

ST SENSOR overview

March 2016





Accelerating Your Success



ST SENSOR categories overview

ENVIRONMENTAL

- Temperature
- Humidity
- Light
- Proximity
- Pressure
- Audio (MEMS mic.)



MOTION

- Accelerometer
- Gyroscope
- Magnetometer







HMI

- Touch sense I/F
- Image
- 3D sensing
- Biosensing









FlightSense™ ranging sensors

FlightSense[™]

Ranging sensors



An Avnet Compar









- How many ways there are to measure a distance ?
- How to select the right technology by application ?

Massurament type	Target objects	Minimum	Maximum	Resolution	Linearity
	Target Objects	distance	distance	range	range
Capacitive sensor	potentially any	< 0.05 mm	~ 10 mm	<1nm	< 10 nm
Inductive sensor (eddy current)	Ferromagnetic material	< 0.5 mm ~ 80 mi		< 1 µm	< 10 µm
IR/Laser triangulation sensor	light reflective materials	< 2 mm	~ 1000 mm	< 10 um	< 100 µm
Laser "Time-of-Flight" sensors	light reflective materials	< 2 mm	~ 100 m	<1mm	< 5 mm
Ultrasound "sonar" sensors	sound reflective materials	< 20 mm	~ 5 m	< 5mm	< 5 mm
IR - reflected light intensity	light reflective materials	< 10 mm	~ 500 mm	< 10 mm	< 50 mm
Camera stereovision (passive triangulation)	light reflective materials	< 100 mm	8	< 20 mm	~0.1%
structured light camera (active triangulation)	light reflective materials	< 20 mm	~ 30 m	< 20 mm	~0.1%
3D camera "Time-of-flight"	light reflective materials	< 30 mm	~ 10 m	< 1 mm	< 5 mm
RADAR (24Ghz industrial/automotive)	radio-waves reflective materials	<1m	~ 30 m	n/a	n/a

 ranges and resolutions are very dependant from the product configuration and the specific target type.











FlightSense™ ToF principle explanation

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









FlightSense[™]

ToF distance measurement system

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



	Conventional IR technologies	ST F light Sense [™]
Signal Amplitude	Yes	Yes
Real distance output	No (computed)	Real distance in mm (readable thru i ² C register)
Maximum distance	20cm	up to 2 meters ⁽¹⁾
Works with all objects color and reflectance	No	Yes even black (3%), gloves, …
Gesture control Tap vs Swipe	No	Yes











FlightSense[™] available products

VL6180X

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

In Mass production

- 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 200cm ranging

Mass Market availability : May 2016

- 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









COMING SOON

SCL

SDA

GPI01

XSHUT

OON FlightSense™ ... for higher distances... VL53L0

Fully integrated miniature module

- 940nm Laser VCSEL
- Ranging sensor with advanced embedded microcontroller
- 4.4 x 2.4 x 1.0mm

Fast, accurate distance ranging

- Measures absolute range beyond 2m
- Reported range is independent of the target reflectance
- Operates in high IR ambient light levels Advanced embedded optical cross-talk compensation to simplify cover glass selection

Eye safe

Easy integration

- Single reflowable component
- No additional optics
- Single power supply
- I2C interface for device control and data transfer
- Xshutdown (Reset) and interrupt GPIO

1D gesture recognition







VL53L0 Module

Slow OSC

MCU Reg Bank

Ranging Core

Core Reg Bank

VCSEL Drive

Host Reg Bank

MOU

RAM

MCU Reg Bank

NVM

ROM

IR+





AVDD

AVSS





Memec



Environmental sensors













MEMS microphones

MEMS vs. ECM microphones













MEMS microphones ev boards

X-NUCLEO-CCA02M1

- MEMS microphone evaluation board
 - STM32Nucleo Expansion, compatible with STM32 ODE
- 2X MP34DT01–M microphones
- 1x miniUSB FS connector:
 - USB audio data streaming
- Up to 4 microphone synchronized acquisition and streaming
- 6X ST MEMS Microphone coupons housing: _______STEVAL_MKI129V1



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STEVAL-MKI129V1 STEVAL-MKI129V2 STEVAL-MKI129V3





USB Connector





MEMS mic.ev boards sw libraries

- PDM filter library
 - It converts from PDM to PCM
- Acoustic echo cancellation
- Beamforming
 - It creates a virtual directional microphone using 2 or 4 microphones
- Audio source localization
 - Localize the sound source over the 360° space using 4 microphones











LPS22HBHigh Accuracy Barometric Sensor / altimeter

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

World's smallest pressure sensor

life.auamented





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Key parameters

- 260 to 1260 mbar absolute pressure (10,000 mt altitude)
- Pressure noise: down to 20µbar & 7.5µbar (LPF)
 - Less than 10cm noise up to 4000 mt
- ODR from 1 to **75Hz**, one shot
- Low power consumption: 15µA (low noise) to 3µA (low power) @1Hz
- 32 samples Embedded FIFO for Pressure and Temperature
- SPI and I²C interfaces
- Smallest and thinnest form factor: 2x2x0.76 mm package







HTS221

humidity + temp. sensor



• Features:

- Humidity (0 to 100% RH) and temperature (-40 to 120 °C) sensor
- Humidity Accuracy ±3.5%RH (20%RH to 80%RH)
- Low Power Consumption: 2 µA @ 1Hz ODR
- SPI and I²C interfaces
- Self-Test





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UVIS25M UV Index Sensor



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Features

Jew!

- 0 15 UV index output range
- Threshold interrupt management
- No factory calibration needed
- UVI available with no need for computation
- Interruption on UV value threshold
- Digital output
- Active and power down modes
- Wide field of view measurement



Key Features

Digital, no calibration needed UVI with UV-A & UV-B computation









MEMS Motion sensors











MEMS Motion sensors

- MEMS is Micro Electro-Mechanical Systems
- MEMS contain movable 3D structure
- Structure move accordingly to external displacement
- In MEMS not only electrons are moving!









MEMS Motion sensors

Accelerometer

- Measures
 acceleration
- Unity measured:
 g (1g is gravity –
 9.8m/sec²)
- Can measure up to 400g!

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Gyroscope

- Measures angular rate
- Unity measured: DPS (Degree Per Second)

(Inertial Measurement Unit)

iNEMO®

• It's power hungry!

Magnetometer

- Measures earth magnetic field
- Unity measured: Gauss
- Measured magnetic field is 1000 times lower than conventional magnetic sensors!

AVINE7

Memec



LIS2DS12 14bit, 3-axis, low power digital accelerometer

- 3-Axis Digital SPI/I2C Accelerometer from ±2 to ±16 g Full Scale
- Up to 14 bit resolution
- Operating voltage: 1.62 1.98V
- Accuracy

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- Sensitivity: 0.244 mg
- 0g offset: ±30mg
- Noise density: $140\mu g/\sqrt{Hz}$
- Temperature drift: ±0.3 mg/°C
- Very low power
 - 2.5µA in Low Power Mode (1Hz)
 - 150µA in High Resolution Mode (6.4KHz)
 - 12.5µA/150µA in LPM/HRM (100Hz)
 - 0.5µA in Power down mode
- 2x2mm LGA12 package







Key Features

- Big FIFO: allow data storage with no MCU access
- Pedometer and motion detection algorithms
- Sensor HUB allows acquiring data from 1 external sensor







ST MEMS accelerometer table

An Avnet Company

Amplications	Package size (mm)					Fastures	
Applications	2 x 2 x 1 mm		3 x 3 x 1 mm		> 4 x 4 x 1 mm	Features	
Consumer & Industrial			12-bit	HLIS331DL			
			8-bit	H3LIS100DL H3LIS200DL		High-g	
			12-bit	LIS331HH			
	16-bit	LIS2HH12	LIS3DSH (smart AXL)				
	14-bit	LIS2DS12					
	12-bit	LIS2DH LIS2DH12	LIS3DH			Low-g	
	8-bit	LIS2DE LIS2DE12	LIS3DE				
			LI344ALH			Analog	
Long-life applications		IIS2DH			IIS328DQ	10-years commitment	
Automotive non- safety					AIS328DQ AES3624DQ	AEC 0400	
Automotive safety (central & peripheral airbags)				AIS1120SX AIS2120SX AIS1200PS		qualified	
Medical		MIS2DH				For implantable devices	
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LSM303AGR high performance e-compass module

MEMS eCompass

- 3-axis accelerometer: up to ± 16g full-scale, LIS2DH12 based
- 3-axis magnetic sensor: ± 50Ga FS
 - Resolution down to 2.5 mGa RMS
 - 10, 20, 50, 100,-OneShot ODR
- Embedded temperature sensor
- Embedded Self test for both sense
- Embedded magnetic Offset coppensat
 - No offset thermal drift
- LGA-12, 2x2, P2P compatible with LSM303C, LIS2DH12, LIS2HH12, LIS2DS12



Key Features

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







LSM6DS3 iNEMO 6 axis Inertial Measurement Unit





LSM6DS3 **iNEMO 6** axis Inertial Measurement Unit

- Low Power
 - 420µA for Accelerometer and Gyro running in Low Power Mode
 - 0.9mA in Normal Mode and 1.25 mA in high performance mode (up to 1.6 KHz) ٠
 - 24µA for the accelerometer in Low Power Mode at ODR <52 Hz ٠
 - 6µA in Power Down mode •
- Low noise level
 - Gyro noise 7 mdps/√Hz
 - Accel noise 90 $\mu g/\sqrt{Hz}$
- Extended digital features
 - Smart FIFO up to 8 Kbytes with dynamic allocation of significant data
 - external sensors, time stamp
 - Sensor Hub:
 - Up to 4 external sensors with configurable data acquisition (synchro., data rate, Nb of data)
 - I2C Master / Aux SPI to collect data from external sensors.
 - Hard-Iron/Soft-Iron correction for external magnetic sensor corrections
 - Event detection interrupts, fully configurable •
 - Tap/double tap, Free-fall, activity-inactivity recognition, Wake-up, 6D-4D orientation
 - Advanced algorithm embedded •
 - Significant motion, tilt, pedometer functions (Step detector and step counters)

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LSM9DS1 high performance 9-axis Inertial Measurement Unit

Main Features

- 3-axis accelerometer: up to ± 16g
- 3-axis gyroscope: up to ± 2000dps
- 3-axis magnetic sensor: up to ± 16Gs
- FIFO, Temperature sensor
- Package: LGA-24, 3.5 x 3 x 1 mm
- Power Supply range: 1.9V to 3.6V

Key Features

- Package: 3.5x3x1 mm
- "Always-on" eco power mode: 1.9 mA
- Mag pwr consumption: 15 μA @ 1 Hz





Advanced Features

- "Always-on" eco power mode down to 1.9 mA
- Low power magnetometer
- Position and motion detection functions
- Click/double-click recognition
- Intelligent power saving for handheld devices







X-NUCLEO-IKS01A1

Motion MEMS and environmental sensor board

Hardware description

- The X-NUCLEO-IKS01A1 is a motion MEMS and environmental sensor evaluation board system.
- It is compatible with the Arduino UNO R3 connector layout, and is designed around ST's latest sensors.

Products on board

6-AXIS IMU: MEMS 3D accelerometer (±2/±4/±8 g) + 3D gyroscope (±245/±500/±2000 dps)

3-Axis Magnetometer: MEMS 3D magnetometer (±4/±8/ ±12/16 gauss)

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

HUMIDITY SENSOR: Capacitive digital relative humidity and temperature

DIL 24-pin: Socket available for additional MEMS adapters and other sensors (UV index)





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X-NUCLEO-IKS01A1 & Open.MEMS **Software libraries**

- X-CUBE-MEMS1 (v1.4.0)
 - Complete middleware to build applications using 6-axis IMU (LSM6DS0 / LSM6DS3), Magnetometer (LIS3MDL), Pressure sensor (LPS25HB) and Humidity/Temperature sensor (HTS221) raw data
 - Sample application to transmit real-time sensor data to a PC
 - Available for STM32F401, STM32L053, STM32L152 and **STM32L476RG**
- OsxMotionFX (v1.3) (X-CUBE-MEMS1 Add-on)
 - iNEMOEnginePRO real-time motion sensor fusion (under ٠ **OPEN.MEMS** license)
 - 6 & 9-axis sensor fusion available thru compilation option •
 - Available for STM32F401, STM32F411 and STM32L476RG
- OsxMotionAR (v1.1) (X-CUBE-MEMS1 Add-on)
 - Real-time activity tracking using accelerometer •
 - Detects: rest; walking; fast walking; jogging; biking; driving •
 - Available for STM32F401
- OsxMotionCP (v1.0) (X-CUBE-MEMS1 Add-on)
 - Real-time carried position using accelerometer

Detects: on desk; in hand; near head; shirt pocket; trouser pocket; arm swing:

Available for STM32F401

All libraries share one GUI











Development Toolchains and Compilers

- IAR Embedded Workbench for ARM (EWARM) toolchain V7.40
- **RealView Microcontroller** Development Kit (MDK-ARM) toolchain V5.16
- System Workbench for STM32 V1.3.0.20150724



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Thank you.







