TEXAS INSTRUMENTS

TPS25830-Q1, TPS25831-Q1

TPS2583x-Q1 USB Type-C and BC1.2 5-V 3.5-A Output, 36-V Input Synchronous Step-Down Regulator with Cable Compensation

1 Features

- AEC-Q100 Qualified for Automotive Applications:
  - Temperature Grade 1: –40°C to +125°C, T_A
  - HBM ESD Classification Level H2
  - CDM ESD Classification Level C5
  - IEC 61000-4-2 Qualified DP_IN, DM_IN, CC1, CC2
    - ±8kV Contact Discharge
    - ±15kV Air-Gap Discharge
- Synchronous Buck Regulator
  - Input Voltage Range: 6 V to 36 V at 3.5 A
  - Adjustable Frequency: 300 kHz to 2.4 MHz
  - Peak-Current Mode Control
  - FPWM with Spread-Spectrum Dithering
  - Programmable Current Limit
  - Cable Droop Compensation
- Compliant to USB-IF Standards
  - USB Type-C Rev 1.3
    - CC Logic, V_{CONN} Source and Discharge
    - USB Cable Polarity Detection ($\overline{POL}$)
  - Battery Charging Specification Rev 1.2
    - CDP: Charging Downstream Port
    - SDP: Standard Downstream Port
    - DCP: Dedicated Charging Port (TPS25831-Q1 only)
- D+ and D- Client Mode for System Update
- Integrated Protection
  - D+ and D- Short-to-V_{BAT} and V_{BUS}
  - CC1 and CC2 Short-to-V_{BAT} Protection
- Gate Drive for Optional NMOS V_{BUS} Switch
- Fault Flag Reports
  - V_{BUS} Overcurrent and Overvoltage
  - CC Overcurrent and Overvoltage
  - DP and DM Overvoltage
- 32-Pin, 5 x 5mm, 0.5mm pitch, QFN Package

2 Applications

- Automotive - Head Units, USB Media Hubs, USB Charger Ports

3 Description

The TPS2583x-Q1 is a USB Type-C and BC1.2 charging solution that includes a synchronous DC/DC converter. With cable droop compensation, the Vbus voltage remains constant regardless of load current, ensuring connected portable devices are charged at optimal current and voltage even under heavy loads.

Device Information[1]

| PART NUMBER	PACKAGE	BODY SIZE (NOM)
TPS25830-Q1	VQFN (32)	5.00 mm x 5.00 mm
TPS25831-Q1	VQFN (32)	5.00 mm x 5.00 mm

(1) For detail part numbers for all available different options, see the orderable addendum at the end of the data sheet.

Device Comparison

PART NUMBER	DCP AUTO	DP AND DM SWITCHES	NTC INPUT	THERMAL WARNING FLAG
TPS25830-Q1	No	Yes	No	No
TPS25831-Q1	Yes	No	Yes	Yes

ADVANCE INFORMATION

Simplified Schematic TPS25830-Q1
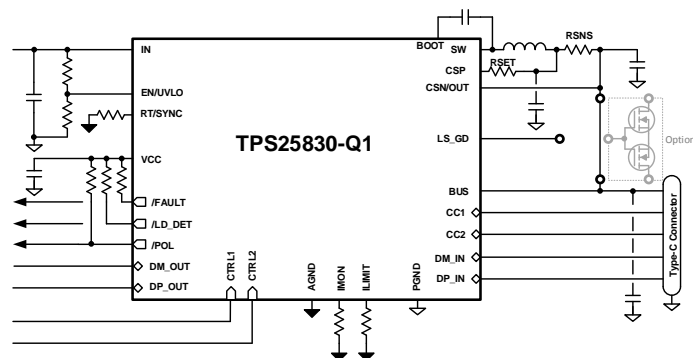
4 Revision History

Changes from Original (June 2018) to Revision A   **Page**

ADVANCE INFORMATION

Product Folder Links: *TPS25830-Q1*

5 Description (continued)

The synchronous buck regulator operates with peak-current mode control and is internally compensated to simplify design. A resistor on the RT pin sets the switching frequency between 300 kHz and 2.4 MHz. Operating below 400 kHz results in better system efficiency. Operation above 2.1 MHz avoids the AM radio bands and allows for use of a smaller inductor.

The TPS2583x-Q1 integrates standard USB Type-C port controller functionality including Configuration Channel (CC) logic for 3 A and 1.5 A current advertisement. Battery Charging (Rev. 1.2) integration provides the required electrical signatures necessary for non-Type-C, legacy USB devices which utilize USB data line signaling to determine USB port current sourcing capabilities.

A precision current sense amplifier is included for user programmable cable droop compensation and current limit tuning. Cable compensation aids portable devices in charging at optimum current and voltage under heavy loads by changing the buck regulator output voltage linearly with load current to counteract the voltage drop due to wire resistance in automotive cabling. The V_{BUS} voltage measured at a connected portable device remains approximately constant, regardless of load current, allowing the portable device's battery charger to work optimally.

The USB specifications require current limiting of USB charging ports, but give system designers reasonable flexibility to choose overcurrent protection levels based on system requirements. The TPS25830x-Q1 uses a novel two-threshold current limit circuit allowing system designers to either program average current limit protection of the buck regulator, or optionally, current limit using an external NMOS between the CSN/OUT and BUS pins. The NFET implementation enables the TPS2583x-Q1 buck regulator to supply a 5-V output for other loads during an overcurrent fault condition on the USB port.

The TPS25830-Q1 includes high bandwidth analog switches for DP and DM pass-through. The TPS25831-Q1 includes a thermistor input pin and thermal warning flag for user programmable thermal overload protection.

Integrated protection features include cycle-by-cycle current limit, hiccup short-circuit protection, undervoltage lockout, V_{BUS} overvoltage and overcurrent, CC overvoltage and overcurrent, data line (D_x) short to V_{BUS} and V_{BAT}, and die over-temperature protection.

ADVANCE INFORMATION

Submit Documentation Feedback   3

Product Folder Links: *TPS25830-Q1*

6 Device and Documentation Support

6.1 Related Links

The table below lists quick access links. Categories include technical documents, support and community resources, tools and software, and quick access to sample or buy.

Table 1. Related Links

PARTS	PRODUCT FOLDER	ORDER NOW	TECHNICAL DOCUMENTS	TOOLS & SOFTWARE	SUPPORT & COMMUNITY
TPS25830-Q1	Click here	Click here	Click here	Click here	Click here
TPS25831-Q1	Click here	Click here	Click here	Click here	Click here

6.2 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.

6.3 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.

6.4 Trademarks

E2E is a trademark of Texas Instruments.

6.5 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.

6.6 Glossary

SLYZ022 — *TI Glossary*.

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

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.

ADVANCE INFORMATION

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
PTPS25830QWRHBTQ1	ACTIVE	VQFN	RHB	32	250	TBD	Call TI	Call TI	-40 to 125		Samples
PTPS25831QWRHBTQ1	ACTIVE	VQFN	RHB	32	250	TBD	Call TI	Call TI	-40 to 125		Samples
TPS25830QWRHBRQ1	PREVIEW	VQFN	RHB	32	3000	TBD	Call TI	Call TI	-40 to 125		
TPS25831QWRHBRQ1	PREVIEW	VQFN	RHB	32	3000	TBD	Call TI	Call TI	-40 to 125		
TPS25831QWRHBTQ1	PREVIEW	VQFN	RHB	32	250	TBD	Call TI	Call TI	-40 to 125		

(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/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.
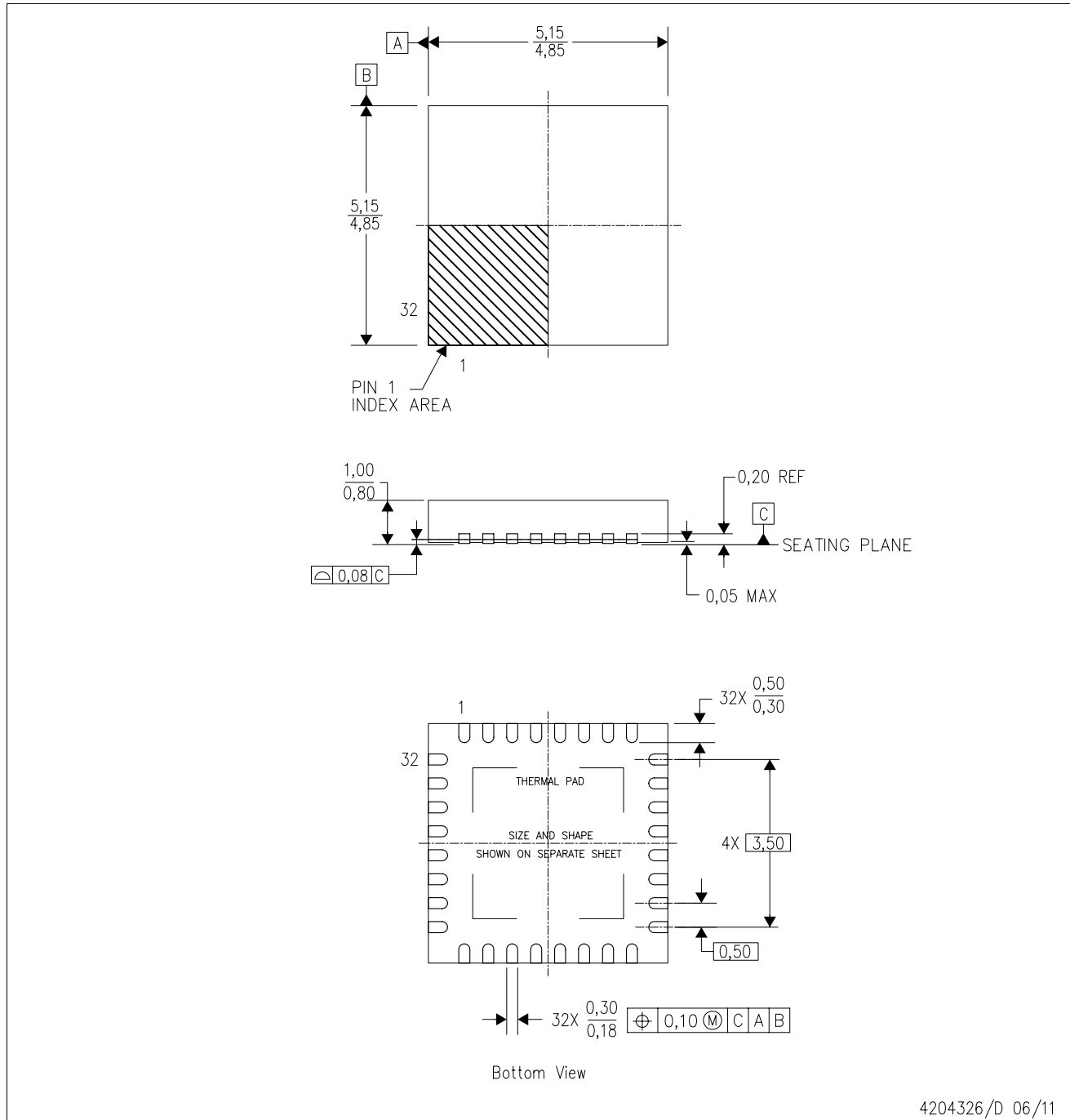
Important Information and Disclaimer: The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. 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.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

RHB (S−PVQFN−N32)   PLASTIC QUAD FLATPACK NO−LEAD

A

B

$\frac{5,15}{4,85}$

$\frac{5,15}{4,85}$

32

1

PIN 1
INDEX AREA

$\frac{1,00}{0,80}$

0,20 REF

C

SEATING PLANE

0,08 C

0,05 MAX

1

32

THERMAL PAD

SIZE AND SHAPE
SHOWN ON SEPARATE SHEET

$32X \frac{0,50}{0,30}$

$4X \boxed{3,50}$

$\boxed{0,50}$

$32X \frac{0,30}{0,18}$ $\bigoplus \boxed{0,10} \text{M} | C | A | B$

Bottom View

4204326/D 06/11

NOTES: A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M−1994.
        B. This drawing is subject to change without notice.
        C. QFN (Quad Flatpack No−Lead) Package configuration.
        D. The package thermal pad must be soldered to the board for thermal and mechanical performance.
        E. See the additional figure in the Product Data Sheet for details regarding the exposed thermal pad features and dimensions.
        F. Falls within JEDEC MO−220.