

# TPS53688 Dual-Channel (N + M ≤ 8 phase) D-CAP+™, Step-Down, Digital Multiphase Controller with VR13.HC SVID

## 1 Features

- Input Voltage Range: 4.5 V to 17 V
- Output Voltage Range: 0.25 V to 5.5 V
- Intel® VR13.HC SVID Compliant
- Dual Output Supporting N+M Phase Configurations (N+M ≤ 8, M ≤ 4)
- Enhanced D-CAP+™ Control to Provide Super Transient Performance with Excellent Dynamic Current Sharing
- Programmable Loop Compensation
- Programmable Phase-Firing Order
- Individual Phase Current Calibrations and Reporting
- Dynamic Phase Shedding with Programmable Thresholds for Optimizing Efficiency at Light and Heavy Loads
- Fast Phase-Adding for Undershoot Reduction (USR)
- Driverless PWM Architecture for Efficient High-Frequency Switching
- Fully Compatible with TI NextFET™ Power Stage for High-Density Solutions
- Accurate, Adjustable, Adaptive Voltage Positioning (AVP)
- Patented AutoBalance™ Phase Current Balancing
- Cycle-by-cycle Per-Phase Current Limit
- PMBus™ v1.3.1 System Interface for Telemetry of Voltage, Current, Power, Temperature, and Fault Conditions
- 5 mm × 5 mm, 40-Pin, QFN Package

## 2 Applications

- [Data center & enterprise computing rack server](#)
- [Hardware accelerator](#)
- [Network interface card \(NIC\)](#)
- [ASIC and high-performance client](#)

## 3 Description

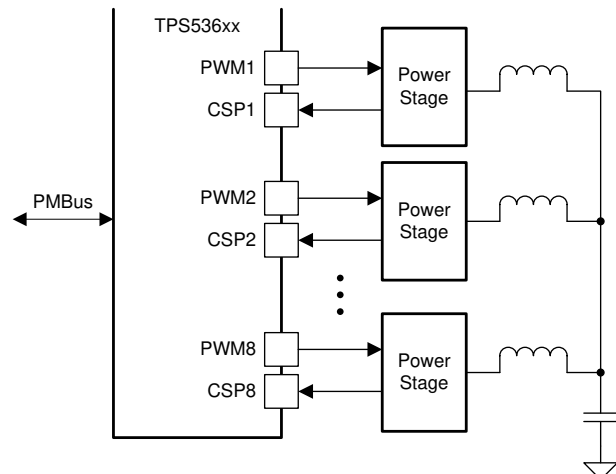
The TPS53688 is a fully VR13.HC SVID compliant step-down controller with two channels, built-in non-volatile memory (NVM), and PMBus™ interface, and is fully compatible with TI NextFET™ smart power stages. Advanced control features such as the D-CAP+™ architecture with undershoot reduction (USR) provide fast transient response, low output capacitance, and good dynamic current sharing. The device also provides a novel phase interleaving strategy and dynamic phase shedding, for efficiency improvement across loading conditions. Adjustable control of output voltage slew rate and adaptive voltage positioning are natively supported. In addition, the device supports the PMBus communication interface, for reporting the telemetry of voltage, current, power, temperature, and fault conditions to the host system. All programmable parameters can be configured through the PMBus interface and stored in NVM as new default values, to minimize the external component count.

The TPS53688 device is offered in a thermally enhanced 40-pin QFN packaged and is rated to operate from –40°C to 125°C.

### Device Information

PART NUMBER	PACKAGE <sup>(1)</sup>	BODY SIZE (NOM)
TPS53688	QFN (40)	5 mm × 5 mm

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



**Simplified Schematic**



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## 4 Revision History

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

<b>Changes from Revision (May 2020) to Revision A (September 2020)</b>	<b>Page</b>
• Updated the numbering format for tables, figures, and cross-references throughout the document.....	1
• Changed document status from <i>Advance Information</i> to <i>Production Data</i> .....	1

## 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](http://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

D-CAP+™, NextFET™, AutoBalance™, NexFET™, the D-CAP+™, and TI E2E™ are trademarks of Texas Instruments.

PMBus™ is a trademark of SMIF, Inc..

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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 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)
<a href="#">TPS53688RSBR</a>	Active	Production	WQFN (RSB)   40	3000   LARGE T&R	Yes	Call TI   Nipdauag	Level-2-260C-1 YEAR	-40 to 125	TPS 53688
TPS53688RSBR.A	Active	Production	WQFN (RSB)   40	3000   LARGE T&R	Yes	Call TI	Level-2-260C-1 YEAR	-40 to 125	TPS 53688
<a href="#">TPS53688RSBT</a>	Active	Production	WQFN (RSB)   40	250   SMALL T&R	Yes	NIPDAUAG	Level-2-260C-1 YEAR	-40 to 125	TPS 53688
TPS53688RSBT.A	Active	Production	WQFN (RSB)   40	250   SMALL T&R	Yes	NIPDAUAG	Level-2-260C-1 YEAR	-40 to 125	TPS 53688

(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.

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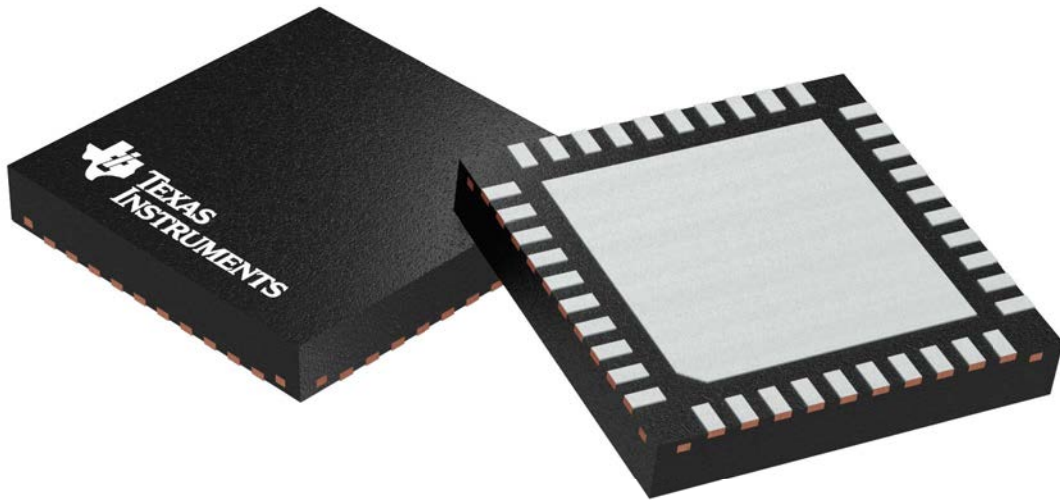
## GENERIC PACKAGE VIEW

**RSB 40**

**WQFN - 0.8 mm max height**

5 x 5 mm, 0.4 mm pitch

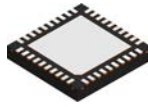
PLASTIC QUAD FLATPACK - NO LEAD



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

4207182/D

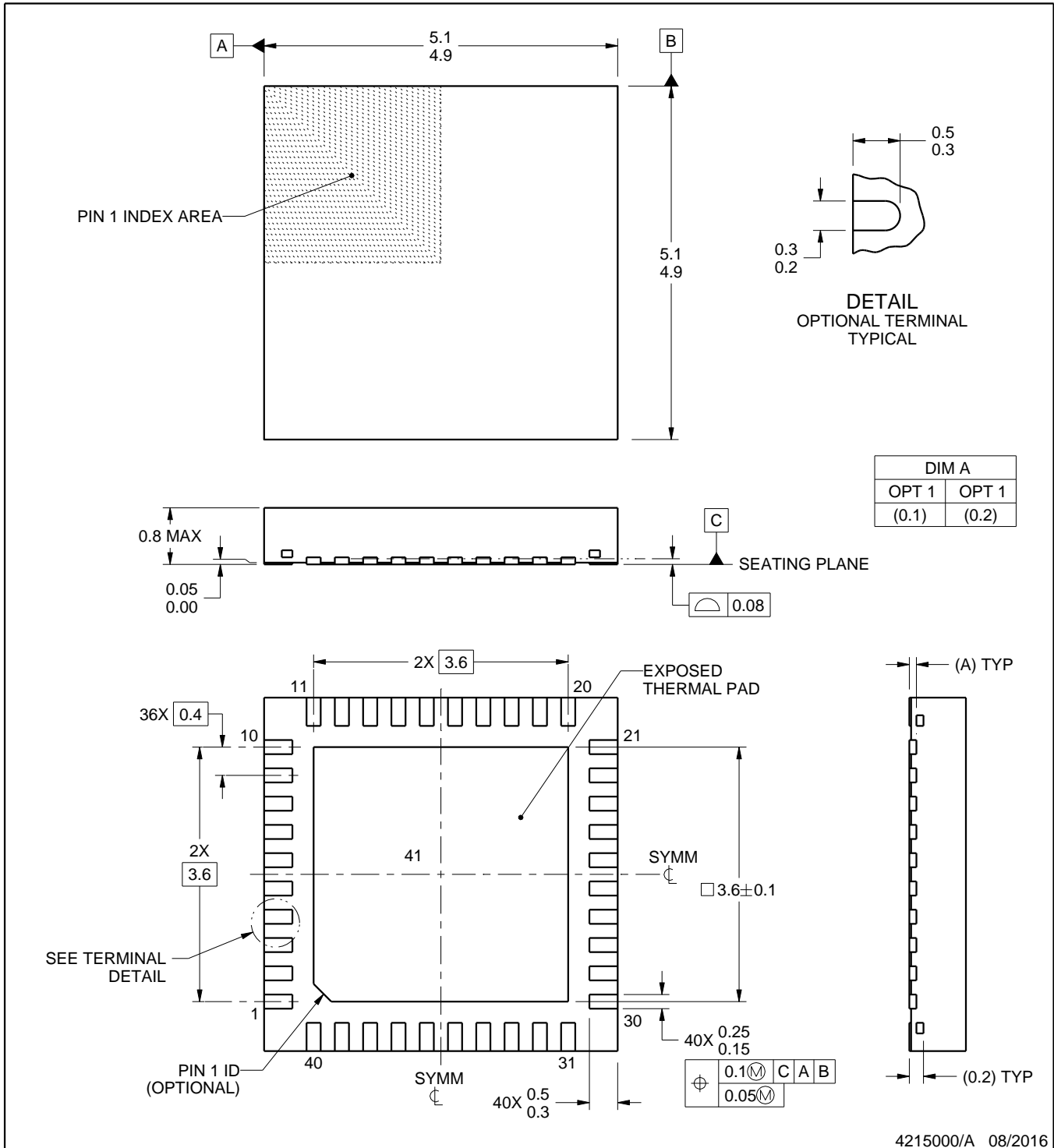
# RSB0040A



# PACKAGE OUTLINE

## WQFN - 0.8 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



4215000/A 08/2016

**NOTES:**

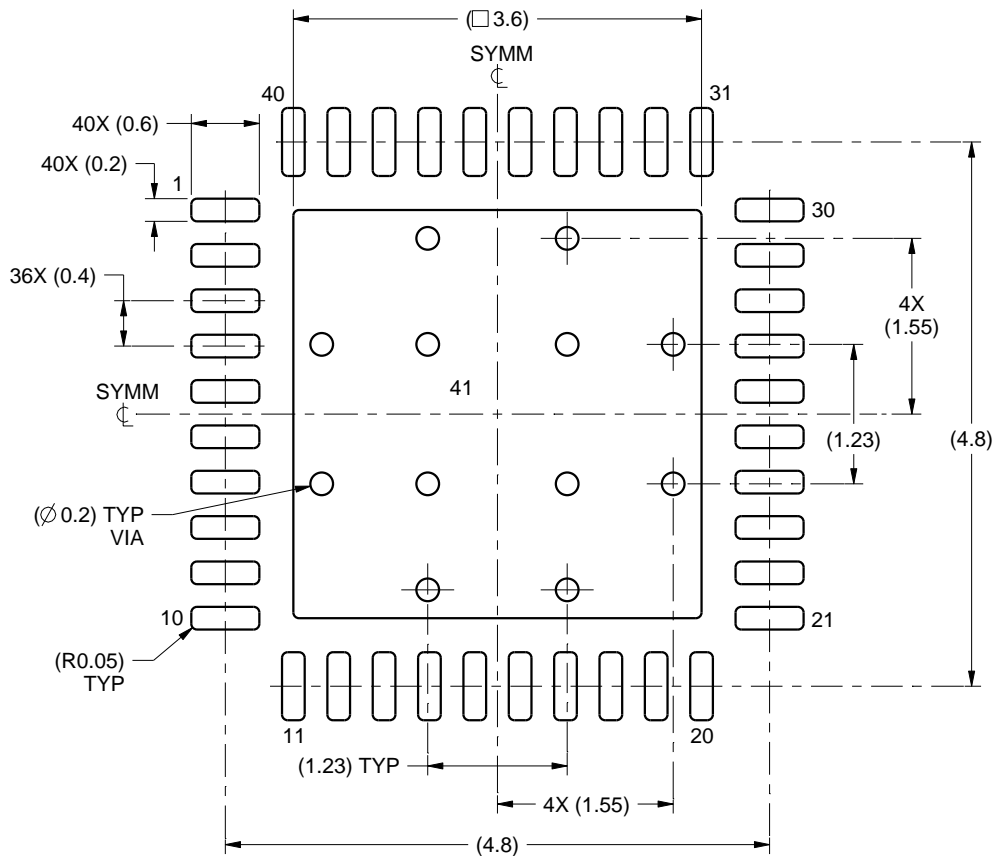
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. The package thermal pad must be soldered to the printed circuit board for thermal and mechanical performance.

# EXAMPLE BOARD LAYOUT

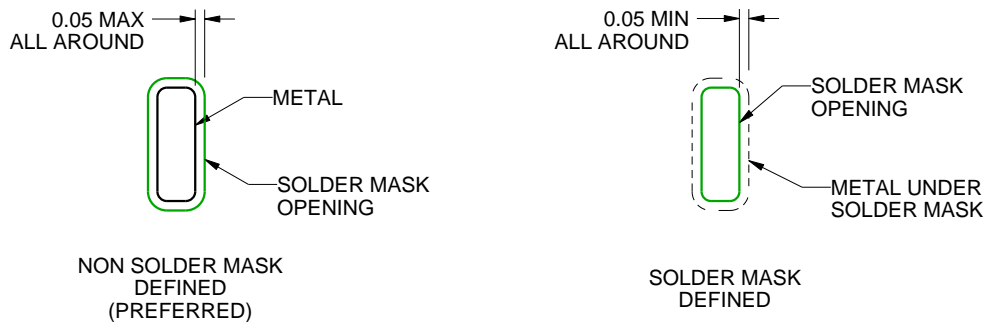
RSB0040A

WQFN - 0.8 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



LAND PATTERN EXAMPLE  
SCALE:15X



SOLDER MASK DETAILS

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NOTES: (continued)

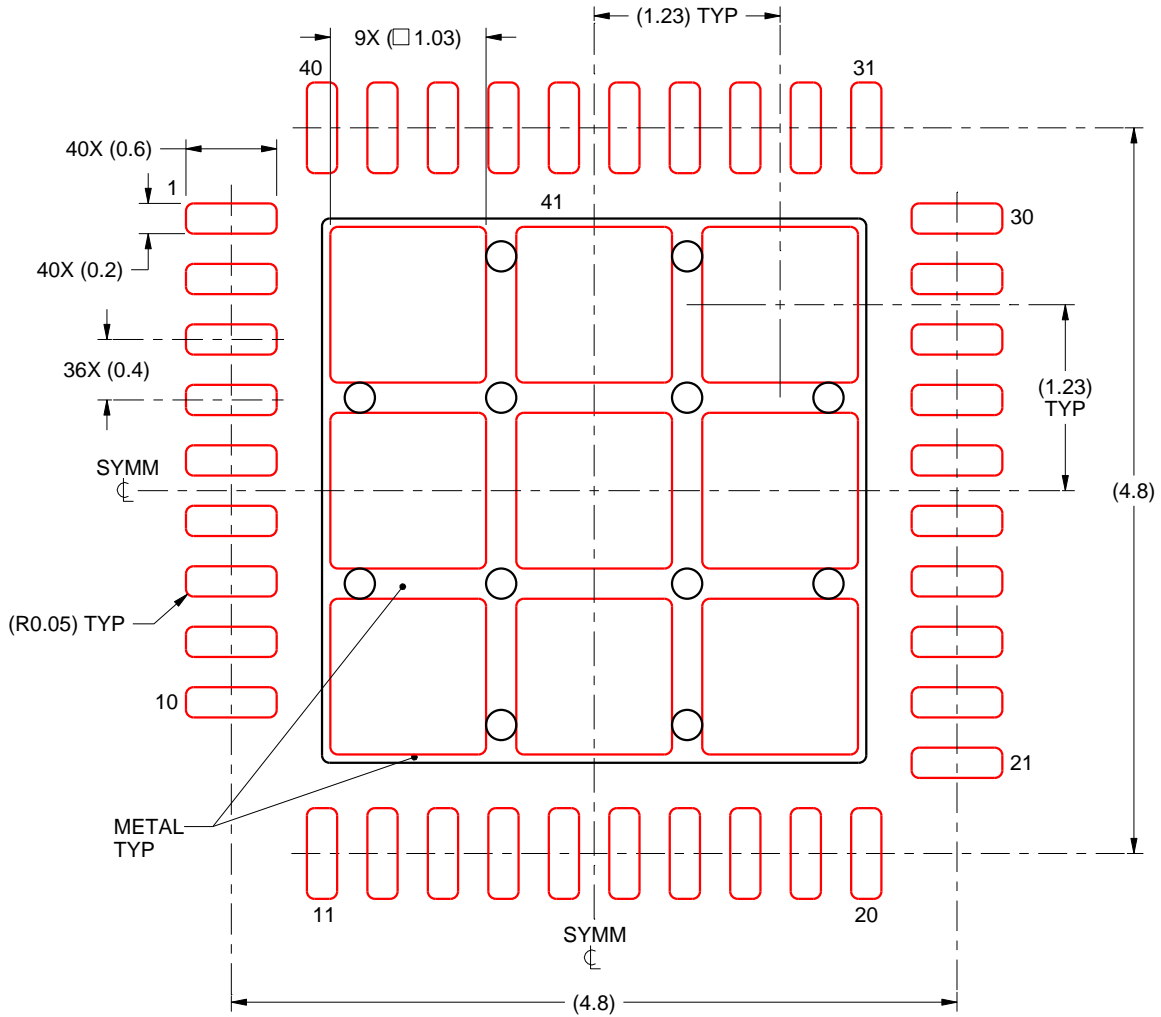
4. This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature number SLUA271 ([www.ti.com/lit/sluea271](http://www.ti.com/lit/sluea271)).
5. Vias are optional depending on application, refer to device data sheet. If any vias are implemented, refer to their locations shown on this view. It is recommended that vias under paste be filled, plugged or tented.

# EXAMPLE STENCIL DESIGN

RSB0040A

WQFN - 0.8 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



SOLDER PASTE EXAMPLE  
BASED ON 0.1 mm THICK STENCIL

EXPOSED PAD 41  
73.7% 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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