

## DS250DF410 25 Gbps Multi-Rate 4-Channel Retimer

### 1 Features

- Quad-Channel Multi-Rate Retimer with Integrated Signal Conditioning
- All Channels Lock Independently from 20.6 to 25.8 Gbps (Including Sub-Rates Like 10.3125 Gbps, 12.5 Gbps, and More)
- Ultra-Low Latency: <500 ps Typical for 25.78125-Gbps Data Rate
- Single Power Supply, No Low-Jitter Reference Clock Required, and Minimal Supply Decoupling to Reduce Board Routing Complexity and BOM Cost
- Integrated 2x2 Cross Point
- Adaptive Continuous Time Linear Equalizer (CTLE)
- Adaptive Decision Feedback Equalizer (DFE)
- Low-Jitter Transmitter With 3-Tap FIR Filter
- Combined Equalization Supporting 35+ dB Channel Loss at 12.9 GHz
- Adjustable Transmit Amplitude: 205 mVppd to 1225 mVppd (Typical)
- On-Chip Eye Opening Monitor (EOM), PRBS Pattern Checker/Generator
- Supports JTAG/AC-JTAG Boundary Scan
- Small 6-mm x 6-mm BGA Package with Easy Flow-Through Routing

### 2 Applications

- Jitter Cleaning for Front-Port Optical
- Active Cable Assemblies
- Backplane/Mid-Plane Reach Extension
- IEEE802.3bj 100GbE, Infiniband EDR, and OIF-CEI-25G-LR/MR/SR/VSR Electrical Interfaces
- SFP28, QSFP28, CFP2/CFP4, CDFP

### 3 Description

The DS250DF410 is a four-channel multi-rate retimer with integrated signal conditioning. It is used to extend the reach and robustness of long, lossy, crosstalk-impaired high-speed serial links while achieving a bit error rate (BER) of  $10^{-15}$  or less.

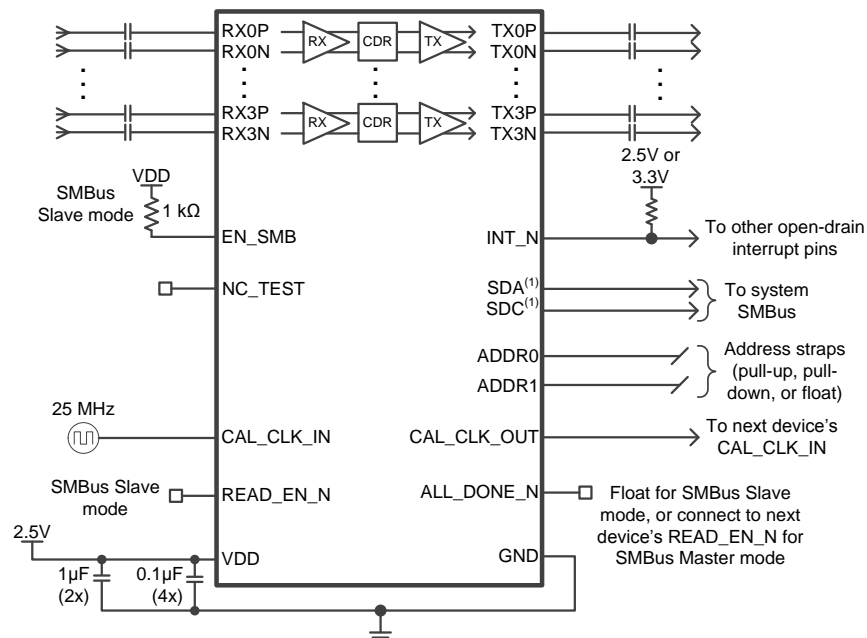
Each channel of the DS250DF410 independently locks to serial data rates in a continuous range from 20.6 Gbps to 25.8 Gbps or to any supported sub-rate ( $\pm 2$  and  $\pm 4$ ), including key data rates such as 10.3125 Gbps and 12.5 Gbps, which allows the DS250DF410 to support individual lane Forward Error Correction (FEC) pass-through.

#### Device Information<sup>(1)</sup>

PART NUMBER	PACKAGE	BODY SIZE (NOM)
DS250DF410	ABM (101)	6.0 mm x 6.0 mm

(1) For all available packages, see the orderable addendum at the end of the data sheet.

#### Simplified Schematic



(1) SMBus signals need to be pulled up elsewhere in the system.



## 4 Description (continued)

The DS250DF410 has a single power supply and minimal need for external components. These features reduce PCB routing complexity and BOM cost.

The advanced equalization features of the DS250DF410 include a low-jitter 3-tap transmit finite impulse response (FIR) filter, an adaptive continuous-time linear equalizer (CTLE), and an adaptive decision feedback equalizer (DFE). This enables reach extension for lossy interconnect and backplanes with multiple connectors and crosstalk. The integrated CDR function is ideal for front-port optical module applications to reset the jitter budget and retime the high-speed serial data. The DS250DF410 implements 2x2 cross-point on each channel pair, providing the host with lane crossing, fanout, and multiplexing options.

The DS250DF410 can be configured either through the SMBus or through an external EEPROM. Up to 16 devices can share a single EEPROM using Common Channel format. A non-disruptive on-chip eye monitor and a PRBS generator/checker allow for in-system diagnostics.

## Table of Contents

<b>1 Features</b> .....	<b>1</b>	6.1 Device Support.....	<b>4</b>
<b>2 Applications</b> .....	<b>1</b>	6.2 Community Resources.....	<b>4</b>
<b>3 Description</b> .....	<b>1</b>	6.3 Trademarks .....	<b>4</b>
<b>4 Description (continued)</b> .....	<b>2</b>	6.4 Electrostatic Discharge Caution.....	<b>4</b>
<b>5 Revision History</b> .....	<b>3</b>	6.5 Glossary .....	<b>4</b>
<b>6 Device and Documentation Support</b> .....	<b>4</b>	<b>7 Mechanical, Packaging, and Orderable Information</b> .....	<b>4</b>

## 5 Revision History

DATE	REVISION	NOTES
February 2016	*	Initial release.

## 6 Device and Documentation Support

### 6.1 Device Support

#### 6.1.1 Development Support

For additional information, see TI's Surface Mount Technology (SMT) References at:

<http://focus.ti.com/quality/docs> under the *Quality & Lead (Pb)-Free Data* menu.

### 6.2 Community Resources

The following links connect to TI community resources. Linked contents are provided "AS IS" by the respective contributors. They do not constitute TI specifications and do not necessarily reflect TI's views; see TI's [Terms of Use](#).

**TI E2E™ Online Community** *TI's Engineer-to-Engineer (E2E) Community*. Created to foster collaboration among engineers. At [e2e.ti.com](http://e2e.ti.com), you can ask questions, share knowledge, explore ideas and help solve problems with fellow engineers.

**Design Support** *TI's Design Support* Quickly find helpful E2E forums along with design support tools and contact information for technical support.

### 6.3 Trademarks

E2E is a trademark of Texas Instruments.

### 6.4 Electrostatic Discharge Caution



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

### 6.5 Glossary

[SLYZ022](#) — *TI Glossary*.

This glossary lists and explains terms, acronyms, and definitions.

## 7 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.

**PACKAGING INFORMATION**

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
DS250DF410ABMR	ACTIVE	FC/CSP	ABM	101	1000	Green (RoHS & no Sb/Br)	SNAGCU	Level-3-260C-168 HR	-40 to 85	DS250DF4	<a href="#">Samples</a>
DS250DF410ABMT	ACTIVE	FC/CSP	ABM	101	250	Green (RoHS & no Sb/Br)	SNAGCU	Level-3-260C-168 HR	-40 to 85	DS250DF4	<a href="#">Samples</a>

(1) The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSOLETE:** TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

**Important Information and Disclaimer:** The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

## TAPE AND REEL INFORMATION



### QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
DS250DF410ABMR	FC/CSP	ABM	101	1000	330.0	16.4	6.3	6.3	1.5	12.0	16.0	Q1
DS250DF410ABMT	FC/CSP	ABM	101	250	178.0	16.4	6.3	6.3	1.5	12.0	16.0	Q1

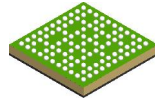
**TAPE AND REEL BOX DIMENSIONS**


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
DS250DF410ABMR	FC/CSP	ABM	101	1000	367.0	367.0	38.0
DS250DF410ABMT	FC/CSP	ABM	101	250	210.0	185.0	35.0



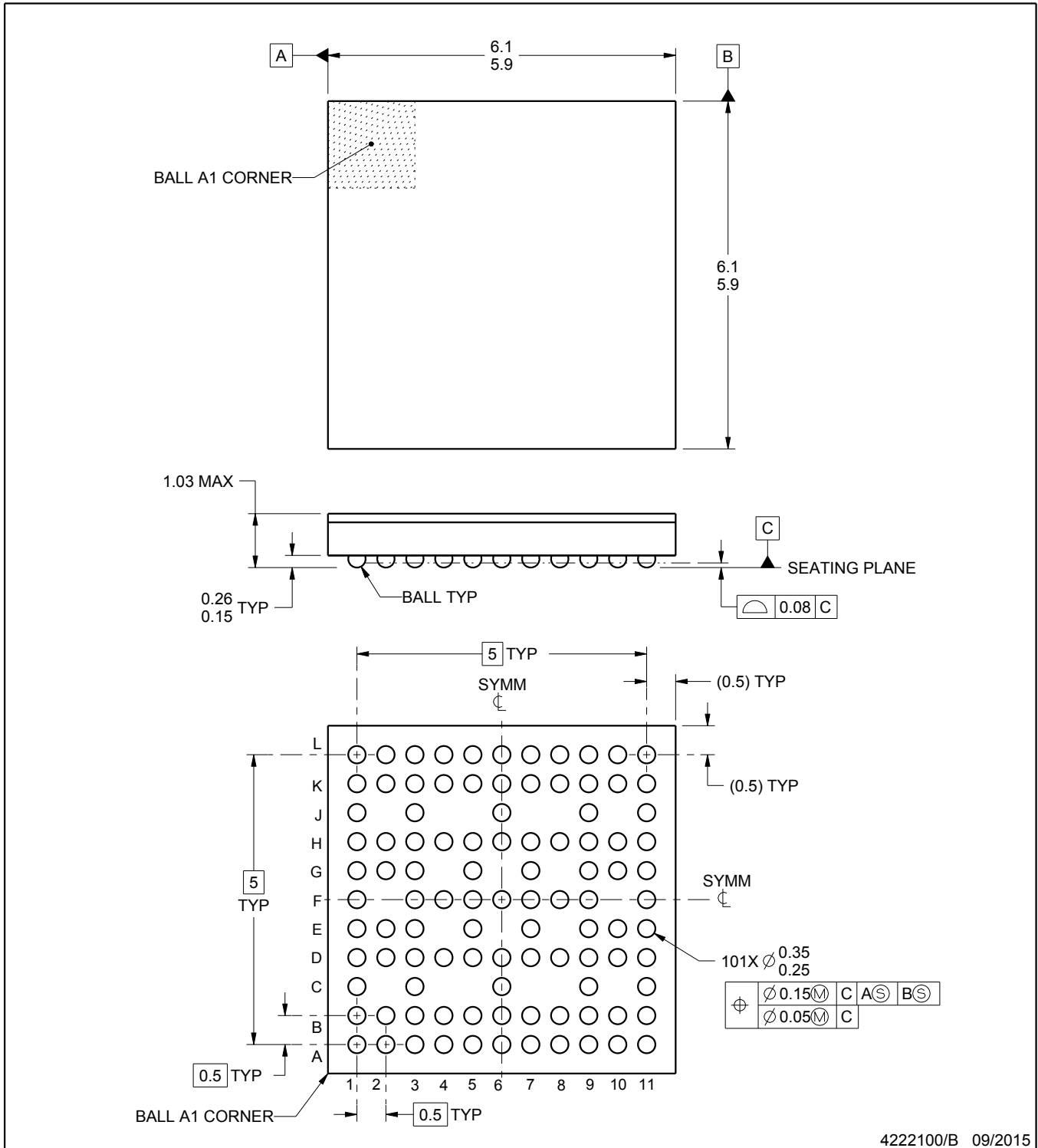
# ABM0101A



# PACKAGE OUTLINE

## FCBGA - 1.03 mm max height

PLASTIC BALL GRID ARRAY



4222100/B 09/2015

**NOTES:**

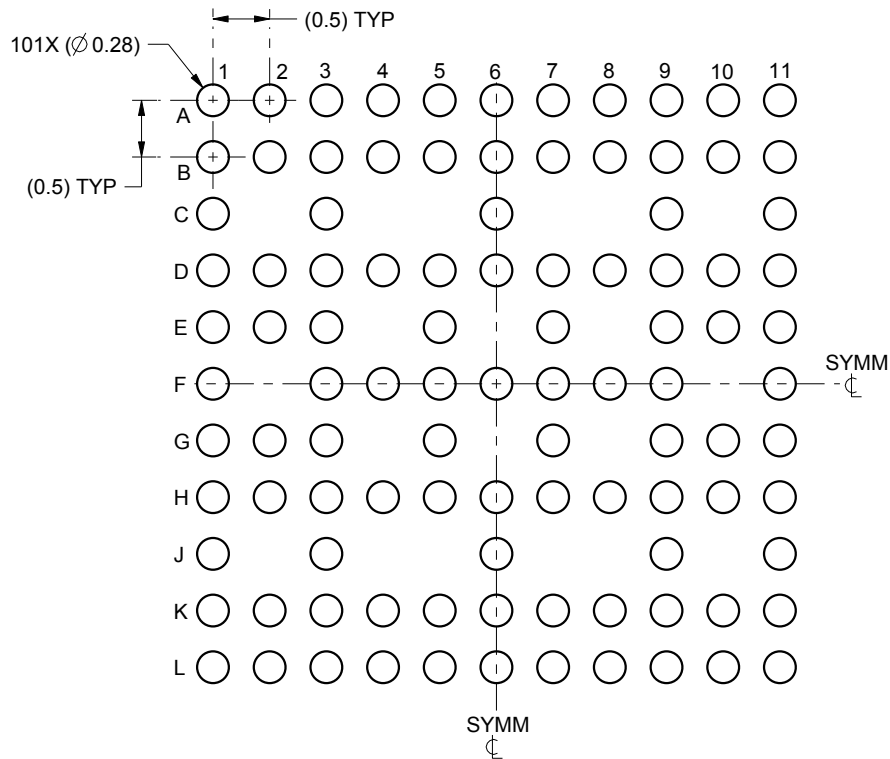
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.

# EXAMPLE BOARD LAYOUT

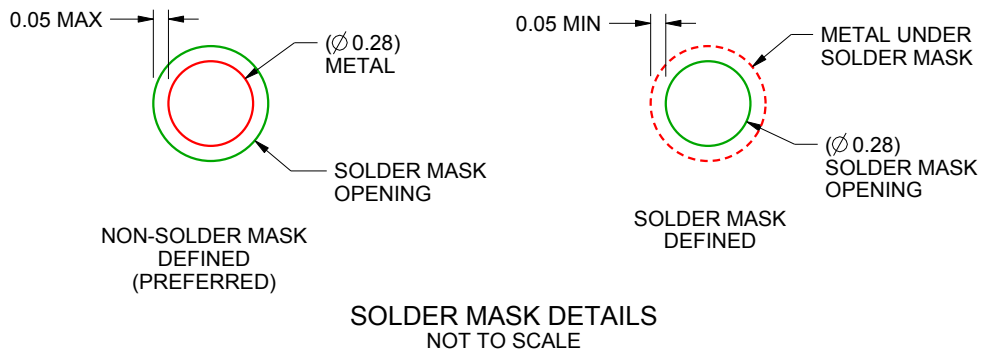
ABM0101A

FCBGA - 1.03 mm max height

PLASTIC BALL GRID ARRAY



LAND PATTERN EXAMPLE  
SCALE: 15X



SOLDER MASK DETAILS  
NOT TO SCALE

4222100/B 09/2015

NOTES: (continued)

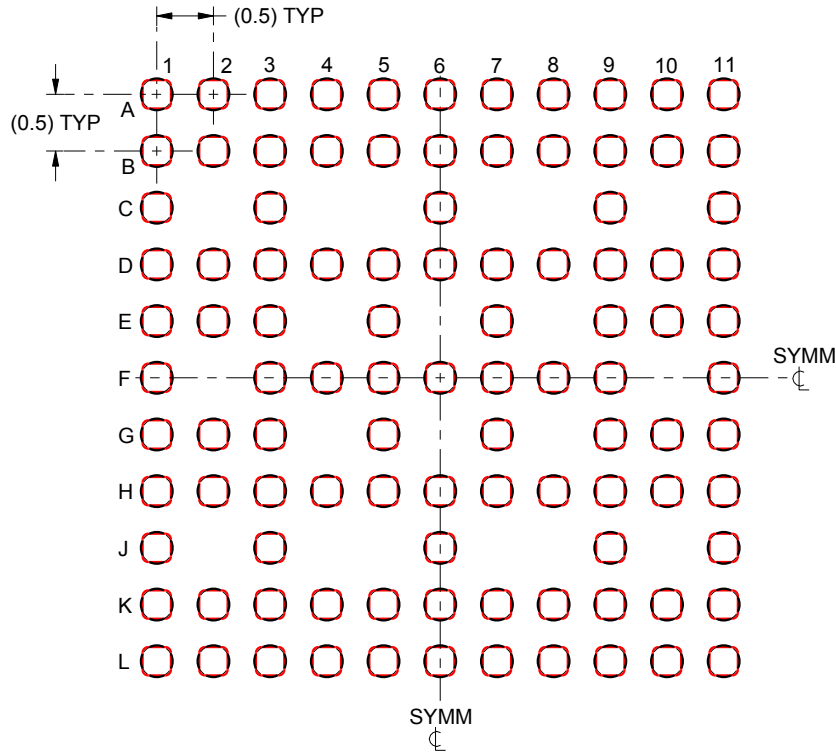
- Final dimensions may vary due to manufacturing tolerance considerations and also routing constraints. For information, see Texas Instruments literature number SPRAA99 ([www.ti.com/lit/spraa99](http://www.ti.com/lit/spraa99)).

# EXAMPLE STENCIL DESIGN

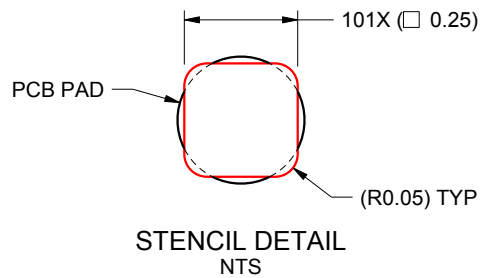
ABM0101A

FCBGA - 1.03 mm max height

PLASTIC BALL GRID ARRAY



SOLDER PASTE EXAMPLE  
BASED ON 0.1 mm THICK STENCIL  
SCALE: 15X



4222100/B 09/2015

NOTES: (continued)

4. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release.

## IMPORTANT NOTICE

Texas Instruments Incorporated (TI) reserves the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete.

TI's published terms of sale for semiconductor products (<http://www.ti.com/sc/docs/stdterms.htm>) apply to the sale of packaged integrated circuit products that TI has qualified and released to market. Additional terms may apply to the use or sale of other types of TI products and services.

Reproduction of significant portions of TI information in TI data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such reproduced documentation. Information of third parties may be subject to additional restrictions. Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyers and others who are developing systems that incorporate TI products (collectively, "Designers") understand and agree that Designers remain responsible for using their independent analysis, evaluation and judgment in designing their applications and that Designers have full and exclusive responsibility to assure the safety of Designers' applications and compliance of their applications (and of all TI products used in or for Designers' applications) with all applicable regulations, laws and other applicable requirements. Designer represents that, with respect to their applications, Designer has all the necessary expertise to create and implement safeguards that (1) anticipate dangerous consequences of failures, (2) monitor failures and their consequences, and (3) lessen the likelihood of failures that might cause harm and take appropriate actions. Designer agrees that prior to using or distributing any applications that include TI products, Designer will thoroughly test such applications and the functionality of such TI products as used in such applications.

TI's provision of technical, application or other design advice, quality characterization, reliability data or other services or information, including, but not limited to, reference designs and materials relating to evaluation modules, (collectively, "TI Resources") are intended to assist designers who are developing applications that incorporate TI products; by downloading, accessing or using TI Resources in any way, Designer (individually or, if Designer is acting on behalf of a company, Designer's company) agrees to use any particular TI Resource solely for this purpose and subject to the terms of this Notice.

TI's provision of TI Resources does not expand or otherwise alter TI's applicable published warranties or warranty disclaimers for TI products, and no additional obligations or liabilities arise from TI providing such TI Resources. TI reserves the right to make corrections, enhancements, improvements and other changes to its TI Resources. TI has not conducted any testing other than that specifically described in the published documentation for a particular TI Resource.

Designer is authorized to use, copy and modify any individual TI Resource only in connection with the development of applications that include the TI product(s) identified in such TI Resource. NO OTHER LICENSE, EXPRESS OR IMPLIED, BY ESTOPPEL OR OTHERWISE TO ANY OTHER TI INTELLECTUAL PROPERTY RIGHT, AND NO LICENSE TO ANY TECHNOLOGY OR INTELLECTUAL PROPERTY RIGHT OF TI OR ANY THIRD PARTY IS GRANTED HEREIN, including but not limited to any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information regarding or referencing third-party products or services does not constitute a license to use such products or services, or a warranty or endorsement thereof. Use of TI Resources may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

TI RESOURCES ARE PROVIDED "AS IS" AND WITH ALL FAULTS. TI DISCLAIMS ALL OTHER WARRANTIES OR REPRESENTATIONS, EXPRESS OR IMPLIED, REGARDING RESOURCES OR USE THEREOF, INCLUDING BUT NOT LIMITED TO ACCURACY OR COMPLETENESS, TITLE, ANY EPIDEMIC FAILURE WARRANTY AND ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, AND NON-INFRINGEMENT OF ANY THIRD PARTY INTELLECTUAL PROPERTY RIGHTS. TI SHALL NOT BE LIABLE FOR AND SHALL NOT DEFEND OR INDEMNIFY DESIGNER AGAINST ANY CLAIM, INCLUDING BUT NOT LIMITED TO ANY INFRINGEMENT CLAIM THAT RELATES TO OR IS BASED ON ANY COMBINATION OF PRODUCTS EVEN IF DESCRIBED IN TI RESOURCES OR OTHERWISE. IN NO EVENT SHALL TI BE LIABLE FOR ANY ACTUAL, DIRECT, SPECIAL, COLLATERAL, INDIRECT, PUNITIVE, INCIDENTAL, CONSEQUENTIAL OR EXEMPLARY DAMAGES IN CONNECTION WITH OR ARISING OUT OF TI RESOURCES OR USE THEREOF, AND REGARDLESS OF WHETHER TI HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

Unless TI has explicitly designated an individual product as meeting the requirements of a particular industry standard (e.g., ISO/TS 16949 and ISO 26262), TI is not responsible for any failure to meet such industry standard requirements.

Where TI specifically promotes products as facilitating functional safety or as compliant with industry functional safety standards, such products are intended to help enable customers to design and create their own applications that meet applicable functional safety standards and requirements. Using products in an application does not by itself establish any safety features in the application. Designers must ensure compliance with safety-related requirements and standards applicable to their applications. Designer may not use any TI products in life-critical medical equipment unless authorized officers of the parties have executed a special contract specifically governing such use. Life-critical medical equipment is medical equipment where failure of such equipment would cause serious bodily injury or death (e.g., life support, pacemakers, defibrillators, heart pumps, neurostimulators, and implantables). Such equipment includes, without limitation, all medical devices identified by the U.S. Food and Drug Administration as Class III devices and equivalent classifications outside the U.S.

TI may expressly designate certain products as completing a particular qualification (e.g., Q100, Military Grade, or Enhanced Product). Designers agree that it has the necessary expertise to select the product with the appropriate qualification designation for their applications and that proper product selection is at Designers' own risk. Designers are solely responsible for compliance with all legal and regulatory requirements in connection with such selection.

Designer will fully indemnify TI and its representatives against any damages, costs, losses, and/or liabilities arising out of Designer's non-compliance with the terms and provisions of this Notice.