# DRV3233-Q1 Automotive 24/12V Battery 3-Phase Gate Driver Unit With Accurate Current Sensing and Enhanced Diagnostics

## 1 Features

- AEC-Q100 qualified for automotive applications - Temperature options:
  - DRV3233EPHP: –40°C to +150°C, $T_A$
  - DRV3233QPHP: –40°C to +125°C,$T_A$
- Functional Safety-Compliant
  - Developed for functional safety applications
  - Documentation to aid ISO 26262 system design available
  - Systematic capability up to ASIL D targeted
- Three phase half-bridge gate driver
  - Drives six N-channel MOSFETs (NMOS)
  - 4.5 to 60V wide operating voltage range
  - Bootstrap architecture for high-side gate driver
  - Charge pump for 50mA average gate current
  - 100% PWM duty cycle support
  - Overdrive supply of external switches
- Smart Gate Drive architecture
  - 45-level configurable peak gate drive current up to 1000 / 2000mA (source / sink)
  - Three-step dynamic drive current control
  - Soft shutdown for power stage protection
- Low-side Current Sense Amplifier
  - Sub-1mV low input offset across temperature
  - 9-level adjustable gain
- SPI-based detailed configuration and diagnostics
- DRVOFF pin to disable driver independently
- High voltage wake up pin (nSLEEP)
- Multiple PWM interface options available
  - 6x, 3x, 1x PWM Modes
  - PWM over SPI
- Supports 3.3V, and 5V Logic Inputs
- Optional programmable OTP for reset settings
- Advanced and configurable protection features
  - Battery and power supply voltage monitors
  - Phase feedback comparator
  - MOSFET $V_{DS}$ and $R_{sense}$ over current monitors
  - Analog Built-In-Self-Test, Clock monitors
  - Fault condition indicator pin

## 2 Applications

- 12V / 24V Automotive Motor-Control Applications
  - Electrical Power Steering and Steer-by-Wire
  - Electrical Mechanical Brake, Brake Boost Assist and Brake-by-Wire
  - Transmission and Shift-by-Wire
  - Automotive Pumps

## 3 Description

The DRV3233-Q1 is an integrated smart gate driver for 12V and 24V automotive three-phase BLDC applications. The device provides three half-bridge gate drivers, each capable of driving high-side and low-side N-channel power MOSFETs. The DRV3233-Q1 generates the correct gate drive voltages using an integrated bootstrap diode and a GVDD charge pump. The Smart Gate Drive architecture supports configurable peak gate drive current from 0.8mA up to 1A source and 2A sink. The DRV3233-Q1 can operate from a single power supply with a wide input range from 4.5 to 60V. A trickle charge pump enables 100% PWM duty cycle control, and provides overdrive supply voltage for external switches.

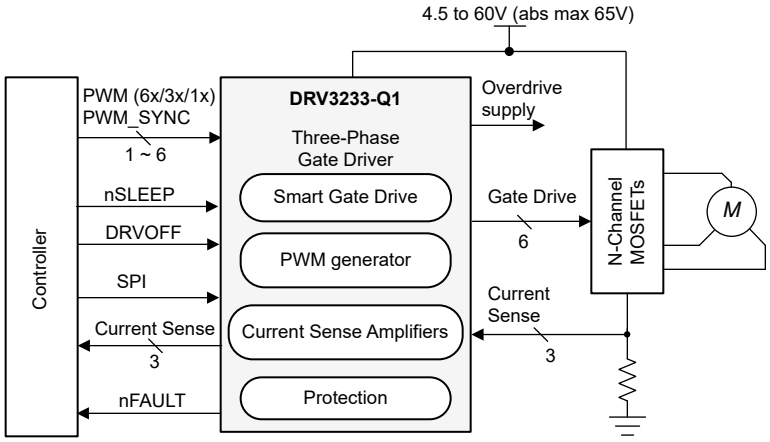
The DRV3233-Q1 provides low-side current sense amplifiers to support resistor based low-side current sensing. The low offset of the amplifiers enables the system to obtain precise motor current measurement.

A wide range of diagnostics and protection features integrated in the DRV3233-Q1 enable a robust motor drive system design and help eliminate the needs of external components. The highly configurable device response allows the device to be integrated seamlessly into a variety of system designs.

**Package Information**

| PART NUMBER | PACKAGE(1) | PACKAGE SIZE (NOM) (2) | BODY SIZE (NOM) |
|---|---|---|---|
| DRV3233-Q1 | HTQFP (48) | 9mm x 9mm | 7mm × 7mm |
| | QFN (48) | 7mm × 7mm | 7mm × 7mm |
| | QFN (32)(3) | 6mm × 4mm | 6mm × 4mm |

(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.
(3) Product preview only. Contact TI for more information.




**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 D (December 2025) to Revision E (January 2026) | Page |
|---|---|
| • Updated the device status for DRV3233ERGZ to production data | 4 |

| Changes from Revision C (July 2025) to Revision D (December 2025) | Page |
|---|---|
| • Updated Functional Safety Compliant status to reflect completion of Functional Safety Assessment | 1 |
| • Added orderable part number for DRV3233QRGZ. | 1 |

| Changes from Revision B (March 2025) to Revision C (July 2025) | Page |
|---|---|
| • Updated the device status for DRV3233ERGZ to preview data | 4 |

| Changes from Revision A (August 2024) to Revision B (July 2025) | Page |
|---|---|
| • Updated the device status for DRV3233QPHP to production data | 4 |

| Changes from Revision * (September 2023) to Revision A (August 2024) | Page |
|---|---|
| • Updated the device status for DRV3233EPHP to production data. | 1 |

## 5 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) |
|---|---|---|---|---|---|---|---|---|---|
| DRV3233EPHPRQ1 | Active | Production | HTQFP (PHP) \| 48 | 1000 \| LARGE T&R | Yes | NIPDAU | Level-3-260C-168 HR | -40 to 150 | DRV3233E |
| DRV3233EPHPRQ1.A | Active | Production | HTQFP (PHP) \| 48 | 1000 \| LARGE T&R | Yes | NIPDAU | Level-3-260C-168 HR | -40 to 150 | DRV3233E |
| DRV3233ERGZRQ1 | Active | Production | VQFN (RGZ) \| 48 | 4000 \| LARGE T&R | Yes | NIPDAU | Level-3-260C-168 HR | -40 to 150 | DRV3233 ERGZ Q1 |
| DRV3233QPHPRQ1 | Active | Production | HTQFP (PHP) \| 48 | 1000 \| LARGE T&R | Yes | NIPDAU | Level-3-260C-168 HR | -40 to 125 | DRV3233Q |
| DRV3233QPHPRQ1.A | Active | Production | HTQFP (PHP) \| 48 | 1000 \| LARGE T&R | Yes | NIPDAU | Level-3-260C-168 HR | -40 to 125 | DRV3233Q |
| DRV3233QRGZRQ1 | Active | Production | VQFN (RGZ) \| 48 | 4000 \| LARGE T&R | Yes | NIPDAU | Level-3-260C-168 HR | -40 to 150 | DRV3233 QRGZ Q1 |

(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.

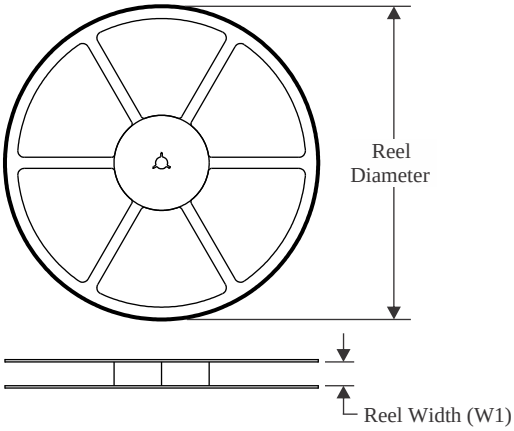
(6) **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

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.

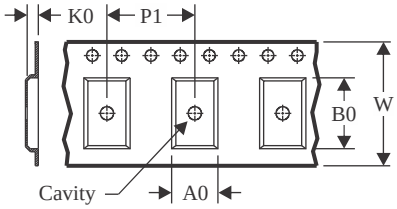
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

## TAPE AND REEL INFORMATION

**REEL DIMENSIONS**

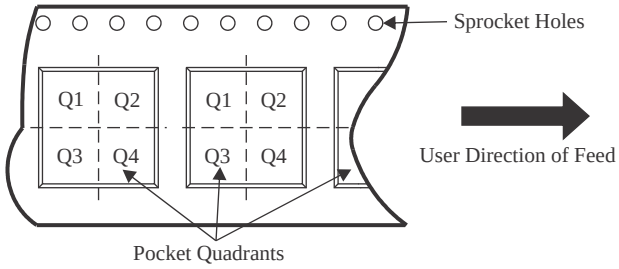



**TAPE DIMENSIONS**




| | |
|---|---|
| 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 |

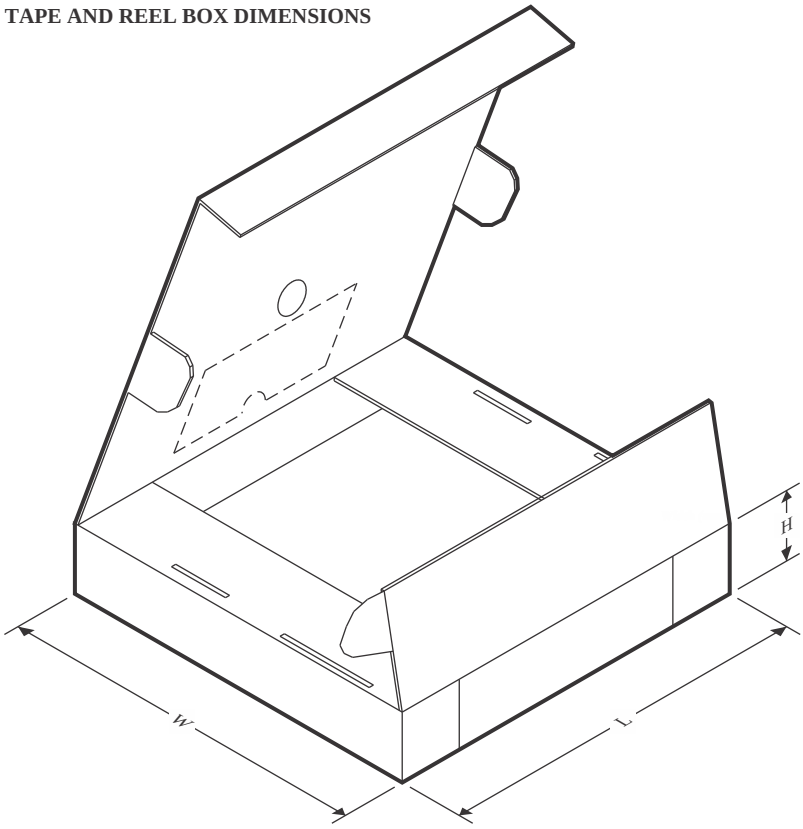
**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**




*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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DRV3233EPHPRQ1 | HTQFP | PHP | 48 | 1000 | 330.0 | 16.4 | 9.6 | 9.6 | 1.5 | 12.0 | 16.0 | Q2 |
| DRV3233QPHPRQ1 | HTQFP | PHP | 48 | 1000 | 330.0 | 16.4 | 9.6 | 9.6 | 1.5 | 12.0 | 16.0 | Q2 |

TAPE AND REEL BOX DIMENSIONS




*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|---|---|---|---|---|---|---|---|
| DRV3233EPHPRQ1 | HTQFP | PHP | 48 | 1000 | 336.6 | 336.6 | 31.8 |
| DRV3233QPHPRQ1 | HTQFP | PHP | 48 | 1000 | 336.6 | 336.6 | 31.8 |

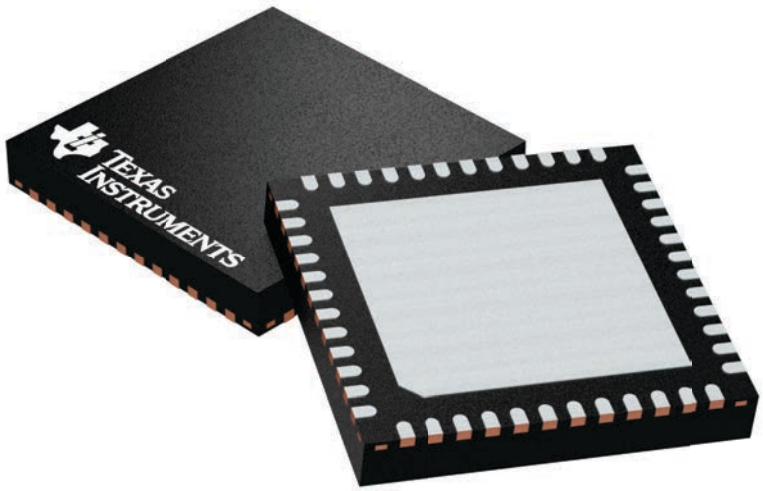
# GENERIC PACKAGE VIEW

## RGZ 48

## VQFN - 1 mm max height

**7 x 7, 0.5 mm pitch**

PLASTIC QUADFLAT PACK- NO LEAD




Images above are just a representation of the package family, actual package may vary.
Refer to the product data sheet for package details.

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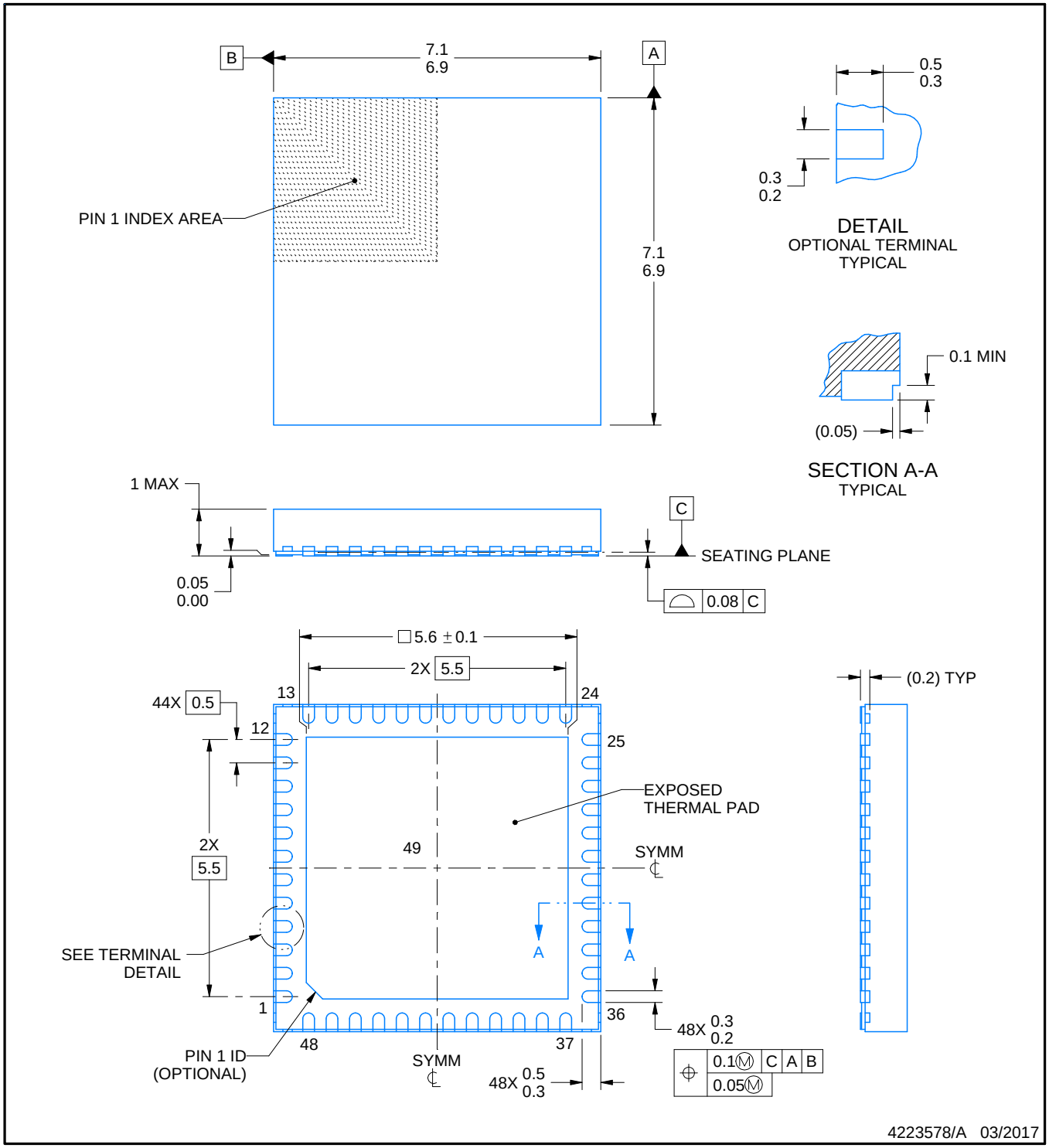
# PACKAGE OUTLINE

## RGZ0048M

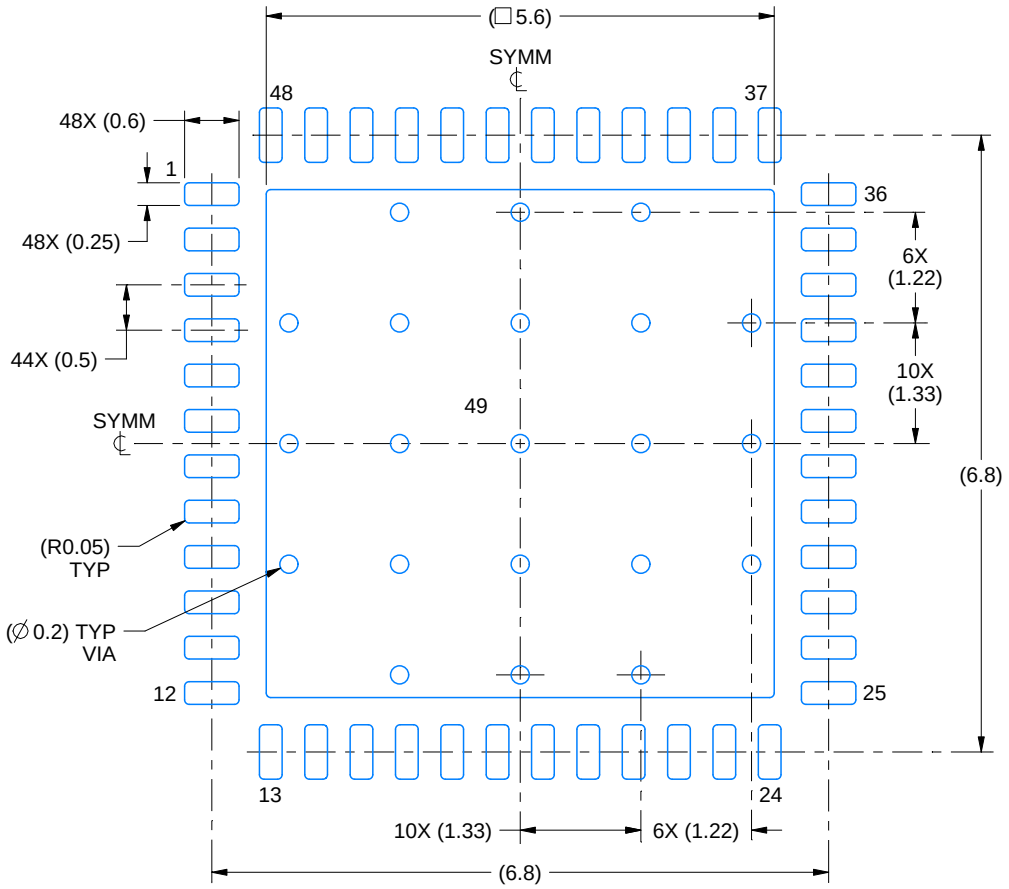
## VQFN - 1 mm max height

PLASTIC QUAD FLATPACK - NO LEAD

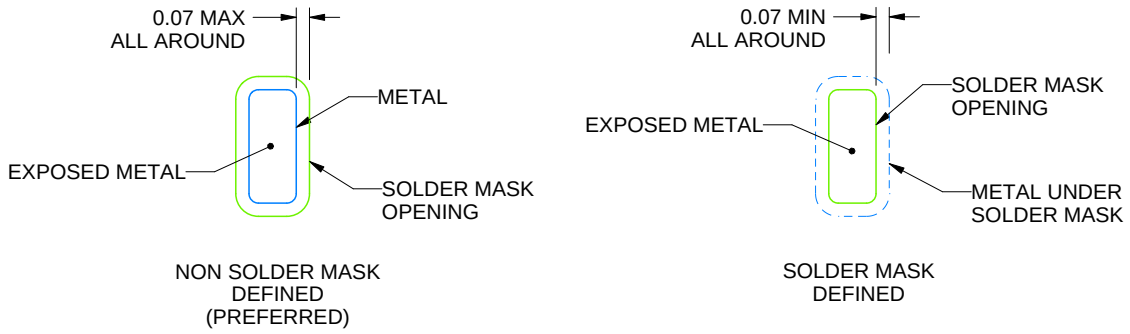



NOTES:

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




LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:12X




SOLDER MASK DETAILS

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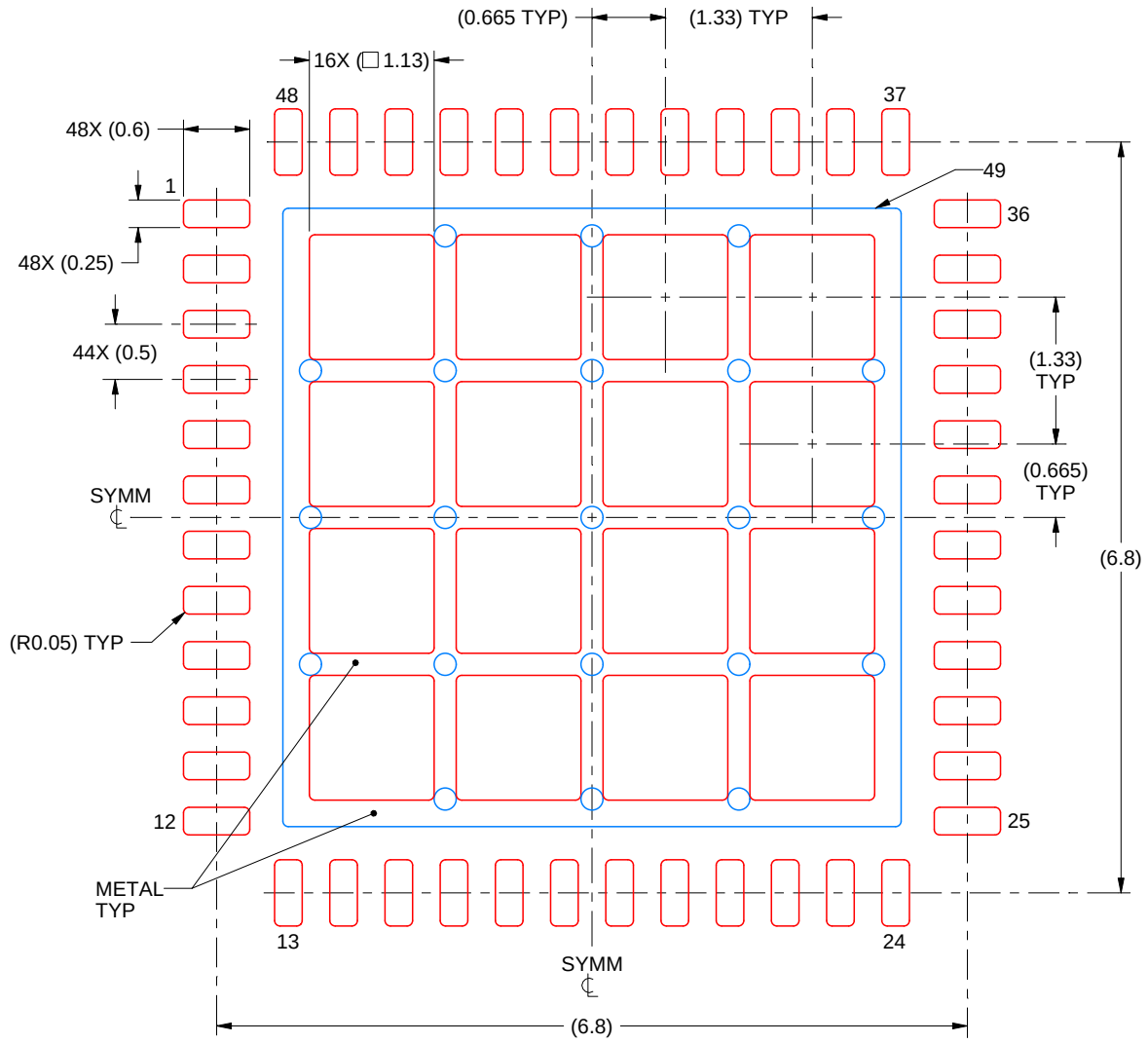
NOTES: (continued)

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.




SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL

EXPOSED PAD 49
66% PRINTED SOLDER COVERAGE BY AREA UNDER PACKAGE
SCALE:15X

4223578/A 03/2017

NOTES: (continued)

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

# GENERIC PACKAGE VIEW

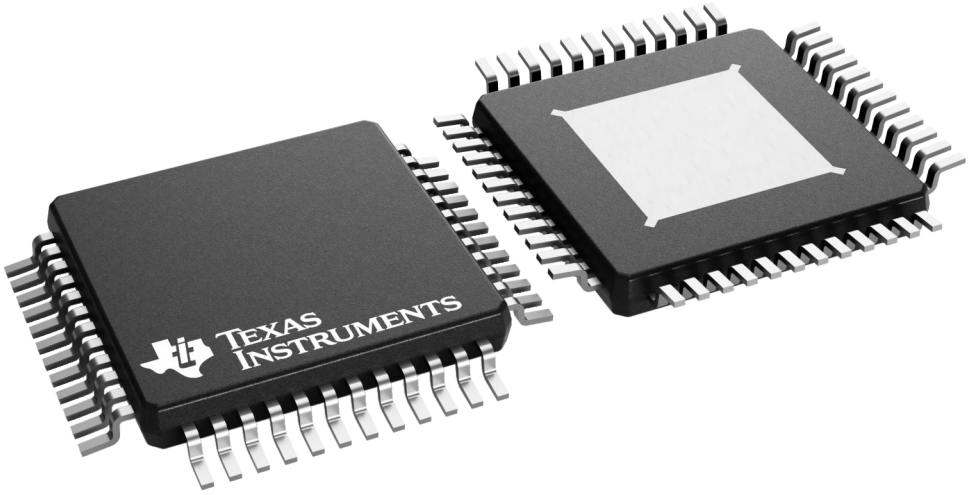
## PHP 48

## TQFP - 1.2 mm max height

**7 x 7, 0.5 mm pitch**

QUAD FLATPACK

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



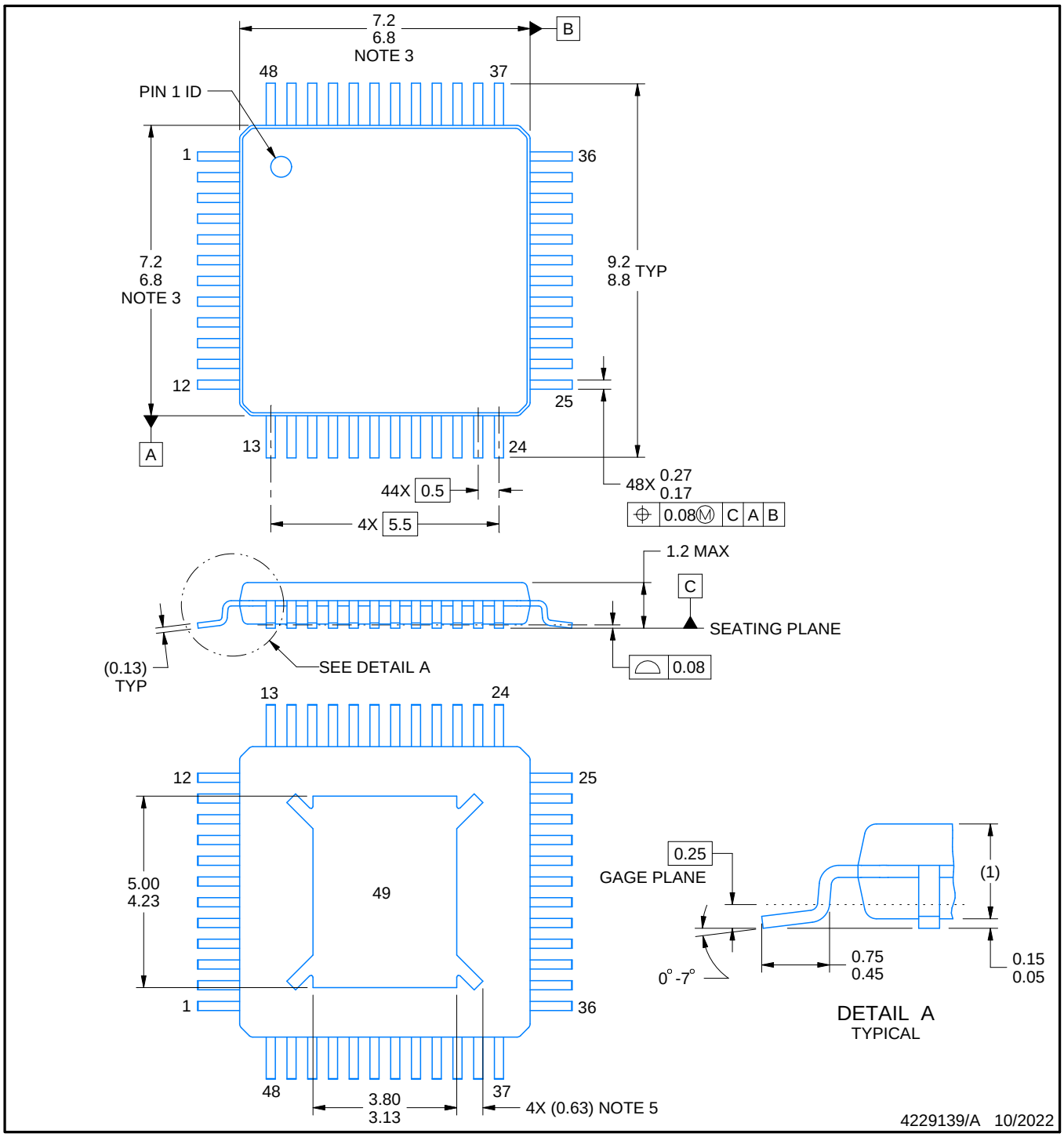

4226443/A

# PACKAGE OUTLINE

## PHP0048P

## PowerPAD™ HTQFP - 1.2 mm max height

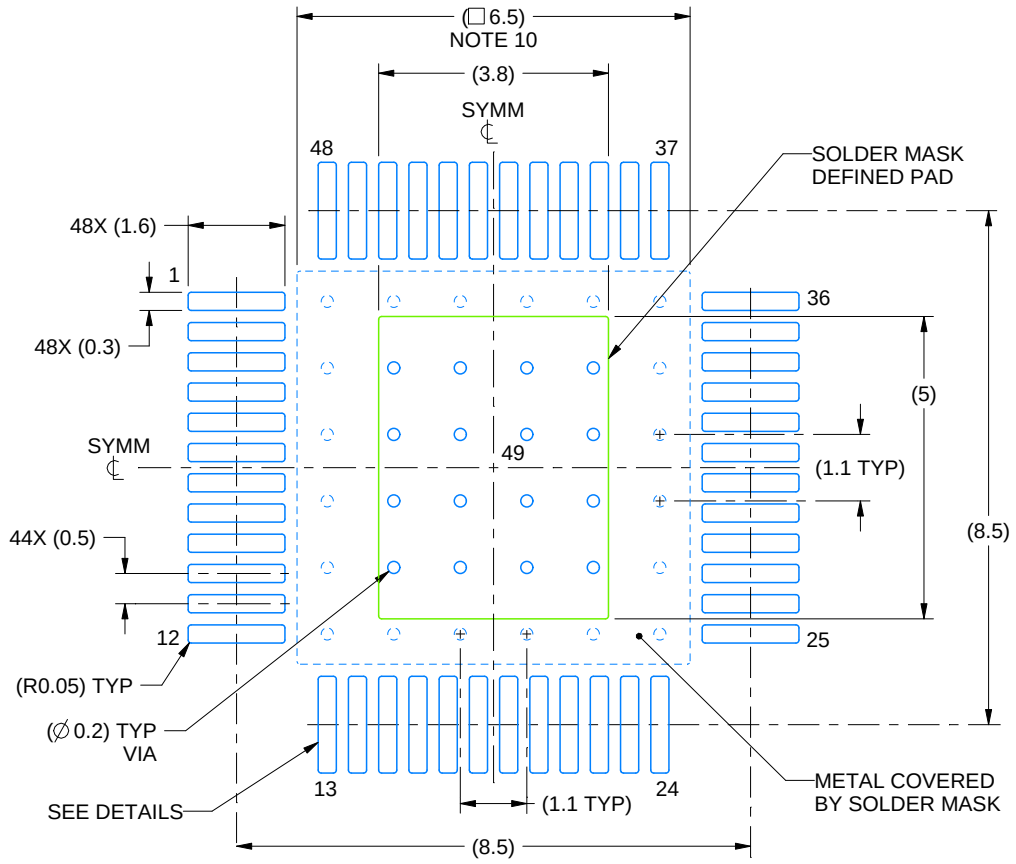
PLASTIC QUAD FLATPACK



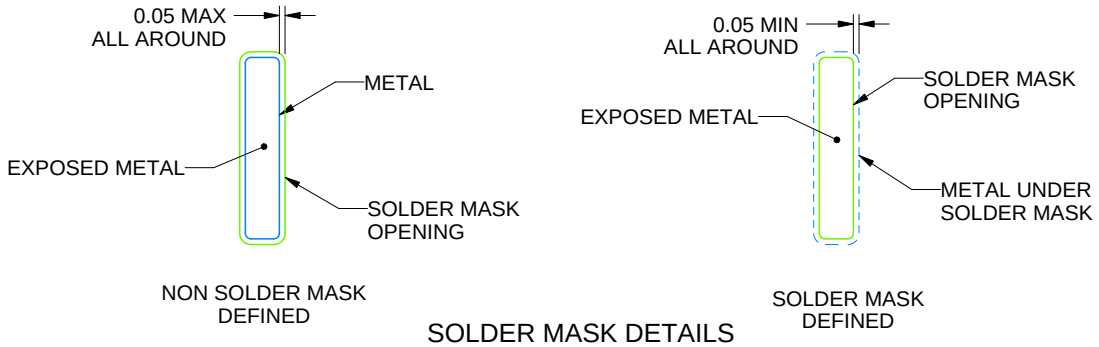

PowerPAD is a trademark of Texas Instruments.

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. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. Reference JEDEC registration MS-026.
5. Feature may not be present.




LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:8X

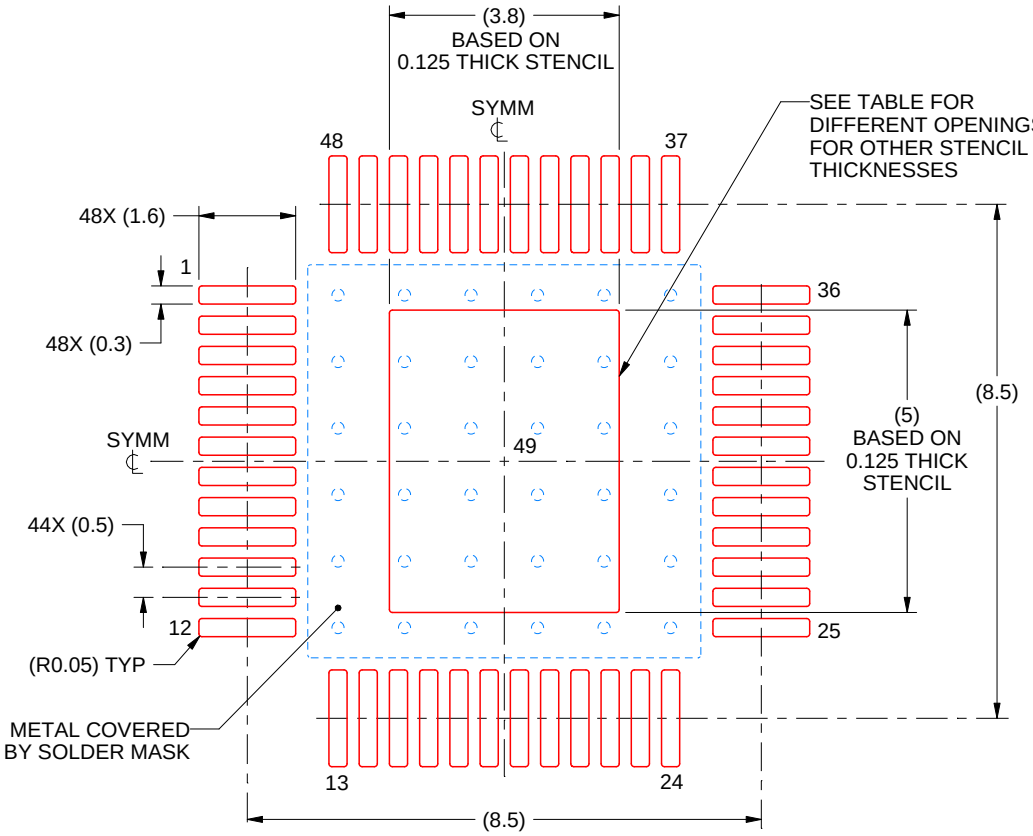



SOLDER MASK DETAILS

4229139/A 10/2022

NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.
8. This package is designed to be soldered to a thermal pad on the board. See technical brief, Powerpad thermally enhanced package, Texas Instruments Literature No. SLMA002 (www.ti.com/lit/slma002) and SLMA004 (www.ti.com/lit/slma004).
9. Vias are optional depending on application, refer to device data sheet. It is recommended that vias under paste be filled, plugged or tented.
10. Size of metal pad may vary due to creepage requirement.




SOLDER PASTE EXAMPLE
EXPOSED PAD
100% PRINTED SOLDER COVERAGE BY AREA
SCALE:8X

| STENCIL THICKNESS | SOLDER STENCIL OPENING |
|---|---|
| 0.1 | 4.25 X 5.59 |
| 0.125 | 3.80 X 5.00 (SHOWN) |
| 0.150 | 3.47 X 4.56 |
| 0.175 | 3.21 X 4.23 |

4229139/A 10/2022

NOTES: (continued)

11. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
12. Board assembly site may have different recommendations for stencil design.

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