

#### Note the following details of the code protection feature on Microchip devices:

- Microchip products meet the specification contained in their particular Microchip Data Sheet.
- Microchip believes that its family of products is one of the most secure families of its kind on the market today, when used in the intended manner and under normal conditions.
- There are dishonest and possibly illegal methods used to breach the code protection feature. All of these methods, to our
  knowledge, require using the Microchip products in a manner outside the operating specifications contained in Microchip's Data
  Sheets. Most likely, the person doing so is engaged in theft of intellectual property.
- Microchip is willing to work with the customer who is concerned about the integrity of their code.
- Neither Microchip nor any other semiconductor manufacturer can guarantee the security of their code. Code protection does not
  mean that we are guaranteeing the product as "unbreakable."

Code protection is constantly evolving. We at Microchip are committed to continuously improving the code protection features of our products. Attempts to break Microchip's code protection feature may be a violation of the Digital Millennium Copyright Act. If such acts allow unauthorized access to your software or other copyrighted work, you may have a right to sue for relief under that Act.

Information contained in this publication regarding device applications and the like is provided only for your convenience and may be superseded by updates. It is your responsibility to ensure that your application meets with your specifications. MICROCHIP MAKES NO REPRESENTATIONS OR WAR-RANTIES OF ANY KIND WHETHER EXPRESS OR IMPLIED, WRITTEN OR ORAL, STATUTORY OR OTHERWISE, RELATED TO THE INFORMATION, INCLUDING BUT NOT LIMITED TO ITS CONDITION. QUALITY. PERFORMANCE. MERCHANTABILITY OR FITNESS FOR PURPOSE. Microchip disclaims all liability arising from this information and its use. Use of Microchip's products as critical components in life support systems is not authorized except with express written approval by Microchip. No licenses are conveyed, implicitly or otherwise, under any Microchip intellectual property rights.

#### **Trademarks**

The Microchip name and logo, the Microchip logo, Accuron, dsPIC, KEELOQ, microID, MPLAB, PIC, PICmicro, PICSTART, PRO MATE, PowerSmart, rfPIC, and SmartShunt are registered trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

AmpLab, FilterLab, Migratable Memory, MXDEV, MXLAB, PICMASTER, SEEVAL, SmartSensor and The Embedded Control Solutions Company are registered trademarks of Microchip Technology Incorporated in the U.S.A.

Analog-for-the-Digital Age, Application Maestro, dsPICDEM, dsPICDEM.net, dsPICworks, ECAN, ECONOMONITOR, FanSense, FlexROM, fuzzyLAB, In-Circuit Serial Programming, ICSP, ICEPIC, Linear Active Thermistor, MPASM, MPLIB, MPLINK, MPSIM, PICkit, PICDEM, PICDEM.net, PICLAB, PICtail, PowerCal, PowerInfo, PowerMate, PowerTool, Real ICE, rfLAB, rfPICDEM, Select Mode, Smart Serial, SmartTel, Total Endurance, UNI/O, WiperLock and Zena are trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

 $\ensuremath{\mathsf{SQTP}}$  is a service mark of Microchip Technology Incorporated in the U.S.A.

All other trademarks mentioned herein are property of their respective companies.

Printed on recycled paper.

QUALITY MANAGEMENT SYSTEM

CERTIFIED BY DNV

ISO/TS 16949:2002

Microchip received ISO/TS-16949:2002 quality system certification for its worldwide headquarters, design and wafer fabrication facilities in Chandler and Tempe, Arizona and Mountain View, California in October 2003. The Company's quality system processes and procedures are for its PICmicro® 8-bit MCUs, KEELOQ® code hopping devices, Serial EEPROMs, microperipherals, nonvolatile memory and analog products. In addition, Microchip's quality system for the design and manufacture of development systems is ISO 9001:2000 certified.



## **Table of Contents**

Preface .		1
	Introduction	1
	Document Layout	1
	Conventions Used in this Guide	2
	Recommended Reading	3
	The Microchip Web Site	
	Customer Support	
	Document Revision History	
Chapter '	1. Product Overview	
-	1.1 Introduction	5
	1.2 What is the MCP73831 Evaluation Board?	6
	1.3 What the MCP73831 Evaluation Kit Includes	
Chapter 2	2. Installation and Operation	
•	2.1 Introduction	7
	2.2 Features	7
	2.3 Getting Started	8
Appendix	A. Schematic and Layouts	
	A.1 Introduction	11
Appendix	с В. Bill Of Materials (ВОМ)	
Worldwic	le Sales and Service	18

MCP/3831 Evaluation Board User's Guide					
NOTES:					



## **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 "DSXXXXXA", where "XXXXX" is the document number and "A" is the revision level of the document.

#### INTRODUCTION

This chapter contains general information that will be useful to know before using the MCP73831 Evaluation Board. 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 MCP73831 Evaluation Board. The manual layout is as follows:

- Chapter 1. "Product Overview" Important information about the MCP73831 Evaluation Board.
- Chapter 2. "Installation and Operation" Includes instructions on how to get started with this evaluation kit and a description of the evaluation boards.
- Appendix A. "Schematic and Layouts" Shows the schematic and layout diagrams for the MCP73831 Evaluation Board.
- Appendix B. "Bill Of Materials (BOM)" Lists the parts used to build the MCP73831 Evaluation Board.

## **CONVENTIONS USED IN THIS GUIDE**

This manual uses the following documentation conventions:

## **DOCUMENTATION CONVENTIONS**

Description	Represents	Examples	
Arial font:			
Italic characters	Referenced books	MPLAB <sup>®</sup> IDE User's Guide	
	Emphasized text	is the only compiler	
Initial caps	A window	the Output window	
	A dialog	the Settings dialog	
	A menu selection	select Enable Programmer	
Quotes	A field name in a window or dialog	"Save project before build"	
Underlined, italic text with right angle bracket	A menu path	<u>File&gt;Save</u>	
Bold characters	A dialog button	Click <b>OK</b>	
	A tab	Click the <b>Power</b> tab	
N'Rnnnn	A number in verilog format, where N is the total number of digits, R is the radix and n is a digit.	4'b0010, 2'hF1	
Text in angle brackets < >	A key on the keyboard	Press <enter>, <f1></f1></enter>	
Courier New font:			
Plain Courier New	Sample source code	#define START	
	Filenames	autoexec.bat	
	File paths	c:\mcc18\h	
	Keywords	_asm, _endasm, static	
	Command-line options	-Opa+, -Opa-	
	Bit values	0, 1	
	Constants	0xFF, 'A'	
Italic Courier New	A variable argument	file.o, where file can be any valid filename	
Square brackets []	Optional arguments	mcc18 [options] file [options]	
Curly brackets and pipe character: {   }	Choice of mutually exclusive arguments; an OR selection	errorlevel {0 1}	
Ellipses	Replaces repeated text	<pre>var_name [, var_name]</pre>	
	Represents code supplied by user	void main (void) { }	

### RECOMMENDED READING

This user's guide describes how to use the MCP73831 Evaluation Board. The following Microchip documents are available and recommended as supplemental reference resources.

MCP73831 Data Sheet, "Miniature Single-Cell, Fully-Integrated Li-Ion, Li-Polymer Charge-Management Controller", (DS21984)

This data sheet provides detailed information regarding the MCP73831 product family.

AN947, "Power Management in Portable Applications: Charging Lithium-Ion/Lithium-Polymer Batteries", (DS00947)

This application note provides general information regarding charging Li-lon batteries.

AN971, "USB Port-Powered Li-lon/Li-Polymer Battery Charging", (DS00971)

This application note provides general information regarding charging Li-lon batteries from a USB port.

## THE MICROCHIP WEB SITE

Microchip provides online support via our web site at www.microchip.com. This web site is used as a means to make files and information easily available to customers. Accessible by using your favorite Internet browser, the web site contains the following information:

- Product Support Data sheets and errata, application notes and sample programs, design resources, user's guides and hardware support documents, latest software releases and archived software
- 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

## **CUSTOMER SUPPORT**

Users of Microchip products can receive assistance through several channels:

- · Distributor or Representative
- · Local Sales Office
- Field Application Engineer (FAE)
- · Technical Support
- · Development Systems Information Line

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 (December 2005)

· Initial Release of this Document.



## **Chapter 1. Product Overview**

## 1.1 INTRODUCTION

The MCP73831 Evaluation Board is used to evaluate Microchip's MCP73831 in simple, stand-alone Li-lon battery charging applications. Two circuit boards are provided in the MCP73831 Evaluation Kit for evaluation of various device options.

This chapter covers the following topics:

- What is the MCP73831 Evaluation Board?
- What the MCP73831 Evaluation Kit Includes

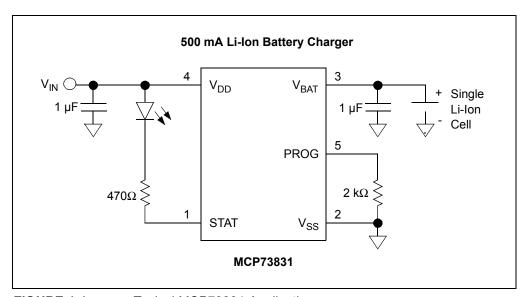


FIGURE 1-1: Typical MCP73831 Application.

## 1.2 WHAT IS THE MCP73831 EVALUATION BOARD?

The MCP73831 Evaluation Board is an evaluation and demonstration tool for Microchip's MCP73831 miniature single-cell, fully-integrated Li-lon, Li-Polymer charge-management controllers.

Two evaluation boards are provided in the MCP73831 Evaluation Kit. The boards are set up to evaluate simple, stand-alone, linear charging of single-cell Li-lon / Li-Polymer battery packs (the battery packs are not included). Each board design provides constant current charging followed by constant voltage charging with automatic charge termination. In addition, the MCP73831-2AC board provides preconditioning of deeply depleted cells.

Each board design provides evaluation of the MCP73831 in two package options: a SOT23-5 and a 2 mm x 3 mm, 8-Lead DFN for higher power handling capability.

When connected, these evaluation boards allow for the evaluation of the MCP73831 devices in a variety of applications.

## 1.3 WHAT THE MCP73831 EVALUATION KIT INCLUDES

This MCP73831 Evaluation Kit includes:

- Two MCP73831 Evaluation Boards. 102-00085
- MCP73831 Evaluation Board User's Guide, DS51596
- MCP73831 Data Sheet, "Miniature Single-Cell, Fully-Integrated Li-Ion, Li-Polymer Charge-Management Controller", DS21984
- AN947, "Power Management in Portable Applications: Charging Lithium-lon/Lithium-Polymer Batteries", DS00947
- AN971, "USB Port-Powered Li-lon/Li-Polymer Battery Charging", DS00971



## Chapter 2. Installation and Operation

## 2.1 INTRODUCTION

The MCP73831 Evaluation Board demonstrates Microchip's MCP73831. The MCP73831 is a miniature single-cell, fully-integrated Li-Ion/Li-Polymer charge-management controller. A number of device options allow the MCP73831 to be utilized in a variety of applications. Refer to the MCP73831 data sheet (DS21984) for device options.

## 2.2 FEATURES

The MCP73831 Evaluation Kit contains two boards for evaluation of various device options. The boards have the following features with the factory installed devices:

- · Charge Voltage: 4.20V
- Programmable Fast Charge Current up to 500 mA
- Preconditioning of deeply depleted cells (MCP73831-2AC)
  - Preconditioning Threshold Voltage: 2.8V
  - Preconditioning Current: 10% of Programmed Fast Charge Current
- No Preconditioning (MCP73831-2DC)
- Automatic Charge Termination
  - Charge termination by minimum current in Constant Voltage Mode
  - Termination Current: 7.5% of Programmed Fast Charge Current
- Automatic Recharge
  - Recharge Threshold Voltage: 4.05V
- · Charge Current Monitor for Fuel Gauging
- · Thermal Regulation
- · Reverse Discharge Protection
- Evaluation in SOT23-5 Package
- Evaluation in 2 mm x 3 mm, 8-Lead DFN package for higher power handling capability
- · Simple Stand-Alone Operation
- Powered from external bench supply or voltage regulated wall cube
- Surface-Mount Design
- · Fully Assembled and Tested

### 2.3 GETTING STARTED

The MCP73831 Evaluation Boards are fully assembled and tested for charging single-cell, Li-lon/Li-Polymer battery packs. The boards provide the appropriate charge algorithm for simple, stand-alone operation.

The boards require the use of an external input voltage source (5V ±10%, recommended) and external load (battery pack or simulated battery load).

## 2.3.1 Power Input and Output Connections

## 2.3.1.1 POWERING A MCP73831 EVALUATION BOARD

- 1. Apply the input voltage source to the appropriate circuit for evaluation. The input voltage source should be limited to the 0V to +6V range. For normal operation, the input voltage should be between +4.5V and +6V. The input voltage must not exceed an absolute maximum of +7V.
- Connect the positive side of the input source (+) to V<sub>DD</sub> of the circuit being evaluated. Connect the negative or return side of the input source (-) to V<sub>SS</sub> of the circuit being evaluated. Refer to Figure 2-1.

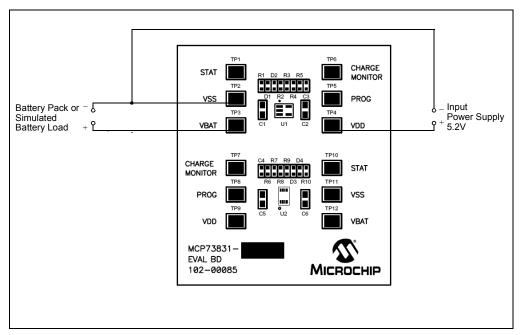


FIGURE 2-1: Setup Configuration Diagram.

### 2.3.1.2 APPLYING THE LOAD TO A MCP73831 EVALUATION BOARD

- To apply a load to a MCP73831 Evaluation Board, the positive side of the load (B+) should be connected to V<sub>BAT</sub> of the circuit being evaluated. The negative or return side of the load (B-) should be connected to V<sub>SS</sub> of the circuit being evaluated. Care should be taken when using electronic loads or ground referenced loads.
- 2. For the MCP73831-2AC board, the charge management controller will only provide 10% of the programmed fast charge current if the battery terminal voltage (V<sub>BAT</sub>) is less than 2.8V with respect to V<sub>SS</sub>. Using a purely resistive load will not work for preconditioning and fast charge currents. The best way to evaluate the charge management circuit is to use a single-cell Li-lon battery pack, or the recommended simulated battery load. Refer to Figure 2-2.

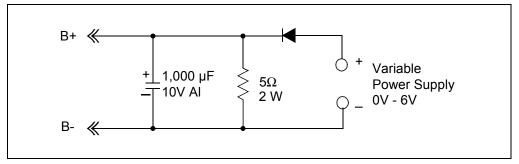


FIGURE 2-2: Simulated Battery Load.

### 2.3.1.3 SETTING THE FAST CHARGE CURRENT

- As provided, the MCP73831 Evaluation Boards have two fast charge current settings: 100 mA and 500 mA. The default fast charge current setting is 100 mA. By jumpering PROG to V<sub>SS</sub> of the circuit being evaluated, the fast charge current is set to 500 mA.
- Alternatively, the appropriate programming resistor can be changed in the hardware to obtain the desired fast charge current setting. Resistor R3 should be changed for the SOT23 circuit, and resistor R8 should be changed for the DFN circuit. Refer to the MCP73831 data sheet for choosing the appropriate value programming resistor for the desired fast charge current.

#### 2.3.1.4 STATUS INDICATORS

 The MCP73831 Evaluation Boards have two LED status indicators for each circuit being evaluated. Table 2-1 represents the state of the status indicators during various states of the charge cycle. ON indicates that the respective LED is illuminated.

TABLE 2-1:	STATUS INDIC	CATORS
------------	--------------	--------

Charge Cycle State	Red LED	Green LED
Qualification	ON	ON
Preconditioning	ON	OFF
Constant Current Fast Charge	ON	OFF
Constant Voltage	ON	OFF
Charge Complete	OFF	ON
Battery Disconnected	ON	ON
Input Voltage Source Removed	OFF	OFF
Input Voltage Source Below UVLO	ON	ON
Shutdown	ON	ON

## 2.3.1.5 CHARGE CURRENT MONITOR

1. The MCP73831 Evaluation Boards have a charge current monitor for each circuit being evaluated. The charge current monitor can be used as a coulomb counter for fuel gauging. The charge current is equivalent to the voltage at CHARGE MONITOR with respect to  $V_{SS}$  divided by the value of the programming resistor in kilo-ohms. For example, the default programming resistor is 10 k $\Omega$ . If the measured voltage at CHARGE MONITOR is 1V, the charge current is equal to 1 divided 10, or 100 mA. If the measured voltage at CHARGE MONITOR is 100 mV, the charge current is 0.1 divided by 10, or 10 mA.

## 2.3.1.6 DEVICE SUPPORT OPTIONS

1. The MCP73831 Evaluation Boards are capable of supporting all of the available MCP73831 device options. The factory installed devices are the MCP73831-2AC and the MCP73831-2DC. Refer to the MCP73831 data sheet for available device options and details regarding the installed device options.



## Appendix A. Schematic and Layouts

## A.1 INTRODUCTION

This appendix contains the following schematic and layouts for the MCP73831 Evaluation Boards.

Diagrams included in this appendix:

- · Board Schematic
- · Board Assembly Drawing
- Board Top Overlay
- · Board Top Layer
- · Board Bottom Layer

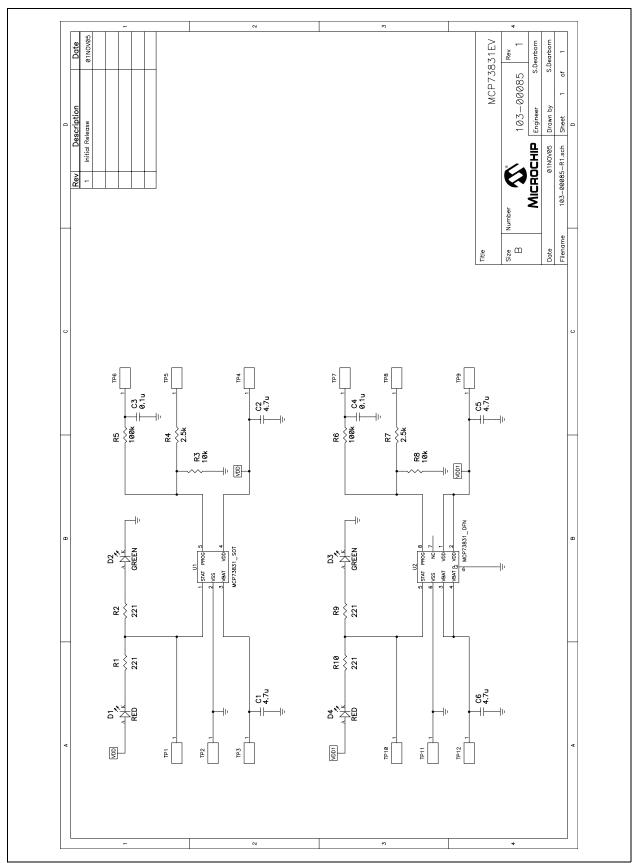


FIGURE A-1: Board Schematic.

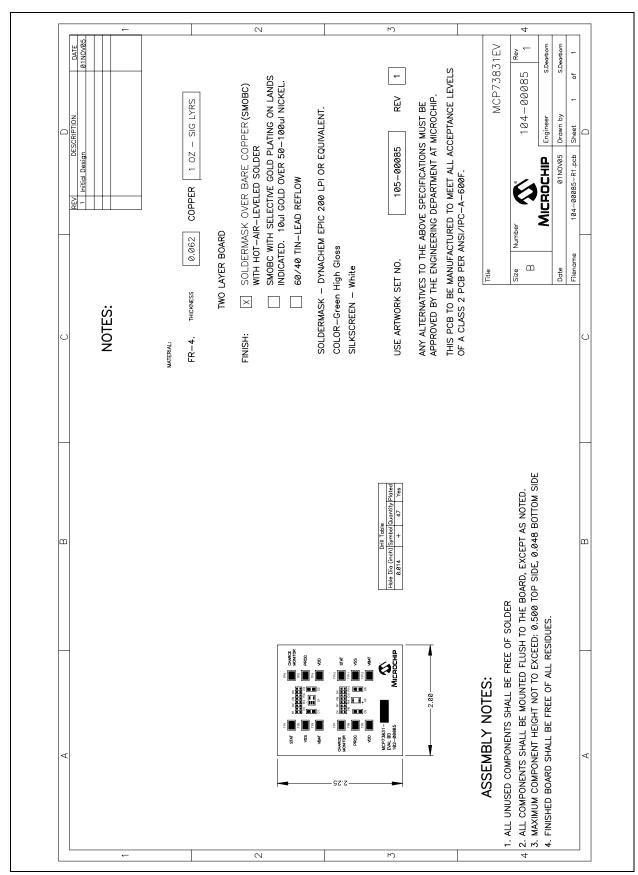


FIGURE A-2: Board - Assembly Drawing.

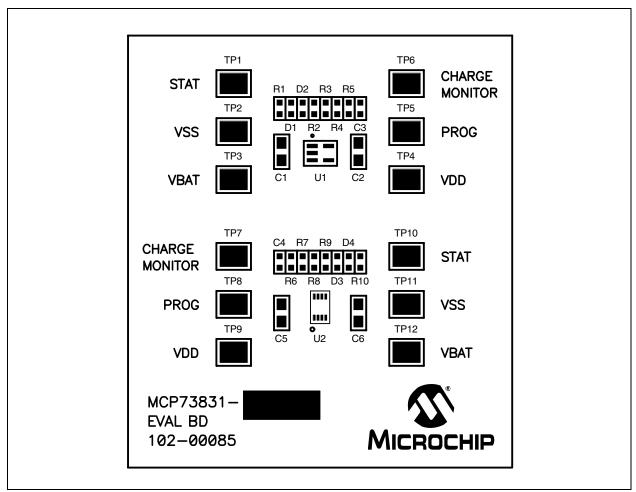


FIGURE A-3: Board - Top Overlay.

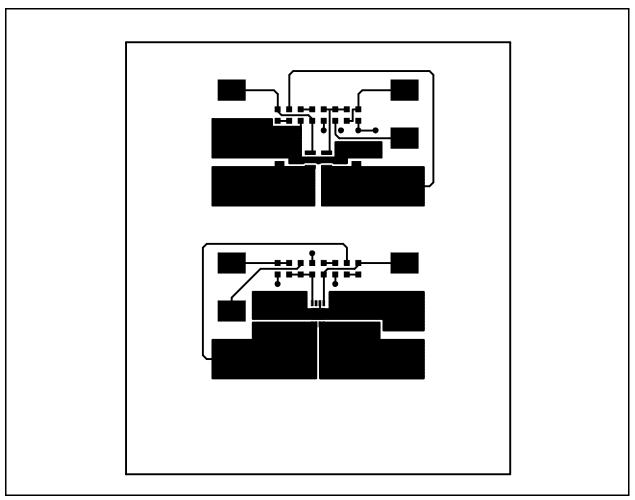


FIGURE A-4: Board - Top Layer.

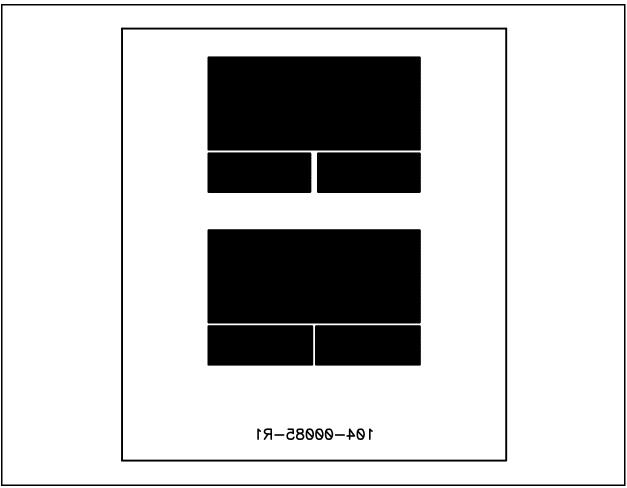


FIGURE A-5: Board - Bottom Layer.



## **Appendix B. Bill Of Materials (BOM)**

TABLE B-1: BILL OF MATERIALS (BOM)

Qty.	Reference	Description	Mfgr.	Part Number
4	C1,C2,C5,C6	4.7uF, X5R Ceramic, 10V, 0805	Panasonic®-ECG	ECJ-GVB1A475M
2	C3,C4	0.1uF, X7R Ceramic, 16V, 0603	Panasonic-ECG	ECJ-1VB1C104K
2	D1,D4	Super Red LED, 0603	Lumex	LTST-C190KRKT
2	D2,D3	Green LED, 0603	Lumex	LTST-C190KGKT
4	R1,R2,R9,R10	221, 1/10W, Chip Resistor, 0603	Panasonic-ECG	ERJ-3EK2210V
2	R3,R8	10.0k, 1/10W, Chip Resistor, 0603	Panasonic-ECG	ERJ-3EK1002V
2	R4,R7	2.49k, 1/10W, Chip Resistor, 0603	Panasonic-ECG	ERJ-3EK2491V
2	R5,R6	100k, 1/10W, Chip Resistor, 0603	Panasonic-ECG	ERJ-3EK1003V
12	TP1-TP12	Surface Mount Test Point, 5016	Keystone	5016
1	U1	Miniature Li-Ion Charger, SOT23-5	Microchip Technology Inc.	MCP73831-2ACI/OT MCP73831-2DCI/OT <sup>(1)</sup>
1	U2	Miniature Li-Ion Charger, 2X3DFN8	Microchip Technology Inc.	MCP73831-2ACI/MC MCP73831-2DCI/MC <sup>(1)</sup>
4	_	Bump-ons	3M	SJ5003
1		Printed Circuit Board	Advanced Circuits	104-00085-R1

Note 1: Installed device option is indicated on board.



## WORLDWIDE SALES AND SERVICE

#### **AMERICAS**

Corporate Office

2355 West Chandler Blvd. Chandler, AZ 85224-6199 Tel: 480-792-7200 Fax: 480-792-7277

Technical Support:

http://support.microchip.com

Web Address: www.microchip.com

Atlanta

Alpharetta, GA Tel: 770-640-0034 Fax: 770-640-0307

**Boston** 

Westborough, MA Tel: 774-760-0087 Fax: 774-760-0088

Chicago Itasca. IL

Tel: 630-285-0071 Fax: 630-285-0075

**Dallas** 

Addison, TX Tel: 972-818-7423 Fax: 972-818-2924

Detroit

Farmington Hills, MI Tel: 248-538-2250 Fax: 248-538-2260

Kokomo

Kokomo, IN Tel: 765-864-8360 Fax: 765-864-8387

Los Angeles

Mission Viejo, CA Tel: 949-462-9523 Fax: 949-462-9608

San Jose

Mountain View, CA Tel: 650-215-1444 Fax: 650-961-0286

**Toronto** 

Mississauga, Ontario, Canada

Tel: 905-673-0699 Fax: 905-673-6509

#### ASIA/PACIFIC

Australia - Sydney

Tel: 61-2-9868-6733 Fax: 61-2-9868-6755

China - Beijing

Tel: 86-10-8528-2100 Fax: 86-10-8528-2104

China - Chengdu

Tel: 86-28-8676-6200 Fax: 86-28-8676-6599

China - Fuzhou

Tel: 86-591-8750-3506 Fax: 86-591-8750-3521

China - Hong Kong SAR

Tel: 852-2401-1200 Fax: 852-2401-3431

China - Qingdao

Tel: 86-532-8502-7355 Fax: 86-532-8502-7205

China - Shanghai

Tel: 86-21-5407-5533 Fax: 86-21-5407-5066

China - Shenyang

Tel: 86-24-2334-2829 Fax: 86-24-2334-2393

China - Shenzhen

Tel: 86-755-8203-2660 Fax: 86-755-8203-1760

China - Shunde

Tel: 86-757-2839-5507 Fax: 86-757-2839-5571

China - Wuhan

Tel: 86-27-5980-5300 Fax: 86-27-5980-5118

China - Xian

Tel: 86-29-8833-7250 Fax: 86-29-8833-7256

#### ASIA/PACIFIC

India - Bangalore

Tel: 91-80-2229-0061 Fax: 91-80-2229-0062

India - New Delhi

Tel: 91-11-5160-8631 Fax: 91-11-5160-8632

India - Pune

Tel: 91-20-2566-1512 Fax: 91-20-2566-1513

Japan - Yokohama

Tel: 81-45-471- 6166 Fax: 81-45-471-6122

Korea - Gumi

Tel: 82-54-473-4301 Fax: 82-54-473-4302

Korea - Seoul

Tel: 82-2-554-7200 Fax: 82-2-558-5932 or

82-2-558-5934

**Malaysia - Penang** Tel: 60-4-646-8870 Fax: 60-4-646-5086

Philippines - Manila

Tel: 63-2-634-9065 Fax: 63-2-634-9069

**Singapore** Tel: 65-6334-8870

Fax: 65-6334-8850 **Taiwan - Hsin Chu** 

Tel: 886-3-572-9526 Fax: 886-3-572-6459

Taiwan - Kaohsiung

Tel: 886-7-536-4818 Fax: 886-7-536-4803

Taiwan - Taipei

Tel: 886-2-2500-6610 Fax: 886-2-2508-0102

Thailand - Bangkok

Tel: 66-2-694-1351 Fax: 66-2-694-1350

#### **EUROPE**

Austria - Wels

Tel: 43-7242-2244-399 Fax: 43-7242-2244-393

Denmark - Copenhagen

Tel: 45-4450-2828 Fax: 45-4485-2829

France - Paris

Tel: 33-1-69-53-63-20 Fax: 33-1-69-30-90-79

Germany - Munich

Tel: 49-89-627-144-0 Fax: 49-89-627-144-44

Italy - Milan

Tel: 39-0331-742611 Fax: 39-0331-466781

Netherlands - Drunen

Tel: 31-416-690399 Fax: 31-416-690340

Spain - Madrid

Tel: 34-91-708-08-90 Fax: 34-91-708-08-91

**UK - Wokingham** Tel: 44-118-921-5869

Fax: 44-118-921-5820



Мы молодая и активно развивающаяся компания в области поставок электронных компонентов. Мы поставляем электронные компоненты отечественного и импортного производства напрямую от производителей и с крупнейших складов мира.

Благодаря сотрудничеству с мировыми поставщиками мы осуществляем комплексные и плановые поставки широчайшего спектра электронных компонентов.

Собственная эффективная логистика и склад в обеспечивает надежную поставку продукции в точно указанные сроки по всей России.

Мы осуществляем техническую поддержку нашим клиентам и предпродажную проверку качества продукции. На все поставляемые продукты мы предоставляем гарантию.

Осуществляем поставки продукции под контролем ВП МО РФ на предприятия военно-промышленного комплекса России, а также работаем в рамках 275 ФЗ с открытием отдельных счетов в уполномоченном банке. Система менеджмента качества компании соответствует требованиям ГОСТ ISO 9001.

Минимальные сроки поставки, гибкие цены, неограниченный ассортимент и индивидуальный подход к клиентам являются основой для выстраивания долгосрочного и эффективного сотрудничества с предприятиями радиоэлектронной промышленности, предприятиями ВПК и научноисследовательскими институтами России.

С нами вы становитесь еще успешнее!

#### Наши контакты:

Телефон: +7 812 627 14 35

Электронная почта: sales@st-electron.ru

Адрес: 198099, Санкт-Петербург,

Промышленная ул, дом № 19, литера Н,

помещение 100-Н Офис 331