

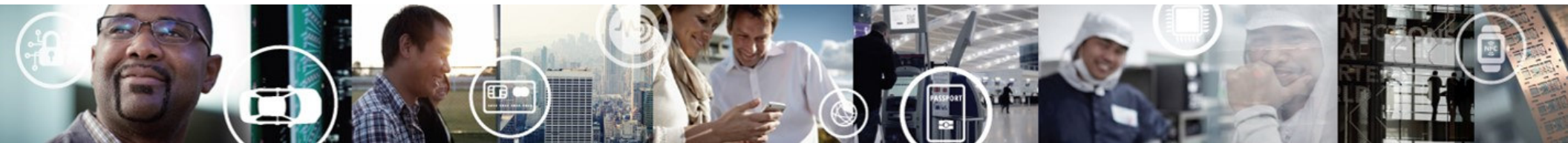
# MOTION SENSORS OVERVIEW

## MOTION SENSORS ROADMAP, APPLICATION UPDATE

JOHNSON GAO

MOTION SENSORS PRODUCT LINE MANAGER

JULY 2016



SECURE CONNECTIONS  
FOR A SMARTER WORLD



What do we offer ?

# NXP SENSOR TECHNOLOGY SUPPORTS KEY APPLICATIONS

## Automotive



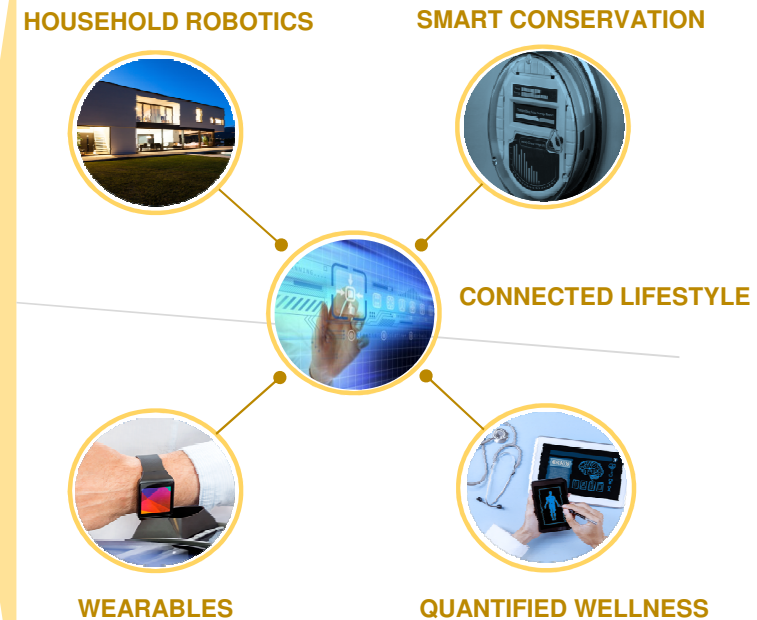
**3**  
BILLION  
UNITS SHIPPED

Magnetic (MR)

Motion (MEMS)

Pressure (MEMS)

## Medical & Industrial



# Sensors Medical Trends

## Market Drivers in Medical Growth

- ▶ Increased cost of Healthcare need to be contained
  - ▶ Increased need for Chronic Disease Management
  - ▶ Clinical Grade Medical Equipment becoming Portable
  - ▶ Wearable / Disposable Sensors proliferating
  - ▶ Increased need for Remote Patient Monitoring

## Technology Drivers for Growth

- ▶ Low Power (battery operated)
- ▶ High Accuracy/Precision Analog
- ▶ Consumer Driven easy to use User Interface required
- ▶ Wireless Connectivity (BLE, WiFi, NFC)
- ▶ Secure Data Required



# Sensors Applications in the Medical Market

## Portable Healthcare

- ▶ Diabetes Care
  - ▶ Blood Glucose Monitors (BGM)
  - ▶ Continuous Glucose Monitors (CGMS)
- ▶ Cardiac Care
  - ▶ Pulse Oximeter (SPO2)
  - ▶ Wearable Wireless Patch
- ▶ Drug Delivery
  - ▶ Inhaler
  - ▶ Injector Pen
  - ▶ Wearable Pump
  - ▶ Cold Chain Monitoring

## Clinical Healthcare

- ▶ Patient Monitor
- ▶ Automatic External Defibrillator (AED)
- ▶ Infusion Pump
- ▶ Electrocardiograph (ECG)
- ▶ Continuous Passive Airway Pressure (CPAP)
- ▶ Connected Health Gateway
- ▶ Digital Hearing Aid

## Consumer Healthcare

- ▶ Health/Wellness
  - ▶ Weight Scale
  - ▶ Wearables

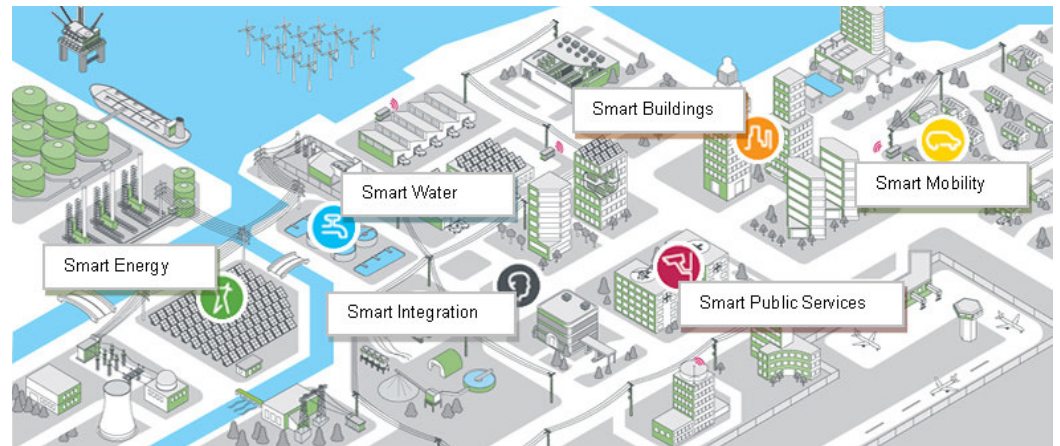
# Sensors Industrial Trends

## Market Drivers in Industrial Growth

- ▶ Smart metering
- ▶ Clinical asset tracking systems
- ▶ Smart grid
- ▶ Building automation

## Technology Drivers for Growth

- ▶ Low Power for remote monitoring and battery powered applications
- ▶ High Accuracy/Precision Analog
- ▶ Consumer Driven UI
- ▶ Wireless Connectivity (BLE, WiFi, NFC)
- ▶ Security



# Sensors Applications in the Industrial Market

Enormous Market and applications. Here are a few focused areas:

### Smart Homes

- ▶ Surveillance
- ▶ Security
- ▶ Home Automation
- ▶ Automated Vacuums

### Industrial Factory Automation

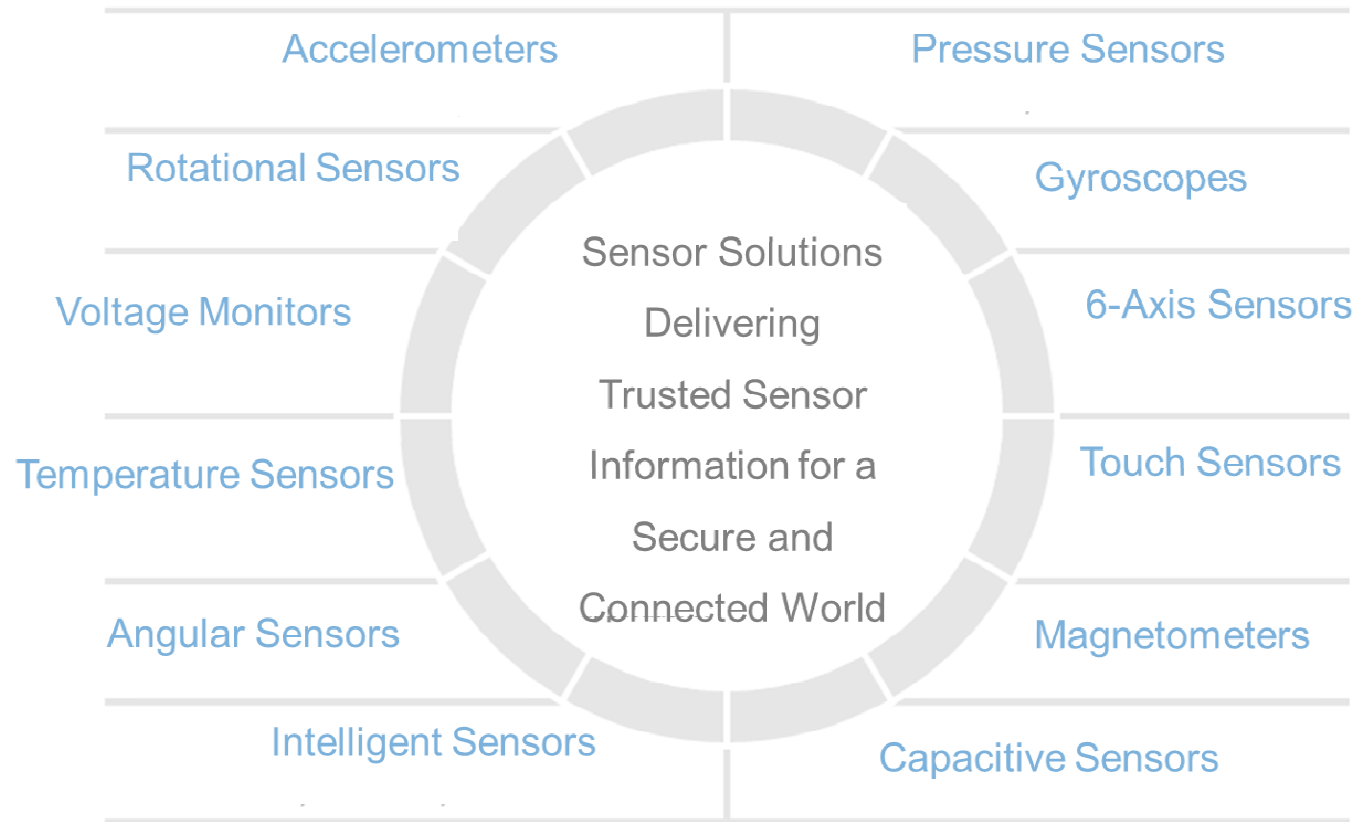
- ▶ Closed loop systems
- ▶ Machine Monitoring

### Industrial IoT

- ▶ Smart Agriculture
- ▶ Smart Metering
- ▶ Fleet Management
- ▶ Asset Tracking
- ▶ Rugged Monitoring



# NXP MEMS Sensor Portfolio







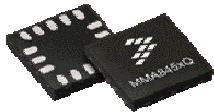
What do we offer ?



## 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

# Accelerometers for the IoT



**MMA845x**

- 3 x 3 x 1 mm QFN
- I<sup>2</sup>C output
- 0.25 mg/count sensitivity
- Extended Features
  - FIFO
  - Configurable P/L trip angles
  - High Pass Filter
  - Transient/Motion Detection
  - Tap Detection



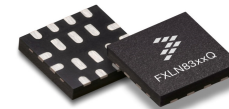
**MMA865x**

- 2 x 2 x 1 mm QFN
- I<sup>2</sup>C output
- 1 mg/count sensitivity
- Extended Features
  - FIFO
  - Configurable P/L trip angles
  - High Pass Filter
  - Transient/Motion Detection
  - Tap Detection



**MMA849x**

- 3 x 3 x 1 mm QFN
- I<sup>2</sup>C output
- XYZ tilt detection outputs
- 700µs detection latency
- Triggerable 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



**FXLS8471**

- 3 x 3 x 1 mm QFN
- SPI output
- 216 µg/√Hz noise density
- 1.6 to 800 Hz output data rate
- Extended Features
  - FIFO
  - Configurable P/L trip angles
  - High Pass Filter
  - Transient/Motion Detection
  - Tap Detection





## 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
  - Image stabilization
  - 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

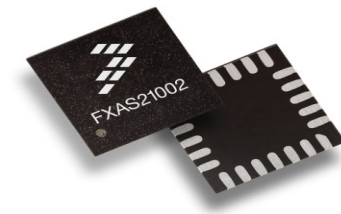
- **Best-in-class power performance: 2.7mA (Active), 1.6mA (Ready), 2uA (Standby)**
- Complete sensor fusion enablement suite

## Product Features

- Enhanced Selectable Full Scale ranges: **+/-250, +/-500, +/-1000, +/-2000**
- 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:  **$\pm 0.02\text{dps}/^\circ\text{C}$  (XY),  $\pm 0.01\text{dps}/^\circ\text{C}$  (Z)**
- Improved Noise: Angular Random Walk = **0.025 dps/rt(Hz)**.
- Angular velocity resolution  $<0.2\%$
- Programmable interrupts, Power saving features
- 1.95-3.6V supply voltage

## Typical Applications

- Controllers: Remotes, Games
- Ruggedized Industrial and Medical Handhelds and Tablets
- Sports Monitoring, Remote control toys, Robots



## Package

4x4x1mm QFN, 0.5mm pitch



## 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
- I2C Output
- 0.1  $\mu$ T sensitivity
- Low power in measurement mode 8.6  $\mu$ A
- Tilt compensation and Soft/Hard Iron calibration software available
- ODR upto 80Hz.



**FXOS8700**

- 3 x 3 x 1.2 mm QFN
- I<sup>2</sup>C output
- Accel + Mag combo
- Wider dynamic range +/- 1200  $\mu$ T
- 1.6 to 800Hz output data rate
- Low power: 80 $\mu$ A @25 Hz
- Magnetic calibration S/W support
- Vector magnitude trigger



**KMA2xx**

- 7.5 x 11 x 2 mm SIL
- Magnetic angle
- Ratiometric analog output
- 1° linearity
- Over-voltage protection
- -40° to 160°C
- AECQ100 qualified



## Pressure Sensors

- Measures the pressure(s) of fluid(s)
  - Absolute pressure
  - Differential pressure
  - Gauge pressure
- Applications
  - Air conditioning
  - Blood pressure monitor
  - Breathing machines
  - Inhalers
  - Engine management
  - LPG/CNG systems
  - Water level monitor





# Pressure Sensor Portfolio

**A – Absolute**  
**D – Differential**  
**G – Gauge**  
**V – Vacuum**

**MPX10/12/53** **D G**  
 10...53 kPa  
 SOP, Unibody

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

**MPX2 Series** **A D G V**  
 10...300 kPa  
 ChipPak, Unibody

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

**MPX7 Series** **D G**  
 ±2...±25 kPa  
 SOP

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

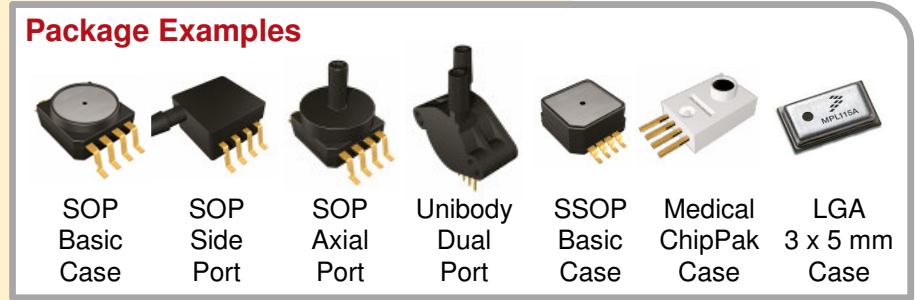
**MPX4 Series** **A D G**  
 6...250 kPa  
 SOP, SSOP, Unibody

**MPX5 Series** **A D G V**  
 4...1'000 kPa  
 SOP, SSOP, Unibody

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

**MPL3115 (Digital I<sup>2</sup>C)** **A**  
 115 kPa Smart Baro/Pressure  
 3 x 5 mm LGA

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



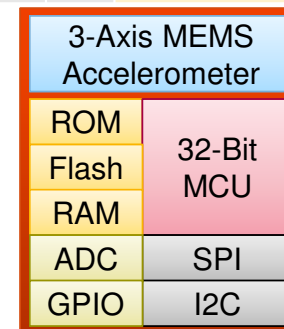


## Processor Integrated Smart Sensors

- Provide algorithmic processing integrated with sensing
  - Pedometer algorithm embedded
  - System power management
  - Partitioning real time algorithms from user interface software
  - Smaller footprint
- Applications
  - Watches
  - Patient monitors
  - Ear buds

# Motion Sensing Platforms

			Sample	Production	Applications
<b>MMA955xL</b> 32-Bit 16K Flash CPU and 3-axis Accelerometer			Now	Now	Tilt Measurement Vibration Monitor Pedometer Home Health Power Management E-Compass Asset Tracking Collision Recorder
<b>FXLC95000CL</b> 32-Bit 128K Flash CPU and 3-axis Accelerometer			Now	Now	
<ul style="list-style-type: none"> <li>Embedded <math>\pm 2</math>, <math>\pm 4</math>, <math>\pm 8</math> g 3-axis 16-Bit accelerometer module</li> <li><b>32-Bit CPU</b> with MAC multiply and accumulate block</li> <li>16K or 128K on-chip Flash, 2K or 16K on-chip SRAM</li> <li>SPI, I<sup>2</sup>C (master and slave), GPIO, ADC, PWM</li> <li>1.8V , 3 x 3 x 1 mm QFN, or 3 x 5 x 1 mm QFN</li> <li>Pre-flashed <b>NXP firmware</b> (3 Versions) or MQX</li> </ul>					
Part Number	Firmware	User Memory Size			
MMA9559L	Basic	14K Flash 1.5K SRAM	Now	Now	
MMA9550L	Infrastructure	6.5K Flash 0.5K SRAM	Now	Now	
MMA9551L	Infrastructure and Gesture	4.5K Flash 0.5K SRAM	Now	Now	
MMA9555L	High accuracy pedometer	1.5K Flash 0.2K SRAM	Now	Now	
FXLC95000	MQX enabled	128K Flash 16K SRAM	Now	Now	





# Sensors: Industrial and Medical IOT Applications

# Wearables

## 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
  - Motion profile

- **Enabled by** Accelerometers, Gyroscopes, Magnetic Sensors and Pressure Sensors
- **MMA9553L** is the intelligent pedometer platform
- **FXLC95000** as a sensor hub and datalogger
- **MMA8652** Small 2x2mm 3-axis accelerometer with low power, good dynamic performance and fast turn on time
- **MAG3110** and **MMA8491** combined in the **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

## Beyond a Fitness Band...



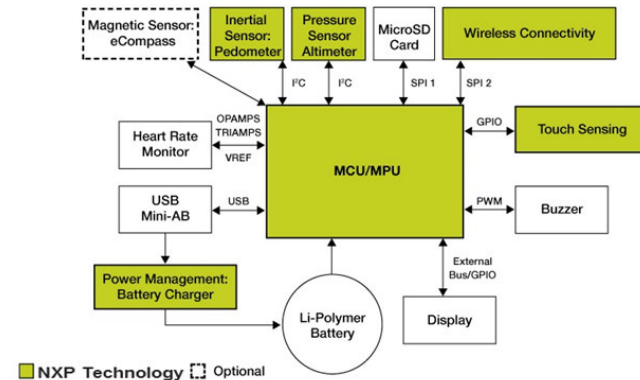
Ulcer Sensor promotes Correct motion



Knee brace provides activity monitoring



motion algorithms that sense when a person is craving nicotine to deliver medication



# Hearing Aid/Earphones

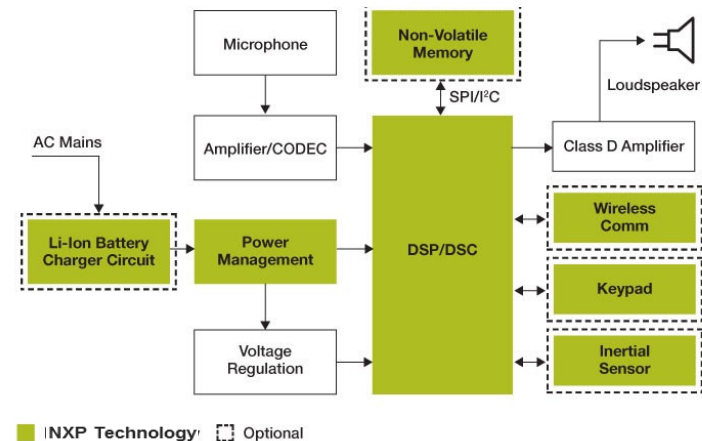
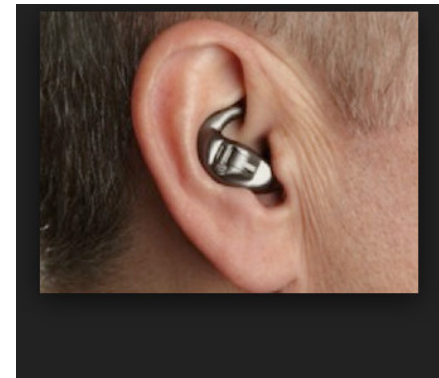
Critical parameters:

- Tap Detect to turn on/off the hearing aid
- Low power consumption in Active Mode
  - Long Battery Life
- Small Size
- ODR(>200 Hz) to accurately capture pulse (10-40ms)
- Accurate Pulse Detection Block
- Full Scale Range
- HPF enabled (remove static g)

Enabled by Accelerometer

- **MMA8652** Small 2x2mm 3-axis accelerometer with low power and fast turn on time
- **MMA8451** High performance 3-axis accelerometer with low noise, 14-bit resolution, and TCO performance or
- **MMA9555** 3-axis accelerometer and intelligent pedometer sensor

Beyond just sound...



# Security Cameras

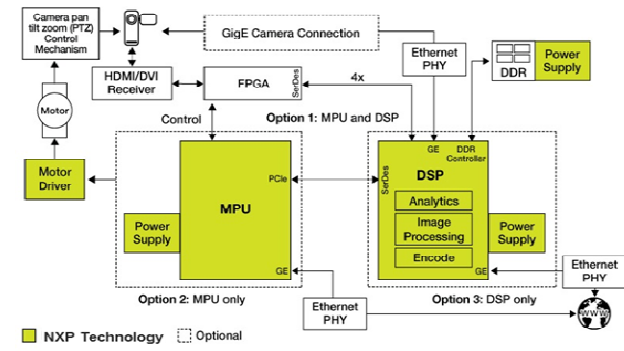
## Critical Parameters:

- Noise(Resolution)
- Non-linearity
- Offset change with Temperature

## Enabled by Accelerometers

- **MMA8451** High performance 3-axis accelerometer with low noise, 14-bit resolution, and TCO performance
- **FXLS8471** High performance 3-axis accelerometer with low noise, 14-bit resolution, and TCO performance with SPI

## Beyond Stationary Security...



# Smart Metering and Tamper Detection

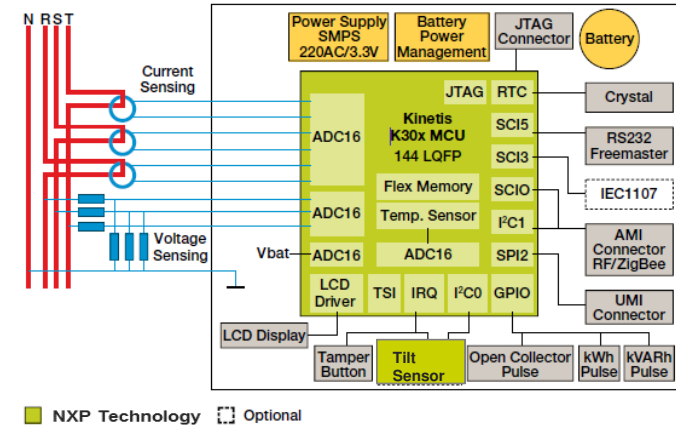
## Critical Parameters

- 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

Beyond Digital metering...



## Electronic Tamper Detection Smart Meter Reference Design



### Enabled by Accelerometers and Magnetic Sensors

- **FXLC95000** accelerometer/32 bit processor for vibration detection
- **MAG3110** magnetometer and **MMA8491** 3 axis accelerometer (tiltmeter) or **FXOS8700**, for orientation, motion, vibration, shock, fall, g-force, altitude changes

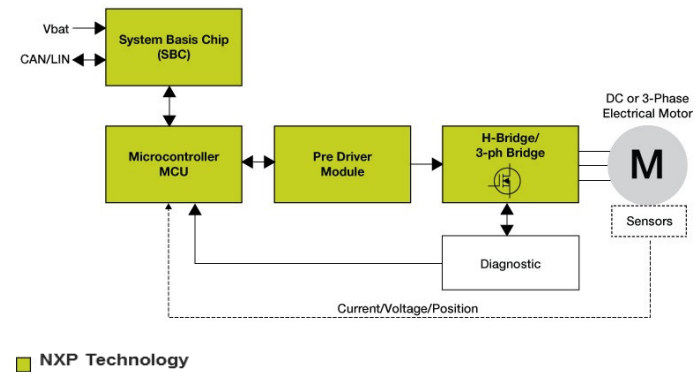
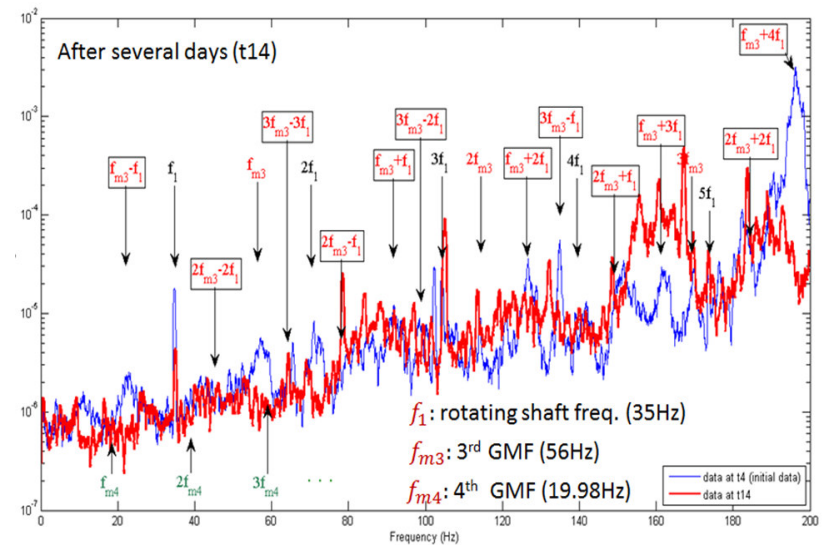


# Motor Monitoring

- Critical parameters
  - High Bandwidth
  - Non-linearity
  - Noise
  - Active Power(battery powered)

Enabled by Accelerometers and FFT algorithms (in Sensor Fusion Library)

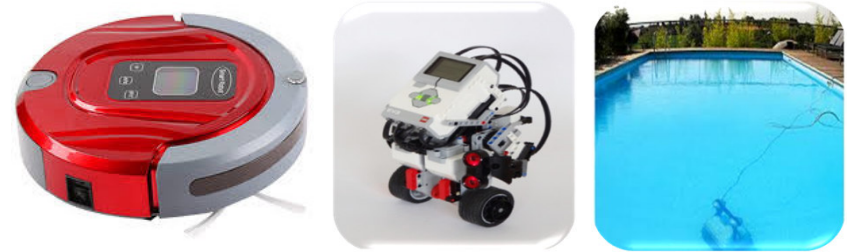
- **FXLC95000** accelerometer/32 bit processor for vibration detection
- **MMA8491** 3 axis accelerometer
- FFT algorithms (in **Sensor Fusion Library**)



# Robotics

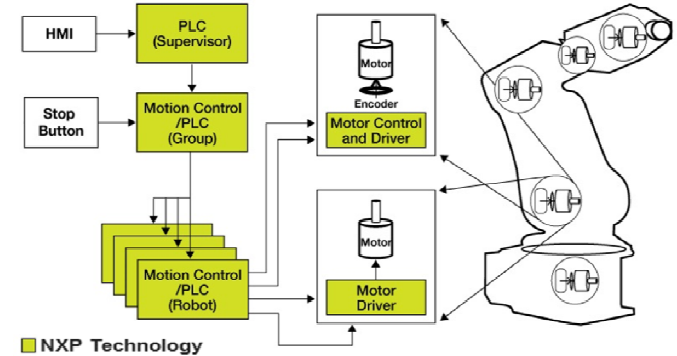
## Critical Parameters:

- Angle Random Walk and Bias Stability
  - 3-axis Angular Rate Detection
- Sensitivity
- Temperature variation of offset(Z axis)
- Temperature variation of sensitivity



## Enabled by Accelerometers, Gyroscopes, and Magnetic Sensors

- **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.
- **MAG3110** magnetometer or **FXOS8700**, for orientation, motion, vibration, shock, fall, g-force, altitude changes



# Virtual Reality for First Responder Training

Beyond physical training...

Critical Parameters:

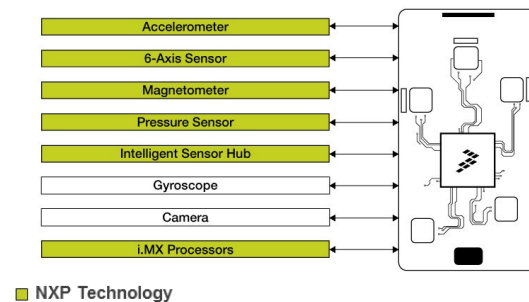
- Accurate Head Orientation(Static)
  - Sensor Fusion
- Linear Displacement
  - Gyro offset Correction
- Zero-g Offset
- High Output Data Rates for fast response time
- Phase/Group delay



Military and First Responder Simulation Training

Enabled by Accelerometers, Gyroscopes, and Magnetic Sensors

- **MMA8451** High performance 3-axis accelerometer with low noise, 14-bit resolution, and TCO performance.
- **MAG3110** magnetometer or **FXOS8700**, for orientation, motion, vibration, shock, fall, g-force, altitude changes
- **FXAS21002** angular acceleration detection with the ability to determine yaw, pitch and roll that complements NXP's broader sensor portfolio.



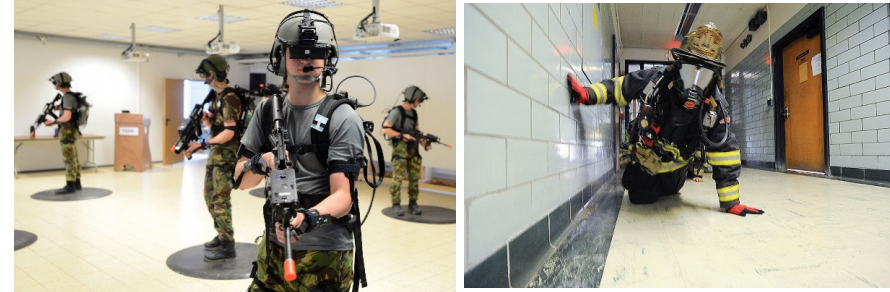
# Augmented Reality for First Responders “Bionic Vision” (10-Axis Inertial solution)

- Critical Parameters:
  - Accurate Sensor Fusion Algorithm
  - Noise(Resolution)
  - Angle Random Walk, Velocity Random Walk and Bias Stability
  - Offset correction for Gyroscope, accelerometer
  - Accurate Magnetic Calibration
  - Accurate Altitude Detection using Digital Pressure Sensor
  - Accurate Roll, Pitch and Yaw under Linear acceleration and magnetic interference
  - Inter axis alignment

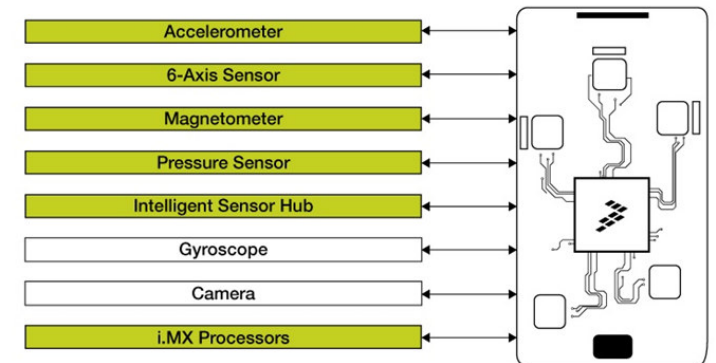
**Enabled by** Accelerometers, Gyroscopes, and Magnetic Sensors

- **MMA8451** High performance 3-axis accelerometer with low noise, 14-bit resolution, and TCO performance.
- **MAG3110** magnetometer or **FXOS8700**, for orientation, motion, vibration, shock, fall, g-force, altitude changes
- **FXAS21002** angular acceleration detection with the ability to determine yaw, pitch and roll that complements NXP's broader sensor portfolio.
- **MPL3115A** digital pressure sensor for altimetry

Beyond your physical limitations...



Enabling technology to provide firefighters, police and military with data about their surroundings, including oxygen levels, temperatures, possible contaminants, exit paths, and even video of the other members in their team.



 NXP Technology

# Door/Window Open Detection

- Critical Parameters:
  - Magnitude of Magnetic field
  - Magnetic Calibration
  - Standby Power
    - Battery enabled
  - Offset change with temperature

**Enabled by** Accelerometers and Magnetic Sensors

- **MMA8451** High performance 3-axis accelerometer with low noise, 14-bit resolution, and TCO performance.
- **MAG3110** magnetometer or **FXOS8700**, for orientation, motion, vibration, shock, fall, g-force, altitude changes



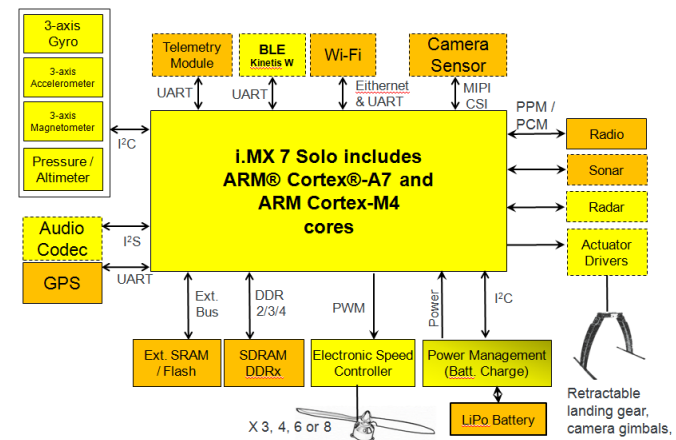
# Unmanned Vehicles/Drones (10-Axis Solution)

## Critical Parameters:

- Accurate Sensor Fusion Algorithm
- Minimum ARW and Offset in Gyroscope
- Offset correction for accelerometer
- Accurate Magnetic Calibration
- Accurate Roll, Pitch and Yaw under Linear acceleration and magnetic interference

Enabled by Accelerometers, Gyroscopes, and Magnetic Sensors

- **MMA8451** High performance 3-axis accelerometer with low noise, 14-bit resolution, and TCO performance.
- **MAG3110** magnetometer or **FXOS8700**, for orientation, motion, vibration, shock, fall, g-force, altitude changes
- **FXAS21002** angular acceleration detection with the ability to determine yaw, pitch and roll that complements NXP's broader sensor portfolio.
- **MPL3115A** digital pressure sensor for altimetry



# Motion Sensing Use Case – Drones, UAVs, Robotics

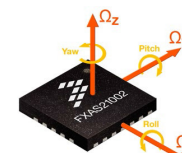
■ Enabling products: **Gyroscope**, Accelerometer, Magnetometer, Altimeter

• Use Case

- Active stabilization for UAVs (toy, hobby)
- Motion control for delivery drones
- Angular position control for robots ([Detailed report on CIA](#))

• NXP Key Advantages

- Complete system solution
  - Sensing: 10-axis motion sensing with **FXAS21002C (gyro)** + FXOS8700C (Accelerometer + Magnetometer) + MPL3115 (Altimeter)
  - Ecosystem: Open source sensor fusion algorithms running on Kinetis MCU (M0+, M4F Arm cores)
- Sensor Performance
  - **Lowest power 3-axis gyro on the market** ( $I_{dd} = 2.7 \text{ mA}$ )
    - Critical for “always on” applications
  - Market leading TCO/TCS for both accelerometer and **gyro**
    - Robust reliable performance over temperature
  - Best in class accelerometer noise / offset
    - Accelerometer is critical compliment to gyro for 6/9-DOF applications
  - **Data rates of up to 800Hz for reduced latency**



# Smart Inhalers

## Pressure Sensor

### Use Case

- Detect when a patient has activated their inhaler
- Allow the patient to easily measure the right amount of medication to be inhaled
- Eliminate the requirement to align breathing with the release of medication.



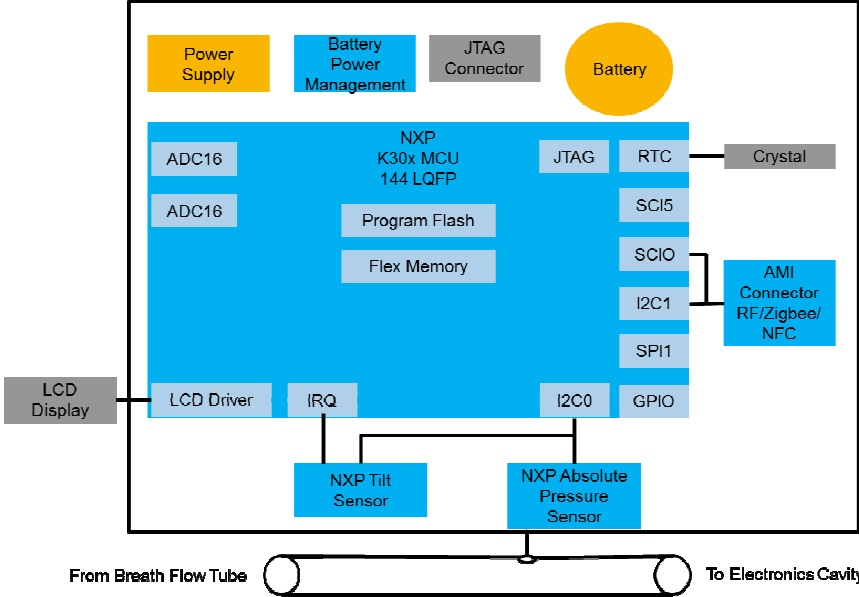
### Critical Factors

- Biomedical compatible components
- Pressure Range
- Critical Temperature Range
- Accuracy
- Repeatability
- Active Power consumption
- ODR (100Hz)
- Sensitivity

Enabled by Pressure Sensors and Tiltmeters

FXPQ3115BV

MMA8491





# Sleep Apnea Pressure Sensor

## Use Case

- Positive airway pressure (PAP) is a method of respiratory ventilation used primarily in the treatment of sleep apnea.
- Barometric measurement is also critical in some applications to avoid altitude deviation.

## Critical Factors

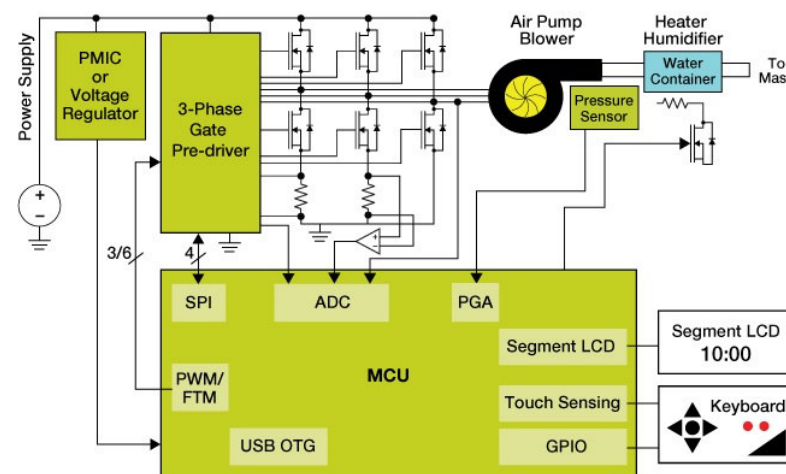
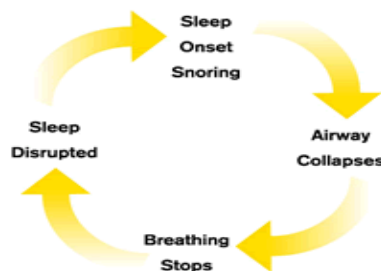
- Media Compatibility
- Biomedical compatible component (in contact with body)
- Gauge
- Sensitivity
- Accuracy
- Pressure Range
- ODR(~100Hz)

Enabled by Pressure Sensors

**MPXV5004GC6T1** and **MPXV7002DP** for air pressure management

**MPL3115A2** or **FXPQ3115BV** for barometric measurement

## Cycle of Obstructive Sleep Apnea



■ NXP Technology



# Blood Pressure Package

## *Pressure Sensor*

### Use Case

- A standard invasive blood pressure monitoring kit - sterile, single-use kits that relay blood pressure information from a pressure monitoring catheter to a patient monitoring system.

### Critical Factors

- Integrated temperature compensation and calibration
- Ratiometric to supply voltage
- Polysulfone case material (Medical, Class V Approved)



Enabled by Pressure Sensors

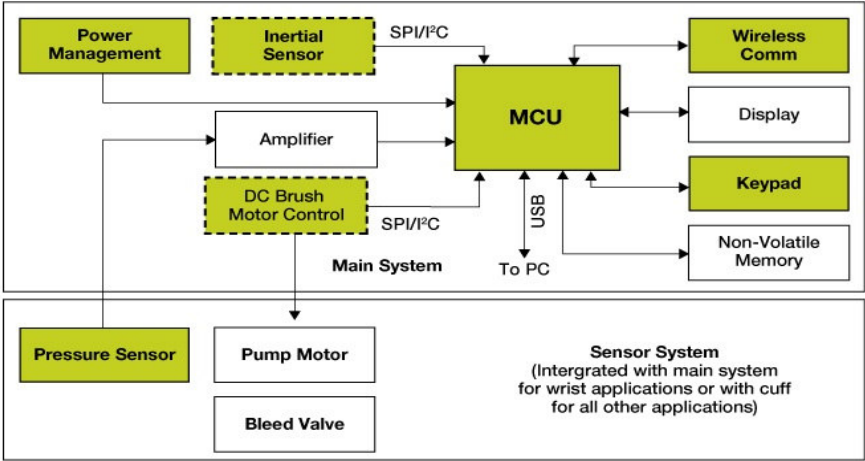
**MPX2300DT1**

# Blood Pressure Monitors

## Pressure Sensor

### Critical Factors:

- Accurate Tilt Detection
  - Linearity
  - Offset change with temperature
  - Embedded Tilt Detection Blocks
- Pressure Sensor Parameters:
  - Pressure Range
  - Accuracy
  - Power consumption
  - Gauged Sensor
  - Sensitivity



■ NXP Technology □ Optional

Enabled by Pressure Sensors

MPXV5050

MPXM2053GS

MMA8491



# Patient Monitoring

## Pressure Sensor

### Critical factors:

- Pressure range
- Temperature compensated over 0°C to +85°C
- Linearity
- Full scale span
- Offset
- Sensitivity
- Gauge ported



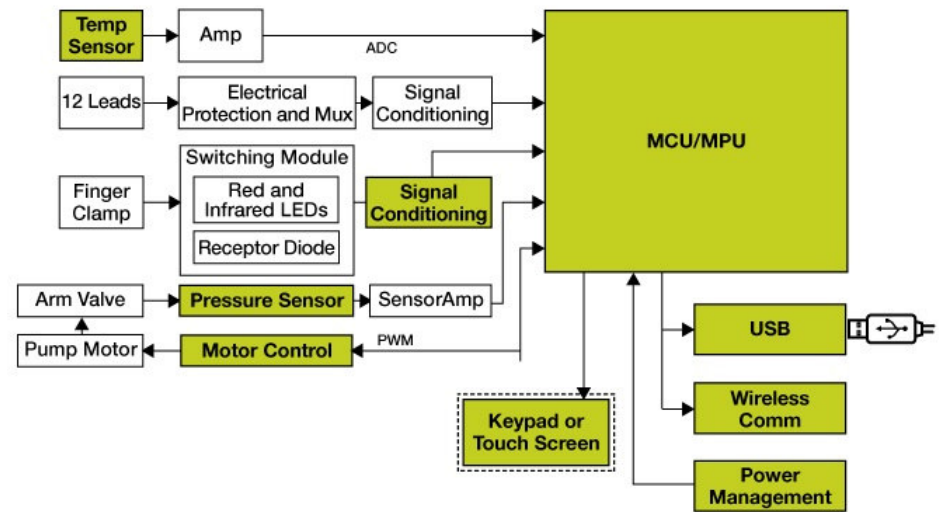
Enabled by Pressure Sensors

### Blood Pressure Monitor Module:

- **MPXM2051** enables measurement
- **MPXM2053** provides protection

### CO2 module:

- **MPXV2010** for flow measurement
- **MPL3115A2** for barometric measurement



■ NXP Technology □ Optional



# Medical Beds

## Use Case

- Prevention of necrosis of the muscle, pressure sores or ulceration

## Critical Factors

- Pressure Range



Enabled by Pressure Sensors

MPX5010 DP

MPXM2010GS

# Negative Pressure Wound Management Pressure Sensor

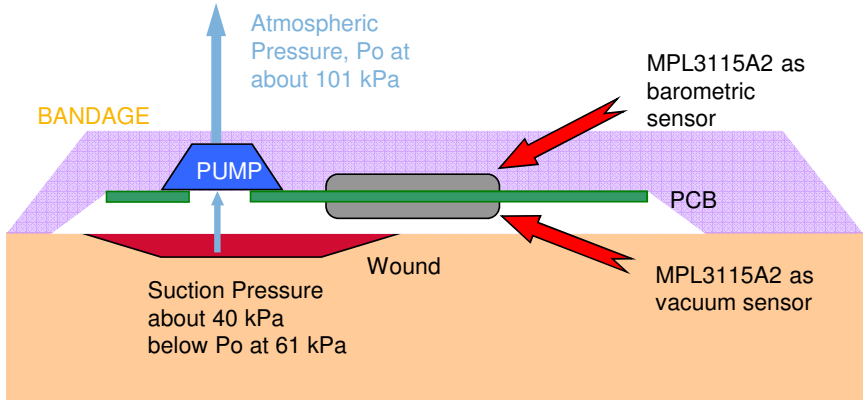
**Use Case:** Negative Pressure Wound Management or Closed Wound Suction is a non-invasive treatment by which controlled localized negative pressure is delivered to a wide variety of acute, sub-acute, and chronic wounds.

### Critical Factors:

- Media Compatibility
- Biomedical compatible components (in contact with body)
- Disposable
- Gauge/Absolute
- Sensitivity
- Accuracy
- Pressure Range

### Enabled by Pressure Sensors

**MPL3115A2 or FXPQ3115BV** acting as a vacuum sensor or for barometric measurement  
**MPXM2053GS, MPXV5100GC6U**



# Smart Utility Meter

## Pressure Sensor + Accelerometer

### Use Case

- Absolute pressure sensors are able to derive the standard volume at the meter and wirelessly transmit the reading to the utility company.



### Critical Factors

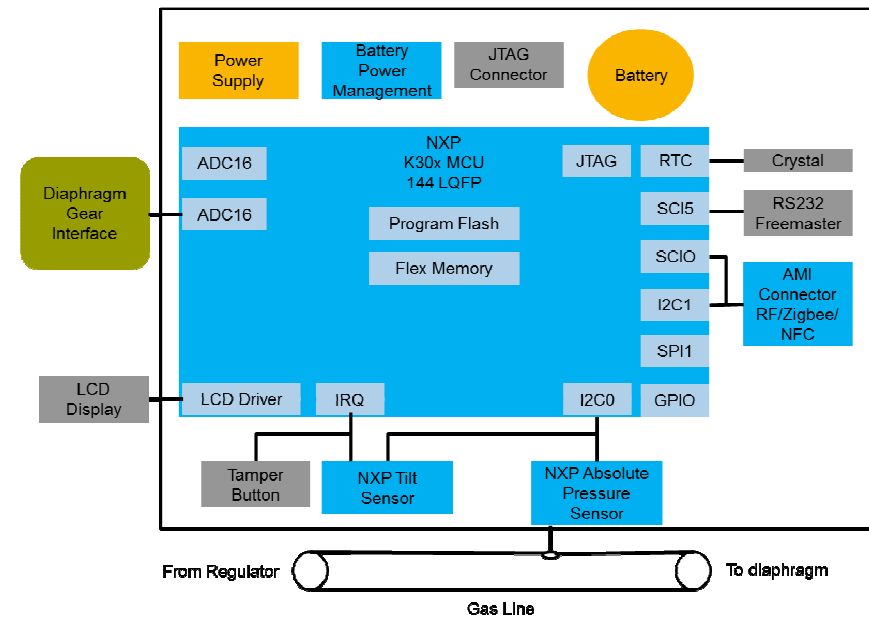
- Media Compatibility(LPG, natural gas)
- Absolute
- Sensitivity
- Accuracy
- Pressure Range
- Temperature Range
- Power consumption (Standby and Active)

Enabled by Pressure Sensors and Accelerometers

**MPVZ4006** Media resistant differential flow sensor

**MPL3115A2** barometric measurement for standard volume delivered to customer

**MMA8491** for tamper detection



# HVAC

## Pressure Sensor

### Use Case

A differential sensor can be used as a system monitoring device to regulate fan speed, fan performance and filter life. 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.

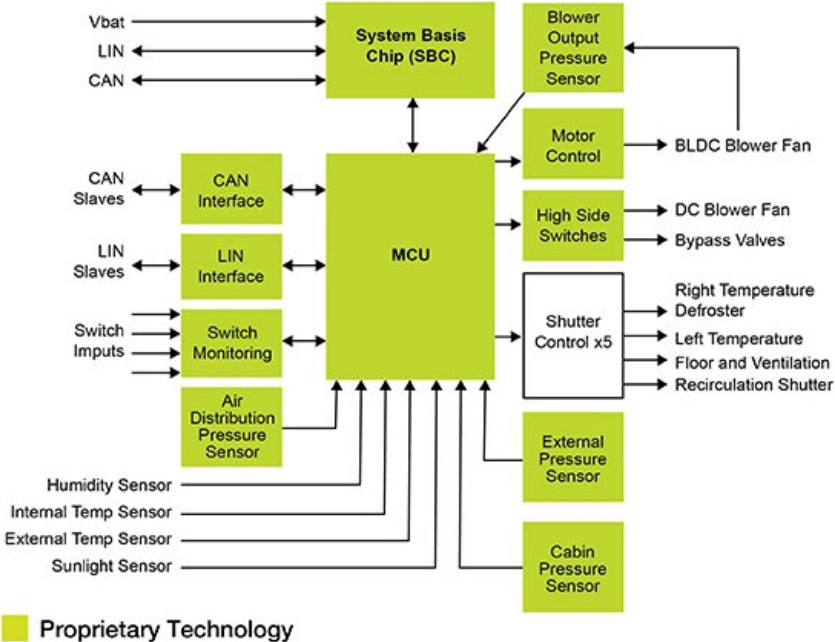
### Critical Factors

- Pressure Range
- Resolution
- Repeatability
- Gauge/Differential
- Sensitivity

Enabled by Pressure Sensors

MPX2010 High performance

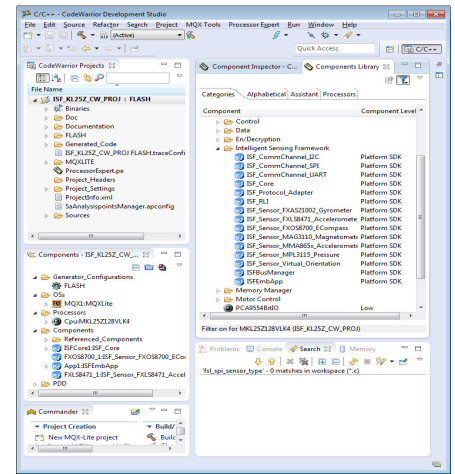
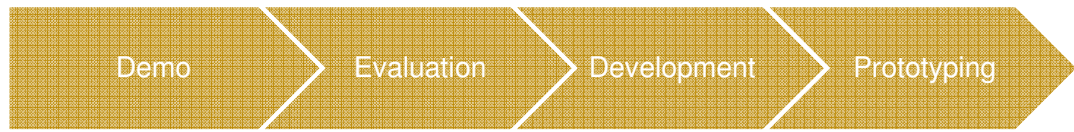
MPX10



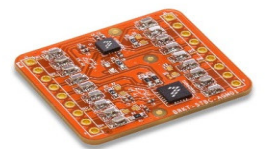


# Freedom Sensor Toolbox

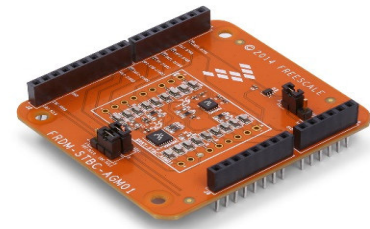
- Your complete ecosystem for product development with NXP's sensors.
- Includes Demo Kit, Shield Development Board and Breakout Board.
- Each board is enabled by **ISF** and **Freedom Sensor Toolbox-Community Edition (STB-CE)**.
- Powerful and convenient development & evaluation platform across NXP's 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, ISF and STB-CE.
  - **Development** of sensor applications enabled by Kinetis MCU's and ISF.
  - **Prototyping** your sensor designs enabled by Breakout Boards, ISF and STB-CE.
- Full enablement from a Demo to Sensor Prototyping (to Design Win 😊)



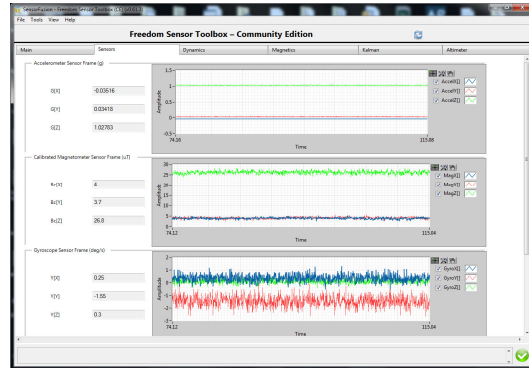
ISF



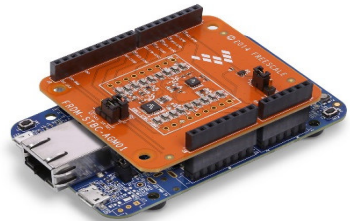
Breakout Board



Shield Board



STB-CE

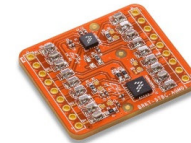


Demo KIT(Shield + MCU)

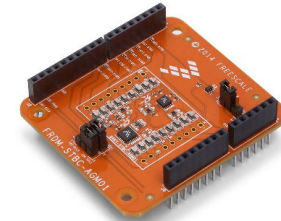


# Sensor Toolbox Board Repository

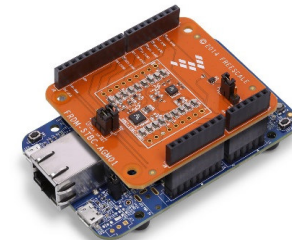
Sensor Toolbox Name	Board Type	Board Name
Sensor Toolbox for 9-Axis Solution	Demo Kits	FRDM-K22F-AGM01
		FRDM-K64F-AGM01
	Shield Board	FRDM-STBC-AGM01
	Breakout Board	BRKT-STBC-AGM01
Sensor Toolbox for FXLC95000CL Intelligent Motion Sensor	Demo Kit	FRDM-K22F-SA9500
	Shield Board	FRDM-STBC-SA9500
	Breakout 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)



# ISF 2.2 for Kinetis MCUs

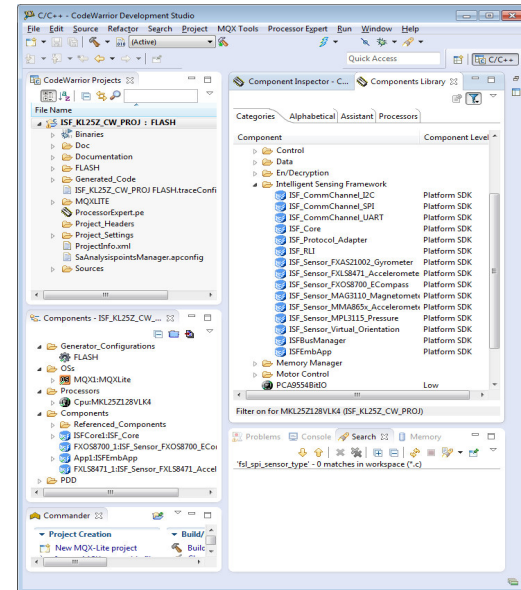
ISF 2.2 for Kinetis MCUs allows you to write an embedded sensor application in less than 30 minutes without writing a single line of code using Processor Expert technology.

## Differentiating Points

- Sensor application code auto-generation using Processor Expert technology
- Deployable across entire line of Freedom development platforms
- Sensor Fusion library has been integrated as an “Orientation” sensor using latest library
- Register Level Interface allows low-level access to sensor registers

## Product Features

- Projects available for FRDM-KL25Z, FRDM-K22F and FRDM-K64F
- Supports a broad set of Freescale sensors including FXAS21002, FXLC95000, FXLN83xx, FXLS8471, FXLS8952, FXOS8700, MAG3110, MMA865x, MMA955x, MPL3115 and others
- Example projects available for the Kinetis Design Studio 3.0 Integrated Development Environment



## Applications

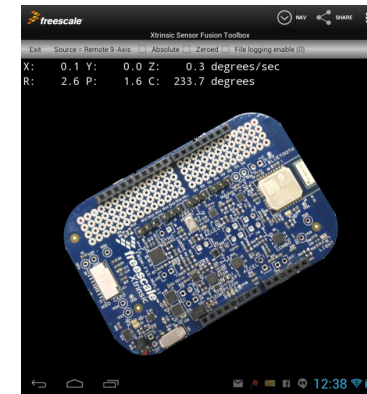
- Sensor Data Analytics
- Internet of Things
- Consumer Electronics
- Wearable Electronics
- Medical Devices



# Sensor Fusion

NXP offers the **lowest cost, most complete, sensor fusion solution available anywhere**, with:

- Zero Cost (see license file for details)
- 3, 6 and 9-axis sensor fusion options
- Source code for all functions
- Working template programs
- Low cost hardware options
- Extensive documentation (data sheet, user manual and multiple app notes, training slides and videos)
- Windows and Android applications to visualize fusion results
- For more details, please search for NXP Sensor Fusion
- Currently Integrated with ISF 2.2 and Freedom Sensor Toolbox-CE



# NXP Sensors

Delivering Trusted Sensor Information for a Secure and Connected World

NXP sensing solutions are trusted in use cases where value accuracy, data integrity, functional reliability, power conservation and an assurance of long term supply continuity must come together to create an overall robust system solution.

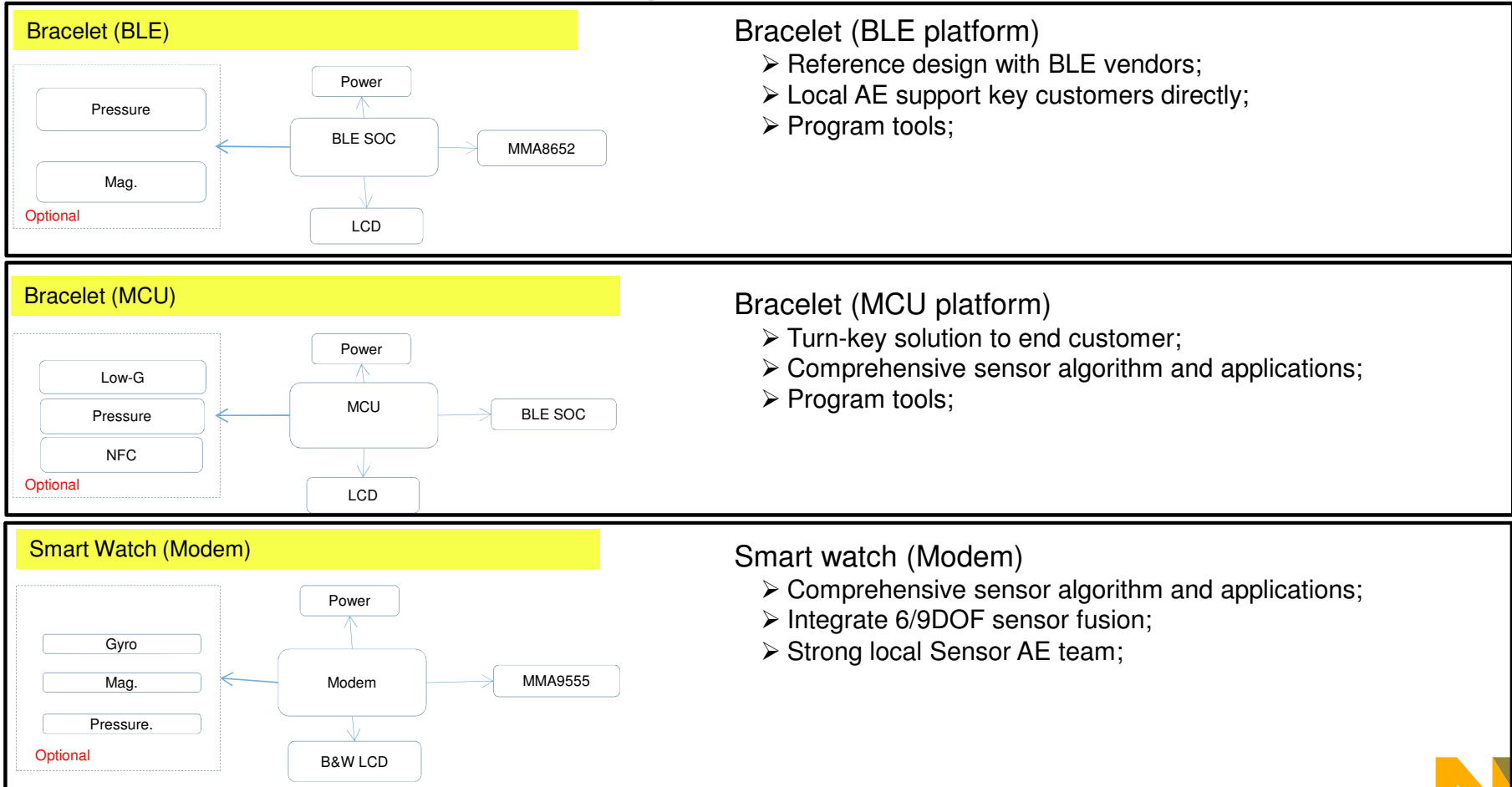
- Healthcare application knowledge, technical expertise, and resources.
- Long Product Lifecycles – 10/15 years
- Key Customer Relationships
- Scalable Family's of low power Sensors
- Application specific integration
- NXP Portfolio of low Power MCUs and connectivity



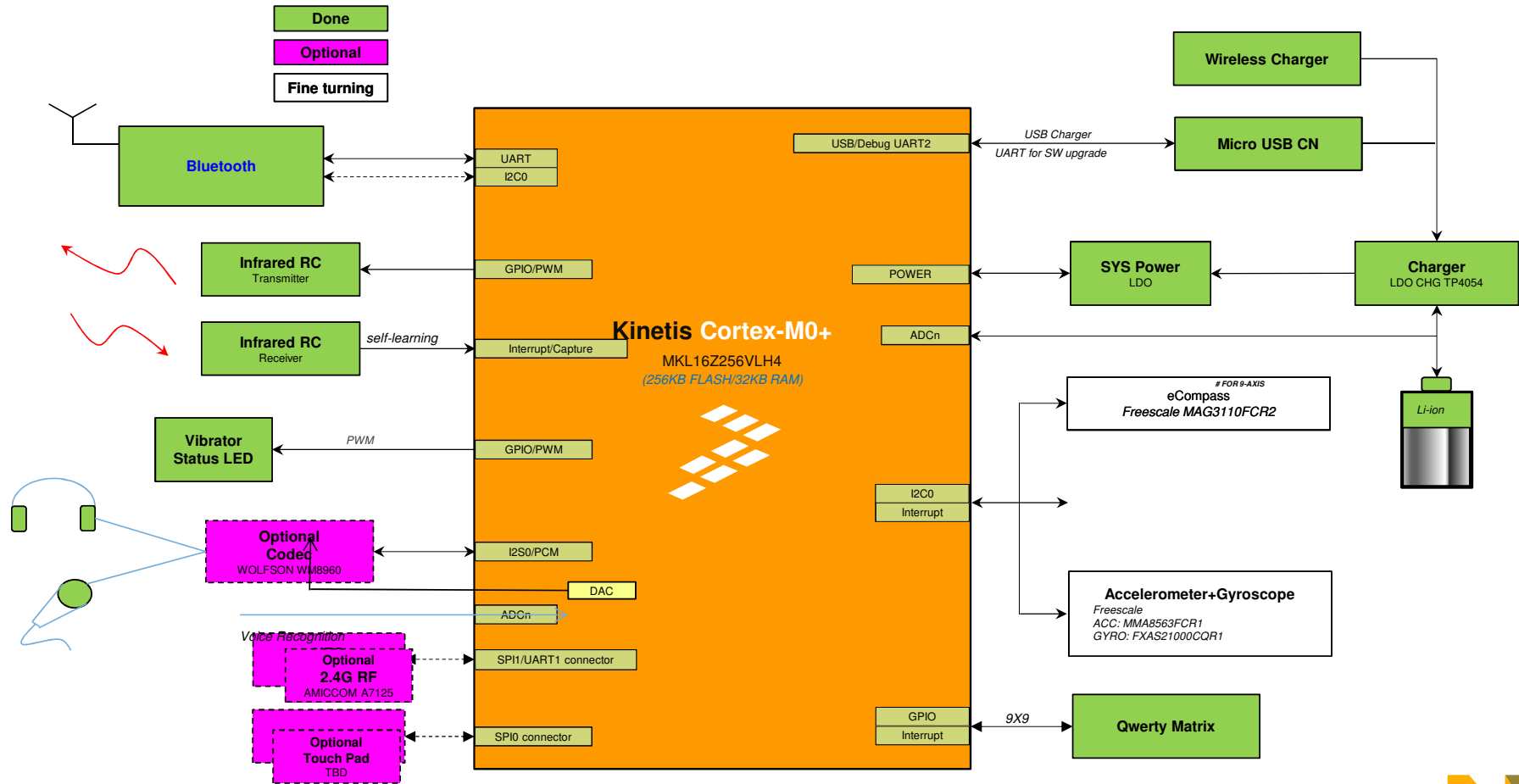


## Sensors: Reference Design

# Wearable Reference Design



# Air Mouse Solution Block Diagram







SECURE CONNECTIONS  
FOR A SMARTER WORLD