

TLC696x1 16-Channel, Local Dimming Backlight LED Driver

1 Features

- Operating voltage V_{CC} range: 3V to 5.5V
- 16 constant current sinks with high precision:
 - Maximum output current / voltage:
 - 30mA / 20V: TLC69601
 - 60mA / 20V: TLC69611
 - 30mA / 50V: TLC69651
 - 60mA / 50V: TLC69661
 - Device-to-device error: $\pm 2\%$ (typ.)
 - Channel-to-channel error: $\pm 2\%$ (typ.)
- Flexible dimming control:
 - Global 8-bit Maximum Current (MC) setting
 - Brightness resolution: up to 15-bit
 - PWM / Hybrid control mode
- High speed daisy chain interface:
 - I/O voltage compatible with: 1.8V / 3.3V
 - Data transfer rate: up to 20MHz
- High system efficiency:
 - Adaptive headroom voltage control (AHVC)
 - Ultra-low device power consumption:
 - Standby mode: $I_{CC} \leq 200\mu A$
 - Normal mode: $I_{CC} \leq 3.5mA$
- EMI enhancement:
 - Programmable interface driving capability
 - Integrated 4 phase-shifting schemes
- Display quality improvement:
 - Minimum brightness update latency
 - Programmable black insertion
 - Variable refresh rate (VRR) without flickering
- Diagnostics:
 - LED open / short detection for each zone
 - Device thermal shutdown detection
 - Report interface option:
 - UART and interrupt pin (INT)
 - Two-wire output: CLK_O and SOUT

2 Applications

- LCD local dimming backlight:
 - TV
 - Monitor
 - Notebook
 - Tablet

3 Description

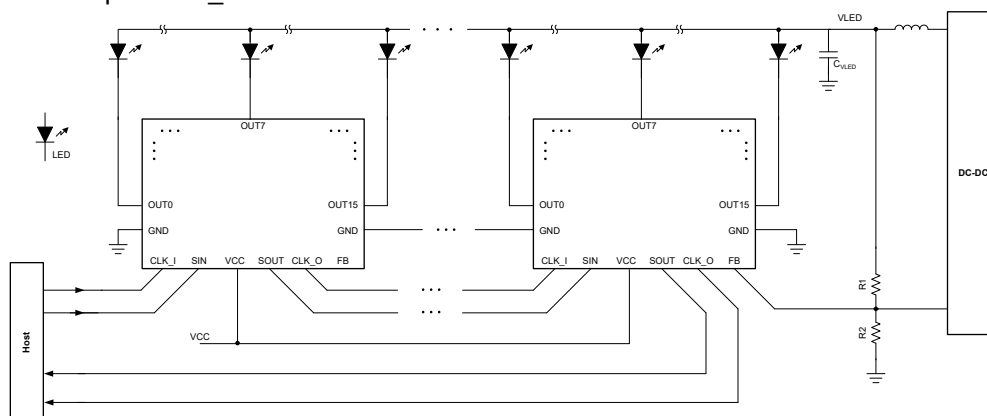
TLC696x1 is a 16-channel, constant current sink driver. Each device integrates 16 constant current sinks with SRAM for brightness storage. The device connects to each other by two-wire serial interface in daisy chain topology and supports up to 1024 devices for 16,000 local dimming zones.

To optimize system efficiency, the device equips with adaptive headroom voltage control scheme to directly control DC/DC. Only the FB pin from last device in serial chain should be connected to DC/DC to achieve simplified system layout. The device also integrates minimum brightness update latency, black insertion and VRR features to improve display quality.

TLC696x1 has three error flags: LED open detection (LOD), LED short detection (LSD) and thermal shutdown detection (TSD) for diagnostic. The device implements two options for readback including UART/INT and SOUT/CLK_O which is programmable by register.

Device Information

| PART NUMBER | PACKAGE ⁽¹⁾ | BODY SIZE (NOM) |
|-------------|------------------------|-----------------|
| TLC696x1 | DSBGA (24) | 1.58mm × 2.43mm |
| | WQFN (24) | 4mm × 4mm |



Simplified Schematic



Table of Contents

| | | | |
|--|---|--|---|
| 1 Features | 1 | 4.3 Trademarks..... | 3 |
| 2 Applications | 1 | 4.4 Electrostatic Discharge Caution..... | 3 |
| 3 Description | 1 | 4.5 Glossary..... | 3 |
| 4 Device and Documentation Support | 3 | 5 Revision History | 3 |
| 4.1 Receiving Notification of Documentation Updates..... | 3 | 6 Mechanical, Packaging, and Orderable Information | 4 |
| 4.2 Support Resources..... | 3 | | |

4 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.

4.1 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on [ti.com](https://www.ti.com). Click on *Notifications* 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.

4.2 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](#).

4.3 Trademarks

TI E2E™ is a trademark of Texas Instruments.
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4.4 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.

4.5 Glossary

[TI Glossary](#) This glossary lists and explains terms, acronyms, and definitions.

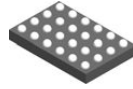
5 Revision History

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

| DATE | REVISION | NOTES |
|------------|----------|-----------------|
| April 2023 | * | Initial Release |

6 Mechanical, Packaging, and Orderable Information

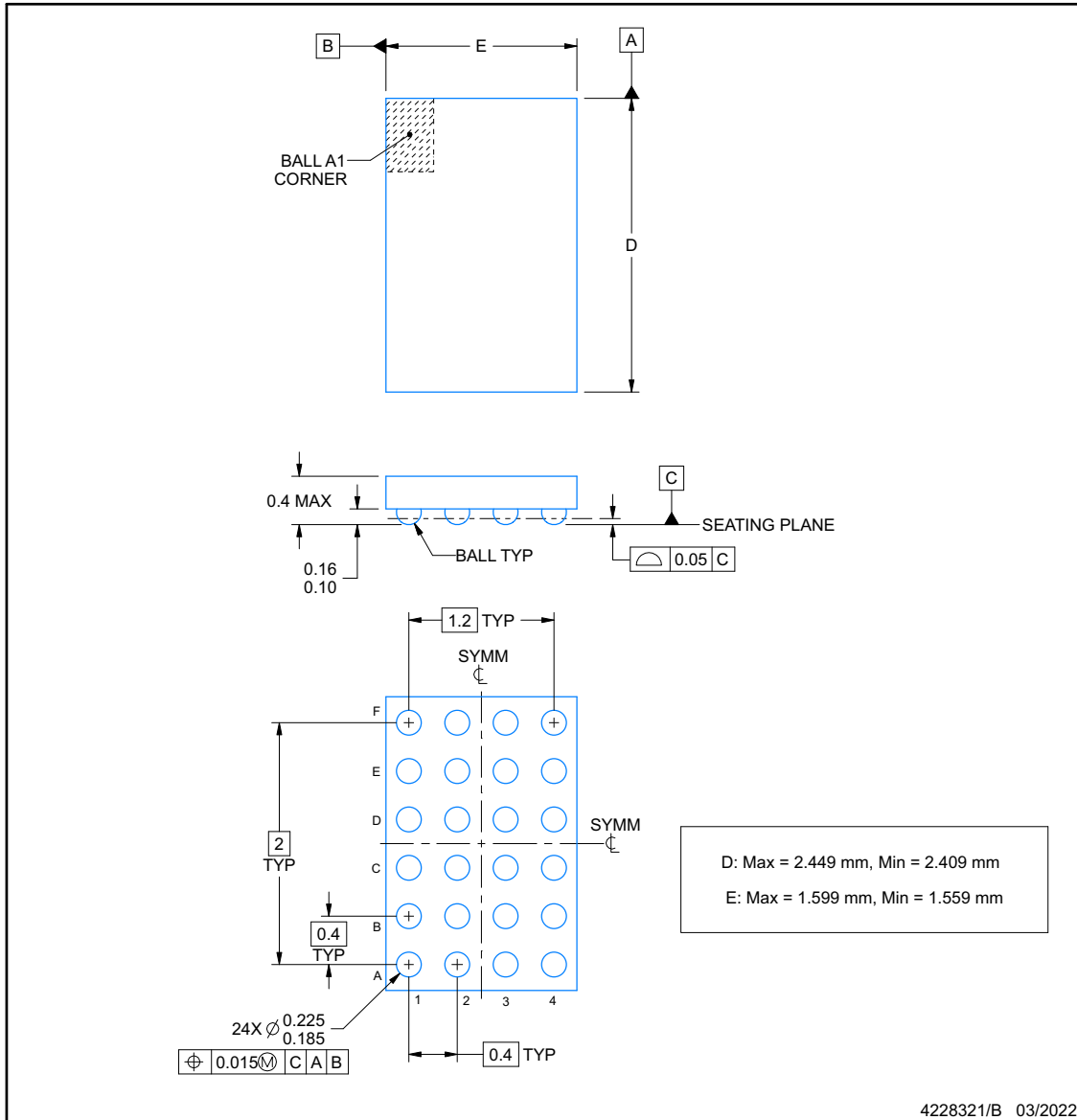
The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.



YBH0024-C01

PACKAGE OUTLINE
DSBGA - 0.4 mm max height

DIE SIZE BALL GRID ARRAY



NOTES:

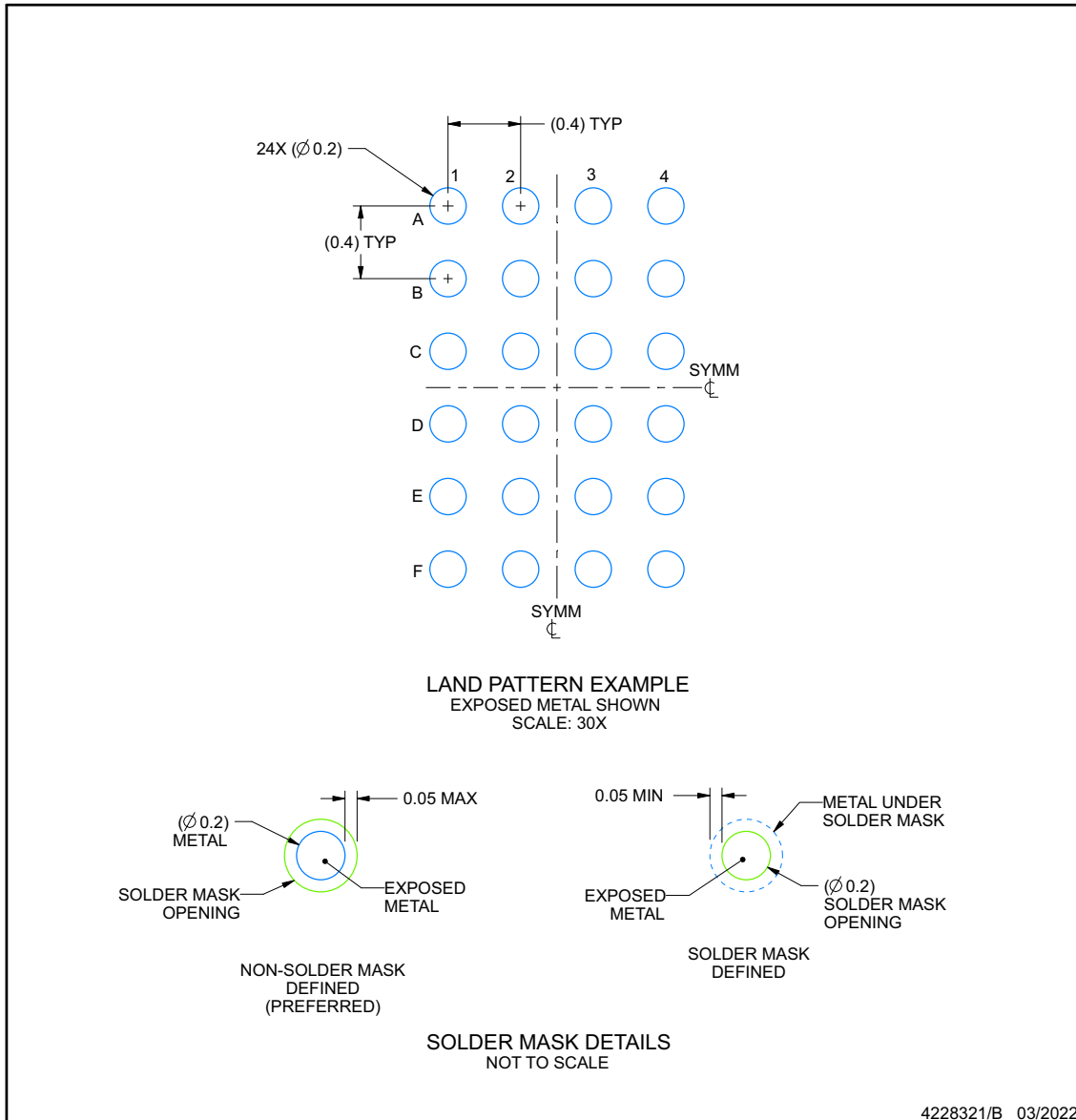
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.

EXAMPLE BOARD LAYOUT

YBH0024-C01

DSBGA - 0.4 mm max height

DIE SIZE BALL GRID ARRAY



NOTES: (continued)

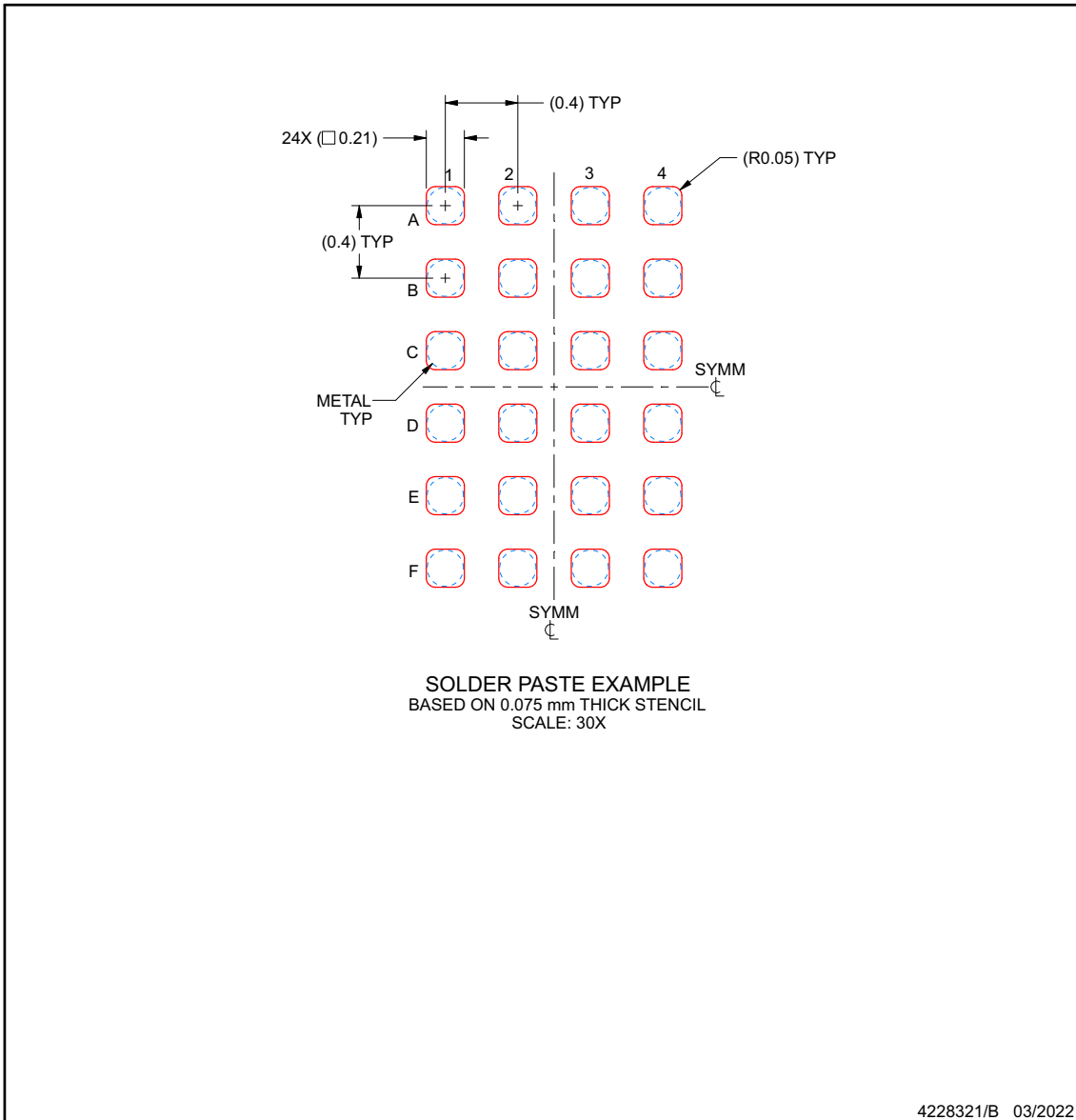
- Final dimensions may vary due to manufacturing tolerance considerations and also routing constraints. See Texas Instruments Literature No. SNVA009 (www.ti.com/lit/snva009).

EXAMPLE STENCIL DESIGN

YBH0024-C01

DSBGA - 0.4 mm max height

DIE SIZE BALL GRID ARRAY



NOTES: (continued)

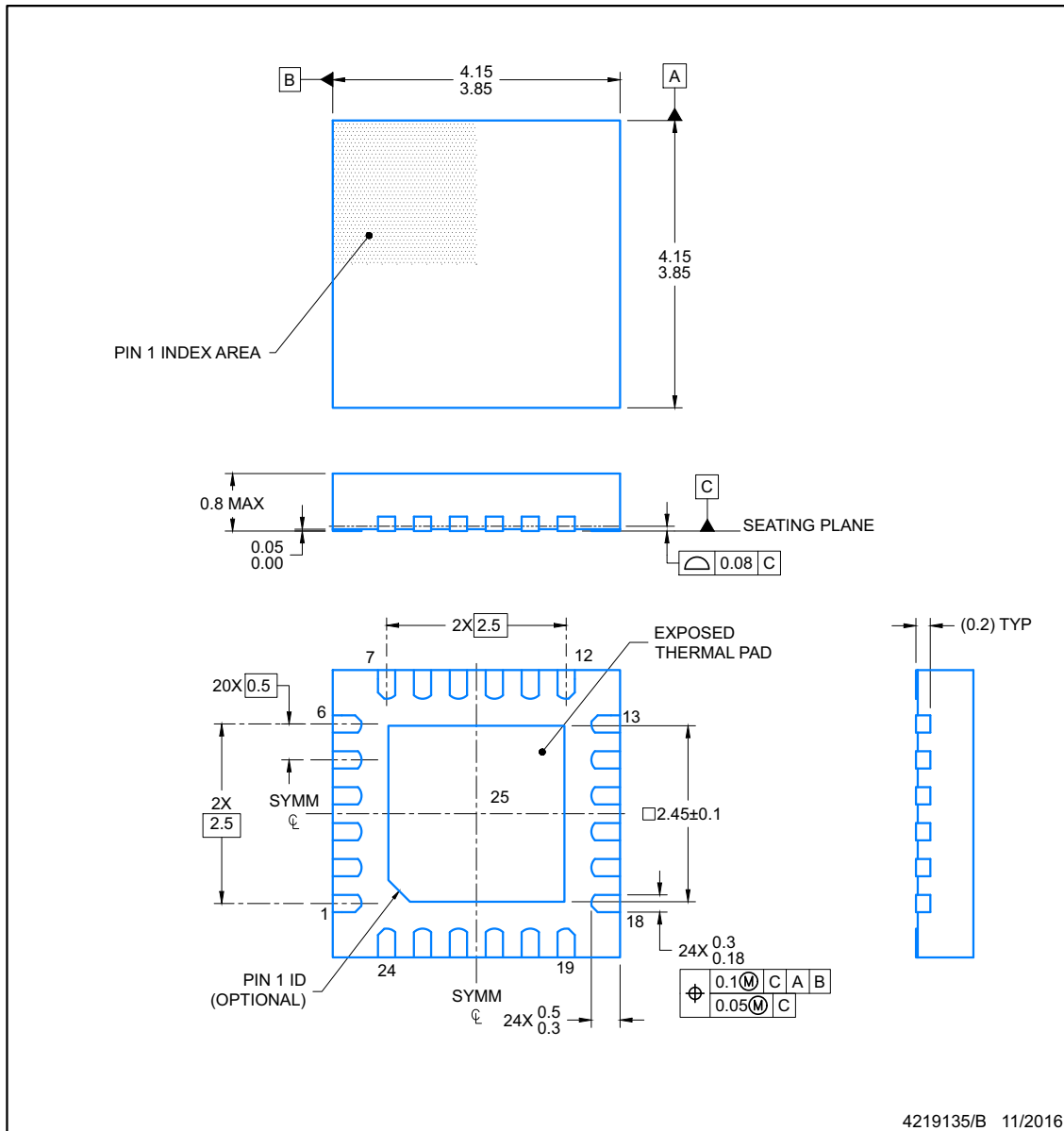
- 4. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release.

PACKAGE OUTLINE

RTW0024B

WQFN - 0.8 mm max height

PLASTIC QUAD FLATPACK-NO LEAD



NOTES:

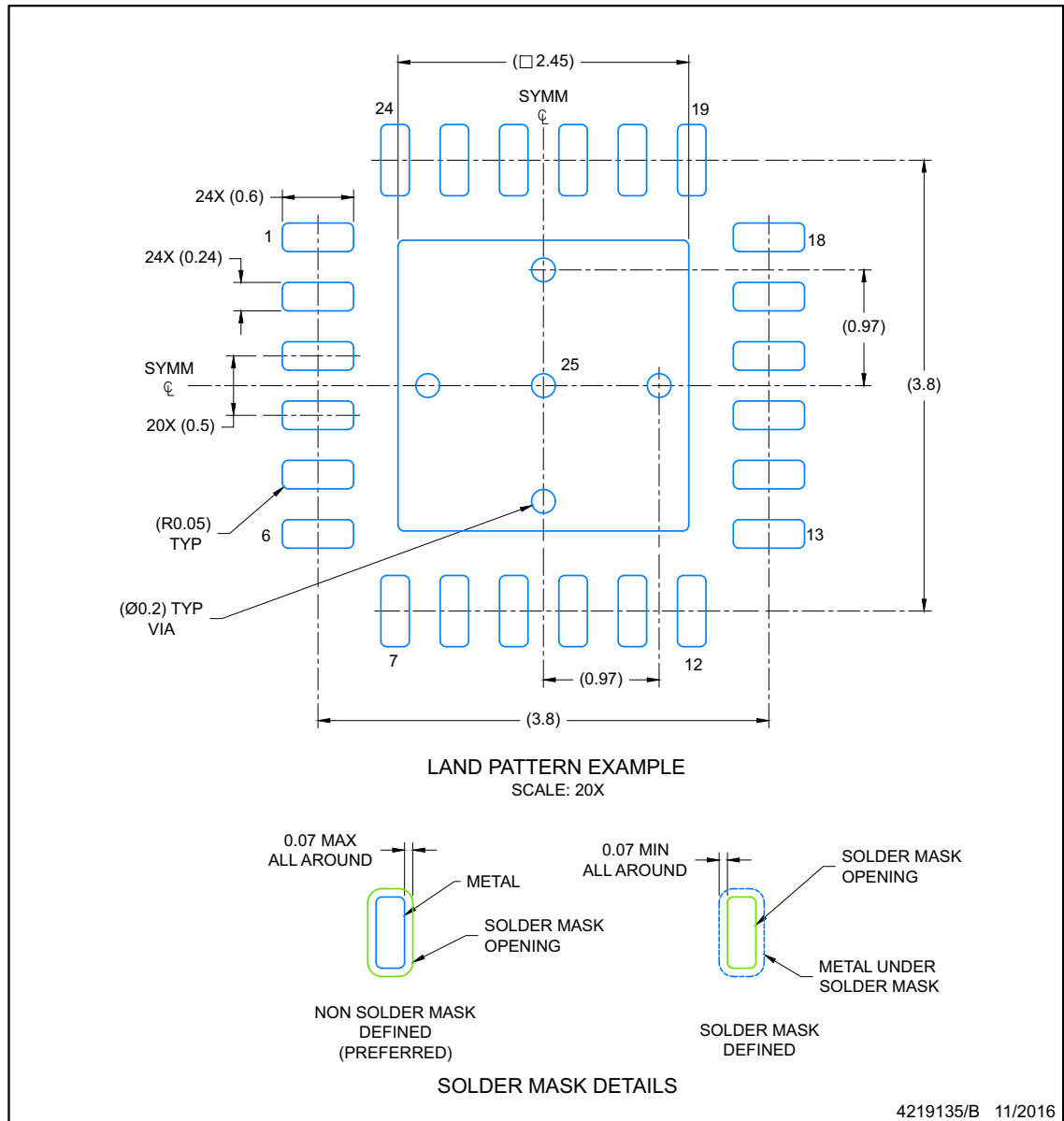
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.

EXAMPLE BOARD LAYOUT

RTW0024B

WQFN - 0.8 mm max height

PLASTIC QUAD FLATPACK-NO LEAD



NOTES: (continued)

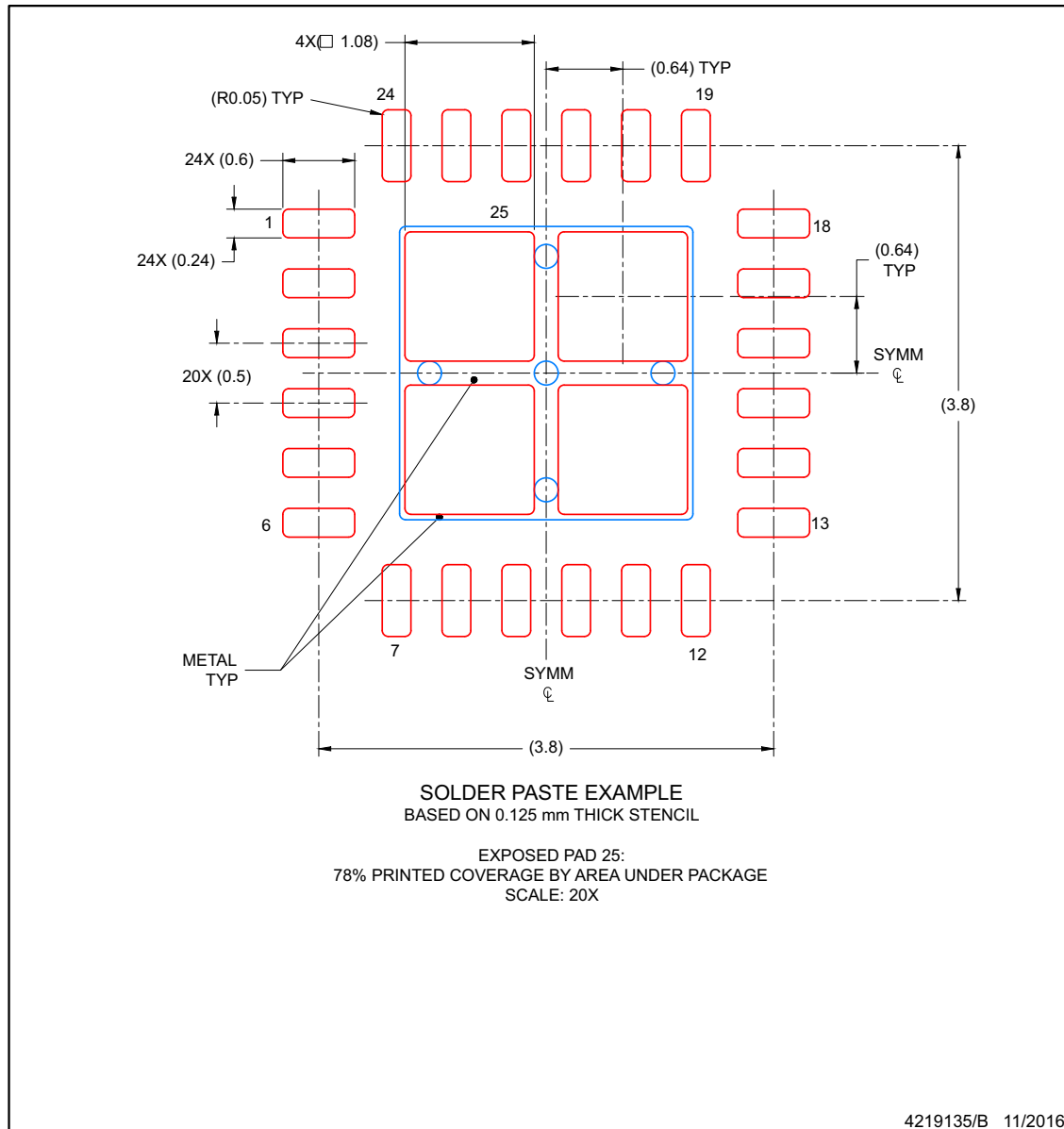
- For more information, see Texas Instruments literature number SLUA271 (www.ti.com/lit/slua271).

EXAMPLE STENCIL DESIGN

RTW0024B

WQFN - 0.8 mm max height

PLASTIC QUAD FLATPACK-NO LEAD



NOTES: (continued)

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

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 |
|------------------|---------------|--------------|-----------------|------|-------------|-----------------|--------------------------------------|----------------------|--------------|-------------------------|---------|
| TLC69601RTWR | ACTIVE | WQFN | RTW | 24 | 3000 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | 69601 | Samples |
| TLC69601YBHR | ACTIVE | DSBGA | YBH | 24 | 3000 | RoHS & Green | SNAGCU | Level-1-260C-UNLIM | -40 to 85 | TLC69601 | Samples |
| TLC69611RTWR | ACTIVE | WQFN | RTW | 24 | 3000 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | 69611 | Samples |
| TLC69611YBHR | ACTIVE | DSBGA | YBH | 24 | 3000 | RoHS & Green | SNAGCU | Level-1-260C-UNLIM | -40 to 85 | TLC69611 | Samples |
| TLC69651RTWR | ACTIVE | WQFN | RTW | 24 | 3000 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | 69651 | Samples |
| TLC69651YBHR | ACTIVE | DSBGA | YBH | 24 | 3000 | RoHS & Green | SNAGCU | Level-1-260C-UNLIM | -40 to 85 | TLC69651 | Samples |
| TLC69661RTWR | ACTIVE | WQFN | RTW | 24 | 3000 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | 69661 | Samples |
| TLC69661YBHR | ACTIVE | DSBGA | YBH | 24 | 3000 | RoHS & Green | SNAGCU | Level-1-260C-UNLIM | -40 to 85 | TLC69661 | 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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OTHER QUALIFIED VERSIONS OF TLC69601, TLC69611, TLC69651, TLC69661 :

- Automotive : [TLC69601-Q1](#), [TLC69611-Q1](#), [TLC69651-Q1](#), [TLC69661-Q1](#)

NOTE: Qualified Version Definitions:

- Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects

GENERIC PACKAGE VIEW

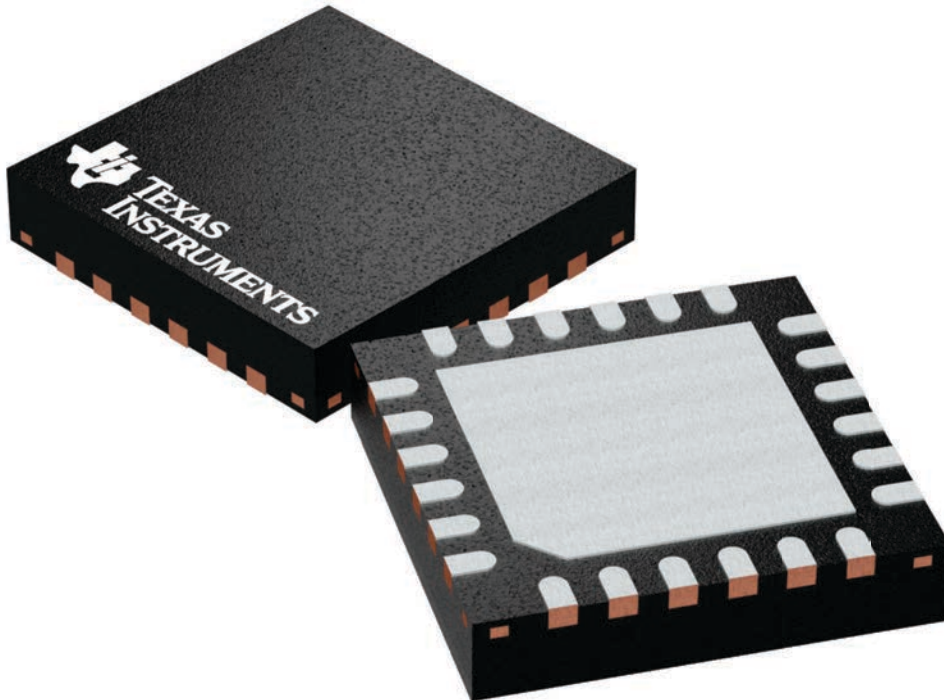
RTW 24

WQFN - 0.8 mm max height

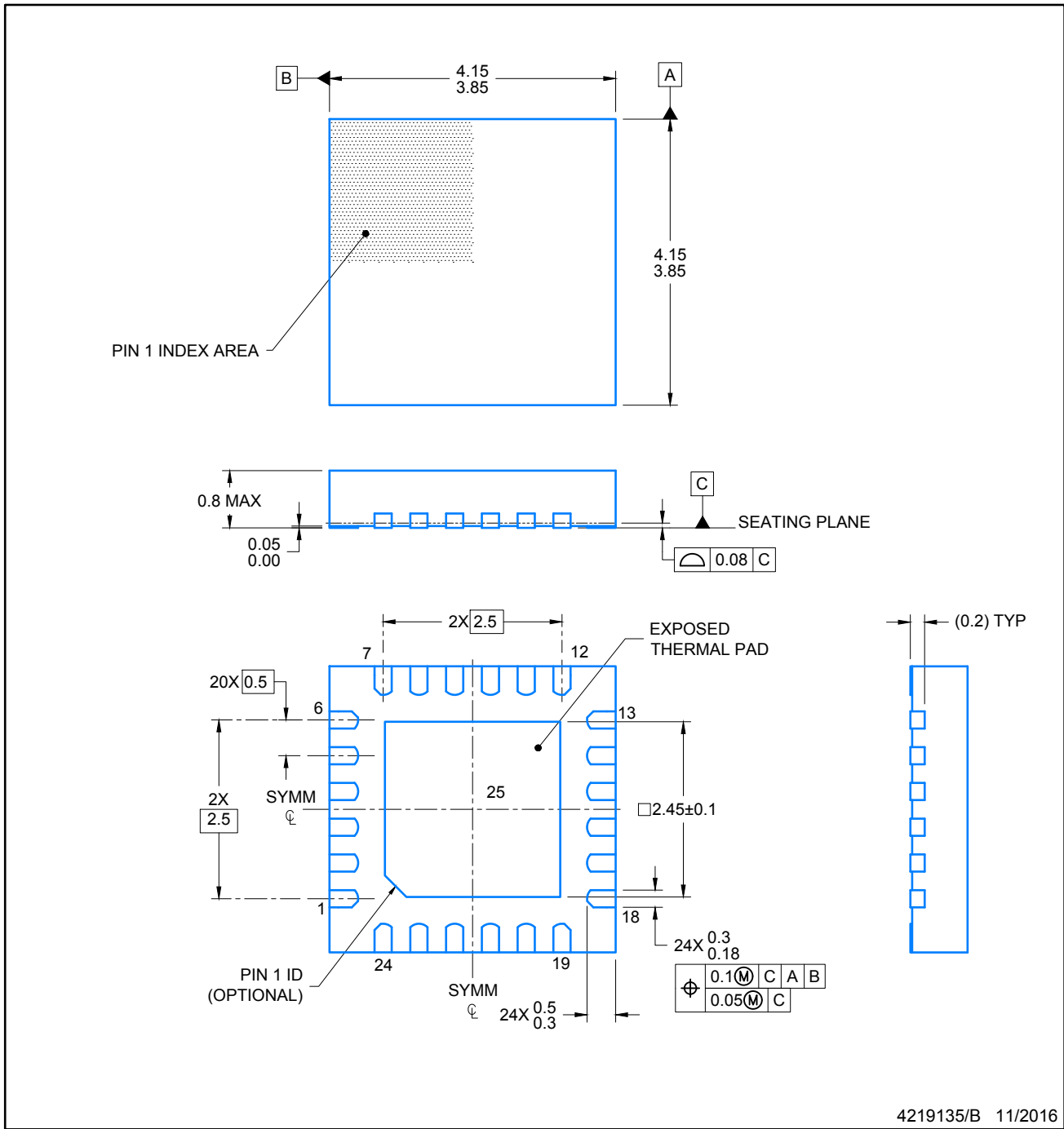
4 x 4, 0.5 mm pitch

PLASTIC QUAD FLATPACK - NO LEAD

This image is a representation of the package family, actual package may vary.
Refer to the product data sheet for package details.

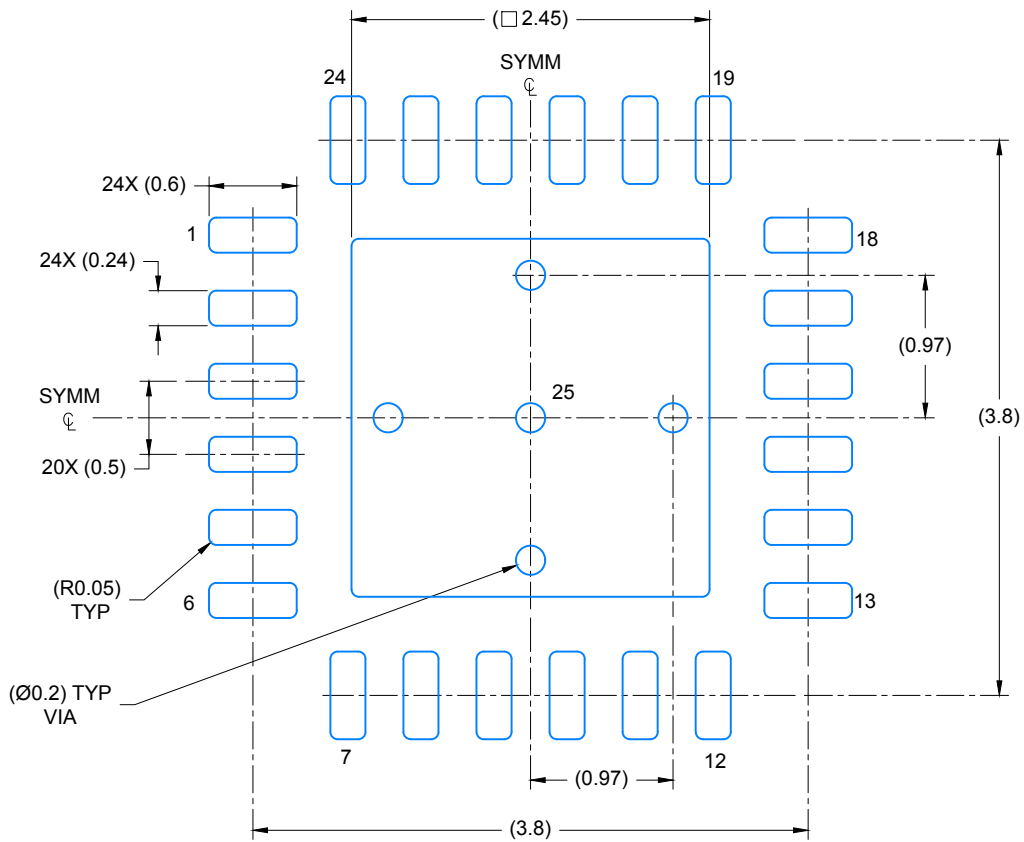


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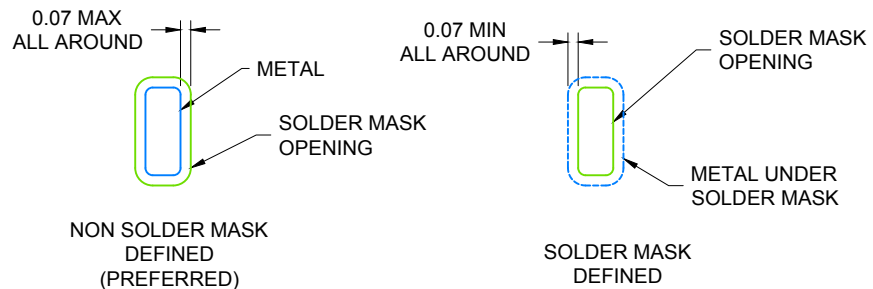


NOTES:

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2. This drawing is subject to change without notice.



LAND PATTERN EXAMPLE
SCALE: 20X

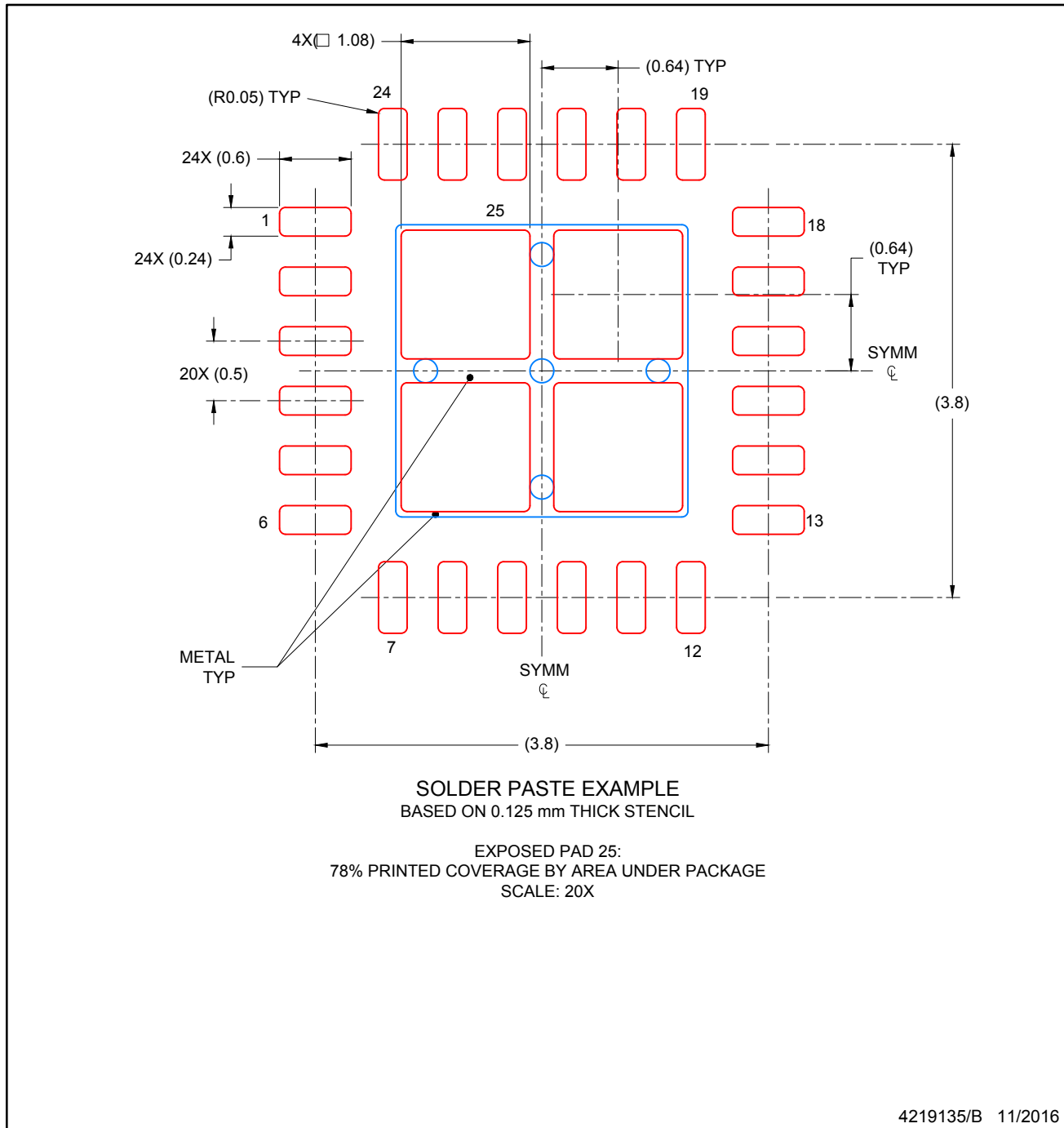


SOLDER MASK DETAILS

4219135/B 11/2016

NOTES: (continued)

- For more information, see Texas Instruments literature number SLUA271 (www.ti.com/lit/sluea271).



NOTES: (continued)

4. 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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