TPS92402 8-Channel 2.5A LED Dot-Controller with Integrated PWM Shunt FETs, SPI Interface and Adaptive Configuration

1 Features

- 4.5V to 65V wide input range
- LED common anode or cathode connection
- 8 integrated PWM shunt FETs
  - 2.5A FET max continuous current
  - Internal 32MHz oscillator for PWM generator
  - Programmable 16-bit, >20kHz PWM dimming
- SPI interface and adaptive configuration
  - Up to 5MHz SPI clock for data transfer
  - Star and daisy chain connection
  - One device for 8-LED or 2x 4-LED strings
  - Stacking up to 4 devices for 32-LED string
- Enhanced EMI performance
  - Programmable PWM slew rate
  - Programmable PWM edge shift
  - Internal charge pump with spread spectrum
- Full protection features
  - LED open detection and protection
  - LED short detection
  - Shunt FET open detection
  - Programmable LED open voltage
  - Thermal warning
- Optional power save mode
  - PWM output to control LED drivers
  - Low power standby mode
- Package: VQFN-36

2 Applications

- Stage and photography lighting
- Surgical lighting
- Machine vision and IP camera LED array
- Cold/warm WLED lighting
- 3D printing
- Industrial transportation

3 Description

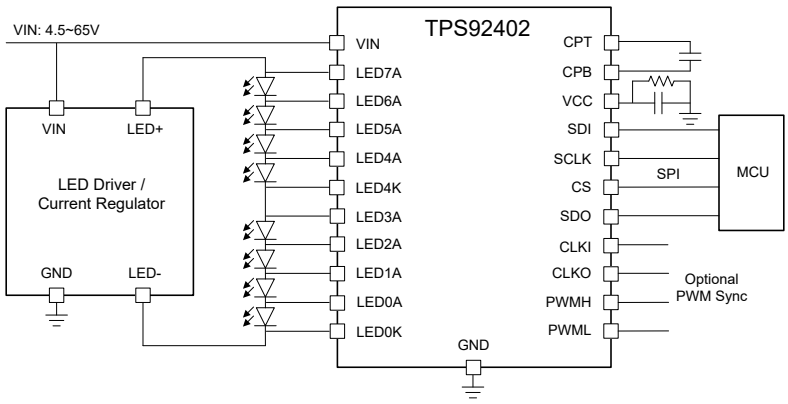
The TPS92402 LED dot-controller device enables 8-channel individual lighting solutions by providing up to 2.5A pixel-level LED dimming control with 4.5V to 65V wide input range. The device includes a string of 8 series-connected integrated shunt FETs, each of which providing PWM dimming for an individual LED. The shunt FET string allows the device to support constant current regulators with either commmon-anode or common-cathode LEDs.

The TPS92402 has an internal oscillator for a system clock to enable integrated PWM generator up to 16-bit with programmable PWM frequency up to 60kHz. The serial peripheral interface (SPI) enables high speed data transmission and supports both daisy chain and star connections. The SPI and optimized pinout allow multiple devices connected in stacking configuration for single-layer PCBs.

The TPS92402 incorporates registers for programming PWM pulse width, slew rate, edge shift and open voltage of each individual LED in the string and for reporting LED open, LED short, shunt FET open and thermal warning. The internal charge pump incorporates spread spectrum feature to enhance EMI performance. The TPS92402 also provides PWM dimming control of constant current regulators and enables multi-channel power save to significantly increase dimming efficiency especially in low brightness condition.

Package Information

PART NUMBER	PACKAGE	BODY SIZE (NOM)
TPS92402	VQFN (36)	6.00mm × 5.00mm



Simplified Application

Table of Contents

4 Device and Documentation Support

4.1 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.

4.2 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.
All trademarks are the property of their respective owners.

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
September 2024	*	Initial release

6 Mechanical, Packaging, and Orderable Information

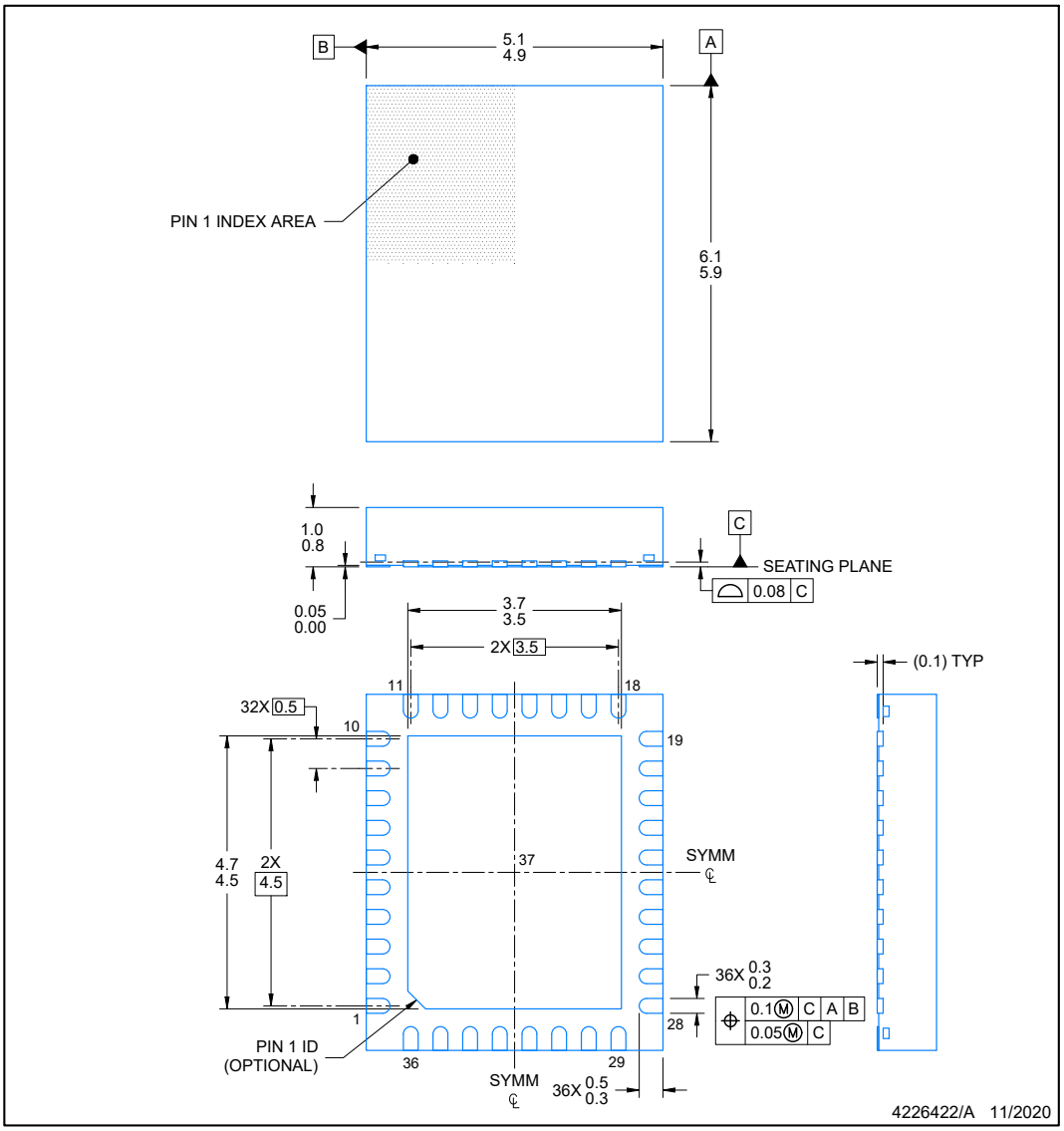
The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand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

PACKAGE OUTLINE

RRV0036A

VQFN - 1 mm max height

PLASTIC QUAD FLATPACK-NO LEAD



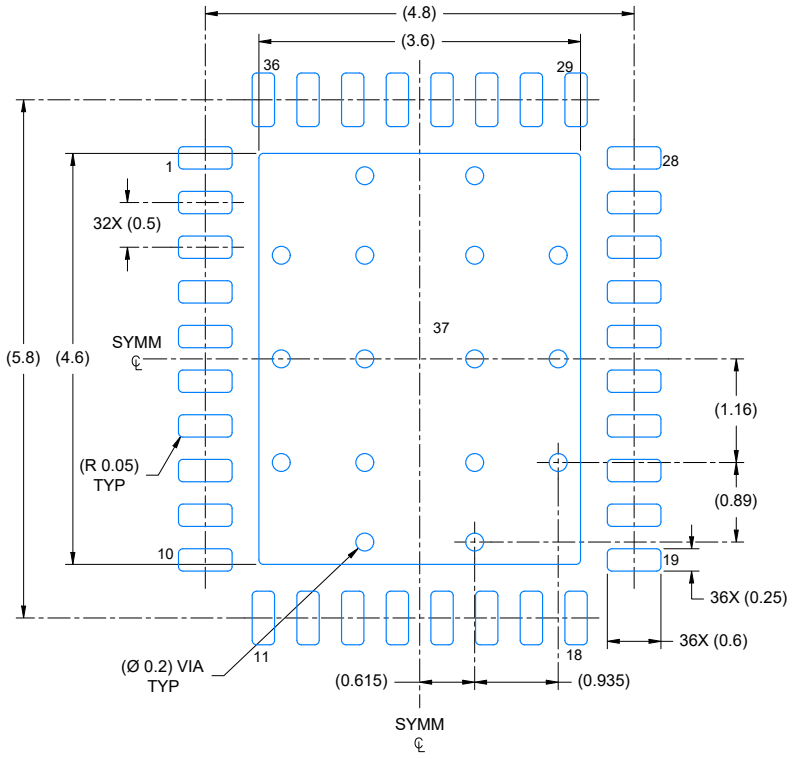
NOTES:

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 optimal thermal and mechanical performance.

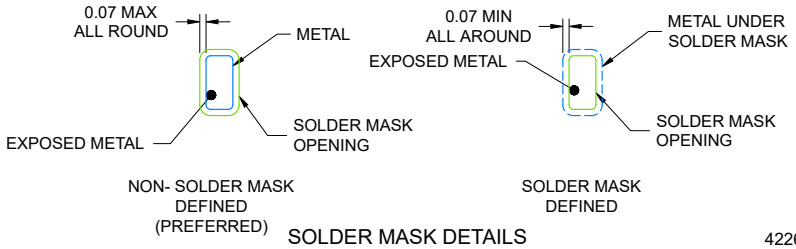
EXAMPLE BOARD LAYOUT

RRV0036A — **VQFN - 1 mm max height**

PLASTIC QUAD FLATPACK-NO LEAD



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 15X



SOLDER MASK DETAILS

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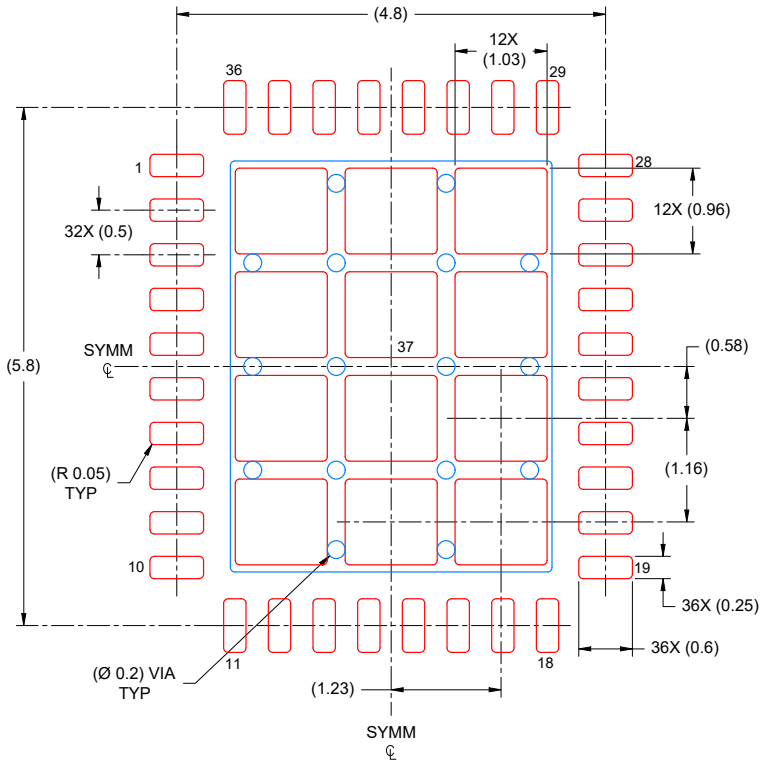
NOTES: (continued)

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.

EXAMPLE STENCIL DESIGN

RRV0036A — **VQFN - 1 mm max height**

PLASTIC QUAD FLATPACK-NO LEAD



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL

EXPOSED PAD
72% PRINTED COVERAGE BY AREA
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.

6.1 Package Option Addendum

Packaging Information

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish(4)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking(5) (6)
TPS92402RRVR	ACTIVE	VQFN	RRV	36	3000	Green (RoHS and no Sb/Br)	Cu NiPdAu	LEVEL1-260C-UNLIM	-40 to 85	92402
TPS92402MRRVR	ACTIVE	VQFN	RRV	36	3000	Green (RoHS and no Sb/Br)	Cu NiPdAu	LEVEL1-260C-UNLIM	-55 to 125	92402M

(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.
PRE_PROD Unannounced device, not in production, not available for mass market, nor on the web, samples not available.
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) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
TBD: The Pb-Free/Green conversion plan has not been defined.
Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.
Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.
Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

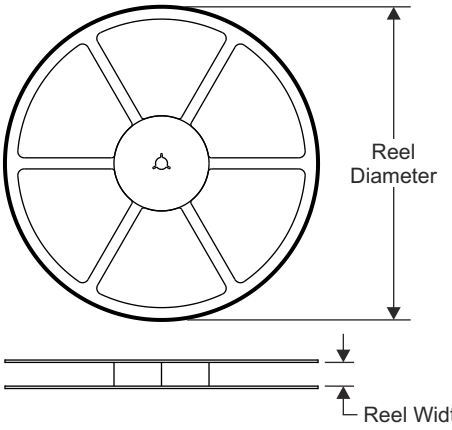
(4) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

(5) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device

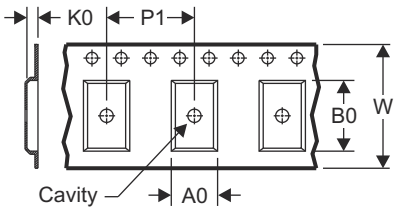
(6) Multiple Device markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

6.2 Tape and Reel Information

REEL DIMENSIONS

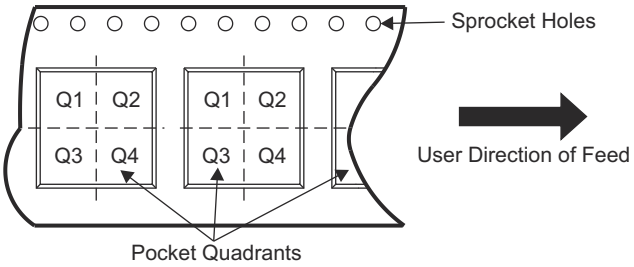


TAPE DIMENSIONS



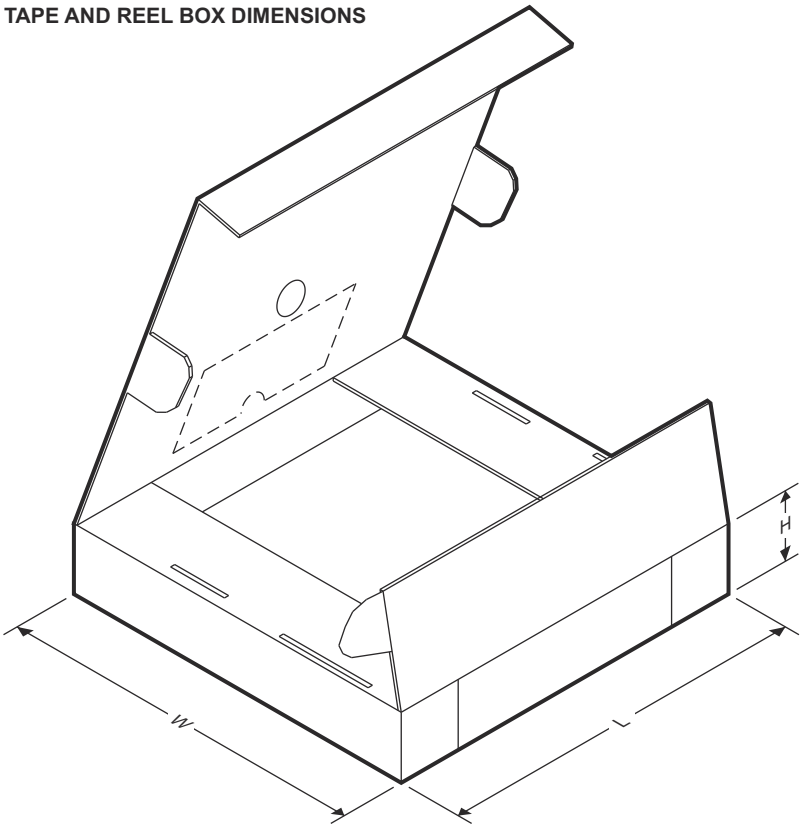
A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

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
TPS92402RRVR	VQFN	RRV	36	3000	330.0	12.4	5.3	6.3	1.15	8.0	12.0	Q1
TPS92402MRRVR	VQFN	RRV	36	3000	330.0	12.4	5.3	6.3	1.15	8.0	12.0	Q1

TAPE AND REEL BOX DIMENSIONS



Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TPS92402RRVR	VQFN	RRV	36	3000	360.0	360.0	36.0
TPS92402MRRVR	VQFN	RRV	36	3000	360.0	360.0	36.0

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
TPS92402MRRVR	ACTIVE	VQFN	RRV	36	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	92402M	Samples
TPS92402RRVR	ACTIVE	VQFN	RRV	36	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	92402	Samples

(1) The marketing status values are defined as follows:
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(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.

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(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.

GENERIC PACKAGE VIEW

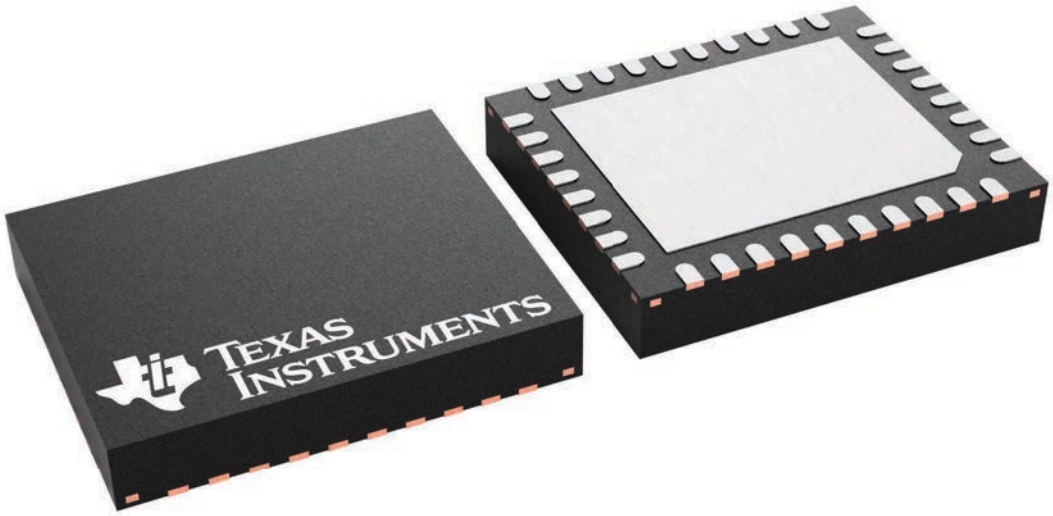
RRV 36

VQFN - 1 mm max height

5 x 6, 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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PACKAGE OUTLINE

RRV0036A

VQFN - 1 mm max height

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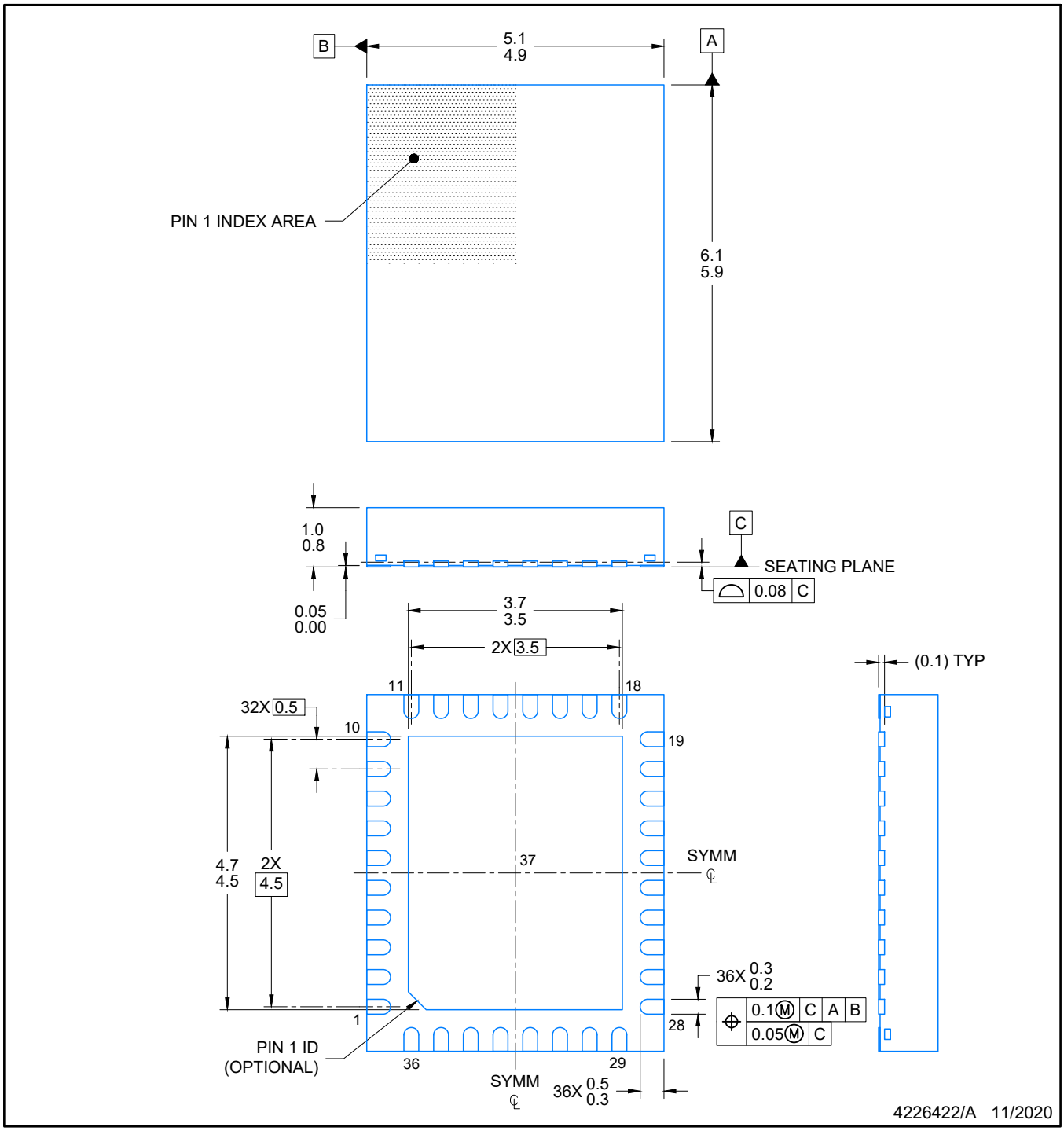

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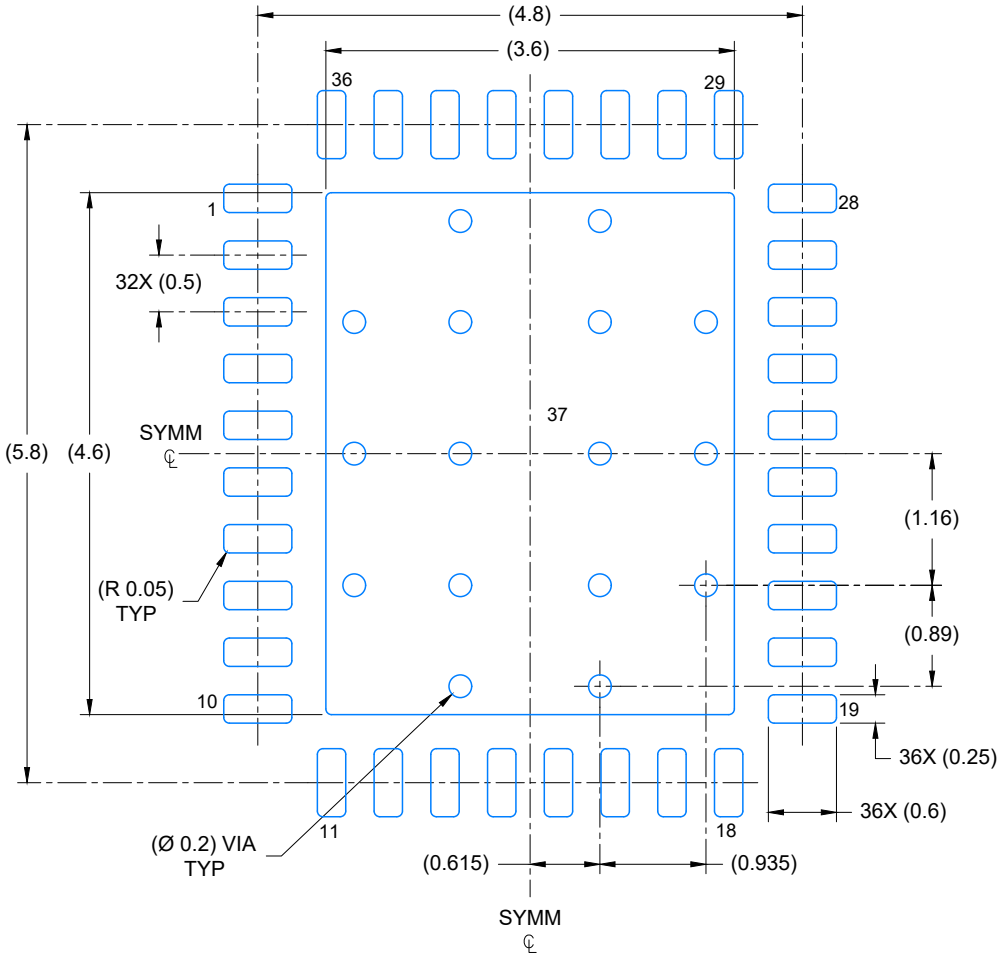
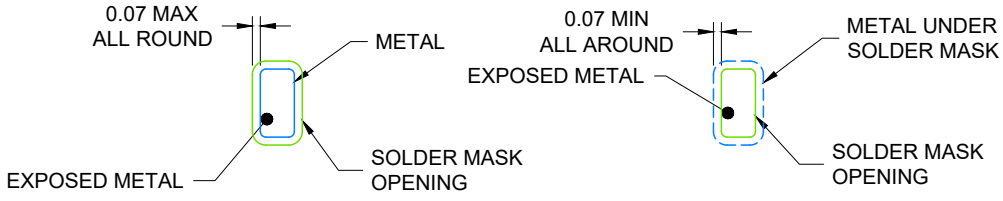


LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 15X



NON- SOLDER MASK DEFINED (PREFERRED)

SOLDER MASK DEFINED

SOLDER MASK DETAILS

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NOTES: (continued)

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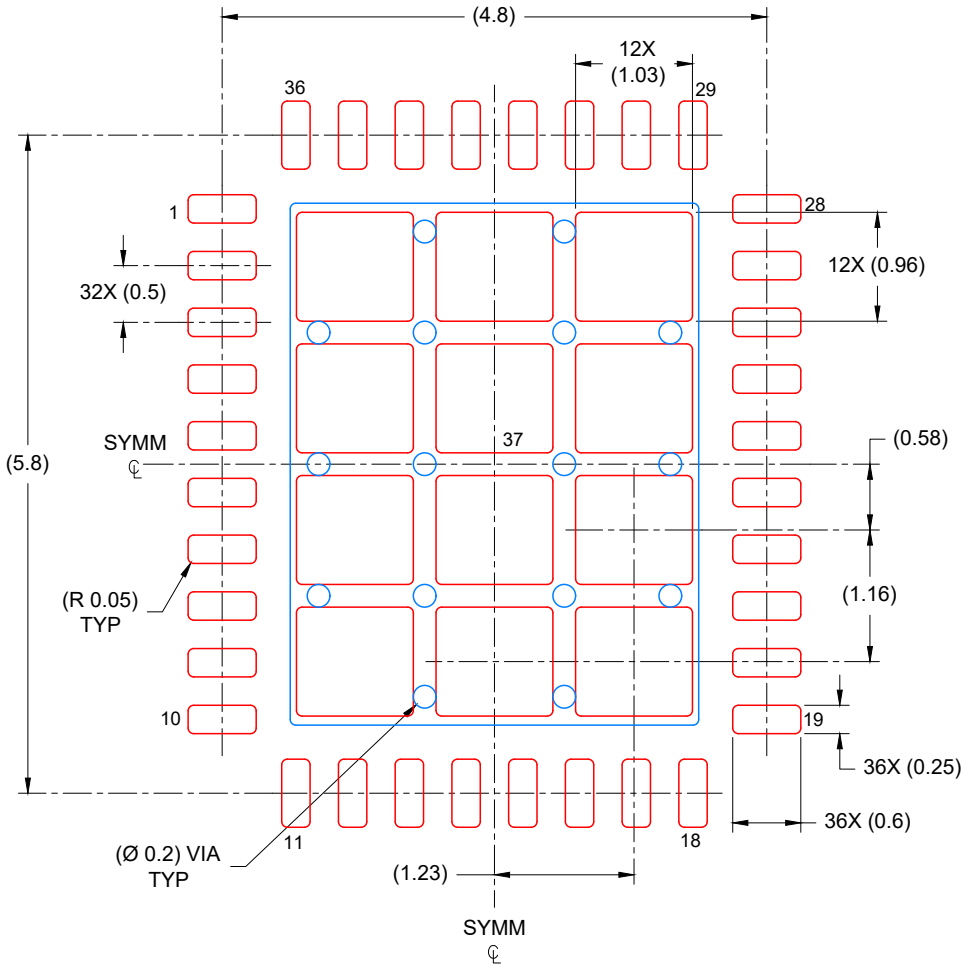

SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL

EXPOSED PAD
72% PRINTED COVERAGE BY AREA
SCALE: 15X

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NOTES: (continued)

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