



**MIC23158/9**  
**Synchronous Buck Regulator**  
**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in this publication regarding device applications and the like is provided only for your convenience and may be superseded by updates.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 unless otherwise stated.

*Microchip received ISO/TS-16949:2009 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® MCUs and dsPIC® DSCs, 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.*

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

**Trademarks**

The Microchip name and logo, the Microchip logo, AnyRate, AVR, AVR logo, AVR Freaks, BeaconThings, BitCloud, CryptoMemory, CryptoRF, dsPIC, FlashFlex, flexPWR, Helder, JukeBlox, KEELoQ, KEELoQ logo, Klear, LANCheck, LINK MD, maxStylus, maxTouch, MediaLB, megaAVR, MOST, MOST logo, MPLAB, OptoLyzer, PIC, picoPower, PICSTART, PIC32 logo, Prochip Designer, QTouch, RightTouch, SAM-BA, SpyNIC, SST, SST Logo, SuperFlash, tinyAVR, UNI/O, and XMEGA are registered trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

ClockWorks, The Embedded Control Solutions Company, EtherSynch, Hyper Speed Control, HyperLight Load, IntelliMOS, mTouch, Precision Edge, and Quiet-Wire are registered trademarks of Microchip Technology Incorporated in the U.S.A.

Adjacent Key Suppression, AKS, Analog-for-the-Digital Age, Any Capacitor, AnyIn, AnyOut, BodyCom, chipKIT, chipKIT logo, CodeGuard, CryptoAuthentication, CryptoCompanion, CryptoController, dsPICDEM, dsPICDEM.net, Dynamic Average Matching, DAM, ECAN, EtherGREEN, In-Circuit Serial Programming, ICSP, Inter-Chip Connectivity, JitterBlocker, KlearNet, KlearNet logo, Mindi, MiWi, motorBench, MPASM, MPF, MPLAB Certified logo, MPLIB, MPLINK, MultiTRAK, NetDetach, Omniscient Code Generation, PICDEM, PICDEM.net, PICKit, PICtail, PureSilicon, QMatrix, RightTouch logo, REAL ICE, Ripple Blocker, SAM-ICE, Serial Quad I/O, SMART-I.S., SQI, SuperSwitcher, SuperSwitcher II, Total Endurance, TSHARC, USBCheck, VariSense, ViewSpan, WiperLock, Wireless DNA, 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.

Silicon Storage Technology is a registered trademark of Microchip Technology Inc. in other countries.

GestIC is a registered trademark of Microchip Technology Germany II GmbH & Co. KG, a subsidiary of Microchip Technology Inc., in other countries.

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

© 2017, Microchip Technology Incorporated, All Rights Reserved.  
ISBN: 978-1-5224-1536-7

---

---

**Object of Declaration: MIC23158/9 Synchronous Buck Regulator Evaluation Board**

EU Declaration of Conformity

This declaration of conformity is issued by the manufacturer.


The development/evaluation tool is designed to be used for research and development in a laboratory environment. This development/evaluation tool is not a Finished Appliance, nor is it intended for incorporation into Finished Appliances that are made commercially available as single functional units to end users under EU EMC Directive 2004/108/EC and as supported by the European Commission's Guide for the EMC Directive 2004/108/EC (8th February 2010).

This development/evaluation tool complies with EU RoHS2 Directive 2011/65/EU.

This development/evaluation tool, when incorporating wireless and radio-telecom functionality, is in compliance with the essential requirement and other relevant provisions of the R&TTE Directive 1999/5/EC and the FCC rules as stated in the declaration of conformity provided in the module datasheet and the module product page available at [www.microchip.com](http://www.microchip.com).

For information regarding the exclusive, limited warranties applicable to Microchip products, please see Microchip's standard terms and conditions of sale, which are printed on our sales documentation and available at [www.microchip.com](http://www.microchip.com).

Signed for and on behalf of Microchip Technology Inc. at Chandler, Arizona, USA.

  
Derek Carlson

VP Development Tools

11-NOV-16  
Date

---

---

**NOTES:**

## Table of Contents

<b>Preface</b>	<b>7</b>
Introduction.....	7
Document Layout .....	7
Conventions Used in this Guide .....	8
Recommended Reading.....	9
The Microchip Website .....	9
Customer Support .....	9
Document Revision History .....	9
<b>Chapter 1. Product Overview</b>	
1.1 Introduction .....	11
1.2 MIC23158/9 Short overview .....	11
1.3 What is the MIC23158/9 Evaluation Board? .....	12
1.4 MIC23158/9 Evaluation Board Kit Contents .....	12
<b>Chapter 2. Installation and Operation</b>	
2.1 Introduction .....	13
2.2 Getting Started .....	13
2.3 Evaluation Board Description .....	14
<b>Appendix A. Schematics and Layout</b>	
A.1 Introduction .....	17
A.2 Schematics - MIC23158/9 Evaluation Board .....	18
A.3 Board – Top Silk .....	19
A.4 Board – Top Copper and Silk .....	20
A.5 Board – Top Copper .....	21
A.6 Board – Bottom Copper .....	22
A.7 Board - Bottom Copper and Silk .....	23
A.8 Board - Bottom Silk .....	24
<b>Appendix B. Bill of Materials (BOM)</b>	
<b>Worldwide Sales and Service</b>	<b>27</b>

# MIC23158/9 Evaluation Board User's Guide

---

NOTES:



# MIC23158/9 EVALUATION BOARD USER'S GUIDE

## 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 “DSXXXXXXA”, where “XXXXXX” 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 online help. Select the Help menu, and then Topics to open a list of available online help files.

## INTRODUCTION

This chapter contains general information that will be useful to know before using the MIC23158/9 Synchronous Buck Regulator Evaluation Board. Items discussed in this chapter include:

- [Document Layout](#)
- [Conventions Used in this Guide](#)
- [Recommended Reading](#)
- [The Microchip Website](#)
- [Customer Support](#)
- [Document Revision History](#)

## DOCUMENT LAYOUT

This document describes how to use the MIC23158/9 Synchronous Buck Regulator Evaluation Board as a demonstration board to evaluate the MIC23158/9 device. The manual layout is as follows:

- **Chapter 1. “Product Overview”** – Provides important information about the MIC23158/9 Synchronous Buck Regulator Evaluation Board.
- **Chapter 2. “Installation and Operation”** – Includes a detailed description of the demo board and instructions on how to use it.
- **Appendix A. “Schematics and Layout”** – Schematics and layout diagrams of the MIC23158/9 Synchronous Buck Regulator Evaluation Board.
- **Appendix B. “Bill of Materials (BOM)”** – Lists the parts used to build the MIC23158/9 Synchronous Buck Regulator Evaluation Board.

# MIC23158/9 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® 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 MIC23158/9 Synchronous Buck Regulator Evaluation Board. The following Microchip documents are available and recommended as supplemental reference resources:

- **MIC23158/9 Data Sheet - “3MHz, PWM, Dual 2A Buck Regulator with Hyper-Light Load® and Power Good”**

This data sheet provides detailed information regarding the MIC23158/9 device.

## THE MICROCHIP WEBSITE

Microchip provides on-line support via our web site at [www.microchip.com](http://www.microchip.com). This website is used as a means to make files and information easily available to customers. Accessible by using your favorite Internet browser, the website 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, on-line 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 A (March 2017)

- Initial conversion of Micrel evaluation board document to Microchip User's Guide DS50002588A. Minor grammatical corrections throughout.
- Updated multiple connector references, schematics, drawings, and BOM to reflect the use of ADM00829 board.

# MIC23158/9 Evaluation Board User's Guide

---

NOTES:

---

## Chapter 1. Product Overview

---

### 1.1 INTRODUCTION

This chapter provides an overview of the MIC23158/9 Evaluation Board and covers the following topics:

- MIC23158/9 Short Overview
- What is the MIC23158/9 Evaluation Board?
- MIC23158/9 Evaluation Board Kit Contents

### 1.2 MIC23158/9 SHORT OVERVIEW

#### 1.2.1 MIC23158/9 Key Features

The key features of the MIC23158/9 include:

- 2.7V to 5.5V Input Voltage
- Adjustable Output Voltage, Down to 1V
- Two Independent 2A Outputs
- Up to 94% Peak Efficiency
- 83% Typical Efficiency at 1 mA
- Two Independent Power Good Indicators
- Independent Programmable Soft-Start
- 45  $\mu$ A Typical Quiescent Current
- 3 MHz PWM Operation in Continuous Conduction Mode
- Ultra-Fast Transient Response
- Output Pre-Bias Safe
- 0.1  $\mu$ A Shutdown Current
- Thermal-Shutdown and Current-Limit Protection
- 20-pin 3 mm x 4 mm QFN Package
- Internal 225 $\Omega$  Pull-Down Circuit on Output (MIC23159)
- $-40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$  Junction Temperature

#### 1.2.2 MIC23158/9 Overview

The MIC23158/9 is a high-efficiency, 3 MHz, dual 2A synchronous buck regulator with HyperLight Load<sup>®</sup> mode, power good output indicator, and programmable soft-start.

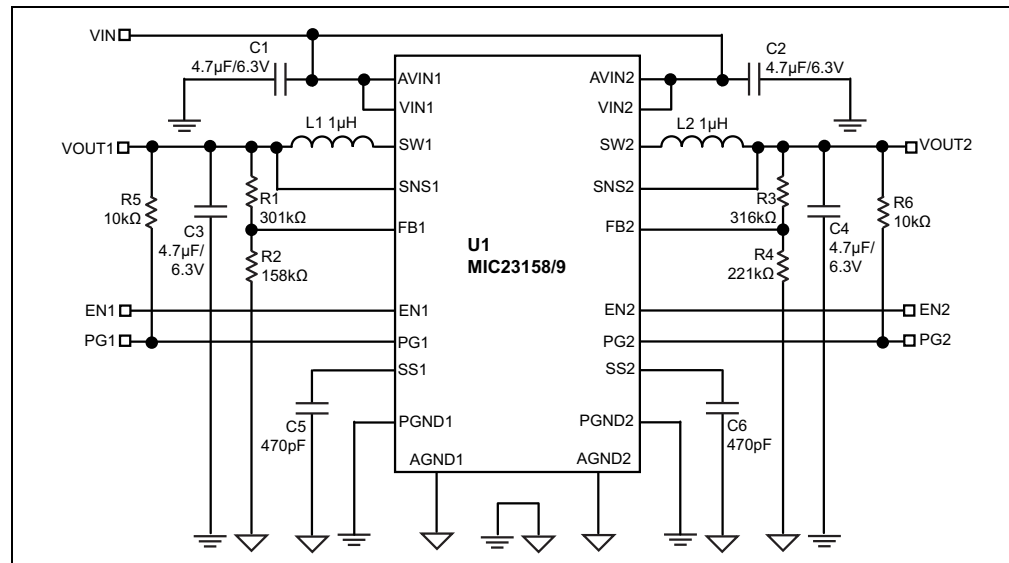
The MIC23159 also provides an auto discharge feature that switches in a 225 $\Omega$  pull-down circuit on its output to discharge the output capacitor when disabled. HyperLight Load provides very high efficiency at light loads and ultra-fast transient response, which makes the MIC23158/9 perfectly suited for supplying processor core voltages. An additional benefit of this proprietary architecture is very low output ripple voltage throughout the entire load range with the use of small output capacitors.

The MIC23158/9 is designed for use with a very small inductor, down to 0.47  $\mu$ H and an output capacitor as small as 2.2  $\mu$ F that enables a total solution size less than 1 mm in height.

# MIC23158/9 Evaluation Board User's Guide

The MIC23158/9 has a very low quiescent current of 45  $\mu\text{A}$  and achieves a peak efficiency of 94% in continuous conduction mode. In discontinuous conduction mode, the MIC23158/9 can achieve 83% efficiency at 1 mA.

The MIC23158/9 is available in a 20-pin 3 mm x 4 mm QFN package with an operating junction temperature range from  $-40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ .



**FIGURE 1-1:** Typical Application.

## 1.3 WHAT IS THE MIC23158/9 EVALUATION BOARD?

The MIC23158/9 Evaluation Board has been developed to evaluate the capabilities of the MIC23158/9 family of devices. The board is populated with the MIC23159 device and it's set for the following voltages:

- Buck1: 1.8V.
- Buck2: 1.5V.

The evaluation board can be easily modified by interchanging the MIC23159 device with MIC23158.

The MIC23158/9 Evaluation Board features independent Enable connectors (EN1 and EN2) with individual pull-up resistors. To disable the regulators independently, a jumper must be placed on J1 (to disable regulator 1) or to J3 (to disable regulator 2).

To check the status of each regulator, power-good connectors are available for each regulator (J2 for regulator 1 and J4 for regulator 2).

The board can be powered from two independent voltage sources on VIN1 and VIN2, or a 0 $\Omega$  resistor can be placed on R3 so that both converters be powered from the same voltage source.

## 1.4 MIC23158/9 EVALUATION BOARD KIT CONTENTS

The MIC23158/9 Evaluation Board kit includes:

- MIC23158/9 Synchronous Buck Regulator Evaluation Board (ADM00829)
- Information Sheet

---

## Chapter 2. Installation and Operation

---

### 2.1 INTRODUCTION

The MIC23158/9 Evaluation Board can be powered by:

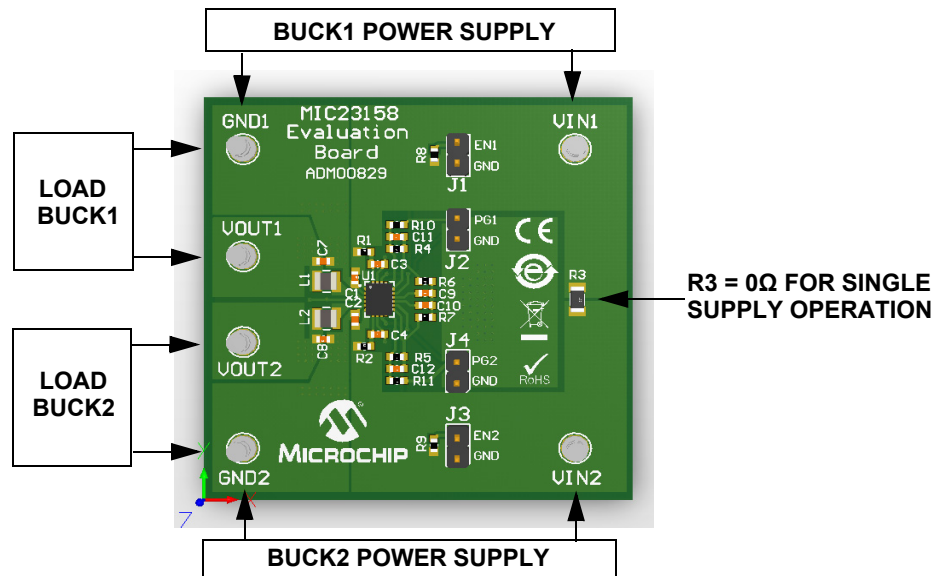
- Two power supplies with at least 2A current capability each (15W total).
- One power supply with at least 4A current capability connected to both VIN1 and VIN2 or connected to either VIN1 or VIN2 when R3 is populated with a 0Ω resistor.

### 2.2 GETTING STARTED

To power up the MIC23158/9 Evaluation Board, the following steps must be completed:

1. Connect an external supply between VIN1 and GND1 terminals (for regulator 1) and between VIN2 and GND2 terminals (for regulator 2).
2. With the output of the power supply disabled, set its voltage to the desired input test voltage ( $2.7V \leq V_{IN} \leq 5.5V$ ). An ammeter may be placed in series between the input supply and the VIN1 and VIN2 terminals. Be sure to monitor the supply voltage at the VIN1 and VIN2 terminal because the ammeter and/or power lead resistance can reduce the voltage supplied to the device.
3. Connect a load to the VOUT1 and GND1 and VOUT2 and GND2 terminals. The load can be either passive (resistive) or active (electronic load). An ammeter may be placed between the load and the output terminals. Ensure the output voltage is monitored at the VOUT1 and VOUT2 terminals.
4. The MIC23158/9 Evaluation Board has pull-up resistors to  $V_{IN}$ . By default, the output voltage will be enabled when an input supply of  $>2.7V$  is applied. To disable the device, apply a voltage below 0.4V to the EN terminals (J1 and/or J3).
5. Power good test points are provided to monitor the power good function (J2 and J4). The power good output will go high approximately 70 μs after the output voltage reaches 90% of its nominal voltage.

# MIC23158/9 Evaluation Board User's Guide



**FIGURE 2-1:** MIC23158/9 Evaluation Board.

## 2.3 EVALUATION BOARD DESCRIPTION

### 2.3.1 Soft-Start Capacitors (C9 and C10)

The MIC23159 has a nominal 296 kΩ resistor charging the capacitor on the SS pin. This enables the output to follow a controlled soft-start characteristic. Setting C9 and C10 to 470 pF sets the startup time to approximately 320 μs. The start-up time can be determined by [Equation 2-1](#).

#### EQUATION 2-1:

$$T_{SS} = 296k\Omega \times \ln(10) \times C_{SS}$$

The action of the soft-start capacitor is to control the rise time of the internal reference voltage between 0% and 100% of its nominal steady state value.

### 2.3.2 Feedback Resistors (R4, R5, R6, and R7) for Adjustable Outputs

The output voltages are set nominally to 1.8V and 1.5V. These outputs can be changed by adjusting the upper resistor, R4 and R5, in the feedback potential divider. Therefore:

#### EQUATION 2-2:

$$R4 = R6 \times (V_O - V_{REF}) / V_{REF}$$

Where:

$$V_{REF} = 0.62V$$

### EQUATION 2-3:

$$R5 = R7 \times (V_O - V_{REF}) / V_{REF}$$

Where:

$$V_{REF} = 0.62V$$

Some example values are shown in [Table 2-1](#):

**TABLE 2-1: FEEDBACK RESISTOR VALUES FOR ADJUSTABLE OUTPUTS**

V <sub>OUT</sub>	R4 and R5	R6 and R7
1.2V	274 kΩ	294 kΩ
1.5V	316 kΩ	221 kΩ
1.8V	301 kΩ	158 kΩ
2.5V	324 kΩ	107 kΩ
3.3V	309 kΩ	71.5 kΩ

To prevent instability problems caused by the internal ripple injection, the recommended feedback resistor dividers should be used. The feed-forward capacitors (C11 and C12) are typically not fitted. The transient performance can be improved slightly by fitting a capacitor at C11 and C12 to inject fast output voltage deviations directly into the feedback comparator. This improved load regulation is at the expense of slightly increasing the amount of noise on the output at higher loads. Values between 100 pF and 1 nF are recommended to prevent instability.

### 2.3.3 Power Good

The evaluation board has a test point provided for monitoring the power good feature. This is an open drain connection with an on-board pull-up resistor of 10 kΩ to the output voltage. Power good is asserted high approximately 70 μs after the output voltage passes 90% of the nominal set voltage.

### 2.3.4 HyperLight Load Mode

MIC23158/9 uses a minimum on and off time proprietary control loop. When the output voltage falls below the regulation threshold, the error comparator begins a switching cycle that turns the PMOS on and keeps it on for the duration of the minimum-on-time. This increases the output voltage. If the output voltage is over the regulation threshold, then the error comparator turns the PMOS off for a minimum-off-time until the output drops below the threshold. The NMOS acts as an ideal rectifier that conducts when the PMOS is off. Using a NMOS switch instead of a diode allows for lower voltage drop across the switching device when it is on. The synchronous switching combination between the PMOS and the NMOS allows the control loop to work in discontinuous mode for light load operations. In discontinuous mode, the MIC23158 works in pulse frequency modulation (PFM) to regulate the output. As the output current increases, the off-time decreases, thus providing more energy to the output. This switching scheme improves the efficiency of MIC23158 during light load currents by only switching when it is needed.

As the load current increases, the MIC23158 goes into continuous conduction mode (CCM) and switches at a frequency centered at 3 MHz. The equation to calculate the load when the MIC23158 goes into continuous conduction mode may be approximated by [Equation 2-4](#):

## EQUATION 2-4:

$$I_{\text{LOAD}} > \left( \frac{(V_{\text{IN}} - V_{\text{OUT}}) \times D}{2L \times f} \right)$$

As shown in the equation above, the load at which MIC23158/9 transitions from Hyper-Light Load mode to PWM mode is a function of the input voltage ( $V_{\text{IN}}$ ), output voltage ( $V_{\text{OUT}}$ ), duty cycle ( $D$ ), inductance ( $L$ ), and frequency ( $f$ ). The MIC23158 will switch at a relatively constant frequency around 3 MHz once the output current is over 180 mA.



---

## **Appendix A. Schematics and Layout**

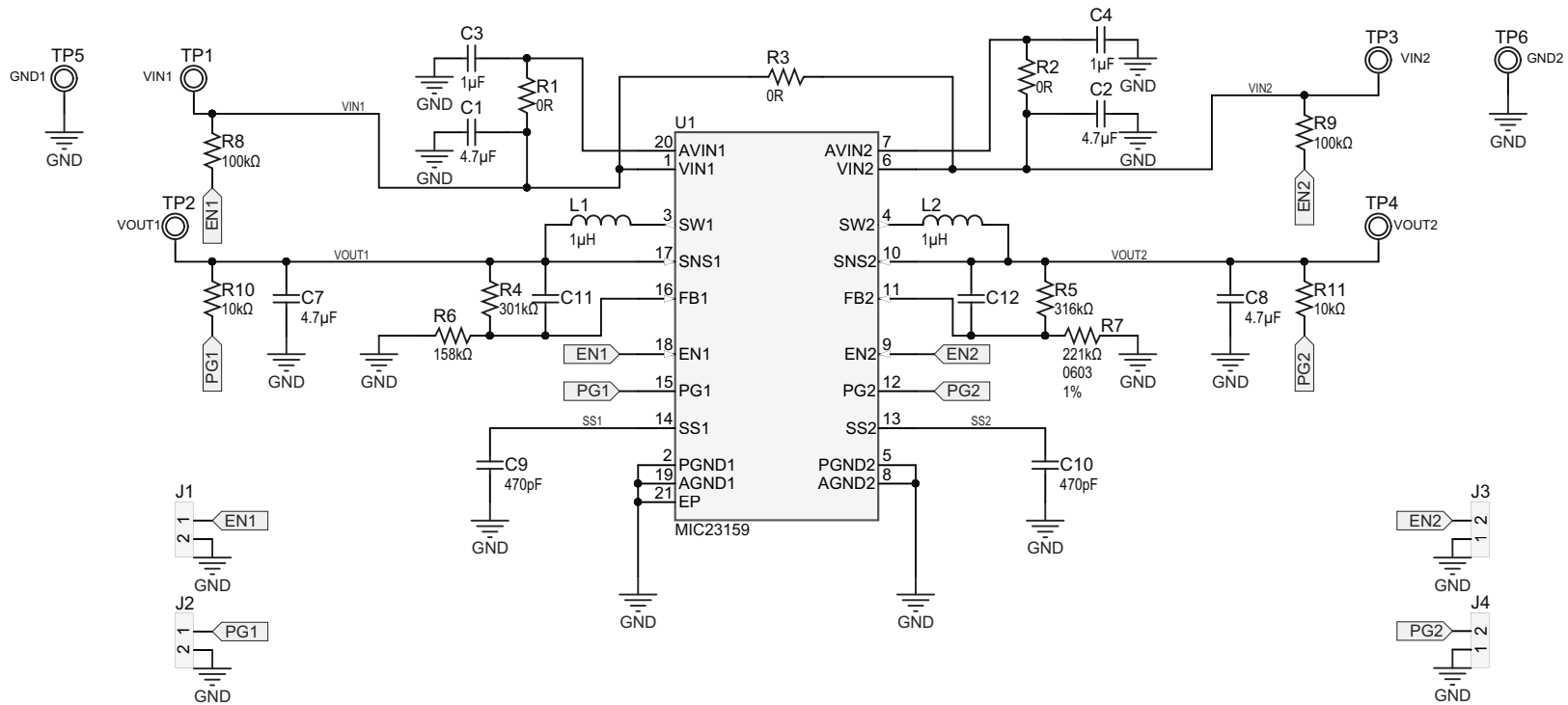
---

### **A.1 INTRODUCTION**

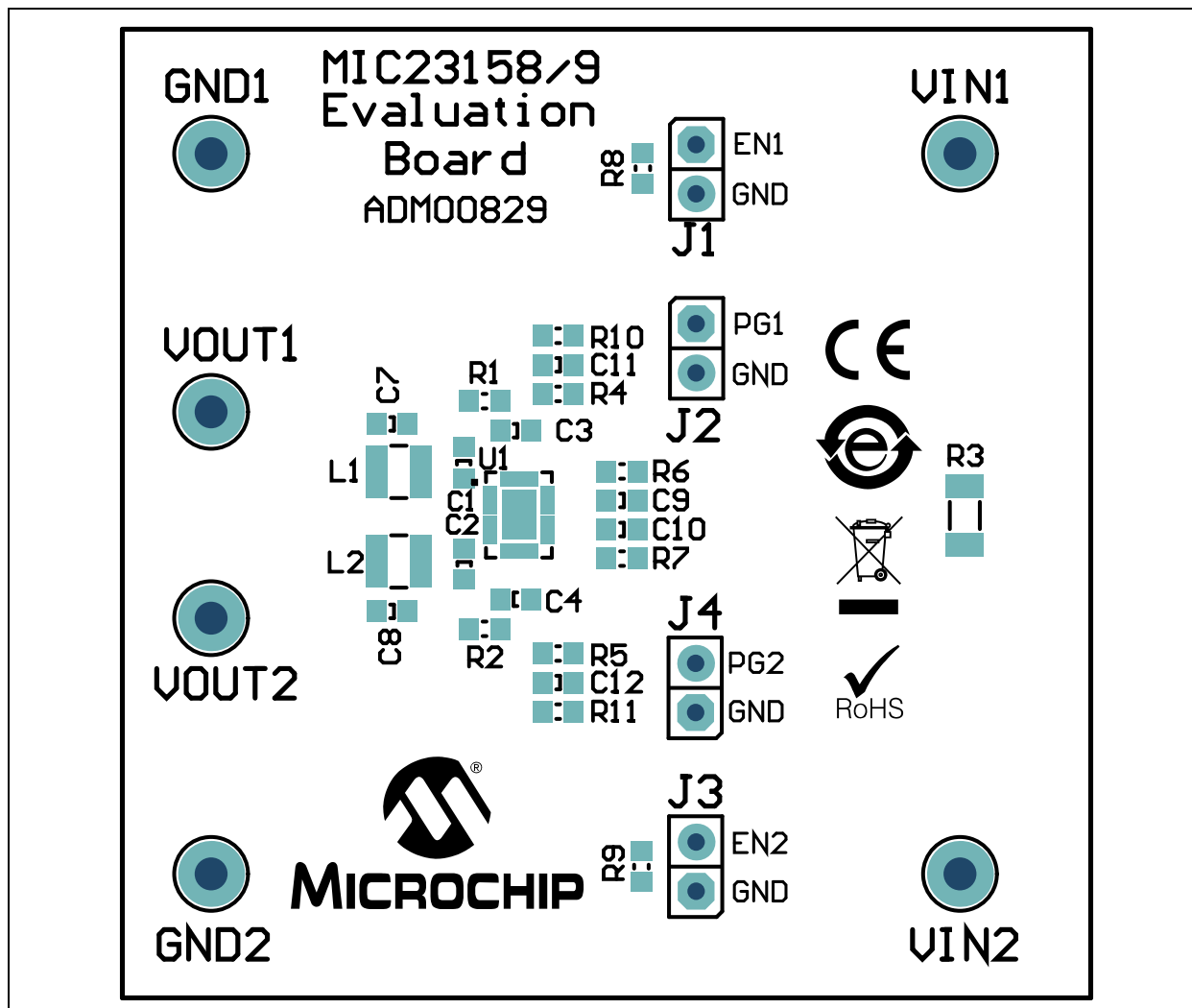
This appendix contains the following schematics and layout of the MIC23158/9 Buck Regulator Evaluation Board:

- Schematics - MIC23158/9 Evaluation Board
- Board – Top Silk
- Board – Top Copper and Silk
- Board – Top Copper
- Board – Bottom Copper
- Board - Bottom Copper and Silk
- Board - Bottom Silk

## A.2 SCHEMATICS - MIC23158/9 EVALUATION BOARD

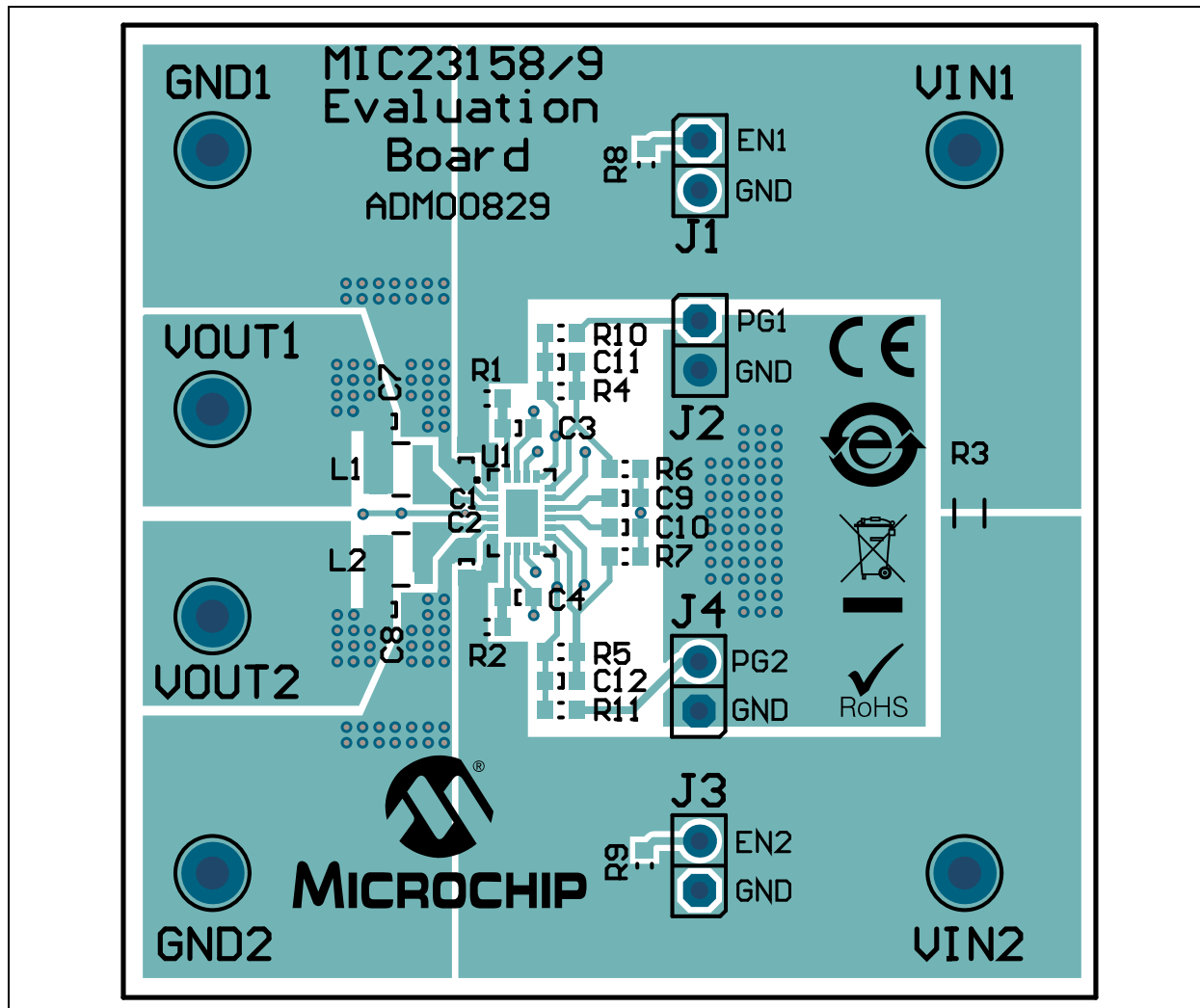


### A.3 BOARD – TOP SILK



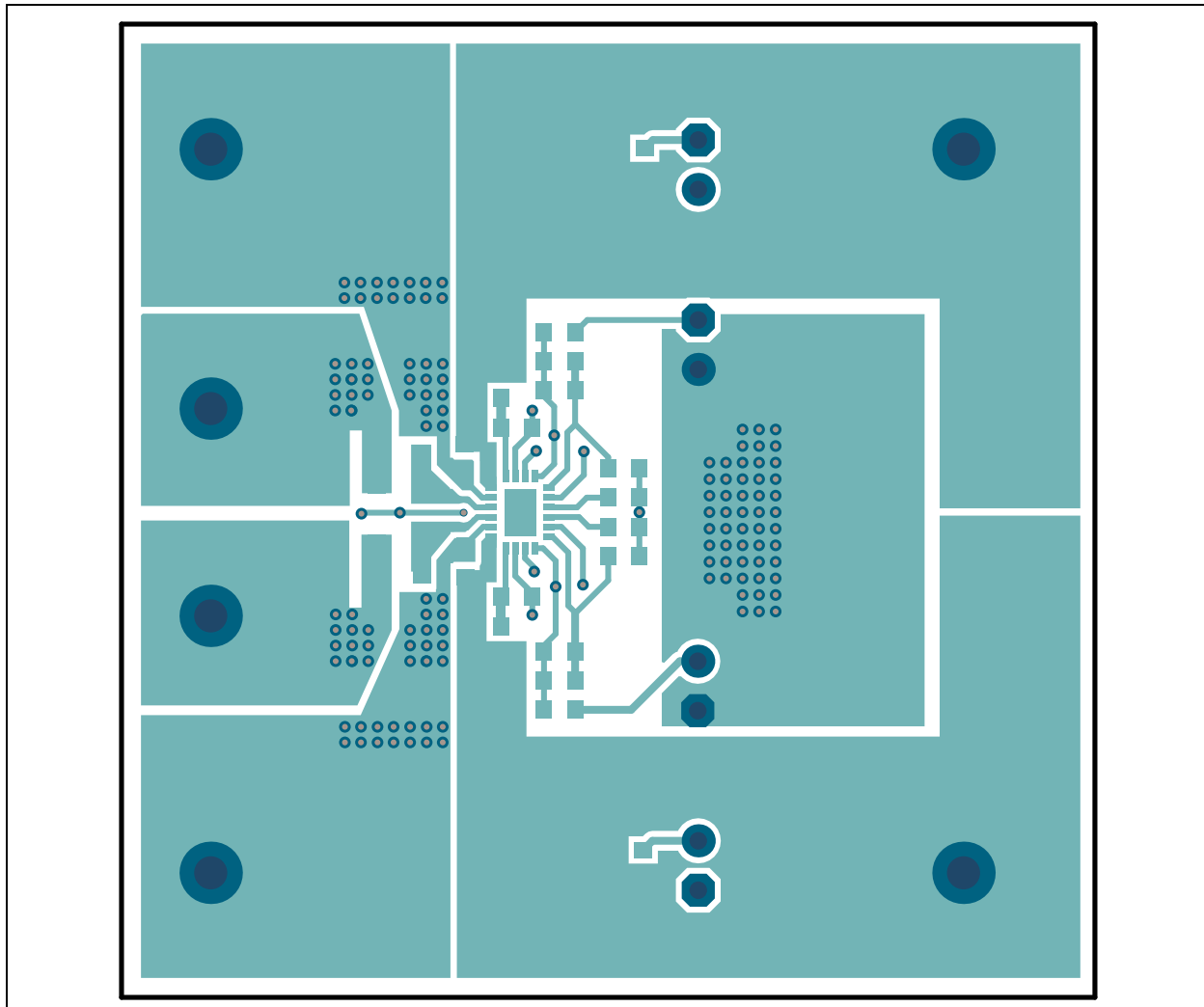
# MIC23158/9 Evaluation Board User's Guide

## A.4 BOARD – TOP COPPER AND SILK

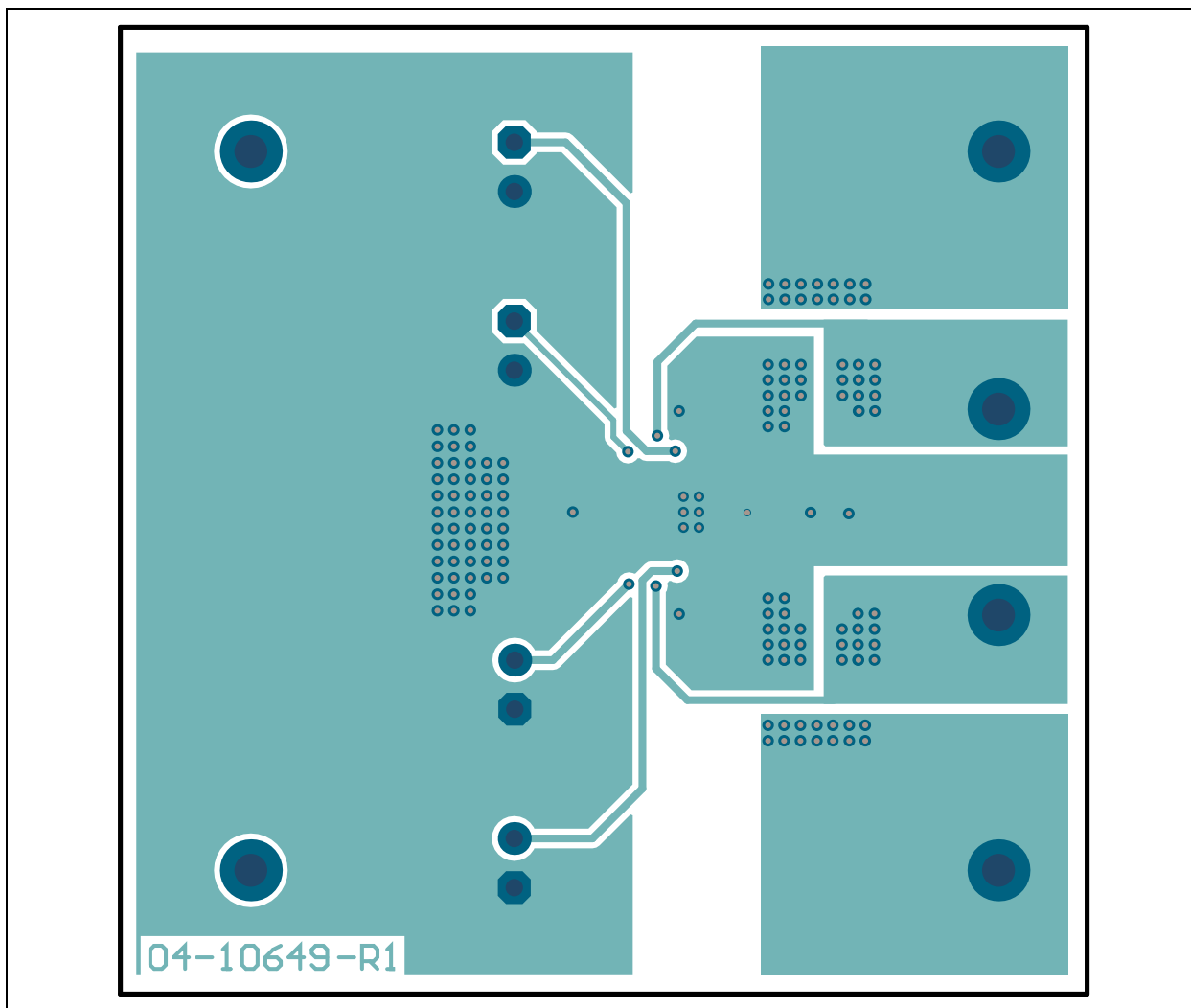


---

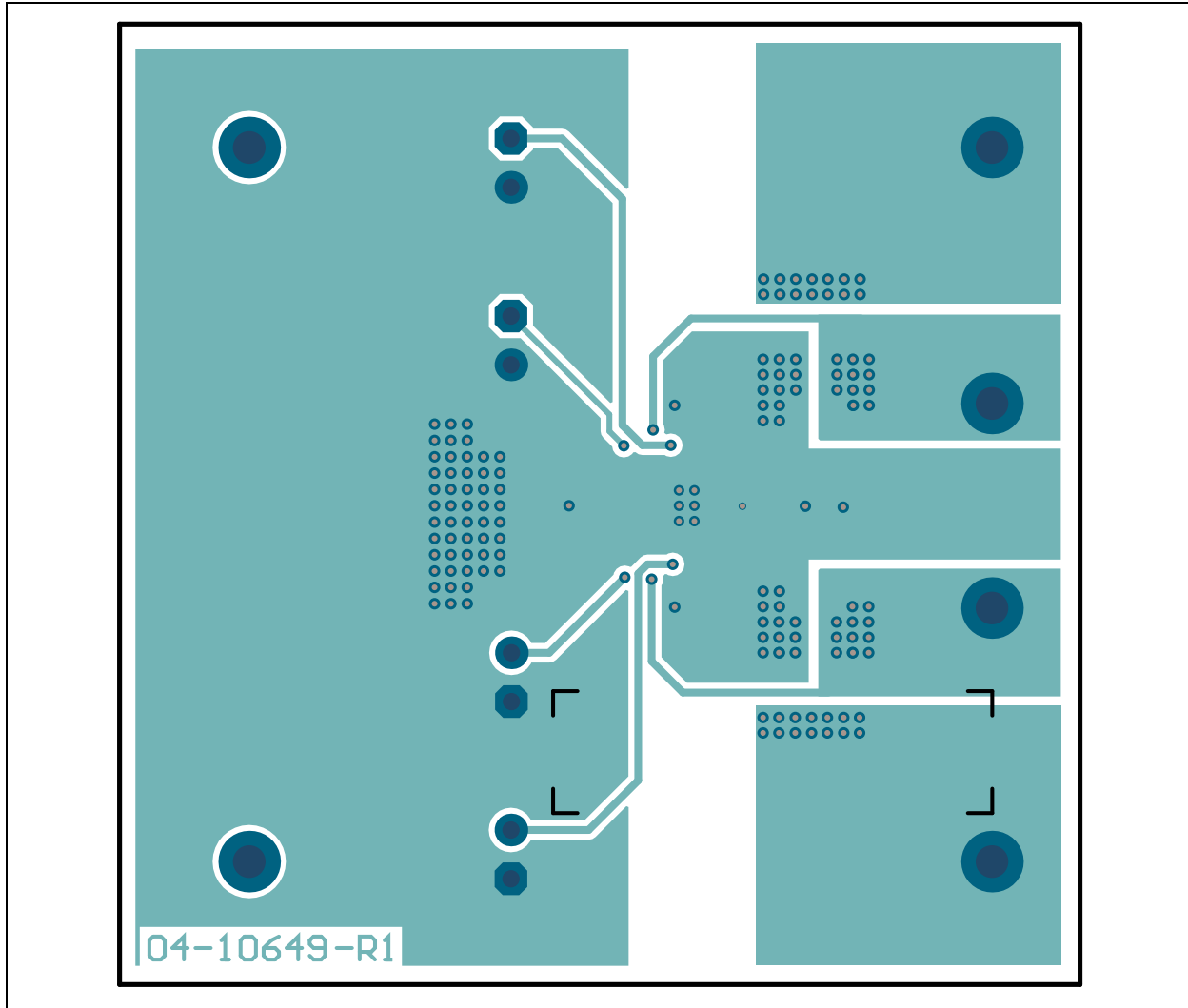
## A.5 BOARD – TOP COPPER



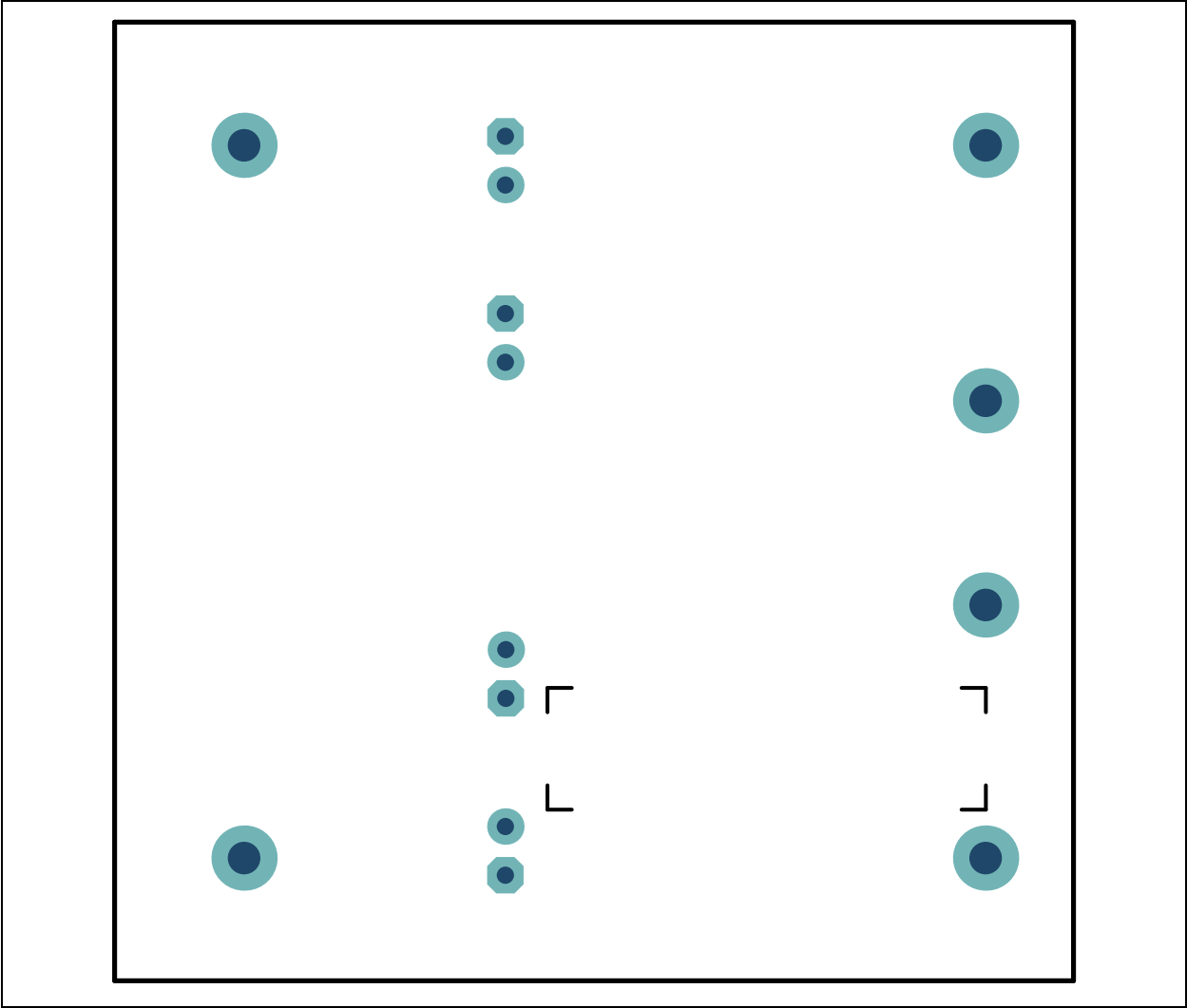
## A.6 BOARD – BOTTOM COPPER



## A.7 BOARD - BOTTOM COPPER AND SILK



A.8 BOARD - BOTTOM SILK





## Appendix B. Bill of Materials (BOM)

**TABLE B-1: BILL OF MATERIALS (BOM)<sup>(1)</sup>**

Qty.	Reference	Description	Manufacturer	Part Number
4	C1, C2, C7, C8	CAP CER 4.7 $\mu$ F 16V 10% X5R SMD 0603	TDK Corporation	C1608X5R1C475K080AC
2	C3, C4	CAP CER 1 $\mu$ F 16V 10% X5R SMD 0603	TDK Corporation	C1608X5R1C105K
2	C9, C10	CAP CER 470 pF 100V 5% C0G SMD 0603	TDK Corporation	CGA3E2C0G2A471J080A A
4	J1, J2, J3, J4	CON HDR-2.54 Male 1x2 Gold 5.84 MH TH VERT	FCI	77311-118-02LF
2	L1, L2	INDUCTOR 1 $\mu$ H 2.3A 20% SMD 2520	TDK Corporation	MLP2520W1R0MT0S1
4	PAD1, PAD2, PAD3, PAD4	MECH HW RUBBER PAD Hemisphere D6.4 H1.9 CLEAR	3M	SJ5382
2	R1, R2	RES TKF 0R 1/10W SMD 0603	Panasonic	ERJ-3GSY0R00V
1	R4	RES TF 301 k $\Omega$ 0.5% 1/16W SMD 0603	Susumu	RR0816P-3013-D-47D
1	R5	RES TKF 316 k $\Omega$ 1% 1/10W SMD 0603	Panasonic	ERJ-3EKF3163V
1	R6	RES TKF 158 k $\Omega$ 1% 1/10W SMD 0603	Yageo	RC0603FR-07158KL
1	R7	RES TKF 221 k $\Omega$ 1% 1/10W SMD 0603	Panasonic	ERJ-3EKF2213V
2	R8, R9	RES TF 100 k $\Omega$ 1% 1/8W SMD 0603	Vishay	MCT06030C1003FP500
2	R10, R11	RES TF 10 k $\Omega$ 1% 1/8W SMD 0603	Vishay	MCT06030C1002FP500
6	TP1, TP2, TP3, TP4, TP5, TP6	CON TP PIN Tin TH	Harwin	H2121-01
1	U1	Dual 2A Buck Regulator MIC23159YML-TR VQFN-20	Microchip Technology Inc.	MIC23159YML-TR

**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.

# MIC23158/9 Evaluation Board User's Guide

---

NOTES:

## 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://www.microchip.com/support>  
Web Address:  
[www.microchip.com](http://www.microchip.com)

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

**Austin, TX**  
Tel: 512-257-3370

**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**  
Novi, MI  
Tel: 248-848-4000

**Houston, TX**  
Tel: 281-894-5983

**Indianapolis**  
Noblesville, IN  
Tel: 317-773-8323  
Fax: 317-773-5453  
Tel: 317-536-2380

**Los Angeles**  
Mission Viejo, CA  
Tel: 949-462-9523  
Fax: 949-462-9608  
Tel: 951-273-7800

**Raleigh, NC**  
Tel: 919-844-7510

**New York, NY**  
Tel: 631-435-6000

**San Jose, CA**  
Tel: 408-735-9110  
Tel: 408-436-4270

**Canada - Toronto**  
Tel: 905-695-1980  
Fax: 905-695-2078

### ASIA/PACIFIC

**Asia Pacific Office**  
Suites 3707-14, 37th Floor  
Tower 6, The Gateway  
Harbour City, Kowloon

**Hong Kong**  
Tel: 852-2943-5100  
Fax: 852-2401-3431

**Australia - Sydney**  
Tel: 61-2-9868-6733  
Fax: 61-2-9868-6755

**China - Beijing**  
Tel: 86-10-8569-7000  
Fax: 86-10-8528-2104

**China - Chengdu**  
Tel: 86-28-8665-5511  
Fax: 86-28-8665-7889

**China - Chongqing**  
Tel: 86-23-8980-9588  
Fax: 86-23-8980-9500

**China - Dongguan**  
Tel: 86-769-8702-9880

**China - Guangzhou**  
Tel: 86-20-8755-8029

**China - Hangzhou**  
Tel: 86-571-8792-8115  
Fax: 86-571-8792-8116

**China - Hong Kong SAR**  
Tel: 852-2943-5100  
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: 86-21-3326-8000  
Fax: 86-21-3326-8021

**China - Shenyang**  
Tel: 86-24-2334-2829  
Fax: 86-24-2334-2393

**China - Shenzhen**  
Tel: 86-755-8864-2200  
Fax: 86-755-8203-1760

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

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

### ASIA/PACIFIC

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

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

**India - Bangalore**  
Tel: 91-80-3090-4444  
Fax: 91-80-3090-4123

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

**India - Pune**  
Tel: 91-20-3019-1500

**Japan - Osaka**  
Tel: 81-6-6152-7160  
Fax: 81-6-6152-9310

**Japan - Tokyo**  
Tel: 81-3-6880-3770  
Fax: 81-3-6880-3771

**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: 886-3-5778-366  
Fax: 886-3-5770-955

**Taiwan - Kaohsiung**  
Tel: 886-7-213-7830

**Taiwan - Taipei**  
Tel: 886-2-2508-8600  
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

**Finland - Espoo**  
Tel: 358-9-4520-820

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

**France - Saint Cloud**  
Tel: 33-1-30-60-70-00

**Germany - Garching**  
Tel: 49-8931-9700

**Germany - Haan**  
Tel: 49-2129-3766400

**Germany - Heilbronn**  
Tel: 49-7131-67-3636

**Germany - Karlsruhe**  
Tel: 49-721-625370

**Germany - Munich**  
Tel: 49-89-627-144-0  
Fax: 49-89-627-144-44

**Germany - Rosenheim**  
Tel: 49-8031-354-560

**Israel - Ra'anana**  
Tel: 972-9-744-7705

**Italy - Milan**  
Tel: 39-0331-742611  
Fax: 39-0331-466781

**Italy - Padova**  
Tel: 39-049-7625286

**Netherlands - Drunen**  
Tel: 31-416-690399  
Fax: 31-416-690340

**Norway - Trondheim**  
Tel: 47-7289-7561

**Poland - Warsaw**  
Tel: 48-22-3325737

**Romania - Bucharest**  
Tel: 40-21-407-87-50

**Spain - Madrid**  
Tel: 34-91-708-08-90  
Fax: 34-91-708-08-91

**Sweden - Gothenberg**  
Tel: 46-31-704-60-40

**Sweden - Stockholm**  
Tel: 46-8-5090-4654

**UK - Wokingham**  
Tel: 44-118-921-5800  
Fax: 44-118-921-5820