# TCAN245x-Q1 Automotive Signal Improvement Capable CAN FD System Basis Chip (SBC) with Integrated Buck Regulator and Watchdog

## 1 Features

- AEC-Q100 qualified for automotive applications
- Meets the requirements of ISO 11898-2:2024 for CAN-FD and CAN-FD Signal Improvement Capability (SIC)
- Integrated 3.3V or 5V Buck regulator (VCC1) with 1 A output capability
  - Pin-selectable output (3.3V or 5V) based on VSEL pin connection
  - Switching frequency options from 1.8MHz to 2.4MHz to enable a smaller on-board inductor
  - Integrated spread spectrum modulation to improve EMC performance
- 5V LDO regulator (VCC2) supporting up to 200mA with off-board capability and short-to-battery protection
- Multiple methods to wake-up from Sleep mode
  - CAN bus wake-up pattern (WUP)
  - Local wake up (LWU) via four WAKE pins
    - Cyclic sensing wake-up using a high-side switch (HSS4)
  - Selective wake/partial networking capability, TCAN2451-Q1 only
  - Digital wake-up using SW pin
- WAKE pins configurable as ID pins to identify ECU location in the vehicle
- Four high-side switches to support multiple loads and allow for cyclic sensing wake
- Fail-safe output pin (LIMP) that can also be used optionally as a low-side switch
- ±58V Bus fault protection
- Advanced CAN bus fault diagnostics
- Timeout, window and Q&A watchdog support
- Access to EEPROM to save device configuration
- Available in 32-pin leadless package with wettable flank for improved automated optical inspection (AOI) capability

## 2 Applications

- Body electronics and lighting
- Car access and security
- Hybrid, electric and powertrain systems
- Industrial transportation

## 3 Description

The TCAN245x-Q1 is a family of system basis chips (SBC) that provide a control area network flexible data rate capable (CAN FD) transceiver that meets the physical layer requirements of ISO-11898:2-2024 including the SIC specification. The CAN FD transceiver supports data rates up to 8Mbps. The TCAN245x-Q1 integrates a buck regulator (VCC1) that can output either 3.3V or 5V, and provide up to 1A output current. The buck regulator integrates spread spectrum modulation to improve EMC performance. VCC2 LDO provides 5V output for loads up to 200 mA. TCAN2451-Q1 supports Partial Networking by recognizing a selective wakeup frame (WUF)

The TCAN245x-Q1 includes features such as LIMP, four local wake inputs and four high side switches. The high side switch can be on/off, 10-bit PWM or timer controlled. Using the GFO pin, it is possible to control an external CAN FD, LIN transceiver, CAN SBC or LIN SBC. The WAKE pins can be configured for static sensing, cyclic sensing (with HSS4 pin) and pulse based for waking up. These devices provide EEPROM to store specific device configuration information thus avoiding extensive reprogramming after power fluctuations.

**Package Information**

| PART NUMBER | PACKAGE(1) | PACKAGE SIZE(2) |
|---|---|---|
| TCAN2450-Q1<br>TCAN2451-Q1 | VQFN (32) | 5mm x 5mm |

(1) For more information, see Section 7.
(2) The package size (length × width) is a nominal value and includes pins, where applicable.

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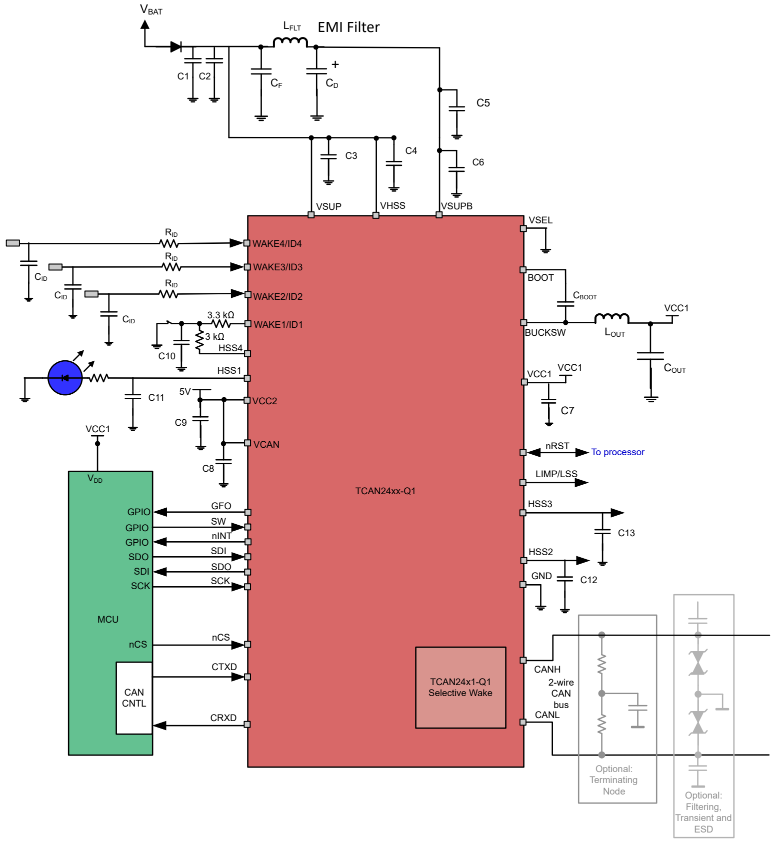


**Typical Application Diagram**

# 4 Pin Configuration and Functions

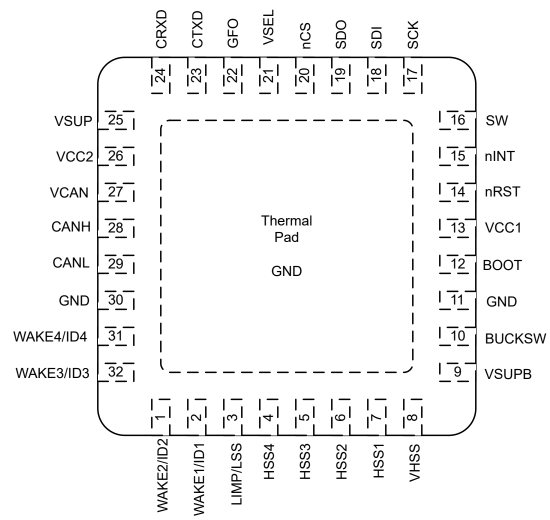


**Figure 4-1. RHB Package, 32 Pin (VQFN) (Top View)**

**Table 4-1. Pin Functions**

| NAME | PIN NO. | TYPE[(1)] | DESCRIPTION |
|---|---|---|---|
| | RHB | | |
| WAKE2/ID2 | 1 | I | High voltage (HV) capable. Local wake input terminal.<br>Configurable as an ID pin |
| WAKE1/ID1 | 2 | I | HV capable. Local wake input terminal. Configurable as an ID pin |
| LIMP/LSS | 3 | O | HV capable. Limp home output (Active low; open-drain output) |
| HSS4 | 4 | O | HV. High side switch 4 output |
| HSS3 | 5 | O | HV. High side switch 3 output |
| HSS2 | 6 | O | HV. High side switch 2 output |
| HSS1 | 7 | O | HV. High side switch 1 output |
| VHSS | 8 | P | HV. Separate input supply for the high side switches. Typically connected to the battery but can also be supplied independently. |
| VSUPB | 9 | P | HV. Input supply from the battery for the buck regulator.<br>VSUPB and VSUP must be to the same battery supply, but separated by the EMI filter as shown in the application schematic to reduce the conducted EMI on the VSUP pin. |
| BUCKSW | 10 | P | HV. Buck regulator switching node. Connect to power inductor. |
| GND | 11 | G | Ground |
| BOOT | 12 | P | HV. Bootstrap supply voltage for internal high-side driver. Connect a high-quality 100nF capacitor from this pin to the BUCKSW pin. |
| VCC1 | 13 | P | Buck regulator output 3.3V or 5V. Connect a high-quality capacitor to GND. |
| nRST | 14 | I/O | Low-voltage (LV) digital. VCC1 under-voltage monitor output pin (active low) and device reset input |
| nINT | 15 | O | LV digital. Interrupt output (active low) |
| SW | 16 | I | LV digital . Programming mode input pin (SPI configurable active high or active low).<br>Internal pull-up (active low configuration) or pull-down (active high configuration) of 60 kΩ |
| SCK | 17 | I | LV digital. SPI clock input |
| SDI | 18 | I | LV digital. SPI data input.<br>Internal pull-up of 60kΩ |
| SDO | 19 | O | LV digital. SPI data output. |
| nCS | 20 | I | LV digital. Chip select input (active low).<br>Internal pull-up of 60kΩ |

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**Table 4-1. Pin Functions (continued)**

| NAME | PIN NO. | TYPE[(1)] | DESCRIPTION |
|---|---|---|---|
| | RHB | | |
| VSEL | 21 | I | LV digital.<br>VCC1 output voltage selector pin.<br>1. Connected to GND: VCC1 = 5V<br>2. Floating: VCC1 = 3.3V.<br><br>Internal pull-up of 30kΩ |
| GFO | 22 | O | LV digital. General function output pin (SPI configurable);<br>Push-pull |
| CTXD | 23 | I | LV digital. CAN transmit data input (low for dominant and high for recessive bus states);<br>Internal pull-up of 60kΩ. |
| CRXD | 24 | O | LV digital. CAN receive data output (low for dominant and high for recessive bus states), tri-state |
| VSUP | 25 | P | HV. Input supply pin, typically connected to battery. |
| VCC2 | 26 | P | 5V LDO output. Short-to-battery protected. |
| VCAN | 27 | P | 5V power supply input for the CAN FD transceiver |
| CANH | 28 | I/O | HV capable. High level CAN bus I/O line |
| CANL | 29 | I/O | HV capable . Low level CAN bus I/O line |
| GND | 30 | G | Ground connection: Must be soldered to ground |
| WAKE4/ID4 | 31 | I | HV capable. Local wake input terminal. Configurable as ID pin |
| WAKE3/ID3 | 32 | I | HV. Local wake input terminal. Configurable as an ID pin |
| NC | - | NC | Not connected internally. |
| GND | Thermal Pad | G | Ground connection: Must be soldered to ground |

(1) I = Input, O = Output, I/O = Input or Output, G = Ground, P = Power, NC = No Connect

# 5 Device and Documentation Support

This device will conform to the following CAN standards. The core of what is needed is covered within this system spec, however reference should be made to these standards and any discrepancies pointed out and discussed. This document should provide all the basics of what is needed. However, for a full understanding of CAN including the protocol these additional sources will be very helpful as the scope of CAN protocol in detail is outside the scope of this physical layer (transceiver) specification.

## 5.1 Documentation Support

### 5.1.1 CAN Transceiver Physical Layer Standards:

- ISO 11898-2:2024: High speed medium access unit with low power mode (super sets -2 standard electrically in several specs and adds the original wake up capability via the bus in low power mode)
- ISO 8802-3: CSMA/CD – referenced for collision detection from ISO11898-2
- SAE J2284-2: High Speed CAN (HSC) for Vehicle Applications at 250 kbps
- SAE J2284-3: High Speed CAN (HSC) for Vehicle Applications at 500 kbps

### 5.1.2 EMC Requirements:

- SAEJ2962-2: US3 requirements for CAN Transceivers (-2, -5, GM will propose updates to address -6 + FD, but this is the best place for a working start)
- HW Requirements for CAN, LIN, FR V1.3: German OEM requirements for CAN and LIN
- ISO 10605: Road vehicles - Test methods for electrical disturbances from electrostatic discharge
- ISO 11452-4:2011: Road vehicles - Component test methods for electrical disturbances from narrowband radiated electromagnetic energy - Part 4: Harness excitation methods
- ISO 7637-1:2015: Road vehicles - Electrical disturbances from conduction and coupling - Part 1: Definitions and general considerations
- ISO 7637-3: Road vehicles - Electrical disturbances from conduction and coupling - Part 3: Electrical transient transmission by capacitive and inductive coupling via lines other than supply lines
- IEC 62132-4:2006: Integrated circuits - Measurement of electromagnetic immunity 150 kHz to 1 GHz - Part 4: Direct RF power injection method
- IEC 61000-4-2
- IEC 61967-4
- CISPR25

### 5.1.3 Conformance Test Requirements:

- HS_TRX_Test_Spec_V_1_0: GIFT / ICT CAN test requirements for High Speed Physical Layer
- ISO/DIS 17987-7.2: Road vehicles -- Local Interconnect Network (LIN) -- Part 7: Electrical Physical Layer (EPL) conformance test specification
- SAEJ2602-2: LIN Network for Vehicle Applications Conformance Test

### 5.1.4 Related Documentation

- “A Comprehensible Guide to Controller Area Network”, Wilfried Voss, Copperhill Media Corporation
- “CAN System Engineering: From Theory to Practical Applications”, 2nd Edition, 2013; Dr. Wolfhard Lawrenz, Springer.

## 5.2 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.

## 5.3 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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### 5.4 Trademarks

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### 5.5 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.

### 5.6 Glossary

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

## 6 Revision History

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

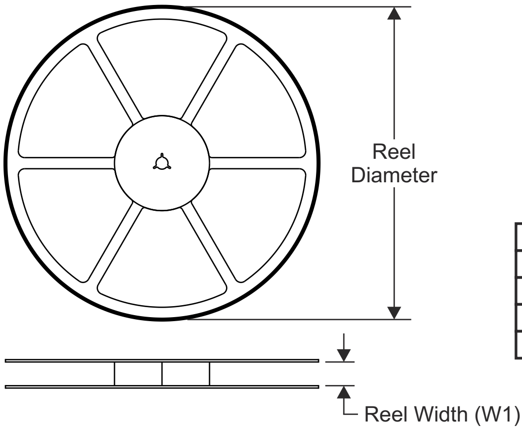
| DATE | REVISION | NOTES |
|---|---|---|
| April 2024 | * | Initial release. |

## 7 Mechanical, Packaging, and Orderable Information

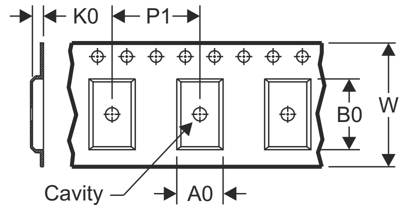
The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand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

## 7.1 Tape and Reel Information

**REEL DIMENSIONS**

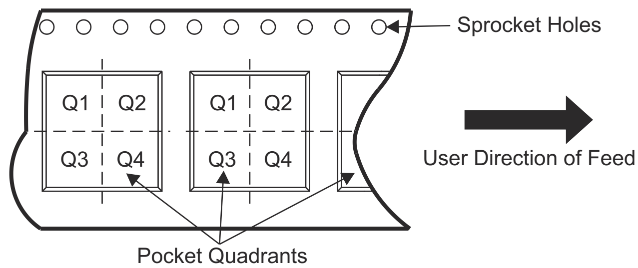



**TAPE DIMENSIONS**




| | |
|---|---|
| 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PTCAN2450RHBRQ1 | VQFN | RHB | 32 | 5000 | 330.0 | 12.4 | 5.3 | 5.3 | 1.1 | 8.0 | 12.0 | Q2 |
| PTCAN2451RHBRQ1 | VQFN | RHB | 32 | 5000 | 330.0 | 12.4 | 5.3 | 5.3 | 1.1 | 8.0 | 12.0 | Q2 |

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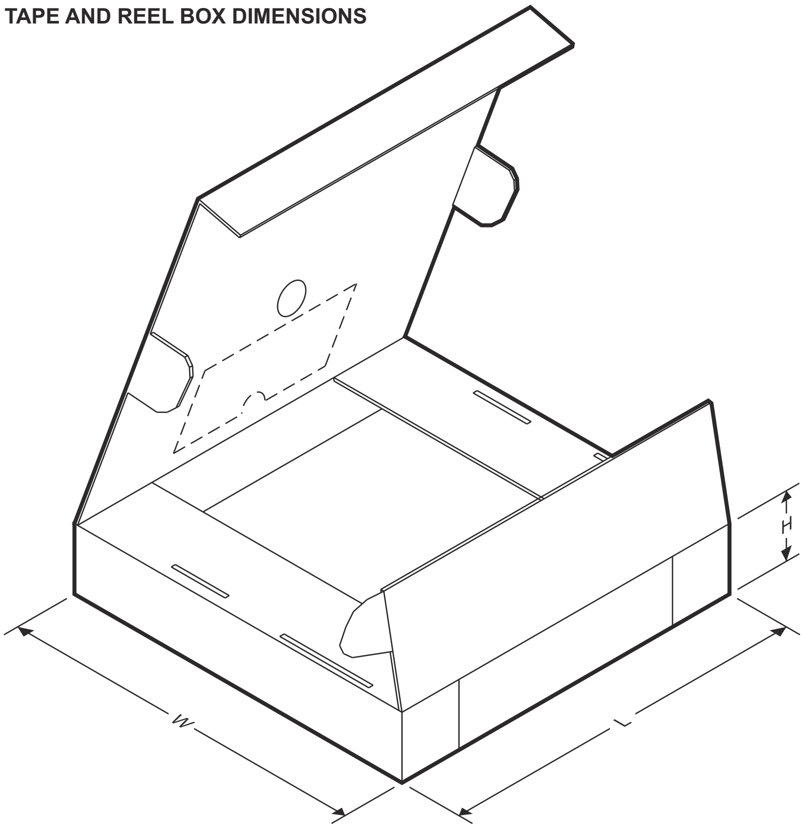
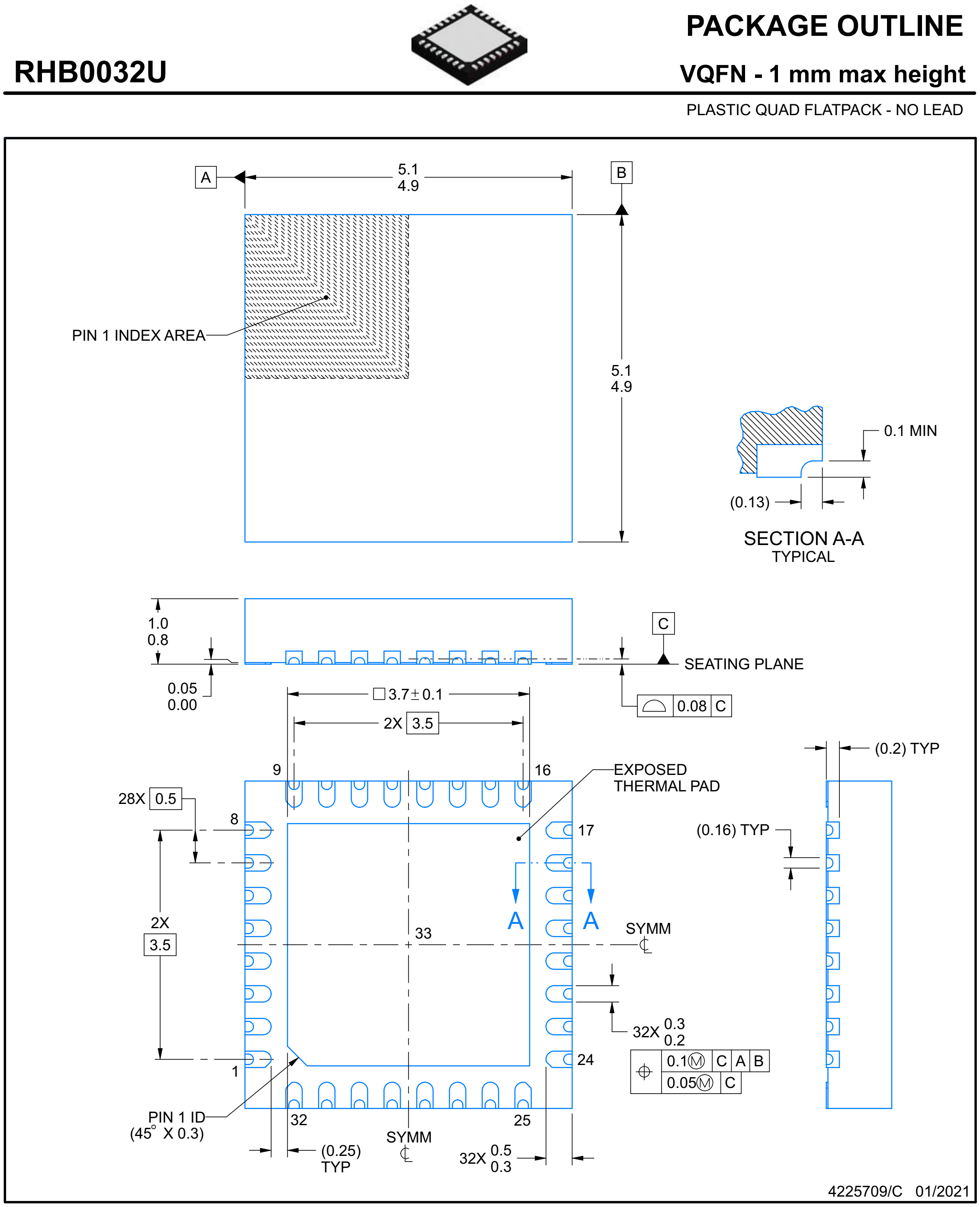
TAPE AND REEL BOX DIMENSIONS




| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|---|---|---|---|---|---|---|---|
| PTCAN2450RHBRQ1 | VQFN | RHB | 32 | 5000 | 367.0 | 367.0 | 35.0 |
| PTCAN2451RHBRQ1 | VQFN | RHB | 32 | 5000 | 367.0 | 367.0 | 35.0 |

## 7.2 Mechanical Data




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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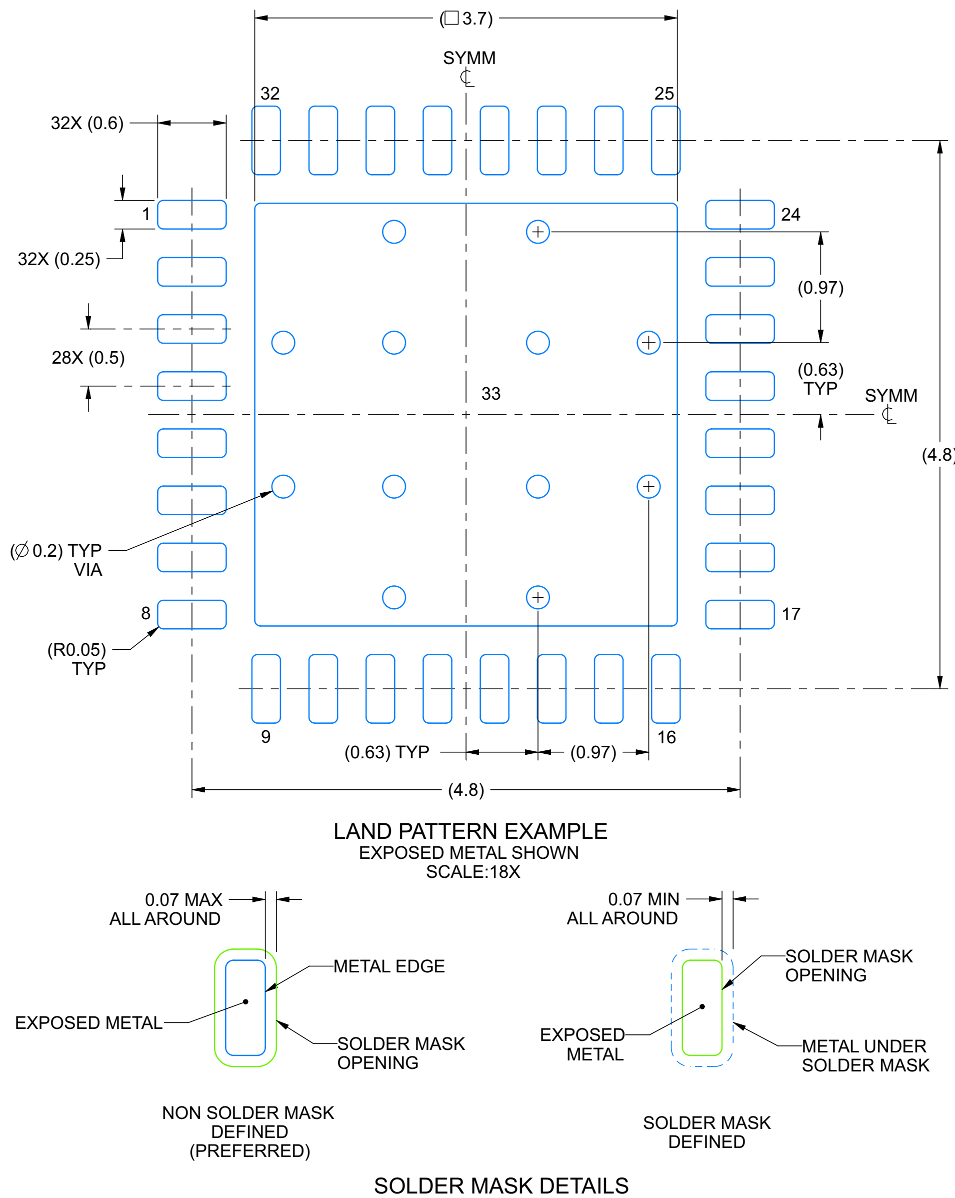
# EXAMPLE BOARD LAYOUT

## RHB0032U

**VQFN - 1 mm max height**

PLASTIC QUAD FLATPACK - NO LEAD

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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.

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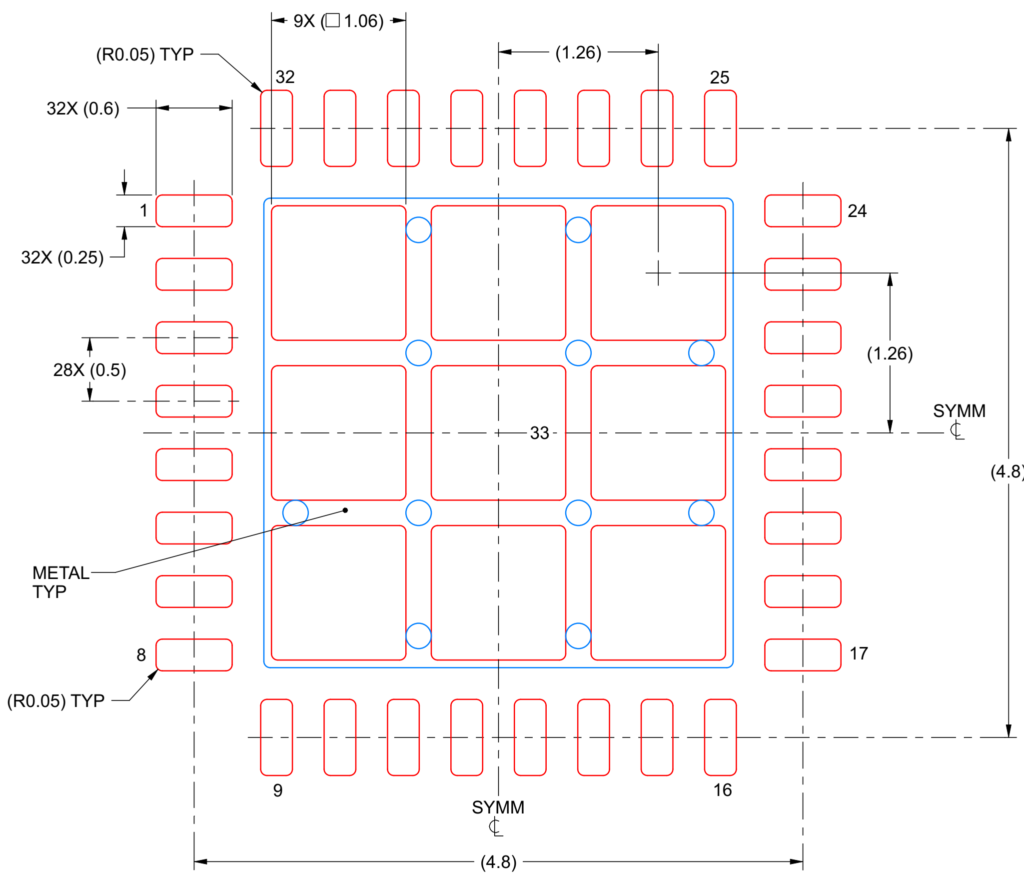
# EXAMPLE STENCIL DESIGN

## RHB0032U

VQFN - 1 mm max height

PLASTIC QUAD FLATPACK - NO LEAD




SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL

EXPOSED PAD 33:
74% 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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## 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PTCAN2450RHBRQ1 | ACTIVE | VQFN | RHB | 32 | 5000 | TBD | Call TI | Call TI | -40 to 125 | | Samples |
| PTCAN2451RHBRQ1 | ACTIVE | VQFN | RHB | 32 | 5000 | TBD | Call TI | Call TI | -40 to 125 | | 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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