



## ± 2g Tri-axis Analog Accelerometer Specifications

PART NUMBER:

KXTC9-2050  
Rev. 2  
Feb-2015

### Product Description

The KXTC9-2050 is a Tri-axis, silicon micromachined accelerometer with a full-scale output range of +/-2g (19.6 m/s/s). The sense element is fabricated using Kionix's proprietary plasma micromachining process technology. Acceleration sensing is based on the principle of a differential capacitance arising from acceleration-induced motion of the sense element, which further utilizes common mode cancellation to decrease errors from process variation, temperature, and environmental stress. The sense element is hermetically sealed at the wafer level by bonding a second silicon lid wafer to the device using a glass frit. A separate ASIC device packaged with the sense element provides signal conditioning and self-test. The accelerometer is delivered in a 3 x 3 x 0.9mm Land Grid Array (LGA) plastic package operating from a 1.8 – 3.6V DC supply. The KXTC9 features a factory programmable low pass filter.



There are 2 factory programmable modes of operation for the KXTC9:

**Mode 00** – The Enable pin must be **high** for normal operation and **low** for power shutdown.

**Mode 01** – The Enable pin must be **low** for normal operation and **high** for power shutdown.

The KXTC9-2050 is factory programmed to be in MODE 00.

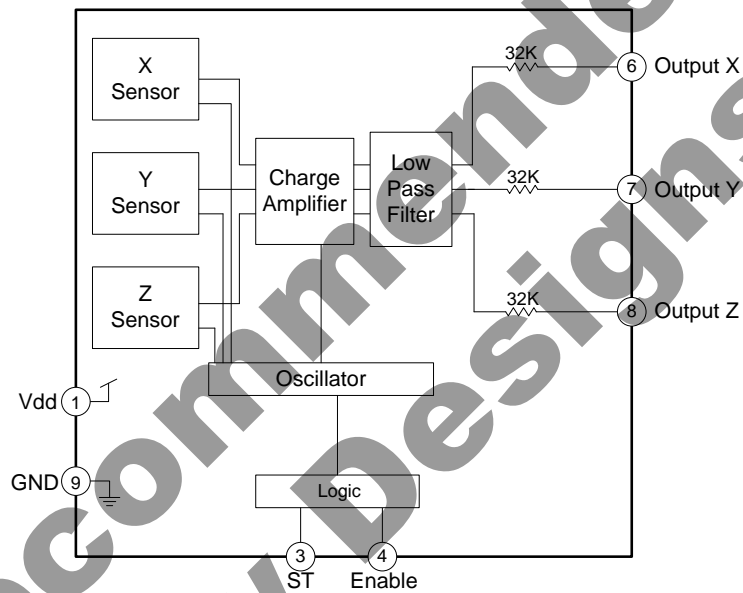


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Rev. 2  
Feb-2015

## Functional Diagram





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Rev. 2  
Feb-2015**

## Product Specifications

**Table 1. Mechanical**

(specifications are for operation at 3.3V and T = 25C unless stated otherwise)

Parameters	Units	Min	Typical	Max
Operating Temperature Range	°C	-40	-	85
Zero-g Offset	V	1.567	1.65	1.732
Zero-g Offset Variation from RT over Temp.	mg/°C		0.7 (xy) 0.4 (z)	
Sensitivity	mV/g	640	660	680
Sensitivity Variation from RT over Temp.	%/°C		0.01 (xy) 0.04 (z)	
Offset Ratiometric Error ( $V_{dd} = 3.3V \pm 5\%$ )	%		0.2	
Sensitivity Ratiometric Error ( $V_{dd} = 3.3V \pm 5\%$ )	%		0.3 (xy) 0.15 (z)	
Self Test Output change on Activation	g		2.9 (x) 2.8 (y) 1.9 (z)	
Mechanical Resonance (-3dB) <sup>1</sup>	Hz		3500 (xy) 1800 (z)	
Non-Linearity	% of FS		0.1	
Cross Axis Sensitivity	%		2	
Noise Density (on filter pins)	μg / √Hz		125	

Notes:

1. Resonance as defined by the dampened mechanical sensor.



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PART NUMBER:

KXTC9-2050  
Rev. 2  
Feb-2015

**Table 2. Electrical**

(specifications are for operation at 3.3V and T = 25C unless stated otherwise)

Parameters		Units	Min	Typical	Max
Supply Voltage (V <sub>dd</sub> )	Operating	V	1.8	3.3	3.6
Current Consumption	Operating (full power)	μA	170	240	310
	Standby	μA		5	
Analog Output Resistance(R <sub>out</sub> )		kΩ	24	32	40
Power Up Time <sup>1</sup>		ms	-	5*R <sub>out</sub> *C	-
Bandwidth (-3dB) <sup>2</sup>		Hz	40	50	60

Notes:

1. Power up time is determined by 5 times the RC time constant of the factory programmed or user defined low pass filter.
2. Factory programmable to have a switched capacitor low pass filter at 2kHz, 1kHz, 500Hz, 100Hz, 50Hz, or no low pass filter. Optionally, the user can define with external capacitors. Maximum defined by the frequency response of the sensors.



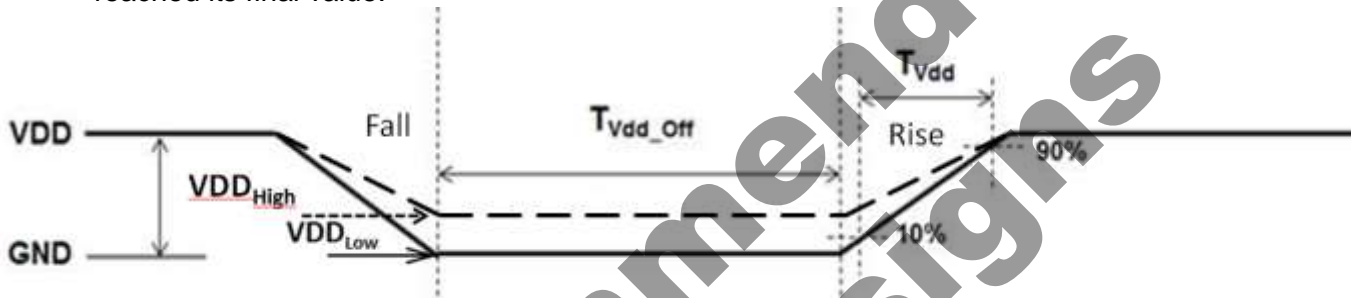
# ± 2g Tri-axis Analog Accelerometer Specifications

**PART NUMBER:**

**KXTC9-2050  
Rev. 2  
Feb-2015**

## Power-On Reset (POR)

Proper functioning of power-on reset (POR) is dependent on the specific  $V_{DD_{Low}}$  and  $T_{Vdd_{off}}$  profile of individual applications. It is recommended to minimize  $V_{DD_{Low}}$  and maximize  $T_{Vdd_{off}}$ . To assure proper POR in all environmental conditions the application should be evaluated over the range of  $V_{DD_{Low}}$ ,  $T_{Vdd_{off}}$  and temperature as POR performance can vary depending on these parameters. It is also advised that the Rise or Fall be monotonic. Note that the outputs will not be stable until  $V_{DD}$  has reached its final value.



Specific application testing will likely demonstrate POR performance regions for a proper POR trigger. To assure POR trigger properly executes, setting operational thresholds consistent with Table 3 below is suggested.

**Example POR performance chart**

		Brownout Low Time (s)										
		0.01	0.02	0.05	0.1	0.2	0.5	1	2	5	10	20
Brownout Low Bias (V)	1.0	1	1	1	1	1	1	1	1	1	1	1
	0.9	1	1	1	1	1	1	1	1	1	1	1
	0.8	1	1	1	1	1	1	1	1	1	1	1
	0.7	1	1	1	1	1	1	1	1	1	1	1
	0.6	1	1	1	1	1	1	1	1	1	1	1
	0.5	1	1	1	1	1	1	0	0	0	0	0
	0.4	1	1	1	1	1	1	0	0	0	0	0
	0.3	1	1	1	1	1	1	0	0	0	0	0
	0.2	1	1	1	1	1	0	0	0	0	0	0
	0.1	1	1	1	1	0	0	0	0	0	0	0
0.0	0	0	0	0	0	0	0	0	0	0	0	

1	No POR trigger: RAM unchanged
0	POR event triggered: RAM set to default

As can be seen in this example POR performance chart, the time and Voltage to activate POR is variable depending on the voltage and time as indicated by  $T_{Vdd_{off}}$  max and min and  $V_{DD_{High}}$  and  $V_{DD_{Low}}$ .



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**PART NUMBER:**

**KXTC9-2050  
Rev. 2  
Feb-2015**

**Table 3. POR Example Performance**

Parameters	Units	Min	Typical	Max
<b>-40°C</b>				
VDD rise time : $T_{Vdd}$	ms			5
VDD fall time : $T_{Vdd}$	ms			5
VDD off time : $T_{Vdd\_Off}$	ms	25		
VDD High voltage : $VDD_{High}$	mV			250
VDD low voltage : $VDD_{Low}$	mV	100		
<b>25°C</b>				
VDD rise time : $T_{Vdd}$	ms			5
VDD fall time : $T_{Vdd}$	ms			5
VDD off time : $T_{Vdd\_Off}$	ms	10		
VDD High voltage : $VDD_{High}$	mV			600
VDD low voltage : $VDD_{Low}$	mV	100		
<b>85°C</b>				
VDD rise time : $T_{Vdd}$	ms			5
VDD fall time : $T_{Vdd}$	ms			5
VDD off time : $T_{Vdd\_Off}$	ms	10		
VDD High voltage : $VDD_{High}$	mV			600
VDD low voltage : $VDD_{Low}$	mV	100		

**Notes:**

1. VDD must always be monotonic ramps without ambiguous state.
2.  $T_{Vdd}$  rise or fall from 10% to 90% of final value needs to be  $\leq T_{Vdd} \text{ Max}$ .
3. In order to prevent the accelerometer from entering an ambiguous state, VDD needs to be pulled down to GND ( $\leq VDD_{Low} \text{ Min}$  for a duration of time  $\geq T_{Vdd\_Off} \text{ Min}$ )
4. Power will be maintained if VDD does not go below  $VDD_{High} \text{ Max}$ .
5. Between  $VDD_{High} \text{ Max}$  and  $VDD_{Low}$  POR may occur.



## ± 2g Tri-axis Analog Accelerometer Specifications

PART NUMBER:

KXTC9-2050  
Rev. 2  
Feb-2015

It is important the user determines the timing ( $T_{Vdd\_Off}$ ) and threshold ( $VDD_{Low}$ ) levels by evaluating the performance in the specific system for which the device will be incorporated.

The data provided by Kionix is intended for initial customer design guidance only. Kionix POR testing looks at a finite number of test configurations. Each customer application will have varying input sensor parameters (electrical, mechanical, and environmental) that will be different than the configurations tested by Kionix. Each customer utilizing the sensor will need to properly validate the sensor (including POR function) within their application under their specific use cases to ensure it responds as required.

Not Recommended for New Designs

	<b>± 2g Tri-axis Analog Accelerometer Specifications</b>	<b>PART NUMBER:</b>  <b>KXTC9-2050</b> <b>Rev. 2</b> <b>Feb-2015</b>
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**Table 4. Environmental**

Parameters		Units	Min	Typical	Max
Supply Voltage (V <sub>dd</sub> )	Absolute Limits	V	-0.3	-	6.0
Operating Temperature Range		°C	-40	-	85
Storage Temperature Range		°C	-55	-	150
Mech. Shock (powered and unpowered)		g	-	-	5000 for 0.5ms 10000 for 0.2ms
ESD	HBM	V	-	-	2000



Caution: ESD Sensitive and Mechanical Shock Sensitive Component, improper handling can cause permanent damage to the device.



This product conforms to Directive 2002/95/EC of the European Parliament and of the Council of the European Union (RoHS). Specifically, this product does not contain lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls (PBB), or polybrominated diphenyl ethers (PBDE) above the maximum concentration values (MCV) by weight in any of its homogenous materials. Homogenous materials are "of uniform composition throughout."



This product is halogen-free per IEC 61249-2-21. Specifically, the materials used in this product contain a maximum total halogen content of 1500 ppm with less than 900-ppm bromine and less than 900-ppm chlorine.

**Soldering**

Soldering recommendations are available upon request or from [www.kionix.com](http://www.kionix.com).



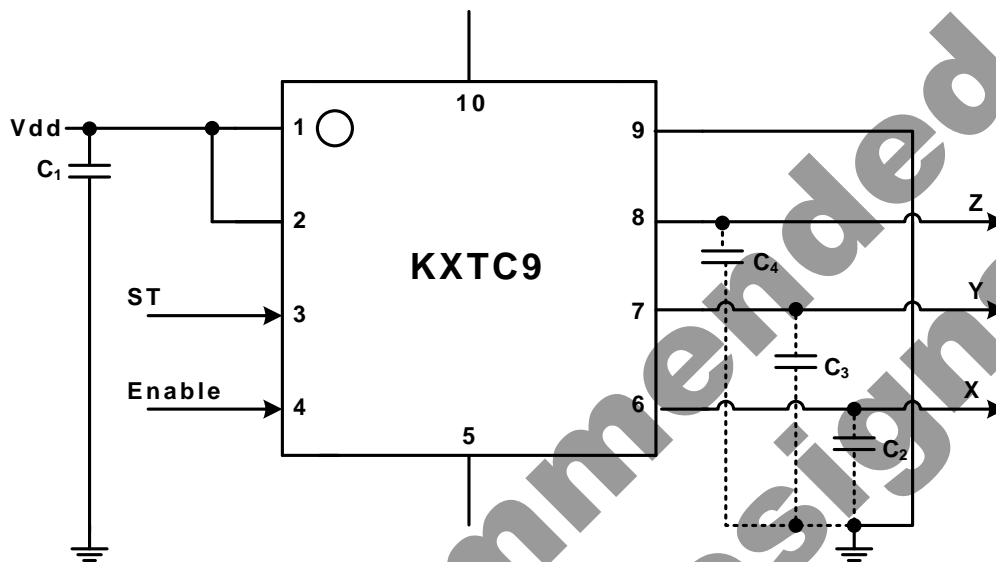


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**PART NUMBER:**

**KXTC9-2050**  
**Rev. 2**  
**Feb-2015**

## Application Schematic



**Table 5. KXTC9 Pin Descriptions**

Pin	Name	Description
1	Vdd	The power supply input. Decouple this pin to ground with a 0.1uF ceramic capacitor (C <sub>1</sub> ).
2	Res	Reserved – Connect to Vdd or Ground
3	ST	Self Test: <b>Low</b> - Normal operation; <b>High</b> - Device is in self-test mode. Connect to Ground if not used.
4	Enable	Enable (1 = Normal Mode, 0 = Power Down Mode)
5	NC	Not Connected Internally – may be connected to Vdd or Ground
6	X Output	Analog output of the x-channel. Optionally, a capacitor (C <sub>2</sub> ) placed between this pin and ground will form a low pass filter.
7	Y Output	Analog output of the y-channel. Optionally, a capacitor (C <sub>3</sub> ) placed between this pin and ground will form a low pass filter.
8	Z Output	Analog output of the z-channel. Optionally, a capacitor (C <sub>4</sub> ) placed between this pin and ground will form a low pass filter.
9	GND	Ground
10	NC	Not Connected Internally – may be connected to Vdd or Ground

## Application Design Equations

The bandwidth is determined by a factory programmable switched capacitor filter. The filter can be set at the factory to be 2kHz, 1kHz, 500Hz, 100Hz, 50Hz, or no low pass filter. Alternatively, bandwidth can be reduced by addition of a capacitor on the output pins 5, 6, and 7 according to the equation:

$$C_2 = C_3 = C_4 = \frac{4.97 \times 10^{-6}}{f_{BW}}$$



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KXTC9-2050  
Rev. 2  
Feb-2015

### Test Specifications



#### *Special Characteristics:*

These characteristics have been identified as being critical to the customer. Every part is tested to verify its conformance to specification prior to shipment.

**Table 6. Test Specifications**

Parameter	Specification	Test Conditions
Zero-g Offset @ RT	1.65 +/- 0.0825 V	25C, Vdd = 3.3 V
Sensitivity @ RT	660 +/- 19.8 mV/g	25C, Vdd = 3.3 V
Current Consumption -- Operating	170 <= Idd <= 310 uA	25C, Vdd = 3.3 V



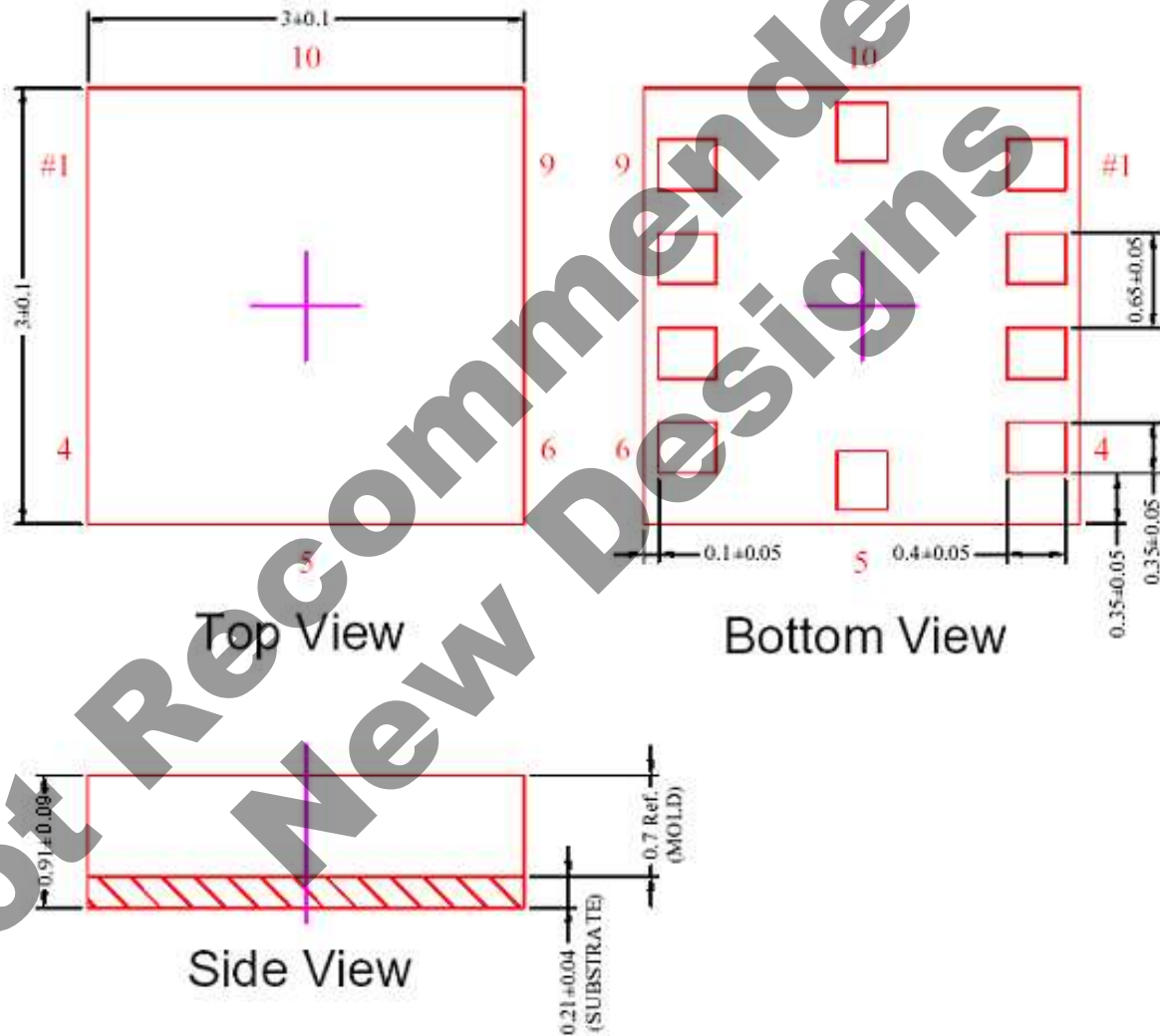
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KXTC9-2050  
Rev. 2  
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## Package Dimensions and Orientation

3 x 3 x 0.9 mm LGA



All dimensions and tolerances conform to ASME Y14.5M-1994



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**KXTC9-2050  
Rev. 2  
Feb-2015**

**Static X/Y/Z Output Response versus Orientation to Earth's surface (1-g):**

Position	1	2	3	4	5	6
Diagram					 Top  Bottom	 Bottom  Top
X	1.65 V	2.31 V	1.65 V	0.99 V	1.65 V	1.65 V
Y	2.31 V	1.65 V	0.99 V	1.65 V	1.65 V	1.65 V
Z	1.65 V	1.65 V	1.65 V	1.65 V	2.31 V	0.99 V
X-Polarity	0	+	0	-	0	0
Y-Polarity	+	0	-	0	0	0
Z-Polarity	0	0	0	0	+	-



Earth's Surface

Not Recommended for New Design



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PART NUMBER:

KXTC9-2050  
Rev. 2  
Feb-2015

## Revision History

REVISION	DESCRIPTION	DATE
1	Initial product release	22-Jun-2010
2	Include POR description	11-Feb-2015

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