



Is Now Part of



**ON Semiconductor®**

To learn more about ON Semiconductor, please visit our website at  
[www.onsemi.com](http://www.onsemi.com)

ON Semiconductor and the ON Semiconductor logo are trademarks of Semiconductor Components Industries, LLC dba ON Semiconductor or its subsidiaries in the United States and/or other countries. ON Semiconductor owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of ON Semiconductor's product/patent coverage may be accessed at [www.onsemi.com/site/pdf/Patent-Marking.pdf](http://www.onsemi.com/site/pdf/Patent-Marking.pdf). ON Semiconductor reserves the right to make changes without further notice to any products herein. ON Semiconductor makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does ON Semiconductor assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. Buyer is responsible for its products and applications using ON Semiconductor products, including compliance with all laws, regulations and safety requirements or standards, regardless of any support or applications information provided by ON Semiconductor. "Typical" parameters which may be provided in ON Semiconductor data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. ON Semiconductor does not convey any license under its patent rights nor the rights of others. ON Semiconductor products are not designed, intended, or authorized for use as a critical component in life support systems or any FDA Class 3 medical devices or medical devices with a same or similar classification in a foreign jurisdiction or any devices intended for implantation in the human body. Should Buyer purchase or use ON Semiconductor products for any such unintended or unauthorized application, Buyer shall indemnify and hold ON Semiconductor and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that ON Semiconductor was negligent regarding the design or manufacture of the part. ON Semiconductor is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.



# 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<sup>2</sup>C 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<sup>2</sup> 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.

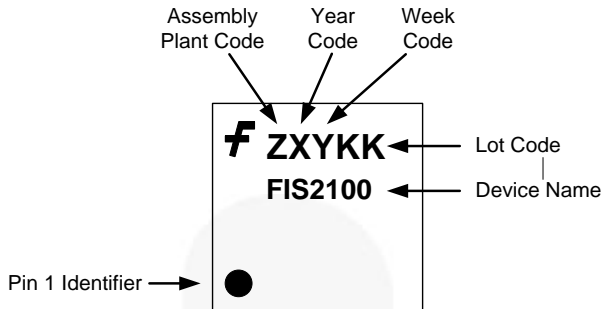
#### Board Alignment with Other Sensors

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

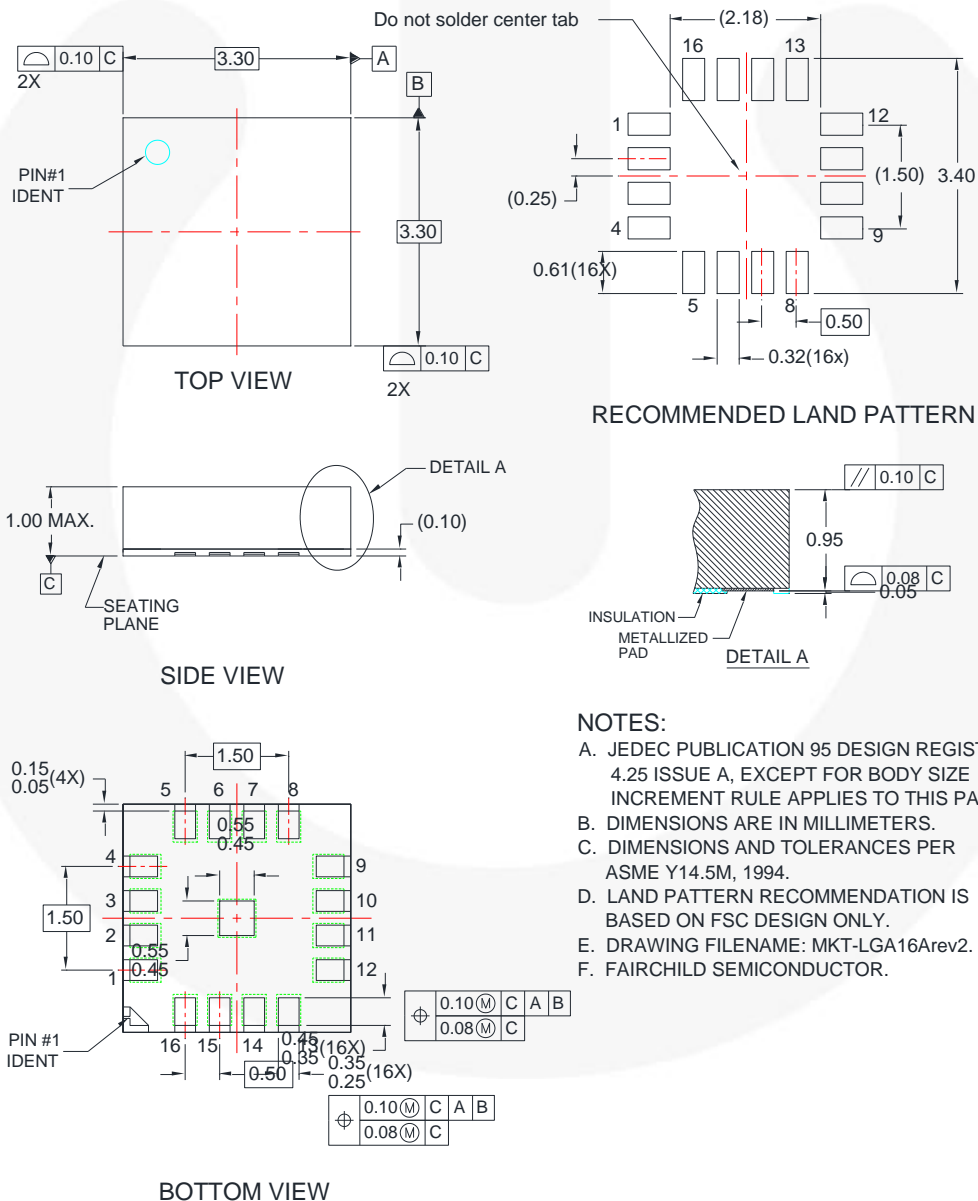
#### PCB Pad Design and Trace Routing

- 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**

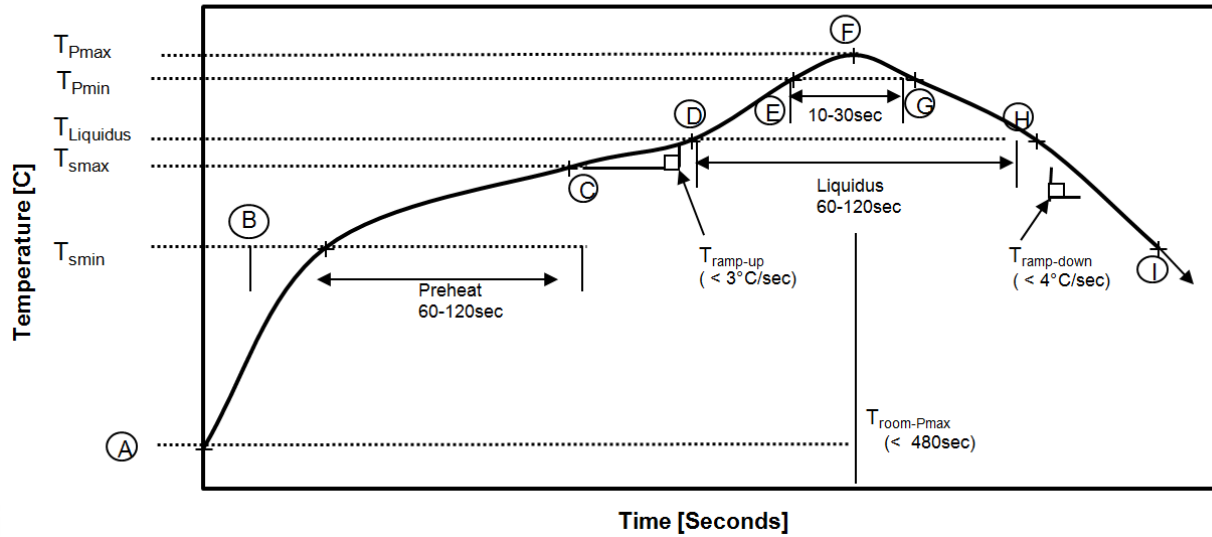
# Manufacturing

## Soldering

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

### Reflow Specification

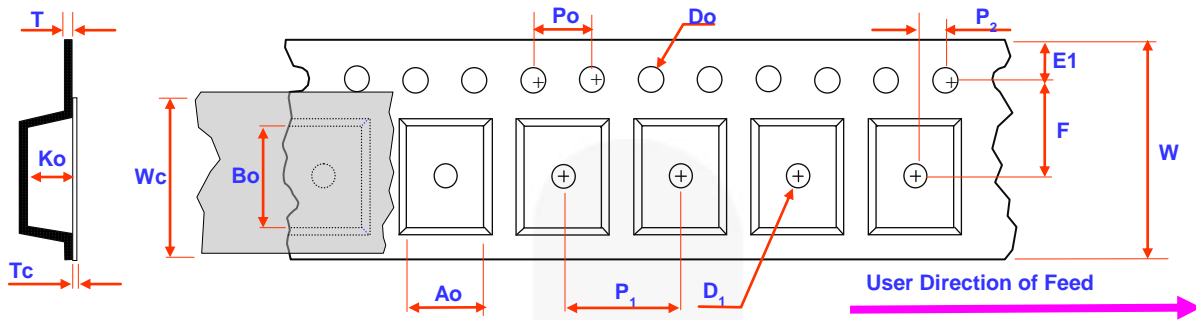
#### LEAD-FREE IR/CONVECTION REFLOW PROFILE



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).

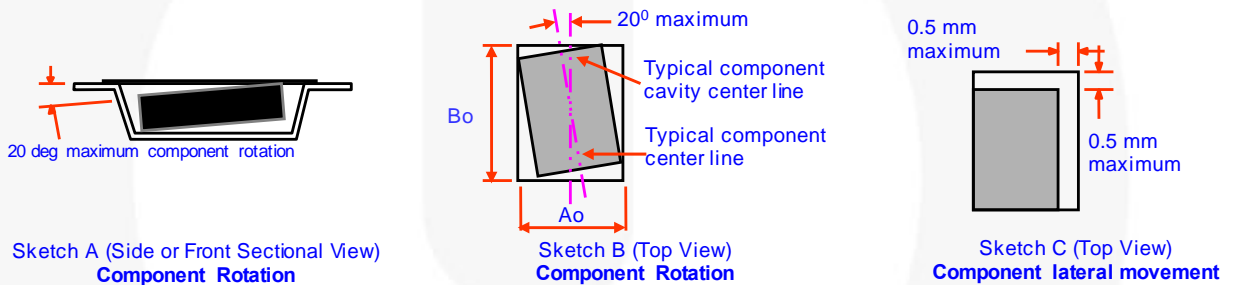


Figure 4. Embossed Carrier Tape Configuration and Dimensions

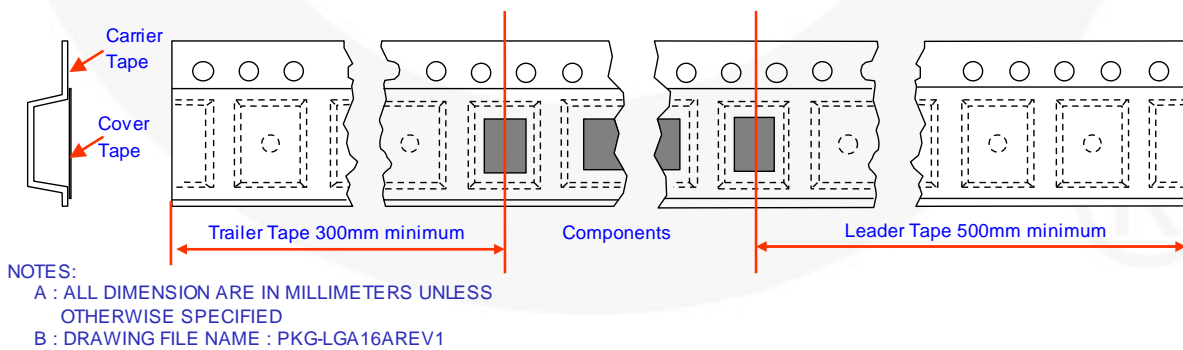
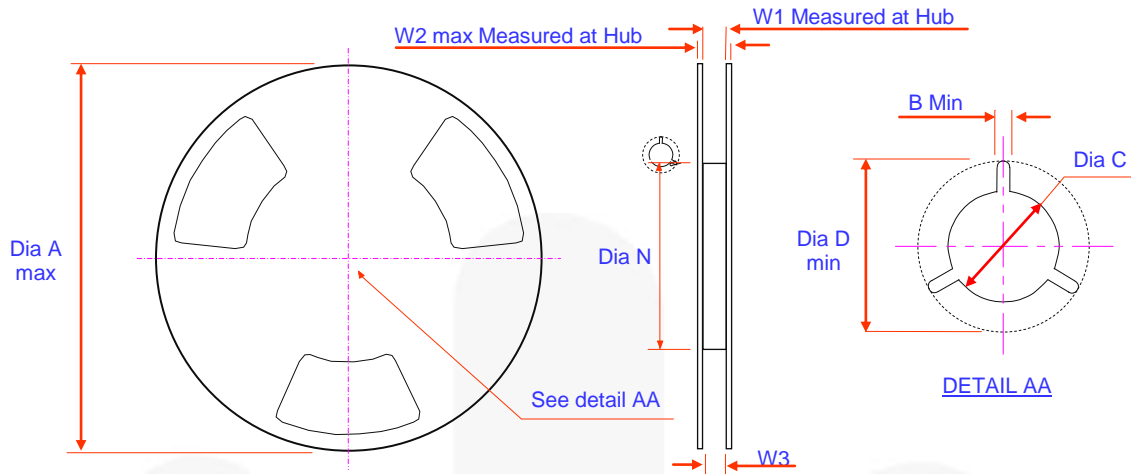


Figure 5. Tape Leader and Trailer Configuration



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

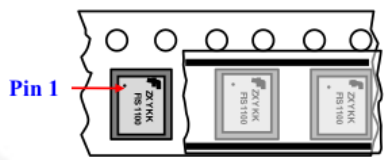
**Figure 6. Reel Configuration**

**Notes:**

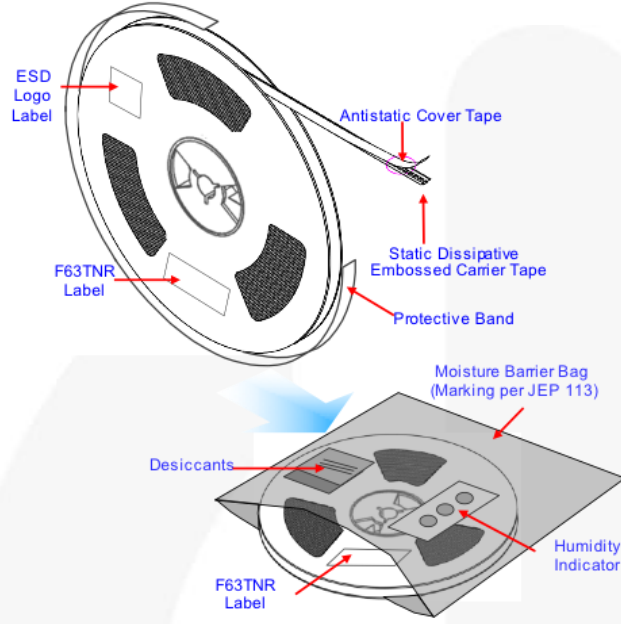
1. All dimensions are in millimeters unless otherwise specified.
2. Drawing file name: PKG-LGA16AREV1.
3. Plastic reel W1 dimension control limit of: 8mm reel =  $\pm 1.0$  mm and 12 mm reel and above =  $\pm 1.5$  mm.

THIS DRAWING IS THE PROPERTY OF FAIRCHILD SEMICONDUCTOR CORPORATION. NO USE THEREOF SHALL BE MADE OTHER THAN AS A REFERENCE FOR PROPOSALS AS SUBMITTED TO FAIRCHILD SEMICONDUCTOR CORPORATION FOR JOBS TO BE EXECUTED IN CONFORMITY WITH SUCH PROPOSALS UNLESS THE CONSENT OF SAID FAIRCHILD SEMICONDUCTOR CORPORATION HAS PREVIOUSLY BEEN OBTAINED. NO PART OF THIS DRAWING SHALL BE COPIED OR DUPLICATED OR ITS CONTENTS DISCLOSED. THE INFORMATION CONTAINED ON THIS DRAWING IS CONFIDENTIAL AND PROPRIETARY.

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



Unit Orientation



**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

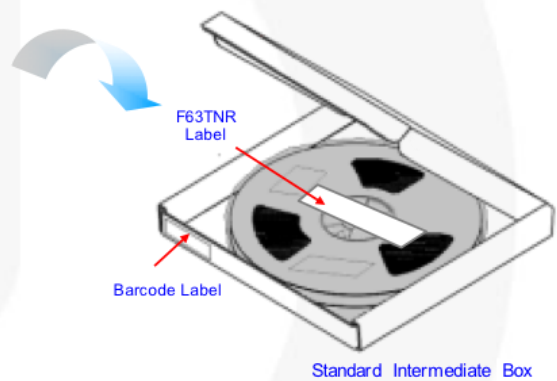


Figure 7. Packing Configuration

LOT: PMH01008888	QTY: 3000
FSID: FIS1100MEMS	SPEC:
D/C1: P1401AA QTY1:	SPEC REV: 2 <sup>nd</sup> Level Interconnect
D/C2: QTY2:	1. Category e4
	2. Maximum safe temperature 260 deg C
	3. MSL 3
	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

### DISCLAIMER

FAIRCHILD SEMICONDUCTOR RESERVES THE RIGHT TO MAKE CHANGES WITHOUT FURTHER NOTICE TO ANY PRODUCTS HEREIN TO IMPROVE RELIABILITY, FUNCTION, OR DESIGN. FAIRCHILD DOES NOT ASSUME ANY LIABILITY ARISING OUT OF THE APPLICATION OR USE OF ANY PRODUCT OR CIRCUIT DESCRIBED HEREIN; NEITHER DOES IT CONVEY ANY LICENSE UNDER ITS PATENT RIGHTS, NOR THE RIGHTS OF OTHERS.

### LIFE SUPPORT POLICY

FAIRCHILD'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF THE PRESIDENT OF FAIRCHILD SEMICONDUCTOR CORPORATION.

As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, or (c) whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in significant injury to the user.
2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.



ON Semiconductor and  are trademarks of Semiconductor Components Industries, LLC dba ON Semiconductor or its subsidiaries in the United States and/or other countries. ON Semiconductor owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of ON Semiconductor's product/patent coverage may be accessed at [www.onsemi.com/site/pdf/Patent-Marking.pdf](http://www.onsemi.com/site/pdf/Patent-Marking.pdf). ON Semiconductor reserves the right to make changes without further notice to any products herein. ON Semiconductor makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does ON Semiconductor assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. Buyer is responsible for its products and applications using ON Semiconductor products, including compliance with all laws, regulations and safety requirements or standards, regardless of any support or applications information provided by ON Semiconductor. "Typical" parameters which may be provided in ON Semiconductor data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. ON Semiconductor does not convey any license under its patent rights nor the rights of others. ON Semiconductor products are not designed, intended, or authorized for use as a critical component in life support systems or any FDA Class 3 medical devices or medical devices with a same or similar classification in a foreign jurisdiction or any devices intended for implantation in the human body. Should Buyer purchase or use ON Semiconductor products for any such unintended or unauthorized application, Buyer shall indemnify and hold ON Semiconductor and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that ON Semiconductor was negligent regarding the design or manufacture of the part. ON Semiconductor is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.

## PUBLICATION ORDERING INFORMATION

### LITERATURE FULFILLMENT:

Literature Distribution Center for ON Semiconductor  
19521 E. 32nd Pkwy, Aurora, Colorado 80011 USA  
**Phone:** 303-675-2175 or 800-344-3860 Toll Free USA/Canada  
**Fax:** 303-675-2176 or 800-344-3867 Toll Free USA/Canada  
**Email:** [orderlit@onsemi.com](mailto:orderlit@onsemi.com)

**N. American Technical Support:** 800-282-9855 Toll Free  
USA/Canada  
**Europe, Middle East and Africa Technical Support:**  
Phone: 421 33 790 2910  
**Japan Customer Focus Center**  
Phone: 81-3-5817-1050

**ON Semiconductor Website:** [www.onsemi.com](http://www.onsemi.com)  
**Order Literature:** <http://www.onsemi.com/orderlit>  
For additional information, please contact your local  
Sales Representative