LOW-POWER SENSORS

EUF-INS-T2290

OCTOBER 2016

NXP

SECURE CONNECTIONS
FOR A SMARTER WORLD

BL Sensors: Introduction

Motion Sensor	Pressure Sensors	Magnetic Sensors

Accelerometers, Gyro, Magnetometer Auto & IoT

TPMS, Engine Mgnt, Medical & Industrial pressure

Angular for Engine Control ABS Speed Sensors

- All passive safety Tier-1's using NXP
- Next generation discrete & integrated UMEMS foundational for Auto & IoT
- Consumer/Industrial Gyroscope, e-compass & accelerometers.
- Active safety motion sensors

- Investing lowest power, smallest size solutions
- High accuracy pressure - flow measurements
- E-inhalers pressure sensors
- Analog differential pressure sensors

- Angular sensors: engine control & steering
- Speed wheel sensors for ABS
- AMR→TMR transition foundational

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NXP® SENSOR TECHNOLOGY SUPPORTS KEY APPLICATIONS

Automotive

INFRA RED

TIRE PRESSURE

PASSIVE SAFETY

SMART VEHICLE

IOT -> VEHICLE

ADAS

ACTIVE VEHICLE STABILITY

3 BILLION UNITS SHIPPED

Magnetic (MR)

Motion (MEMS)

Pressure (MEMS)

Medical & Industrial

HOUSEHOLD ROBOTICS

SMART CONSERVATION

CONNECTED LIFESTYLE

WEARABLES

QUANTIFIED WELLNESS

Accelerometers

- Detect acceleration resulting from tilt, motion, shock, and vibration
- Single, dual, or triple axis sensing capability with wide g ranges
- Applications
  - Activity monitors
  - Anti-tampering
  - Asset tracking
  - Crash detection
  - Human machine interface
  - Inclinometer
  - Pedometer
  - Vehicle stability
  - Vibration monitoring

NXP Accelerometer Typical Block Diagram

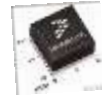FXLS8471Q Xtrinsic 14-bit Accelerometer Block Diagram
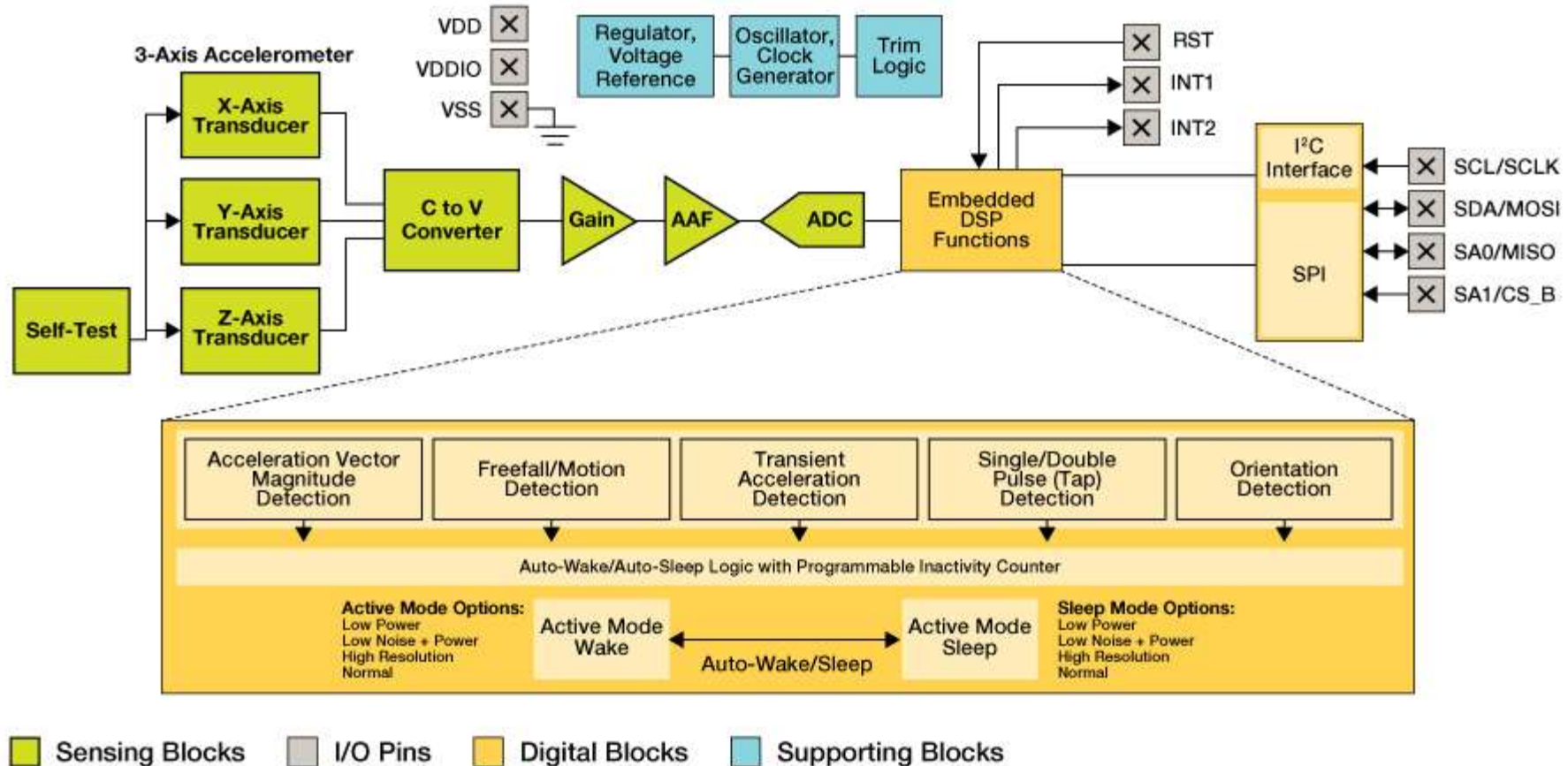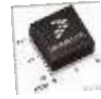
Accelerometers for the IoT / Industrial

MMA845x

- **3 x 3 x 1 mm QFN**
- I^2C output
- 0.25mg/count sensitivity
- Extended Features
  - FIFO
  - Configurable P/L trip angles
  - High Pass Filter

MMA865x

- **2 x 2 x 1 mm DFN**
- I^2C output
- 1 mg/count sensitivity
- Extended Features
  - FIFO
  - Configurable P/L trip angles
  - High Pass Filter

FXLS8962/72AF

- **2 x 2 x 1 mm DFN**
- SPI/I^2C/ one wire output
- < 650nA @ low ODR
- Cost Efficient
- High Performance
- Rich Features
  - P/L detection
  - High Pass Filter

MMA849x

- **3 x 3 x 1 mm QFN**
- I^2C output
- XYZ tilt detection outputs
- 700μs detection latency
- Trigger able sampling: 0.4μA/Hz

MMA83xx

- **3 x 3 x 1 mm QFN**
- Analog output
- Up to ±16g
- Up to 2.7kHz bandwidth
- 150 μg/√Hz noise density
- -40° to 105°C
- 1.7V to 3.6V

MMA8471

- **3 x 3 x 1 mm QFN**
- SPI /I^2C output
- 0.25mg/count
- Extended Features
  - FIFO
  - Configurable P/L trip angles
  - High Pass Filter
  - Vector magnitude

| Highest performance | Low cost | Lowest power | Tamper detection | Analog Industrial | Highest Performance |

2H17

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NXP 3 Axis Accelerometer Typical Performance

Differentiating Points

- Best-in-class **offset accuracy** for accurate tilt detection: ±20mg vs. ± 35-50mg for competition

- Superior **TCO** down to 0.15mg/°C and **temperature sensitivity** 0.008%/°C for accuracy over temperature

- Complete **integrated feature set** including
  - Vector magnitude, FIFO and high pass filter
  - Auto wake up/sleep mode
  - Portrait-landscape, motion, free fall & transient detect

Product Features

- SPI/I²C digital output interface w/interrupts
- 1.7 V/1.95 V to 3.6 V supply voltage
- ±2g/±4g/±8g or up to 16±g dynamically selectable range
- Output data rate (ODR) from 800 Hz to 1.563 Hz
- Programmable OS for power consumption/noise trade-off
- Benchmark Output Noise (<100ug/r Hz)
- Resolution up to 0.25mg/count for the 14-bit resolution

Package
3x3x1 mm QFN, 0.5 mm pitch

Package
2x2x1 mm DFN, 0.5 mm pitch

Package
3x3x1.05 mm DFN, 0.65 mm pitch

Digital Accelerometers
Key Products

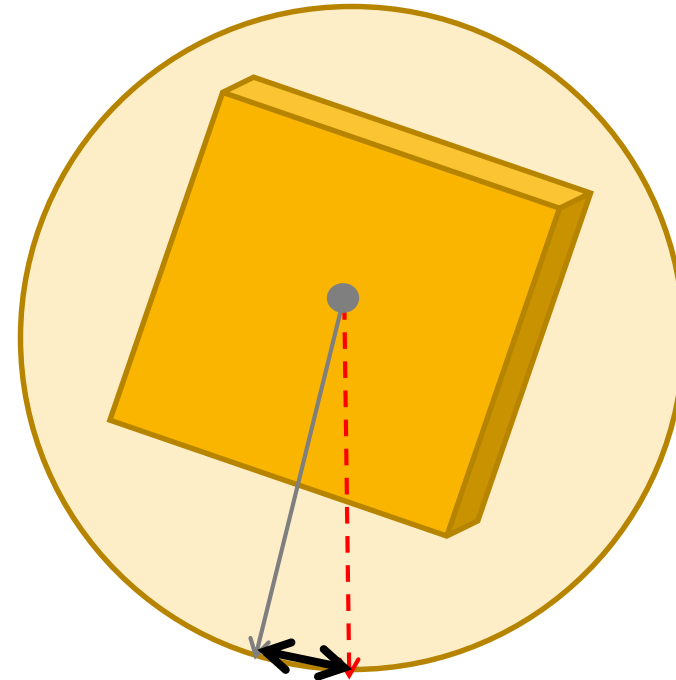|	Sample	Production	Applications
MMA8451/52/53 3-axis ±2, ±4, ±8 g 10/12/14-bit **Digital I²C**			Tilt Measurement Pedometer Power Management Compass Asset Tracking Activity Monitor Sports Watch Fleet Management Remote Controls Appliance
• Embedded function and interrupt : (FIFO, High pass filter, P/L,…) • Ultra low noise (99 µg/√Hz), low TCO (0.15mg/°C) • High performance Consumer & Industrial • Down to 0.25mg/LSB sensitivity • 1.95...3.6 Volt, 3 x 3 x 1 mm QFN	Web	Now	
FXLS8471 3-axis ±2, ±4, ±8 g 14-bit **Digital SPI or I²C**	Now	Now	
• Embedded functions and interrupts (all + Vector magnitude) • High performance industrial grade • 1.95...3.6 Volt, 3 x 3 x 1 mm QFN			
MMA8652/53 3-axis ±2, ±4, ±8 g 10/12-bit **Digital I²C**	Web	Now	
• Embedded functions and interrupts (8652 same as MMA8451) • Software compatible with the MMA845x family • Low cost • 1.95...3.6 Volt, 2 x 2 mm DFN			
MMA8491 3-axis Tilt Sensor 14-bit **Digital I²C + 3 Logic Out**	Now	Now	Tamper Sensor Rolling Ball Switch Alarm/Security Freefall Detect Remote Control Low Power Wake-up
• Ultra low power down to 400 nA/hz, • 3 logic outputs to flag tilt on the 3 axis • I²C interface to read raw acceleration data • 1.95...3.6 Volt, 3 x 3 x 1 mm DFN			

Drivers available on request

New : Accelerometer Delta Vector-Magnitude Function Use Case (see AN4458)

- Detection of a linear acceleration exceeding a threshold (completely independent from the mounting orientation)

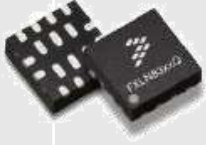- Detection of change of tilt angle exceeding a threshold

$$\sqrt{(a\_x\_out - a\_x\_ref)^2 + (a\_y\_out - a\_y\_ref)^2 + (a\_z\_out - a\_z\_ref)^2} > A\_VECM\_THS$$

Available in FXLS8471 and FXOS8700CQ

Trigger an interrupt on Delta magnitude change ⇔ orientation change

Analog Accelerometer Family

	Sample	Production	Applications
FXLN8361 3-axis ±2/±8 g **Analog Out, low bandwidth**	Now	Now	Vibration Monitoring High Precision Industrial Control Sport Applications Preventive Maintenance
FXLN8362 3-axis ±4/±16 g **Analog Out, low bandwidth**	Now		
FXLN8371 3-axis ±2/±8 g **Analog Out, high bandwidth**	Now		
FXLN8372 3-axis ±4/±16 g **Analog Out, high bandwidth**	Now		

- High Bandwidth: up to 2.7 kHz on XY
- Low Bandwidth : up to 1.1 kHz on XY
- Low power 180 µA in running mode, low voltage
- High performance industrial grade
- -40°C to 105°C operating range
- Sensitivity up to 229 mV/g
- **1.7...3.6 Volt**, 3 x 3 x 1mm, 0.65mm pitch 12 pins QFN

Drivers available on request
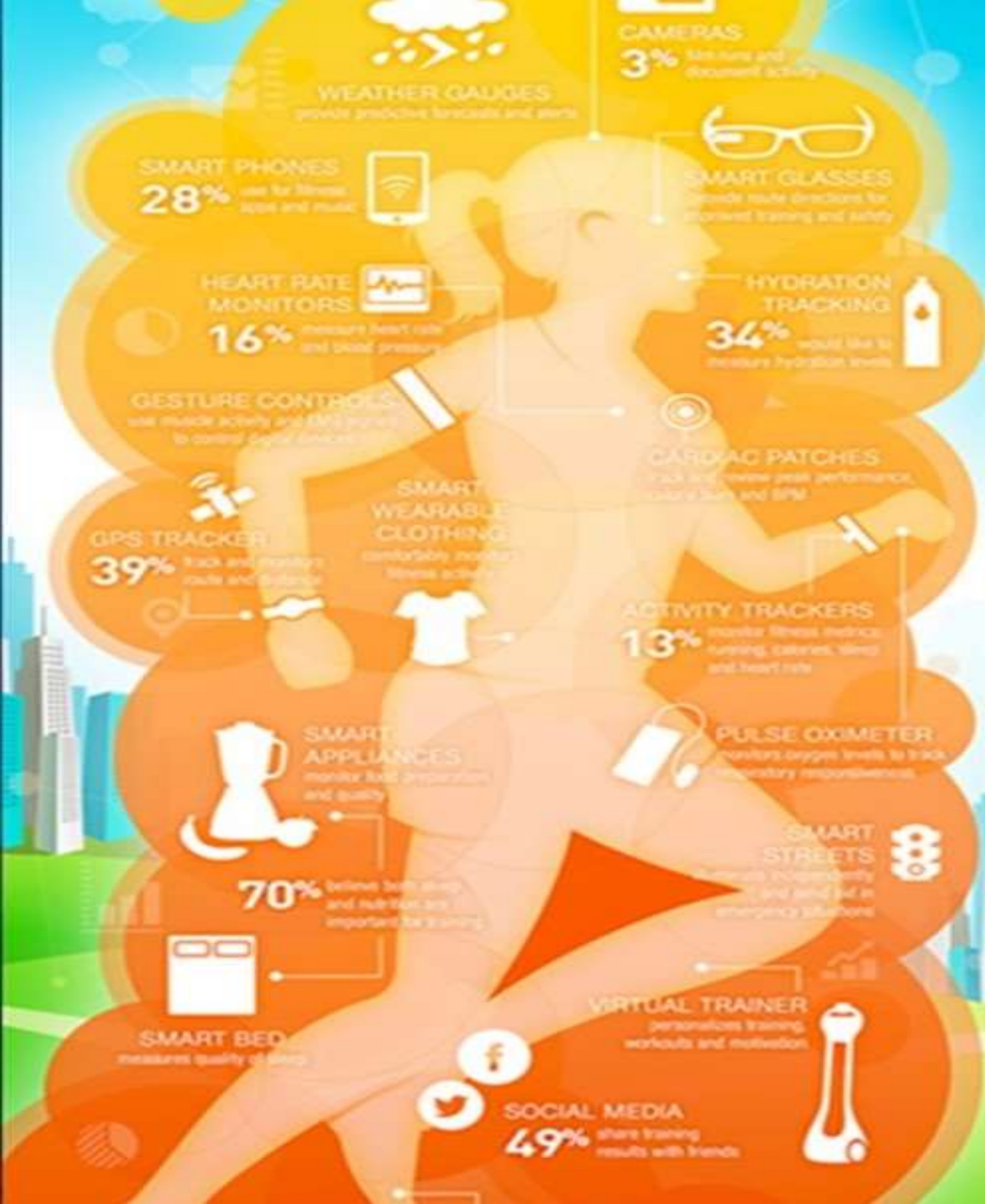
Intelligent Sensor hubs

- Provide algorithmic processing integrated with sensing
  - Pedometer algorithm embedded
  - System power management
  - Partitioning real time algorithms from user interface software
  - Smaller footprint

- Applications
  - Industrial vibration monitoring
  - Watches
  - Patient monitors
  - Ear buds
  - Inclinometer

MMA955x Sensor Products

Products	MMA9550	MMA9551	MMA9553	MMA9555	MMA9559	FXLC95000CL
Silicon	Accel + MCU	Accel + MCU	Accel + MCU	**Accel + MCU**	Accel + MCU	Accel + MCU
Package	3x3 LGA	3x3 LGA	3x3 LGA	**3x3 LGA**	3x3 LGA	3x5 LGA
User Flash	6.5 KBytes	4.5 KBytes	1 KBytes	-	14 Kbytes	128 Kbytes
User RAM	576 Bytes	452 Bytes	0.2 KBytes	-	1.5 Kbytes	16 Kbytes
Preloaded Functions	Infrastructure only functions	Infrastructure + Gestures	Infrastructure + Pedometer	**Orientation + Pedometer**	Lightweight Infrastructure	Open Platform / Sensor Hub

- MMA955xL devices are pre-loaded with application at the factory

- User can add custom software using the remaining portion of Flash memory

- **MMA9555: Full turnkey Pedometer Software and Orientation Detection.**

  Low-power pedometer with rich output information (117µA full running mode) :

  - **Step counting**

  - **Speed, distance, calorie count estimation**

  - **Activity level (rest, walking, jogging, running).**

Gyroscopes

- Measure angular rate of a moving object, insensitive to linear motion
- 3-axis sensing capability with configurable ranges up to 4000 dps
- Applications
  - Activity tracking
  - Gyro-compensated compass
  - Human machine interface
  - **Sport applications**
  - Inertial measurement unit
  - Inertial navigation
  - **Robotics**
  - Virtual reality and augmented reality
  - Vehicle stability

FXAS21002C

3 Axis Gyro With Market Leading Power Consumption: Over 40% Better Than The Leading Competitors

- Differentiating points

  - Best-in-class power performance: 2.7 mA (Active), **1.6 mA (Ready**), 2uA (Standby)

  - Complete sensor fusion enablement suite

- Product features

  - Enhanced selectable full scale ranges: +/-250, +/-500, +/-1000, +/-2000, **+/-4000 dps suited for sport application**

  - Fast transition from standby to active mode (60 ms)

  - Expanded output data rates (ODR) from 12.5 Hz to 800Hz

  - Zero rate change over temperature: ±0.02dps/°C (XY), ±0.01dps/°C (Z)

  - Improved noise: angular random walk = 0.025 dps/rt(Hz)

  - Angular velocity resolution <0.2°/s

  - Programmable interrupts, power saving features

  - 1.95-3.6 V supply voltage

Package
4x4x1 mm QFN, 0.5 mm pitch

Gyroscopes for Robotics

- ## Single axis gyroscopes are often used in robotics

  - One typical use case involves a wheeled robot where translational motion is controlled with wheel encoders and turning is controlled by a z-axis gyro

  - Power consumption and package size are not critical in these applications.

  - Performance is important (Offset, Sensitivity, TCO, TCS, Noise, Linearity)

- ## The z-axis of FXAS21002 is significantly better than xy

  - Z-axis sensor is a higher performance design compared to the xy sensor

  - This can help us in robotics as shown on next slide

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FXAS21002 Z-axis Performance

- Z-axis is better than xy axes in critical parameters such as zero-rate offset, TCO, TCS, Cross Axis Sensitivity, Noise, and Linearity (See table and graph below)

- More details provided in Comprehensive CZ Report (Request from PLM, share under NDA)

Parameter	Datasheet Typical Spec	x-axis			y-axis			z-axis		
		Mean	Sigma	μ + 1σ "Typical"	Mean	Sigma	μ + 1σ "Typical"	Mean	Sigma	μ + 1σ "Typical"
Zero-Rate Offset	± 50 LSB	4.1	11.9	± 16 LSB	-5.2	14.3	± 20 LSB	1.4	7.8	**± 9 LSB**
TCO	XY: ± 0.02 dps/°C Z: ± 0.01 dps/°C	0.004	0.01	± 0.014 dps/°C	0.001	0.011	± 0.012 dps/°C	0.003	0.007	**± 0.010 dps/°C**
TCS	XY: ± 0.08 %/°C Z: ± 0.01 %/°C	0.046	0.008	± 0.05 %/°C	-0.066	0.012	± 0.08 %/°C	0.002	0.004	**± 0.006 %/°C**
Cross-Axis Sensitivity	± 1.5%	-0.19	0.72	± 0.9%	0.6	0.78	± 1.4%	0.74	0.24	**± 1.0%**
Noise	25 mdps/√Hz	Median = 29.5 mdps/√Hz			Median = 25.1 mdps/√Hz			**Median = 16.9 mdps/√Hz**		
Bias Stability	Not specified	Mean = 19.7 deg/hr			Mean = 12.3 deg/hr			**Mean = 10.6 deg/hr**		

Not included on External Version

TCO and TCS are computed over range -40°C to 85°C

Zero-Rate Offset, Cross-Axis Sensitivity, and Noise are measured at 25°C

All parameters are Post Boardmount except Cross-Axis Sensitivity

Cross-Axis Sensitivity shown in table is worst case of 2 cross-axis values

Sample sizes are roughly 3 lots x 30 parts for all tests except Bias Stability
Bias Stability is based on random selection of 5 parts taken from noise study

Integral non-linearity (z-axis @ 25°C)
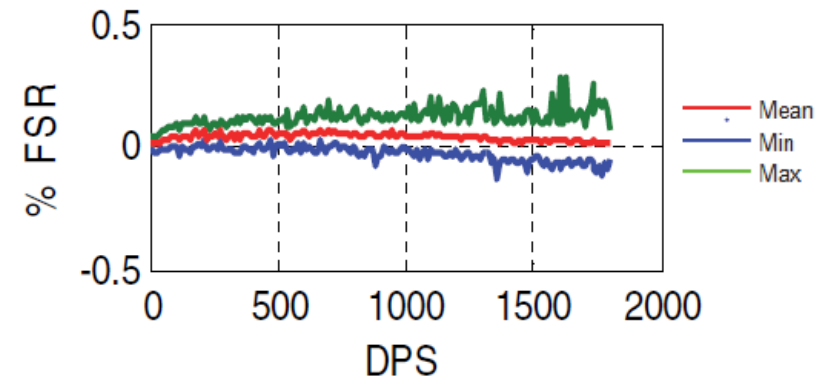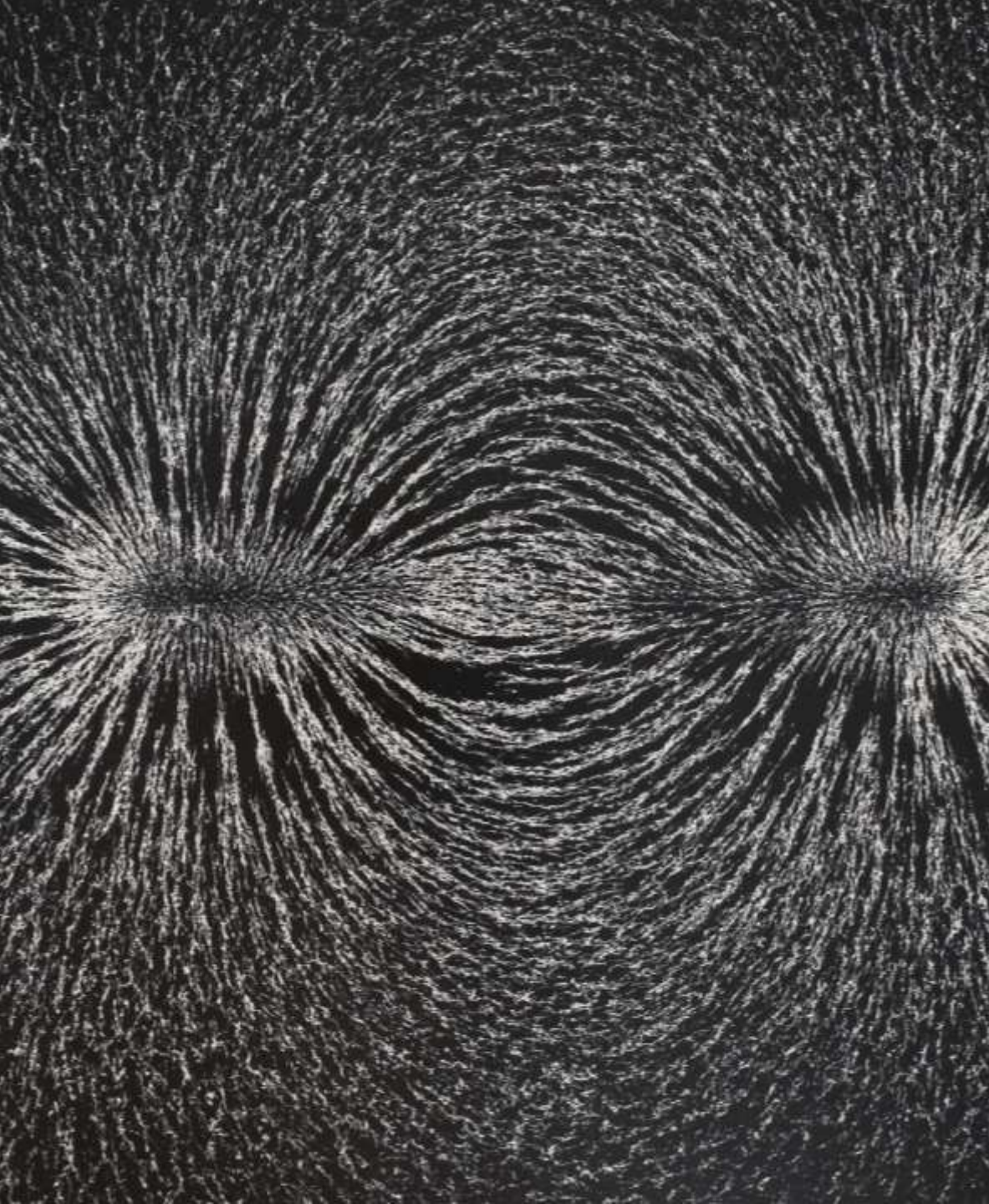
Magnetometers

- Measure direction and/or magnitude of a magnetic field
- Can be used to measure radial distances, angular positions and rates
- Applications
  - **Angular position monitor**
  - Angular rate monitor
  - **Anti-tampering**
  - Dosimeter
  - **Electronic compass**
  - **Magnetic field measurements**
  - **Wheel speed detection**

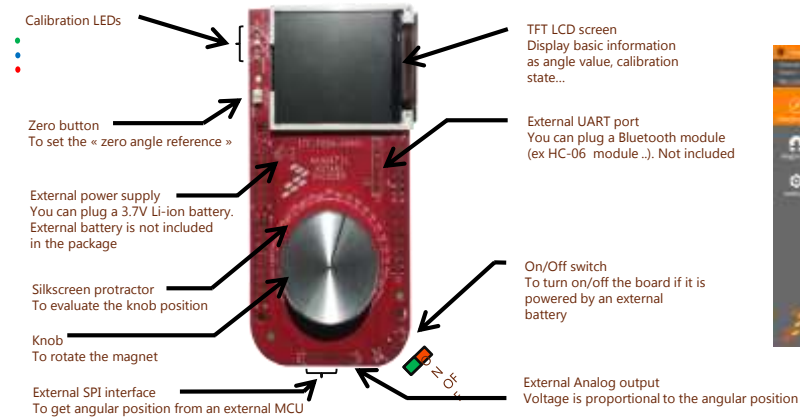# Magnetometers for the IoT

MAG3110

- **2 x 2 x 0.85 mm DFN**
- I^{2}C output
- 0.10μT sensitivity
- 0.25 μT rms noise
- Magnetic calibration S/W support
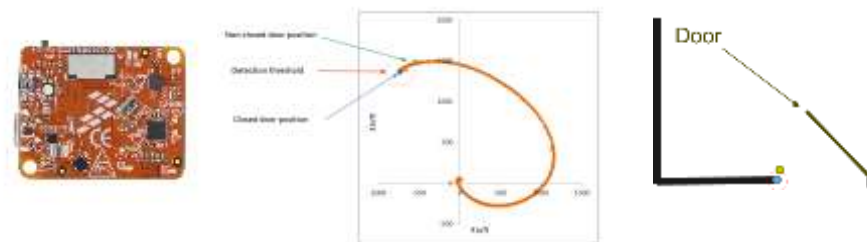- Up to 80Hz output data rate

FXOS8700

- **3 x 3 x 1.2 mm QFN**
- I^{2}C output
- Accel + Mag combo
- 1.6 to 800Hz output data rate
- Low power: 80μA @25 Hz
- Magnetic calibration S/W support
- Vector magnitude trigger

- Electronic compass (open source calibration library)
- Rotary encoder (open source library + Reference design)

Calibration LEDs

Zero button
To set the « zero angle reference »

External power supply
You can plug a 3.7V Li-ion battery.
External battery is not included
in the package

Silkscreen protractor
To evaluate the knob position

Knob
To rotate the magnet

External SPI interface
To get angular position from an external MCU

TFT LCD screen
Display basic information
as angle value, calibration
state...

External UART port
You can plug a Bluetooth module
(ex HC-06 module ..). Not included

On/Off switch
To turn on/off the board if it is
powered by an external
battery

External Analog output
Voltage is proportional to the angular position

RD-KL46Z-MRE

- Door state detection (open source library + Reference design based on RD-KL25-AGPM01)

Pressure Sensors

- Measure absolute pressure or differential pressure
- Gauge pressure sensor is a differential
- Applications
  - Barometric pressure measurement
  - Altitude measurement
  - Liquid level
  - **Inhalers**
  - CPAP system
  - Gaz flow measurement
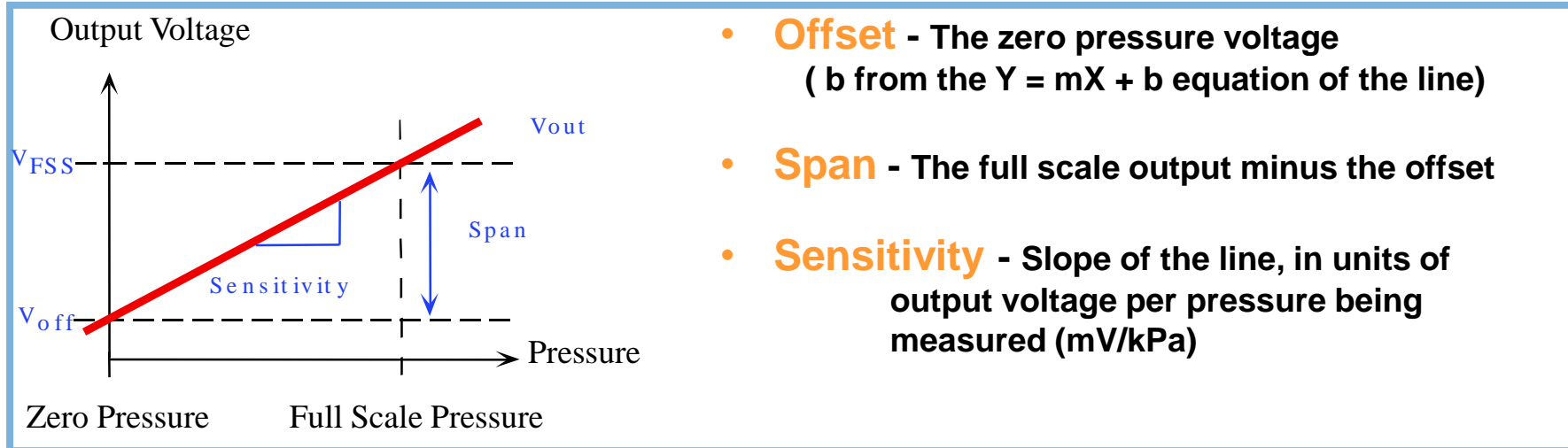 - **Gaz pressure measurement**
  - **Tyre pressure monitoring**

Pressure Sensors Family Overview

| Pressure Sensor Family	Full scale pressure	Typical Applications
Barometric pressure	105, 110, 115, 130, 200 kPa abs.	Engine management, Altimetry, barometer
LPG and CNG	250, 300, 400 kPa abs.	Engine management LPG and CNG
Differential/Gauge low pressure	4, 6,10 kPa diff.	Industrial applications
Differential/Gauge Medium pressure	40, 50, 80, 100, 115 kPa diff.	Industrial and medical applications
Differential/Gauge High pressure	150, 200, 250, 500, 700, 1000 kPa diff.	Industrial applications
Vacuum Sensors	±2, ±7, ±25, ±50, ±115 kPa diff	Medical, Industrial applications
TPMS	450, 900, 1500 kPa abs.	Tire pressure monitoring

Unibody SOP Chip Pak SSOP M-Pak LGA QFN

JBL

Basic Pressure Sensors Specifications

- *Do you need a special trim for your application ? Ask NXP !*

- **Offset** - The zero pressure voltage
  (b from the Y = mX + b equation of the line)

- **Span** - The full scale output minus the offset

- **Sensitivity** - Slope of the line, in units of output voltage per pressure being measured (mV/kPa)

Types of Pressure Measurements

- **Differential** - Measures differences between two pressures

- **Gauge** - Differential with atmosphere reference

- **Absolute** - One side accessible and reference vacuum sealed inside
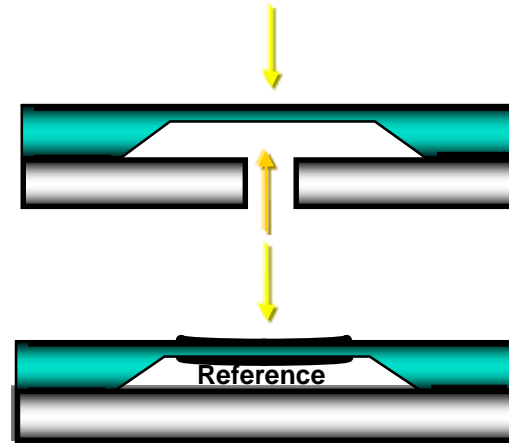
FXPQ3115BVT1: Biomedical Precision Pressure Sensor

Differentiating Points :

Biomedically approved gel coating

Internally compensated, software is not needed

Direct reading pressure in Pascals

• On-board intelligence

Product Features

• Pressure resolution: 1.5 Pa

• Pressure range: 20 – 110 kPa

• Calibrated pressure range: 50 – 110 kPa

• 1.95V to 3.6V supply voltage

• Variable output sampling rate (OST)

• I²C digital interface

• Interrupt driven events (window for breath in /out detect)

• 32-Sample FIFO

The only bio-compatible pressure sensor on the market for medical grade
Best in class low power , down to 8.5μA
Unique window interrupt capability for breath-in, breath-out detection

Typical Applications

• Inhalers/Nebulizers

• CPAP Masks

• Medical Tablets

• Health Activity Monitors

• Oxygen Concentrators

Package

• 3 x 5 x 1.1 mm LGA

Xtrinsic MPL3115A2
## Precision Digital Pressure Sensor

Differentiating Points

- Internally compensated, software is not needed
- Direct reading pressure in Pascals and altitude in meters
- On-board intelligence

Product Features

- Altitude resolution : < 1 foot / 0.3 m
- Pressure resolution: 1.5 Pa
- Pressure range: 20 – 110 kPa
- Calibrated pressure range: 50 – 110 kPa
- 1.95V to 3.6V supply voltage
- Variable output sampling rate (OST) up to 140 Hz
- Current Consumption:
  - Standby mode: 2 µA
  - Low-power mode: 8.5 µA at 1 Hz
- I²C digital interface

Typical Applications

- High Accuracy Altimeter
- Smartphones / Tablets
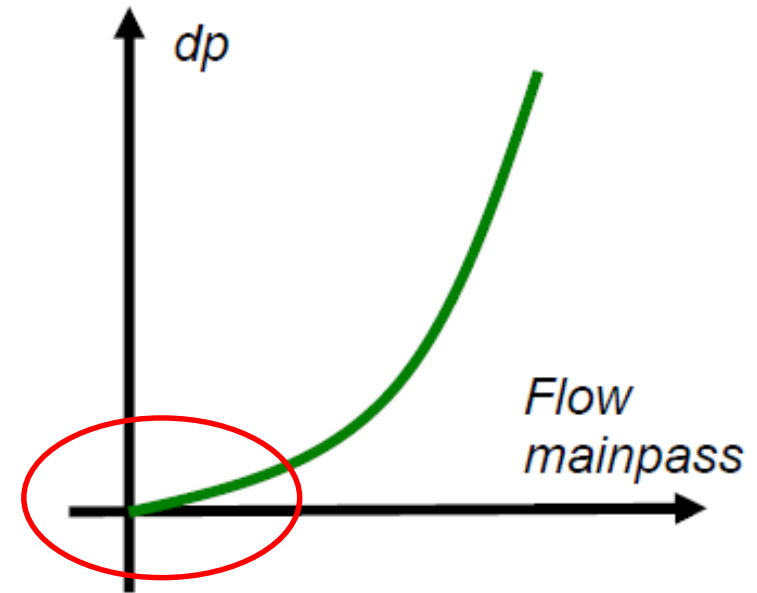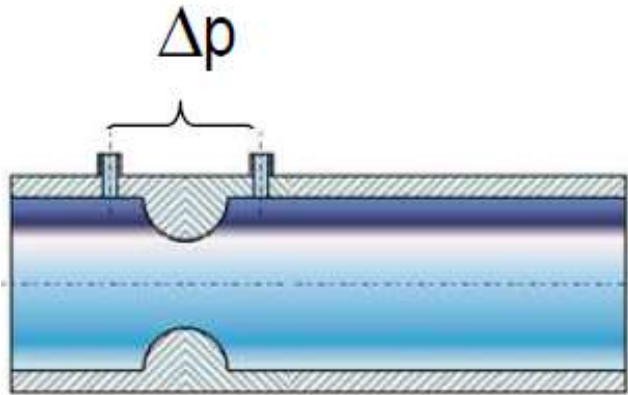- GPS Enhancement for Location Based Services
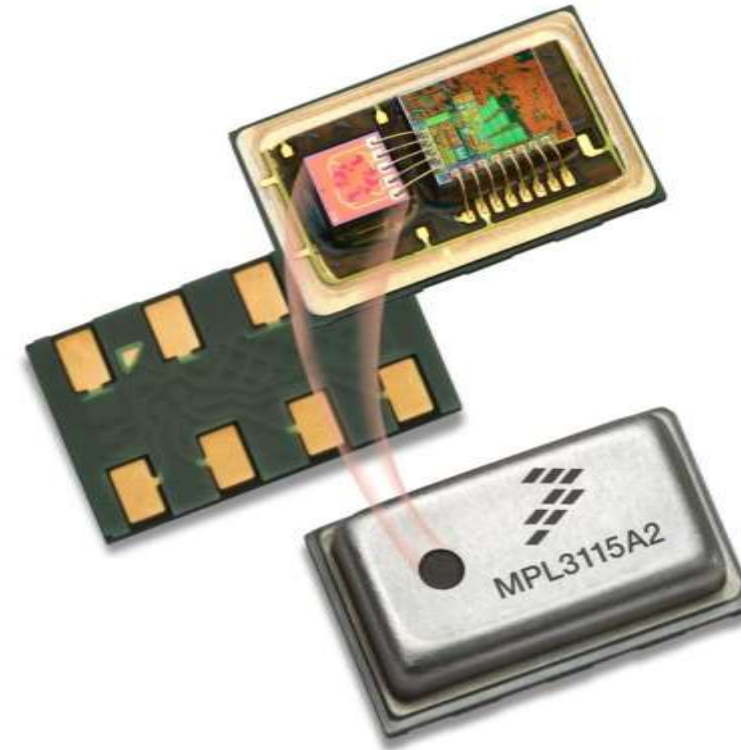
Package
3 x 5 x 1.1 mm LGA

Availability
Samples: NOW
Production: NOW

How to Measure Flow with a Differential Pressure Sensor ?
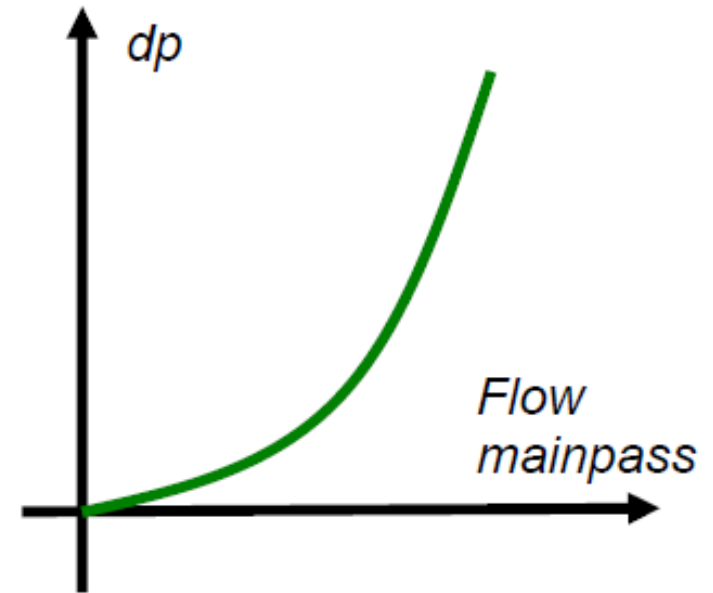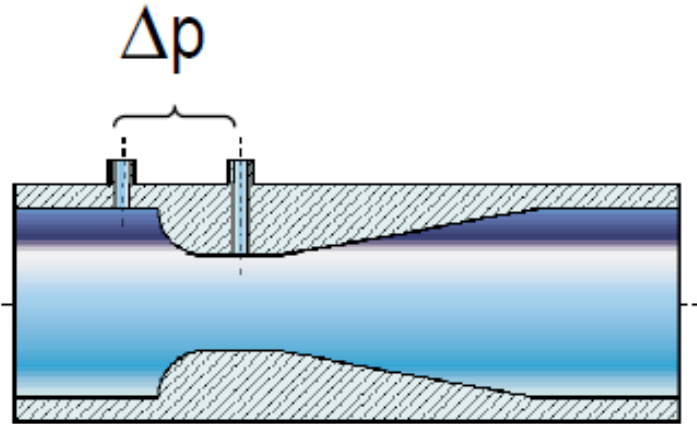# Use a Bypass Element to Generate a Differential Pressure

Simple orifice, quadratic response

Requires very high accuracy for small flow @ low pressure

How to Measure Flow with a Differential Pressure Sensor ?
Use a Bypass Element to Generate a Differential Pressure

Simple orifice, quadratic response

How to Measure Flow with a Differential Pressure Sensor ?
Use a Bypass Element to Generate a Differential Pressure

Laminar element, linear response
Higher dynamic range
Better accuracy at small flow
More expensive
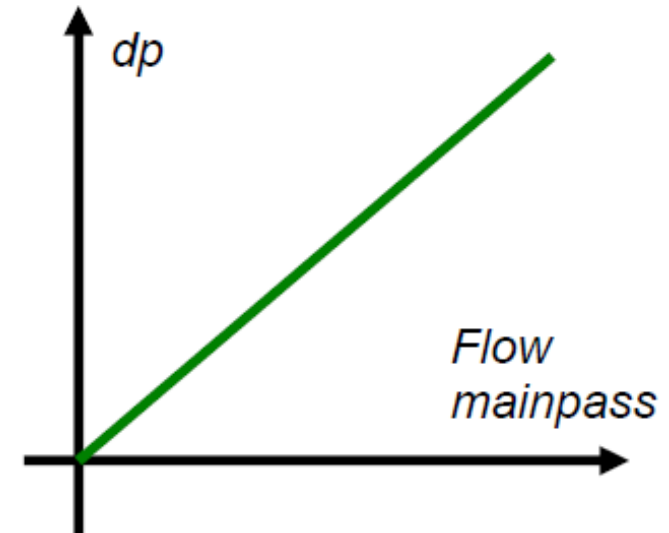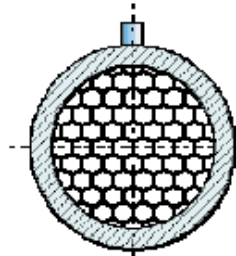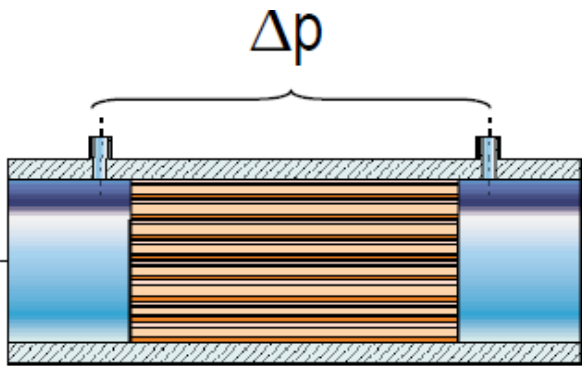
Digital Barometric Air Pressure Sensor

- **Product features**
  - Pressure Ranges
    - 15kPa to 115kPa, 40kPa to 115kPa
    - 15Kpa to 550Kpa high pressure
    - Custom pressure range on demand
  - Maximum voltage range: -0.3V – 5.5V
  - Temperature Range: -40C to 130C
  - Accuracy: ±1.5% over full Pressure and Temperature Range
  - Digital Signal Processing
  - Standby current of 0.5mA
  - Low Power Sleep Mode with Wake on Select

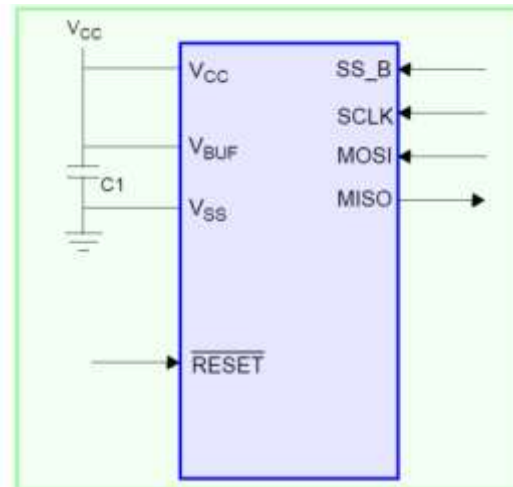- **32-Bit SPI Compatible Interface**
- **I2C Compatible Interface**
- **Analog Output**

- **Package: 4 mm x 4 mm x 1.98 mm Cavity QFN**
- **Automotive Qualified (AEC-Q100)**

**New
QFN4x4**

SPI Application Diagram

Part Numbers	Description
FXPS7015A4T1	15-115 kPa, Analog Output
FXPS7115DS4T1	40-115 kPa, BAP Product Digital SPI
FXPS7115DI4T1	40-115 kPa, BAP Product Digital I2C
FXPS7015DS4T1	15-115 kPa, BAP Product Digital SPI
FXPS7015DI4T1	15-115 kPa, BAP Product Digital I2C
FXPS7250A4T1	up to 250 kPa, analog
FXPS7400A4T1	up to 400 kPa, analog
FXPS7550A4T1	up to 550 kPa, analog

Tire Pressure Monitoring System Application Diagram
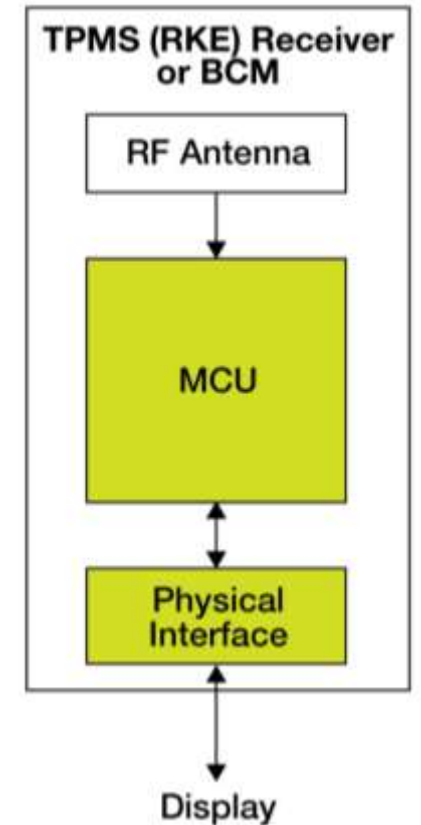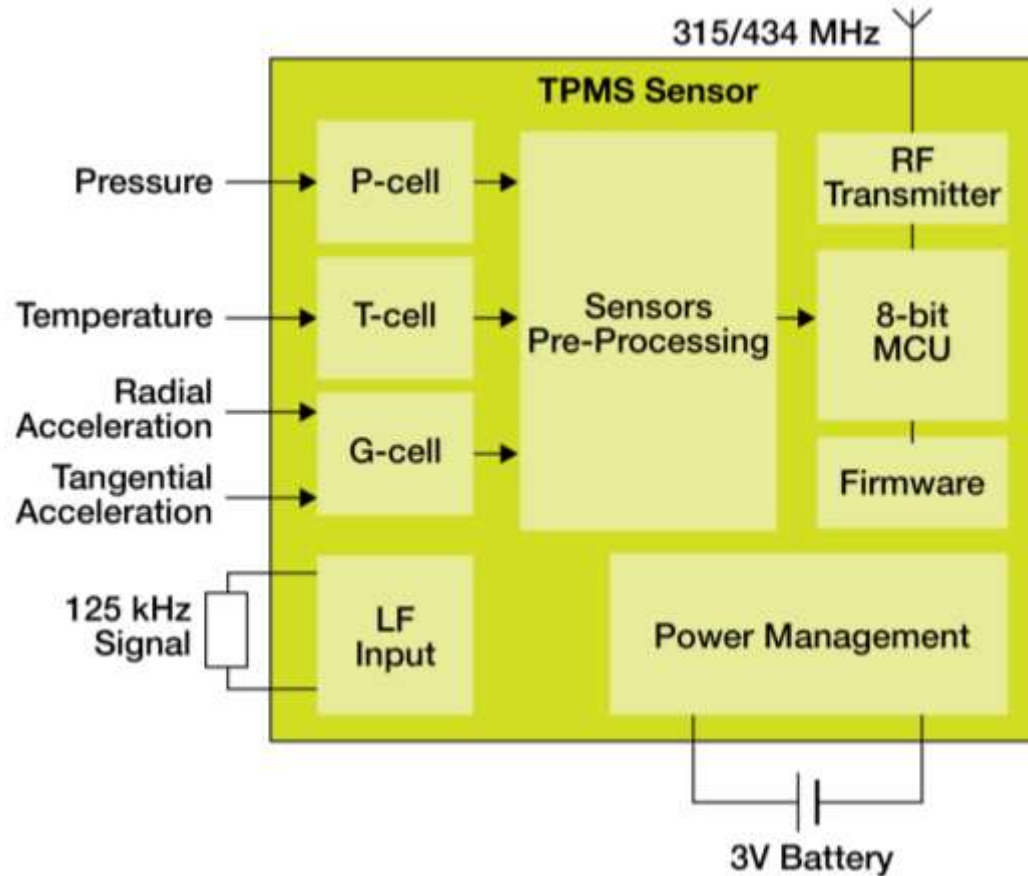
FXTH87(E) Summary – World's Smallest TPM Sensor

- **Smallest TPMS sensor on the market**
  - QFN 7x7x2.2 mm

- **Multiple pressure sensor ranges**
  - 450, 900 and 1500kPa
  - Ideal for passenger cars, trucks, aftermarket

- **Dual axis accelerometer** for extended sensing functionalities

- Embedded **MCU** and **dedicated TPMS Library**
  - Large memory space for customer application

- **LF and RF** wireless interface

- Ultra low power consumption

- **Volume production**
  - 450, 900kPa and 1500kPa released

FXTH87 Eco-System

NEW !
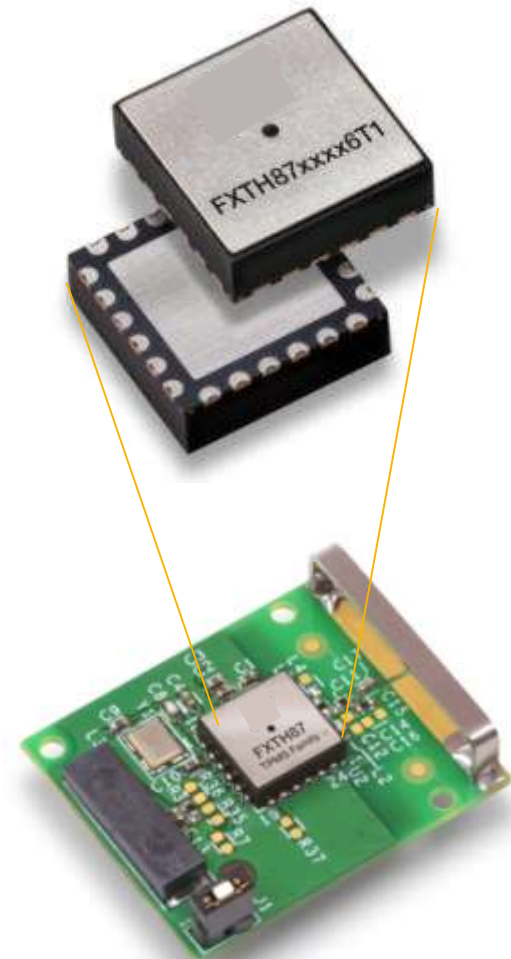
Evaluation Boards (*) : Emulate typical customer wheel unit module containing FXTH87 sensor, LF coil, RF antenna, battery, and all passives
- TPMS870911-434 (900 kPa – 315 MHz)
- TPMS870911-315 (900 kPa – 434 MHz)
- TPMS871511-315 (1500 kPa – 315 MHz)
- TPMS871511-434 (1500 kPa – 434 MHz)

Application Notes / Reference Manuals for FXTH87 TPMS family

- **FXTH87EDRM:** FXTH87 Family Evaluation Design Reference Manual

- **FXTH87XX22FWUG:** FXTH87xx22 Embedded Firmware User Guide

- **AN4277:** Interfacing to NXP's FXTH87xx In-Flash Firmware Routines Using C-language Constructors

- **AN4391:** Using the FXTH87 Family of LF Receivers for TPMS Application

- **AN1902:** Assembly Guidelines for QFN and DFN Packages to cover the QFN7x7mm packages

- **AN5136:** Applying the Kinetis MKW01 as the receiver for the FXTH87 Tire Pressure Monitoring Sensor.

General support topics:

- **Assistance with implementing a wireless (LF/RF) boot-loader** to re-program customer application memory space.

- **Assistance with selectively increasing customer application memory space** with the FXTH8715117T1 and FXTH8715027T1.

- **Assistance with tuning RF matching network** to suit customer specific antenna choices

For further information please refer to: http://www.nxp.com/products/interface-and-connectivity/interface-and-system-management/advanced-automotive-safety/tire-pressure-monitoring-sensors:TPMS?cof=0&am=0

(*) = Contact NXP Sales Representative for availability.

TPMS Implementation in Light or Heavy Vehicles

Modules installed on the valve stems

– Rim or valve stem mounted

– Pressure and temperature sensing

– Roll switch, wheel localization

– Battery operated

– Independent from the tires

Modules installed on the tire treads

– Tire mounted sensors

– Pressure, temperature, radial and

  tangential tire acceleration

– Battery operated or battery less

– Linked to the tire

Modules installed on the tip of the valves

– Sensors mounted on top of the tire valves

– Pressure, temperature, radial tire acceleration

– Battery operated

– Common in aftermarket solutions

ENABLEMENT

PUBLIC

SECURE CONNECTIONS
FOR A SMARTER WORLD

The Sensor Evaluation Ecosystem in a Nutshell

FSTB-CE GUI(s)
- Configurable to match user evaluation needs
- Easy to distribute
- Easy to add new functionality

ISSDK
- Kinetis compatible application programming environment

FRDM Board + Sensor Shield(s)
- Easy to set up
- Easy to program
- Easy to swap out sensors

Freedom Sensor Toolbox (CE)
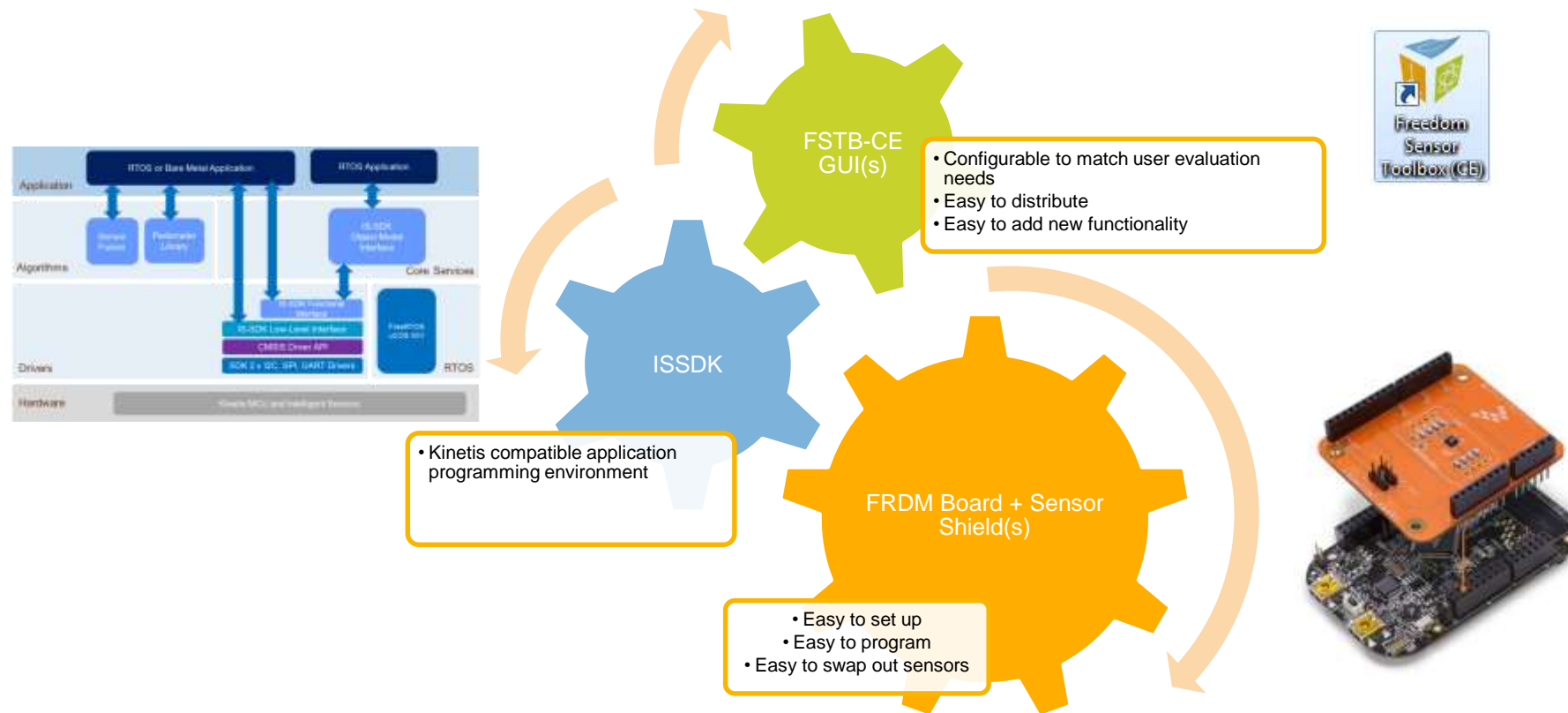
Freedom Sensor Toolbox Ecosystem Overview

Evaluation

- Kits - FRDM board + shield
- Example Applications
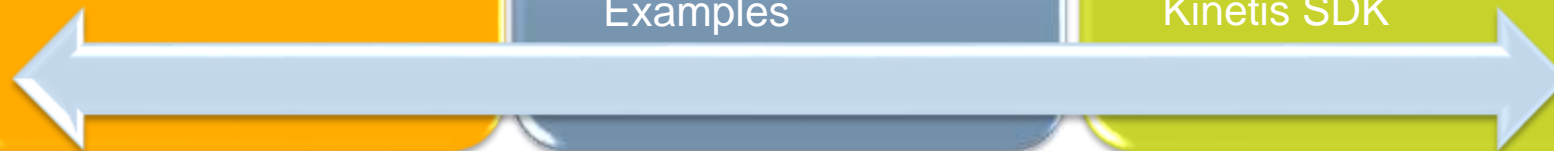- Freedom Sensor Toolbox GUI

Prototyping

- Breakout boards
- ISSDK + Kinetis SDK + Driver Examples + Application Examples
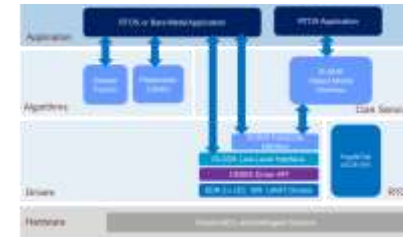- Algorithms + Examples

Product

- Customer Hardware
- Derived Applications & Algorithms
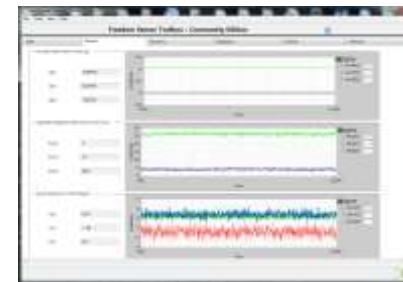- ISSDK/ Kinetis SDK

Freedom Sensor Toolbox

- Your complete ecosystem for product development with NXP's sensors.

- Includes demo kit, Shield development board and breakout board.

- Each board is enabled by ISF and Freedom Sensor Toolbox-Community Edition (STB-CE).

- Powerful and convenient development & evaluation platform across NXP's broad sensor portfolio.
  - 'Out of the box' demonstration enabled by demo kits and STB-CE. (plug and play)
  - Sensor evaluation enabled by Shield boards, compatible FRDM boards, ISSDK and STB-CE.
  - Development of sensor applications enabled by Kinetis MCU's and ISSDK.
  - Prototyping your sensor designs enabled by breakout boards, ISSDK and STB-CE.

- Full enablement from a demo to sensor prototyping (to design win ☺)

Demo ▸ Evaluation ▸ Development ▸ Prototyping

Breakout Board

ISSDK

Shield Board

STB-CE

Demo KIT(Shield + MCU)

Sensor Toolbox Board Repository

Sensor Toolbox Name	Board Type	Board Name
Sensor Toolbox for 9-Axis Solution	Demo Kits	FRDM-K22F-AGM01
		FRDM-K64F-AGM01
	Shield Board	FRDM-STBC-AGM01
	Breakout Board	BRKT-STBC-AGM01
Sensor Toolbox for FXLC95000CL Intelligent Motion Sensor	Demo Kit	FRDM-K22F-SA9500
	Shield Board	FRDM-STBC-SA9500
	Breakout Board	BRKT-STBC-SA9500
Sensor Toolbox for FXLS8471Q 3-Axis linear Accelerometer	Demo Kit	FRDMKL25-A8471
	Shield Board	FRDMSTBC-A8471
	Breakout Board	BRKTSTBC-A8471
Sensor Toolbox for MMA8491Q 3-Axis Digital Accelerometer	Demo Kit	FRDMKL25-A8491
	Shield Board	FRDMSTBC-A8491
	Breakout Boards	BRKTSTBC-A8491
Sensor Toolbox for MPL3115A2 Pressure Sensor/ Altimeter	Demo Kit	FRDMKL25-P3115
	Shield Board	FRDMSTBC-P3115
	Breakout Boards	BRKTSTBC-P3115
Sensor Toolbox for MPXV5004DP Analog Pressure Sensor	Shield Board	FRDMSTBCDP5004
	Breakout Boards	BRKTSTBCDP5004
Sensor Expansion board for multiple sensors	Shield Board	FRDM-FXS-MULT2-B

Breakout Board

Shield Board

KIT(Shield + MCU)

Integrated with MCU

- Freedom Sensor Toolbox Shields are compatible with Kinetis and LPC Arduino development boards

- Development with Kinetis SDK 2.0 and LPC Open SDK

IoT Sensing SDK (ISSDK)

- Leverage Kinetis SDK 2.0
  - Drivers, Tools, Release Infrastructure
- Leverage Open APIs based on CMSIS Driver standards (ARM) for portability
- Focus on the Rapid Prototyping and Small Profile Production Applications
- A La Carte Model for Software Delivery and Usage
  - From Register Level to Object Oriented APIs
- Supports Bare Metal development and all RTOS supported by SDK 2.0
- Supports all IDEs supported by SDK 2.0
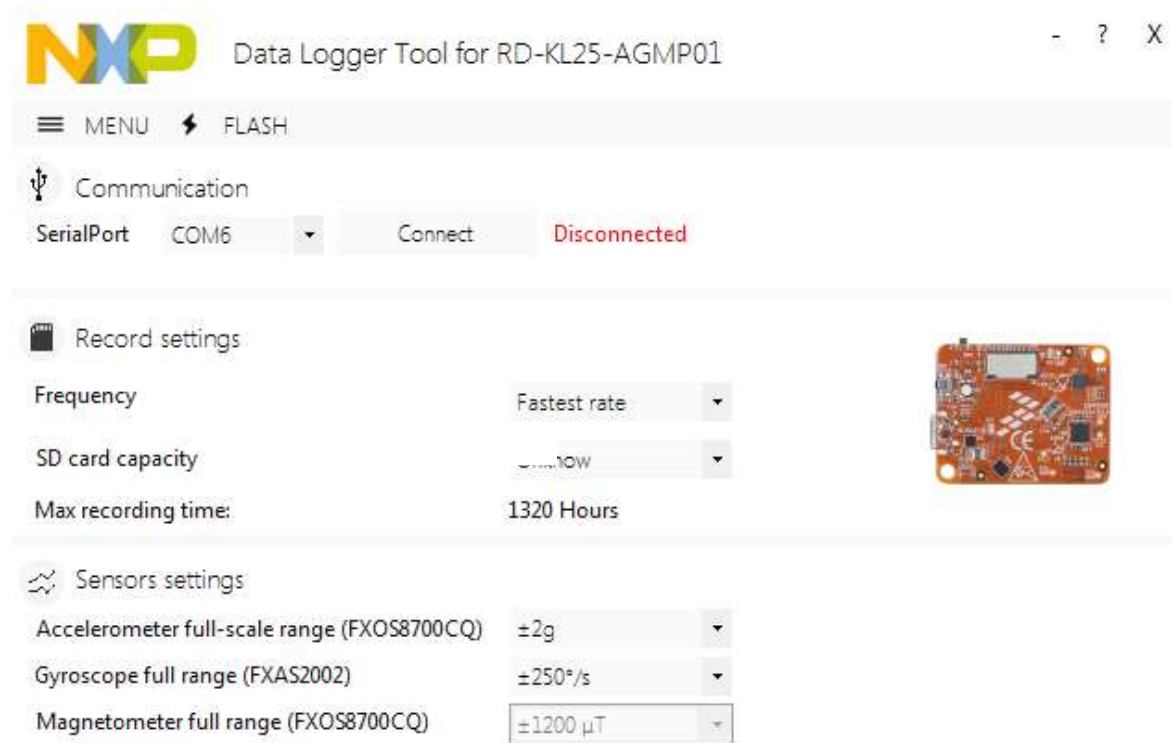- Targets all Kinetis MCUs supported by SDK 2.0

ISSDK Architecture
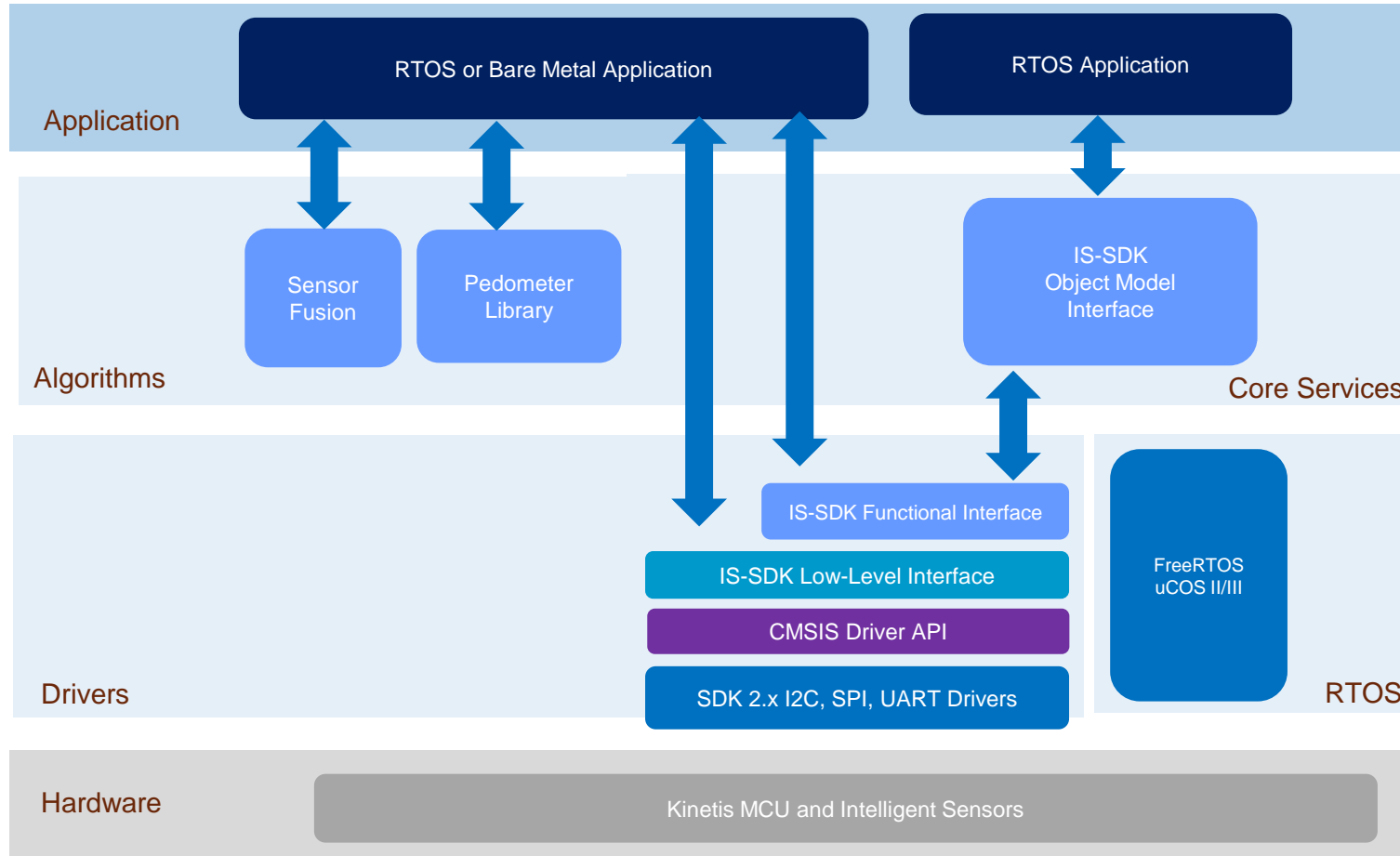
Supported Sensors

Sensor Part Number	Sensor Type	Interface
FXAS21002	Gyroscope	SPI I2C
FXLC95000	Intelligent Accelerometer	SPI I2C
FXLN83XX	Analog Accelerometer	via KSDK ADC and GPIO
FXLS8471	Digital Accelerometer	SPI I2C
FXLS8952	Digital Accelerometer	I2C
FXOS8700	Digital Accelerometer and Magnetometer	SPI I2C
MAG 3110	Digital Magnetometer	I2C
MMA845X	Digital Accelerometer	I2C
MMA8491	Digital Accelerometer	I2C
MMA865X	Digital Accelerometer	I2C
MMA9553	Intelligent Accelerometer	I2C
MPL3115	Digital Pressure	I2C

Data Logger Board for Quick Proof of Concept Validation

SD CARD slot for data storage

3 cm

FXOS8700CQ accelero
FXOS8700CQ magneto
(similar to FXLS8471)

RD-KL25-AGPM01

FXAS21002 Gyroscope

MPL3115 pressure sensor

Data Logger Tool for RD-KL25-AGMP01

— ? X

☰ MENU ⚡ FLASH

⬆ Communication

SerialPort   COM6   ▼   Connect   Disconnected

📇 Record settings

Frequency   Fastest rate   ▼

SD card capacity   ...ow   ▼

Max recording time: 1320 Hours

〽 Sensors settings

Accelerometer full-scale range (FXOS8700CQ)   ±2g   ▼

Gyroscope full range (FXAS2002)   ±250°/s   ▼

Magnetometer full range (FXOS8700CQ)   ±1200 µT   ▼

Datalogger GUI