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TEXAS INSTRUMENTS

BQ25970, BQ25971 I2C Controlled Single Cell High Efficiency 8-A Switched Cap Fast Chargers With ADC

1 Features

- 97% Efficient power stage for 8-A fast charge
- Patent pending switched cap charger architecture optimized for 50% duty cycle
  - Input voltage is 2x battery voltage (3.5 V to 4.65 V)
  - Output current is 2x of input current (up to 4.5 A)
  - Reduces power loss across the cable
- Integrated programmable protection features for safe operation
  - Input over-voltage protection (BUS_OVP)
  - Input over-current protection (BUS_OCP) with adjustable alarm
  - Input over-voltage with external OVP FET (VAC_OVP up to 17 V, BQ25970 only)
  - Battery over-voltage protection (BAT_OVP) with adjustable alarm
  - Output over-voltage (VOUT_OVP)
  - Input over-current protection (BUS_OCP) with adjustable alarm
  - IBAT over-current protection (BAT_OCP) with adjustable alarm
  - Switching MOSFET cycle by cycle current limit
  - Battery temperature monitoring
  - Connector Temperature Monitoring
- Programmable settings for system optimization
  - Optional VBATREG and IBATREG regulation for system load and wall adapter transients (BQ25970 only with External OVP FET)
  - STAT, FLAG, and MASK options for interrupts
  - ADC Readings and configuration

- Integrated 12-bit effective analog-to digital converter (ADC)
  - ±0.5% BUS Voltage
  - ±0.5% VOUT Voltage
  - −0.4% to 0.2% BAT Voltage with differential sensing
  - ±1.5% BAT Current at 6 A with external R_{SENSE}
  - ±1% BAT Temperature
  - ±1% BUS Temperature
  - ±4°C Die temperature

2 Applications

- Smartphone
- Tablet PC

3 Description

The BQ2597x is a 97% efficient, 8-A battery charging solution using a switched cap architecture. This architecture and the integrated FETs are optimized to enable a 50% duty cycle, allowing the cable current to be half the current delivered to the battery, reducing the losses over the charging cable as well as limiting the temperature rise in the application.
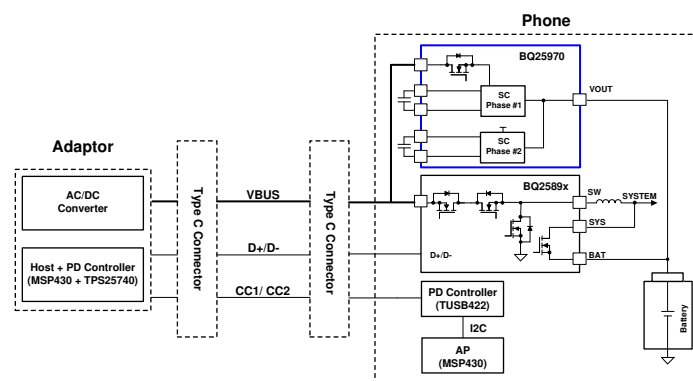
Device Information[1]

PART NUMBER	PACKAGE	BODY SIZE (NOM)
BQ25970[2]	DSBGA (56)	3.00 mm x 3.20 mm
BQ25971[3]	DSBGA (56)	3.00 mm x 3.20 mm

(1) For all available packages, see the orderable addendum at the end of the data sheet.
(2) External OVP Capable
(3) No External OVP

Simplified Application

4 Revision History

Product Folder Links: *BQ25970 BQ25971*

5   Description (continued)

The dual-phase architecture reduces the input cap requirements as well as reducing the output voltage ripple. When used with a standard charger such as the BQ2589x, the system enables the fastest charging at the lowest power loss from pre-charge through CC, CV, and termination.

The device integrates all the necessary protection features to ensure safe charging, including input over-voltage and over-current protection, output over-voltage and over-current protection, temperature sensing for the battery and cable, and monitoring the die temperature.

The device includes a 12-bit effective analog-to-digital converter (ADC) to provide bus voltage, bus current, output voltage, battery voltage, battery current, bus temperature, bat temperature, die temperature, and other calculated measurements needed to manage the charging of the battery from the smart wall adapter or power bank.

6 Device and Documentation Support

6.1 Device Support

6.1.1 Third-Party Products Disclaimer

TI'S PUBLICATION OF INFORMATION REGARDING THIRD-PARTY PRODUCTS OR SERVICES DOES NOT CONSTITUTE AN ENDORSEMENT REGARDING THE SUITABILITY OF SUCH PRODUCTS OR SERVICES OR A WARRANTY, REPRESENTATION OR ENDORSEMENT OF SUCH PRODUCTS OR SERVICES, EITHER ALONE OR IN COMBINATION WITH ANY TI PRODUCT OR SERVICE.

6.1.2 Device Nomenclature

IADAPT (A) Output current of adapter

VADAPT (V) Output voltage of adapter

VCONADROP (V) Voltage drop across the adapter connector

VCONA (V) Output voltage after adapter connector (same as the voltage at the beginning of the cable)

VCABLEDROP (V) Voltage drop

VCABLED (V) Voltage at the cable, going into the device

VCOND (V) Output voltage after the device connector

VDEVCON (V) Output voltage after the device control FETs (controlled by the PD controller)

IIN (A)   Input current to the BQ2597x

VIN (V)   Input voltage to the BQ2597x

VOUT (V)   Output voltage of the BQ2597x

VCONBDROP (V) Voltage drop across the battery connector and sense resistor

VBAT (V)   Voltage at the battery

IBAT (A)   Current at the battery

6.2 Documentation Support

6.2.1 Related Documentation

For related documentation see the following:
*   *BQ2597xEVM-xxx User's Guide*

6.3 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
BQ25970	Click here	Click here	Click here	Click here	Click here
BQ25971	Click here	Click here	Click here	Click here	Click here

6.4 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.

6.5 Community 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.

6.6 Trademarks

E2E is a trademark of Texas Instruments.
All other trademarks are the property of their respective owners.

6.7 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.

6.8 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.

PACKAGE OPTION ADDENDUM

PACKAGING INFORMATION

Orderable part number	Status (1)	Material type (2)	Package | Pins	Package qty | Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
BQ25970YFFR	Active	Production	DSBGA (YFF) | 56	3000 | LARGE T&R	Yes	SNAGCU	Level-1-260C-UNLIM	-40 to 85	BQ25970
BQ25970YFFR.A	Active	Production	DSBGA (YFF) | 56	3000 | LARGE T&R	Yes	SNAGCU	Level-1-260C-UNLIM	-40 to 85	BQ25970
BQ25970YFFT	Active	Production	DSBGA (YFF) | 56	250 | SMALL T&R	Yes	SNAGCU	Level-1-260C-UNLIM	-40 to 85	BQ25970
BQ25970YFFT.A	Active	Production	DSBGA (YFF) | 56	250 | SMALL T&R	Yes	SNAGCU	Level-1-260C-UNLIM	-40 to 85	BQ25970
BQ25971YFFR	Active	Production	DSBGA (YFF) | 56	3000 | LARGE T&R	Yes	SNAGCU	Level-1-260C-UNLIM	-40 to 85	BQ25971
BQ25971YFFR.A	Active	Production	DSBGA (YFF) | 56	3000 | LARGE T&R	Yes	SNAGCU	Level-1-260C-UNLIM	-40 to 85	BQ25971
BQ25971YFFT	Active	Production	DSBGA (YFF) | 56	250 | SMALL T&R	Yes	SNAGCU	Level-1-260C-UNLIM	-40 to 85	BQ25971
BQ25971YFFT.A	Active	Production	DSBGA (YFF) | 56	250 | SMALL T&R	Yes	SNAGCU	Level-1-260C-UNLIM	-40 to 85	BQ25971

(1) **Status:** For more details on status, see our product life cycle.

(2) **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

(3) **RoHS values:** Yes, No, RoHS Exempt. See the TI RoHS Statement for additional information and value definition.

(4) **Lead finish/Ball material:** Parts 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.

(5) **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

(6) **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

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

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.

PACKAGE MATERIALS INFORMATION

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

*All dimensions are nominal

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
BQ25970YFFR	DSBGA	YFF	56	3000	330.0	12.4	3.0	3.55	0.81	8.0	12.0	Q1
BQ25970YFFR	DSBGA	YFF	56	3000	330.0	12.4	3.22	3.55	0.81	8.0	12.0	Q1
BQ25970YFFT	DSBGA	YFF	56	250	330.0	12.4	3.22	3.55	0.81	8.0	12.0	Q1
BQ25971YFFR	DSBGA	YFF	56	3000	330.0	12.4	3.0	3.55	0.81	8.0	12.0	Q1
BQ25971YFFT	DSBGA	YFF	56	250	330.0	12.4	3.0	3.55	0.81	8.0	12.0	Q1

TAPE AND REEL BOX DIMENSIONS

*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
BQ25970YFFR	DSBGA	YFF	56	3000	335.0	335.0	25.0
BQ25970YFFR	DSBGA	YFF	56	3000	367.0	367.0	35.0
BQ25970YFFT	DSBGA	YFF	56	250	367.0	367.0	35.0
BQ25971YFFR	DSBGA	YFF	56	3000	335.0	335.0	25.0
BQ25971YFFT	DSBGA	YFF	56	250	335.0	335.0	25.0

B ──── E ──── A

BUMP A1
CORNER

D

0.625 MAX

0.30
0.12

BALL TYP

C

SEATING PLANE

△ | 0.05 | C

2.4 TYP

SYMM
₵

H G F E D C B A

2.8
TYP

SYMM
₵

0.4 TYP

1 2 3 4 5 6 7

0.4 TYP

56X ∅ 0.3
0.2

⊕ | 0.015Ⓢ | C | AⓈ | BⓈ

D: Max = 3.361 mm, Min =3.301 mm

E: Max = 2.813 mm, Min =2.753 mm

4219481/A   10/2014

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.
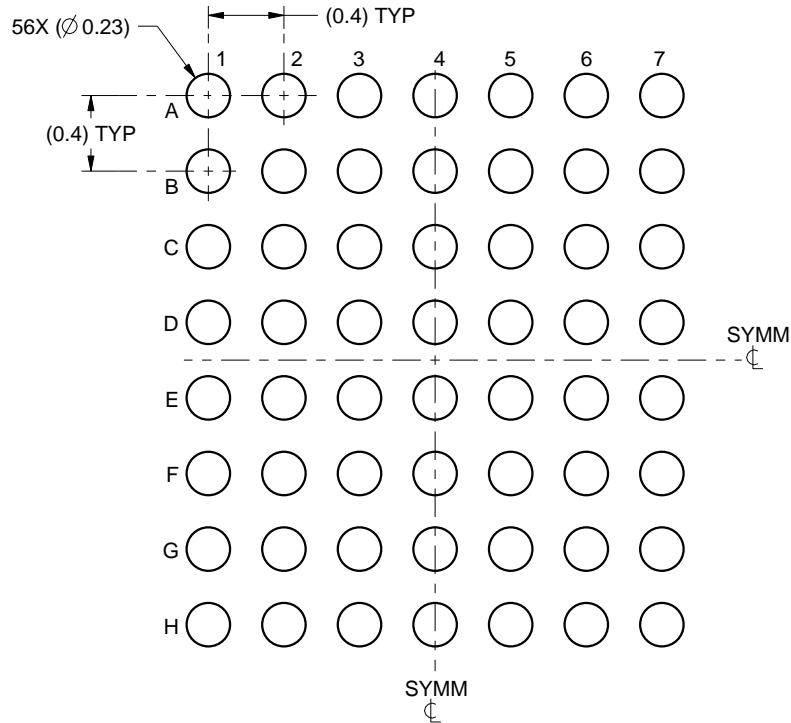
LAND PATTERN EXAMPLE
SCALE:25X

(∅ 0.23)
METAL

SOLDER MASK
OPENING

NON-SOLDER MASK
DEFINED
(PREFERRED)

0.05 MAX

0.05 MIN

(∅ 0.23)
SOLDER MASK
OPENING

METAL UNDER
SOLDER MASK

SOLDER MASK
DEFINED

SOLDER MASK DETAILS
NOT TO SCALE
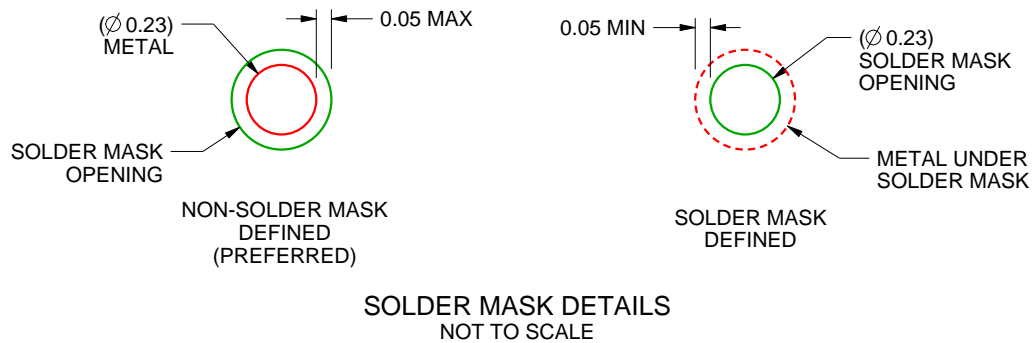
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NOTES: (continued)

3. Final dimensions may vary due to manufacturing tolerance considerations and also routing constraints.
   For more information, see Texas Instruments literature number SBVA017 (www.ti.com/lit/sbva017).

YFF0056

(0.4) TYP

56X (□ 0.25)

(R0.05) TYP

(0.4) TYP

METAL TYP

SYMM ₵

SYMM ₵
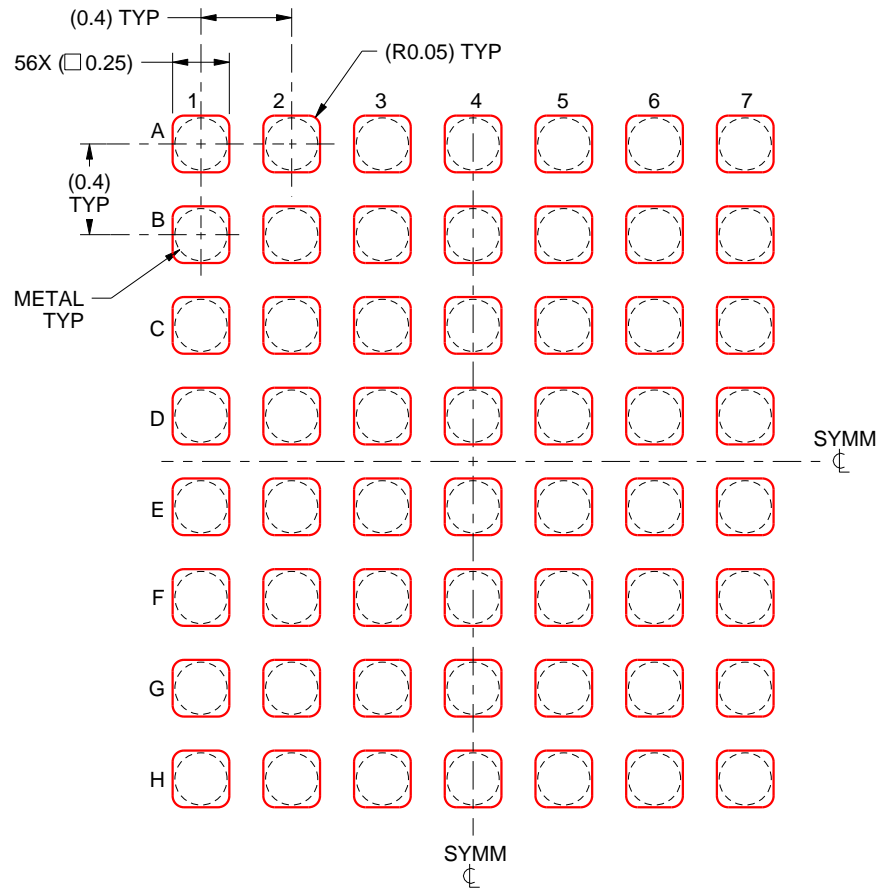
SOLDER PASTE EXAMPLE
BASED ON 0.1 mm THICK STENCIL
SCALE:30X

4219481/A   10/2014

NOTES: (continued)

4. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release.

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