

TPS51633 3-Phase, D-CAP+™ Step-Down Controller for VR12.6 V_{CPU}

1 Features

- Intel® VR12.6 PWM Specification serial VID (SVID) compliant
- 1-, 2-, or 3-phase operation
- Full VR12.6 mobile feature set including digital current monitor, PS3 and PS4 operation
- 8-Bit DAC with 0.50-V to 2.30-V output range
- Optimized efficiency at light and heavy loads
- 8 independent levels of overshoot reduction (OSR) and undershoot reduction (USR)
- Driverless configuration for efficient high-frequency switching
- Supports discrete, Power Block, Power Stage or DrMOS MOSFET implementations
- Accurate, adjustable voltage positioning
- 300-kHz to 800-kHz frequency selections
- Patented AutoBalance Phase Balancing
- Selectable 8-level current limit
- 4.5-V to 28-V conversion voltage range
- Small, 4 × 4, 32-Pin, QFN PowerPAD™ integrated circuit package

2 Applications

- Adapter
- Battery
- NVDC
- 5-V or 12-V Rails

3 Description

The TPS51633 device is a driverless step-down controller that is fully compliant with the SVID communications protocol, meeting the Intel VR12.6 specification. Advanced control features such as D-CAP+ architecture with overlapping pulse support undershoot reduction (USR) and overshoot reduction (OSR) provide fast transient response, lowest output capacitance and high efficiency. The TPS51633 device also supports single-phase operation in CCM or DCM for light-load efficiency. The TPS51633 device integrates the full complement of VR12.6 I/O features including VR_READY (PGOOD), $\overline{\text{ALERT}}$ and $\overline{\text{VR_HOT}}$. The SVID interface address allows programming from 0 to 7.

In PS4, the quiescent power consumption of the controller is typically 0.25 mW. Adjustable control of VCPU slew rate and voltage positioning round out the VR12.6 features. Paired with the new TPS51604 FET gate driver, the solution delivers exceptionally high speed and low switching loss. The TPS51633 device works with selected TI Power Stage™ products for optimum efficiency as well as DrMOS products.

The TPS51633 device is available in space saving, thermally enhanced 32-pin QFN package that operates from –40°C to 105°C.

PART NUMBER ⁽¹⁾	PACKAGE	BODY SIZE (NOM)
TPS51633	VQFN (32)	4.00 mm × 4.00 mm

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

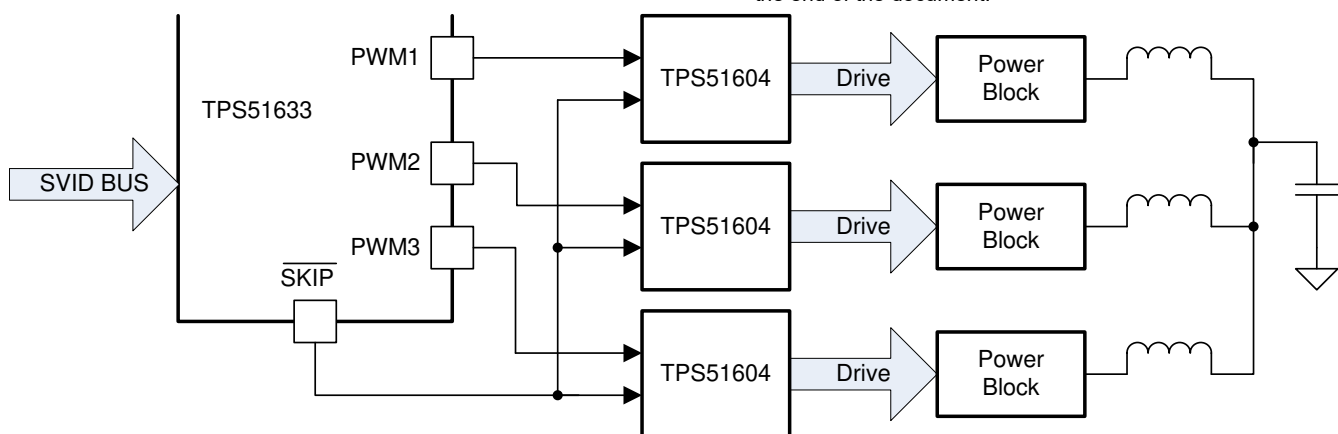


Figure 3-1. Simplified Schematic



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4 Revision History

DATE	REVISION	NOTES
June 2022	*	Initial release.

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](https://www.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.

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.

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
TPS51633RSMR	ACTIVE	VQFN	RSM	32	3000	RoHS & Green	NIPDAU	Level-2-260C-1 YEAR	-40 to 105	TPS 51633	
TPS51633RSMT	ACTIVE	VQFN	RSM	32	250	RoHS & Green	NIPDAU	Level-2-260C-1 YEAR	-40 to 105	TPS 51633	

(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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TAPE AND REEL INFORMATION

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
TPS51633RSMR	VQFN	RSM	32	3000	330.0	12.4	4.25	4.25	1.15	8.0	12.0	Q2
TPS51633RSMT	VQFN	RSM	32	250	180.0	12.4	4.25	4.25	1.15	8.0	12.0	Q2

TAPE AND REEL BOX DIMENSIONS


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TPS51633RSMR	VQFN	RSM	32	3000	367.0	367.0	35.0
TPS51633RSMT	VQFN	RSM	32	250	210.0	185.0	35.0

GENERIC PACKAGE VIEW

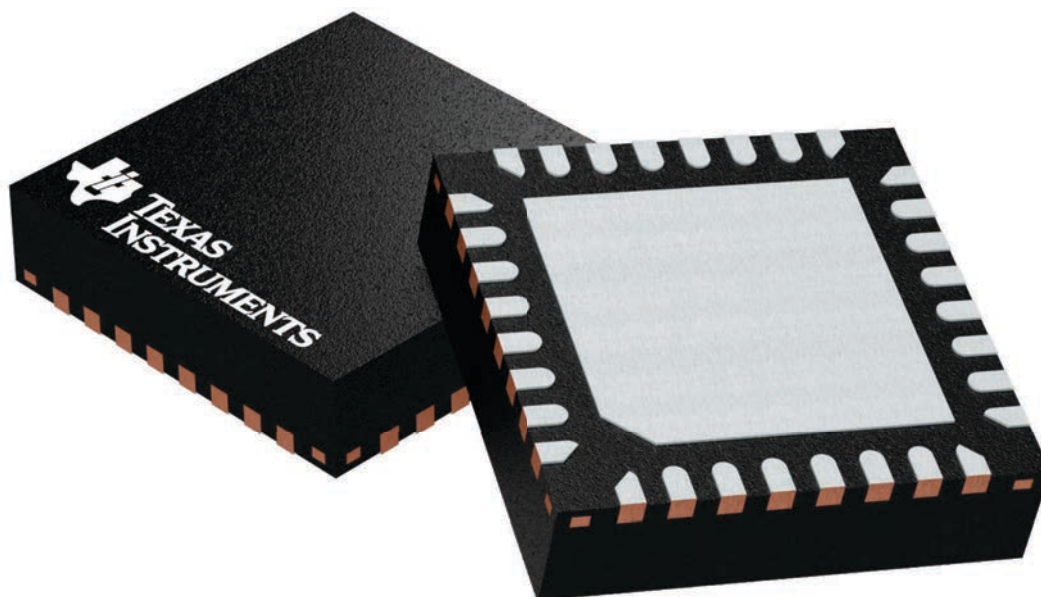
RSM 32

VQFN - 1 mm max height

4 x 4, 0.4 mm pitch

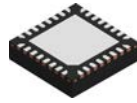
PLASTIC QUAD FLATPACK - NO LEAD

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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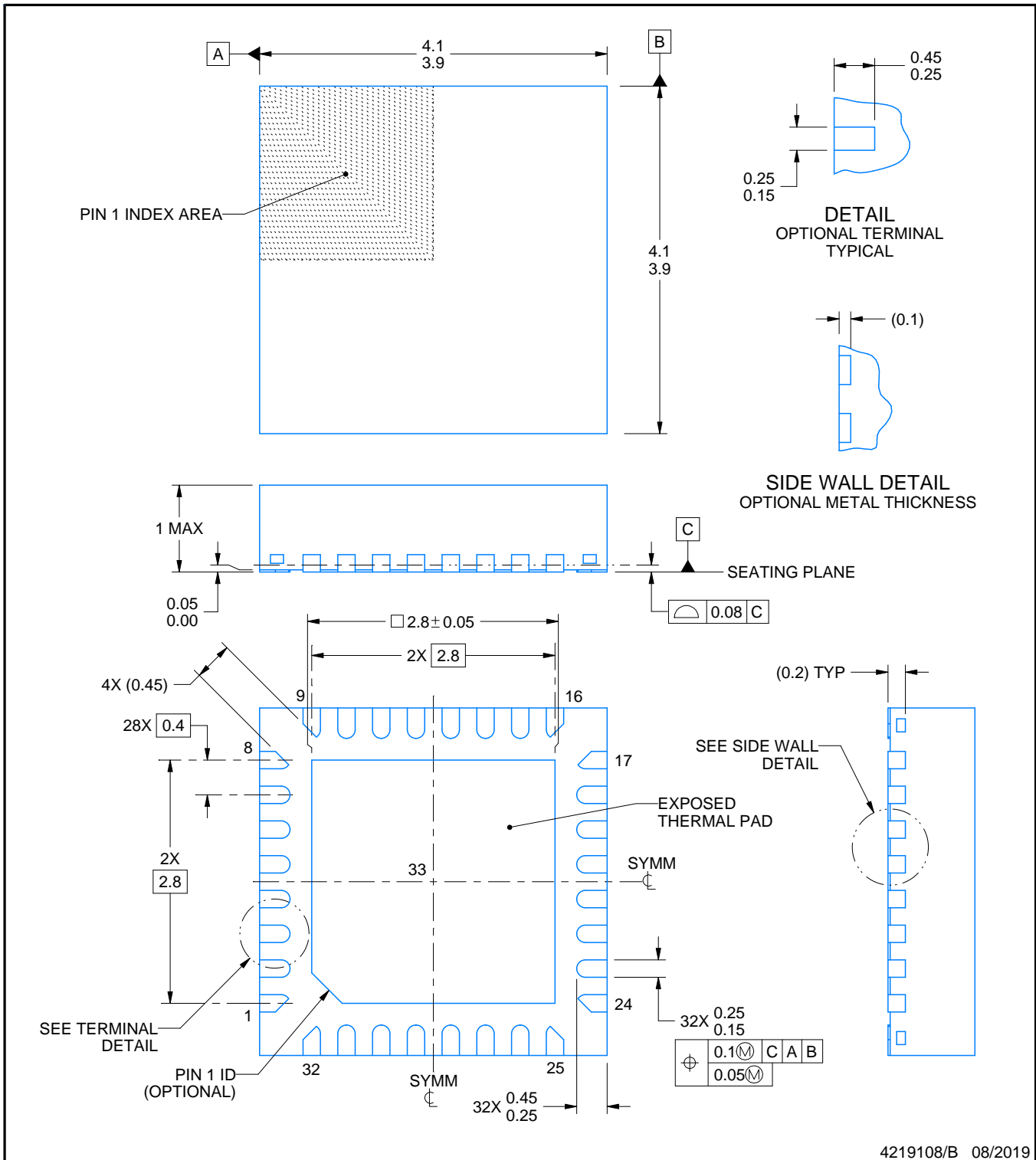
RSM0032B



PACKAGE OUTLINE

VQFN - 1 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



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NOTES:

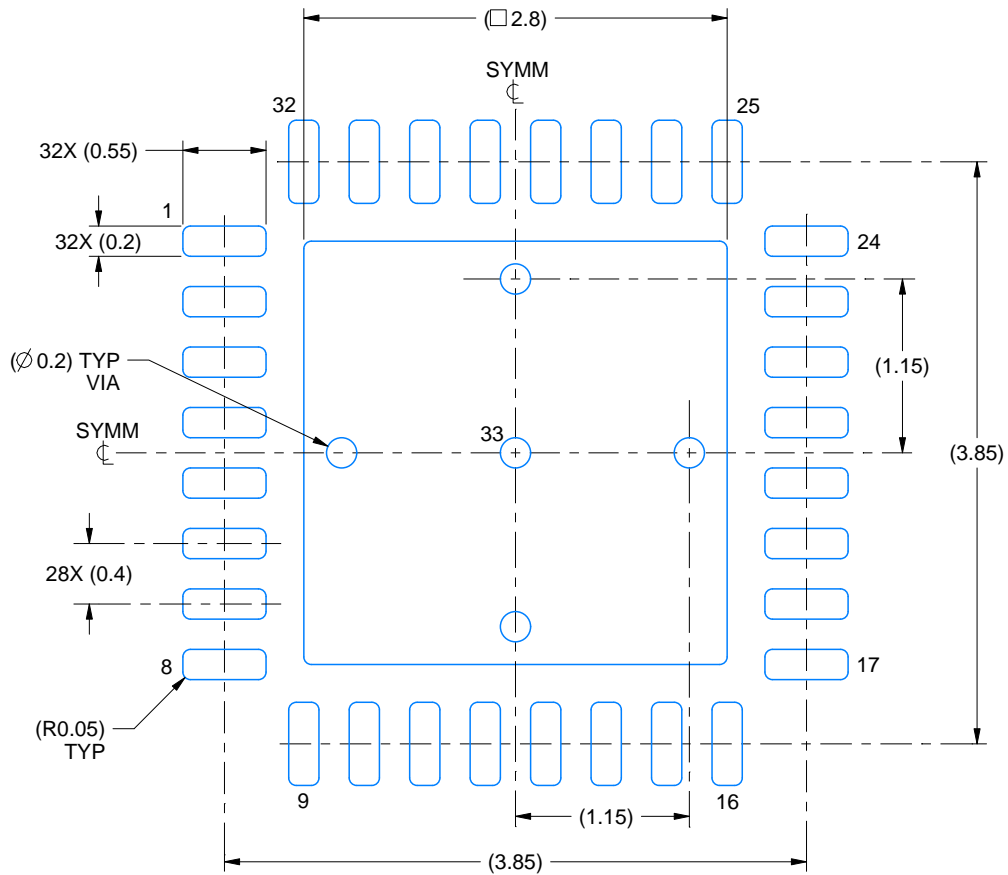
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. The package thermal pad must be soldered to the printed circuit board for thermal and mechanical performance.

EXAMPLE BOARD LAYOUT

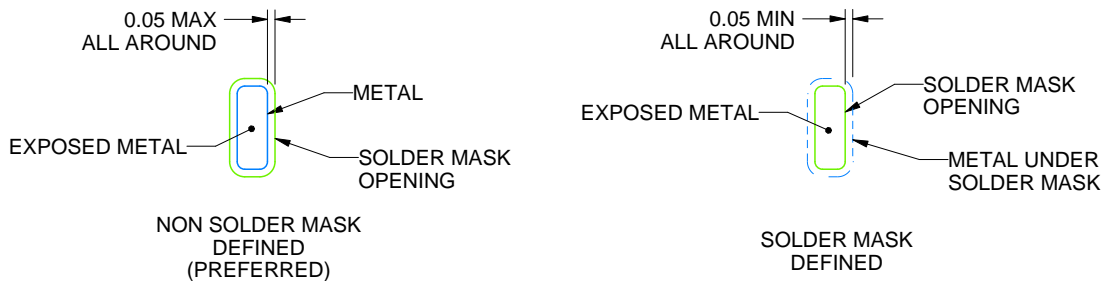
RSM0032B

VQFN - 1 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:20X



SOLDER MASK DETAILS

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NOTES: (continued)

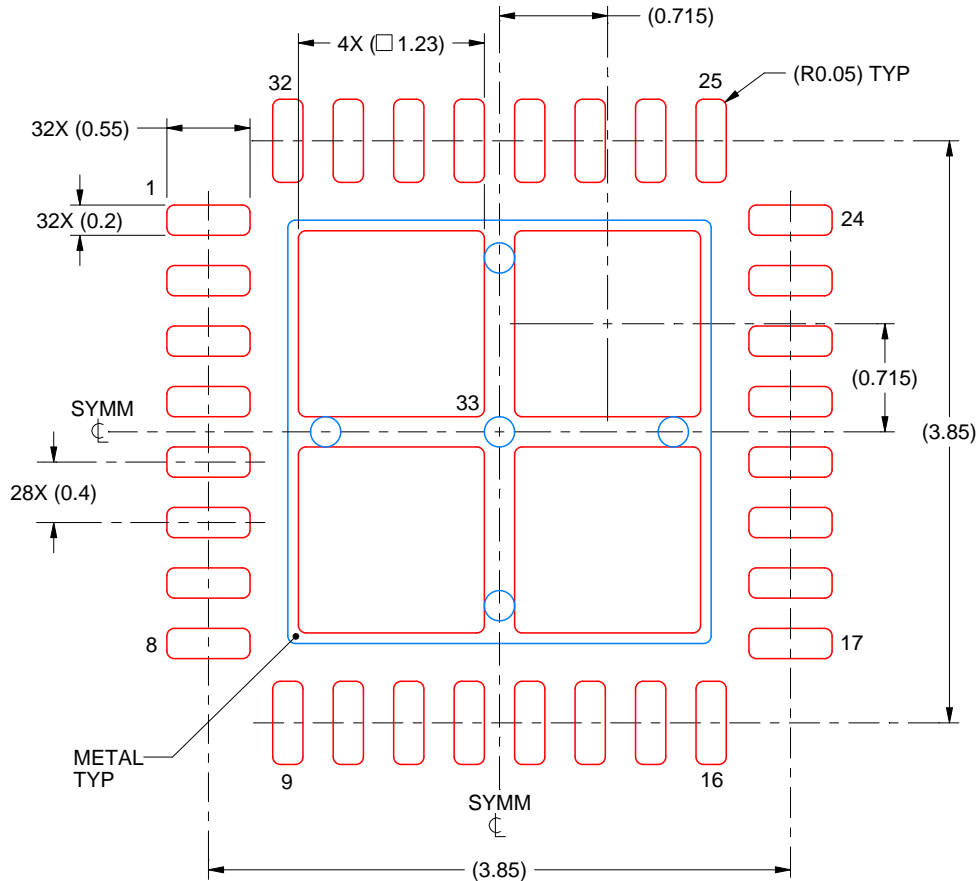
4. This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature number SLUA271 (www.ti.com/lit/slue271).
5. Vias are optional depending on application, refer to device data sheet. If any vias are implemented, refer to their locations shown on this view. It is recommended that vias under paste be filled, plugged or tented.

EXAMPLE STENCIL DESIGN

RSM0032B

VQFN - 1 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



SOLDER PASTE EXAMPLE
BASED ON 0.1 mm THICK STENCIL

EXPOSED PAD 33:
77% PRINTED SOLDER COVERAGE BY AREA UNDER PACKAGE
SCALE:20X

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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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