# DS560MB410 Low-Power 56-Gbps PAM4 4-Channel Linear Redriver with Crosspoint

## 1 Features

- Quad-channel multi-protocol linear equalizer supporting up to 28-GBd (PAM4) and 32-GBd (NRZ) interfaces
- Suitable for up to CEI-56G, Ethernet (400 GbE), Fibre Channel (64GFC), InfiniBand™ (HDR), and CPRI/eCPRI PCB and copper cable applications
- Selectable CTLE boost profiles to compensate either PCB or cable loss
- Integrated 2×2 crosspoint with pin or register control for mux, fanout, and signal crossing
- Low power consumption: 160 mW / channel (typical)
- No heat sink required
- Linear equalization with CTLE for seamless support of CR/KR link training, auto-negotiation, and FEC pass-through
- Extends long-reach links by 18-dB+ beyond normal ASIC-to-ASIC capability at 13.28 GHz
- Eye expander for PAM-4 eye symmetry enhancement
- Low input-to-output latency: 80 ps (typical)
- Low additive random jitter
- Small 6.00 mm × 6.00 mm BGA package for easy flow-through routing
- No reference clock required
- Single 2.5-V ± 5% power supply
- –40°C to +85°C ambient temperature range

## 2 Applications

- Backplane (KR) and midplane C2C attachment unit interface (AUI) reach extension
- Active copper cables (ACC) (SFP56, QSFP56, QSFP-DD, or OSFP)
- Mux and de-mux for failover redundancy

## 3 Description

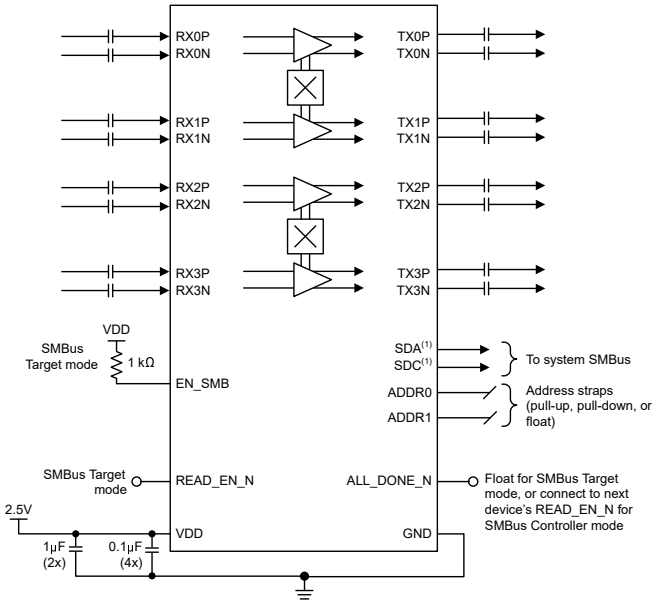
The DS560MB410 is a low-power, high-performance four-channel linear equalizer supporting multi-rate, multi-protocol interfaces up to 28 GBd using four-level pulse amplitude modulation (PAM4), or up to 32 GBd using non-return-to-zero (NRZ) modulation. It is used to extend the reach and robustness of high-speed serial links for backplane, midplane, and active copper cable (ACC) applications. The DS560MB410 can increase the reach between two ASICs by 18+ dB beyond the normal ASIC-to-ASIC reach.

Each channel operates independently with a user-selectable CTLE boost profile optimized for equalizing either PCB or copper cable loss profiles. The linear nature of the DS560MB410's equalization preserves input signal characteristics traveling through the redriver. This transparency allows link partner ASICs to negotiate Tx equalizer coefficients freely during link training and to support individual lane Forward Error Correction (FEC) pass-through in mission mode with minimal effect on latency.

**Package Information**

| PART NUMBER | PACKAGE(1) | PACKAGE SIZE(2) |
|---|---|---|
| DS560MB410 | ZAS (nFBGA, 101) | 6 mm × 6 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.




**Simplified Schematic**

# Table of Contents



## 4 Revision History

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

| Changes from Revision * (December 2022) to Revision A (October 2023) | Page |
|---|---|
| • Updated *Package Information* table to include package leads | 1 |
| • Added clarification that signal crossover configuration supports NRZ only (up to 32 GBd) | 3 |

## 5 Description (Continued)

The DS560MB410 includes a full 2×2 crosspoint between each pair of adjacent channels to enable 2-to-1 multiplexing and 1-to-2 de-multiplexing for failover redundancy, 1-to-2 fanout for diagnostic monitoring, and signal crossover (NRZ only up to 32 GBd) for PCB routing flexibility. The crosspoint is controllable through pins or the SMBus register interface.

The DS560MB410's small package dimensions and optimized high-speed signal escape are an excellent choice for small form-factor applications. Simplified equalization control, low power consumption, and ultra-low additive jitter make it suitable for chip-to-chip reach extension and signal distribution over backplanes and midplanes. The small 6.00 mm × 6.00 mm footprint easily fits in active copper cable (ACC) assembly applications without the need for a heat sink.

The DS560MB410 has a single power supply and minimal need for external components. These features reduce PCB routing complexity and bill of materials (BOM) cost. The DS560MB410 can be configured through SMBus or through an external EEPROM. Up to 16 devices can share a single EEPROM.

# 6 Device and Documentation Support

## 6.1 Documentation Support

### 6.1.1 Related Documentation

For related documentation see the following:

- Texas Instruments, *DS560MB410 Programmer's Guide*
- Texas Instruments, *50 GbE PAM4 Equalization Optimization with TI DS560MB410 Redrivers*

## 6.2 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.

## 6.3 Support Resources

## 6.4 Trademarks

InfiniBand™ is a trademark of InfiniBand Trade Association.
All trademarks are the property of their respective owners.

## 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.

## 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) |
|---|---|---|---|---|---|---|---|---|---|
| DS560MB410ZASR | Active | Production | NFBGA (ZAS) \| 101 | 2500 \| LARGE T&R | Yes | SNAGCU | Level-3-260C-168 HR | -40 to 85 | DS56MB410 |
| DS560MB410ZASR.A | Active | Production | NFBGA (ZAS) \| 101 | 2500 \| LARGE T&R | Yes | SNAGCU | Level-3-260C-168 HR | -40 to 85 | DS56MB410 |
| DS560MB410ZASR.B | Active | Production | NFBGA (ZAS) \| 101 | 2500 \| LARGE T&R | Yes | SNAGCU | Level-3-260C-168 HR | -40 to 85 | DS56MB410 |
| DS560MB410ZAST | Active | Production | NFBGA (ZAS) \| 101 | 250 \| SMALL T&R | Yes | SNAGCU | Level-3-260C-168 HR | -40 to 85 | DS56MB410 |
| DS560MB410ZAST.A | Active | Production | NFBGA (ZAS) \| 101 | 250 \| SMALL T&R | Yes | SNAGCU | Level-3-260C-168 HR | -40 to 85 | DS56MB410 |
| DS560MB410ZAST.B | Active | Production | NFBGA (ZAS) \| 101 | 250 \| SMALL T&R | Yes | SNAGCU | Level-3-260C-168 HR | -40 to 85 | DS56MB410 |

(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.

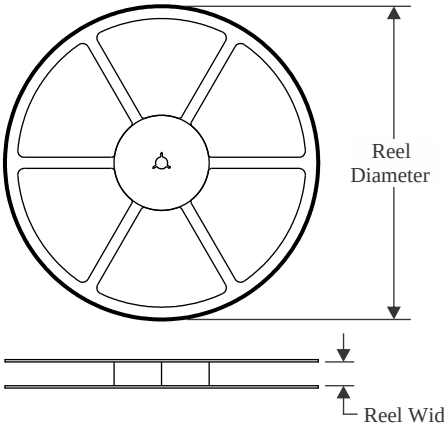
(5) **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will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

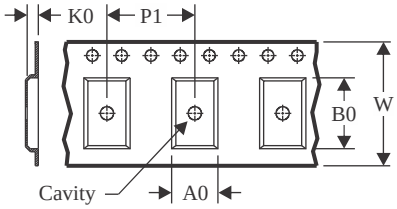
Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

## TAPE AND REEL INFORMATION

**REEL DIMENSIONS**

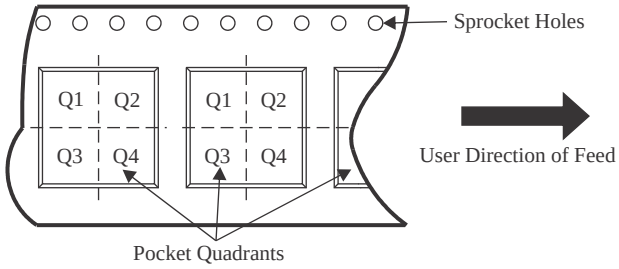



**TAPE DIMENSIONS**




| | |
|---|---|
| A0 | Dimension designed to accommodate the component width |
| B0 | Dimension designed to accommodate the component length |
| K0 | Dimension designed to accommodate the component thickness |
| W | Overall width of the carrier tape |
| P1 | Pitch between successive cavity centers |

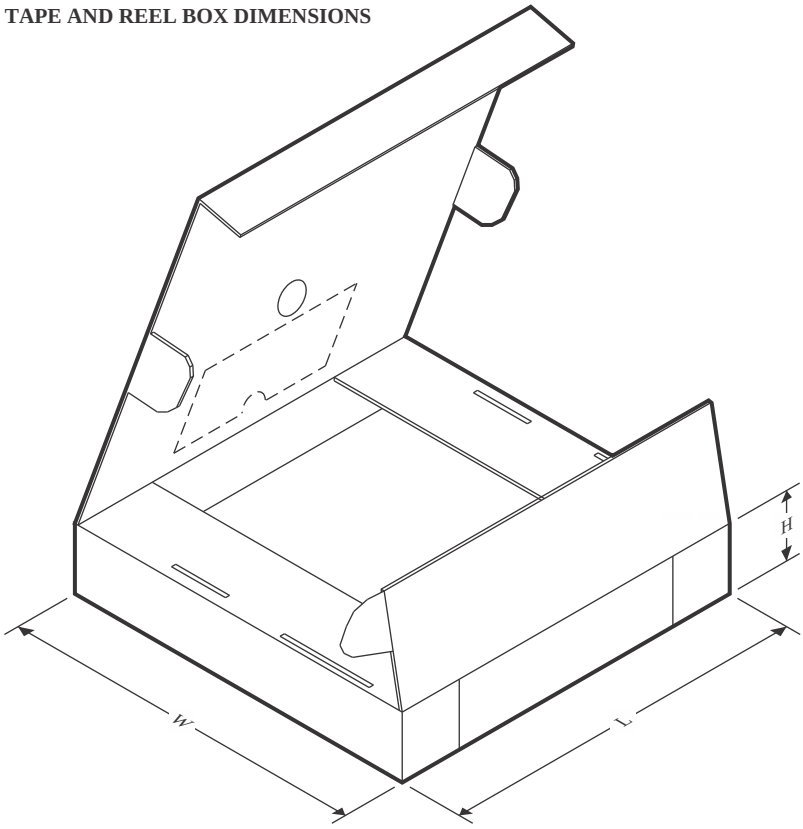
**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**




*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DS560MB410ZASR | NFBGA | ZAS | 101 | 2500 | 330.0 | 16.4 | 6.3 | 6.3 | 2.1 | 8.0 | 16.0 | Q1 |

TAPE AND REEL BOX DIMENSIONS




*All dimensions are nominal

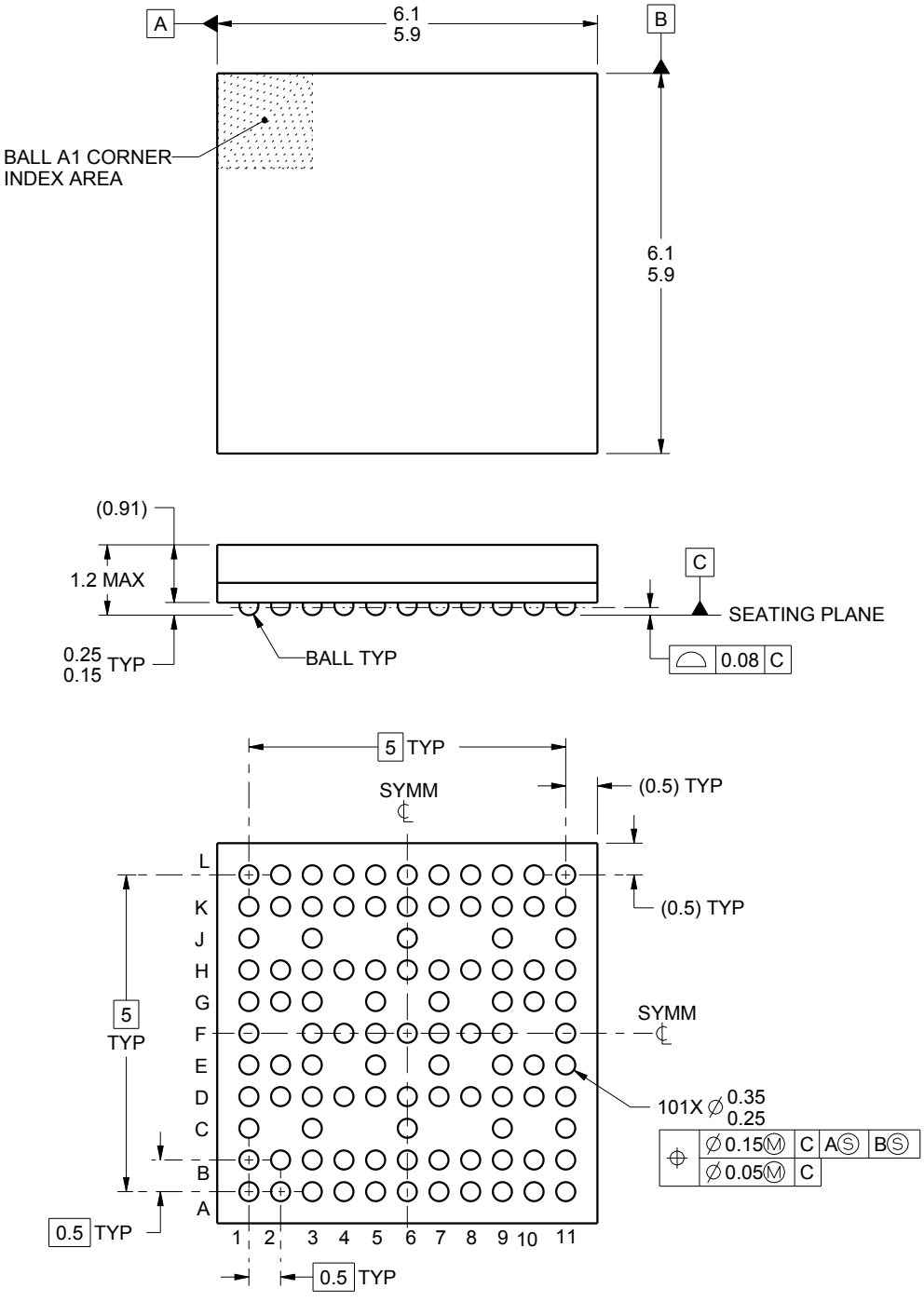
| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|---|---|---|---|---|---|---|---|
| DS560MB410ZASR | NFBGA | ZAS | 101 | 2500 | 336.6 | 336.6 | 31.8 |

# PACKAGE OUTLINE

## ZAS0101A

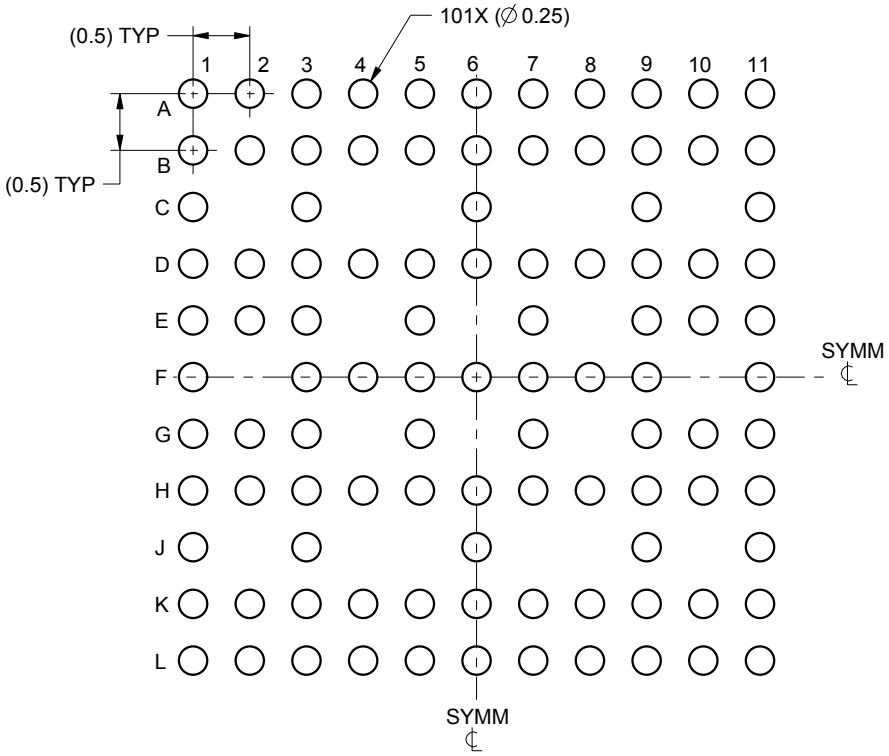
## NFBGA - 1.2 mm max height

PLASTIC BALL GRID ARRAY

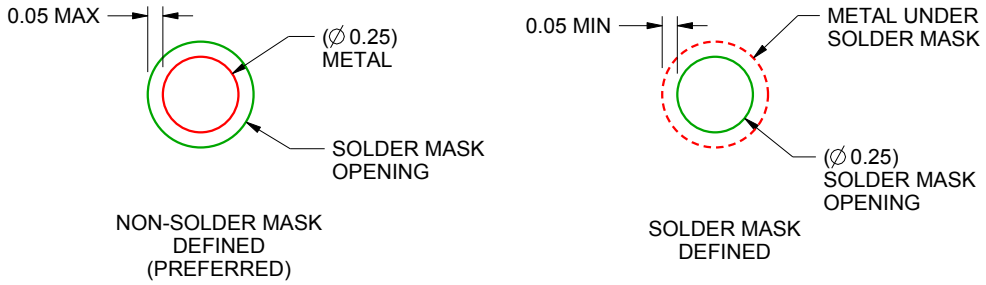



NOTES:

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.




LAND PATTERN EXAMPLE
SCALE:15X




SOLDER MASK DETAILS
NOT TO SCALE

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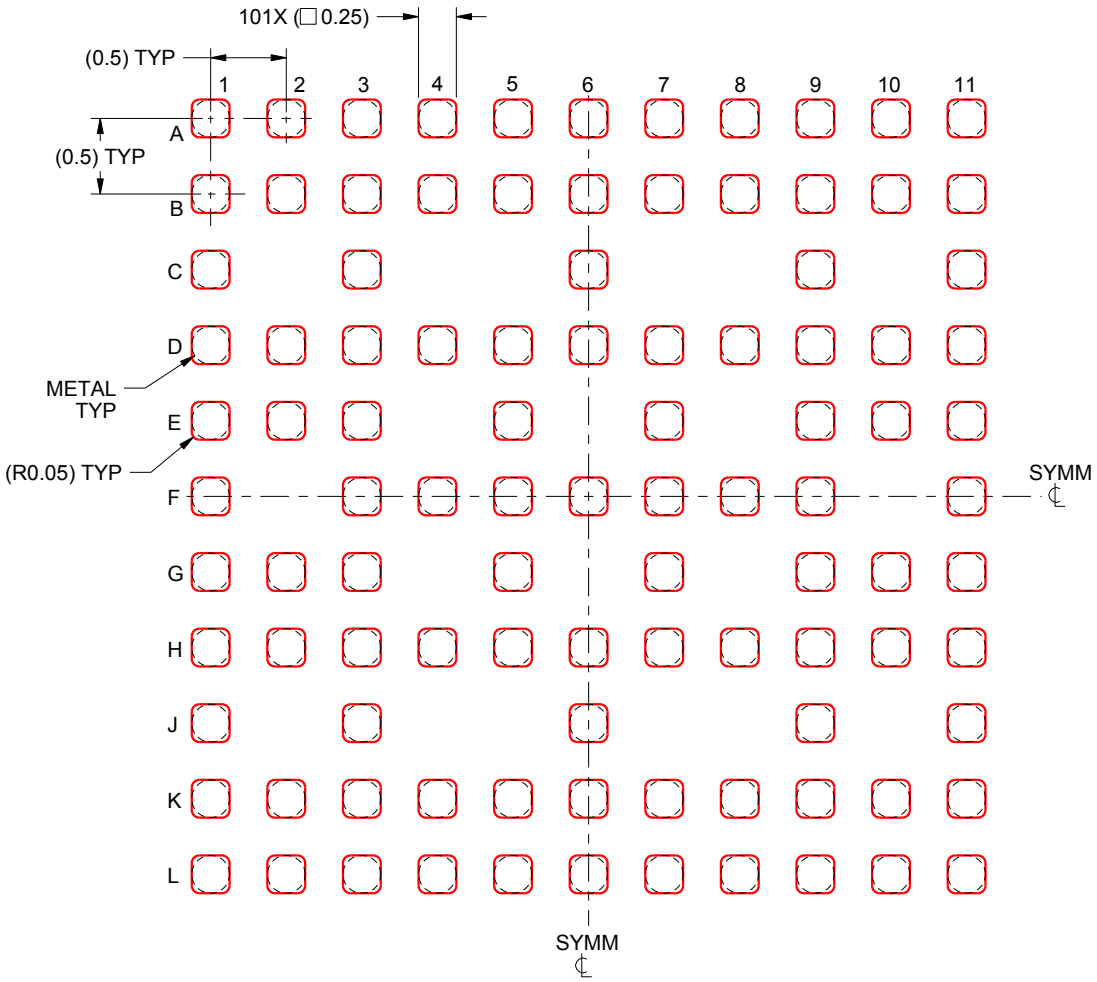
NOTES: (continued)

3. Final dimensions may vary due to manufacturing tolerance considerations and also routing constraints.
For information, see Texas Instruments literature number SPRAA99 (www.ti.com/lit/spraa99).




SOLDER PASTE EXAMPLE
BASED ON 0.1 mm THICK STENCIL
SCALE:20X

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NOTES: (continued)

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

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