
전지 응용기술로서의 스마트전지시스템과 펄스충전시스템

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(SME)

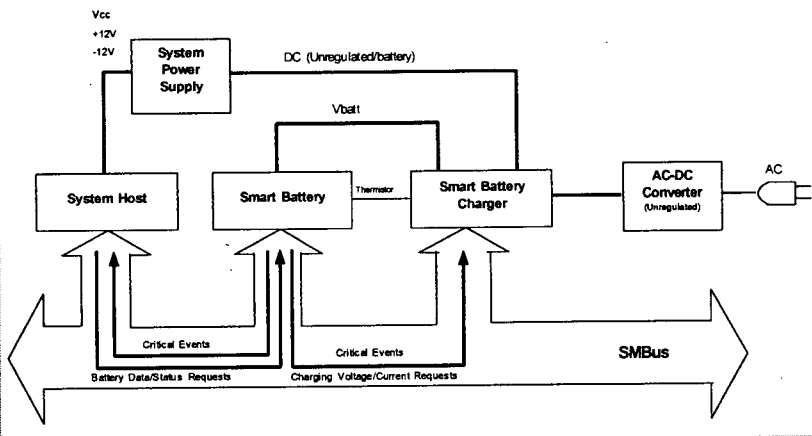
Smart Battery System

SME

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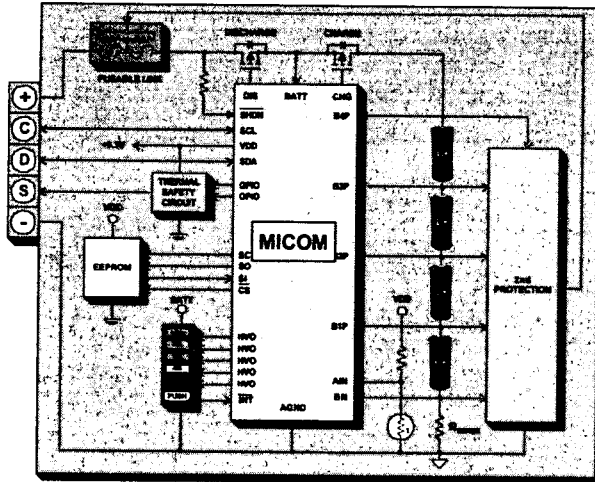
Smart Batteries Modeling

Smart Batteries Modeling



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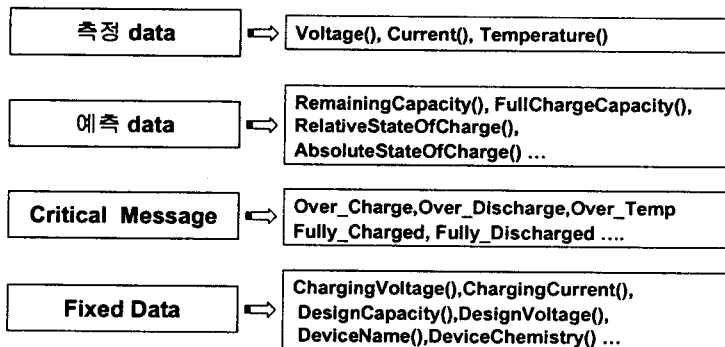
Smart Battery Block Diagram



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Smart Battery Function

• Smart Battery Function (Data)



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Smart Battery Function

Function	Code	Access	Data
ManufactureAccess	0x00	r/w	word
RemainingCapacityAlarm*	0x01	r/w	mAH or 10mWH
RemainingTimeAlarm*	0x02	r/w	minutes
BatteryMode	0x03	r/w	bit flags
AtRate	0x04	r/w	mA or 10mW
AtRate TimeToFull	0x05	r	minutes
AtRate TimeToEmpty*	0x06	r	minutes
AtRateOK*	0x07	r	Boolean
Temperature	0x08	r	0.1 'K
Voltage	0x09	r	mV
Current	0x0a	r	mA
AverageCurrent	0x0b	r	mA
MaxError	0x0c	r	percent
RelativeStateOfCharge	0x0d	r	percent
AbsoluteStateOfCharge	0x0e	r	percent
RemainingCapacity	0x0f	r	mAH or 10mWH

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Smart Battery Function

Function	Code	Access	Data
FullChargeCapacity	0x10	r	mAH or 10mWH
RunTimeToEmpty*	0x11	r	minutes
AverageTimeToEmpty*	0x12	r	minutes
AverageTimeToFull	0x13	r	minutes
ChargingCurrent	0x14	r	mA
ChargingVoltage	0x15	r	mV
BatteryStatus*	0x16	r	bit flags
CycleCount	0x17	r	count
DesignCapacity	0x18	r	mAH or 10mWH
DesignVoltage	0x19	r	mV
SpecificationInfo	0x1a	r	unsigned int
ManufactureData	0x1b	r	unsigned int
SerialNumber	0x1c	r	number
ManufactureName	0x20	r	string
DeviceName	0x21	r	string
DeviceChemistry	0x22	r	string
ManufactureData	0x23	r	data

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Why use Smart Battery

• Why use Smart Battery

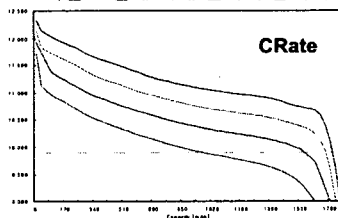
- **System** : 예기치 않은 **Shutdown**을 예방하고, 정확한 **End Point** 결정에 따른 사용 시간 증가 (RSOC)
- **ACPI : Power Management**에 필요한 정보 제공
- **User** : 정확한 **Battery** 잔존용량과 사용가능 시간에 대한 정보 제공 (RSOC, Time)
- **Battery** : 효율적인 충방전 관리로 수명 연장 (BatteryStatus)
- **Charger** : **Battery** 종류에 상관없이 충전 제어 (ChargingCurrent, ChargingVoltage)

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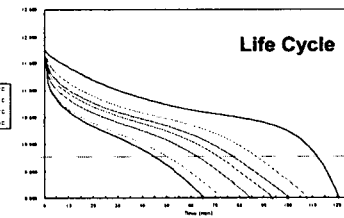
Why use Smart Battery

• Voltage를 근거로 한 End Point 결정은 부적절

- **Battery Voltage**는 **Discharge Current, Temperature, Life Cycle**, 기타 다른 요인에 의해 변화가 심하다



0.1C
0.2C
0.5C
1.0C



100%
50%
25%
10%



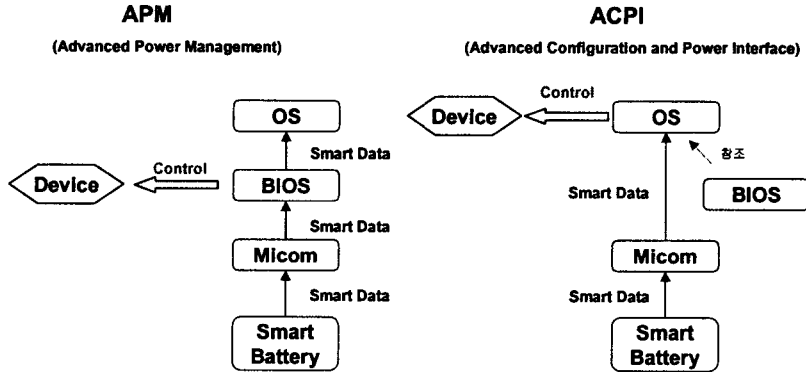
• Smart Battery 잔존용량에 의한 End Point 결정 (RSOC)

- 방전 종료를 단순화 하며 사용 시간 증가, 예기치 않은 **Shutdown** 예방

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Why use Smart Battery

• Power Management



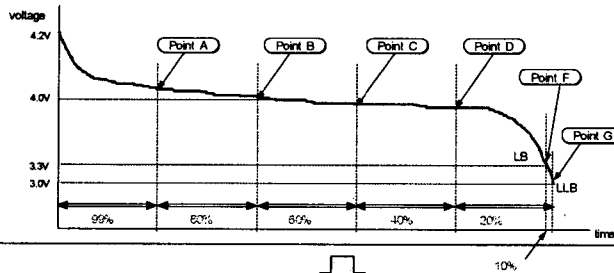
ACPI를 수행하기 위하여 반드시 Smart Battery는 OS에 아래 Data를 항상 제공해야 한다
 Battery State / Battery Current / Battery Capacity / Battery Voltage

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Why use Smart Battery

• Voltage를 근거로 한 Battery 잔존용량 정보는 부정확

- Battery Voltage는 Discharge Current, Temperature, Life Cycle, 기타 다른 요인에 의해 변화가 심하다



• Predictive Algorithms 으로 Battery 잔존용량 정보 제공 (1% accuracy)

- 정확한 Battery 잔존용량과 사용가능 시간에 대한 정보 제공

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Why use Smart Battery

- 효율적인 충방전 관리로 수명연장
- **Critical Message**
 - **OCA : Over Charge Alarm** : 충전 중지
 - **TCA : Terminate Charge Alarm** : 충전 중지
 - **OTA : Over Temp Alarm** : 충전 중지
 - **TDA : Terminate Discharge Alarm** : 방전 중지
 - **RCA : Remaining Capacity Alarm**
 - **RTA : Remaining Time Alarm**
 - **FC : Fully Charged** : 충전 종료
 - **FD : Fully Discharged**

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Why use Smart Battery

- **기존 (Dumb) Battery**
 - 일방적인 충전으로 과충전 가능
 - **Battery Chemistry** 구분 위해 Id 단자 사용

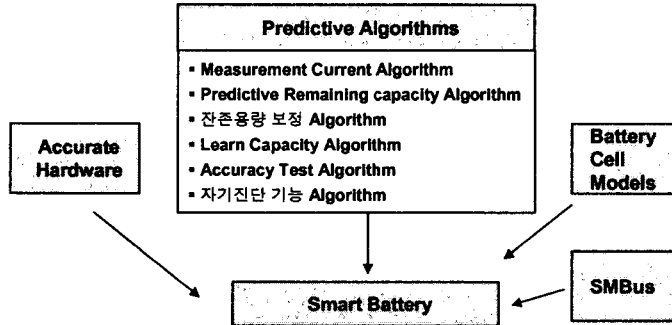


- **Smart Battery**
 - **Smart Battery**가 충방전 제어의 주체
 - **Battery** 종류에 상관 없이 충전 가능
 - **Battery Chemistry**
 - **Charging Voltage**
 - **Charging Current**
 - **Battery Vendor**
 - **Model Name**

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What Makes A Smart Battery

• What Makes A Smart Battery



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Predictive Remaining Capacity (Current 적산법)

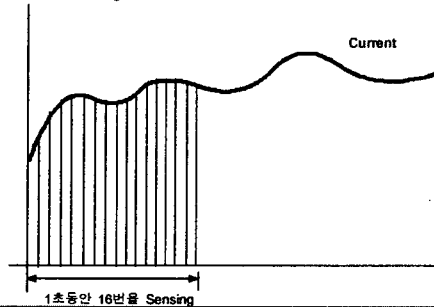
$$RC(n) = RC(n-1) \pm I_{batt} * \Delta t * E_f * Life - I_{self}$$

I_{batt} : 1초 동안 16번을 Sensing한 평균값 Δt : 시간

E_f : 충방전 전류 (CRate) 온도에 의한 충방전 효율 (Matrix Table)

$Life$: LifeCycle에 의한 충방전 효율

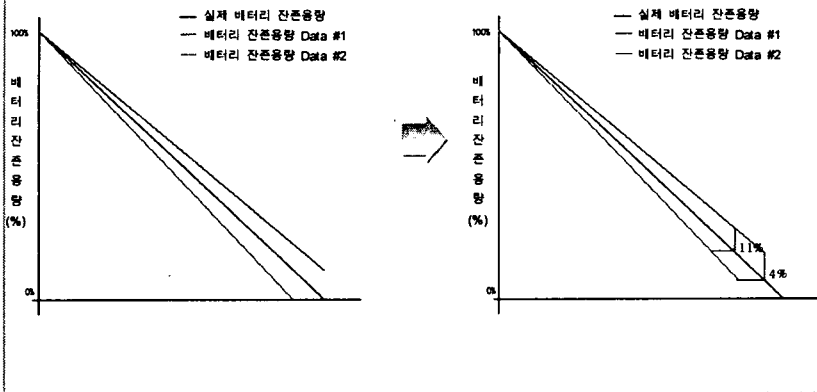
I_{self} : Self Discharge 보정 계수



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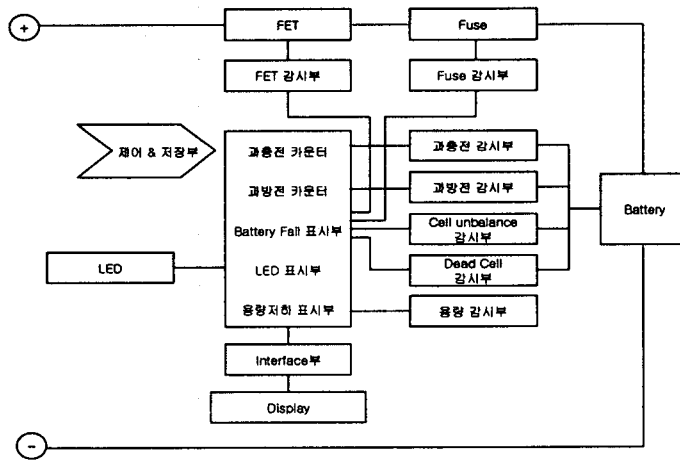
Bridge Passage Method

• Bridge Passage Method (잔존용량 보정 Algorithm)



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자가진단 Algorithm



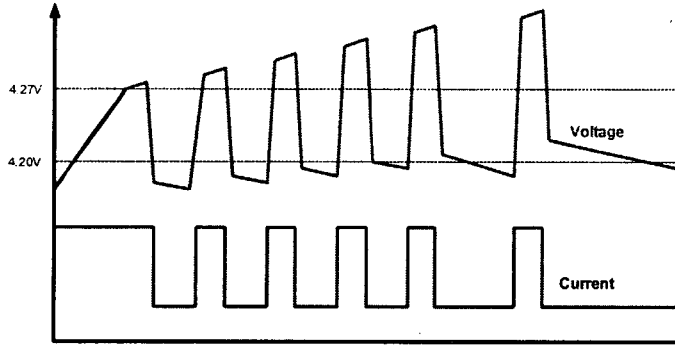
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Pulse Charging

• Pulse Charge control

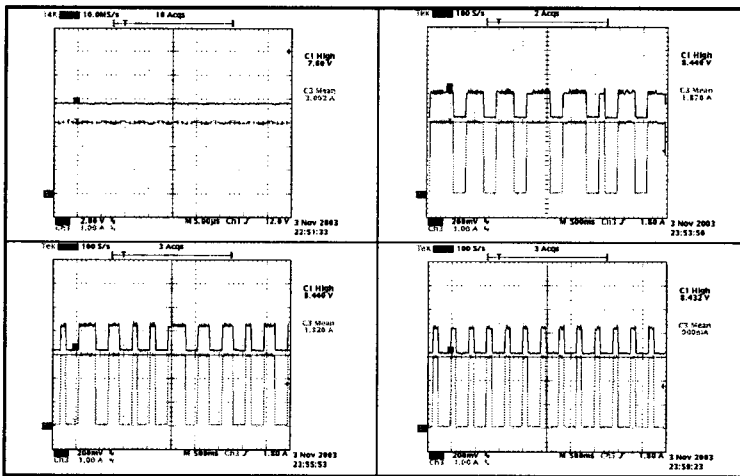
Charge FET turns off if any cell voltage is $4.27 \pm 0.05V$ or Over (125ms)

Charge FET turns on if all cell voltage is $4.20 \pm 0.05V$ or less (250ms)



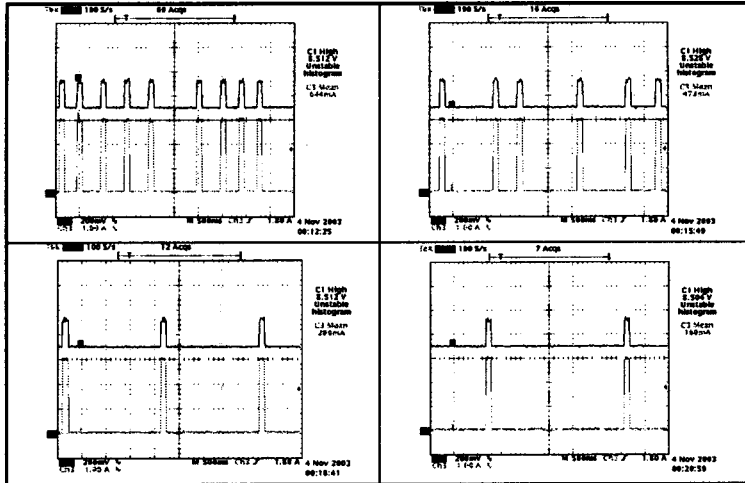
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Pulse Charging



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Pulse Charging



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감사합니다

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