AFE80xx RF Sampling Transceiver

1 Features

- Request full data sheet
- AFE80xx versions:
  - AFE8000: 8 TX, 10 RX
  - AFE8004: 4 TX, 4 RX
  - AFE8010: 10 RX
- 12 GSPS RF Sampling DACs
- 4 GSPS RF Sampling ADCs
- Maximum RF signal bandwidth:
  - TX: 800 MHz (8 ch) or 1.2 GHz (4 ch)
  - RX: 800 MHz (8 ch) or 400 MHz (8 ch) + 800 MHz (2 ch)
- RF frequency range:
  - TX: 5 MHz to 7.125 GHz
  - RX: 100 MHz to 7.125 GHz
- Digital Step Attenuators (DSA):
  - TX: 40 dB range, 1 dB analog and 0.125 dB digital steps
  - RX/FB: 25 dB range, 1 dB step
- Single or dual-band DUC, DDCs
- Dual NCOs per chain 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
  - 8 SerDes transceivers up to 32.5 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

- Radar
- Seeker front end
- Defense radio
- Tactical communications infrastructure
- Wireless communications test

3 Description

The AFE8000 is a high performance, wide bandwidth multi-channel transceiver, integrating eight RF sampling DACs and 10 RF sampling ADCs. Pin and programming compatible lower channel count versions (AFE8004 with 4TX and 4RX channels, AFE8010 with 10RX channels) are available to allow scalable system designs.

Each receiver (RX) chain includes a 25 dB range DSA (Digital Step Attenuator) followed by a 4 GSPS ADC (analog-to-digital converter). The 10 ADCs are connected to 8 receiver paths (1RX though 8RX) and 2 feedback paths (1FB and 2FB). The ADCs are identical between RX and FB but the digital down converter paths are different (the FB paths are capable of wider bandwidth and can be used as receivers). Each receiver channel has analog peak power detectors and digital peak and 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 800 MHz of signal BW for 8 channels or 400 MHz for 8 channels in addition to 800 MHz for 2 channels.

Each transmitter (TX) chain includes a single or dual digital up converter (DUC). Supporting up to 800 MHz signal bandwidth for eight channels or 1200 MHz for 4 channels. The output of the DUCs drives a 12-GSPS DAC (digital-to-analog converter) with a mixed mode output option to enhance 2nd 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.

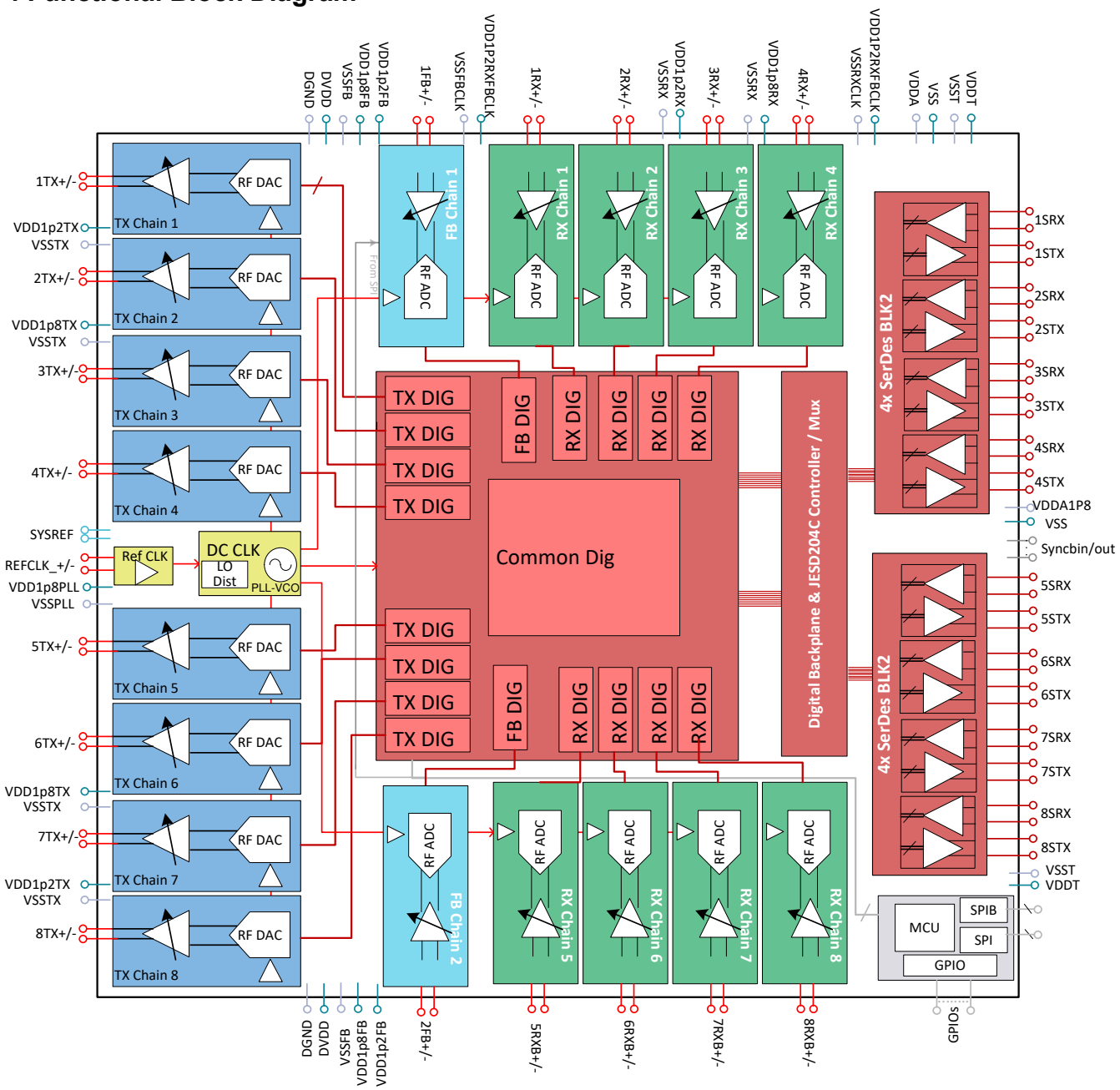
Package Information

PART NUMBER	PACKAGE(1)	PACKAGE SIZE(2)
AFE8000 AFE8004 AFE8010	FC-BGA	17 mm × 17 mm

(1) For all available packages, see the orderable addendum at the end of the data sheet.
(2) The package size (length × width) is a nominal value and includes pins, where applicable.

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



5 Revision History

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

Changes from December 31, 2022 to June 14, 2023 (from Revision * (December 2022) to Revision A (June 2023)) **Page**

- Changed note 2 to the *Package Information* table. Removed Product preview from the AFE8004 and AFE8010 devices 1

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6 Device and Documentation Support

TI offers an extensive line of development tools. Tools and software to evaluate the performance of the device, generate code, and develop solutions are listed below.

6.1 Documentation Support

6.1.1 Related Documentation

6.2 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on ti.com. Click on *Subscribe to updates* 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.

6.3 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.

Linked content is 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.

6.4 Trademarks

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6.5 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.

6.6 Glossary

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 part number	Status (1)	Material type (2)	Package | Pins	Package qty | Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
AFE8000IABJ	Active	Production	FCBGA (ABJ) | 400	90 | JEDEC TRAY (5+1)	Yes	SNAGCU	Level-3-260C-168 HR	-40 to 85	AFE8000
AFE8000IALK	Active	Production	FCBGA (ALK) | 400	90 | JEDEC TRAY (5+1)	No	SNPB	Level-3-220C-168 HR	-40 to 85	AFE8000 SNPB
AFE8004IABJ	Active	Production	FCBGA (ABJ) | 400	90 | JEDEC TRAY (5+1)	Yes	SNAGCU	Level-3-260C-168 HR	-40 to 85	AFE8004
AFE8004IALK	Active	Production	FCBGA (ALK) | 400	90 | JEDEC TRAY (5+1)	No	SNPB	Level-3-220C-168 HR	-40 to 85	AFE8004 SNPB
AFE8010IABJ	Active	Production	FCBGA (ABJ) | 400	90 | JEDEC TRAY (5+1)	Yes	SNAGCU	Level-3-260C-168 HR	-40 to 85	AFE8010
AFE8010IALK	Active	Production	FCBGA (ALK) | 400	90 | JEDEC TRAY (5+1)	No	SNPB	Level-3-220C-168 HR	-40 to 85	AFE8010 SNPB

(1) **Status:** For more details on status, see our product life cycle.

(2) **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

(3) **RoHS values:** Yes, No, RoHS Exempt. See the TI RoHS Statement for additional information and value definition.

(4) **Lead finish/Ball material:** Parts 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.

(5) **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

(6) **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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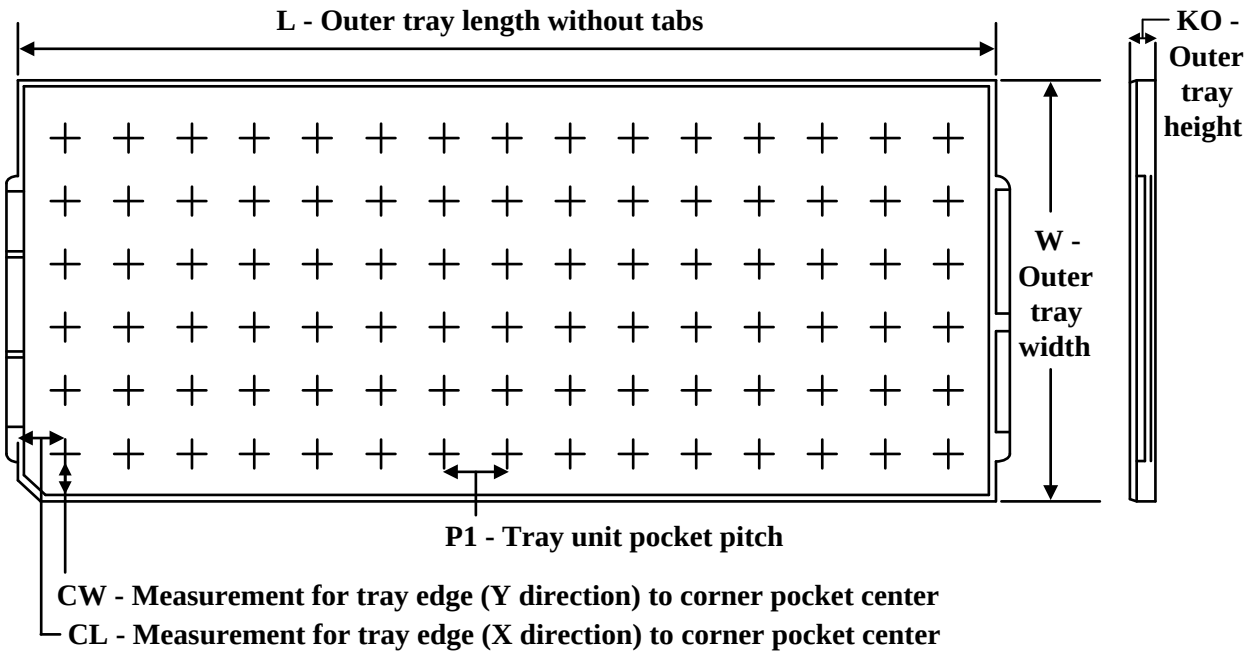
TRAY



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

*All dimensions are nominal

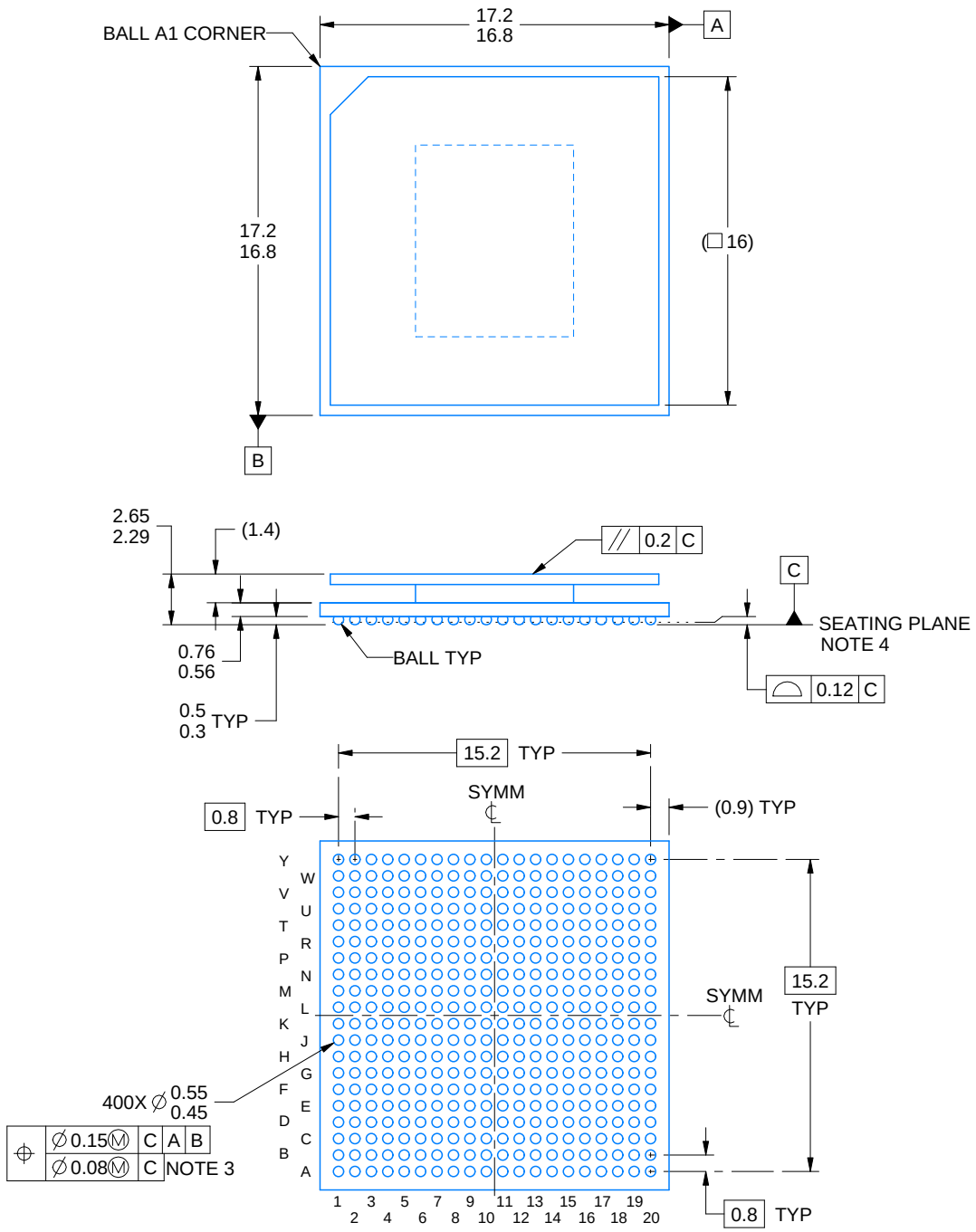
Device	Package Name	Package Type	Pins	SPQ	Unit array matrix	Max temperature (°C)	L (mm)	W (mm)	K0 (µm)	P1 (mm)	CL (mm)	CW (mm)
AFE8000IABJ	ABJ	FCBGA	400	90	6 x 15	150	315	135.9	7620	19.5	21	19.2
AFE8000IALK	ALK	FCBGA	400	90	6 x 15	150	315	135.9	7620	19.5	21	19.2
AFE8004IABJ	ABJ	FCBGA	400	90	6 x 15	150	315	135.9	7620	19.5	21	19.2
AFE8004IALK	ALK	FCBGA	400	90	6 x 15	150	315	135.9	7620	19.5	21	19.2
AFE8010IABJ	ABJ	FCBGA	400	90	6 x 15	150	315	135.9	7620	19.5	21	19.2
AFE8010IALK	ALK	FCBGA	400	90	6 x 15	150	315	135.9	7620	19.5	21	19.2

ALK0400A

PACKAGE OUTLINE

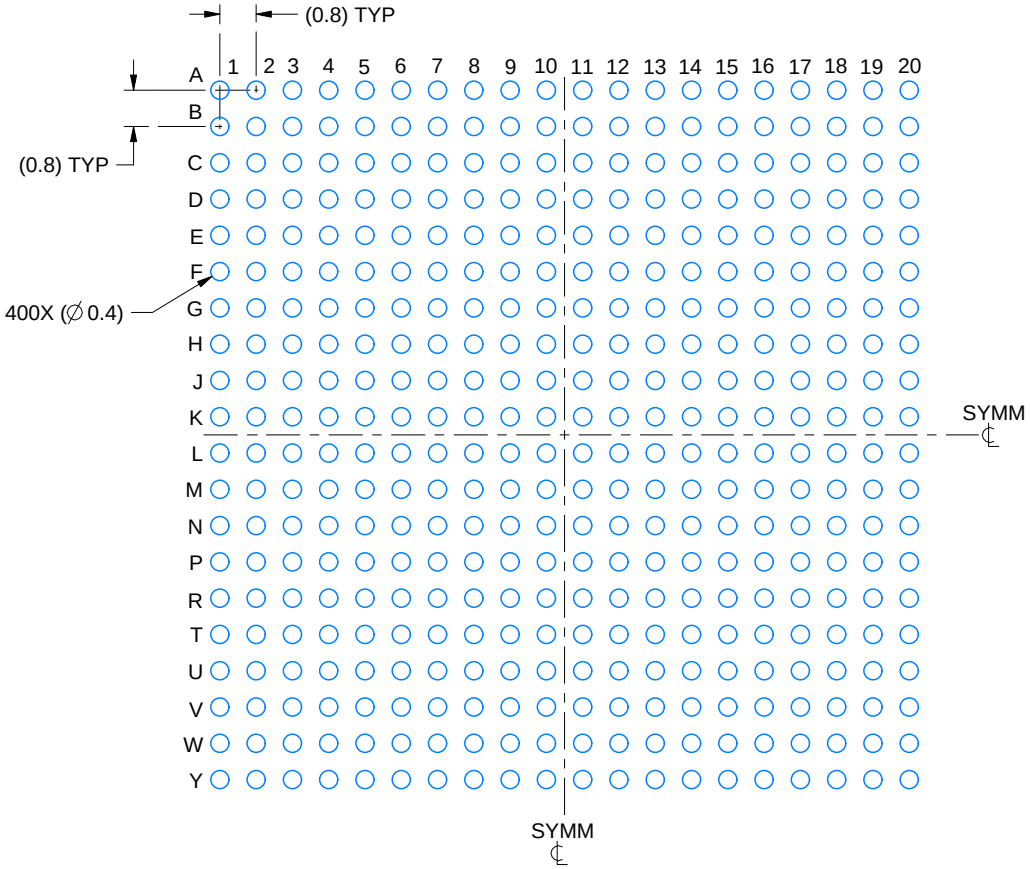
FCBGA - 2.65 mm max height

BALL GRID ARRAY

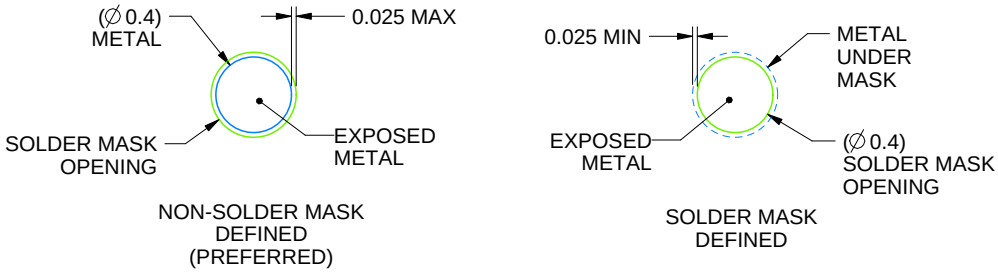


NOTES:

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. Pb-Free die bump and SnPb solder ball.
6. The lids are electrically floating (e.g. not tied to GND).



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:6X



SOLDER MASK DETAILS
NOT TO SCALE

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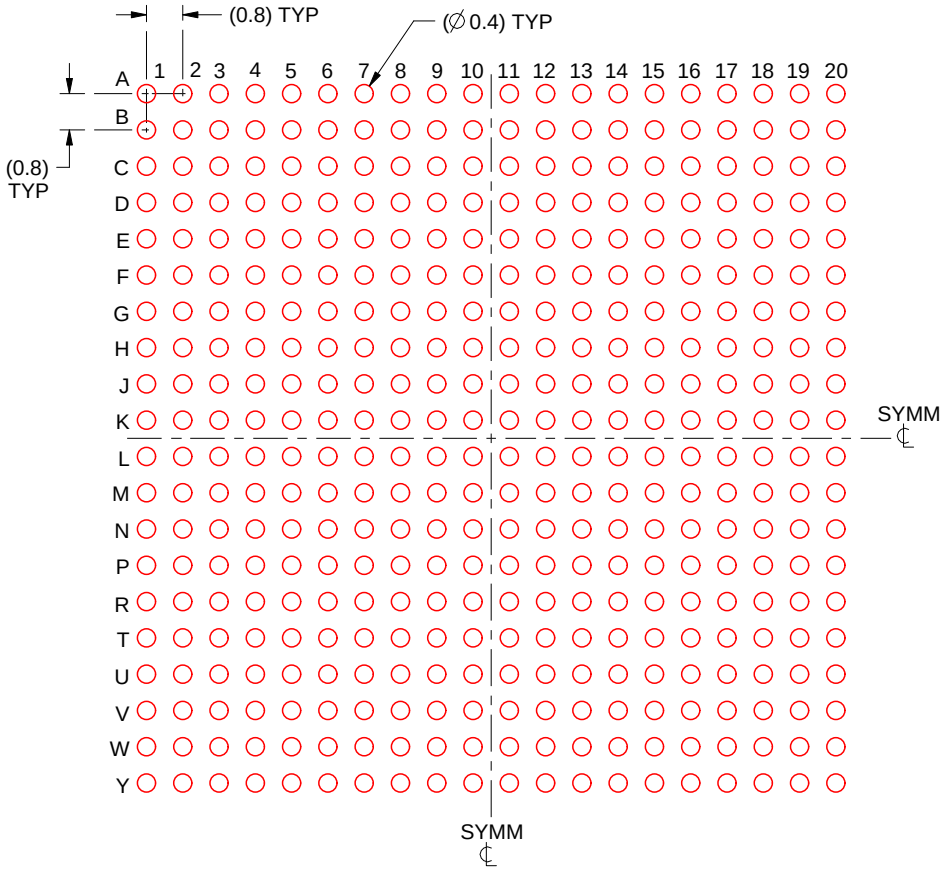
NOTES: (continued)

7. 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

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NOTES: (continued)

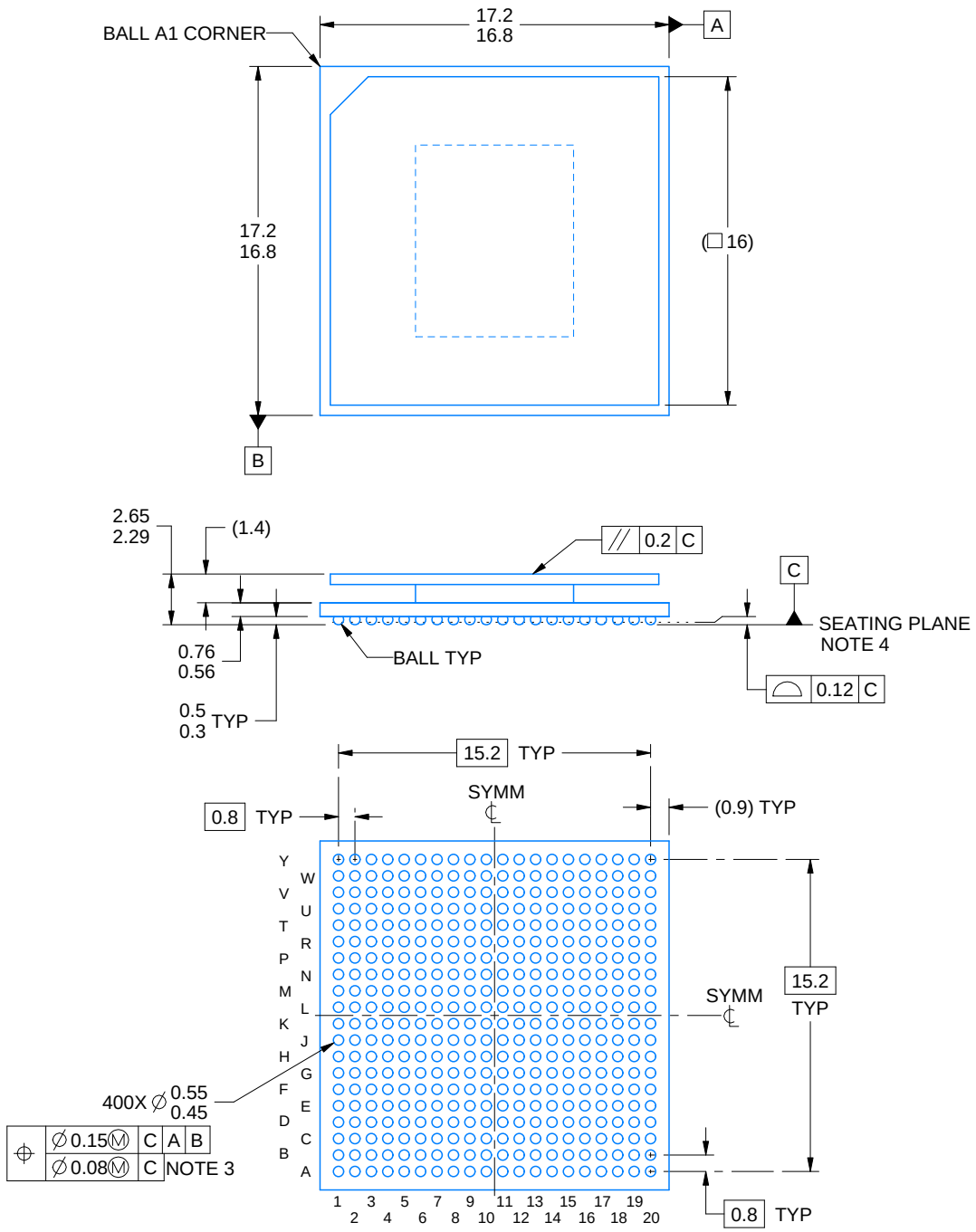
8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release.

PACKAGE OUTLINE

ABJ0400A

FCBGA - 2.65 mm max height

BALL GRID ARRAY



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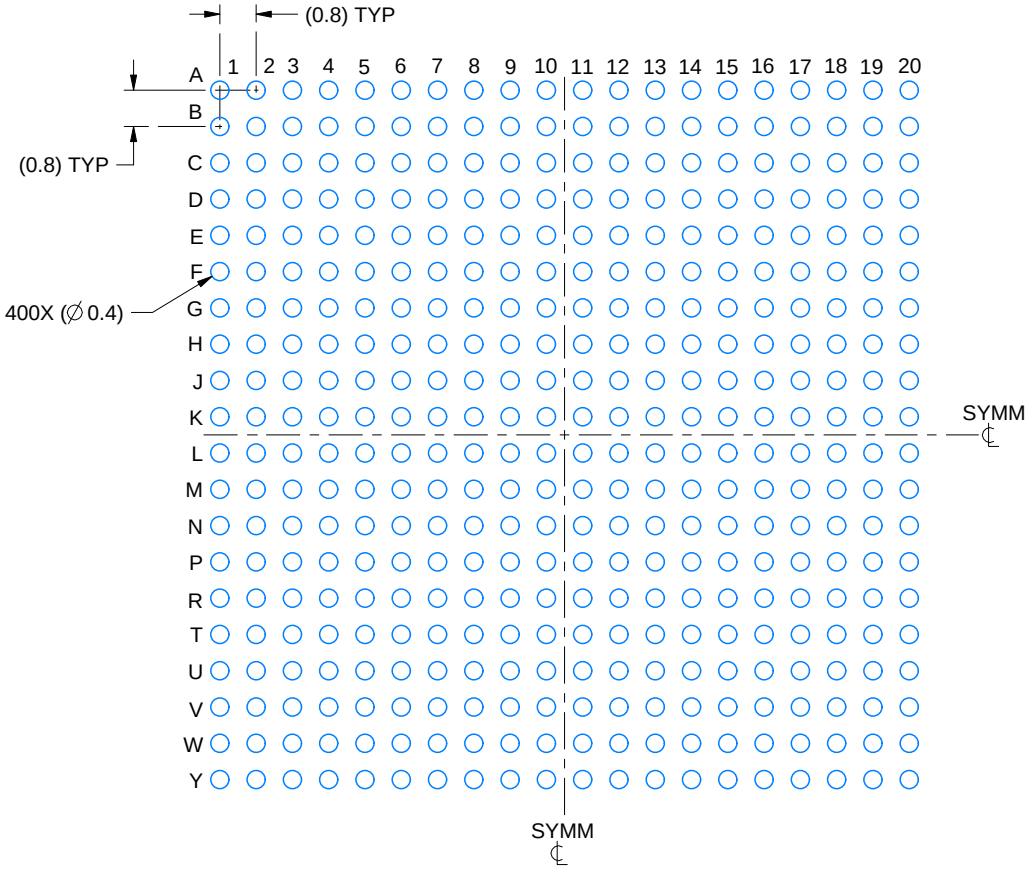
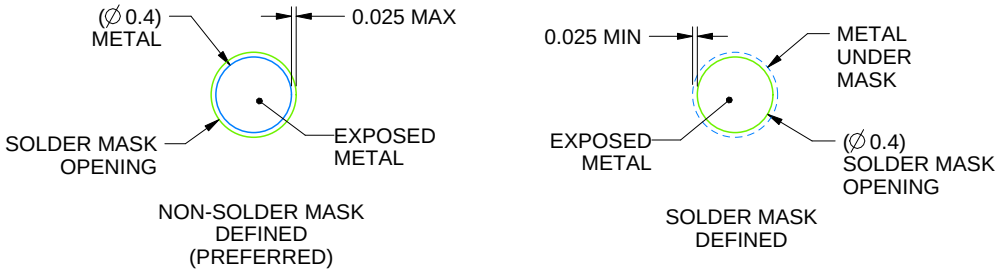


LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:6X



SOLDER MASK DETAILS
NOT TO SCALE

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NOTES: (continued)

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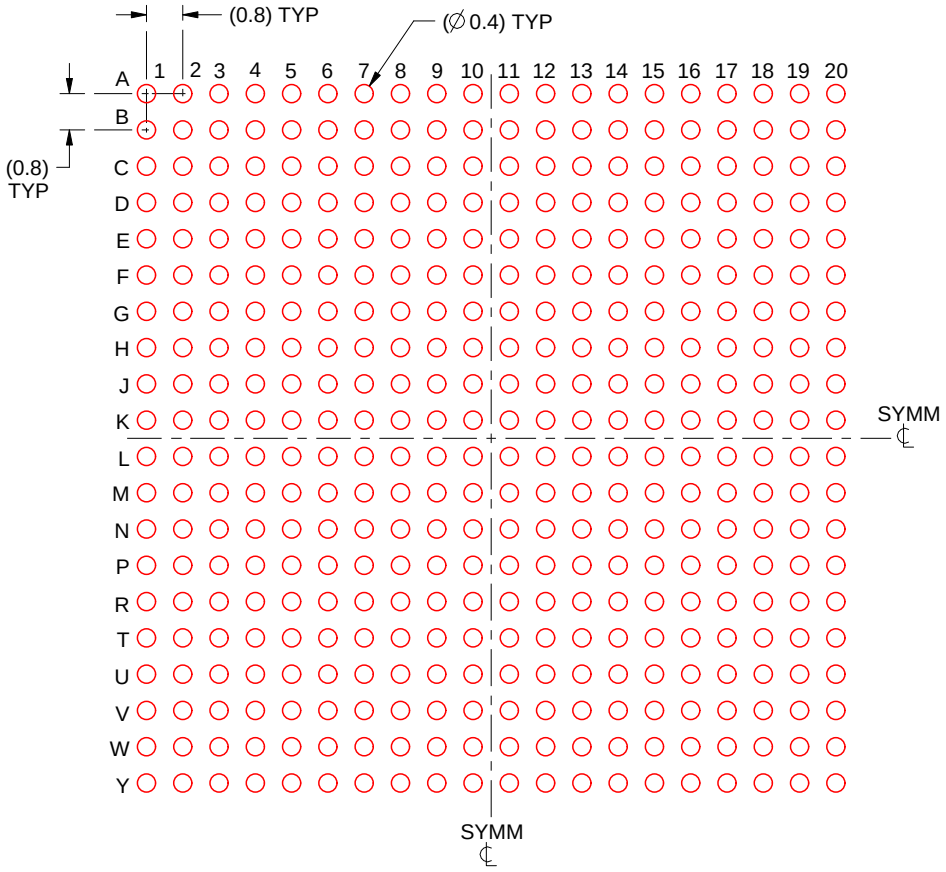

SOLDER PASTE EXAMPLE
BASED ON 0.15 mm THICK STENCIL
SCALE:6X

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NOTES: (continued)

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

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