# TPS92662-Q1 High-brightness LED Matrix Manager for Automotive Headlight Systems

## 1 Features

- AEC-Q100 qualified for automotive applications
  - Grade 1: –40°C to 125°C ambient operating temperature
  - Device HBM classification level H1C
  - Device CDM classification level C5
- Input voltage range: 4.5 V to 60 V
- 12 Integrated bypass switches
  - Four sub-strings of three series switches
  - 20-V maximum across switch
  - 62-V maximum switch to ground
- Multi-drop UART communication interface
  - Up to 31 addressable devices
- Compatible with CAN physical layer
  - Minimum number of wires in cable harness
- Eight-bit ADC with two MUXed inputs
- Crystal oscillator driver
- External EEPROM $I^2C$ interface
- Programmable 10-bit PWM dimming
  - Individual phase shift and pulse width
  - Device-to-device synchronization
- LED open and short detection and protection

## 2 Applications

- Automotive headlight systems
- High-brightness LED matrix systems
- ADB or glare-free high beam
- Sequential turn and animated daytime running lights

## 3 Description

The TPS92662-Q1 LED matrix manager device enables fully dynamic adaptive lighting solutions by providing individual pixel-level LED control.

The device includes four sub-strings of three series-connected integrated switches for bypassing individual LEDs. The individual sub-strings allow the device to accept either single or multiple current sources. It also allows paralleling up to four switches for bypassing high current LEDs.

A master microcontroller is used to control and manage the TPS92662-Q1 devices via a multi-drop universal asynchronous receiver transmitter (UART) serial interface. The serial interface supports the use of CAN transceivers for a more robust physical layer. The $I^2C$ communication interface can be used to read from and write to an external EEPROM that can store system calibration data.

An on-board 8-bit ADC with two multiplexed inputs can be used for system temperature compensation and used to measure a binning value which allows for LED binning and coding.

The internal charge pump rail supplies the gate drive voltage for the LED bypass switches. The low on-resistance ($R_{DS(on)}$) of the bypass switch minimizes conduction loss and power dissipation.

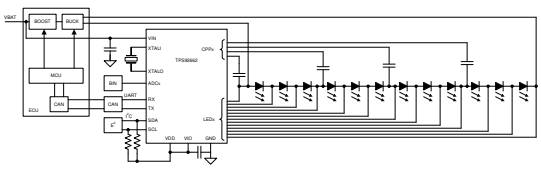
The phase shift and pulse width for each individual LED in the string are programmable. The device uses an internal register to adjust the PWM frequency. Multiple devices can be synchronized. The switch transitions during PWM dimming operation have a programmable slew rate to mitigate EMI concerns.

The device features open LED protection with programmable threshold. The serial interface reports open LED or short LED faults.

**Device Information**

| PART NUMBER | PACKAGE(1) | BODY SIZE (NOM) |
|---|---|---|
| TPS92662-Q1 | PHP (48) | 7.00 mm × 7.00 mm |

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



**Simplified Application**

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.

## Table of Contents

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## 4 Revision History

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

| Changes from Revision A (January 2019) to Revision B (July 2020) | Page |
|---|---|
| • Added the CLK low-level ($V_{IH-TH)}$ and high-level ($V_{IH-TH}$ threshold input voltage thresholds to the *Electrical Characteristics* | 0 |
| • Updated the numbering format for tables, figures and cross-references throughout the document | 1 |

| Changes from Revision * (June 2017) to Revision A (January 2019) | Page |
|---|---|
| • Updated *Section 2* | 1 |
| • Updated *Section 3* | 1 |


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# 5 Device and Documentation Support

## 5.1 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.

## 5.2 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.

## 5.3 Trademarks

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## 5.4 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.

## 5.5 Glossary

| | |
|---|---|
| TI Glossary | This glossary lists and explains terms, acronyms, and definitions. |

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## 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.


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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) |
|---|---|---|---|---|---|---|---|---|---|
| TPS92662QPHPRQ1 | Active | Production | HTQFP (PHP) \| 48 | 1000 \| LARGE T&R | Yes | NIPDAU | Level-3-260C-168 HR | -40 to 125 | 92662Q |
| TPS92662QPHPRQ1.A | Active | Production | HTQFP (PHP) \| 48 | 1000 \| LARGE T&R | Yes | NIPDAU | Level-3-260C-168 HR | -40 to 125 | 92662Q |
| TPS92662QPHPTQ1 | Active | Production | HTQFP (PHP) \| 48 | 250 \| SMALL T&R | Yes | NIPDAU | Level-3-260C-168 HR | -40 to 125 | 92662Q |
| TPS92662QPHPTQ1.A | Active | Production | HTQFP (PHP) \| 48 | 250 \| SMALL T&R | Yes | NIPDAU | Level-3-260C-168 HR | -40 to 125 | 92662Q |

(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.

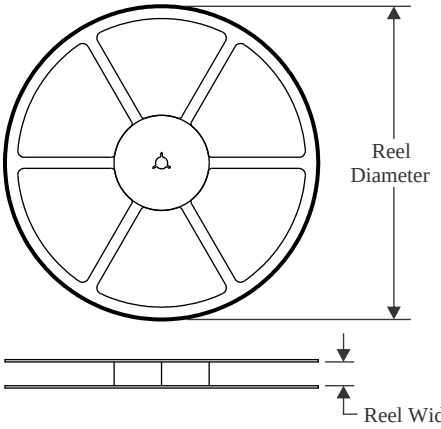
Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

**Important Information and Disclaimer:**The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

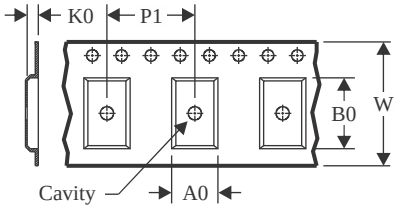
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

## TAPE AND REEL INFORMATION

**REEL DIMENSIONS**

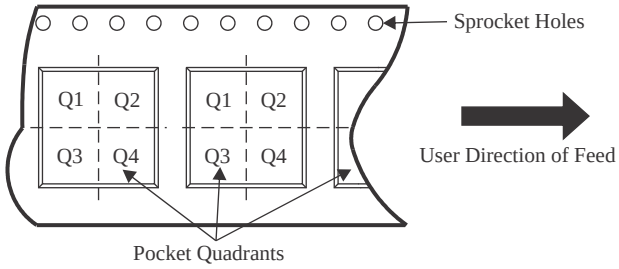



**TAPE DIMENSIONS**




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

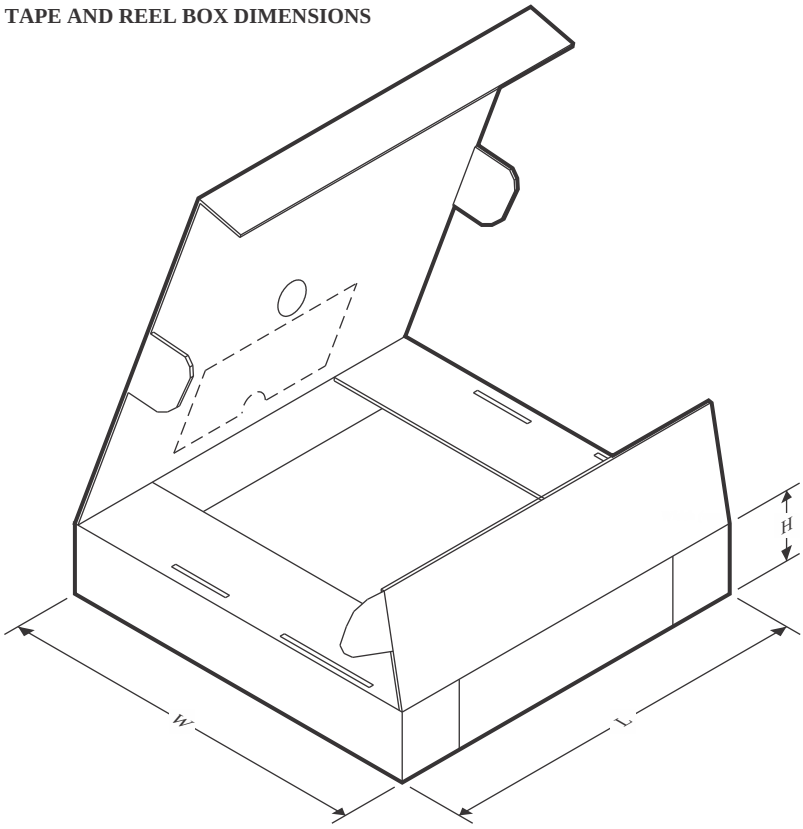
**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**




*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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TPS92662QPHPRQ1 | HTQFP | PHP | 48 | 1000 | 330.0 | 16.4 | 9.6 | 9.6 | 1.5 | 12.0 | 16.0 | Q2 |
| TPS92662QPHPRQ1 | HTQFP | PHP | 48 | 1000 | 330.0 | 16.4 | 9.8 | 9.8 | 2.0 | 12.0 | 16.0 | Q2 |
| TPS92662QPHPRQ1 | HTQFP | PHP | 48 | 1000 | 330.0 | 16.4 | 9.6 | 9.6 | 1.5 | 12.0 | 16.0 | Q2 |
| TPS92662QPHPTQ1 | HTQFP | PHP | 48 | 250 | 330.0 | 16.4 | 9.8 | 9.8 | 2.0 | 12.0 | 16.0 | Q2 |
| TPS92662QPHPTQ1 | HTQFP | PHP | 48 | 250 | 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) |
|---|---|---|---|---|---|---|---|
| TPS92662QPHPRQ1 | HTQFP | PHP | 48 | 1000 | 350.0 | 350.0 | 43.0 |
| TPS92662QPHPRQ1 | HTQFP | PHP | 48 | 1000 | 356.0 | 356.0 | 36.0 |
| TPS92662QPHPRQ1 | HTQFP | PHP | 48 | 1000 | 336.6 | 336.6 | 31.8 |
| TPS92662QPHPTQ1 | HTQFP | PHP | 48 | 250 | 356.0 | 356.0 | 36.0 |
| TPS92662QPHPTQ1 | HTQFP | PHP | 48 | 250 | 336.6 | 336.6 | 31.8 |

# GENERIC PACKAGE VIEW

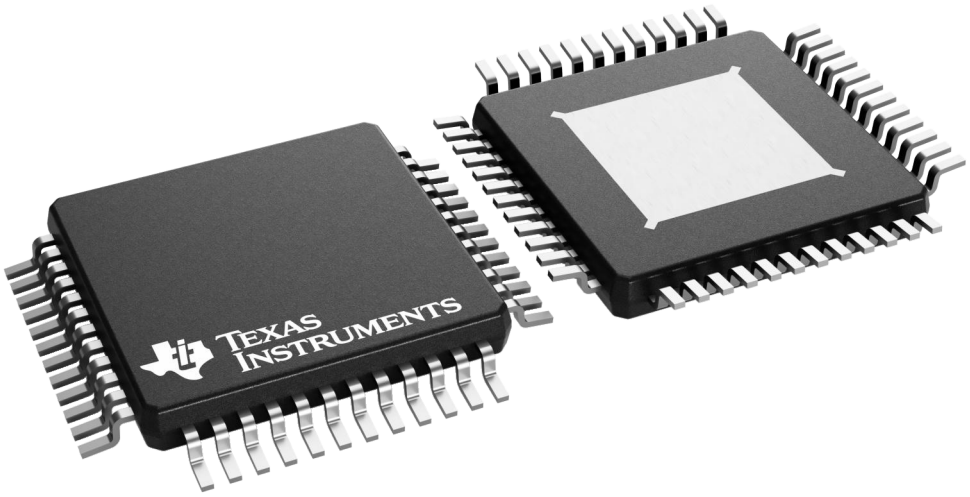
## PHP 48

## 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.



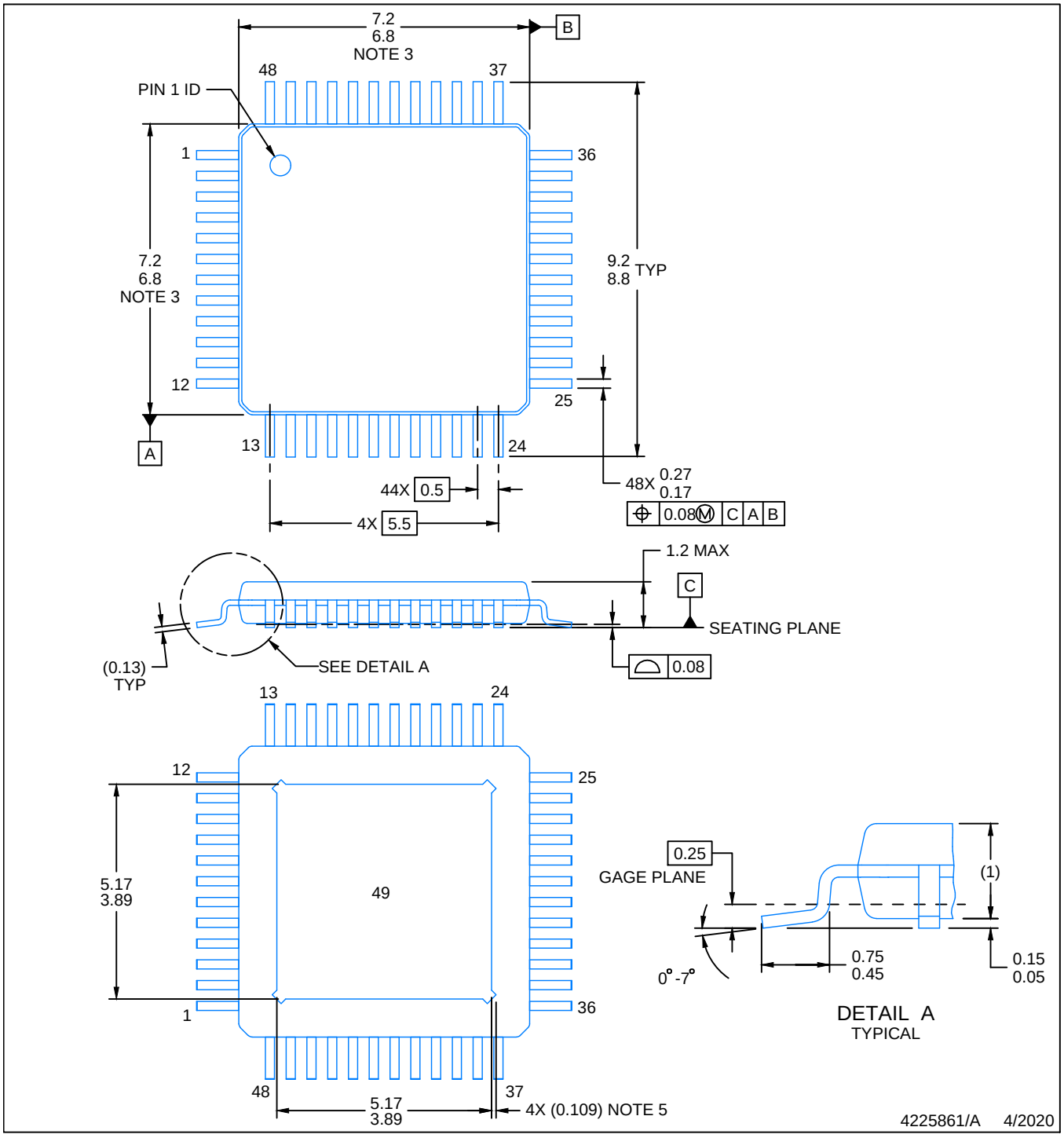

4226443/A

# PACKAGE OUTLINE

## PHP0048G

## PowerPAD™ HTQFP - 1.2 mm max height

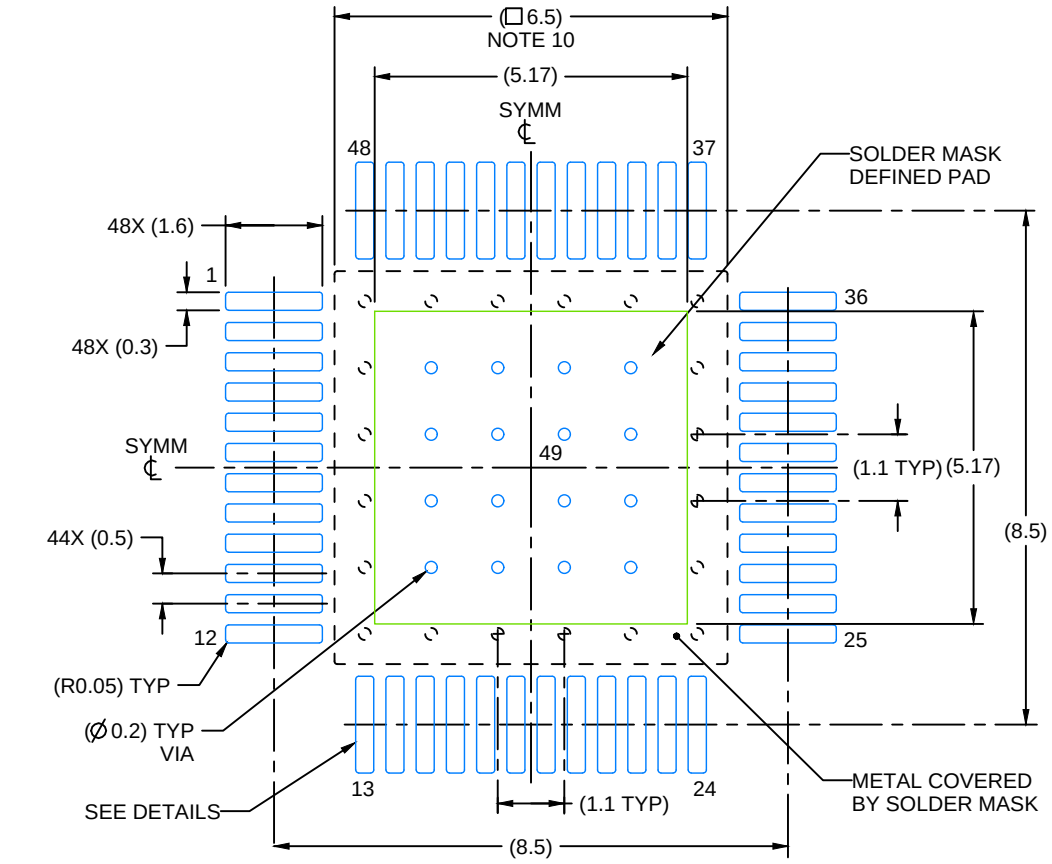
PLASTIC QUAD FLATPACK



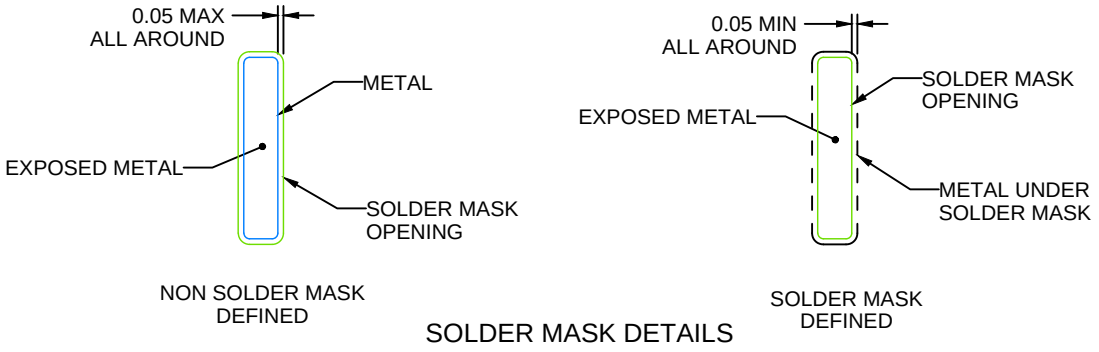

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NOTES:

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

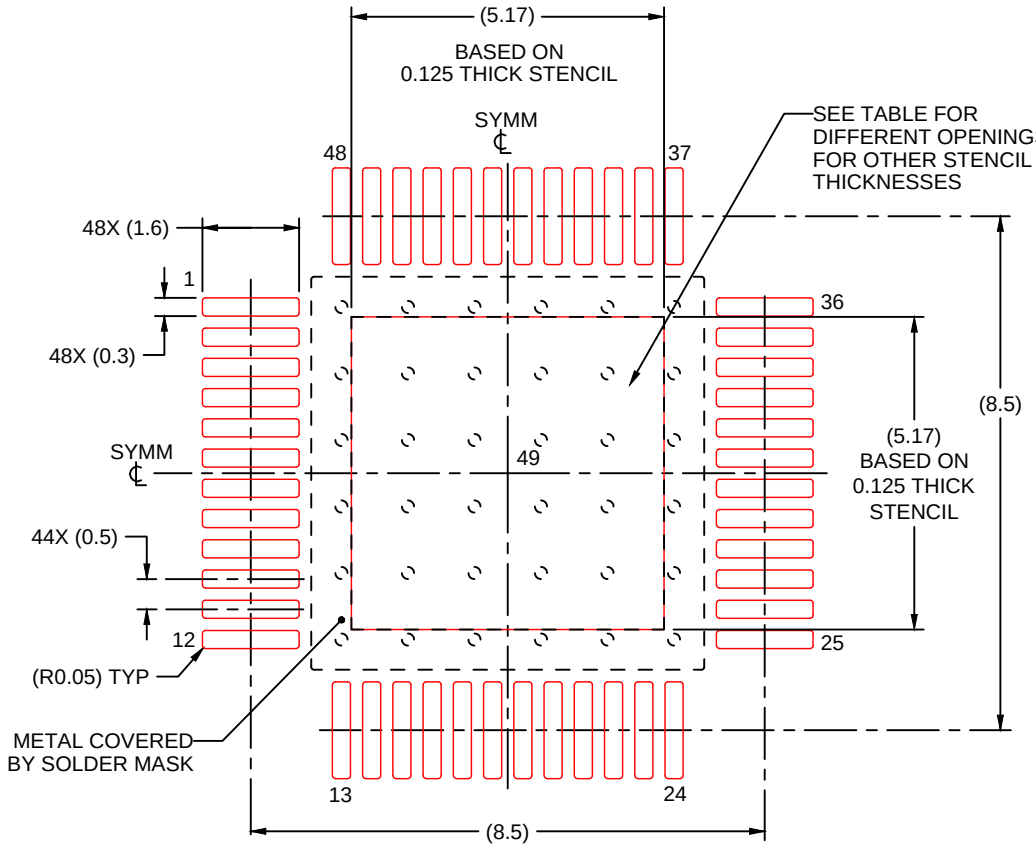



SOLDER MASK DETAILS

4225861/A 4/2020

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 | 5.78 X 5.78 |
| 0.125 | 5.17 X 5.17 (SHOWN) |
| 0.150 | 4.72 X 4.72 |
| 0.175 | 4.37 X 4.37 |

4225861/A 4/2020

NOTES: (continued)

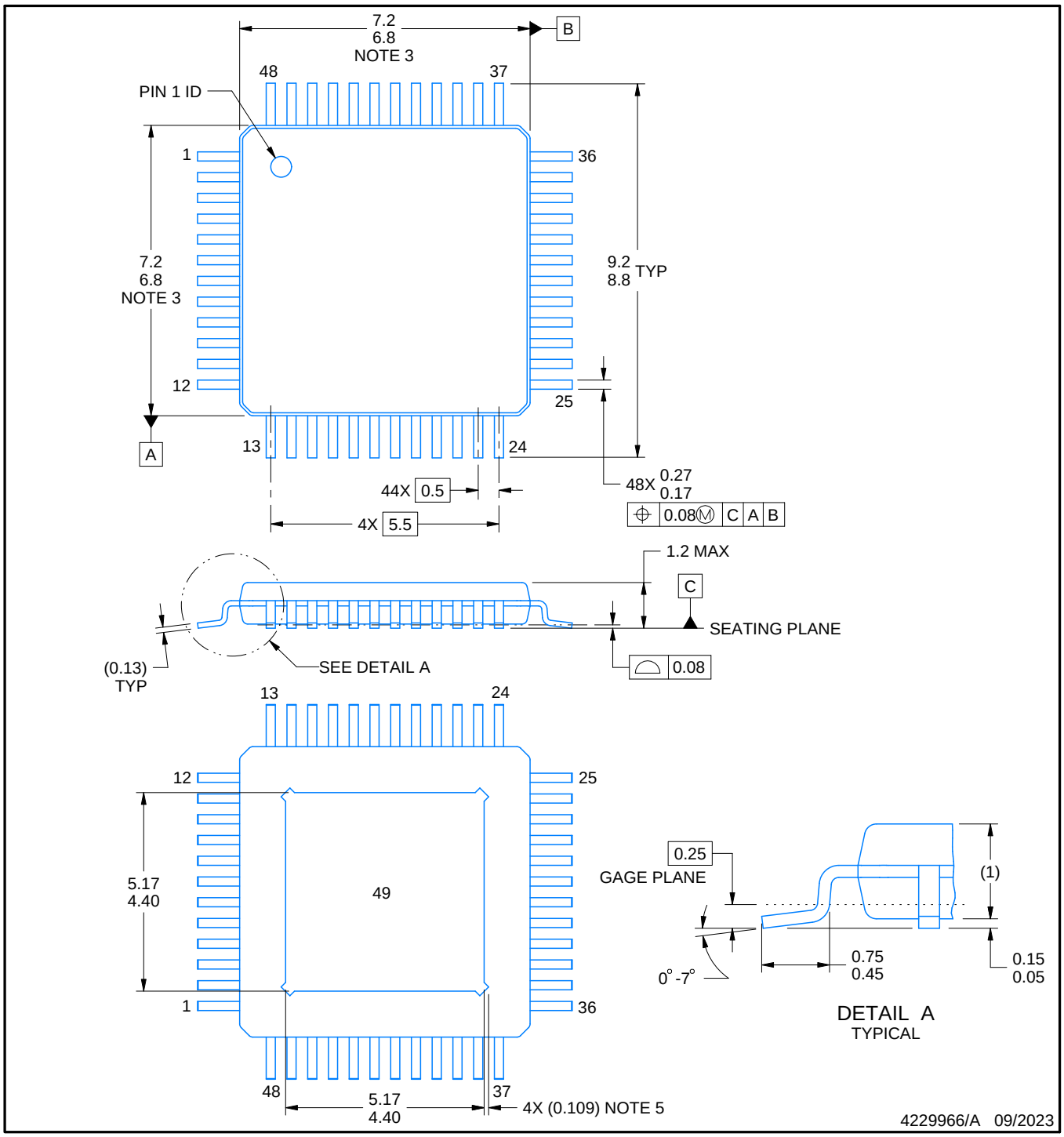
11. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
12. Board assembly site may have different recommendations for stencil design.

# PACKAGE OUTLINE

## PHP0048N

## PowerPAD™ HTQFP - 1.2 mm max height

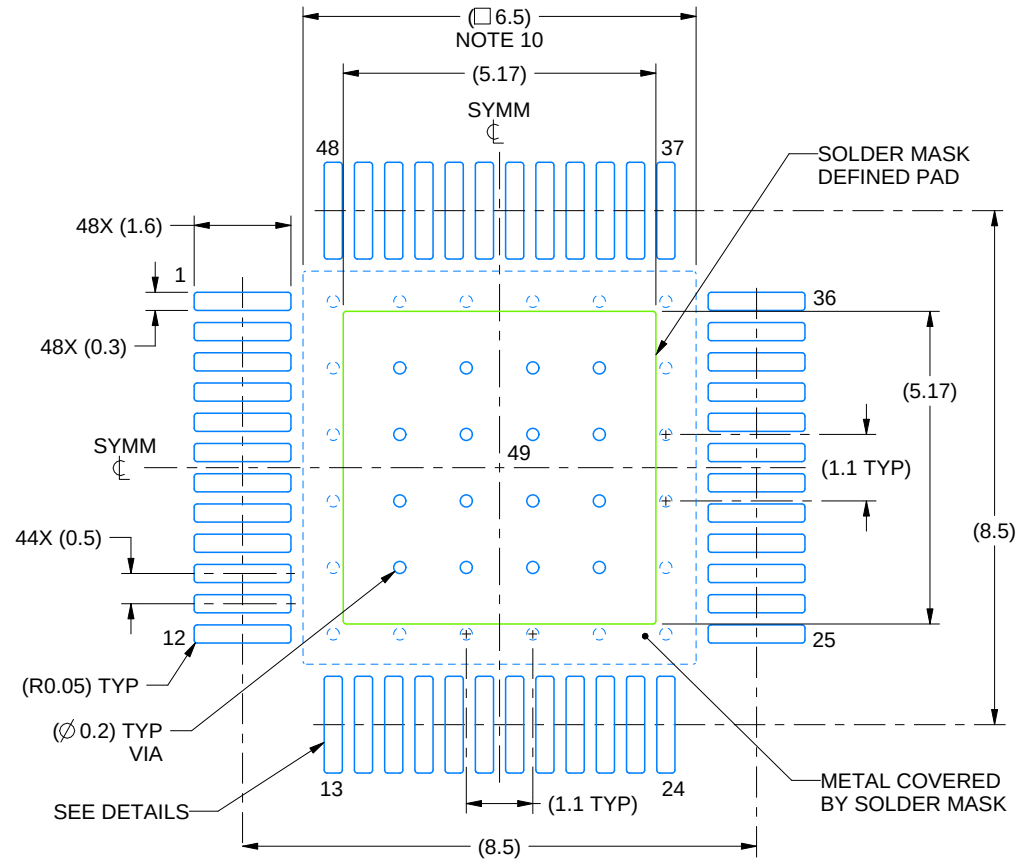
PLASTIC QUAD FLATPACK



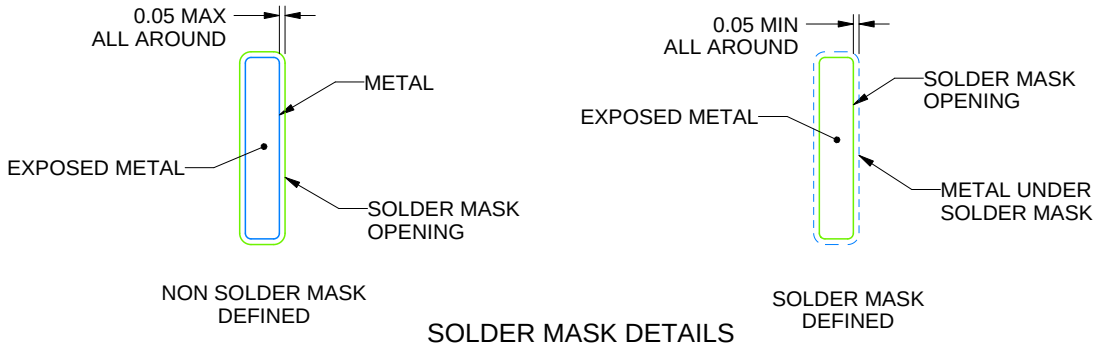

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NOTES:

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

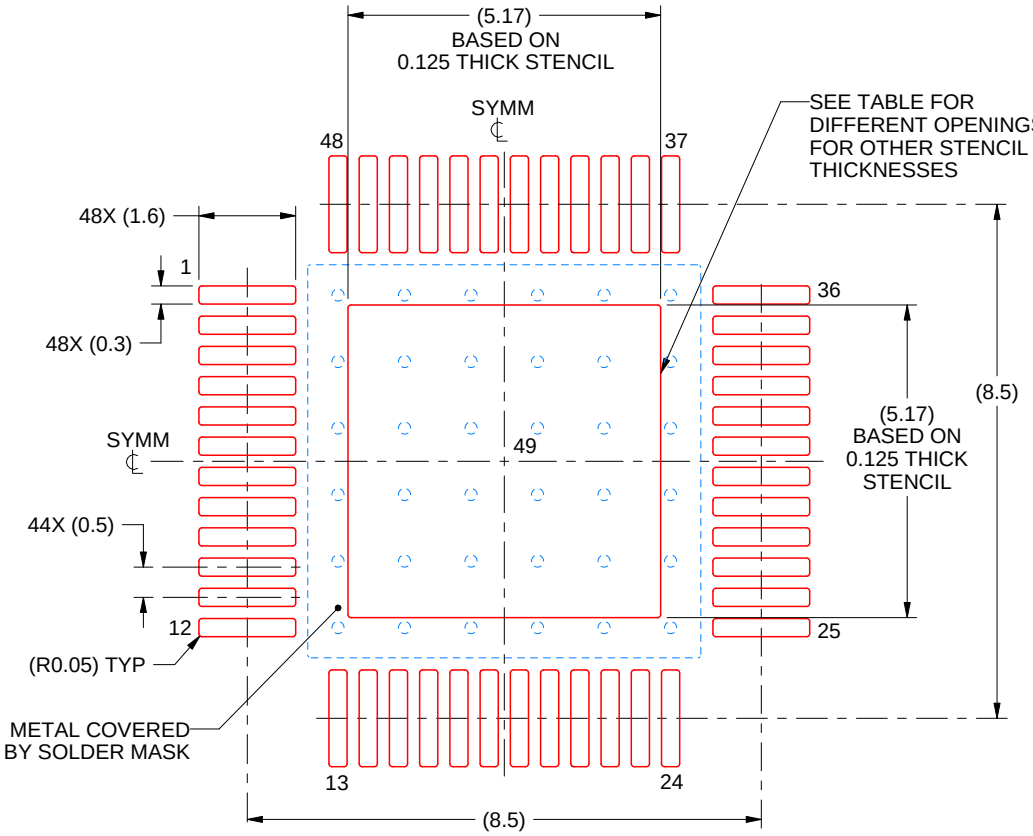



SOLDER MASK DETAILS

4229966/A 09/2023

NOTES: (continued)

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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 |
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4229966/A 09/2023

NOTES: (continued)

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12. Board assembly site may have different recommendations for stencil design.

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