BATTERY MANAGEMENT

MIXED-SIGNAL DESIGN SOLUTIONS

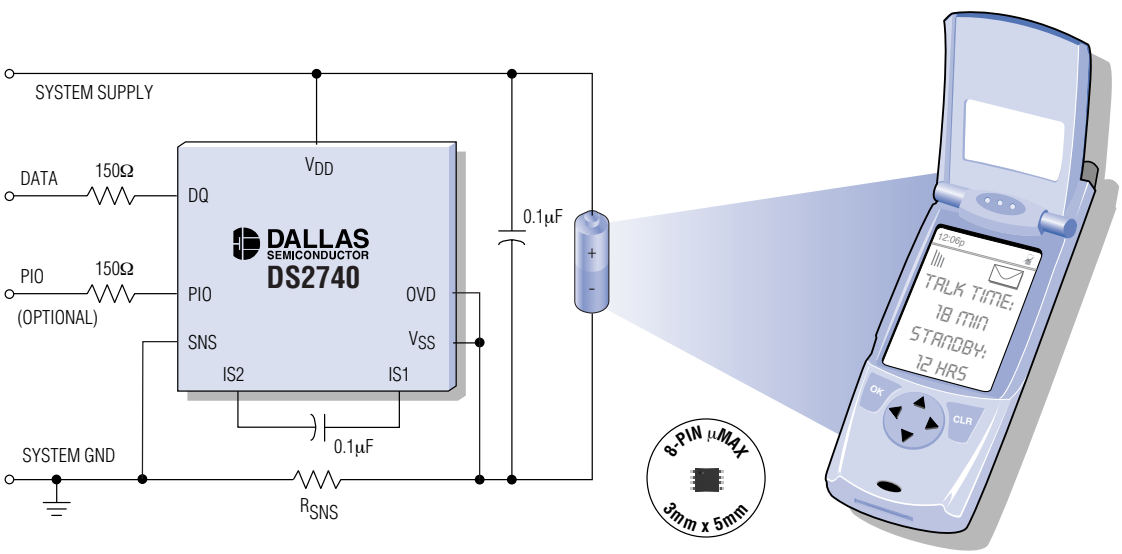
Data Sheets • Applications Solutions • Free Samples

NEW

4th EDITION

World's Best Performing Fuel Gauge Costs Less than $1

Low ADC Offset and Gain Error in a Low-Cost Coulomb Counter Reduces Portable Runtime Uncertainty



The DS2740's 15-bit current measurement has a resolution of 78µA and a 2.56A dynamic range when used with a 20mΩ sense resistor. An analog input filter extends this dynamic range for pulse-load applications. With a current ADC offset of less than 2µV and a gain error of less than 1%, the DS2740 provides a highly accurate report of remaining battery capacity.

- **Current Accumulation Has 0.3125mAh Resolution with 20mΩ Sense Resistor**
- **2µV ADC Offset Error, Typical**
- **Low Power: <1µA Standby, <65µA Active**
- **1-Wire® Interface with Unique 64-Bit Serial Number**
- **Tiny 8-Pin µMAX Package**
- **Priced at $0.98†**

Over 50 Products to Manage Your Battery!

- Linear and Switch-Mode Chargers
- Single-, Dual-, and USB-Input Chargers
- Battery Monitors w/ Data and ID Memory
- 1-Wire and SMBus™ Interfaces
- Pack-Protection ICs
- Fuel Gauges
- Multiple Battery Control Switches

1-Wire is a registered trademark of Dallas Semiconductor. SMBus is a trademark of Intel Corp.

†100k-up recommended resale. Prices provided are for design guidance and are FOB USA. International prices will differ due to local duties, taxes, and exchange rates.

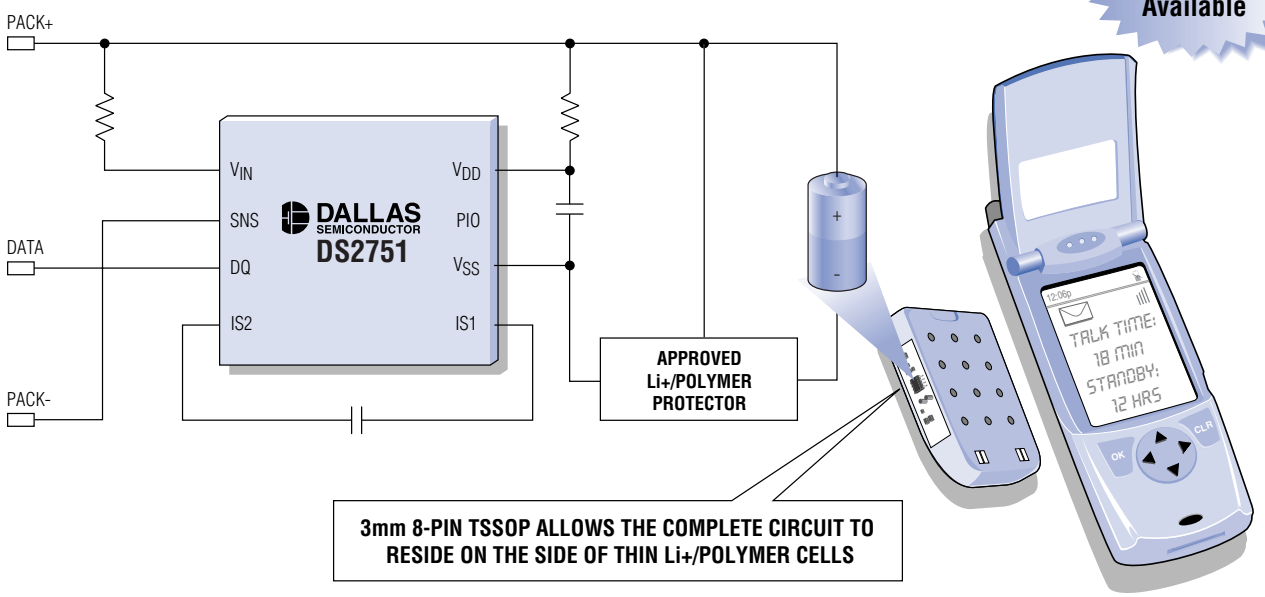
DALLAS SEMICONDUCTOR MAXIM

NEW

Battery Fuel Gauging Made Simple and Inexpensive*!

Add world-class battery management performance to your approved battery pack safety circuitry. The DS2751 has no safety approval requirements and is packaged in a small 3mm TSSOP, making product integration easier than ever.

Evaluation Kit Available



- **Optional 25mΩ Current-Sense Resistor Integrated On-Chip**
- **Offset-Induced Error <±15mAhr/Day Using a 25mΩ Sense-Resistor**
- **8-Pin TSSOP Package**
- **90µA (max) Operating Current, 2µA Standby**
- **User-Programmable I/O**
- **1-Wire, Multinode, Digital Communication Interface**
- **32 Bytes of NV EEPROM**
- **Ideal for DSC-, PDA-, WiFi-, GSM-, and CDMA-Enabled Handsets**

Calibrating Offset Registers

The DS2761 contains a current offset register that can be utilized by the designer to eliminate inherent offset introduced by the current ADC within the IC. Improper calibration of this register, however, can negate any positive effect it has on increasing the accuracy of the current measurements, especially at low currents. This application note describes a step-by-step approach to properly calibrate the correct value that should be placed into the current offset register within the fully assembled battery pack. Although the application note is specifically written for the DS2761, it is applicable to the DS2760 and DS2751.

For This Complete App Note, Visit

www.maxim-ic.com/app224

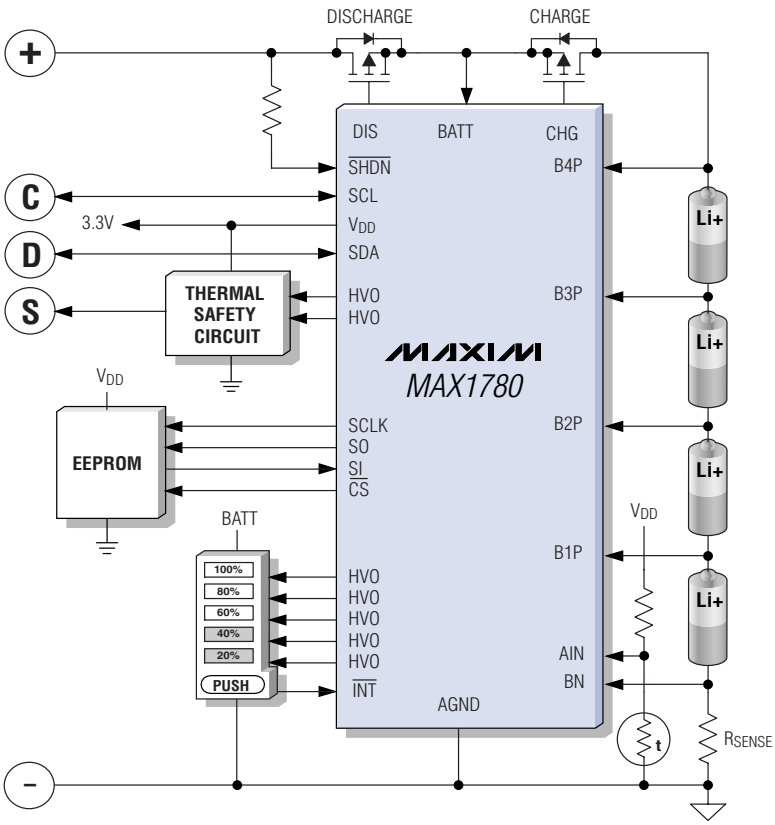
*$1.90 1,000-up recommended direct pricing. Prices provided are for design guidance and are FOB USA. International prices will differ due to local duties, taxes, and exchange rates.

DALLAS SEMICONDUCTOR MAXIM

Maximize Your Battery-Pack Capacity Using the Most Accurate Fuel Gauge

The MAX1780 battery-pack controller is a smart battery-pack supervisor that integrates a user-programmable microcontroller core, a coulomb counter-based fuel gauge, a multichannel data-acquisition unit, and a master/slave SMBus interface. The 8-bit RISC controller is user programmable and provides battery-pack designers complete flexibility to develop fuel gauging and control algorithms. The data-acquisition unit measures individual cell voltages to within 50mV, total battery stack voltage up to 20.48V, and chip internal/external temperature. With user-adjustable current comparators and individual cell measurements, the MAX1780 does not require a separate pack-protection IC.

- **User Programmable Using an External EEPROM**
- **Most Accurate Fuel Gauge Uses Voltage-to-Frequency (V-to-F) Method:**
  - **<1µV Input Offset Voltage**
  - **Minimizes Pack Cost with No External Calibration**
- **Eliminates Separate Primary Protection IC:**
  - **50mV Accurate Individual Cell Voltage Measurements**
  - **Built-In Protection MOSFET Gate Drivers**
  - **Overcharge and Discharge Current Protection**
- **Fully Integrated LDO (V_{IN} = 4V to 28V)**
- **8-Bit RISC Microcontroller Core:**
  - **On-Board 1.5k ROM and 0.5k RAM**
  - **Fast Startup 3.5MHz Instruction Oscillator**
  - **Watchdog Timer**
- **Hardware SMBus with Master Capability**
- **<500µA Typical Operating Current**
- **<1µA Shutdown Current**



NEW

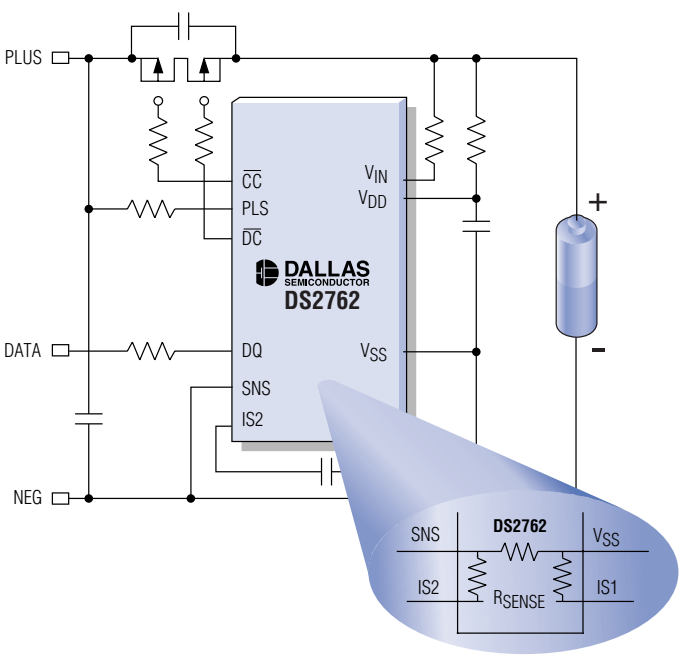
Tiny Flip-Chip Package Integrates Li+ Battery Fuel Gauge, Protector, and Sense Resistor

The DS2762 is a single-cell Li+ fuel gauge and protection circuit integrated into a tiny 2.46mm x 2.74mm flip-chip package. It saves space by integrating the high-precision resistor needed for sensing and measuring current for the fuel-gauge function. Its small size and high level of integration make it ideal for use in mobile phone battery packs and hand-held products such as PDAs. The integrated protector continuously monitors the cell for overvoltage, undervoltage, and overcurrent during charging and discharging. Unlike standalone protection ICs, the DS2762 allows the host processor to electronically monitor/override the on state of the safety FETs, which allows system power control through the DS2762 protection circuitry. The DS2762 is also able to charge a deeply depleted cell by providing a current-limited recovery charge path while the cell voltage is less than 3V.

The DS2762 provides precision monitoring of battery-cell current, voltage, and temperature with levels of dynamic range and resolution required for measuring all common mobile communication standards. The current measurements are integrated over an internally generated time base to facilitate fuel gauging. Fuel-gauge accuracy is enhanced through real-time continuous and automatic offset correction. The internal sense resistor enables resistance variations from processing and temperature to be trimmed out, further enhancing fuel-gauge accuracy. Critical data is stored in 32-byte lockable EEPROM; 16-byte SRAM stores more dynamic data. All communication with the DS2762 is achieved through a 1-Wire, multinode communication interface, ensuring a minimal number of connections between the pack and the host.

- **Single-Cell Li+ Protector**
- **High-Precision Current (Fuel Gauge), Voltage, and Temperature Measurement**
- **Optional Integrated 25mΩ Sense Resistor, Individually Trimmed on Each DS2762**
- **0V Battery Recovery Charge**
- **32 Bytes of Lockable EEPROM, 16 Bytes of SRAM, 64-Bit ROM**
- **1-Wire, Multinode, Digital Communication Interface**
- **Multipack Power Management Support and System Power Control Using Protection FETs**
- **Only 2µA (max) Supply Current in Sleep Mode**
- **90µA (max) Supply Current in Active Mode**
- **2.46mm x 2.74mm Flip-Chip Package or 16-Pin TSSOP, Both with or Without Sense Resistor**
- **Evaluation Kit Available**

COMPLETE Li+ BATTERY PACK DESIGN

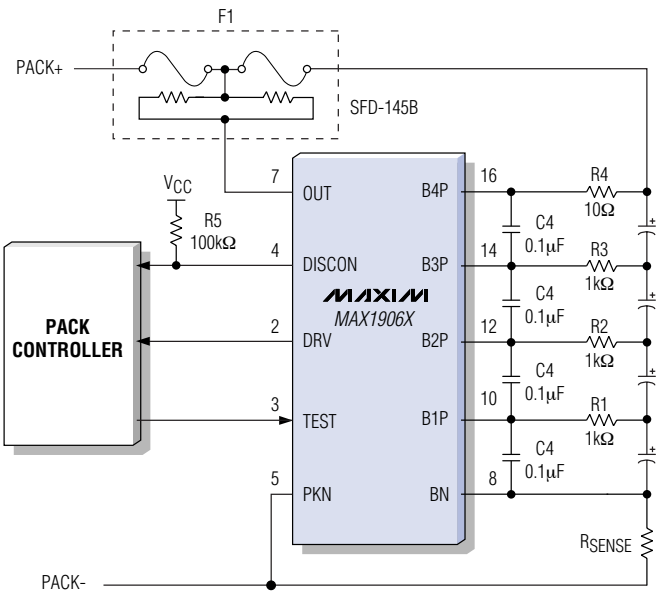


INTEGRATED SENSE RESISTOR

Li+ Battery Pack Protector Has Integrated Protection Fuse Driver

The MAX1906 protects against overvoltage condition in Li+/polymer battery packs by blowing a 3-terminal protection fuse. The MAX1906 blows the fuse by activating an internal SCR, or by driving the gate of an external MOSFET. The MAX1906 can be used with 2-, 3-, or 4-series cell battery packs and is available in a thermally enhanced 16-pin QFN package.

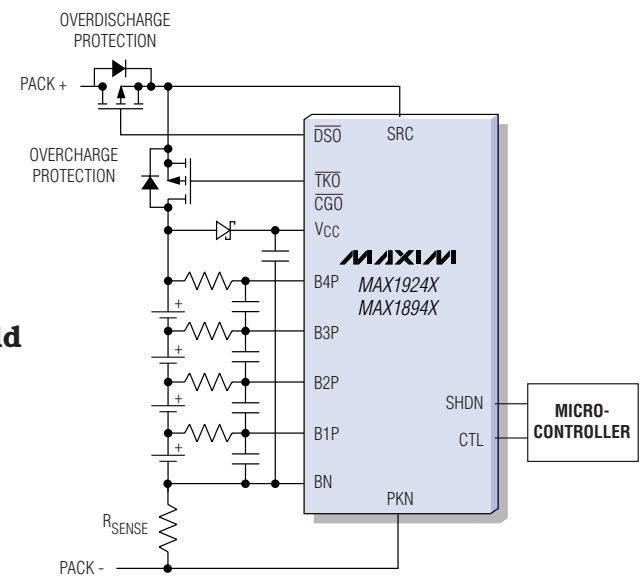
- **Protects Against Overvoltage**
  - **±1% Accurate Protection Thresholds**
  - **Integrated 2.25s Fault Delay Timer**
- **Built-In 1.5A SCR Fuse Driver**
- **Test Mode for Functional Verification in Assembled Pack**
- **5µA Supply Current**
- **800nA Standby Current**
- **Protects Against Disconnected B1P–B4P Pins**



Advanced Li+ Battery Pack Protectors Safely Increase Battery Pack Capacity

The MAX1894/MAX1924 advanced Li+ battery-pack protectors guard rechargeable Li+ cells against overvoltage, undervoltage, charge current, discharge current, and pack-short faults. Fully integrated MOSFET drivers do not require external pullup resistors. The protectors are available in two versions: for 3 series (MAX1924V) and for 4 series (MAX1894X, MAX1924X) Li+ battery packs. They are packaged in a small, 16-pin QSOP.

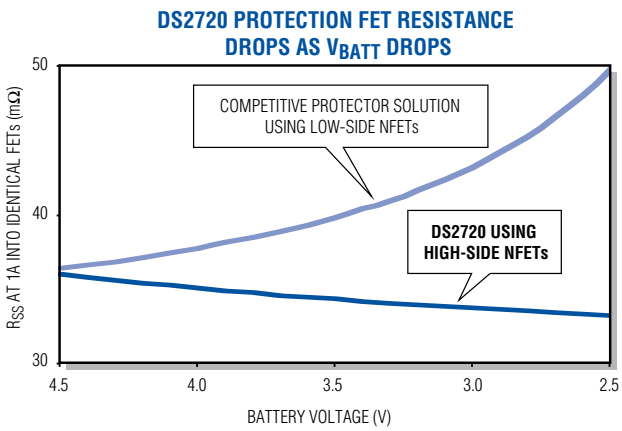
- **±0.5% Accurate Overvoltage Threshold**
- **±10% Accurate Discharge-Current Fault Threshold**
- **Separate Pack-Short and Discharge-Current Fault Thresholds**
- **30µA Operating Current (typ) and 0.7µA Shutdown Current**



Single-Cell Li+ Protector Reduces Pack Resistance as Battery Depletes

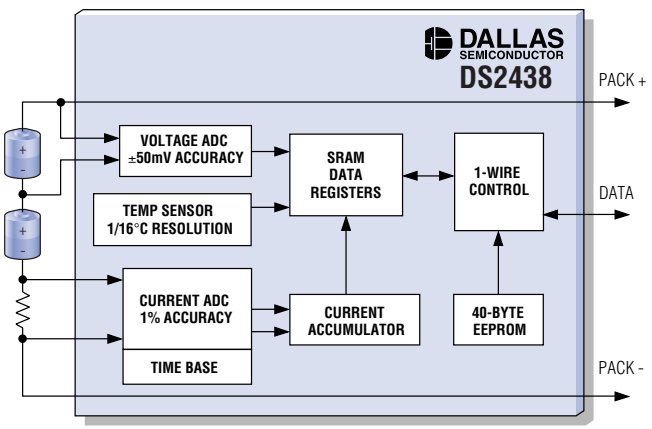
The DS2720 single-cell Li+ protection IC integrates memory, overtemperature protection, and the ability to communicate with the host processor along with the standard over/undervoltage and overcharge protection found in popular standalone protectors. The DS2720's regulated high-side N-FET drive results in lower switch resistance even at the end of discharge. The result is longer runtime for portable equipment.

- **Monitors Cell for Over/Undervoltage, Overcurrent, and Overtemperature**
- **Regulated Charge Pump Supports High-Side N-Channel MOSFETs**
- **8-Byte EEPROM**
- **Integrated Multiple Battery Selector**
- **Low Power: 15µA Active, 1µA Standby**
- **1-Wire Communication Interface**
- **Available in Tiny 8-Pin µSOP Package**



Complete Multicell Precision Battery Monitor in Small 8-Pin SO

Monitors 1 to 2 Li+ or 3 to 6 Ni Cells

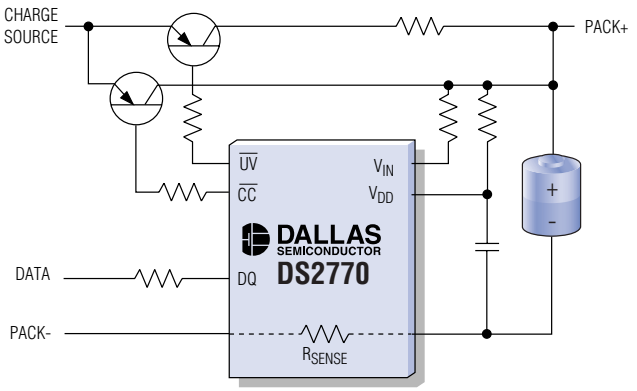


The DS2438 performs all of the necessary functions to monitor a battery including current, voltage, and temperature measurement, as well as information storage and identification. The current measurements are integrated over an internally generated timebase to facilitate fuel gauging. All measurements are made inside the pack for greatest accuracy and can be reported as digital values to the host controller through a 1-Wire communication interface or stored in the on-chip SRAM memory. Additionally, 40 bytes of user NV EEPROM memory are available to store critical pack-specific data.

- **10V Input Voltage Monitors Multiple Cells**
- **Voltage ADC Measures Two Voltages**
- **Current Accumulator with User-Programmable Threshold Enables 5% Fuel-Gauging Accuracy**
- **40-Byte User EEPROM Permanently Stores Critical Data**
- **Uniquely Addressable Interface Allows Multiple Devices on 1-Wire Bus**
- **Current Measurement with Offset Correction**

Industry's Only Charger with Integrated Fuel Gauge Circuitry and Sense Resistor

- **User-Selectable Li+ Pulse Charge or Ni Charge with dT/dt Charge Termination**
- **High-Precision Current Measurement with Real-Time Offset Correction Enables 5% Accuracy Fuel Gauging**
- **Measures Voltage in 5mV and Temperature in 0.125°C Increments**
- **Optional Integrated 25mΩ Sense Resistor, Individually Trimmed on Each DS2770**
- **32 Bytes of Lockable EEPROM**
- **16 Bytes of SRAM, 64-Bit ROM**
- **1-Wire, Multinode Digital Communication Interface**
- **16-Pin TSSOP, With or Without Optional Sense Resistor**



The DS2770 is a battery fuel-gauge device integrated with a charge controller for Li+ or Ni battery chemistries. It contains an optional 25mΩ sense resistor, needed to perform the current measurements for the fuel-gauging function. The DS2770 internally measures the voltage and temperature values needed for charge-termination thresholds and safe-charge environment thresholds. All measurements can be stored in the DS2770's SRAM memory while its EEPROM memory is reserved for user-programmable purposes. All information is reported to the host system through a 1-Wire communication interface.

Battery-Pack Solutions

Part	64-Bit ROM	Real-Time Clock	Interface	Memory (Bytes)	Local Temp Sensor (Bits)	Voltage ADC (Bits)	Fuel Gauge	Li+ Protector	EV Kit	Pin-Package (mm²)
DS2415	✓	✓	1-Wire	—	—	—	—	—	—	6-TSOC, Flip Chip (1.4 x 1.1)
DS2436	✓	—	1-Wire	32 EEPROM	13	10	—	—	DS2436K	TO-92, 8-SO
DS2438	✓	✓	1-Wire	40 EEPROM	13	10	✓	—	DS2438K	8-SO
DS2720	✓	—	1-Wire	8 EEPROM	—	—	—	Single Cell	DS2720K	8-µSOP
NEW DS2740	✓	—	1-Wire	—	—	—	✓	—	DS2740K	8-µMAX
NEW DS2751	✓	—	1-Wire	32 EEPROM	11	11	✓	—	DS2751K	8-TSSOP
DS2762	✓	—	1-Wire	32 EEPROM	11	11	✓	Single Cell	DS2761K	16-TSSOP, Flip Chip (2.5 x 2.7)
DS2770	✓	—	1-Wire	32 EEPROM	11	11	✓	—	DS2770K	16-TSSOP
MAX1780	—	—	SMBus	1.5k ROM	11,13,15, and 16	11,13,15, and 16	✓	2, 3, or 4 Cell	MAX1780 EV Kit	48-TQFP
MAX1894/ MAX1924	—	—	—	—	—	—	—	3 or 4 Cell	MAX1894 EV Kit	16-QSOP
MAX1906	—	—	—	—	—	—	—	2, 3, or 4 Cell	MAX1906 EV Kit	16-QFN

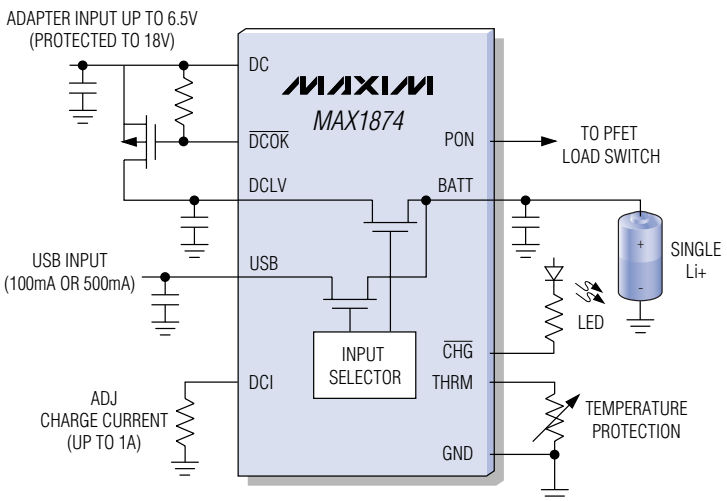
NEW

Li+ Charger Has Dual Input USB and AC Adapter, OVP, and Thermal Regulation

Simple, Low-Cost Application Circuit for 1-Cell Li+ Charging

The MAX1874 charges a single-cell Li+ battery from both USB and AC adapter sources, limiting the need for a bulky wall cube. In its simplest application, the MAX1874 needs no external MOSFET or diodes, and accepts input voltages of up to 6.5V. Overvoltage protection (OVP) up to 18V can be added to the DC input with a single SOT PFET. When the MAX1874 thermal limit is reached, the charger reduces—but does not stop—the charging current.

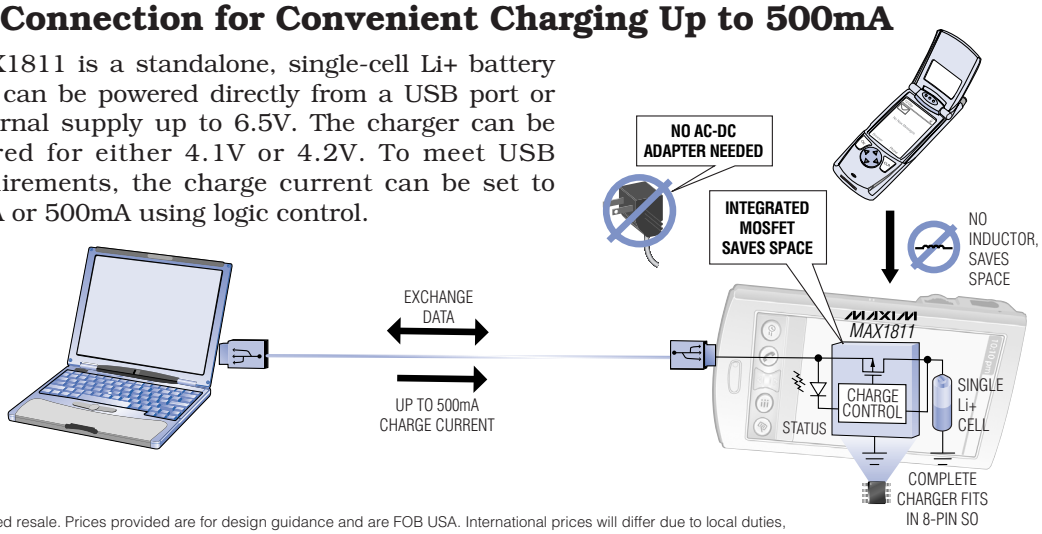
- **Charge from USB or AC Adapter**
- **Automatic Switchover When AC Adapter is Plugged in**
- **On-Chip Thermal Limiting Simplifies Board Design**
- **Small, High-Power 16-Pin QFN Package**
- **Soft-Start Reduces Loading Surges on USB or AC Adapter**
- **Automatic Load Switch From Battery to DC Source (PON Pin)**
- **Priced at $1.75†**



Low-Cost Li+ Battery Charger IC Is Powered by AC Adapter or USB

Charge from the USB Port and Eliminate the Extra AC-DC Adapter; Use USB Connection for Convenient Charging Up to 500mA

The MAX1811 is a standalone, single-cell Li+ battery charger that can be powered directly from a USB port or from an external supply up to 6.5V. The charger can be pin configured for either 4.1V or 4.2V. To meet USB current requirements, the charge current can be set to either 100mA or 500mA using logic control.

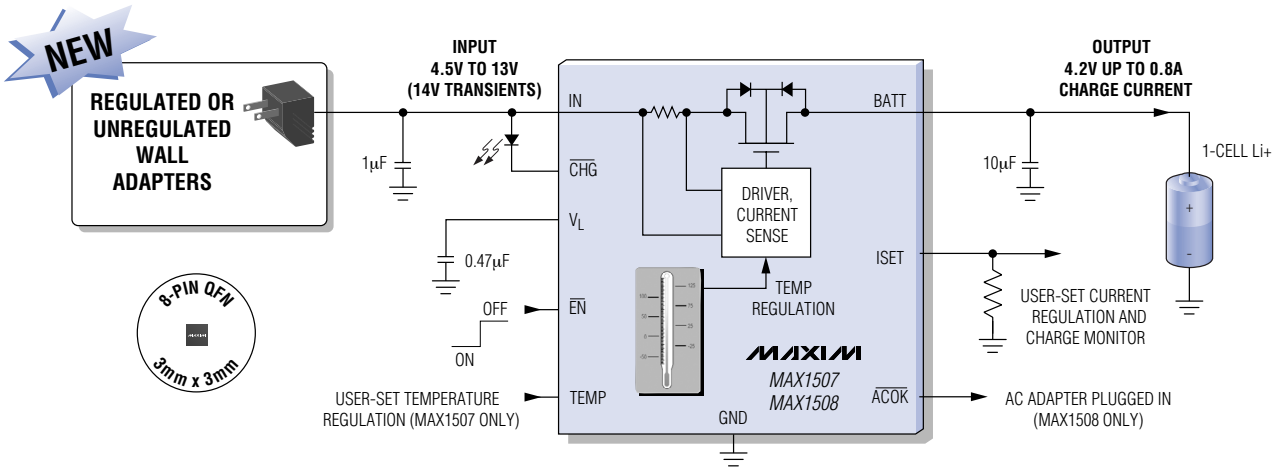


†1000-up recommended resale. Prices provided are for design guidance and are FOB USA. International prices will differ due to local duties, taxes, and exchange rates. Not all packages are offered in 1k increments, and some may require minimum order quantities.

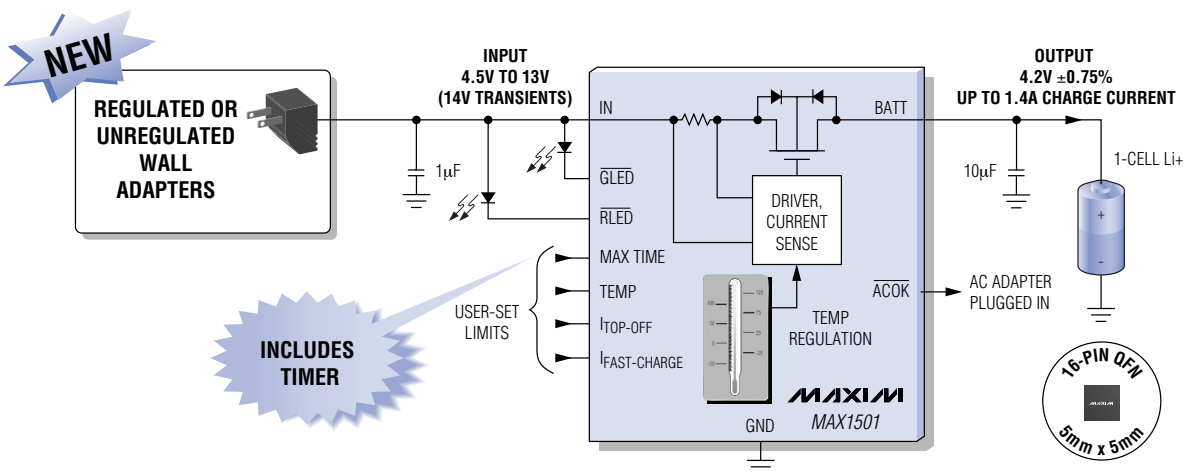
DALLAS SEMICONDUCTOR MAXIM

Smallest 14V Temperature-Regulated, CC-CV Li+ Battery Chargers

All Have Built-In PMOS FET, Reverse Blocking Diode, and R_{SENSE}



- **Tiny 3mm x 3mm 8-Pin QFN Package, 0.85mm High**
- **Proprietary Temperature and CC-CV Regulation**
- **Overvoltage Protection Above 7V Input**
- **Programmable Fast-Charge Current Up to 0.8A**
- **Charge-Current Monitor**
- **0.25V Dropout Voltage at 0.5A**
- **Soft Start**



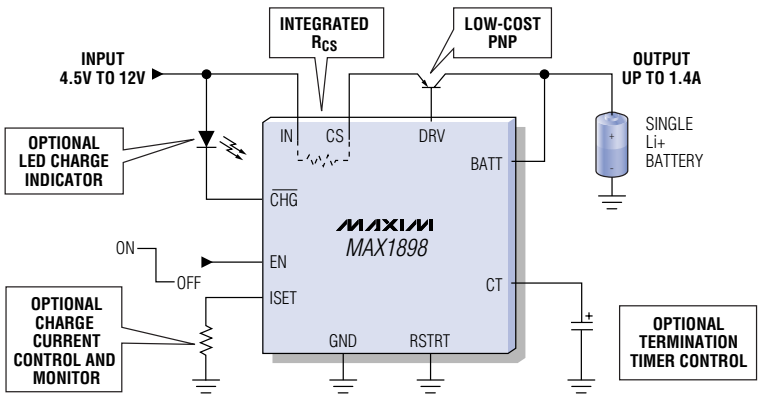
- **Standalone or Microprocessor-Controlled Linear Charging**
- **Charging Stops at Input Voltage >6.5V**
- **Programmable Safety Timer**
- **Current-Sense Monitor Output**
- **Autorestart When V_{BATT} Falls <4V**
- **Priced at $2.41†**

†1000-up recommended resale. Prices provided are for design guidance and are FOB USA. International prices will differ due to local duties, taxes, and exchange rates. Not all packages are offered in 1k increments, and some may require minimum order quantities.

DALLAS SEMICONDUCTOR MAXIM

Simplest Single-Cell Li+ Charger

Complete CC-CV Linear Charging Solution Requires Only a Low-Cost PNP Transistor, Fits in 10-Pin µMAX



- **Simple and Safe Linear Charging Solution**
- **Internal Current-Sense Resistor**
- **Low-Cost PNP or PMOS Pass Element**
- **AC Adapter Detection**
- **±0.75% Battery Voltage Regulation**
- **Programmable Charging Current**
- **Programmable Safety Timer**

Battery Chargers

	Part	No. of Series Li+ Cells	Cell Chemistry	Charge Rate	Charge Termination Method	EV Kit	Features	Pin-Package
	DS2770	1	Li+/Ni	Fast	I_{min},Timer, dT/dt	DS2770K	$15V_{IN}$ ext switch pulse charger integrated with fuel gauge	16-TSSOP
	MAX745	1 to 4	Li+	Fast	Voltage and Current Limit	Yes	High-efficiency switch-mode controller	20-SSOP
NEW	MAX1501	1	Li+	Fast, Up to 1.4A	Voltage and Current Limit, Timer	Yes	$14V_{IN}$, linear, temperature regulated, built-in timer	16-QFN (5mm x 5mm)
NEW	MAX1507/ MAX1508	1	Li+	Fast, Up to 800mA	Voltage and Current Limit	Yes	$14V_{IN}$, temperature regulated, small, $\overline{ACOK}$ (MAX1508)	8-QFN (3mm x 3mm)
FUTURE	MAX1551*/ MAX1555	1	Li+	Fast, Up to 350mA	Voltage and Current Limit	Yes	Dual input USB and AC adapter, linear	5-SOT23
	MAX1645A	1 to 4	Independent	Fast	SMBus Controlled	Yes	SBS level 2 (1.0 compliant) smart battery charger, SMBus interface, current-limiting input	28-QSOP
	MAX1647	1 to 4	Independent	Fast, Up to 4A	SMBus Controlled	Yes	SMBus serial interface, level 2 Duracell/ Intel®-compliant charger	16-NSO, 20-SSOP
	MAX1667	4	Independent	Fast, Up to 4A	SMBus Controlled	Yes	SMBus serial interface, level 2 duracell/Intel-compliant charger	20-SSOP
	MAX1737	1 to 4	Li+	Fast, Up to 4A	Voltage and Current Limit	Yes	Highest efficiency tightest I_{CHARGE} accuracy	28-SSOP
	MAX1757	1 to 3	Li+	Fast, Up to 1.5A	Voltage and Current Limit	Yes	$14V_{IN}$ internal switches, sync rectified step-down, input-current-limit loop, timers	28-SSOP
	MAX1758	1 to 4	Li+	Fast, Up to 1.5A	Voltage and Current Limit	Yes	$28V_{IN}$ internal switches, sync rectified step-down, input-current-limit loop, timers	28-SSOP
	MAX1772	2 to 4	Independent	Fast	Voltage and Current Limit	Yes	$28V_{IN}$ ext switches, sync rectified step-down controller, input-current-limit loop	28-QSOP
	MAX1811	1	Li+	Fast, Up to 500mA	Voltage and Current Limit	—	Linear charger, internal switch, power through USB port, 0.5% precision	8-SO (1.4W)
	MAX1873R/S/T	2/3/4	Li+/Ni	Fast, Up to 4A	Voltage and Current Limit	Yes	$28V_{IN}$ lowest cost step-down controller, 300kHz PWM, input-current-limit loop	16-QSOP
NEW	MAX1874*	1	Li+	Fast, Up to 1A	Voltage and Current Limit	Yes*	Dual input linear charger, USB and AC adapter inputs (18V)	16-QFN (5mm x 5mm)
	MAX1879	1	Li+	Fast, Up to 800mA	Voltage and Current Limit	—	Pulse charger, ext switch, no heat dissipation, upgrade to MAX1679	8-µMAX
NEW	MAX1908/9	2 to 4	Independent	Fast	Voltage and Current Limit	Yes*	$28V_{IN}$ ext switches, sync rectified step-down controller, input-current-limit loop	28-QSOP
	MAX1925/6	1	Li+	Fast, Up to 1A	Voltage and Current Limit	Yes	$12V_{IN}$ ext switches, step-down controller, temp sensor, timers	12-QFN (4mm x 4mm)

*Future product—contact factory for availability.
Intel is a registered trademark of Intel Corp.

NEW

0.5% Accurate Multichemistry Battery Charger Family for Single- and Dual-Battery Systems

The MAX1909 is designed for single-battery systems. If an AC adapter is present, the MAX1909 automatically selects between the adapter and a battery to supply the system. The MAX1908 is designed for high-end, dual-battery systems and offers synchronous rectification using high- and low-side N-channel MOSFETs. Both ICs have 3% accurate current-sense amplifiers and are available in a tiny, 5mm x 5mm, 28-pin QFN package.

MAX1908/MAX1909

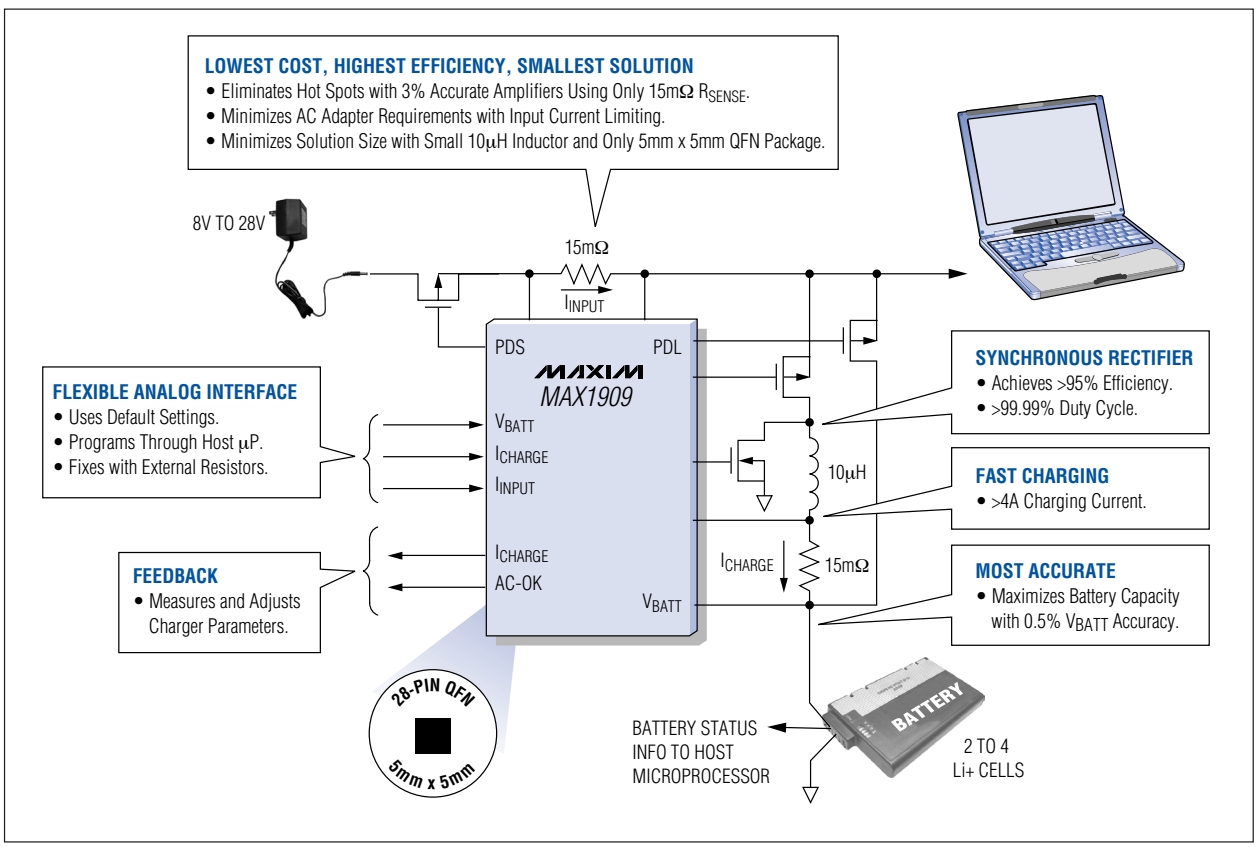
- **400kHz Operation Allows Use of Small 10µH Inductors**
- **3% Accurate Current-Sense Amplifiers**
  - **Use 15mΩ Current-Sense Resistors and Eliminate Hot Spots in the System Chassis**
  - **Maximize Input Current Limit and Charge Current Accuracy**

MAX1908

- **Synchronous Operation with High-Side N-Channel MOSFET**
- **Works with MAX1773 Dual-Battery Selector for Dual-Battery Systems**

MAX1909

- **Automatic Power Path Selection**
- **Battery Calibration to Maximize Battery Capacity**
- **Synchronous or Nonsynchronous Operation**

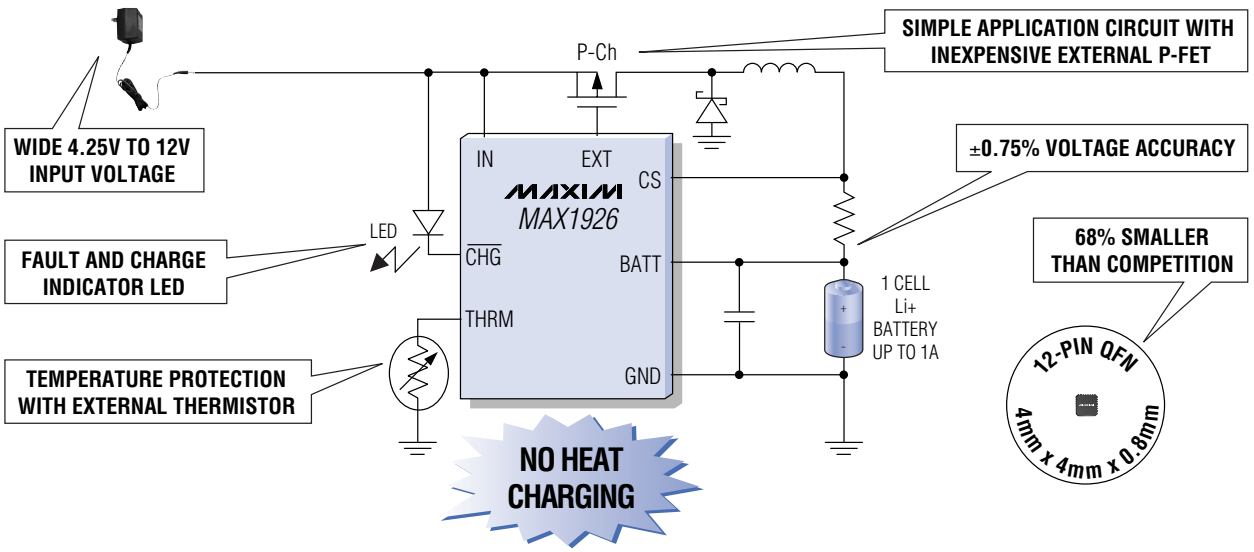


DALLAS SEMICONDUCTOR MAXIM

Smallest, Simplest, Switch-Mode Li+ Charger Dissipates No Heat

Low-Cost, Simple Application Circuit for 1-Cell Li+ Charging

The MAX1925/MAX1926 are single-cell Li+ switch-mode battery chargers for use in digital still cameras (DSCs) and PDAs. The MAX1925/MAX1926 use an external PMOS pass element step-down configuration for high efficiency. Additional features include automatic input power detection, logic-controlled enable, and temperature monitoring with an external thermistor. The MAX1925 disables charging for inputs greater than 6.1V, while the MAX1926 charges for inputs between 4.25V and 12V.



- **4.25V to 12V Input Range**
- **±0.75% Battery Regulation Voltage**
- **Adjustable Charge Current**
- **LED (or Logic-Out) Charge Status and Fault Indicator**
- **Programmable Safety Timer**
- **Thermistor Monitor Input**
- **EV Kit Available to Speed Design**
- **Priced at $1.70†**

How to Design Battery Charger Applications that Require External Microcontrollers and Related System-Level Issues

Notebook computers increasingly require complex battery-charging algorithms and systems. This article provides information and background on lithium-ion (Li+), nickel-cadmium (NiCd), and nickel-metal-hydride (NiMH) batteries and related system-level, switch-mode, and linear battery chargers.

For This Complete App Note, Visit

www.maxim-ic.com/AN680

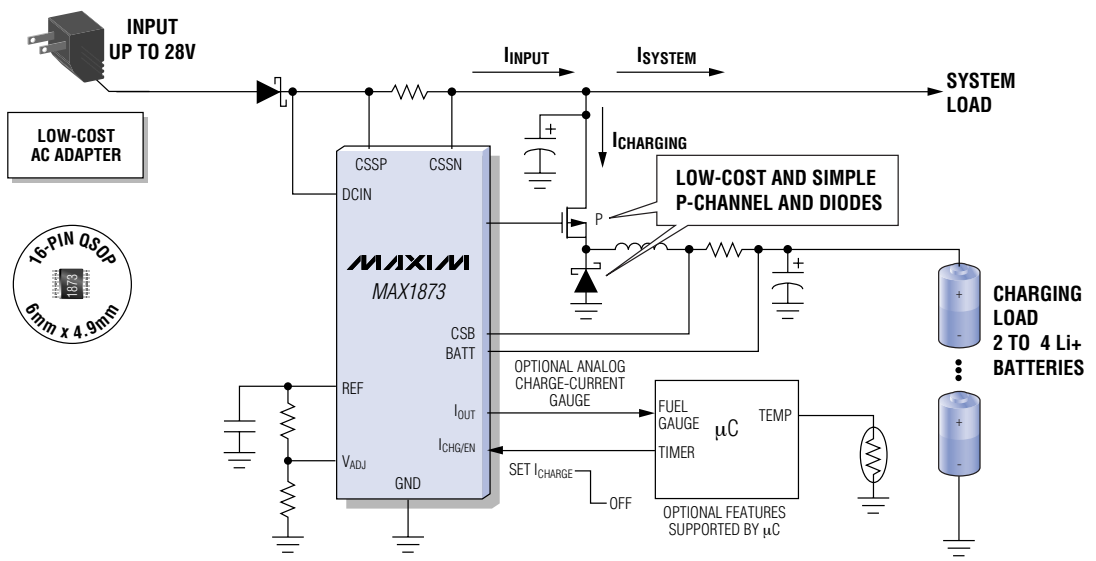
†1000-up recommended resale. Prices provided are for design guidance and are FOB USA. International prices will differ due to local duties, taxes, and exchange rates. Not all packages are offered in 1k increments, and some may require minimum order quantities.

Lowest Cost Switch-Mode Li+ Charger Includes Input-Current Limiting Loop

Charge 2, 3, or 4 Li+ Cells in Notebooks and Internet Tablets

The MAX1873 is the lowest cost Li+ battery charger for 2-, 3-, and 4-cell notebook and Internet tablet systems. It can also be used as a current source for charging 5 to 10 NiMH or NiCd batteries. It provides precise voltage and current regulation and cuts cost by allowing thermal and time monitoring to be controlled by the system's microprocessor and/or keyboard controller. It also includes an input-current control loop that monitors the total draw from the AC adapter. If the sum of the system and charging currents exceeds the wall adapter's current rating, the charging current is reduced, allowing for a low-cost adapter.

LOW-COST SWITCH-MODE Li+ CHARGER INCLUDES INPUT-CURRENT LIMITING

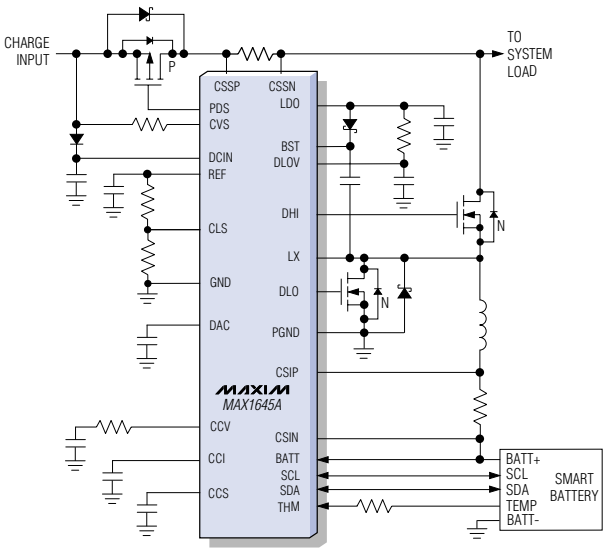


The MAX1873 effectively monitors the input current, charging current, and system current. It reduces the charging current if necessary to prevent the AC adapter from being overdrawn. The MAX1873R is preset for 2 Li+ cells, the MAX1873S for 3 cells, and the MAX1873T for 4 cells.

- **Low-Cost and Simple Li+ Charging**
- **Uses Low-Cost P-Channel and Diode**
- **Charge-Current, System-Current, and Input-Current Control Loops**
- **±0.75% Battery Regulation Voltage**
- **5µA Shutdown Battery Current**
- **Adjustable Current Limit**
- **200mV Dropout Voltage/ 100% Duty-Cycle Capable**
- **Low-Noise 300kHz PWM Step-Down Controller**
- **Evaluation Kit Available to Speed Designs**

SMBus-Controlled, Chemistry-Independent Charger with Input-Current Limiting and Safety Timer

The high-efficiency MAX1645A charges batteries of any chemistry. Input current may be limited so it does not exceed a predetermined current drawn from the DC source, reducing the size and cost of the AC adapter. A 170s charge safety timer prevents “runaway charging” if the MAX1645A stops receiving charging voltage and current commands. Its advanced synchronous buck-regulator control circuitry lowers the minimum input-voltage-to-output-voltage drop by allowing the duty cycle to exceed 99%. The MAX1645A can easily charge 3 to 4 series Li+ cells with only 0.3V of headroom.

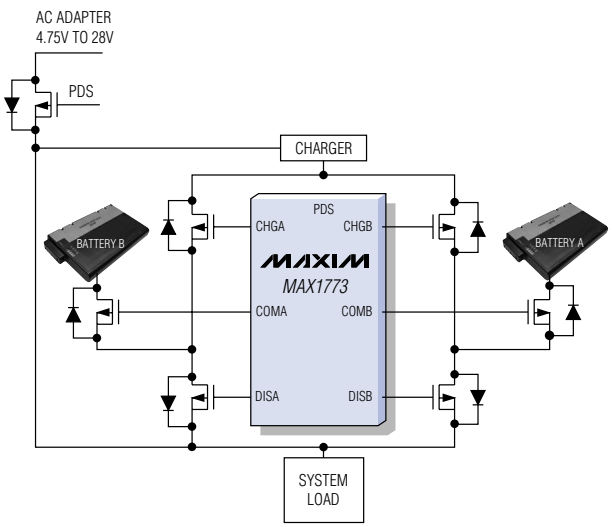


- **Input-Current Limiting**
- **170s Charge Safety Timeout**
- **±0.8% Charge Voltage Accuracy**
- **99.99% Duty Cycle for Low-Dropout Operation**

Power-Source Selector Minimizes System Cost and Complexity

The highly integrated MAX1773 serves as the control logic for systems with multiple power sources. It directly drives external P-channel MOSFETs to select from an AC adapter and dual-battery sources for charge and discharge. The selection is made based on the presence of the power sources and the state of the batteries.

The MAX1773 is designed for use with a buck-topology charger. It provides a simple and easily controlled solution to a difficult analog power control problem. The MAX1773 provides most of the power-source monitoring and selection, freeing the power-management microprocessor (µP) for other tasks. This not only simplifies development of the power management firmware for the µP, but also allows the µP to enter standby, thereby reducing system power consumption.



- **Patented 7-MOSFET Topology Offers Low-Cost Solution**
- **Automatically Detects and Responds to:**
  - **Low-Battery Voltage Condition**
  - **Battery Insertion and Removal**
- **AC Adapter Presence**
- **Simplifies Power-Management Software**

Battery Management ICs

Battery-Pack Protectors

- ☆ DS2720 1-Cell Li+
- ☆ DS2760/DS2761/ DS2762 Li+ Fuel Gauge w/ Pack Protection
- ☆ MAX1666 2/3/4-Cell Li+
- ☆ MAX1894X 4-Cell Li+
- ☆ MAX1906S 2-Cell Li+
- ☆ MAX1906V 3-Cell Li+
- ☆ MAX1906X 4-Cell Li+
- ☆ MAX1924V 3-Cell Li+
- ☆ MAX1924X 4-Cell Li+

Battery-Pack Controller

- ☆ MAX1780 Fuel Gauge w/ RISC Core, V-to-F, Voltage ADC, SMBus

Battery-Pack ID

- ☆ DS1822 Digital Therm, EEPROM
- DS2401 Lowest Cost Pack ID
- DS2415 Real-Time Clock
- DS2432 EEPROM w/ SHA-1 Encrypt
- ☆ DS2436 Digital Therm, EEPROM, Voltage ADC
- ☆ DS2438 Fuel Gauge, Voltage ADC, Digital Therm, EEPROM
- ★☆ DS2740 Fuel Gauge
- ★☆ DS2751 Multichemistry Fuel Gauge
- ★☆ DS2760/DS2761/DS2762 Li+ Fuel Gauge w/ Pack Protection
- ☆ DS2770 Fuel Gauge w/ Li+/Ni Charger

Battery Data Acquisition

- ☆ DS1822 Digital Therm EEPROM
- DS2415 Real-Time Clock
- ☆ DS2436 Digital Therm, EEPROM, Voltage ADC

Fuel Gauges

- ☆ DS2438 Fuel Gauge, Voltage ADC, Digital Therm, EEPROM
- ★☆ DS2740 Fuel Gauge
- ★☆ DS2751 Multichemistry Fuel Gauge
- ★☆ DS2760/DS2761/ DS2762 Li+ Fuel Gauge w/ Pack Protection
- ☆ DS2770 Fuel Gauge w/ Li+/Ni Charger
- ☆ MAX1780 Fuel Gauge w/ RISC Core, V-to-F, Voltage ADC, SMBus

Accessory Supplies

- MAX1615 Backup LDO, $28V_{IN}$, 8µA I_Q
- MAX1725/ MAX1726 Backup LDO, $12V_{IN}$, 2µA I_Q
- MAX1773 Controls Systems w/ Multipower and Battery Sources
- ☆ MAX1776 Backup Step-Down in 8-µMAX, $24V_{IN}$, 500µA Out, 15µA I_Q
- ☆ MAX1836/MAX1837 Backup Step-Down in 6-SOT23, $24V_{IN}$, 125mA/250µA Out, 12µA I_Q

Battery Chargers

- ☆ DS2770 Li+/Ni Pulse Charger w/ Fuel Gauge
- ★☆ MAX1501 $14V_{IN}$, Linear, Li+, Temp. Regulation, Built-in Timer
- ★☆ MAX1507/ MAX1508 $14V_{IN}$, Linear, Li+, Temp. Regulation, Smallest, $\overline{ACOR}$ (MAX1508)
- † MAX1551/MAX1555 Dual-Input,1-Cell Li+ Linear Charger, Up to 350mA Charge Current, SOT23
- ☆ MAX1645A 2- to 4-Cell Li+/Ni Switcher, Charger, SMBus
- ☆ MAX1737 1-4 Cell Li+ Switcher,Tightest Charge, Current Tolerance
- ☆ MAX1772 2- to 4-Cell Li+/Ni Switcher, Charger, w/o SMBus
- MAX1811 1-Cell Li+ Linear Charger, Powered from USB Port
- ☆ MAX1873 2- to 4-Cell Li+ Switcher, Lowest Cost
- ★☆ MAX1874 1-Cell Li+ Linear Charger, Dual-Input Powered from USB or AC Adapter
- ☆ MAX1879 1-Cell Li+ Pulse Charger
- ☆ MAX1898 1-Cell Li+ Linear Charger, $12V_{IN}$
- ★☆ MAX1908 2- to 4-Cell Li+ Switcher Charger Dual Battery Systems
- ★☆ MAX1909 2- to 4-Cell Li+ Switcher Charger Single Battery Systems
- ☆ MAX1925/ MAX1926 1- to 4-Cell Li+ Switcher,$12V_{IN}$, Temp Sensor and Timers

★ New product
† Future product
☆ Evaluation kit available