TC110 Boost Converter Demo Board User's Guide

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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 "DSXXXXXA", 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 TC110 Boost Converter Demo 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 TC110 Boost Converter Demo Board 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 TC110 Boost Converter Demo Board.
- **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. "Schematics and Layouts"** – Shows the schematic and layout diagrams for the TC110 Boost Converter Demo Board.
- **Appendix B. "Bill Of Materials (BOM)"** – Lists the parts used to build the TC110 Boost Converter Demo 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® 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	*File>Save*
Bold characters	A dialog button	Click **OK**
	A tab	Click the **Power** 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>
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	`var_name [, var_name...]`
	Represents code supplied by user	`void main (void) { ... }`

RECOMMENDED READING

This user's guide describes how to use TC110 Boost Converter Demo Board. Other useful documents are listed below.

TC110 Data Sheet, *"PFM/PWM Step-Up DC/DC Controller"*, DS21355

This data sheet provides detailed information regarding the TC110 product family.

MCP73831/2 Data Sheet, *"Miniature Single-Cell, Fully Integrated Li-Ion, Li-Polymer Charge Management Controller"*, DS21984

This data sheet provides detailed information regarding the MCP73831/2 product family.

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

Customers should contact their distributor, representative or field application engineer 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 (February 2007)

- Initial Release of this Document.

NOTES:

Chapter 1. Product Overview

1.1 INTRODUCTION

The TC110 Boost Converter Demo Board can charge Li-Ion Batteries with single-cell Alkaline battery or 2-cell Alkaline battery at maximum 500 mA constant current. The TC110 Boost Converter Demo Board is used to evaluate Microchip's TC110 PFM/PWM Step-Up DC/DC Controller. The TC110 is a step-up (Boost) switching controller that can regulate output voltage with a typical start-up voltage of 0.9V. The TC110 Boost Converter Demo Board also includes a MCP73832 Miniature Single-Cell, Fully Integrated Li-Ion, Li-Polymer Charge Management Controllers. Microchip's MCP73832 is a highly advanced linear charge management controllers for use in space-limited, cost-sensitive applications. The TC110 Boost Converter Demo Board is a ready to use solution for portable applications when no DC plug is available. The TC110 Boost Converter Demo Board can efficiently transfer energy from Alkaline batteries to Li-Ion battery pack.

This chapter covers the following topics:

- What is the TC110 Boost Converter Demo Board?
- What the TC110 Boost Converter Demo Board Kit includes.

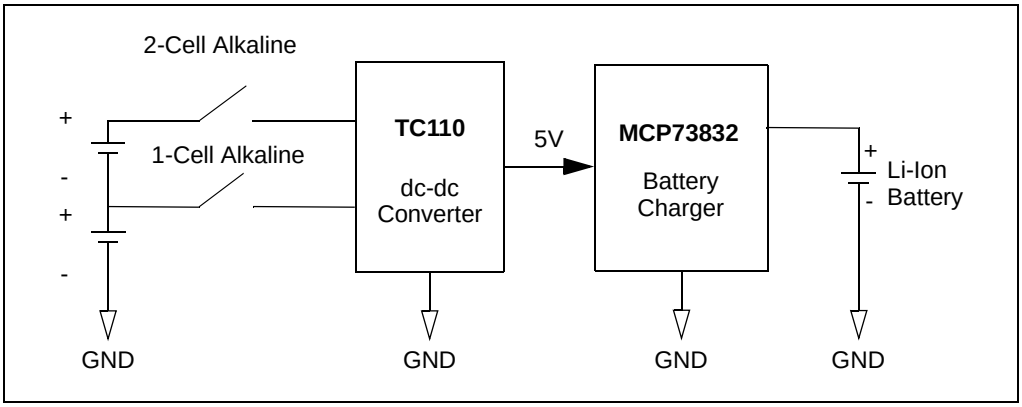


FIGURE 1-1: *TC110 Boost Converter Demo Board System Level Block Diagram.*

1.2 WHAT IS THE TC110 DEMO BOARD?

The TC110 Boost Converter Demo Board demonstrates the use of a PFM/PWM Step-Up DC/DC Controller (TC110) to supply input voltage for a Miniature Single-Cell, Fully Integrated Li-Ion, Li-Polymer Charge Management controller (MCP73832) that charges a Li-Ion Battery from 1-Cell or 2-Cell Alkaline batteries.

The TC110 Boost Converter Demo Board is setup to evaluate simple dc-to-dc conversion while demonstrating the potential integration into a portable battery charger application.The TC110 Boost Converter Demo Board charges Li-Ion battery at constant current of 200 mA for single Alkaline application set-up. However, the charge current can be programmed up to 500 mA by changing a resistor value. This demo board is designed to be able to select between 1-cell Alkaline battery and 2-cell Alkaline battery using a single switch.

The TC110 Boost Converter Demo Board utilizes Microchip's TC110 (PFM/PWM Step-Up DC/DC Controller) with the MCP73832 (Miniature Single-Cell Integrated Li-Ion, Li-Polymer Charge Management Controller) that effectively transfers the energy from 1-cell or 2-cell Alkaline battery source to a single-cell Li-Ion battery.

The additional test probes can connect to DC source and loads directly for bench testings.

1.3 WHAT THE TC110 DEMO BOARD KIT INCLUDES

This TC110 Boost Converter Demo Board kit includes:

- TC110 Boost Converter Demo Board (102-00122)
- Analog and Interface Products Demonstration Boards CD-ROM (DS21912)
  - TC110 Boost Converter Demo Board User's Guide (DS51646)

Chapter 2. Installation and Operation

2.1 INTRODUCTION

The TC110 Boost Converter Demo Board demonstrates Microchip's 0.9V start-up PFM/PWM Step-Up DC/DC Controller. A single cell Alkaline battery operates between 0.9V to 1.5V. Thus, the TC110 is a good Boost converter for applications that run from 1-cell or 2-cell Alkaline batteries. The TC110 is a Boost switching controller that provides output current of up to 300 mA with a typical efficiency of 84%. The TC110 Boost Converter Demo Board normally operates in pulse width modulation (PWM) mode, but automatically switches to pulse frequency modulation (PFM) mode at low output loads for higher efficiency.

The MCP73832 employs a constant-current/constant-voltage algorithm with selectable preconditioning and charge termination. Both constant-current and constant-voltage features will be reviewed in the section 2.2.

The TC110 Boost Converter Demo Board has built-in mechanical switches to turn off and select voltage source between 1-cell Alkaline or 2-cell Alkaline batteries.

2.2 FEATURES

The TC110 Boost Converter Demo Board has the following features:

- Single-Cell Li-Ion Battery Charger, operates stand-alone without firmware added for economic and fast pace design cycle
- Charges 1-cell Li-Ion battery pack from 0.9V to 3.0V Input (Battery types from 1-cell to 2-cell Alkaline batteries or similar rating NiCd and NiMH)
- Regulates output dc voltage to 5.0V. (TC110 Output voltages available in 3.0V, 3.3V, and 5V)
- 300 kHz fixed frequency (TC110 is available in 100 kHz and 300 kHz fixed frequency)
- ON/OFF button used to enable and disable system
- 3-position toggle switch to select single, dual battery input or disable
- LED ON/OFF to show the charging activity and standby mode
- Easy adjust constant charging current with single resistor modification (The default current is 200 mA to optimize 1-cell Alkaline battery, but can go up to 500 mA for fast charging cycle while running in 2-cell Alkaline battery
- MCP73832 is used to charge Li-Ion battery pack at constant voltage (The MCP73832 is available in 4.20V, 4.35V, 4.40V, or 4.50V fixed voltage rating to accommodate emerging battery charging requirements)
- TC110 Boost Converter Demo Board operates directly from single cell AA battery or DC power source for evaluations
- Ready to use design or simple modification to support various new portable applications.

2.3 GETTING STARTED

The TC110 Boost Converter Demo Board is fully assembled and tested for generating a regulated 5V output voltage from TC110 from a 0.9V to 3V input voltage source while charging Li-Ion battery pack at constant current up to 500 mA.

2.3.1 Power Input and Output Connection

2.3.1.1 POWERING THE TC110 BOOST CONVERTER DEMO BOARD

1. Insert the AA Alkaline batteries into battery holders. Brand new Alkaline batteries are recommended to use for each charge.
2. Connect the positive side of the Li-Ion battery pack voltage to TP8 VBAT, connect the battery pack return to the TP7 GND.
3. Turn on the TC110 Boost Converter Demo Board by moving dip switch toward Microchip logo. Once the switch is turned on, the TC110 Boost Converter Demo Board is powered. When powered, adjusting toggle switch position can select between 1-cell or 2-cell Alkaline battery source. The charging cycle is disabled, if the switch is keep in OFF position.
4. LED D2 will be illuminated when the charging cycle running.
5. LED D2 blinks when the system is on without Li-Ion battery pack (or load) present.
6. During normal operation of the TC110 Boost Converter Demo Board, the system can switch between both input sources or pause by adjusting the toggle switch position.

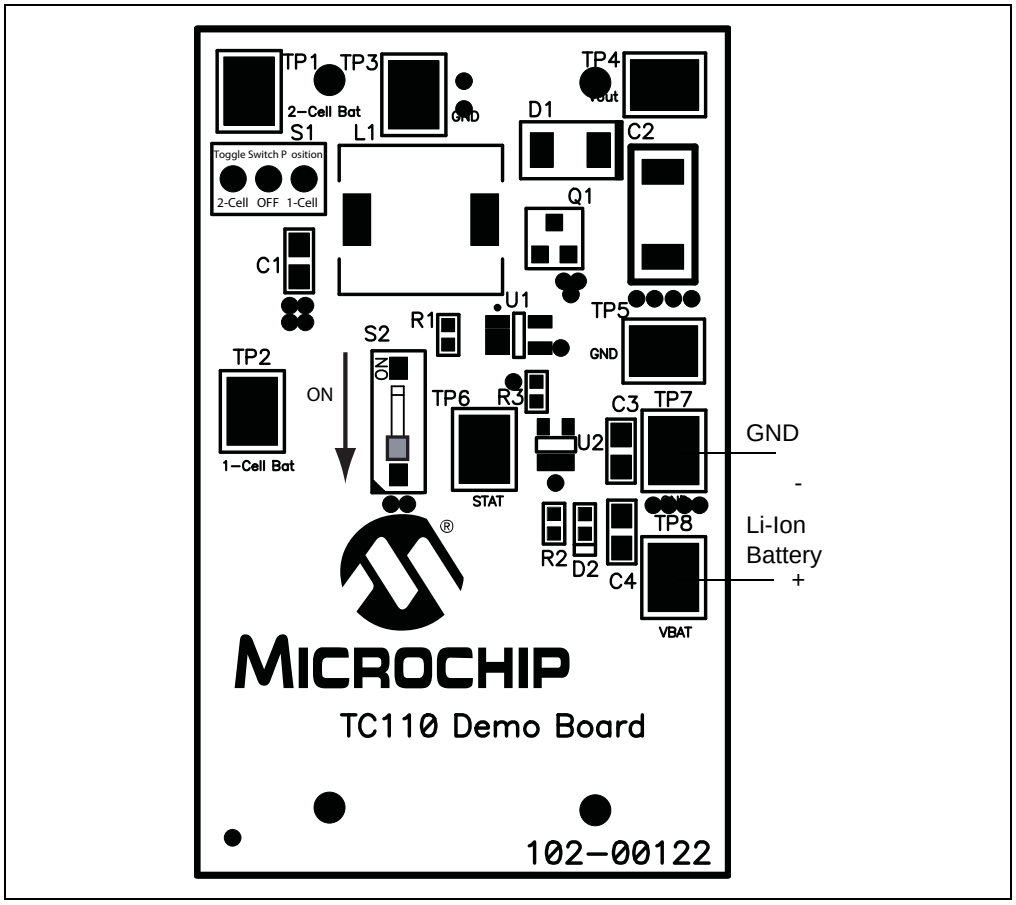


FIGURE 2-1: *Board Top Assembly and Connections.*

2.3.1.2 APPLYING BATTERY TO TC110 BOOST CONVERTER DEMO BOARD

A 1-cell Li-Ion battery pack shall be connected to the VBAT and GND connectors before applying input power and turn on S1 and S2 to start the charging cycle. Once the system starts charging cycle, V_{OUT} (TP4) is a constant 5V, 2-cell Bat (TP1) and 1-cell Bat (TP2) are test points that used to measure the battery voltage from Alkaline batteries (A good Alkaline battery should rate between 0.9V to 1.5V).

2.3.1.3 LED STATUS INDICATION

The LED is connected between VBAT and STAT pins to demonstrate the charging activity. The LED illuminates when the charging cycle begins (battery pack presents, S1 and S2 are in the ON mode). The LED blinks when no load is present, and remain off when S1 or S2 are disable or OFF.

2.3.1.4 ADJUST CONSTANT CHARGING CURRENT

The TC110 Boost Converter Demo Board is designed to operate with 200 mA constant current. However, it can be easily programmed to operate with various constant charging current by changing the value of R3. As shown in Figure 2-2, the constant programmed current can go up to 500 mA for fast charge by applying 2 kΩ resistor to R3. Therefore, the constant charging current can easily be adjusted from selecting different resistor values.

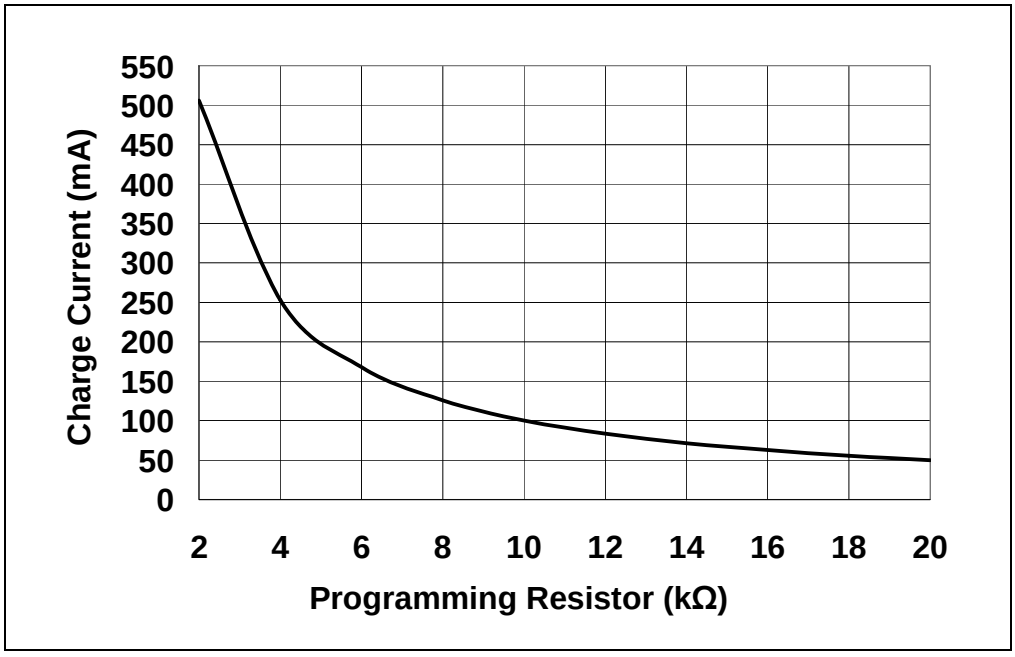


FIGURE 2-2: *Charging Current (I_{OUT}) vs. Programming Resistor (R3).*

NOTES:

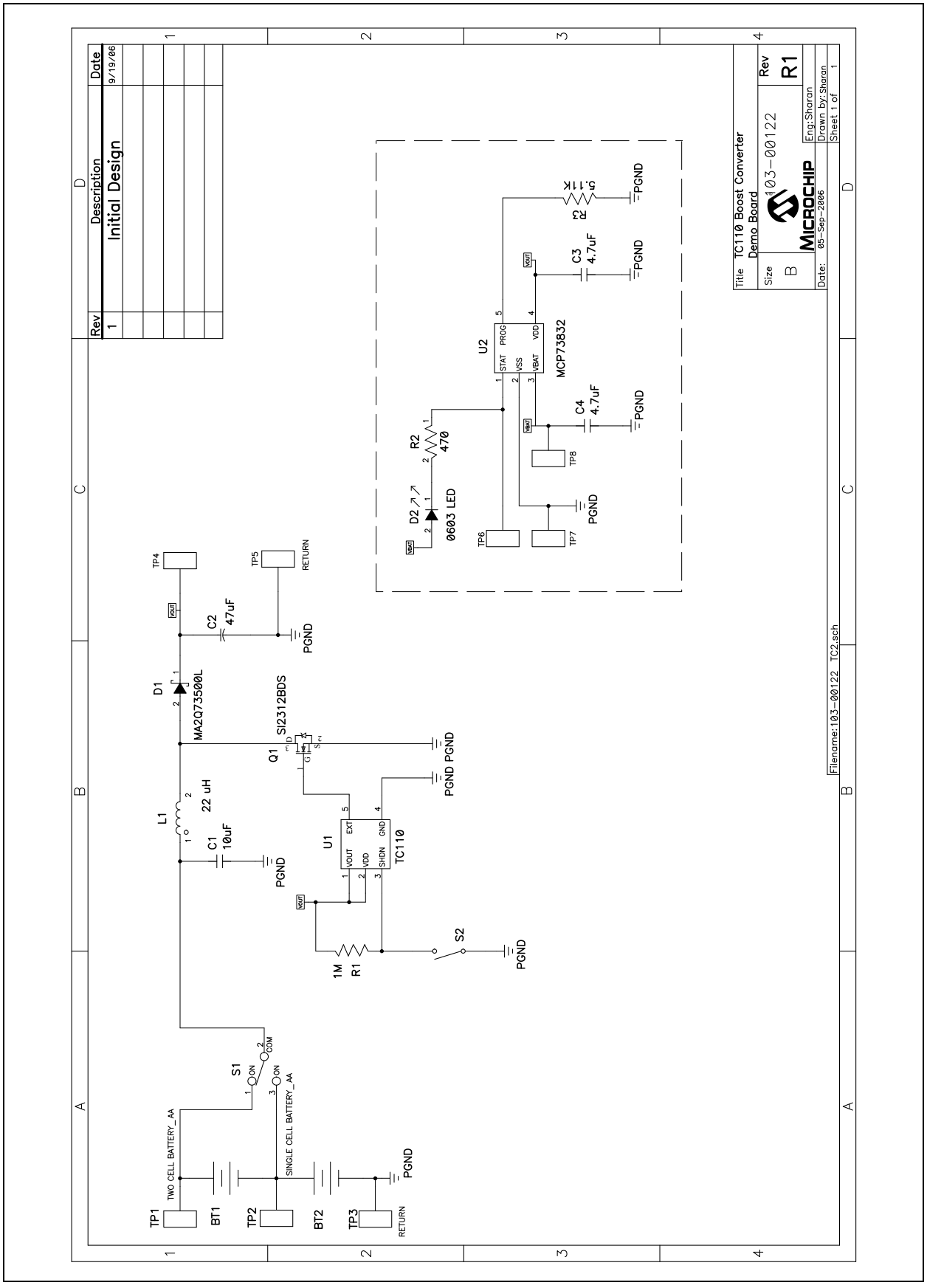
Appendix A. Schematics and Layouts

A.1 INTRODUCTION

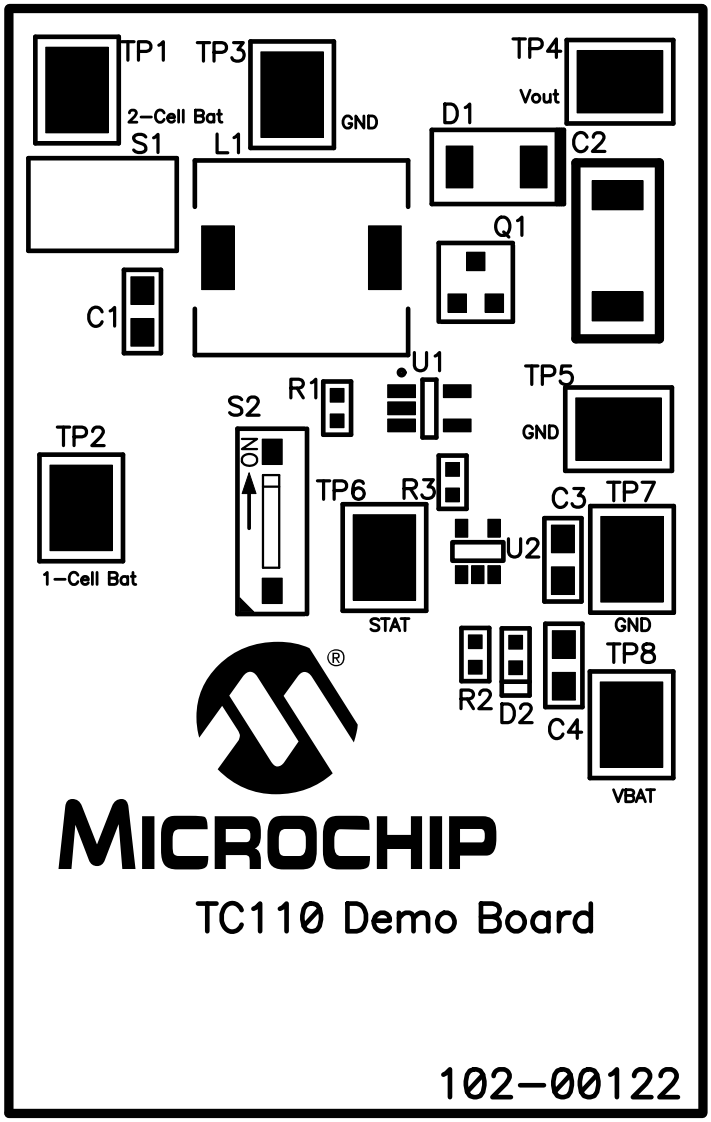
This appendix contains the following schematics and layouts for the TC110 Boost Converter Demo Board:

- Board Schematic
- Board Layout – Top Layer
- Board Layout – Top Metal Layer
- Board Layout – Bottom Layer
- Board Layout – Bottom Metal Layer

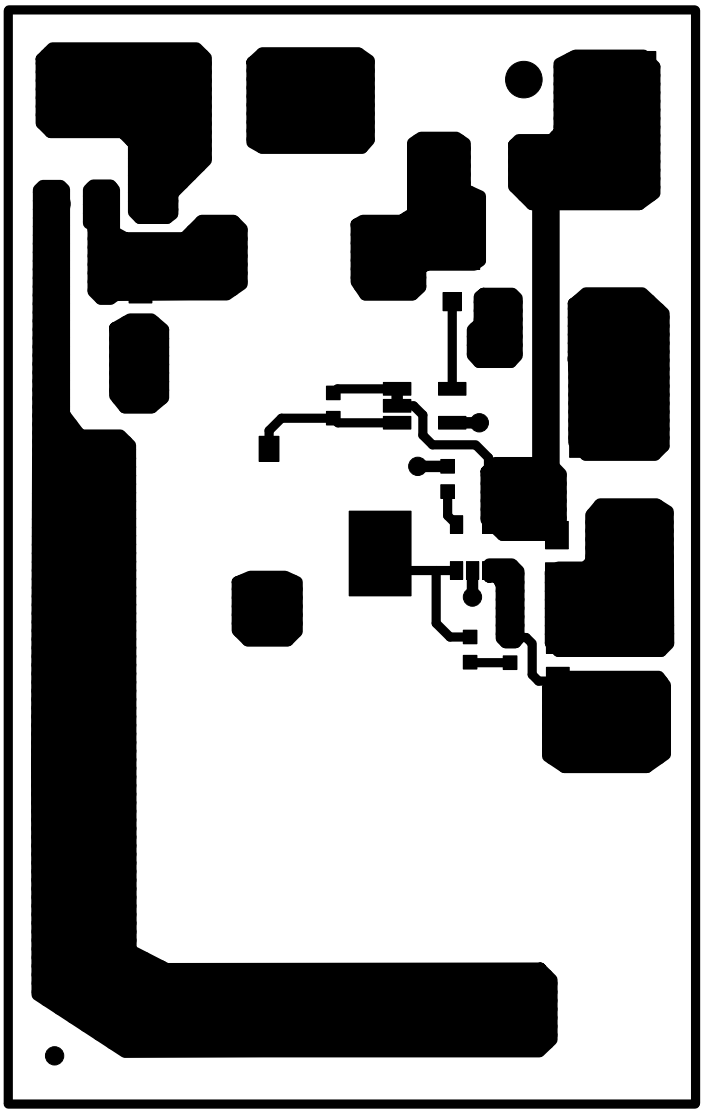
A.2 BOARD SCHEMATIC



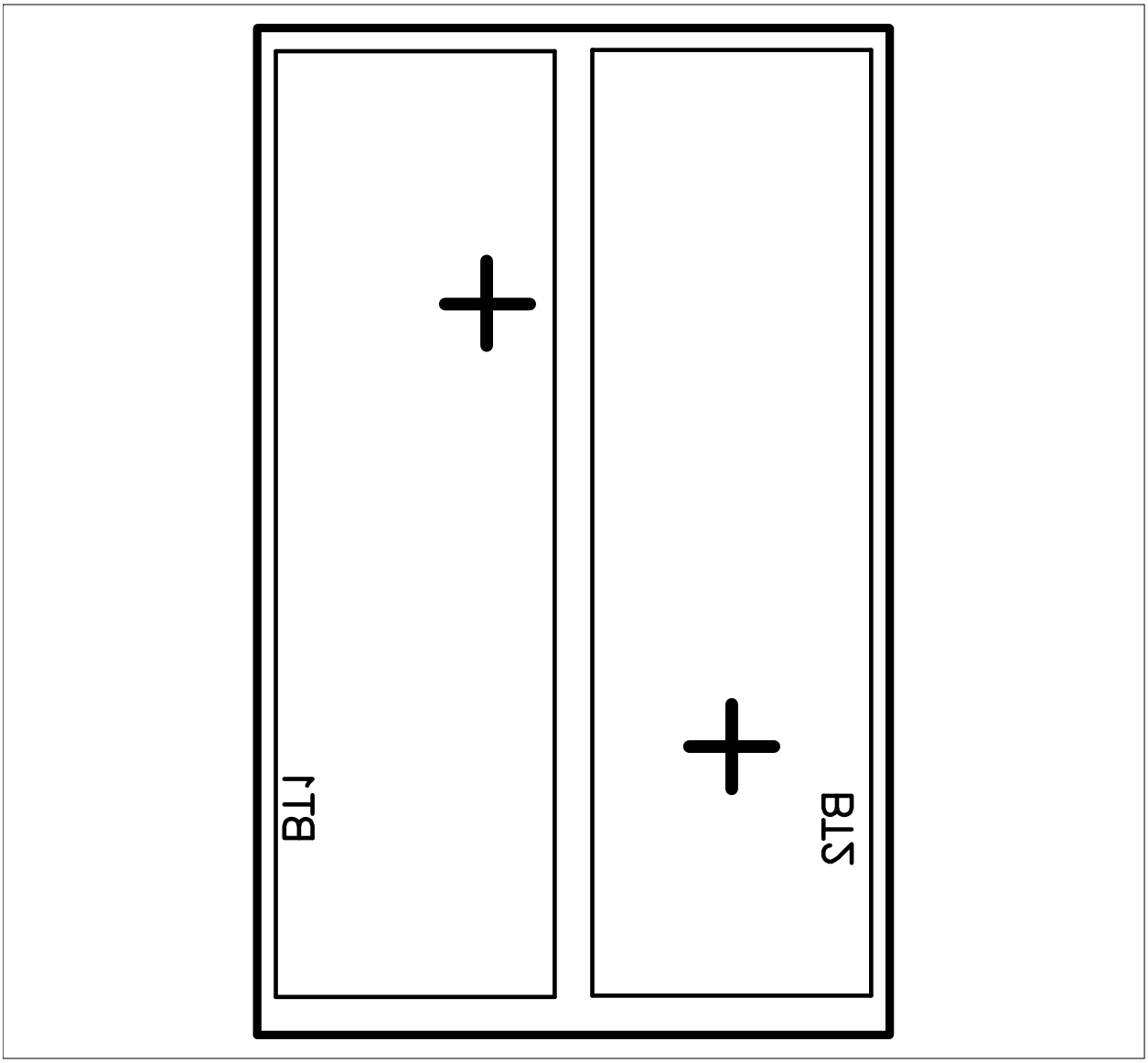
A.3 BOARD – TOP SILK LAYER



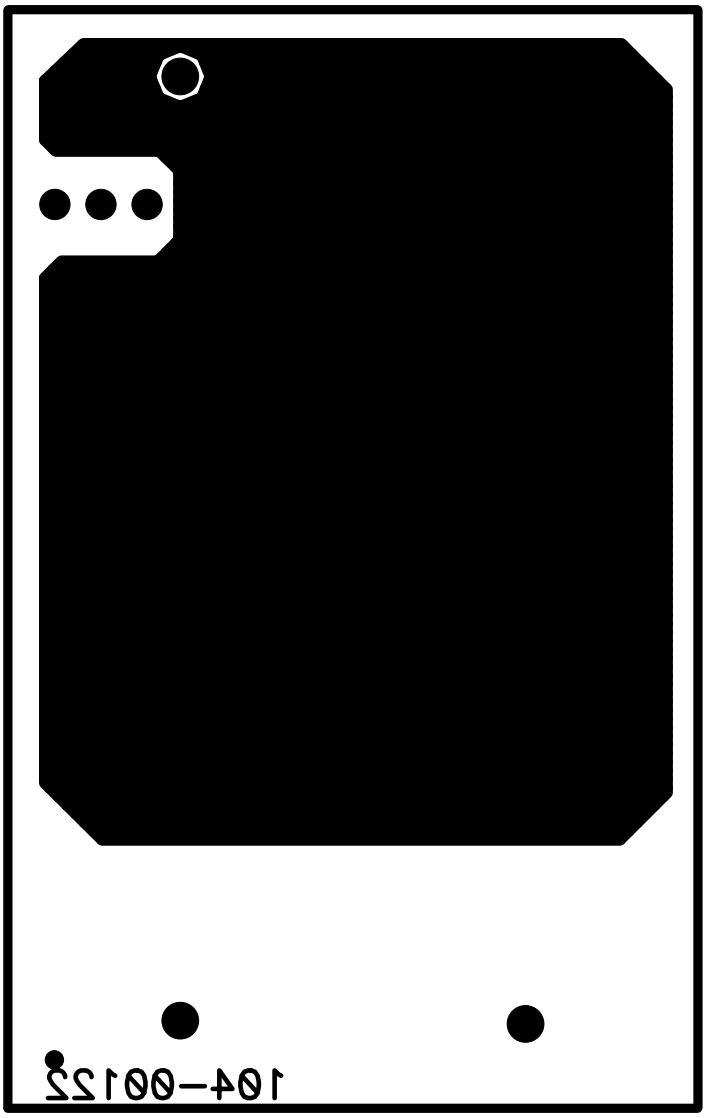
A.4 BOARD – TOP METAL LAYER



A.5 BOARD – BOTTOM SILK LAYER



A.6 BOARD – BOTTOM METAL LAYER



Appendix B. Bill Of Materials (BOM)

TABLE B-1: BILL OF MATERIALS (BOM)

Qty	Reference	Description	Manufacturer	Part Number
2	BT1,BT2	Battery Holder, 1Cell AA PC Mount	Keystone Electronics®	2460
1	C1	CAP 10UF 6.3V Ceramic X5R 0805	Panasonic® - ECG	ECJ-2FB0J106M
1	C2	CAP 47UF 8V SPEC Polymer SMD	Panasonic - ECG	EEF-CD0K470R
2	C3, C4	CAP Ceramic 4.7uF 10V X5R 0805	Panasonic - ECG	ECJ-GVB1A475M
1	D1	DIODE Schottky 40V 1A NMP 2P	Panasonic - SSG	MA2Q73600L
1	D2	LED Super Red Clear 0603 SMD	LITE-ON Inc	LTST-C190KRKT
1	L1	Inductor Shield PWR 22 UH SMD	Coiltronics	DR1050-220-R
1	PCB	RoHS Compliant Bare PCB, TC110 Demo Board	Advanced Circuits	104-00122
1	Q1	MOSFET N-CH 20V 5.0A SOT-23	Vishay® Intertechnology	Si2312DS-T1-E3
1	R1	RES 1.00M OHM 1/10W 1% 0603 SMD	Panasonic - ECG	ERJ-3EKF1004V
1	R2	RES 475 OHM 1/10W 1% 0603 SMD	Panasonic - ECG	ERJ-3EKF4750V
1	R3	RES 5.11K OHM 1/10W 1% 0603 SMD	Panasonic - ECG	ERJ-3EKF5111V
1	S1	Switch Toggle SPDT 3A PC MNT 4PC	E-Switch	200MSP3T1B1M2QEH
1	S2	Switch DIP 1-POS Half Pitch SMD	Copal Electronics Inc	CHS-01TB
8	TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP8	PC Test Point Compact SMT	Keystone Electronics	5016
1	U1	PFM/PWM Step-Up DC/DC Converter	Microchip Technology Inc.	TC110503ECT
1	U2	IC Controller LI-ION 4.2V SOT23-5	Microchip Technology Inc.	MCP73832T-2ACI/OT

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.

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