



**TC115  
PFM/PWM  
Evaluation Board  
User's Guide**

---

**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in this publication regarding device applications and the like is provided only for your convenience and may be superseded by updates.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 WARRANTIES 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 devices in life support and/or safety applications is entirely at the buyer's risk, and the buyer agrees to defend, indemnify and hold harmless Microchip from any and all damages, claims, suits, or expenses resulting from such use. 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, KEELOQ logo, MPLAB, PIC, PICmicro, PICSTART, rfPIC, SmartShunt and UNI/O are registered trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

FilterLab, Linear Active Thermistor, MXDEV, MXLAB, 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, CodeGuard, dsPICDEM, dsPICDEM.net, dsPICworks, dsSPEAK, ECAN, ECONOMONITOR, FanSense, In-Circuit Serial Programming, ICSP, ICEPIC, Mindi, MiWi, MPASM, MPLAB Certified logo, MPLIB, MPLINK, mTouch, PICkit, PICDEM, PICDEM.net, PICTail, PIC<sup>32</sup> logo, PowerCal, PowerInfo, PowerMate, PowerTool, REAL ICE, rfLAB, Select Mode, Total Endurance, WiperLock and ZENA are trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

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.

© 2009, Microchip Technology Incorporated, Printed in the U.S.A., All Rights Reserved.

 Printed on recycled paper.

**QUALITY MANAGEMENT SYSTEM**  
**CERTIFIED BY DNV**  
**== ISO/TS 16949:2002 ==**

*Microchip received ISO/TS-16949:2002 certification for its worldwide headquarters, design and wafer fabrication facilities in Chandler and Tempe, Arizona; Gresham, Oregon and design centers in California and India. The Company's quality system processes and procedures are for its PIC<sup>®</sup> MCUs and dsPIC<sup>®</sup> DSCs, KEELOQ<sup>®</sup> 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.*



# TC115 EVALUATION BOARD USER'S GUIDE

---

---

## Table of Contents

---

---

<b>Preface</b> .....	<b>1</b>
<b>Chapter 1. Product Overview</b>	
1.1 Introduction .....	5
1.2 What is the TC115 Evaluation Board? .....	5
1.3 What the TC115 Evaluation Board kit includes? .....	5
<b>Chapter 2. Installation and Operation</b>	
2.1 Introduction .....	7
2.2 Features .....	7
2.3 Getting Started .....	8
<b>Appendix A. Schematic and Layouts</b>	
A.1 Introduction .....	9
A.2 Board Schematic .....	10
A.3 Board – Top Overlay .....	11
A.4 Board – Top Layer .....	12
A.5 Board – Bottom Layer .....	13
<b>Appendix B. Bill of Materials (BOM)</b>	
<b>Worldwide Sales and Service</b> .....	<b>16</b>

# TC115 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](http://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 “DSXXXXA”, where “XXXX” 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 TC115 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 TC115 Evaluation 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 TC115 Evaluation Board.
- **Chapter 2. “Installation and Operation”** – Includes a description of the evaluation board, as well as instructions on how to get started.
- **Appendix A. “Schematic and Layouts”** – Shows the schematic and layout diagrams for the TC115 Evaluation Board.
- **Appendix B. “Bill of Materials (BOM)”** – Lists the parts used to build the TC115 Evaluation Board.

# TC115 Evaluation Board User's Guide

## CONVENTIONS USED IN THIS GUIDE

This manual uses the following documentation conventions:

### DOCUMENTATION CONVENTIONS

Description	Represents	Examples
<b>Arial font:</b>		
Italic characters	Referenced books	<i>MPLAB<sup>®</sup> IDE User's Guide</i>
	Emphasized text	...is the <i>only</i> 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><i>File&gt;Save</i></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>
<b>Courier New font:</b>		
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	<i>file.o</i> , where <i>file</i> can be any valid filename
Square brackets [ ]	Optional arguments	mcc18 [options] <i>file</i> [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 TC115 Evaluation Board. Other useful documents are listed below. The following Microchip documents are available and recommended as supplemental reference resources.

- **TC115 Data Sheet - “PFM/PWM Step-Up DC/DC Converter” (DS21361)**

This data sheet provides detailed information regarding the TC115 step-up converter.

## THE MICROCHIP WEB SITE

Microchip provides online support via our web site at [www.microchip.com](http://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

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 B (January 2009)

- Updated Board Schematic (see **Appendix A. “Schematic and Layouts”**).
- Updated **Appendix B. “Bill of Materials (BOM)”**.

### Revision A (September 2005)

- Initial Release of this Document.

# TC115 Evaluation Board User's Guide

---

NOTES:



---

---

## Chapter 1. Product Overview

---

---

### 1.1 INTRODUCTION

The TC115 Evaluation Board is used to evaluate Microchip's TC115 in a single-cell boost converter application. As provided, the TC115 Evaluation Board generates a 3.0V output from a single-cell battery.

This chapter covers the following topics:

- What is the TC115 Evaluation Board?
- What the TC115 Evaluation Board Kit Includes?

### 1.2 WHAT IS THE TC115 EVALUATION BOARD?

The TC115 Evaluation Board is a complete, step-up, switch-mode, dc-dc power converter. The TC115 Evaluation Board generates a regulated 3.0V output at load currents up to 110 mA. Different output voltages are obtainable by replacing the fixed 3.0V output TC115 with a fixed 3.3V or 5.0V device. Since the TC115 operates from a minimum input voltage of 0.9V, the input voltage can be provided by a single-cell battery.

The TC115 Evaluation Board is provided with an aluminum electrolytic output capacitor. However, there are ceramic and tantalum capacitor pads so other capacitor technologies can be evaluated.

Test points are provided for input power, output load and shutdown control.

### 1.3 WHAT THE TC115 EVALUATION BOARD KIT INCLUDES?

This TC115 Evaluation Board Kit includes:

- The TC115 Evaluation Board (102-00074)
- Analog and Interface Products Demonstration Boards CD-ROM (DS21912) includes:
  - TC115 Evaluation Board User's Guide (DS51578)

# TC115 Evaluation Board User's Guide

---

NOTES:

---

---

## Chapter 2. Installation and Operation

---

---

### 2.1 INTRODUCTION

The TC115 Evaluation Board demonstrates Microchip's TC115 PFM/PWM step-up dc-dc converter in a single cell battery powered application. The TC115 is a high-efficiency step-up, dc-dc converter for small, low input voltage or battery-powered systems. The device has a start-up voltage of 0.9V. Due to its integrated MOSFET feature, the TC115 may be used in conjunction with only an external diode, an inductor and a capacitor to design a complete boost converter.

The TC115 Evaluation Board is shipped with an aluminum electrolytic output capacitor. However, there are additional surface-mount pads on the board to evaluate tantalum or ceramic capacitors.

### 2.2 FEATURES

The TC115 Evaluation Board has the following features:

- Regulated 3.0V output voltage
- Maximum output current: 110 mA
- Automatic PFM/PWM modes of operation
- Test point to apply external Enable signal

# TC115 Evaluation Board User's Guide

---

## 2.3 GETTING STARTED

The TC115 Evaluation Board is fully assembled and tested for generating a regulated 3.0V output voltage. The TC115 Evaluation Board requires the use of an external input voltage source (0.9V - 3.0V).

### 2.3.1 Power Input and Output Connections

#### 2.3.1.1 POWERING THE TC115 EVALUATION BOARD

1. Apply the input voltage to the  $V_{IN}$  test point (TP1) and GND test point (TP4). The input voltage should be limited to the 0V to +3.0V range. For normal operation, the input voltage should be between +0.9V and +3.0V.

**Note 1:** Since the TC115 Evaluation Board is a boost converter, applying an input voltage greater than 3.0V will result in an output voltage equal to the input voltage. The TC115 Evaluation Board cannot regulate to an output voltage that is lower than the input voltage.

- 2: With the boost topology, there always exist a path from the input source to the output load.

#### 2.3.1.2 APPLY THE LOAD TO THE REGULATED OUTPUT VOLTAGE TEST POINTS

1. To apply a load to the TC115 Evaluation Board, the positive side (+) of the load should be connected to the  $V_{OUT}$  test point (TP3). The negative side (-) of the load should be connected to the GND test point (TP2).

**Note:** Since the TC115 device receives bias from the output, it may be necessary to remove the load before starting the TC115 Evaluation Board.

2. The TC115 Evaluation Board is supplied with a fixed 3.0V output voltage version of the TC115. However, by changing the TC115 device, other output voltages can be achieved. Besides the fixed 3.0V version, the TC115 is also offered in a fixed 3.3V or 5.0V version.

#### 2.3.1.3 ENABLING/DISABLING THE TC115 EVALUATION BOARD

The  $\overline{SHDN}$  pin of the TC115 is pulled-up to  $V_{IN}$  to always enable the device. Test point TP5 can be used to apply an external Enable signal to the device.



# TC115 EVALUATION BOARD USER'S GUIDE

---

---

## Appendix A. Schematic and Layouts

---

---

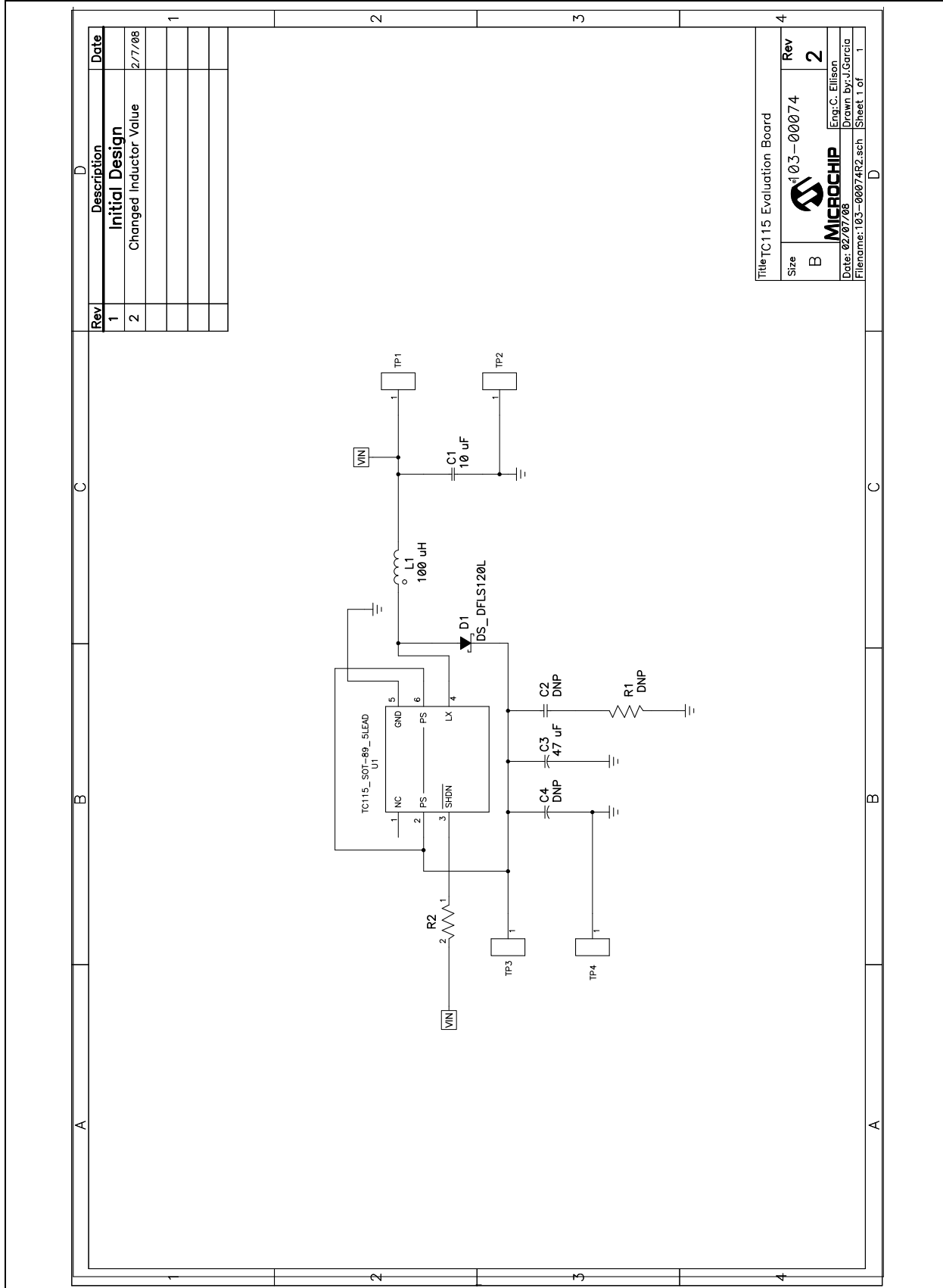
### A.1 INTRODUCTION

This appendix contains the following schematic and layout diagrams for the TC115 Evaluation Board:

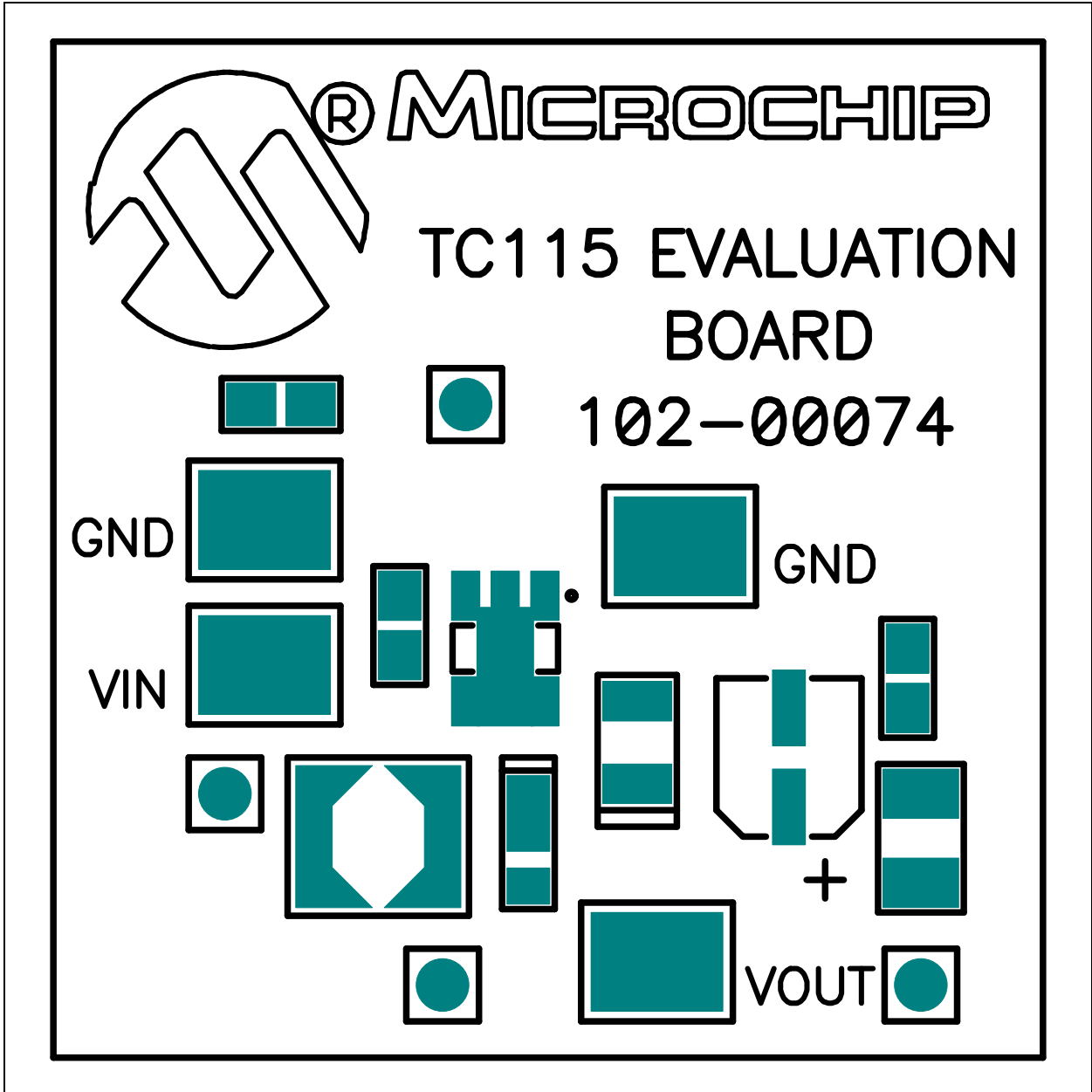
- Board Schematic
- Board – Top Overlay
- Board – Top Layer
- Board – Bottom Layer

# TC115 Evaluation Board User's Guide

## A.2 BOARD SCHEMATIC



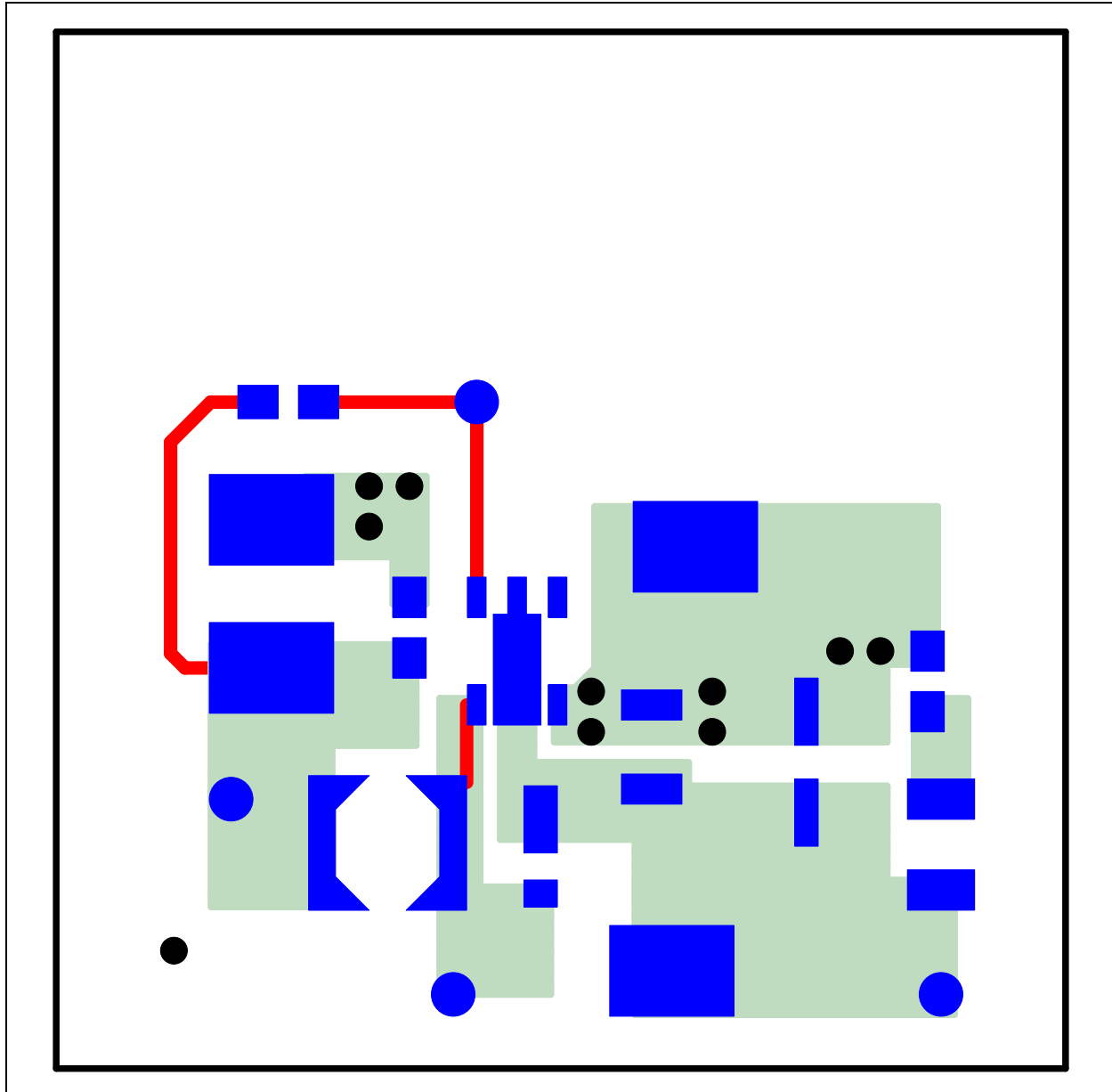
A.3 BOARD – TOP OVERLAY



# TC115 Evaluation Board User's Guide

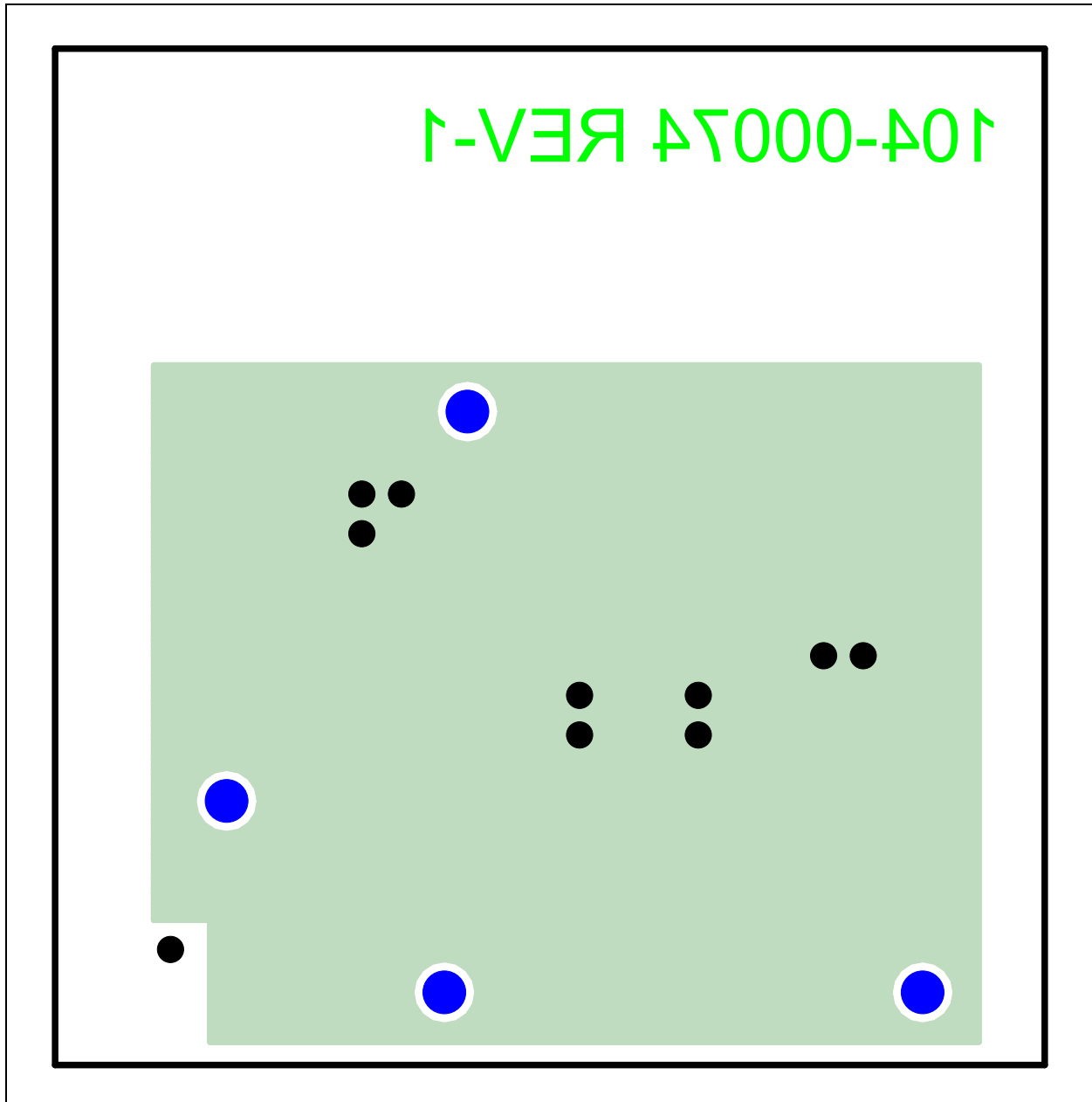
---

## A.4 BOARD – TOP LAYER





## A.5 BOARD – BOTTOM LAYER



# TC115 Evaluation Board User's Guide

---

NOTES:

**Appendix B. Bill of Materials (BOM)**

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

Qty.	Reference	Description	Mfgr.	Part Number
1	C1	10 $\mu$ F, X5R Ceramic, 6.3V 0805	Panasonic®	ECJ-CV50J106M
-	C2	Do Not Populate	—	—
1	C3	47 $\mu$ F, Electrolytic Capacitor, 6.3V	Nichicon	UWT0J470MCL1GB
-	C4	Do Not Populate	—	—
1	D1	1A, 20V Schottky Diode	Diodes Inc.	DFLS120L
1	L1	100 $\mu$ H, Inductor, SD25	Coiltronics®	SD25-101-R
1	PCB	RoHS Compliant Bare PCB, TC115 PFM/PWM Boost Evaluation Board	—	104-00074
-	R1	Do Not Populate	—	—
1	R2	475K, 1/8W, 1%, Chip Resistor, 0805	Rohm	MCR10EZH4753
4	TP1, TP2, TP3, TP4	Test Point	Keystone Electronics®	5016
1	U1	TC115 Step-up dc-dc Converter	Microchip Technology Inc.	TC115301EMTTR



## 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](http://www.microchip.com)

**Atlanta**  
Duluth, GA  
Tel: 678-957-9614  
Fax: 678-957-1455

**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

**Santa Clara**  
Santa Clara, CA  
Tel: 408-961-6444  
Fax: 408-961-6445

**Toronto**  
Mississauga, Ontario,  
Canada  
Tel: 905-673-0699  
Fax: 905-673-6509

### ASIA/PACIFIC

**Asia Pacific Office**  
Suites 3707-14, 37th Floor  
Tower 6, The Gateway  
Harbour City, Kowloon  
Hong Kong  
Tel: 852-2401-1200  
Fax: 852-2401-3431

**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: 86-28-8665-5511  
Fax: 86-28-8665-7889

**China - Hong Kong SAR**  
Tel: 852-2401-1200  
Fax: 852-2401-3431

**China - Nanjing**  
Tel: 86-25-8473-2460  
Fax: 86-25-8473-2470

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

**China - Xiamen**  
Tel: 86-592-2388138  
Fax: 86-592-2388130

**China - Xian**  
Tel: 86-29-8833-7252  
Fax: 86-29-8833-7256

**China - Zhuhai**  
Tel: 86-756-3210040  
Fax: 86-756-3210049

### ASIA/PACIFIC

**India - Bangalore**  
Tel: 91-80-4182-8400  
Fax: 91-80-4182-8422

**India - New Delhi**  
Tel: 91-11-4160-8631  
Fax: 91-11-4160-8632

**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 - Daegu**  
Tel: 82-53-744-4301  
Fax: 82-53-744-4302

**Korea - Seoul**  
Tel: 82-2-554-7200  
Fax: 82-2-558-5932 or  
82-2-558-5934

**Malaysia - Kuala Lumpur**  
Tel: 60-3-6201-9857  
Fax: 60-3-6201-9859

**Malaysia - Penang**  
Tel: 60-4-227-8870  
Fax: 60-4-227-4068

**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: 43-7242-2244-39  
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

## X-ON Electronics

Largest Supplier of Electrical and Electronic Components

*Click to view similar products for [Power Management IC Development Tools](#) category:*

*Click to view products by [Microchip](#) manufacturer:*

Other Similar products are found below :

[EVB-EP5348UI](#) [MIC23451-AAAYFL EV](#) [MIC5281YMME EV](#) [124352-HMC860LP3E](#) [DA9063-EVAL](#) [ADP122-3.3-EVALZ](#) [ADP130-0.8-EVALZ](#) [ADP130-1.8-EVALZ](#) [ADP1740-1.5-EVALZ](#) [ADP1870-0.3-EVALZ](#) [ADP1874-0.3-EVALZ](#) [ADP199CB-EVALZ](#) [ADP2102-1.25-EVALZ](#) [ADP2102-1.875EVALZ](#) [ADP2102-1.8-EVALZ](#) [ADP2102-2-EVALZ](#) [ADP2102-3-EVALZ](#) [ADP2102-4-EVALZ](#) [AS3606-DB](#) [BQ25010EVM](#) [BQ3055EVM](#) [ISLUSBI2CKIT1Z](#) [LP38512TS-1.8EV](#) [EVAL-ADM1186-1MBZ](#) [EVAL-ADM1186-2MBZ](#) [ADP122UJZ-REDYKIT](#) [ADP166Z-REDYKIT](#) [ADP170-1.8-EVALZ](#) [ADP171-EVALZ](#) [ADP1853-EVALZ](#) [ADP1873-0.3-EVALZ](#) [ADP198CP-EVALZ](#) [ADP2102-1.0-EVALZ](#) [ADP2102-1-EVALZ](#) [ADP2107-1.8-EVALZ](#) [ADP5020CP-EVALZ](#) [CC-ACC-DBMX-51](#) [ATPL230A-EK](#) [MIC23250-S4YMT EV](#) [MIC26603YJL EV](#) [MIC33050-SYHL EV](#) [TPS60100EVM-131](#) [TPS65010EVM-230](#) [TPS71933-28EVM-213](#) [TPS72728YFFEVM-407](#) [TPS79318YEQEVM](#) [UCC28810EVM-002](#) [XILINXPWR-083](#) [LMR22007YMINI-EVM](#) [LP38501ATJ-EV](#)