**

SMD: Significant Motion Detection
FSM: Finite State Machine
OIS: Optical Image Stabilization

FF: Free Fall
WU: Wake Up

life.augmented

MLC: From Low Power Sensor to Low Power System

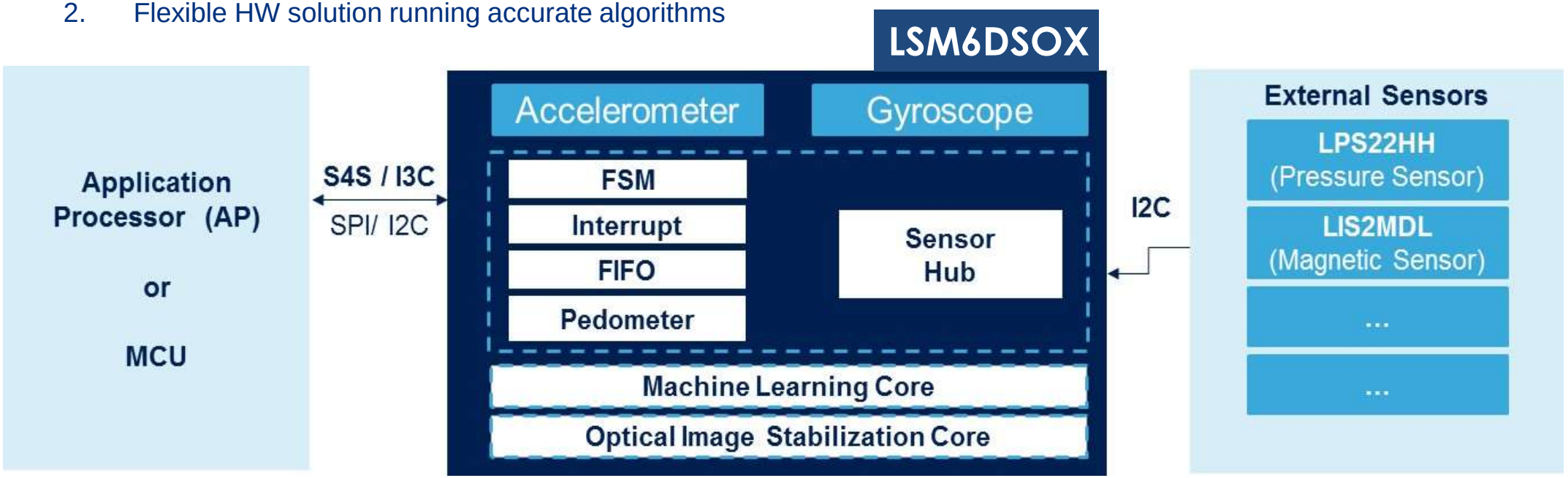
ST introduced a new feature called MLC (**M**achine **L**earning **C**ore) in LSM6DSO**X**

Best in class IMU **Power Consumption** (0.55 mA combo mode HP)

10 to 1000 time energy saving by running Machine Learning on Sensor HW (vs. AP)

Simplified And Lean System Concept based on 2 mainstreams:

1. Configurable power mode and high speed communication
2. Flexible HW solution running accurate algorithms



Note: FSM→ Finite State Machine

Sensors for Consumer

Sensor	Main Application	Pruduct Strength
Altimeter / Pressure sensor **LPS22HH** In Mass Prod Water Proof Pressure sensor **LPS33W / LPS27HHW** In Mass Prod	   Wearables, Drone, Vaccuum Cleaner Weather station, e-cigarettes	**LPS22HH** • Low power @ high resolution & accuracy • Size and superior robustness. Unique package technology (full molded) **LPS33W** • IPx8-Water resistant **LPS27HHW** • 10Bar Water resistant
Microphone **MP34DT05-A, MP34DT06J & MP23ABS1** In Mass Prod **MP23DB01HP & MP23DB02MM** MP: Q4 2019 Temperature sensor (Analog & Digital) **STML20 / STTS751** In Mass Prod **STTS22H** In Mass Prod	     Asset tracking, IoT, Remore Control, Hand free kit/eCall, Voice Assistant	**MP34DT05-A, MP34DT06J & MP23ABS1** • High performance (SNR, AoP) **MP23DB01HP & MP23DB02MM** • Multimode for lower power consumption • Improved performances (SNR, Sensitivity) **STML20 & STTS751** Standard products with competitive features **STTS22H** • Improved accuracy (±0.5°C) • Fast response time

life.augmented

LPS22HH

High Accuracy Atmospheric Pressure sensor

- 260 to 1260 mbar absolute pressure (1.6bar Max)
- Absolute accuracy **±0.5hPa**, Noise RMS **0.65Pa**
- ODR from 1 to **200Hz**, one shot
- FIFO for Pressure and Temperature (32 samples)
- **Temperature sensor calibrated**
  - Embedded Temperature compensation
- SPI and I²C interfaces
- Full molded package 2x2x0.76 mm package, 6 holes
- Low power:
  - 12µA (HPM) to 4µA (LPM) @1Hz, 0.9µA in PDM

life.augmented

LPS33W & LPS33HW & LPS27HHW

Atmospheric & **Waterproof** Pressure sensor

General Features – LPS33W, LPS33HW

- High Accuracy Waterproof Barometric Sensors
- 260 to 1260 mbar absolute pressure (2bar Max)
- ODR from 1 to 75Hz, one shot
- Embedded Temperature compensation
- 32 samples Embedded FIFO for Pressure and Temperature
- SPI and I²C interfaces

Wearable

- Chlorine, Bromine mixed, Salt water test
- Over Pressure Test (up to 10Bar / up to 24hr) (swimming pool, sea use case)

Industrial

- n-Pentane Chemical liquid (corrosion test for industry)

Specific Features to LPS27HHW

- ODR up to 200Hz
- Higher accuracy embedded Temperature sensor
- Improved power consumption
- 128 samples FIFO

life.augmented

LPS33W

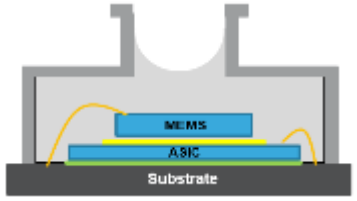
LPS33W

- 3.3x3.3x2.9 mm, CCLGA - 10L
- O-ring shaped PKG with full metal lid
- 15µA (HPM), 4µA (LPM) @1Hz

LPS33HW

LPS33HW – Water Proof

- 3.3x3.3x2.9 mm, CCLGA - 10L
- O-ring shaped PKG with full metal lid
- **10bar resistant (100m)**
- 15µA (HPM), 4µA (LPM) @1Hz



LPS27HHW

LPS27HHW – Water Proof

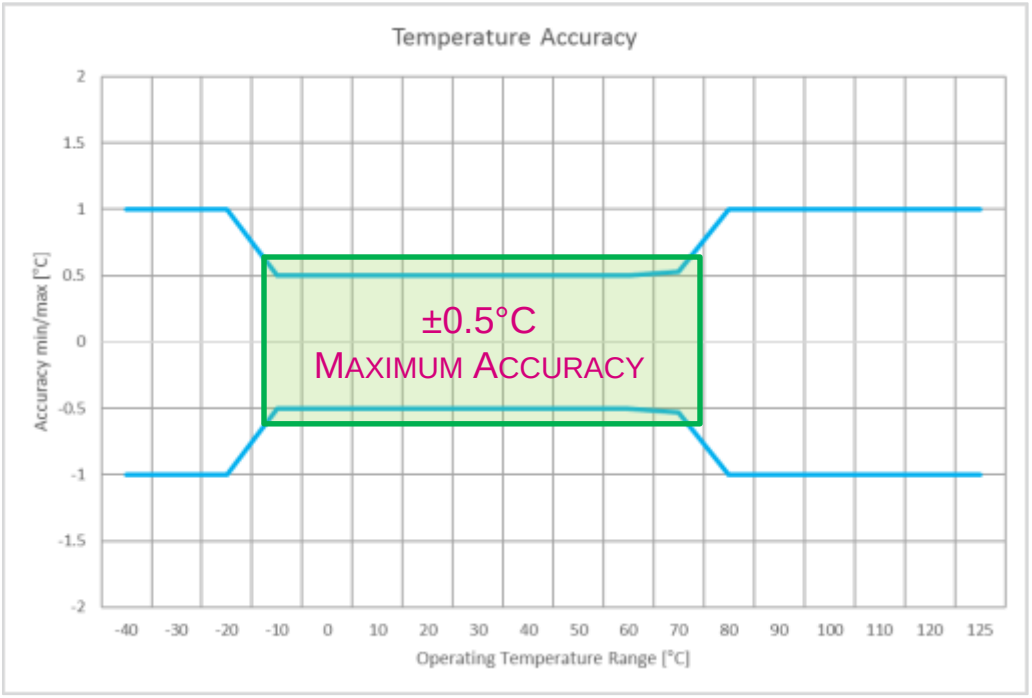
- 2.7x2.7x1.7mm
- O-ring shaped PKG with full metal lid
- **10bar resistant (100m)**
- Absolute accuracy ±2hPa
- Noise RMS [HP] - 0.7Pa
- 13µA (HPM), 4µA (LPM) @1Hz, 0.9µA PDM

STTS22H

High accuracy 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**
- Selectable I²C address (up to 4)
- Accuracy: **±0.5°C (max) [-10°C – 60°C]**
- **Selectable ODR** (down to 1Hz), 25, 50, 100, 200Hz
- **One shot reading mode (for ODR <1Hz)**
- Package: UDFN-6L 2.0 x 2.0 x 0.5mm with **exposed pad down** for better temperature matching with external environment.



life.augmented

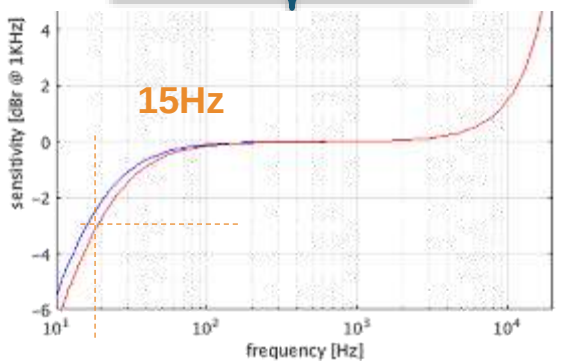
MP23ABS1

Analog single ended with flat frequency response

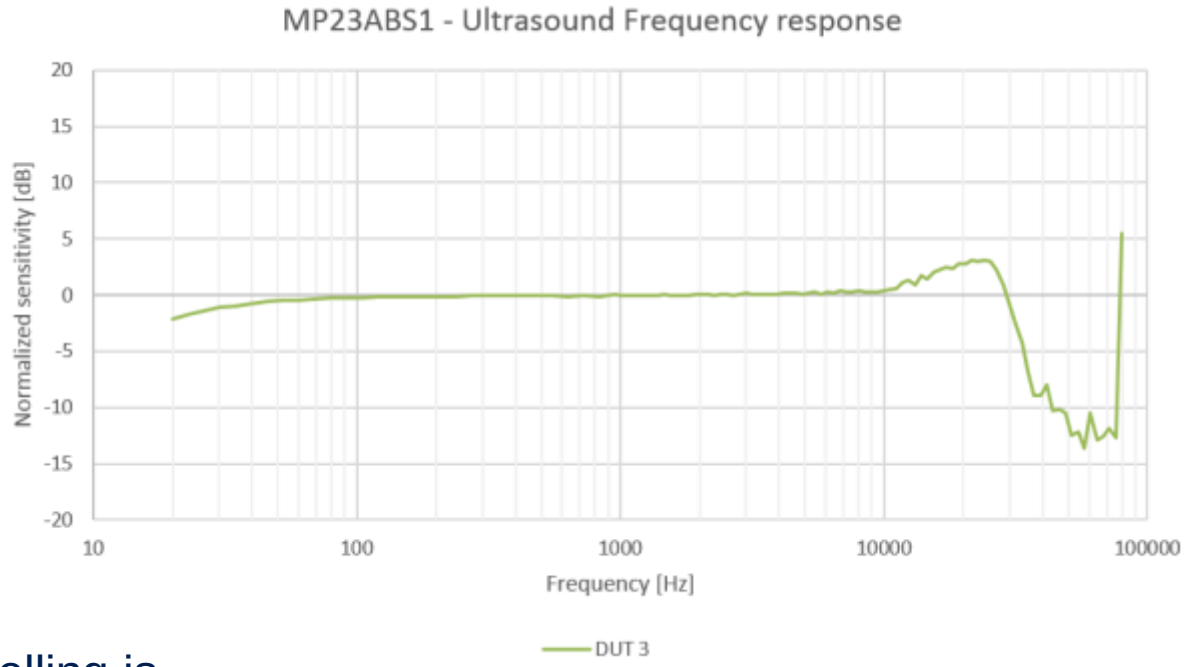
Wide Dynamic range Analog single ended microphone

- Analog bottom port single ended microphone with **64dB SNR min** and low distortion with **AOP of 130dB**
- **Low power** and with ultra flat frequency response:

roll off @ 15Hz



Industry standard
3.5x2.65x0.98
5Leads



- Adapted to applications where effective Noise Cancelling is needed and Ultrasonic measurement thanks to 80KHz BW

life.augmented

MP34DT05-A, MP34DT06J

Digital Microphone TOP Port High Performance

Best in class for audio fidelity (THD) among 3x4

- ST is currently offering **High end TOP** port Microphones
- **MP34DT05-A/MP34DT06J are best in class** for audio fidelity

Industry standard 3x4x1

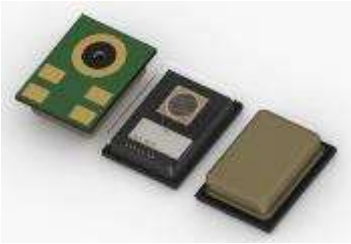
Product	Sensitivity	SNR	AOP	Notes
MP34DT05-A	-26dB ±3dB	64dB	122.5dB	High performance
MP34DT06J	-26dB ±1dB	64dB	122.5dB	Enhanced sensitivity matching

life.augmented

MP23DB01HP* / MP23DB02MM*

breakthrough digital bottom port microphones

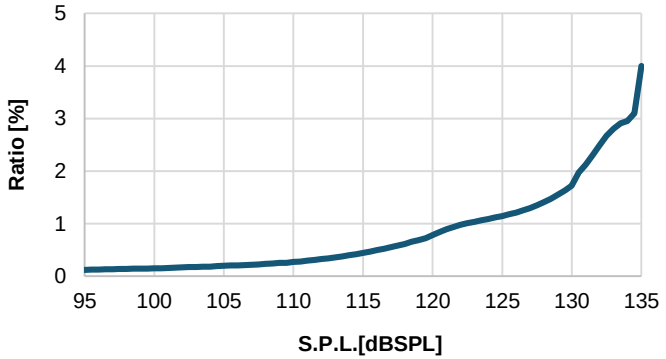
Digital Microphones for High Fidelity Applications



Industry standard
3.5x2.65x0.98, 5Leads

- **MP23DB01HP** / **MP23DB02MM** are Bottom Port Digital Multi-Mode high performance microphones with PDM interface
- **MP23DB01HP:** Best in class ultra low distortion device in the digital domain:

  -41 ±1dBFS, SNR 65dB, AOP >135dBSPL



- **MP23DB02MM: -26 ±1dBFS, SNR 65dB, AOP 120dBSPL**
- The Multi-Mode operation leveraging dynamic switch between Low Power and Normal mode makes **MP23DB01HP** / **MP23DB02MM** proper candidate also for low power apps

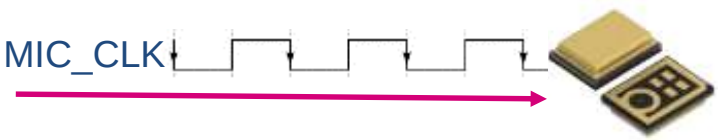
life.augmented

*Contact ST for more info, Samples available, Mass Production in Q4 2019

MP23DB01HP* / MP23DB02MM*

Operating Modes

- MP23DB01HP/MP23DB2MM have 3 different working regions based on clock frequency:
  - **Power Down** → Sleep mode
  - **Low Power Mode** → Low current consumption
  - **Normal Mode** → High Performance



Condition	F_{MIN}	F_{TYP}	F_{MAX}	Sensitivity
Power Down	0Hz		150kHz	
Low Power Mode	540kHz	768kHz	1100kHz	-24dBFS **-26dBFS***
Normal Mode	**1.5MHz**	2.4MHz	3.3MHz	-41dBFS **-26dBFS***

(Clock frequencies outside Operating mode regions are not allowed)

***MP23DB02MM**

*Contact ST for more info, Samples available, Mass Production in Q4 2019

MEMS microphone support

4 steps of your customer realization:

PoC & validation	HW	SW	Acoustic
Support to PoC & Prototype	Schematic and Gerber review	Support in audio SW integration	Support to mechanical integration

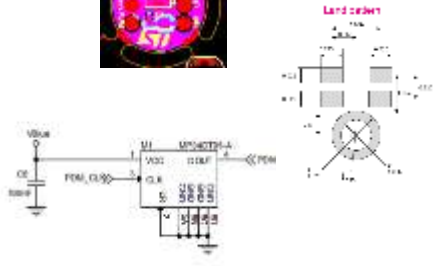
Eval board and associated SW demo

Coupon boards

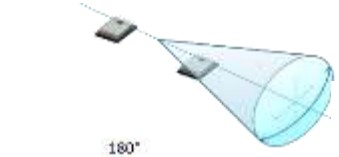
BlueCoin

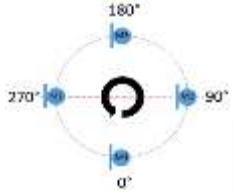
SW demo package :

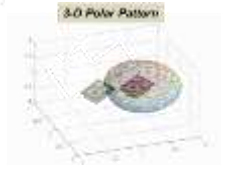
- **X-CUBE-MEMSMIC1**
- **FP-AUD-SMARTMIC1**
- **FP-AUD-BVLINK2**
- **FP-SNA-ALLMEMS1**
- **….**



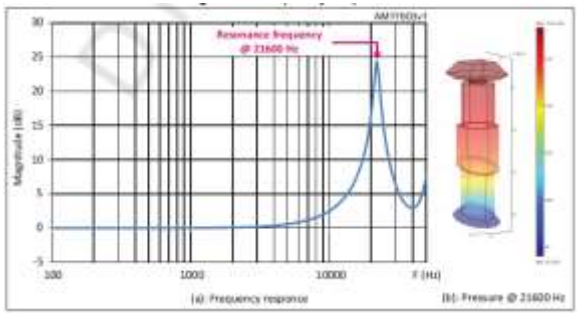
- **AN4211 : Guidelines for soldering MEMS microphones**
- **AN4428 : Best practices in the manufacturing process**
- **Support to HW integration**
- **Schematic review**
- **…**







- **Microphone acquisition**
- **SW Algo : AEC, BF, SL,..**
- **VoiceOverBLE**
- **…**



- **AN4427 : Gasket design for optimal acoustic performance**
- **Acoustic waveguide 3D review**
- **Optional acoustic simulation**

life.augmented

LIS2MDL, LSM303AH, LSM303AGR

CONSUMER Magnetometer

LIS2MDL

- **3-axis digital Standalone magnetometer**
- **±50Ga** FS (module), **3mGa** RMS resolution
- ODR on single mode operation and from 10 to 100Hz (150Hz in LPM)
- Embedded magnetic **Offset cancellation** enabling no offset thermal drift

LSM303AH

- **Digital e-compass combining**
- **LIS2DS12 based accelerometer (up to 14bit)**
- LIS2MDL based magnetometer

LSM303AGR

- **Digital e-compass combining**
- **LIS2DH12 based accelerometer (up to 12bit)**
- LIS2MDL based magnetometer

Common Features

Digital SPI/I2C

Same pinout - 2x2 LGA-12, 0.5mm pitch

life.augmented

H3LIS100DL, H3LIS200DL & H3LIS331DL

3-axis Low-power High-G Axel

Features

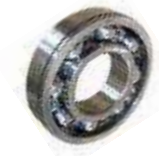
- **3 axis, High-g Full Scale (100g/200g/400g)**
- Low power consumption - 300 µA in Active mode - 10µA in low-power mode
- Programmable interrupt
- Package LGA, 3x3x1 mm³, 16 Leads

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 devices

Applications

- Ideal for all space and power-constrained applications requirinig 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



life.augmented

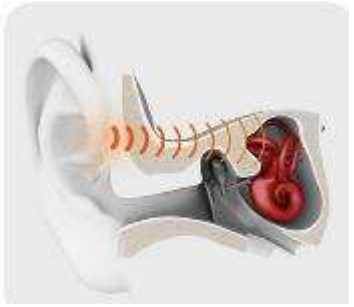
LIS25BA

Audio Accelerometer

Bone vibration detection

Beam forming enhancement

Voice detection enhancement



Typical architecture

Product specifications

- Supply voltage: 1.71V – 1.99V
- Current consumption: 5mA (max in NM)
- ODR: 8Hz, 16Hz, 24Hz
- Output interface: TDM
- Full scale: 3.85g – 7.7g
- Zero-g level offset: ±300mg (max)
- Zero-g level drift vs temperature: ±500mg (max)
- Acceleration electrical noise @ BW = 2.4kHz: 30µg/√Hz
- Bandwidth: 2.4kHz
- Latency: 80µs
- LGA 14L 2.5 x 2.5 x 0.86mm

life.augmented

Condition Monitoring & Predictive Maintenance

Industrial products and roadmap

life.augmented

SENSORS & MOTION MEMS

INDUSTRIAL

- High Accuracy
- Dedicated products
- 10 Years Longevity


AXL


6-axis IMU


Mag, E-compass


Microphone


Dedicated AXL

Latest qualified products	New products for H2 2019	New products for 2020
IIS2DLPC	IIS2ICLX	IIS3DWB
IIS3DHHC	ISM330DHCX	
IMP34DT05	STTS22H	LPS22HH* eq.

- IIS2DLPC, IIS3DHHC, IMP34DT05: in Mass Production

NEW
- **ISM330DHCX: in Mass Production**

NEW
- STTS22H: **in Mass Production**, belongs to 10Y longevity pg

NEW
- IIS2ICLX: Mass Production targeted in 19Q4
- IIS3DWB: Mass Production targeted in 20Q1

NEW Product recently introduced

NEW Product recently qualified

life.augmented

IIS2DH, IIS2DLPC

INDUSTRIAL Accelerometer

IIS2DH

- ±2 to ±16g FS Accelerometer
- **Up to 12 bit resolution** for Performance and Embedded Functionalities. **LPM** & **HRM** available
- Power consumption:
  - **6µA/11µA** in **LPM/HRM** (@50Hz)
  - **2µA** in **HRM** (@1Hz)
- Embedded features (Interrupts, Filters, FIFO, Temperature sensor, Self-Test)

IIS2DLPC

- ±2 to ±16g FS Accelerometer
- From **12 to 14 bit** resolution, Low Power and High Performance Modes, low noise enabled fct
- Ultra Low Power:
  - **0.38µA** in Low Power Mode @1.6Hz
  - **3µA** in Low Power Mode @50Hz
  - 90 / 120µA in HPM @1.6kHz
  - **50nA** in PD
- single shot and ODR from **1.6 to 1.6kHz**, FIFO, Temperature sensor, Self-Test, Interrupts

10 Years longevity
Industrial sensors

Common Features

Industrial applications
10Years longevity

life.augmented

IIS2ICLX, IIS3DHHC

INDUSTRIAL Inclinometer

IIS2ICLX*

- 2-axis High Performance inclinometer
- Full scale from **±0.5** to **±3g**
- BW from 25 to 200Hz
- **15µg/√Hz noise**
- High Temperature performance:
  - **<0.075 mg/K**
  - -40 to 105°C temperature range
- **Enable to reach <0.5° accuracy over temperature & time**
- **FIFO, Up to 16x FSM, up to 8x MLC**
- -40 to **105°C** temperature range
- Very low power: 420µA

IIS3DHHC

- 3-axis Inclinometer
- ±2.5g Full Scale, **45µg/√Hz** noise
- BW 235, 440Hz
- Temperature behavior optimized:
  - **< 0.4 mg/K**
  - **0.7%** sensitivity change
  - Ceramic package
- Embedded features (Filters, FIFO, Temperature sensor, Self-Test)
- **Enable to reach ~1.5° accuracy over temp & time**

Dedicated Inclinometer

Industrial applications
10Years longevity

*Contact ST for more info, SAMPLES Now for alpha customers, SOP in October 2019

life.augmented

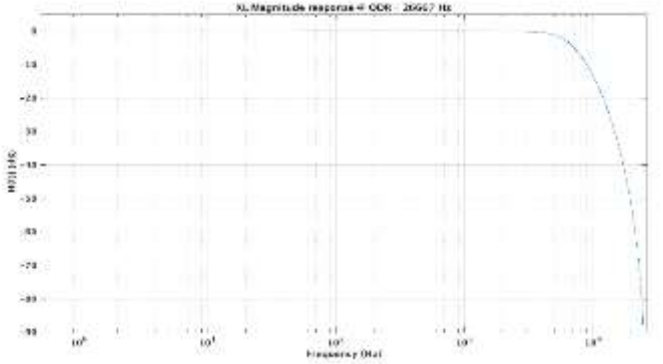
IIS3DWB

INDUSTRIAL Vibrometer

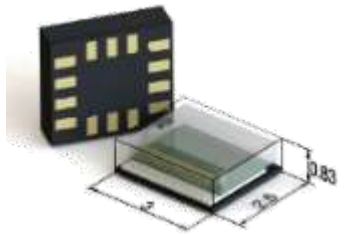
NEW

IIS3DWB*

- Up to 3-axis accelerometer
- From ±2 to ±16g Full Scale, 75µg/√Hz noise (60µg/√Hz in single axis)
- BW >**5kHz** (ODR @26.7kHz)
  - Ultra-wide and flat frequency response range: from DC to 6 kHz (±3 dB point)
- -40 to **105°C** temperature range
- Embedded features (programmable Filters, 3KB FIFO, Temperature sensor, Self-Test)
- Low power: 1.1 mA



LGA-14 2.5x3mm2



10 Years longevity
Industrial sensors

Dedicated Vibrometer

Industrial applications
10Years longevity

*Contact ST for more info, SAMPLES Now for alpha customers, SOP in Q1 2020

life.augmented

ISM330DLC, ISM330DHCX

INDUSTRIAL 6-axis IMU

ISM330DLC

- 3-axis axel, from ±2 to ±16 g Full Scale
- 3-axis gyro, from ±125 to ±2000 dps Full Scale
- Ultra Low noise, wide bandwidth, high-stability
- Ultra low power, 4KB FIFO

ISM330DHCX

- 3-axis axel, from ±2 to ±16 g Full Scale
- 3-axis gyro, from ±125 to **±4000** dps Full Scale
- Ultra Low noise, wide bandwidth, high-stability, improved temperature behavior
- ARW: 0.21 deg/√Hz BI: 3deg/hour (**High accuracy**)
- Programmable FSM
- 4KB FIFO
- -40 to **+105°C** temperature range
- **MLC embedded**

Common Features

Industrial applications
10Years longevity

life.augmented

IIS2MDC, ISM303DAC

INDUSTRIAL Magnetometer

IIS2MDC

- **3-axis digital Standalone magnetometer**
- **±50Ga** FS (module), **3mGa** RMS resolution
- ODR on single mode operation and from 10 to 100Hz (150Hz in LPM)
- Embedded magnetic **Offset cancellation** enabling no offset thermal drift

ISM303DAC

- **Digital e-compass combining**
- **Accelerometer with ± 2g to ± 16g Full scale (up to 14bit resolution)**
- IIS2MDC based magnetometer

Common Features

Digital SPI/I2C

Same pinout - 2x2 LGA-12, 0.5mm pitch

10 Years longevity
Industrial sensors

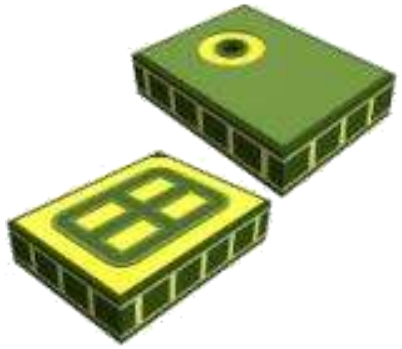
life.augmented

IMP34DT05

1st Digital Microphone for Industrial Applications

- Top port high robustness organic package (CbM)
- Sensitivity: -26dB ±3dB
- SNR: 64dB
- AOP: 122.5dB
- Digiital output (PDM) is the optimal solution for complexity, cost and reliability

HCLGA 4LD
3x4x1 mm



life.augmented

Accelerometer for medical application:

MIS2DH

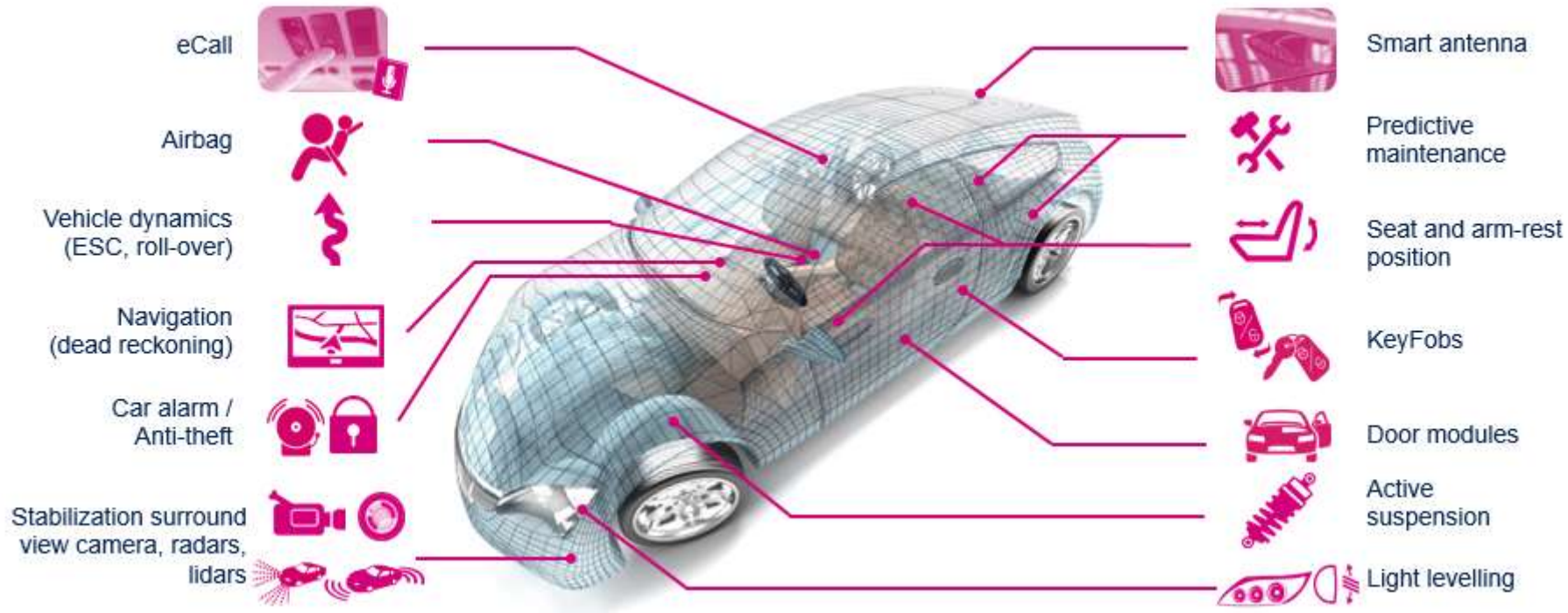
For FDA Class III Medical Applications

- Dynamically user selectable FS: ±2g/±4g/±8g/±16g
- I2C/SPI digital output interface
- Output data rate: from 1Hz up to 5kHz
- 3 Operative modes: low power(8bits) / normal mode(10bits) / high resolution(12 bits)
- Ultra low power consumption: down to 2uA in low power mode and 0.5uA in power down
- Smart power saving features: sleep to wake-up/return to sleep
- Embedded FIFO: 32 levels – 4 different operating modes
- Programmable interrupt signals for 4D/6D orientation, motion detection, free-fall and other conditions
- Embedded Self-Test functionality & Temperature Sensor
- LGA -12L 2x2x1 mm3
- **Activity Monitoring and posture detection in Implantable for applications (FDA Class III) like pacemaker, neurostimulator**

Key features

Low power accelerometer
FDA Class III

life.augmented



Automotive products and roadmap

life.augmented

SENSORS & MOTION MEMS

AUTOMOTIVE

AEC-Q100

>10 Years Longevity

AXL

Gyro

6-axis IMU

Latest qualified products	New products for H2 2019	New products for 2020
ASM330LHH		ASM330LHHX
AIS2DW12		AIS2IH

- ASM330LHH: In Mass Production
- NEW • ASM330LHHX: Mass Production targeted in 20Q2

- NEW • **AIS2DW12: PPAP now, in Mass Production**
- AIS2IH: PPAP in 19Q4, Mass Production end of 20Q1

life.augmented

NEW Product recently introduced

NEW Product recently qualified

AIS328DQ, AI3624DQ , AIS2DW12, AIS2IH*

AUTOMOTIVE Accelerometer

AIS328DQ AIS3624DQ

- 12bit resolution, 3-axis
- From 2 to 8g Full scale (AIS328DQ)
- From 6 to 24g Full scale (AIS3624DQ)
- ODR from 50 to 1000Hz

AIS2DW12

- **12 to 14 bit resolution**
- 3-axis, Up to 4g full scale
- Ultralow power: **0.38µA** @1.8V @1.6Hz
- ODR up to **100Hz**
- **4** running modes to select accuracy / power consumption
- Embedded features (Interrupts, Filters, FIFO, Temperature sensor, Self-Test)
- Operating temp: -40 to 85°C
- LGA wettable flanks (for easy check)

AIS2IH*

- **12 to 14 bit resolution**
- 3-axis, Up to **16g** full scale
- Ultralow power: **0.67µA** @3V @1.6Hz
- ODR up to **1.6kHz**
- **5** running modes to select accuracy / power consumption + **low noise mode**
- Embedded features (Interrupts, Filters, FIFO, Temperature sensor, Self-Test)
- Operating temp: -40 to **105°C**
- LGA wettable flanks (for easy check)

*PPAP in **Q4 2019**

Common Features

Automotive applications
AEC-Q100

life.augmented

*Contact ST for more info, SAMPLES NOW, SOP in 20Q1

ASM330LHH & ASM330LHHX

AUTOMOTIVE 6-axis IMU

ASM330LHH

- 3-axis axel, from ±2 to ±16 g Full Scale
- 3-axis gyro, from ±125 to ±4000 dps Full Scale
- Ultra Low noise, wide bandwidth, high-stability, improved temperature behavior
- 2x Interrupt lines for basic movement recognition
- ARW: 0.21 deg/√Hz, BI: <4°/hour (High accuracy)
- 4KB FIFO
- -40 to +105°C temperature range

ASM330LHHX*

Integrate a ASM330LHH plus following features:

- Low Power Mode
- Machine Learning Core
- Finite State Machine

Common Features

AEC-Q100
Automotive applications

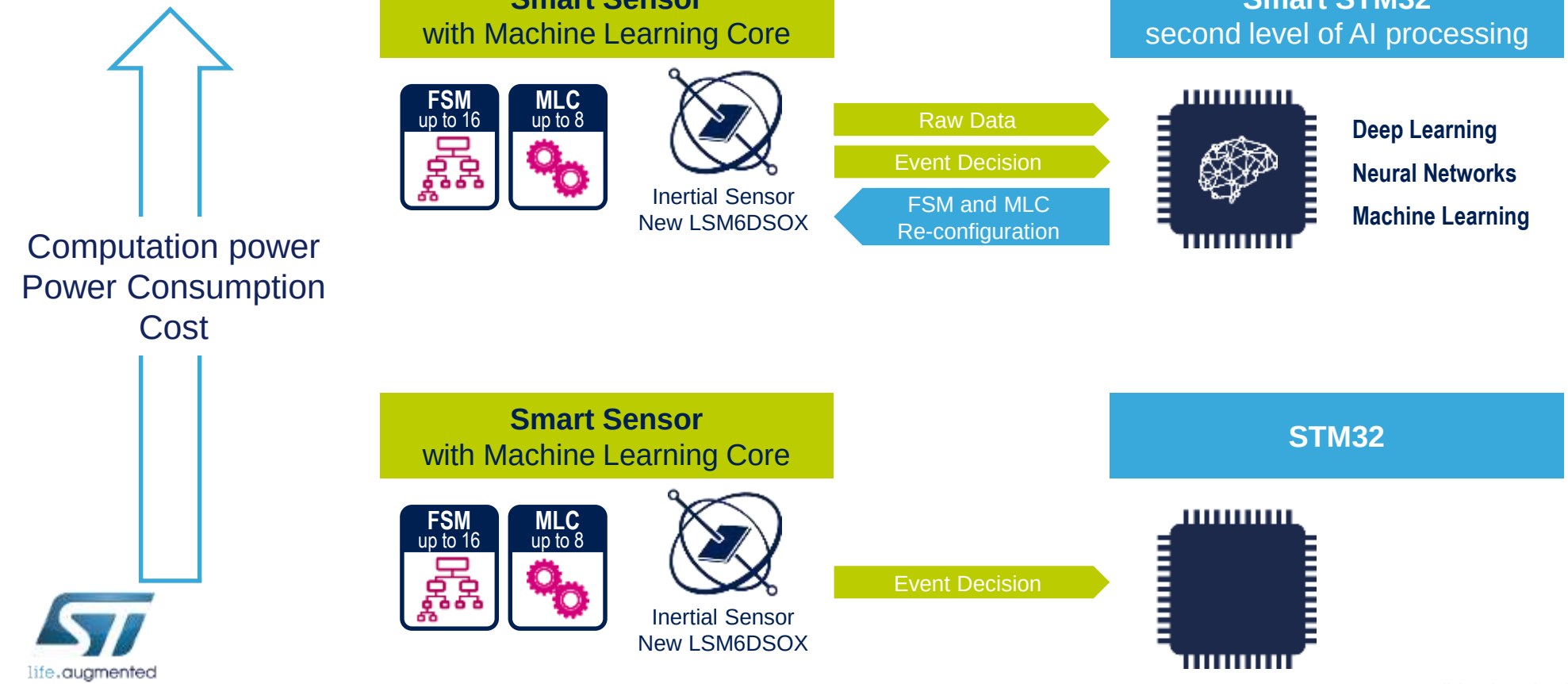
*Contact ST for more info, SAMPLES in October for alpha customers, SOP in 20Q2

Extra Features (FSM, MLC)

life.augmented

From Low Power Sensor to Low Power System

- Machine Learning Core (MLC) enables a real Edge computing by enabling system flexibility



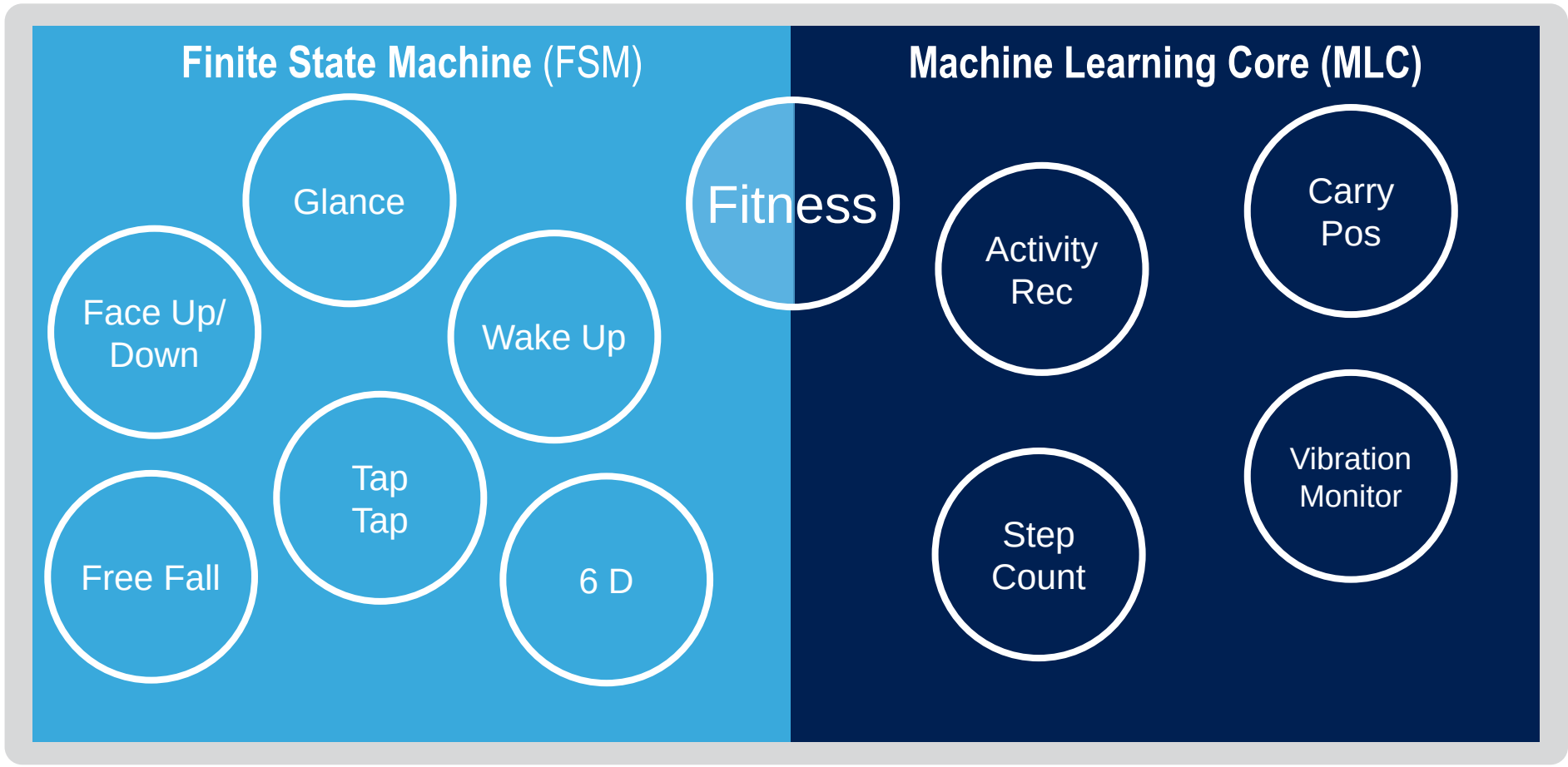
life.augmented

The 2 New added features on New ST Sensors

FSM / MLC*

*FSM: a new feature

*MLC: a new feature for “X” products



Algorithms can be achieved by **SW** or by **HW**

* FSM & MLC present in LSM6DSOX, LSM6DSRX, ISM330DHCX and soon on IIS2ICLX, ASM330LHHX

life.augmented

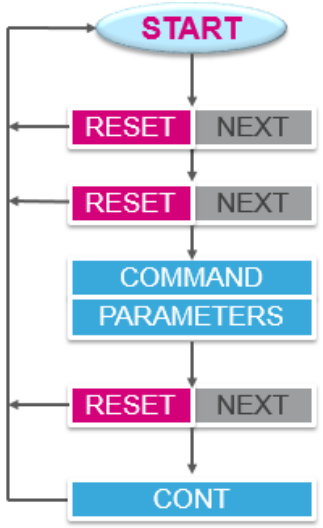
Finite State Machine - BENEFITS

Innovative Embedded Solution

Inertial Sensor LSM6DSO

FSM

Up to 16



1x FSM

Each FSM is intended to detect: single specific gesture

- Wrist Tilt
- Free Fall
- Pick Up
- Wake-Up
- Shake
- Glance
- Tap
- Motion / Stationary
- Etc…

FSM are executed **simultaneously** or **sequentially**
FSM outputs are **Interrupts** / Sources information

Pros

- ✓ Ultra Low Power
- ✓ Parallel processing of many Algos
- ✓ Lower interaction with MCU
- ✓ Interrupts
- ✓ Flexible Configurability
- ✓ Evaluation of multiple sensors

life.augmented

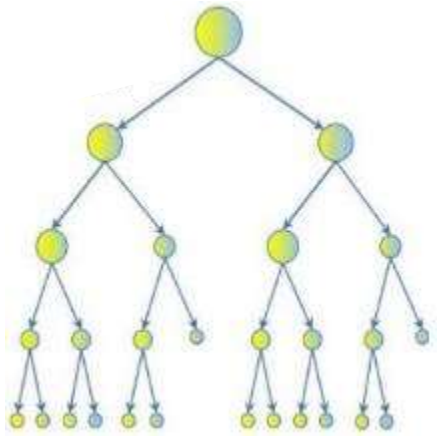
* FSM present in LSM6DSOX, LSMDSR, LSM6DSRX, ISM330DHCX and soon on IIS2ICLX, ASM330LHHX

Machine Learning Core - BENEFITS

Enhanced Innovative Embedded Solution

Inertial Sensor*
I.e. LSM6DSOX

FSM	MLC
Up to 16	Up to 8



1x Decision tree

Each Application is intended to detect:
User contexts

- Activity recognition
- Fitness activities
- Motion intensity
- Vibration intensity
- Carry position
- Context awareness
- False positive rejection
- Etc…

MLC is based on inductive method, constructed from **measured data**
MLC is built starting from observed data
MLC outputs are **Interrupts** / Sources information

Pros

- ✓ Up to 8x MLC
- ✓ Dramatically decreases MCU load and current consumption
- ✓ Combined with FSM
- ✓ Handles complex algorithms
- ✓ BOM reduction (no DSP needed)

1

life.augmented

* MLC present in LSM6DSOX, LSM6DSRX, ISM330DHCX and soon on IIS2ICLX, ASM330LHHX

Machine Learning Core (MLC)

Workflow

1

User defines Classes to be recognized

2

Collect Logs for each class

3

Define Features that best characterize the identified classes

4

Machine Learning tools generate decision tree based on Logs and Features

5

Configure the LSM6DSOX or LSM6DSRX and run the application

5 simple steps for 10 to 1,000 times power saving

life.augmented

FSM / MLC

Power Consumption comparison

FSM and MLC are incredibly efficient in current consumption needs:

+ ~3 µA for each Finite State Machine

+ 1-15 µA Machine Learning Core

MLC Algorithm example	Sensors used	ODR	Number of decision trees	Number of nodes	MLC add. Current consumption
Vibration Monitoring	A	26 Hz	1	2	1 µA
Motion Intensity	A	12.5 Hz	1	7	1 µA
6D position recognition	A	26 Hz	1	8	2 µA
Activity Recognition for mobile	A	26 Hz	1	126	4 µA

life.augmented

MLC:
Current consumption improvement

10 to 100 times better current consumption with MLC*!

Activity recognition algorithm running inside LSM6DSOX MLC

LSM6DSOX Sensor	Sensor Current consumption
Core	15 µA
MLC	4 µA

MCU	Wake-up rate	MCU Current consumption
STM32F401RE	1 s	9.27 µA
	30 s	3.02 µA
	100 s	2.8 µA
STM32L152RE	1 s	3.24 µA
	30 s	1.46 µA
	100 s	1.4 µA

Activity recognition library (MotionAR*) running in MCU

LSM6DSOX Sensor	Sensor Current consumption
Core	15 µA
MLC – not used	0 µA

MCU	Wake-up rate	MCU Current consumption
STM32F401RE	1/16 = 63ms	91 µA
STM32L152RE	1/16 = 63ms	82 µA

* for one library

NEW Application Examples

life.augmented

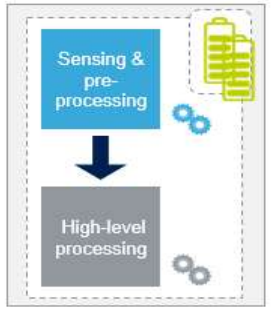
Sensors Enabling Differentiating factor with ST sensors

3 Major Trends

1 Artificial Intelligence

Context Awareness / Gesture Recognition

Low power, value added for application

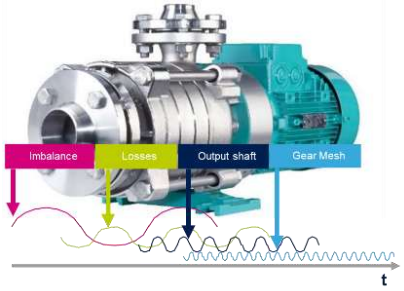


Machine Learning Core for improved performance & lower power consumption

2 Industry 4.0

Inclinometer & Predictive Maintenance

Turnkey solution for Industrial applications

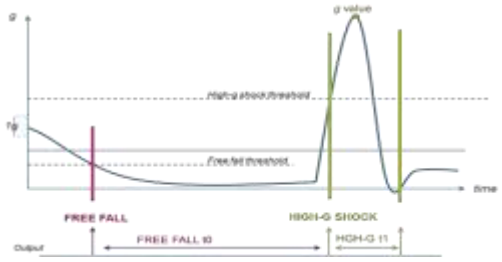


Data collection, processing, Analytics with FFT, Ultra Sound, Sensors fusion data

3 Shock sensing

People, Vehicle, Goods, Asset Tracking

Tracking & monitoring



Complete Sensor + connectivity solution for Tracking & Monitoring

life.augmented

Industry 4.0
Sensor & Connectivity Opportunities

Cloud

Analytics

Storage

- Analytics
- Post processing
- Machine learning
- **Security**

- Decisions
- Actions

Tracking and monitoring

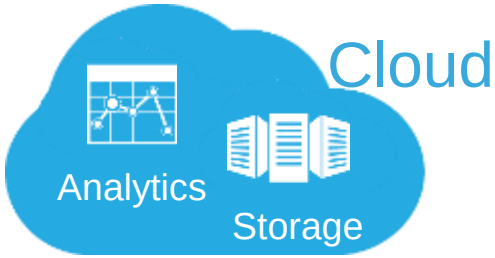
Predictive Maintenance & Smart Installation

Tracking, Safety, Effectiveness

life.augmented

Macro Trends for Industrial Application

ST Sensors



A complete set of sensors to control the equipment from the shipment to end of life

Shipment

Installation

Operation

Battery operated

Shock monitor
Vibration
Temperature
Humidity

Shock monitor
Inclination
Environment vibration
Humidity & Temperature
Pressure

Vibration monitor
Ultrasound monitor & source localization
Inclination (Structure Stability)
Shock Monitor
Humidity & Temperature
Pressure

Artificial Intelligence

life.augmented

Applications for Inclinometer Products

IIS3DHHC & IIS2ICLX is targeted inclinometer applications in Industrial due to:

- High stability
  - Low noise density (direct connection to angle)
    - Resolution and sensitivity
  - Very low full scale
- Temperature behavior
  - Extended temperature range till 105°C
  - Very low offset & sensitivity change vs. temperature
  - Ceramic package providing better stability
- Low power consumption
- Resistance to vibrations

- Standard Inclinometer applications / customers
  - Elevators / Forklift / Cranes
  - Door Automation (garage)
  - Tilt alarm, tip-over detection (Industrial vehicles)
  - Antenna and Solar Panel positioning / stabilization
  - Platform leveling and stabilization
  - Leveling instruments, outdoor tools
  - ….

life.augmented

NEW Applications for Inclinometer

IIS3DHHC / IIS2ICLX

- Inclinometer can also be used to measure small variation of acceleration, deformation monitoring in structures
  - Building, infrastructure monitoring
    - Bridge, viaduct, tunnel, Barrage
    - Nuclear stations
    - Railway track
  - Structure Maintenance during construction
    - Monitoring of deep foundations subjected to large loads
    - Monitoring excavation near facilities
  - Historical monument monitoring
    - Churches, castle
  - Geotechnical probes for Landslide, Tsunami, Earthquake, volcano, avalanche, seismology







For safety, for Accuracy and Safeguarding historical heritage

life.augmented

Predictive Maintenance

What is monitored

Accelerometer
For vibration measurements

Signal Bandwidth. Frequency Response & Filtering
Different defects/wears shows up at different frequencies and should be captured without ambiguity

Noise Density
Lower Noise allows to identify earlier defects and wears

Operating Temp Range
Sensor should match the operating condition of the monitored equipment

Number of axis
3 axis allows to monitor all kind of defects/wears (imbalance, misalignment, bearings, etc.)

Power Consumption
Important merit figure for battery operated sensor nodes

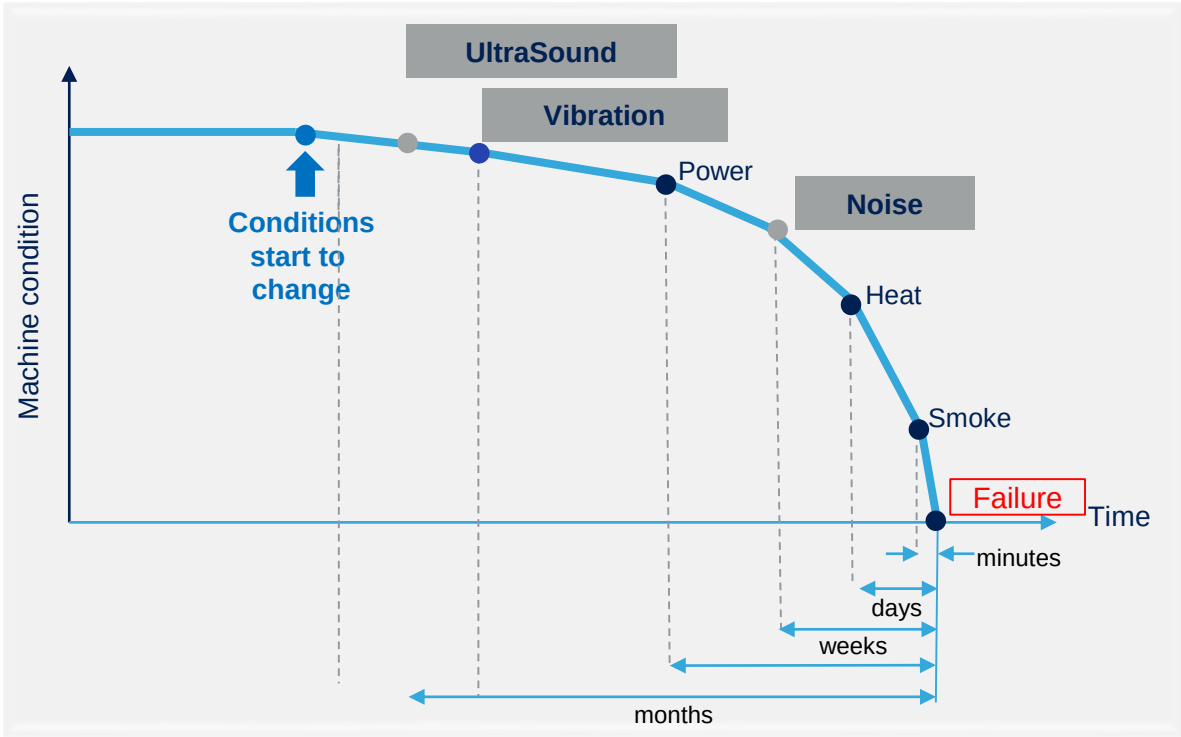
Output Interface
Digital output is the optimal solution for complexity, cost and reliability

Microphone
For Ultrasound & Noise sensing

Operative Bandwidth
Microphone working in standard audio bandwidth as well as in the ultrasonic domain

Dynamic Range
AOP (acoustic overload pressure) is required to keep sensing despite of the presence of strong environmental sound emissions

Output Interface
Both analog and digital for wide compatibility with processing units



Predictive Maintenance

ST MEMS Sensors

Unbalance
Looseness
Misalignment

Roller Bearings
Gearing
Cavitation

Bearings
Gear Box
Lubrication

Fan Bearings
Venting Occlusion
Cooling failure

Type of Defect / Wear

IIS3DWB*

ISM330DLC

Sound analysis (10-10KHz)

Ultrasound analysis

IIS2DH

IMP34DT05 - MP23ABS1

Bandwidth

2Khz

5Khz

10Khz

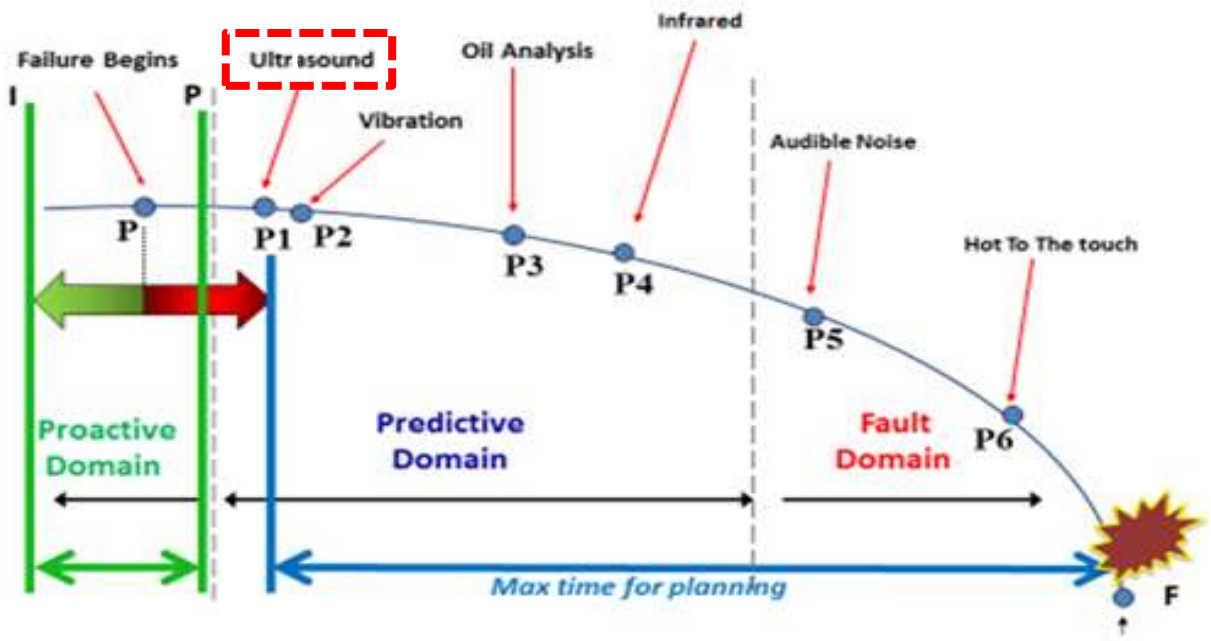
>50Khz

life.augmented

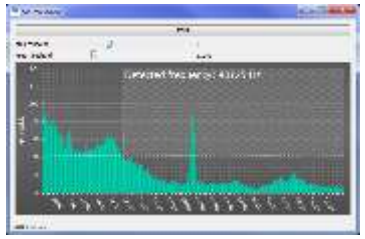
* Available in 20Q1

Ultrasound Inspection

Condition monitoring for early stage fault detection

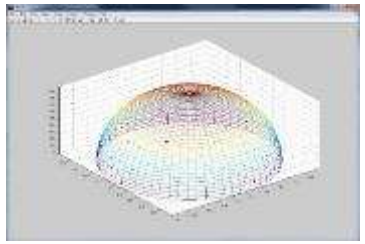


- Compressed fluid leaks
- Vacuum leaks
- Steam trap failures
- Bearing condition monitoring
- Electrical arcing/tracking
- Fan and motor unbalance



ULTRASOUND DETECTION

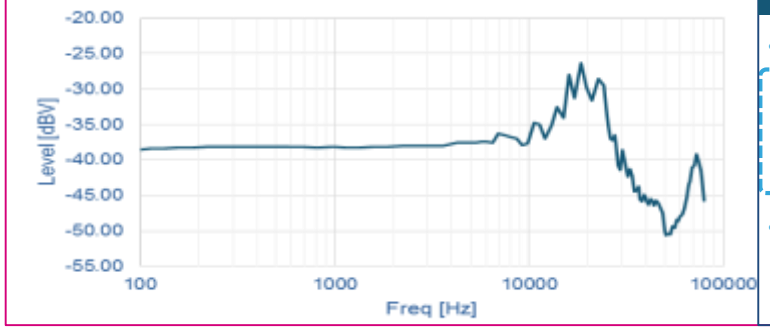
- **Single Microphone**
  - ✓ **MP23ABS1:** analog, up to 80 KHz
  - ✓ **IMP34DT05**: digital, up to 24 KHz
- **STM32 Embedded Spectral Analysis**



ULTRASOUND 3D LOCALIZATION

- **3 MEMS microphones array**
  - ✓ Very small geometry
- **STM32 Embedded 3D DoA**

MP23ABS1 ULTRASOUND CHARACTERIZATION



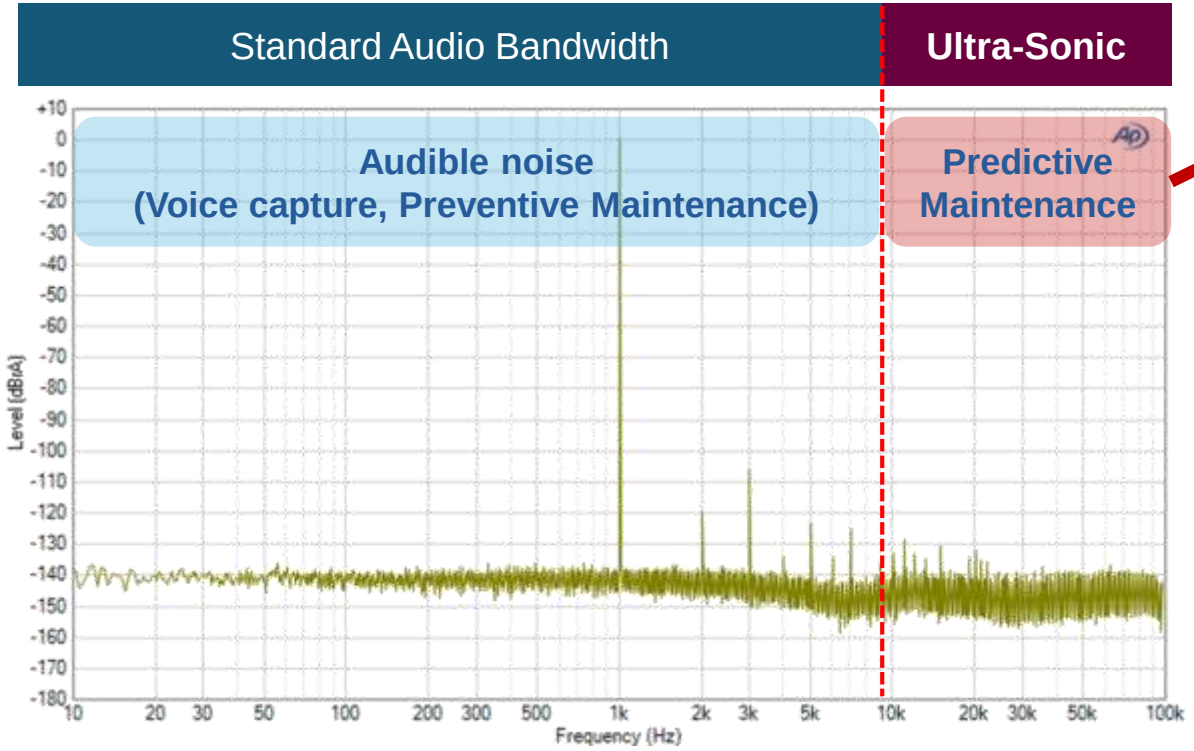
MP23ABS1

- Main parameters
  - *** Sensitivity : 38 dB ±1dB**
  - *** SNR: 64 dB(A)**
  - *** AOP: 130dBSPL**
- Wide Acoustic Bandwidth (up to 80 kHz)

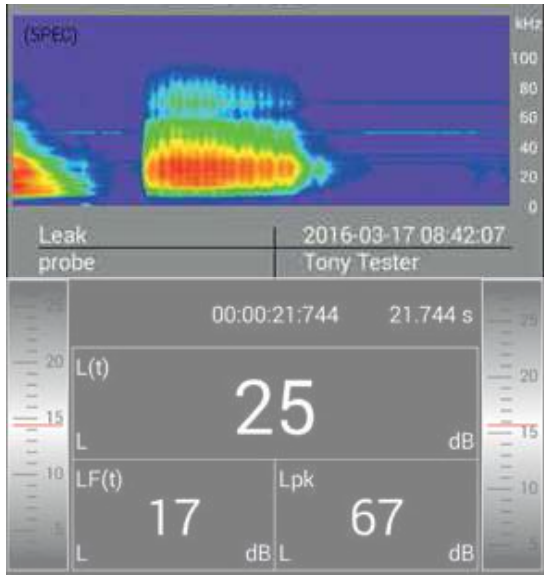
life.augmented

Symptoms According to Audio Frequency:

Standard Audio vs Ultrasonic



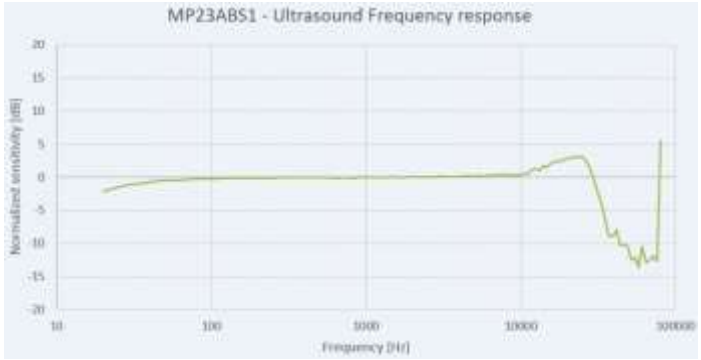
Post processing analysis
Ultrasonic frequencies to detect and classify leaks



RHLGA 4LD
3.5x2.65x0.98 mm

MP23ABS1

- Main parameters
  - **Sensitivity : 38 dB ±1dB**
  - **SNR: 64 dB(A)**
  - **AOP: 130dBSPL**
- Wide Acoustic Bandwidth (up to 80 kHz)



Also IMP34DT05 Digital Top Port Microphone with up to 25kHz response

life.augmented

A.I. and Machine Learning Core Applications

End customer use case examples

The Machine Learning Core identifies if a data pattern (motion, pressure, temperature, magnetometer, etc) matches an activity in a user defined set of classes, for instance it recognize if you are Running, Walking, Driving, in an Airplane, etc

Activity recognition

Stationary, walking, fast walking, jogging, biking, driving.

Gym activity recognition

Bicep curls

Squats

Count the number of bicep curls, squats and push-ups, etc

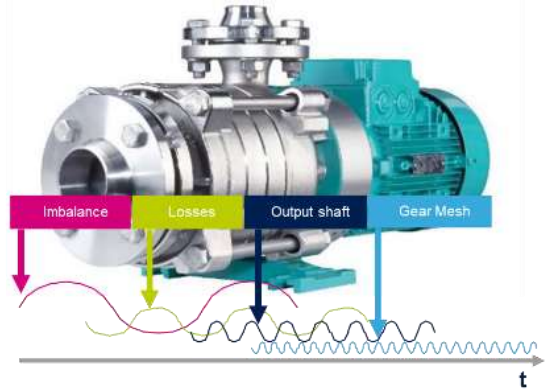
Airplane Mode detection

Take off

Interrupt generation

Recognize Take-off and Landing to set the Smartphone (Radio off)

Predictive Maintenance



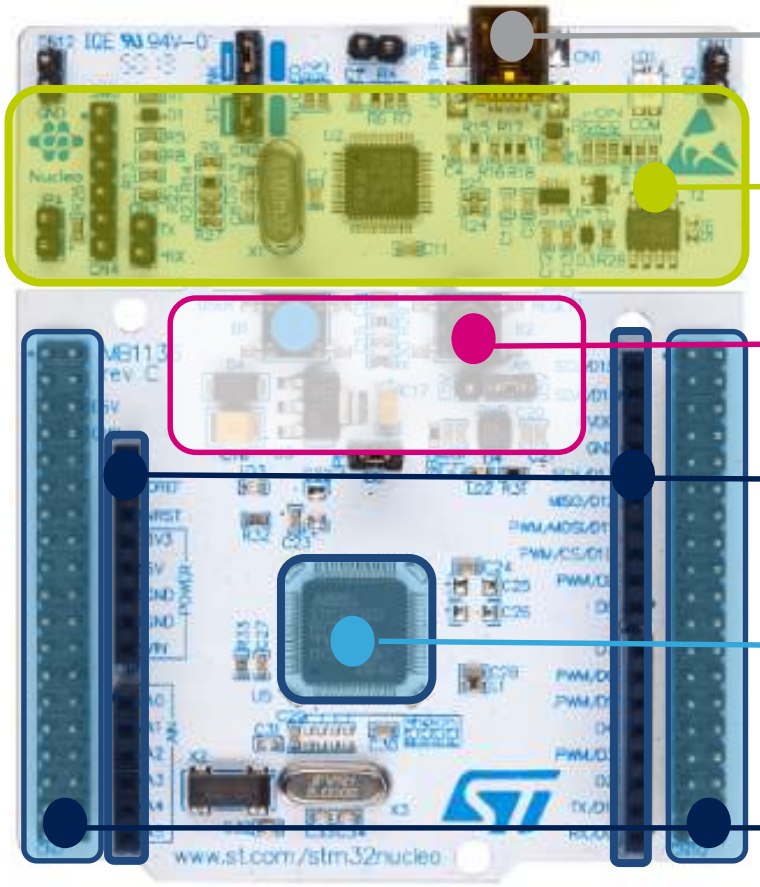
Data collection, processing, Analytics with FFT, Vibration, Sensors fusion data

life.augmented

Tools, SW & Evaluation Kits

life.augmented

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-IKS01A3
with Consumer products

NOW

Sense

Motion MEMS and environmental sensor expansion board for STM32 Nucleo

• The X-NUCLEO-IKS01A3 is the NEW motion MEMS and environmental sensor evaluation board system with consumer products

Key products on board:

LSM6DSO: MEMS 3D accelerometer (±2/±4/±8/±16 g) + 3D gyroscope (±245/±500/±2000 dps)

LIS2MDL: MEMS 3D magnetometer (±50 gauss)

LIS2DW12: MEMS 3D accelerometer (±2/±4/±8/±16 g)

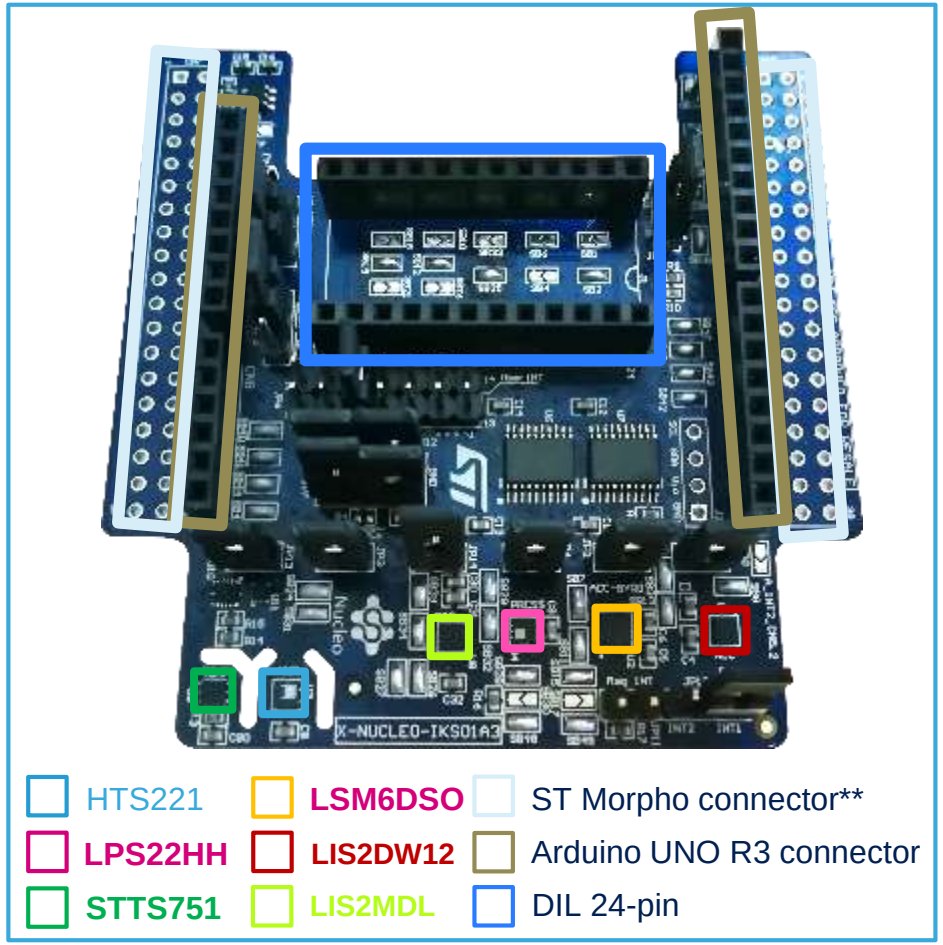
LPS22HH: MEMS pressure sensor, 260-1260 hPa absolute digital output barometer

HTS221: Capacitive digital relative humidity and temperature

STTS751: digital temperature sensor

DIL 24-pin: Socket available for additional MEMS adapters and other sensors

I2C, SPI support



** Connector for the STM32 Nucleo Board

life.augmented

X-NUCLEO-CCA02M2

NOW

Digital MEMS microphone expansion board for STM32 Nucleo

- The X-NUCLEO-CCA02M2 is the NEW MEMS microphone evaluation board system based on MP34DT06J

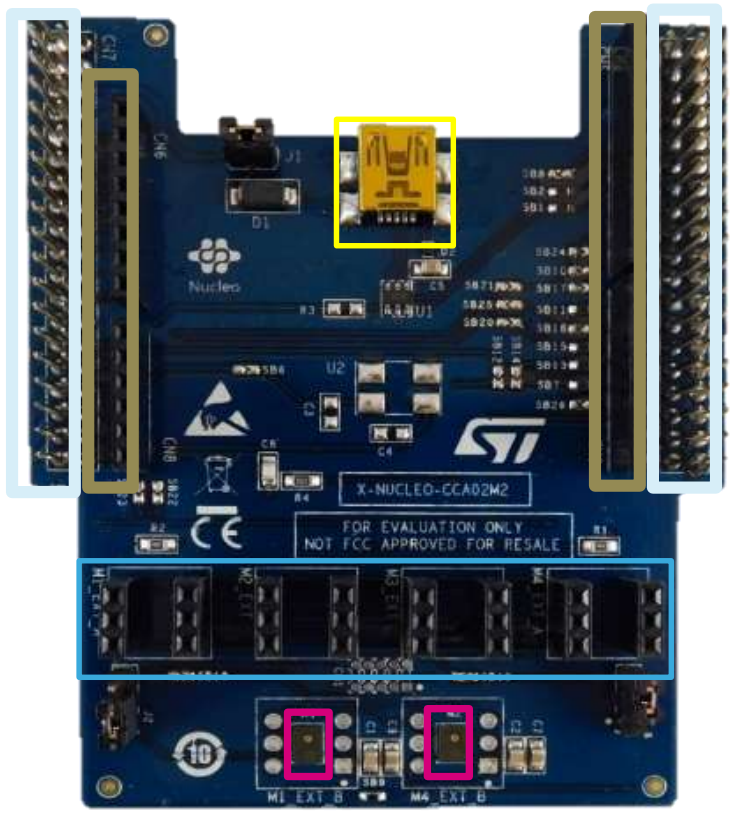
Key products on board:

MP34DT06J Ultra-compact, low-power, omnidirectional, digital MEMS microphone.

High Performance : 26 dBFS ± 1 dB sensitivity, 122,5dB AOP

6x slots to plug in digital microphone coupon boards such as **STEVAL-MIC001V1**, **STEVAL-MIC002V1** and **STEVAL-MIC003V1**

1x miniUSB FS connector for USB audio data streaming



- MP34DT06J
- ST MEMS Coupons housing
- ST Morpho connector**
- Arduino UNO R3 connector
- MiniUSB FS connector

** Connector for the STM32 Nucleo Board

life.augmented

Coming in Q4

Sense

X-NUCLEO-IKS02A1
with Industrial products

Motion MEMS and environmental sensor expansion board for STM32 Nucleo for Industrial

- The is the NEW motion MEMS and environmental sensor evaluation board system with INDUSTRIAL products

Key products on board:
ISM330DHCX: MEMS – 6-axis IMU - accelerometer / gyroscope
IIS2DLPC: MEMS 3D accelerometer
II2DMC: MEMS 3D Magnetometer
IMP34DT05: MEMS microphone

DIL 24-pin: Socket available for additional MEMS adapters and other sensors
I2C, SPI support

life.augmented

Main Boards available

X-Nucleo V3
X-NUCLEO-IKS01A3

- Sensors
  - LSM6DSO: 6-axis IMU
  - LIS2MDL: Magnetometer
  - LIS2DW12: Accelerometer
  - LPS22HH: Barometer
  - HTS221: humidity and temperature
  - STTS751: temperature sensor
  - DIL 24-pin: Socket for MEMS adapters

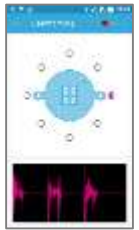
In Mass Prod

BlueTile
STEVAL-BCN002V1B

Bottom view

- Sensors
  - LSM6DSO: 6-axis IMU
  - LPS22HH: Barometer
  - LIS2MDL: Magnetometer
  - HTS221 Relative Humidity and Temperature
  - VL53L1 : Time of Flight
  - MP34DT05TR-A: MEMS Microphone

In Mass Prod



NEW

STWIN: Wireless Industrial Node
STEVAL-STWINKT1

STM32L4+ MCU — AI Ready — Ultra Low Power Cortex-M4F@120MHz

Industrial-grade Sensors

Inertial, Acoustic, Environmental

Built-in secure wireless (wired) connectivity — BlueNRG-2 — WiFi — Micro USB — RS485

MP: Q1 2020

NEW

SensorTile.Box
STEVAL-MKSBOX1V1

IIS3DWB incl.

LSM6DSOX incl.

IP54-compliant
57 x 38 x 20 mm

- Sensors:
  - **LSM6DSOX** ultra-low-power & high-performance 6-axis IMU with FSM & MLC
  - **LIS2DW12 & LIS3DHH** ultra low power Accelerometer and Inclinometer
  - **LIS2MDL** high performance magnetometer
  - **LPS22HH** absolute pressure and temperature sensors acting as a barometer
  - **MP23ABS1** wide band analog microphone
  - **HTS221** humidity and temperature sensors
  - **STTS751** temperature sensor
- Features:
  - **3** operational modes (Entry, Expert, PRO)
  - **Entry mode** for sensors functionalities discovery using pre-defined functions with no need to program
  - Pedometer, Barometer, Data recorder, Compass & tilt level, vibration*, tracking*, baby crying detection*
  - **Expert mode** for developer who build their application (examples included)

* Coming soon

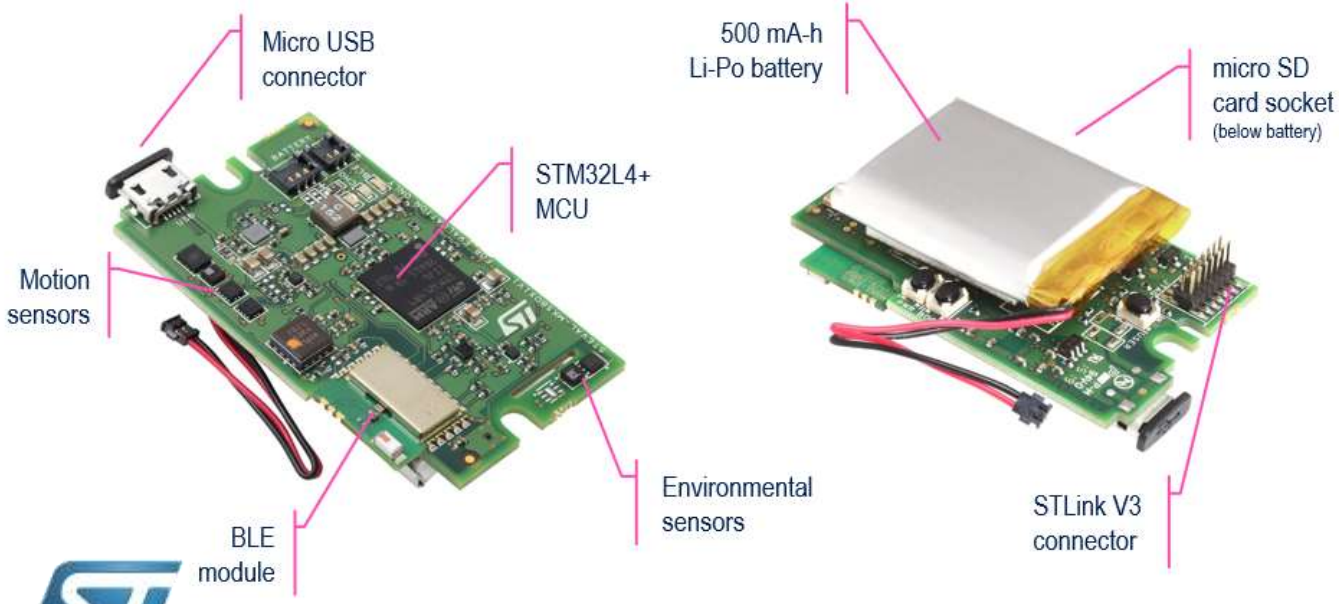
In Mass Prod

life.augmented

SensorTile.BOX

STEVAL-MKSBOX1V1

Outside the Box

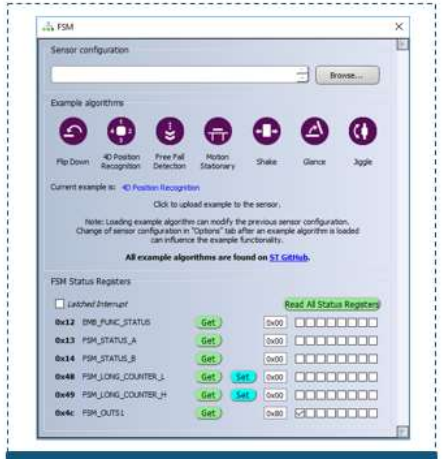


Inside the Box

ST Devices

SensorTile.BOX

STEVAL-MKSBOX1V1



No need to program anything

New App without programming

Development for MLC

- Entry:
  - Pre-recorded application / use case

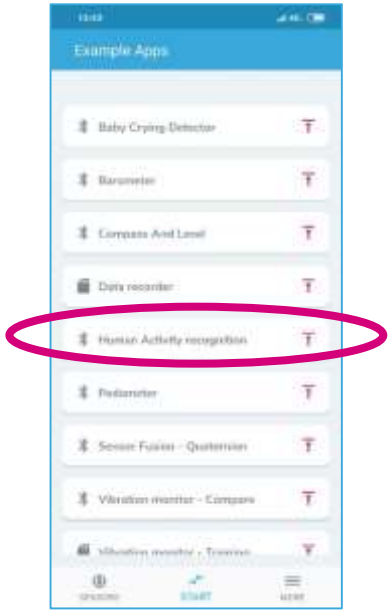
- Expert
  - The developer uses a graphical app on his smartphone to
    - Define additional applications, like in lego bricks
    - Build his own application, without programming

- PRO
  - Full compatibility and support of STM32 Open Development Environment
  - FP-SNS-STBOX1 , FP-SNS-ALLMEMS2, FP-AI-SENSING1, Function Packs available

life.augmented

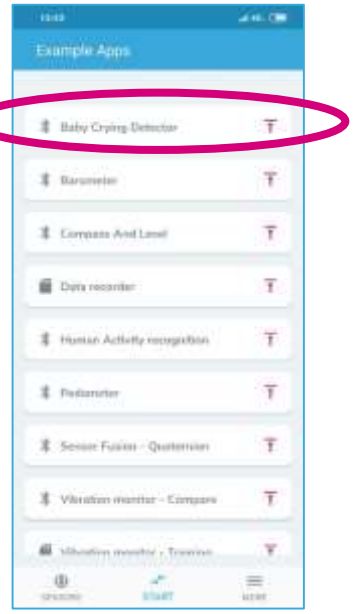
2x new ST BLE Sensor app examples with AI

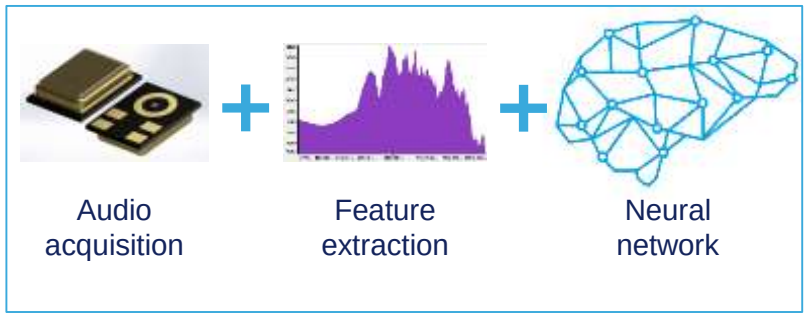
Human Activity Recognition based on MLC



- Recognized activities are
  - Still
  - Walking
  - Jogging / Running
  - Biking

Baby Crying Detection based on a Neural Network running on STM32



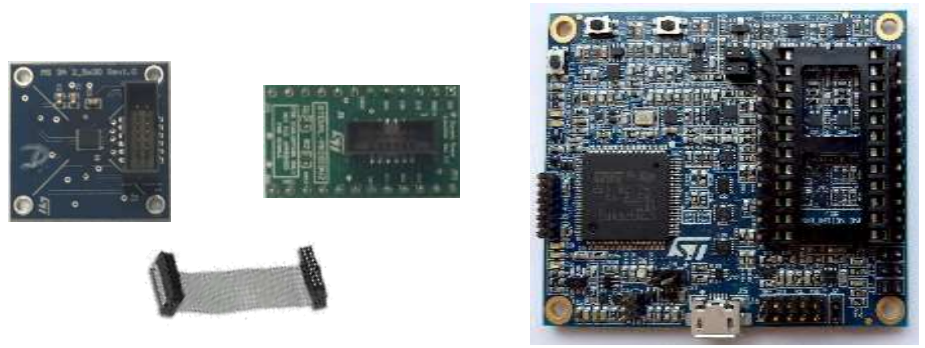


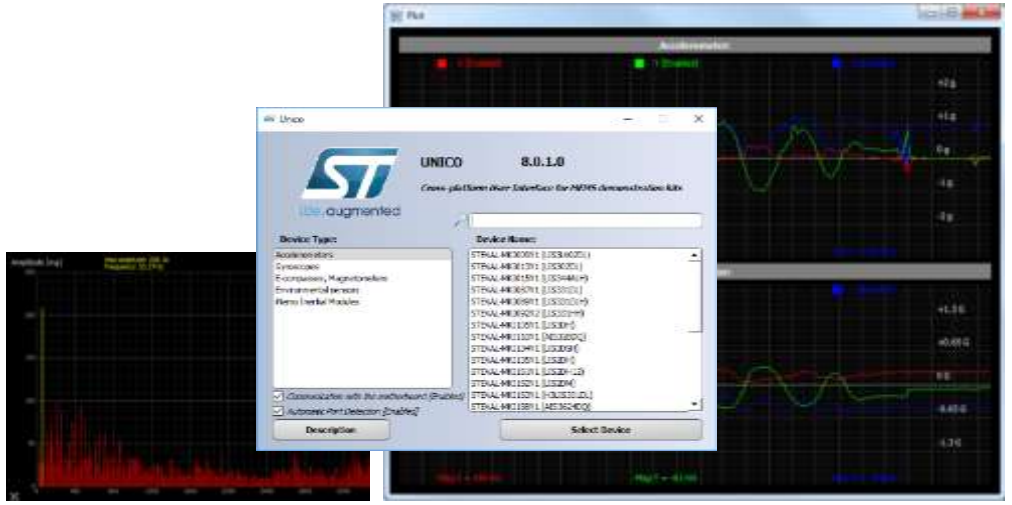
life.augmented

IIS3DWB evaluation tool

STEVAL-MKI109V3 + IIS3DWB DIL24

- ProfiMEMS Tools STEVAL-MKI109V3
- IIS3DWB square board connectable to DIL24 adapter / ribbon cable (STEVAL-MKIxxxV1 tbc)
- STSW-MKI109M - Unico GUI - MEMS evaluation kit software package for Windows
- Raw data logging, real time FFT, register access and control over Unico GUI



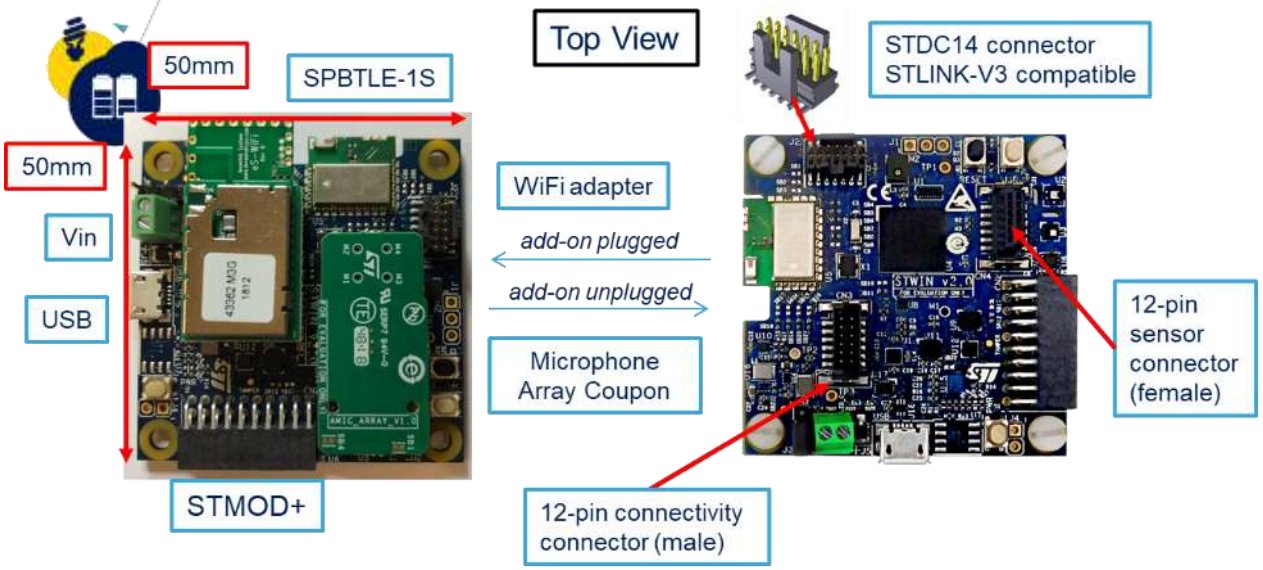


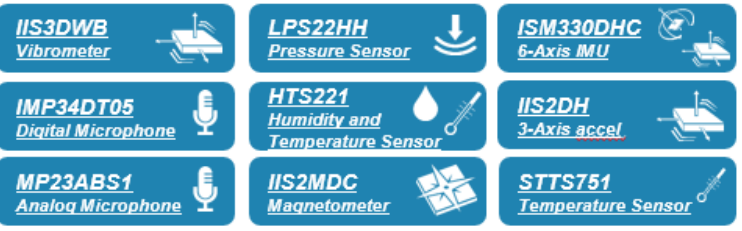
life.augmented

STWIN Expansions

NEW

Modular platform ecosystem to fast prototype your Industrial IoT designs





life.augmented

Software

STSW-STWINKT01 - Firmware for STEVAL-STWINKT1 evaluation kit for predictive maintenance, smart industry, IoT and remote monitoring applications

FP-IND-PREDMNT1 - STM32Cube function pack for multi sensors node with signal processing to enable predictive maintenance

STEVAL-STWINKT1

STWIN Core System

STEVAL-STWINMAV1

Analog Mic-Array

4x MP23ABS1

STEVAL-STWINWFV1

WiFi Expansion

Inventek WiFi Module

Other expansion samples

ToF Expansion

2x VL53L1X

Digital Mic-Array

4x IMP34DT05

STMOD+ LoRa Add-on

Planar option

Stacked option (with Flex 40-pin)

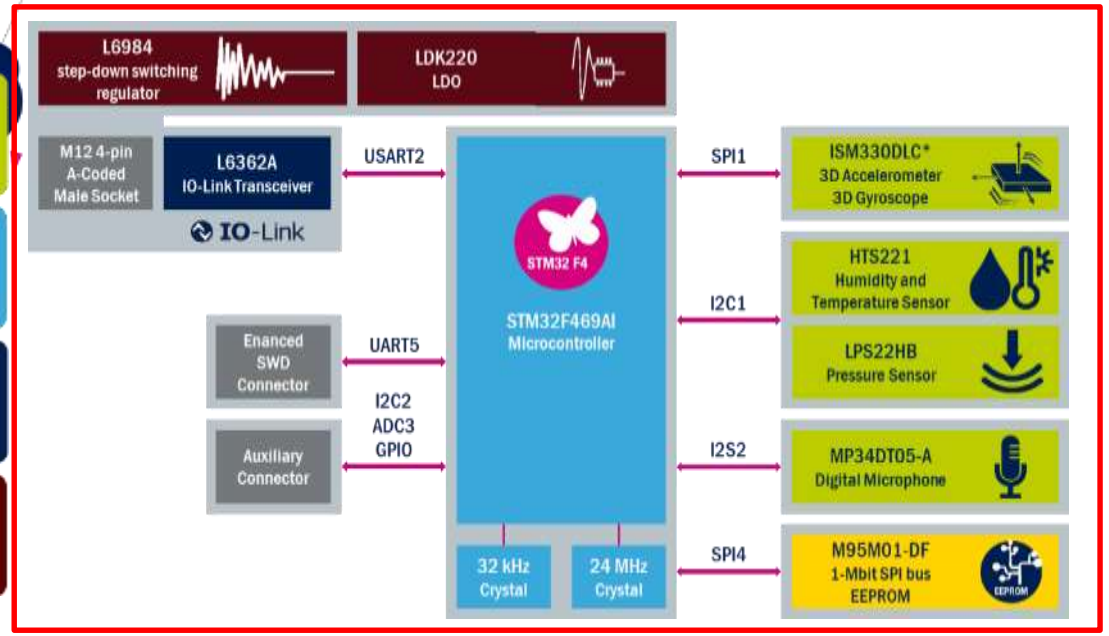
STMOD+ Cellular Add-on

LTE Add-on available in P-L496G-CELL0x

STEVAL-BFA001V1B

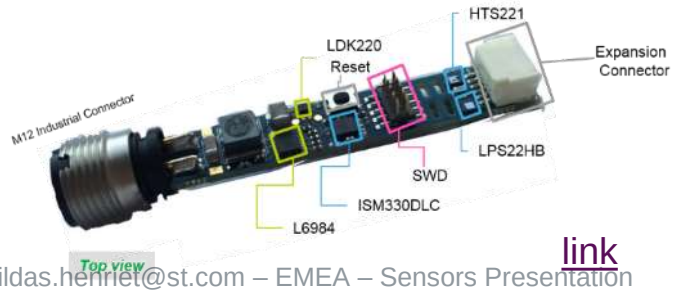
Hardware Overview

The **STEVAL-BFA001V1B** kit is designed around the **STEVAL-IDP005V1**



STEVAL-IDP005V1 Block diagram

- ✓ Main supply voltage: 18..32V
- ✓ Embedding Industrial Grade Axel+Gyro and Digital Microphone for vibration and acoustic analysis
- ✓ Embedded EEPROM for data and settings storage
- ✓ Embedded algorithm for sensors data analysis running on the embedded STM32F4 (up to 180MHz). Integrated MotionSP middleware.
- ✓ IO-Link capability with the embedded L6362A (**)
- ✓ Optimized form factor for industrial M12 connector
- ✓ Expansion connector with GPIO, ADC, I2C bus



ISM330DLC bandwidth is 3 kHz, coming soon replacement with IIS3DWB (5 kHz) – STEVAL-BFA001V2B

**IO-Link stack available by end Q3

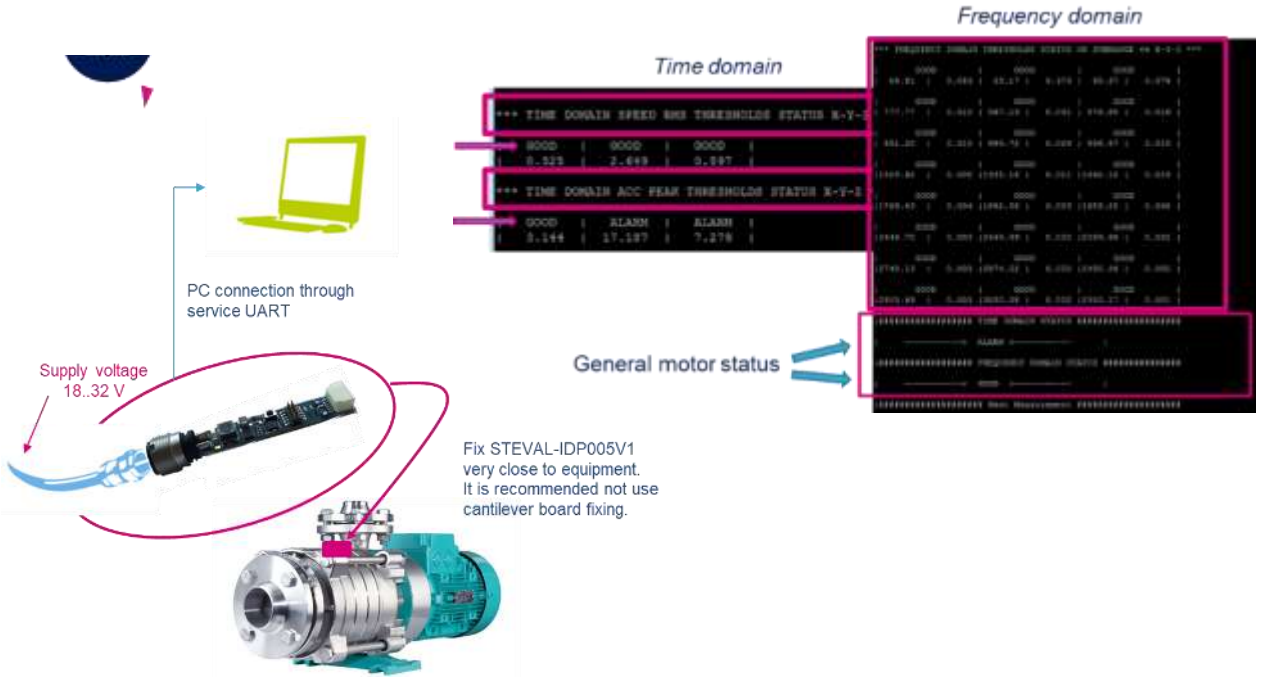
link

STEVAL-BFA001V1B

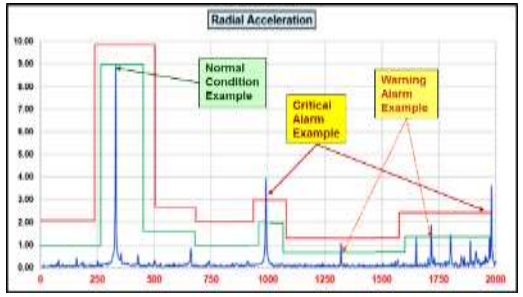
Demonstration Firmware

Two ways to work with STEVAL-BFA001V1B

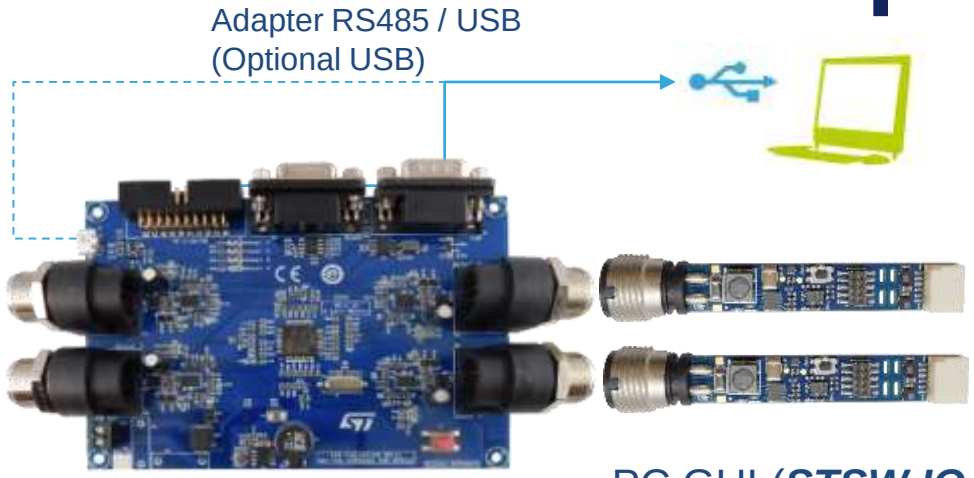
STEVAL-BFA001V1B Stand Alone Sensor Node



Condition Monitoring and Predictive Maintenance demonstrations examples available



STEVAL-IPD004V1 Expand your capabilities up to 4 nodes



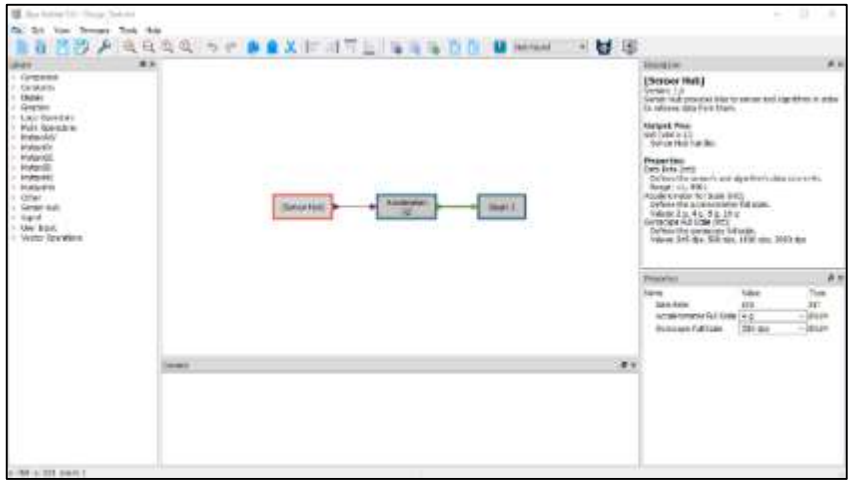
PC GUI (***STSW-IO-LINK***)

Condition Monitoring demonstrations example available

Support on SW:

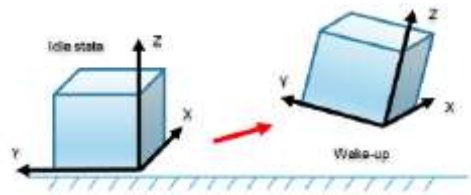
SW examples, libraries & Graphical Tools

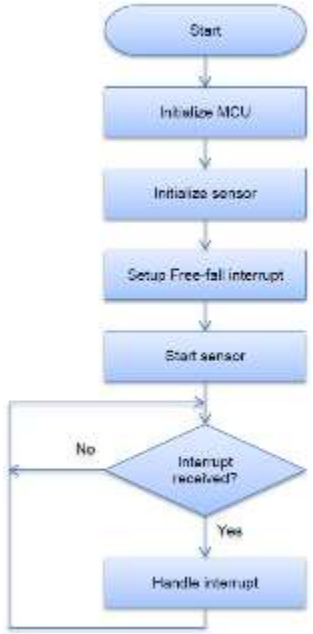
- >**22 libraries** / algorithms available
  - Integrated in CubeMX
  - FOC, ready to use (when STM32)
  - Possible customization
- SW available
  - Low Level Drivers, Examples:
    - Internal / External Web sources
  - Framework for project development (Functional Pack)
- **AlgoBuilder** graphical tool to handle in a simple way these libraries
- **Unicleo-GUI** common Graphical User Interface for all ST Boards



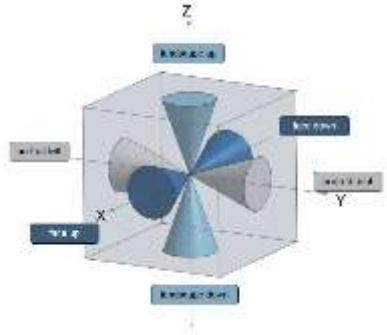
Support on HW design:
Design Tips

- Description and utilization of embedded features of ST accelerometers:
  - 6D
  - Wake-up
  - Tap / Double Tap
  - Single data conversion
  - Freefall





- Flow charts
- Recommended sensor configurations
- Example source codes for LIS2DW12, LIS2DH12,…
- Available on st.com



life.augmented

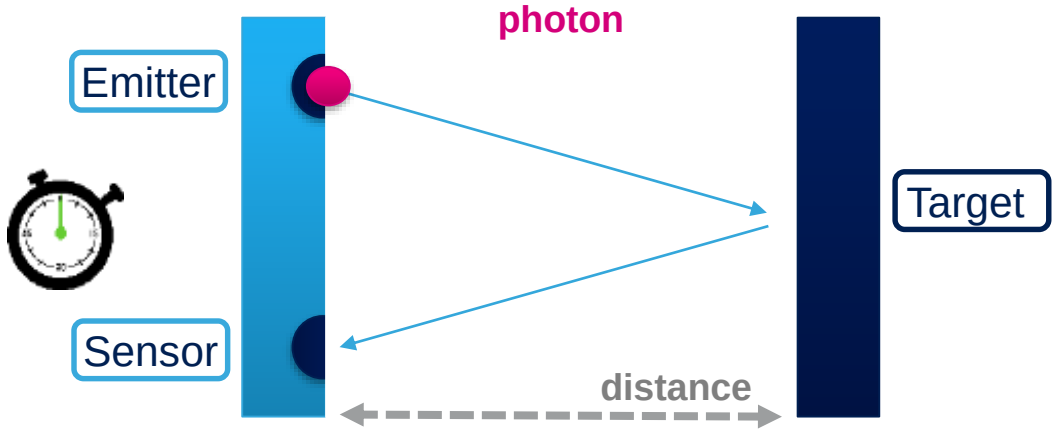
FlightSense, ToF

life.augmented

Flightsense™ Breakthrough Technology

Measurement at the speed of light !

FlightSense™ Principle



Measured distance = Photon travel time / 2 x Speed of light

Light is 1 million times faster than sound

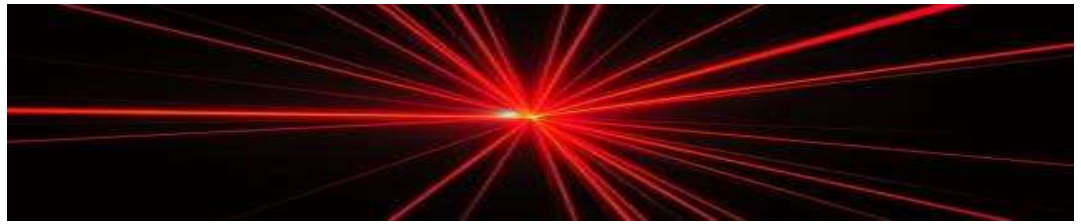
Key benefits:

Direct distance measurement
Independent of target size, color & reflectance

Fully Integrated Time of Flight Module
ST #1 World Wide Supplier

Very fast (few ms)

Low power



life.augmented

FlightSense – Key features

VL6180X	VL53L0X	VL53L1X
Proximity, gesture & ALS sensor	Ranging and gesture sensor	Long distance ranging sensor
Proximity distance measurement **Proximity detection** **Accuracy of ±10mm*** 2.8 x 4.8 x 1 mm package	**Up to 2 meters distance measurement** **<250uW in low power mode** **Accuracy of ±3 %*** **4x Programmable modes** (speed, distance, power, accuracy) 2.4 x 4.4 x 1 mm package	**Up to 4 meters distance measurement** **Programmable FoV** **Accuracy of ±2 %*** **Improved performance under ambient light** **High flexibility on programmable modes** 2.5 x 4.9 x 1.56 mm package

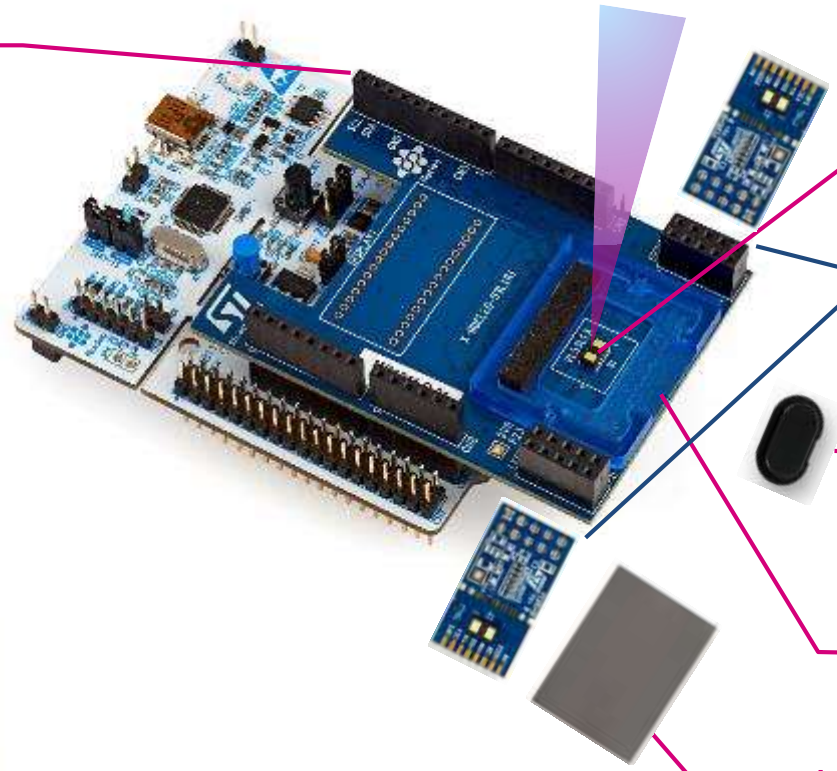
life.augmented

*Depending on conditions like Ambient light, target reflectance and product settings

VL53L1X Nucleo Pack – STM32F401RE based

Distance measurement, selectable ROI

Arduino
Connectors



VL53L1X
Ranging sensor

2 connections for external VL53L1X satellites

Clip Cover Glass
(PMMA material. Low XTalk)

Cover Glass holder
(Can hold Cover Glass and spacers)

Cover glass sample
And Spacers
to create various air gaps below CG

Graphical User Interface

Order code:

P-NUCLEO-53L1A1/ (with STM32F401RE “Full features”)
X-NUCLEO-53L1A1/ (expansion board stand alone)

life.augmented

Takeaway: Why Choose ST ?

Our Strenghts

- ST'S MARKET-PROVEN MANUFACTURING TECHNOLOGY
- HIGH-VOLUME MANUFACTURING CAPABILITY
- EXPERTISE IN MULTI-AXIS SENSOR INTEGRATION
- PARTNERSHIP WITH OEMS IN PRODUCT DEVELOPMENT
- Sensor to Cloud Tools, SW, libraries

Paving the Future with Unique Assets and Focused Market Leadership

life.augmented

Promotional tools: Sample Kits

Consumer

STEVAL-MKIT01V1

LSM6DSL, LIS2DW12, LIS2MDL, LPS22HB

Industrial

STEVAL-MKIT02V1

IIS2MDC, IIS2DH, ISM330DLC, IIS3DHHC

Environmental

STEVAL-MKIT03V1

STTS751, LPS22HH, LPS33HW, HTS221

Quick reference Guide

Quick reference guide
for MEMS & Environmental Sensors

1

The aim of this guide is to provide you with an overview of ST's MEMS & Sensors products as well as helping you with understanding their benefits, parameters and characteristics.

What MEMS & Sensors do we have in ST's portfolio?

Accelerometer
Accelerometers measure linear acceleration. ST's MEMS accelerometers embeds several useful features for motion and acceleration detection including for instance free-fall, wakeup, single/double-tap recognition, activity/inactivity detection and 6D/4D orientation. They can be also used for specific purpose such as inclination or vibration measurement. Output of ST's MEMS Accelerometer corresponds to [g], where 1g is equal to 9.81 m/s2 (standard gravity).

Gyroscope
Gyroscopes measure angular rate. They are usually combined with an accelerometer in a common package to allow advanced algorithms like sensor fusion (for orientation estimation in 3D space). In that case we call them iNEMO (Inertial Modules) or more generally IMU (Inertial Measurement Unit, which can also contain a magnetometer). Output of ST's MEMS gyroscope corresponds to [dps] (degrees per second).

$$1\ [dps] = \frac{\pi}{180}\ [rad/s]$$

Magnetometer
Magnetometers measure magnetic field such as Earth's magnetic field. They can be packed in combination with an accelerometer to allow in application tilt compensation. Devices integrating both, magnetometer and accelerometer in one package are called E-Compasses. Output of ST's Magnetometer corresponds to [gauss] (usually abbreviated as [G] or [Gs].

$$1\ [G] = 100\ [\mu T]$$

Atmospheric pressure
Pressure sensors measure absolute ambient pressure (barometer). They are commonly used for indoor navigation (floor detection) or weather monitoring. Output of ST's Pressure sensor corresponds to [hPa].

$$1\ [hPa] = 1\ [mbar] \sim 0.0145\ [psi]$$

Humidity
ST's Humidity sensor integrates the temperature and relative humidity sensors in the sensing element. Outputs correspond to [%RH] and [°C].

Temperature
There are analog and digital temperature sensors in our portfolio for absolute ambient temperature measurement. Voltage is directly proportional to the absolute temperature in case of analog temperature sensors. Output of digital temperature sensor corresponds to [°C].

Microphone
MEMS microphone senses voice or sound/ultrasound. There are two types of microphones: Analog and Digital. Both types can be directly connected to microcontroller (e.g. to STM32). ST's MEMS microphone output is single ended (analog) or PDM (digital).

Proximity
Unlike other proximity sensors that use simple IR (Infra-Red) technology, which only measure signal strength and can be affected by the object's reflectivity, ST's FlightSense™ sensors directly measure distance to the object based on the time for emitted photons to be reflected, enabling accurate distance ranging regardless of the object's surface characteristics.

life.augmented

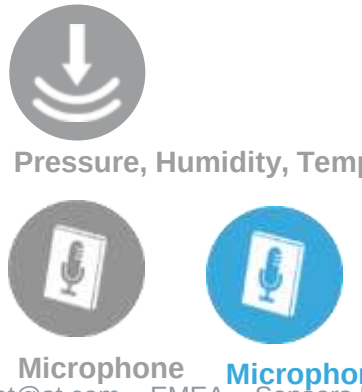
TOP SELLING MEMS Products

- **Consumer** AXL: **LIS2DE12 / LIS2DH12 / LIS2DW12 / LIS2DTW12 / LIS25BA**
- **Consumer** High-g: AXL (up to 400g): **H3LIS100DL / H3LIS200DL / H3LIS331DL**
- **Industrial**: **IIS328DQ / I3G4250D / IIS2DH / IIS2DLPC / IIS3DHHC / IIS3DWB / IIS2ICLX**
- **Automotive** AXL: **AIS328DQ / AIS3624DQ / AIS2DW12 / AIS2IH**

- **Consumer** Magnetometer and 6-Axis e-Compass: **LSM303AGR / LSM303AH / LIS2MDL**
- **Industrial** Magnetometer, e-Compass: **ISM303DAC / IIS2MDC**

- **Consumer** 6-axis IMU (A+G): **LSM6DSL / LSM6DSO / LSM6DSOX / LSM6DSR / LSM6DSRX**
- **Industrial** 6-axis IMU: **ISM330DLC / ISM330DHCX**
- **Automotive** Gyro and 6-axis IMU: **A3G4250D / ASM330LHH**

- **Environmental Sensors**: **LPS22HH / LPS33HW / HTS221 / STML20 / STTS751 / LPS33W / LPS27HHW / STTS22H**
- **Microphones**: **MP23ABS1 / MP34DT05-A / MP34DT06J / MP23DB01HP / MP23DB02MM**
- **Industrial** Microphone: **IMP34DT05**



life.augmented

In Mass Prod / New Product in Mass Prod / Sample available for alpha customers

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

For EMEA – a dedicated team

Product Marketing:
gildas.henriet@st.com

Technical support
ams-support-emea@st.com

On st.com, you can subscribe to (after registration):
MEMS and Sensors newsletter (quarterly)
ST News & Updates newsletter (monthly)

life.augmented