LMG708B0 80V_{IN}, 20A_{OUT}, High Power Density GaN Synchronous Buck Converter

ADVANCE INFORMATION

1 Features

- 20A synchronous buck DC/DC converter
  - Low $R_{DS(on)}$ gallium-nitride (GaN) power FETs
  - Wide input voltage range of 5V to 80V
  - Adjustable output voltage from 1V to 55V, or fixed output options of 5V or 12V
  - Maximum junction temperature of 125°C
  - Frequency adjustable from 200kHz to 2.64MHz
  - 25ns $t_{ON(min)}$ for high step-down conversion
  - CV or CC regulation with dynamic adjustment
- High efficiency across the full load range
  - 97% at 48V_{IN}, 12V_{OUT}, 20A, 400kHz
  - Optimized near-zero deadtime switching
  - Multiphase stackable for higher output current
  - Dual-input VCC subregulator with BIAS option
  - Thermally-enhanced eQFN-22 package with optional top-side cooling
- Designed for ultra-low emissions requirements
  - Spread spectrum (DRSS) frequency modulation
  - Optional external clock synchronization
  - Selectable FPWM or PFM mode at light loads
  - Integrated bootstrap capacitor
- Integrated protection features for robust design
  - Hiccup-mode overcurrent protection
  - Average output current monitoring (IMON)
  - Precision enable and PGOOD functions
  - VIN, VCC, and gate-drive UVLO protection
- Create a custom design using the LMG708B0 with the WEBENCH® Power Designer

2 Applications

- Communications systems: wireless infrastructure
- Industrial: test and measurement, power delivery
- Enterprise systems: high-performance computing

3 Description

The LMG708B0 is a GaN synchronous buck DC/DC converter offered from a family of devices that provide ultra-high current density and excellent power conversion efficiency. The integrated low $R_{DS(on)}$ GaN FETs with near-zero deadtime switching performance enable up to 20A of output current across a wide input voltage range of 5V to 80V.

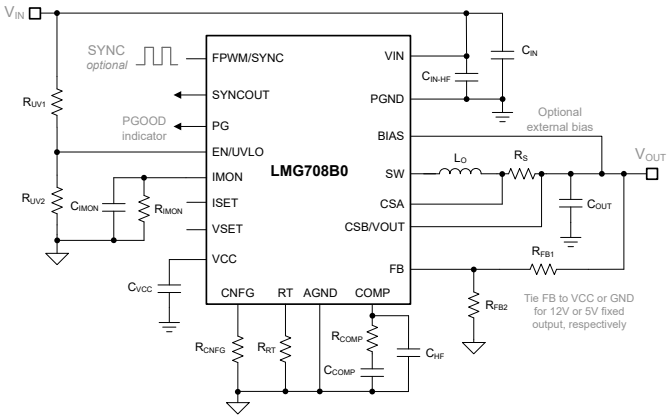
Phase stackable with synchronized interleaving, the peak current-mode architecture of the LMG708B0 supports accurate current sharing with paralleled phases for even higher output current. Along with constant-voltage (CV) operation, a dual-loop architecture with shared compensation provides constant-current (CC) regulation for battery charging and other current-source type loads. This cohesive approach enables a seamless transition between CV and CC modes, and high accuracy for voltage (±1%) and current (±4.5%) regulation, effectively reducing the bill-of-materials (BOM) cost for applications that require average output current control. VSET and ISET inputs facilitate dynamic adjustment of the respective CV and CC loop setpoints, and an IMON output provides average output current monitoring.

The LMG708B0 has a thermally enhanced package (TEP) with optional top-side cooling (TSC) through exposed package connections and low package parasitic inductance for quiet switching performance.

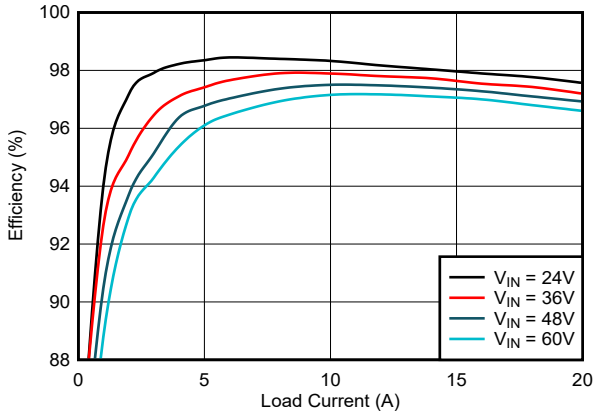
Package Information

PART NUMBER	PACKAGE(1)	PACKAGE SIZE(2)
LMG708B0	VBT (VQFN, 22)	4.5mm × 6mm

(1) For more information, see Section 5.
(2) The package size (length × width) is a nominal value and includes pins, where applicable.



Typical Schematic



Efficiency, V_{OUT} = 12V, F_{SW} = 400kHz

A high-side switch minimum on-time of 25ns facilitates large step-down ratios, enabling the direct conversion from 24V or 48V inputs to low-voltage rails for reduced system design cost and complexity. The LMG708B0 continues to operate during input voltage dips as low as 5V, at close to 100% duty cycle if needed. The 20µA sleep quiescent current with the output voltage in regulation extends operating run-time in battery-powered systems.

The LMG708B0 includes several features to simplify compliance with CISPR 11 and CISPR 32 conducted emissions requirements. Predictably timed GaN FET gate drivers along with integrated bootstrap switch and capacitor minimize deadtime during switching transitions, reducing switching losses and improving EMI performance at high input voltage and high switching frequency. To reduce input capacitor ripple current and EMI filter size, interleaved operation using a SYNCOUT signal with programmable phase shift works well for cascaded, multichannel or multiphase designs. Resistor-adjustable switching frequency as high as 2.2MHz can be synchronized to an external clock source up to 2.64MHz to eliminate beat frequencies in noise-sensitive applications. Finally, the LMG708B0 has dual-random spread spectrum (DRSS), a unique EMI-reduction feature that combines low-frequency triangular and high-frequency random modulations to mitigate EMI disturbances across lower and higher frequency bands, respectively.

Additional features of the LMG708B0 include 125°C maximum junction temperature operation, user-selectable PFM mode for lower current consumption during light-load conditions, integrated bootstrap capacitor with synchronous charging for robust level shifting, open-drain power-good (PG) indicator for fault reporting and output monitoring, precision enable input for input UVLO, monotonic start-up into prebiased loads, dual-input VCC bias subregulator, 30mV full-scale current sensing, hiccup-mode overload protection, and thermal shutdown protection with automatic recovery for the controller.

The LMG708B0 comes in a 4.5mm × 6mm, thermally enhanced, 22-pin eQFN package using a flip-chip routable leadframe (FCRLF) packaging technique. Leveraging high-performance GaN power FETs (based on TI's proprietary GaN IC technology), thermal management and EMI mitigation features, CC/CV operation, and small design size, the LMG708B0 represents an excellent point-of-load regulator choice for applications requiring the most efficient GaN design with useable current, lifetime reliability, and cost advantages.

ADVANCE INFORMATION

4 Device and Documentation Support

4.1 Device Support

4.1.1 Development Support

For development support, see the following:

- LMG708B0 Quickstart Calculator
- LMG708B0 Simulation Models
- LMG708B0 Altium *layout* source files
- For TI's reference design library, visit TI Designs
- For TI's WEBENCH Design Environment, visit the WEBENCH® Design Center
- EVM user's guides:
  - *LMG708B0 80V_{IN}, 20A_{OUT} GaN Buck Converter Evaluation Module*
- TI Designs:
  - *Automotive EMI and Thermally Optimized Synchronous Buck Converter Reference Design*
  - *Wide Input Synchronous Buck Converter Reference Design With Frequency Spread Spectrum*
- Technical articles:
  - *Increasing Power Density with an Integrated GaN Solution*
  - *High-Density PCB Layout of DC/DC Converters*
- To view a related device of this product, see the LM5190 CC/CV synchronous buck controller

4.1.1.1 Custom Design With WEBENCH® Tools

Click here to create a custom design using the LMG708B0 device with the WEBENCH® Power Designer.

1. Start by entering the input voltage (V_{IN}), output voltage (V_{OUT}), and output current (I_{OUT}) requirements.
2. Optimize the design for key parameters such as efficiency, footprint, and cost using the optimizer dial.
3. Compare the generated design with other possible designs from Texas Instruments.

The WEBENCH Power Designer gives a customized schematic along with a list of materials with real-time pricing and component availability.

In most cases, these actions are available:

- Run electrical simulations to see important waveforms and circuit performance
- Run thermal simulations to understand board thermal performance
- Export customized schematic and layout into popular CAD formats
- Print PDF reports for the design, and share the design with colleagues

Get more information about WEBENCH tools at www.ti.com/WEBENCH.

4.2 Documentation Support

4.2.1 Related Documentation

For related documentation, see the following:

- Texas Instruments, *LM5190-Q1 CC-CV Buck Controller Evaluation Module* EVM user's guide
- Application briefs:
  - Texas Instruments, *Key Parameters and Driving Requirements of GaN FETs*
  - Texas Instruments, *Nomenclature, Types, and Structure of GaN Transistors*
  - Texas Instruments, *GaN Applications*
  - Texas Instruments, *GaN Driver Schematic and Layout Recommendations*

4.2.1.1 Low-EMI Design Resources

- Texas Instruments, *Low EMI* landing page
- Texas Instruments, *Tackling the EMI challenge* company blog
- Texas Instruments, *An Engineer's Guide to Low EMI in DC/DC Regulators* e-book
- Texas Instruments, *Designing a low-EMI power supply* video series
- White papers:

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  - Texas Instruments, *An Overview of Conducted EMI Specifications for Power Supplies*
  - Texas Instruments, *An Overview of Radiated EMI Specifications for Power Supplies*
  - Texas Instruments, *Time-Saving and Cost-Effective Innovations for EMI Reduction in Power Supplies*
  - Texas Instruments, *Valuing Wide V_{IN}, Low EMI Synchronous Buck Circuits for Cost-driven, Demanding Applications*
- Texas Instruments, *Improve High-Current DC/DC Regulalor EMI for Free With Optimized Power Stage Layout* application brief
- Texas Instruments, *Reduce Buck Converter EMI and Voltage Stress by Minimizing Inductive Parasitics* analog design journal

4.2.1.2 Thermal Design Resources

- Texas Instruments, *Improving Thermal Performance in High Ambient Temperature Environments With Thermally Enhanced Packaging* white paper
- Applications notes:
  - Texas Instruments, *Thermal Design by Insight, Not Hindsight*
  - Texas Instruments, *A Guide to Board Layout for Best Thermal Resistance for Exposed Pad Packages*
  - Texas Instruments, *Semiconductor and IC Package Thermal Metrics*
  - Texas Instruments, *PowerPAD™ Thermally Enhanced Package*
  - Texas Instruments, *Using New Thermal Metrics*
- Texas Instruments, *PowerPAD™ Made Easy* application brief

4.2.1.3 PCB Layout Resources

- LMG708B0-EVM12V *Altium layout* source files
- Texas Instruments, *Improve High-Current DC/DC Regulator EMI Performance for Free With Optimized Power Stage Layout* application brief
- Texas Instruments, *AN-1149 Layout Guidelines for Switching Power Supplies* application note
- Texas Instruments, *Constructing Your Power Supply – Layout Considerations* seminar

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

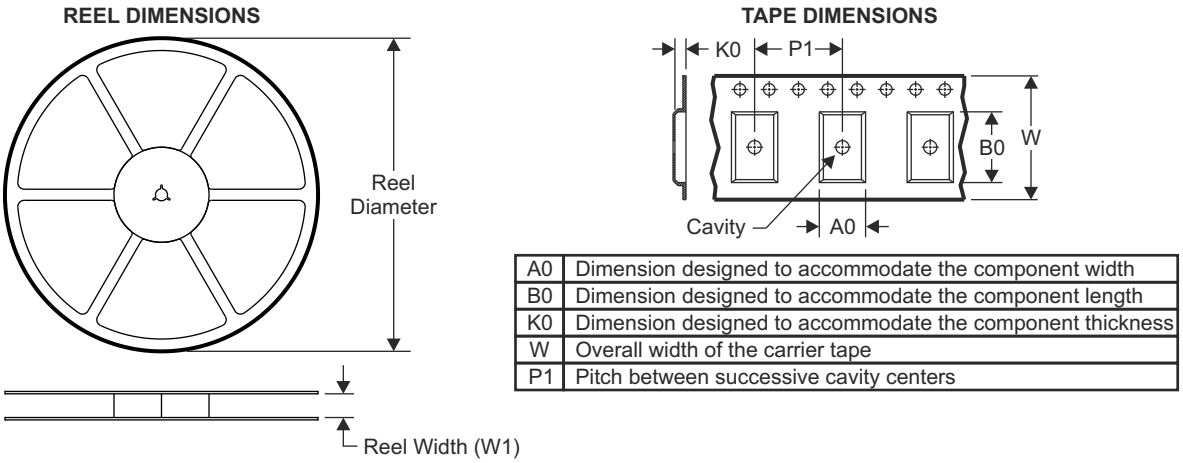
TI Glossary	This glossary lists and explains terms, acronyms, and definitions.

ADVANCE INFORMATION

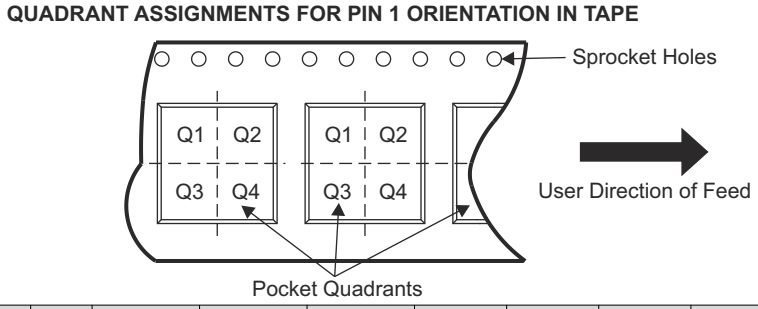
5 Mechanical, Packaging, and Orderable Information

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.

5.1 Tape and Reel Information



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



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
PLMG708B0VBTR	VQFN-FCRLF	VBT	22	3000	330.0	16.4	4.8	6.3	1.1	8.0	16.0	Q1

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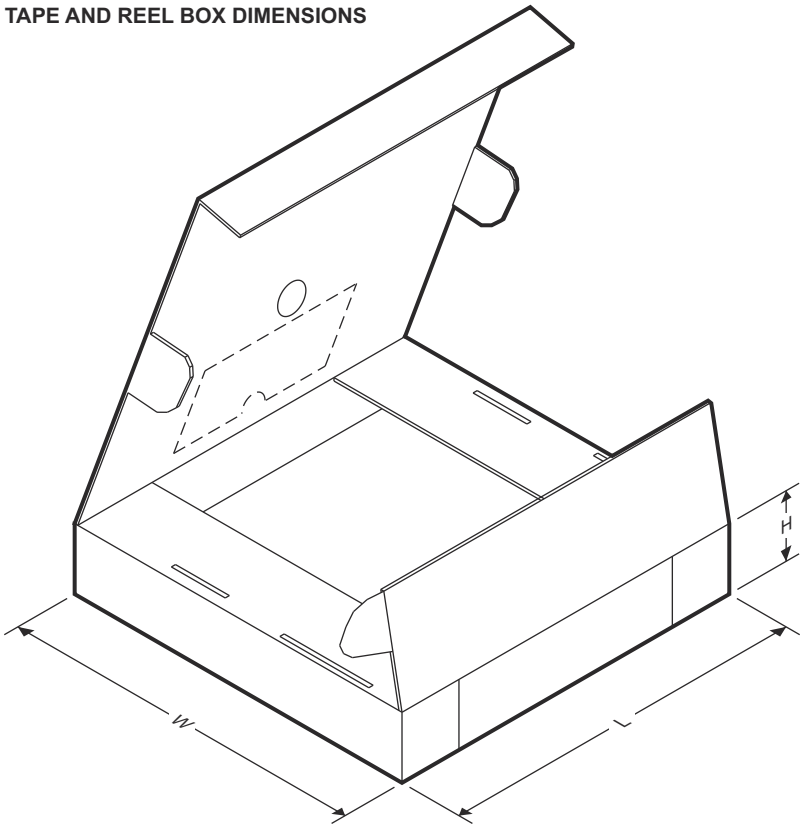
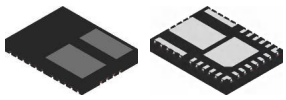
TAPE AND REEL BOX DIMENSIONS



Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
PLMG708B0VBTR	VQFN-FCRLF	VBT	22	3000	367.0	367.0	38.0

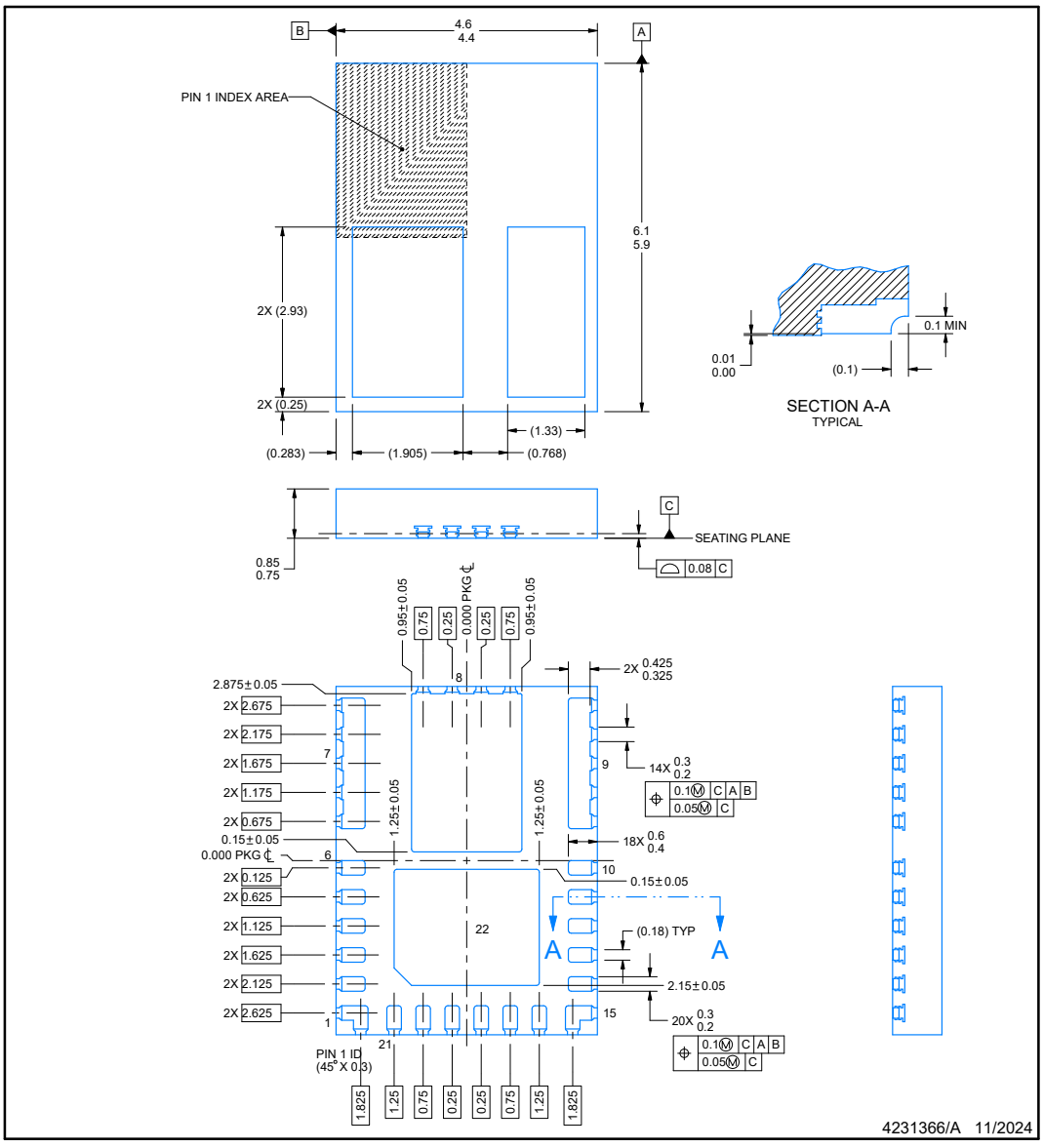
PACKAGE OUTLINE

VBT0022B



VQFN-FCRLF - 0.85 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.

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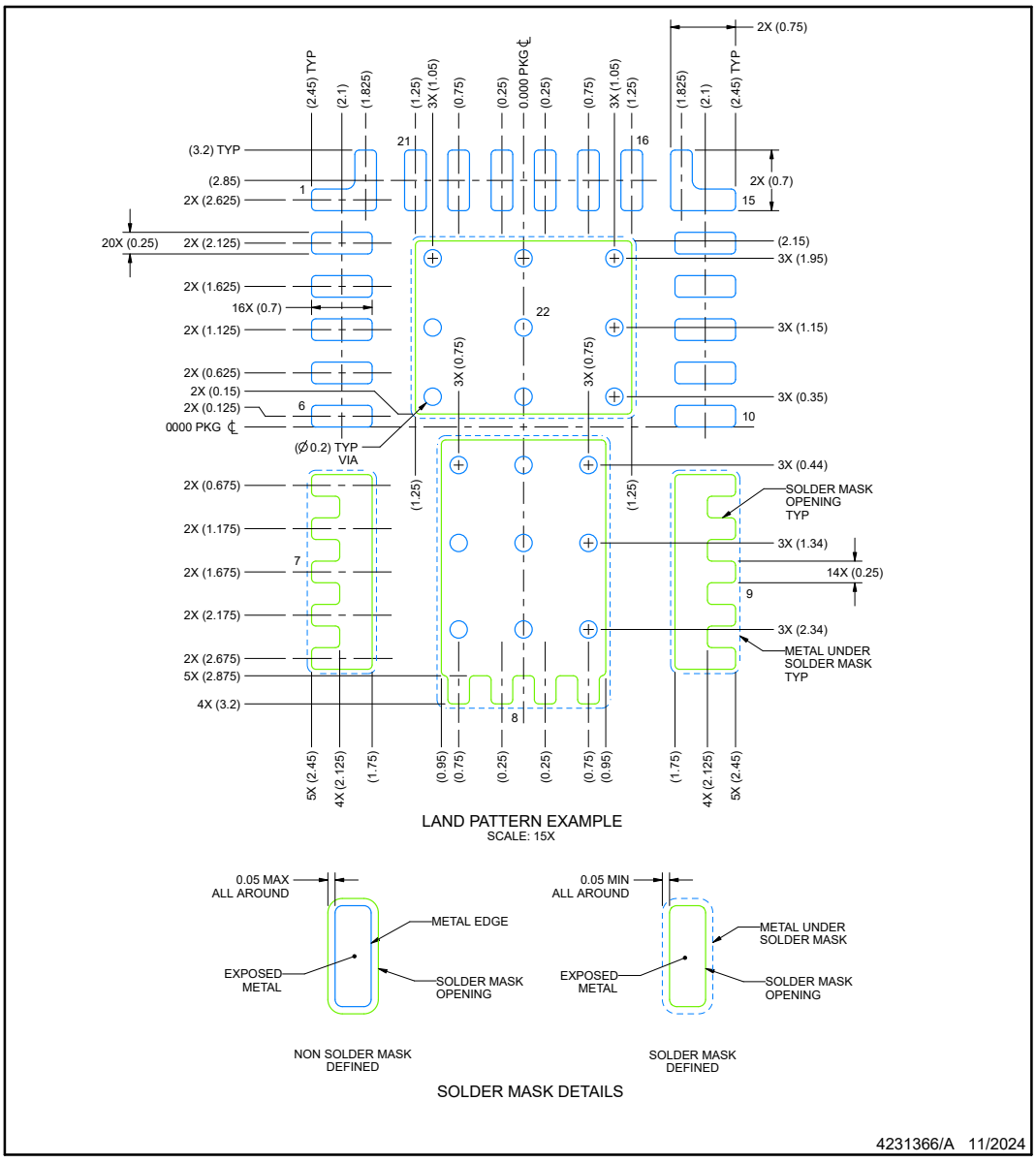
EXAMPLE BOARD LAYOUT

VBT0022B

VQFN-FCRLF - 0.85 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



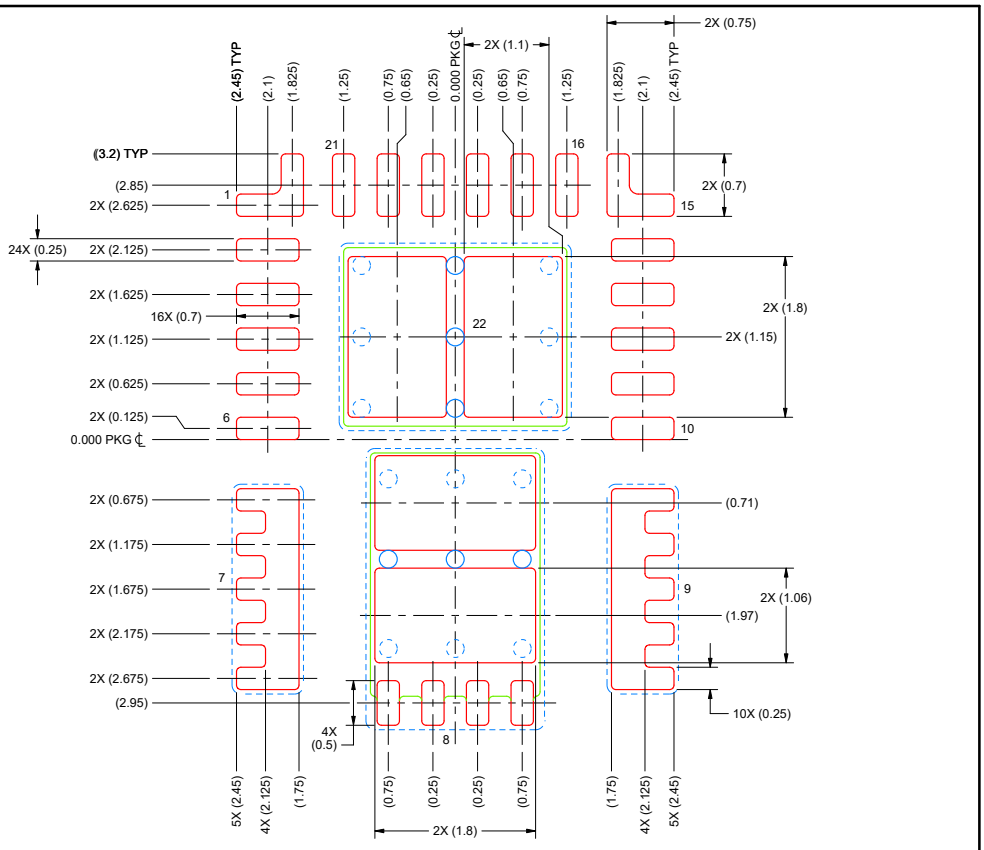
NOTES: (continued)

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

VBT0022B — **VQFN-FCRLF - 0.85 mm max height**

PLASTIC QUAD FLATPACK - NO LEAD



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

SOLDER COVERAGE BY AREA UNDER PACKAGE
PAD 8: 78%
PAD 22: 79%

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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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