

# Battery Management Solutions



Harvest the power of the world's energy

- Battery Authentication
- Battery Fuel Gauge
- Battery Charge Management
- Charger Front-End Protection
- Lithium-Ion Protection
- Solar Charging
- Wireless Power



## → Introduction and Contents

Texas Instruments (TI) offers complete battery-management portfolio with a full line of high-performance products. These products range from battery chargers to highly-efficient battery fuel gauges. Also included are power protection, authentication, and alternative charging sources such as solar and wireless power.

TI makes designing easier by providing leading-edge support tools such as training, a broad selection of evaluation modules (EVMs), application notes, comprehensive technical documentation and more. TI also offers samples and small orders (shipped within 24 hours via TI authorized distributors) that will help you accelerate your time-to-market.

Included in this selection guide you will find design factors, featured products, graphical representations of portfolios and parametric tables.

For more information about battery management products, visit [www.ti.com/battery](http://www.ti.com/battery)

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<b>TI Worldwide Technical Support</b>	(back cover)

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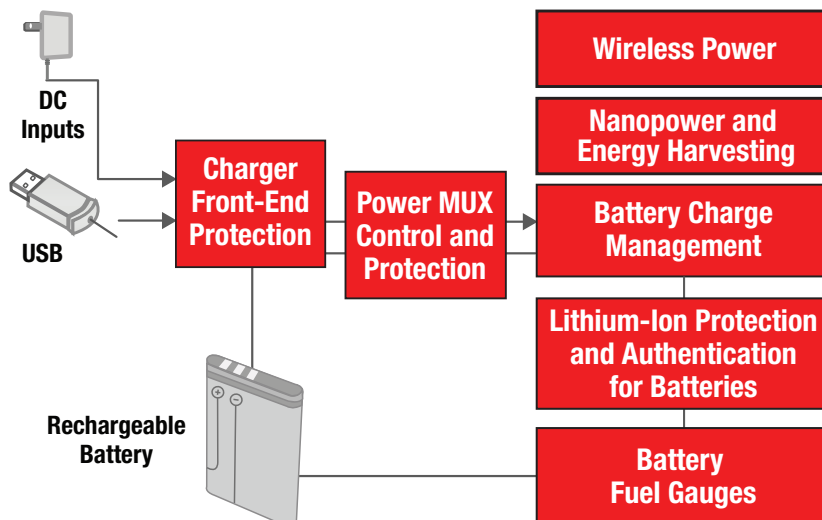
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## → Battery Management Systems Overview

End applications in wireless, computing, consumer and industrial/medical markets continue to expand into the portable space. TI's battery management solutions help address system protection, cost-effective linear and highly efficient switchmode battery charging. New advances in switch-mode charging increase efficiency, thus decreasing power dissipation and promoting a green environment by wasting less energy. With battery-powered systems demanding increased reliability, TI ensures maximum product safety with chargers that protect batteries from overvoltage and over-current conditions.





# Battery Management Solutions

## → Battery Management Systems Overview

Space is of utmost importance in portable applications. TI offers advanced solutions that incorporate QFN and wafer-level chip-scale packaging and feature a high degree of integration to reduce solution size. In addition to reducing board space, many of these solutions provide lower power dissipation and increase overall efficiency. TI battery management solutions support a wide range of battery chemistries and cell counts, from popular Lithium-Ion (Li-Ion) technologies to industry-standard nickel-metal-hydride and lead-acid batteries.

TI products support applications such as mobile phones, smartphones, tablets, portable consumer devices, portable navigation devices, notebook computers and many industrial and medical applications. TI has the battery-management device to match your design

specifications, we also offer the evaluation modules, application notes, samples and data sheets needed to get your design to market faster.

### Design Factors

**Battery Chemistry** — Each battery chemistry has different operating characteristics, such as discharge profiles and self-discharge rate. TI gas-gauge ICs are developed to account for these differences and accurately display remaining energy in the battery. Also, each battery chemistry has unique requirements for its charge algorithm, which is critical for maximizing its capacity, cycle life and safety.

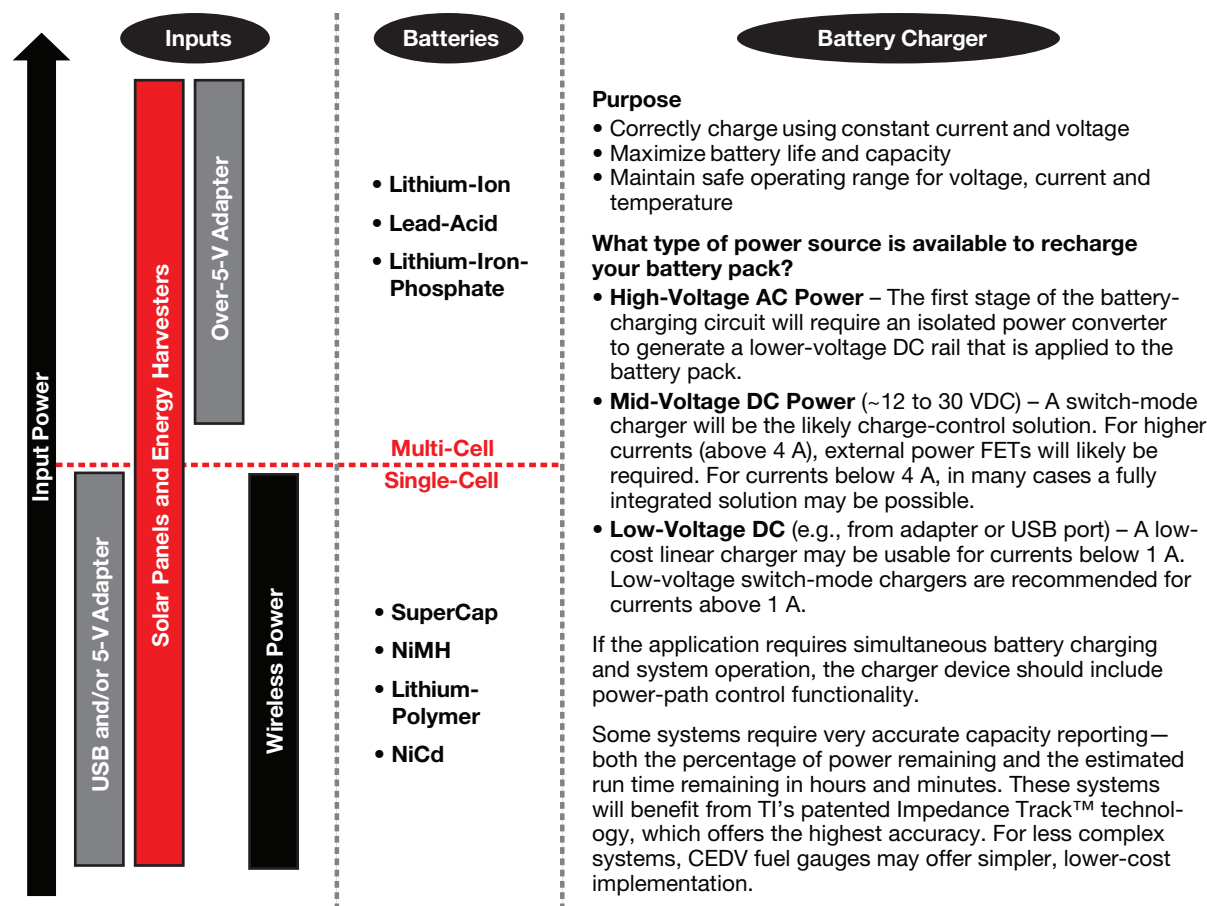
**Charge-Control Topology** — A simple linear topology works well in applications with low-power (e.g., one- or two-cell Li-Ion) battery packs that are charged at less than 1 A. A switch-mode topology

is ideally suited for fast charging from USB ports or for large battery packs that require charge rates  $>1$  A. The switch-mode conversion minimizes heat generation during charging. A wireless power topology uses shared magnetic fields to provide the benefit of contactless power transfer. Wireless charging provides an additional battery-charging option for portable devices or as a replacement for other 5-V charging sources.

**Input Voltage** — Wide input-voltage range of the IC and input overvoltage protection offer maximum safety and allow use of low-cost unregulated wall adapters.

**Number of Series Cells** — A battery pack is constructed from a string of series and parallel cells. Each series cell, or group of parallel cells, requires protection from overcharge, overdischarge and short-circuit conditions.

## Battery Management



## → Emerging Power Applications

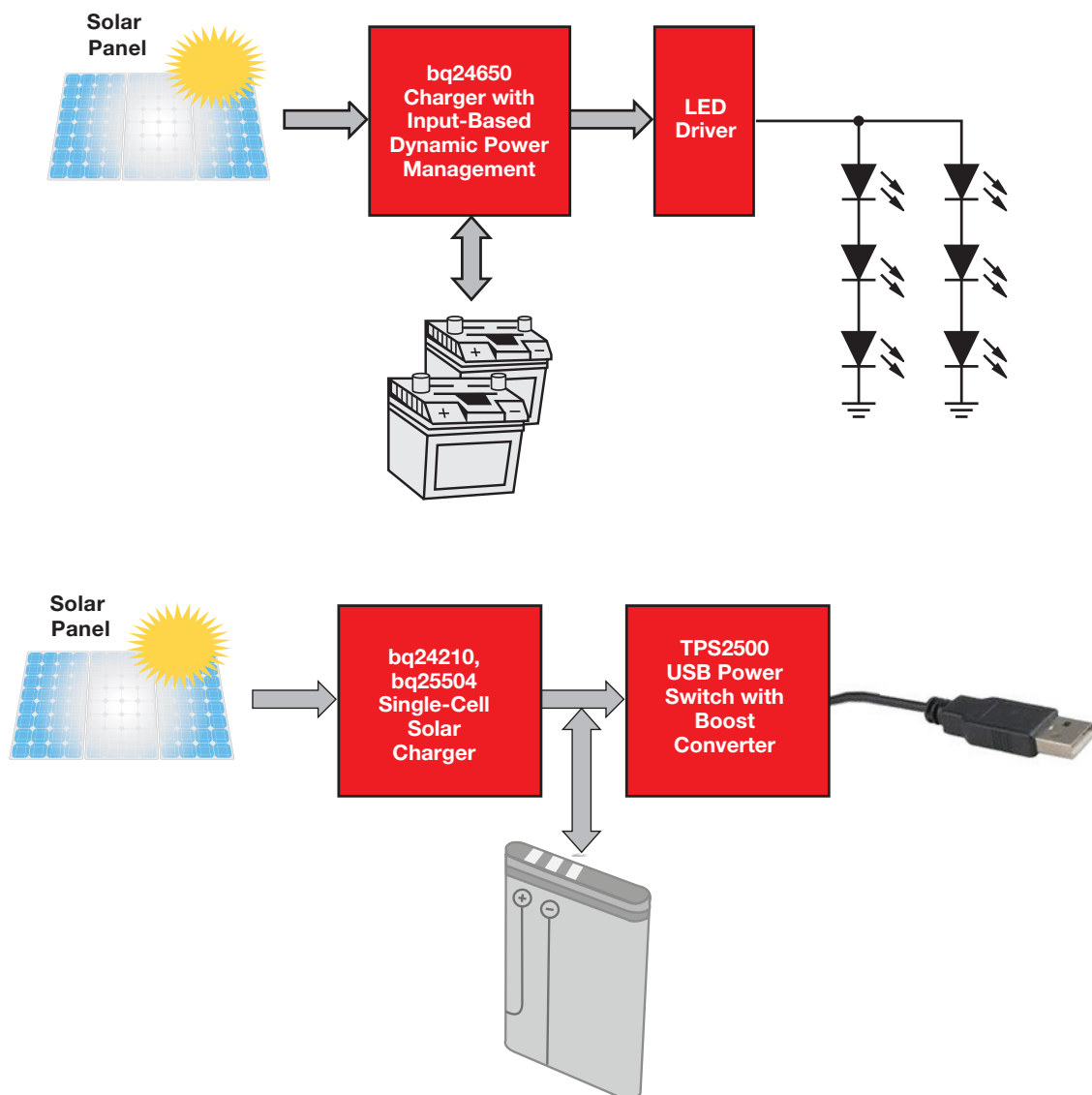
### Solar Charging

Photovoltaic technologies have evolved that can now provide more cost-effective and efficient energy harvesting from the sun. Most solar harvesting today uses high-power installations that provide supplemental AC power to the home or to commercial buildings and are generally tied to the utility grid. However, much of the world is still not yet tied to the grid, or the grid is unreliable, or being tethered to the AC power supply is just not practical. In these applications, using

the sun to charge a battery that supplies power to off-grid applications is a more practical solution. For these applications, a trade-off between cost and PV efficiency is often required. Maximizing power from the panel is balanced with the cost and size of the overall system.

The diagrams below illustrate two examples of low-cost solar-charger applications where the battery charger is integrated with simple circuitry to maximize the power point from the solar

panel as well as with circuitry for load regulation. Simple solar streetlights or solar lanterns can be developed by adding devices such as LED drivers. The implementation of a USB switch with a boost converter can create a simple solar charger for portable devices. Other applications can implement motor drivers for solar-powered fans or water pumps. These are but a few of the options enabled by TI's new family of solar-charger ICs.



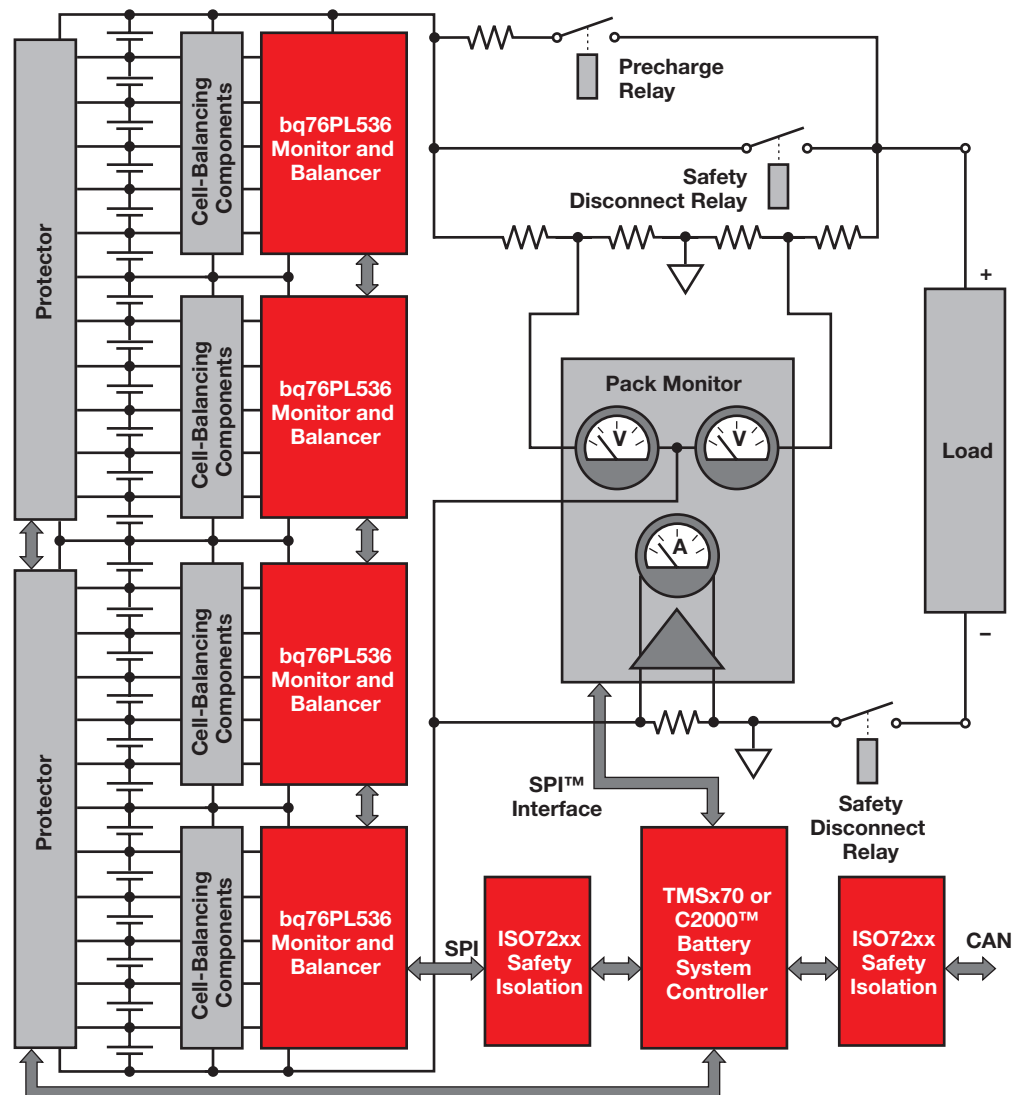
## → Emerging Power Applications

### HEV Battery Management

The battery-management system (BMS) is a key element in the overall HEV architecture. An intelligent implementation will extend not only the battery's lifetime but also the possible range of a vehicle in fully electric drive mode, which is a

key selling point to end users. The BMS modules require battery supervision and battery cell-balancing features, often connected through different communication paths to ensure system redundancy. Built-in temperature management is

also a crucial element for a system's lifetime and safety. The complete BMS represents a highly safety-critical function; therefore, reliable communication and accurate data measurement are necessities.



# Battery Management Solutions

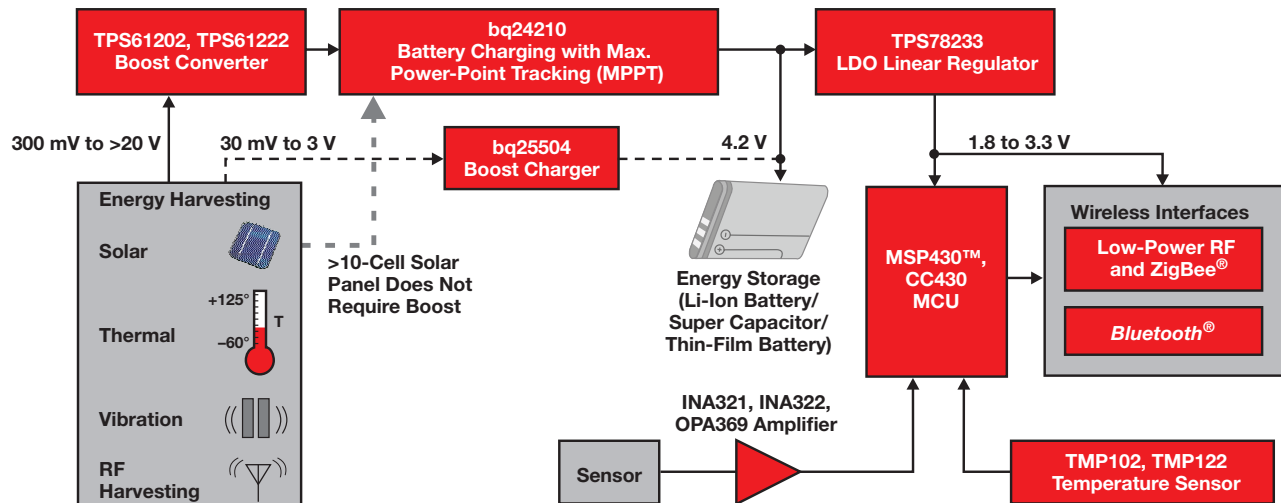
## → Emerging Power Applications

### Energy Harvesting

As new forms of alternative (off-grid) energy are being developed, power-management technologies are required to harvest, store and regulate this power. Energy from such sources as photovoltaic panels, kinetic (vibration) MEMs and thermoelectric elements (utilizing Peltier, Thompson or Seebeck effects) presents

the challenge of converting ultra-low levels of “nano” power to more usable levels and storing the energy for later use. TI continues to develop new power-management ICs to meet these harvesting challenges, including ultra-low-power devices such as LDOs and high-efficiency boost converters and battery

chargers. These power-management devices complement TI’s portfolio of low-power MCUs and RF, amplifier and sensor ICs—providing a total solution for systems powered by new forms of ultra-low-power alternative energy.



### Wireless Power (bqTESLA™)

TI is leading the new wireless-power market with the very first Qi-compliant devices. The 81+ members, including TI, of the Wireless Power Consortium are setting the international standard for inter-operable wireless charging with the Qi standard.

The bqTESLA chipset enables customers to power their electronic devices up to 5 W, meeting the Qi standard. The

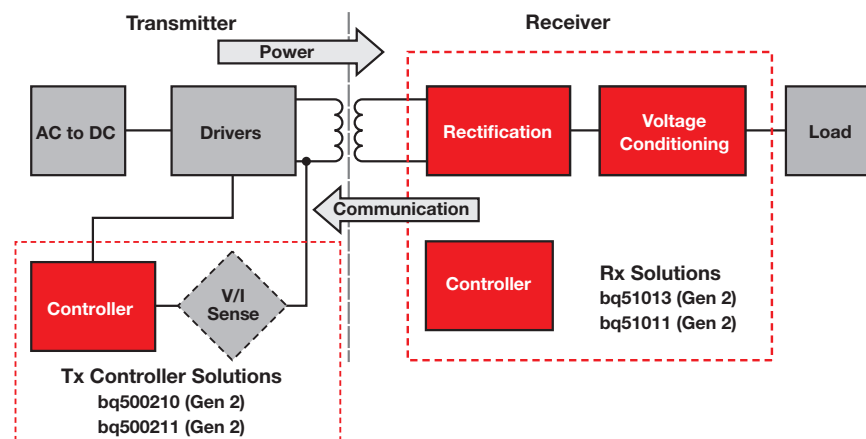
transmitter and receiver solutions that make up the bqTESLA chipset are ready for mass production today.

The bqTESLA receiver family includes the bq51013 and bq51011, which output 5 V and provide closed-loop control to the via-embedded communications techniques. Software is already programmed into the devices, so no software programming is required. The bqTESLA

transmitter family includes the bq500210 and bq500211, which operate and control the Qi-compliant wireless-power functionality.

Device datasheets, bqTESLA EVM user guides and bqTESLA EVM modules are available at:

[www.ti.com/wirelesspower](http://www.ti.com/wirelesspower)



## → Charger Front-End Protection

### Li+ Charger Front-End Protection IC

#### bq24314

Get samples, datasheets, evaluation modules and app reports at: [www.ti.com/product/bq24314](http://www.ti.com/product/bq24314)

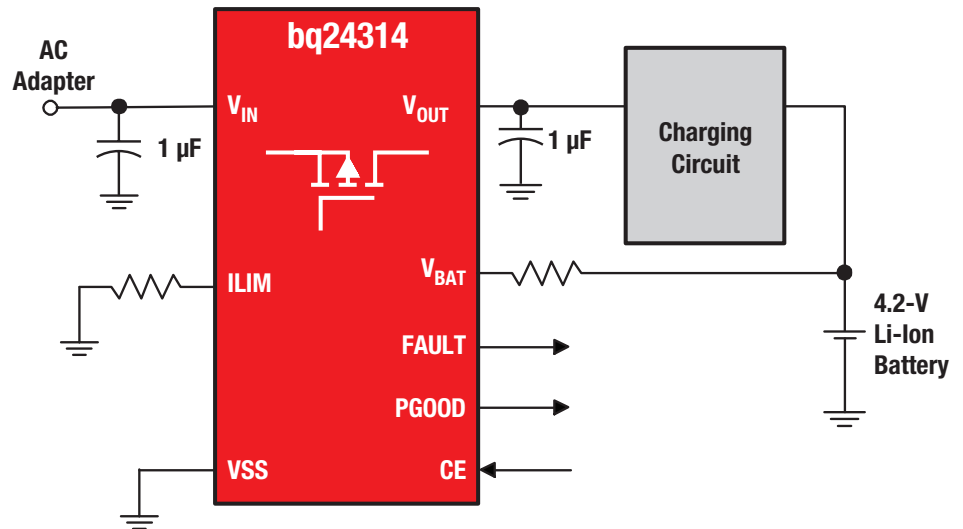
Charger front-end protection ICs provide protection from input overvoltage, input overcurrent and battery overvoltage conditions. The tri-level protection offers maximum safety when charging a handheld device. With integrated FET, the protection IC comes in 2x2-mm and 3x4-mm SON packages.

#### Key Features

- 30-V maximum input
- Up to 1.5-A input current
- Thermal shutdown
- Enable input
- Provides protection for three variables:
  - Input overvoltage (rapid response <1  $\mu$ s)
  - User-programmable overcurrent with current limiting
  - Battery overvoltage

#### Applications

- Mobile phones and smart phones
- Portable navigation devices
- MP3 Players
- Low-power handheld devices
- *Bluetooth*® headsets



#### Selection Guide

Device	V <sub>IN</sub> Max (V)	OVP (V)	OCP	Battery OVP (V)	LDO Output (V)	Max Operating Current ( $\mu$ A)	Package(s)	EVM	Comments	Price*
bq24300/4/5	30	10.5	Fixed 300 mA	4.35	5.5/4.5/5.0	400/500/500	8-QFN/SON	✓	Reverse polarity protection	0.55
bq24308	30	6.3	Fixed 700 mA or Prog. <1.5 A	4.35	5	500	8-QFN/SON	✓	Reverse polarity protection	0.55
bq24312	30	5.85	Prog. <1.5 A	4.35	—	500	8/12-QFN/SON	✓	Fault indication	0.48
bq24314/A	30	5.85	Prog. <1.5 A	4.35	—	600	8/12-QFN/SON	✓	Fault indication	0.48
bq24315	30	5.85	Prog. <1.5 A	4.35	5.5	600	8-QFN/SON	✓	Fault indication	0.48
bq24316	30	6.8	Prog. <1.5 A	4.35	—	600	8/12-QFN/SON	✓	Fault indication	0.48
bq24380	30	6.3	No OCP	4.35	5.5	250	8-QFN/SON	✓	Fault indication	0.55
bq24381	30	7.1	No OCP	4.35	5	300	8-QFN/SON	✓	Fault indication	0.55
bq24382	30	10.5	No OCP	4.35	5	300	8-QFN/SON	✓	Fault indication	0.55
bq24350	30	6.17	Fixed 1.2 A	4.35	5.5	500	8-QFN/SON	✓	Integrated charge FET	0.65
<b>bq24351</b>	30	10.5	Fixed 1.2 A	4.35	6.38	500	8-QFN/SON	✓	Integrated charge FET	0.65
bq24352	30	7.1	Fixed 1.2 A	4.35	5.5	500	8-QFN/SON	✓	Integrated charge FET	0.65

\*Suggested resale price in U.S. dollars in quantities of 1,000.

New devices are listed in **bold red**.

## → Battery Charge Management

### Industry's Most Efficient Boost Charger for Nanopower Energy-Harvesting Applications

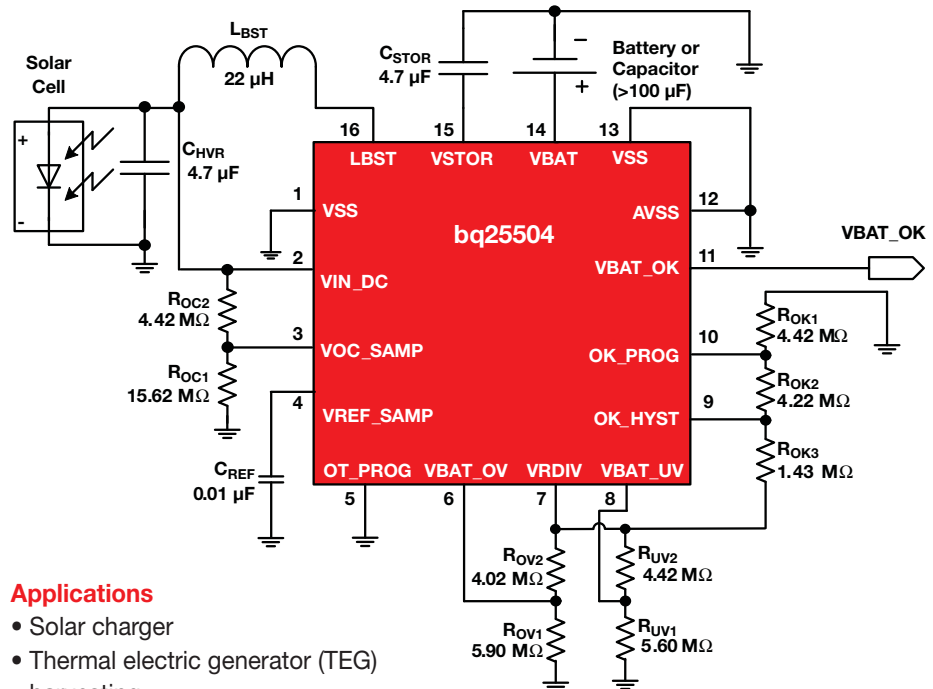
#### bq25504

Get samples, datasheets, evaluation modules and app reports at: [www.ti.com/product/bq25504](http://www.ti.com/product/bq25504)

The bq25504 is a highly efficient boost charger IC for nano (ultra-low) power energy-harvesting and management applications. The device manages micro-watts ( $\mu\text{W}$ ) to milliwatts ( $\text{mW}$ ) of power generated from a variety of sources such as solar, thermal electric, electromagnetic and vibration energy.

#### Key Features

- Low quiescent current (330 nA typ) and high conversion efficiency
- Maximum power point tracking (MPPT) optimizes energy extracted from DC harvesters such as solar panels and thermoelectric generators
- User programmable settings support a variety of energy sources and energy storage elements (different battery chemistries or super capacitors)
- Low cold-start voltage (330 mV typ) supports startup from single-cell solar panels (under low light) and other low-voltage sources.
- Battery status outputs allows conditional enabling of external loads and protects the storage element



#### Applications

- Solar charger
- Thermal electric generator (TEG) harvesting
- Wireless sensor networks
- Industrial and environmental monitoring
- Smart building controls
- Portable and wearable health devices
- Remote controls

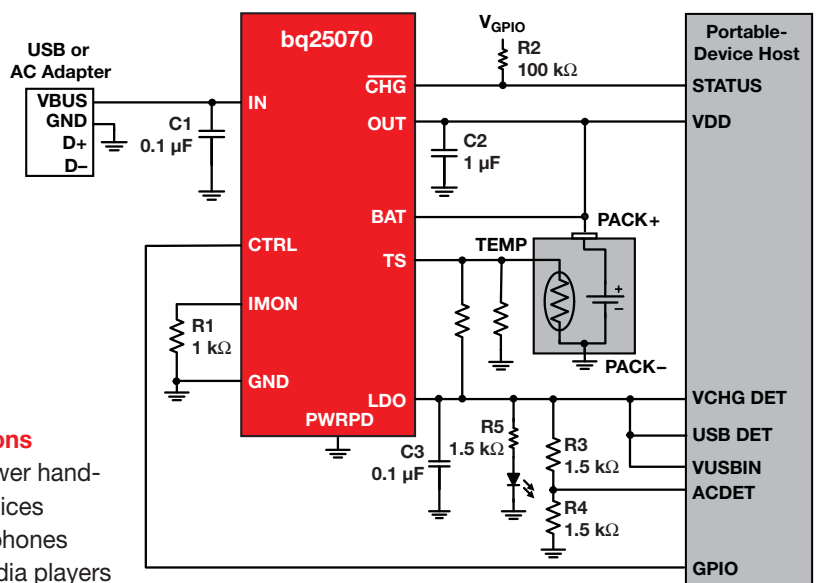
### 1-A, Single-Input, Single-Cell LiFePO<sub>4</sub> Linear Battery Charger with 50-mA LDO

#### bq25070

Get samples, datasheets, evaluation modules and app reports at: [www.ti.com/product/bq25070](http://www.ti.com/product/bq25070)

#### Key Features

- Single-cell LiFePO<sub>4</sub> charging algorithm
- 3.75- to 10.2-V  $V_{IN}$  (10.5-V OVP) with 30-V input rating (max)
- Up to 1-A charge current
- Integrated 4.9 V at 50 mA LDO linear regulator
- Single output allows simultaneous battery charging and powering of system
- Programmable charge current through single input interface (CTRL)
- Single USB port or AC-adaptor input source
- Thermal regulation and protection
- Soft-start feature
- Battery NTC monitoring
- Charging-status indication
- Small 2 × 3-mm 10-pin SON package



#### Applications

- Low-power hand-held devices
- Mobile phones
- Multimedia players



# Battery Management Solutions

## → Battery Charge Management

### 2.5-A, Dual Input, Switch-Mode Charger with Power-Path Management with Host I<sup>2</sup>C Control or Stand Alone

**bq24160, bq24161, bq24163, bq24168 — bq24165, bq24166, bq24167**

The bq2416x family of highly integrated, single-cell, Li-Ion battery chargers include system power-path management. They are targeted for space-limited, portable applications with high-capacity batteries.

#### Key Features

- Startup system from deeply discharged battery or no battery
- Sync 1.5-MHz PWM switch mode
- Supports USB 2.0 and USB 3.0 charger applications
- 20-V max  $V_{IN}$  rating
- Integrated FETs with 2.5-A charging from  $V_{IN}$  and 1.5 A on USB input
- Integrated power path and driver for optional external discharge FET

- Dual inputs are fully isolated
- Integrated input current sensing and limiting ( $\pm 5\%$ )
- Control charge parameters, timers,  $V_{INDPM}$  threshold
- Thermal regulation protection for output current control
- 2.8x2.8-mm WCSP and 4x4-mm QFN package options

#### bq24160/1/3/8 Features

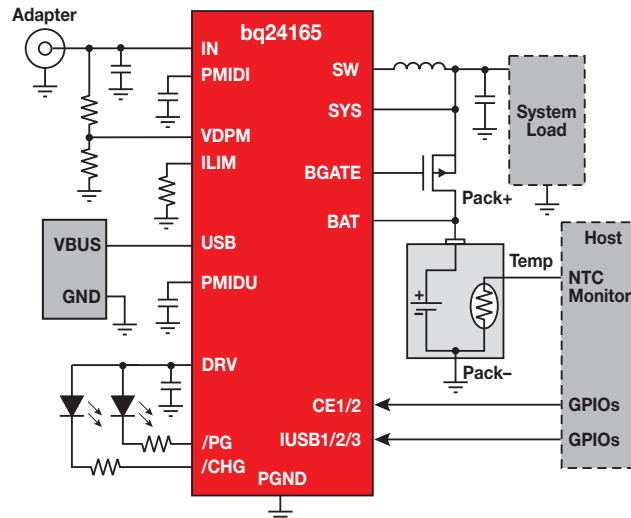
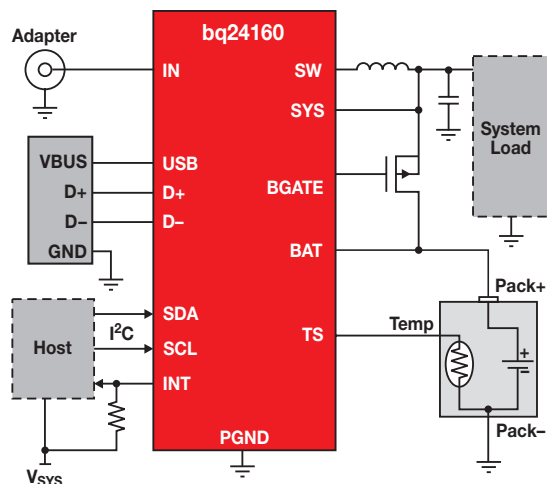
- I<sup>2</sup>C interface (1.8 V, 400 kbps)
- Automatic USB input detection based on D+/D- (bq24160/3) or pin selectable (bq24161/8)
- User programmable input current limits

#### bq24165/6/7

- USB settings via  $I_{USB1/2/3}$  pins
- Charge parameter selector inputs
- Adjustable charge current, input current, and  $V_{INDPM}$  threshold
- Voltage based, NTC temp monitoring input (TS); JEITA (CE1/2) for bq24165, standard temperature range (bq24166), and JEITA (CE1/2) bq24167

#### Applications

- Handheld portable products
- Portable computing
- Portable media players
- DSC and DVR equipment



#### Single-Cell Charger Controllers Selection Guide

Device	Number of Cells	$V_{IN}$ Type	$V_{IN}$ Abs Max (V)	$V_{IN}$ OVP (V)	Charge Current (A)	Charge Voltage (V)	Topology	Internal FET	Primary Charge Termination	Charge Timer	Temp Monitor	WCSP	QFN	EVM	USB Detection	Price*
<b>Host Mode with I<sup>2</sup>C System Interface</b>																
<b>bq24160</b>	1	Adapter and USB	20	10.5 6.5 USB	2.5 1.5 USB	3.5 to 4.4	Switching	Yes	Host-controlled	Yes	Yes, JEITA	24	24	✓	D+/D-	3.00
<b>bq24161</b>	1	Adapter and USB	20	10.5 6.5 USB	2.5 1.5 USB	3.5 to 4.4	Switching	Yes	Host-controlled	Yes	Yes, Std	24	24	✓	PSEL	3.00
<b>bq24163</b>	1	Adapter and USB	20	10.5 6.5 USB	2.5 1.5 USB	3.5 to 4.4	Switching	Yes	Host-controlled	Yes	Yes, JEITA	24	24	✓	D+/D-	3.00
<b>bq24168</b>	1	Adapter and USB	20	6.5 6.5 USB	2.5 1.5 USB	3.5 to 4.4	Switching	Yes	Host-controlled	Yes	Yes, JEITA	24	—	✓	PSEL	3.00
<b>Stand Alone System Interface</b>																
<b>bq24165</b>	1	Adapter and USB	20	10.5 6.5 USB	2.5 1.5 USB	4.2/4.06	Switching	Yes	10% $I_{CHG}$	Yes	via Host JEITA Adj CE1/2	24	24	✓	$I_{USB1/2/3}$	3.00
<b>bq24166</b>	1	Adapter and USB	20	10.5 6.5 USB	2.5 1.5 USB	4.2/4.06	Switching	Yes	10% $I_{CHG}$	Yes	Yes/Std	24	24	✓	$I_{USB1/2/3}$	3.00
<b>bq24167</b>	1	Adapter and USB	20	10.5 6.5 USB	2.5 1.5 USB	4.2/4.06	Switching	Yes	10% $I_{CHG}$	Yes	via Host JEITA Adj CE1/2	24	24	✓	$I_{USB1/2/3}$	3.00

\*Suggested resale price in U.S. dollars in quantities of 1,000.

New devices are listed in bold red. Preview devices are bold blue.

## → Battery Charge Management

### Switch-Mode Li-Ion and Li-Polymer Stand-Alone Battery Charger

#### bq24170

Get samples, datasheets, evaluation modules and app reports at: [www.ti.com/product/bq24170](http://www.ti.com/product/bq24170)

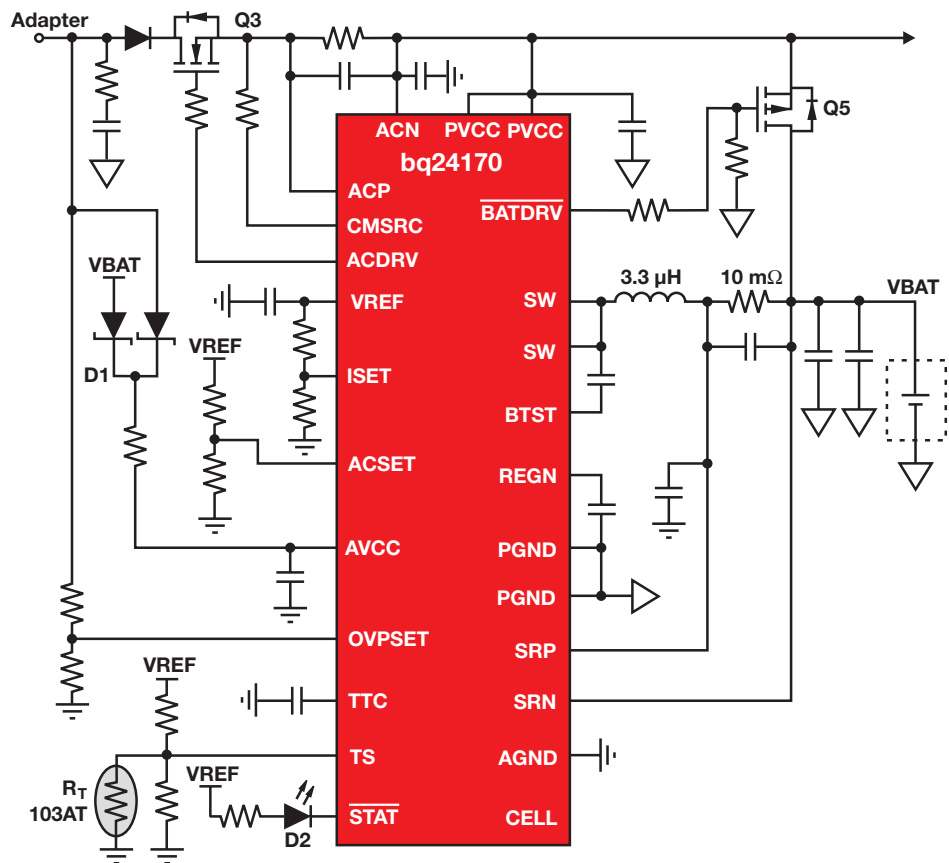
The bq24170 is a highly integrated stand-alone Li-Ion or Li-Polymer switch-mode battery charger with two integrated n-channel power MOSFETs. It offers a constant-frequency synchronous PWM controller with highly accurate regulation of input current, charge current and voltage. It closely monitors the battery-pack temperature to allow charging only in a preset temperature window. It also provides battery detection, preconditioning, charge termination and charge-status monitoring.

#### Key Features

- 1.6-MHz synchronous switch-mode charger with 4-A integrated n-channel MOSFETs
- Up to 94% efficiency
- 4.5-V to 17-V input operating range
- Battery charge voltage: 1, 2 or 3 cells with 4.2 V per cell

#### Applications

- Tablet PCs
- Netbooks and ultra-mobile computers
- Portable data-capture terminals
- Portable printers
- Medical-diagnostics equipment
- Battery-bay chargers
- Battery back-up systems



### Chargers with Internal FETs Selection Guide

Device	Number of Cells	Control Topology	Host or Stand Alone	Integrated Power FET	Charge Current (A)	V <sub>IN</sub> Max (V)	Primary Charge Termination Method <sup>1</sup>	Safety Timer	Temp Monitor	Packaging: QFN/MLP	EVM	Comments	Price*
<b>Multi-Cell Switch-Mode Stand-Alone Battery Chargers with Internal FETs (Converters) — Lithium-Ion</b>													
<b>bq24170</b>	1 to 3	Switching	Stand Alone	Yes	4.0	20	Min current	Yes	Yes	24	✓		1.80
<b>bq24171</b>	1 to 3	Switching	Stand Alone	Yes	4.0	20	Min current	Yes	Yes	24	✓	Supports JEITA	1.80
<b>bq24172</b>	1 to 3	Switching	Stand Alone	Yes	4.0	20	Min current	Yes	Yes	24	✓	Supports adjustable charge voltage	1.80
<b>bq24133</b>	1 to 3	Switching	Stand Alone	Yes	2.5	20	Min current	Yes	Yes	24	✓	Supports 2.5-A charge current	1.80
<b>bq24130</b>	1 to 3	Switching	Host	Yes	4.0	20	Min current/Host controlled	—	Yes	24	✓		
bq24100	1	Switching	Stand Alone	Yes	2.0	20	Min current	Yes	Yes	20	✓	On/Off status pin; bq24120 offers enhanced EMI performance	2.00
bq24108	1	Switching	Stand Alone	Yes	2.0	20	Min current	Yes	Yes	20	✓	Blinking status pin; bq24120 offers enhanced EMI performance	2.00
bq24103A	1 or 2	Switching	Stand Alone	Yes	2.0	20	Min current/Host controlled	Yes	Yes	20	✓	bq24123 offers enhanced EMI performance	2.00
bq24113A	1 or 2	Switching	Host	Yes	2.0	20	Min current/Host controlled	Yes	Yes	20	✓	bq24123 offers enhanced EMI performance	2.00
bq24105†	1 to 3	Switching	Host	Yes	2.0	20	Min current/Host controlled	Yes	Yes	20	✓	bq24125 offers enhanced EMI performance	3.50
bq24115	1 to 3	Switching	Host	Yes	2.0	20	Min current/Host controlled	Yes	Yes	20	✓	bq24125 offers enhanced EMI performance	3.50

<sup>1</sup>Host controlled = system processor must terminate charging.

<sup>†</sup>Devices qualified for Automotive applications are available. Different pricing may apply.

New devices are listed in bold red.

# Battery Management Solutions

## → Battery Charge Management

### Stand-Alone Synchronous Switch-Mode Li-Ion or Li-Polymer Battery Charger

#### bq24610

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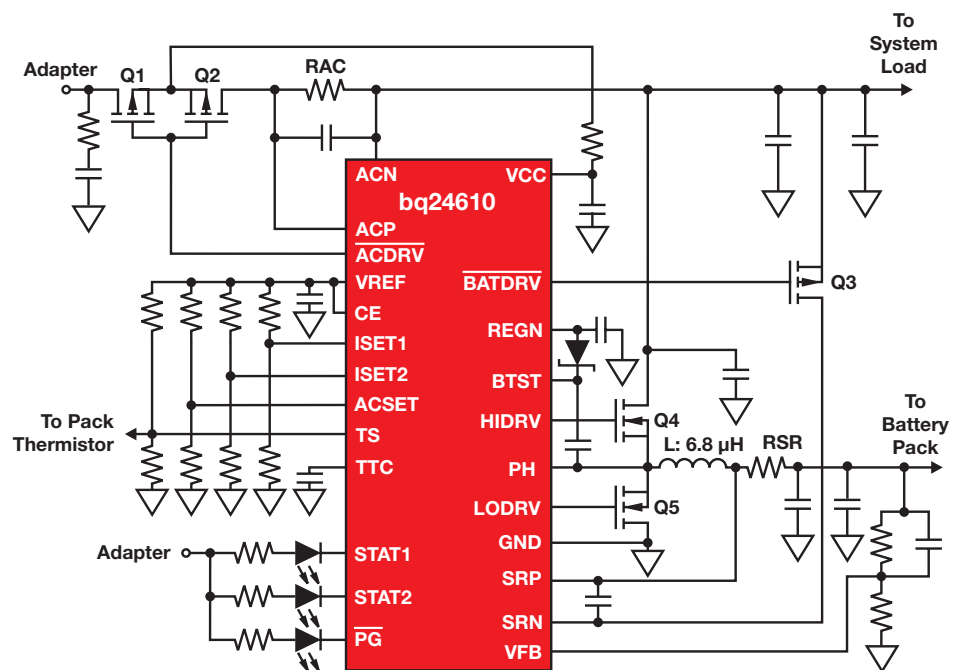
The bq24610 is a highly integrated Li-Ion or Li-Polymer switch-mode battery charger. It offers a constant-frequency synchronous switching PWM controller with highly accurate regulation of charge current and voltage. It also provides charge preconditioning, termination, adapter current regulation and charge-status monitoring.

#### Key Features

- 600-kHz NMOS/NMOS synchronous buck converter
- Stand-alone charger support for Li-Ion or Li-Polymer battery
- Supports up to six battery cells (bq24610) and has an input operating range of 5- to 28-V  $V_{CC}$
- Up to 10-A charge current and adapter current

#### Applications

- Netbooks, mobile Internet devices and ultra-mobile PCs
- PDAs
- Handheld terminals
- Industrial and medical equipment



### Multi-Cell Charger Controllers Selection Guide

Device	Number of Cells	Control Topology	Integrated Power FET	$V_{IN}$ Max (V)	Primary Charge Termination Method	Safety Timer	Temp Monitor	Packaging: QFN/MLP	EVM	Comments	Price*
<b>Multi-Cell Switch-Mode Stand-Alone Battery Chargers with External FETs (Controllers) — Lithium-Ion (except where noted)</b>											
bq24600	1 to 6	Switching	No	32	Min current	Yes	Yes	16/24	✓	1200 kHz	2.50
bq24610	1 to 6	Switching	No	32	Min current	Yes	Yes	16/24	✓	600 kHz	2.90
bq24616	1 to 6	Switching	No	32	Min current	Yes	Yes	16/24	✓	JEITA, 600 kHz	2.90
bq24617	1 to 5	Switching	No	26	Min current	Yes	Yes	—	✓	600 kHz	2.90
<b>bq24618</b>	1 to 6	Switching	No	32	Min current	Yes	Yes	16/24		Supports 4.7 $V_{IN}$	2.90
bq24620	1 to 7	Switching	No	32	Min current	Yes	No	16/24	✓	LiFePO <sub>4</sub>	2.90
<b>bq24630</b>	1 to 7	Switching	No	32	Min current	Yes	No	16/24	✓	LiFePO <sub>4</sub> , system power selector	2.90
<b>bq24640</b>	1 to 9	Switching	No	33	SuperCap-specific	No	Yes	16	✓	Supports SuperCap	3.65
<b>bq24650</b>	1 to 6	Switching	No	33	Min current	Yes	Yes	16	✓	Solar charger for Li-Ion/polymer, LiFePO <sub>4</sub> , lead-acid chemistries	2.85

\*Suggested resale price in U.S. dollars in quantities of 1,000.

New devices are listed in bold red.

# Battery Management Solutions

## → Battery Charge Management

### Selection Guide

(Device parameters continued on next page)

Device	Number of Cells	V <sub>IN</sub> Type	V <sub>IN</sub> Max Operating (V)	V <sub>IN</sub> Absolute Max (V)	V <sub>IN</sub> OVP (V)	Charge Current (A)	Charge Voltage (V)	Control Interface	Topology	Integrated Power FET	
Multi-Chemistry (Li-Ion and NiCd/NiMH)											
bq24030/31	1	Adapter/USB	16	18	6.4	2	4.2/4.1	Stand Alone	Linear	Yes	
bq24032A	1	Adapter/USB	16	18	6.4	2	4.2	Stand Alone	Linear	Yes	
bq24035	1	Adapter/USB	16	18	6.4	2	4.2	Stand Alone	Linear	Yes	
bq24038	1	Adapter/USB	16	18	6.4	2	4.2/4.36	Stand Alone	Linear	Yes	
bq24040	1	Adapter/USB	6.45	30	6.6	0.800	4.2	Stand Alone	Linear	Yes	
bq24041	1	Adapter/USB	6.45	30	7.1	0.800	4.2	Stand Alone	Linear	Yes	
bq24050/52	1	Adapter/USB	6.45	30	6.6	0.800	4.2	Stand Alone	Linear	Yes	
bq24055	1	Adapter/USB	6.45	30	6.6	0.800	4.2	Stand Alone	Linear	Yes	
bq24072/72T	1	Adapter/USB	6.4	30	6.6	1.5	4.3/4.2	Stand Alone	Linear	Yes	
bq24073	1	Adapter/USB	6.4	28	6.6	1.5	4.2	Stand Alone	Linear	Yes	
bq24074	1	Adapter/USB	10.2	28	10.5	1.5	4.2	Stand Alone	Linear	Yes	
bq24075T/79T	1	Adapter/USB	6.4	28	6.6	1.5	4.2/4.1	Stand Alone	Linear	Yes	
bq24090/91	1	Adapter/USB	6.45	7	6.6	0.800	4.2	Stand Alone	Linear	Yes	
bq24092/93	1	Adapter/USB	6.45	7	6.6	0.800	4.2	Stand Alone	Linear	Yes	
bq25040	1	Adapter/USB	6.7	30	6.9	1.1	4.2	Stand Alone	Linear	Yes	
bq25050	1	Adapter/USB	6	20	6.5	1.25	3.5 to 4.4	I <sup>2</sup> C	Switching	Yes	
bq25060	1	Adapter/USB	10.2	30	10.5	1	4.2	Stand Alone	Linear	Yes	
bq24130	1 to 3	Adapter/USB	18	20	Host Controlled	4	Adj	I <sup>2</sup> C	Switching	Yes	
bq24133	1 to 3	Adapter/USB	17	20	Programmable	2.5	Adj	Stand Alone	Switching	Yes	
bq24140	1	Adapter/USB	9	20	9.8	1.5	Adj	I <sup>2</sup> C	Switching	Yes	
bq24160	1	Adapter & USB	18	20	10.5/6.5 (USB)	2.5/1.5	3.5 to 4.4	I <sup>2</sup> C	Switching	Yes	
bq24161	1	Adapter & USB	18	20	10.5/6.5 (USB)	2.5/1.5	3.5 to 4.4	I <sup>2</sup> C	Switching	Yes	
bq24163	1	Adapter & USB	18	20	10.5/6.5 (USB)	2.5/1.5	3.5 to 4.4	I <sup>2</sup> C	Switching	Yes	
bq24165	1	Adapter & USB	18	20	10.5/6.5 (USB)	2.5/1.5	4.2	Stand Alone	Switching	Yes	
bq24166	1	Adapter & USB	18	20	10.5/6.5 (USB)	2.5/1.5	4.2	Stand Alone	Switching	Yes	
bq24167	1	Adapter & USB	18	20	10.5/6.5 (USB)	2.5/1.5	4.2	Stand Alone	Switching	Yes	
bq24168	1	Adapter & USB	18	20	6.5/6.5 (USB)	2.5/1.5	3.5 to 4.4	Stand Alone	Switching	Yes	
bq24153A	1	Adapter/USB	6	20	6.5	1.25	3.5 to 4.4	I <sup>2</sup> C	Switching	Yes	
bq24156A	1	Adapter/USB	9	20	9.8	1.5	3.5 to 4.4	I <sup>2</sup> C	Switching	Yes	
bq24180	1	Adapter/USB	16	20	16.5	1.5	3.5 to 4.4	I <sup>2</sup> C	Switching	Yes	
bq24185	1	Adapter/USB	16	20	16.5	1.5	3.5 to 4.4	I <sup>2</sup> C	Switching	Yes	
bq24170	1 to 3	Adapter/USB	17	20	Programmable	4	4.2	Stand Alone	Switching	Yes	
bq24171	1 to 3	Adapter/USB	17	20	Programmable	4	Adj	Stand Alone	Switching	Yes	
bq24172	1 to 3	Adapter/USB	17	20	Programmable	4	Adj	Stand Alone	Switching	Yes	
bq24600	1 to 6	Adapter	28	33	32	10 (Ext)	Adj	Stand Alone	Switching	No	
bq24610	1 to 6	Adapter	28	33	32	10 (Ext)	Adj	Stand Alone	Switching	No	
bq24616	1 to 6	Adapter	28	33	32	10 (Ext)	Adj	Stand Alone	Switching	No	
bq24617	1 to 5	Adapter	24	33	32	10 (Ext)	Adj	Stand Alone	Switching	No	
bq24618	1 to 6	Adapter/USB	28	33	32	10 (Ext)	Adj	Stand Alone	Switching	No	
bq24707A	1 to 4	Adapter	24	30	Programmable	8	Adj	SMBus	Switching	No	
bq24725A	2 to 4	Adapter	24	30	Programmable	8	Adj	SMBus	Switching	No	
bq24735	1 to 4	Adapter	24	30	Programmable	8	Adj	SMBus	Switching	No	

New devices are listed in **bold red**. Preview devices are **bold blue**.



# Battery Management Solutions

## → Battery Charge Management

(Device parameters continued from previous page)

	Device	Primary Charge Termination	Charge Timer	Temperature Monitor	Packaging					EVM	Comments	Price*
					WCSP	QFN/MLP	MSOP	TSSOP	SOIC			
	Multi-Chemistry (Li-Ion and NiCd/NiMH)											
	bq24030/31	Min Current	Yes	Yes	20					✓	Dynamic Power-Path Management powers the system and charges battery. Regulated 6-V output for AC input condition	1.80
	bq24032A	Min Current	Yes	Yes	20					✓	Dynamic Power-Path Management powers the system and charges battery. Regulated 4.4-V output for AC input condition	1.80
	bq24035	Min Current	Yes	Yes	20					✓	Dynamic Power-Path Management powers the system and charges battery. Cutoff at 6 V	1.80
	bq24038	Min Current	Yes	Yes	20					✓	Dynamic Power-Path Management powers the system and charges battery. Regulated 4.4-V output for AC input condition	1.80
	bq24040	Programmable	Yes	Yes	10					✓		0.90
	bq24041	C/10	Yes	Yes	10					✓		0.90
	bq24050/52	Min Current	Yes	Yes	10					✓	JEITA charging (100K NTC — bq24052)	0.99
	bq24055	Min Current	Yes	Yes	12					✓	JEITA, PG pin	0.99
	bq24072/72T	Min Current	Yes	Yes	16					✓	V <sub>OUT</sub> tracks V <sub>BAT</sub> , V <sub>IN_DPPM</sub>	1.20
	bq24073	Min Current	Yes	Yes	16					✓	V <sub>IN_DPPM</sub>	1.20
	bq24074	Programmable	Yes	Yes	16					✓	V <sub>IN_DPPM</sub>	1.20
	bq24075T/79T	Min Current	Yes	Yes	16					✓	SYSOFF pin disconnects battery, V <sub>IN_DPPM</sub> , powers system while charging battery	1.20
	bq24090/91	Min Current	Yes	Yes	10					✓	10K NTC (100K NTC — bq24091)	0.70
	bq24092/93	Min Current	Yes	Yes	10					✓	JEITA, 10K NTC (JEITA, 100K NTC — bq24093)	0.70
	bq25040	Min Current	No	Yes	10					✓	USB compliant with 50-mA integrated LDO	1.20
	bq25050	Programmable	Yes	No	20						USB OTG supported with boost	1.20
	bq25060	Min Current	No	Yes	10					✓	USB compliant with 50-mA integrated LDO	1.20
	bq24130	Host Controlled	No	Yes	20					✓		2.30
	bq24133	Min Current	Yes	Yes	24					✓		1.75
	bq24140	Min Current	Yes	No	30					✓	Simultaneous charge and USB OTG output	2.20
	bq24160	Host Controlled	Yes	Yes	24					✓	JEITA, D+/D– detect,	3.00
	bq24161	Host Controlled	Yes	Yes	24					✓	USB selection pin	3.00
	bq24163	Host Controlled	No	No	24	24				✓	D+/D– detect, JEITA	3.00
	bq24165	10% I <sub>CHG</sub>	Yes	No	24	24				✓	I <sub>USB</sub> 1/2/3 USB select, no temp monitor, JEITA	3.00
	bq24166	10% I <sub>CHG</sub>	Yes	Yes	24	24				✓	I <sub>USB</sub> 1/2/3 USB select, temp monitor, std temp	3.00
	bq24167	10% I <sub>CHG</sub>	Yes	Yes	24	24				✓	I <sub>USB</sub> 1/2/3 USB select, temp monitor, JEITA	3.00
	bq24168	10% I <sub>CHG</sub>	Yes	Yes	24					✓	USB select pins, JEITA, no timers	3.00
	bq24153A	Host Controlled	Yes	No	20					✓	USB OTG supported with boost	2.00
	bq24156A	Host Controlled	Yes	No	20					✓		2.00
	bq24180	Host Controlled	Yes	Yes	25					✓	Accessory power output	2.20
	bq24185	Host Controlled	Yes	Yes	25					✓	USB OTG supported with boost	2.30
	bq24170	Min Current	Yes	Yes	24					✓		1.80
	bq24171	Min Current	Yes	Yes	24					✓	JEITA	1.80
	bq24172	Min Current	Yes	Yes	24					✓	Adjustable charge voltage	1.80
	bq24600	Min Current	Yes	Yes	16					✓	1200 kHz	2.50
	bq24610	Min Current	Yes	Yes	24					✓		2.90
	bq24616	Min Current	Yes	Yes	24					✓	JEITA	2.90
	bq24617	Min Current	Yes	Yes	24					✓	600 kHz	2.90
	bq24618	Programmable	Yes	Yes	24					✓	USB V <sub>IN</sub> and adapter	2.90
	bq24707A	SMBus	Yes	No	20					✓	Programmable switching frequency	2.90
	bq24725A	SMBus	Yes	No	20					✓	Programmable switching frequency, enhanced safety, battery learn	2.90
	bq24735	SMBus	Yes	No	20					✓	Intel™ CPU Turbo Mode support	3.00

\*Suggested resale price in U.S. dollars in quantities of 1,000.

New devices are listed in **bold red**. Preview devices are **bold blue**.

# Battery Management Solutions

## → Battery Charge Management

### Selection Guide

(Device parameters continued on next page)

Device	Number of Cells	V <sub>IN</sub> Type	V <sub>IN</sub> Max Operating (V)	V <sub>IN</sub> Absolute Max (V)	V <sub>IN</sub> OVP (V)	Charge Current (A)	Charge Voltage (V)	Control Interface	Topology	Integrated Power FET	
<b>Solar/Energy Harvesting (Li-Ion)</b>											
bq24210	1	Adapter/USB	18	20	7.7	0.800	4.2	Stand Alone	Linear	Yes	
bq24650	1 to 6	Solar Panel	28	33	32	10 (Ext)	Adj	Stand Alone	Switching	No	
<b>bq25504</b>	1	Solar/TEG/Low DC (0.13 V min)	3	5.5	Adj	0.1	2.5 to 5.25	Stand Alone	Boost	Yes	
<b>LiFePO<sub>4</sub></b>											
bq25070	1	Adapter/USB	28	30	10.5	1	3.5	Stand Alone	Linear	Yes	
bq24620	1 to 7	Adapter	28	33	32	10 (Ext)	Adj	Stand Alone	Switching	No	
bq24630	1 to 7	Adapter	28	33	32	10 (Ext)	Adj	Stand Alone	Switching	No	
<b>Super Cap</b>											
bq24640	1 to 9	Adapter	28	33	32	10 (Ext)	Adj	Stand Alone	Switching	No	
<b>NiCd/NiMH Chemistry</b>											
bq2002/C/E/F	Multiple	Adapter	6	7	—	>2	6	Stand Alone	Current-limited	No	
bq2004/E/H	Multiple	Adapter	5.5	7	—	>2	5.5	Stand Alone	Switching	No	
bq2005	Multiple	Adapter	5.5	7	—	>2	5.5	Stand Alone	Switching	No	
bq24400/1	Multiple	Adapter	5.5	7	—	>2	5.5	Stand Alone	Switching	No	
<b>Lead-Acid Chemistry</b>											
bq24450	Multiple	Adapter	40	40	—	>2	—	Stand Alone	Linear	No	
UC3909	Multiple	Adapter	40	40	—	>2	—	Stand Alone	Switching	No	
bq2031	Multiple	Adapter	5.5	7	—	>2	—	Stand Alone	Switching	No	
<b>Multi-Chemistry (Li-Ion and NiCd/NiMH)</b>											
bq2000/T	Multiple	—	—	7 V	—	—	—	Stand Alone	Switching	Yes	
bq24765	2 to 4	—	—	30 V	—	—	—	Stand Alone	Switching	Yes	
bq24650	1 to 6	Solar Panel	28	33	32	10A (Ext)	Adj	Stand Alone	Switching	No	
bq24747	2 to 4	—	—	30 V	—	—	—	Stand Alone	Switching	No	
<b>Wireless Power</b>											
bq51013	Reg V <sub>OUT</sub>	Coil/USB/Adapter	10	20	15	1	5	Stand Alone	Linear	Yes	
bq51011	Reg V <sub>OUT</sub>	Coil/USB/Adapter	10	20	15	1	5	Stand Alone	Linear	Yes	

*New devices are listed in bold red.*

*For a complete list of Resources, visit: [www.ti.com/battery](http://www.ti.com/battery)*

# Battery Management Solutions

## → Battery Charge Management

(Device parameters continued from previous page)

Device	Primary Charge Termination <sup>1</sup>	Charge Timer	Temperature Monitor	Packaging						EVM	Comments	Price*	
				WCSP	QFN/MLP	MSOP	TSSOP	SOIC	DIP				
Solar/Energy Harvesting (Li-Ion)													
bq24210	Min Current	Yes	Yes		10					✓	Solar panel V <sub>IN</sub>	1.10	
bq24650	C/10	Yes	Yes		16					✓	Max power point tracking	2.85	
bq25504	Voltage	—	Yes		16					✓	Energy harvester, ultra-low power and quiescent current, high efficiency, dynamic MPPT	—	
LiFePO <sub>4</sub>													
bq25070	Min Current	No	Yes		10					✓	LiFePO <sub>4</sub> , 50-mA LDO	0.85	
bq24620	C/10	Yes	Yes		16					✓	LiFePO <sub>4</sub> , 300 kHz	2.90	
bq24630	Programmable	Yes	Yes		24					✓	LiFePO <sub>4</sub> , 300 kHz, power selector	2.90	
Super Cap													
bq24640	Min Current	No	Yes		16					✓	SuperCap	2.90	
NiCd/NiMH Chemistry													
bq2002/C/E/F	ΔV, PVD, ΔT/Δt,	Yes	Yes					8	8		Trickle charge	0.85	
bq2004/E/H	ΔV, PVD, ΔT/Δt,	Yes	Yes					16	16		Selectable timers and pulse-trickle rates	2.15	
bq2005	ΔV, ΔT/Δt,	Yes	Yes					20	20		Sequential fast charge of two battery packs	2.15	
bq24400/1	PVD /ΔT / Δt,	Yes	Yes					8	8			1.55	
Lead-Acid Chemistry													
bq24450	Max V, min I	No	No					16	16		Temp-compensated internal reference	2.75	
UC3909	Max V, min I	No	Yes					20	20		Differential current sense input	3.05	
bq2031	Max V, −Δ2 V, min I	Yes	Yes					16	16	✓	Three user-selectable charge algorithms to accommodate cyclic and standby applications	2.80	
Multi-Chemistry (Li-Ion and NiCd/NiMH)													
bq2000/T	PVD, ΔT/Δt, min current	Yes	Yes					8	8	8	✓	Charges NiCd, NiMH, and Li-Ion	1.50
bq24765	SMBus	Yes	No		34						✓	SMBus charger with integrated power FETs	3.95
bq24650	C/10	Yes	Yes		16						✓	Max power point tracking	2.85
bq24747	SMBus	Yes	No		28						✓	SMBus with input current-detect comp.	2.90
Wireless Power													
bq51013	EPT Cmd to Tx	No	Yes		28						✓	Receiver, regulated voltage output, compliant to WPC specification 1.0	3.50
bq51011	EPT Cmd to Tx	No	Yes		28							Receiver, current limited	3.50

<sup>1</sup>PVD = peak voltage detection;  $\Delta T/\Delta t$  = rate of temperature rise; host controlled = system processor must terminate charging;  
 $-\Delta V$  = negative voltage change; max V = maximum voltage; min I = minimum current;  $-\Delta 2V$  = second difference of cell voltage.

\*Suggested resale price in U.S. dollars in quantities of 1,000.

New devices are listed in **bold red**.

For a complete list of Resources, visit: [www.ti.com/battery](http://www.ti.com/battery)

# Battery Management Solutions

## → Single-Cell Solutions — Battery Fuel Gauges

### Design Factors

**Battery Chemistry** — Each battery chemistry has different operating characteristics, such as discharge profiles and the self-discharge rate. The battery chemistry is programmed in the dataflash of the TI fuel gauge to account for these differences. In addition, the conditions of the end-equipment system can be programmed in the gas gauge. Designers can choose to implement the gauge in the

host system or inside the battery pack. The programmed information is processed in TI's Impedance Track™ gauging technology for prediction of remaining battery capacity with >99% accuracy.

### Features

TI gas gauges and battery monitors accurately track battery activity to compute the remaining battery capacity and system run-time. The following features are available:

- Patented Impedance Track battery fuel-gauging technology for >99% accuracy
- System- and pack-side implementation
- Turnkey solution with complete CPU and battery fuel-gauge firmware
- Interrupt-driven gas gauge signaling the host with the battery's specific state-of-charge status
- Gas gauge with integrated LDO in small packages

## System-Side Impedance Track™ Fuel Gauge with Integrated LDO

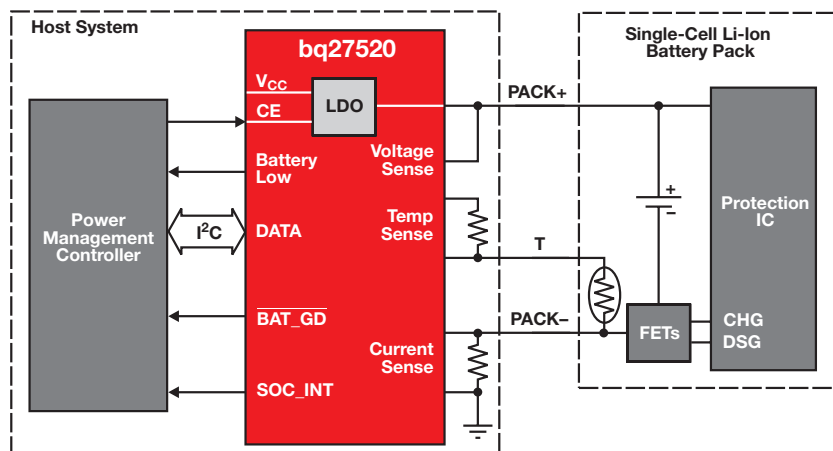
### bq27520

Get samples, datasheets, evaluation modules and app reports at: [www.ti.com/product/bq27520](http://www.ti.com/product/bq27520)

The bq27520 is a high-performance, system-side fuel gauge with excellent accuracy, low power consumption and extremely small package size. By integrating the fuel-gauge function into the system board, portable-equipment designers can use an embedded or removable standard battery pack while adding the capability to accurately display remaining pack capacity and estimated run time. The bq27520 features an integrated voltage regulator that reduces the total component count for the system. The bq27520 also has an interrupt-generation capability that reduces the software burden on the system processor because the fuel gauge does not require repetitive polling from the host.

The bq27520 uses the patented Impedance Track™ algorithm for fuel gauging and provides information such as remaining battery capacity, state of charge, minimum run time to empty, battery voltage, temperature and state

of health. Battery fuel gauging with the bq27520 requires only PACK+ (P+), PACK- (P-) and thermistor (T) connections to a removable battery pack or embedded battery circuit.



### Selection Guide

Device	Approx. Battery Capacity (mAh)	Min Max Series Cell	SHA-1 Authentication	System or Pack	Communication Protocol	Other Features	Package	Price*
<b>Lithium-Ion, Lithium-Polymer Chemistry</b>								
bq27000	300 to 6000	1	No	Pack	HDQ	Fuel gauge with fixed-voltage EOD	10-pin DRK	1.15
bq27200	300 to 6000	1	No	Pack	I <sup>2</sup> C	Fuel gauge with fixed-voltage EOD	10-pin DRK	1.15
bq27010	300 to 6000	1	No	Pack	HDQ	Fuel gauge with compensated-voltage EOD	10-pin DRK	1.25
bq27210	300 to 6000	1	No	Pack	I <sup>2</sup> C	Fuel gauge with compensated-voltage EOD	10-pin DRK	1.25
bq27500	300 to 6000	1	No	System	I <sup>2</sup> C	System-side fuel gauge with Impedance Track™ technology	12-pin QFN	1.35
bq27510	300 to 6000	1	No	System	I <sup>2</sup> C	System-side fuel gauge with Impedance Track technology with integrated LDO	12-pin QFN	1.45
bq27541	300 to 6000	1	Yes	Pack	I <sup>2</sup> C/HDQ	Pack-side fuel gauge with Impedance Track technology	12-pin QFN	1.45
bq27501	300 to 6000	1	No	System	I <sup>2</sup> C	System-side fuel gauge with Impedance Track technology with battery ID resistor	12-pin QFN	1.35
bq27505	300 to 6000	1	No	System	I <sup>2</sup> C	System-side fuel gauge with Impedance Track technology	12-ball CSP	1.40
bq27520	300 to 6000	1	No	System	I <sup>2</sup> C	System-side fuel gauge with Impedance Track technology with integrated LDO	15-ball CSP	1.50
<b>bq27410</b>	300 to 6000	1	No	System	I <sup>2</sup> C	System-side fuel gauge with Impedance Track Lite technology with integrated LDO	12-pin QFN	1.40
<b>bq27425</b>	300 to 6000	1	No	System	I <sup>2</sup> C	System-side fuel gauge with Impedance Track Lite technology with integrated sense resistor	15-ball CSP	1.40
<b>bq28550</b>	300 to 6000	1	Yes	Pack	SMBus	Pack-side fuel gauge with CEDV technology with integrated LDO	12-pin QFN	2.90

\*Suggested resale price in U.S. dollars in quantities of 1,000.

New devices are listed in bold red.



## ➔ Single-Cell Solutions — Authentication for Batteries and Peripherals

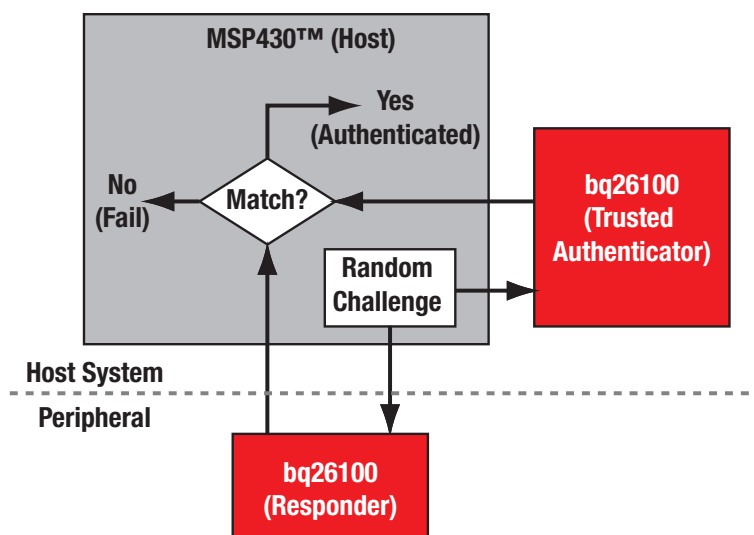
### Design Factors

Original equipment manufacturers specify products to achieve required performance and safety goals. Authentication ensures that connected devices fulfill the established requirements and are safe for the consumer.

### Features

TI authentication devices use three levels of security.

- **Identification Number** — The host controller can request an identification number that is answered with a fixed response.
- **CRC Algorithm** — The host processor sends a random challenge and reads the response that is an encoding of the challenge and a shared secret key through a CRC with a shared secret polynomial.
- **SHA-1 Encryption** — The host processor sends a random challenge and reads the response that is an encoding of the challenge and a shared secret key through the SHA-1 cryptographic primitive.



Typical host/peripheral authentication configuration.

### Selection Guide

Device	Interface	Pins	Security	Temp (°C)	Price*
bq2022A	SDQ™	3	ID number	–40 to 85	0.90
bq2024	SDQ	3	ID number	–40 to 85	0.95
bq26150	HDQ	5	CRC algorithm	–20 to 70	0.95
bq26100	SDQ	5	SHA-1 encryption	–20 to 70	0.99
bq27541	I²C/HDQ	12	SHA-1 encryption	—	1.45

\*Suggested resale price in U.S. dollars in quantities of 1,000.

## → Multi-Cell Solutions — Battery Fuel Gauges and Monitors

### Design Factors

**Battery Chemistry** — Each battery chemistry has different operating characteristics, such as discharge profiles and self-discharge rate. TI gas gauge ICs are developed by chemistry to account for these differences to accurately display remaining energy in the battery.

### Features

TI gas gauges and battery monitors accurately track battery activity to compute the remaining battery capacity and system run-time. They feature:

- Simple communication protocols.
- High-resolution analog-to-digital converters for accurate charge/discharge measurement.

- Integrated CPU on gas gauges to compute remaining battery capacity and run-time.
- Advanced charge management satisfies JEITA specification of variable charging current and voltage with battery conditions.

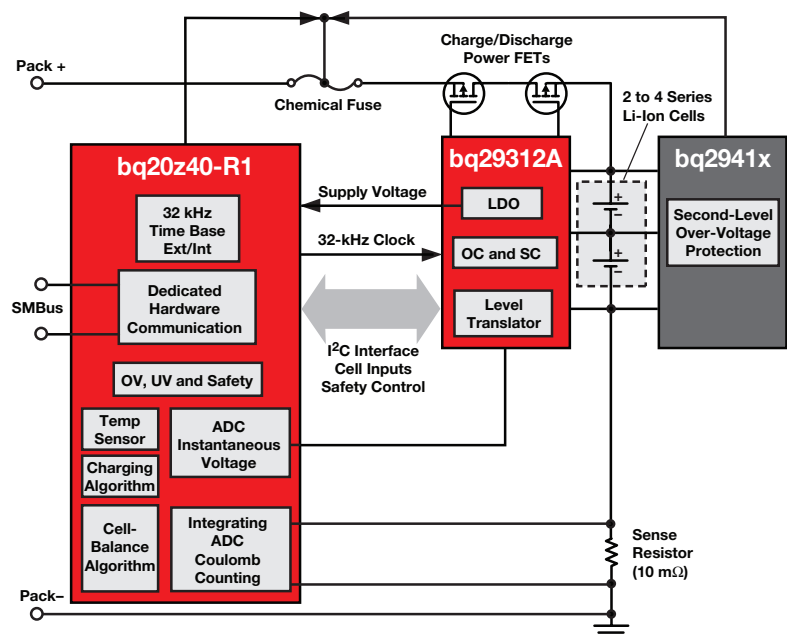
### 99% Accurate Gas Gauge Maximizes Run-Time

**bq20z40-R1, bq20z45-R1, bq20z60-R1, bq20z65-R1, bq20z655-R1, bq34z651**

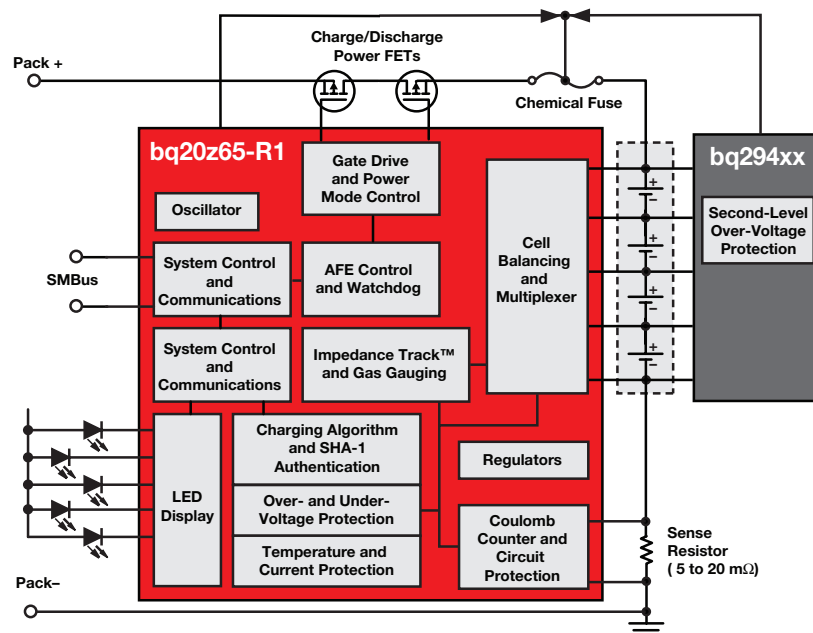
Get samples, datasheets, evaluation modules and app reports at:

[www.ti.com/product/bq20z65-R1](http://www.ti.com/product/bq20z65-R1)

The dynamic Impedance Track™ gas gauge algorithm in the bq20z65 extends battery usability, allowing use of the full chemical capacity available in a battery pack. Additional features include instant state-of-charge and real-time impedance learning. Impedance Track also enables reduction in development and production time. Remaining capacity is reported over the entire life of the battery pack with better than 99% accuracy. The bq20z65-R1 is ideally suited for battery packs used in medical and industrial equipment, back-up batteries and laptop computers.



Example of two-chip solution (gas gauge plus AFE).



Example of single-chip solution (gas gauge plus integrated AFE).

# Battery Management Solutions

## ➔ Multi-Cell Solutions — Battery Fuel Gauges and Monitors

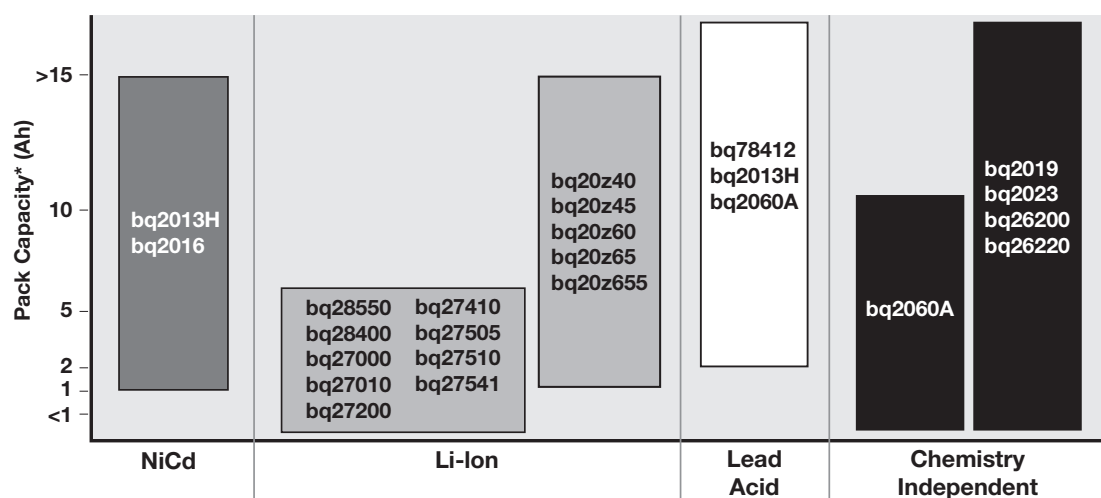
### Multi-Cell Fuel Gauges Selection Guide

Device	Approx. Battery Capacity (mAh)	Min Max Series Cell	Number of LEDs	Communication Protocol	Other Features	Package	Price*
<b>NiCd, NiMH Chemistry</b>							
bq2013H	2000 to 15000	—	5	Single wire (HDQ)	Programmable offset error compensation	16-pin SOIC	3.70
bq2014H	500 to 6000	—	5	Single wire (HDQ)	Register compatible with bq2050H	16-pin SOIC	4.60
bq2016	1000 to 4500	—	5	Single wire (HDQ)	Automatic offset calibration	28-pin SSOP	3.75
<b>Lithium-Ion, Lithium-Polymer Chemistry</b>							
<b>bq28400</b>	500 to 16000	2	—	SMBus	CEDV+ gas gauge with integrated protector	20-pin TSSOP	3.20
bq3060	500 to 32000	2 to 4	—	SMBus	CEDV+ gas gauge with integrated protector	24-pin TSSOP	3.55
bq20z40-R1	800 to 32000	2 to 4	—	SMBus	Impedance Track™ fuel gauge for use with bq29330 protector	20-pin TSSOP	3.65
bq20z45-R1	800 to 32000	2 to 4	—	SMBus	Impedance Track fuel gauge with integrated protector	38-pin TSSOP	4.45
bq20z60-R1	800 to 32000	2 to 4	3, 4 or 5	SMBus	Impedance Track fuel gauge with LED for use with bq29330 protector	30-pin TSSOP	3.90
bq20z65-R1	800 to 32000	2 to 4	3, 4 or 5	SMBus	Impedance Track fuel gauge with LED and integrated protector	44-pin TSSOP	4.75
<b>bq20z655-R1</b>	800 to 32000	2 to 4	3, 4, 5 or LCD	SMBus	Impedance Track fuel gauge with LED or LCD and integrated protector	44-pin TSSOP	5.20
bq78PL114	1000 to 650,000	3 to 12	—	SMBus	High-power gas gauge with protection and advanced cell balancing	48-pin QFN	4.50
<b>bq78PL116</b>	1000 to 650,000	3 to 16	—	SMBus	High-power gas gauge with protection and advanced cell balancing	48-pin QFN	4.50
<b>bq76PL102</b>	—	1 to 2	—	PowerLAN™	2-cell cell expansion to bq78PL114 and bq78PL116	12-pin QFN	0.90
<b>Lead Acid Chemistry</b>							
<b>bq78412</b>	1000 to 327,000	—	10	UART	Pb-acid battery state-of-charge indicator with run-time display	44-pin HTSSOP	3.90
<b>Multi-Chemistry</b>							
<b>bq34z541</b>	800 to 32000	1 to 14	4	SMBus or HDQ	Highly accurate multi-chemistry gauge	14-pin TSSOP	2.50
bq2060A	800 to 10000	2 to 4	5	SMBus or HDQ	Highly accurate multi-chemistry gauge	28-pin SSOP	3.90
<b>Super Cap</b>							
<b>bq33100</b>	—	2 to 5	—	SMBus	Fully integrated 2, 3, 4 and 5 series super capacitor manager	24-pin TSSOP	4.20
<b>Battery Monitors</b>							
bq2019	>20000	—	—	Single wire (HDQ)	64-bit ID ROM and 1 program output non-volatile memory	8-pin TSSOP	1.95
bq2023	>20000	—	—	Single wire (SDQ)	64-bit ID ROM and 1 program output automatic offset error calibration	8-pin TSSOP	2.00
bq26200	>20000	—	—	Single wire (HDQ)	High-performance battery, coulomb counter	8-pin TSSOP	2.00
bq26220	>20000	—	—	Single wire (HDQ)	64-bit ID ROM and 1 program output on-chip voltage measurement	8-pin TSSOP	2.05
<b>bq76PL536A</b>	—	3 to 192	—	SPI	3- to 6-cell EV and UPS stackable monitor and cell-balancing AFE	64-pin HTQFP	4.30

\*Suggested resale price in U.S. dollars in quantities of 1,000.

New devices are listed in bold red. Preview devices are bold blue.

### Battery Fuel Gauges Family of Products



\*Pack capacity ratings provide an approximate range for each gas gauge.

For a complete list of Resources, visit: [www.ti.com/battery](http://www.ti.com/battery)

## → Multi-Cell Solutions — Lithium-Ion Protection

### Design Factors

**Number of Series Cells** — A battery pack is constructed from a string of series and parallel cells. Each series cell, or group of parallel cells, requires protection from overcharge, overdischarge and short-circuit conditions.

**Threshold Voltage** — Li-Ion and Li-Polymer cells are produced by many manufacturers. Some manufacturers' technologies create cells of different maximum stress voltages, otherwise known as the "overvoltage threshold." This data is available from the cell supplier.

**Threshold Tolerance** — The overvoltage threshold has a tolerance that needs to be accounted for in the design for safety reasons.

**Shutdown Current** — In battery pack applications, constant current draw needs to be very low to preserve battery life.

**Charge/Discharge Current** — The pass element associated with each protection IC is rated for maximum current whether it be an internal or external FET.

### Features

- BiCMOS process results in low current consumption.
- Different overvoltage thresholds allow one design to work with several cell suppliers.
- Sleep current consumption of less than 3.5  $\mu\text{A}$  enables extended battery life.
- 50 mV precision internally trimmed thresholds maximize safety.
- Short-circuit protection eliminates the need for an external fuse.

### Stand-Alone Multi-Cell Precision Protector for Li-Ion Chemistries

#### bq77910A

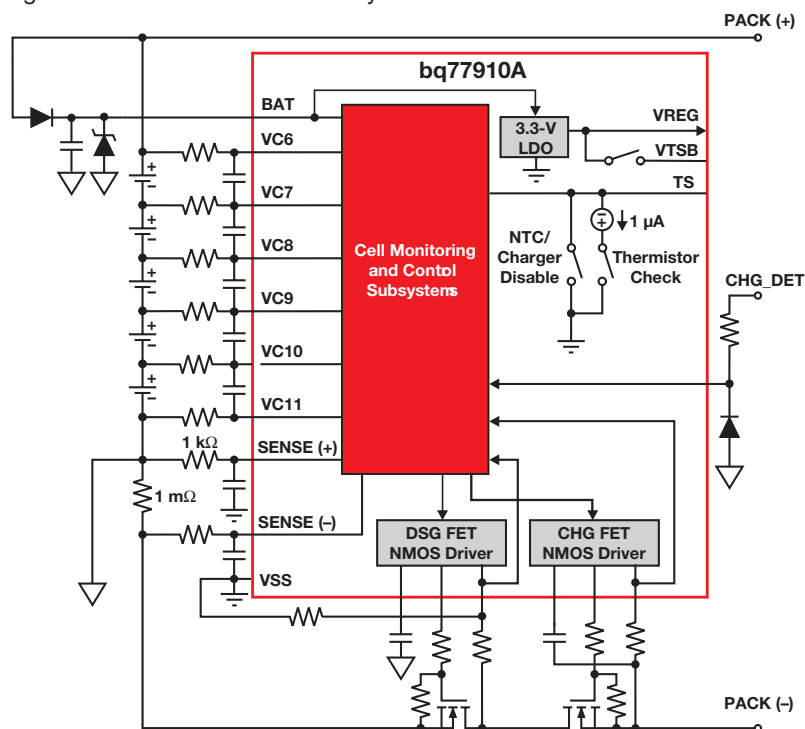
Get datasheets at: [www.ti.com/product/bq77910A](http://www.ti.com/product/bq77910A)

The bq77910A precision protector is a complete stand-alone, self-contained battery-protection and cell-balancing device intended for Li-Ion/Li-Polymer battery packs.

The bq77910A monitors 4 to 10 series individual cell voltages and provides fast-acting outputs that can be used to drive n-channel MOSFETs to interrupt the power path. Activation delays and recovery methods for each safety condition are fully programmable in nonvolatile memory.

#### Key Features

- 4-, 5-, 6-, 7-, 8-, 9- or 10-series cell protection
- Individual cell-voltage monitoring
- Low-side NMOS FET drive for charge and discharge control
- Compatible with 1-m $\Omega$  current-sense resistor
- Supply-voltage range: 5.6 V to 50 V
- Integrated 3.3-V micropower LDO regulator



5-cell, series FET configuration schematic using the bq77910A.

### Selection Guide

Device	Number of Series Cells	Charge/Discharge Current (A)	Shutdown Current ( $\mu\text{A}$ )	Other Features	Package(s)	Price*
bq2920x	2	—	3	Overvoltage safety with cell balancing	8-pin SON	0.30
bq29330	2, 3 or 4	External FET	1	Integrated LDO, works directly with bq20z90 gas gauge	20-pin TSSOP	1.00
bq2941x	2, 3 or 4	—	3	Overvoltage safety for chemical fuse activation; PTC	8-pin TSSOP	0.45
bq2944x	2, 3 or 4	—	3	Overvoltage safety for chemical fuse activation	8-pin SON	0.45
<b>bq2945x</b>	2 or 3	—	4	Overvoltage safety for chemical fuse activation	6-pin SON	0.40
bq76925	3 to 6	—	1	Host-controlled protector with cell balancing	20-pin TSSOP, 24-pin QFN	1.50
bq77PL900	5 to 10	External PFET	—	Stand-alone or host-controlled protector with cell balancing	48-pin SSOP	2.95
<b>bq77910A</b>	4 to 10	External NFET	5	Stand-alone protector with cell balancing	38-pin TSSOP	2.70
bq77PL157A4225	3 to 6	External NFET	3	Stackable overvoltage protector; stack 3 for 18 series cells	16-pin TSSOP	0.65

\*Suggested resale price in U.S. dollars in quantities of 1,000.

New devices are listed in bold red.



## → Wireless Power

### Overview

The market demand for the convenience and safety of wireless power systems is growing rapidly. Portable devices like smart phones, music/video players, cameras, and game controllers are just a few of the battery-powered products that can be upgraded to a wireless power system to keep their batteries charged.

While near-field inductive power coupling has been around for some time, applications have been limited to very low power levels. Since today's portable devices require increasing amounts of power, and higher-power batteries require more advanced control systems, a number of safety risks in the design of wireless power systems must be considered. Compliance with Wireless Power Consortium (WPC) specifications helps designers avoid safety problems and ensures interoperability between systems.

The basic wireless power system consists of a power transmitter that is

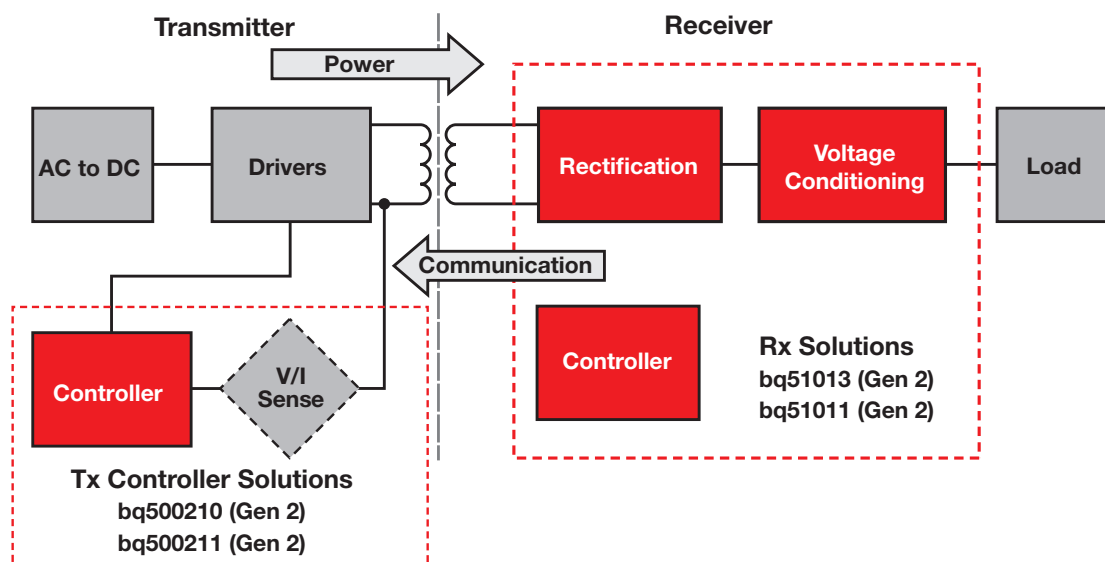
typically located in a base station powered by an AC line or other stable power source. The power receiver is located in the battery-powered device that uses the power received to charge a battery. Both the transmitter and receiver contain wire coils, and power is transferred between them without electrical contact via inductive coupling. Since power is inductively transferred from the transmitter to the receiver via coils, the transmitter must power the coil with a switching current that has sufficient frequency to optimize coupling between coils. The receiver coil then picks up the near-field inductive energy and uses rectifiers and voltage-conditioning circuitry to produce a DC output. To control the power transfer, it is important for the receiver to constantly communicate with the transmitter to indicate when power is required, how much power to send and when to stop sending power. This communications data is exchanged through the same coils that couple the power.

TI offers a growing family of wireless power transmitters and receivers that support the WPC Qi specification. The bq500210 is a new Qi-compliant transmitter manager that offers intelligent control of the power transfer between a base station and a mobile device. The bq5101x Qi-compliant integrated receivers provide a regulated DC output and digital-control feedback to the transmitter. The following pages provide more details about these devices. For more information, visit:

[www.ti.com/wirelesspower](http://www.ti.com/wirelesspower)

### Receiver-Side Solutions

TI's Qi-compliant receivers integrate a low-impedance, full synchronous rectifier, a low-dropout regulator (LDO), digital control and accurate voltage and current loops. The entire power stage (rectifier and LDO) utilize low-impedance NMOS FETs to ensure high efficiency and low power dissipation.



## → Wireless Power

### Integrated, Qi-Compliant, Wireless Power-Supply Receivers

#### bq51011, bq51013

Get samples, datasheets, evaluation modules and app reports at: [www.ti.com/product/bq51013](http://www.ti.com/product/bq51013)

Together with the bq500210 transmitter controller, the bq5101x family of receivers enables a complete contactless power-transfer system for a wireless power-supply solution.

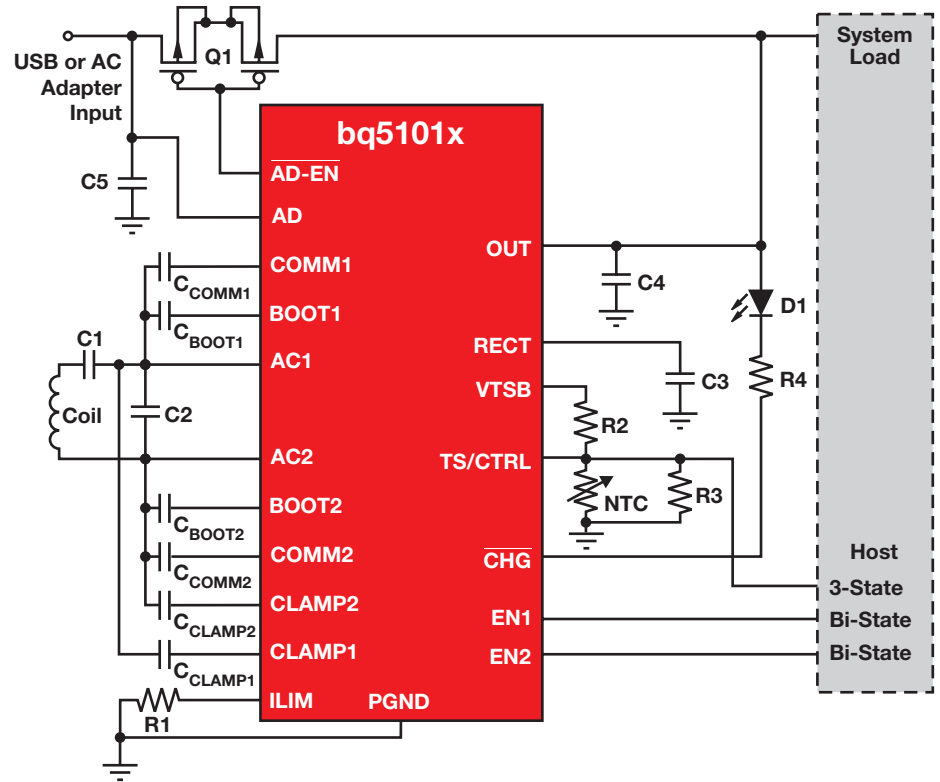
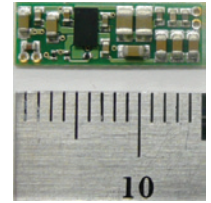
#### Key Features

- Integrated wireless power receiver with a 5-V regulated supply
- 93% overall peak AC-to-DC efficiency
- Full synchronous rectifier
- WPC v1.0-compliant communication control
- Output-voltage conditioning
- Only IC required between Rx coil and 5-V DC output voltage
- Internal dynamic rectifier control for improved load-transient response
- Supports 20-V maximum input
- Low-power dissipative rectifier over-voltage clamp ( $V_{OVP} = 15\text{ V}$ )
- Thermal shutdown
- Single NTC/control pin
- 1.9 x 3-mm WCSP package

#### Applications

- Cell and smart phones
- Headsets
- Digital cameras
- Portable media players
- Handheld devices

Example 5 x 15-mm PCB with all receiver-side circuitry.



#### Selection Guide

(Device parameters continued below)

Device	Number of Cells	$V_{IN}$ Type	$V_{IN}$ Max Operating (V)	$V_{IN}$ Absolute Max (V)	$V_{IN}$ OVP (V)	Charge Current (A)	Charge Voltage (V)	Control Interface	Topology	Integrated Power FET
bq51013	Reg $V_{OUT}$	Coil/USB/Adapter	10	20	15	1	5	Stand Alone	Linear	Yes
bq51011	Reg $V_{OUT}$	Coil/USB/Adapter	10	20	15	1	5	Stand Alone	Linear	Yes

(Device parameters continued from above)

Device	Primary Charge Termination	Charge Timer	Temperature Monitor	Packaging		EVM	Comments	Price*
				WCSP	QFN/MLP			
bq51013	EPT Cmd to Tx	No	Yes	28		✓	Receiver, regulated voltage output, compliant to WPC specification 1.0	3.50
bq51011	EPT Cmd to Tx	No	Yes	28			Receiver, current Limited	3.50

\*Suggested resale price in U.S. dollars in quantities of 1,000.

## → Wireless Power

### Transmitter-Side Solutions

TI offers dedicated digital controllers that integrate the logic functions required to control wireless power transfer in a single-channel, WPC-compliant, contactless-charging base station. These intelligent controllers periodically ping the

surrounding environment for available devices to be powered, monitor all communication from the device being wirelessly powered, and adjust power applied to the transmitter coil per feedback received from the powered device. They also monitor transfer efficiency with

real-time analysis, which protects the controllers and power receivers from excessive power loss and heat associated with parasitic metal objects placed in the power-transfer path.

### Qi-Compliant, Wireless Power-Transmitter Manager

#### **bq500210**

Get samples, datasheets, evaluation modules and app reports at: [www.ti.com/product/bq500210](http://www.ti.com/product/bq500210)

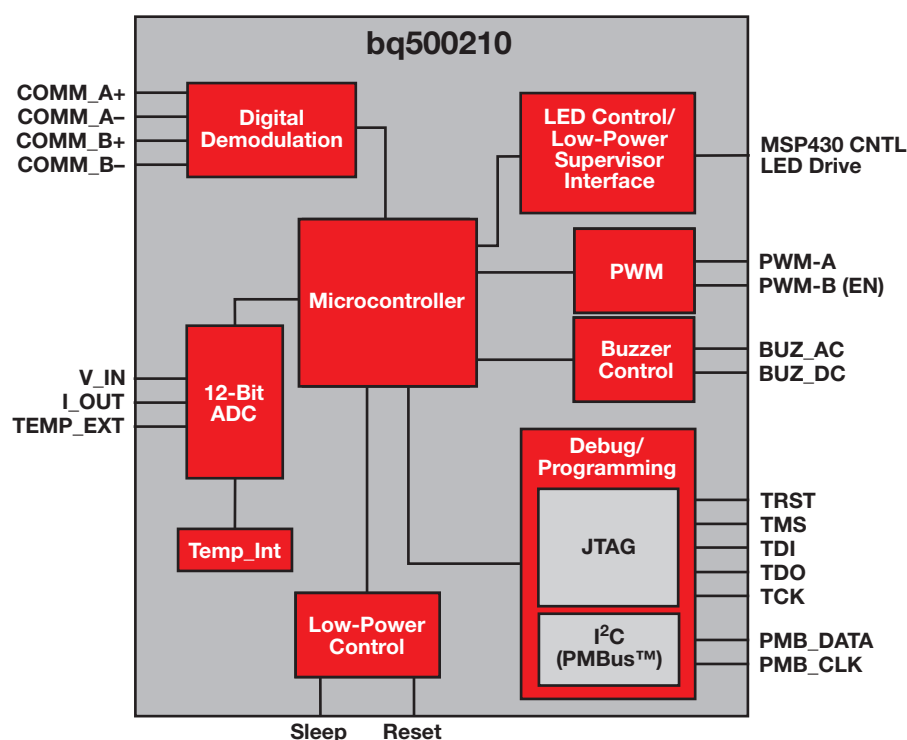
Together with the bq5101x receivers, the bq500210 transmitter controller enables a complete, contactless power-transfer system for a wireless power-supply solution.

#### Key Features

- Intelligent control of the power transfer between base station and mobile device
- Conforms to WPC v1.0.2 specification
- Demodulates and decodes WPC-compliant message packets from the power-receiving device over the same wireless link that transfers electrical power
- Implements closed-loop communications to control power transfer by varying frequency of the voltage on the transmitting coil
- Parasitic metal-object detection (PMOD)
- Operating-mode status indicators
  - Standby
  - Power transfer
  - Charge complete
  - Fault
- Overload and overtemperature protection
- 7 x 7-mm, 48-pin QFN package

#### Applications

- Transmitter pad for contactless charging with WPC compliance
- Low-power (<5-W) end equipment: Cell phones, digital cameras, portable media players, remote/gaming controllers, *Bluetooth*® headsets and other portable devices



#### Selection Guide

Device	Description	Number of Channels	Supported Communication Modulation	WPC-Standard Compliance	Transmitter Power Class (W)	Transmitter Input Voltage (Typ) (V)	Package	Price*
bq500110	Generation 1 wireless power transmitter manager	1	Resistive and Capacitive	Yes	5	19	48-pin VQFN	5.00
<b>bq500210</b>	Generation 2 Qi-compliant wireless power transmitter manager	1	Resistive and Capacitive	Yes	5	19	48-pin VQFN	4.50

\*Suggested resale price in U.S. dollars in quantities of 1,000.

New devices are listed in **bold red**.

# Battery Management Solutions

## → Wireless Power

### bqTESLA™ Development Modules

#### bq500210EVM-689 (Tx) and bq51013EVM-725 (Rx)

Get more information at: [www.ti.com/wirelesspower](http://www.ti.com/wirelesspower)

TI's combined bqTESLA evaluation modules provide a high-performance, easy-to-use development kit for the design of low-power wireless solutions. The kit features the bq500210 single-channel transmitter and the bq51013 5-V power-supply receiver, enabling designers to speed development of their end applications.

#### Key Features

- bq500210 single-channel transmitter
- bq51013 5-V power-supply receiver
- No additional software development required
- Allows for true plug-and-play functionality
- Compatible with WPC Qi specifications



Development kit includes bq500210 and bq51013 evaluation modules.

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Domestic	Toll-Free Number

**Note:** Toll-free numbers do not support mobile and IP phones.

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China	800-820-8682
Hong Kong	800-96-5941
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Indonesia	001-803-8861-1006
Korea	080-551-2804
Malaysia	1-800-80-3973
New Zealand	0800-446-934
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Singapore	800-886-1028
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Thailand	001-800-886-0010

Fax	+8621-23073686
Email	<a href="mailto:tiasia@ti.com">tiasia@ti.com</a> or <a href="mailto:ti-china@ti.com">ti-china@ti.com</a>
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