TX7332 Three-Level, 32-Channel Transmitter With 1.2-A Pulser, T/R Switch, and Integrated Transmit Beamformer

1 Features

- TX7332 supports:
  - 32-channel three-level pulser and active transmit/receive (T/R) switch
  - Very low power on-chip beamforming mode:
    - In receive-only mode: 0.45 mW/ch
    - In transmit-receive mode: 16.4 mW/ch
    - In CW mode: 160 mW/ch
    - In global power-down mode: 0.1 mW/ch
- Three-level pulser:
  - Maximum output voltage: ±100 V
  - Minimum output voltage: ±1 V
  - Maximum output current: 1.2 A to 0.3 A
  - Maximum clamp current: 0.5 A to 0.12 A
  - Second harmonic : –45 dBc at 5 MHz
  - CW mode jitter: 100 fs measured from 100 Hz to 20 kHz
  - CW mode close-in phase noise: -154 dBc/Hz at 1 kHz offset for 5-MHz signal
  - –3-dB bandwidth with 2-kΩ || 120-pF load
    - 20 MHz (for ±100-V supply)
    - 25 MHz (for ±70-V supply)
- Active T/R switch with:
  - ON, OFF control signals
  - Bandwidth: 50 MHz
  - HD2: –50 dBc
  - Turnon resistance: 24 Ω
  - Turnon time: 0.5 µs
  - Turnoff time: 1.75 µs
  - Transient glitch: 50 mV_{PP}
- Off-chip beamformer with:
  - Jitter cleaning using synchronization feature
  - Maximum synchronization clock frequency: 200 MHz
- On-chip beamformer with:
  - Delay resolution: one beamformer clock period
  - Maximum delay: 2^{13} beamformer clock period
  - Maximum beamformer clock speed: 200 MHz
  - On-chip RAM to store
    - 16 delay profiles
    - 32 pattern profiles
- High-speed (100 MHz maximum) 1.8-V and 2.5-V CMOS serial programming interface
- Automatic thermal shutdown
- No specific power sequencing requirement
- Small package: 260-pin NFBGA (17 mm × 11 mm) with 0.8-mm pitch

2 Applications

- Ultrasound imaging system
- Piezoelectric driver
- In-probe ultrasound imaging

3 Description

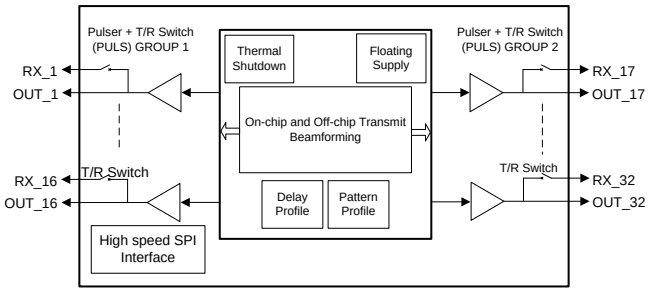
The TX7332 is a highly integrated, high-performance transmitter solution for ultrasound imaging system. The device has total 32 pulser circuits (PULS), 32 transmit/receive (T/R) switches, and supports both on-chip and off-chip beamformer (TxBF). The device also integrates on-chip floating power supplies that reduce the number of required high voltage power supplies.

Device Information(1)

PART NUMBER	PACKAGE	BODY SIZE (NOM)
TX7332	NFBGA (260)	17.00 mm × 11.00 mm

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

Simplified Block Diagram



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4 Revision History

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

DATE	REVISION	NOTES
March 2019	*	Initial release

5 Description (continued)

The TX7332 has a pulser circuit that generates three-level high voltage pulses (up to ±100 V) that can be used to excite multiple channels of an ultrasound transducer. The device supports total 32 outputs. The maximum output current is configurable from 1.2 A to 0.3 A.

A T/R switch under OFF state protects the receiver circuit by providing high isolation between the high-voltage transmitter and the low-voltage receiver when the pulser is generating high-voltage pulses. When the transducer is receiving echo signals, the T/R switch turns ON and connects the transducer to the receiver. The ON/OFF operation of the T/R switch is either controlled by an external pin or controlled by on-chip beamforming engine in the device. The T/R switch offers 24-Ω impedance in the ON state.

Ultrasound transmission relies on the excitation of multiple transducer elements with the delay profile of the excitation across the different elements defining the direction of the transmission. Such an operation is referred to as transmit beamforming. The TX7332 supports staggered pulsing of the different channels, allowing for transmit beamforming. The device supports both off-chip and on-chip beamforming operation.

In the off-chip beamformer mode, the output transition of each pulser and TR switch ON/OFF operation is controlled by external control pins. To eliminate the effect of jitter from the external control signals, the device supports a synchronization feature. When the synchronization feature is enabled, the external control signals are latched using a low-jitter beamformer clock signal.

In the on-chip beamformer mode, the delay profile for the pulsing of the different channels is stored within the device. The device supports a transmit beamformer delay resolution of one beamformer clock period and a maximum delay of 2^{13} beamformer clock periods. An internal pattern generator generates the output pulse patterns based on pattern profiles stored in a profile RAM. Up to 16 beamforming profiles and 32 pattern profiles can be stored in the profile RAM. On-chip beamforming mode reduces the number of control signals that must be routed from the FPGA to the device..

The TX7332 is available in a 17-mm × 11-mm 260-pin NFBGA package and is specified for operation from 0°C to 70°C.

6 Device and Documentation Support

6.1 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on www.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.

6.2 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, 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.
All other trademarks are the property of their respective owners.

6.4 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.

6.5 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
TX7332ZBX	ACTIVE	NFBGA	ZBX	260	120	Green (RoHS & no Sb/Br)	SNAGCU	Level-3-260C-168 HR	0 to 70	TX7332	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.

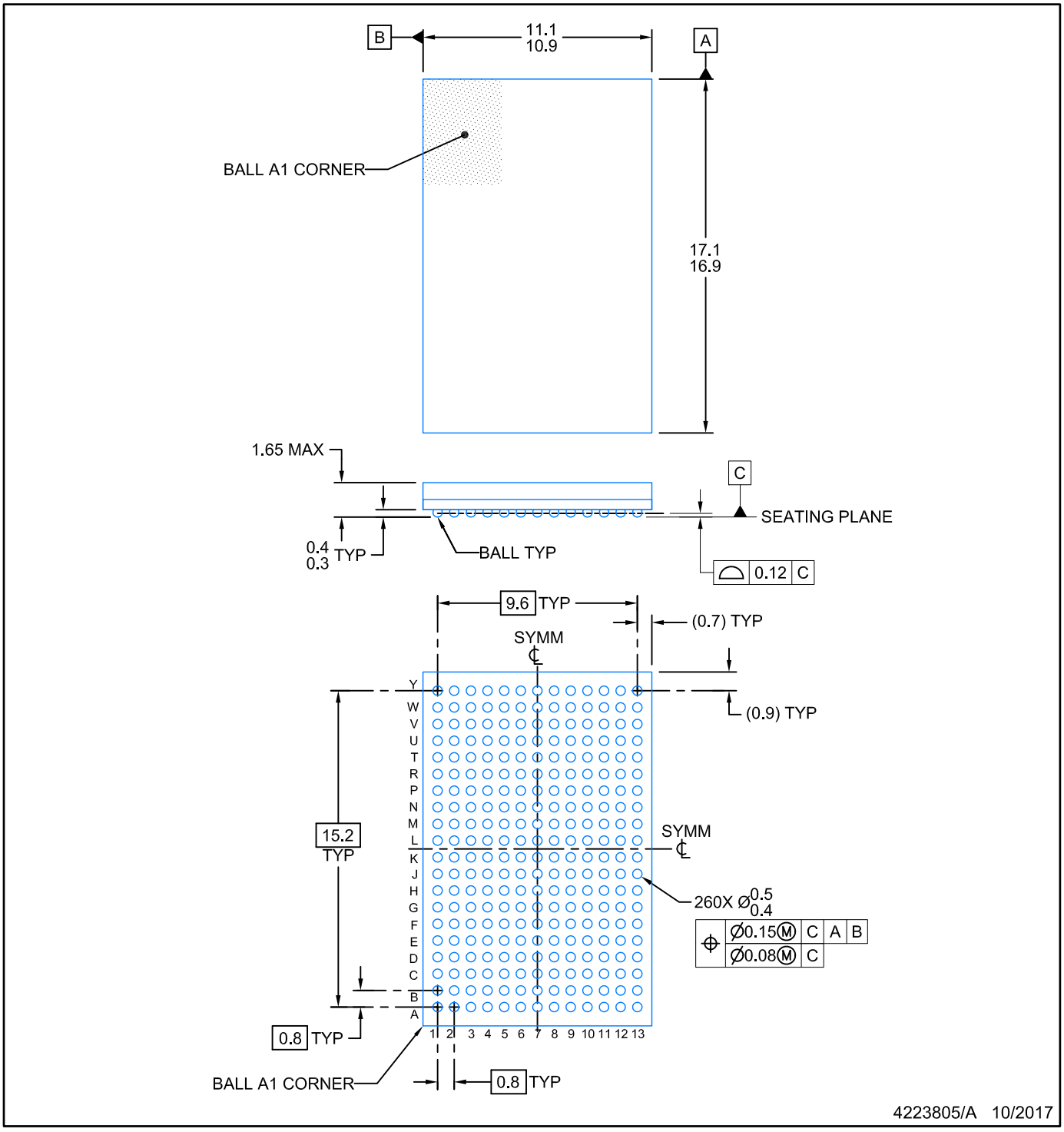
(6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

PACKAGE OUTLINE

ZBX0260A

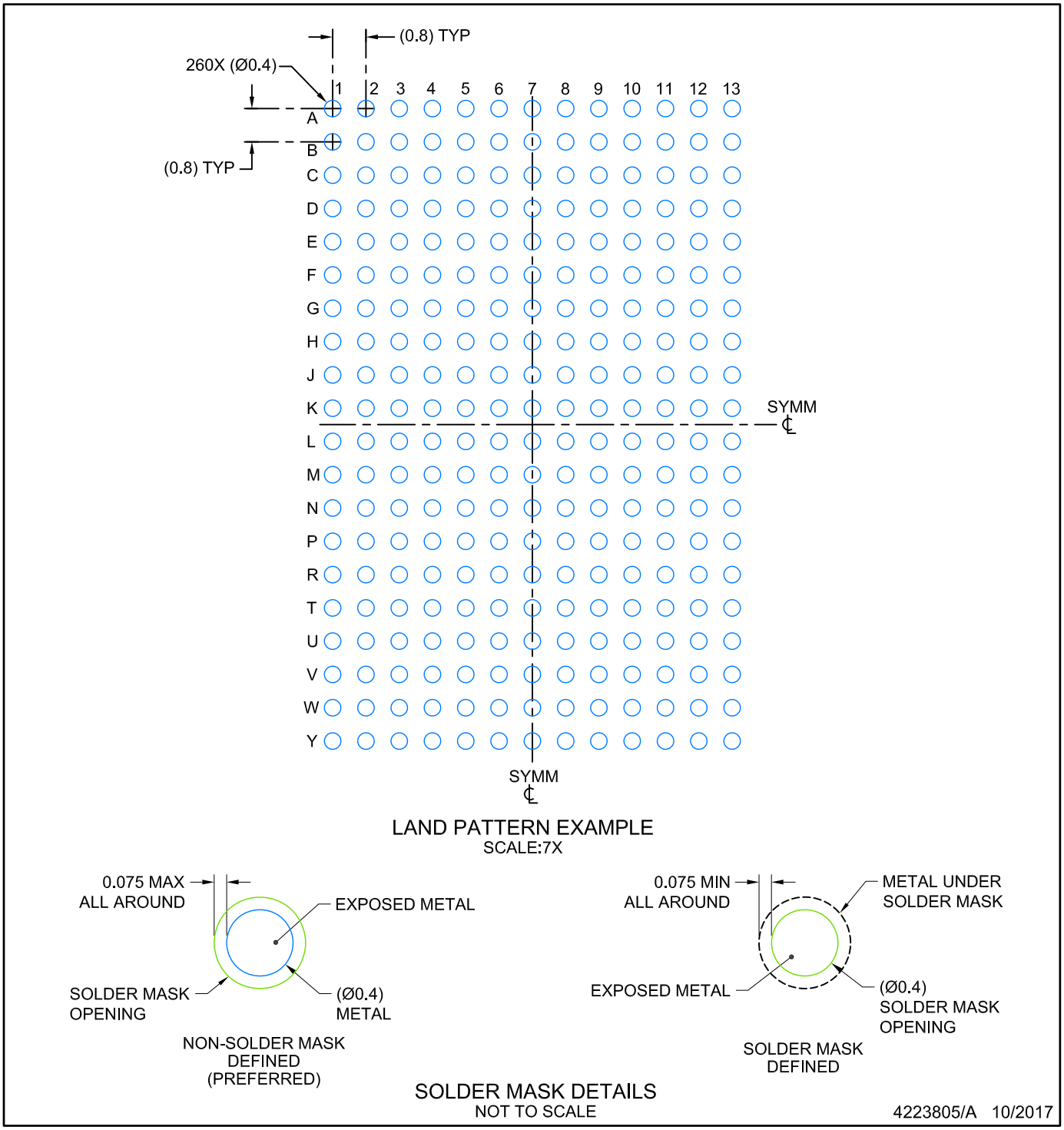
NFBGA - 1.65 mm max height

PLASTIC 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. The package thermal pad must be soldered to the printed circuit board for optimal thermal and mechanical performance.



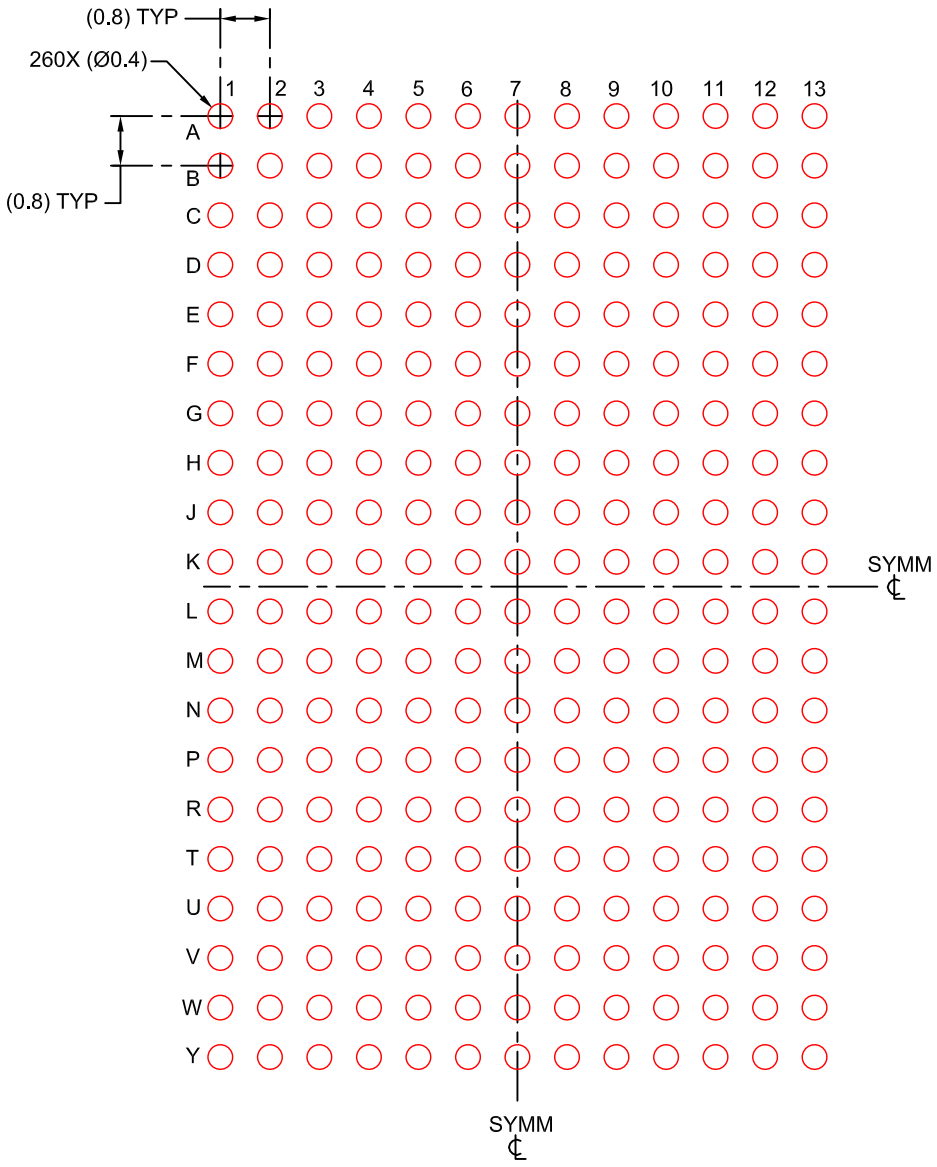
NOTES: (continued)

4. This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature number SLUA271 (www.ti.com/lit/slua271).
5. Vias are optional depending on application, refer to device data sheet. If any vias are implemented, refer to their locations shown on this view. It is recommended that vias under paste be filled, plugged or tented.

EXAMPLE STENCIL DESIGN

NFBGA - 1.65 mm max height

PLASTIC BALL GRID ARRAY



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE:8X

4223805/A 10/2017

NOTES: (continued)

6. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.

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