

LMR36506-Q1 3 V - 65 V, 0.6-A Ultra-Small Synchronous Step-Down Converter with 4µA I_q

1 Features

- AEC-Q100-qualified for automotive applications:
 - Device temperature grade 1: -40°C to $+125^{\circ}\text{C}$, T_A
- Designed for automotive applications
 - Junction temperature range -40°C to $+150^{\circ}\text{C}$
 - Wide input voltage range: 3.0V (falling threshold) to 65V
 - Low EMI and minimized switch node ringing
 - Adjustable, 3.3-V and 5-V fixed output voltage option available
- Suited for scalable automotive power supplies
 - Pin compatible with LMR36503-Q1 (65 V, 300 mA)
 - Adjustable switching frequency: 200 kHz to 2.2 MHz with RT pin variant
 - Synchronizable with MODE/SYNC pin variant
 - PFM and Forced PWM selection with MODE/SYNC pin variant
- Internal compensation reduces solution size and cost
 - Ultra-small, 2-mm x 2-mm HotRod™ package with wettable flanks
- Low power dissipation across load range
 - 89.5% peak efficiency at 2.2MHz (12 V_{IN} , 5 V_{OUT} fixed)
- Ultra-low operating quiescent current at no load
 - 4µA at 24 V_{IN} to 3.3 V_{OUT} (fixed output option)

2 Applications

- Rear view and surround view camera module
- Automotive body control module
- General purpose Wide- V_{IN} step down converter

3 Description

The LMR36506-Q1 is an easy-to-use, synchronous step-down DC/DC converter. With integrated high-side and low-side power MOSFETs, the LMR36506-Q1 can deliver up to 0.6 A of output current over a wide input voltage range of 3 V to 65 V with input voltage tolerance up to 70V. With the right BOM selection, the LMR36506-Q1 can support fixed 3.3 V, 5 V or other adjustable output voltages.

The LMR36506-Q1 uses peak current mode control to provide direct conversion from an input of 24V to an output of 5 V at a fixed frequency of 2.2 MHz, helps maintain a regulated output voltage over the wide switching frequency of operation from 200kHz to 2.2MHz. The open drain PGOOD output in the LMR36506-Q1 with filtering and delayed release, provides a true indication of the output voltage status, eliminating the requirement for an external supervisor. A seamless transition from FPWM to PFM at light load with an ultra low standby quiescent current at no load, helps ensure high light load efficiency. The MODE/SYNC variant helps to synchronize the LMR36506-Q1 to an external clock, or select the Pulse Frequency Modulation (PFM) mode for higher efficiency at light load.

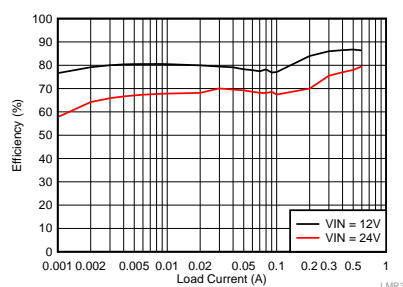
The LMR36506-Q1 is available in an ultra-small 2 mm x 2 mm HotRod™ package, has excellent EMI performance, requires very few external components and has a pinout designed for a simple PCB layout. The small solution size and feature set of the LMR36506-Q1 are designed to simplify implementation for a wide range of automotive end equipment.

Device Information⁽¹⁾

PART NUMBER	PACKAGE	BODY SIZE (NOM)
LMR36506-Q1	VQFN-HR (9)	2.00 mm x 2.00 mm

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

Efficiency vs Output Current
 $V_{OUT} = 5 \text{ V (Adj.)}, 2.2 \text{ MHz}$



Simplified Schematic

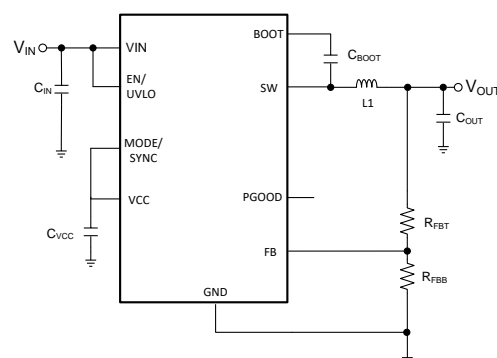


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4 Device Comparison Table

ORDERABLE PART NUMBER	OUTPUT VOLTAGE	MODE/SYNC or RT	F _{SW}	Spread Spectrum
LMR36506MSCQRPERQ1	Adjustable	MODE/SYNC	2.2 MHz	Yes
LMR36506MSC5RPERQ1	5-V Fixed	MODE/SYNC	2.2 MHz	Yes
LMR36506MSC3RPERQ1	3.3-V Fixed	MODE/SYNC	2.2 MHz	Yes
LMR36506RS3QRPERQ1	3.3-V Fixed	RT (Default PFM at light load)	Adjustable	Yes

5 Device and Documentation Support

5.1 Documentation Support

5.1.1 Related Documentation

For related documentation see the following:

- [Thermal Design by Insight not Hindsight](#)
- [A Guide to Board Layout for Best Thermal Resistance for Exposed Pad Packages](#)
- [Semiconductor and IC Package Thermal Metrics](#)
- [Thermal Design Made Simple with LM43603 and LM43602](#)
- [PowerPAD™ Thermally Enhanced Package](#)
- [PowerPAD Made Easy](#)
- [SBVA025 Using New Thermal Metrics](#)
- [Layout Guidelines for Switching Power Supplies](#)
- [Simple Switcher PCB Layout Guidelines](#)
- [Construction Your Power Supply- Layout Considerations](#)
- [Low Radiated EMI Layout Made Simple with LM4360x and LM4600x](#)

5.2 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on ti.com. In the upper right corner, click on *Alert me* 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.

5.3 Community Resources

The following links connect to TI community resources. Linked contents are 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](#).

TI E2E™ Online Community *TI's Engineer-to-Engineer (E2E) Community*. Created to foster collaboration among engineers. At e2e.ti.com, you can ask questions, share knowledge, explore ideas and help solve problems with fellow engineers.

Design Support *TI's Design Support* Quickly find helpful E2E forums along with design support tools and contact information for technical support.

5.4 Trademarks

HotRod, PowerPAD, E2E are trademarks of Texas Instruments.

5.5 Electrostatic Discharge Caution



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

5.6 Glossary

SLYZ022 — *TI Glossary*.

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

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
LMR36506MSC3RPERQ1	ACTIVE	VQFN-HR	RPE	9	3000	RoHS & Green	SN	Level-2-260C-1 YEAR	-40 to 150	MCCQ	Samples
LMR36506MSC5RPERQ1	ACTIVE	VQFN-HR	RPE	9	3000	RoHS & Green	SN	Level-2-260C-1 YEAR	-40 to 150	MCBQ	Samples
LMR36506MSCQRPERQ1	ACTIVE	VQFN-HR	RPE	9	3000	RoHS & Green	SN	Level-2-260C-1 YEAR	-40 to 150	MCAQ YMJ	Samples
LMR36506RS3QRPERQ1	ACTIVE	VQFN-HR	RPE	9	3000	RoHS & Green	SN	Level-2-260C-1 YEAR	-40 to 150	MCDQ	Samples

(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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OTHER QUALIFIED VERSIONS OF LMR36506-Q1 :

- Catalog : [LMR36506](#)

NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product

GENERIC PACKAGE VIEW

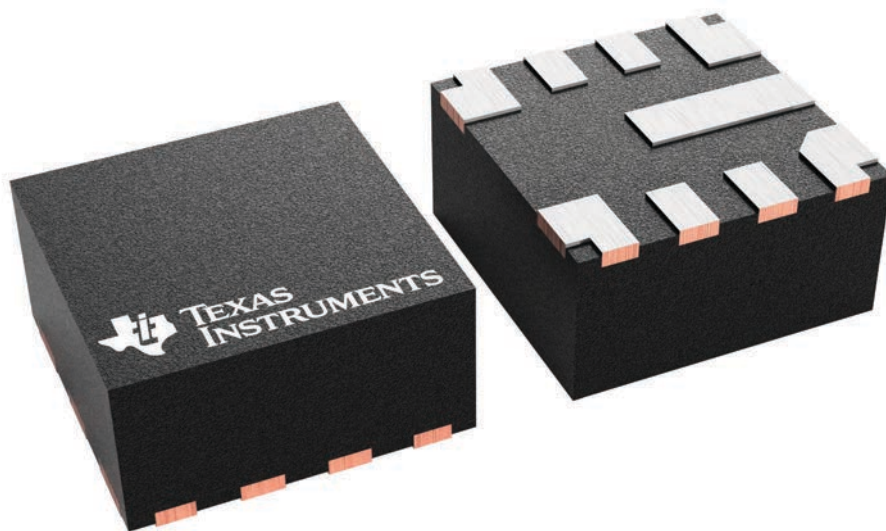
RPE 9

VQFN-HR - 1.0 mm max height

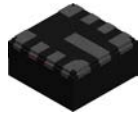
2 x 2, 0.5 mm pitch

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.



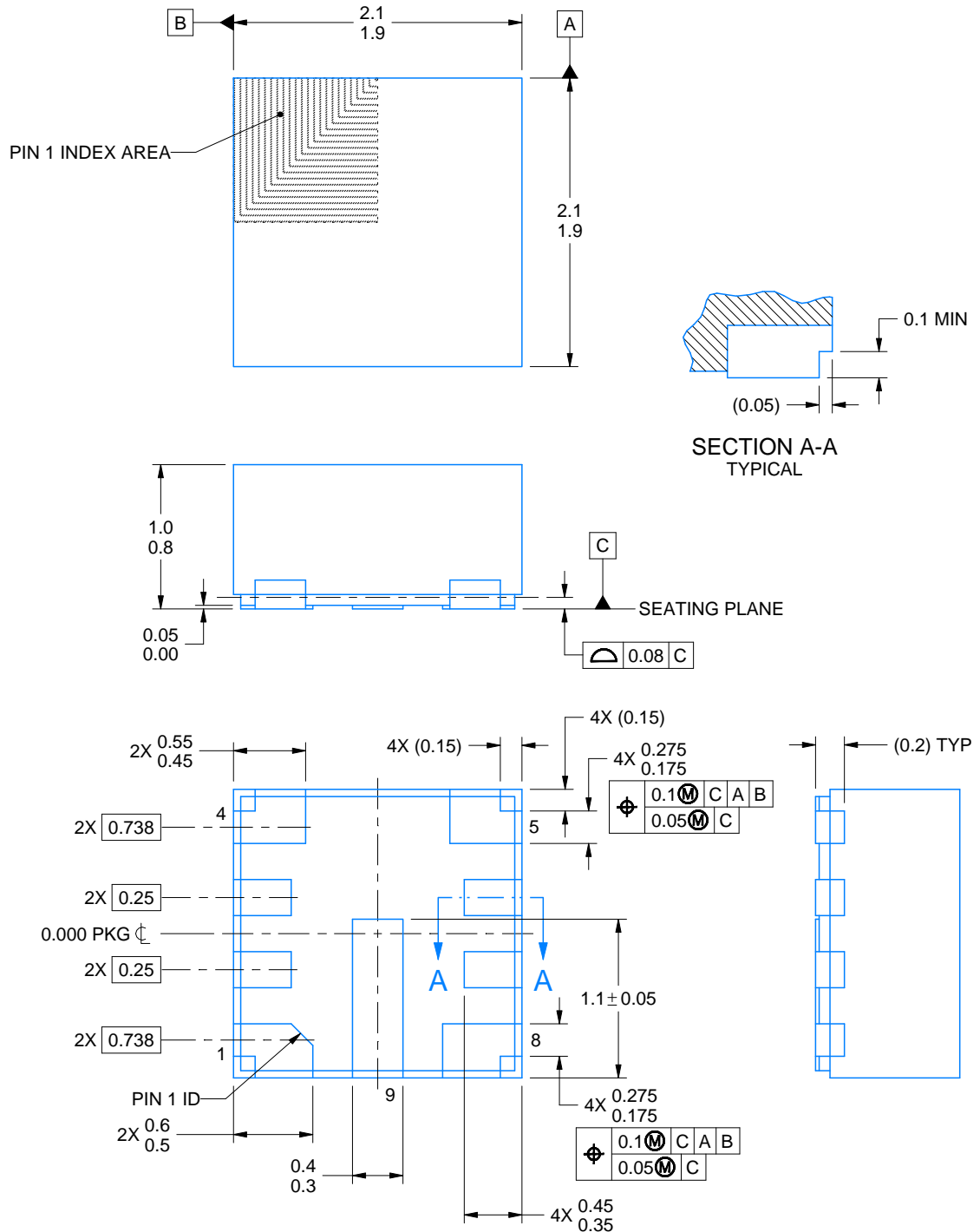
RPE0009A



PACKAGE OUTLINE

VQFN-HR - 1.0 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



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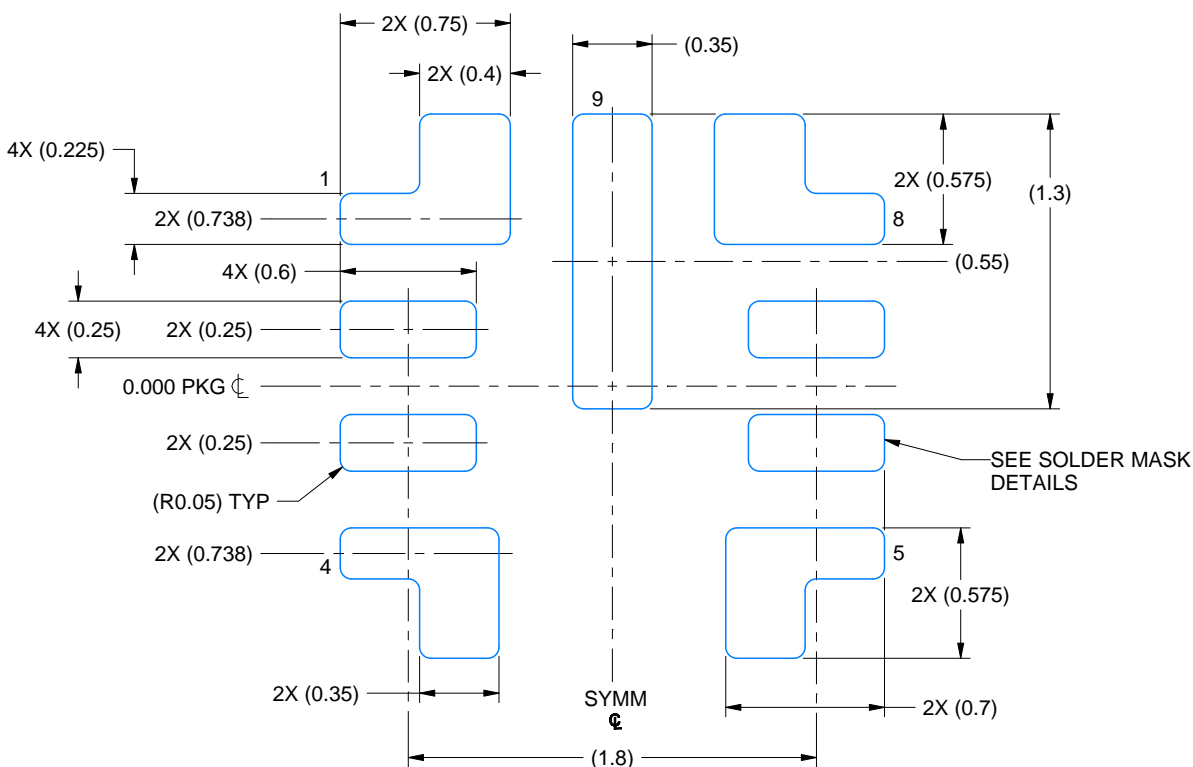
NOTES:

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.

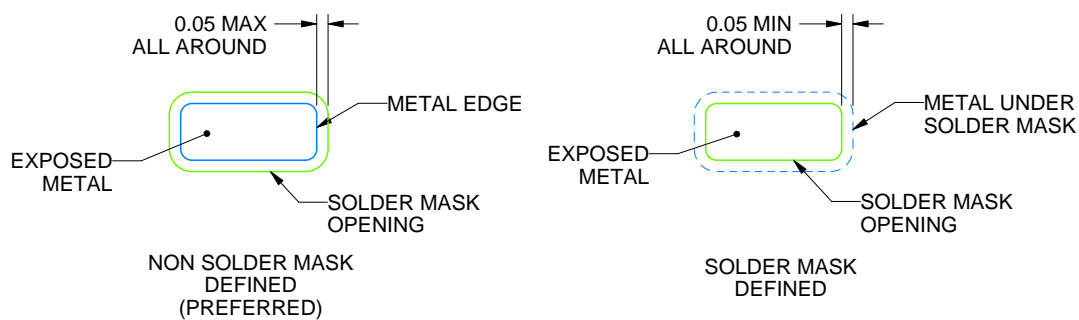
RPE0009A

VQFN-HR - 1.0 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 30X



SOLDER MASK DETAILS

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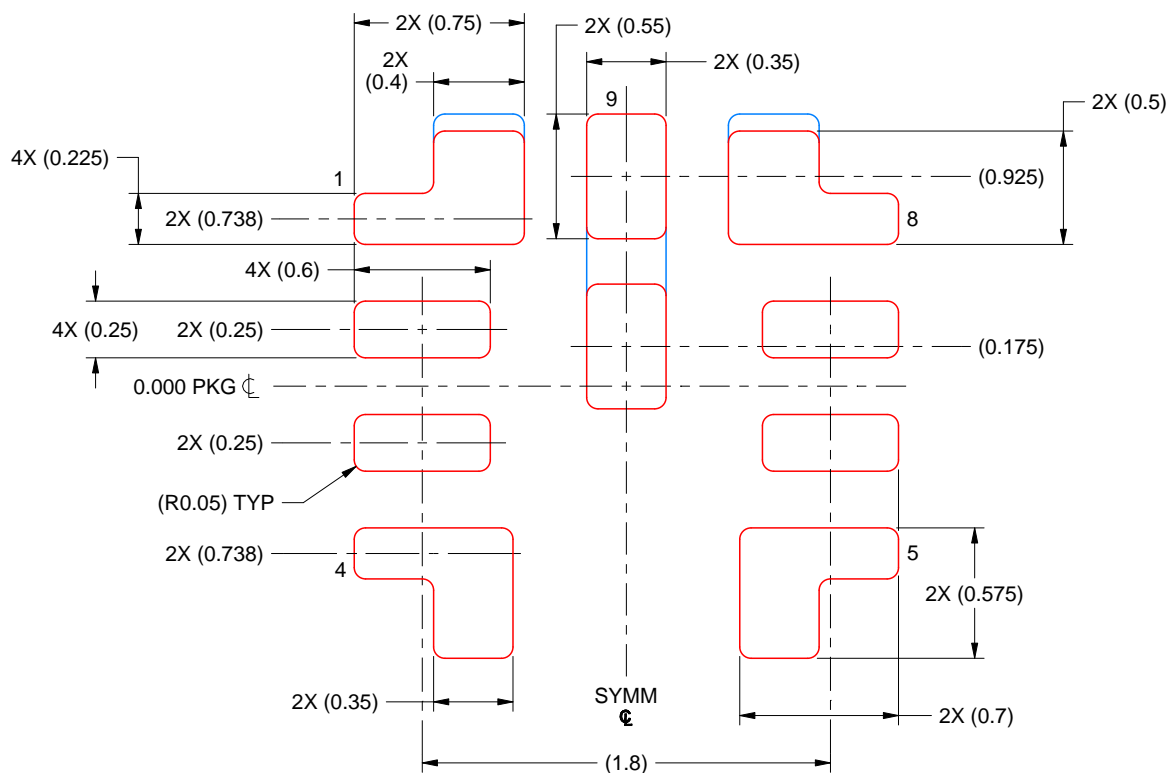
NOTES: (continued)

3. For more information, see Texas Instruments literature number SLUA271 (www.ti.com/lit/slua271).
4. 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.

RPE0009A

VQFN-HR - 1.0 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



SOLDER PASTE EXAMPLE
BASED ON 0.125 MM THICK STENCIL
SCALE: 30X

PADS 1 & 8:
90% PRINTED SOLDER COVERAGE BY AREA UNDER PACKAGE
PAD 9:
85% PRINTED SOLDER COVERAGE BY AREA UNDER PACKAGE

DWG_NO:5/REV:5 MM_YYYY:5

NOTES: (continued)

5. 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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