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Selecting the Right Battery System For Cost-Sensitive Portable Applications While Maintaining Excellent Quality

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INTRODUCTION

Portable electronic devices have played an important role in a person's daily digital life and have changed the way people live and work. Commonly seen portable electronic devices are Cellular Phone, Media Players, Digital Camera, Digital Camcorder, Handheld GPS, Digital Reader and PDA. With the emerging technologies that are available today, portable electronic designers are trying to integrate more features into thinner and smaller form-factors while maximizing the battery life.

Batteries are the main power source for portable electronic devices, and selecting a right battery system for an unique application is one of the important factors in the portable electronic design process. It involves selecting a battery chemistry and charge management control circuitry. The battery life indicates the length a product can be used under portable mode. Longer battery life can simply make a portable device standout in the market automatically. This can usually be achieved by reducing system power consumption and implementing an advanced battery technology.

When it comes to production, reliability, safety, low-cost and easy installation are the important elements while maintaining good quality. Each battery chemistry has its advantage over another. This application note is intended to assist portable electronic product designers and engineers in selecting the right chemistry for today's low cost portable applications with design simplicity. The solutions are ideal for use in space-limited and cost-sensitive applications that can also accelerate the product time-to-market rate.

DESCRIPTION

This application note shows characteristics of some popular battery chemistries for portable applications and fully integrated low cost single-cell Lithium-Ion/Lithium Polymer battery charge management solutions.

References to documents that treat these subjects in more depth and breadth have been included in **Section "References"**.

1.0 BATTERY CHEMISTRIES

There are three key attributes in a battery:

1. Energy Density (Size and Weight)
2. Charge/Discharge Cycles (Life Cycle)
3. Capacity (Operational Duration Without AC Adapter Presence)

Like with most engineering applications, key attributes do not exist in the same technology. There is always a trade-off between them. In today's portable world, the product life cycle is very short, meaning the battery life cycle is of minimal concern for customers and manufacturers. The operating duration, package size and overall system weight become the most important factors when selecting the battery chemistry for a portable application.

Batteries usually occupy a considerable space and weight in today's portable devices. The energy density for each chemistry dominates the size and weight for the battery pack. Table 1 indicates that Li-Ion (Lithium-Ion) has advantages in both energy density weight and energy density volume among other available battery technologies.

TABLE 1: BATTERY COMPARISONS 1 [8]

Chemistry	Energy Density Weight (W-hr/Kg)	Energy Density Volume (W-hr/L)	Operating Voltage (V)	Open Circuit Voltage (V)	End Voltage (V)	Charge Voltage (V)
Alkaline	145	400	1.2	1.6	0.9	N/A
SLA	30–40	50–80	2.0	2.25	1.75	2.8
NiCd	40–80	100–150	1.2	1.3	0.9	1.6
NiMH	60–100	160–230	1.2	1.3	0.9	1.5
Li-Ion	110–130	210–320	3.6	4.2	2.8	4.2

TABLE 2: BATTERY COMPARISONS 2 [8]

Chemistry	Self-Discharge per Month (%)	Internal Resistance (mΩ)	Charge/Discharge Cycles	Discharge Rate (mA-hr)	Operating Temperature (°C)	Initial Cost
Alkaline	0.3	100–300	1	0.25C	-20–+55	Very Low
SLA	2–8	2.5–25	50-500	< 15C	-20–+50	Low
NiCd	15–20	3.5–300	1500	< 10C	-20–+60	Low
NiMH	20–25	10–400	800	< 3C	0–+60	Medium
Li-Ion	6–10	50–500	1000	< 2C	-20–+60	High

Each battery chemistry is briefly reviewed as follows:

Alkaline

Alkaline batteries are not rechargeable, but are commonly seen as a portable power source because it's low self-discharge rate and always ready to use off the shelf. Therefore, it is included in the Table 1 and Table 2 as reference against secondary (rechargeable) batteries. Rechargeable Alkaline batteries are available, but they are not very practical and reliable to use in a system due to its fast degradation after a few charge cycles.

SLA (Sealed Lead Acid)

SLA batteries are mature and inexpensive battery solutions, and have an advantage in low self discharge rate. However, it is not an ideal candidate for portable applications due to it's low energy density, low charge/discharge cycles and it is not environmentally friendly.

NiCd (Nickel-Cadmium)

NiCd batteries have the best charge/discharge cycles among rechargeable batteries (Table 1) and are good substitutes to Alkaline batteries because they employ the same basic voltage profile. NiCd batteries are required to be exercised periodically due to the memory effect. It is a very low-cost rechargeable solution because of the matured battery technology and simple charge algorithm.

NiMH (Nickel-Metal Hydride)

NiMH batteries are considered improved version of NiCd batteries that provide higher energy density and environmentally friendly material. Both NiMH and NiCd batteries have high self discharge rate (Table 2) and are subject to memory effect. Although NiMH and NiCd batteries share similar charge algorithm, NiMH batteries require a more complex design due to the heat that NiMH batteries generate during charging and the difficult $-\Delta V/\Delta t$ detection.

Li-Ion (Lithium-Ion)

Li-Ion batteries have advantages in high energy density, low maintenance requirement, relatively low self discharge rate, and higher voltage per cell. (Table 1 and Table 2) The major drawbacks of Li-Ion batteries are higher initial cost and aging effect. Li-Ion batteries age over time regardless of the usage. Protection circuitry is required for Li-Ion battery to prevent over voltage during charge cycle and under voltage during discharge cycle.

Li-Polymer (Lithium Polymer)

Li-Polymer batteries should be recognized as Li-Ion Polymer batteries. It is designed as an improved version of Li-Ion with flexible form-factors and very low profile. It is perfect for miniature applications, such as Bluetooth® headsets or MP3 players. It has similar characteristics as Li-Ion and can be charged with same algorithm. It is a different technology compared to Li-Ion, but will be discussed as Li-Ion in this application note.

2.0 SELECTING THE RIGHT BATTERY SYSTEM FOR COST-SENSITIVE APPLICATIONS

In some high-end portable devices, the performances and compactness of batteries are the most important attributes when designers select the right battery system. Performances include battery run time, charge/discharge cycles, self discharge rate and safety. Battery run time, weight and compactness are based on the energy density and cell capacity.

Most recent portable electronic devices are cost-sensitive with fashion in design. Even high-end devices will face lower cost during a manufacture cycle. Selecting the right battery system that can satisfy manufacturers and customers becomes a nightmare for designers and engineers. The battery system includes a battery pack and a charge management controller. With highly integrated charge management controller and design simplicity, the portable electronic device designers can reduce design time and speed up time to market for new product development.

Based on the previous statement, NiMH and Li-Ion are the most popular battery chemistries that meet today's portable applications.

2.1 NiMH or Li-Ion?

Table 3 depicts the critical metrics between Li-Ion and NiMH.

TABLE 3: CRITICAL METRICS

	Li-Ion	NiMH
Nominal Voltage	3.6V	1.2V
Cycle Life	1000	800
Memory Effect	No	Yes
Cost ($/Wh)[4]	2.5	1.3
Energy Density: Volume (Wh/L)	210-320	160-230
Energy Density: Weight (Wh/kg)	110-130	60-100

Besides the cost, the Li-Ion batteries have significant advantages over the NiMH batteries. The 3.6V nominal voltage also makes Li-Ion a perfect supply voltage to most portable devices. Cell balancing can be an important issue when more than one battery cell is required for the system. For NiMH batteries to supply 3.6V, 3-cell NiMH is usually needed to maintain the voltage. A single-cell Li-Ion battery supplies the same voltage while taking less space and without worrying about cell balancing.

No memory effect and maintenance free (e.g. no power cycling to prolong the battery's life) also drive Li-Ion as a good candidate for portable applications. Although NiMH has improved the memory effect issue compared to NiCd, it still could have premature termination from deceptive peaks during early charge cycle. Premature termination ends charge before a battery is fully charged. Consumers can charge Li-Ion battery operated handheld devices at any time during normal operation because the memory effect is not an issue with Li-Ion batteries.

Mass production and extensive research and development from battery manufacturers have scaled down the cost between NiMH and Li-Ion batteries. This has led many portable device designers/engineers to favor Li-Ion over NiMH in many portable applications.

2.2 Charge Algorithm

Appropriate Charge Algorithm for the selected battery chemistry can effect the life, reliability and safety of a battery. Different chemistries have different charge profiles and different battery manufacturers have different recommendations when it comes to restoring energy (charge) back to batteries.

The C-rate is the rated capacity for battery charge/discharge current. The rated capacity for a battery is the total amount of current it can produce or store. For example, 1C charge rate for a battery rated at 500 mAh is approximately 500 mA per hour.

2.2.1 CHARGING NIMH BATTERIES

Charging NiMH batteries can be simple or complicated. The simple and low-cost solution is to charge batteries at a low constant current (e.g. 0.1C or 0.2C). However, it takes a long time to completely charge and can easily overcharge the NiMH batteries. A timer is usually implemented for charge termination. Minimum 10 hours is required if a battery is charged at 0.1C. Overcharge may occur without proper end of charge detection and can reduce the life of batteries (charge/discharge cycles).

The rate of voltage decrease ($-\Delta V/\Delta t$) charge termination has improved the charge algorithm and allows fast charge until charge termination is reached. False voltage drop termination can happen from voltage fluctuations and noise that are caused by the charger and the battery.

The rate of temperature decrease ($-\Delta T/\Delta t$) charge termination can increase the design cost, but can also increase the battery life cycle.

To improve the battery life and maintain capacity, a combination of all methods should be applied to the charge algorithm. Figure 1 depicts the complete NiMH charge algorithm.

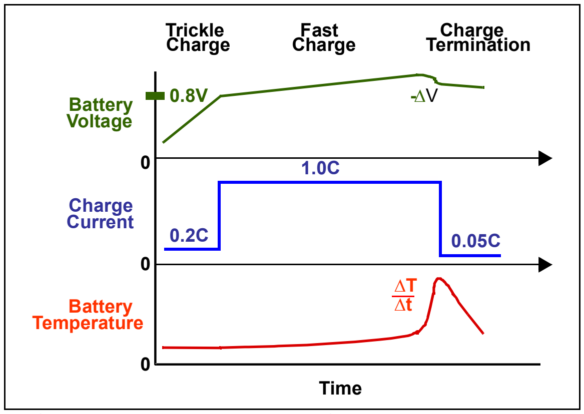

FIGURE 1: *NiMH Charge Algorithm [8].*

Stage 1: Trickle Charge: NiMH charge algorithm starts restoring energy to battery cell at 0.1C or 0.2C trickle charge until the battery reaches the minimum working voltage for fast charge. It can be either 0.8V or 0.9V per cell.

Stage 2: Fast Charge: Fast charge restores the battery cell at a constant current rate of 1C. The charge efficiency has a noticeable improvement at fast charge rate compare to slow charging rate. It will continuously charge at 1C until one of the termination requirements is satisfied.

Stage 3: Charge Termination: The charge cycle goes to the termination stage when either $-\Delta V/\Delta t$ or $-\Delta T/\Delta t$ is detected. A duration of small charge current (~0.05C) can fill up the battery cell to maximum capacity.

Integrated solutions are available to charge NiMH batteries, but the cost is usually high and may not be very flexible to set battery voltage, $-\Delta V/\Delta t$, $-\Delta T/\Delta t$, charge rate and timer.

With the broad range of Microchip's PIC® microcontroller product line, the microcontroller can be sized for the job. In many applications, a microcontroller is already resident. By adding the Microchip analog high-speed Pulse-Width Modulator (PWM) to the MCP1630 family, a power train can be easily added to the design. [6] The cost of using this solution is relatively low and can easily program all parameters compared to the total integrated solutions.

2.2.2 CHARGING LI-ION BATTERIES

Unlike NiMH, the preferred charge algorithm for Lithium-Ion/Lithium-Ion Polymer batteries is a CC-CV (constant or controlled current; constant voltage) algorithm that can be broken up into four stages. Figure 2 depicts this charge algorithm.

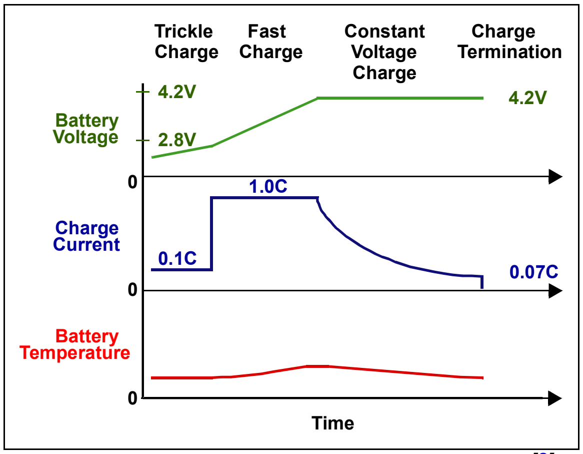

FIGURE 2: Li-Ion Charge Algorithm [8].

Stage 1: Trickle Charge: Trickle charge is employed to restore charge to deeply depleted cells. When the cell voltage is below approximately 2.8V, the cell is charged with a constant current of 0.1C maximum. An optional safety timer can be utilized to terminate the charge if the cell voltage has not risen above the trickle charge threshold in approximately 1 hour.

Stage 2: Fast Charge: Once the cell voltage has risen above the trickle charge threshold, the charge current is raised to perform fast charging. The fast charge current should not be more than 1.0C. 1.0C is used in this example. In linear chargers, the current is often ramped-up as the cell voltage rises in order to minimize heat dissipation in the pass element. An optional safety timer can be utilized to terminate the charge if no other termination has been reached in approximately 1.5 hours from the start of the fast charge stage (with a fast charge current of 1C).

Stage 3: Constant Voltage: Fast charge ends, and the Constant Voltage mode is initiated when the cell voltage reaches 4.2V. In order to maximize capacity, the voltage regulation tolerance should be better than ±1%.

Stage 4: Charge Termination: Charging is typically terminated by one of two methods: minimum charge current or a timer (or a combination of the two). The minimum current approach monitors the charge current during the constant voltage stage and terminates the charge when the charge current diminishes below approximately 0.07C. The second method determines when the constant voltage stage is invoked. Charging continues for an additional two hours before being terminated. It is not recommended to continue to trickle charge Lithium-Ion batteries.

Charging in this manner replenishes a deeply depleted battery in roughly 165 minutes. Advanced chargers employ additional safety features. For example, charge is suspended if the cell temperature is outside a specified window, typically 0°C to 45°C. [7] [10]

When the cost between NiMH and Li-Ion batteries is no longer an issue, the only concern remaining is the cost to implement a charging circuit to portable devices.

Advanced semiconductor technology makes it possible to provide a fully-integrated Li-Ion/Li-Polymer battery charge management controller in a small package with a competitive price.

After detailed review and consideration between NiMH and Li-Ion, the Li-Ion battery system is the most reliable solution that is chosen for the low cost portable devices.

2.2.3 LI-ION/LI-POLYMER CHARGE MANAGEMENT SOLUTIONS

Two complete Li-Ion / Li-Polymer battery charge management design examples that utilize Microchip's MCP73831 and MCP73812 are proposed for designing a new low-cost portable devices or the cost of an alternative for an existing product.

3.0 EXAMPLE 1: DESIGN LOW-COST LI-ION/LI-POLYMER BATTERY CHARGE MANAGEMENT WITH MCP73831 [10]

3.1 Device Overview

The MCP73831 device is a highly advanced linear charge management controller for use in space-limited and cost-sensitive applications. The MCP73831 is available in an 8-Lead, 2 mm x 3 mm DFN package or a 5-Lead, SOT-23 package. Along with its small physical size, the low number of external components required make the MCP73831 ideally suited for portable applications. For applications charging from a USB port, the MCP73831 adheres to all the specifications governing the USB power bus.

The MCP73831 employs a constant-current / constant-voltage charge algorithm with selectable preconditioning and charge termination. The constant voltage regulation is fixed with four available options: 4.20V, 4.35V, 4.40V or 4.50V, to accommodate new, emerging battery charging requirements. The constant current value is set with one external resistor.

The MCP73831 device limits the charge current based on die temperature during high power or high ambient conditions. This thermal regulation optimizes the charge cycle time while maintaining device reliability.

Several options are available for the preconditioning threshold, preconditioning current value, charge termination value and automatic recharge threshold.

The preconditioning value and charge termination value are set as a ratio, or percentage, of the programmed constant current value. Preconditioning can be disabled.

The MCP73831 is fully-specified over the ambient temperature range of -40°C to +85°C. Figure 3 depicts the operational flow algorithm from charge initiation to completion and automatic recharge.

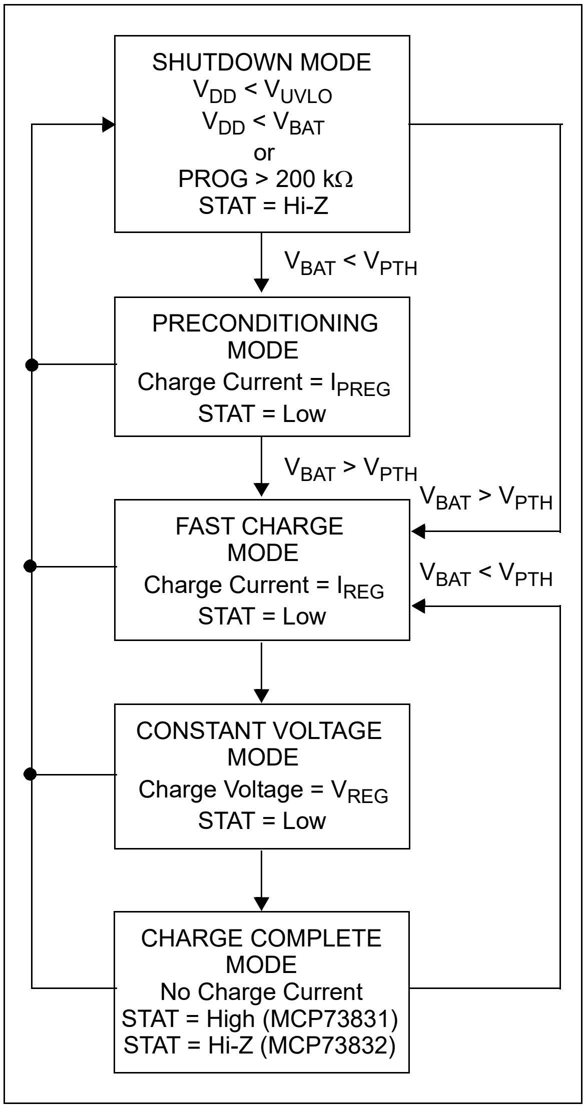

FIGURE 3: *MCP73831 Flowchart.*

3.2 Charge Qualification And Preconditioning Trickle Charge

An internal under voltage lockout (UVLO) circuit monitors the input voltage and keeps the charger in shutdown mode until the input supply rises above the UVLO threshold. For a charge cycle to begin, all UVLO conditions must be met and a battery or output load must be present. A charge current programming resistor must be connected from PROG to V_{SS}.

If the voltage at the V_{BAT} pin is less than the preconditioning threshold, the MCP73831 enter a preconditioning or Trickle Charge mode. The preconditioning threshold is factory set. In this mode, the MCP73831 supplies a percentage of the charge current (established with the value of the resistor connected to the PROG pin) to the battery. The percentage or ratio of the current is factory set.

When the voltage at the V_{BAT} pin rises above the preconditioning threshold, the MCP73831 enters the Constant-Current or Fast Charge mode.

Fast Charge: Constant-Current Mode

During the Constant-Current mode, the programmed charge current is supplied to the battery or load. The charge current is established using a single resistor from PROG to V_{SS}. Constant-Current mode is maintained until the voltage at the VBAT pin reaches the regulation voltage, V_{REG}.

Program Current Regulation

Fast charge current regulation can be set by selecting a programming resistor (R_{PROG}) from PROG to V_{SS}. The charge current can be calculated using the following equation:

EQUATION 1: PROGRAM FAST CHARGE CURRENT

$$I_{REG} = \frac{1000V}{R_{PROG}}$$

Where:

R_{PROG} = kilo-ohms

I_{REG} = milliamperes

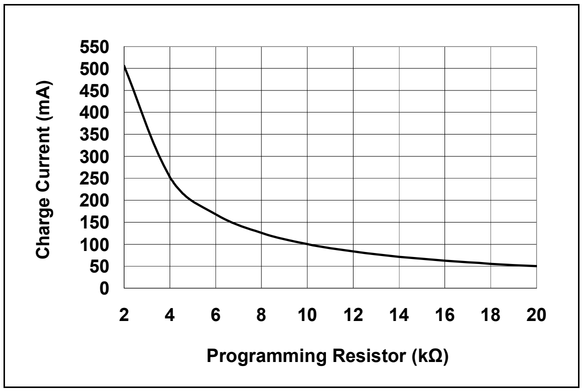

FIGURE 4: *I_{OUT} vs. R_{PROG}.*

Figure 4 shows the relationship between fast charge current and programming resistor.

The preconditioning trickle charge current and the charge termination current are ratio metric to the fast charge current based on the selected device option.

Constant-Voltage Mode

When the voltage at the V_{BAT} pin reaches the regulation voltage, V_{REG}, constant voltage regulation begins. The regulation voltage is factory set to 4.2V, 4.35V, 4.40V, or 4.50V with a tolerance of ±0.75%.

Charge Termination

The charge cycle is terminated when, during Constant-Voltage mode, the average charge current diminishes below a percentage of the programmed charge current (established with the value of the resistor connected to the PROG pin). A 1 ms filter time on the termination comparator ensures that transient load conditions do not result in premature charge cycle termination. The percentage or ratio of the current is factory set. The charge current is latched off and the MCP73831 enters a Charge Complete mode.

Automatic Recharge

The MCP73831 continuously monitors the voltage at the V_{BAT} pin in the Charge Complete mode. If the voltage drops below the recharge threshold, another charge cycle begins and current is once again supplied to the battery or load.

Thermal Regulation And Thermal Shutdown

The MCP73831 limits the charge current based on the die temperature. The thermal regulation optimizes the charge cycle time while maintaining device reliability. The MCP73831 suspends charge if the die temperature exceeds 150°C. Charging will resume when the die temperature has cooled by approximately 10°C.

Charge Status Indicator

The charge status output of the MCP73831 has three different states: High (H), Low (L), and High-Impedance (Hi-Z). The charge status output can be used to illuminate 1, 2, or tri-color LEDs. Optionally, the charge status output can be used as an interface to a host microcontroller.

Table 4 summarize the state of the status output during a charge cycle.

TABLE 4: STATUS OUTPUT

Charge Cycle State	MCP73831
Shutdown	Hi-Z
No Battery Present	Hi-Z
Constant-Current Fast Charge	L
Preconditioning	L
Constant Voltage	L
Charge complete - Standby	H

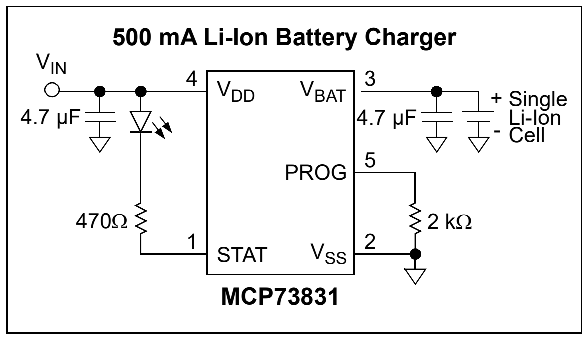

FIGURE 5: *MCP73831 Typical Application Circuit.*

Due to the low efficiency of linear charging, the most important factors are thermal design and cost, which are a direct function of the input voltage, output current and thermal impedance between the battery charger and the ambient cooling air. The worst-case situation is when the device has transitioned from the Preconditioning mode to the Constant-Current mode.

In this situation, the battery charger has to dissipate the maximum power. A trade-off must be made between the charge current, cost and thermal requirements of the charger.

The power dissipation has to be considered in the worst-case.

EQUATION 2: POWER DISSIPATION

$$PowerDissipation = (V_{DDMAX} - V_{PTHMIN}) \times I_{REGMAX}$$

Where:

V_{DDMAX}	=	the maximum input voltage
I_{REGMAX}	=	the maximum fast charge current
V_{PTHMIN}	=	the minimum transition threshold voltage

EXAMPLE 1: POWER DISSIPATION EXAMPLE

Assume:

V_{IN}	=	5V ±10%
I_{REGMAX}	=	550 mA
V_{PTHMIN}	=	2.7V
Power Dissipation	=	(5.5V - 2.7V) x 550 mA = 1.54W

External Components

The MCP73831 is stable with or without a battery load. A minimum capacitance of 4.7 µF is recommended to bypass the V_{BAT} pin to V_{SS} and V_{IN} pin to V_{SS} to maintain good AC stability in the constant-voltage mode. A single resistor between PROG pin and V_{SS} is required to control fast charge current. Equation 1 and Figure 4 can be applied to find R_{PROG} value. LED and R_{LED} are required for status indicator.

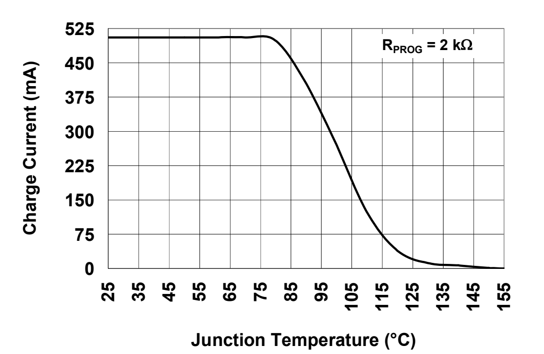

FIGURE 6: *Thermal Regulation.*

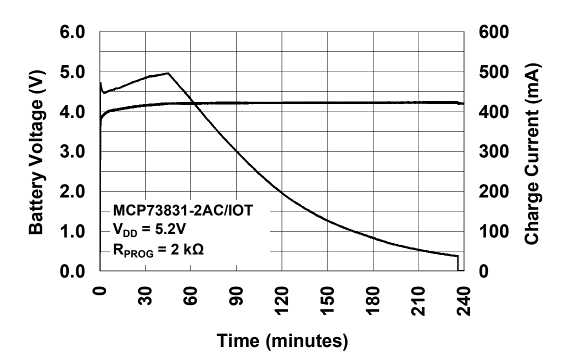

FIGURE 7: *MCP73831 Typical Charge Profile in Thermal Regulation (1000 mAh Battery).*

4.0 EXAMPLE 2: DESIGN ULTRA LOW-COST LI-ION / LI-POLYMER BATTERY CHARGE MANAGEMENT WITH MCP73812 [9]

4.1 Device Overview

The MCP73812 Simple, Miniature Single-Cell Fully Integrated Li-Ion/Li-Polymer Charge Management Controller is designed for use in space limited and cost sensitive applications. The MCP73812 provides specific charge algorithms for single cell Li-Ion or Li-Polymer battery to achieve optimal capacity in the shortest charging time possible. Along with its small physical size and the low number of external components required make the MCP73812 ideally suited for portable applications.

The MCP73812 employs a constant current/constant voltage charge algorithm like MCP73831. The constant voltage regulation is fixed at 4.20V, with a tight regulation tolerance of ±1%. The constant current value is set with one external resistor. The MCP73812 limits the charge current based on die temperature during high power or high ambient conditions. This thermal regulation optimizes the charge cycle time while maintaining device reliability.

The MCP73812 is fully-specified over the ambient temperature range of -40°C to +85°C. The MCP73812 is available in a 5-Lead, SOT-23 package.

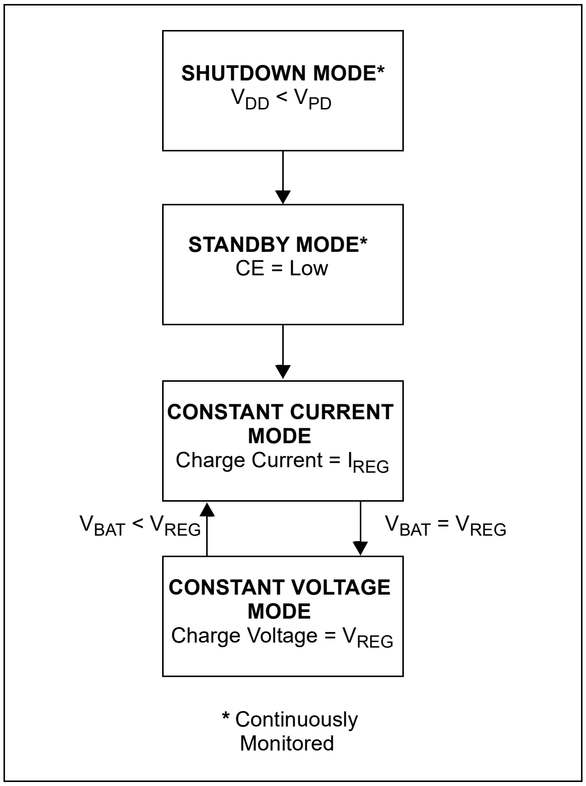

FIGURE 8: MCP73812 Flowchart.

4.2 Charge Qualification And Preconditioning Trickle Charge

The MCP73812 does not employ under voltage lockout (UVLO). When the input power is applied, the input supply must rise 150 mV above the battery voltage before the MCP73812 becomes operational.

The automatic power down circuit places the device in a shutdown mode if the input supply falls to within +50 mV of the battery voltage. The automatic circuit is always active. Whenever the input supply is within +50 mV of the voltage at the V_{BAT} pin, the MCP73812 is placed in a shutdown mode. During power down condition, the battery reverse discharge current is less than 2 µA.

For a charge cycle to begin, the automatic power down conditions must be met and the charge enable input must be above the input high threshold.

The MCP73812 does not support preconditioning of deeply depleted cells, and it begins with fast charge once charging conditions satisfy.

Fast Charge: Constant-Current Mode

During the Constant-Current mode, the programmed charge current is supplied to the battery or load. For the MCP73812, the charge current is established using a single resistor from PROG to V_{SS}. The MCP73812 shares the same program method with MCP73831. The program resistor and the charge current are calculated using the Equation 1. See Figure 4 for the Charge Current and Programming Resistor.

Constant-Voltage Mode

When the voltage at the V_{BAT} pin reaches the regulation voltage, V_{REG}, constant-voltage regulation begins. The regulation voltage is factory set to 4.2V with a tolerance of ±1.0%.

Charge Termination

The charge cycle is terminated by removing the battery from the charger, removing input power, or driving the charge enable input (CE) to a logic low. An automatic charge termination method is not implemented.

Automatic Recharge

The MCP73812 does not support automatic recharge cycles since automatic charge termination has not been implemented. In essence, the MCP73812 is always in a charge cycle whenever the qualification parameters have been met.

Thermal Regulation And Thermal Shutdown

The MCP73812 limits the charge current based on the die temperature. The thermal regulation optimizes the charge cycle time while maintaining device reliability. The MCP73812 suspends charge if the die temperature exceeds 150°C. Charging will resume when the die temperature has cooled by approximately 10°C. The thermal shutdown is a secondary safety feature in the event that there is a failure within the thermal regulation circuitry.

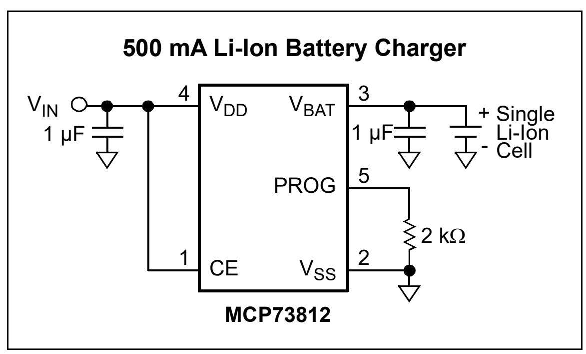

FIGURE 9: MCP73812 Typical Application Circuit.

The MCP73812 shares similar application with MCP73831, but Charge Enable (CE) is designed to replace charge status pin. A logic high enables battery charging while a logic low disables battery charging. The charge enable input is compatible with 1.8V logic.

The power dissipation has to be considered in the worst case. The power dissipation for the MCP73812 is same as the MCP73831. Therefore, equation 2 will be applied for the MCP73812 power dissipation calculation.

EXAMPLE 2: POWER DISSIPATION EXAMPLE

Assume:

V_{IN} = 5V ±10%

I_{REGMAX} = 500 mA

V_{PTHMIN} = 2.7V

Power Dissipation = (5.5V - 2.7V) x 500 mA = 1.4W

External Components

The MCP73812 is stable with or without a battery load. A minimum capacitance of 1 µF is recommended to bypass the V_{BAT} pin to V_{SS} and V_{IN} pin to V_{SS} to maintain good AC stability in the constant-voltage mode. A single resistor between PROG pin and V_{SS} is required to control fast charge current. Equation 1 and Figure 4 can be applied to find R_{PROG} value. LED and R_{LED} are required for status indicator.

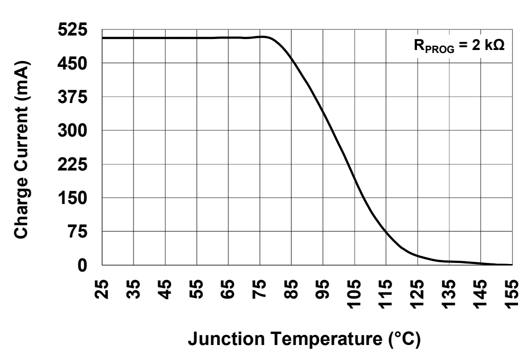

FIGURE 10: Thermal Regulation.

Typical Charge Profile

MCP73812 shares same charge profile with MCP73831, but no available preconditioning and automatically charge termination.

MCP73831 VS. MCP73812

TABLE 5: MCP73831 VS. MCP73812

	MCP73831	MCP73812
Cost	Low	Ultra Low
Applications	Simple	Simple
Space Requirement	Small	Small
Voltage Reg. Accuracy	±0.75%	±1.0%
Programmable Current (Note 1)	Yes	Yes
UVLO	Yes	No
Preconditioning	Yes	No
End-of-Charge Control	Yes	No
Charge Status	Yes	No
Charge Enable PIN	No	Yes
Automatic Recharge	Yes	No
Automatic Power-Down	Yes	No
Thermal Regulation	Yes	Yes
Fully Integrated	Yes	Yes
Voltage Reg. Options (Note 2)	Yes	No

Note 1: MCP73812 family is also available in selectable Charge Current: 85 mA or 450 mA for applications charging from USB port with device number - MCP73811. Refer to MCP73811/2 Data Sheet (DS20002036) for detail information.

2: MCP73831 voltage regulation is fixed with four available options: 4.20V, 4.35V, 4.40V or 4.50V. MCP73812 comes with a standard 4.20V constant voltage regulation.

CONCLUSION

Li-Ion batteries are not only good NiMH and NiCd battery substitutes for advanced portable electric devices, but also for cost-sensitive designs. Although, high capacity, compact size, light weight and maximum charge/discharge cycles do not exist in the same package; there is always a trade-off when engineers/designers select the key factors for the design. Due to the phase out rate of today's portable electric products, charge/discharge cycles is always the first to be eliminated. The aging issue of Li-Ion batteries are often ignored and rarely recommended to customers for the same reason.

Selecting the right charge management controller can improve the product performance, reduce design time, simplify design cycle and optimize cost performance. The MCP73831 is a good solution to meet all of the above needs. For systems that do not require many features and are designed on a tight budget, the MCP73812 is the right candidate to perform well in battery charging applications.

REFERENCES

[1] "Lithium Batteries", Gholam-Abbas Nazri and Gianfranco Pistoia Eds.; Kluwer Academic Publishers, 2004.

[2] "Handbook of Batteries, Third Edition", David Linden, Thomas B. Reddy; McGraw Hill Inc, 2002.

[3] "Batteries in a Portable World Second Edition", Isidor Buchmann; Cadex Electronics Inc., 2000.

[4] "Portable Electronics Product Design and Development", Bert Haskell; McGraw Hill, 2004.

[5] "Brief of Li-Polymer Battery's Research and Development", W.T. Wen; Taiwan National Science Cuncil Monthly No.7, 2001.

[6] AN960, "New Components and Design Methods Bring Intelligence to Battery Charger Applications", Terry Cleveland and Catherine Vannicola; Microchip Technology Inc., DS0000960, 2004.

[7] AN947, "Power Management in Portable Applications: Charging Lithium-Ion/Lithium-Polymer Batteries", Scott Dearborn; Microchip Technology Inc., DS0000947, 2004.

[8] Microchip RTC Training Class: "Portable Power Management", Microchip Technology Inc., 2006.

[9] MCP73811/2 Data Sheet, "Simple, Miniature Single-Cell, Fully Integrated Li-Ion/Li-Polymer Charge Management Controllers", Microchip Technology Inc., DS20002036, 2007.

[10] MCP73831/2 Data Sheet, "Miniature Single-Cell, Fully Integrated Li-Ion/Li-Polymer Charge Management Controllers", Microchip Technology Inc., DS20001984, 2006.

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