AFE79xx Quad-Channel RF Transceiver With Feedback Path

1 Features

- Quad RF sampling 12-GSPS transmit DACs
- Quad RF sampling 3-GSPS receive ADCs
- Dual RF sampling 3-GSPS feedback ADCs (AFE792x only)
- Maximum RF signal bandwidth:
  - TX/FB: 1200 MHz (AFE7920/88) or 400 MHz (AFE7989) or 800MHz (AFE7921)
  - RX: 600 MHz (AFE7920/88) or 400 MHz (AFE7921/AFE7989)
- Digital Step Attenuators (DSA):
  - TX: 40 dB range, 1-dB analog and 0.125-dB digital steps
  - RX: 25 dB range, 0.5-dB steps
  - FB: 25 dB range, 0.5-dB steps
- Single or dual-band DUC/DDCs (AFE7920/88 only) for TX and RX
- Dual NCOs for fast frequency switching
- Supports TDD operation with fast switching between TX and RX
- Internal PLL/VCO to generate DAC/ADC clocks
- Optional external CLK at DAC or ADC rate
- SerDes data interface:
  - JESD204B and JESD204C compliant
  - 8 SerDes transceivers up to 29.5 Gbps
  - 8b/10b and 64b/66b encoding
  - 12-bit, 16-bit, 24-bit, and 32-bit resolution
  - Subclass 1 multi-device synchronization
- Package: 17-mm × 17-mm FCBGA, 0.8-mm pitch

2 Applications

- Macro remote radio unit (RRU)
- Active antenna system mMIMO (AAS)
- Small cell base station
- Repeater
- Distributed Antenna Systems (DAS)

3 Description

The AFE79xx is a family of high performance, wide bandwidth multi-channel transceivers, integrating four RF sampling transmitter chains, four RF sampling receiver chains, and up to two RF sampling digitizing auxiliary chains (feedback paths). The high dynamic range of the transmitter and receiver chains allows the device to generate and receive 3G, 4G, and 5G signals from wireless base stations, while the wide bandwidth capability of the AFE79xx devices is designed for multi-band 4G and 5G base stations.

Each receiver chain includes a 25-dB range DSA (Digital Step Attenuator), followed by a 3-GSPS ADC (analog-to-digital converter). Each receiver channel has an analog peak power detector and various digital power detectors to assist an external or internal autonomous automatic gain controller, and RF overload detectors for device reliability protection. The single or dual digital down converters (DDC) provide up to 600 MHz of combined signal BW. In TDD mode, the receiver channel can be configured to dynamically switch between the traffic receiver (TDD RX) and wideband feedback receiver (TDD FB), with the capability of re-using the same analog input for both purposes.

Each transmitter chain includes a single or dual digital up converters (DUCs) supporting up to 1200-MHz combined signal bandwidth. The output of the DUCs drives a 12-GSPS DAC (digital to analog converter) with a mixed mode output option to enhance 2nd or 3rd Nyquist operation. The DAC output includes a variable gain amplifier (TX DSA) with 40-dB range and 1-dB analog and 0.125-dB digital steps.

The feedback path includes an 25-dB range DSA driving a 3-GSPS RF sampling ADC, followed by a DDC with up to 1200-MHz bandwidth.

Device Information[(1)]

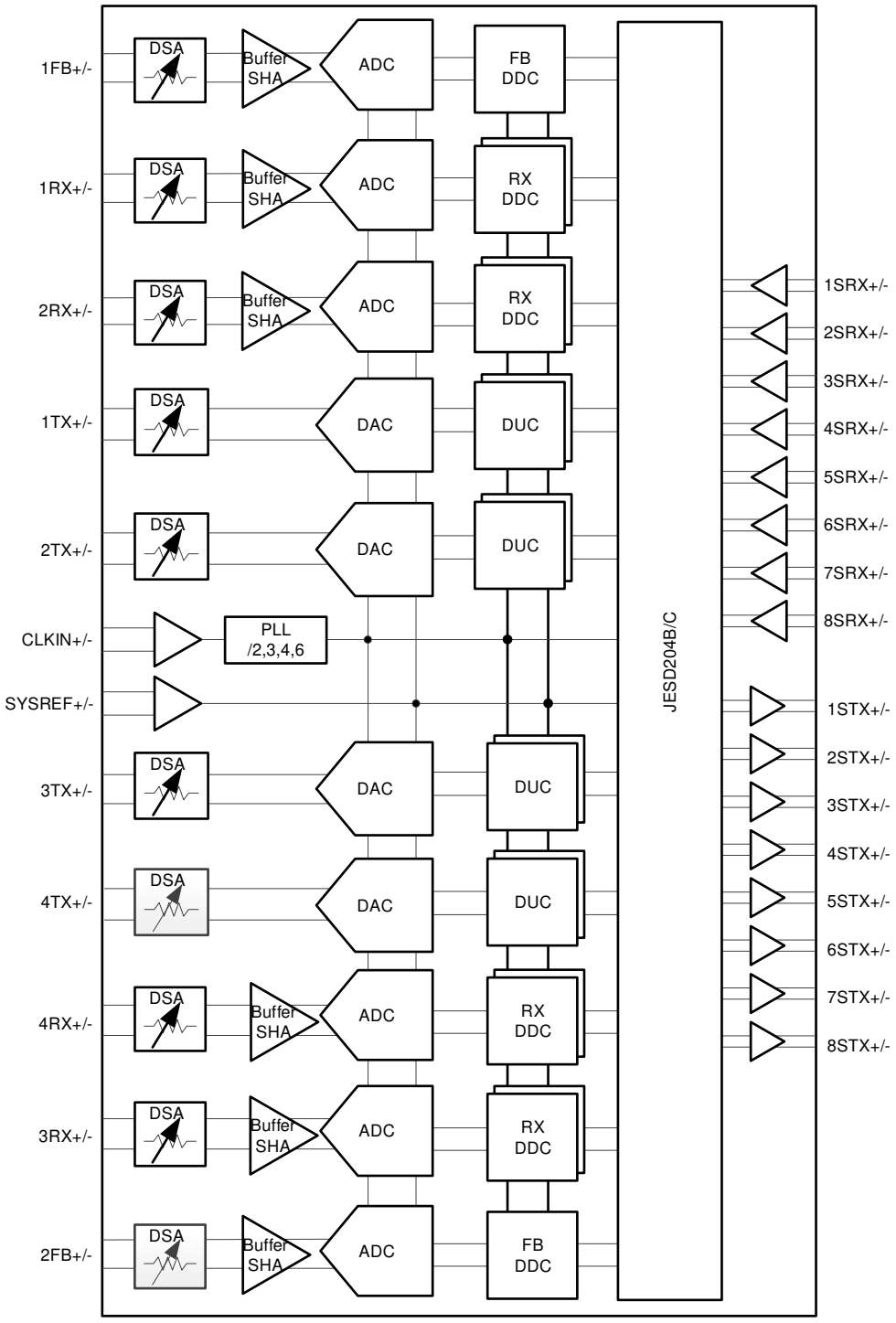
PART NUMBER	PACKAGE	BODY SIZE
AFE7989	FC-BGA	17.00 mm × 17.00 mm
AFE7920	FC-BGA	17.00 mm × 17.00 mm
AFE7988	FC-BGA	17.00 mm × 17.00 mm
AFE7921	FC-BGA	17.00 mm × 17.00 mm

(1) For more information, see *Mechanical, Packaging, and Orderable Information*.

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.

4 Functional Block Diagram

4.1 AFE7920/AFE7921 Functional Block Diagram



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4.2 AFE7988/89 Functional Block Diagram

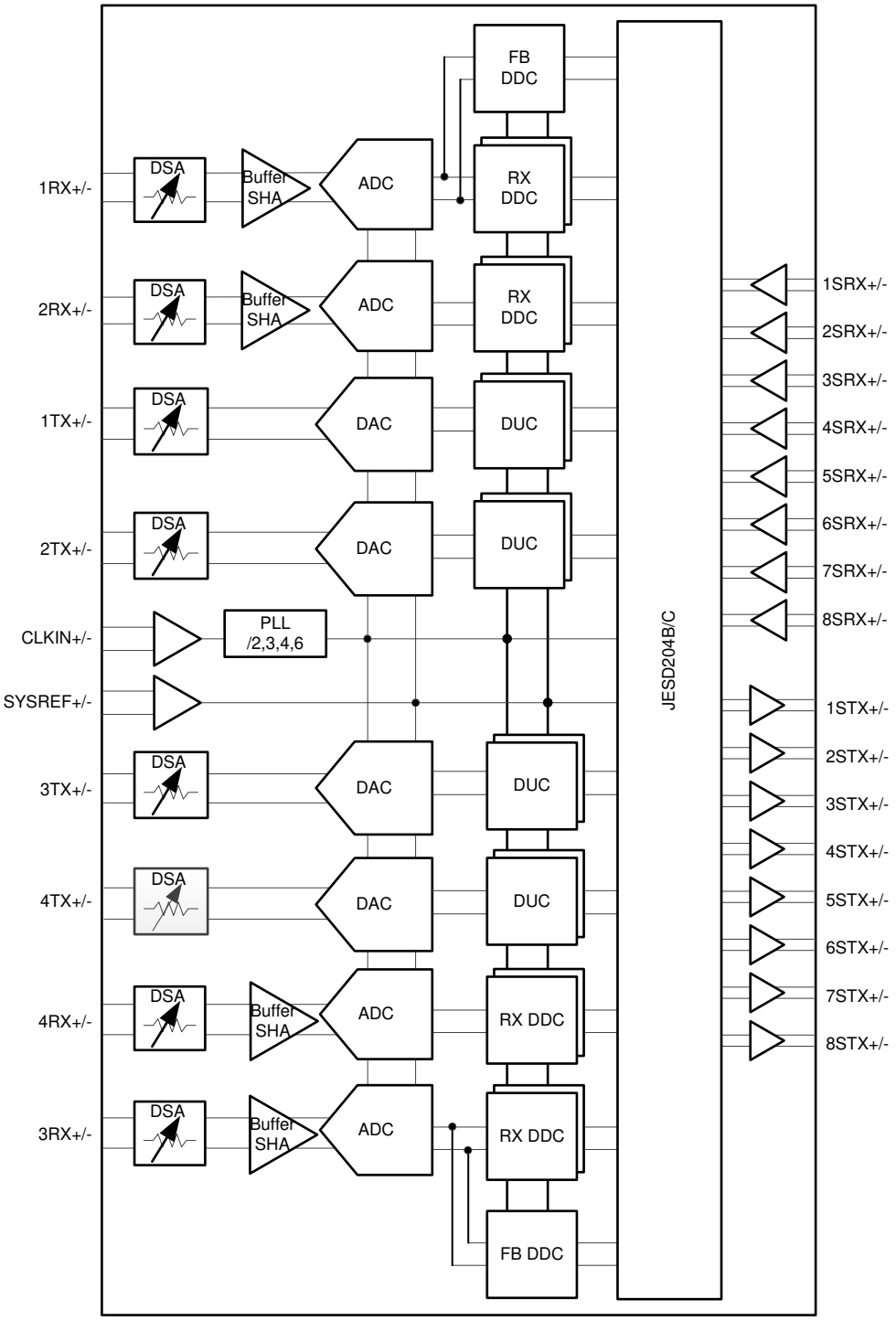


Table of Contents

1 Features ... 1
2 Applications ... 1
3 Description ... 1
4 Functional Block Diagram ... 2
4.1 AFE7920/AFE7921 Functional Block Diagram ... 2
4.2 AFE7988/89 Functional Block Diagram ... 3
5 Revision History ... 4
6 Device and Documentation Support ... 5
6.1 Device Support ... 5
6.2 Related Links ... 5
6.3 Receiving Notification of Documentation Updates ... 5
6.4 Support Resources ... 5
6.5 Trademarks ... 5
6.6 Electrostatic Discharge Caution ... 5
6.7 Glossary ... 5
7 Mechanical, Packaging, and Orderable Information ... 6

5 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Revision B (April 2020) to Revision C	Page
• Changed AFE7921 device status from advanced information to production data	1
• Changed AFE7921 maximum TX/FB RF signal bandwidth from 400MHz to 800MHz.	1

Changes from Revision A (February 2020) to Revision B	Page
• Changed AFE7988 device status from advanced information to production data	1

Changes from Original (December 2019) to Revision A	Page
• Changed AFE7920 device status from advanced information to production data	1

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6 Device and Documentation Support

6.1 Device Support

6.1.1 Third-Party Products Disclaimer

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6.2 Related Links

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

Table 1. Related Links

PARTS	PRODUCT FOLDER	ORDER NOW	TECHNICAL DOCUMENTS	TOOLS & SOFTWARE	SUPPORT & COMMUNITY
AFE7920	Click here	Click here	Click here	Click here	Click here
AFE7921	Click here	Click here	Click here	Click here	Click here
AFE7988	Click here	Click here	Click here	Click here	Click here
AFE7989	Click here	Click here	Click here	Click here	Click here

6.3 Receiving Notification of Documentation Updates

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.

6.4 Support Resources

TI E2E™ support forums are an engineer's go-to source for fast, verified answers and design help — straight from the experts. Search existing answers or ask your own question to get the quick design help you need.

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6.5 Trademarks

E2E is a trademark of Texas Instruments.
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6.6 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.

6.7 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.

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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
AFE7920IABJ	ACTIVE	FCBGA	ABJ	400	90	RoHS & Green	SNAGCU	Level-3-260C-168 HR	-40 to 85	AFE7920I	Samples
AFE7921IABJ	ACTIVE	FCBGA	ABJ	400	90	RoHS & Green	SNAGCU	Level-3-260C-168 HR	-40 to 85	AFE7921I	Samples
AFE7988IABJ	ACTIVE	FCBGA	ABJ	400	90	RoHS & Green	SNAGCU	Level-3-260C-168 HR	-40 to 85	AFE7988I	Samples
AFE7989IABJ	ACTIVE	FCBGA	ABJ	400	90	RoHS & Green	SNAGCU	Level-3-260C-168 HR	-40 to 85	AFE7989I	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.

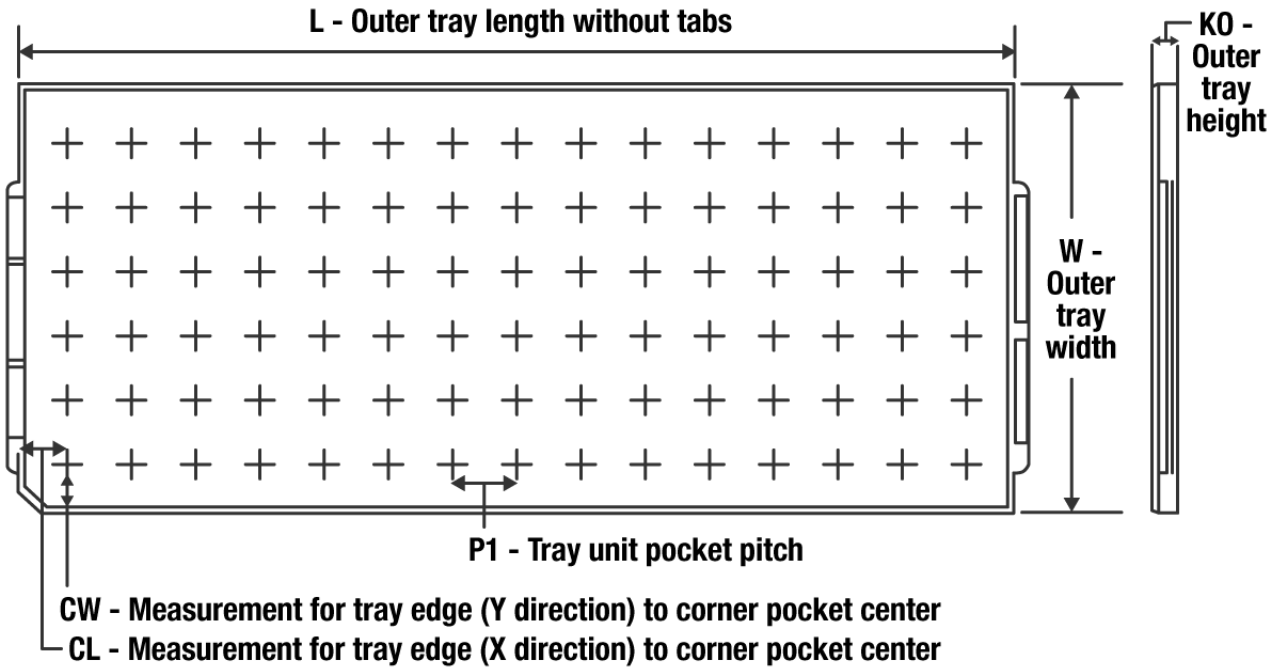
(6) Lead finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

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TRAY



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

*All dimensions are nominal

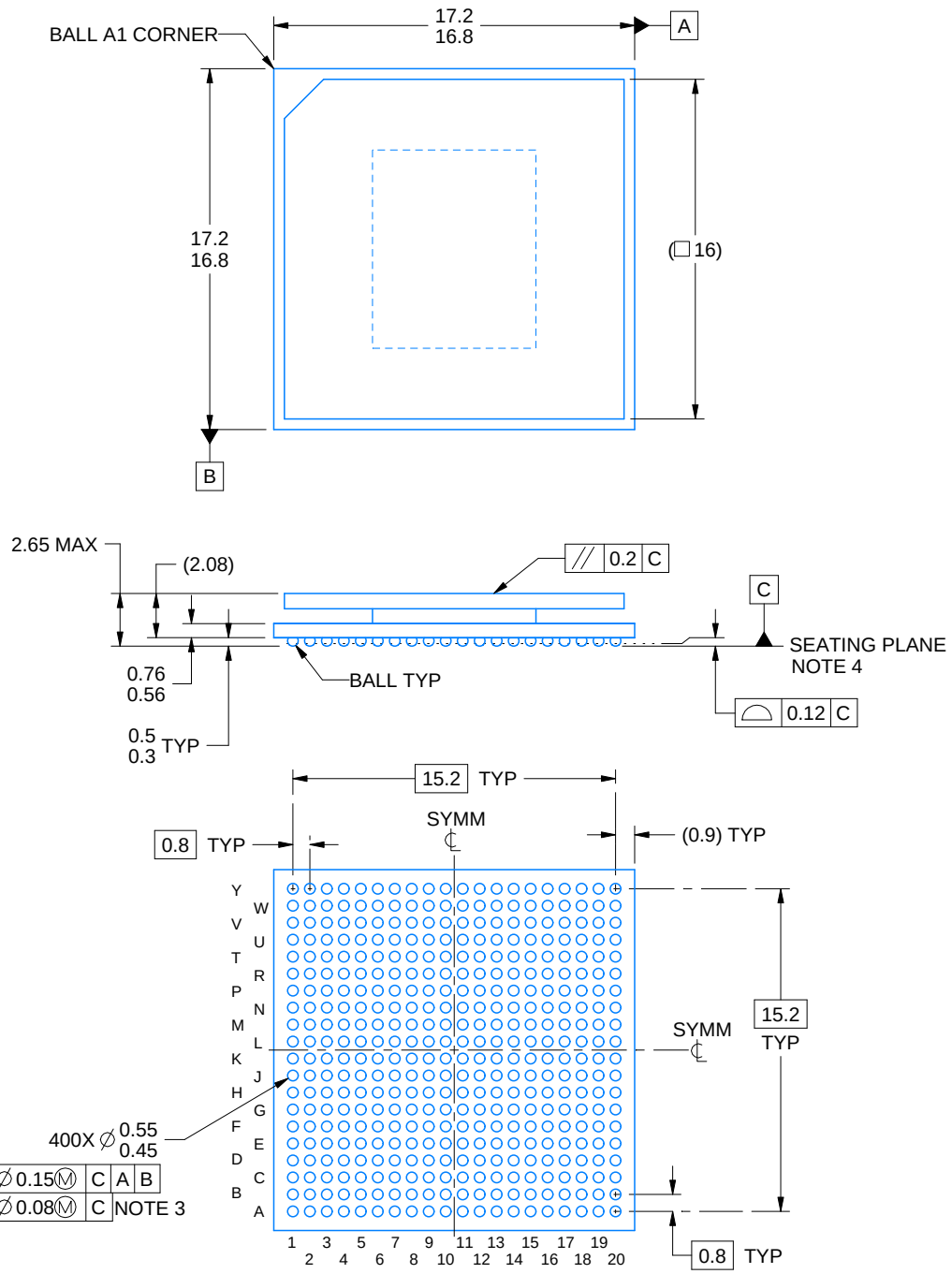
Device	Package Name	Package Type	Pins	SPQ	Unit array matrix	Max temperature (°C)	L (mm)	W (mm)	K0 (µm)	P1 (mm)	CL (mm)	CW (mm)
AFE7920IABJ	ABJ	FCBGA	400	90	6 x 16	150	315	135.9	7620	19.5	21	19.2
AFE7921IABJ	ABJ	FCBGA	400	90	6 x 16	150	315	135.9	7620	19.5	21	19.2
AFE7988IABJ	ABJ	FCBGA	400	90	6 x 16	150	315	135.9	7620	19.5	21	19.2
AFE7989IABJ	ABJ	FCBGA	400	90	6 x 16	150	315	135.9	7620	19.5	21	19.2

PACKAGE OUTLINE

ABJ0400A

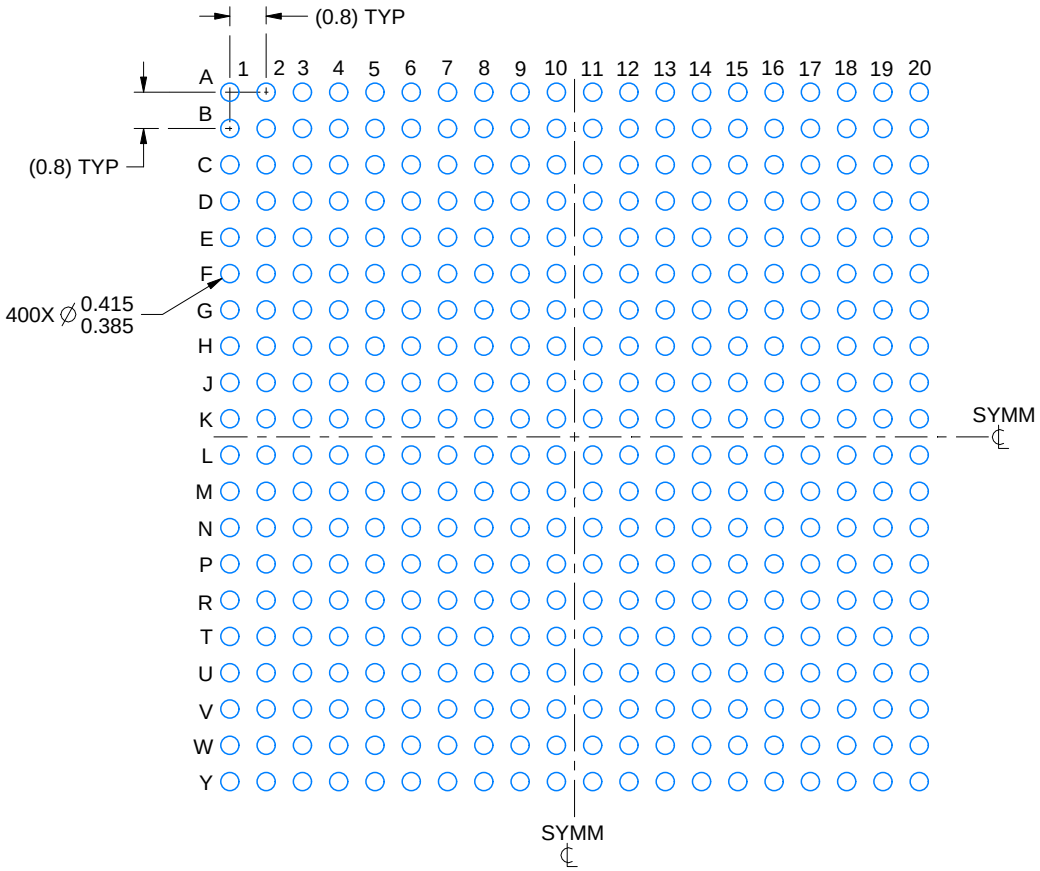
FCBGA - 2.65 mm max height

BALL GRID ARRAY

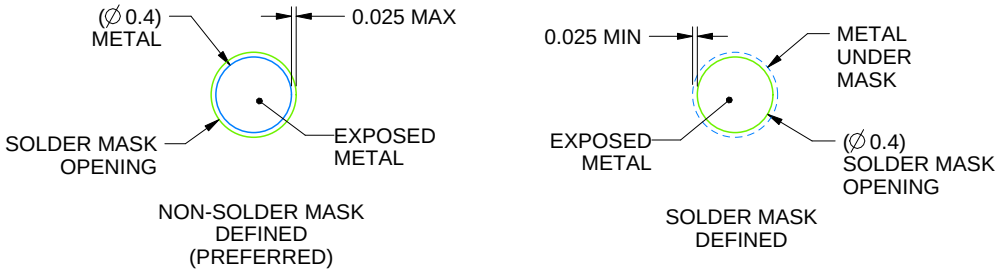


NOTES:

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

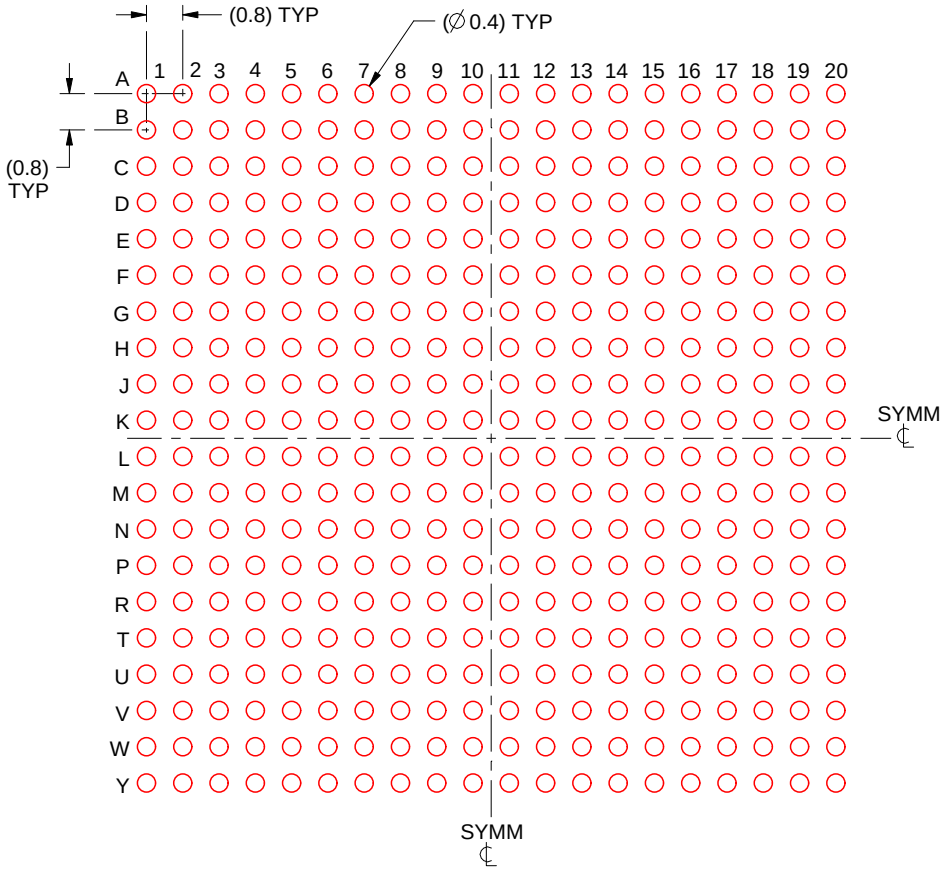


SOLDER MASK DETAILS
NOT TO SCALE

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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