Introduction

This technical note is intended to provide guidelines for the handling, mounting, and soldering of Kionix's sensors. These guidelines are general in nature and based on recommended industry practices. The user must apply their actual experiences and development efforts to optimize designs and processes for their manufacturing techniques and the needs of varying end-use applications.

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Component Handling

Physical Package

Kionix sensors package should not be altered or modified. Material should not be removed, scraped or added to the sensor part.

Moisture Sensitivity Level (MSL)

Kionix sensors are rated moisture sensitivity level 3 (MSL3) as described in IPC/JEDEC J-STD-020D.1 "Joint Industry Standard: Moisture/Reflow Sensitivity Classification for Nonhermetic Solid State Surface Mount Devices." Exposure to moisture levels or solder reflow temperatures, which exceed those stated in J-STD-020D.1, can result in yield and reliability degradation.

Please refer to IPC/JEDEC J-STD-033C "Joint Industry Standard: Handling, Packing, Shipping and Use of Moisture/Reflow Sensitive Surface Mount Devices" for the proper handling techniques. Typical factory floor life is 1 week at ambient ≤30C/60% RH.

Electrostatic Discharge (ESD)

Kionix sensors have ESD protection circuitry built in and can withstand 2,000V of HBM electrostatic discharge. However, similar to other integrated circuits, proper ESD handling should be observed. Please refer to JESD625-B "Requirements for Handling Electrostatic-Discharge-Sensitive (ESDS) Devices" for the proper handling techniques.

Mechanical shock

Kionix sensors are sensitive mechanical devices that are designed to tolerate high-g shock events, but direct impact to the package and dropping of the component to a hard surface will generate extremely high forces and should be avoided. ***If the component is dropped from a height greater than 5 cm or directly impacted by a hard object during assembly, it should be discarded and not used.*** The best practice would be to discard any part that has been dropped.

Chip shooters and IC placers generate repetitive shocks that can exceed the shock survivability specifications of MEMS sensors. Therefore, Kionix recommends that the pick and place set be reviewed to eliminate impact by the pick up nozzle. Metal nozzles are not preferred and either plastic or nozzles with compliant tips are recommended. Kionix advises that the sensor be one of the last components placed onto the printed circuit board. Also, the sensor should be placed with minimal direct force. Therefore, it is recommended that the chip shooters or IC placers have placement force control.

Ultrasonic cleaning of the PCB assembly should not be done to avoid damaging the MEMS sensor.

Physical Mounting Recommendations

Physical location of the sensor on a printed circuit board (PCB) is very important. Incorrect placement of the sensor on the PCB can have detrimental effects on its performance. Obviously, each product will present its own physical limitations for sensor placement (PCB size, shape, and location in the housing, allowable component height, etc.). Therefore, these guidelines are general in nature. Engineering judgment should be used to try to avoid the following locations:

- Near PCB anchor points or bends to avoid excessive mechanical stress
- Where epoxy resin partially covers the sensor, causing asymmetric mechanical stress
- Near hot-spots that can elevate the temperature of the sensor, changing performance parameters
- Directly under buttons to avoid excessive mechanical stress and surface contact
- Near excessive-vibration areas to avoid application performance degradation (noise)
- Where the top surface of the sensor is in direct contact with conductive materials to reduce the effect of capacitive coupling

Avoid placing any components or vias at a distance less than 2 mm from the package.

The following figures loosely illustrate incorrect and correct placement of the sensor on a PCB as described in the guidelines above.

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Incorrect Mounting Locations

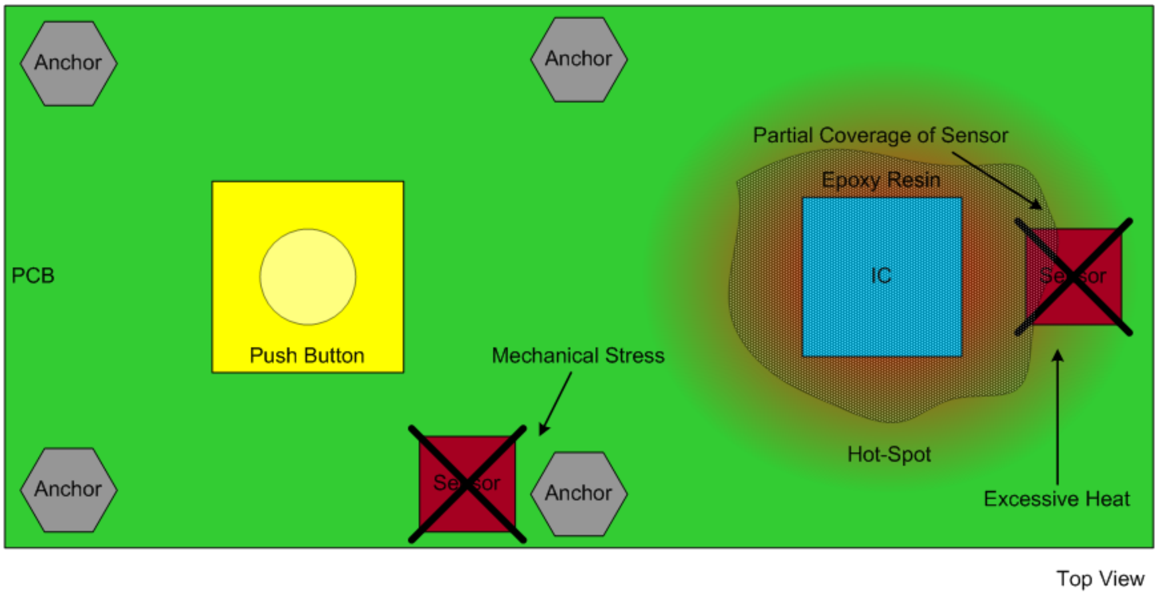


Figure 1. Incorrect sensor locations (Top view)

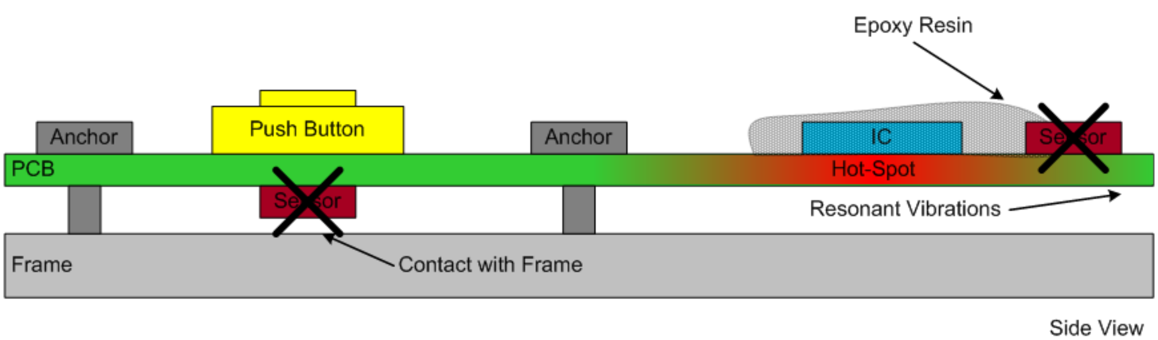


Figure 2. Incorrect sensor locations (Side View)

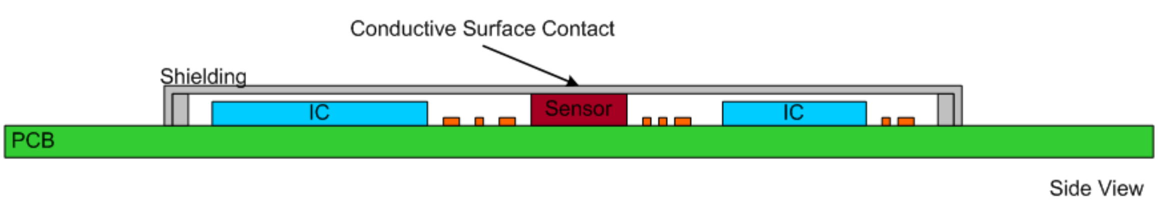


Figure 3. Incorrect conductive shielding height

Correct Mounting Locations

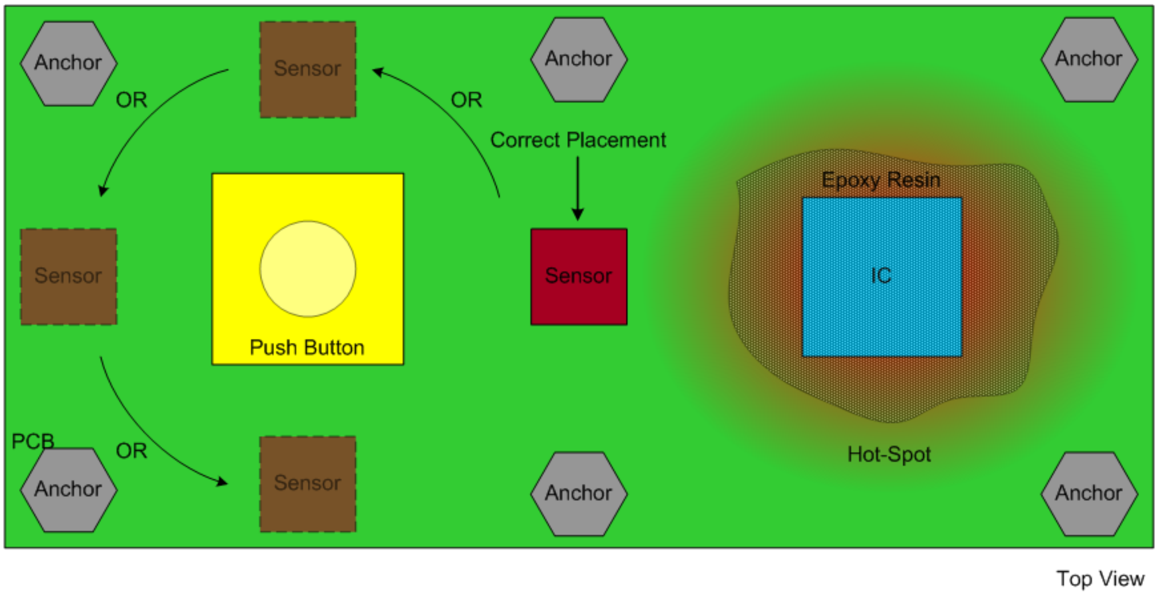


Figure 4. Correct sensor location (Top View)

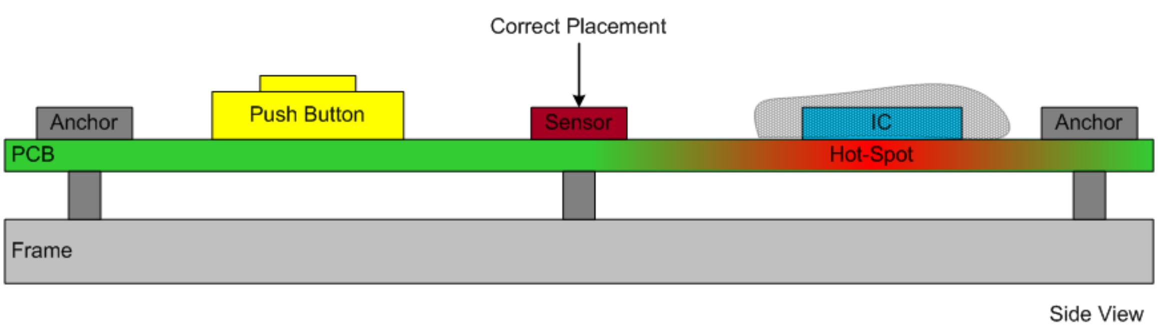
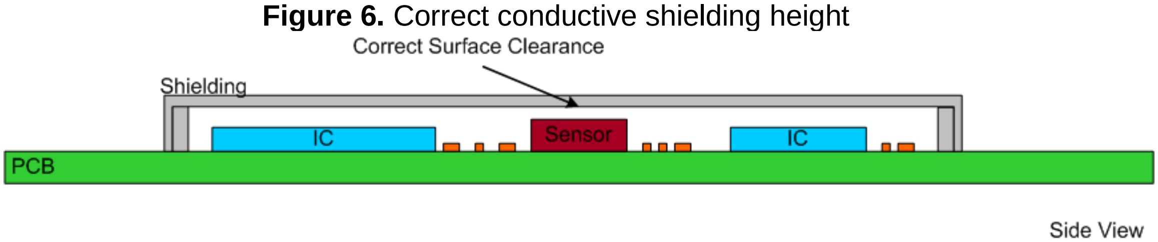


Figure 5. Correct sensor location (Side View)

Figure 6. Correct conductive shielding height



Soldering Guidelines

A system board reflow profile depends on the thermal mass of the entire populated board, so it is not practical to define a specific soldering profile just for the sensor. Use the time and temperature reflow profile that is customized for your manufacturing practice and application.

The following profile is provided as a reference (IPC/JEDEC J-STD-020D.1):

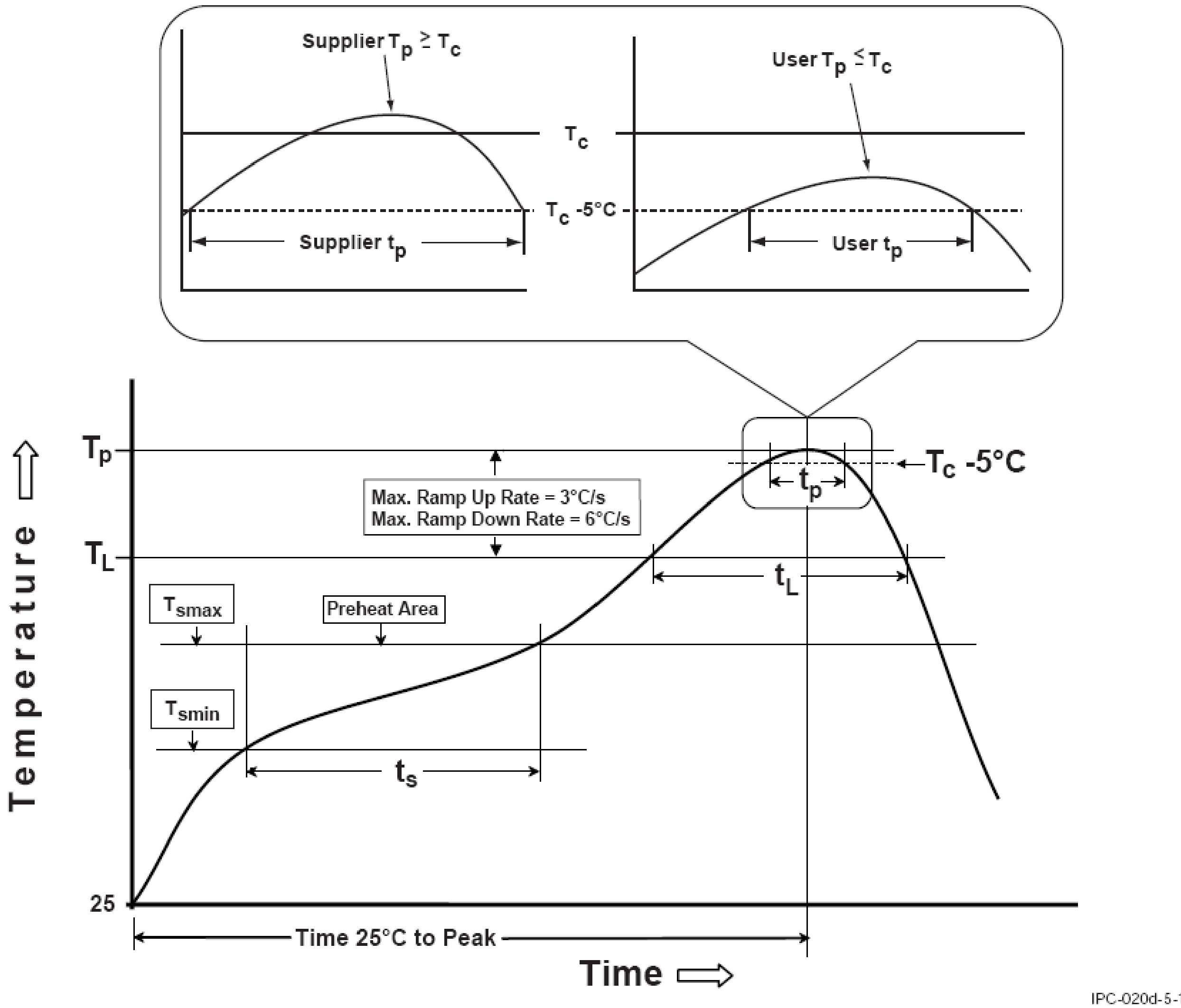


Figure 7. JEDEC reflow profile for Sn-Pb AND Pb-free assemblies

Profile Feature	Sn-Pb Eutectic Assembly	Pb-Free Assembly
Average Ramp-Up Rate (t_{SMAX} to t_P)	3°C/second max.	3°C/second max.
Preheat Temperature Min (t_{SMIN}) Temperature Max (t_{SMAX}) Time (t_{SMIN} to t_{SMAX})	 100°C 150°C 60-120 seconds	 150°C 200°C 60-180 seconds
Time maintained above: Temperature (t_L) Time (t_L)	183°C 60-150 seconds	217°C 60-150 seconds
Peak/Classification Temperature (t_P)	240°C (+0/-5°C)	260°C (+0/-5°C)*
Time within 5°C of Actual Peak Temperature (t_P)	10-30 seconds	10-40 seconds
Ramp-Down Rate	6°C/second max.	6°C/second max
Time 25°C to Peak Temperature	6 minutes max.	8 minutes max

*Do not exceed 260° C for more than ten seconds.

Standard tin-lead Sn63/Pb37 solder paste or a lead-free solder (Sn96.5/Ag3/Cu0.5 or Sn95.5/Ag4/Cu0.5 or others) paste may be used. Because lead-free alloys require processing temperatures 20 - 25° C warmer than 63Sn/37Pb, equipment concerns should be considered. Many new lead-free alloy compositions are being released. When testing the alternative solder compositions the user must consider several issues:

• Is the material selected going to be compatible with the plating on the sensor leads or the finish specified on the circuit board?
• Will the material chosen compromise manufacturability?
• What is the residual effect of the alternative reflow profile on the sensor package, the passive components, and the board itself?

Kionix recommends following the IPC/JEDEC J-STD-020D.1 guidelines.

If the sensor is attached to a two-sided printed circuit board, thus incorporating a two-pass solder reflow scheme, Kionix recommends that the sensor is included in the second pass, limiting the number of reflows that the part is exposed to.

When using a no self-cleaning solder paste, it is necessary to clean the flux from the board after the soldering process to eliminate the possibility of leakage between adjacent pads.

Typical LGA packages expose metal traces on the package sides; so no solder material should be allowed to contact the package sides.

Number of Solder Reflow Cycles

Kionix qualifies sensor products to withstand a total of up to 4 solder reflow cycles. For MSL 3 testing, 1 reflow cycle initially solders the parts to the test boards, and then pre-conditioning performs 3 more reflow cycles. If a de-soldering / re-work step is needed, this would count as a reflow cycle.

De-soldering / Re-work

The following process provides a guideline for the development of a successful removal process for Kionix sensors. These guidelines are general in nature and are based on recommended industry practices. The user must apply their actual experiences and development efforts to optimize the process for their manufacturing techniques. When a sensor is properly removed from a PCB, potential problems are more quickly diagnosed.

Bake

Prior to removal, it is strongly recommended that the PCB assembly be baked for at least 4 hours at 125C to remove any residual moisture from the assembly. This bake should prevent moisture-induced cracking or delamination of the PCB.

Package Reheat and Removal

Proper pre-heating of the PCB and localized reheating of the sensor are necessary for the successful removal of the sensor. Therefore, a reflow profile, similar to the one used for sensor attachment, should be used to melt the solder joints of the sensor. A soldering iron alone should not be used to attempt part removal from the PCB. Never place a soldering iron in direct contact with the part.

The first step in this process is to heat the PCB to a temperature of 100ºC from the bottom side of the board using convective heaters or a hot plate. This will mimic the pre-heat seen by the assembly during the sensor attachment reflow. Next, nozzles, appropriate for the size of the sensor, should be used to direct localized hot air from a distance of approximately 15-25 mm to the surface of the sensor. Excessive airflow and heat should be avoided: air velocity of 15-20 liters per minute and a temperature of approximately 425ºC is a good starting point. A circular motion can be used to ensure the adequate heat transfer needed to reflow solder adhering all pads, including the center pad. This step will mimic the ramp up/critical zone portion of the attachment reflow profile. After approximately 4-7 seconds or once the solder adhering the sensor to the PCB has become liquid, the sensor can be removed with vacuum lift-off or tweezers. Take care not to remove the sensor prematurely and potentially shearing pads off of the component or PCB. If any resistance is felt while trying to lift off the sensor, do not try to pull the sensor off. Apply more heat until all the solder has melted, and then re-attempt to lift off the sensor. Lastly, remove the bottom heat source from the PCB to mimic a reflow profile ramp down to ambient temperature.

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Sensor Pad Cleaning

In order to ensure proper contact when the removed sensor is retested, the following cleaning process should be used as a guideline. It is recommended to use a combination of a soldering iron and de-soldering braid or solder wick to remove residual solder from the exposed pads. Avoid direct contact between the soldering iron and the sensor package. Minimize the amount of time the soldering iron is in contact with the de-soldering braid. Once the residual solder is removed, the pads should be cleaned with a solvent that is recommended for the specific type of paste used in the original assembly. Do not use ultrasonic cleaning methods.

PCB Pad Redress

If the PCB is to be re-populated with a new sensor, the following process can be used as a guideline. After the sensor has been removed from the PCB, the site needs to be cleaned properly. It is recommended to use a combination of a soldering iron and de-soldering braid or solder wick to remove residual solder from the exposed pads. Once the residual solder is removed, the pads should be cleaned with a solvent that is recommended for the specific type of paste used in the original assembly. The PCB pads should now be ready for the re-application of solder paste and the soldering of a new sensor.

Revision History

Rev	Date	Description of Change
-	24-Jul-08	Initial release
1	14-Aug-08	Added Table of Contents and number of reflow cycles
2	3-Oct-09	Added comments about nozzle for handling.
3	19-Feb-10	Updated Figure 7, “J-STD-020C” to “J-STD-020D.1”, number of reflow cycles to 4 and added explanation of how the 4 cycles were counted.
4	01-Jul-10	Replaced “accelerometer” with “sensor”.
5	11-Dec-12	Updated Reference to JEDEC Documents J-STD-033C and JESD625-B
6	12-Dec-12	Added the Physical Package section
7	15-Oct-14	Added No solder on side of package recommendation.
8	10-July-15	Document Renamed and Uploaded to SharePoint