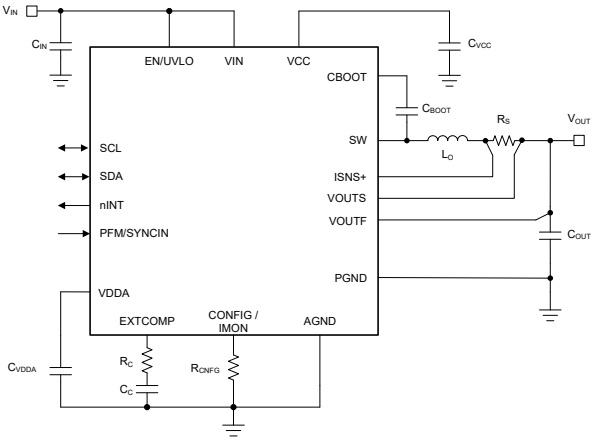
LM72880-Q1 80V, 5A, 8A, Automotive, High-Efficiency CC-CV Buck Converter With I2C

1 Features

- AEC-Q100 qualified for automotive applications:
  - Device temperature grade 1: –40°C to +125°C ambient operating temperature
- Synchronous CC-CV buck converter with I^2C
  - Wide input voltage range: 4.5V to 80V
    - Meets LV148 / ISO21780 requirements
  - 1% accurate, programmable V_{OUT} from 1V (3.3V) to 24V (48V) in 10mV (20mV) steps
  - 3% accurate, programmable $I_{LIM(avg)}$ from 0.5A (0.8A) to 7.5A (12A) in 50mA (80mA) steps
  - Output slew rate: 0.5mV/µs to 40mV/µs
  - Adjustable cable drop compensation
  - Output active discharge
- Designed for pairing with TPS2674X-Q1 USB Type-C PD controllers
- Designed for low EMI requirements
  - Facilitates CISPR 25 Class 5 compliance
  - ±8% dual-random spread spectrum with programmable modulation frequency
  - Programmable f_{SW}: 200kHz to 2.2MHz
  - Programmable PFM or FPWM operation
- Programmable protection features
  - UV/OV (PG) warning: ±5% or ±10%
  - OVP warning, fault: 5% to 36% in 1% steps
  - Internal hiccup-mode overcurrent protection
  - Enable, interrupt, and thermal shutdown
- 6mm × 6mm thermally optimized, RoHS compliant, QFN-29 package with Pb-free plating

2 Applications

- Automotive electronic systems
- Infotainment and cluster
- Automotive USB charging



Typical Application Circuit

3 Description

The LM72880-Q1 is an 80V, ultra-low I_Q, synchronous buck converter with constant-current constant-voltage (CC-CV) regulation and I^2C interface. The device is designed to work with the TPS2674X-Q1 USB Type-C PD controllers.

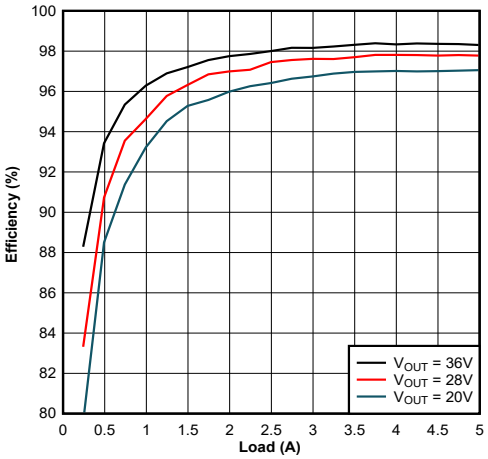
The converter uses a peak current-mode control architecture for easy loop compensation, fast transient response, and excellent load and line regulation. The highly accurate CC-CV operation enables seamless transition between constant-current and constant-voltage modes. The I^2C interface allows programming of output voltage in 10mV or 20mV steps, average output current limit in 50mA steps, as well as output voltage slew rate, switching frequency, soft-start slew rate, mode of operation, current loop compensation, output active discharge strength, and cable drop compensation gain.

The LM72880-Q1 also features an array of safety features including undervoltage and overvoltage protection with programmable thresholds, overcurrent protection with programmable hiccup mode, and thermal shutdown.

Package Information

PART NUMBER	PACKAGE(1)	PACKAGE SIZE(2)
LM72880-Q1	RRX (QFN-29)	6mm × 6mm

(1) For more information, see *Mechanical, Packaging, and Orderable Information*.
(2) The package size (length × width) is a nominal value and includes pins, where applicable.



LM72880QEVM-400 Efficiency, V_{IN} = 48V

ADVANCE INFORMATION

Additional features of the LM72880-Q1 include programmable diode emulation for lower current consumption at light-load conditions, open-drain nINT flag for fault reporting and output monitoring, precision enable input, monotonic start-up into prebiased load, integrated dual input (VIN and VOUTF) VCC supply regulator, and oversized VDDA regulator for powering external loads, such as companion USB PD controllers.

The LM72880-Q1 converter comes in a 6mm × 6mm thermally-optimized, 29-pin QFN package. The three die-attach pads (VIN, SW, and PGND) improve thermal performance and board level reliability (BLR).

4 Device and Documentation Support

4.1 Device Support

4.1.1 Development Support

For development support, see the following:

- For TI's reference design library, visit TI Designs
- TI designs:
  - *ADAS 8-Channel Sensor Fusion Hub Reference Design with Two 4-Gbps Quad Deserializers*
  - *Automotive EMI and Thermally Optimized Synchronous Buck Converter Reference Design*
  - *Automotive High Current, Wide V_{IN} Synchronous Buck Controller Reference Design Featuring LM5141-Q1*
  - *25W Automotive Start-Stop Reference Design Operating at 2.2 MHz*
  - *Synchronous Buck Converter for Automotive Cluster Reference Design*
  - *137W Holdup Converter for Storage Server Reference Design*
  - *Automotive Synchronous Buck With 3.3V @ 12.0A Reference Design*
  - *Automotive Synchronous Buck Reference Design*
  - *Wide Input Synchronous Buck Converter Reference Design With Frequency Spread Spectrum*
  - *Automotive Wide V_{IN} Front-end Reference Design for Digital Cockpit Processing Units*
- Technical articles:
  - *High-Density PCB Layout of DC/DC Converters*
  - *Synchronous Buck Controller Solutions Support Wide V_{IN} Performance and Flexibility*
  - *How to Use Slew Rate for EMI Control*

4.2 Documentation Support

4.2.1 Related Documentation

For related documentation, see the following:

- Application notes:
  - Texas Instruments, *Improve High-current DC/DC Regulator Performance for Free with Optimized Power Stage Layout Application Report*
  - Texas Instruments, *AN-2162 Simple Success with Conducted EMI from DC-DC Converters*
  - Texas Instruments, *Maintaining Output Voltage Regulation During Automotive Cold-Crank with LM5140-Q1 Dual Synchronous Buck Controller*
- Analog design journal:
  - Texas Instruments, *Reduce Buck Converter EMI and Voltage Stress by Minimizing Inductive Parasitics*
- White papers:
  - Texas Instruments, *An Overview of Conducted EMI Specifications for Power Supplies*
  - Texas Instruments, *An Overview of Radiated EMI Specifications for Power Supplies*
  - Texas Instruments, *Valuing Wide V_{IN}, Low EMI Synchronous Buck Circuits for Cost-driven, Demanding Applications*

4.2.1.1 PCB Layout Resources

- Application notes:
  - Texas Instruments, *Improve High-current DC/DC Regulator Performance for Free with Optimized Power Stage Layout*
  - Texas Instruments, *AN-1149 Layout Guidelines for Switching Power Supplies*
  - Texas Instruments, *AN-1229 SIMPLE SWITCHER® PCB Layout Guidelines*
  - Texas Instruments, *Low Radiated EMI Layout Made SIMPLE with LM4360x and LM4600x*
- Seminars:
  - Texas Instruments, *Constructing Your Power Supply – Layout Considerations*

4.2.1.2 Thermal Design Resources

- Application notes:

ADVANCE INFORMATION

- Texas Instruments, *AN-2020 Thermal Design by Insight, Not Hindsight*
- *AN-1520 A Guide to Board Layout for Best Thermal Resistance for Exposed Pad Packages*
- Texas Instruments, *Semiconductor and IC Package Thermal Metrics*
- Texas Instruments, *Thermal Design Made Simple with LM43603 and LM43602*
- Texas Instruments, *PowerPAD™ Thermally Enhanced Package*
- Texas Instruments, *PowerPAD Made Easy*
- Texas Instruments, *Using New Thermal Metrics*

4.3 Receiving Notification of Documentation Updates

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

4.4 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.

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4.6 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.

4.7 Glossary

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

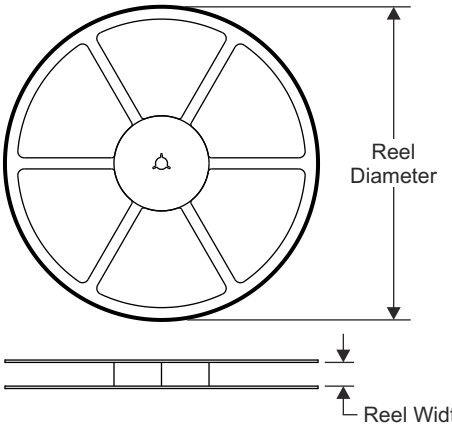
5 Mechanical, Packaging, and Orderable Information

The following pages show 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.

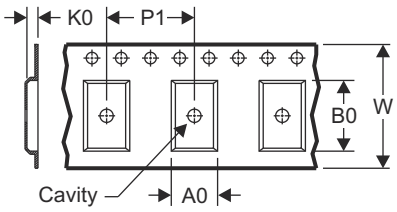
ADVANCE INFORMATION

5.1 Tape and Reel Information

REEL DIMENSIONS

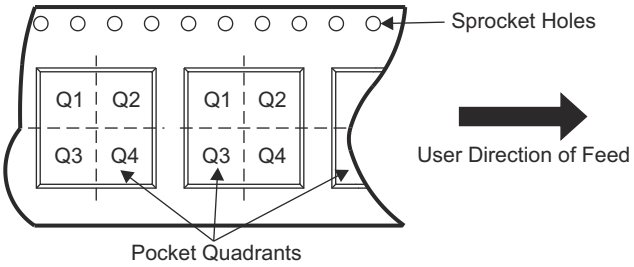


TAPE DIMENSIONS



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

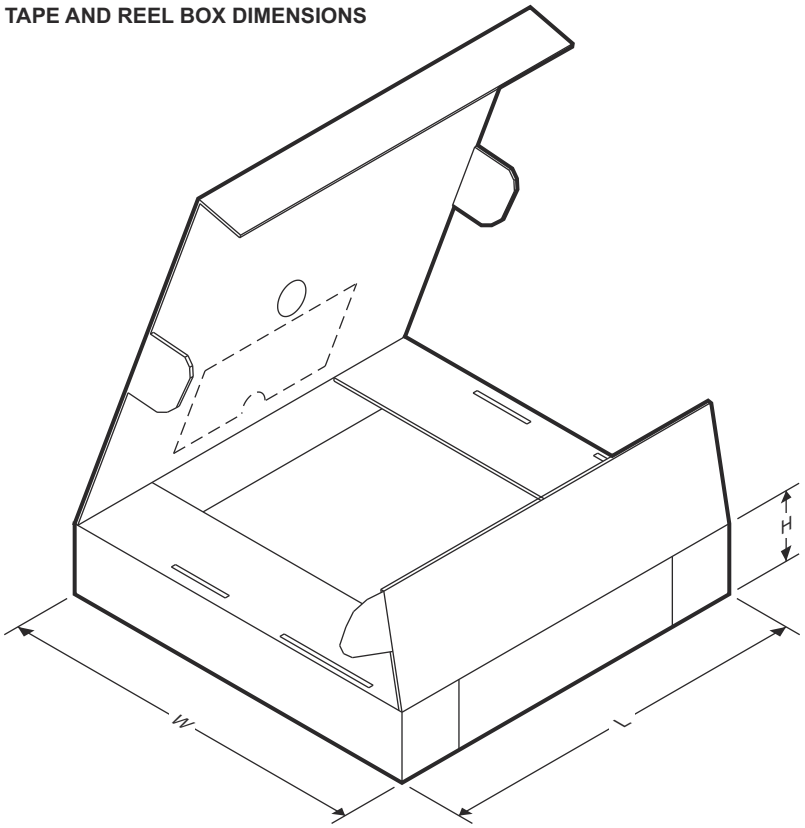


Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
PLM72880QRRXRQ1	QFN	RRX	29	3000	330.0	12.4	3.8	5.8	1.2	8.0	12.0	Q2

ADVANCE INFORMATION

ADVANCE INFORMATION

TAPE AND REEL BOX DIMENSIONS



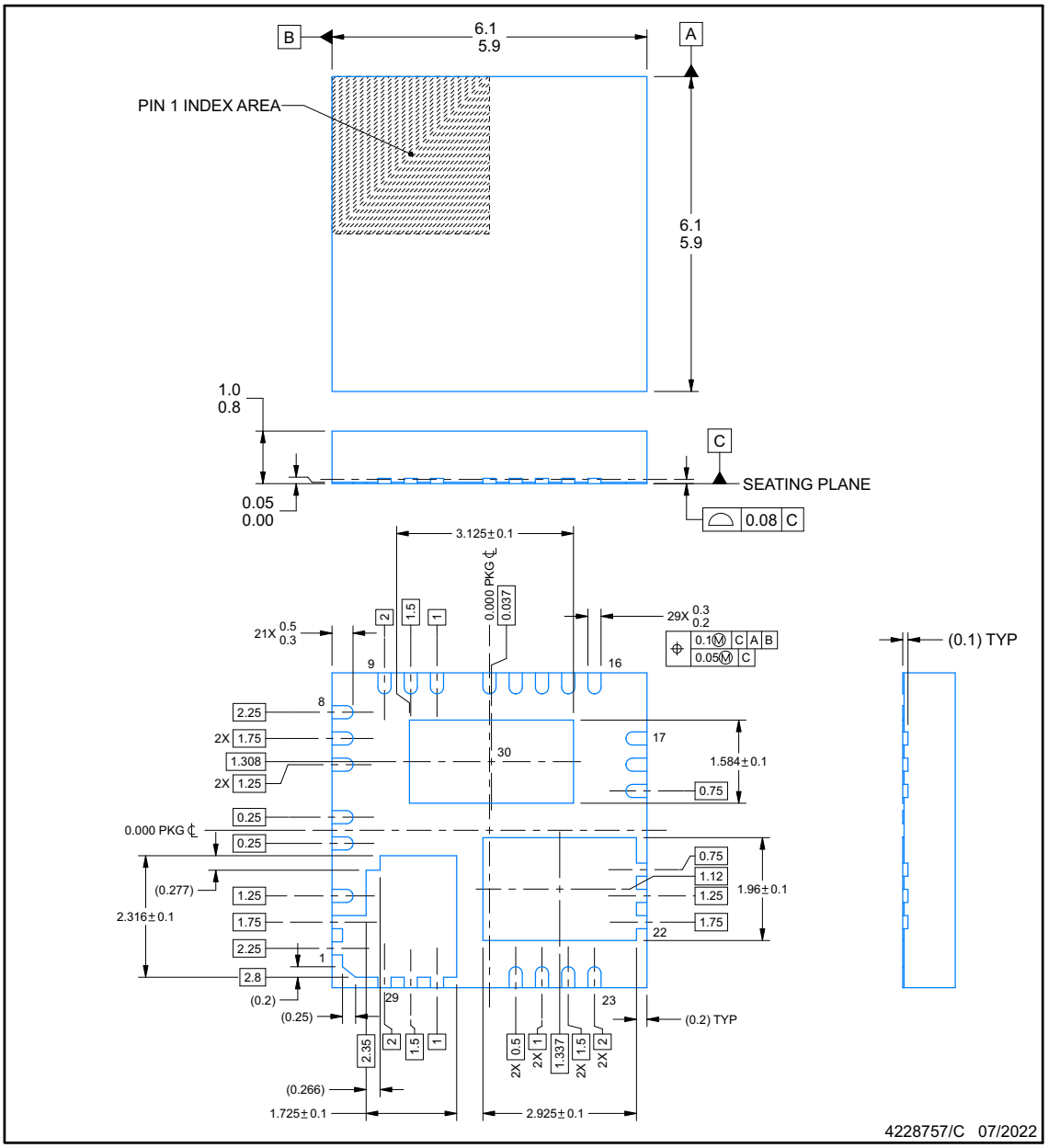
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
PLM72880QRRXRQ1	QFN	RRX	29	3000	367.0	367.0	35.0

PACKAGE OUTLINE

RRX0029B

VQFN - 1.0 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



NOTES:

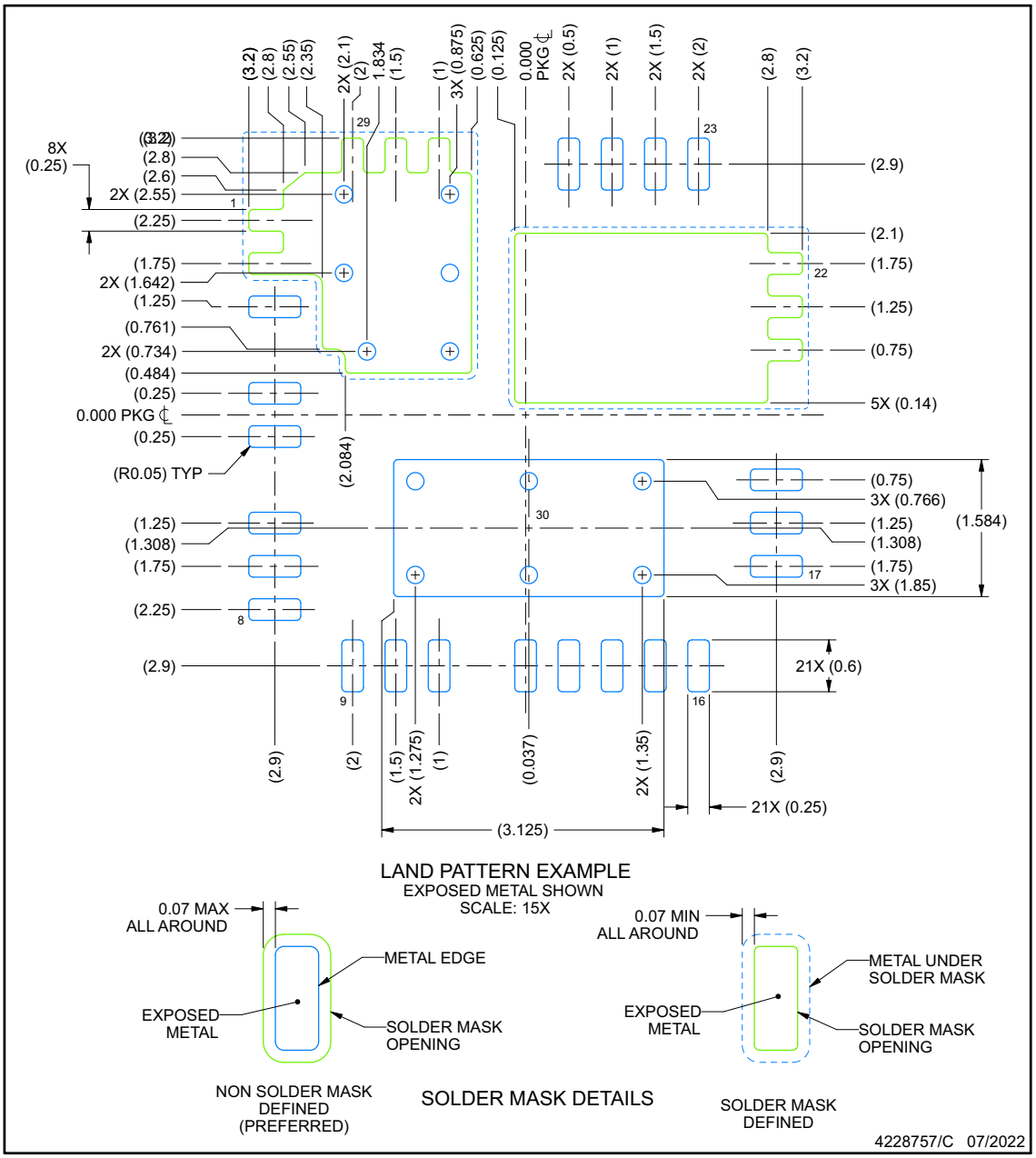
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. The package thermal pad must be soldered to the printed circuit board for thermal and mechanical performance.

ADVANCE INFORMATION

EXAMPLE BOARD LAYOUT

RRX0029B — VQFN - 1.0 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



NOTES: (continued)

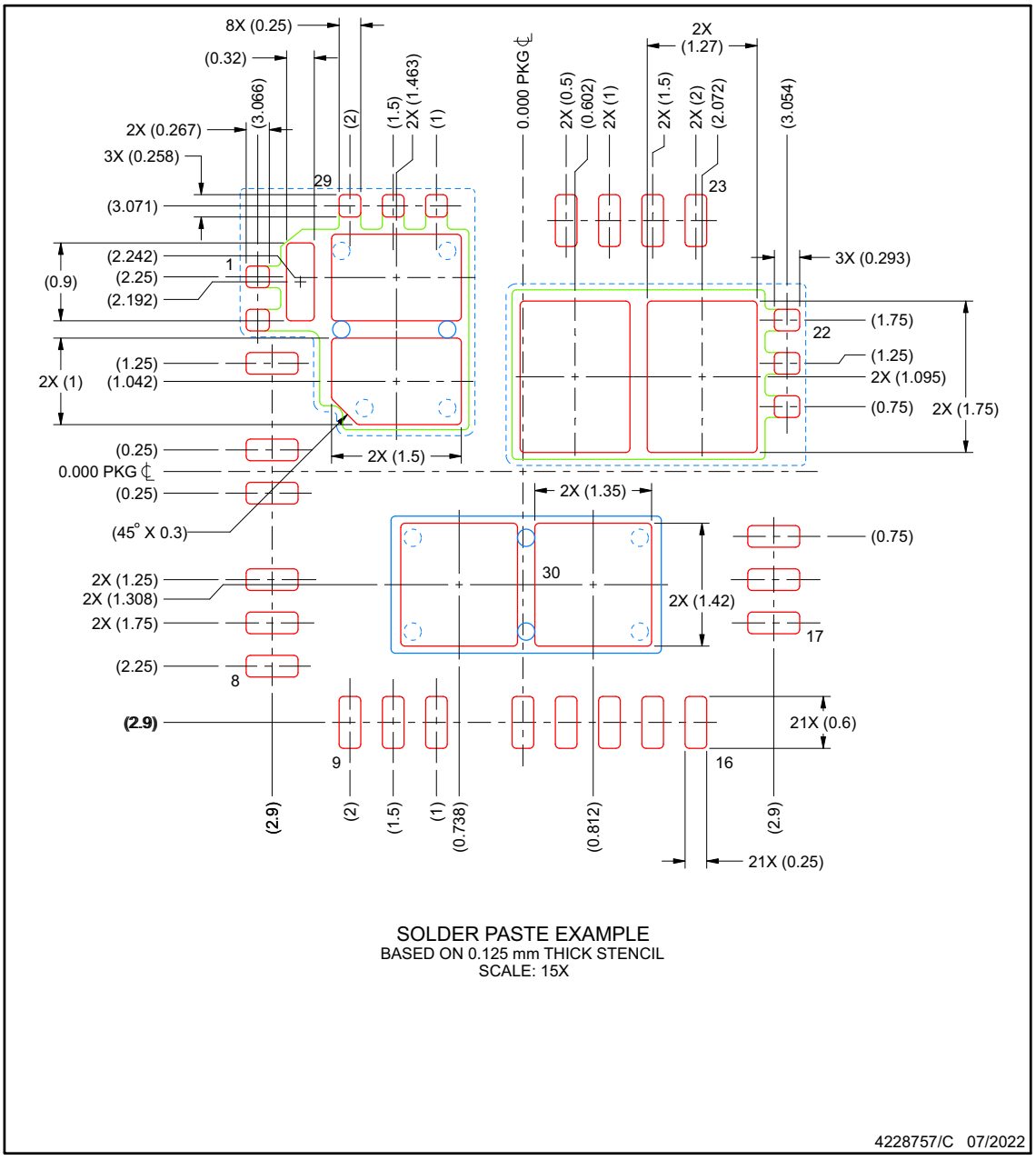
4. This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature number SLUA271 (www.ti.com/lit/slua271).
5. Vias are optional depending on application, refer to device data sheet. If any vias are implemented, refer to their locations shown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

EXAMPLE STENCIL DESIGN

RRX0029B

VQFN - 1.0 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE: 15X

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NOTES: (continued)

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

ADVANCE INFORMATION

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)
PLM72880QRRXRQ1	Active	Preproduction	VQFN (RRX) | 29	490 | JEDEC TRAY (10+1)	-	Call TI	Call TI	-40 to 150	
PLM72880QRRXRQ1.A	Active	Preproduction	VQFN (RRX) | 29	490 | JEDEC TRAY (10+1)	-	Call TI	Call TI	-40 to 150	
PLM72880QRRXRQ1.B	Active	Preproduction	VQFN (RRX) | 29	490 | JEDEC TRAY (10+1)	-	Call TI	Call TI	-40 to 150	

(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.

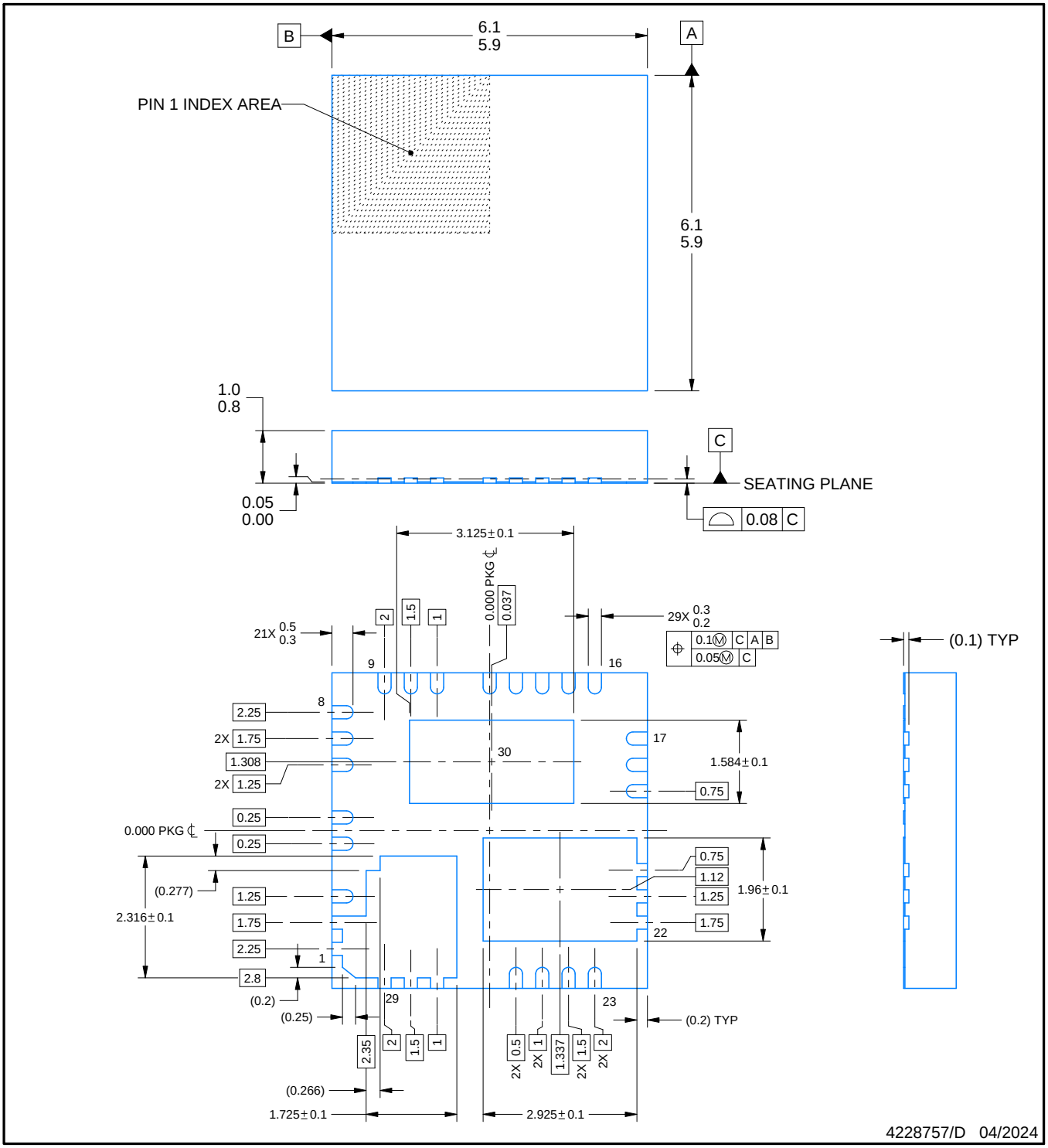
Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

PACKAGE OUTLINE

RRX0029B

VQFN - 1.0 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



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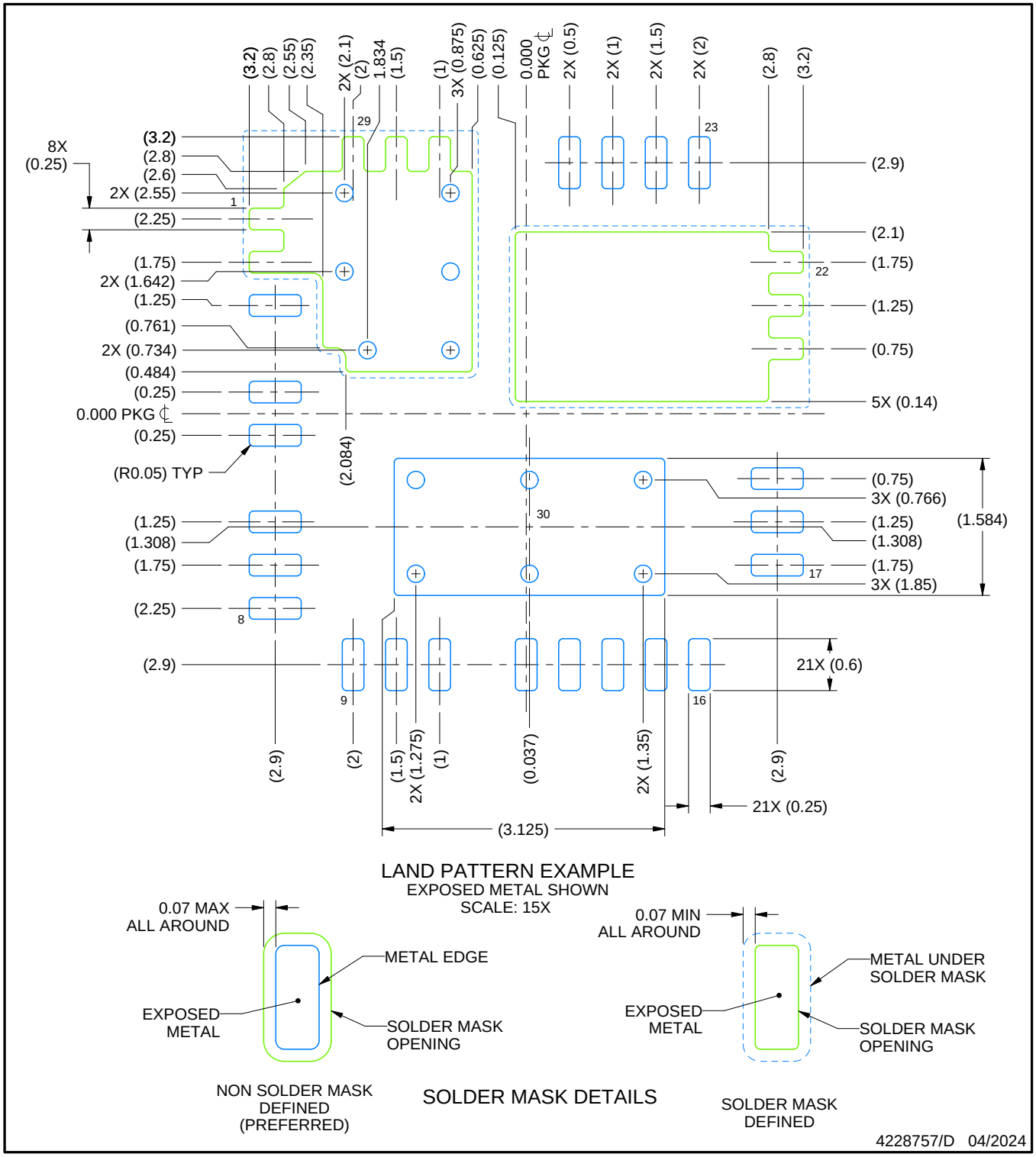

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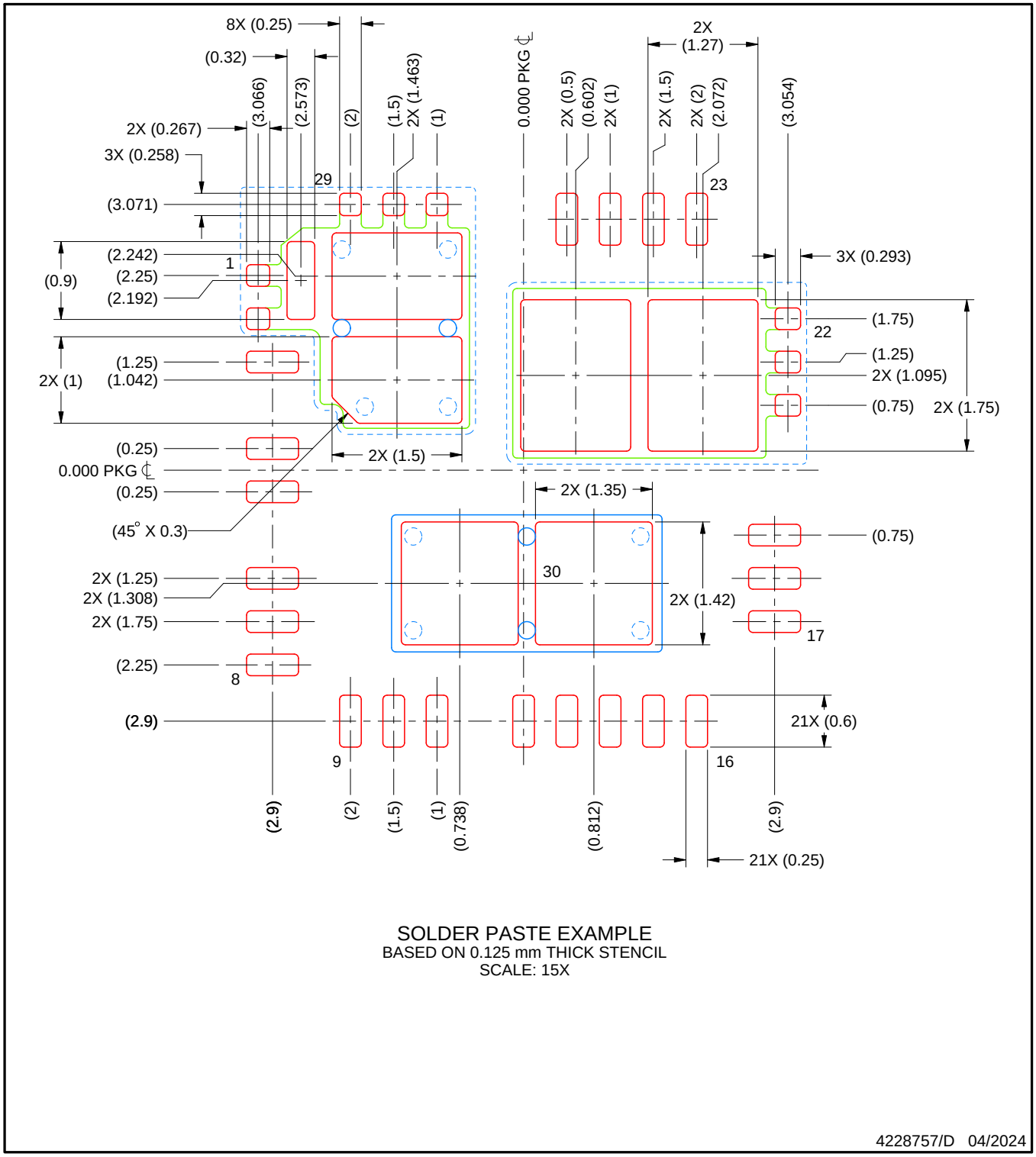

SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE: 15X

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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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