

Battery Management Guide



Charging

Gauging

Protection

Authentication

Monitoring



Battery Management Guide

Introduction and Contents

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

TI makes designing easier with leading-edge design tools and support, a broad selection of evaluation modules (EVMs), application notes, comprehensive technical documentation, and more. Samples and small orders (shipped within 24 hours via TI authorized distributors) 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 and resources, visit www.ti.com/battery

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Get Longer Running, Healthier Batteries from TI

Innovative Products

Longer run-time and faster, safer charging



- Broadest portfolio
- Longest possible run-time, most accurate battery capacity measurement
- Faster, safer charging eliminates the need to over design or overcompensate

Robust Design Tools

Streamline development cycle



- Evaluation modules, development kits, software, reference designs
- Find the right IC for your application's performance
- Streamlined process means easier implementation and faster time to market

Battery Experts

TI knows batteries



- Decades of design experience at work for you
- Battery chemistry library covers all known battery types
- Battery scientists drive new technologies and devices

Get more out of your battery with TI Battery Management Solutions

Battery Management System Applications

Overview

End applications in wireless, computing, consumer, medical, industrial, and automotive markets continue to expand into the portable space. Battery management solutions from TI help address system protection, cost-effective linear, and highly-efficient switch-mode battery charging. New advances in switch-mode charging increase efficiency and decrease power dissipation, 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 over-voltage and overcurrent conditions.

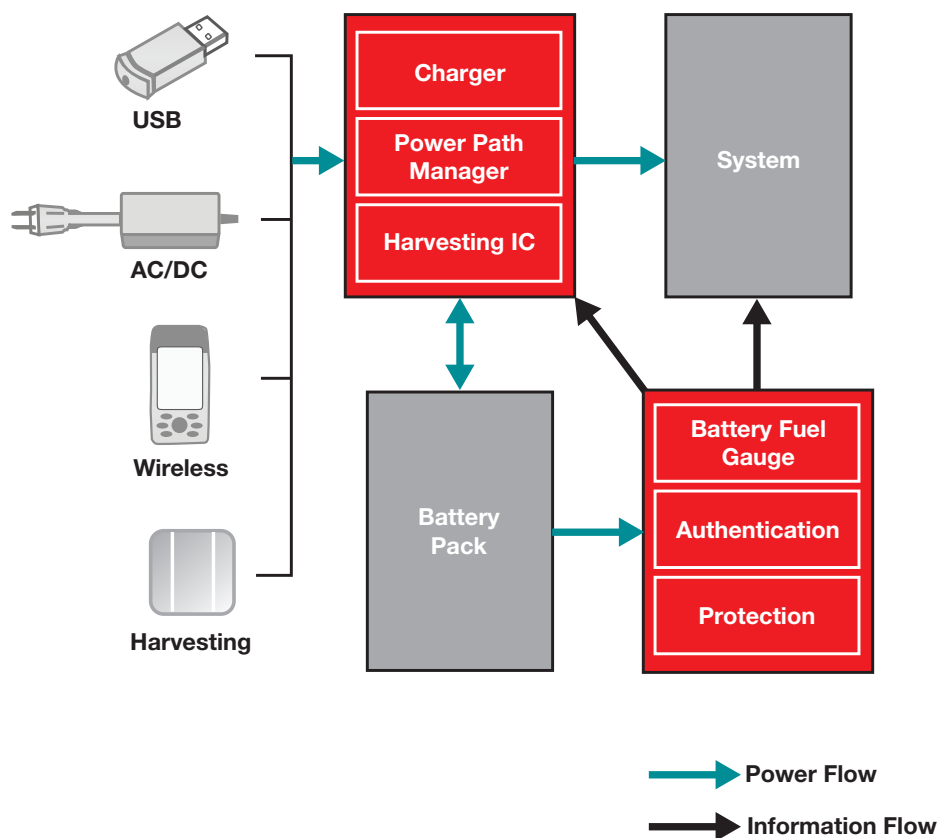
Battery Chemistry

Lithium Ion (Li-Ion) is the most widely used chemistry family for rechargeable batteries. There are different chemistries in the Li-Ion family with different operating characteristics such as discharge profiles and self-discharge rate. TI battery management devices are developed by chemistry to account for these differences to charge the battery more efficiently and report the remaining energy in the battery more accurately.

Fundamentals

TI products support portable applications such as mobile phones, smartphones, tablets, consumer devices, navigation devices, notebook computers, many medical, industrial, and automotive applications. TI has a 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.

Portable Power system Diagram



Battery Management System Applications

Energy Harvesting and Nano Power Solutions

Design Factors

Harvester Element — The type of element used for energy harvesting depends on the power requirements of the load. The energy capable of being harvested varies according to the element selection. TI's energy harvesting solutions can interface to a variety of harvesters such as solar (PV) cells, thermo-electric generators (TEGs) and piezo devices.

Storage Element — Energy that is harvested is usually stored for later use in periods of "dark time" when harvesting

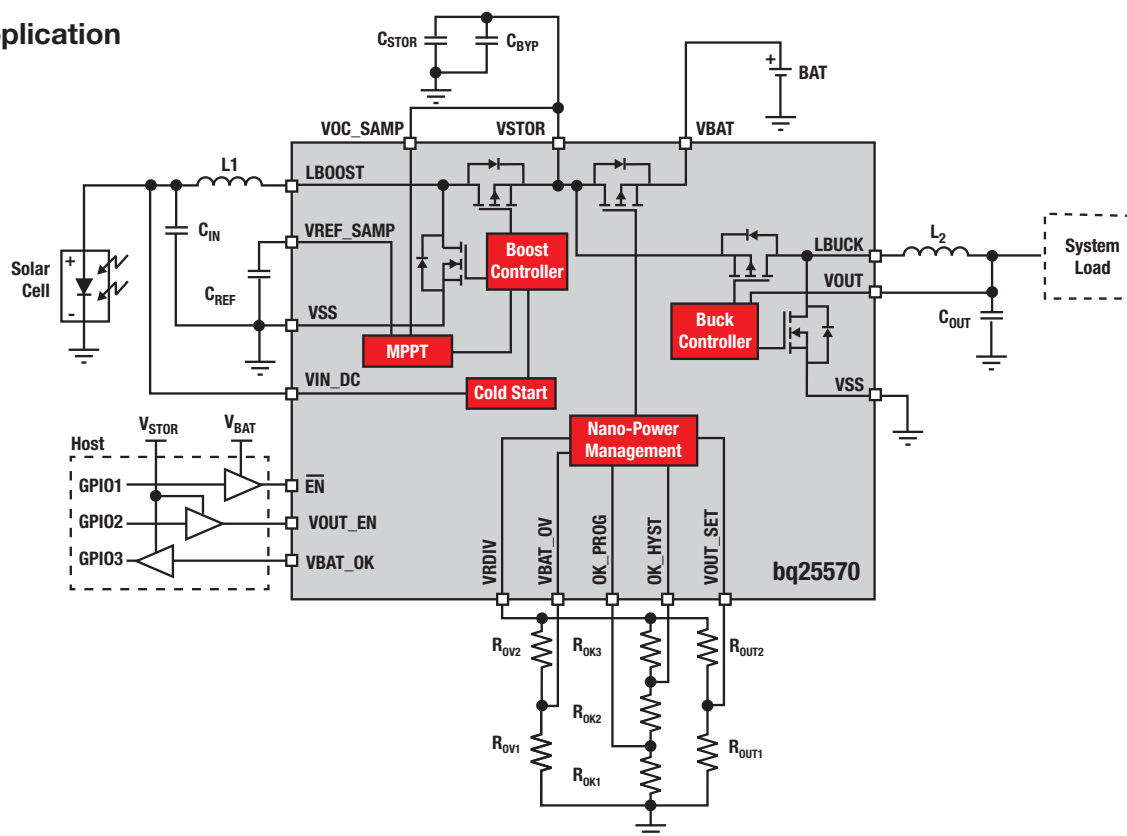
may not be possible due to insufficient ambient energy. TI's energy harvesting solutions are capable of storing energy in different types of storage elements such as Li-Ion rechargeable cells, super-caps, conventional caps and thin-film batteries (solid-state batteries).

Ultra-Low-Power Conversion Unit — The low-level input delivered by a harvester element needs to be converted to a usable level for downstream microelectronics and the power-conversion solution must be very efficient. TI's energy harvesting solutions

have the industry's lowest active current requirements, thus allowing most of the harvested energy to be transferred to the load.

Activity Level — Energy harvesting systems spend most of their time in sleep state; waking up periodically to take and report measurements, then going back to sleep until it is time for the next measurement. The power consumed in the sleep state is very critical for extended and reliable operation to prevent premature shutdown.

Typical Application



Get more information: www.ti.com/product/bq25570

Featured Energy-Harvesting Devices

| Device | Description |
|------------------------|--|
| bq25505 | Ultra-low-power boost converter with battery management and autonomous power-path multiplexing |
| bq25504 | Ultra-low-power boost converter with battery management |
| bq25570 | Ultra-low-power boost converter with battery management and buck output regulation |
| TPS62736/37 | Ultra-low I_Q nano-buck regulators |
| bq25504EVM-674 | Evaluation module for bq25504 ultra-low-power boost converter |
| TPS62736EVM-205 | Evaluation module for TPS62736 programmable-output, ultra-low-power buck converter |

New products are listed in bold red.

Battery Management System Applications

Electric Bicycle Solutions

In many parts of the world, electric bicycles (e-bikes) offer a convenient and affordable alternative to the automobile or public transportation. Compared to traditional, purely mechanical bicycles, e-bikes provide motor assistance for riders to conquer tough uphill inclines and render a daily commute nearly effortless.

Today, roughly 150 million e-bikes are already on the road and this number is projected to double in less than half a decade. In Asia, the majority of current and older generation models still employ a lead acid battery, while those sold in Europe use Lithium-Ion chemistry. With the price between the two reigning chemistries converging, the future development trend for e-bikes is in favor of Lithium-Ion, which offers several tangible benefits for the typical bicycle owner.

Features

- Higher gravimetric and volumetric density translates to smaller and lighter battery packs that can be easily removed for charging
- Extended cycle life for reliable operation of three years and beyond
- Eco-friendly with far less toxicity than lead acid

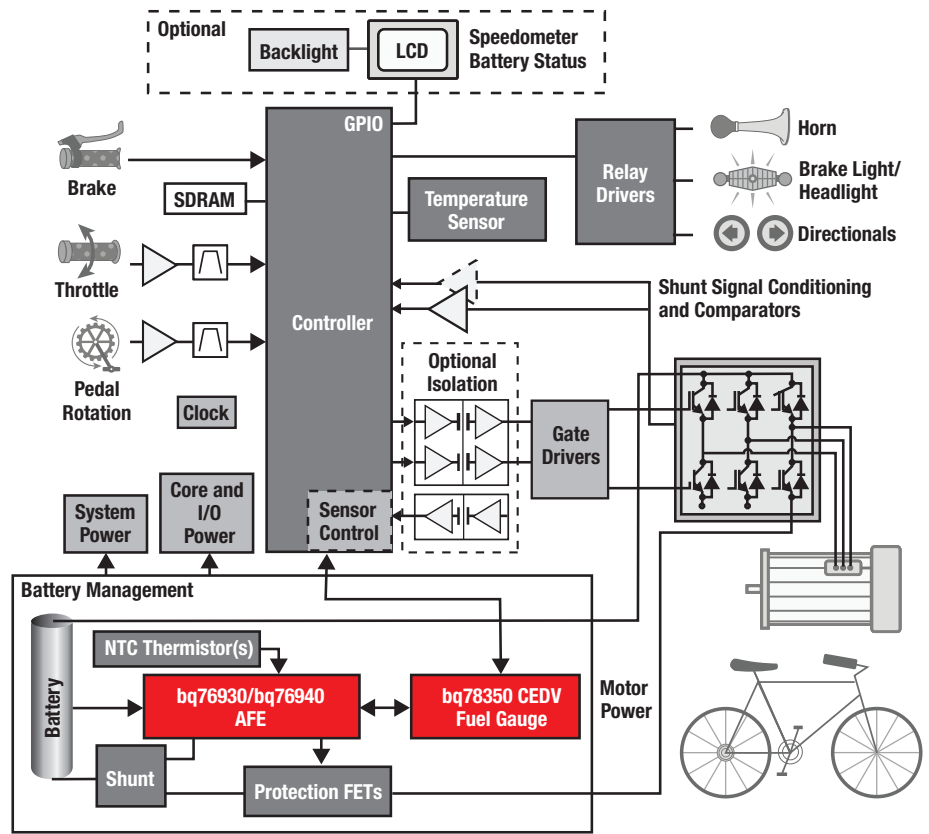
A typical e-bike system includes three core components — a battery pack, motor drive unit and user display.

- **Battery pack** — Integrates all electronics needed for safe charging and discharging and may include more sophisticated electronics to calculate things such as remaining capacity and battery health.

- **Motor drive unit** — Powered by the battery, a complex mix of sensors and a motor controller that provides torque assistance while the bike is in operation. Some high-end solutions also offer features such as regenerative braking, electronic gearshift and maximum speed limiting.

- **User display** — Serves as the primary interface to the rider and provides up-to-date information on the bicycle. Displays metrics such as remaining distance, motor power output and battery condition.

Typical Application



Featured E-Bike Devices

| Device | Description |
|----------------|--|
| bq76930 | 6-10S next-generation analog front-end with digital I ² C interface, integrated ADCs and hardware protection |
| bq76940 | 9-15S next-generation analog front-end with digital I ² C interface, integrated ADCs and hardware protection |
| bq78350 | CEDV fuel gauging battery manager with configurable protection, lifetime data logging, cell balancing and SMBus interface and LED display. Pair with bq76920/bq76930/bq76940 |

| Device | Description |
|------------------|--|
| bq34z110 | Pack-based Impedance Track™ fuel gauge for lead acid |
| bq77PL900 | 18-V, 24-V and 36-V (5-10S) dual-mode, analog front-end and standalone voltage, current and temperature pack protector |
| bq771800 | 5S secondary overvoltage protector |
| bq771600 | 4S secondary overvoltage protector |

New devices are listed in bold red.

Battery Management System Applications

Wireless Power Devices

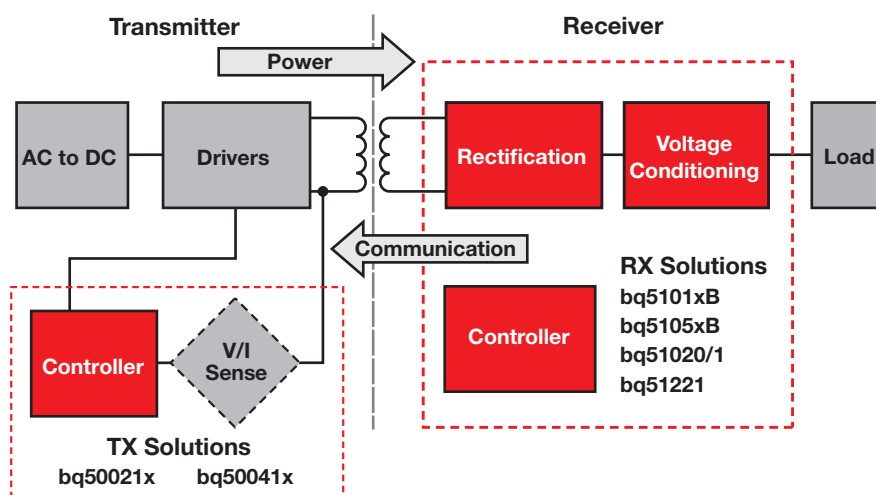
A wireless power system consists of a transmitter (charging pad) and a receiver (mobile device). Both contain a coil and electronics. Power is transferred wirelessly between the coils via inductive coupling. These systems are typically used for charging batteries in mobile devices, or powering subsystems.

Applications

- Smartphones
- Accessory chargers
- Digital cameras
- Bluetooth® headsets
- Tablet computers
- Portable industrial devices
- Portable and wearable equipment for medical, health and fitness applications
- In-car charging systems
- Speakers

Typical features included with RX and TX devices are compliant to WPC v1.1 specification, foreign-object detection (FOD), 5-V, 12-V, or 19-V support for transmitter power, 5-V, 7-V or adjustable receiver output options, and automatic adapter detection. A built-in Li-Ion charge controller is also included in some of the receiver devices.

Typical Application



Featured Wireless Power Devices

| Device | Description |
|------------------|--|
| bq51003 | 2.5-W highly integrated wireless-receiver Qi-compliant (WPC v1.1) power supply |
| bq51013B | 5-W Qi-compliant, fully-integrated wireless-power receiver device |
| bq51010B | 5-W highly-integrated wireless receiver, Qi-compliant power supply |
| bq51020 | Qi-compliant high-efficiency, 5-W receiver with adjustable output voltage |
| bq51021 | Qi-compliant high-efficiency, 5-W receiver with adjustable output voltage and I ² C control |
| bq51050B | 4.2-V Qi-compliant, highly-integrated, secondary-side, direct Lithium-Ion charger |
| bq51051B | 4.35-V integrated wireless power, Li-Ion-charger receiver, Qi-compliant |
| bq51221 | Dual-mode, WPC v1.1/PMA high-efficiency receiver with adjustable output voltage I ² C control |
| bq500210 | WPC v1.0 transmitter solution for 19-V _N systems |
| bq500212A | Latest WPC v1.1, 5-V transmitter with reduced BOM and improved, simplified FOD |
| bq500412A | Latest WPC v1.1, 12-V transmitter with reduced BOM and improved, simplified FOD |
| bq500414Q | AEC-Q100-qualified, A6 transmitter for automotive applications |
| bq51025 | 10-W WPC v1.1-compliant single-chip wireless power receiver |
| bq500215 | Fixed frequency 10-W WPC v1.1 wireless power transmitter |

New products are listed in bold red.

Get more information: www.ti.com/wirelesspower

Battery Management System Applications

Handheld Consumer Medical Equipment

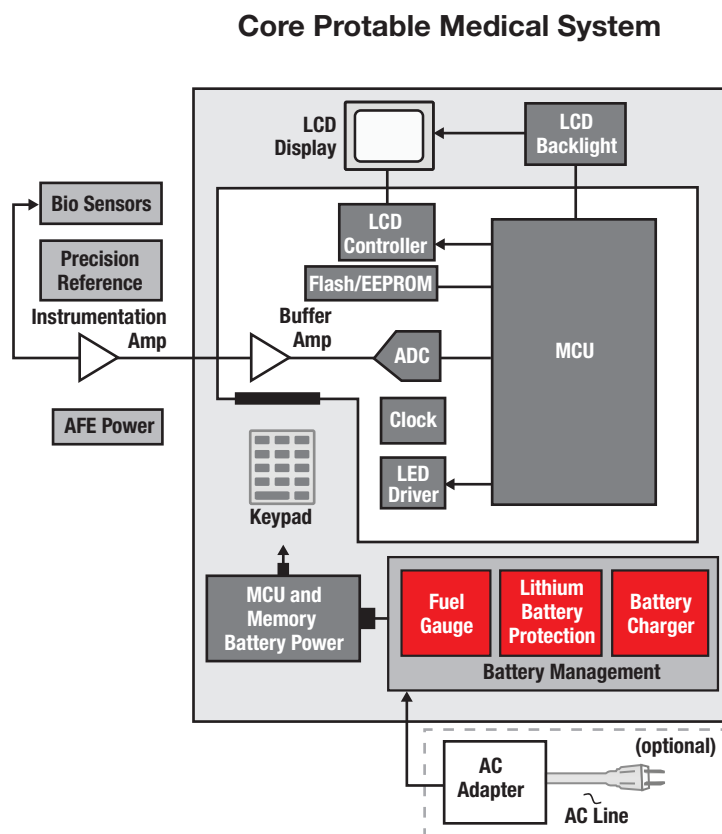
Rechargeable Li-Ion batteries are becoming common place in consumer medical devices where extended battery life is a key requirement. Features such as additional memory, audio feedback and wireless connectivity drive the need for higher power, which means higher battery capacities. Many applications are now available as portable devices.

Applications

- Blood glucose meters
- Digital blood pressure meters
- Digital thermometers
- Digital pulse/heart rate monitors
- Blood cholesterol meters
- Portable and wearable equipment for medical, health and fitness applications

Li-Ion charge controllers and fuel gauges have become key components in these systems. Typical features included on these power management devices include power-path support, USB and AC adapter support, wide input-voltage capability, battery-status outputs, cell balancing and battery-capacity tracking.

Typical Application



Featured Medical Equipment Devices

| Device | Description |
|------------|---|
| bq24040/45 | 1-A, single-input, single-cell Li-Ion battery charger with auto start |
| bq24250 | 2-A, single-input, I ² C/standalone, switch-mode Li-Ion battery charger |
| bq24253 | 2-A, single-input, I ² C/standalone, switch-mode Li-Ion battery charger |
| bq51050B | Qi-compliant, wireless-power, secondary-side, direct Li-Ion charger |
| bq500212A | Qi-compliant, 5-V wireless-power transmitter manager |
| bq27541 | Single-cell, Li-Ion-battery fuel gauge for battery-pack integration |
| bq27742 | Single-cell, Li-Ion-battery fuel gauge with integrated protection |
| bq24314A/C | Overvoltage and overcurrent protection IC with Li+ charger front-end protection |
| bq24133 | Synchronous switch-mode Li-Ion and Li-Polymer stand-alone battery charger |
| bq24610 | Stand-alone synchronous switch-mode Li-Ion or Li-Polymer battery charger with 5-V to 28-V V _{CC} input |

Battery Management System Applications

Portable Industrial Solutions

The increasing need to harness renewable power sources such as photovoltaic and wind energy, coupled with the proliferation of cloud data services, have led to a surge of interest in industrial energy storage systems (ESS). Some ESS are optimized for extended runtime. For

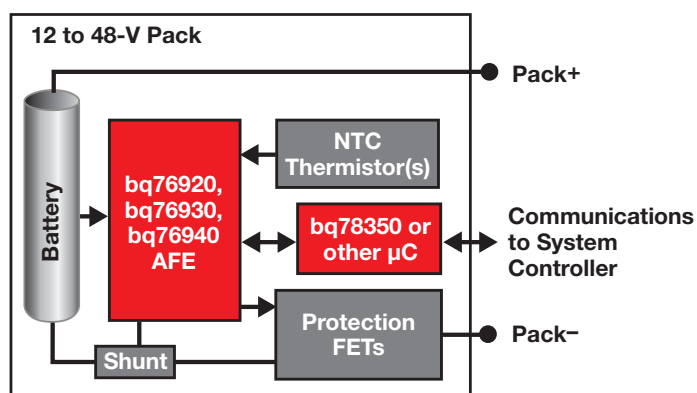
example, a home off-grid PV-to-battery system where solar energy charges a battery during daylight hours, which in turn is used at night.

Others applications are geared towards high-rate brief discharges, such as data center backup during emergency-system

power loss. From simple protectors and analog front ends (AFEs) to sophisticated pack-management controllers and fuel gauges, TI's industrial battery management solutions are designed to maximize scalability across the full spectrum of ESS application requirements.

Intelligent Pack with Monitoring Application

The bq76920/bq76930/bq76940 AFE family offers a modular approach to pack management, with built-in ADCs and a fully digital interface to any host microcontroller.



Key Features

- Handles up to 48-V modules; large systems may be built by stacking modules
- Measures cell voltage, temperature and integrated pack current
- Built-in overvoltage, undervoltage, overcurrent and short-circuit protection
- Output LDO in either 2.5-V or 3.3-V options
- Pairs with optional MCU for fuel gauging
- I²C communication to MCU

Featured Industrial Power Devices

| Device | Description |
|-------------------|---|
| bq76920 | 3-5S next-generation analog front-end with digital I ² C interface, integrated ADCs and hardware protection |
| bq76930 | 6-10S next-generation analog front-end with digital I ² C interface, integrated ADCs and hardware protection |
| bq76940 | 9-15S next-generation analog front-end with digital I ² C interface, integrated ADCs and hardware protection |
| bq78350 | Companion CEDV fuel-gauge battery manager with LED driver for bq76940, bq76930 and bq76920 |
| bq76925 | 3-6S analog front-end with analog output and hardware short circuit detection |
| bq76PL536A | 3-6S stackable analog front-end with integrated precision ADC and SPI interface |

| Device | Description |
|------------------|---|
| bq24133 | Synchronous switch-mode Li-Ion and Li-Polymer stand-alone battery charger |
| bq24610 | Stand-alone synchronous switch-mode Li-Ion or Li-Polymer battery charger with 5-V to 28-V V _{CC} input |
| bq34z110 | Pack-based Impedance Track™ fuel gauge for lead acid |
| bq77PL900 | 18-V, 24-V and 36-V (5-10S) dual-mode analog front end and standalone voltage, current and temperature pack protector |
| bq771800 | 5S secondary overvoltage protector |
| bq771600 | 4S secondary overvoltage protector |

New products are listed in bold red.

Battery Management System Applications

Automotive Power Solutions

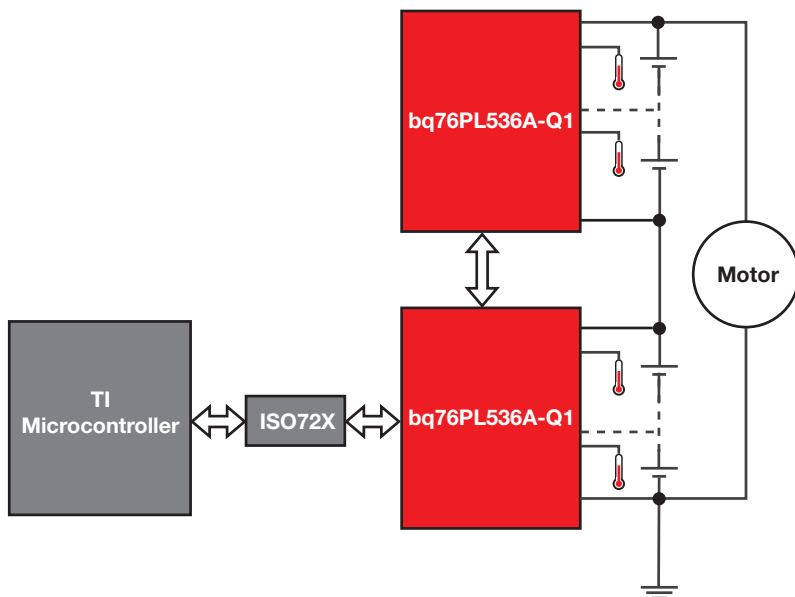
TI's battery management devices for electric, hybrid and plug-in-hybrid vehicles are designed to provide high accuracy, communication robustness and hot-plug performance. Products such as the bq76PL536A-Q1 integrated protector help minimize board space and component count.

The bq76PL536A-Q1 is good design choice for monitoring voltage, temperature and other sensors in applications that use a large-capacity battery.

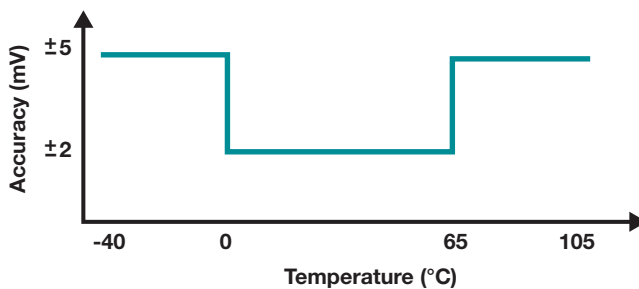
Key Features

- 3- to 6-series cell support for all chemistries
- Stackable vertical interface
- Hot-pluggable
- No isolation components required between devices
- Qualified for automotive applications
- Temperature range -40°C to 105°C
- High accuracy (± 1 mV typical)
- Two temperature inputs and one general-purpose input
- Built-in comparators (secondary protector) for:
 - Over and undervoltage protection
 - Overtemperature protection
- Low power

Typical Application



bq76PL536A Accuracy Rating vs. Temperature



Featured Automotive Power Devices

| Device | Description |
|---------------|---|
| bq76PL536A-Q1 | 3- to 6-series cell Lithium-Ion battery monitor and secondary protection IC for EV and HEV applications |
| EMB1428Q | Active-balancing, switch-matrix gate driver |
| EMB1499Q | Active-balancing, bidirectional current DC/DC controller |

Battery Management Products

Battery Chargers

Design Factors

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

Purpose

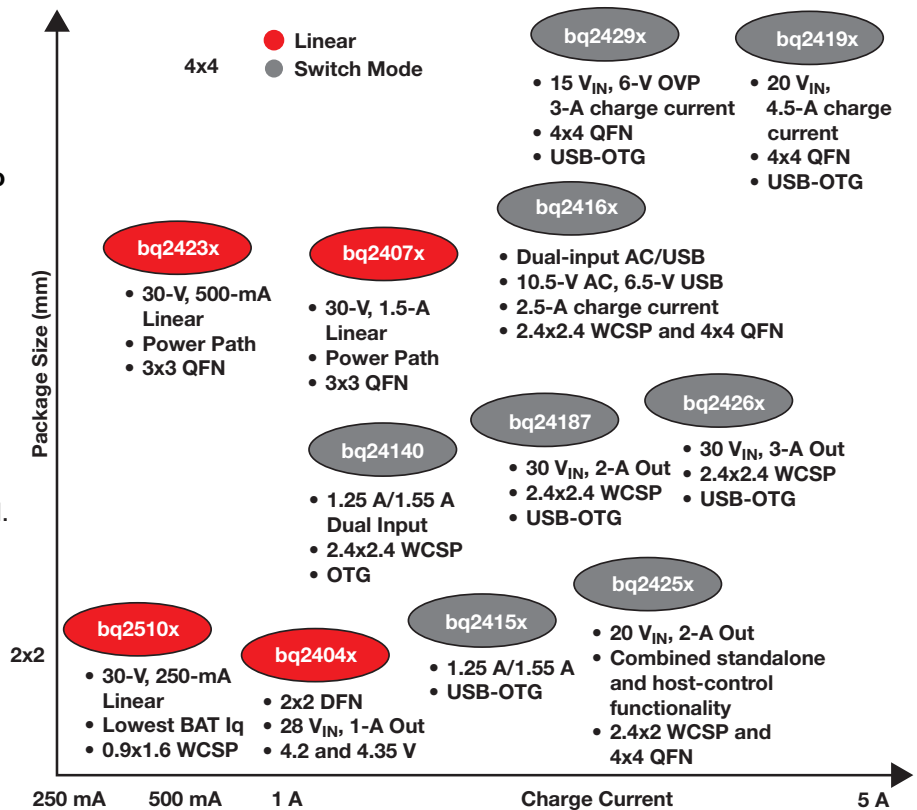
- Correctly charge using constant current and voltage
- Maximize battery life and capacity
- Maintain safe operating range for voltage, current and temperature

What type of power source is available to recharge your battery pack?

- **High-Voltage AC Power** — The first stage of the battery-charging circuit requires an isolated power converter to generate a lower-voltage DC rail that is used to charge the battery pack.
- **Mid-Voltage DC Power** (~12 to 30 VDC) — A switch-mode charger will be the likely charge-control solution. For higher currents (above 4 A), external power FETs will likely be required. For currents below 4 A, in many cases a fully integrated solution may be possible.
- **Low-Voltage DC** (e.g., from adapter or USB port) — A low-cost linear charger may be usable for currents below 1 A. Low-voltage switch-mode chargers are recommended for currents above 1 A.

If the application requires simultaneous battery charging and system operation, the charger device should include power-path control functionality.

Single-Cell Li-Ion Charger Quick Reference



Battery Management Products

Battery Chargers

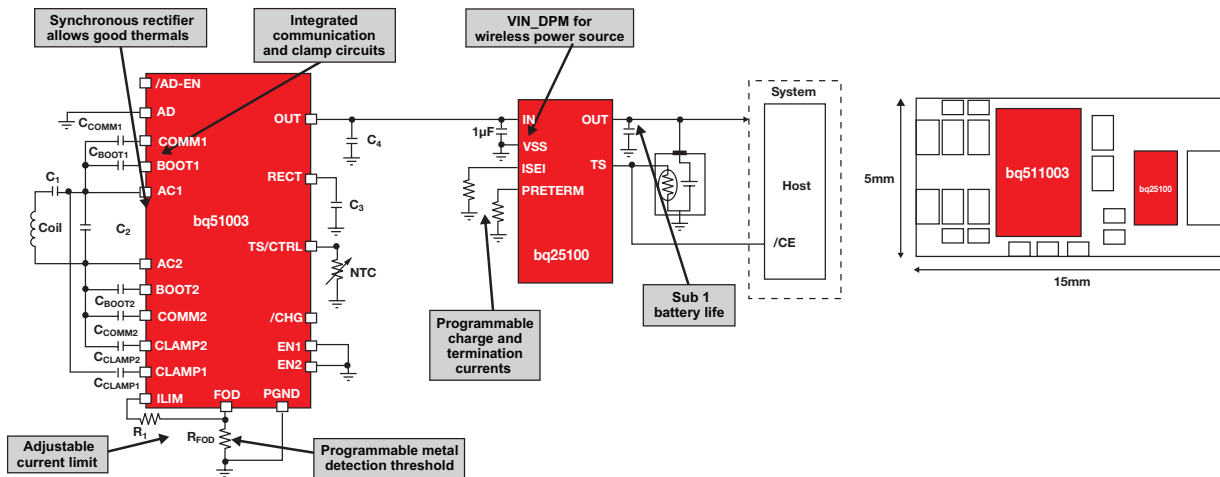
Ultra-Small 250-mA Linear Charger in 0.9mm x 1.6mm WCSP

bq2510x

The bq2510x family is the new 250-mA linear charger designed for low-current applications such as wearables. The bq2510x holds the industries' lowest I_q (quiescent current) at only 75 nA max. The bq2510x features a more accurate charge current control (down to 10 mA), which makes it ideal for small-capacity battery. This family comes in an ultra-small 0.9 x 1.6mm WCSP package.



Qi (WPC) Compliant Wireless Charger for Low Power Wearable Application
www.ti.com/tool/TIDA-00318



| Device | VBATREG | ICHG | BAT Leakage | OVP | Min Term | Charge LED Driver | TS | WCSP | Size |
|----------|---------|--------|-------------|-------|----------|-------------------|-------|---------|--------------|
| bq25100 | 4.2 V | 250 mA | 50 nA | 6.5 V | 1 mA | No | JEITA | 6 balls | 0.9mm x1.6mm |
| bq25100A | 4.3 V | 250 mA | 50 nA | 6.5 V | 1 mA | No | JEITA | 6 balls | 0.9mm x1.6mm |
| bq25100H | 4.35 V | 250 mA | 50 nA | 6.5 V | 1 mA | No | JEITA | 6 balls | 0.9mm x1.6mm |
| bq25101 | 4.2 V | 250 mA | 50 nA | 6.5 V | 1 mA | Yes | JEITA | 6 balls | 0.9mm x1.6mm |

Get more information: www.ti.com/product/bq25100

Ultra-Low-Power, Harvester PMIC with Boost Charger and Autonomous Power Multiplexor

bq25505

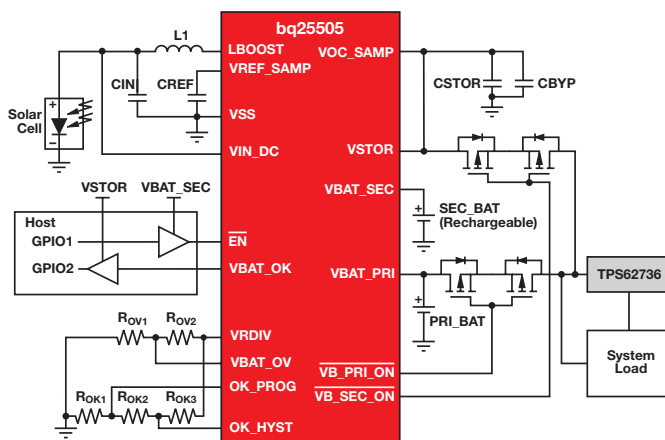
The bq25505 is the first of a new family of intelligent integrated energy-harvesting, nano-power management solutions that are well suited for meeting the special needs of ultra-low-power applications. The product is specifically designed to efficiently acquire and manage the microwatts (μW) to milliwatts (mW) of power generated from a variety of DC sources like photovoltaic (solar) or thermal electric generators (TEGs).

Key Features

- Cold-start voltage: $V_{IN} \geq 330$ mV
- Continuous energy harvesting from input sources as low as 100 mV
- Ultra-low quiescent current: 320 nA
- Energy can be stored to rechargeable Li-Ion batteries, thin-film batteries, super capacitors or conventional capacitors
- Programmable maximum power point tracking (MPPT)

Applications

- Energy harvesting, solar charger, thermal electric generator (TEG)
- Wireless sensor networks (WSN)



Get more information: www.ti.com/product/bq25505

Battery Management Products

Battery Chargers

2.5-A, Dual-Input, Switch-Mode Charger with Power-Path Management and Host I²C Control or Stand Alone

bq2416x Family

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.

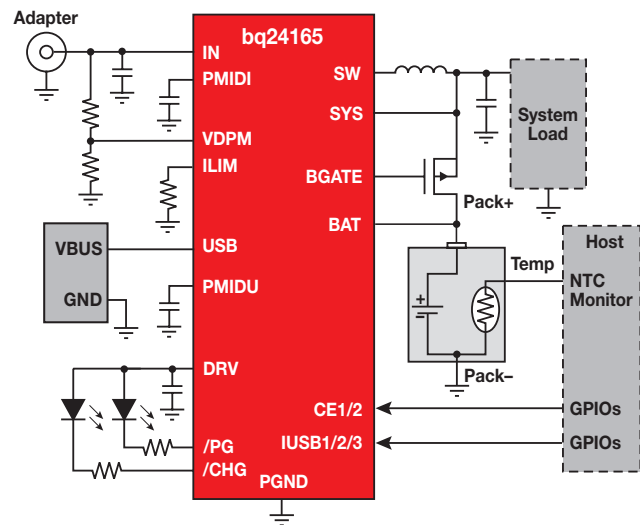
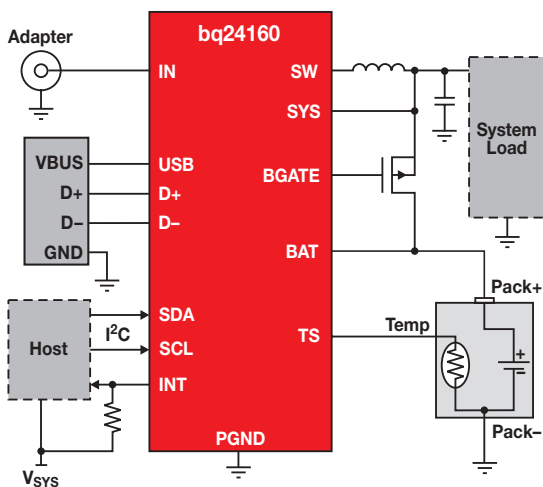
Key Features

- Start-up 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
- Integrated input current sensing and limiting (±5%)
- Dual inputs are fully isolated

- 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

Applications

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



Get more information: www.ti.com/product/bq24160 or [bq24165](http://www.ti.com/product/bq24165)

Single-Cell Chargers Selection Guide

| Device | Number of Cells | V _{IN} OVP (V) | Charge Current (A) | Charge Voltage (V) | Topology | Internal FET | Temp Monitor | WCSP | QFN | EVM | USB Detection | Price* |
|---|-----------------|-------------------------|--------------------|--------------------|-----------|--------------|--------------------------|------|-----|-----|-----------------------|--------|
| Host Mode with I²C System Interface | | | | | | | | | | | | |
| bq24160/A | 1 | 10.5/6.5 (USB) | 2.5/1.5 (USB) | 3.5 to 4.4 | Switching | Yes | Yes, JEITA | 49 | 24 | ✓ | D+/D- | 1.95 |
| bq24161/B | 1 | 10.5/6.5 (USB) | 2.5/1.5 (USB) | 3.5 to 4.4 | Switching | Yes | Yes, Std | 49 | — | ✓ | PSEL | 1.95 |
| bq24163 | 1 | 10.5/6.5 (USB) | 2.5/1.5 (USB) | 3.5 to 4.4 | Switching | Yes | Yes, JEITA | 49 | 24 | ✓ | D+/D- | 1.95 |
| bq24168 | 1 | 6.5/6.5 (USB) | 2.5/1.5 (USB) | 3.5 to 4.4 | Switching | Yes | Yes, JEITA | 49 | 24 | ✓ | PSEL | 1.95 |
| Stand Alone System Interface | | | | | | | | | | | | |
| bq24165 | 1 | 10.5/6.5 (USB) | 2.5/1.5 (USB) | 4.2 | Switching | Yes | via Host JEITA Adj CE1/2 | 49 | 24 | ✓ | I _{USB1/2/3} | 1.95 |
| bq24166 | 1 | 10.5/6.5 (USB) | 2.5/1.5 (USB) | 4.2 | Switching | Yes | Yes/Std | 49 | 24 | ✓ | I _{USB1/2/3} | 1.95 |
| bq24167 | 1 | 10.5/6.5 (USB) | 2.5/1.5 (USB) | 4.2 | Switching | Yes | via Host JEITA Adj CE1/2 | 49 | 24 | ✓ | I _{USB1/2/3} | 1.95 |

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

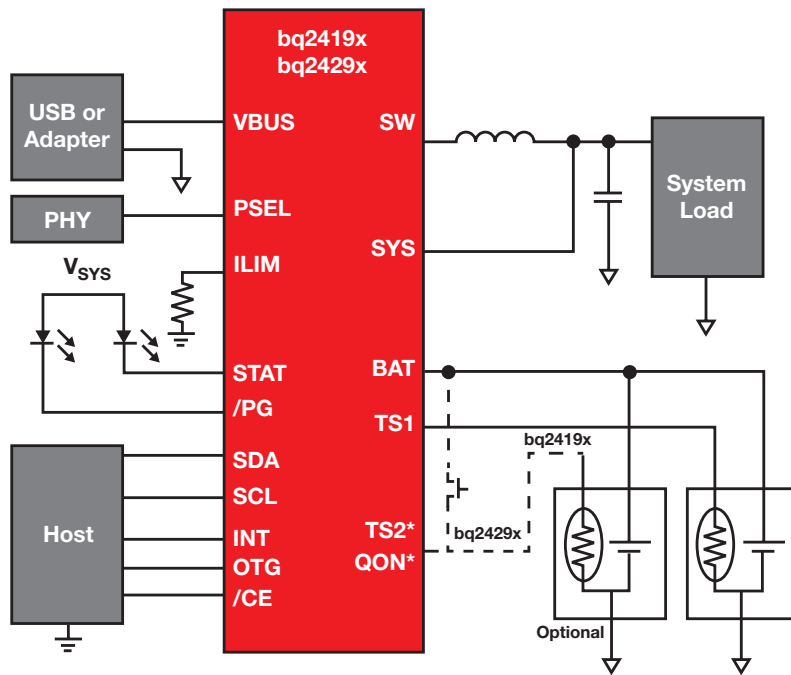
Battery Management Products

Battery Chargers

High-Current, High-Efficiency, Narrow-VDC Chargers for Single-Cell Li-Ion with Power-Path Management and USB OTG

bq2419x, bq2429x Families

The bq2419x/29x families of fully integrated single-cell 4.5/3-A NVDC-1 chargers feature power-path management. These devices achieve fast charging, USB detection, and high USB on-the-go (OTG) efficiency with small overall solution size.



*TS2 for bq2419x, QON for bq2429x

Key Features

- NVDC-1 system with power-path management, system instant-on with no battery or deeply discharged battery
- I²C host control or autonomous charging with default parameters
- High integration including battery FET, AC switching FETS, current sensing and compensation
- Input-voltage range:
 - bq2419x: 3.9 to 17 V
 - bq2429x: 5 V
- USB-compliant 2.5/4.5-A charger with 1.5-MHz switching mode and D+/D- detection or PSEL
- High charging efficiency:
 - bq2419x: 92% at 2.5 A and 90% at 4 A
 - bq2429x: 88% at 2 A
- High USB OTG efficiency: 90% at 1 A
- Programmable thermal-regulation
- 4 x 4-mm QFN package, pin-to-pin compatible

Applications

- Tablets and E-readers
- Fast charging for smartphones
- Applications requiring high instant system power

Get more information: www.ti.com/product/bq24190 or [bq24295](http://www.ti.com/product/bq24295)

Single-Cell Integrated Chargers with I²C

| Device | Number of Cells | V _{IN} Abs Max (V) | V _{IN} OVP (V) | Charge Current (A) | Default Charging Current (A) | Charge Voltage (V) | Default Charging Voltage (V) | Topology | Integrated Power FET | Temp Monitor | QFN/MLP | EVM | USB Detection | Price* |
|---|-----------------|-----------------------------|-------------------------|--------------------|------------------------------|--------------------|------------------------------|-----------|----------------------|--------------|---------|-----|---------------|--------|
| Host Control with I²C System Interface or Autonomous Charging and USB OTG | | | | | | | | | | | | | | |
| bq24190 | 1 | 20 | 18 | 4.5 | 2 | 3.5 to 4.4 | 4.2 | Switching | Yes | Yes, Std | 24 | ✓ | D+/D- | 2.90 |
| bq24192 | 1 | 20 | 18 | 4.5 | 2 | 3.5 to 4.4 | 4.2 | Switching | Yes | Yes, Std | 24 | ✓ | PSEL | 2.90 |
| bq24192I | 1 | 20 | 18 | 4.5 | 1 | 3.5 to 4.4 | 4.1 | Switching | Yes | Yes, Std | 24 | ✓ | PSEL | 2.90 |
| bq24193 | 1 | 20 | 18 | 4.5 | 2 | 3.5 to 4.4 | 4.2 | Switching | Yes | Yes, JEITA | 24 | ✓ | PSEL | 2.90 |
| bq24196 | 1 | 20 | 18 | 2.5 | 2 | 3.5 to 4.4 | 4.2 | Switching | Yes | Yes, Std | 24 | ✓ | PSEL | 1.95 |
| bq24296 | 1 | 15 | 6.4 | 3 | 2 | 3.5 to 4.4 | 4.2 | Switching | Yes | Yes, Std | 24 | ✓ | PSEL | 1.95 |
| bq24297 | 1 | 15 | 6.4 | 3 | 2 | 3.5 to 4.4 | 4.2 | Switching | Yes | Yes, Std | 24 | ✓ | D+/D- | 1.95 |

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

New devices are listed in bold red.

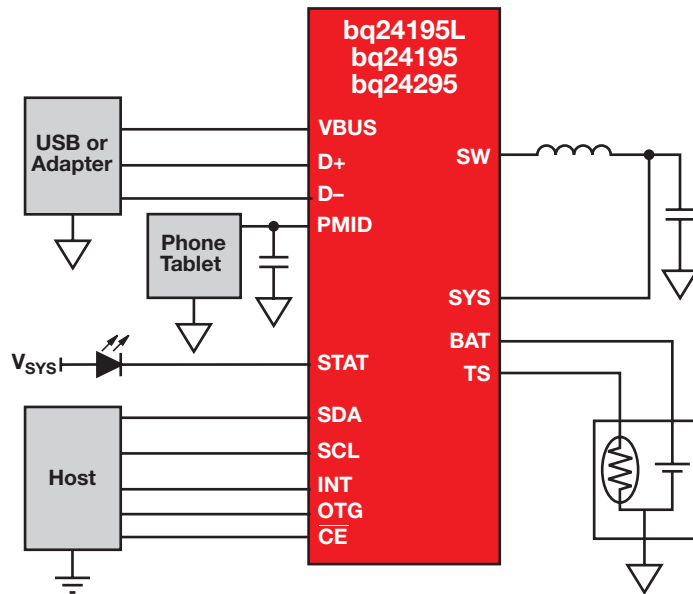
Battery Management Products

Battery Chargers

2.5/4.5/3-A, I²C-Controlled, Single-Cell USB/Adapter Charger with 1.0/2.1/1.5-A Synchronous Boost Operation

bq24195L, bq24195, bq24295

The bq24195L is a fully integrated 2.5-A charger with 1-A synchronous boost operation. The bq24195 is a fully integrated 4.5-A charger with 2.1-A synchronous boost operation. The bq24295 is a fully integrated 3-A 5-V charger with 1.5-A synchronous boost operation. They are the one-chip solutions for 1S battery backup with high synchronous boost efficiency.



Key Features

- Fully integrated single-chip solution for 1S battery
- USB-compliant 1.5-MHz switching-mode charger with D+/D- detection
- High synchronous boost efficiency:
 - bq2419x: 94% at 1 A and 90% at 2.1 A
 - bq24295: 88% 1.5 A
- High charging efficiency:
 - bq2419x: 92% at 2.5 A and 90% at 4A
 - bq24295: 90% at 2 A
- I²C host control or autonomous charging with default parameters
- Input-voltage range:
 - bq2419x: 3.9 to 17 V
 - bq24295: 5 V
- 4 x 4-mm QFN package, pin-to-pin compatible

Applications

- Power bank, power pack, juice pack for smartphone and tablet backup power

Get more information: www.ti.com/product/bq24195L or [bq24195](http://www.ti.com/product/bq24195)

Single-Cell Integrated Chargers with I²C for Power Bank Applications

| Device | Number of Cells | V _{IN} Abs Max (V) | V _{IN} OVP (V) | Charge Current (A) | Default Charging Current (A) | Charge Voltage (V) | Default Charging Voltage (V) | Topology | Integrated Power FET | Temp Monitor | QFN/MLP | EVM | USB Detection | Price* |
|---|-----------------|-----------------------------|-------------------------|--------------------|------------------------------|--------------------|------------------------------|-----------|----------------------|--------------|---------|-----|---------------|--------|
| Host Control with I²C System Interface or Autonomous Charging and Synchronous Boost Operation | | | | | | | | | | | | | | |
| bq24195L | 1 | 20 | 18 | 2.5 | 2 | 3.5 to 4.4 | 4.2 | Switching | Yes | Yes | 24 | ✓ | D+/D- | 2.90 |
| bq24195 | 1 | 20 | 18 | 4.5 | 2 | 3.5 to 4.4 | 4.2 | Switching | Yes | Yes | 24 | ✓ | D+/D- | 3.25 |
| bq24295 | 1 | 15 | 6.4 | 3 | 2 | 3.5 to 4.4 | 4.2 | Switching | Yes | Yes, Std | 24 | ✓ | D+/D- | 1.95 |

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

New devices are listed in bold red.

Battery Management Products

Battery Chargers

2.0-A Switch-Mode Charger with Power-Path Management and Host I²C or Stand Alone Control Option

NEW

bq2425x Family

The bq2425x family of chargers is ideal for space-constrained portable applications. The combination of I²C control and standalone functionality on a single device provides full system-design flexibility across customer platforms. In addition, with a 1- μ A shipmode current, battery life can be extended for accessories applications.

Key Features

- 20-V-input tolerant; operation up to 10.5 V (bq24250/1/3) or 6.5 V (bq24257)
- NVDC architecture
- Input-voltage dynamic power management allows compatibility with multiple external adapter types

- Charge-time optimizer—fastest possible charge rate at any power level
- Compliant with BC1.2 and JEITA standards

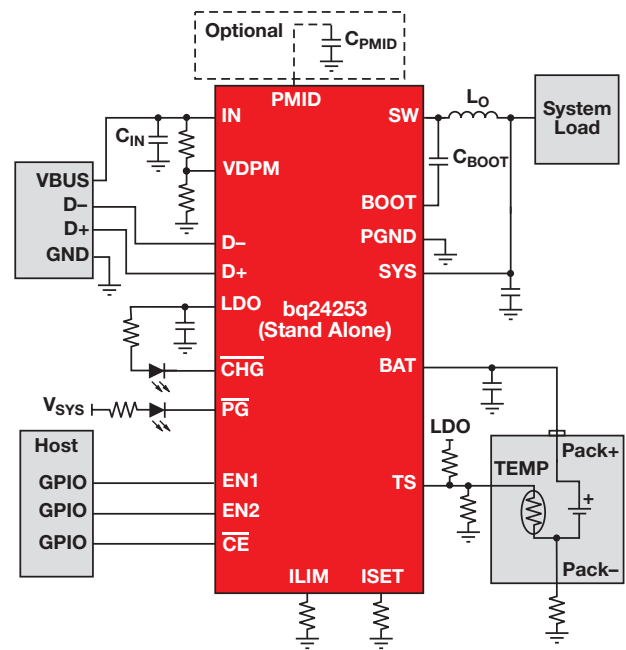
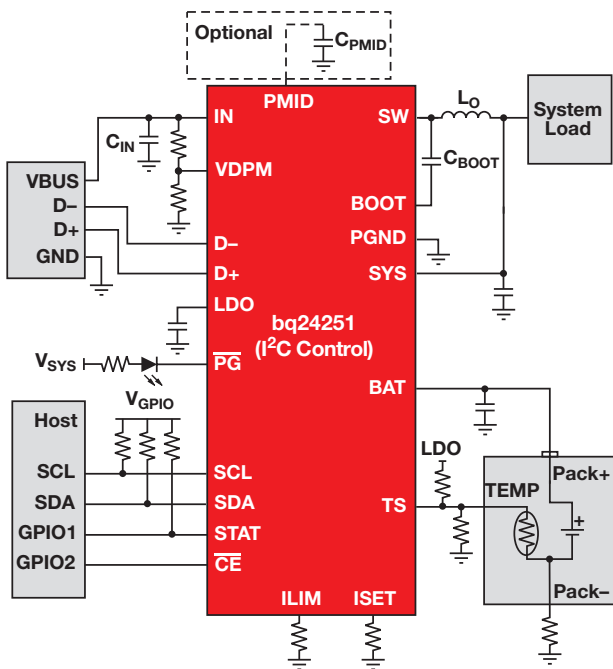
bq24250/1/7 Features

- I²C Interface or stand-alone mode in one device

- Automatic USB current setting from D+/D- (bq24251/7) or EN1/EN2 from host (bq24250), compliant with BC1.2
- Programmable battery-charge output between 3.5 and 4.44 V using I²C or 4.2 V fixed

bq24253 Features

- Fixed battery-charge regulation at 4.2 V
- USB charge rate select using D+/D- detection
- Resistor-programmable current limits



Get more information: www.ti.com/product/bq24251 or [bq24253](http://www.ti.com/product/bq24253)

Selection Guide

| Device | Number of Cells | V _{IN} Absolute Max (V) | V _{IN} OVP (V) | Charge Current (A) | Charge Voltage (V) | Control Interface | Topology | Integrated Power FET | Temperature Monitor | Packaging | | | Comments | Price* |
|-------------------|-----------------|----------------------------------|-------------------------|--------------------|--------------------|------------------------------|-----------|----------------------|---------------------|-----------|---------|-----|---|--------|
| | | | | | | | | | | WCSP | QFN/MLP | EVM | | |
| bq24250/51 | 1 | 20 | 10.5 | 2.0 | 3.5 to 4.4 | I ² C/Stand Alone | Switching | Yes | Yes | 30 | 24 | ✓ | EN1-2 or D+/D- detection, JEITA, Power Path | 1.15 |
| bq24253 | 1 | 20 | 10.5 | 2.0 | 4.2 | Stand Alone | Switching | Yes | Yes | 30 | 24 | ✓ | D+/D- detection, JEITA, Power Path | 1.15 |
| bq24257 | 1 | 20 | 6.5 | 2.0 | 3.5 to 4.4 | I ² C/Stand Alone | Switching | Yes | Yes | 30 | 24 | ✓ | D+/D- detection, JEITA | 1.15 |

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

New products are listed in bold red.

Battery Management Products

Battery Chargers

3.0-A-Output, 30-V-Input Switch-Mode Charger with Power-Path Management and USB OTG Support Host, I²C Control or Stand Alone

NEW

bq2426x Family

The bq2426x family of chargers offers higher current levels and wide-input-voltage tolerance. 30-V capability provides a robust system design in a very small footprint.

Key Features

- 30-V-input tolerant; operation up to 6.5 V (bq24262), 10.5 V (bq24260) or 14 V (bq24261/6) allows compatibility with 5-V or 12-V adapter types
- NVDC architecture
- USB OTG support (5-V output at 1 A)
- Charge-time optimizer—fastest possible charge rate at any power level

- Compliant with BC1.2 and JEITA standards

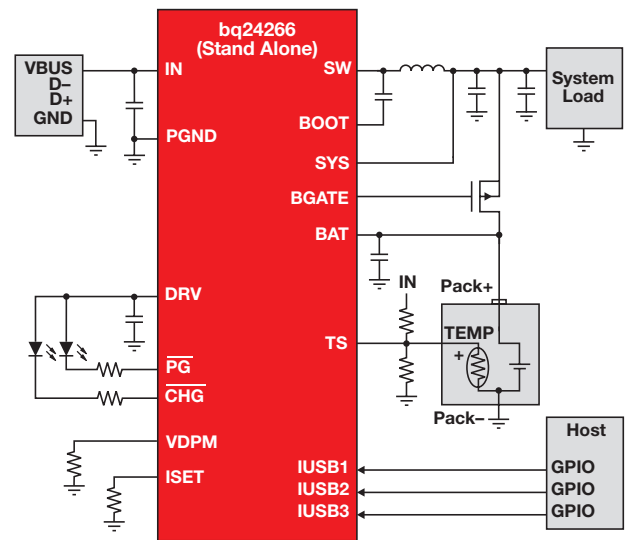
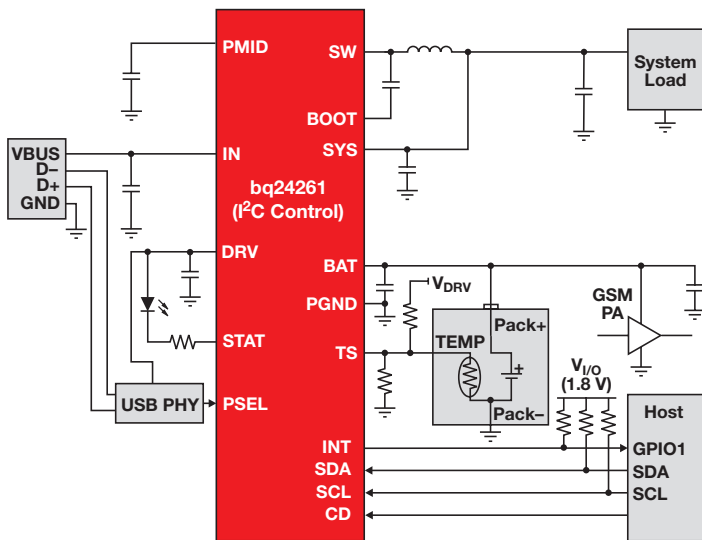
bq24260/1/2 Features

- I²C control
- Automatic USB current setting from D+/D- (bq24260) or PSEL from USB PHY (bq24261/2)

- Programmable battery-charge output between 3.5 and 4.4 V
- Programmable charge-termination current

bq24266 Features

- Stand-alone operation
- Fixed battery-charge regulation at 4.2 V
- Voltage-based, JEITA-compatible NTC monitoring input
- USB input current limit and VinDPM adjustable by host GPIO



Selection Guide

| Device | Number of Cells | V _{IN} Absolute Max (V) | V _{IN} OVP (V) | Charge Current (A) | Charge Voltage (V) | Control Interface | Topology | Integrated Power FET | Temperature Monitor | Packaging | | | Comments | Price* |
|----------------|-----------------|----------------------------------|-------------------------|--------------------|--------------------|-------------------|-----------|----------------------|---------------------|-----------|---------|-----|--------------------------------------|--------|
| | | | | | | | | | | WCSP | QFN/MLP | EVM | | |
| bq24260 | 1 | 30 | 10.5 | 3.0 | 3.5 to 4.4 | I ² C | Switching | Yes | Yes | 36 | 24 | ✓ | D+/D- detect, JEITA, Power Path, OTG | 1.75 |
| bq24261 | 1 | 30 | 14 | 3.0 | 3.5 to 4.4 | I ² C | Switching | Yes | Yes | 36 | 24 | ✓ | PSEL detect, JEITA, Power Path, OTG | 1.75 |
| bq24262 | 1 | 30 | 6.5 | 3.0 | 3.5 to 4.4 | I ² C | Switching | Yes | Yes | 36 | 24 | ✓ | PSEL detect, JEITA, Power Path, OTG | 1.75 |
| bq24266 | 1 | 30 | 14 | 3.0 | 4.2 | Stand Alone | Switching | Yes | Yes | | 24 | ✓ | JEITA, Power Path, OTG | 1.75 |

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

New devices are listed in bold red.

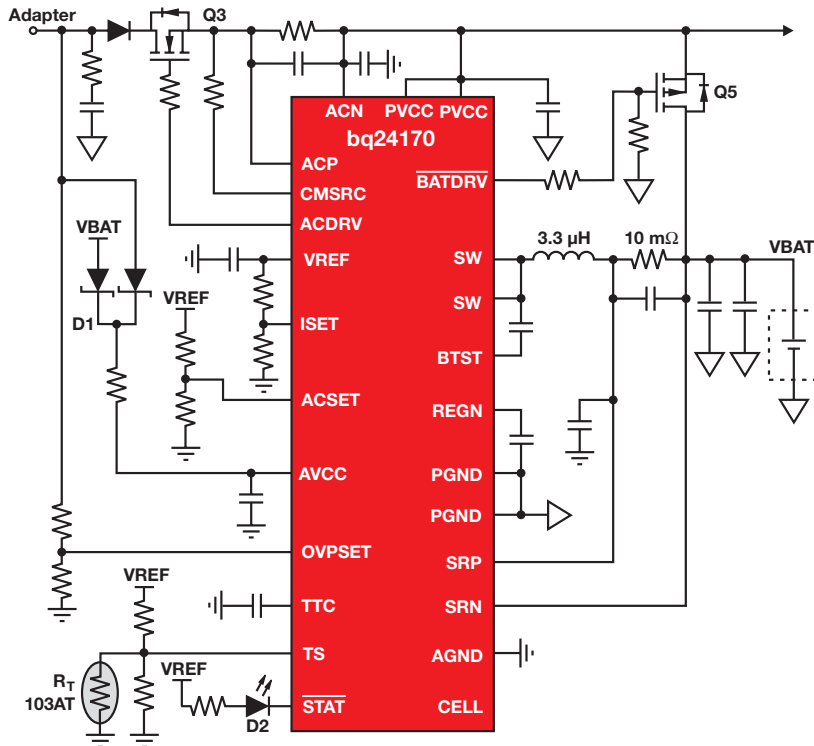
Battery Management Products

Battery Chargers

Switch-Mode Multi-Cell (1 to 3) Li-Ion Battery Chargers with Integrated FETs

bq241xx Family

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

Get more information: www.ti.com/product/bq24170

Chargers with Internal FETs Selection Guide

| Device | Number of Cells | Control Topology | Host or Stand Alone | Integrated Power FET | Charge Current (A) | V _{IN} Max (V) | Primary Charge Termination Method ¹ | Safety Timer | Temp Monitor | Packaging: QFN/MLP | EVM | Comments | Price* |
|--|-----------------|------------------|---------------------|----------------------|--------------------|-------------------------|--|--------------|--------------|--------------------|-----|--|--------|
| Multi-Cell Switch-Mode Stand-Alone Battery Chargers with Internal FETs (Converters) — Lithium-Ion | | | | | | | | | | | | | |
| bq24170 | 1 to 3 | Switching | Stand Alone | Yes | 4.0 | 20 | Min current | Yes | Yes | 24 | ✓ | Power Path | 1.80 |
| bq24171 | 1 to 3 | Switching | Stand Alone | Yes | 4.0 | 20 | Min current | Yes | Yes | 24 | ✓ | JEITA Power Path | 1.80 |
| bq24172 | 1 to 3 | Switching | Stand Alone | Yes | 4.0 | 20 | Min current | Yes | Yes | 24 | ✓ | Adjustable charge voltage, Power Path | 1.80 |
| bq24133 | 1 to 3 | Switching | Stand Alone | Yes | 2.5 | 20 | Min current | Yes | Yes | 24 | ✓ | Power Path | 1.75 |
| bq24130 | 1 to 3 | Switching | Host | Yes | 4.0 | 20 | Min current/Host controlled | — | Yes | 20 | ✓ | Charges battery or super capacitor | 1.95 |
| 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 controlle | Yes | Yes | 20 | ✓ | bq24125 offers enhanced EMI performance | 3.50 |

¹Host controlled = system processor must terminate charging.

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

Battery Management Products

Battery Chargers

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

bq246xx

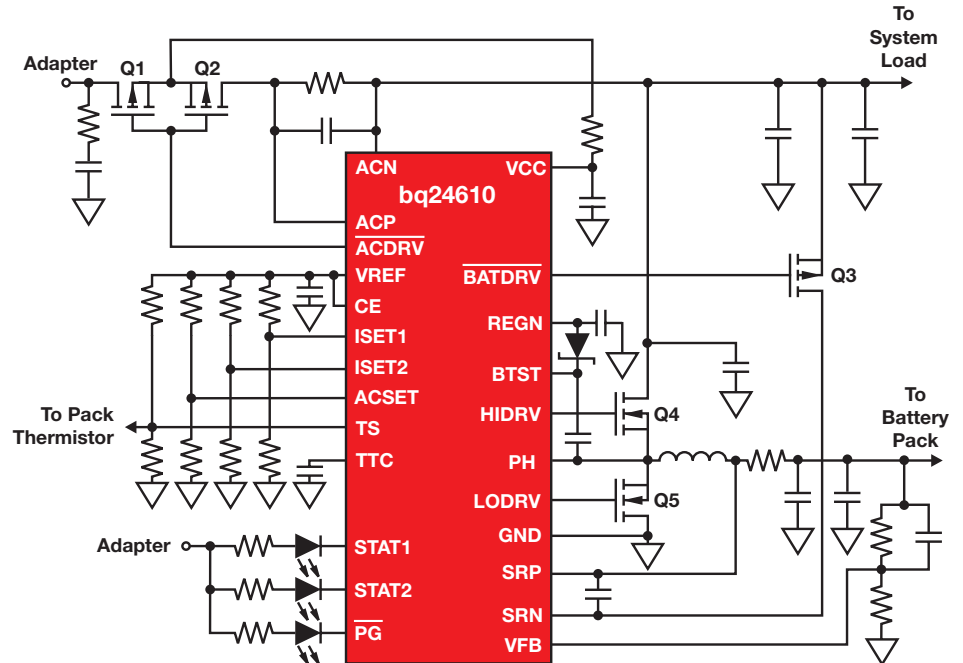
The bq24610 is a highly integrated Li-Ion or Li-Polymer switch-mode battery charger. It offers a constant-frequency synchronous switching PWM controller with highly accurate regulation of charge current and voltage. It also provides charge preconditioning, termination, adapter current regulation and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



Get more information: www.ti.com/product/bq24610

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* |
|--|-----------------|------------------|----------------------|------------------|-----------------------------------|--------------|--------------|--------------------|-----|---|--------|
| Multi-Cell Switch-Mode Stand-Alone Battery Chargers with External FETs (Controllers) — Lithium-Ion (except where noted) | | | | | | | | | | | |
| 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 |
| bq24618 | 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 ₄ | 2.90 |
| bq24630 | 1 to 7 | Switching | No | 32 | Min current | Yes | No | 16/24 | ✓ | LiFePO ₄ , system power selector | 2.90 |
| bq24640 | 1 to 9 | Switching | No | 33 | SuperCap-specific | No | Yes | 16 | ✓ | Supports SuperCap | 3.65 |
| bq24650 | 1 to 6 | Switching | No | 33 | Min current | Yes | Yes | 16 | ✓ | Solar charger for Li-Ion/polymer, LiFePO ₄ , lead-acid chemistries | 2.85 |

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

Battery Management Products

Battery Chargers

Selection Guide

| Device | Number of Cells | V _{IN} Absolute Max (V) | V _{IN} OVP (V) | Charge Current (A) | Charge Voltage (V) | Control Interface | Topology | Integrated Power FET | Temperature Monitor | Packaging | | | Comments | Price* |
|--|-----------------|----------------------------------|-------------------------|--------------------|---------------------|-------------------|------------|----------------------|---------------------|-----------|---------|-----|---|--------|
| | | | | | | | | | | WCSP | QFN/MLP | EVM | | |
| Multi-Chemistry (Li-Ion or NiCd/NiMH) | | | | | | | | | | | | | | |
| bq24030/31/35 | 1 | 18 | 6.4 | 2 | 4.2/4.1/4.2 | Stand Alone | Linear | Yes | Yes | | 20 | ✓ | Regulated 4.4-V output for AC input condition | 1.80 |
| bq24032A/38 | 1 | 18 | 6.4 | 2 | 4.2/ (4.24/4.36) | Stand Alone | Linear | Yes | Yes | | 20 | ✓ | Regulated 4.4-V output for AC input condition | 1.80 |
| bq24040/41 | 1 | 30 | 6.6/7.1 | 1 | 4.2 | Stand Alone | Linear | Yes | Yes | | 10 | ✓ | | 0.45 |
| bq24045 | 1 | 30 | 6.6/7.1 | 1 | 4.35 | Stand Alone | Linear | Yes | Yes | | 10 | ✓ | | 0.45 |
| bq24050/52 | 1 | 30 | 6.6 | 0.8 | 4.2 | Stand Alone | Linear | Yes | Yes | | 10 | ✓ | JEITA Charging (100K NTC — bq24052) | 0.50 |
| bq24055 | 1 | 30 | 6.6 | 0.8 | 4.2 | Stand Alone | Linear | Yes | Yes | | 12 | ✓ | JEITA, PG Pin | 0.60 |
| bq24072/72T | 1 | 28 | 6.6 | 1.5 | 4.3 / 4.2 | Stand Alone | Linear | Yes | Yes | | 16 | ✓ | V _{OUT} tracks V _{BAT} , V _{IN_DPPM} | 1.00 |
| bq24073 | 1 | 28 | 6.6 | 1.5 | 4.2 | Stand Alone | Linear | Yes | Yes | | 16 | ✓ | V _{IN_DPPM} | 1.00 |
| bq24074 | 1 | 28 | 10.5 | 1.5 | 4.2 | Stand Alone | Linear | Yes | Yes | | 16 | ✓ | V _{IN_DPPM} | 1.00 |
| bq24075T/79T | 1 | 28 | 6.6 | 1.5 | 4.2/4.1 | Stand Alone | Linear | Yes | Yes | | 16 | ✓ | SYSOFF pin disconnects battery, V _{IN_DPPM} , powers system and charges battery | 1.00 |
| bq24090/91 | 1 | 12 | 6.6 | 1 | 4.2 | Stand Alone | Linear | Yes | Yes | | 10 | ✓ | 10K NTC (100K NTC — bq24091) | 0.40 |
| bq24092/93 | 1 | 12 | 6.6 | 1 | 4.2 | Stand Alone | Linear | Yes | Yes | | 10 | ✓ | JEITA, 10K NTC (JEITA, 100K NTC — bq24093) | 0.40 |
| bq24095 | 1 | 12 | 6.6 | 1 | 4.35 | Stand Alone | Linear | Yes | Yes | | 10 | ✓ | 10K NTC | 0.40 |
| bq24140 | 1 | 20 | 9.8 | 1.5 | Adj | ƒC | Switching | Yes | No | 30 | | ✓ | Simultaneous charge and USB OTG output | 1.60 |
| bq24153A/58 | 1 | 20 | 6.5 | 1.25 | 3.5 to 4.4 | ƒC | Switching | Yes | No | 20 | | ✓ | USB OTG supported with boost, no battery detect on power up (bq24158) | 0.95 |
| bq24156A/59 | 1 | 20 | 9.8 | 1.5 | 3.5 to 4.4 | ƒC | Switching | Yes | No | 20 | | ✓ | No battery detect on power up (bq24159) | 0.95 |
| bq24157 | 1 | 20 | 6.5 | 1.25 | 3.5 to 4.4 | ƒC | Switching | Yes | No | 20 | | ✓ | USB OTG supported with boost, no battery detect on power up, safety timer disabled | 0.90 |
| bq24160/A | 1 | 20 | 10.5/6.5(USB) | 2.5/1.5 | 3.5 to 4.4 | ƒC | Switching | Yes | Yes | 49 | 24 | ✓ | D+/D− detect, JEITA, 3-V V _{BAT_SHORT} | 1.95 |
| bq24161/B | 1 | 20 | 10.5/6.5(USB) | 2.5/1.5 | 3.5 to 4.4 | ƒC | Switching | Yes | Yes | 49 | | ✓ | USB selection pin, std temp | 1.95 |
| bq24163 | 1 | 20 | 10.5/6.5(USB) | 2.5/1.5 | 3.5 to 4.4 | ƒC | Switching | Yes | Yes | 49 | 24 | ✓ | D+/D− detect, JEITA | 1.95 |
| bq24165 | 1 | 20 | 10.5/6.5(USB) | 2.5/1.5 | 4.2 | Stand Alone | Switching | Yes | Yes | 49 | 24 | ✓ | I _{USB} 1/2/3 USB select, no temp monitor, JEITA | 1.95 |
| bq24166 | 1 | 20 | 10.5/6.5(USB) | 2.5/1.5 | 4.2 | Stand Alone | Switching | Yes | Yes | 49 | 24 | ✓ | I _{USB} 1/2/3 USB select, temp monitor, std temp | 1.95 |
| bq24167 | 1 | 20 | 10.5/6.5(USB) | 2.5/1.5 | 4.2 | Stand Alone | Switching | Yes | Yes | 49 | 24 | ✓ | I _{USB} 1/2/3 USB select, temp monitor, JEITA | 1.95 |
| bq24168 | 1 | 20 | 6.5/6.5(USB) | 2.5/1.5 | 3.5 to 4.4 | ƒC | Switching | Yes | Yes | 49 | 24 | ✓ | USB select pins, JEITA, no timers | 1.95 |
| bq24180 | 1 | 20 | 16.5 | 1.5 | 3.5 to 4.4 | ƒC | Switching | Yes | Yes | 25 | 24 | ✓ | Accessory power output | 1.00 |
| bq24185 | 1 | 20 | 16.5 | 1.5 | 3.5 to 4.4 | ƒC | Switching | Yes | Yes | 25 | 24 | ✓ | USB OTG supported with boost | 1.00 |
| bq24187 | 1 | 30 | 6.5 | 2.0 | 3.5 to 4.4 | ƒC | Switching | Yes | Yes | 36 | 24 | ✓ | PSEL detect, JEITA, Power Path, OTG | 1.75 |
| bq24190 | 1 | 20 | 18 | 4.5 | 3.5 to 4.4 | ƒC/Stand Alone | Switching | Yes | Yes | 24 | | ✓ | D+/D−, 1.3-A OTG, standard temp., 12-mΩ battery FET | 2.90 |
| bq24192 | 1 | 20 | 18 | 4.5 | 3.5 to 4.4 | ƒC/Stand Alone | Switching | Yes | Yes | 24 | | ✓ | PSEL, 1.3-A OTG, standard temp., 12-mΩ battery FET | 2.90 |
| bq24192I | 1 | 20 | 18 | 4.5 | 3.5 to 4.4 | ƒC/Stand Alone | Switching | Yes | Yes | 24 | | ✓ | PSEL, 1.3-A OTG, standard temp., 1-A default charging | 2.90 |
| bq24193 | 1 | 20 | 18 | 4.5 | 3.5 to 4.4 | ƒC/Stand Alone | Switching | Yes | Yes | 24 | | ✓ | PSEL, 1.3-A OTG, JEITA, 12-mΩ battery FET | 2.90 |
| bq24196 | 1 | 20 | 18 | 2.5 | 3.5 to 4.4 | ƒC/Stand Alone | Switching | Yes | Yes | 24 | | ✓ | PSEL, 1.3-A OTG, standard temp., 12-mΩ battery FET | 1.95 |
| bq24195L | 1 | 20 | 18 | 2.5 | 3.5 to 4.4 | ƒC/Stand Alone | Switching | Yes | Yes | 24 | | ✓ | D+/D−, 1.0-A synchronous boost for power bank | 2.90 |
| bq24195 | 1 | 20 | 18 | 4.5 | 3.5 to 4.4 | ƒC/Stand Alone | Switching | Yes | Yes | 24 | | ✓ | D+/D−, 2.1-A synchronous boost for power bank | 3.25 |
| bq24232 | 1 | 28 | 10.5 | 0.5 | 4.2 | Stand Alone | Linear | Yes | Yes | | 16 | ✓ | SYSOFF pin disconnects battery, V _{IN_DPPM} , powers system and charges battery | 1.00 |
| bq24232H | 1 | 28 | 10.5 | 0.5 | 4.35 | Stand Alone | Footnote 1 | Yes | Yes | | 16 | ✓ | Higher voltage battery pack flexibility (4.35 V), USB friendly, powers system and charges battery | 1.15 |
| bq24250/51 | 1 | 20 | 10.5 | 2.0 | 3.5 to 4.4 | ƒC/Stand Alone | Switching | Yes | Yes | 30 | 24 | ✓ | EN1-2 or D+/D− detection, JEITA, Power Path | 1.15 |
| bq24253 | 1 | 20 | 10.5 | 2.0 | 4.2 | Stand Alone | Switching | Yes | Yes | 30 | 24 | ✓ | D+/D− detection, JEITA, Power Path | 1.15 |
| bq24257 | 1 | 20 | 6.5 | 2.0 | 3.5 to 4.4 | ƒC/Stand Alone | Switching | Yes | Yes | 30 | 24 | ✓ | D+/D− detection, JEITA | 1.15 |
| bq24260 | 1 | 30 | 10.5 | 3.0 | 3.5 to 4.4 | ƒC | Switching | Yes | Yes | 36 | 24 | ✓ | D+/D− detect, JEITA, Power Path, OTG | 1.75 |
| bq24261 | 1 | 30 | 14 | 3.0 | 3.5 to 4.4 | ƒC | Switching | Yes | Yes | 36 | 24 | ✓ | PSEL detect, JEITA, Power Path, OTG | 1.75 |
| bq24262 | 1 | 30 | 6.5 | 3.0 | 3.5 to 4.4 | ƒC | Switching | Yes | Yes | 36 | 24 | ✓ | PSEL detect, JEITA, Power Path, OTG | 1.75 |
| bq24266 | 1 | 30 | 14 | 3.0 | 4.2 | Stand Alone | Switching | Yes | Yes | 24 | | ✓ | JEITA, Power Path, OTG | 1.75 |
| bq24270/71 | 1 | 20 | 6.5 | 1.5 | 3.5 to 4.4 | ƒC | Switching | Yes | Yes | 49 | 24 | ✓ | D+/D− detect or PSEL, JEITA, Power Path | 1.25 |
| bq24272 | 1 | 20 | 10.5 | 2.5 | 3.5 to 4.4 | ƒC | Switching | Yes | Yes | 49 | 24 | ✓ | Power Path | 1.25 |
| bq24273 | 1 | 20 | 10.5 | 2.5 | 3.5 to 4.4 | ƒC | Switching | Yes | Yes | 49 | | ✓ | non-Power Path | 1.25 |
| bq24278 | 1 | 20 | 10.5 | 2.5 | 4.2 | Stand Alone | Switching | Yes | Yes | 49 | 24 | ✓ | Input current limit programming input | 1.25 |
| bq25040 | 1 | 30 | 6.9 | 1.1 | 4.2 | Stand Alone | Linear | Yes | Yes | | 10 | ✓ | USB compliant w/50-mA integrated LDO | 0.55 |
| bq25050 | 1 | 30 | 6.5 | 1 | 4.2 | Single Wire | Linear | Yes | Yes | | 10 | ✓ | Single-wire interface | 0.60 |
| bq25060 | 1 | 30 | 10.5 | 1 | 4.2 | Stand Alone | Linear | Yes | Yes | | 10 | ✓ | USB compliant w/50-mA integrated LDO | 0.65 |

¹Linear/Switch-Mode/CC/CV

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

New devices are listed in bold red.

Battery Management Products

Battery Chargers

Selection Guide (Continued)

| Device | Number of Cells | V _{IN} Absolute Max (V) | V _{IN} OVP (V) | Charge Current (A) | Charge Voltage (V) | Control Interface | Topology | Integrated Power FET | Temperature Monitor | Packaging | | | EVM | Comments | Price* |
|--|-----------------|----------------------------------|-------------------------|--------------------|--------------------|-------------------|-----------|----------------------|---------------------|-----------|---------|--|-----|---|--------|
| | | | | | | | | | | WCSOP | QFN/MLP | | | | |
| Multi-Chemistry (Li-Ion or NiCd/NiMH) (Continued) | | | | | | | | | | | | | | | |
| bq25100 | 1 | 30 | 6.5 | 0.25 | 4.2 | Stand Alone | Linear | Yes | Yes | 6 | | | ✓ | Small solution with 1-mA termination support and extremely low battery leakage | 0.75 |
| bq25100A | 1 | 30 | 6.5 | 0.25 | 4.3 | Stand Alone | Linear | Yes | Yes | 6 | | | — | Small solution with 1-mA termination support and extremely low battery leakage | 0.75 |
| bq25100H | 1 | 30 | 6.5 | 0.25 | 4.35 | Stand Alone | Linear | Yes | Yes | 6 | | | — | Small solution with 1-mA termination support and extremely low battery leakage | 0.75 |
| bq25101 | 1 | 30 | 6.5 | 0.25 | 4.2 | Stand Alone | Linear | Yes | Yes | 6 | | | — | Small solution with 1-mA termination support and extremely low battery leakage. Charge pin indication | 0.75 |
| bq24130 | 1 to 3 | 20 | Adj | 4 | Adj | I ² C | Switching | Yes | Yes | | 20 | | ✓ | Host control, supports Li-Ion and Super Cap | 1.95 |
| bq24133 | 1 to 3 | 20 | Adj | 2.5 | 4.2/Cell | Stand Alone | Switching | Yes | Yes | | 24 | | ✓ | Power Path | 1.75 |
| bq24170 | 1 to 3 | 20 | Adj | 4 | 4.2/Cell | Stand Alone | Switching | Yes | Yes | | 24 | | ✓ | Power Path | 1.80 |
| bq24171 | 1 to 3 | 20 | Adj | 4 | Adj | Stand Alone | Switching | Yes | Yes | | 24 | | ✓ | JEITA, Power Path | 1.80 |
| bq24172 | 1 to 3 | 20 | Adj | 4 | Adj | Stand Alone | Switching | Yes | Yes | | 24 | | ✓ | Adjustable charge voltage, Power Path | 1.80 |
| bq24707A | 1 to 4 | 30 | Adj | 8 | Adj | SMBus | Switching | No | No | | 20 | | ✓ | Programmable switching frequency | 2.90 |
| bq24735 | 1 to 4 | 30 | Adj | 8 | Adj | SMBus | Switching | No | No | | 20 | | ✓ | Intel CPU Turbo Mode support | 3.00 |
| bq24617 | 1 to 5 | 33 | 32 | 10 (Ext) | Adj | Stand Alone | Switching | No | Yes | | 24 | | ✓ | 600 kHz | 2.75 |
| bq24600 | 1 to 6 | 33 | 32 | 10 (Ext) | Adj | Stand Alone | Switching | No | Yes | | 16 | | ✓ | 1200 kHz | 2.00 |
| bq24610 | 1 to 6 | 33 | 32 | 10 (Ext) | Adj | Stand Alone | Switching | No | Yes | | 24 | | ✓ | 600 kHz | 2.75 |
| bq24616 | 1 to 6 | 33 | 32 | 10 (Ext) | Adj | Stand Alone | Switching | No | Yes | | 24 | | ✓ | JEITA | 2.75 |
| bq24618 | 1 to 6 | 33 | 32 | 10 (Ext) | Adj | Stand Alone | Switching | No | Yes | | 24 | | ✓ | USB V _{IN} and adapter | 2.75 |
| bq24715 | 2 to 3 | 30 | 26 | 8 | Adj | SMBus | Switching | No | No | | 20 | | ✓ | NVDC charger | 2.25 |
| bq24725A | 2 to 4 | 30 | Adj | 8 | Adj | SMBus | Switching | No | No | | 20 | | ✓ | Programmable switching frequency, enhanced safety, battery learn | 2.00 |

| Device | Number of Cells | V _{IN} Absolute Max (V) | V _{IN} OVP (V) | Charge Current (A) | Charge Voltage (V) | Control Interface | Topology | Integrated Power FET | Temperature Monitor | Packaging | | | EVM | Comments | Price* | |
|---|-----------------|----------------------------------|-------------------------|--------------------|--------------------|-------------------|-----------------|----------------------|---------------------|-----------|-------|------|-----|----------|---|------|
| | | | | | | | | | | QFN/MLP | TSSOP | SOIC | | | | DIP |
| Solar/Energy Harvesting (Li-Ion) | | | | | | | | | | | | | | | | |
| bq24210 | 1 | 20 | 7.7 | 0.800 | 4.2 | Stand Alone | Linear | Yes | Yes | 10 | | | | ✓ | Solar panel V _{IN} | 1.10 |
| bq25504 | 1 | 5.5 | Adj | 0.1 | 2.5 to 5.25 | Stand Alone | Boost | Yes | Yes | 16 | | | | ✓ | Energy harvester, ultra-low power and quiescent current, high efficiency, dynamic MPPT | 2.10 |
| bq25505 | 1 | 5.5 | Adj | 0.1 | 2.5 to 5.25 | Stand Alone | Boost | Yes | Yes | 16 | | | | ✓ | Energy harvester, 330-nA ultra-low power and quiescent current, high efficiency, dynamic MPPT, autonomous power-path multiplexing | 2.40 |
| bq25570 | 1 | 5.5 | Adj | 0.1 | 2.5 to 5.25 | Stand Alone | Boost-Buck | Yes | Yes | 16 | | | | ✓ | Energy harvester, <488-nA ultra-low power and quiescent current, high efficiency, dynamic MPPT | 2.90 |
| bq24650 | 1 to 6 | 33 | 32 | 10 (Ext) | Adj | Stand Alone | Switching | No | Yes | 16 | | | | ✓ | Max power point tracking (MPPT) | 2.85 |
| LiFePO₄ | | | | | | | | | | | | | | | | |
| bq25070 | 1 | 30 | 10.5 | 1 | 3.5 | Stand Alone | Linear | Yes | Yes | 10 | | | | ✓ | LiFePO ₄ , 50-mA LDO | 0.75 |
| bq25071 | 1 | 30 | 10.5 | 1 | 3.5 | Stand Alone | Linear | Yes | Yes | 10 | | | | ✓ | Standard one charger solution for LiFePO ₄ and 50-mA LDO | 0.75 |
| bq24620 | 1 to 7 | 33 | 32 | 10 (Ext) | Adj | Stand Alone | Switching | No | Yes | 16 | | | | ✓ | LiFePO ₄ , 300 kHz | 2.90 |
| bq24630 | 1 to 7 | 33 | 32 | 10 (Ext) | Adj | Stand Alone | Switching | No | Yes | 24 | | | | ✓ | LiFePO ₄ , 300 kHz, power selector | 2.90 |
| Super Cap | | | | | | | | | | | | | | | | |
| bq24640 | 1 to 9 | 33 | 32 | 10 (Ext) | Adj | Stand Alone | Switching | No | Yes | 16 | | | | ✓ | SuperCap | 2.90 |
| NiCd/NiMH Chemistry | | | | | | | | | | | | | | | | |
| bq2002/C/E/F | Multiple | 7 | — | >2 | 6 | Stand Alone | Current-limited | No | Yes | | | 8 | 8 | — | Trickle charge | 0.85 |
| bq2004/E/H | Multiple | 7 | — | >2 | 5.5 | Stand Alone | Switching | No | Yes | | | 16 | 16 | — | Selectable timers and pulse-trickle rates | 2.15 |
| bq2005 | Multiple | 7 | — | >2 | 5.5 | Stand Alone | Switching | No | Yes | | | 20 | 20 | — | Sequential fast charge of two battery packs | 2.15 |
| bq24400/1 | Multiple | 7 | — | >2 | 5.5 | Stand Alone | Switching | No | Yes | | 8 | 8 | — | | | 1.55 |

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

New devices are listed in bold red.

Battery Management Products

Battery Chargers

Selection Guide (Continued)

| Device | Number of Cells | V _{IN} Absolute Max (V) | V _{IN} OVP (V) | Charge Current (A) | Charge Voltage (V) | Control Interface | Topology | Integrated Power FET | Temperature Monitor | Packaging | | | | EVM | Comments | Price* | |
|---|-----------------|----------------------------------|-------------------------|--------------------|--------------------|-------------------|-----------|----------------------|---------------------|-----------|-------|------|-----|-----|--|--|------|
| | | | | | | | | | | QFN/MLP | TSSOP | SOIC | DIP | | | | |
| Lead-Acid Chemistry | | | | | | | | | | | | | | | | | |
| bq24450 | Multiple | 40 | — | >2 | — | Stand Alone | Linear | No | No | | | 16 | 16 | — | Temp-compensated internal reference | 2.75 | |
| bq2031 | Multiple | 7 | — | >2 | — | Stand Alone | Switching | No | 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 | Multiple | 7 | — | — | — | Stand Alone | Switching | Yes | Yes | | | 8 | 8 | 8 | ✓ | Charges NiCd, NiMH, and Li-Ion | 1.50 |
| bq24650 | 1 to 6 | 33 | 32 | 10 (Ext) | Adj | Stand Alone | Switching | No | Yes | 16 | | | | | ✓ | Max power point tracking | 2.85 |
| bq24765 | 2 to 4 | 30 | — | — | — | Stand Alone | Switching | Yes | No | 34 | | | | | ✓ | SMBus charger with integrated power FETs | 3.95 |

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

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

| Device | Standard | Output Current (A) | Output Voltage (V) | Function | V _{IN} Absolute Max (V) | Control Interface | Integrated FET | Temperature Monitor | Package | Chip Scale (mm) | EVM | Comments | Price* |
|---------------------------------|------------------|--------------------|--------------------|-----------------|----------------------------------|-------------------|----------------|---------------------|---------|-----------------|-----|---|--------|
| Wireless Power Receivers | | | | | | | | | | | | | |
| bq51003 | WPC v1.1 | 0.5 | 5 | Power Supply | 20 | Stand Alone | Yes | Yes | CSP | 3x2x0.5 | ✓ | 2.5-W WPC v1.1 receiver solution for wearable applications | 1.30 |
| bq51013B | WPC v1.1 | 1 | 5 | Power Supply | 20 | Stand Alone | Yes | Yes | QFN | 3x2x0.5 | ✓ | 5-W WPC v1.1 receiver solution | 1.50 |
| bq51050B/51B | WPC v1.1 | 1 | 4.2/4.35 | Battery Charger | 20 | Stand Alone | Yes | Yes | QFN | 3x2x0.5 | ✓ | 5-W direct battery charger, WPC v1.1 receiver solution | 1.90 |
| bq51010B | WPC v1.1 | 1 | 7 | Power Supply | 20 | Stand Alone | Yes | Yes | QFN | 3x2x0.5 | ✓ | 5-W WPC v1.1 receiver solution with 7-V outputs for reduced power loss | 1.70 |
| bq51020 | WPC v1.1 | 1.5 | Adj (4-8) | Power Supply | 20 | Stand Alone | Yes | Yes | CSP | 3.6x2.9x0.5 | ✓ | High-efficiency, 5-W WPC v1.1 receiver solution with adjustable output voltage | 2.50 |
| bq51021 | WPC v1.1 | 1.5 | Adj (4-8) | Power Supply | 20 | I ² C | Yes | Yes | CSP | 3.6x2.9x0.5 | ✓ | High-efficiency, 5-W WPC v1.1 receiver solution with adjustable output voltage and I ² C control | 2.60 |
| bq51221 | WPC v1.1/ PMA | 1.5 | Adj (4-8) | Power Supply | 20 | I ² C | Yes | Yes | CSP | 3.6x2.9x0.5 | ✓ | Dual-mode, high-efficiency, 5-W WPC v1.1 and PMA receiver solution | 3.00 |
| bq51025 | WPC v1.1 | 2 | Adj (4.5-10) | Power Supply | 20 | I ² C | Yes | Yes | — | 3.6x2.9x0.5 | ✓ | Low WPC v.1.1 receiver to be used with the bq500215 | 4.00 |

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

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

| Device | Standard | Coil Type | Number of Coils Supported | V _{IN} (V) | Power (W) | Dynamic Power Limit | Automotive Qualified | Comments | Price* |
|------------------------------------|----------|-----------|---------------------------|---------------------|-----------|---------------------|----------------------|--|--------|
| Wireless Power Transmitters | | | | | | | | | |
| bq500210 | WPC v1.0 | A1/A10 | 1 | 19 | 5 | No | No | WPC v1.0 transmitter solution for 19-V systems | 1.90 |
| bq500212A | WPC v1.1 | A5/A11 | 1 | 5 | 5 | Yes | No | Latest WPC v1.1, 5-V transmitter with reduced BOM and improved, simplified FOD | 2.00 |
| bq500412 | WPC v1.1 | A6 | 1,2,3 | 12 | 5 | Yes | No | Latest WPC v1.1, A6 transmitter with reduced BOM and improved, simplified FOD | 2.10 |
| bq500414Q | WPC v1.1 | A6 | 1,2,3 | 12 | 5 | No | Yes | AEC-Q100-qualified A6 transmitter for automotive applications | 3.40 |
| bq500215 | WPC v1.1 | A29 | 1 | 12 | 5 | No | No | WPC v1.1 receiver to be used with the bq51025 | 4.00 |

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

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

For a complete list of resources, visit: www.ti.com/chargers or www.ti.com/wirelesspower

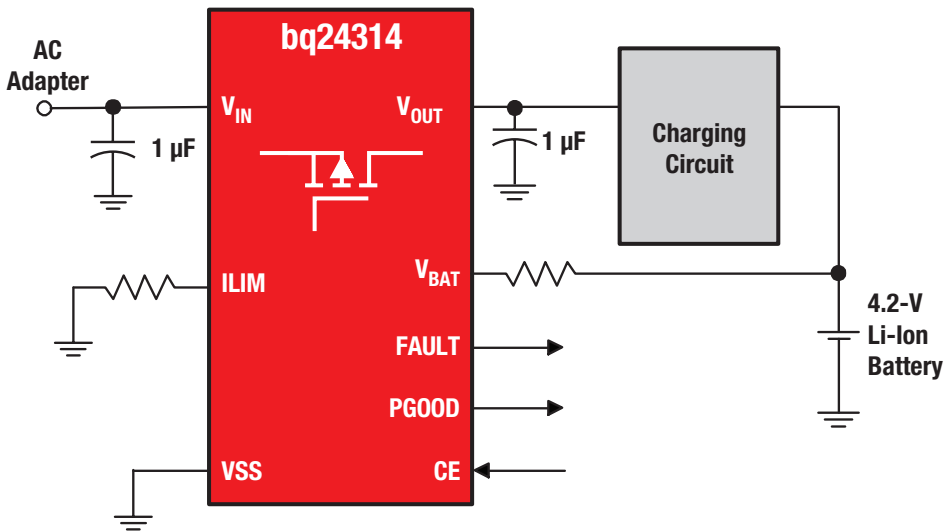
Battery Management Products

Battery Charger Protection

Li+ Charger Front-End Protection IC

bq24314

Charger front-end protection devices 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 device 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 µs)
 - User-programmable overcurrent with current limiting
 - Battery overvoltage

Applications

- Mobile phones and smartphones
- Portable navigation devices
- MP3 players
- Low-power handheld devices
- Bluetooth® headsets

Get more information: www.ti.com/product/bq24314

Selection Guide

| Device | V _{IN} Max (V) | OVP (V) | OCP | Battery OVP (V) | LDO Output (V) | Max Operating Current (µA) | 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 | 0.30 |
| bq24308 | 30 | 6.3 | Fixed 700 mA or Prog. <1.5 A | 4.35 | 5 | 500 | 8-QFN/SON | ✓ | Reverse polarity protection | 0.30 |
| bq24312 | 30 | 5.85 | Prog. <1.5 A | 4.35 | — | 500 | 8/12-QFN/SON | — | Fault indication | 0.35 |
| bq24313 | 11 | 10.5 | Prog. <1.5 A | 4.35 | — | 500 | 8/12-QFN/SON | — | Fault indication | 0.35 |
| bq24314/A | 30 | 5.85 | Prog. <1.5 A | 4.35 | — | 600 | 8/12-QFN/SON | ✓ | Fault indication | 0.35 |
| bq24314C | 30 | 5.85 | Prog. <1.5 A | 4.45 | — | 600 | 8/12-QFN/SON | ✓ | Fault indication | 0.35 |
| bq24315 | 30 | 5.85 | Prog. <1.5 A | 4.35 | 5.5 | 600 | 8-QFN/SON | ✓ | Fault indication | 0.35 |
| bq24316 | 30 | 6.8 | Prog. <1.5 A | 4.35 | — | 600 | 8/12-QFN/SON | ✓ | Fault indication | 0.35 |
| bq24380 | 30 | 6.3 | No OCP | 4.35 | 5.5 | 250 | 8-QFN/SON | ✓ | Fault indication | 0.25 |
| bq24381 | 30 | 7.1 | No OCP | 4.35 | 5 | 300 | 8-QFN/SON | ✓ | Fault indication | 0.25 |
| bq24382 | 30 | 10.5 | No OCP | 4.35 | 5 | 300 | 8-QFN/SON | — | Fault indication | 0.25 |
| bq24350 | 30 | 6.17 | Fixed 1.2 A | 4.35 | 5.5 | 500 | 8-QFN/SON | ✓ | Integrated charge FET | 0.40 |
| bq24351 | 30 | 10.5 | Fixed 1.2 A | 4.35 | 6.38 | 500 | 8-QFN/SON | ✓ | Integrated charge FET | 0.40 |
| bq24352 | 30 | 7.1 | Fixed 1.2 A | 4.35 | 5.5 | 500 | 8-QFN/SON | ✓ | Integrated charge FET | 0.40 |

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

Battery Management Products

Battery Fuel Gauges—Single-Cell Solutions

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 gauge. Designers can choose to implement the

gauge in the host system or inside the 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.

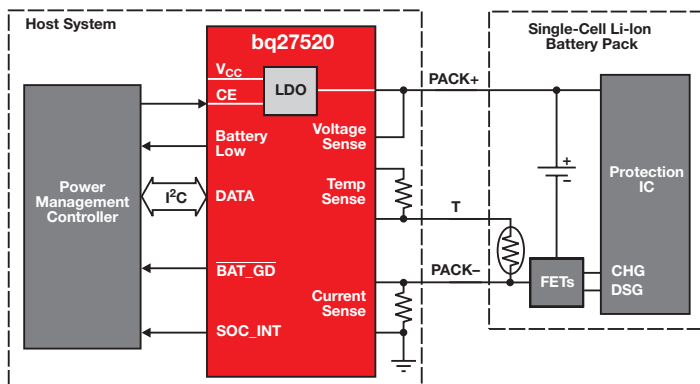
Available features:

- 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

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 either embedded or removable standard battery packs 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.



Get more information: www.ti.com/product/bq27520

Key Features

- Interrupt-generation capability reduces software burden on the system processor
- Patented Impedance Track™ algorithm for fuel gauging provides information such as remaining battery capacity, state of charge, minimum run time to empty, battery voltage, temperature and state of health.
- Requires only PACK+ (P+), PACK- (P-) and thermistor (T) connections to a removable battery pack or embedded battery circuit

Selection Guide

| Device | Min Max Series Cell | SHA-1 Authentication | System or Pack | Communication Protocol | Other Features | Package | Price* |
|---|---------------------|----------------------|----------------|------------------------|--|-------------|--------|
| Lithium-Ion, Lithium-Polymer Chemistry | | | | | | | |
| bq27411-G1 | 1 | — | Pack | I ² C | Pack-side Impedance Track™ fuel gauge/battery gas gauge | 12-pin SON | 1.15 |
| bq27541-G1 | 1 | Yes | Pack | I ² C/HDQ | Pack-side fuel gauge with Impedance Track technology | 12-pin SON | 1.45 |
| bq27742-G1 | 1 | Yes | Pack | I ² C/HDQ | Single-cell Li-Ion battery fuel gauge with integrated protection | 15-pin CSP | 1.45 |
| bq27621-G1 | 1 | — | System | I ² C | System-side fuel gauge with dynamic voltage correlation battery gas gauge | 9-pin CSP | 1.10 |
| bq27441-G1 | 1 | — | System | I ² C | System-side Impedance Track battery fuel gauge | 12-pin SON | 1.15 |
| bq27421 | 1 | — | System | I ² C | System-side fuel gauge with Impedance Track technology with integrated sense resistor | 9-pin CSP | 1.40 |
| bq27425 | 1 | — | System | I ² C | System-side fuel gauge with Impedance Track Lite technology with integrated sense resistor | 15-ball CSP | 1.40 |
| bq27510-G3 | 1 | — | System | I ² C | System-side fuel gauge with Impedance Track technology with integrated LDO | 12-pin SON | 1.45 |
| bq27520-G4 | 1 | — | System | I ² C | System-side fuel gauge with Impedance Track technology with integrated LDO | 15-ball CSP | 1.50 |
| bq2753x | 1 | — | System | I ² C | Impedance Track technology fuel gauge with charger control | 15-pin CSP | 1.80 |

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

New devices are listed in bold red.

Battery Management Products

Battery Fuel Gauges—Multi-Cell Solutions

Design Factors

Battery Chemistry — Each battery chemistry has different operating characteristics, such as discharge profiles and self-discharge rate. TI gas gauge devices 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

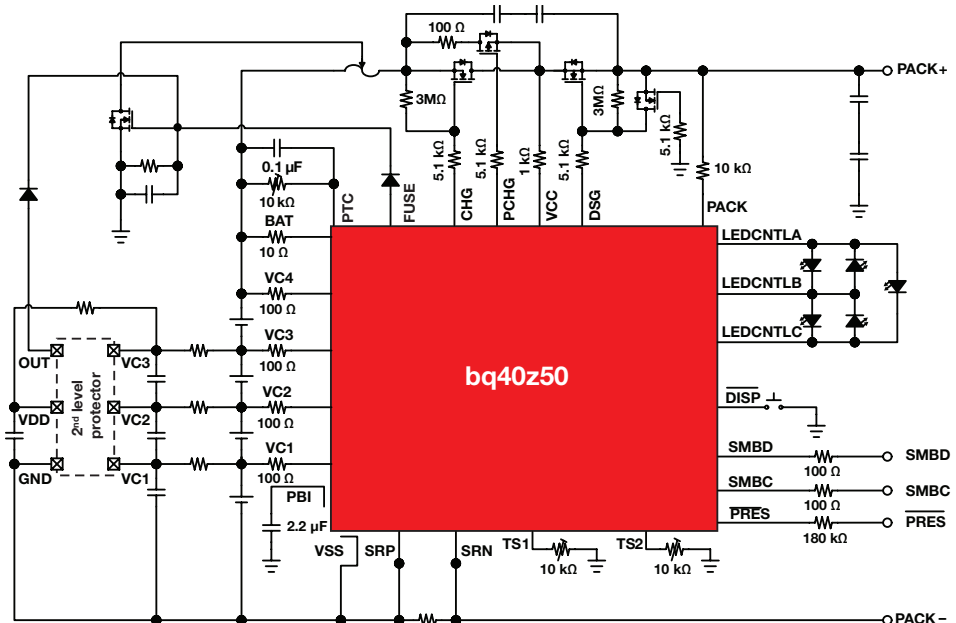
bq40z50

The bq40z50 device, incorporating patented Impedance Track™ technology, is a fully-integrated, single-chip, pack-based solution that provides a rich array of features for gas gauging, protection, and authentication for 1-series, 2-series, 3-series, and 4-series cell Li-Ion and Li-Polymer battery packs.

Using its integrated high-performance analog peripherals, the bq40z50 device measures and maintains an accurate record of available capacity, voltage, current, temperature, and other critical parameters in Li-Ion or Li-Polymer batteries, and reports this information to the system host controller over an SMBus v1.1 compatible interface.

Applications

- Notebook/ netbook PCs
- Medical and test equipment
- Portable instrumentation



Get more information: www.ti.com/product/bq40z50

Multi-Cell Fuel Gauges Selection Guide

| Device | Approx. Battery Capacity (mAh) | Min Max Series Cell | Number of LEDs | Communication Protocol | Other Features | Package | Price* |
|---|--------------------------------|---------------------|----------------|-------------------------|--|--------------|--------|
| Lithium-Ion, Lithium-Polymer, LiFePO₄ Chemistry | | | | | | | |
| bq3060 | 500 to 32000 | 2 to 4 | — | SMBus | CEDV+ gas gauge with integrated protector | 24-pin TSSOP | 3.55 |
| bq40z50 | 500 to 32000 | 1 to 4 | 3, 4, or 5 | SMBus | Fully integrated, single-chip, pack-based solution with protection and authentication with SHA-1 encryption and features high-side N-channel FET drive | 32-pin QFN | 3.45 |
| bq20z655-R1 | 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 |
| bq34z950 | 800 to 32000 | 2 to 4 | 3, 4 or 5 | SMBus or HDQ | Gas gauge and protection with Impedance Track technology | 44-pin TSSOP | 2.30 |
| bq78350 | — | 3 to 15 | 1 to 5 | SMBus | CEDV Li-Ion and LiFePO ₄ battery management controller that is companion to bq769x0 family | 30-pin TSSOP | 2.20 |
| Lead Acid Chemistry | | | | | | | |
| bq34z110 | Up to 650 Ah | 1 to 16 | 4 | I ² C or HDQ | Wide-range fuel gauge with Impedance Track technology | 14-pin TSSOP | 3.90 |
| Super Cap | | | | | | | |
| bq33100 | — | 2 to 5 | — | SMBus | Fully integrated 2, 3, 4 and 5 series super capacitor manager | 24-pin TSSOP | 4.20 |

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

New devices are listed in bold red.

Battery Management Products

Battery Fuel Gauges—Multi-Cell Solutions

Multi-Cell Fuel Gauges Selection Guide

| Device | Approx. Battery Capacity (mAh) | Min Max Series Cell | Number of LEDs | Communication Protocol | Other Features | Package | Price* |
|-------------------------|--------------------------------|---------------------|----------------|------------------------|---|----------------------------|--------|
| Battery Monitors | | | | | | | |
| bq76920 | — | 3 to 5 | — | I ² C | Battery monitor with digital I ² C interface, integrated ADCs and hardware protection | 20-pin TSSOP | 1.50 |
| bq76930 | — | 6 to 10 | — | I ² C | Battery monitor with digital I ² C interface, integrated ADCs and hardware protection | 30-pin TSSOP | 2.75 |
| bq76940 | — | 9 to 15 | — | I ² C | Battery monitor with digital I ² C interface, integrated ADCs and hardware protection | 44-pin TSSOP | 3.95 |
| bq76925 | — | 3 to 6 | — | I ² C | Battery monitor with analog voltage output and hardware short circuit detection | 20-pin TSSOP or 24-pin QFN | 0.99 |
| bq76PL536A | — | 3 to 192 | — | SPI | 3-6S EV and UPS stackable analog front-end with integrated precision ADC and SPI interface, AEC-100 qualified | 64-pin HTQFP | 6.30 |
| bq77PL900 | — | 5 to 10 | — | I ² C | Dual-mode analog front-end and standalone voltage, current and temperature pack protector | 48-pin SSOP | 2.95 |

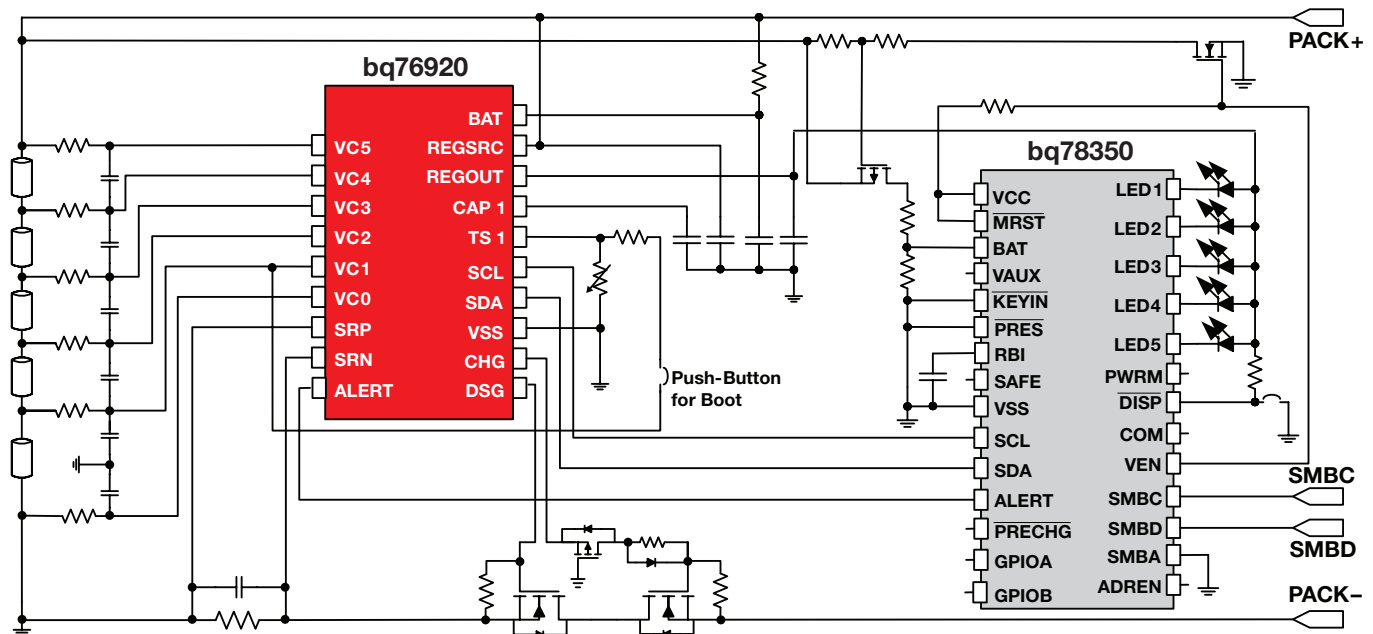
*Suggested resale price in U.S. dollars in quantities of 1,000.

New devices are listed in bold red.

Li-Ion and Li-Phosphate Battery Monitors

bq769x0

The bq769x0 family of robust analog front-end (AFE) devices serves as part of a complete pack monitoring and protection solution for next-generation, high-power systems. Typical applications are light electric vehicles, power tools, and uninterruptible power supplies. The bq769x0 is designed with low power in mind. The bq76920 device supports up to 5-series cells or typical 18-V packs; the bq76930 handles up to 10-series cells or typical 36-V packs; and the bq76940 works for up to 15-series cells or typical 48-V packs. A variety of battery chemistries may be managed with these AFEs, including Lithium Ion, Lithium iron phosphate, and more.



Find out more information about the bq769x0 family at www.ti.com/bmsindustrial

Battery Management Products

Battery and Peripheral Authentication

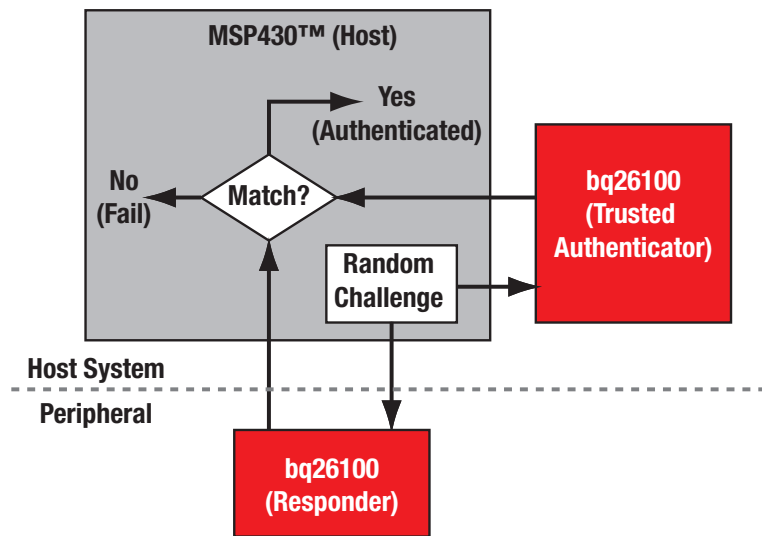
Design Factors

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



Single-cell battery pack with gas gauge and authentication.

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 |
| bq2026 | SDQ | 3 | CRC | -20 to 70 | 0.90 |
| bq26100 | SDQ | 5 | SHA-1 encryption | -20 to 70 | 0.99 |
| bq27541 | I ² C/HDQ | 12 | SHA-1 encryption | -40 to 85 | 1.45 |
| bq27742 | I ² C/HDQ | 15 | SHA-1 | -40 to 85 | 1.45 |
| bq2028 | HDQ | 12 | ID number | -40 to 85 | 1.10 |
| bq40z50 | SMB | 32 | SHA-1 | -40 to 85 | 3.45 |

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

Battery Management Products

Battery (Li-Ion) Protection Solutions

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 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 μA enables extended battery life
- 50 mV precision internally trimmed thresholds maximize safety
- Short-circuit protection eliminates the need for an external fuse

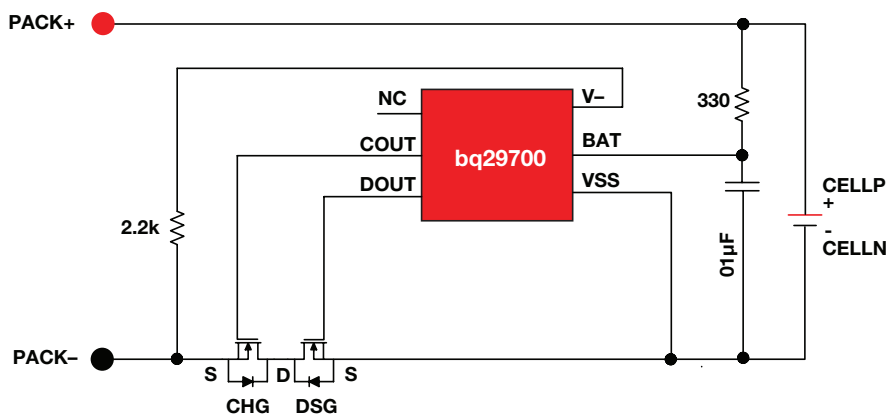
Single-Cell Primary Protector

bq29700

The bq297xy battery cell protection device provides an accurate monitor and trigger threshold for overcurrent protection during high discharge/charge current operation or battery overcharge conditions.

Key Features

- VSS 0.3-V to 12-V input voltage range pack+
- Control external charge and discharge FETs
- Voltage sensing across external FETs for overcurrent protection within ± 5 mV (typical)
- Power delivery interruption during fault condition using FET control circuitry (COUT/DOUT output)
- Zero voltage charging for depleted battery
- Low current consumption = 4 μA (typical)



Get more information: www.ti.com/product/bq29700

Selection Guide

| Device | Number of Series Cells | Other Features | Package(s) | Price* |
|-----------------|------------------------|--|------------|--------|
| bq29200 | 2 | Voltage protector with cell balancing | 8-pin SON | 0.30 |
| bq2945xx | 2 to 3 | Voltage protector with internal pre-programmed delay timer | 6-pin SON | 0.40 |
| bq2946xy | 1 | Overvoltage safety for chemical fuse activation | 6-pin SON | 0.38 |
| bq29700 | 1 | Voltage and current protector with low-side NFET drive | 6-pin SON | 0.26 |
| bq771600 | 2 to 4 | Voltage protector with capacitor-programmed delay timer | 8-pin QFN | 0.51 |
| bq771800 | 2 to 5 | Voltage protector with internal pre-programmed delay timer | 8-pin QFN | 0.79 |

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

New devices are listed in bold red.

Battery Management Products

Wireless Power

A wireless power system consists of a transmitter (charging pad) and a receiver (mobile device). Both contain a coil and electronics. Power is transferred wirelessly between the coils via inductive coupling. These systems are typically used for charging batteries in mobile devices, or powering subsystems.

Design Factors

Coil System – There are many types of coil systems. The specific type of coil system is dependent on the wireless power standard being used. Usually, the coil system consists of the coil and a magnetic shield to localize the magnetic field.

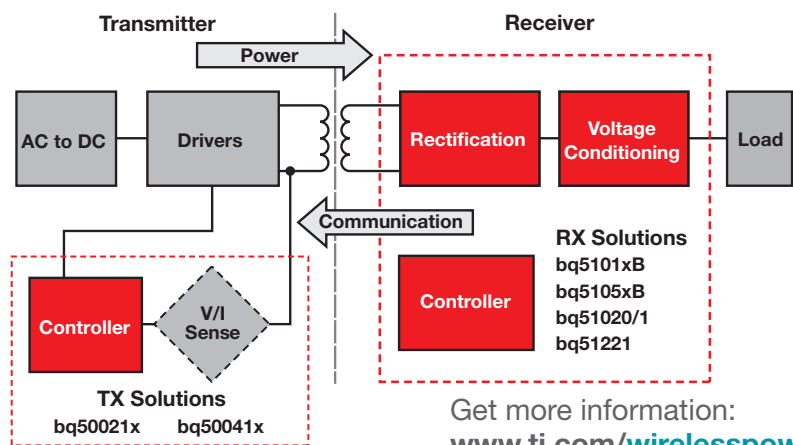
Interoperability – Compliance to a particular standard ensures that devices can be used with compatible devices from different manufacturers. Certain applications may not need to conform to a standard. TI's wireless power solutions can be used to design compliant as well as non-compliant solutions.

Power Requirements – Requirements for power vary from one mobile device to another. Most handheld consumer devices need between 1 and 5 W for operation. TI has multiple solutions to meet these power levels. Usually, the particular standard selected also dictates the power level allowed to be transferred.

Communication and Control – To safely control power transfer, it is critical that a communication scheme between the transmitter and receiver is built-in.

Communication of control and status includes data such as the amount of power to send, start power transfer and stop power transfer. This communications data is exchanged through the same coils that couple the power.

High Level of Integration – In space-constrained applications, a high level of integration is required. TI's transmitter and receiver solutions are very highly integrated with small footprints.



Get more information:
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.

Selection Guide

| Device | Standard | Output Current (A) | Output Voltage (V) | Function | V _{IN} Absolute Max (V) | Control Interface | Integrated FET | Temperature Monitor | Package | Chip Scale (mm) | EVM | Comments | Price* |
|---------------------------------|------------------|--------------------|--------------------|-----------------|----------------------------------|-------------------|----------------|---------------------|---------|-----------------|-----|---|--------|
| Wireless Power Receivers | | | | | | | | | | | | | |
| bq51003 | WPC v1.1 | 0.5 | 5 | Power Supply | 20 | Stand Alone | Yes | Yes | CSP | 3x2x0.5 | ✓ | 2.5-W WPC v1.1 receiver solution for wearable applications | 1.30 |
| bq51013B | WPC v1.1 | 1 | 5 | Power Supply | 20 | Stand Alone | Yes | Yes | QFN | 3x2x0.5 | ✓ | 5-W WPC v1.1 receiver solution | 1.50 |
| bq51050B/51B | WPC v1.1 | 1 | 4.2/4.35 | Battery Charger | 20 | Stand Alone | Yes | Yes | QFN | 3x2x0.5 | ✓ | 5-W direct battery charger, WPC v1.1 receiver solution | 1.90 |
| bq51010B | WPC v1.1 | 1 | 7 | Power Supply | 20 | Stand Alone | Yes | Yes | QFN | 3x2x0.5 | ✓ | 5-W WPC v1.1 receiver solution with 7-V outputs for reduced power loss | 1.70 |
| bq51020 | WPC v1.1 | 1.5 | Adj (4-8) | Power Supply | 20 | Stand Alone | Yes | Yes | CSP | 3.6x2.9x0.5 | ✓ | High-efficiency, 5-W WPC v1.1 receiver solution with adjustable output voltage | 2.50 |
| bq51021 | WPC v1.1 | 1.5 | Adj (4-8) | Power Supply | 20 | I ² C | Yes | Yes | CSP | 3.6x2.9x0.5 | ✓ | High-efficiency, 5-W WPC v1.1 receiver solution with adjustable output voltage and I ² C control | 2.60 |
| bq51221 | WPC v1.1/ PMA | 1.5 | Adj (4-8) | Power Supply | 20 | I ² C | Yes | Yes | CSP | 3.6x2.9x0.5 | ✓ | Dual-mode, high-efficiency, 5-W WPC v1.1 and PMA receiver solution | 3.00 |
| bq51025 | WPC v1.1 | 2 | Adj (4.5-10) | Power Supply | 20 | I ² C | Yes | Yes | – | 3.6x2.9x0.5 | ✓ | Low WPC v1.1 receiver to be used with the bq500215 | 4.00 |

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

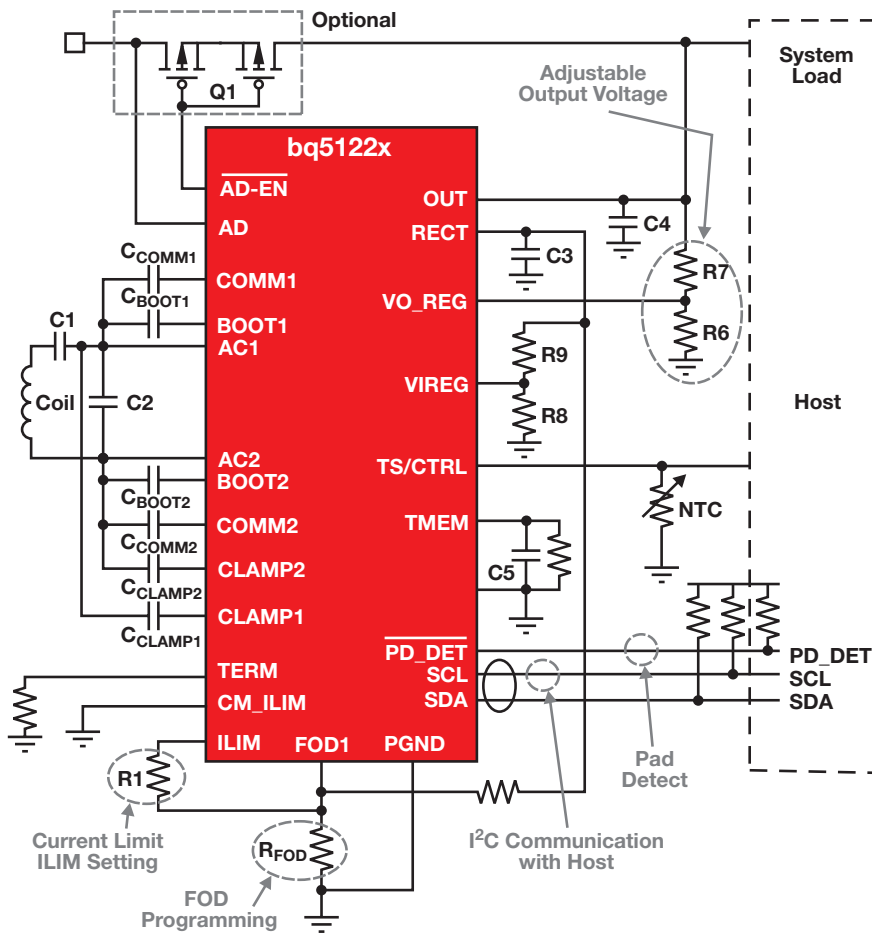
New devices are listed in **bold red**.
Preview devices are listed in **bold teal**.

Battery Management Products

Wireless Power

Dual-Mode/WPC, 5-W Single-Chip Wireless Power Receiver

bq51221, bq51021, bq51020

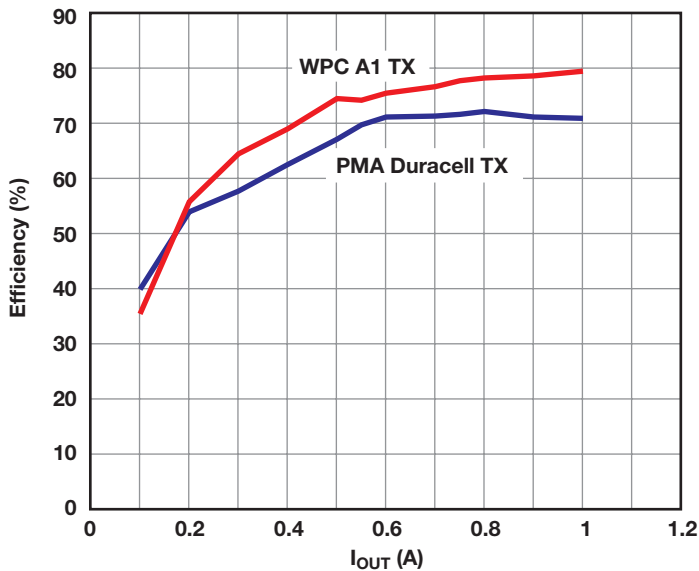


Key Features

- WPC v1.1 compliant receivers (bq51221 receiver is also PMA compliant and automatically switches to correct protocol in dual-mode)
- 5-W operation ensures faster charging and minimizes heat loss
- Adjustable output voltage (4.5 to 8 V) allows output to be optimized to the system to reduce power dissipation
- Linear versus switching post regulator means a large external inductor is not needed
- Pad-detect feature improves user experience
- I²C interface adds design flexibility and provides unique features such as programmable current limit
- Smallest solution size for 5-W system allows all electronics to fit into less than 75 mm²
- bq51020 and bq51021 are WPC-only versions of this device
- Package: 3.6x2.9x0.5-mm CSP

Applications

- Smartphones
- Tablets and headsets
- Wi-Fi hotspots
- Power banks
- Other handheld devices



bq51221 WPC and PMA efficiency for dual-mode implementation.

Get more information: www.ti.com/product/bq51221, [bq51021](http://www.ti.com/product/bq51021) or [bq51020](http://www.ti.com/product/bq51020)

www.ti.com/tool/bq51221EVM-520 or www.ti.com/tool/bq51020EVM-520

Battery Management Products

Wireless Power

Transmitter-Side Solutions

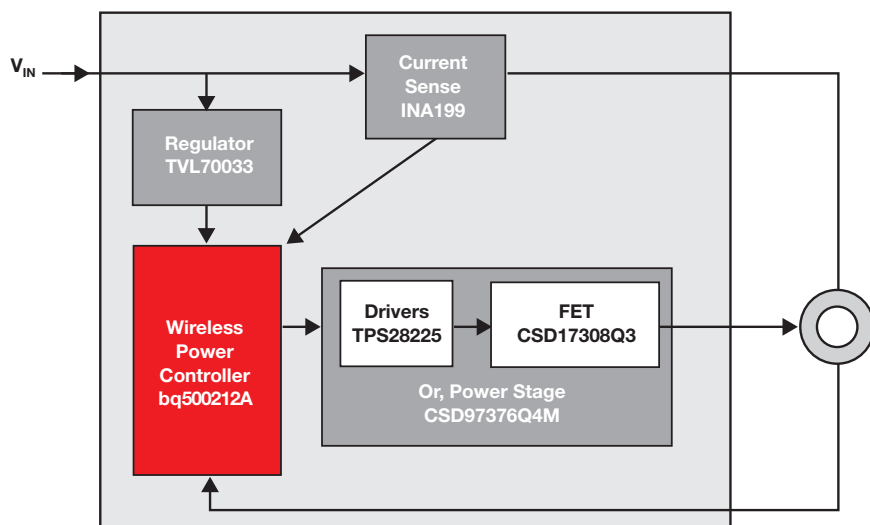
TI offers dedicated digital controllers that integrate the logic functions required to control wireless power transfer in a single-channel, WPC-compliant, contactless-charging base station. These intelligent controllers periodically ping the

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 to protect the controllers and receivers from excessive power loss and heat associated with foreign-object detection placed in the power-transfer path.

Qi-Compliant, 5-V Wireless Power Transmitter Manager

bq500212A



Key Features

- Proven, Qi-certified value solution for transmit-side applications
- Lowest component count for full WPC v1.1 compliance
- 5-V operation conforms to Wireless Power Consortium (WPC v1.1) type A5 or A11 transmitter specification
- Fully Qi-compliant, including improved foreign-object detection (FOD) method
- Permits X7R resonant capacitors for reduced cost
- Dynamic Power Limiting™ for USB and limited source operation
- Digital demodulation reduces components
- LED indication of charging state and fault status
- 7 x 7-mm, 48-pin QFN package

Applications

- WPC v1.1 compliant wireless chargers for:
 - Qi-certified smartphones, handhelds, and accessories
 - Accessories for cars and other vehicles

Get more information: www.ti.com/product/bq500212A

Selection Guide

| Device | Standard | Coil Type | Number of Coils Supported | V _{IN} (V) | Power (W) | Dynamic Power Limit | Automotive Qualified | Comments | Price* |
|------------------------------------|----------|-----------|---------------------------|---------------------|-----------|---------------------|----------------------|--|--------|
| Wireless Power Transmitters | | | | | | | | | |
| bq500210 | WPC v1.0 | A1/A10 | 1 | 19 | 5 | No | No | WPC v1.0 transmitter solution for 19-V systems | 1.90 |
| bq500212A | WPC v1.1 | A5/A11 | 1 | 5 | 5 | Yes | No | Latest WPC v1.1, 5-V transmitter with reduced BOM and improved, simplified FOD | 2.00 |
| bq500412 | WPC v1.1 | A6 | 1,2,3 | 12 | 5 | Yes | No | Latest WPC v1.1, A6 transmitter with reduced BOM and improved, simplified FOD | 2.10 |
| bq500414Q | WPC v1.1 | A6 | 1,2,3 | 12 | 5 | No | Yes | AEC-Q100-qualified A6 transmitter for automotive applications | 3.40 |
| bq500215 | WPC v1.1 | A29 | 1 | 12 | 5 | No | No | WPC v1.1 receiver to be used with the bq51025 | 4.00 |

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

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

Battery Management Products

Wireless Power

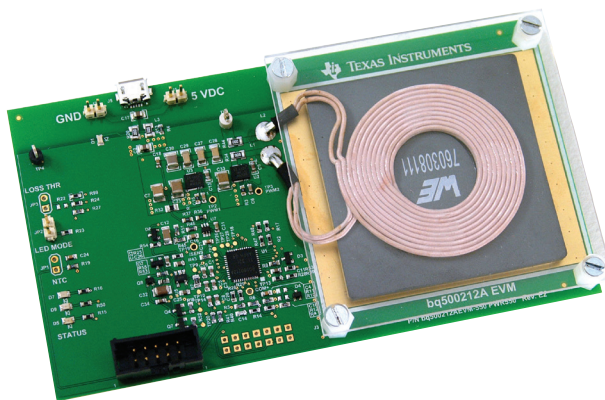
Wireless Power Development Modules

Reduce the design cycle of wireless power solutions and get to market faster with TI's wide range of TX, RX evaluation modules. Whether implementing wireless charging within an existing design, or adding it to a new one, we've got the tools, support and expertise to help you. Two of the available evaluation modules are shown below.

WPC v1.1 Compliant, 5-V Low-Cost Wireless Power Transmitter Evaluation Module

bq500212AEVM-550

The bq500212AEVM-550 evaluation module provides all major functions for evaluation of the bq500212A device in a fully functional WPC v1.1-compliant A5 and A11 wireless transmitter.



Key Features

- Uses low-cost X7R resonant capacitors
- Reduced BOM components and cost
- Accepts 5 V from power supply or micro-USB cable

Get more information: www.ti.com/tool/bq500212AEVM-550

WPC v1.1 Compliant, Integrated Wireless Power Receiver Evaluation Module

bq51013BEVM-764

The bq51013BEVM-764 wireless power receiver evaluation module (EVM) is a high-performance, easy-to-use development tool for the design of wireless power transfer in portable applications. The EVM provides AC/DC power conversion while integrating the digital control required to comply with the communication protocol.



bq51013b evaluation module

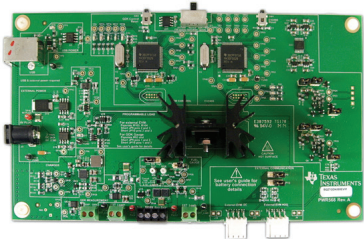
Key Features

- Integrated Qi-compliant receiver with a 5-V regulated supply
- 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 for optimal safety and I/O with host

Get more information at: www.ti.com/tool/bq51013BEVM-764

Design and Development Tools

Resources



Evaluation Modules

The Battery Management evaluation library consists of an array of boards. Depending on your needs, the list of hardware products has several features to help move forward to production.



Battery Management University

Get technical training from the battery experts to solve your design challenges.

www.ti.com/bmsuniversity



Battery Management Studio

Reduce design time with easy-to-configure Gauge Studio software. The Gauge Studio file size is nearly ten times smaller than TI's previous software to minimize configuration and system firmware development to get your design to market faster.

www.ti.com/bqstudio

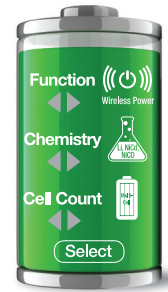


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TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

Products

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