TEXAS INSTRUMENTS

bq25898, bq25898D

SLUSCI7B –MARCH 2016–REVISED DECEMBER 2016

bq25898, bq25898D I2C Controlled Single Cell 4-A Fast Charger with MaxCharge™ Technology for High Input Voltage and Adjustable Voltage USB On-the-Go Boost Mode

1 Features

- High Efficiency 4-A, 1.5-MHz Switch Mode Buck Charge
  - 92% Charge Efficiency at 3 A and 91% Charge Efficiency at 4 A Charge Current
  - Optimize for High Voltage Input (9 V / 12 V)
  - Low Power PFM mode for Light Load Operations
- USB On-the-Go (OTG) with Adjustable Output from 4.5 V to 5.5 V
  - Selectable 500-KHz / 1.5-MHz Boost Converter with up-to 2.4 A Output
  - 94% Boost Efficiency at 5 V at 1 A Output
  - Accurate Hiccup Mode Overcurent Protection
- Single Input to Support USB Input and Adjustable High Voltage Adapters
  - Support 3.9-V to 14-V Input Voltage Range
  - Input Current Limit (100 mA to 3.25 A with 50-mA resolution) to Support USB2.0, USB3.0 standard and High Voltage Adapters
  - Maximum Power Tracking by Input Voltage Limit up-to 14V for Wide Range of Adapters
  - Auto Detect USB SDP, CDP, DCP, and Non-Standard Adapters (bq25898)
  - Programmable D+/D- Drivers for Non-Standard Adapter Handshake
- Remote Battery Sensing
- Input Current Optimizer (ICO) to Maximize Input Power without Overloading Adapters
- Resistance Compensation (IRCOMP) from Charger Output to Cell Terminal
- Highest Battery Discharge Efficiency with 5-mΩ Battery Discharge MOSFET up to 9 A
- Integrated ADC for System Monitor (Voltage, Temperature, Charge Current)
- Narrow VDC (NVDC) Power Path Management
  - Instant-on Works with No Battery or Deeply Discharged Battery
  - Ideal Diode Operation in Battery Supplement Mode
- BATFET Control to Support Ship Mode, Wake Up, and Full System Reset
- Flexible Autonomous and I2C Mode for Optimal System Performance

- High Integration includes all MOSFETs, Current Sensing and Loop Compensation
- 12-µA Low Battery Leakage Current to Support Ship Mode
- High Accuracy
  - ±0.5% Charge Voltage Regulation
  - ±5% Charge Current Regulation
  - ±7.5% Input Current Regulation
- Safety
  - Battery Temperature Sensing for Charge and Boost Mode
  - Thermal Regulation and Thermal Shutdown
- Available in 2.8-mm x 2.5-mm 42-Ball DSBGA Package

2 Applications

- Smart Phone
- Tablet PC
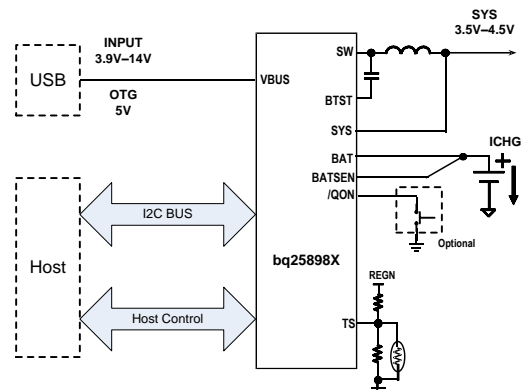- Portable Internet Devices

3 Description

The bq25898, bq25898D are highly-integrated 4-A switch-mode battery charge management and system power path management devices for single cell Li-Ion and Li-polymer battery. The devices support high input voltage fast charging.

Device Information[1]

PART NUMBER	PACKAGE	BODY SIZE (NOM)
bq25898	DSBGA (42)	2.80 mm x 2.50 mm
bq25898D	DSBGA (42)	2.80 mm x 2.50 mm

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

Simplified Schematic

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4 Revision History

Changes from Revision A (April 2016) to Revision B — **Page**

Changes from Original (March 2016) to Revision A — **Page**

Product Folder Links: *bq25898 bq25898D*

5   Description (Continued)

The low impedance power path optimizes switch-mode operation efficiency, reduces battery charging time and extends battery life during discharging phase. The I^{2}C Serial interface with charging and system settings makes the device a truly flexible solution.

The bq25898/98D is a highly-integrated 4-A switch-mode battery charge management and system power path management device for single cell Li-Ion and Li-polymer battery. It features fast charging with high input voltage support for a wide range of smartphone, tablet and portable devices. Its low impedance power path optimizes switch-mode operation efficiency, reduces battery charging time and extends battery life during discharging phase. It also integrates Input Current Optimizer (ICO) and Resistance Compensation (IRCOMP) to deliver maximum charging power to battery. The solution is highly integrated with input reverse-blocking FET (RBFET, Q1), high-side switching FET (HSFET, Q2), low-side switching FET (LSFET, Q3), and battery FET (BATFET, Q4) between system and battery. It also integrates the bootstrap diode for the high-side gate drive and battery monitor for simplified system design. The I^{2}C serial interface with charging and system settings makes the device a truly flexible solution.

The device supports a wide range of input sources, including standard USB host port, USB charging port, and USB compliant adjustable high voltage adapter. To support fast charging using adjustable high voltage adapter, the bq25898D provides support for MaxCharge™ handshake using D+/D- pins and DSEL pin for USB switch control. In addition, both bq25898D and bq25898 include interface to support adjustable high voltage adapter using input current pulse protocol. To set the default input current limit, device uses the built-in USB interface (bq25898D) or takes the result from detection circuit in the system (bq25898), such as USB PHY device. The device is compliant with USB 2.0 and USB 3.0 power spec with input current and voltage regulation. In addition, the Input Current Optimizer (ICO) supports the detection of maximum power point detection of the input source without overload. The device also meets USB On-the-Go (OTG) operation power rating specification by supplying 5 V (Adjustable 4.5V-5.5V) on VBUS with current limit up to 2.4 A.

The power path management regulates the system slightly above battery voltage but does not drop below 3.5V minimum system voltage (programmable). With this feature, the system maintains operation even when the battery is completely depleted or removed. When the input current limit or voltage limit is reached, the power path management automatically reduces the charge current to zero. As the system load continues to increase, the power path discharges the battery until the system power requirement is met. This operation prevents overloading the input source.

The device initiates and completes a charging cycle without software control. It automatically detects the battery voltage and charges the battery in three phases: pre-conditioning, constant current and constant voltage. At the end of the charging cycle, the charger automatically terminates when the charge current is below a preset limit in the constant voltage phase. When the full battery falls below the recharge threshold, the charger will automatically start another charging cycle.

The charger provides various safety features for battery charging and system operations, including battery temperature negative thermistor monitoring, charging safety timer and overvoltage/overcurrent protections. The thermal regulation reduces charge current when the junction temperature exceeds 120°C (programmable). The STAT output reports the charging status and any fault conditions. The $\overline{PG}$ output (bq25898) indicates if a good power source is present. The INT immediately notifies host when fault occurs.

The device also provides a 7-bit analog-to-digital converter (ADC) for monitoring charge current and input/battery/system (VBUS, BAT, SYS, TS) voltages. The QON pin provides BATFET enable/reset control to exit low power ship mode or full system reset function.

The devices are available in a 42-ball, 2.8 mm x 2.5 mm DSBGA package.

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	SAMPLE & BUY	TECHNICAL DOCUMENTS	TOOLS & SOFTWARE	SUPPORT & COMMUNITY
bq25898	Click here	Click here	Click here	Click here	Click here
bq25898D	Click here	Click here	Click here	Click here	Click here

6.2 Device Support

6.2.1 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.

6.3 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

MaxCharge, E2E are trademarks of Texas Instruments.
All other trademarks are the property of their respective owners.

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.

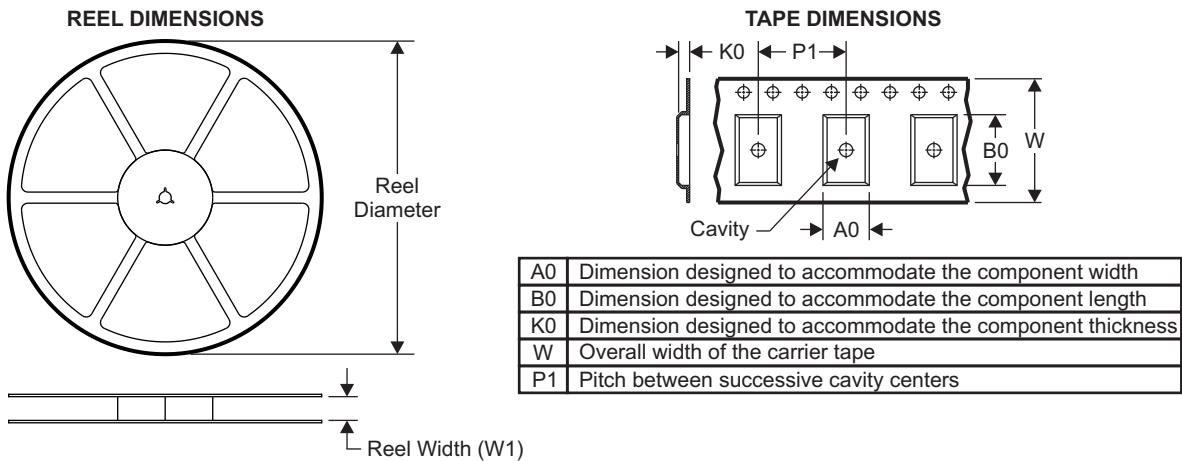## 7.1 Package Option Addendum

7.1.1 Packaging Information

Orderable Device	Status [1]	Package Type	Package Drawing	Pins	Package Qty	Eco Plan [2]	Lead/Ball Finish	MSL Peak Temp [3]	Op Temp (°C)	Device Marking[4][5]
BQ25898YFFR	ACTIVE	DSBGA	YFF	42	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 85	BQ28598
BQ25898YFFT	ACTIVE	DSBGA	YFF	42	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 85	
BQ25898DYFFR	ACTIVE	DSBGA	YFF	42	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 85	BQ28598D
BQ25898DYFFT	ACTIVE	DSBGA	YFF	42	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 85	

(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) 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 on 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.
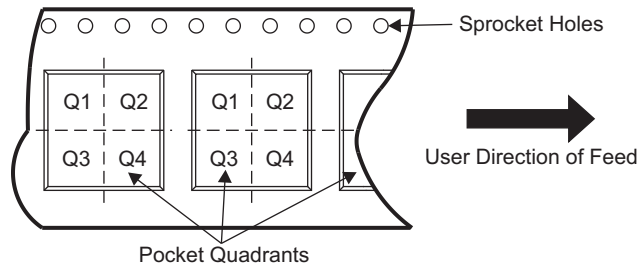
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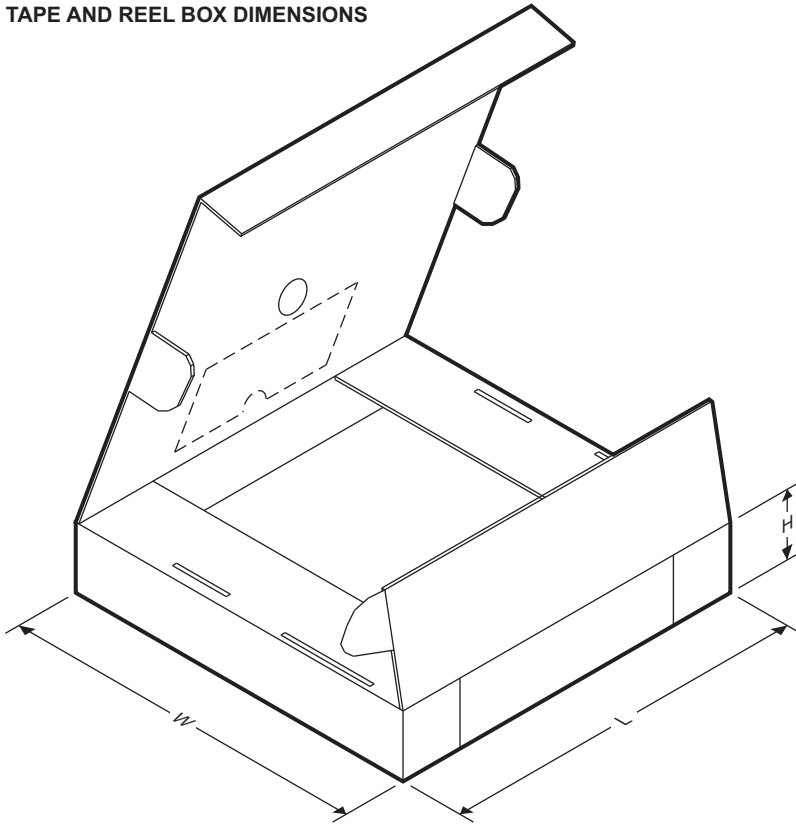
7.1.2 Tape and Reel Information

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
BQ25898YFFR	DSBGA	YFF	42	3000	180	8.4	2.66	2.95	0.81	4.0	8.0	Q1
BQ25898YFFT	DSBGA	YFF	42	250	180	8.4	2.66	2.95	0.81	4.0	8.0	Q1
BQ25898DYFFR	DSBGA	YFF	42	3000	180	8.4	2.66	2.95	0.81	4.0	8.0	Q1
BQ25898DYFFT	DSBGA	YFF	42	250	180	8.4	2.66	2.95	0.81	4.0	8.0	Q1

Product Folder Links: *bq25898 bq25898D*

TAPE AND REEL BOX DIMENSIONS

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
BQ25898YFFR	DSBGA	YFF	42	3000	182	182	20
BQ25898YFFT	DSBGA	YFF	42	250	182	182	20
BQ25898DYFFR	DSBGA	YFF	42	3000	182	182	20
BQ25898DYFFT	DSBGA	YFF	42	250	182	182	20

IMPORTANT NOTICE

Products		Applications	
Audio	www.ti.com/audio	Automotive and Transportation	www.ti.com/automotive
Amplifiers	amplifier.ti.com	Communications and Telecom	www.ti.com/communications
Data Converters	dataconverter.ti.com	Computers and Peripherals	www.ti.com/computers
DLP® Products	www.dlp.com	Consumer Electronics	www.ti.com/consumer-apps
DSP	dsp.ti.com	Energy and Lighting	www.ti.com/energy
Clocks and Timers	www.ti.com/clocks	Industrial	www.ti.com/industrial
Interface	interface.ti.com	Medical	www.ti.com/medical
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Power Mgmt	power.ti.com	Space, Avionics and Defense	www.ti.com/space-avionics-defense
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