

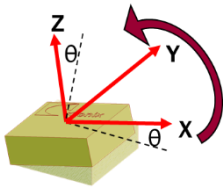
Kionix MEMS Sensors

Kionix Overview

- Founded 1993, Ithaca, NY with Cornell based technology
- A top 3 global supplier of MEMS accelerometers
- Product expansion into MEMS gyroscopes, magnetometers, 6-axis combos, and 9-axis sensor fusion
- Focused on consumer electronics and automotive
- Captive MEMS foundries and backend test and final packaging
- Capacity growth year-over-year doubling to >800MU/year by 2015
- Wholly-owned subsidiary of Rohm Co., Ltd.



Products - Overview



Accelerometer

- They sense linear movement and tilt
- Accelerometers detect gravitational force (g)



Gyro



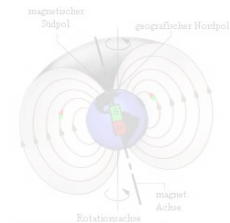
- Gyroscopes measure Angular Rate (not linear acceleration)



Magnetometer



- Magnetometers measure the earth magnetic field



Focus on accelerometers

Combo - Devices



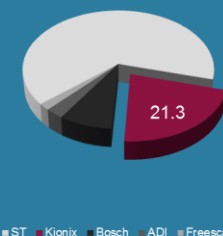
- Magnetometer – gives an “absolute” heading
- Accelerometer – gives an “absolute” down
- Gyroscope – gives a relative rotation



Applications - Overview

Consumer Electronics Category	2012	2013	2014	2015	2016
Mobile handsets	59%	56%	55%	55%	55%
Media tablets	14%	15%	17%	17%	16%
Gaming	9%	10%	9%	9%	7%
Cameras	8%	7%	6%	5%	5%
Laptops	3%	4%	3%	4%	5%
Remote controllers	2%	3%	4%	3%	3%
Other consumer goods	0.9%	2%	2%	3%	4%
Fitness and Wearable Consumer Electronics	0.8%	1%	1%	2%	3%
Toy helicopters	1%	0.9%	0.8%	0.7%	0.8%
MP3 players	1%	1.1%	0.7%	0.5%	0.4%
White goods	0.4%	0.4%	0.4%	0.4%	0.4%
PND	0.4%	0.3%	0.3%	0.3%	0.3%
Stand alone projectors	0.2%	0.2%	0.2%	0.2%	0.2%

Laptops and Tablets
2012 Discrete accelerometer
market share, Revenue



Typical Function:

- Device/screen orientation
- Freefall detection/Drop protection
- Input function like Gesture/Motion recognition/ Tap Detection
- Power management, Wake-up, Active/Inactive monitoring
- Tilt/Inclination detection
- Vibration detection

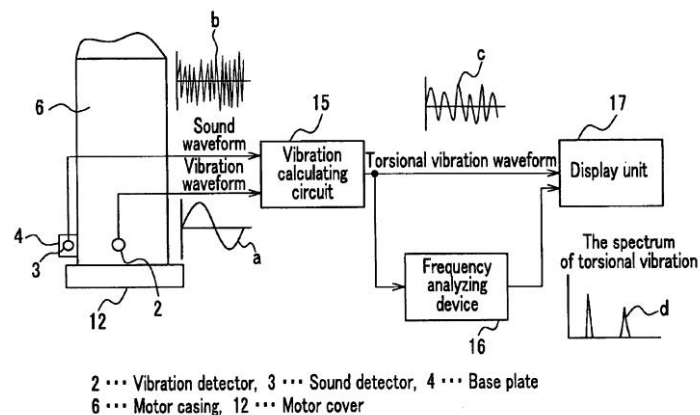
Applications - Overview

Vibration control for motors:



Required features:

- High sensitivity
- High bandwidth
- Low noise
- High reliability
- Algorithms for vibration monitoring or preprocessing
- Integrated low-power logic engine (CNL or MCU)



Applications - Overview

Wearables and Health and Fitness:



Required features:

- Low power accelerometer
- Low power gyro outputs
- Key capabilities: self-test, hibernate/wake on motion, tap/d-tap
- Small size/ability to support integration
- Algorithms for activity monitoring or preprocessing
- Integrated low-power logic engine (CNL or MCU)
- Integration with low-power communications

Current Products



Development Focus Areas

CSP
Power reduction
Algorithms, Pre-processing
Synchronization
MCU integration
BT LE integration

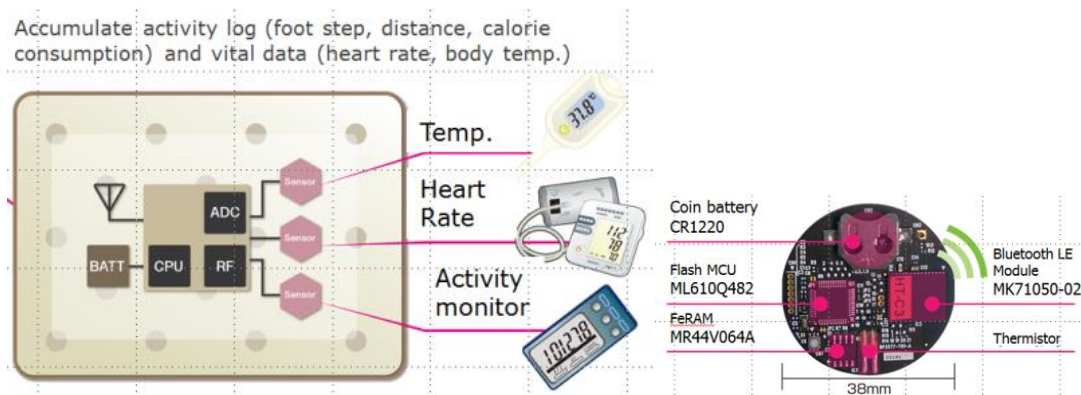


Applications - Overview

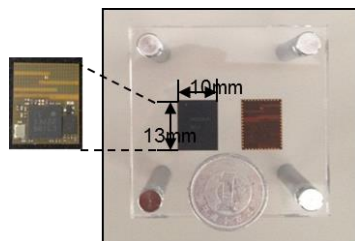
Synergy with other ROHM/LAPIS devices:

ROHM has several products which match perfectly together for wearable applications:

- Low Power MCU
- Bluetooth LE
- Kionix Sensors
- Other Sensors like ALS



Because of this LAPIS also plans additional Modules using these devices:



MK71050-03

BLE+MCU in a module
MCU : ML610Q794 (sensor HUB MCU)
ES : 2014/10, MP : 2015/3

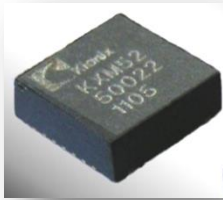
MK71050-04

BLE+MCU+ACC (Accelerometer) in a module
ACC: KX023 from Kionix inc.
ES : 2014/10 (TBD), MP : 2015/3 (TBD)

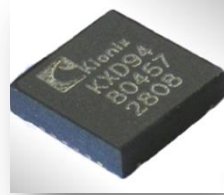
MK71050-05

BLE+MCU+NFC(Felica) in a module
NFC : RS-981 from Sony corp.
ES : 2014/10 (TBD), MP : 2015/3 (TBD)

Product Technology



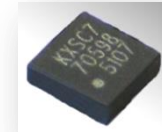
5x5x1.8mm
2004



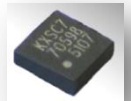
5x5x1.2mm
2005



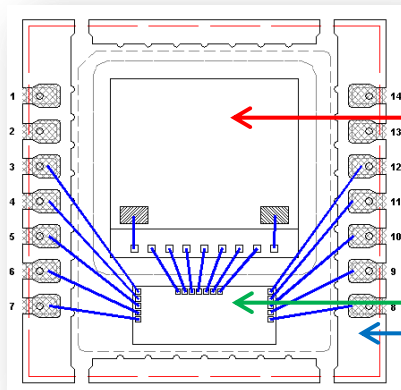
3x5x0.9mm
2006



3x3x0.9mm
2008



2x2x0.9mm
2011



MEMS Sense Element

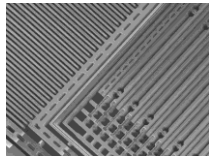
- Proprietary design, technology and manufacturing

Mixed-Signal IC

- Mixed-signal IC design in standard 0.18 μ m processes

Package

- Standard LGA and DFN



Products - Overview

Product	Full Scale G Range	Pins and Package Type	Current Consumption (μA)	I ² C	SPI	FIFO Buffer	High-Pass Filter	Embedded Algorithms	XAC Sensor for High Stability	Motion Wake-Up	Low Noise	Other
Digital												
2x2x0.9mm												
KX022	User-selectable 2g, 4g, 8g	12-pin, LGA	10-130	X	X	X	X	X	X	X		
KXTJ2	User-selectable 2g, 4g, 8g	12-pin, LGA	10-135	X					X	X	X	
3x3x0.7mm												
KXCJA	User-selectable 2g, 4g, 8g	10-pin, LGA	10-135	X					X	X	X	
3x3x0.9mm												
KX023	User-selectable 2g, 4g, 8g	12-pin, LGA	10-130	X	X	X	X	X	X	X		
KXCNL	User-selectable 2g, 4g, 6g, 8g	16-pin, LGA	8-250	X					X		X	Dual User-Programmable State Machines
KXCJK	User-selectable 2g, 4g, 8g	16-pin, LGA	10-135	X					X	X		
KXCJ9	User-selectable 2g, 4g, 8g	10-pin, LGA	10-135	X					X	X	X	
KXTJ9	EOL announced								X	X	X	
KXTI9	User-selectable 2g, 4g, 8g	10-pin, LGA	100-325	X		252-byte		X				
KXTIK	User-selectable 2g, 4g, 8g	16-pin, LGA	100-325	X		252-byte		X				
KXTIA	User-selectable 2g, 4g, 8g	10-pin, LGA	100-325		X	252-byte		X				



Products - Overview

Product	Full Scale G Range	Pins and Package Type	Current Consumption (μA)	I ² C	SPI	Multiplexed	Low-Pass Filter	Embedded Algorithms	Auxiliary Input for A/D Conversion	Low Noise	Other
Analog											
3x3x0.9mm											
KXTH9	1.5g - 6g	10-pin, LGA	150-550			X			X		
KXTC9	1.5g - 6g	10-pin, LGA	170-310				X				
3x5x0.9mm											
KXTH5	1.5g - 6g	14-pin, LGA	150-550			X	X		X		
4x4x0.9mm											
KXTC8	2g - 6g	16-pin, LGA	180-280							X	High Shock Survivability
5x5x0.9mm											
KXSC4	1.5g - 6g	14-pin, DFN	195-265							X	
KXD94	5g - 15g	14-pin, DFN	700 - 1500			X					
Analog & Digital											
3x5x0.9mm											
KXSS5	2.5g - 8g	14-pin, LGA	400-1000	X	X						High-g Motion Interrupt, Freefall Motion Interrupt
KXSB5	2.5g - 6g	14-pin, LGA	300-700		X	X			X		High Shock Survivability
KXRB5	1.5g - 6g	14-pin, LGA	300-700		X	X			X	X	
5x5x0.9mm											
KXR94	1.0g - 4g	14-pin, DFN	500-1400		X	X				X	



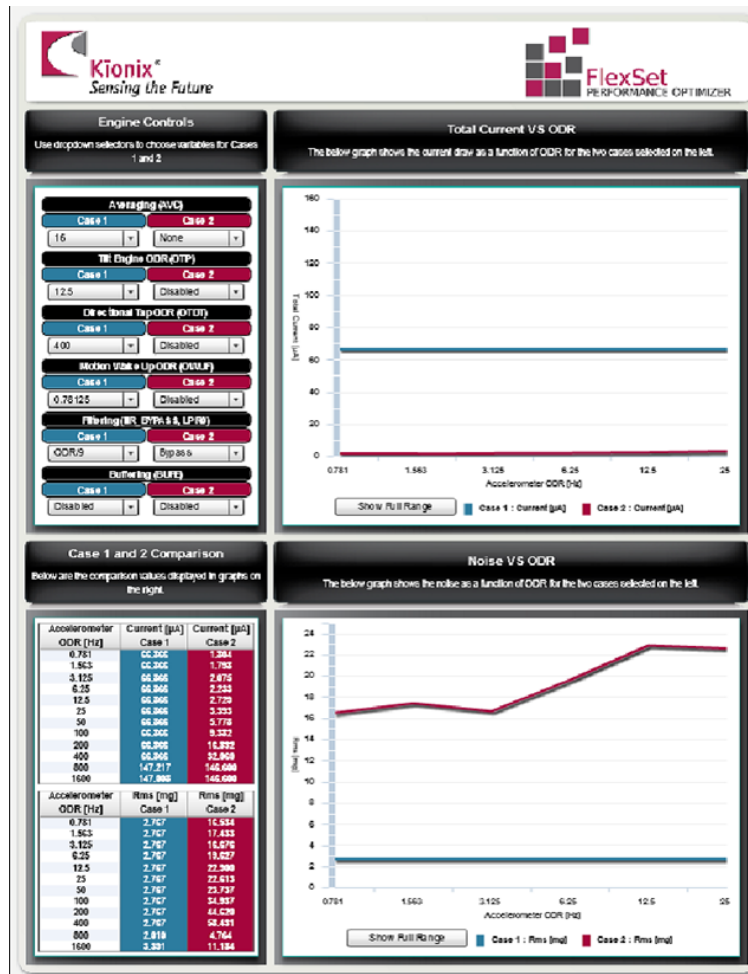
Our Newest and most advanced products.

- KX023 – 3x3x0.9mm accelerometer
- KX022 – 2x2x0.9mm accelerometer
- 12-pin package
- $\pm 2g, 4g, 8g$ Range
- Digital I²C/SPI
- FlexSet Performance Optimizer

Features	Benefits
User-configurable wake-up function	Conserves battery power in mobile devices
Low current consumption (<1 μA standby, 10 μA low resolution, 135 μA high resolution)	Conserves battery power and makes this part ideal for mobile applications
252-byte FIFO/FILO Buffer	Programmable watermark for sample threshold settings
XAC sense element	Excellent performance over temperature, in shock tests and in reflow
Internal voltage regulator	Constant internal operating voltages over 1.8 – 3.6V range of input supply, increased stability and virtually undetectable ratiometric error
Up to 14-bit resolution	Greater precision



FlexSet Performance Optimizer



Unique design tool developed by Kionix

Gives product designers unparalleled control over noise and power consumption options

Can dynamically change power/noise profile depending on the state of the device

Flash-based tool allows designers to almost infinitely adjust parameters and then set registers

Currently included with KX022 and KX023

KXCJ9, KXTJ2

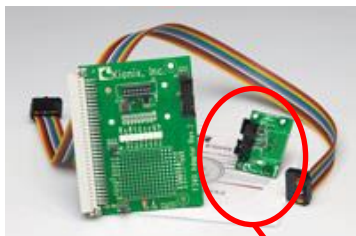
High volume, highly popular products, very cost competitive

- KXCJ9 – 3x3x0.9mm, 10-pin tri-axis accelerometer. Pin compatible with KXTF9 and KXTI9
- KXTJ2 – 2x2x0.9mm, 12-pin tri-axis accelerometer
- Same features, different sizes

Features	Benefits
User-configurable wake-up function	Conserves battery power in mobile devices
Low current consumption (2 μ A standby, 10 μ A low resolution, 135 μ A high resolution)	Conserves battery power, making these parts ideal for low power, mobile applications
XAC sense element	Excellent performance over temperature, in shock tests and in reflow
Internal voltage regulator	Constant internal operating voltages over 1.8 – 3.6V range of input supply, increased stability and virtually undetectable ratiometric error
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Development Kits



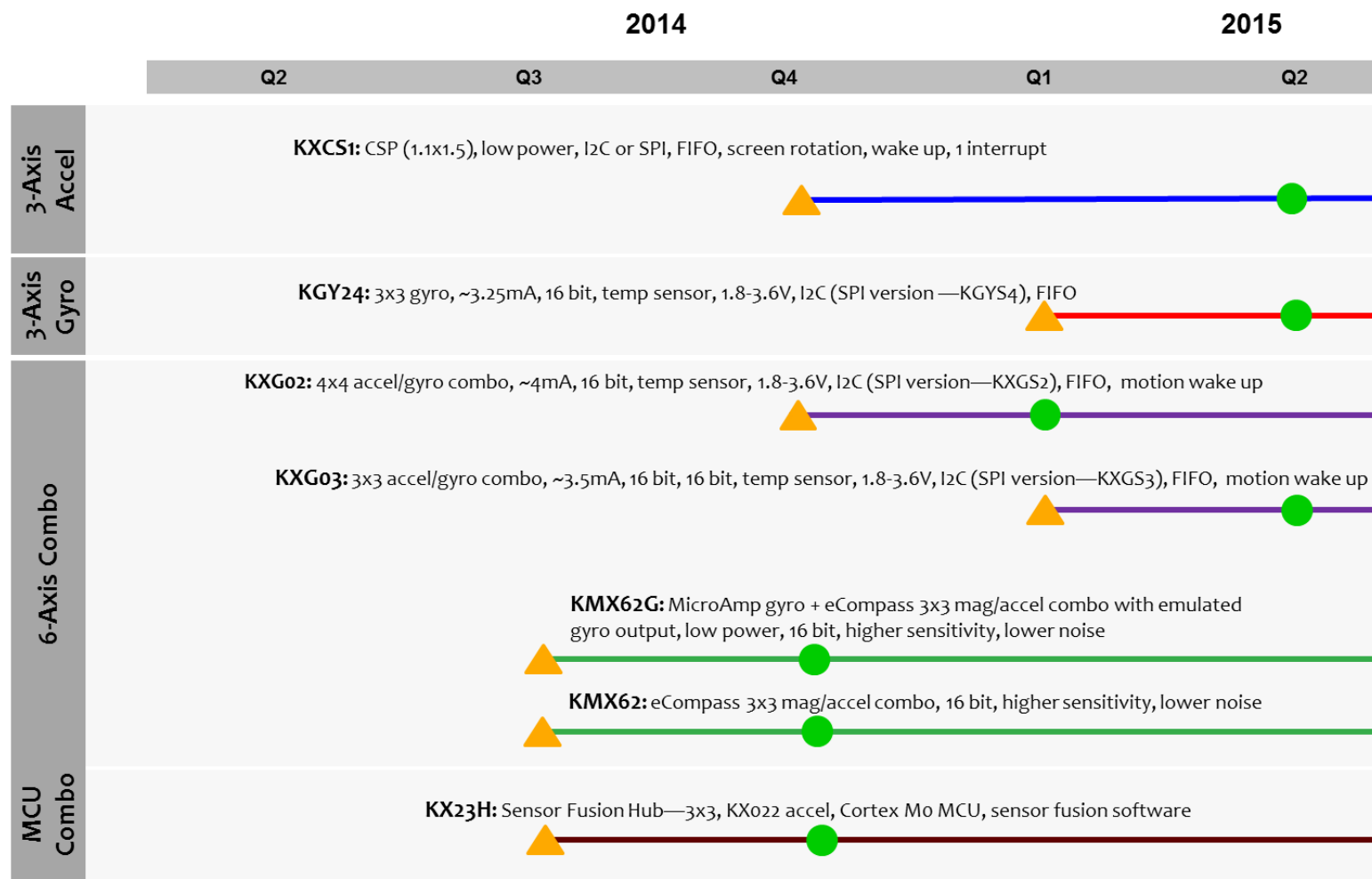
The Kionix Accelerometer **Application and Firmware Development Kit** provides a simple environment to quickly begin the development of applications and firmware that incorporate Kionix accelerometers. The Development Kit provides a common interface to Kionix evaluation boards. The included software provides an easy-to-use interface for displaying and recording acceleration data.

Evaluation Boards



To facilitate prototype work with Kionix accelerometers, Kionix has created **evaluation boards** for each accelerometer product. The evaluation boards provide access to the pins of the accelerometer, contain all of the appropriate decoupling capacitors and pull-up resistors, and allow for easy connection into a prototyping system.

Roadmap



Key: Sampling Mass Production Ready

131217

