TPS92542-Q1 65V Automotive Synchronous BOOST Controller, and Two-Channel 2A Synchronous CC/CV BUCK Converter

1 Features

- AEC-Q100 qualified for automotive applications
  - Grade 1: –40°C to 125°C ambient operating temperature
  - Device HBM classification level H1C
  - Device CDM classification level C5
- Functional Safety-Capable
  - Documentation available to aid functional safety system design
- 4.5V to 65V wide input voltage range
- Two-channel synchronous Buck with integrated switches
- Configurable constant voltage (CV) and constant current (CC) operation
  - Up to 2A continuous output current
  - 4% regulation accuracy (voltage and current mode)
- Synchronous BOOST controller
  - Programmable output voltage up to 65V
- BOOST and BUCK spread-spectrum for EMI mitigation
- BUCK switch thermal protection
- UART serial communication
  - Internal oscillator for system clock
  - LMM compatible
- Internal EEPROM
  - Default settings
  - Customer calibration data

2 Applications

- Automotive headlight and adaptive LED driving module

3 Description

The TPS92542 device contains a synchronous BOOST controller and a two-channel monolithic synchronous buck LED driver with a wide 4.5V to 65V operating BUCK input voltage range.

The synchronous BOOST controller implements a peak current-mode controller to operate in constant voltage mode. The Boost can be programmed to operate as dual-phase, or three-phase together with other TPS9254x devices. The output voltage can be programmed using a programmable 8-bit DAC. The BOOST controller incorporates programmable frequency modulation technique for EMI reduction.

The monolithic synchronous BUCK implements an adaptive on-time average current mode control and is designed to generate constant voltage (CV) or constant current (CC) output. In the CC mode, the BUCK is compatible with shunt FET dimming techniques and LED matrix manager-based dynamic beam headlamps. In CV mode, the adaptive ontime control enables high bandwidth operation with fast transient response. The control provides near constant switching frequency that can be set between 100kHz and 1.0MHz. Inductor current sensing and closed-loop feedback enable better than ±4% accuracy over wide input voltage, output voltage and ambient temperature range. In CC mode, the BUCK can independently modulate LED current using both analog or PWM dimming techniques.

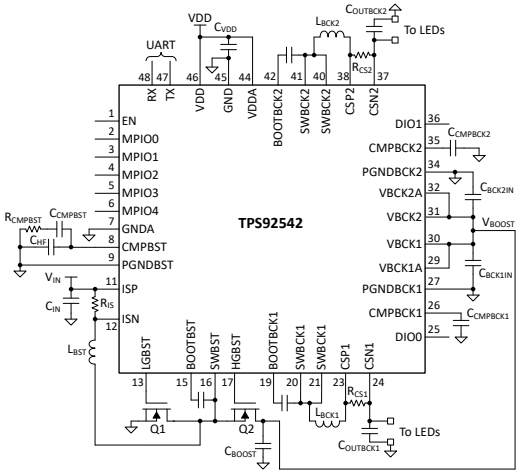
The UART serial interface is compatible with TPS9266x, and TPS9254x devices. The internal EEPROM can store system defaults as well as calibration and lighting module data. The five configurable MPIOs and two DIOs can be configured as digital inputs or outputs. The MPIOs can be configured as ADC inputs.

The TPS92542-Q1 is available in a 7.0mm × 7.0mm thermally-enhanced 48-pin HTQFP package with top-exposed pad.

Device Information

PART NUMBER(1)	PACKAGE	BODY SIZE (NOM)
TPS92542-Q1	PKD (HTQFP, 48)	7.0mm × 7.0mm

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



Simplified Schematic

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4 Device and Documentation Support

4.1 Documentation Support

4.1.1 Related Documentation

For related documentation see the following:

Texas Instruments, *TPS92542-Q1 Launchpad Evaluation Module User's Guide*

4.2 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.

4.3 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.

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.

4.4 Trademarks

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4.5 Glossary

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

5 Revision History

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

DATE	REVISION	NOTES
December 2024	*	Initial release

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.

6.1 Package Option Addendum

Packaging Information

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish(4)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking(5) (6)
TPS92542QPKDRQ1	ACTIVE	HTQFP	PKD	48	1000	Green (RoHS and no Sb/Br)	NIPDAU	EVEL3-260C-168 HR	-40 to 125	TPS92542

(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.
PRE_PROD Unannounced device, not in production, not available for mass market, nor on the web, samples not available.
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) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
TBD: The Pb-Free/Green conversion plan has not been defined.
Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.
Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.
Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

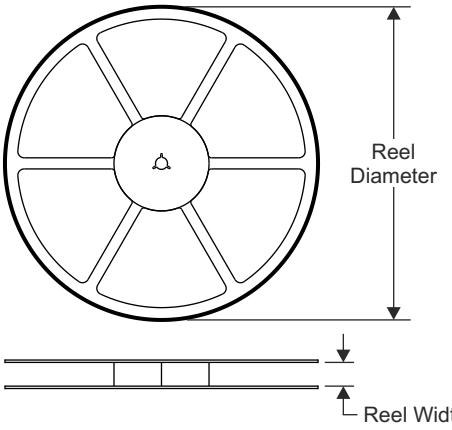
(4) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

(5) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device

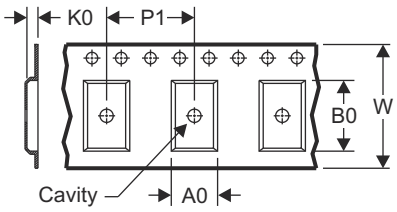
(6) Multiple Device markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

6.2 Tape and Reel Information

REEL DIMENSIONS

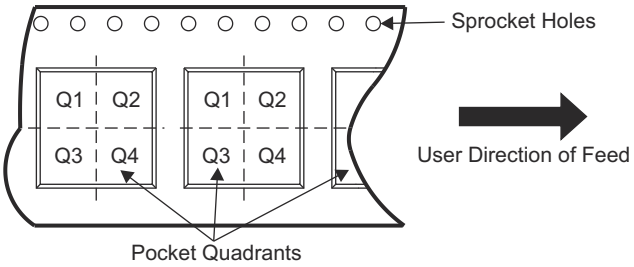


TAPE DIMENSIONS



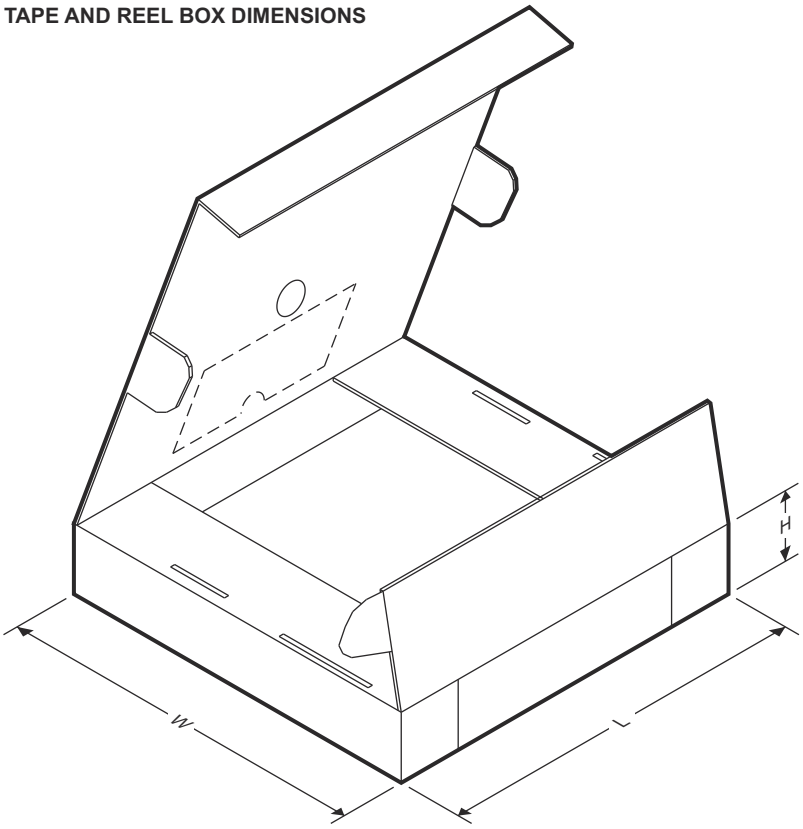
A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

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
TPS92542QPKDRQ1	HTQFP	PKD	48	1000	330	16.4	9.6	9.6	1.5	12	16	Q2

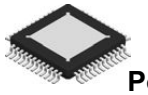
TAPE AND REEL BOX DIMENSIONS



Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TPS92542QPKDRQ1	HTQFP	PKD	48	1000	336.6	336.6	31.8

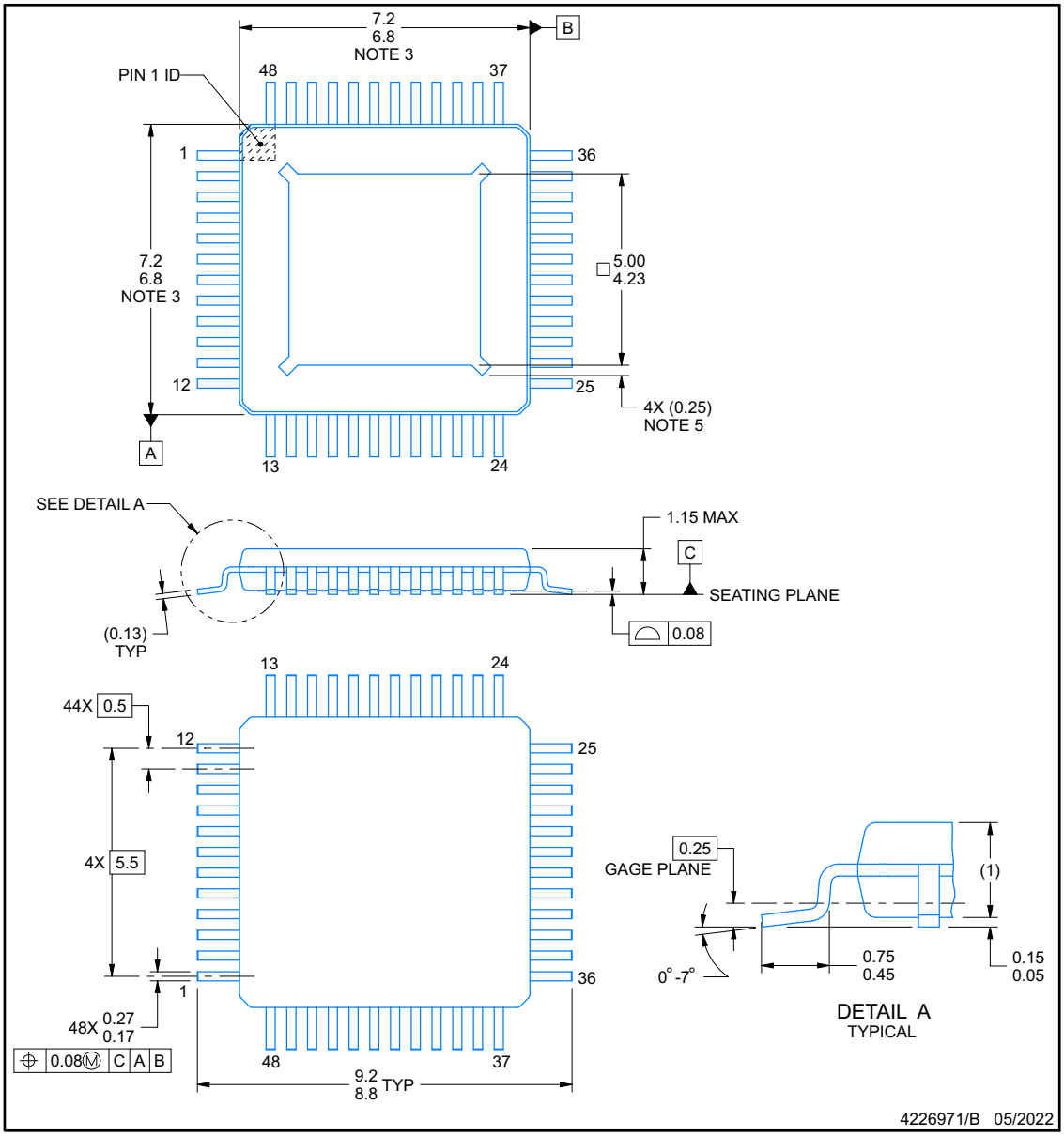
PACKAGE OUTLINE

PKD0048A



PowerPAD™ HTQFP - 1.15 mm max height

PLASTIC QUAD FLATPACK



PowerPAD is a trademark of Texas Instruments.

NOTES:

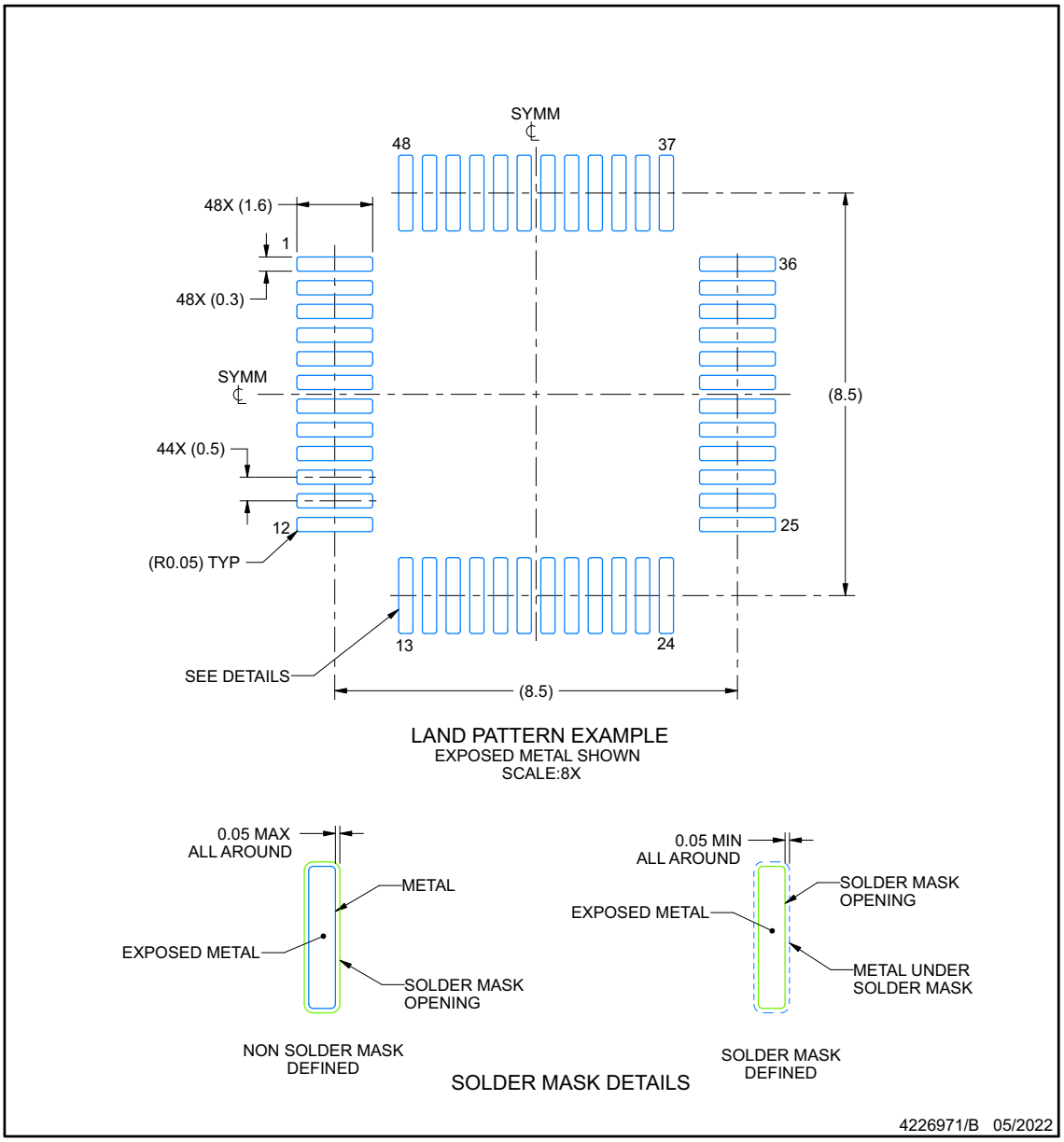
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. Reference JEDEC registration MS-026.
5. Feature may not be present.

EXAMPLE BOARD LAYOUT

PKD0048A

PowerPAD ™HTQFP - 1.15 mm max height

PLASTIC QUAD FLATPACK



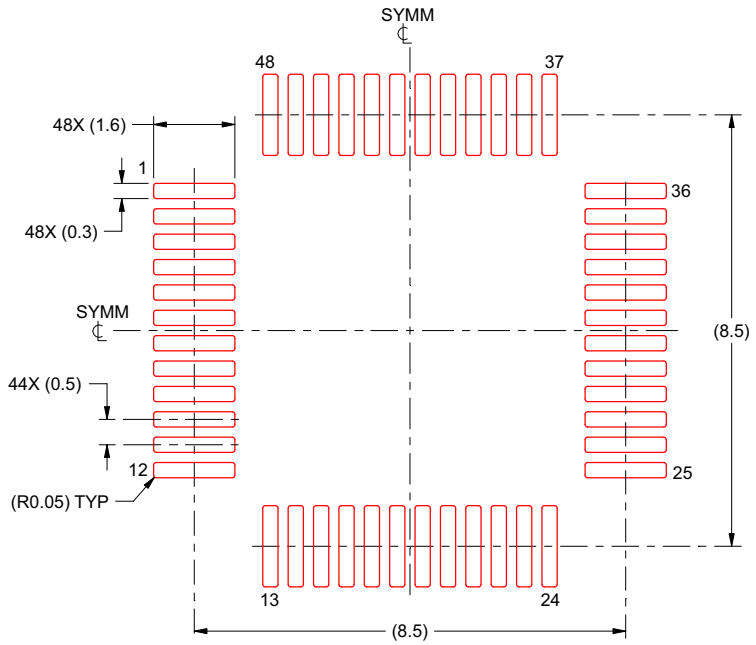
NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.
8. This package is designed to be soldered to a thermal pad on the board. See technical brief, Powerpad thermally enhanced package, Texas Instruments Literature No. SLMA002 (www.ti.com/lit/slma002) and SLMA004 (www.ti.com/lit/slma004).
9. Vias are optional depending on application, refer to device data sheet. It is recommended that vias under paste be filled, plugged or tented.
10. Size of metal pad may vary due to creepage requirement.

EXAMPLE STENCIL DESIGN

PKD0048A — **PowerPAD ™HTQFP - 1.15 mm max height**

PLASTIC QUAD FLATPACK



SOLDER PASTE EXAMPLE
SCALE:8X

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NOTES: (continued)

11. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
12. Board assembly site may have different recommendations for stencil design.

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