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AN-5087

MEMS Manufacturing and Handling Guide

Summary

This document describes suggested guidelines for handling, soldering, and mounting of Fairchild's FIS series of MEMS IMU devices.

Fairchild Semiconductor IMUs are precision MEMS sensors that incorporate a mechanical die and a CMOS ASIC that precisely respond to acceleration and rotation. By design, these acceleration and rotation inputs cause the MEMS mechanical sensing elements to move slightly, resulting in changes in capacitance that are processed by the onboard signal conditioning circuitry and then output using the parts' SPI or I^2C serial bus.

Since MEMS IMUs use mechanical devices to measure motion, care must be taken in the system design to minimize mechanical stresses that could couple into the sense nodes of the devices and thus could adversely affect the sensor readings.

MEMS devices are soldered to Printed Circuit Boards (PCBs), to make electrical connection to the system, thus much of this handling guide discusses methods of reducing the stress coupled into the MEMS devices via the PCB.

Placement and Board Layout

Good system design minimizes component stress and vibration by taking the following items into account:

Component Placement

- Do not place near items causing board stress such as standoffs, buttons, and keyboards. Further, since a plane is uniquely determined by 3 points, it may be best for board stress to only affix the PCB to the device housing using a maximum of 3 points. If more are used, place the IMU on a location on the PCB where board stress is a minimum.
- MEMS devices have mechanical resonance frequencies. Place MEMS IMUs away from sources of vibration such as buzzers and speakers, which might otherwise couple into the sensor.
- Keep the device away from heat sources. Thermal gradients can couple mechanical stress into the system due to variations in thermal expansion caused by the gradient. Additionally, since the PCB and the packaging and die of the IMU have different Coefficients of Thermal Expansion (CTE), changes in ambient temperature can affect device performance by coupling stress into the parts. Good hardware design can help mitigate these effects, as can sensor fusion, such as Fairchild's XKF3. More details on XKF3 can be found in application note AN-5084.
- Do not operate with parts in sockets; it is best to solder the parts in place onto a printed circuit board. When placed in a socket, the parts may be subjected to small unintended movements which could affect measurement accuracy.
- Make sure the top surface of the part does not come into contact with any materials located above the PCB.
- Do not use any under-fill material.
- Do not cover part with epoxy resin coating material or allow such material to be placed near the part.
- If using very small circuit boards, on the order of 2x2 cm^2 or less, firmly affix the board to a larger housing, which can reduce the effects of unintended movement.

Exposed Pad

- Do not solder the exposed pad in the middle of the device.

Board Alignment with Other Sensors

Proper alignment with other sensors such as magnetometers is important for good cross-axis performance. Be sure to properly align axes of parts.

PCB Pad Design and Trace Routing

- Minimize stress by using a land pattern consisting of an array of equal-sized rectangular pads as shown in Figure 2.
- It is recommended to use Non-Solder-Mask-Defined (NSMD) pads due to the tighter tolerance of PCB metallization vs. solder mask, and due to fact that NSMD pads allow for solder to adhere to the edges of the PCB pads and to the NSMD FIS pin edges, providing superior adhesion.
- To have equal stress on all pins, it is best to have symmetric trace routing of signals out from the pads.
- Do not run traces under the sensor or have vias under the part. It is best to have a ground plane under the part.
- If stacked boards are used, it is best to have a ground plane in the area above the part.

Packaging and Land Pattern

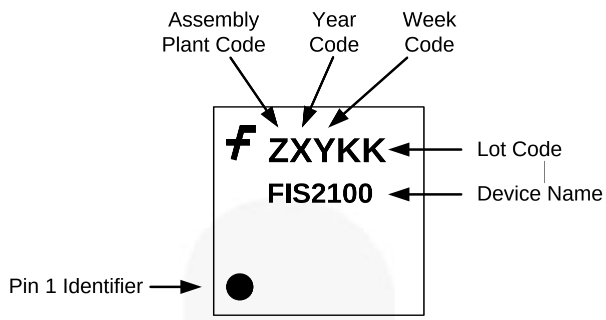


Figure 1. Package Top Mark (not to scale)

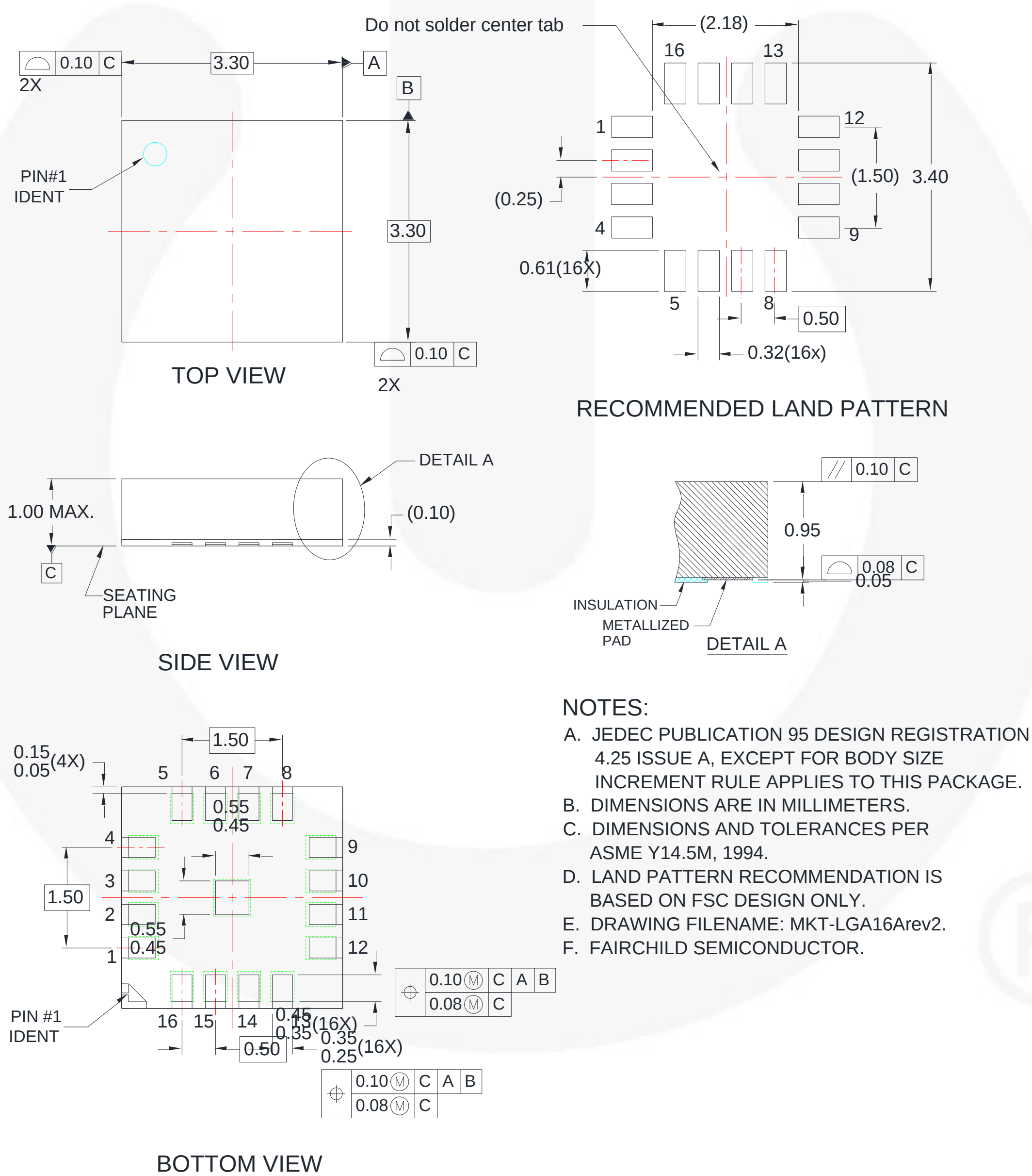


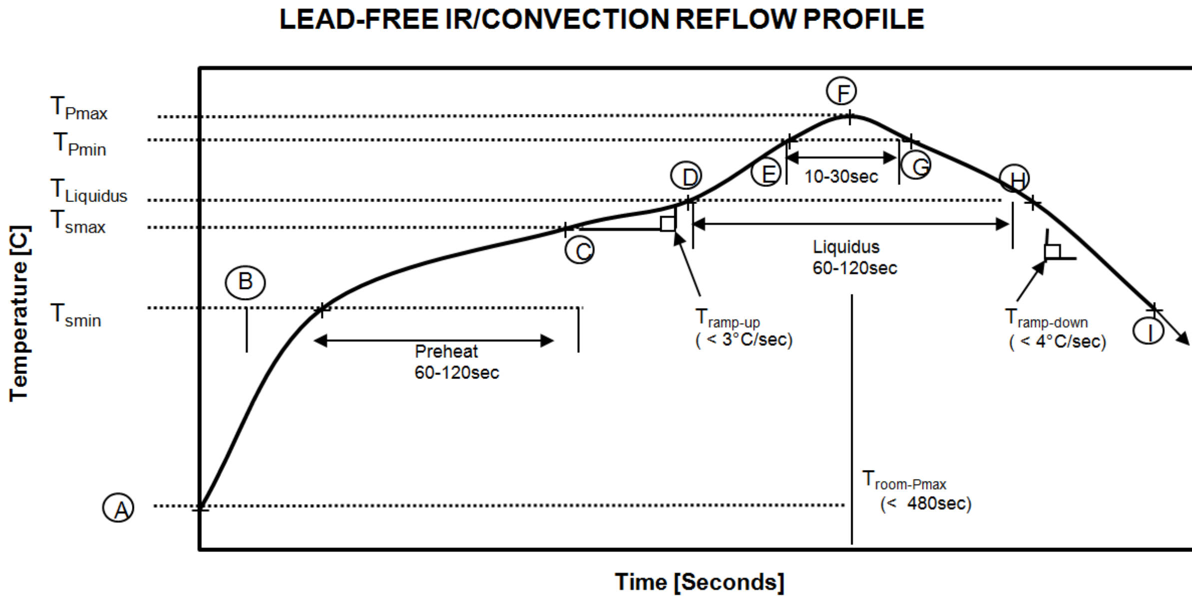
Figure 2. 16 Pin LGA (3.3 x 3.3 x 1 mm) Package Diagram and Land Pattern

Manufacturing

Soldering

- Use reflow soldering – do not use manual soldering (see profile and set points shown below).

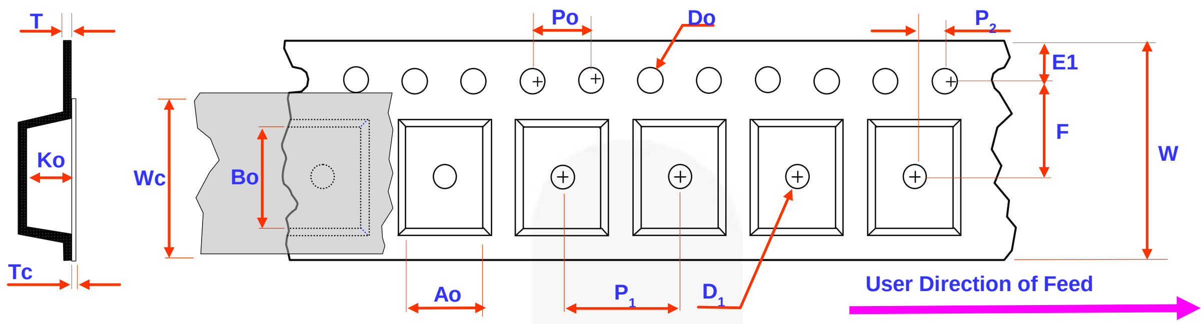
Reflow Specification



Step	Setting	Constraints		
		Temperature [°C]	Time [s]	Rate [°C/s]
A	T_{room}	25		
B	T_{Smin}	150		
C	T_{Smax}	200	$60 < t_{BC} < 120$	
D	$T_{Liquidus}$	217		$r_{(TL-TPmax)} < 3$
E	$T_{Pmin[<TPmax.255°C]}$	255		$r_{(TL-TPmax)} < 3$
F	$T_{Pmax[<TPmax.260°C]}$	260	$t_{AF} < 480$	$r_{(TL-TPmax)} < 3$
G	T_{Pmin}	255	$t_{EG} < 30$	$r_{(TPmax-TL)} < 6$
H	$T_{Liquidus}$	217	$60 < t_{DH} < 120$	
I	T_{room}	25		

Figure 3. Reflow Profile

Tape and Reel Specification



Dimensions are in millimeters														
Package	Ao ±0.10	Bo ±0.10	Do ±0.05	D1 Min	E1 ±0.10	F ±0.10	Ko ±0.10	P1 TYP	Po TYP	P2 ±0.10	T TYP	Tc ±0.005	W ±0.30	Wc TYP
3.3X3.3	3.60	3.60	1.55	1.5	1.75	5.5	1.20	8.0	4.0	2.0	0.30	0.07	12.0	9.3

Notes: Ao, Bo, and Ko dimensions are determined with respect to the EIA /Jedec RS-481 rotational and lateral movement requirements (see sketches A, B, and C).

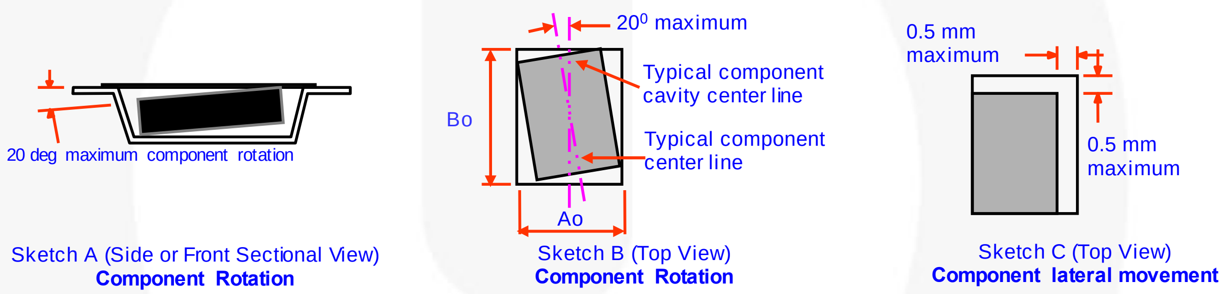
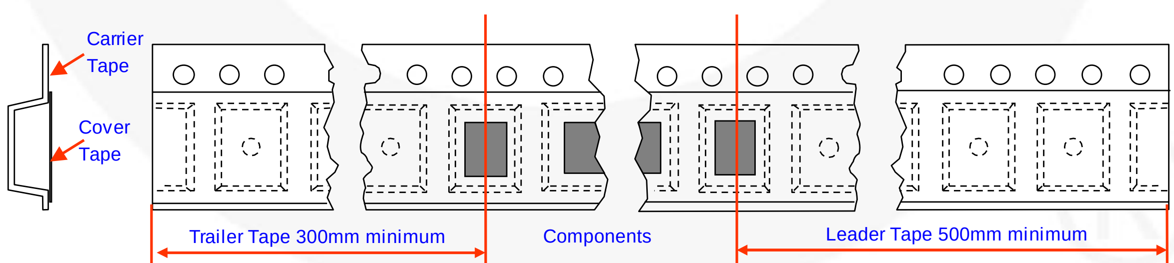
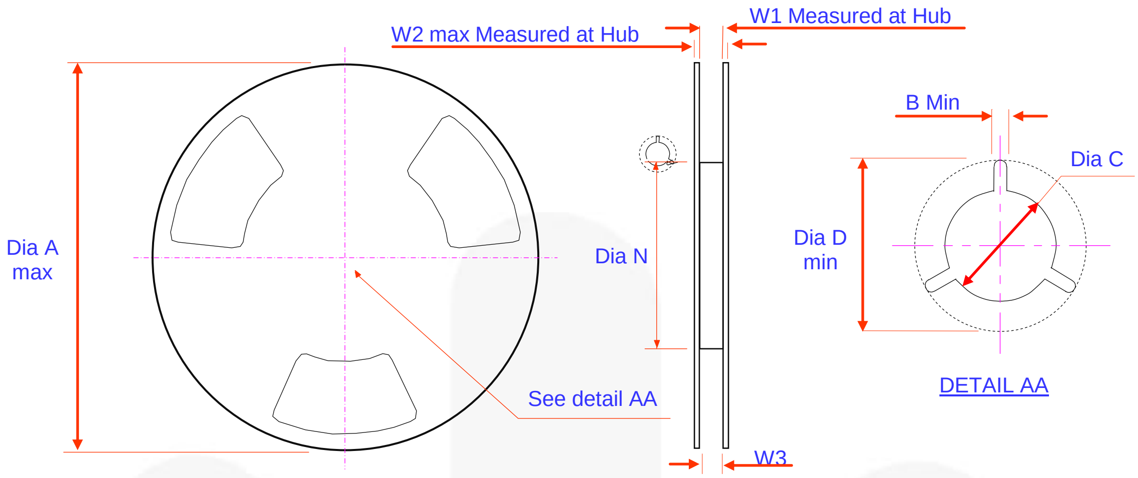


Figure 4. Embossed Carrier Tape Configuration and Dimensions



NOTES:
A : ALL DIMENSION ARE IN MILLIMETERS UNLESS OTHERWISE SPECIFIED
B : DRAWING FILE NAME : PKG-LGA16AREV1

Figure 5. Tape Leader and Trailer Configuration



Dimensions are in millimeters									
Tape Width	Reel Option	Dia A max	Dia B min	Dia C +0.5/-0.2	Dia D min	Dim N min	Dim W1 +2/-0	Dim W2 Max	Dim W3 (LSL-USL)
12mm	13"Dis	330	1.5	13	20.2	178.0	12.4	18.4	11.9-15.4

Figure 6. Reel Configuration

Notes:

1. All dimensions are in millimeters unless otherwise specified.
2. Drawing file name: PKG-LGA16AREV1.
3. Plastic reel W1 dimension control limit of: 8mm reel = ± 1.0 mm and 12 mm reel and above = ± 1.5 mm.

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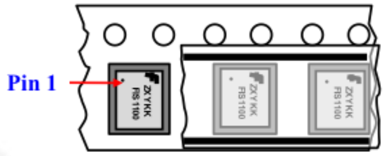
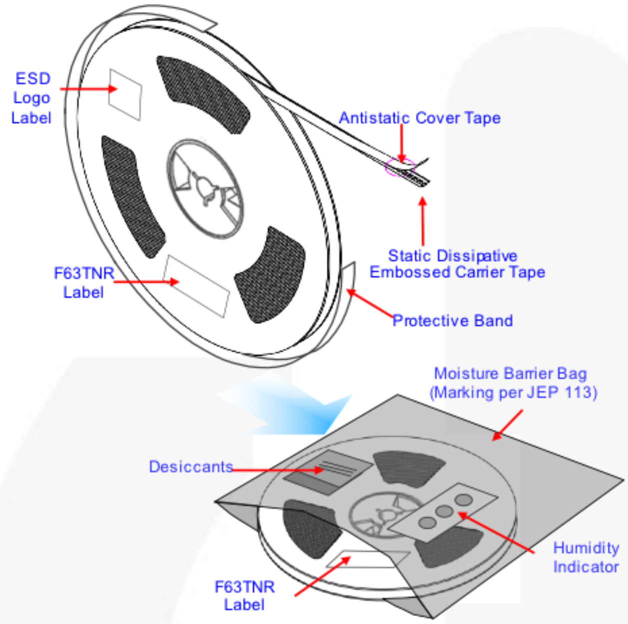
REVISIONS				
REV	DESCRIPTION	ECN	DATE	NAME/SITE
1	RELEASE TO DOCUMENT CONTROL	N/A	14FEB '14	HM ANG





Packing Description:

LGA16 leads is classified under Moisture Sensitive Level 3 at 260 °C peak package body temperature.

The carrier tape is made from dissipative polystyrene or polycarbonate resin. The cover tape is a multilayer film primarily composed of polyester film, adhesive layer, heat activated sealant, and anti-static sprayed agent. These reeled parts in standard option are shipped with 3000 units per 330 mm diameter reel. The reels is made of polystyrene plastic (anti-static coated or intrinsic).

These full reels are individually barcode labeled and placed inside a pizza box made of recyclable corrugated brown paper with a Fairchild logo printing. The reel is packed single reel in the pizza box. And these pizza boxes are placed inside a barcode labeled shipping box which comes in different sizes depending on the number of parts shipped.

LGA16A Packing Information	
Packaging Option	Standard (no flow code)
Packaging type	TNR
Qty per Reel	3000
Reel Size	13" Dia
Box Dimension (mm)	1352X340X51
Max qty per Box	3000

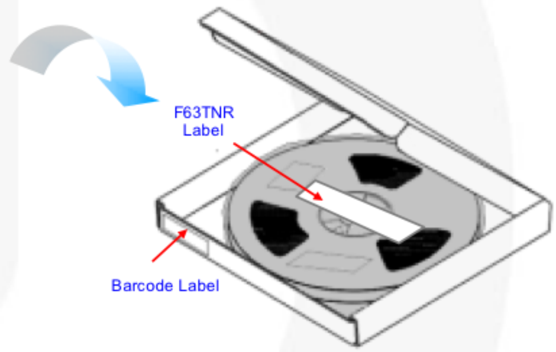


Figure 7. Packing Configuration

LOT: PMH010088888
QTY: 3000
FSID: FIS1100MEMS
SPEC:
D/C1: P1401AA QTY1:
SPEC REV:
2nd Level Interconnect
1. Category e4
2. Maximum safe temperature 260 deg C
3. MSL 3
D/C2: QTY2:
Green Component
RoHS COMPLIANT
FAIRCHILD SEMICONDUCTOR
(F63TNR)6.1

Figure 8. F63TNR Label Sample

Calibration

You can mitigate the effects of stress and alignment errors by implementing Post board mount calibration.

Sensor Fusion

You can mitigate the effects of some sensor errors through the use of sensor fusion, such as Fairchild's XKF3, which comes standard with the Fairchild FIS series of IMUs (see AN-5084).

MEMS Handling Instructions

MEMS devices can break when subjected to excessive shock. Best practices dictate the following:

- Do not drop onto hard surfaces; pay attention to not exceed the parts' 10,000 g rating.
- Do not snap apart boards, as the shock induced by this action could exceed 10,000 g.
- Do not clean boards in ultrasonic bath, as the ultrasonic energy can destructively couple to the MEMS devices.

Related Material

FIS1100 Product Folder

AN-5083 FIS1100 AttitudeEngine™ - Low Power Motion Co-Processor for High Accuracy Tracking Applications

AN-5084 XKF3 - Low Power, Optimal Estimation of 3D Orientation using Inertial and Magnetic Sensing

AN-5085 FIS1100 Board Level Calibration

Revision History

Rev.	Date	Description
1.0	May 2016	Initial Release

PUBLICATION ORDERING INFORMATION

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