

# 具有 14 位 9GSPS DAC 和 14 位 3GSPS ADC 的 AFE76xx 四通道/双通道、射频采样模拟前端

## 1 器件概述

### 1.1 特性

- 14 位分辨率
- 采样率：
  - DAC: 9GSPS
  - ADC: 3GSPS
- 射频频率范围：高达 5.2GHz
- 最大射频信号带宽
  - 四通道模式 (4T4R): 800MHz (单频带) ; 300MHz (双频带)
  - 双通道模式 (2T2R): 1200MHz (TX)/1000MHz (RX) (单频带) ; 800MHz (双频带)
- 每 RX 通道配备片上双频可选择 DSA
- 集成型 TX DSA 功能
- 数字：
  - 双频带数字上变频器 (DUC)
  - 双频带数字下变频器 (DDC)
- 用于 DUC/DDC 的 32 位 NCO
- 插值率：6 倍、8 倍、9 倍、12 倍、16 倍、18 倍、24 倍、36 倍
- 抽取率：/2、/3、/4、/6、/8、/9、/12、/16、/18、/24、/32
- 适用于 TDD 的 RX/FB 动态转换
- 接口：
  - 8 个高达 15Gbps 的 SerDes 收发器
  - 采用 8b/10b 编码的 16 位和 12 位 JESD204B 传输层格式
  - 子类 1 多器件同步
- 时钟：
  - 用于生成 DAC 和 ADC 时钟的内部 PLL/VCO
- 封装：17mm x 17mm FC BGA，间距为 0.8mm
- 电源：1.85V、1.15V、1.0V、-1.8V

### 1.2 应用

- 蜂窝基站
- 宽带通信
- 微波回程连线
- 分布式天线系统 (DAS)

### 1.3 说明

AFE76xx 是一系列高性能四通道/双通道 14 位集成式射频采样模拟前端 (AFE)，配备 9 个 GSPS DAC 和 3 个 GSPS ADC，支持合成和数字化宽带信号。高动态范围使得 AFE76xx 能够为无线基站生成和数字化 3G/4G 信号。在 TDD 模式下，接收器通道经过配置可在流量接收器 (TDD RX) 状态 and 宽带反馈接收器 (TDD FB) 状态间动态切换以辅助发送器路径上功率放大器 (PA) 的 DPD (数字预失真)。

AFE76xx 系列在接收器通道上具有集成式 DSA，同时支持发送器通道上等同于 DSA 的功能。每个接收器通道都有一个模拟射频峰值功耗检测器和多个数字功耗检测器，可在接收器通道上辅助进行自动增益控制 (AGC)，另有两个射频过载检测器可实现器件可靠性保护。AFE76xx 系列拥有 8 个兼容 JESD204B 的 SerDes 收发器，运行速率高达 15Gbps。这些器件每 TX 通道拥有多达 2 个 DUC，每 RX 通道拥有 2 个 DDC，采用多种插值/抽取率以及具有频率灵活的独立 NCO 的数字正交调制器/解调器。这些器件在单频带模式下支持超过 1000MHz (4T4R 下为 800MHz) 射频信号带宽，在双频带模式下支持每频带高达 800MHz (4T4R 下为 300MHz) 射频信号带宽。低抖动 PLL/VCO 通过允许使用频率较低的参考时钟来简化采样时钟的生成。

器件信息<sup>(1)</sup>

器件型号	封装	封装尺寸
AFE7685	FC-BGA	17.00mm x 17.00mm
AFE7686	FC-BGA	17.00mm x 17.00mm
AFE7684	FC-BGA	17.00mm x 17.00mm
AFE7683	FC-BGA	17.00mm x 17.00mm
AFE7681	FC-BGA	17.00mm x 17.00mm

(1) 如需了解所有可用封装，请参阅数据表末尾的可订购产品附录。





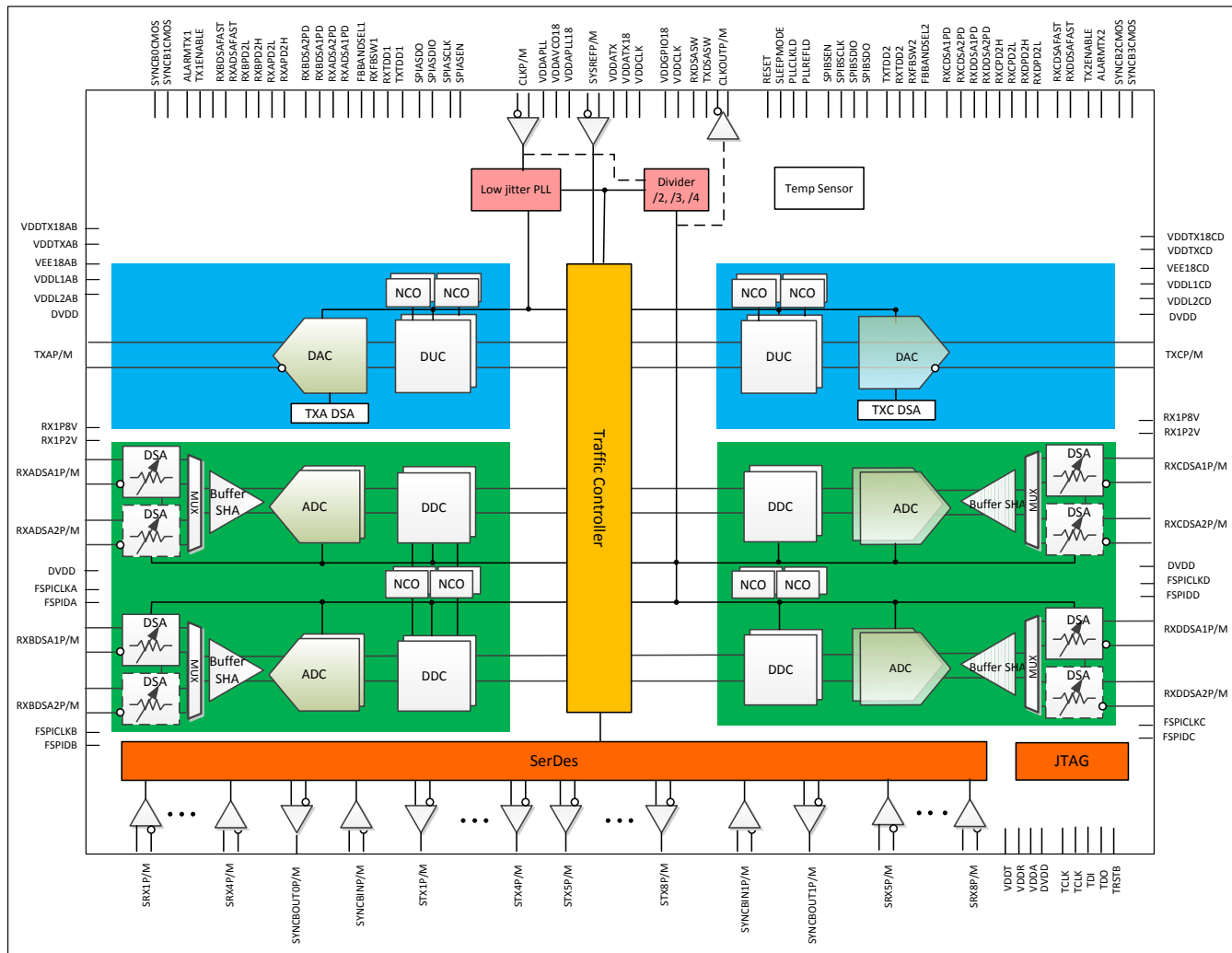


图 1-2. AFE7684 功能方框图

## 2 修订历史记录

Changes from Revision D (December 2018) to Revision E	Page
<ul style="list-style-type: none"> <li>已更改 将 AFE7681 从“预告信息”更改为“生产数据”.....</li> </ul>	<a href="#">1</a>
Changes from Revision C (October 2018) to Revision D	Page
<ul style="list-style-type: none"> <li>已添加 AFE7681 作为“预告信息”，AFE7683 作为“生产数据”.....</li> </ul>	<a href="#">1</a>
Changes from Revision B (September 2018) to Revision C	Page
<ul style="list-style-type: none"> <li>已更改 将 AFE7684 从“预告信息”更改为“生产数据”.....</li> </ul>	<a href="#">1</a>
Changes from Revision A (July 2018) to Revision B	Page
<ul style="list-style-type: none"> <li>已更改 将 AFE7686 从“预告信息”更改为“生产数据”.....</li> </ul>	<a href="#">1</a>

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Changes from Original (May 2018) to Revision A	Page
• 已更改 将 AFE7684 从“产品预览”更改为“预告信息”，将 AFE7685 从“产品预览”更改为“生产数据”.....	<a href="#">1</a>
• 已删除 从数据手册中删除了 AFE7683 .....	<a href="#">1</a>

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### 3 Device Comparison

**Table 3-1. Device Features Comparison**

DEVICE	# of TXs/RXs	# of DUCs/TX	# of DDCs/RX	MAX INPUT/OUTPUT DATA RATE (MSPS)
AFE7685	4T4R	1	1	750
AFE7686	4T4R	2	2	1500
AFE7684	2T4R	2	2	1500
AFE7683	2T4R	1	1	750
AFE7681	4T2R	1	1	750

## 4 器件和文档支持

### 4.1 器件支持

#### 4.1.1 第三方产品免责声明

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### 4.2 文档支持

如需接收文档更新通知，请访问 [ti.com.cn](http://ti.com.cn) 上的器件产品文件夹。单击右上角的通知我 进行注册，即可每周接收产品信息更改摘要。有关更改的详细信息，请查阅已修订文档中包含的修订历史记录。

下面列出了介绍 DSP、相关外设以及其他配套技术资料的最新文档。

#### 4.2.1 相关文档

《AFE76xx EVM 设计文档用户指南》(SLAU761)

《AFE76xx 技术参考手册》(SLAU744)

《AFE76xx 编程人员用户指南》(SLAU767)

### 4.3 相关链接

下表列出了快速访问链接。类别包括技术文档、支持与社区资源、工具和软件，以及申请样片或购买产品的快速链接。

表 4-1. 相关链接

器件	产品文件夹	样片与购买	技术文档	工具与软件	支持和社区
AFE7681	<a href="#">请单击此处</a>	<a href="#">请单击此处</a>	<a href="#">请单击此处</a>	<a href="#">请单击此处</a>	<a href="#">请单击此处</a>
AFE7683	<a href="#">请单击此处</a>	<a href="#">请单击此处</a>	<a href="#">请单击此处</a>	<a href="#">请单击此处</a>	<a href="#">请单击此处</a>
AFE7684	<a href="#">请单击此处</a>	<a href="#">请单击此处</a>	<a href="#">请单击此处</a>	<a href="#">请单击此处</a>	<a href="#">请单击此处</a>
AFE7685	<a href="#">请单击此处</a>	<a href="#">请单击此处</a>	<a href="#">请单击此处</a>	<a href="#">请单击此处</a>	<a href="#">请单击此处</a>
AFE7686	<a href="#">请单击此处</a>	<a href="#">请单击此处</a>	<a href="#">请单击此处</a>	<a href="#">请单击此处</a>	<a href="#">请单击此处</a>

### 4.4 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](#).

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**TI Embedded Processors Wiki** Established to help developers get started with Embedded Processors from Texas Instruments and to foster innovation and growth of general knowledge about the hardware and software surrounding these devices.

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ESD 的损坏小至导致微小的性能降级，大至整个器件故障。精密的集成电路可能更容易受到损坏，这是因为非常细微的参数更改都可能会导致器件与其发布的规格不相符。

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## 4.8 Glossary

**TI Glossary** This glossary lists and explains terms, acronyms, and definitions.

## 5 机械、封装和可订购信息

### 5.1 封装信息

以下页面包含机械、封装和可订购信息。这些信息是指定器件的最新可用数据。数据如有变更，恕不另行通知，且不会对此文档进行修订。如需获取此数据表的浏览器版本，请查阅左侧的导航栏。



**PACKAGING INFORMATION**

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
AFE7681IABJ	ACTIVE	FCBGA	ABJ	400	90	RoHS & Green	SNAGCU	Level-3-260C-168 HR	-40 to 85	AFE7681I	<a href="#">Samples</a>
AFE7683IABJ	ACTIVE	FCBGA	ABJ	400	90	RoHS & Green	SNAGCU	Level-3-260C-168 HR	-40 to 85	AFE7683I	<a href="#">Samples</a>
AFE7684IABJ	ACTIVE	FCBGA	ABJ	400	90	RoHS & Green	SNAGCU	Level-3-260C-168 HR	-40 to 85	AFE7684I	<a href="#">Samples</a>
AFE7685IABJ	ACTIVE	FCBGA	ABJ	400	90	RoHS & Green	SNAGCU	Level-3-260C-168 HR	-40 to 85	AFE7685I	<a href="#">Samples</a>
AFE7686IABJ	ACTIVE	FCBGA	ABJ	400	90	RoHS & Green	SNAGCU	Level-3-260C-168 HR	-40 to 85	AFE7686I	<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) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

**RoHS Exempt:** TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

**Green:** TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

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

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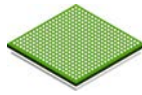
**TRAY**


Chamfer on Tray corner indicates Pin 1 orientation of packed units.

\*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	Unit array matrix	Max temperature (°C)	L (mm)	W (mm)	K0 (µm)	P1 (mm)	CL (mm)	CW (mm)
AFE7681IABJ	ABJ	FCBGA	400	90	6 x 15	150	315	135.9	7620	19.5	21	19.2
AFE7683IABJ	ABJ	FCBGA	400	90	6 x 15	150	315	135.9	7620	19.5	21	19.2
AFE7684IABJ	ABJ	FCBGA	400	90	6 x 15	150	315	135.9	7620	19.5	21	19.2
AFE7685IABJ	ABJ	FCBGA	400	90	6 x 15	150	315	135.9	7620	19.5	21	19.2
AFE7686IABJ	ABJ	FCBGA	400	90	6 x 15	150	315	135.9	7620	19.5	21	19.2

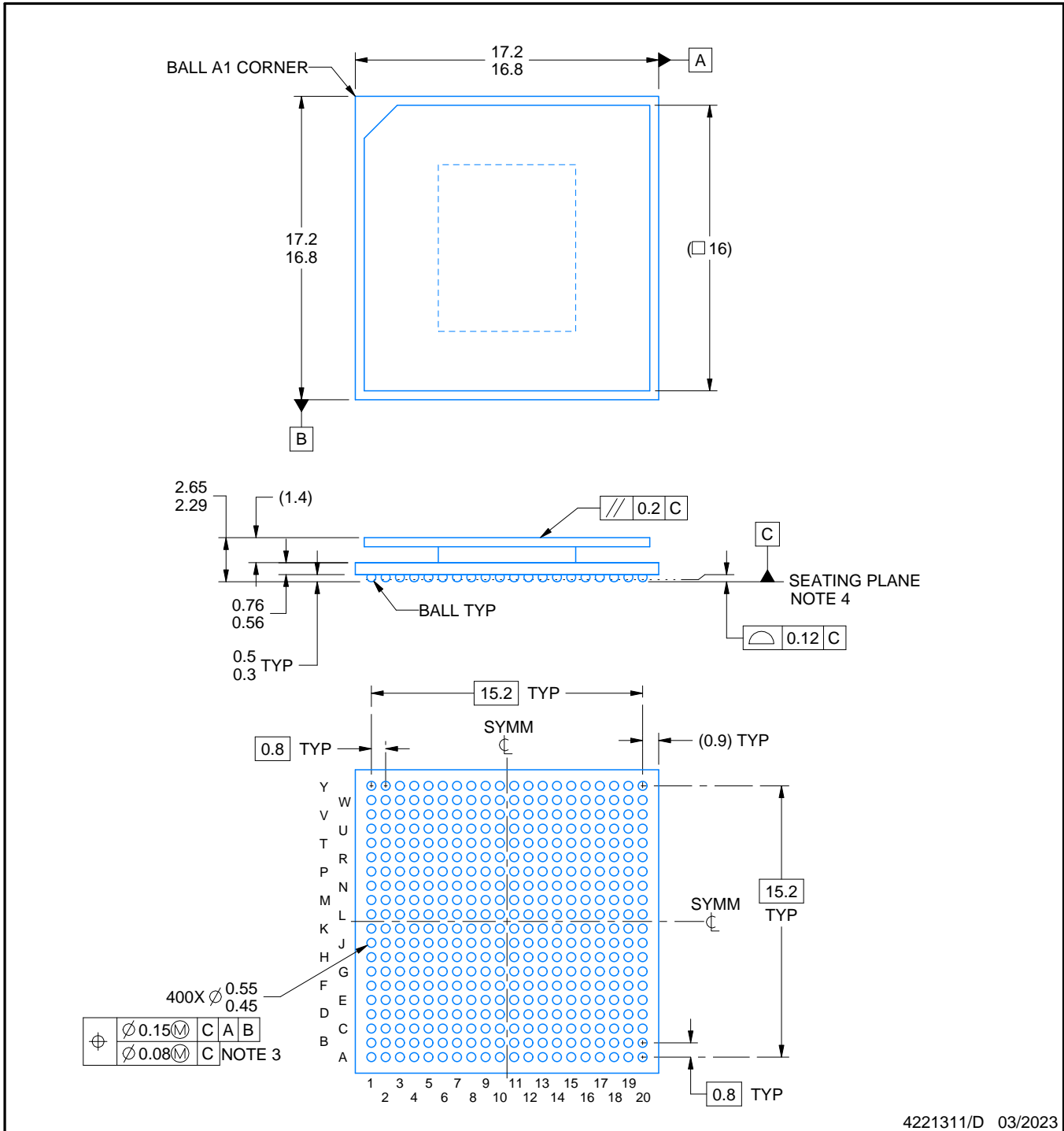
# ABJ0400A



# PACKAGE OUTLINE

FCBGA - 2.65 mm max height

BALL GRID ARRAY



## NOTES:

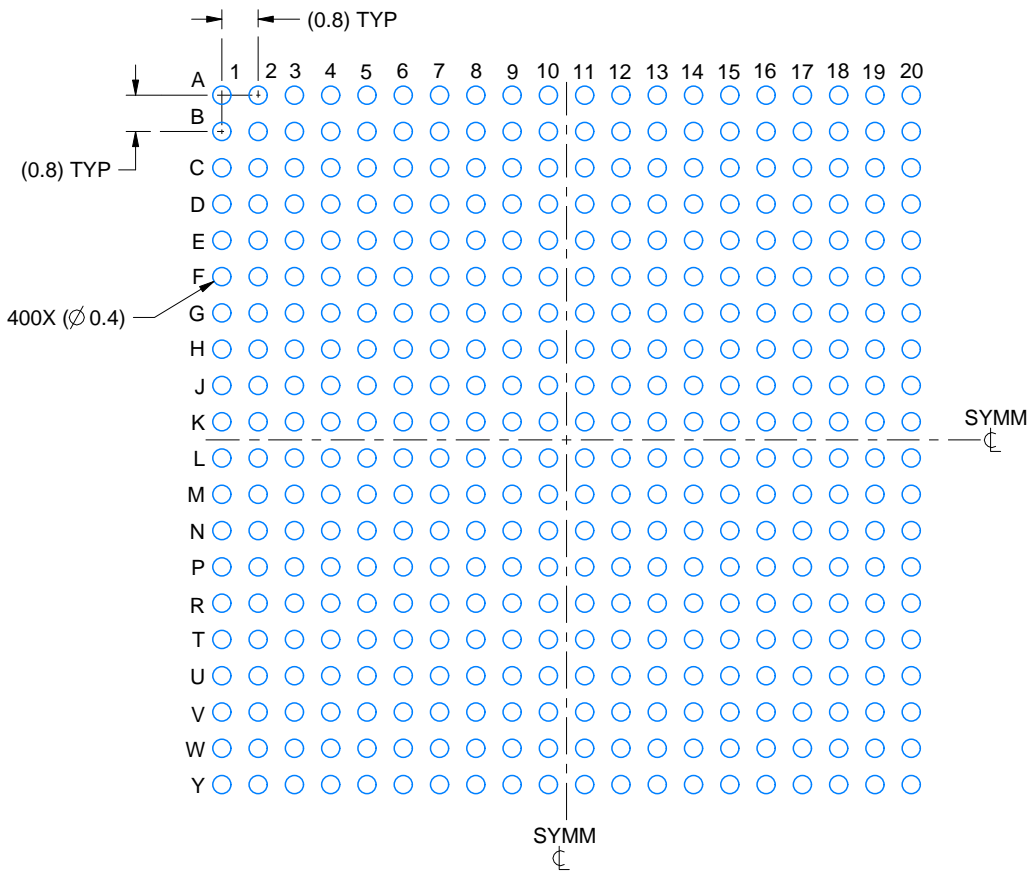
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. Dimension is measured at the maximum solder ball diameter, parallel to primary datum C.
4. Primary datum C and seating plane are defined by the spherical crowns of the solder balls.
5. The lids are electrically floating (e.g. not tied to GND).

# EXAMPLE BOARD LAYOUT

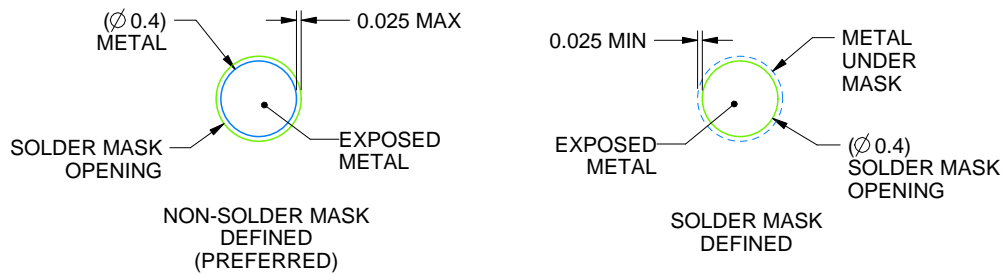
**ABJ0400A**

**FCBGA - 2.65 mm max height**

BALL GRID ARRAY



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE:6X



SOLDER MASK DETAILS  
NOT TO SCALE

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NOTES: (continued)

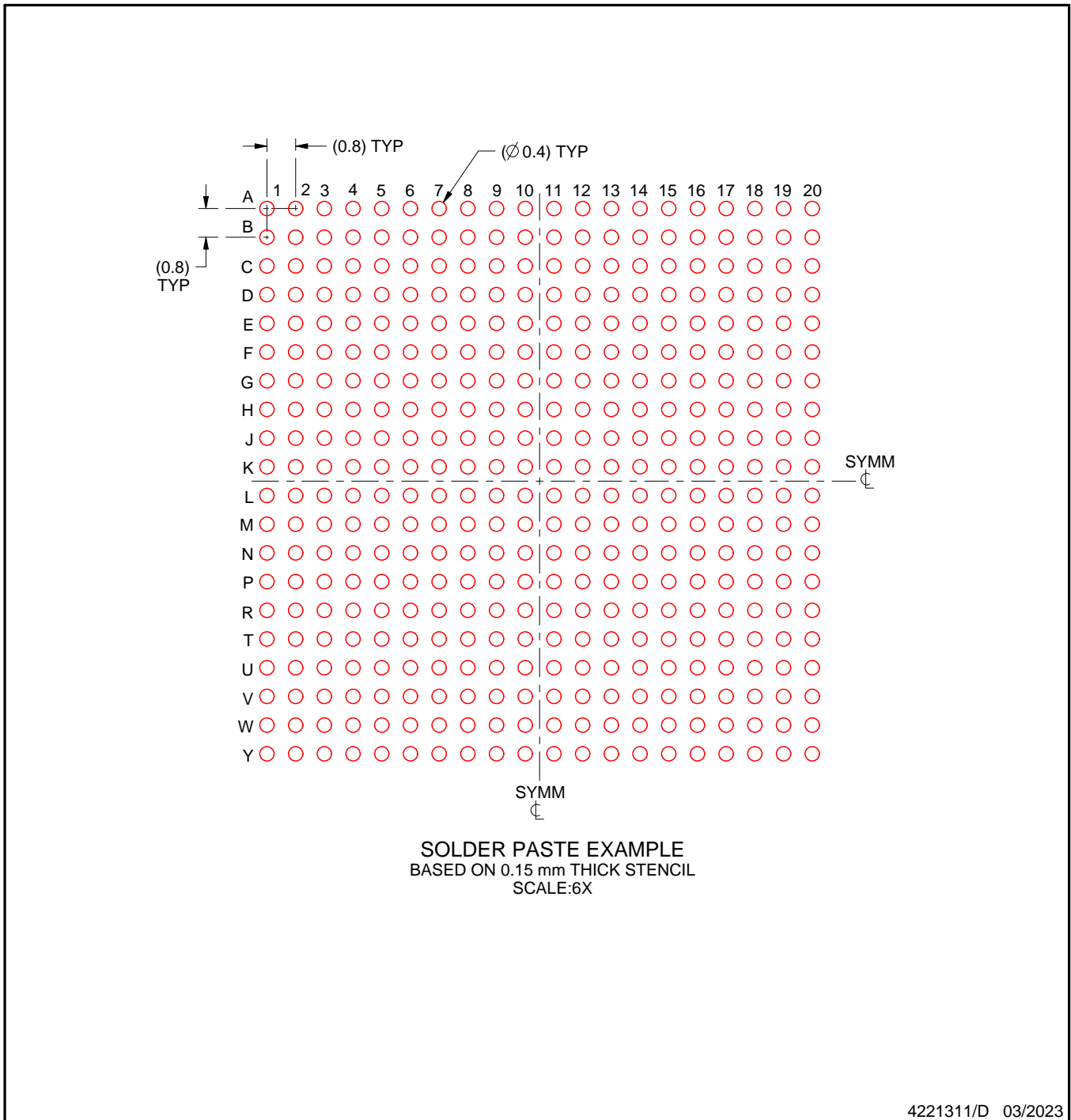
- Final dimensions may vary due to manufacturing tolerance considerations and also routing constraints. For more information, see Texas Instruments literature number SPRU811 ([www.ti.com/lit/spru811](http://www.ti.com/lit/spru811)).

# EXAMPLE STENCIL DESIGN

## ABJ0400A

### FCBGA - 2.65 mm max height

BALL GRID ARRAY



NOTES: (continued)

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

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