AFE76xx Quad/dual-channel, RF sampling analog front-end with 14-bit 9GSPS DACs and 14-bit 3GSPS ADCs

1 Device Overview

1.1 Features

- 14-Bit resolution
- Sample rate:
  - DAC: 9GSPS
  - ADC: 3GSPS
- RF Frequency range: up to 5.2 GHz
- Maximum RF signal bandwidth
  - Quad-channel mode (4T4R): 800 MHz (single-band); 300 MHz (dual-band)
  - Dual-channel mode (2T2R): 1200 MHz (TX)/1000 MHz (RX) (single-band); 800MHz(dual-band)
- On-chip dual selectable DSAs per RX channel
- Integrated TX DSA functionality
- Digital:
  - Dual band digital up-converters (DUCs)
  - Dual Band digital down-converters (DDCs)
  - 32-Bit NCOs for DUCs/DDCs
  - Interpolation ratio: 6x, 8x, 9x, 12x, 16x, 18x, 24x, 36x
  - Decimation ratio: /2, /3, /4, /6, /8, /9, /12, /16, /18, /24, /32
  - RX/FB Dynamic switching for TDD
- Interface:
  - 8 SerDes Transceivers up to 15Gbps
  - 16-Bit and 12-bit JESD204B transport layer formatting with 8b/10b encoding
  - Subclass 1 multi-device synchronization
- Clock:
  - Internal PLL/VCO to generate DAC and ADC clocks
- Package: 17mm x 17mm FC BGA, 0.8mm pitch
- Power supplies: 1.85 V, 1.15 V, 1.0 V, –1.8 V

1.2 Applications

- Cellular base stations
- Wideband communications
- Microwave backhaul
- Distributed antenna systems (DAS)

1.3 Description

The AFE76xx is a family of high performance, quad/dual channel, 14-bit, integrated RF sampling analog front ends (AFEs) with 9 GSPS DACs and 3 GSPS ADCs, capable of synthesizing and digitizing wideband signals. High dynamic range allows the AFE76xx to generate and digitize 3G/4G signals for wireless base stations. In TDD mode, the receiver channel can be configured to dynamically switching between traffic receiver (TDD RX) status and wideband feedback receiver (TDD FB) status to assist DPD (Digital Pre-Distortion) of the Power Amplifier (PA) on the transmitter path.

The AFE76xx family has integrated DSA on the receiver channels and also supports DSA equivalent functionality on the transmitter channels. Each receiver channel has one analog RF peak power detector and various digital power detectors to assist AGC control for receiver channels, and two RF overload detectors for device reliability protection. The AFE76xx family has 8 of JESD204B compatible SerDes transceivers running up to 15 Gbps. The devices have up to two DUCs per TX channel and two DDCs per RX channel, with multiple interpolation/decimation rates and digital quadrature modulators/demodulators with independent, frequency flexible NCOs. The devices support more than 1000 MHz (800 MHz as 4T4R) RF signal bandwidth in single-band mode, and up to 800 MHz (300 MHz as 4T4R) RF signal bandwidth per band in dual-band mode. A low jitter PLL/VCO simplifies the sampling clock generation by allowing use of a lower frequency reference clock.

Device Information[1]

PART NUMBER	PACKAGE	BODY SIZE
AFE7685	FC-BGA	17.00 mm x 17.00 mm
AFE7686	FC-BGA	17.00 mm x 17.00 mm

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

An IMPORTANT NOTICE at the end of this data sheet addresses availability, warranty, changes, use in safety-critical applications, intellectual property matters and other important disclaimers. PRODUCTION DATA.

Device Information[(1)] (continued)

PART NUMBER	PACKAGE	BODY SIZE
AFE7684	FC-BGA	17.00 mm x 17.00 mm
AFE7683	FC-BGA	17.00 mm x 17.00 mm
AFE7681	FC-BGA	17.00 mm x 17.00 mm

1.4 Functional Block Diagram

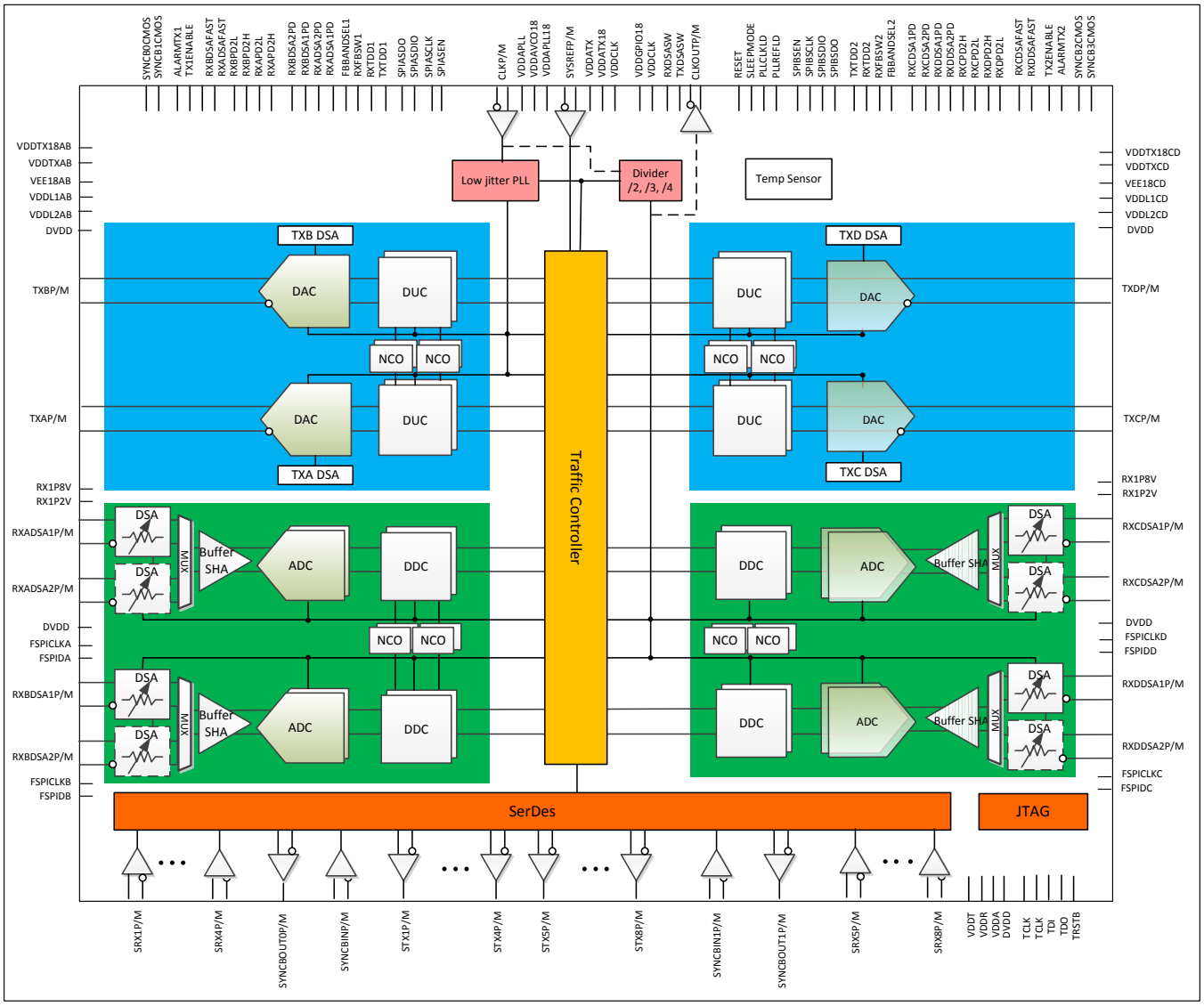


Figure 1-1. Functional Block Diagram of AFE7685/AFE7686

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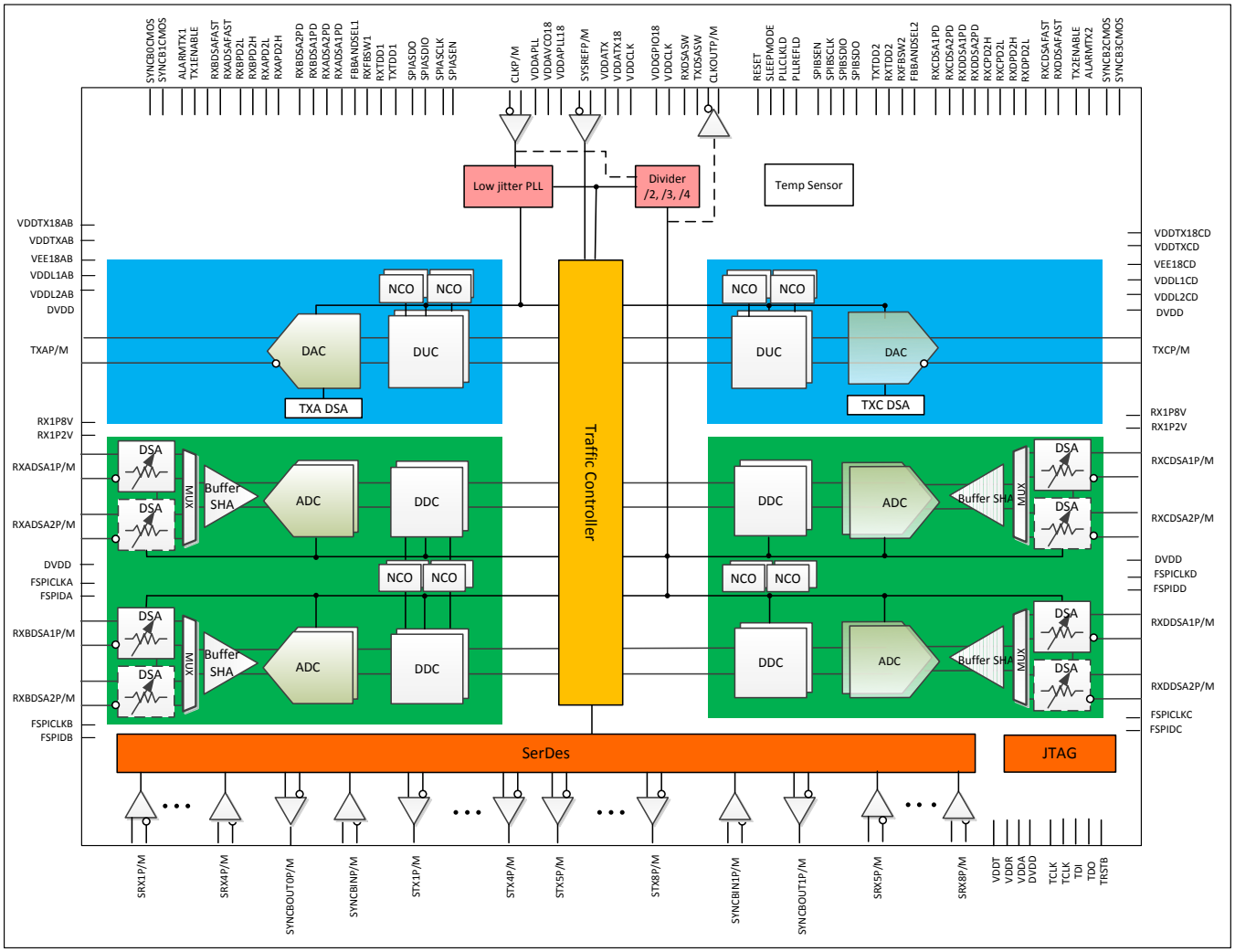


Figure 1-2. Functional Block Diagram of AFE7684

2 Revision History

Changes from Revision D (December 2018) to Revision E — **Page**

- Changed AFE7681 from Advance Information to Production Data 1

Changes from Revision C (October 2018) to Revision D — **Page**

- Added AFE7681 as Advance Information and AFE7683 as Production Data 1

Changes from Revision B (September 2018) to Revision C — **Page**

- Changed AFE7684 from Advance Information to Production Data 1

Changes from Revision A (July 2018) to Revision B — **Page**

- Changed AFE7686 from Advance Information to Production Data 1

Changes from Original (May 2018) to Revision A **Page**

- Changed AFE7684 from Product Preview to Advance Information, AFE7685 from Product Preview to Production Data..... 1
- Deleted AFE7683 from data manual 1

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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

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4 Device and Documentation Support

4.1 Device Support

4.1.1 Third-Party Products Disclaimer

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4.2 Documentation Support

To receive notification of documentation updates, navigate to the device product folder on ti.com. In the upper right corner, click on *Alert me* to register and receive a weekly digest of any product information that has changed. For change details, review the revision history included in any revised document.

The current documentation that describes the DSP, related peripherals, and other technical collateral is listed below.

4.2.1 Related Documentation

AFE76xx EVM Design Document User's Guide (SLAU761)

AFE76xx Technical Reference Manual (SLAU744)

AFE76xx Programmer's User's Guide (SLAU767)

4.3 Related Links

The table below lists quick access links. Categories include technical documents, support and community resources, tools and software, and quick access to sample or buy.

Table 4-1. Related Links

PARTS	PRODUCT FOLDER	SAMPLE & BUY	TECHNICAL DOCUMENTS	TOOLS & SOFTWARE	SUPPORT & COMMUNITY
AFE7681	Click here	Click here	Click here	Click here	Click here
AFE7683	Click here	Click here	Click here	Click here	Click here
AFE7684	Click here	Click here	Click here	Click here	Click here
AFE7685	Click here	Click here	Click here	Click here	Click here
AFE7686	Click here	Click here	Click here	Click here	Click here

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.

TI E2E™ Online Community The TI engineer-to-engineer (E2E) community was created to foster collaboration among engineers. At e2e.ti.com, you can ask questions, share knowledge, explore ideas and help solve problems with fellow engineers.

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.

4.5 Trademarks

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4.6 Electrostatic Discharge Caution



This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

4.7 Export Control Notice

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4.8 Glossary

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

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5 Mechanical, Packaging, and Orderable Information

5.1 Packaging 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.

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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
AFE7681IABJ	ACTIVE	FCBGA	ABJ	400	90	Green (RoHS & no Sb/Br)	SNAGCU	Level-3-260C-168 HR	-40 to 85	AFE7681I	Samples
AFE7683IABJ	ACTIVE	FCBGA	ABJ	400	90	Green (RoHS & no Sb/Br)	SNAGCU	Level-3-260C-168 HR	-40 to 85	AFE7683I	Samples
AFE7684IABJ	ACTIVE	FCBGA	ABJ	400	90	Green (RoHS & no Sb/Br)	SNAGCU	Level-3-260C-168 HR	-40 to 85	AFE7684I	Samples
AFE7685IABJ	ACTIVE	FCBGA	ABJ	400	90	Green (RoHS & no Sb/Br)	SNAGCU	Level-3-260C-168 HR	-40 to 85	AFE7685I	Samples
AFE7686IABJ	ACTIVE	FCBGA	ABJ	400	90	Green (RoHS & no Sb/Br)	SNAGCU	Level-3-260C-168 HR	-40 to 85	AFE7686I	Samples

(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/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.

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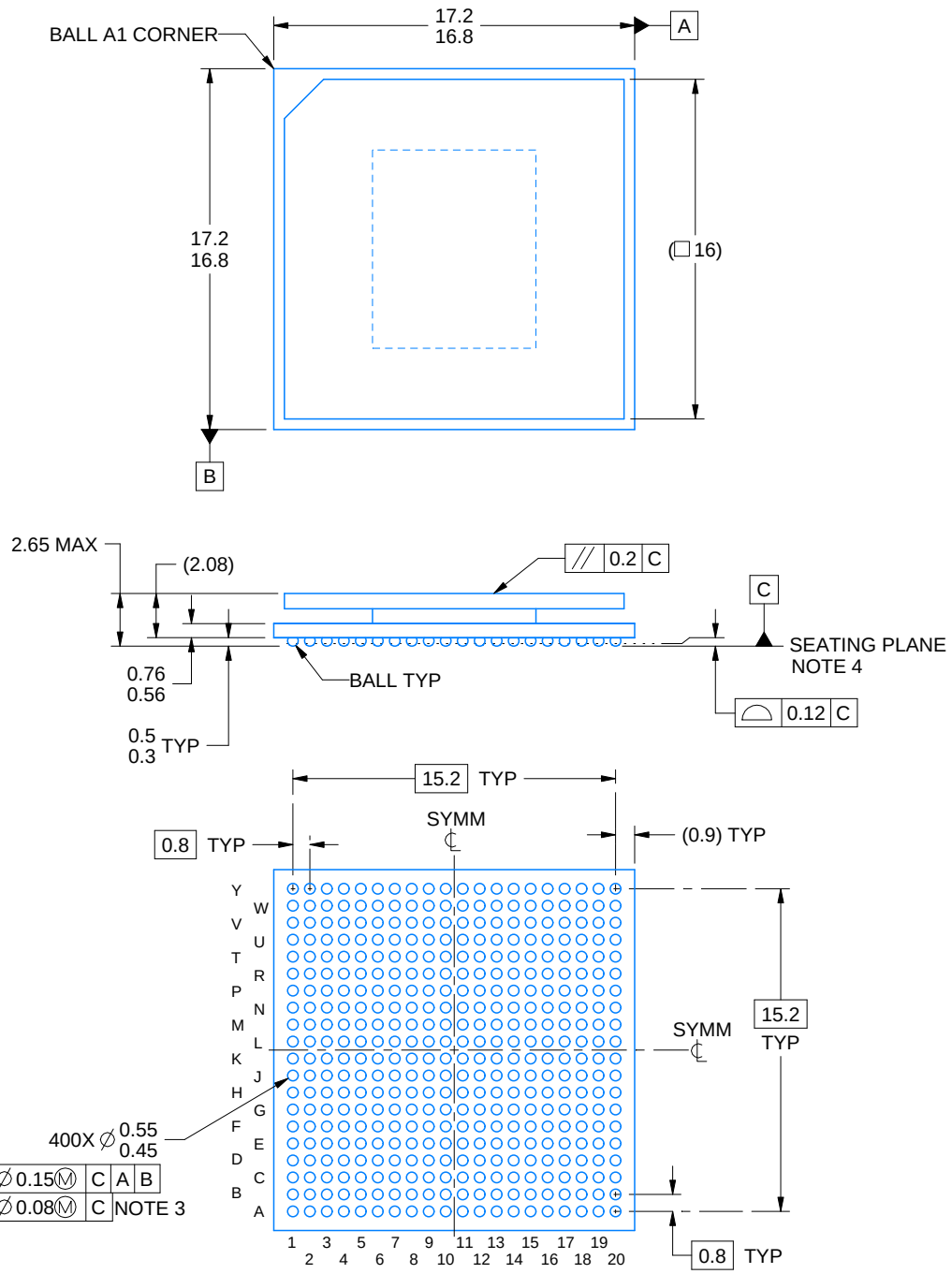
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PACKAGE OUTLINE

ABJ0400A

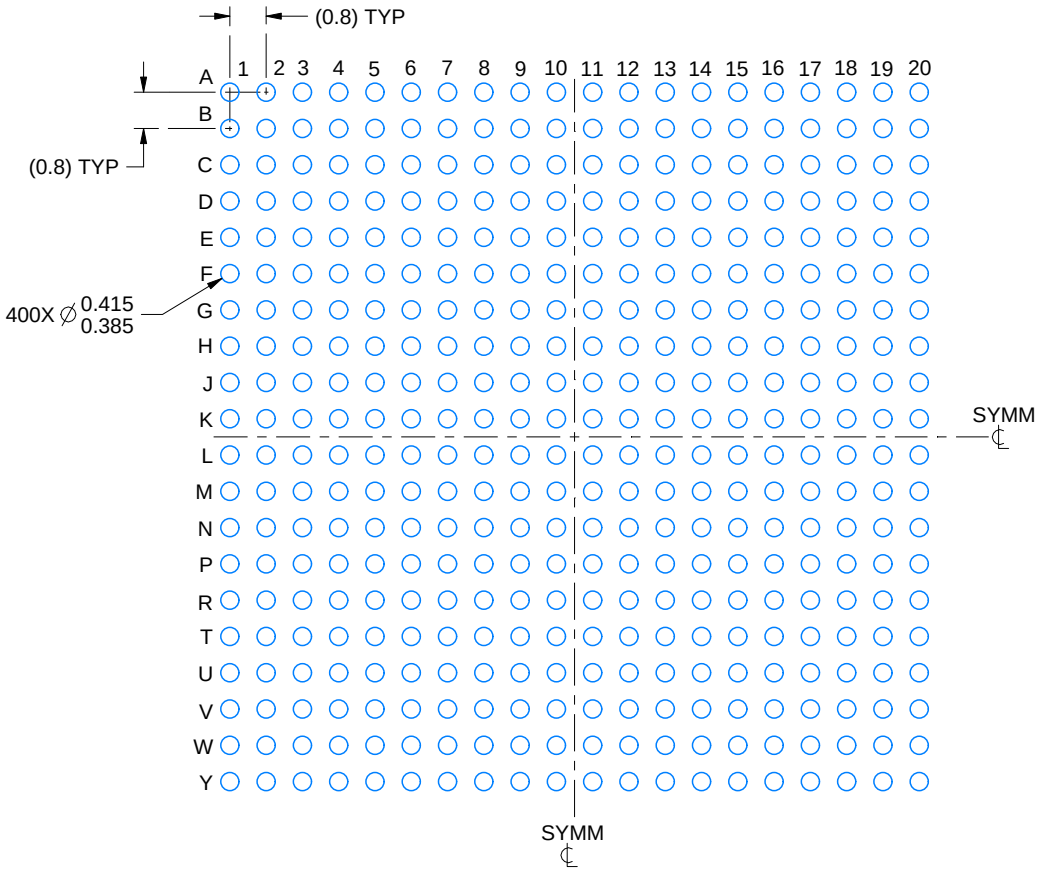
FCBGA - 2.65 mm max height

BALL GRID ARRAY

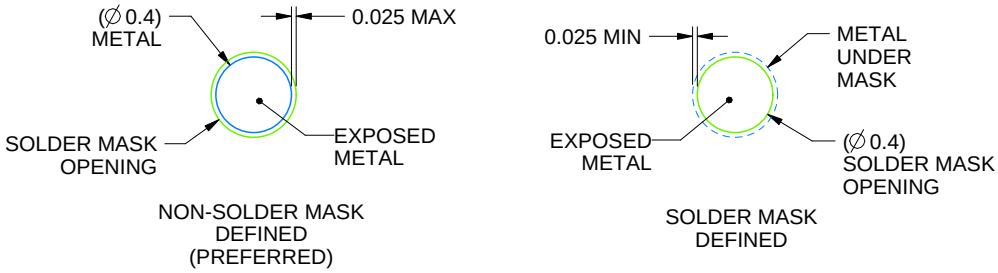


NOTES:

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.



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:6X

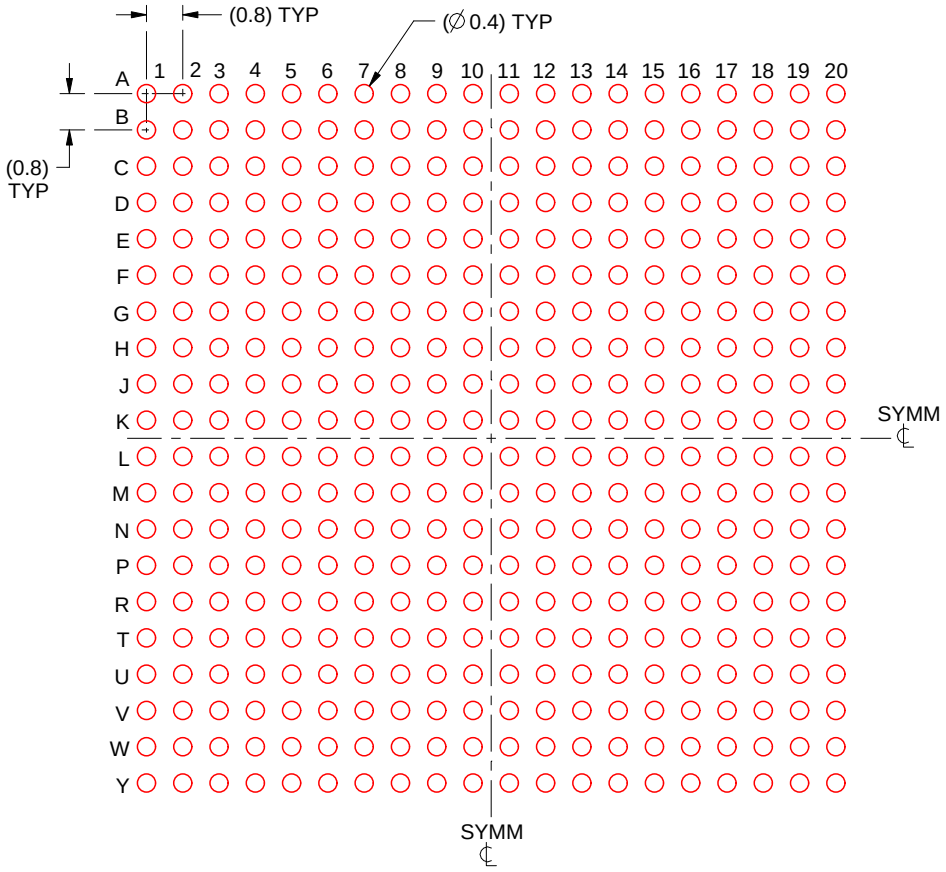


SOLDER MASK DETAILS
NOT TO SCALE

4221311/B 04/2020

NOTES: (continued)

5. 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).



SOLDER PASTE EXAMPLE
BASED ON 0.15 mm THICK STENCIL
SCALE:6X

4221311/B 04/2020

NOTES: (continued)

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

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