NXP Sensors Portfolio Overview for IoT Applications

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Product Line MANAGER – Motion Sensors

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Agenda

• NXP’s sensor offerings and 2018 Sensor NPI Update
  - Industrial IoT Market and Applications
  - Critical sensor parameters for example applications
  - Introducing NXP’s new Sensor Toolbox
    ▪ Showcasing NXP’s sensor board repository
    ▪ IoT Sensing Software Development Kit (ISSDK) for Embedded Application Development
    ▪ Freedom Sensor Toolbox – Community Edition for Sensor Data Visualization

• Additional Customer Enablement:
  - Reference Designs, CZ reports, Qual Reports

• More Information/Q&A
Session Goals

• After this session the audience will be able to:
  – Understand NXP’s Sensor offerings
  – Learn about different IoT Sensor Applications
  – Learn about the Sensor toolbox for each phase of product development
  – Use NXP Enablement and Boards to simplify evaluation and prototyping
# NXP Sensors Overview

## Why Customers Choose Us
- Low power
- Small size
- High performance
- Precision sense and control
- Broad sensor portfolio
- Robust and reliable designs over temperature and harsh media
- Functional safety and 30+ year auto experience
- Software and algorithm enablement
- NXP portfolio for complete system solutions
- Trusted supplier with long term product commitments

## Applications

<table>
<thead>
<tr>
<th>Safety Systems</th>
<th>Automotive Systems</th>
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<tbody>
<tr>
<td>- Airbag deployment sensors</td>
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<tr>
<td>- Tire pressure monitoring sensor system</td>
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<tr>
<td>- Wheel rotation speed sensing</td>
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<tr>
<td>- Power train and engine management</td>
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<tr>
<td>- Steering angle and BLDC rotor position detection</td>
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<table>
<thead>
<tr>
<th>Industrial &amp; Medical</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Industrial IoT applications</td>
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<tr>
<td>- Surveillance &amp; monitoring</td>
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<tr>
<td>- Telehealth</td>
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<tr>
<td>- Medical devices and hearables</td>
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<thead>
<tr>
<th>Performance Consumer</th>
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</thead>
<tbody>
<tr>
<td>- Activity and asset tracking</td>
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<tr>
<td>- Intuitive human interface</td>
</tr>
<tr>
<td>- Quantified wellness and personal fitness</td>
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<tr>
<td>- Connected and smart home</td>
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</tbody>
</table>

## Market Leadership
- #1 Merchant Automotive MEMS
- #4 Inertial and Pressure MEMS sensors
NXP Sensor Technology Supports Key Applications

3 billion units shipped

**Automotive**
- Magnetic (MR)
- Motion (MEMS)
- Pressure (MEMS)

**Medical & Industrial**
- Magnetic (MR)
- Motion (MEMS)
- Pressure (MEMS)

- Infra Red
- TIRE PRESSURE
- SMART VEHICLE
- ACTIVE VEHICLE STABILITY
- IOT → VEHICLE
- ADAS

- HOUSEHOLD ROBOTICS
- WEARABLES
- MEDICAL DEVICES
- QUANTIFIED WELLNESS
- HEARABLES
Motion Sensor Target Markets
- Internet of Tomorrow Applications

**Industrial Transportation**
- Heavy Machinery – ex: Forklifts
- Farm Equipment
- Asset Tracking

**Patient Care**
- Medical Wearables
- Portable Healthcare
- Asset Tracking
- Clinical care
  (Patient Monitor, Infusion Pump)
- Drug Delivery
  (Inhalers, Insulin pen)

**Connected Portables**
- Wearables
- ePOS
- Asset tracking

**Connected Home**
- Smart Doors/windows
- Smart appliances

**Building Control**
- HVAC
- Access / Security
- Surveillance

**Remote Sensor**
- Tamper Detect
- System Monitors

**Factory Automation**
- Robotics
- Vibration Monitors
- BLDC Control

**Conservation**
- Smart metering
  (tamper detection)
- Tools & Appliances

**Connected Home**
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- Smart metering
  (tamper detection)
- Tools & Appliances
Accelerometers

- Detects acceleration resulting from orientation vs gravity, motion, shock, and vibration
- Single, dual, or triple axis sensing capability with wide g ranges
- Applications
  - Activity monitors
  - Anti-tampering
  - Asset tracking
  - Human machine interface
  - Inclinometer
  - Pedometer
  - Vibration monitoring

Auto Qualified in Q1’2019
**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
  - Inertial measurement unit
  - Inertial navigation
  - Robotics
  - Virtual reality and augmented reality

**FXAS21002C**

3 Axis Gyro with low power consumption, Compatible with NXP’s 9-axis Sensor Fusion Solution.

**Product Features**

- Low power performance: 2.7mA (Active), 1.6mA (Ready), 2uA (Standby)
- Enhanced Selectable Full Scale ranges: +/-250, +/-500, +/-1000, +/-2000, +/-4000
- 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
- 1.95-3.6V supply voltage
- Complete sensor fusion enablement suite

**Ideal for applications that require**

- z-axis such as Robotics, power tools – with highly accurate z-axis
- High rate sensing – our gyro supports up to 4000 dps
- Market leading TCO/TCS - Industrial applications where performance over temperature is critical
- Sensor Fusion – Proven with NXP’s open source sensor fusion for development and production

**AEC-Q100 Qualified version available in 2019 (samples), 2020 (production)**
Magnetometers

- Measure direction and 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
  - Electronic compass
  - Magnetic field measurements
  - Wheel speed detection

Magnetometers for the IoT

FXOS8700

- 3 x 3 x 1.2 mm QFN
- I2C, SPI output
- Accel + Mag combo
- Resolution: 14 bit accel, 16 bit mag
- 1.6 to 800Hz output data rate
- Low power: 80μA @25 Hz (Hybrid Mode)
- Auto Wake Sleep Feature
- Accel Events: Vector magnitude, Tap, Freefall, Transient, Motion detection
- Mag Events: Hard Iron Calibration, magnetic min/max detection
- Magnetic calibration S/W support (Sensor Fusion)
IoT Pressure Sensor Applications

**Industrial**
- HVAC
- Gas metering
- Water metering
- Water Heaters
- Leak detection for gas & water media
- Beverage dispensing

**Commercial**
- Washing machines
- Dishwashers
- Smart appliances
- Smart watches
- Bike computers
- Fitness trackers

**Medical**
- Drug Delivery Systems
- Respiratory Monitoring
- Medical Implant Monitoring
- Activity monitors
- Blood Pressure Monitoring
- Liquid level detection
- Surgical equipment
- Negative pressure wound management
Pressure Sensors

- Types of Pressure Sensors
  - Absolute pressure
  - Differential pressure
  - Gauge pressure
- Medical/Industrial Applications
  - Air conditioning
  - Blood pressure monitor
  - Breathing machines
  - Inhalers
  - Water level monitor
- Automotive Applications
  - Engine Management
  - Safety
  - Emission control
  - LPG/CNG systems
Pressure Sensor Portfolio

**Uncompensated**
- High sensitivity analog output
- Need external circuit for compensation and amplification

**Temperature Compensated**
- Integrated temperature compensation
- Need external circuit for amplification

**Integrated Pressure Sensor**
- Integrated signal conditioning for temperature compensation, linearization and amplification

**Package Examples**
- SOP
- Basic Case
- Side Port
- Axial Port
- Unibody Dual Port
- SSOP Basic Case
- Medical ChipPak Case
- LGA 3 x 5 mm Case

**Integrated Digital Pressure Sensor**
- I2C Digital Interface with digitized output in Pascals or meters.

**MPX10/12/53**
- 10...53 kPa
- SOP, Unibody

**MPX2 Series**
- 10...300 kPa
- ChipPak, Unibody

**MPX7 Series**
- ±2...±25 kPa
- SOP

**MPX4 Series**
- 6...250 kPa
- SOP, SSOP, Unibody

**MPX5 Series**
- 4...1’000 kPa
- SOP, SSOP, Unibody

**MPX6 Series**
- 100...400 kPa
- SOP, SSOP

**MPL3115 (Digital I2C)**
- 115 kPa Smart Baro/Pressure
- 3 x 5 mm LGA

A – Absolute
D – Differential
G – Gauge
V – Vacuum
FXPQ3115BV: Biomedical Precision pressure sensor

Unique bio-compatible pressure sensor on the market
Biomedically approved gel coating
Internally compensated, software is not needed

- Pressure resolution: 1.5 Pa
- **Pressure range:** 50 – 115 kPa
- Absolute Accuracy: 50 Pa
- Short term drift < 20 Pa
- 1.95V to 3.6V supply voltage
- Variable output sampling rate (OST)
- I²C digital interface
- Interrupt driven events on :
  - Window pressure threshold (over and/or under pressure)
  - Window temp threshold (over and/or under temp)
- 32-Sample FIFO registers

In production

Inhaler demo available on demand:
Dose calculation, automated drug delivery on breath-in detection

LGA 3x5x1.1 mm
NPS30xx:
Precision Differential/Gauge Low Pressure Sensor family

- Calibrated pressure range: -2 kPa to 5 kPa
- Repeatability: ±3 Pa (0.3 mm H2O)
- Ultra Low power (below 10µA)
- Digitized pressure/temperature output in counts

Operating Voltage Range of 3 V to 5.5 V
Direct Compensated Pressure Reading 16-bit
Direct Compensated Temperature Reading 16-bit
Programmable Interrupt Events with two interrupt pins
I2C or SPI digital interface
Calibrated Temperature Range -40°C to 105°C
Output Data Rate from 1Hz to 3200Hz
Patented automated calibration algorithm

High precision is achieved through our MEMS technology coupled with a digital state machine that compensates, calibrates and digitizes the output.

Target Market:
- Ventilation system
- Fan control
- HVAC/transmitters
- Medical systems (CPAP, ventilators, inhalers)
- Process gas monitoring
- Pitot sensor
- Water heaters

4x5x1.35mm 12-pin Ceramic LGA with dual vents
Samples & evaluation boards: Now
Qual Complete: January 2019
SENSORS: INDUSTRIAL IOT APPLICATIONS
Industrial IoT Applications

• Smart Connected Home
• Smart Door, Small Appliances, Personal Care Devices
• Intelligent HVAC System Monitoring
• Smart Metering and Tamper Detection
• Motor Monitoring – Industrial motors
• Asset Tracking
• Security Cameras
• Robotics
• Sports Activity Monitoring
Smart Home Products

• Use Case
  - **Smart Iron**: Sleep on No-Motion/Tilt, Wake up on Motion, Steam Press on forward movement
  - **Smart Torch**: Automated flash light switches ON in dark places on a Shake Motion.
  - **Smart Stove**: Sensor Data Analytics can use vibrations to determine whether the ‘Rice is cooked’ or not.
  - **Smart Washing Machine**: Sensor Data Analytics can be used to identify the different operating states of a machine.

• Critical parameters
  - Low Power Wake up
  - Transient Detection, Motion Detection, Vector Magnitude
  - Auto wake Sleep for power savings
  - Low noise, high BW
  - Low TCO
  - High Tilt Accuracy (Good sensitivity)

**MMA8652**: small 2x2 mm 3-axis accelerometer with low power, good dynamic performance and fast turn on time

**MMA8451** high performance 3-axis accelerometer with low noise, 14-bit resolution and TCO performance.

**RD-KL25-AGMP01** 9-axis small factor data logger board useful for data analytic applications
Smart Door

• **Use Case**
  - Accelerometer to detect door knock, door/window tamper and vibration.
  - Accelerometer to avoid magnetic jamming for door open/close detection.
  - Magnetometer to determine door position for door open/close detection.
  - Magnetometer to detect presence of person or vehicle.

• **Critical parameters**
  - Low Active power for battery powered products
  - Transient Detection, Motion Detection
  - Auto wake Sleep for power savings
  - Magnetometer Sensitivity
  - Efficient Magnetic calibration
  - Offset change with temperature

• **Enabled by accelerometers and magnetic sensors**
  - **FXOS8700CQ 6-axis sensor** high resolution (14/16 bit), low noise and low power hybrid mode
  - **MMA8451** high performance 3-axis accelerometer with low noise, 14-bit resolution, and TCO performance.
Intelligent HVAC System Monitoring

• Use case
  - A differential sensor can be used as a system monitoring device to regulate fan speed, fan performance and filter life in a Variable Air Volume (VAV) system. The device is typically located inside the duct work, filter housing or fan housing.
  - Two pressures sources are measured as for example pre-filter and post-filter to determine filter performance.

• Critical factors
  - Pressure range
  - Resolution
  - Repeatability
  - Gauge/differential
  - Sensitivity

• Enabled by pressure sensors
  - MPX2010 high performance
  - MPX10
  - NPS30 family currently in development
Smart Metering and Tamper Detection

**Sensor Use Cases**
- Motion Sensors for Tamper detection or damage from storm
- Accelerometers for orientation detection confirming correct installation
- Absolute pressure sensors are able to derive the actual pressure and temperature at the inlet of the gas meter.
- Allowing the utility company to more accurately compute the standard volume, at the meter, and wirelessly transmit the reading to the utility company

**Critical parameters**
- Standby power (minimum power draw from the meter)
- Low active power for always on application
- Zero-g offset change with temperature
- Preconfigured tilt detection trigger

**Enabled by**
- NPS30 family differential pressure for flow rate
- MPL3115A2 absolute pressure for standard volume delivered to customer
- MPVZ4006 media resistant differential flow sensor
- MMA8491 for tamper detection
Motor Condition Monitoring

- **Sensors Use Case:**
  - Accelerometer used to detect the fundamental frequency of a motor along with its harmonics
  - Accelerometer used to determine Vibration signature through measuring wavelength, transfer coefficients, statistical measures, standard deviations, variances; available through Anomaly Detection Toolbox.
  - Anomaly detection toolbox encompasses a set of machine learning techniques used to flag when a system departs from normal or expected behavior based upon features extracted from sensor data.

- **Critical parameters**
  - High bandwidth
  - Low Non-linearity
  - Low noise
  - Active power (battery powered to avoid loose wires)

- **Enabled by**
  - FXOS8700: 14-Bit Resolution, Low noise
  - FXLN83xxQ: Analog Accelerometers
  - FXLS8471Q: ±2g/±4g/±8g, Low g, 14-Bit Digital Accelerometer
  - FFT algorithms (in Sensor Fusion library)
  - Anomaly Detection Toolbox: Demo Available
Asset Tracking

• **Sensor Use Cases**
  - Motion Sensors to detect the journey of a package in transit
  - Detects critical events such as Freefall, Shock, Orientation change, Magnetic Anomaly and Angular Rate Anomaly
  - Events can be stored in the SD card or memory
  - Motion profile can be analyzed at the end of the journey and sent to the cloud.

• **Critical parameters**
  - Low active power for always on application
  - Embedded interrupts such as Freefall, Shock etc.
  - High Full Scale Range
  - Small form factor based module with SD card/EEPROM

• **Enabled by**
  - FXAS21002 gyroscope
  - FXOS8700 6-axis sensor
  - RD-KL25-AGMP01 reference design
Security Cameras

• **Sensors Use Case:**
  - An accelerometer is used to detect heading information, angle along with tamper and vibration detection
  - Magnetometer for tilt compensation

• **Critical parameters:**
  - Accurate compass heading
  - Yaw detection
  - Accurate magnetic calibration
  - Tilt compensation
  - Offset change with temperature
  - Sensitivity change with temperature

• **Enabled by accelerometer + magnetometer**
  - FXOS8700, for orientation, motion, vibration, shock, fall, g-force, altitude changes etc. are present
  - MMA8451 High performance 3-axis accelerometer with low noise, 14-bit resolution, and TCO performance.
Robotics and Instrumentation

- **Sensor Use Cases:**
  - Angle of robot arm
  - Vibration signature
  - Tamper detection
  - Safety switch

- **Critical parameters:**
  - Angle random walk and bias stability
  - 3-axis angular rate detection
  - High Sensitivity
  - Temperature variation of offset(Z axis)
  - Temperature variation of sensitivity

- **Enabled by:**
  - **MMA8451** High performance 3-axis accelerometer with low noise, 14-bit resolution, and TCO performance.
  - **FXAS21002** angular acceleration detection with the ability to determine yaw, pitch and roll that complements NXP’s broader sensor portfolio.
  - **FXOS8700** for orientation, motion, vibration, shock, fall, g-force, altitude changes
Sports Activity Monitoring

- **Use Case**
  Sensors inside the Ball detect acceleration, rotation and change in Pressure or Temperature. Used with wireless connectivity to report sensor data and statistics to smart phone or tablet.
  - Accelerometers for low power motion wake up
  - Sensor Fusion for detecting orientation, acceleration and rotation
  - Accelerometer and Gyroscope Data Logging and Analytics
  - Pressure sensors for impact measurement, over/under inflation

- **Critical parameters**
  - Active power: Battery life in use
  - Standby power: Auto shutoff when not in use
  - Size: Fit into a small space
  - Full scale range and bandwidth

- **Enabled by accelerometers, gyroscopes, magnetic sensors and pressure sensors**
  - RD-KI25-AGMP01 is the 11-axis data logger module, ideal for data analytics applications
  - MMA8652 small 2x2 mm 3-axis accelerometer with low power, good dynamic performance and fast turn on time
  - FXOS8700, for orientation, motion, vibration, shock, fall, g-force, altitude changes etc. are present
  - FXAS21002 gyroscope provides the stability needed for drift free readings
  - MPL3115A digital pressure sensor for altimetry
Introducing the Sensor Toolbox Ecosystem
Sensor Toolbox Ecosystem

The complete Hardware and Software ecosystem for NXP sensors

NXP Sensor Toolbox

Sensor Evaluation Boards — Demonstration kits, Custom Kits, Shield boards and Breakout boards

Sensor Evaluation & Visualization Software—Sensor Toolbox Community Edition (STB-CE)

Embedded Software Framework — IoT Sensing SDK (ISSDK)

IoT Sensing SDK (ISSDK)

Sensor Toolbox - Community Edition (STB-CE)

Demo Kit (Shield + MCU)
Shield Board
Breakout Board
Custom Kit
## Supported Sensors by Sensor Toolbox Ecosystem

<table>
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<tr>
<th>Sensor Part Number</th>
<th>Sensor Type</th>
<th>Interface</th>
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<tr>
<td></td>
<td></td>
<td>SPI</td>
<td>I2C</td>
<td>ADC</td>
</tr>
<tr>
<td>FXAS21002</td>
<td>Gyroscope</td>
<td>✓</td>
<td>✓</td>
<td>—</td>
</tr>
<tr>
<td>FXLC95000</td>
<td>Intelligent Accelerometer</td>
<td>✓</td>
<td>✓</td>
<td>—</td>
</tr>
<tr>
<td>FXLS8471</td>
<td>Digital Accelerometer</td>
<td>✓</td>
<td>✓</td>
<td>—</td>
</tr>
<tr>
<td>FXOS8700</td>
<td>Digital Accelerometer and Magnetometer</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>MAG3110</td>
<td>Digital Magnetometer</td>
<td>—</td>
<td>✓</td>
<td>—</td>
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<tr>
<td>MMA845X</td>
<td>Digital Accelerometer</td>
<td>—</td>
<td>✓</td>
<td>—</td>
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<tr>
<td>MMA8491</td>
<td>Digital Accelerometer</td>
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<tr>
<td>MMA865X</td>
<td>Digital Accelerometer</td>
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<tr>
<td>MMA9553</td>
<td>Intelligent Accelerometer</td>
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<tr>
<td>MPL3115</td>
<td>Digital Pressure</td>
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<tr>
<td>FXLS8962</td>
<td>Accelerometer</td>
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<tr>
<td>FXPQ3115</td>
<td>Pressure/Bio-Compatible</td>
<td>—</td>
<td>✓</td>
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<tr>
<td>MPXV5004DP</td>
<td>Differential and gauge, integrated analog pressure sensor</td>
<td>—</td>
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<td>✓</td>
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<tr>
<td>NPS300xxx</td>
<td>Precise low-pressure gauge/differential sensor</td>
<td>✓</td>
<td>✓</td>
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</tr>
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</table>
Hardware: Sensor Evaluation Boards

**Demo Kit (Shield + MCU)**
- Complete Solution for ‘Out of Box’ sensor demonstration, evaluation and development

**Shield Board**
- Evaluation Boards, pin compatible with most Arduino and FRDM development boards

**Breakout Board**
- Boards for product prototyping, can be easily wired to host MCU

**Custom Kit (NEW)**
- Attach the shield board with the corresponding MCU board for quick demonstration, evaluation and development

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**Sensor Toolbox Name** | **Board Type** | **Board Name**
--- | --- | ---
Sensor Toolbox for 9-Axis Solution | Demo Kit | FRDM-K22F-AGM01
| Custom Kit (New) | 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 Expansion board for multiple sensors | Shield Board | FRDM-FXS-MULT2-B
| Custom Kit (New) | FRDM-K64F with FRDM-FXS-MULT2-B

Find all NXP sensor boards at [nxp.com/sensorevaluationboards](http://nxp.com/sensorevaluationboards)
MCU Attach: Sensor Enablement SW

MCUXpresso Software and Tools
for NXP Cortex M based Microcontrollers

MCUXpresso IDE
Edit, compile, debug and optimize in an intuitive and powerful IDE

MCUXpresso SDK
Runtime software including peripheral drivers, middleware, RTOS, demos and more

MCUXpresso Config Tools
Online and desktop tool suite for system configuration and optimization

Sensor Toolbox – CE: Visualization / Out of Box
- Quickly Demonstrate & Evaluate
- Customizable GUIs
- Integrated with IoT Sensing SDK
- Supports all Sensor kits (Demo kits + custom kits)

IoT Sensing SDK
- Go-To Solution for Sensor Application Development
- Provides Sensor Drivers, Algorithms and Examples
- Enables prototyping and production applications
- Supports Kinetis, LPC and I.MXRT+ sensors (All sensor kits)
- Supports sensor based Host Io Applications

Application Algorithms / SW
- 6 & 9 axis Sensor Fusion
- Pedometer
- Precision inclinometer

Current MCUs supported:
I.MX: I.MXRT1050, I.MXRT1020

QN: QN9080
LPC: LPCXpresso54114
**ISSDK Provides**

- **Out of Box Projects** for every Sensor Kit: Visualize sensor output on Terminal Application

- **Template** to create custom Embedded Applications: Modify the out of box templates for custom use cases with NXP sensor kits.

- **Detailed sensor register definition File**: Complete bit map of each sensor register. Can be used for development with any MCU platform.

- **Generic sensor drivers**: Easy to use common set APIs such as Sensor Init, Configure, Read and DeInit for quick application development

- **Arduino IO Header Pin Mapping files**: Arduino board + NXP Sensor shield pin mapping definition files for Arduino enthusiasts.

- **Generic Host Io Template Projects**: Enables sensor data transmission including STB-CE, cloud or any host GUI.
Sensor Toolbox- Community Edition

The sensor evaluation and visualization SW tool for NXP sensors

- **Quick Sensor Demonstration**: Enables quick visualization of sensor data and other sensor outputs based on the pre-configured sensor settings in the firmware.
- **Real Time Sensor Evaluation**: Enables changing critical sensor settings (ODR, FSR, power modes) and data logging during sensor demonstrations.
- **Register Interface**: Provides a register map for the sensors and allows quick read and write of different register bits, allowing detailed sensor evaluation.

Latest version of STB-CE 2.5 released on May 2018
Different PHASES of PRODUCT Development
End to End Tools for Product Development with NXP Sensors

**Demonstration and Evaluation**
- **Hardware**: Sensor Demonstration Kits
- **Embedded Software/Firmware**: Binaries auto-loaded with STB-CE
- **Visualization Software**: STB-CE ‘Out of Box’ Demonstration

**Development**
- **Hardware**: NXP MCU + any sensor Shield board
- **Embedded Software/Firmware**: Develop firmware using ISSDK and MCUXpresso
- **Visualization Software**: Serial Terminal or STB-CE standalone projects

**Prototyping**
- **Hardware**: NXP MCU + Any sensor Breakout board
- **Embedded Software/Firmware**: Develop firmware using ISSDK and MCUXpresso
- **Visualization Software**: Serial Terminal or STB-CE standalone projects
Other Customer Enablement
10-axis Data Logger (Reference Design)

- The **RD-KL25-AGMP01** provides a total system solution for data collection applications. This size of the board is an efficient 1.2 x 1.5 square inches for portability and ease of use.
  - This board supports the **FXOS8700CQ** 6-axis e-compass sensor, the **FXAS21002C** 3-axis gyroscope, and the **MPL3115** pressure sensor driven by a Kinetis **KL25Z MCU**.
  - A microSD card slot is provided should the user decide to collect the sensor or application data in cases where a host computer might not be available.
  - Includes NXP’s smart Li-ion battery charger and power management
  - The board is semi-enclosed, generating a flat surface on one side of the design, to allow easy mounting to different surfaces.

Search for “10-Axis” on NXP.com

Includes: Demo Code, schematics, reference for vibration and other materials
Magnetic Rotary Encoder (Reference Design)

- A reference design showing a contactless knob for angle measurement. Demonstrator for many other Smart home and IoT solutions with magnetometer. See the tool first hand and learn how to demonstrate it to your customers.

Smart Run Insole (Reference Design)

✓ BLE connectivity: QN9080
✓ 9-axis sensors: FXOS8700 and FXAS21002
✓ Small Size: 1.5 in.sq
✓ Battery Charging circuitry
✓ Output on BLE app:
  - Propulsive Power
  - Velocity
  - Metabolic Efficiency
  - Stride Symmetry
  - Peak forces from Heel to Toe
✓ Low Power consumption
  - 3 mA for BLE transmission
  - 8uA for low power motion wake up
✓ IoT Sensing SDK enabled (www.nxp.com/iotsensingsdk)
Anomaly Detection Toolbox
(Reference Design)

- Machine learning on the edge of the cloud
- Learn normal system behavior and then raise a flag when abnormal behavior occurs
- Supported sensors: Accelerometer, Gyroscope, Magnetometer, and (soon) Pressure Sensor
- Runs on an ARM® Cortex® M4F

Recommended:
NXP® FXOS8700CQ and FXAS21002C sensors
Smart Door Lock Demo
The smart low cost sensor solution to ensure home security

Detect door positioning using
**FXOS8700CQ 6DOF sensor**
(magnetometer plus accelerometer)

Demonstration based on
**RD-KL25Z-AGMP01**

Asset Tracking Demo
Track the journey of a package using Motion Sensors


2. The reference design records 9-axis motion sensor data & critical sensor events on a SD card
   - Components used: FXAS21002 + FXOS8700 9-axis sensors, FRDM-KL25Z MCU & 4GB microSD card
   - Firmware: Enables logging of 9-axis motion sensor data and critical events to a .csv file in the SD card
   - Sensor Data logged: Accelerometer, Magnetometer, Gyroscope and Timestamp (at a rate of 100Hz)
   - Motion Events logged: Shock, Freefall, Angular Velocity Anomaly, Orientation Change & Magnetic Anomaly

3. Launch the Asset Tracking software on a Windows PC to analyze the motion profile of the package.
4. The software reads the SD card data, generates the motion profile locally and sends it to the cloud.

Motion Profile of the package in transit
Smart Sensing Inhaler Demo
Uses tidal breathing to trigger medication dispensing, for both adults and infants

- High precision, biocompatible, digital pressure sensor FXPQ3115
- Intelligent trigger function to align dispensation with tidal breathing
- Tilt sensor FXOS8700 assures inhaler posture
- Used with wireless (BLE) connectivity to report on patient adherence and compliance
- Using authentication and encryption to the cloud helping physicians treat more effectively
Smart IoT Ball Demo

- Demonstrating how a Sensor attached to a MCU can become an end node of an IoT ecosystem.
- Enabled by IoT Sensing SDK (ISSDK) Software Framework and powered by IBM Bluemix Services.
- Showcasing how motion and pressure digital sensor data (11-axis) from a Sports ball with embedded sensors can be forwarded to the cloud and visualized on a web browser.

Find more information about ISSDK here: www.nxp.com/iotsensingsdk
Sensor Fusion Demo on Android Tablet

• Demonstrating the latest NXP Sensor Fusion demo on an Android device
• 3, 6 and 9-axis sensor fusion options available for accurate orientation detection
• Ideal for applications like drones, wearables, virtual reality etc.
• Based on the open source Sensor Fusion library included in ISSDK (In MCUXpresso)
• Lowest cost, most complete sensor fusion solution available anywhere

Find more information here: www.nxp.com/sensorfusion
Technical Documentation and Collateral

• Datasheets and app notes for design in use available for all products today.

• New standardized Characterization and Qual Reports are planned for all products to provide customers the needed data to plan for production devices variations.
What data goes into a Sensor Spec?

For just a single spec line
• 9 data sets
• Over temp (-40, room, +85)
• X, Y and Z axis

One number to represent all data?
• Typical spec is generally based on mean ± 1 sigma (i.e. ~67% of parts will meet)
• Worst case represented across all 9 graphs
Characterization Reports

- Generated for most new products
- Make requests through any convenient SSD channel
  - Marketing
  - PLM
  - Applications
- Report releases are controlled by Applications Team
Resources

Sensors
www.nxp.com/sensors
www.nxp.com/motionsensors
www.nxp.com/pressure sensors

Sensor Toolbox Ecosystem
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