

# Sine On™

An Analog Product Catalog

1Q 2003

# Battery Management

## Charge Management

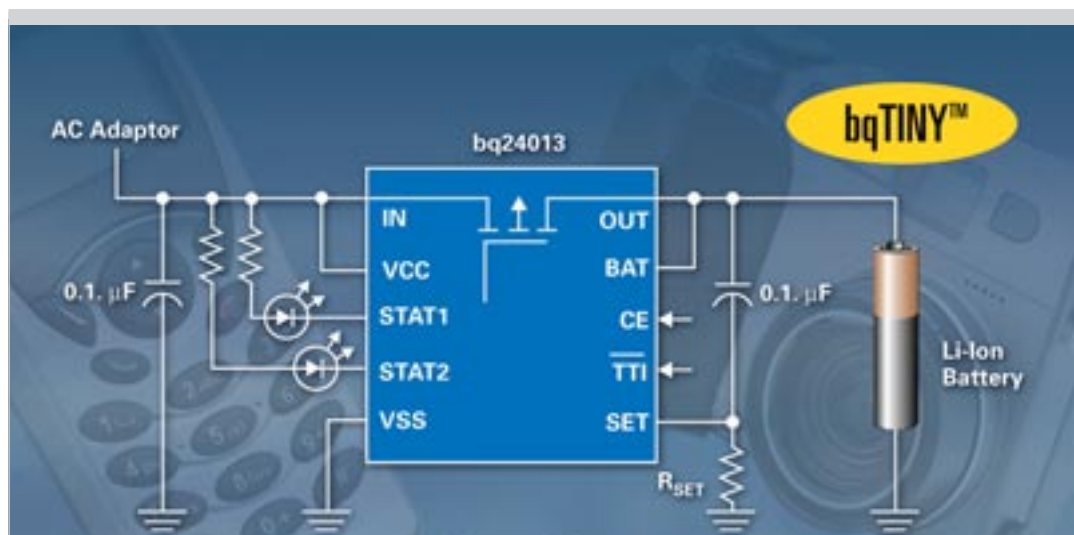
- 2** 1-cell Li-Ion charger with 1-A FET and current sense  
Single-chip Li-Ion charger with autonomous USB Port
- 3** 1-cell Li-Ion charger for off-line applications  
Li-Ion charger with integrated FET in 5x5-mm QFN/MLP package
- 4** Programmable, multi-chemistry charge management IC  
Single-chip Li-Ion charge management IC for current-limited applications

## Battery Fuel Gauge

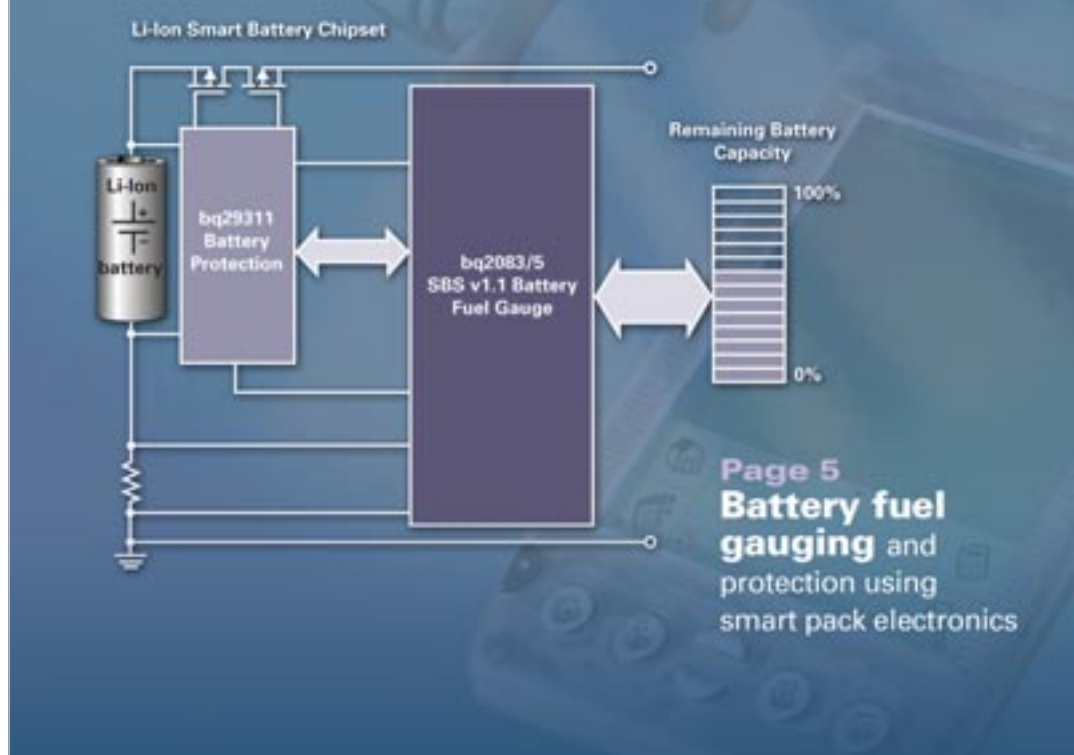
- 5** Smart battery pack electronics for three to four series Li-Ion battery packs  
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bqTINY™ II



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**Battery fuel gauging** and protection using smart pack electronics

## Charge Management

### bqTINY™ – 1-cell Li-Ion charger with 1-A FET and current sense

NEW

#### bq2401x



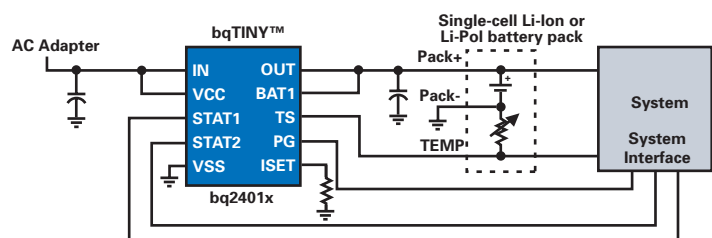
Get samples, datasheets, EVMs and app notes at:

[www.ti.com/sc/device/partnumber](http://www.ti.com/sc/device/partnumber)

Replace **partnumber** in URL with bq24010, bq24012, bq24013

- Integrated powerFET, current sensor, and reverse-blocking Schottky diode
- Charges single-cell Li-Ion or Li-Polymer battery pack with up to 1-A charge current and low dropout
- Input voltage: 3 V to 18 V
- Power Good (AC adapter present) status output
- Charge-status outputs for LED or host processor interface to indicate charge in progress, charge completion and fault
- Current and voltage regulation control
- Charge termination by minimum current and time
- Pre-charge conditioning with safety timer
- Small 3x3mm<sup>2</sup> QFN/MLP package
- Optional temperature monitoring battery
- Automatic low-power sleep mode
- Packaging: QFN/MLP-10; Device name package is DRC ex. bq24010DRC
- Suggested resale price starts at \$1.84 each in quantities of 1,000

#### Small, integrated charging solution for single-cell Li-Ion



#### Applications include:

All 1-cell Li-Ion battery-operated products, including:

- PDAs
- Smartphones
- Internet audio players
- Data loggers
- GPS systems
- Bluetooth™ headsets

### bqTINY™ II – Single-chip Li-Ion charger with autonomous USB port and AC adapter supply management

NEW

#### bq2402x



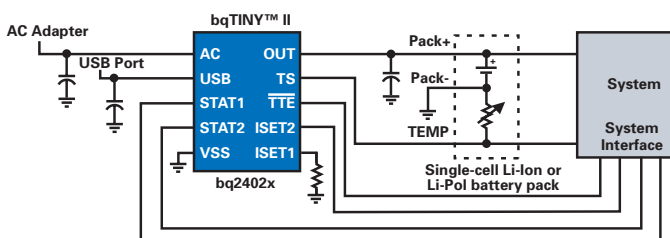
Get samples, datasheets, EVMs and app notes at:

[www.ti.com/sc/device/partnumber](http://www.ti.com/sc/device/partnumber)

Replace **partnumber** in URL with bq24020, bq24022, bq24023

- Autonomously charges and powers the system from either the AC adapter or USB port
- Integrated USB charge control with selectable 100-mA and 500-mA charge rates
- Integrated 1-A power FET, current sensor and reverse current protection
- Charges single-cell Li-Ion or Li-Polymer battery pack with up to 1-A charge current and low dropout
- Charge enable and termination of timer enable
- Charge-status outputs for LED or host processor interface to indicate charge in progress, charge completion and fault
- Current and voltage regulation control
- Charge termination by minimum current and time
- Pre-charge conditioning with safety timer
- Small 3x3-mm<sup>2</sup> QFN/MLP package
- Automatic 10-μA, low-power sleep mode
- Packaging: QFN/MLP-10
- Suggested resale price starts at \$2.09 each in quantities of 1,000

#### Small, Integrated Solution for USB and AC charging



#### Applications include:

All 1-cell Li-Ion or Li-Pol battery-operated products, including:

- PDAs & Smartphones
- Internet audio players
- Digital cameras
- Internet appliances
- Bluetooth™ audio headsets

## Charge Management

### 1-cell Li-Ion charger for off-line applications

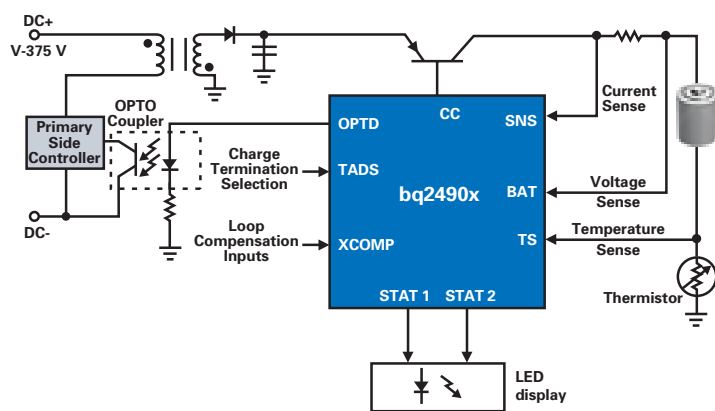
#### bq24901



Get samples, datasheets and EVMs at:  
[www.ti.com/sc/device/bq24901](http://www.ti.com/sc/device/bq24901)

- Ideal for off-line charger design for single-cell Li-Ion packs with graphite anodes (4.2 V)
- Provides control feedback to a primary-side controller, such as TOPSwitch® or TinySwitch™
- Charge current and voltage regulation feedback to primary side for high-accuracy charging
- Charge termination by minimum current and time
- Pre-charge conditioning regulator with safety timer
- Enable input for charge suspension
- Charge status outputs for LED or host processor interface indicates charge-in progress, charge completion and fault conditions
- Temperature monitoring before and during charge
- Packaging: 14-pin TSSOP
- Suggested resale price starts at \$1.99 each in quantities of 1,000

Typical 1-cell Li-Ion offline charger application circuit



#### Applications include:

- Digital camera chargers
- Any compact standalone charger

### Li-Ion charger with integrated FET now in 5x5-mm QFN/MLP package

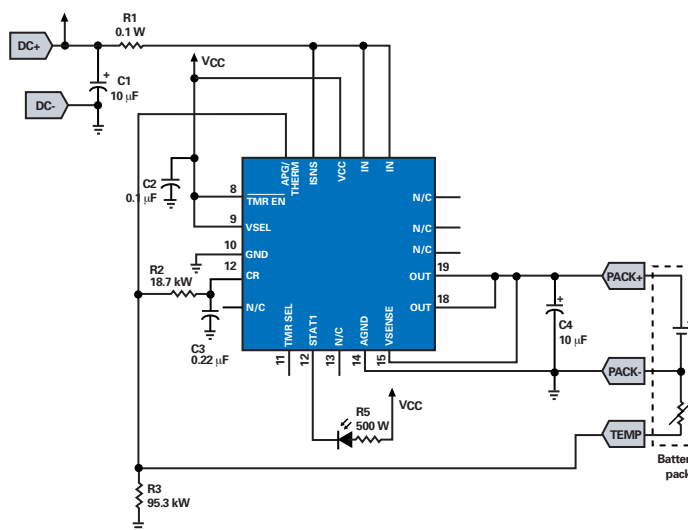
#### bq24007



Get samples, datasheets and EVMs at:  
[www.ti.com/sc/device/bq24007](http://www.ti.com/sc/device/bq24007)

- Highly integrated solution with FET pass transistor, reverse-blocking Schottky diode and thermal protection
- Up to 1.2-A continuous charge current with low dropout voltage
- Safety charge timer during preconditioning and fast charge
- Timer-enable function allows host to disable charge timer and minimum current termination when charge current is shared with a load or when battery is absent
- Integrated voltage and current regulation with programmable charge current
- High-accuracy voltage regulation (<1%)
- Integrated cell conditioning for reviving deeply discharged cells
- Two charge-status output options: single or bicolor LED
- 1- $\mu$ A low-power sleep mode
- Packaging: 20-pin QFN/MLP, 20-pin TSSOP
- Suggested resale price starts at \$1.69 each in quantities of 1,000

1-A single-cell charger with safety timer disabled



#### Applications include:

- Cellular phones
- PDAs
- Internet appliances

## Charge Management

### Programmable, multi-chemistry charge management IC

#### bq2000, bq2000T



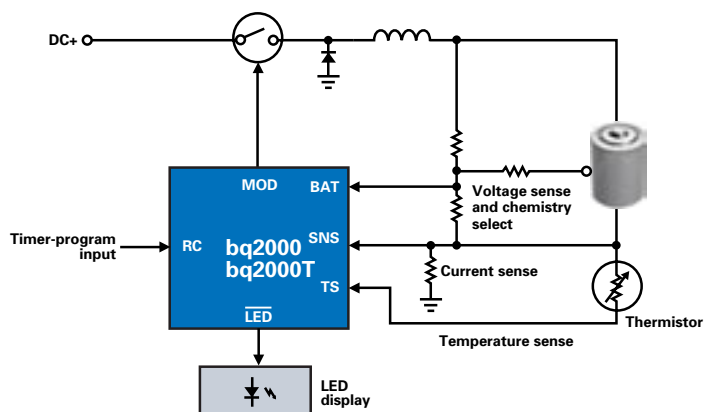
Get samples, datasheets, EVMs and app notes at:

[www.ti.com/sc/device/partnumber](http://www.ti.com/sc/device/partnumber)

Replace **partnumber** in URL with bq2000, bq2000t

- Safe management of fast-charge for NiCd, NiMH or Li-Ion/Li-Pol battery packs
- Integrated high-frequency, switching controller for efficient and simple charger design
- Pre-charge qualification for detecting shorted, damaged or overheated cells
- Fast-charge termination by peak voltage (bq2000), rate of temperature rise (dT/dt) (bq2000T), minimum current (Li-Ion), maximum temperature and maximum charge time
- Selectable top-off mode for achieving maximum capacity in NiMH batteries
- Programmable trickle-charge mode for reviving deeply discharged batteries and for post-charge maintenance
- Built-in battery removal and insertion detection
- Sleep mode for low power consumption
- Packaging: 8-pin TSSOP, 8-pin SOIC, 8-pin DIP
- Suggested resale price starts at \$1.59 each in quantities of 1,000

#### Switch mode, multi-chemistry charger



#### Applications include:

- Desktop chargers
- Handheld terminals
- Portable medical and test equipment
- PDAs

### Single-chip Li-Ion charge management IC for current-limited applications

#### bq2420x



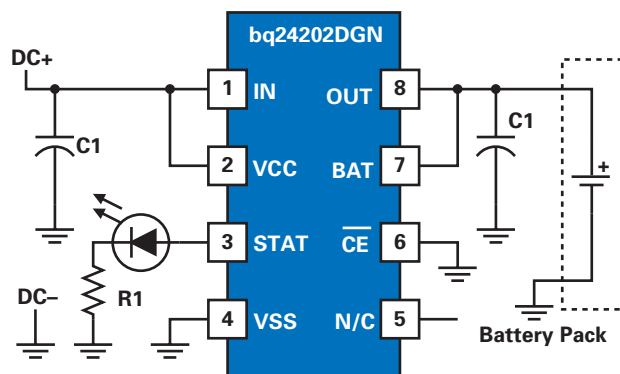
Get samples, datasheets, EVMs and app notes at:

[www.ti.com/sc/device/partnumber](http://www.ti.com/sc/device/partnumber)

Replace **partnumber** in URL with bq24200, bq24201, bq24202, bq24203, bq24204, bq24205

- Designed specifically to work with current-limited wall supplies
- Ideal for low dropout charger design for single-cell Li-Ion packs with coke or graphite anodes
- Integrated PowerFET for 500 mA
- Integrated voltage regulation with 0.5% accuracy
- Battery insertion and removal detection
- Charge termination by minimum current and time
- Pre-charge conditioning with safety timer
- Sleep mode for low-power consumption
- Charge status output for LED or host processor interface – indicates charge-in-progress, charge completion and fault-conditions
- Optional temperature monitoring before and during charge
- Packaging: 8-pin PowerPAD™ MSOP
- Suggested resale price starts at \$1.39 each in quantities of 1,000

#### Li-Ion charger in typical current-limited application



#### Applications include:

- Cellular telephones
- Internet audio players
- PDAs
- Smartphones

## Battery Fuel Gauge

### Smart battery pack electronics for three or four series Li-Ion battery packs

#### bq2083/5 and bq29311

**NEW**

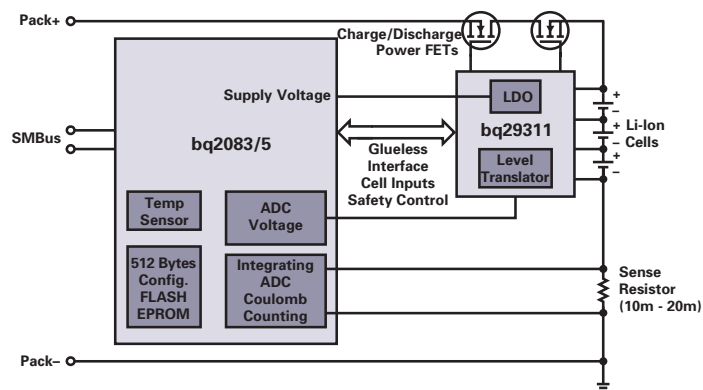

Get samples, datasheets and EVMs at:

[www.ti.com/sc/device/partnumber](http://www.ti.com/sc/device/partnumber)

Replace partnumber in URL with bq2083, bq2085, bq29311

- Provides battery fuel gauging (bq2083/5) and protection (bq29311) for 10.8-V or 14.4-V Li-Ion battery packs
- Integrated time-base on bq2085
- Supports SBS Smart Battery Data specification v1.1
- Chipset solution for maximum safety and minimal component count
- Measures charge flow using a high resolution 16-bit integrating converter
  - Better than 3-nVh of resolution
  - Self-calibrating
  - Offset error less than 1 $\mu$ V
- Programmable cell modeling and sensitive integrating converter maximize battery fuel gauge accuracy
- On-board configuration data Flash
- Packaging: bq2083DBT, bq2085DBT = 38-pin TSSOP, bq29311PW = 24-pin TSSOP
- Suggested resale pricing starts at \$4.25/\$4.35 and \$1.20 each for the bq2083/5 and bq29311, respectively, in quantities of 1,000

#### Typical Application Diagram



#### Applications include:

- Handheld terminals
- Medical and test equipment
- Portable instrumentation
- Communication radios
- Notebook computers

### Smart battery pack electronics for two series Li-Ion battery packs

#### bq2084 and bq29312

**Available March 2003**

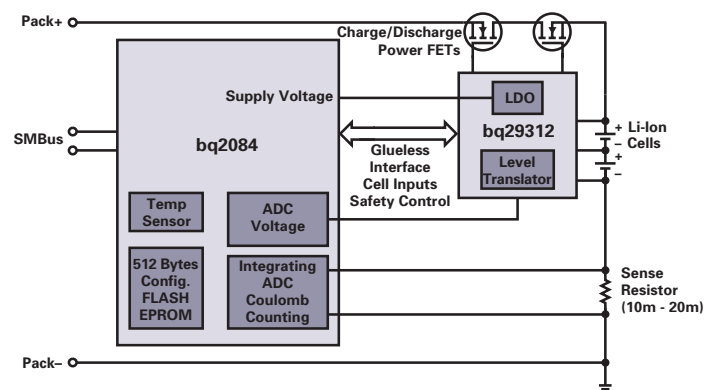

Get datasheets at:

[www.ti.com/sc/device/partnumber](http://www.ti.com/sc/device/partnumber)

Replace partnumber in URL with bq2084, bq29312

- Provides battery fuel gauging (bq2084) and protection (bq29312) for 8.4-V, 10.8-V or 14.4-V Li-Ion battery packs
- Supports SBS Smart Battery Data specification v1.1
- Chipset solution for maximum safety and minimal component count
- 4x4-mm bq29312 package for reduced solution size
- Measures charge flow using a high resolution 16-bit integrating converter
  - Better than 3 nVh of resolution
  - Self-calibrating
  - Offset error less than 1 $\mu$ V
- Programmable cell modeling and sensitive integrating converter maximize battery fuel gauge accuracy
- On-board configuration data Flash
- Packaging: bq2084DBT = 38-pin TSSOP, bq29312RGF = 24-pin QFN
- Suggested resale pricing starts at \$4.25 and \$1.20 for the bq2084 and bq29312, respectively, in quantities of 1,000

#### Typical Application Diagram



#### Applications include:

- Handheld terminals
- Medical and test equipment
- Portable instrumentation
- Communication radios
- Notebook computers
- Tablet computing machines

## Battery Fuel Gauge

### Flash-based precision battery monitors for battery fuel gauging

#### bq26200/bq26220



Get samples, datasheets, and EVMs at:

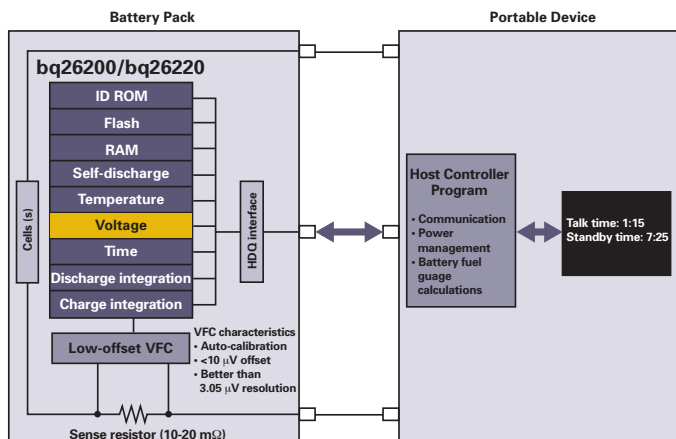
[www.ti.com/sc/device/partnumber](http://www.ti.com/sc/device/partnumber)

Replace partnumber in URL with bq26200, bq26220

- High performance voltage-to-frequency converter (VFC) for accurate measurement of charge and discharge currents
- On-chip voltage measurement on bq26220
- Allows the host controller to accurately track remaining battery capacity and predict remaining system run time
- Works with any battery chemistry
- Auto measurement calibration ensures low VFC offset error (1 $\mu$ V typical) over temperature and voltage variations
- 8 bytes of ID ROM can store unique battery pack or system identification code
- 32 bytes of RAM and 64 bytes of Flash memory
- Internal temperature sensor can eliminate thermistor in a battery pack
- Low operating current of <30 $\mu$ A with <1- $\mu$ A standby (bq26220)
- Packaging: 8-pin TSSOP
- Suggested resale price starts at \$1.87 (bq26200) and \$1.92 (bq26220) each in quantities of 1,000

#### Portable System Interface

The bq26200/bq26220 monitors critical battery parameters and communicates the information to the portable device.



Note: On-chip voltage measurement with bq26220

#### Applications include:

- PDAs
- Cellular handsets
- Portable instrumentation

### Host software development notes for battery monitors

A battery monitor is a low-power measurement device that monitors charge/discharge activity of the battery, battery voltage and temperature. It is the fundamental building block for a low-cost battery fuel gauge. The system's host micro-controller must read data from the battery monitor and calculate meaningful data such as remaining system run-time. The gas gauge algorithm developed for the host micro-controller consists of software routines that:

- Periodically read the battery monitor registers
- Calculate remaining battery capacity based on the charge/discharge readings
- Make efficiency and self-discharge adjustments
- Calculate the predicted run time to empty

This gas gauge algorithm can be developed with the help of four TI application development notes:

#### Gas Gauging Basics Using TI Battery Monitor ICs

(SLVA102) - [power.ti.com/gasgaugebasics](http://power.ti.com/gasgaugebasics)

- Describes using a battery monitor for battery fuel gauging
- Reviews how a battery monitor accurately counts charge and discharge (coulomb counting)
- Shows how to select the proper sense resistor
- Details how to perform basic calculations using data from the battery monitor

#### HDQ Communication Basics for TI Battery Monitor ICs

(SLVA101) - [power.ti.com/hdqbasics](http://power.ti.com/hdqbasics)

- Describes how to implement the HDQ battery monitor communication protocol using a micro-controller general purpose input/output port (GPIO) or a Universal Asynchronous Receiver Transmitter (UART)
- Includes example code to read from and write to a battery monitor

#### Advanced Gas Gauge Host Firmware for TI Battery Monitor ICs

(SLVA100) - [power.ti.com/hostfirmware](http://power.ti.com/hostfirmware)

#### Advanced Gas Gauge Firmware Flowchart for TI Battery Monitor ICs

- [power.ti.com/firmwareflowchart](http://power.ti.com/firmwareflowchart)

- Describes and flowcharts an example gas gauge algorithm for the host micro-controller
- Includes a practical illustration of the host code required to implement a battery fuel gauge using a battery monitor IC from TI

### Selection Guides

Charger Selection Guide															
Device	Control Topology <sup>1</sup>	Comments	Charge Termination Method		Features			Packaging					Price <sup>3</sup>		
			Primary <sup>2</sup>	Secondary	Safety Timer	Temperature Monitoring	Charge Status Outputs	QFN / MLP	MSOP	TSSOP	SOIC	DIP		EVM	
<b>Multi-Chemistry (Li-Ion &amp; NiCd/NiMH)</b>															
bq2000	Switching	Chemistry-specific charge termination for NiCd, NiMH and Li-Ion	PVD, min current	Max temp, time	Yes	Yes	1			8	8	8	✓	1.59	
bq2000T	Switching	Chemistry-specific charge termination for NiCd, NiMH and Li-Ion	$\Delta T/\Delta t$ , min current	Max temp, time	Yes	Yes	1			8	8	8	✓	1.59	
bq24700	Switching	Programmable triple loop PWM, Dynamic Power Management	Host controlled	Host controlled	No	No	0			24			✓	1.89	
bq24701	Switching	Programmable triple loop PWM, Dynamic Power Management	Host controlled	Host controlled	No	No	0			24			✓	1.89	
<b>Lithium-Ion Chemistry</b>															
<b>bq24200</b>	Current-limited	Integrated FET (500 mA), 4.2-V regulation	Min current	Max temp, time	Yes	Yes	1			8			✓	1.39	
<b>bq24201</b>	Current-limited	Integrated FET (500 mA), 4.1-V regulation	Min current	Max temp, time	Yes	Yes	1			8			✓	1.39	
<b>bq24202</b>	Current-limited	Integrated FET (500 mA), 4.2-V regulation	Min current	Time	Yes	No	1			8			✓	1.39	
<b>bq24203</b>	Current-limited	Integrated FET (500 mA), 4.1-V regulation	Min current	Time	Yes	No	1			8			✓	1.39	
<b>bq24204</b>	Current-limited	Integrated FET (500 mA), 4.2-V regulation	Min current	Time	Yes	No	0			8			✓	1.39	
<b>bq24205</b>	Current-limited	Integrated FET (500 mA), 4.1-V regulation	Min current	Time	Yes	No	0			8			✓	1.39	
bq2057	Linear	Low dropout, 4.1-V regulation, AutoComp™	Min current	Max temp	No	Yes	1			8	8	8	✓	1.26	
bq2057C	Linear	Low dropout, 4.2-V regulation, AutoComp	Min current	Max temp	No	Yes	1			8	8	8	✓	1.26	
bq2057T	Linear	Low dropout, 8.2-V regulation, AutoComp	Min current	Max temp	No	Yes	1			8	8	8	✓	1.26	
bq2057W	Linear	Low dropout, 8.4-V regulation, AutoComp	Min current	Max temp	No	Yes	1			8	8	8	✓	1.26	
bq24001	Linear	Integrated FET (1.2 A), 4.1-V/4.2-V regulation	Min current	Max temp, time	Yes	Yes	1	20		20			✓	1.69	
bq24002	Linear	Integrated FET (1.2 A), 4.1-V/4.2-V regulation	Min current	Max temp, time	Yes	Yes	2	20		20			✓	1.69	
bq24003	Linear	Integrated FET (1.2 A), 4.1-V/4.2-V regulation	Min current	Max temp, time	Yes	Yes	Bi-color	20		20			✓	1.69	
bq24004	Linear	Integrated FET (1.2 A), 8.2-V/8.4-V regulation	Min current	Max temp, time	Yes	Yes	1	20		20			✓	1.69	
bq24005	Linear	Integrated FET (1.2 A), 8.2-V/8.4-V regulation	Min current	Max temp, time	Yes	Yes	2	20		20			✓	1.69	
bq24006	Linear	Integrated FET (1.2 A), 8.2-V/8.4-V regulation	Min current	Max temp, time	Yes	Yes	Bi-color	20		20			✓	1.69	
bq24007	Linear	Integrated FET (1.2 A), 4.1-V/4.2-V regulation, timer enable	Min current	Max temp, time	Yes	Yes	1	20		20			✓	1.69	
bq24008	Linear	Integrated FET (1.2 A), 4.1-V/4.2-V regulation, timer enable	Min current	Max temp, time	Yes	Yes	Bi-color	20		20			✓	1.69	
<b>bq24010</b>	Linear	Integrated FET (1 A) and current sense, 4.2-V regulation, AC present (AC)	Min current	Max temp, time	Yes	Yes	2	10					✓	1.84	
<b>bq24012</b>	Linear	Integrated FET (1 A) and current sense, 4.2-V regulation, AC present, charge enable	Min current	Time	Yes	No	2	10				4	✓	1.84	
<b>bq24013</b>	Linear	Integrated FET (1 A) and current sense, 4.2-V regulation, charge (CE), timer and termination enable (TTE)	Min current	Time	Yes	No	2	10					✓	1.84	
<b>bq24020</b>	Linear	USB/AC charging, integrated FET (1 A) and current sense, 4.2-V regulation, CE, temperature sense	Min current	Max temp, time	Yes	Yes	2	10					✓	2.09	
<b>bq24022</b>	Linear	USB/AC charging, integrated FET (1 A) and current sense, 4.2-V regulation, AC, CE	Min current	Time	Yes	No	2	10					✓	2.09	
<b>bq24023</b>	Linear	USB/AC charging, integrated FET (1 A) and current sense, 4.2-V regulation, CE, timer and termination enable	Min current	Time	Yes	No	2	10					✓	2.09	
<b>bq24901</b>	Switching	Primary-side controller for offline chargers, 4.2 V	Min current	Time	Yes	Yes	2					14	✓	1.99	
bq2054	Switching	200-kHz PWM control, low-side current sense, 2 LED modes	Min current	Time	Yes	Yes	3					16	16	✓	2.19
bq2954	Switching	200-kHz PWM control, low/high-side current sense, 3 LED modes	Min current	Max temp, time	Yes	Yes	2					16	16	✓	2.34
UCC3956	Switching	PWM control, differential current sense, programmable charge termination, 20-V V <sub>CC</sub> rating	Min current	Time	Yes	No	2					20	20	✓	1.92
<b>NiCd/NiMH Chemistry</b>															
bq2002/C/E/F	Current-limited	Low-cost Nickel charging solution, different timing and voltage threshold options	- $\Delta V$ , PVD	Max temp, time	Yes	Yes	1					8	8	✓	0.99
bq2002D/T	Current-limited	Low-cost Nickel charging solution, different timing and voltage threshold options	$\Delta T/\Delta t$	Max temp, time	Yes	Yes	1					8	8	✓	0.99
bq24400	Switching	High-frequency switching controller for complete, efficient and simple charger designs	PVD, min current	Max temp, time	Yes	Yes	1			8	8	8		1.45	
bq24401	Switching	High-frequency switching controller for complete, efficient and simple charger designs	$\Delta T/\Delta t$ , min current	Max temp, time	Yes	Yes	1			8	8	8		1.45	
bq2003	Switching	Discharge-before-charge option for NiCd batteries	- $\Delta V$ , $\Delta T/\Delta t$	Max temp, time	Yes	Yes	2					16	16	✓	1.99
bq2004/E/H	Switching	Advanced dual-LED charge status display with three user-selectable modes, different timing options	- $\Delta V$ , PVD, $\Delta T/\Delta t$	Max temp, time	Yes	Yes	2					16	16	✓	1.99
bq2005	Switching	Sequential fast charge of two NiCd/NiMH battery packs	- $\Delta V$ , $\Delta T/\Delta t$	Max temp, time	Yes	Yes	4					20	20	✓	1.99

<sup>1</sup>Current-limited — gating control of external, current-regulated/limited source.

<sup>2</sup>PVD — peak voltage detection; - $\Delta V$  — negative voltage change;  $\Delta T/\Delta t$  — rate of temperature rise;  $\Delta^2 V$  — second difference of cell voltage.

<sup>3</sup>Suggested resale price in U.S. dollars in quantities of 1,000.

New devices indicated in red.

## Selection Guides

## Charger Selection Guide

Device	Control Topology <sup>1</sup>	Comments	Charge Termination Method		Features			Packaging				Price <sup>3</sup>		
			Primary <sup>2</sup>	Secondary	Safety Timer	Temperature Monitoring	Charge Status Outputs	QFN / MLP	MSOP	TSSOP	SOIC		DIP	EVM
<b>Lead-Acid Chemistry</b>														
UC3906	Linear	Temperature-compensated internal reference, 40-V V <sub>CC</sub> rating	Max voltage, min current		No	No	1				16	16	2.50	
UC3909	Switching	Differential current sense input, 40-V V <sub>CC</sub> rating	Max voltage, min current		No	Yes	2				20	20	2.90	
bq2031	Switching	Three user-selectable charge algorithms to accommodate cyclic and stand-by applications	Max voltage, -Δ <sup>2</sup> V, min current	Time	Yes	Yes	3				16	16	2.66	

<sup>1</sup>Current-limited — gating control of external, current-regulated/limited source.<sup>3</sup>Suggested resale price in U.S. dollars in quantities of 1,000.<sup>2</sup>PVD — peak voltage detection; -ΔV — negative voltage change; ΔT/Δt — rate of temperature rise; Δ<sup>2</sup>V — second difference of cell voltage.

New devices indicated in red.

## Gas Gauges and Battery Monitors Selection Guide

Device	Approx. Battery Capacity (mAh) <sup>1</sup>	Charge/Discharge Relationship <sup>2</sup>	Number of LEDs	Communication Protocol <sup>3</sup>	Other Features	Safety Enhancement	Available Packages	Price <sup>4</sup>
<b>NiCd Chemistry</b>								
bq2010	500 to 6000	C = D	5 or 6	DQ	—	No	16-pin SOIC	3.64
bq2011	800 to 2000	D>>C	5	DQ	—	No	16-pin SOIC	3.54
bq2012	500 to 6000	C = D	5 or 6	DQ	Slow charge control	No	16-pin SOIC	3.64
bq2013H	2000 to 15000	D>>C	5	HDQ	Programmable offset error compensation	No	16-pin SOIC	3.49
bq2014	500 to 6000	C = D	5	DQ	Works with bq2004	No	16-pin SOIC	3.64
bq2014H	500 to 6000	C = D	5	HDQ	Register compatible with bq2050H	No	16-pin SOIC	3.49
bq2016	1000 to 4500	D>>C	5	HDQ	Automatic offset calibration	No	28-pin SSOP	3.29
<b>NiMH Chemistry</b>								
bq2010	500 to 6000	C = D	5 or 6	DQ	—	No	16-pin SOIC	3.64
bq2012	500 to 6000	C = D	5 or 6	DQ	Slow charge control	No	16-pin SOIC	3.64
bq2013H	2000 to 15000	D>>C	5	HDQ	Programmable offset error compensation	No	16-pin SOIC	3.49
bq2014	500 to 6000	C = D	5	DQ	Works with bq2004	No	16-pin SOIC	3.64
bq2014H	500 to 6000	C = D	5	HDQ	Register compatible with bq2050H	No	16-pin SOIC	3.49
bq2016	1000 to 4500	D>>C	5	HDQ	Automatic offset calibration	No	28-pin SSOP	3.29
<b>Lithium-Ion, Lithium-Polymer Chemistry</b>								
bq2050	500 to 6000	C = D	5	DQ	—	No	16-pin SOIC	3.64
bq2050H	500 to 6000	C = D	5	HDQ	Register compatible with bq2014H	Yes	16-pin SOIC	3.49
bq2063	800 to 10000	C = D	4 or 5	SMBus or HDQ16	SBS version 1.1 compliant with protector interface S-8243	Yes	28-pin SSOP	3.69
<b>bq2083</b>	800 to 10000	C = D	3, 4 or 5	SMBus	SBS V 1.1 works with bq29311	Yes	38-pin TSSOP	4.25
<b>bq2085</b>	800 to 10000	C = D	3, 4 or 5	SMBus	bq2083 with integrated time base	Yes	38-pin TSSOP	4.35
<b>Primary Lithium Chemistry</b>								
bq2052	1000 to 12000	NA	2, 4 or 5	HDQ	Automatic discharge compensation	No	16-pin SOIC	3.80
<b>Lead Acid Chemistry</b>								
bq2013H	2000 to 15000	D>>C	5	HDQ	Programmable offset error compensation	No	16-pin SOIC	3.49
<b>Multi-Chemistry</b>								
bq2040	800 to 10000	C = D	4	SMBus	SBS version 1.0 compliant	No	16-pin SOIC	3.64
bq2060	800 to 10000	C = D	4 or 5	SMBus or HDQ16	SBS version 1.1 compliant	Yes	28-pin SSOP	3.69
bq2092	800 to 10000	C = D	4	SMBus	SBS version 0.95 compliant	No	16-pin SOIC	3.54

Device	VFC Resolution (μVh)	Temperature Measurement Resolution (°C)	Communication Protocol <sup>3</sup>	ID-ROM (Bits)	Memory	Program Output Ports	Other Features	Available Packages	Price <sup>4</sup>
<b>Battery Monitors</b>									
bq2018	12.5	10	HDQ	—	RAM	0	—	8-pin SOIC/TSSOP	1.77
bq2019	3.05	1	HDQ	64	RAM, FLASH	1	Non-volatile memory	8-pin TSSOP	1.82
bq2023	3.05	0.25	SDQ	64	RAM, FLASH	1	Automatic offset error compensation	8-pin TSSOP	1.87
<b>bq26200</b>	3.05	1	HDQ	64	RAM, FLASH	1	Differential current sense	8-pin TSSOP	1.87
<b>bq26220</b>	3.05	0.25	HDQ	64	RAM, FLASH	1	On-chip voltage measurement	8-pin TSSOP	1.92
bq26231	12.5	10	HDQ	—	—	0	—	8-pin TSSOP	1.42

<sup>1</sup>Battery capacity ratings provide an approximate range for each gas gauge.

New devices indicated in red.

<sup>2</sup>C = D — charge rate similar to discharge rate; D>>C — discharge rate much greater than charge rate; NA — not applicable.<sup>3</sup>DQ — 1-wire 8-bit at 333 bps; HDQ — 1-wire 8-bit at 2 kbps; HDQ16 — 1-wire 16-bit at 2 kbps; SMBus — 2-wire 100 kHz; SDQ — Single-wire serial interface.<sup>4</sup>Suggested resale price in U.S. dollars in quantities of 1,000.

## Total Portable Power Solutions

### Battery Management

There are three main components to battery management: *Charge management* - Charge management ICs integrate all of the functionality required to safely charge rechargeable batteries in a manner that maximizes the charge capacity and minimizes charge time.

*Battery fuel gauging* - Battery fuel gauge ICs allows the system to acquire the exact state of battery charge. The information from a TI battery fuel gauge IC can form the basis of a complete power management routine in a portable system, enabling the system to extend its run time.

*Battery protection* - Li-Ion battery packs need protection from overcharge or over discharge conditions. TI's line of protection ICs offers protection for 1-to-4 series Li-Ion battery packs. In some instances, a TI Li-Ion protection IC works with a TI battery fuel gauge IC to offer a comprehensive battery fuel gauge/ protection solution.

### DC/DC Conversion

TI offers several DC/DC solutions that meet cost, performance and application requirements.

*Switching converters with integrated FETs* - These DC/DC ICs integrate the power supply switching FETs. The integrated FETs and synchronous switching provide a space-saving, efficient DC/DC solution.

*Controllers* - DC/DC ICs control external power supply FETs for a flexible solution to a wide range of input/output characteristics.

*Charge pumps* - Charge pumps are non-inductive solutions ideal for applications requiring low-noise and high efficiency.

*LDOs* - Cost-effective DC/DC solutions with a wide selection of input/output limits.

*Multi-functional or specialized DC/DC converters* - TI offers specialized DC/DC converters or combines the above functionality on single chips.

- TPS61042 - White light LED supply IC
- TPS61120 - 1.8-V to 5.5-V input boost converter with 200-mA LDO
- TPS5130 - 4.5-V to 28-V input triple buck controller with LDO controller

### CCFL Backlight Control

TI's CCFL backlight controllers are specialized power converter ICs optimized for cold cathode fluorescent lamps (CCFL), a common light source for LCD displays. These ICs work with either a magnetic or piezo transformer to generate the AC voltage necessary for optimal lamp operation.

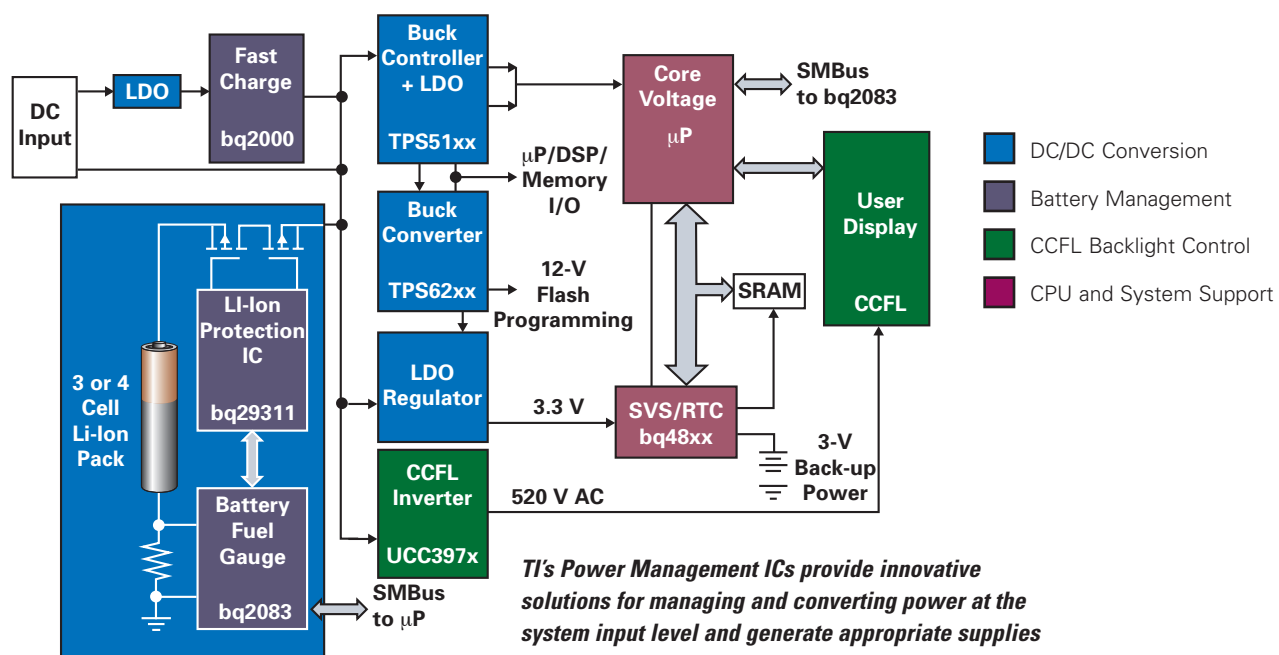
### CPU and System Support

ICs in TI's Power Management portfolio also perform auxiliary power functions, such as:

*Supply voltage supervisors (SVS)* - Supply voltage supervisors monitor the system's power supplies and alert the system when power is dropping with a microprocessor interrupt.

*Real-time clocks (RTCs)* - TI's real-time clocks are microprocessor peripherals that count seconds through years. RTCs automatically switch over to battery power when system power brownouts or goes away. The battery power keeps the clock running until system power returns.

*Non-volatile static memory (NVS RAM)* - These low-power memory devices feature a simple SRAM interface with data retention in the absence of system power. The devices are ideal for storing system configuration data or the data required to gracefully restart a system after a brownout or power loss.



### Evaluation Modules



To order any of the following evaluation modules (EVM's), please call the order desk, **1-800-477-8924, ext. 5800**, in North America. To order from other regions, please contact the TI Product Information Center (see listings on page 11) or local TI distributor.

bq2013HEVM-001	bq2013H Evaluation Kit for NiCd, 16.8 V	\$99	bq2052EVM-001	bq2052 Evaluation Kit for Primary Lithium, 15 V	\$99
bq2014HEVM-001	bq2014H Evaluation Kit for NiMH, 10.8 V	\$99	bq2060EVM-001	bq2060 Evaluation Kit for Li-Ion	\$99
bq2018EVM-001	bq2018 Evaluation Kit for Multi-Chemistry	\$99	bq2060EVM-002	bq2060 Evaluation Kit for NiMH	\$99
bq2019EVM-001	bq2019 Evaluation Kit for Multi-Chemistry	\$99	bq2083EVM-001	bq2083 Evaluation Kit for Li-Ion	\$99
bq2023EVM-001	bq2023 Evaluation Kit for Multi-Chemistry	\$99	bq26200EVM-001	bq26200 Evaluation Kit for	\$99
bq2040EVM-001	bq2040 Evaluation Kit for NiMH, 10.8 V	\$99		Multi-Chemistry, 2.8 to 5.5 V	
bq2050HEVM-002	bq2050H Evaluation Kit for Li-Ion, 10.8 V	\$99			

### Application Reports



To access any of the following application reports, type the URL [www.ti.com/sc/litnumber](http://www.ti.com/sc/litnumber) and replace **litnumber** with the number below in red.

Designed To Go Universal Battery Monitor Using the bq2018 Power Minder IC	<b>SLUA016</b>	HDQ Communication Basics for TI's Battery Monitor ICs	<b>SLVA101</b>
Using the bq2040 Smart Battery System Gas Gauge IC	<b>SLUA233</b>	Gas Gauging Basics Using TI's Battery Monitor ICs	<b>SLVA102</b>
Using the bq2010 — A Tutorial for Gas Gauging	<b>SLUA014</b>	Advanced Gas Gauge Host Firmware Flow Chart for the TI Battery Monitor ICs	<b>SLVA114</b>
Using the bq2050 to Monitor Lead-Acid Batteries	<b>SLUA021</b>		
Advanced Gas Gauge Host Firmware Guide for the TI Battery Monitor ICs	<b>SLVA100</b>		

### Gas Gauging Evaluation Modules (EVMs)

PC-based EVMs allow quick evaluation of battery gas gauge ICs in the target application.

#### Gas gauging EVMs include:

- Circuit board with gas gauge IC, current sense resistor and battery capacity LED indicators
- Interface circuit and serial cable for PC interface
- PC software to monitor all gas gauge functions and internal registers
- PC software User Guide and other documentation



The bq2083 EVM circuit module connects directly across the cells in a battery.



The EV2200 PC-interface board allows the PC to talk to the gas gauge IC using the PC serial port.



Gas Gauge Evaluation Kit PC GUI polls and logs the accessible gas gauge registers for monitoring and analysis of gas gauge operation in the application.

## Charge Management Evaluation Modules

Charge management EVMs provide a development environment for each charge IC. The EVMs illustrate typical circuit implementations for the ICs using gating, switching or linear charge control topologies. With the EVMs, the user can evaluate the performance of a charge management IC solution with a battery pack.

### Charge Management EVMs include:

- EVM documentation and schematic
- Single board with complete charge management circuit for each IC
- Direct connections for a power supply and battery allow plug-and-play
- On-board jumpers to configure charge management IC for various charge levels and parameters, safety timers and status indicators
- On-board charge status LED indicators
- Multiple EVMs for some ICs to meet different charge and power requirements



The charge management EVM connects directly to a power supply and a battery pack

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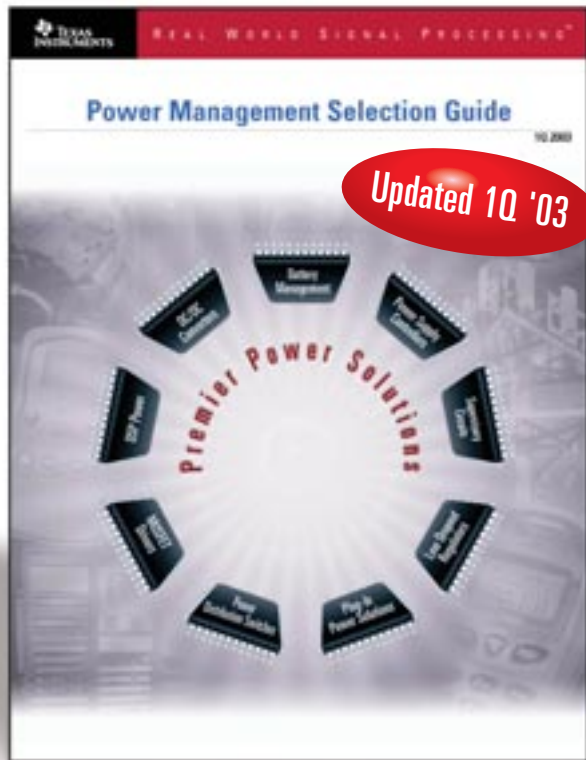
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The Power Management Selection Guide provides a single, concise tool to obtain information quickly on TI's high-performance power management products.

The selection guide layout enables anyone, from a new system designer to an experienced power designer, to review key areas rapidly for each of the represented product spaces, identify a family that meets the design's needs, and then select the corresponding TI device number.

Key features of the guide include parametric values, specification tables and a resource section identifying additional information and tools. A power-supply decision tree also is included to help quickly identify the type of device required.

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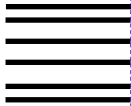
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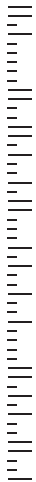
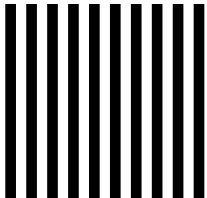


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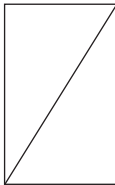
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