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# LI-ION SYSTEM PPM
## REFERENCE DESIGN

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Preface

NOTICE TO CUSTOMERS

All documentation becomes dated, and this manual is no exception. Microchip tools and documentation are constantly evolving to meet customer needs, so some actual dialogs and/or tool descriptions may differ from those in this document. Please refer to our web site (www.microchip.com) to obtain the latest documentation available.

Documents are identified with a “DS” number. This number is located on the bottom of each page, in front of the page number. The numbering convention for the DS number is “DSXXXXXXA”, where “XXXXX” is the document number and “A” is the revision level of the document.

For the most up-to-date information on development tools, see the MPLAB® IDE on-line help. Select the Help menu, and then Topics to open a list of available on-line help files.

INTRODUCTION

This chapter contains general information that will be useful to know before using the Li-Ion System PPM Reference Design. Items discussed in this chapter include:

• Document Layout
• Conventions Used in this Guide
• Recommended Reading
• The Microchip Web Site
• Customer Support
• Document Revision History

DOCUMENT LAYOUT

This document describes how to use the Li-Ion System PPM Reference Design as a development tool to emulate and debug firmware on a target board. The manual layout is as follows:

• Chapter 1. “Product Overview” – Important information about the Li-Ion System PPM Reference Design.
• Chapter 2. “Installation and Operation” – Includes instructions on how to get started with this user’s guide and a description of the user’s guide.
• Appendix A. “Schematic and Layouts” – Shows the schematic and layout diagrams for the Li-Ion System PPM Reference Design.
• Appendix B. “Bill Of Materials (BOM)” – Lists the parts used to build the Li-Ion System PPM Reference Design.
CONVENTIONS USED IN THIS GUIDE

This manual uses the following documentation conventions:

## DOCUMENTATION CONVENTIONS

<table>
<thead>
<tr>
<th>Description</th>
<th>Represents</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Arial font:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Italic characters</td>
<td>Referenced books</td>
<td><em>MPLAB® IDE User's Guide</em></td>
</tr>
<tr>
<td>Emphasized text</td>
<td>...is the <em>only</em> compiler...</td>
<td></td>
</tr>
<tr>
<td>Initial caps</td>
<td>A window</td>
<td>the Output window</td>
</tr>
<tr>
<td></td>
<td>A dialog</td>
<td>the Settings dialog</td>
</tr>
<tr>
<td></td>
<td>A menu selection</td>
<td>select Enable Programmer</td>
</tr>
<tr>
<td>Quotes</td>
<td>A field name in a window or dialog</td>
<td>“Save project before build”</td>
</tr>
<tr>
<td>Underlined, italic text with right angle bracket</td>
<td>A menu path</td>
<td>*File&gt;*Save</td>
</tr>
<tr>
<td>Bold characters</td>
<td>A dialog button</td>
<td><em>Click OK</em></td>
</tr>
<tr>
<td></td>
<td>A tab</td>
<td><em>Click the Power tab</em></td>
</tr>
<tr>
<td>N’Rnnnn</td>
<td>A number in verilog format, where N is the total number of digits, R is the radix and n is a digit.</td>
<td>4’b0010, 2’hF1</td>
</tr>
<tr>
<td>Text in angle brackets &lt; &gt;</td>
<td>A key on the keyboard</td>
<td><em>Press &lt;Enter&gt;, &lt;F1&gt;</em></td>
</tr>
<tr>
<td><strong>Courier New font:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plain Courier New</td>
<td>Sample source code</td>
<td><em>#define START</em></td>
</tr>
<tr>
<td>Filenames</td>
<td>autoexec.bat</td>
<td></td>
</tr>
<tr>
<td>File paths</td>
<td>c:\mcc18\h</td>
<td></td>
</tr>
<tr>
<td>Keywords</td>
<td>_asm, _endasm, static</td>
<td></td>
</tr>
<tr>
<td>Command-line options</td>
<td>-Opa+, -Opa-</td>
<td></td>
</tr>
<tr>
<td>Bit values</td>
<td>0, 1</td>
<td></td>
</tr>
<tr>
<td>Constants</td>
<td>0xFF, ‘A’</td>
<td></td>
</tr>
<tr>
<td>Italic Courier New</td>
<td>A variable argument</td>
<td><em>file.o</em>, where file can be any valid filename</td>
</tr>
<tr>
<td>Square brackets []</td>
<td>Optional arguments</td>
<td><em>mcc18 [options] file [options]</em></td>
</tr>
<tr>
<td>Curly brackets and pipe character: {}</td>
<td>Choice of mutually exclusive arguments; an OR selection</td>
<td>*errorlevel {0</td>
</tr>
<tr>
<td>Ellipses...</td>
<td>Replaces repeated text</td>
<td><em>var_name [, var_name...]</em></td>
</tr>
<tr>
<td></td>
<td>Represents code supplied by user</td>
<td><em>void main (void) { ... }</em></td>
</tr>
</tbody>
</table>
RECOMMENDED READING

This user's guide describes how to use Li-Ion System PPM Reference Design. The following Microchip document is recommended as supplemental reference resources.

**MCP73832 Data Sheet, “Miniature Single-Cell, Fully Integrated Li-Ion, Li-Polymer Charge Management Controllers”, DS21984**

This data sheet provides detailed information regarding the MCP73832 product family.

**MCP73833 Data Sheet, “Stand-Alone Linear Li-Ion / Li-Polymer Charge Management Controller”, DS22005**

This data sheet provides detailed information regarding the MCP73833 product family.

**AN1149, “Design A Load Sharing System Power Path Management with Microchip’s Stand-Alone Li-Ion Battery Charger”, DS01149**

This application note provides general information regarding designing with Microchip’s stand-alone Li-Ion / Li-Polymer charge management controller product family.

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- **General Technical Support** – Frequently Asked Questions (FAQs), technical support requests, online discussion groups, Microchip consultant program member listing
- **Business of Microchip** – Product selector and ordering guides, latest Microchip press releases, listing of seminars and events, listings of Microchip sales offices, distributors and factory representatives

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Users of Microchip products can receive assistance through several channels:

- Distributor or Representative
- Local Sales Office
- Field Application Engineer (FAE)
- Technical Support

Customers should contact their distributor, representative or field application engineer (FAE) for support. Local sales offices are also available to help customers. A listing of sales offices and locations is included in the back of this document.

Technical support is available through the web site at: http://support.microchip.com

DOCUMENT REVISION HISTORY

**Revision A (July 2008)**

- Initial Release of this Document.
Chapter 1. Product Overview

1.1 INTRODUCTION

Portable electronics has played an important role in modern era. Due to the natural characteristics of Li-Ion / Li-Polymer batteries, they are the most popular power sources for mobile devices. However, extra care in design is always important to implement Li-Ion / Li-Polymer batteries. System Power Path Management allows end-users to charge their batteries without interruption. This reference design is developed to assist product designers in reducing product design cycle and time by utilizing Microchip’s favorite stand-alone Li-Ion battery charge management controllers with system power path management.

This chapter provides an overview of the Li-Ion Battery Charger System Power Path Management Reference Design and covers the following topics:

• “What is the Li-Ion Battery Charger System Power Path Management Reference Design?”

• “What the Li-Ion Battery Charger System Power Path Management Reference Design Kit includes.”

FIGURE 1-1: MCP73833 With System Power Path Management Application.
1.2 WHAT IS THE LI-ION BATTERY CHARGER SYSTEM POWER PATH MANAGEMENT REFERENCE DESIGN?

The Li-Ion Battery Charger System Power Path Management Reference Design demonstrates the features of Microchip’s MCP73832 “Miniature Single-Cell, Fully Integrated Li-Ion, Li-Polymer Charge Management Controllers” and MCP73833 “Miniature Single-Cell, Fully Integrated Li-Ion, Li-Polymer Charge Management Controllers” with the load sharing system power path management capability.

There are two independent circuits on the reference design. First circuit is designed with MCP73832, which allows maximum programmable fast charge current up to 500 mA. The second circuit is designed with MCP73833, which allows maximum programmable fast charge current up to 1A and has a power good indicator and an additional status output. Two preset values of fast charge current are available for each circuit by a SPDT dip on the board for users to experience different speed.

Note: Please refer to Table 2-1 for Charge Status Outputs and Table 2-2 for charge current setups.

Both circuits come with load sharing system power path management feature. This feature allows a DC Power Source to support system load while charging a Li-Ion battery. When the DC Power Source is absent, the Li-Ion battery will support system load and stop charging.

The Li-Ion Battery Charger System Power Path Management Reference Design is designed to observe the performance and features on the circuits via multiple test points. Circuits can also be implemented into suitable applications without additional work.

1.3 WHAT THE LI-ION BATTERY CHARGER SYSTEM POWER PATH MANAGEMENT DESIGN KIT INCLUDES

This Li-Ion Battery Charger System Power Path Management Reference Design kit includes:

- Li-Ion Battery Charger System Power Path Management Reference Design, 102-00120
- Analog and Interface Products Demonstration Boards CD-ROM (DS21912)
  - Li-Ion System PPM Reference Design, DS51746
  - MCP73833 Data Sheet, “Miniature Single-Cell, Fully Integrated Li-Ion, Li-Polymer Charge Management Controllers”, DS21984
  - MCP73832 Data Sheet, “Stand-Alone Linear Li-Ion / Li-Polymer Charge Management Controller”, DS22005
Chapter 2. Installation and Operation

2.1 INTRODUCTION

The Li-Ion Battery Charger System Power Path Management Reference Design demonstrates Microchip's stand-alone Linear Li-Ion Battery Chargers - MCP73832 and MCP73833 while allowing input power source to operate the system load. The system load can also be supported by the Li-Ion battery when input power is disconnected. A number of device options allow the MCP73832 and the MCP73833 to be utilized in a variety of applications. Please refer to the MCP73832 data sheet (DS21984) and MCP73833 data sheet (DS22005) for device options.

Typical applications for the reference design are Smart Phones, PDA, Portable Media Players, MP3 Players, Digital Cameras, Handheld Medical devices, Bluetooth headsets, Ultra-Mobile PC and Portable Communicators.

2.2 FEATURES

The Li-Ion Battery Charger System Power Path Management Reference Design has the following features:

• Load sharing system power path management that support charging single cell Li-Ion battery and system load at the same time without affecting charging algorithm of Microchip's stand-alone charge management controllers.
• The system load is supported by Li-Ion battery when input power source is removed
• Blue LED indicates charge status
• Additional Red LED to indicate Power-Good (PG) and Green LED to indicate charge complete (Available from MCP73833)
• Dip Switch to select programmable fast charge current between 1000 mA (H) and 50 mA (L) for MCP73833 and 400 mA (H) and 25 mA (L) for MCP73832
• Available THERM pin on the MCP73833 for temperature monitoring with a thermister. It is disabled by default and can be enabled to use with NTC thermister.
• Preconditioning of deeply depleted cells.
• Internal Safety Timer (available from MCP73833)
• Automatic Charge Termination
• Automatic Recharge
• Thermal Regulation
• Small DFN packages with Exposed Pad as additional heat sink.
2.3 GETTING STARTED

The Li-Ion Battery Charger System Power Path Management Reference Design is fully assembled and tested for charging a single-cell Li-Ion or Li-Polymer battery with or without system load.

2.3.1 Power Input and Output Connection

2.3.1.1 POWERING THE LI-ION BATTERY CHARGER SYSTEM POWER PATH MANAGEMENT REFERENCE DESIGN

1. Connect the positive battery terminal to $V_{BAT^+}$ and negative battery terminal to $V_{BAT^-}$.
2. Connect the 5V DC power supply Negative Terminal to $V_{SS}$.
3. Connect the 5V DC power supply Positive Terminal to $V_{DD}$.
4. It should initiate the battery charging cycle when the power source is present.
5. Position the DIP Switch to “H” for 400 mA fast charge current rate of MCP73832 and 1000 mA fast charge current rate of MCP73833.
6. Position the DIP Switch to “L” for 25 mA fast charge current rate of MCP73832 and 50 mA fast charge current rate of MCP73833.

**Note:** Fast Charge Current can be programmed with various resistors that based on the Figure 2-1 and Figure 2-2.

**Note:** The Li-Ion battery pack can be replaced with test circuit or electronic load that can sink current with DC power supply. Please refer to Figure 2-3.

7. Connect positive of load to System Load on the board and negative of load to either $V_{SS}$ or $V_{BAT^-}$. The load can be a power resistor or E-Load.
8. Remove DC power supply, the load should be supported by the Li-Ion battery now.

**Note:** MCP73832 circuit is labeled “A” on the reference design while MCP73833 circuit is labeled “B” on the reference design.

**FIGURE 2-1:** MCP73833 Charge Current ($I_{OUT}$) vs. Programming Resistor ($R_{PROG}$).
FIGURE 2-2: MCP73832 Charge Current (I\textsubscript{OUT}) vs. Programming Resistor (R\textsubscript{PROG}).

FIGURE 2-3: Simulated Battery Load.
TABLE 2-1: MCP73833 CHARGE STATUS OUTPUTS

<table>
<thead>
<tr>
<th>CHARGE CYCLE STATE</th>
<th>STAT1 (BLUE)</th>
<th>STAT2 (GREEN)</th>
<th>PG (RED)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shutdown</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
</tr>
<tr>
<td>Standby</td>
<td>OFF</td>
<td>OFF</td>
<td>ON</td>
</tr>
<tr>
<td>Charge in Progress</td>
<td>ON</td>
<td>OFF</td>
<td>ON</td>
</tr>
<tr>
<td>Charge Complete (EOC)</td>
<td>OFF</td>
<td>OFF</td>
<td>ON</td>
</tr>
<tr>
<td>Temperature Fault</td>
<td>OFF</td>
<td>OFF</td>
<td>ON</td>
</tr>
<tr>
<td>Timer Fault</td>
<td>OFF</td>
<td>OFF</td>
<td>ON</td>
</tr>
<tr>
<td>System Test Mode</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
</tr>
</tbody>
</table>

TABLE 2-2: MCP73832 CHARGE STATUS OUTPUTS

<table>
<thead>
<tr>
<th>CHARGE CYCLE STATE</th>
<th>STAT (BLUE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shutdown</td>
<td>OFF</td>
</tr>
<tr>
<td>No Battery Present</td>
<td>OFF</td>
</tr>
<tr>
<td>Preconditioning</td>
<td>ON</td>
</tr>
<tr>
<td>Constant-Current Fast Charge</td>
<td>ON</td>
</tr>
<tr>
<td>Constant Voltage</td>
<td>ON</td>
</tr>
<tr>
<td>Charge Complete - Standby</td>
<td>OFF</td>
</tr>
</tbody>
</table>
Appendix A. Schematic and Layouts

A.1 INTRODUCTION

This appendix contains the following schematics and layouts for the Li-Ion Battery Charger System Power Path Management Reference Design:

- Board – Schematic
- Board – Top Layer
- Board – Top Metal Layer
- Board – Bottom Layer
A.3 BOARD – TOP LAYER

MCP73832

TP4
TP1
STAT
R1
VDDA
R10
R3
SW1
H
L

MCP73833

TP7
TP18
TP9
VDDD
VBATB~
VBATB+
R11
C3
C4
R7
TP_.V5
STAT1
TP_.V6
STAT2

TP8

Li–Ion Battery Charger System Power Path Management Reference Design 102–00184

A.4 BOARD – TOP METAL LAYER

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A.5 BOARD – BOTTOM LAYER
### Appendix B. Bill Of Materials (BOM)

#### TABLE B-1: BILL OF MATERIALS (BOM)

<table>
<thead>
<tr>
<th>Qty</th>
<th>Description</th>
<th>Manufacture</th>
<th>Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Bump BUMPON HEMISPHERE .44X.20 WHITE</td>
<td>3M</td>
<td>SJ5003-9-ND</td>
</tr>
<tr>
<td>4</td>
<td>CAP CERAMIC 4.7 uF 10 X5R 0603</td>
<td>Taiyo Yuden</td>
<td>LMK107BJ475KA-T</td>
</tr>
<tr>
<td>2</td>
<td>Blue Water Clear 0603 SMD LED</td>
<td>Para Light USA</td>
<td>L-C191LBC7-U1</td>
</tr>
<tr>
<td>1</td>
<td>True Green Water Clear 0603 SMD LED</td>
<td>Para Light USA</td>
<td>L-C191LGCT-U1</td>
</tr>
<tr>
<td>1</td>
<td>Super Red Water Clear 0603 SMD LED</td>
<td>Para Light USA</td>
<td>L-C191KRCT-U1</td>
</tr>
<tr>
<td>1</td>
<td>Printed Circuit Board —</td>
<td>—</td>
<td>104-00184-R1</td>
</tr>
<tr>
<td>4</td>
<td>RES 221 OHM 1/10W 1% 0603 SMD</td>
<td>Panasonic® - ECG</td>
<td>ERJ-3EKF2210V</td>
</tr>
<tr>
<td>1</td>
<td>RES 41.2K OHM 1/10W 1% 0603 SMD</td>
<td>Panasonic - ECG</td>
<td>ERJ-3EKF4122V</td>
</tr>
<tr>
<td>1</td>
<td>RES 2.49K OHM 1/10W 1% 0603 SMD</td>
<td>Panasonic - ECG</td>
<td>ERJ-3EKF2491V</td>
</tr>
<tr>
<td>3</td>
<td>RES 10K OHM 1/10W 1% 0603 SMD</td>
<td>Panasonic - ECG</td>
<td>ERJ-3EKF1002V</td>
</tr>
<tr>
<td>1</td>
<td>RES 1K OHM 1/10W 1% 0603 SMD</td>
<td>Panasonic - ECG</td>
<td>ERJ-3EKF1001V</td>
</tr>
<tr>
<td>1</td>
<td>RES 20K OHM 1/10W 1% 0603 SMD</td>
<td>Panasonic - ECG</td>
<td>ERJ-3EKF2002V</td>
</tr>
<tr>
<td>2</td>
<td>SWITCH SLIDE SPDT SMD J-LEAD</td>
<td>Copal Electronics Inc</td>
<td>CJS-1200TA</td>
</tr>
<tr>
<td>10</td>
<td>PC Test Point Compact SMT</td>
<td>Keystone Electronics®</td>
<td>5016</td>
</tr>
<tr>
<td>1</td>
<td>Miniature Single Cell, Fully Integrated Li-Ion, Li-Polymer Charge Management</td>
<td>Microchip Technology Inc</td>
<td>MCP73832-2ATI/MC</td>
</tr>
<tr>
<td>1</td>
<td>Stand-Alone Linear Li-Ion / Li-Polymer Charge Management Controller</td>
<td>Microchip Technology Inc</td>
<td>MCP73833-AMI/MF</td>
</tr>
<tr>
<td>2</td>
<td>MOSFET/SCHOTTKY P-CH MICROFET2X2</td>
<td>Fairchild Semiconductor®</td>
<td>FDFMA2P857</td>
</tr>
</tbody>
</table>

**Note 1:** The components listed in this Bill of Materials are representative of the PCB assembly. The released BOM used in manufacturing uses all RoHS-compliant components.
## World Wide Sales and Service

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  - Fax: 630-285-0075
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  - Fax: 248-538-2260
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  - Fax: 765-864-8387
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  - Tel: 949-462-9523
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  - Fax: 408-961-6445
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