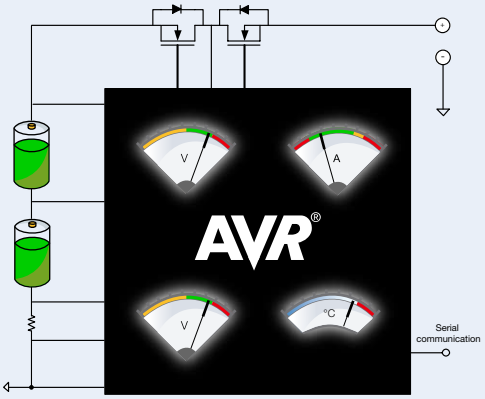
Battery Management Devices for Lithium-ion Batteries

Lithium-ion batteries is the technology of choice for portable handheld applications due to the high energy density at low weight and volume.

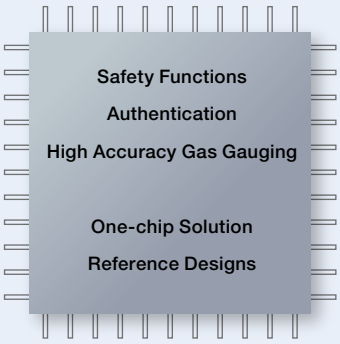
Battery management devices are designed to protect and extend the lifetime of lithium-ion batteries. The main functions of the electronic protection are:

- Overvoltage protection
- Undervoltage protection
- Short circuit protection
- Overcurrent protection
- Temperature supervision



Safety is a major criterion for battery usage and recent industry problems – generating huge recalls from manufacturers – illustrates the importance of safe and accurate control functions. End-user equipment manufacturers are endorsing the responsibility in case of problem, so it is important for them to make sure that users will permanently use certified battery pack and not a copy pack of unknown quality. This require for authentication mechanisms on the battery itself.

Combining AVR® microcontroller's performance with leading-edge high-voltage technology and with a long-established cooperation with key battery manufacturers, Atmel® has developed a full range of microcontrollers dedicated to Li-Ion battery management supporting from 1 to 4 cells in series. This product family offers a unique set of features to optimize performance and security. This includes an outstanding voltage measurement accuracy of ±12.5 mV in the 0 to +60°C temperature range, helping customers to extend the battery energy that can be safely used between recharging.



The one-chip solution is minimizing the component count on the PCB and is available in tiny packages. A full range of development tools is available to facilitate battery design. This includes reference designs with firmware, evaluation kit and PC software.

Battery management made smart!

Atmel's battery management solutions give designers and users significant benefits in addition to safe operation.

Safety

Atmel's high accuracy analog functions combined with several layers of safety functions ensures the safest operation of the lithium-ion batteries.

Communication

Communication with the battery enables advanced functions that can be used to improve the safety as well as extend the battery life. Such functions are authentication, communication with smart chargers, Gas gauging, Battery history and the possibility to do field upgrades of the code or battery parameters.

Gas gauging

For applications that require a controlled shut down of the system, gas gauging is the solution. Notebook PC's need to store user data, digital cameras need to retract the zoom-lens and close the lens protection, and smart phones can still be operative if the non-vital functions are powered down early enough.

Authentication

To ensure safe detection of potentially unsafe copy batteries, authentication should be used. When detecting a unsafe battery, it can be charged and discharged in a safe way.

History log

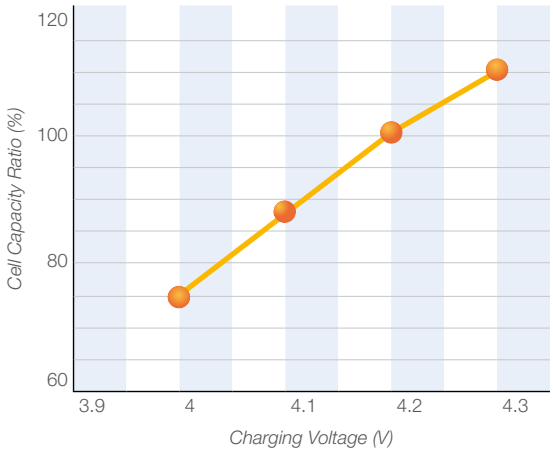
During the lifetime of a product, warranty claims sometimes happen. If the battery includes an MCU, the battery performance history and usage log will be of great help during battery analysis.

Flexibility

Since the Lithium-ion battery is still a young technology, the programmable microcontroller solution offers full flexibility to support new regulations.

Accuracy and safety

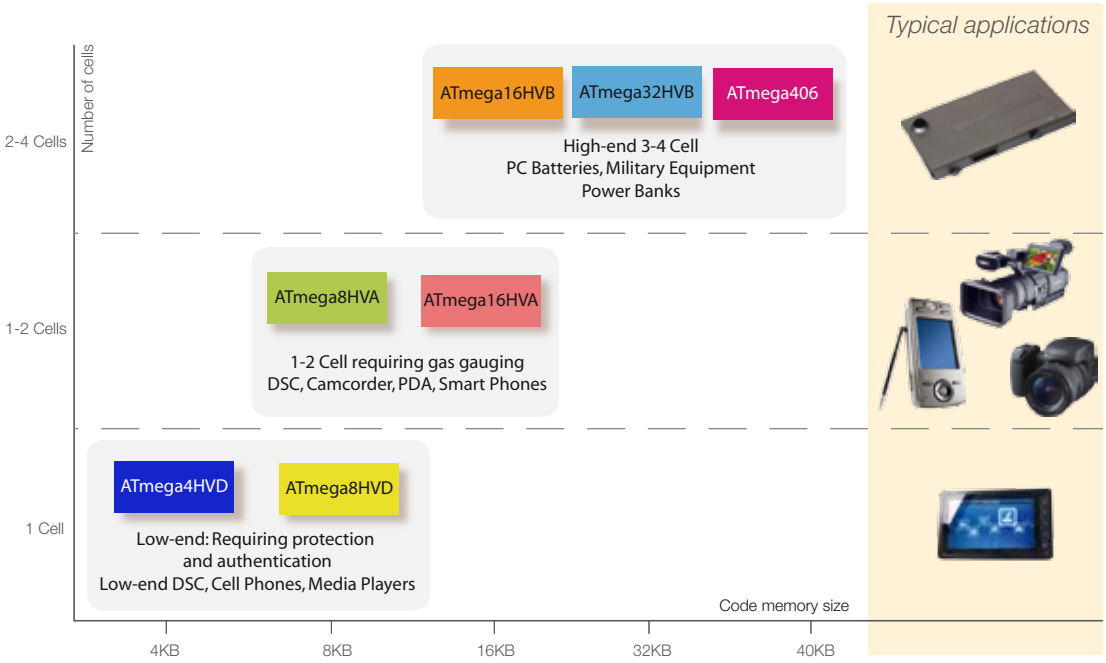
Accuracy and safety are two major functions that need to be considered for a successful battery management system. The gas gauge enabled battery management devices have a very accurate internal voltage reference, enabling voltage protection with an absolute accuracy of ±25 mV over the entire temperature and voltage range, and ±12.5 mV over the 0-60°C range. This enables the battery to deliver maximum amount of energy without risking damage to the device or the user by over charging or too deep discharging. With an absolute accuracy of ±12.5 mV, Atmel's battery management solutions are able to safely use 95% of the available battery energy. If the accuracy is reduced to ±100 mV, only 70% of the energy can be used. To simplify manufacturing, calibration values are recorded and stored in the device by Atmel during chip testing. This enables customers to get the maximum performance of the chip with a minimal calibration effort.



Complete solution

Atmel's battery management devices combine all the necessary functions into one monolithic chip. Manufactured in Atmel's patented high voltage process with elements of the picoPower™ design techniques, the devices offer a unique performance and flexibility at very low power consumption. The integrated and high accuracy analog functions ensure the maximum available energy in the batteries can be used while keeping the cost down.

The AVR Battery Management offering



Product	Li-ion cells	Flash (KB)	EEPROM (Bytes)	SRAM (Bytes)	I/O pins	FET Drive (Chanel)	Vgs typ (V)	Battery Protection	12-bit A/D (Channel)	Voltage Measurement Accuracy (mV)(a)	Coulomb Counter	JTAG/OCD	Vcc Range (V)	Clock Speed (MHz)	Package (b)	Temp. Range
ATmega8HVA	1-2	8	256	512	6	N	4.5	Y	5	12.5	18-bit	Y	1.8 - 9.0	4	LGA36, TSOP28	-10°C to +85°C
ATmega16HVA	1-2	16	256	512	6	N	4.5	Y	5	12.5	18-bit	Y	1.8 - 9.0	4	LGA36, TSOP28	-10°C to +85°C
ATmega406	2-4	40	512	2048	18	P	1		10	12.5	18-bit	Y	4.0 - 25	1	LQFP48	-40°C to +85°C
ATmega4HVD	1	4	256	512	5	N	4.5	Y	2 (10-bit)	50		Y	2.0 - 5.5	4	DFN18	-40°C to +85°C
ATmega8HVD	1	8	256	512	5	N	4.5	Y	2 (10-bit)	50		Y	2.0 - 5.5	4	DFN18	-40°C to +85°C
ATmega16HVB	2-4	16	512	1024	18	N	12	Y	10	12.5	18-bit	Y	4.0 - 25	8	TSSOP44	-40°C to +85°C
ATmega32HVB	2-4	32	1024	2048	18	N	12	Y	10	12.5	18-bit	Y	4.0 - 25	8	TSSOP44	-40°C to +85°C

a) In the 0°C to +60°C temperature range.
b) Pb-free packaging alternative, complies to the European Directive for Restriction of Hazardous Substances (RoHS directive). Also Halide free and fully Green.

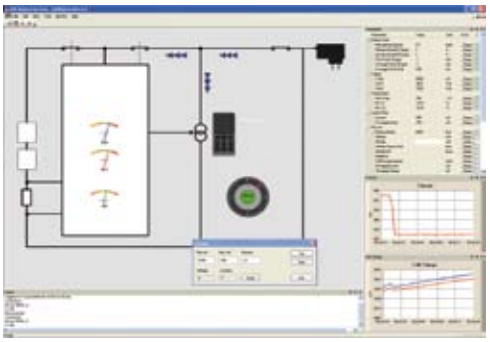
Development tools

Atmel's battery management reference designs show how to get the most out of the AVR battery management devices. The firmware provides all needed safety measures for a Lithium-ion battery design. This includes over- and undervoltage protection and protection against excessive charge and discharge currents. The reference designs also features:

- High accuracy voltage and current measurements
- Gas gauging
- Temperature checks
- AES based authentication
- SHA2 based authentication
- Command set based on SMBus specification

SB200 evaluation kit

The ATAVRSB200 evaluation kit includes Lithium-ion batteries, a programmable charger and load, and a USB communication gateway. The SB200 connects to AVR Studio® by starting the AVR battery management services plug-in. Through this interface all battery parameters can be observed and modified, and the ATAVRSB200 functions are also controlled through this interface.



Reference designs

Device	#cells	Reference design
ATmega8HVA - ATmega16HVA	1-2	ATAVRSB201
ATmega16HVB - ATmega32HVB	2-4	ATAVRSB202
ATmega4HVD - ATmega8HVD	1	ATAVRSB204
ATmega406	2-4	ATAVRSB206

The reference design source code is available by registering on Atmel's web-site. The source code can be debugged using Atmel's lineup of On-chip debug interfaces including the JTAG ICE, AVR Dragon and AVR ONE! The source code can be modified using a standard AVR C-compiler.

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Rev.: 7927A-AVR-08/08/