



The following document contains information on Cypress products. The document has the series name, product name, and ordering part numbering with the prefix “MB”. However, Cypress will offer these products to new and existing customers with the series name, product name, and ordering part number with the prefix “CY”.

How to Check the Ordering Part Number

1. Go to www.cypress.com/pcn.
2. Enter the keyword (for example, ordering part number) in the **SEARCH PCNS** field and click **Apply**.
3. Click the corresponding title from the search results.
4. Download the Affected Parts List file, which has details of all changes

For More Information

Please contact your local sales office for additional information about Cypress products and solutions.

About Cypress

Cypress is the leader in advanced embedded system solutions for the world's most innovative automotive, industrial, smart home appliances, consumer electronics and medical products. Cypress' microcontrollers, analog ICs, wireless and USB-based connectivity solutions and reliable, high-performance memories help engineers design differentiated products and get them to market first. Cypress is committed to providing customers with the best support and development resources on the planet enabling them to disrupt markets by creating new product categories in record time. To learn more, go to www.cypress.com.



AN205124

F²MC-8FX Family MB95200H/210H Series 8-Bit Microcontroller Battery Charger Reference Solution**Associated Part Family: MB95200H/210H Series**

This application note describes the features of a Power Tool Battery Charger demo board. The battery charger solution is based on LPC MCU MB95F223K and MB39A132.

Contents

1	Introduction.....	1	4	Hardware.....	4
2	Demo Platform.....	2	4.1	System Block Diagram	4
2.1	Platform	2	4.2	Schematic.....	5
3	Features	3	4.3	MCU Pin Assignment	6
3.1	Battery Insertion Detection	3	5	Firmware	7
3.2	Support 2, 3 and 4 Cell Battery Pack.....	3	5.1	Flowchart.....	7
3.3	Support Setting Charger Voltage.....	3	5.2	Firmware Project	8
3.4	Support Setting Charger Current.....	3	6	Additional Information.....	9
3.5	LED Display the Charger Status.....	4		Document History.....	10

1 Introduction

Power Tool Battery Charger Demo Board is used to charge the battery of handset. The battery charger solution is based on LPC MCU MB95F223K and MB39A132. MB95F223K is a SOP16 package MCU, which integrates composite timer, 8/10 A/D converter on chip. The MB39A132 is a DC/DC converter IC for charging Li-ion battery.

This demo set supports features below:

- Battery insertion detection
- 2, 3 and 4 cell battery pack
- Setting charger voltage
- Setting charger current
- LED display the charger status.

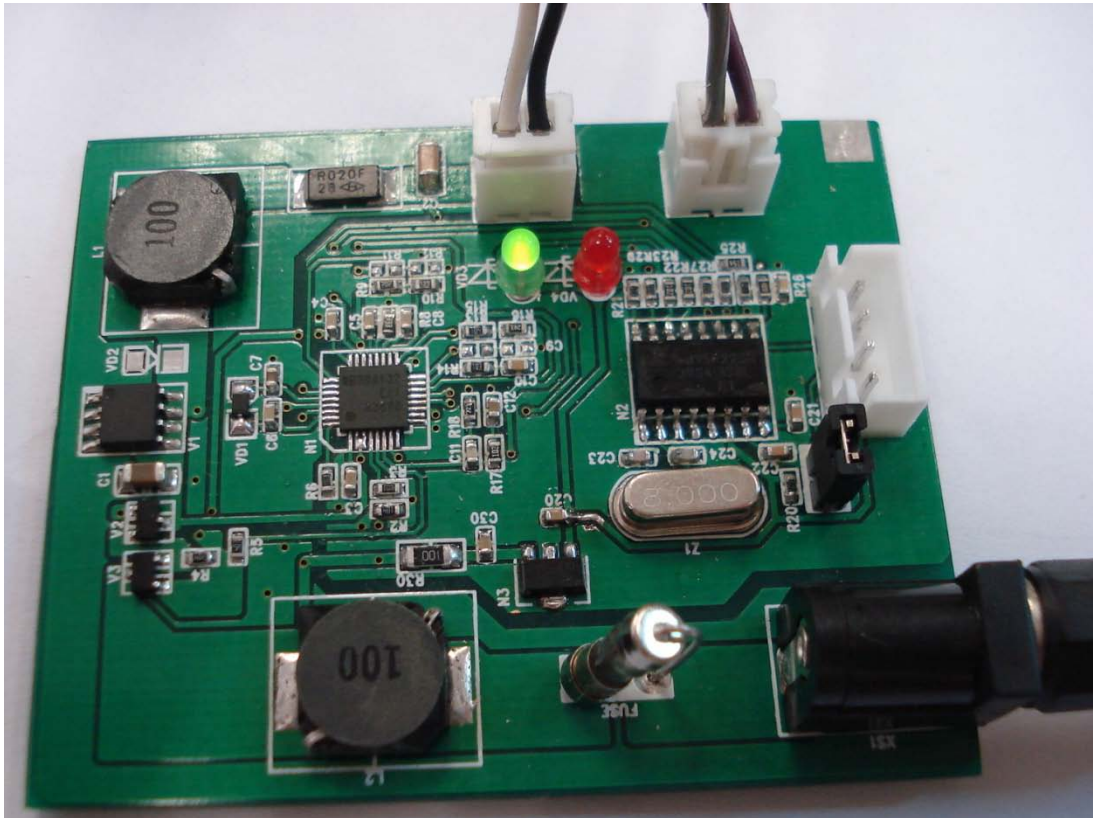
2 Demo Platform

Demo Platform of Battery Charger

2.1 Platform

Figure 1 shows the demo platform of battery charger. The red and green LEDs show the charger status.

Figure 1. Demo Platform



3 Features

Features of Battery Charger

3.1 Battery Insertion Detection

When battery insertion is detected, the charger checks the voltage and temperature of the inserted battery. The charger is stopped if it is abnormal.

Charger stops the charge process and the red LED starts to flash when charger detects that battery type is unmatched. Charger continues the charge process when a new battery is inserted.

3.2 Support 2, 3 and 4 Cell Battery Pack

Adjusting R11 and R12 can change the number of charger cell.

When R11 is unconnected and R12 is 0 Ω, the charger supports 2 cells.

When R11 is unconnected and R12 is unconnected, the charger supports 3 cells.

When R11 is 0 Ω and R12 is unconnected, the charger supports 4 cells.

The demo current status supports 3 cells.

3.3 Support Setting Charger Voltage

Upon the setting of cell number, R9 and R10 can be adjusted to change the charge voltage.

$$N_{ADJ3} = \frac{R10}{R9 + R10}$$

When $N_{ADJ3} \geq 0.82$, one cell charge voltage is 4.20 V.

When $0.48 \leq N_{ADJ3} \leq 0.78$, one cell charge voltage is 4.35 V.

When $0 \leq N_{ADJ3} \leq 0.18$, one cell charge voltage is 4.00 V.

When $0.22 \leq N_{ADJ3} \leq 0.44$, one cell charge voltage is $2 \times 5 \times N_{ADJ3}$ V.

Now the demo R9 is 2 K and R10 is 12 K, one cell charge voltage is 4.2 V and the charger voltage is 12.6 V.

3.4 Support Setting Charger Current

Upon above setting, R15 and R16 can be adjusted to change the upper limit of charge current.

$$N_{ADJ2} = \frac{R16}{R15 + R16}$$

When $N_{ADJ2} \geq 0.92$, the upper limit of charge current is 2.85 A.

When $0 \leq N_{ADJ2} \leq 0.88$, the upper limit of charge current is $2 \times (5 \times N_{ADJ2} - 0.075)$ A.

Now the demo R15 is 100 K and R16 is 24 K, the upper limit of charge current is 1.8 A.

3.5 LED Display the Charger Status

The demo has two LEDs: green LED and red LED.

The green LED keeps on showing that the charger enters standby mode when charging is started or the battery is fully charged.

The green light flashes to show that the charger is charging.

The red LED keeps on showing that the charger detects an over temperature in battery.

The red LED flashes to show that the battery is unmatched.

Charger stops the charge process when the red LED lights on or flash. Charger continues the charge process when a new battery is inserted or resumes to normal status.

4 Hardware

Hardware of Battery Charger

4.1 System Block Diagram

Figure 2 shows the demo system block diagram. The demo charger is developed based on MCU MB95F223K and MB39A132.

- MCU: AD module, switch control module and LED signal module
- DC input
- Charge manager
- LED
- Battery

Figure 2. System Block Diagram

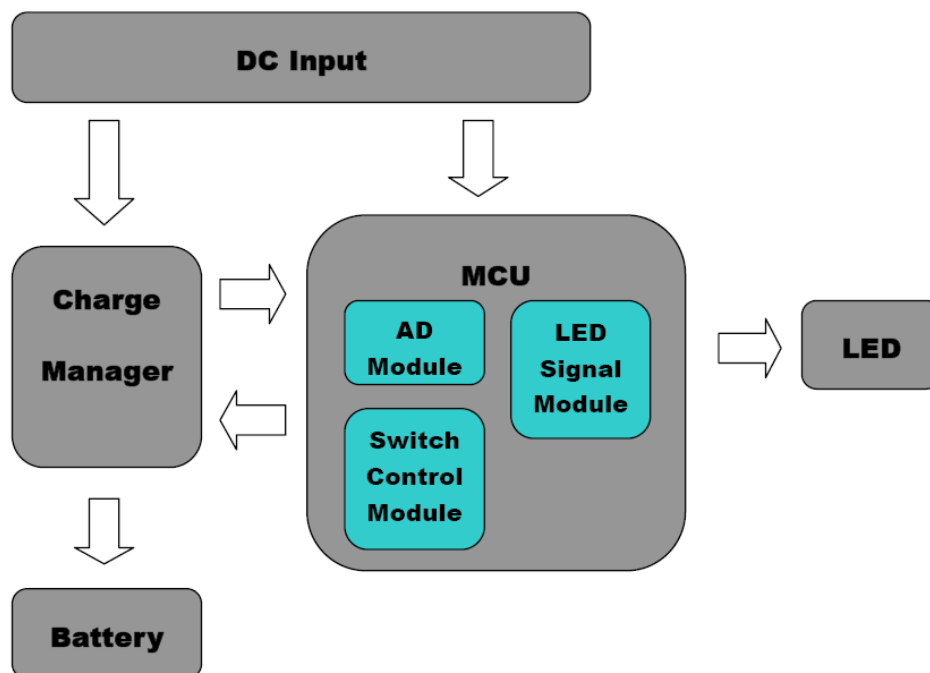
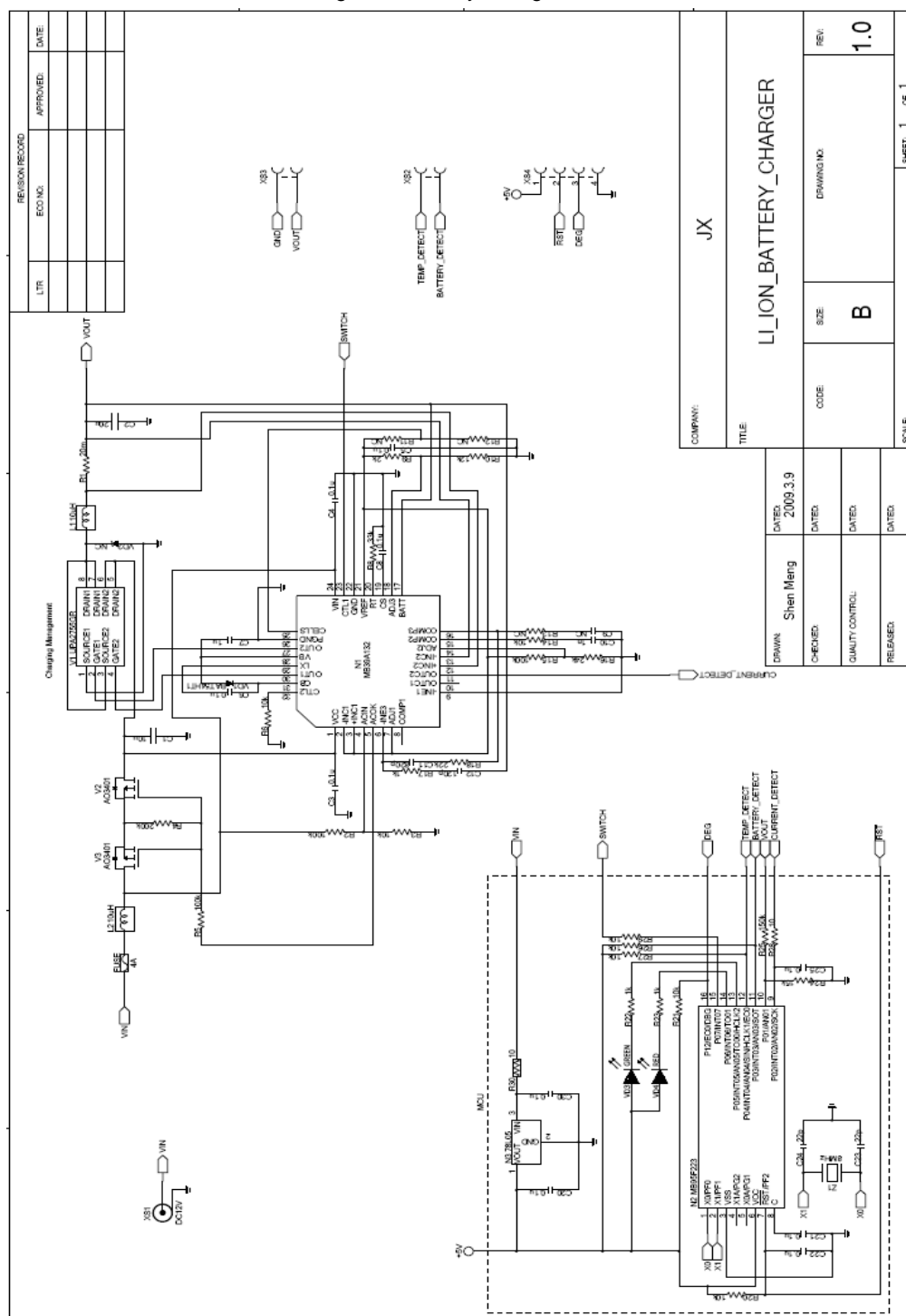


Figure 3 shows the schematic.

Figure 3. Battery Charger



4.3 MCU Pin Assignment

Table 1 shows the MB95F223K pin assignment in this system.

Table 1. Pin Assignment

Pin Number	Pin	Function
10	P01/INT01	AD input, VOUT
9	P02/INT02	AD input, CURRENT_DETECT
11	P03/INT03	AD input, BATTERY_DETECT
12	P04/INT04	AD input, TEMP_DETECT
13	P05/INT05	LED output, Green LED
14	P06/INT06	LED output, Red LED
15	P07/INT07	Switch output

5 Firmware

Firmware of Battery Charger

5.1 Flowchart

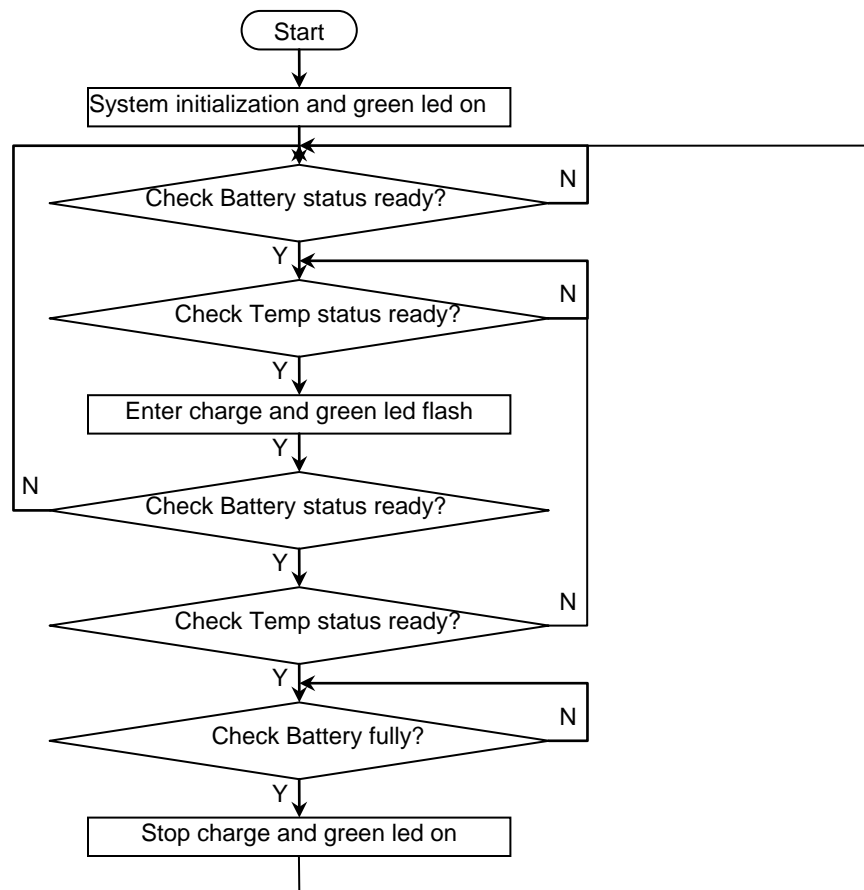
MCU initializes the on-chip peripherals and initializes the system parameters when the battery is detected and battery temperature is normal.

When above status is normal, the system will entry charging process and continue to check the battery status and temperature.

When the battery is fully charged, the charge process stops.

The description of main loop function is shown in [Figure 4](#).

Figure 4. Main Loop Flowchart



5.2 Firmware Project

This demo uses MB95F223K to implement all the functions. MB2146-08-E and SOFTUNE V3 are used to debug the demo.

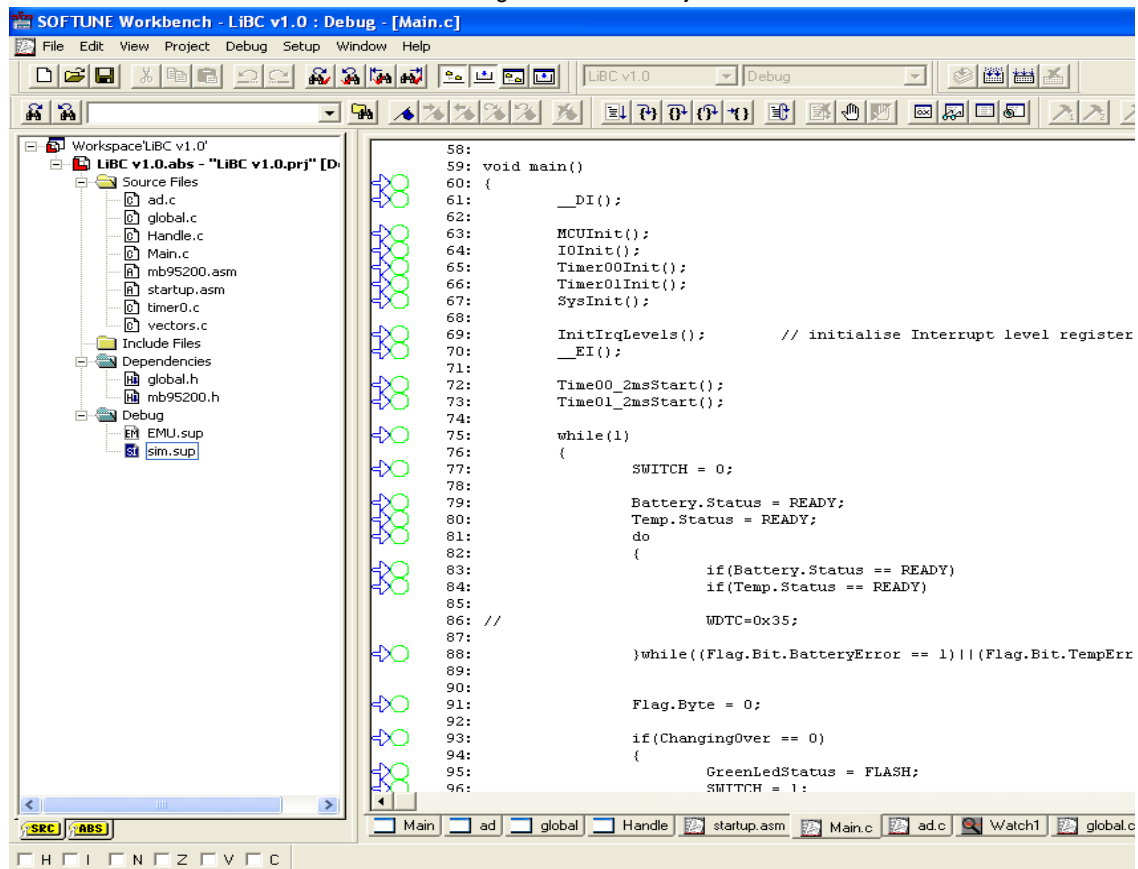
The table below explains the functions of the main files.

Table 2. Battery Charger Function

Files	Function
ad.c	Detect battery type, temperature, current and voltage
Global.c	Define global variable
Handle.c	Function module
Main.c	Main function
Ma95200.asm	Cypress MCU head file
Startup.asm	MCU configure file
Timer0.c	System clock function
Vecter.c	Interrupt setting file

The project is shown in Figure 5.

Figure 5. Demo Project



6 Additional Information

For more information on Cypress products, visit the following website:

<http://www.cypress.com/cypress-microcontrollers>

Document History

Document Title: AN205124 – F²MC-8FX Family MB95200H/210H Series 8-Bit Microcontroller Battery Charger Reference Solution

Document Number: 002-05124

Revision	ECN	Orig. of Change	Submission Date	Description of Change
**	-	HUAL	09/27/2010	Initial release
*A	5276162	HUAL	05/18/2016	Migrated Spansion Application Note MCU-AN-500100-E-10 to Cypress format.

Worldwide Sales and Design Support

Cypress maintains a worldwide network of offices, solution centers, manufacturer's representatives, and distributors. To find the office closest to you, visit us at [Cypress Locations](#).

Products

ARM® Cortex® Microcontrollers	cypress.com/arm
Automotive	cypress.com/automotive
Clocks & Buffers	cypress.com/clocks
Interface	cypress.com/interface
Lighting & Power Control	cypress.com/powerpsoc
Memory	cypress.com/memory
PSoC	cypress.com/psoc
Touch Sensing	cypress.com/touch
USB Controllers	cypress.com/usb
Wireless/Rf	cypress.com/wireless

PSoC® Solutions

[PSoC 1](#) | [PSoC 3](#) | [PSoC 4](#) | [PSoC 5LP](#)

Cypress Developer Community

[Forums](#) | [Projects](#) | [Videos](#) | [Blogs](#) | [Training](#) | [Components](#)

Technical Support

cypress.com/support

PSoC is a registered trademark and PSoC Creator is a trademark of Cypress Semiconductor Corporation. All other trademarks or registered trademarks referenced herein are the property of their respective owners.



Cypress Semiconductor
198 Champion Court
San Jose, CA 95134-1709
Phone : 408-943-2600
Fax : 408-943-4730
Website : www.cypress.com

© Cypress Semiconductor Corporation, 2010-2016. This document is the property of Cypress Semiconductor Corporation and its subsidiaries, including Spansion LLC ("Cypress"). This document, including any software or firmware included or referenced in this document ("Software"), is owned by Cypress under the intellectual property laws and treaties of the United States and other countries worldwide. Cypress reserves all rights under such laws and treaties and does not, except as specifically stated in this paragraph, grant any license under its patents, copyrights, trademarks, or other intellectual property rights. If the Software is not accompanied by a license agreement and you do not otherwise have a written agreement with Cypress governing the use of the Software, then Cypress hereby grants you a personal, non-exclusive, nontransferable license (without the right to sublicense) (1) under its copyright rights in the Software (a) for Software provided in source code form, to modify and reproduce the Software solely for use with Cypress hardware products, only internally within your organization, and (b) to distribute the Software in binary code form externally to end users (either directly or indirectly through resellers and distributors), solely for use on Cypress hardware product units, and (2) under those claims of Cypress's patents that are infringed by the Software (as provided by Cypress, unmodified) to make, use, distribute, and import the Software solely for use with Cypress hardware products. Any other use, reproduction, modification, translation, or compilation of the Software is prohibited.

TO THE EXTENT PERMITTED BY APPLICABLE LAW, CYPRESS MAKES NO WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, WITH REGARD TO THIS DOCUMENT OR ANY SOFTWARE OR ACCOMPANYING HARDWARE, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. To the extent permitted by applicable law, Cypress reserves the right to make changes to this document without further notice. Cypress does not assume any liability arising out of the application or use of any product or circuit described in this document. Any information provided in this document, including any sample design information or programming code, is provided only for reference purposes. It is the responsibility of the user of this document to properly design, program, and test the functionality and safety of any application made of this information and any resulting product. Cypress products are not designed, intended, or authorized for use as critical components in systems designed or intended for the operation of weapons, weapons systems, nuclear installations, life-support devices or systems, other medical devices or systems (including resuscitation equipment and surgical implants), pollution control or hazardous substances management, or other uses where the failure of the device or system could cause personal injury, death, or property damage ("Unintended Uses"). A critical component is any component of a device or system whose failure to perform can be reasonably expected to cause the failure of the device or system, or to affect its safety or effectiveness. Cypress is not liable, in whole or in part, and you shall and hereby do release Cypress from any claim, damage, or other liability arising from or related to all Unintended Uses of Cypress products. You shall indemnify and hold Cypress harmless from and against all claims, costs, damages, and other liabilities, including claims for personal injury or death, arising from or related to any Unintended Uses of Cypress products.

Cypress, the Cypress logo, Spansion, the Spansion logo, and combinations thereof, PSoC, CapSense, EZ-USB, F-RAM, and Traveo are trademarks or registered trademarks of Cypress in the United States and other countries. For a more complete list of Cypress trademarks, visit cypress.com. Other names and brands may be claimed as property of their respective owners.