MCP16331 High-Voltage Input Buck Converter Evaluation Board User's Guide

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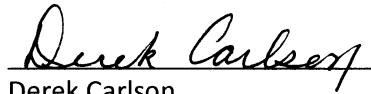
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Signed for and on behalf of Microchip Technology Inc. at Chandler, Arizona, USA

Derek Carlson

Derek Carlson
VP Development Tools

16-July-2013

Date

NOTES:

MCP16331 HIGH-VOLTAGE INPUT BUCK CONVERTER EVALUATION BOARD USER'S GUIDE

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MCP16331 HIGH-VOLTAGE INPUT BUCK CONVERTER 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) 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 "DSXXXXXXXXA", where "XXXXXXXX" 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 MCP16331 High-Voltage Input Buck Converter 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 MCP16331 High-Voltage Input Buck Converter Evaluation Board as a development tool. The manual layout is as follows:

- **Chapter 1. "Product Overview"** – Important information about the MCP16331 High-Voltage Input Buck Converter Evaluation 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. "Schematic and Layouts"** – Shows the schematic and layout diagrams for the MCP16331 High-Voltage Input Buck Converter Evaluation Board.
- **Appendix B. "Bill of Materials (BOM)"** – Lists the parts used to build the MCP16331 High-Voltage Input Buck Converter 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® 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 MCP16331 High-Voltage Input Buck Converter Evaluation Board. Another useful document is listed below. The following Microchip document is available and recommended as a supplemental reference resource:

- **MCP16331 Data Sheet - "*High-Voltage Input Integrated Switch Step-Down Regulator*" (DS2005308)**

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Technical support is available through the web site at:
http://www.microchip.com/support.

DOCUMENT REVISION HISTORY

Revision A (June 2014)

- Initial Release of this Document.

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MCP16331 HIGH-VOLTAGE INPUT BUCK CONVERTER EVALUATION BOARD USER'S GUIDE

Chapter 1. Product Overview

1.1 INTRODUCTION

This chapter provides an overview of the MCP16331 High-Voltage Input Buck Converter Evaluation Board and covers the following topics:

- MCP16331 Short Overview
- What is the MCP16331 High-Voltage Input Buck Converter Evaluation Board?
- What the MCP16331 High-Voltage Input Buck Converter Evaluation Board Contains

1.2 MCP16331 SHORT OVERVIEW

The MCP16331 is a compact, high-voltage, high-efficiency, fixed-frequency, step-down DC-DC converter. The integrated features include a high-side switch, fixed frequency, internal compensation, and overtemperature protection. To deliver a fast response to sudden line and load changes, the MCP16331 uses a high performance peak-current mode control system. This product provides an easy-to-use power supply solution, with a minimum number of external components.

The key features of the MCP16331 include:

- Up to 94% Typical Efficiency
- Input Voltage Range: 4.2V to 50V
- Adjustable Output Voltage Range: 2.0V to 24V
- 2% Output Voltage Accuracy
- Integrated N-Channel Buck Switch: 600 mΩ
- 500 mA Output Current
- 500 kHz Fixed Frequency
- Low Device Shutdown Current
- Peak Current Mode Control
- Internal Compensation
- Internal Soft-Start
- Internal Pull-Up on the EN pin
- Cycle-by-Cycle Peak Current Limit
- Undervoltage Lockout (UVLO): 4.1V to Start, 3.5V to Stop
- Overtemperature Protection: 160°C Thermal Shutdown, with 30°C Hysteresis
- Available Packages: 6-Lead SOT-23, 8-Lead 2x3 TDFN

The goal of the MCP16331 High-Voltage Input Buck Converter Evaluation Board is to demonstrate the features of the MCP16331.
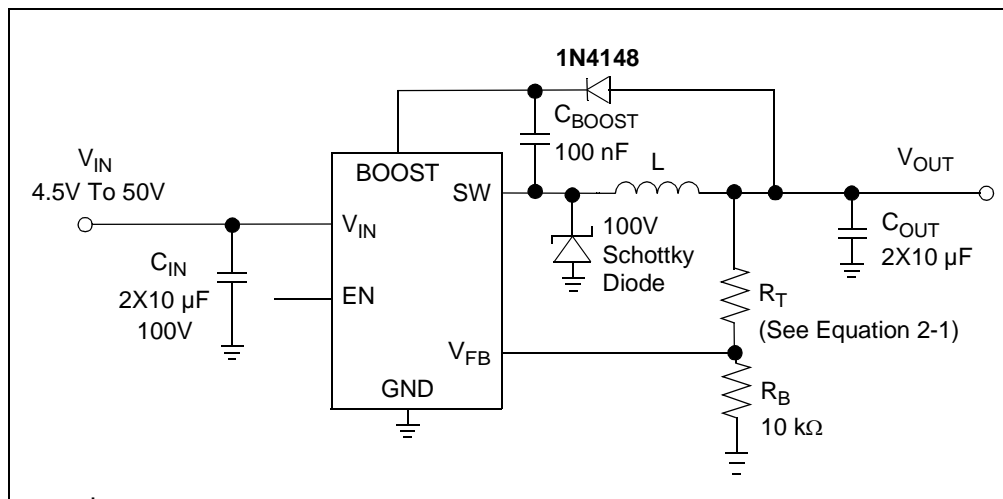
FIGURE 1-1:   *Typical MCP16331 Buck Converter.*

1.3   WHAT IS THE MCP16331 HIGH-VOLTAGE INPUT BUCK CONVERTER EVALUATION BOARD?

The MCP16331 High-Voltage Input Buck Converter Evaluation Board is used to evaluate and demonstrate Microchip Technology's MCP16331 product. This board demonstrates the MCP16331 in a buck-converter application with two selectable output voltages. It can be used to evaluate the SOT-23 package. Test points are provided for the input and output, allowing the board to be connected directly to a system. Also, additional test points are provided to access the EN pin, in order to modify the state of the converter, and also access the SW pin, in order to see the switching waveform.The MCP16331 High-Voltage Input Buck Converter Evaluation Board was developed to help engineers reduce product design cycle time.

Two common output voltages can be selected, 3.3V and 5.0V.

1.4   WHAT THE MCP16331 HIGH-VOLTAGE INPUT BUCK CONVERTER EVALUATION BOARD CONTAINS

This MCP16331 High-Voltage Input Buck Converter Evaluation Board kit includes:

• MCP16331 High-Voltage Input Buck Converter Evaluation Board (ADM00519)
• Important Information Sheet

Chapter 2. Installation and Operation

2.1 INTRODUCTION

The MCP16331 is a compact, high-efficiency, fixed-frequency, step-down DC-DC converter and has been developed to provide high-input voltage applications with a precise low voltage regulated rail.

The MCP16331 is capable of regulating the output voltage over a wide 2V to 24V range from an input rail of up to 50V and typically can deliver over 500 mA. The regulated output voltage, V_{OUT}, should be lower than the input voltage, V_{IN}, in order to ensure proper operation.
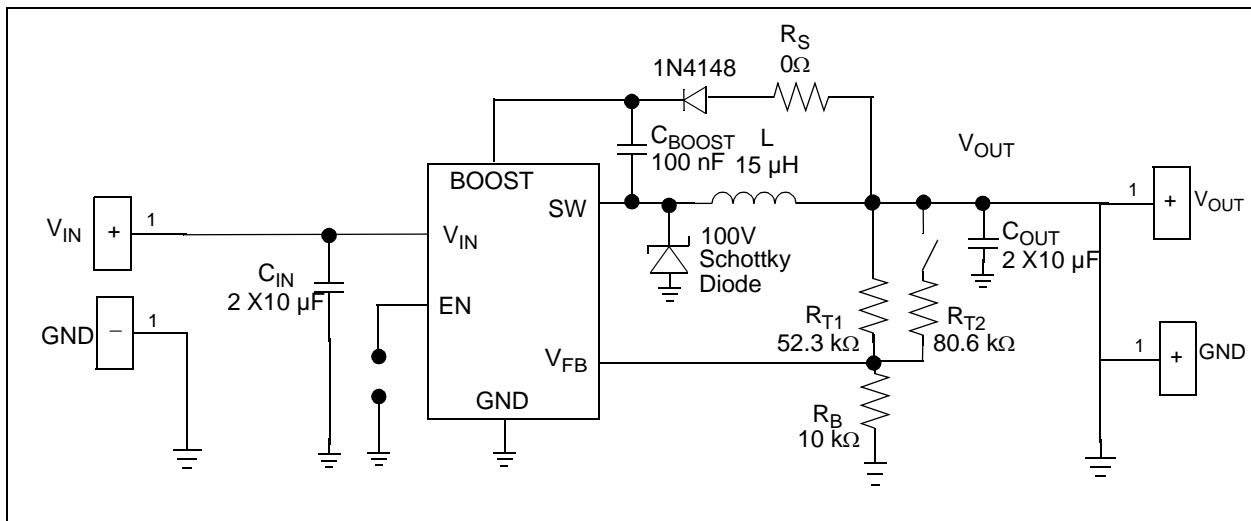
FIGURE 2-1: *MCP16331 Evaluation Board Application.*

2.2 FEATURES

The MCP16331 Buck Converter Evaluation Board has the following features:

- Input voltage range, V_{IN}: 6V to 50V
- Converter can be turned on/off by using a jumper on the EN/GND connector
- Fixed output voltage: 3.3V and 5.0V selectable trough a switch
- Output current: typical 500 mA
- PWM Switching Frequency = 500 kHz
- Internal compensation
- Internal soft-start
- Overtemperature protection (if the die temperature exceeds 150°C, 25°C hysteresis)

2.3   GETTING STARTED

The MCP16331 Buck Converter Evaluation Board is fully assembled and tested to evaluate and demonstrate the MCP16331 product. Before testing the MCP16331 Buck Converter Evaluation Board, it is recommended that the MCP16331 data sheet is read and all the limits for input voltage, output voltage and maximum current are taken into consideration.

2.3.1   Power Input and Output Connection

2.3.1.1   BOARD POWER UP PROCEDURE:

1. Connect system load to V_{OUT} and GND terminals; maximum load varies with input and output voltage; see the MCP16331 data sheet for more information on the maximum load.
2. Connect the Power Supply to the V_{IN} and GND terminals. Because the EN is internally pulled up, the converter will start once power is applied on the input. To turn off the device, a jumper can be used on the EN/GND connector.
3. The measured output voltage should be 3.3V/5V. Adjusting the input voltage and load should not cause the output to vary more than a few mV over the operating range of the converter.
4. The output voltage can be changed from 3.3V to 5V by using the V_{OUT} SEL switch on the board.
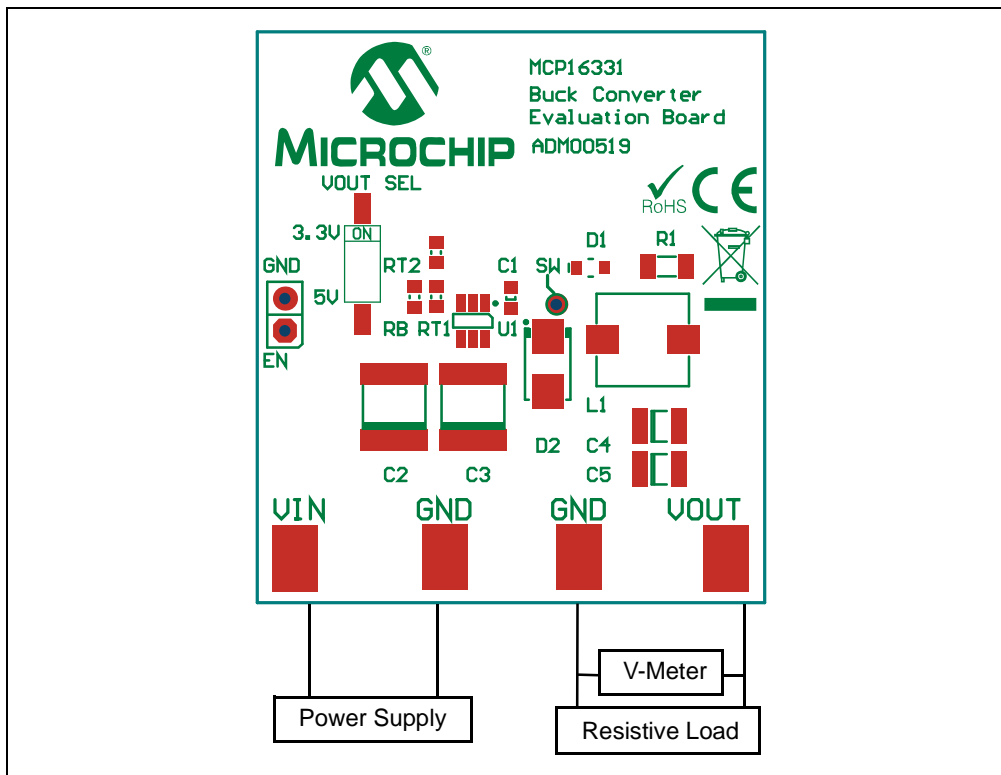

FIGURE 2-2:   *MCP16331 Evaluation Board Setup.*

2.3.1.2 ADJUSTABLE V$_{OUT}$ SETTING

The resistor divider R$_T$ and R$_B$ is used to set the converter output voltage. For a specific output voltage, the top resistor can be calculated as in Equation 2-1. A good trade-off between noise and quiescent current is to use a 10 kΩ resistor for the bottom resistor.

EQUATION 2-1:

$$R_T = R_B \times \left[\left(\frac{V_{OUT}}{V_{FB}} \right) - 1 \right]$$

Where: V$_{FB}$ = 0.8V

When changing the value of the feedback resistor, the V$_{OUT}$ SEL switch will not have the same functionality, as it will add an additional resistor in parallel with the top resistor.

Additionally, when modifying the output voltage, the inductor value must be modified in order to get the best results in terms of efficiency and load and line step responses. For typical output voltage, see Table 2-1 for the recommended inductor values.

TABLE 2-1: RECOMMENDED INDUCTOR VALUES

V$_{OUT}$	Inductor Value
2.0V	10 µH
3.3V	15 µH
5.0V	22 µH
12V	56 µH
15V	68 µH
24V	100 µH

Because the MCP16331 integrates the high-side N-Channel MOSFET, a high-side driver is needed to supply the drive for the gate of the MOSFET above the input voltage in order to turn it on. For the MCP16331 Buck Converter Evaluation Board, the output voltage is used to charge the boost capacitor. For output voltages above 5V, the voltage used to charge the boost capacitor needs to be clamped to less then 5V to avoid damaging the part. An easy way to achieve this is to remove the resistor (R1) in series with the bootstrap diode and add a Zener diode of appropriate voltage. For more information, refer to the MCP16331 Data Sheet.

NOTES:

Appendix A. Schematic and Layouts

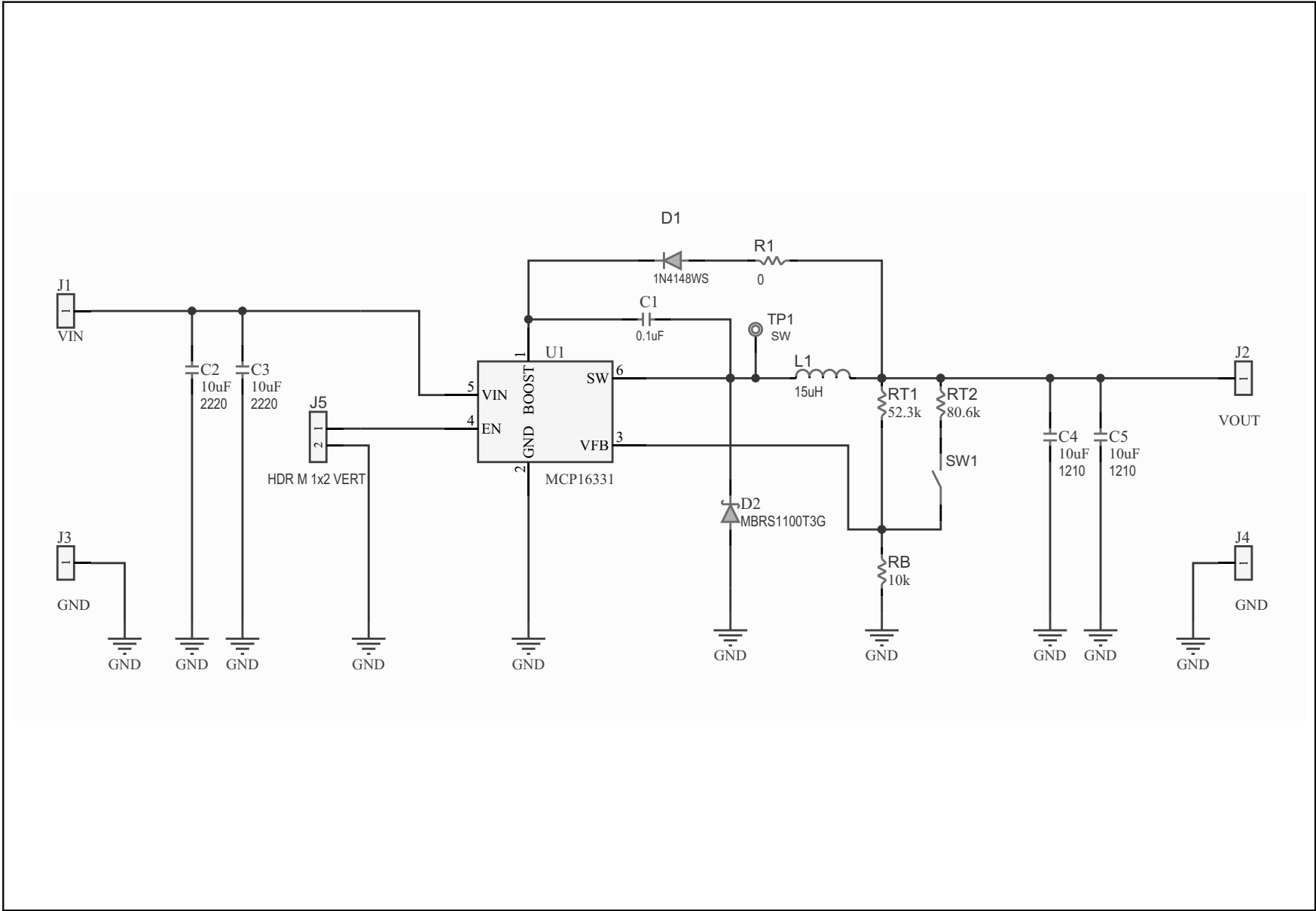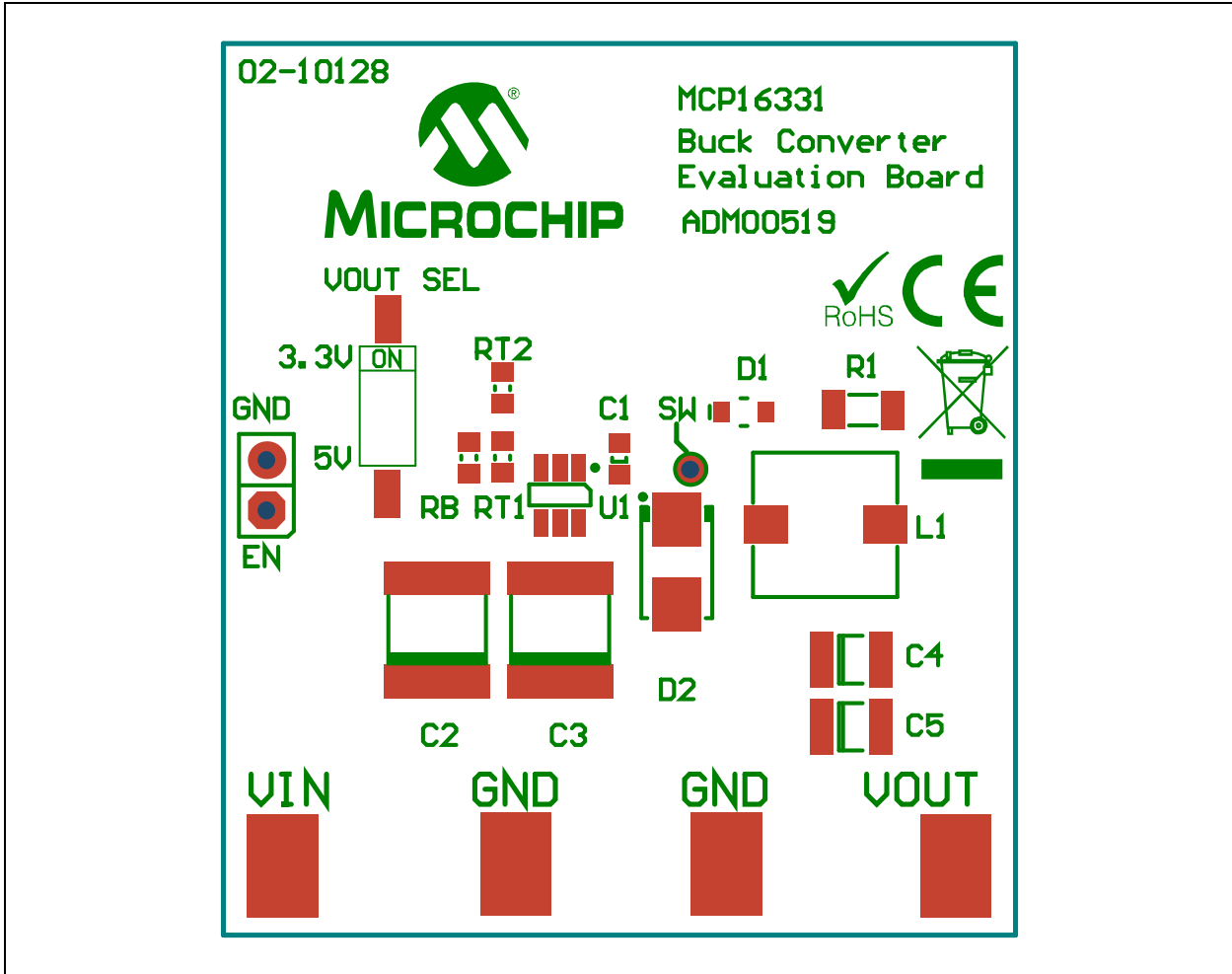## A.1 INTRODUCTION

This appendix contains the following schematics and layouts for the MCP16331 Buck Converter Evaluation Board:

- Board – Schematic
- Board – Top Silk
- Board – Top Silk And Copper
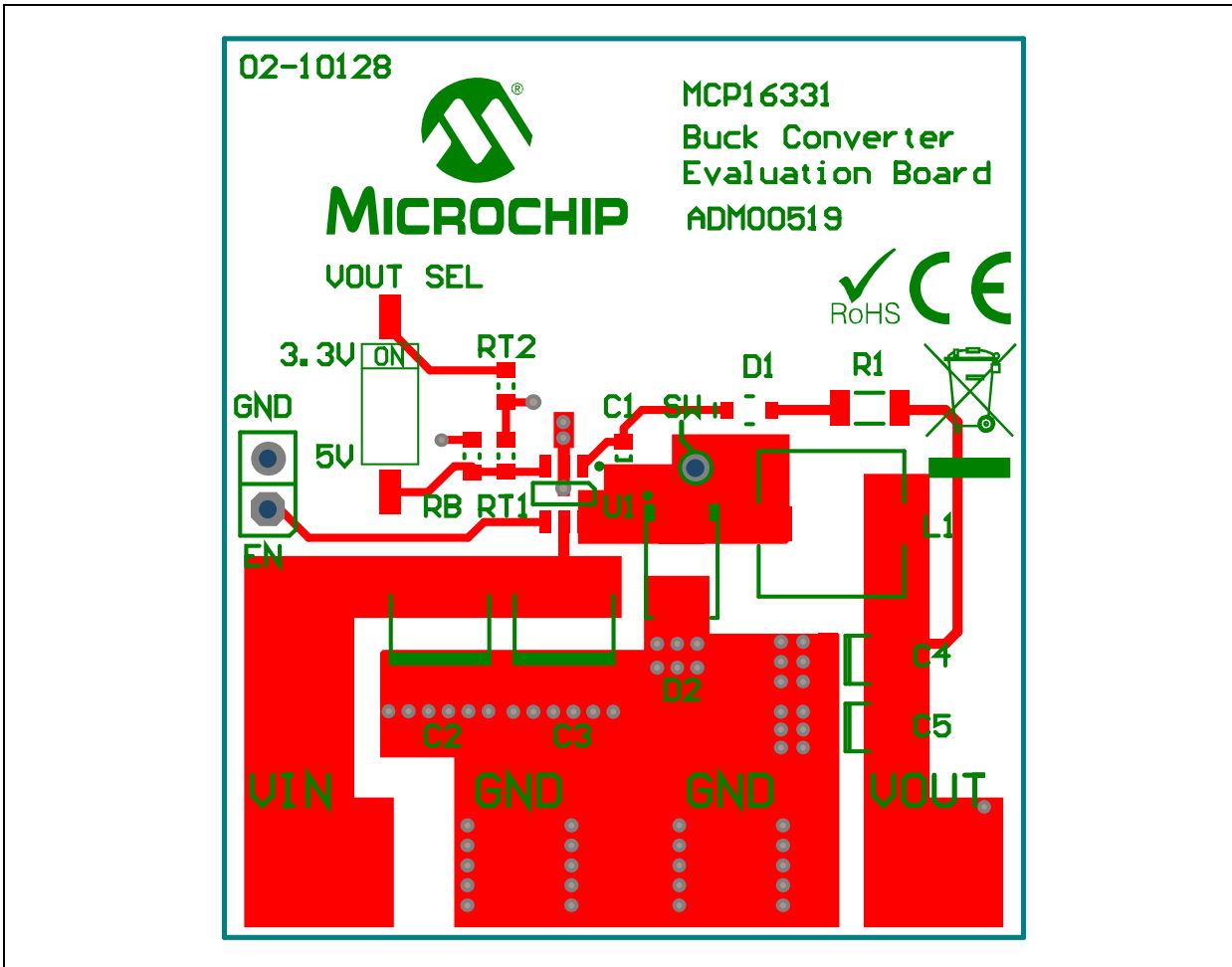- Board – Bottom Copper
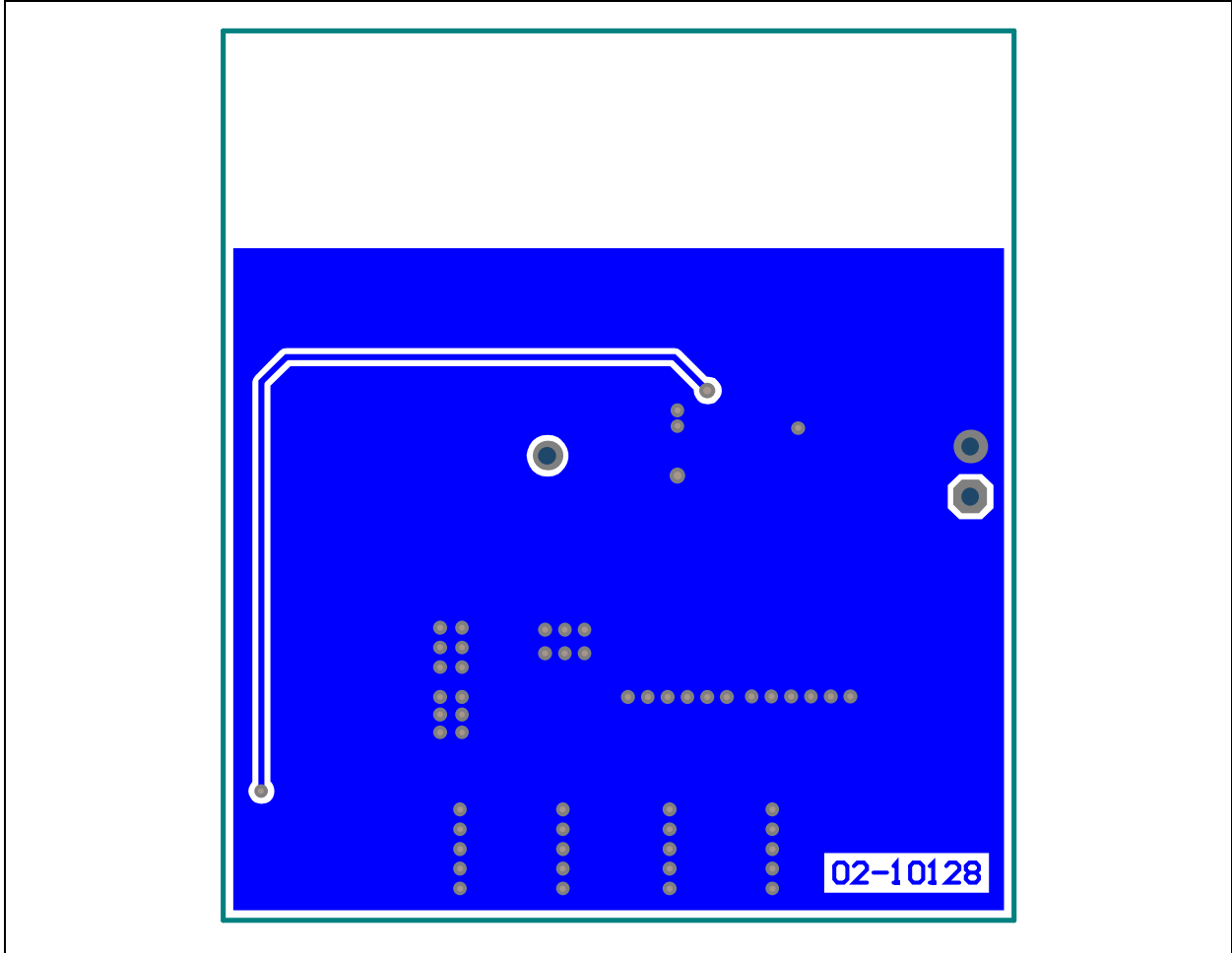
A.2   BOARD − SCHEMATIC

Schematic and Layouts

A.3   BOARD – TOP SILK

A.4   BOARD – TOP SILK AND COPPER

A.5   BOARD – BOTTOM COPPER

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Appendix B. Bill of Materials (BOM)

TABLE B-1:   BILL OF MATERIALS (BOM)

Qty.	Reference	Description	Manufacturer	Part Number
1	C1	Cap. ceramic 0.1 µF 50V X7R 10% 0603	TDK Corporation	C1608X7R1H104K
2	C2,C3	Cap. ceramic 10 µF 100V X7S 2220	TDK Corporation	C5750X7S2A106M230KB
2	C4, C5	Cap. ceramic 10 µF 50V X7S 1210	TDK Corporation	C3225X7S1H106M
1	D1	Diode switch 75V 150 mA SOD323	Micro Commercial Components Corp.	1N4148WX-TP
1	D2	Diode Schottky 100V 1A SMB	ON Semiconductor®	MBRS1100T3G
4	J1, J2, J3, J4	PC test point tin SMD	Harwin Plc.	S1751-46R
1	L1	Choke, SMD, 15 µH	Wurth Elektronik Group	7447779115
1	R1	Res. 0.0 Ω 1/4W jump 1206 SMD	Panasonic® ECG	ERJ-8GEY0R00V
1	RB	Res. 10 kΩ 1/10W 1% 0603 SMD	Panasonic ECG	ERJ-3EKF1002V
1	REN	Res. 1 MΩ 1/10W 1% 0603 SMD	Panasonic ECG	ERJ-3EKF1004V
1	RT1	Res. 52.3 kΩ 1/10W 1% 0603 SMD	Panasonic ECG	ERA-3AEB5232V
1	RT2	Res. 80.6 kΩ 1/10W 1% 0603 SMD	Panasonic ECG	ERJ-3EKF80R6V
2	SW1, SW2	2.54 mm SW_SMD_DIP	Wurth® Group	418121270801
1	U1	High-Voltage Input Buck Converter	Microchip Technology Inc.	**MCP16331T-E/CH**

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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