

# SENSOR highlights

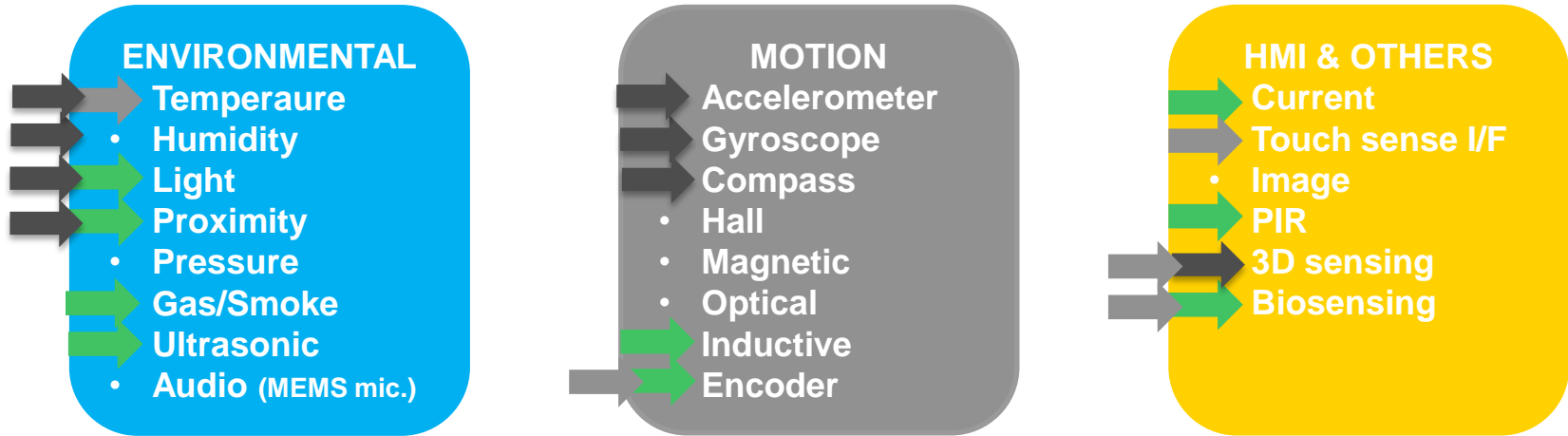
E.Marinoni – v 1.0 January 2018

**AVNET**<sup>®</sup> SILICA



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# SENSOR categories overview



- **Not only pure sensor elements**
- **Combined functions**
- **Sometimes integrated in the MCU**



# LIS2DW12

ultra low-power high performance 3-axis femto

Ultra low power, high-performance and small package combined into a single product

- Wide supply voltage: 1.62 to 3.6V
- Independent IO supply
- Ultra low power consumption:
  - 50nA in low power mode
  - below 1uA in active low-power mode
- Very low noise: down to 1.3 mg RMS in low-power mode
- Multiple operating modes with multiple bandwidths
- $\pm 2g/\pm 4g/\pm 8g/\pm 16g$  full scale
- Single data conversion on demand
- 32 level FIFO
- Embedded temperature sensor
- 10000g shock survivability
- Ultra small: 2.0 x 2.0 x 0.7mm LGA package



Parameter	High-Performance Mode	Low-Power Mode 4	Low-Power Mode 3	Low-Power Mode 2	Low-Power Mode 1
Resolution [bit]	14-bit	14-bit	14-bit	14-bit	12-bit
ODR [Hz]	12.5 - 1600	1.6 - 200	1.6 - 200	1.6 - 200	1.6 - 200
BW [Hz]	ODR/2 (N/A for 1600 Hz), 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 [ $\mu g/\sqrt{Hz}$ ] @ FS = $\pm 2g$ , ODR=200 Hz	110	160	210	300	550
Current consumption [ $\mu A$ ] @ Vdd=1.8 V	ODR=1.6 Hz	-	0.65	0.55	0.38
	ODR=12.5 Hz	90	4	2.5	1
	ODR=25 Hz	90	8.5	4.5	1.5
	ODR=50 Hz	90	16	9	3
	ODR=100 Hz	90	32	17.5	5
	ODR=200 Hz	90	63	34.5	10
	ODR=400, 800, 1600 Hz	90	-	-	-

1.5 $\mu A$  @  
25Hz

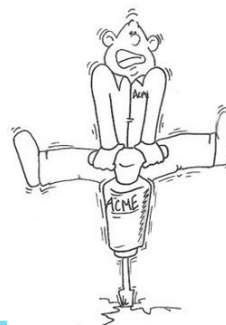
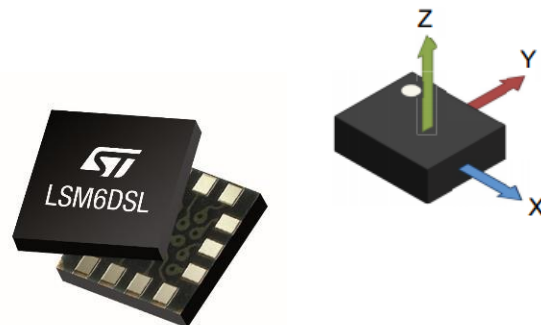
try this vs. ADI ADXL362

# ST accelerometer comparison

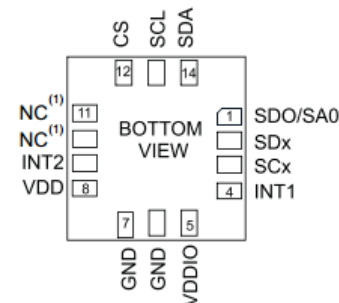
	LIS2DW12	LIS2DS12	LIS2HH12	LIS2DH12	LIS2DE12
Package (mm)	2x2x0.7 – LGA-12	2x2x.86 – LGA-12	2x2x1 – LGA-12	2x2x1 – LGA-12	2x2x1 – LGA-12
Full scales (g)	±2/±4/±8/±16	±2/±4/±8/±16	±2/±4/±8	±2/±4/±8/±16	±2/±4/±8/±16
Resolution	5 modes: Low power (12 bit), 4x High res (14 bit)	3 modes: Low power (10 bit), 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

## Features

- Sel.  $\pm 2/\pm 4/\pm 8/\pm 16$  g accel. full scale
- Sel.  $\pm 125/\pm 245/\pm 500/\pm 1000/\pm 2000$  dps gyro full scale
- Power consumption:
  - 400  $\mu$ A in combo normal mode
  - 650  $\mu$ A in combo high-performance mode
- SPI & I2C serial interface with main processor data synchronization feature
- Smart FIFO up to 4 kbyte based on features set
- Android M compliant
- Hard, soft ironing for external magnetic sensor corrections
- Compact footprint, 2.5 mm x 3 mm x 0.83 mm
- Pedometer, step detector and step counter
- Significant motion and tilt function
- Standard interrupts: free-fall, wakeup, 6D/4D orientation, click and double-click
- Embedded temperature sensor



**Vibration monitoring  
application up to 3.3Khz  
(6.6Khz ODR)**



### Inertial module tailored for industry 4.0 applications

#### Features

- Sel.  $\pm 2/\pm 4/\pm 8/\pm 16$  g accel. full scale
- Sel.  $\pm 125/\pm 245/\pm 500/\pm 1000/\pm 2000$  dps gyro full scale
- 16 bit resolution
- $90 \mu\text{g}/\sqrt{\text{Hz}}$  typ. accelerometer noise density
- SPI & I2C serial interface with main processor data synchronization feature
- Smart FIFO up to 4 kbyte based on features set
- Sensor hub feature to efficiently collect data from additional external sensors
- Embedded hard, soft ironing for external magnetic sensor corrections
- Embedded temperature sensor
- Embedded self-test both for gyroscope and accelerometer
- High shock survivability
- Extended operating temperature range ( $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ )



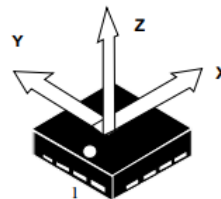
Ultra high-resolution  
temperature  
behaviour

3-axis accelerometer specific for high precision INCLINOMETER

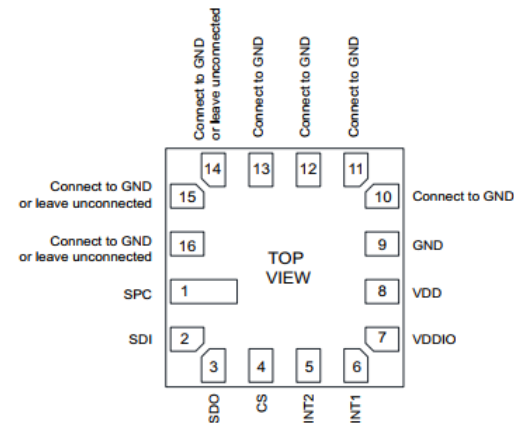
LIS3DHH

## Features

- 16bit accelerometer
- Supply voltage 1.7 to 3.6V
- Full -Scale +/-2.5g
- Zero-g noise density : 45 $\mu$ g/ $\sqrt{\text{Hz}}$  (Max)
- High StabilityZero-g level change vs. temperature <0.4mg/°C
- Sensitivity change vs. temperature < 2%
- Embedded FIFO 32 Levels
- SPI 4-Wire digital output Interface
- Embedded temperature sensor (12-bit data output)
- CeramiccavityLGA16 5x5x1.7mm



(TOP VIEW)  
DIRECTION OF THE  
DETECTABLE  
ACCELERATIONS

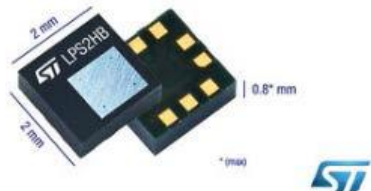


DIL24 socket  
available for fast  
prototyping

P/N STEVAL-MKI180V1

Optimizing the main blocks, we enhanced the performances: **better noise, improved accuracy and reduced current consumption**

World's smallest  
pressure sensor

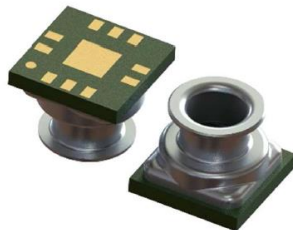


### Features

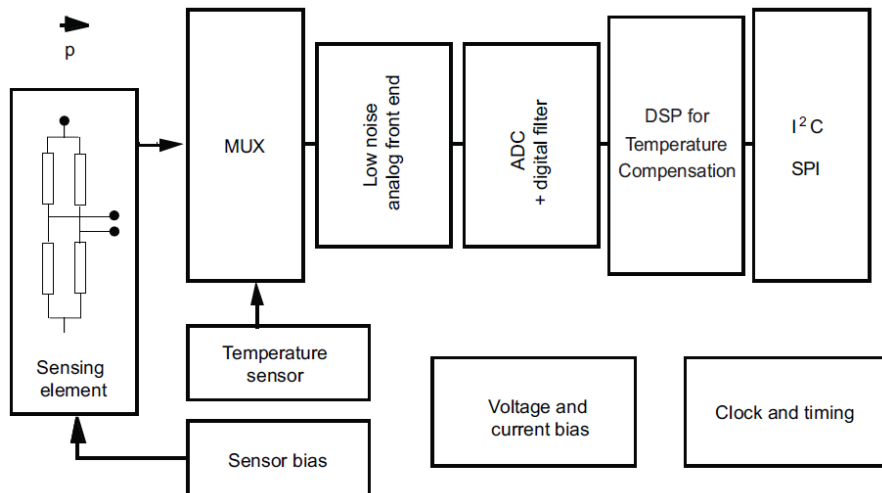
- 260 to 1260 mbar absolute pressure
- Pressure noise: down to 20 $\mu$ bar & **7.5 $\mu$ bar (LPF)**
- ODR from 1 to **75Hz**, one shot
- Low power consumption: **12 $\mu$ A**(low noise) to **3 $\mu$ A**(low power) @1Hz
- 32 samples Embedded FIFO for **Pressure and Temperature**
- SPI and I<sup>2</sup>C interfaces
- Smallest and thinnest form factor: 2x2x0.76 mm package

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





CCLGA 10L 3.3 x 3.3 x 2.9 mm



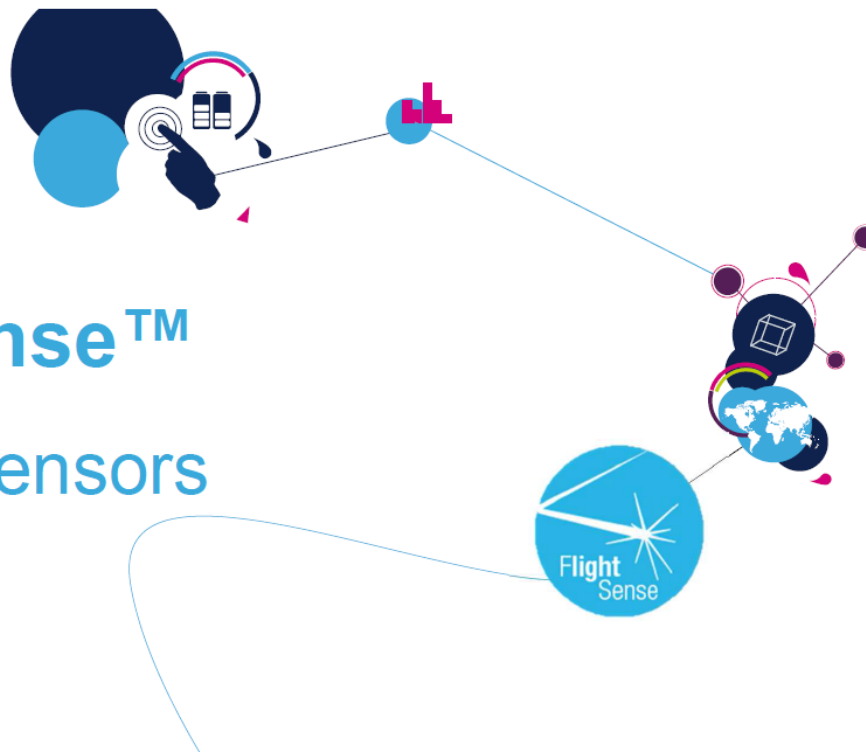
### Features

- 260 to 1260 mbar absolute pressure
- Less than 1Pa RMS of noise
- ODR from 1 Hz to 75 Hz
- Low power consumption: 4  $\mu$ A
- SPI and I<sup>2</sup>C interfaces
- High shock survivability: > 20,000g
- Embedded FIFO

**ISO 22810 Horology Certified**  
**(Water Resistant Watches Standard)**  
**IEC60529 (IP Code): IPx7 and IPx8 certified**

# FlightSense™

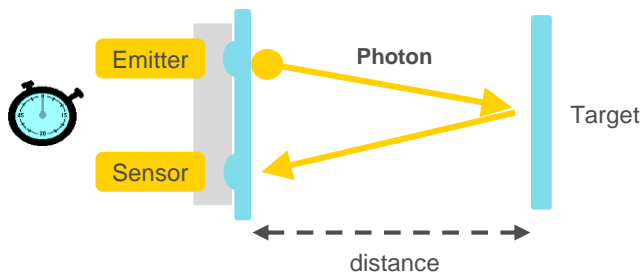
## Ranging sensors



Measurement at the speed of light ! 1cm round-trip at 67ps

3.3ps / mm !!

## FlightSense™ Principle



$$\text{Measured distance} = \text{Photon travel time / 2} \times \text{Speed of light}$$

**Fully Integrated Time of Flight Module**

*ST #1 World Wide Supplier*

**True distance measurement**

*Independent of target size, color & reflectance*

**Very fast (few ms)**

**Low power**



FlightSense™ by ST is the only technology on the market today offering accurate measurements with tiny and low power modules



	Conventional IR technologies	ST FlightSense™
Signal Amplitude	Yes	Yes
Real distance output	No (computed)	Real distance in mm (readable thru i2C register)
Maximum distance	20cm	up to 2 meters <sup>(1)</sup>
Works with all objects color and reflectance	No	Yes even black (3%), gloves, ...
Gesture control Tap vs Swipe	No	Yes



## VL6180X

- Proximity, Gesture & ALS sensor
- Up to 40cm Ranging

### Proximity & Ambient Light Sensing

Small 3-in-1 module, 4.8 x 2.8 x 1.0 mm

850nm IR emission (Vcsel)

Advanced microcontroller and light rejection

Gesture control capability

Proximity detection and ranging,  
Smart lighting



## VL53L0X

- Ranging sensor
- Up to 2m ranging

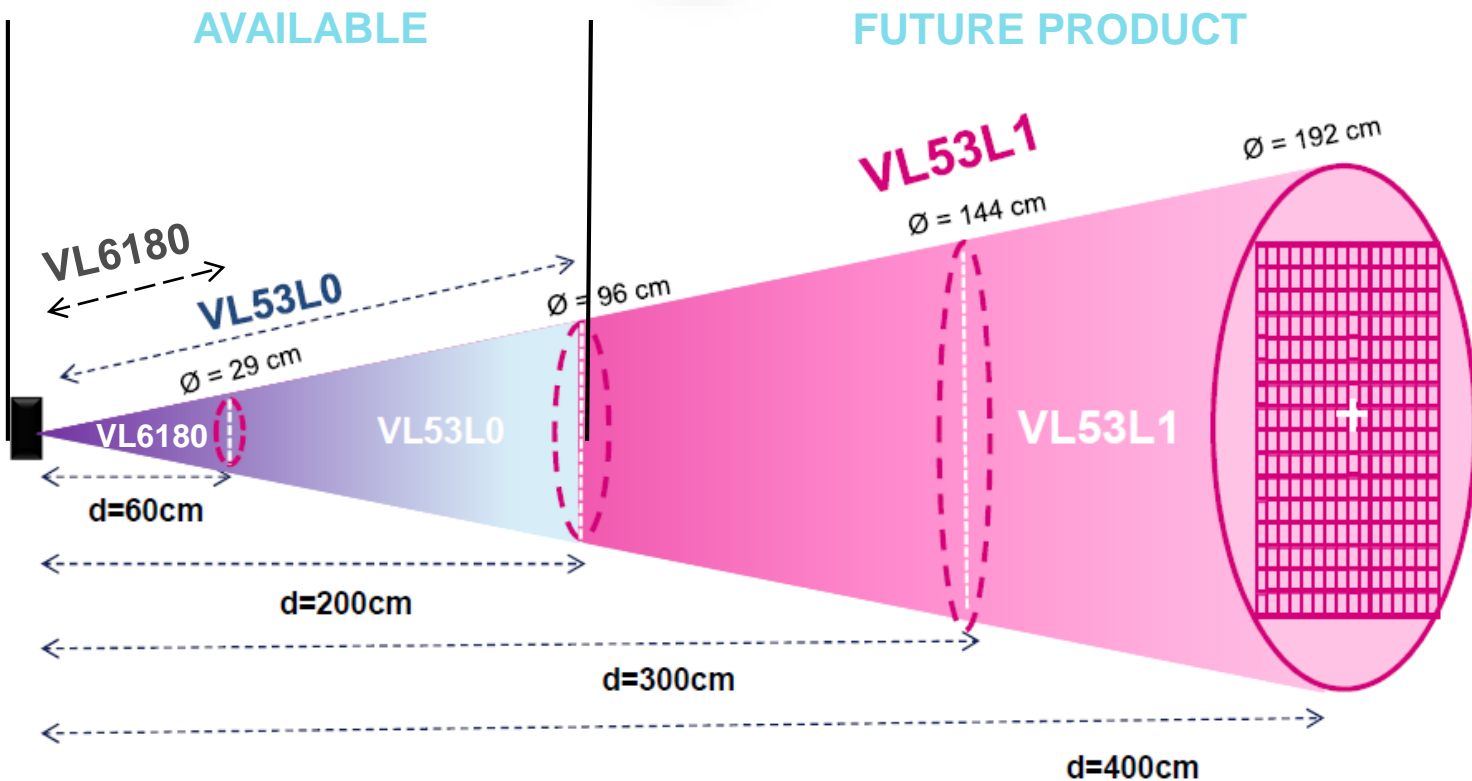
- Smallest ToF sensor in the market
  - Miniature 4.4 x 2.4 x 1.0 mm
- 940nm IR emission (Vcsel)
- Advanced microcontroller and light rejection
- User detection, long ranging

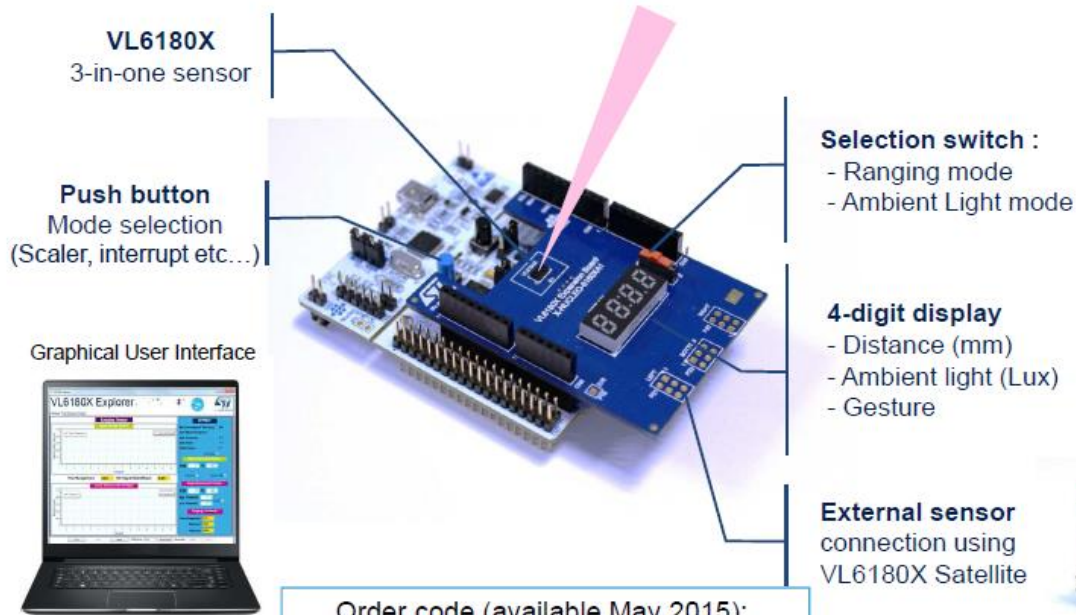


## VL53L1X

- Multi object ToF sensor
- Up to 4m ranging

- Full FoV ranging : 400cm+ (white target, no IR)
- Multi-object detection and Xtalk free
- Multi-zone scanning capable (100+ combinations for array selection)
- Enhanced speed (60Hz / ranging)



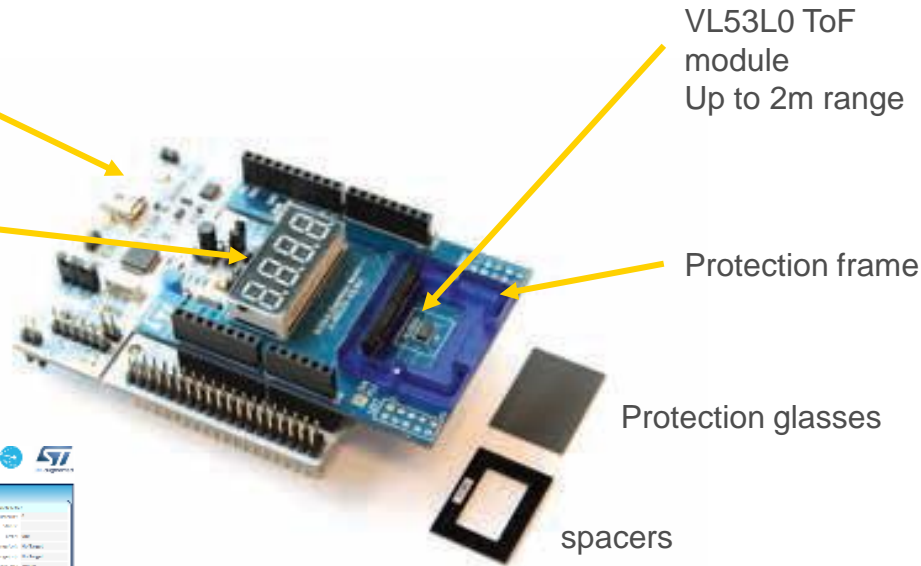
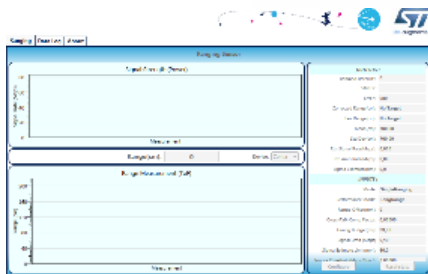


Order code (available May 2015):  
P-NUCLEO-6180X1 (with stm32F401)  
P-NUCLEO-6180X2 (with stm32L053)  
X-NUCLEO-6180XA1 (expansion board)

STM32F401  
MCU platform

4DGT LED  
Dysplays range

Windows GUI  
for evaluation



p/n: **P-NUCLEO-53L0A1** (complete system)

p/n: **X-NUCLEO-53L0A1** (shield only)



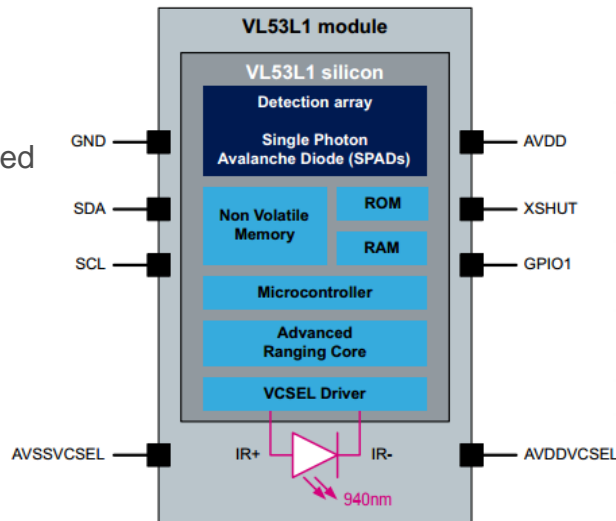
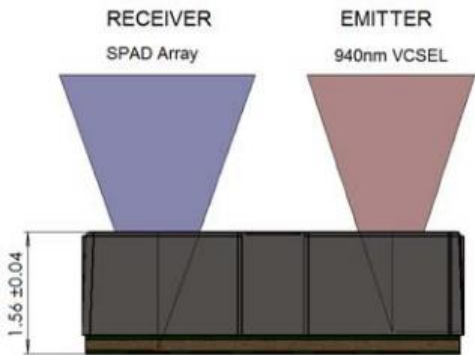
## Advanced multi-zone and multi-object detection

### Fully integrated miniature module






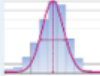
- Emitter: 940nm invisible laser (VCSEL) and its analog driver
- Receiving array with integrated lens
- Low-power micro-controller running advanced digital firmware
- Size: 4.9 x 2.5 x 1.56mm

### Fast, accurate distance ranging

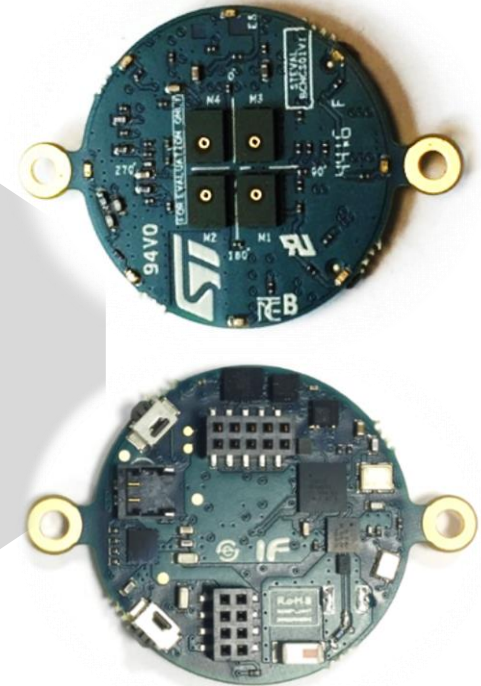
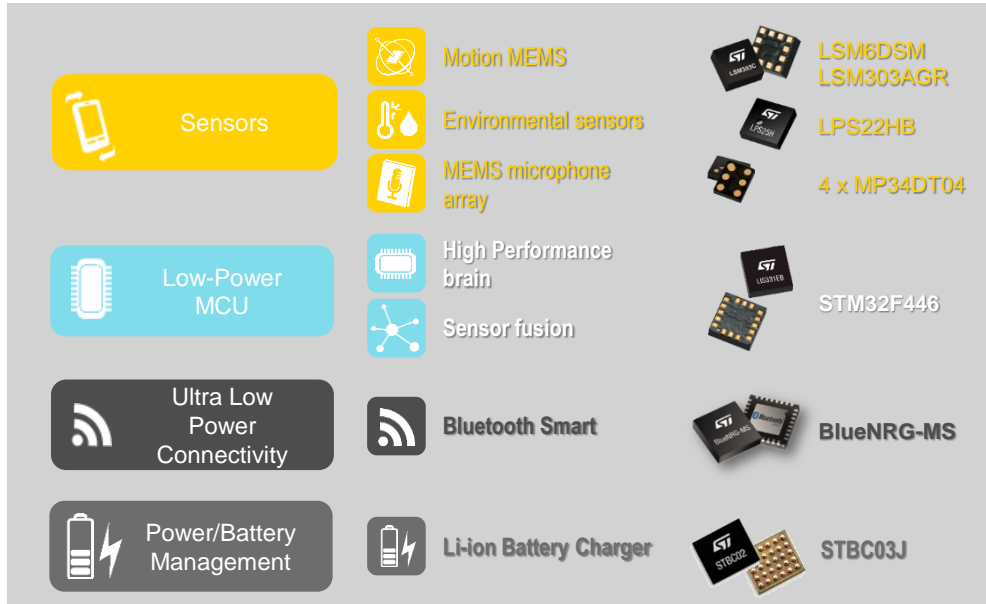
- **400cm+** detection with full FoV
- 60Hz ranging capable up to 300cm
- Immune to coverglass cross-talk and fingerprint smudge at long distance with patented algorithms (direct ToF)
- Multi-object detection capable
- Multi-zone scanning with selectable array (2x2, 3x3, 4x4, or defined by user through software)



## MEMS vs. ECM microphones

		MEMS Microphones	ECM: Electret Condenser Microphones
Soldering		Easy Reflow	Temperature stability issue: requires additional controls
Form Factor		Convenient for ultra thin or multiple Mics designs	Usually bigger
Vibrations Robustness		More robust	requires rubber gasket
Temperature		Immune to variation	Impacted
Electromagnetic Interferences		Immune (package is a Faraday cage)	More impacted
Part-to-part Sensitivity Matching		Excellent (+/- 0.2dBFS standard deviation)	Difficult

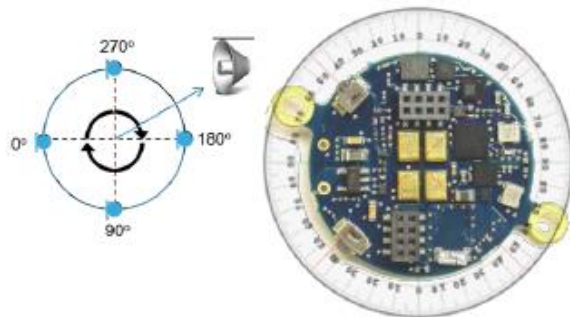
## STEVAL-BCNKT01V1



## osxAcousticSL

### Sound Source Localization

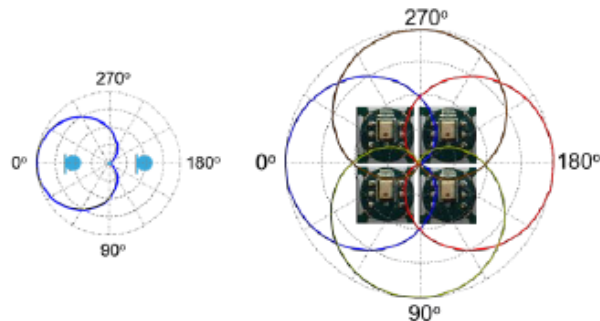
Estimates the angle of arrival of audio signal using a MEMS microphone array



## osxAcousticBF

### Beamforming

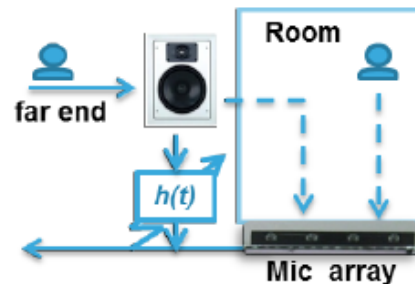
Small and compact directional virtual microphone based on ST MEMS microphone array



## osxAcousticEC

### Acoustic Echo Cancellation

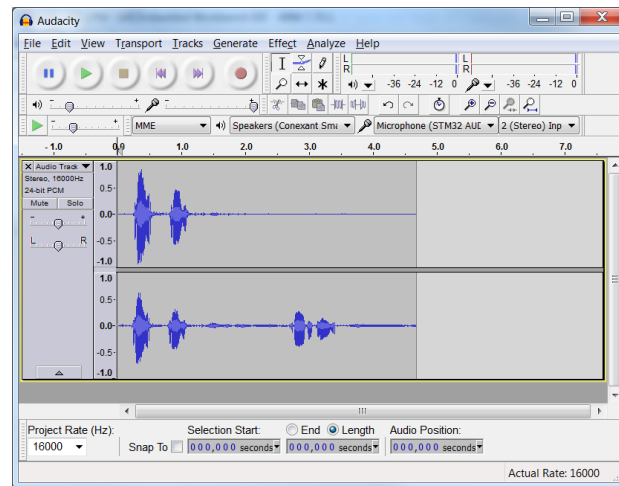
Based on the *Speex.org* Open Source libraries



**μ4(micro-4) architecture :The smallest microphone array architecture ever!**  
Microphone's sound inlets are just 3mm away from each other

# Bluecoin – the Robotic Ear

## DEMO set up



BlueCoin starter kit  
p/n **STEVAL-BCNKT01V1**

**SMARTMIC1 GUI**  
Included in the  
SMARTMIC1 library  
package



**FREE AUDIO  
RECORDER**  
Like i.e. Audacity





Thank you!