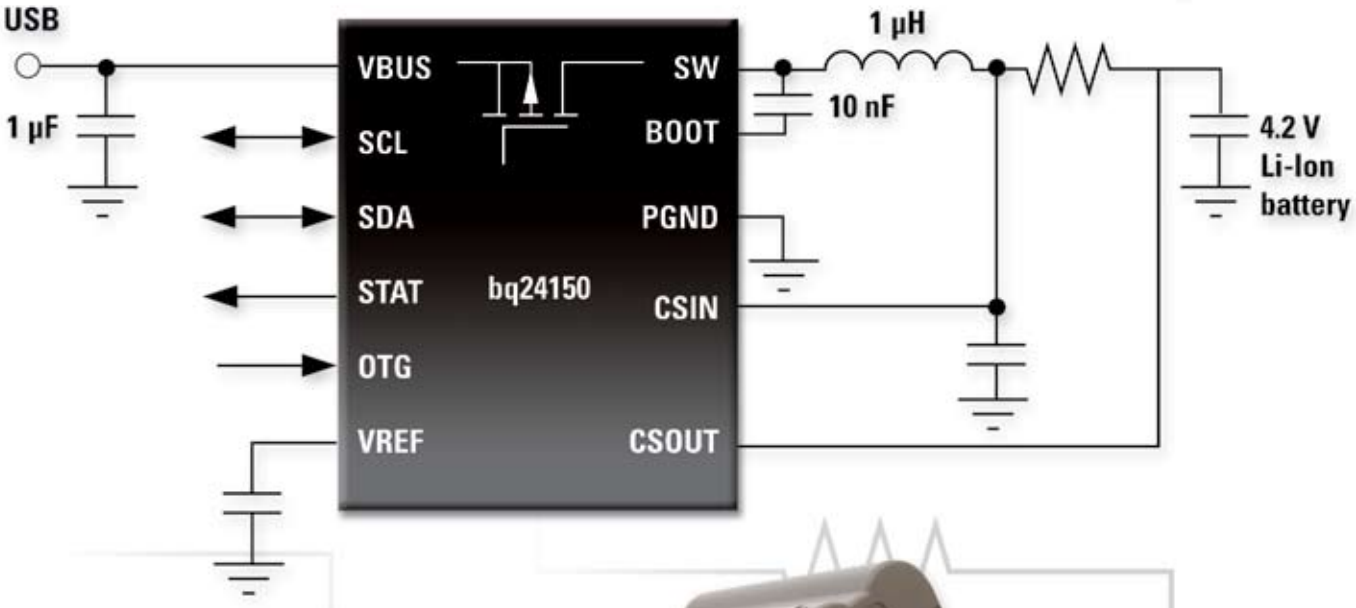
Battery Chargers Catalog

Texas Instruments

Products for mobile phones, smart phones, headsets, portable media players, portable navigation devices, notebook computers, industrial and medical devices



3Q 2008

Making portable possible with linear and switch-mode battery-charging solutions

End applications in wireless, computing, consumer and industrial/medical markets continue to expand into the portable space. TI's battery management solutions help address system protection, cost-effective linear and highly efficient switch-mode battery charging.

New advancements in switch-mode charging increase efficiency, thus decreasing power dissipation and promoting a green environment by wasting less energy.

With battery-powered systems demanding increased reliability, TI ensures maximum safety with products in addition to battery chargers that protect from over-voltage and over-current conditions.

Space is of utmost importance in portable applications. TI offers advanced solutions that incorporate QFN and wafer-level chip-scale packaging and feature a high degree of external component integration to reduce solution size. In addition to reducing board space, many of these solutions provide lower power dissipation and increase overall efficiency.

TI battery management solutions support a wide range of battery chemistries and cell counts, from popular Lithium-Ion (Li-Ion) technologies to industry-standard nickel metal hydride and lead acid batteries.

Whatever your battery management needs may be, TI is the place to find the solutions.

TI products support your battery management design challenges

TI's products support applications such as mobile phones, smartphones, headsets, portable media players, portable navigation devices, notebook computers, industrial and medical. TI has the battery management device to match your design specifications, and this catalog puts you in touch with the evaluation modules, application notes, samples and data sheets you will need to get your design to market faster.

Visit **power.ti.com**

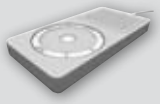
Products for mobile phones and smartphones

Key features: Input over-voltage protection, input over-current protection, USB current limiting, mini-USB interface, USB-OTG output, power path management, small solution size

Products for headsets and accessories

Key features: Small solution size, input over-voltage protection, USB charging

Products for portable media players



Key features: Input over-voltage protection, power path management, fast and efficient charging, small solution size

Products for portable navigation devices

Key features: Fast and efficient charging, longer battery life in higher temperature environment, power path management

Products for notebook computers

Key features: High efficiency and accuracy, flexible programmability, dynamic power management, automatic power source selection, small solution size

Products for industrial and medical applications

Key features: High efficiency and accuracy, flexible programmability, dynamic power management

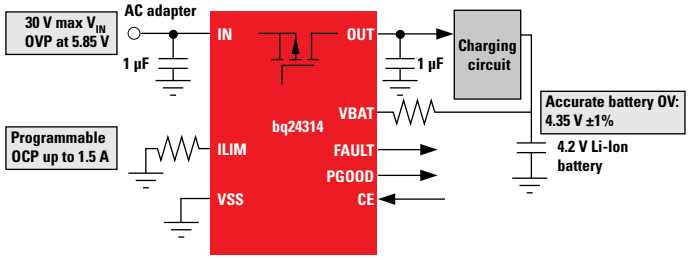
Resources

Small charger front-end protection IC

bq24314

Get samples, datasheets, app reports and evaluation modules at: **www.ti.com/sc/device/bq24314**

The bq24314 provides protection from input over-voltage, input over-current and battery over-voltage conditions. The three-level protection offers maximum safety when charging a handheld device. With integrated FET, the bq24314 comes in 2-mm x 2-mm and 3-mm x 4-mm SON packages.



Key Features

- Provides protection from input over-voltage, input over-current and battery over-voltage
- Maximum input voltage: 30 V
- Integrated power FET and current sensor that supports up to 1.5-A input current
- Less than 1-µs response time against input over-voltage
- High immunity against false triggering because of voltage spikes and current transients
- Status indication – fault condition
- Thermal shutdown
- Packaging: 2-mm x 2-mm and 3-mm x 4-mm SON

Charger Front-End Protection Devices

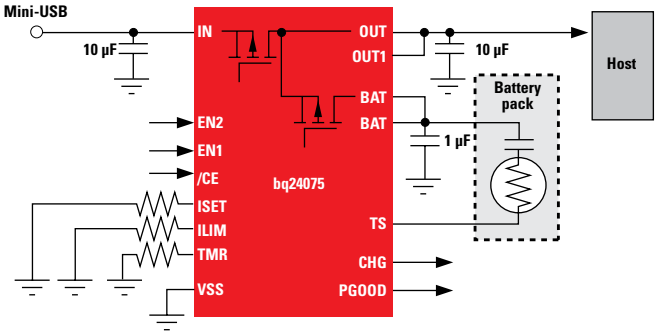
Device	OVP (V)	OCP	LDO output (V)	Max operating current (µA)	Operating temp. range (° C)	Features	Packaging
bq24300	10.5	Fixed 300 mA	5.5	500	0 to 125	Reverse polarity protection	8-SON
bq24304	10.5	Fixed 300 mA	4.5	500	0 to 125	Reverse polarity protection	8-SON
bq24305	10.5	Fixed 300 mA	5	500	0 to 125	Reverse polarity protection	8-SON
bq24314	5.85	Prog. <1.5 A	—	600	0 to 125	Fault indication	8/12-SON
bq24314A	5.85	Prog. <1.5 A	—	600	–40 to 125	Fault indication	8-SON
bq24315	5.85	Prog. <1.5 A	5.5	600	–40 to 125	Fault indication	8-SON
bq24316	6.5	Prog. <1.5 A	—	600	0 to 125	Fault indication	8/12-SON
bq24380	6.3	No OCP	5.5	250	–40 to 125	Fault indication	8-SON
bq24381	7.1	No OCP	5	250	–40 to 125	Fault indication	8-SON

USB-friendly Li-Ion charger and power path management IC

bq24075

Get samples and datasheets at: **www.ti.com/sc/device/bq24075**

The bq24075 operates either from a USB port or a wall adapter. The 28-V input voltage rating along with input over-voltage protection and input current limiting add robustness to the charging circuits. The power path management feature allows the system be powered directly off the input, reducing battery charge and discharge cycles and enabling instant system turn-on even with a depleted battery. The SYSOFF function disconnects the battery from the system, enabling factory programming with no battery installed and allowing the battery fuel gauge to measure open circuit voltage.



Key Features

- Fully compliant USB charger
  - o Selectable 100-mA and 500-mA maximum input current
  - o Input-based dynamic power management for protection against poor USB sources
- 28-V input rating, up to 1.5-A output current
- Integrated dynamic power management feature
- SYSOFF input disconnects battery from system
- Programmable pre-charge and fast-charge safety timers
- Thermal regulation for charge control
- Reverse current, short-circuit and thermal protection
- Status indication: Charging/Done, Power Good
- Packaging: small 16-lead, 3-mm x 3-mm QFN

Charger and Power Path Management Devices

Device	# Inputs	Max V_{IN} (V)	Max output current (A)	Charge current	Input current limiting	OVP (V)	Vsys (V)	Battery voltage (V)	Package (SON)
bq24230	single	28	1.5	25 mA – 500 mA	USB: 100/500 mA Adapter: prog. 200-500 mA	6.6	4.4	4.2	3 x 3-16
bq24232	single	28	1.5	25 mA – 500 mA	USB: 100/500 mA Adapter: prog. 200-500 mA	10.5	4.4	4.2	3 x 3-16
bq24072	single	28	1.5	300 mA – 1.2 A	USB: 100/500 mA Adapter: prog. 200 mA-1.5 A	6.6	V_{BAT}+200 mV	4.2	3 x 3-16
bq24073	single	28	1.5	300 mA – 1.2 A	USB: 100/500 mA Adapter: prog. 200 mA-1.5 A	6.6	4.4	4.2	3 x 3-16
bq24074	single	28	1.5	300 mA – 1.2 A	USB: 100/500 mA Adapter: prog. 200 mA-1.5 A	10.5	4.4	4.2	3 x 3-16
bq24075	single	28	1.5	300 mA – 1.2 A	USB: 100/500 mA Adapter: prog. 200 mA-1.5 A	6.6	5.5	4.2	3 x 3-16
bq24070	single	18	2	100 mA – 1.5 A	USB only: 100/500 mA	n/a	4.4	4.2	3.5 x 4.5-20
bq24071	single	18	2	100 mA – 1.5 A	USB only: 100/500 mA	n/a	6	4.2	3.5 x 4.5-20
bq24030	dual	18	2	100 mA – 1.5 A	USB only: 100/500 mA	n/a	6	4.2	3.5 x 4.5-20
bq24031	dual	18	2	100 mA – 1.5 A	USB only: 100/500 mA	n/a	6	4.1	3.5 x 4.5-20
bq24032A	dual	18	2	100 mA – 1.5 A	USB only: 100/500 mA	n/a	4.4	4.2	3.5 x 4.5-20
bq24035	dual	18	2	100 mA – 1.5 A	USB only: 100/500 mA	6	V_{IN} - V_{DROP}	4.2	3.5 x 4.5-20
bq24038	dual	18	2	100 mA – 1.5 A	USB only: 100/500 mA	n/a	4.4	4.36	3.5 x 4.5-20

One-cell Li-Ion charger with autonomous USB and AC-adapter supply management

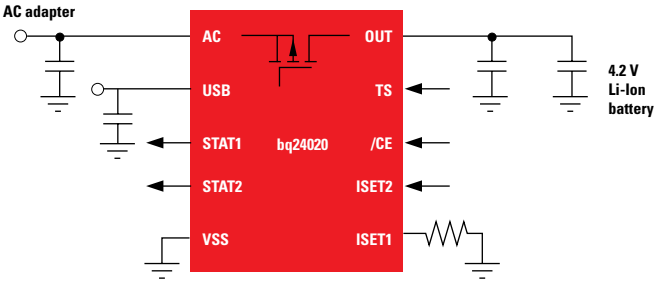
bq24020

Get samples, datasheets, app reports and evaluation modules at: **www.ti.com/sc/device/bq24020**

The bq24020 automatically selects the USB port or the AC adapter as the power source for the system. In the USB configuration, the host can select from two preset charge rates of 100 mA or 500 mA. In the AC adapter configuration, an external resistor sets the charge current.

Key Features

- Integrated 1-A FET and current sensor
- Integrated USB control with selectable 100-mA and 500-mA charge rates
- Autonomous power source selection
- Status indication: Charging/Done, Power Good
- Packaging: small 10-lead, 3-mm x 3-mm QFN



One-cell Li-Ion charger with input over-voltage protection

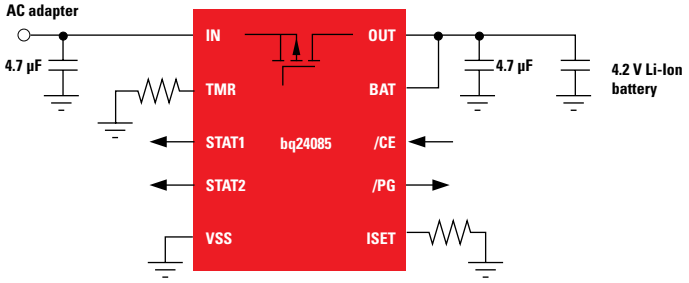
bq24085

Get samples, datasheets, app reports and evaluation modules at **www.ti.com/sc/device/bq24085**

The bq24085 provides the most cost-effective charging solution for a single-cell Li-Ion. With integrated FET, current sensor and reverse leakage protection, it requires minimum external components. Its input voltage rating of 18 V and over-voltage protection allow use of low-cost unregulated AC adapters. The thermal regulation feature maximizes charge rate in any charging environment.

Key Features

- 18-V input rating
- 6.5-V or 10.5-V input over-voltage protection
- Integrated 750-mA FET and current sensor
- Programmable pre-charge and fast-charge safety timers
- Thermal regulation for charge control
- Reverse current, short-circuit and thermal protection
- Status indication: Charging/Done, Power Good
- Packaging: small 10-lead, 3-mm x 3-mm QFN



USB Chargers

Device	Topology	Max V_{IN} (V)	Max current (A)	Input current limiting (mA)	Notes	Packaging
bq24150	switching	20	1.2	USB & adapter: 100/500/800 or no limit	See page 8	2 x 2 WCSP-16
bq2402x	linear	7	1	USB only: 100/500	See page 6	SON 3 x 3-10
bq2407x	linear	28	2	USB:100/500; adapter: 200 mA-2 A	See page 5	SON 3 x 3-16
bq2403x	linear	18	2	USB only: 100/500	See page 5	SON 3.5 x 4.5-20

Linear Chargers

Device	# Inputs	Max V_{IN} (V)	Max current (A)	Timer (hrs.)	OVP (V)	Functions	Vbat (V)	Packaging (SON)
bq24085	single	18	0.75	* 3-10	6.5	/PG, /CE	4.2	3 x 3-10
bq24086	single	18	0.75	* 3-10	6.5	/PG, TS	4.2	3 x 3-10
bq24087	single	18	0.75	* 3-10	6.5	/TE, /CE	4.2	3 x 3-10
bq24088	single	18	0.75	* 3-10	10.5	/PG, TS	4.2	3 x 3-10
bq24080	single	7	1	7	n/a	/PG, /CE	4.2	3 x 3-10
bq24081	single	7	1	7	n/a	/TE, TS	4.2	3 x 3-10
bq24083	single	7	1	7	n/a	/PG, /CE	4.2 or 4.06	3 x 3-10
bq24010	single	18	1	6	n/a	/PG, TS	4.2	3 x 3-10
bq24012	single	18	1	6	n/a	/PG, /CE	4.2	3 x 3-10
bq24013	single	18	1	6	n/a	/CE, /TTE	4.2	3 x 3-10
bq24014	single	18	1	6	n/a	/CE, TS	4.2	3 x 3-10
bq24018	single	18	1	6	n/a	/CE, /TTE	4.36	3 x 3-10
bq24060	single	18	1	* 3-10	6.5	/PG, TS	4.2	3 x 3-10
bq24061	single	18	1	* 3-10	6.5	/PG, /CE	4.2	3 x 3-10
bq24064	single	18	1	* 3-10	10.5	/PG, TS	4.2	3 x 3-10
bq24020	dual	7	1	5	n/a	/CE, TS	4.2	3 x 3-10
bq24022	dual	7	1	5	n/a	/PG, /CE	4.2	3 x 3-10
bq24023	dual	7	1	5	n/a	/CE, /TTE	4.2	3 x 3-10
bq24024	dual	7	1	5	n/a	/TTE, TS	4.2	3 x 3-10
bq24025	dual	7	1	7	n/a	/CE, TS	4.2	3 x 3-10
bq24026	dual	7	1	7	n/a	/TE, TS	4.2	3 x 3-10
bq24027	dual	7	1	7	n/a	/PG, /CE	4.2	3 x 3-10

*Programmable by resistor

Synchronous switch-mode charger with integrated FETs and USB OTG support

bq24150

Get samples, datasheets and evaluation modules at: **www.ti.com/sc/device/bq24150**

The bq24150 offers the smallest solution size for single-cell Li-Ion applications. The 3-MHz PWM controller can work with ultra-small inductors. The IC with internal-power FETs and compensation network comes in a 2-mm x 2-mm WCSP package. Its high efficiency, input over-voltage protection, input current limiting and integrated boost converter—which provides USB On-the-Go output—make it ideal for USB applications.

Key Features

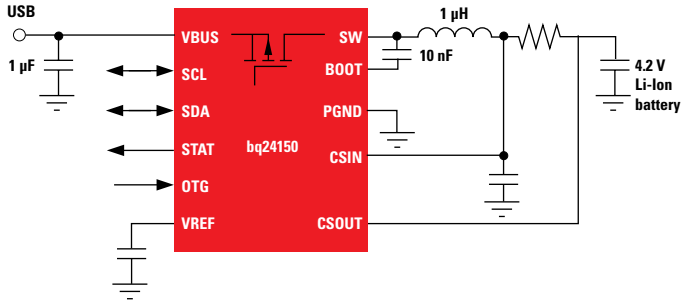
- Synchronous 3-MHz PWM controller
- Integrated power FETs for up to 1.2-A charge rate
- Integrated current sensing and compensation
- Maximum input voltage: 20-V with 6-V OVP
- Safety timer with reset control
- 0.8-µA max charge current from USB
- Input current limiting for both USB and adapter
- USB OTG support
- High-speed (3.4 MHz) I^2C interface
- Short-circuit, over-voltage and thermal protection
- Packaging: 16-pin, 2-mm x 2-mm WCSP

Benefits

- Maximum battery charging performance and design flexibility in USB powered applications
- Significantly improves charge time
- Minimizes heat dissipation when charging
- Cuts board space in half
- Can achieve high peak-efficiency of up to 92%, while supporting a USB battery charging current up to 900 mA
- Features a reverse boost USB OTG mode that generates a voltage supply to power accessories
- USB-friendly boot-up sequence allows the charge IC to boot autonomously, which helps replenish deeply discharged batteries

Applications

- Smart phones
- Portable media players
- Portable consumer electronics



bq24150 Selection Table

Device	Max V_{IN} (V)	Max current (A)	Input current limiting	OVP (V)	Charge voltage (V)	Charge term.	Package	Power up behavior
bq24150	20	1.2	100/500/800 mA or no limit, set by I^2C or OTG pin	6	Prog. by I^2C, 3.5 - 4.42 V	Host-controlled through I^2C	2 x 2 WCSP-16	Battery detect, automatically initiates charging if battery present
bq24151	20	1.2	100/500/800 mA or no limit, set by I^2C or OTG pin	6	Prog. by I^2C, 3.5 - 4.42 V	Host-controlled through I^2C	2 x 2 WCSP-16	Does not automatically initiate charging
bq24152	20	1.2	100/500/800 mA or no limit, set by I^2C or OTG pin	6	Prog. by I^2C, 3.5 - 4.42 V	Host-controlled through I^2C	2 x 2 WCSP-16	No battery detect, initiate charging anyway

1.1-MHz synchronous switch-mode charger with FETs for one- to three-cell Li-Ion

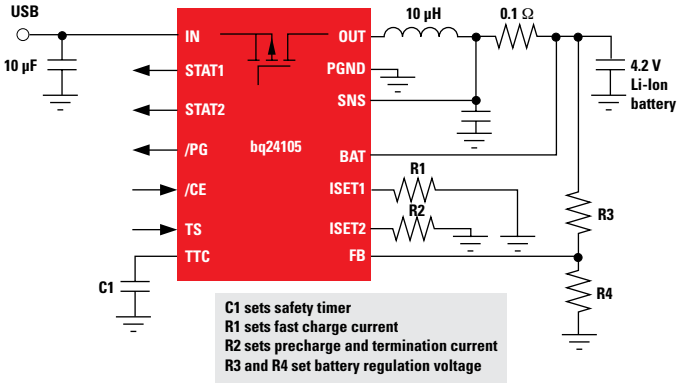
bq24105

Get samples, datasheets, app reports and evaluation modules at: **www.ti.com/sc/device/bq24105**

The bq24105 is ideal for a wide variety of applications that use up to a 3-cell Li-Ion battery. It can accept up to 20-V input voltage. With integrated 2-A FETs and internal loop compensation, the bq24105 offers minimum solution size for space-limited portable applications. The synchronous power conversion offers high efficiency to applications that work with high-input voltage or high-charge rate.

Key Features

- Synchronous 1.1-MHz PWM controller
- Integrated power FETs for up to 2-A charge rate
- Integrated loop compensation
- Maximum input voltage: 20 V
- Battery pack temperature sensing
- Packaging: 20-pin, 3.5-mm x 4.5-mm QFN
- Low EMI versions available: bq2412x



bq24105 Selection Table

Device	Max V_{IN} (V)	Max current (A)	Charge voltage (A)	Charge termination	Package
bq24100	18	2	4.2	Standalone	3.5 x 4.5 QFN-20
bq24103	18	2	4.2 or 8.4	Standalone	3.5 x 4.5 QFN-20
bq24105	18	2	Prog. by resistor, 2.1 - 15.5	Standalone	3.5 x 4.5 QFN-20
bq24108	18	2	4.2	Standalone	3.5 x 4.5 QFN-20
bq24113	18	2	4.2 or 8.4	Host-controlled through /CE pin	3.5 x 4.5 QFN-20
bq24115	18	2	Prog. by resistor, 2.1 - 15.5	Host-controlled through /CE pin	3.5 x 4.5 QFN-20

Single-chip Li-Ion charger and DC/DC converter IC

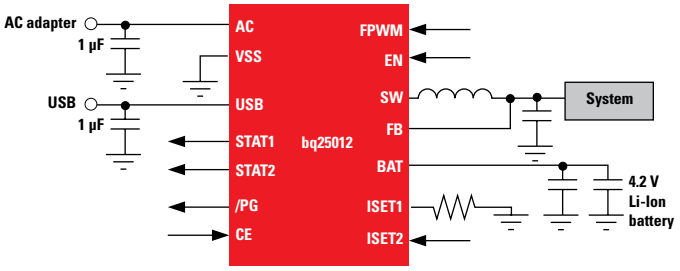
bq25012

Get samples, datasheets, app reports and evaluation modules at: **www.ti.com/sc/device/bq25012**

The bq25012 integrates a dual-input charger and a low-power, high-efficiency DC/DC converter in a single chip. The linear charger has internal-power FET and current sensor for up to 500 mA. The DC/DC converter operates at a synchronized 1-MHz switching frequency, allowing for the use of small inductors.

Key Features

- Li-Ion charger and synchronous DC/DC converter in a single chip
- Autonomous power source selection between USB and AC adapter
- Internal USB current limiting at 100 mA or 500 mA
- DC/DC converter maximum load current 150 mA
- Optional forced PWM mode
- Packaging: small 20-lead, 3.5-mm x 4.5-mm QFN



bq25012 Selection Table

Device	Buck converter current (mA)	Buck converter output (V)
bq25010	150	Adjustable
bq25012	150	1.8
bq25015	300	Adjustable
bq25017	300	1.8

ENERGY STAR®-compliant switch-mode charger with system power selector

bq24751A

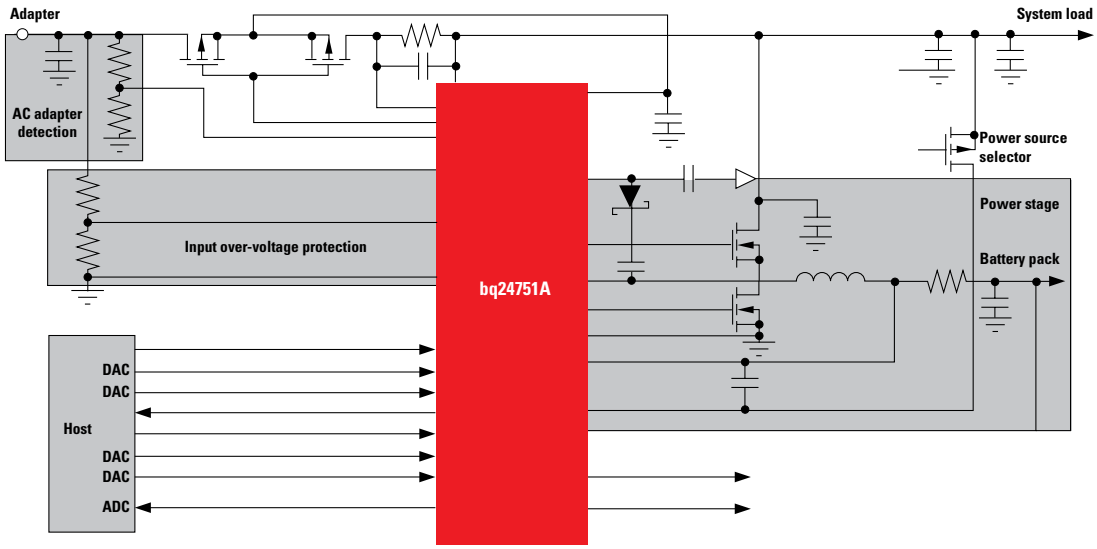
PRODUCT SAMPLES | DATA SHEETS | EVALUATION MODULE

Get samples, datasheets and evaluation modules at: **www.ti.com/sc/device/bq24751A**

The bq24751A is a high-efficiency, synchronous battery charge controller with integrated compensation and system power selector, offering the lowest component count for notebook computers and industrial applications. Ratiometric charge current and voltage programming facilitate very high regulation accuracies, and can be either hardwired with resistors or programmed by the system microcontroller using a DAC or with GPIOs.

Key Features

- Fixed 300-kHz, NMOS-NMOS synchronous buck with 6-V gate drive
- 30-ns minimum driver dead-time and 99.5% maximum duty cycle
- ±0.5% charge voltage regulation accuracy
- ±4% charge and adapter current regulation accuracy at 4 A
- ±2% 20x input current sense amplifier accuracy
- Input voltage range: 5 V-28 V, charging a two- to four-cell Li-Ion
- Packaging: 28-lead, 5-mm x 5-mm QFN



Switch-Mode Charge Controllers

Device	Max V_{IN} (V)	Power selector	AC over power protection	Temp sense	Input OVP	DPM active indicator	Compensation	Standalone	Package
bq24705	28	✓	✓	✓	—	✓	Internal	No	4 x 4 QFN-24
bq24750	28	✓	✓	✓	—	✓	Internal	No	5 x 5 QFN-28
bq24751A	28	✓	✓	—	✓	—	Internal	No	5 x 5 QFN-28
bq24740	28	—	—	—	—	✓	Internal	No	5 x 5 QFN-28
bq2954	7	—	—	✓	—	—	External	Yes	PDIP or SOIC-16
bq2000	7	—	—	✓	—	—	N/A	Yes	PDIP, TSSOP or SOIC-8

SMBus-controlled, level 2, multi-chemistry battery charger

bq24745

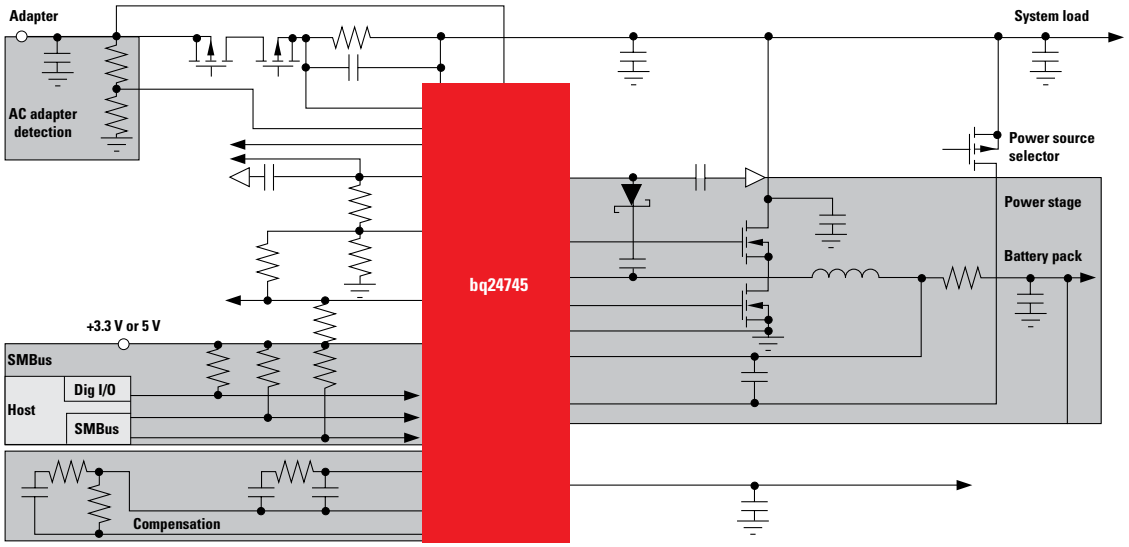
PRODUCT SAMPLES | DATA SHEETS | EVALUATION MODULE

Get samples, datasheets and evaluation modules at: **www.ti.com/sc/device/bq24745**

The bq24745 is a high-efficiency, synchronous battery charger with an integrated input-current comparator, offering low component count for space-constrained, multi-chemistry battery-charging applications. Input-current, charge-current and charge-voltage DACs can be easily programmed by the system power-management microcontroller using SMBus. The bq24745 charges one to four-series Li+ cells and is available in a 28-pin, 5-mm x 5-mm QFN package.

Key Features

- NMOS-NMOS synchronous buck converter with fixed 300-KHz frequency and >95% efficiency
- 0.5% charge-voltage regulation accuracy
- 3% charge-current regulation accuracy
- 3% input-current limiting accuracy
- 2% input-current sense amplifier accuracy
- Dynamic power management
- Input current comparator
- Input over-voltage protection
- Simplified SMBus control
  - o Charge voltage (1.024 V – 19.2 V)
  - o Charge current (128 mA – 8.064 A)
  - o Adapter current (256 mA – 11.004 A)
- Packaging: 28-pin, 5-mm x 5-mm QFN



Simple NiMH/NiCd charger

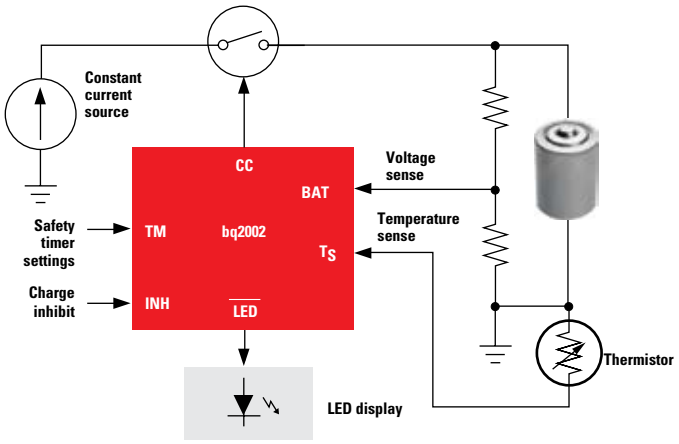
bq2002

Get samples, datasheets, app reports and evaluation modules at: **www.ti.com/sc/device/bq2002**

The bq2002 controls a current-limited or constant-current supply to build a cost-effective charger for NiMH or NiCd batteries. It integrates fast charge with optional top-off and pulse-trickle charge. Fast charge is terminated by any of the five factors: peak voltage detection, negative delta voltage, maximum voltage, maximum temperature and maximum time.

Key Features

- Spins available for ΔT/Δt, -ΔV and PVD charge termination
- Direct LED output displays charge status
- Internal band-gap voltage reference
- Optional top-off charge
- Selectable pulse trickle charge rates
- Packaging: 8-pin DIP or SOIC



Battery charger design factors

Battery chemistry — Each battery chemistry has unique requirements for its charge algorithm, which is critical for maximizing its capacity, cycle life and safety.

Control topology — A simple linear topology works well in applications with low-power (e.g., one- or two-cell Li-Ion) battery packs that are charged at less than 1 A. A switch-mode topology is ideally suited for fast charging from USB ports or for large battery packs that require charge rates >1 A. The switch-mode conversion minimizes heat generation during charging.

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

NiMH/NiCd Chargers

Device	Max V_{IN} (V)	Charge current	Timer, top-off, pulse trickle options	Discharge before charge option	Charge status outputs	Package
bq2002	7	limited by external supply	3-level setting	—	1	8-pin DIP or SOIC
bq2000	7	set by resistor	Prog. by RC	—	1	8-pin DIP, SOIC or TSSOP
bq2004	7	set by resistor	9-level setting	✓	2 status outputs, 3-mode display options	16-pin DIP or SOIC

Battery chargers application reports

To access any of the following application reports, type the URL **www-s.ti.com/sc/techlit/litnumber** and replace **litnumber** with the number in the Lit Number column.

For a complete list of battery charger application reports, visit **ti.com/batterycharge** and click on application notes.

Dual Battery Pack Charger	slua462
Battery Charger Front-End IC Improves Charging System Safety	slyt294
Host-side Gas-Gauge-System Design Considerations for Single-Cell Handheld Apps	slyt285
Extending Single-Input Charger to Dual-Input Applications	slua437
Enhanced-Safety, Linear Li-Ion Battery Charger with Thermal Regulation and Input OV	slyt269
Input Filter Design for Portable Power Management System	slua413
Drive High-Current LEDs	slva265
Dynamic Power Path Management and Dynamic Power Management	slua400
Selecting the Correct IC for Power-Supply Applications	slyt259
Dynamic Power Path Management Simplifies Battery Charging from Solar Panels	slua394
Battery Charger Termination Issues With System Load Applied Across Battery (Rev. A)	slva166a
Li-Ion Switching Charger Integrates Power FETs	slyt224
Power Dissipation Analysis and Circuit Design for Sync Switching Battery Charger	slua345
Battery Charger Termination Issues With System Load Applied Across Battery	slva166

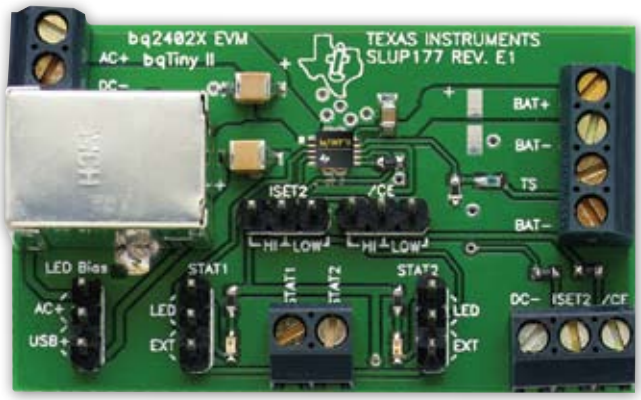
Online training

Visit **www.ti.com/training**, select ‘Analog’ and look for the Power Management heading for the following courses of online training.

- Battery Capacity Monitoring Design Considerations for Li-Ion Batteries
- Battery Charging System Practical Design Considerations
- Improving Power Supply Efficiency - The Global Perspective
- Li-Ion Battery Fundamentals and Battery Pack Electronics Design
- Practical Considerations in Troubleshooting & Optimizing Power Supply Control
- Safety Considerations in Power Supply Design
- Green-Mode Power by the Milli-Watt

Battery charger evaluation modules (EVMs)

TI's battery-charger evaluation modules allow you to determine how a specific product will operate in your system, so you can deliver winning designs to market faster. To order any of the following evaluation modules, visit the product folder or contact your local TI Product Information Center or your local distributor.



Description	Part No.	Price
bq24314 evaluation module	BQ24314EVM	$49.00
bq24020 bq TINY-II evaluation module	BQ24020EVM	$49.00
bq24105 evaluation module	BQ24105 EVM	$49.00
bq24751A evaluation module	BQ24751AEVM	$149.00
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bq24085 battery charger evaluation module	BQ24085EVM	$49.00
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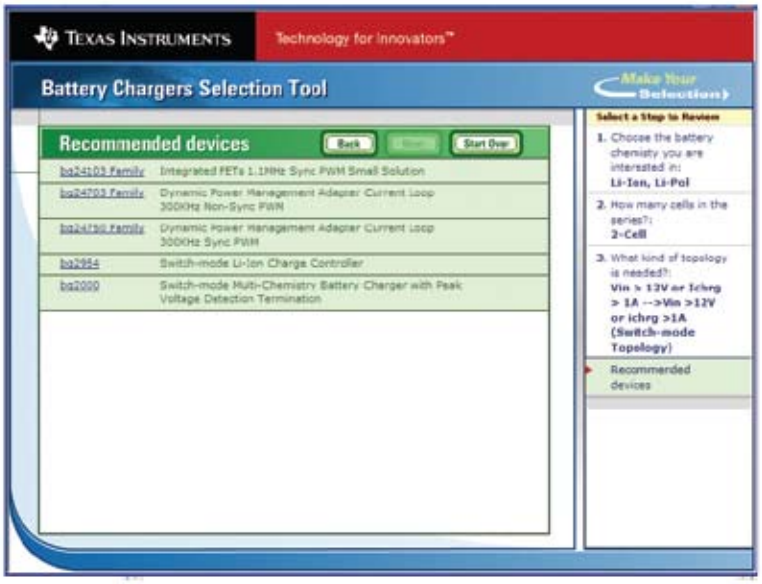

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