MCP16311/2 Synchronous Buck Converter Evaluation Board User's Guide

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Derek Carlson
VP Development Tools

16-July-2013
Date

NOTES:

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MCP16311/2 SYNCHRONOUS 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 "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 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 MCP16311/2 Synchronous 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 MCP16311/2 Synchronous Buck Converter Evaluation Board as a development tool. The manual layout is as follows:

- **Chapter 1. "Product Overview"** – Important information about the MCP16311/2 Synchronous 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 MCP16311/2 Synchronous Buck Converter Evaluation Board.
- **Appendix B. "Bill of Materials (BOM)"** – Lists the parts used to build the MCP16311/2 Synchronous Buck Converter Evaluation Board.

CONVENTIONS USED IN THIS GUIDE

This manual uses the following documentation conventions:

DOCUMENTATION CONVENTIONS

<table>
<tr><th>Description</th><th>Represents</th><th>Examples</th></tr>
<tr><td colspan="3">Arial font:</td></tr>
<tr><td rowspan="2">Italic characters</td><td>Referenced books</td><td>MPLAB® IDE User’s Guide</td></tr>
<tr><td>Emphasized text</td><td>...is the only compiler...</td></tr>
<tr><td rowspan="3">Initial caps</td><td>A window</td><td>the Output window</td></tr>
<tr><td>A dialog</td><td>the Settings dialog</td></tr>
<tr><td>A menu selection</td><td>select Enable Programmer</td></tr>
<tr><td>Quotes</td><td>A field name in a window or dialog</td><td>“Save project before build”</td></tr>
<tr><td>Underlined, italic text with right angle bracket</td><td>A menu path</td><td><u>File>Save</u></td></tr>
<tr><td rowspan="2">Bold characters</td><td>A dialog button</td><td>Click OK</td></tr>
<tr><td>A tab</td><td>Click the Power tab</td></tr>
<tr><td>N‘Rnnnn</td><td>A number in verilog format, where N is the total number of digits, R is the radix and n is a digit.</td><td>4‘b0010, 2‘hF1</td></tr>
<tr><td>Text in angle brackets < ></td><td>A key on the keyboard</td><td>Press <Enter>, <F1></td></tr>
<tr><td colspan="3">Courier New font:</td></tr>
<tr><td rowspan="7">Plain Courier New</td><td>Sample source code</td><td><code>#define START</code></td></tr>
<tr><td>Filenames</td><td><code>autoexec.bat</code></td></tr>
<tr><td>File paths</td><td><code>c:\mcc18\h</code></td></tr>
<tr><td>Keywords</td><td><code>_asm, _endasm, static</code></td></tr>
<tr><td>Command-line options</td><td><code>-Opa+, -Opa-</code></td></tr>
<tr><td>Bit values</td><td><code>0, 1</code></td></tr>
<tr><td>Constants</td><td><code>0xFF, ‘A’</code></td></tr>
<tr><td>Italic Courier New</td><td>A variable argument</td><td><code>file</code><code>.o</code>, where <code>file</code> can be any valid filename</td></tr>
<tr><td>Square brackets [ ]</td><td>Optional arguments</td><td><code>mcc18 [options] file [options]</code></td></tr>
<tr><td>Curly brackets and pipe character: { | }</td><td>Choice of mutually exclusive arguments; an OR selection</td><td><code>errorlevel {0|1}</code></td></tr>
<tr><td rowspan="2">Ellipses...</td><td>Replaces repeated text</td><td><code>var_name [, var_name...]</code></td></tr>
<tr><td>Represents code supplied by user</td><td><code>void main (void)
{ ...
}</code></td></tr>
</table>

RECOMMENDED READING

This user's guide describes how to use the MCP16311/2 Synchronous Buck Converter Evaluation Board. Another useful document is listed below. The following Microchip document is available and recommended as a supplemental reference resource.

- **MCP16311/2 Data Sheet – *"30V Input, 1A Output, High-Efficiency, Integrated Synchronous Switch Step-Down Regulator"* (DS20005254)**

This data sheet provides detailed information regarding the MCP16311/2 device.

THE MICROCHIP WEB SITE

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Technical support is available through the web site at:
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DOCUMENT REVISION HISTORY

Revision A (December 2013)

- Initial Release of this Document.

NOTES:

Chapter 1. Product Overview

1.1 INTRODUCTION

The MCP16311/2 is a compact, high-efficiency, fixed-frequency, step-down DC-DC converter. The integrated features include a high-side and a low-side switch, fixed frequency, internal compensation, peak current limit and overtemperature protection. This product provides an easy-to-use power supply solution, with a minimum number of external components.

The MCP16311 automatically selects the best operating mode for efficiency, Pulse-Width Modulation (PWM) or Pulse Frequency Modulation (PFM), while the MCP16312 is a PWM-only device. The MCP16311/2 family of devices have a wide input voltage range (4V to 30V) and a wide output voltage range (2V – 15V). An integrated, precise 0.8V reference, combined with an external resistor divider, sets the desired converter output voltage. The internal reference voltage is controlled during start-up, minimizing the output voltage overshoot and the inrush current.

The device is available in 8LD MSOP and 2 x 3 mm TDFN packages.

The scope of this evaluation board is to demonstrate the features of the MCP16311/2.

This chapter provides an overview of the MCP16311/2 Synchronous Buck Converter Evaluation Board and covers the following topics:

- What is the MCP16311/2 Synchronous Buck Converter Evaluation Board?
- What the MCP16311/2 Synchronous Buck Converter Evaluation Board Contains

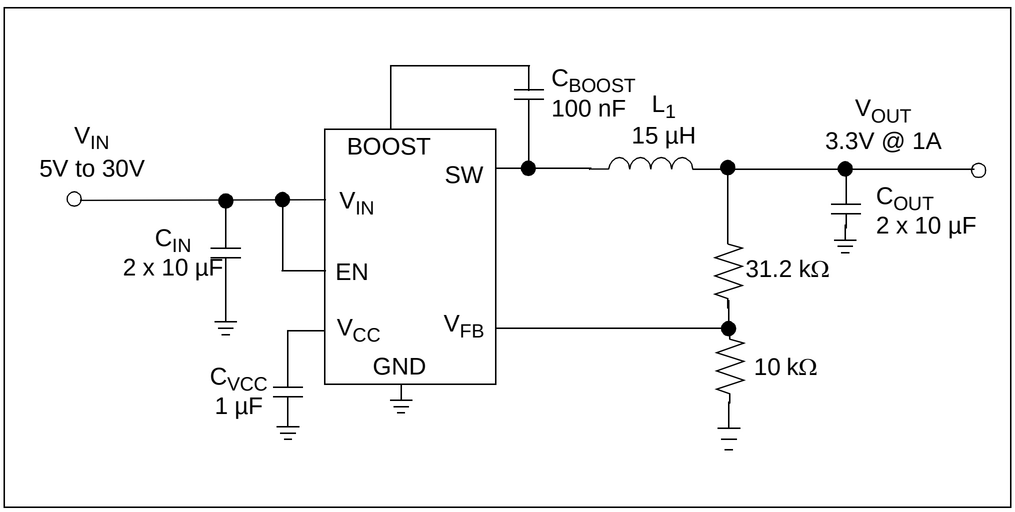


FIGURE 1-1: *Typical MCP16311/2 Buck Converter Application.*

1.2 WHAT IS THE MCP16311/2 SYNCHRONOUS BUCK CONVERTER EVALUATION BOARD?

The MCP16311/2 Synchronous Buck Converter Evaluation Board is used to evaluate and demonstrate Microchip Technology's MCP16311/2 product. This board demonstrates the MCP16311 (PFM/PWM – low quiescent current) and the MCP16312 (PWM only – low output voltage ripple) in two buck converter applications with two output voltages. It can be used to evaluate both package options, 8LD MSOP and 8LD 2 x 3 TDFN. The MCP16311/2 Synchronous Buck Converter Evaluation Board was developed to help engineers reduce the product design cycle time.

Two common output voltages can be selected: 3.3V and 5.0V. The first converter with the 8LD MSOP package is a PWM/PFM device with a fixed output of 3.3V, while the second converter with the 2 x 3 8LD TDFN package is a PWM-only device, with a fixed output of 5V.

1.3 WHAT THE MCP16311/2 SYNCHRONOUS BUCK CONVERTER EVALUATION BOARD CONTAINS

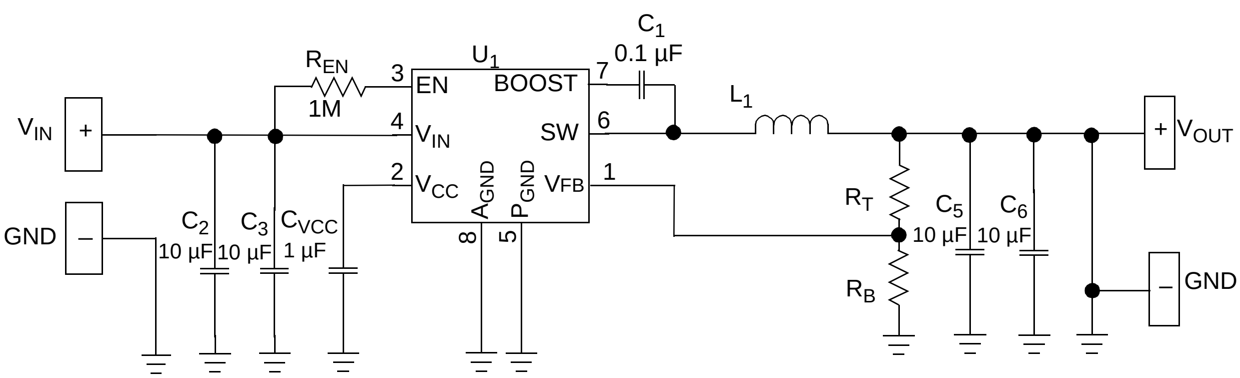
The MCP16311/2 Synchronous Buck Converter Evaluation Board kit includes:

- MCP16311/2 Synchronous Buck Converter Evaluation Board (ADM00467)
- Important Information Sheet

Chapter 2. Installation and Operation

2.1 INTRODUCTION

The MCP16311/2 device is capable of regulating the output voltage over a wide 2V to 15V range, and typically can deliver over 1A of load current at 3.3V output when supplied from a 12V input. The input voltage range is 4V to 30V. The regulated output voltage (V_{OUT}) should be lower than the input voltage (V_{IN}).



Note: Calculate RT resistors for a particular V_{OUT} as:

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

V_{FB} = 0.8V (for **MCP16311/2**)

For the inductor value, see Table 2-1.

FIGURE 2-1: *MCP16311/2 Synchronous Buck Typical Application.*

The MCP16311/2 Synchronous Buck Converter Evaluation Board offers both package types in two buck-converter applications for 3.3V and 5.0V output voltage options. The output voltage can be modified by changing the resistors in the feedback loop based on the formula in Figure 2-1.

2.2 BOARD FEATURES

The MCP16311/2 Synchronous Buck Converter Evaluation Board has the following features:

- Input Voltage Range (V_{IN}): 4V to 30V
- Fixed Output Voltage: 3.3V and 5.0V
- Output Current: typically 1A @ 3.3V Output, 12V Input
- Automatic PFM/PWM Operation for MCP16311, or PWM-only for MCP16312
- 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 MCP16311/2 Synchronous Buck Converter Evaluation Board is fully assembled and tested to evaluate and demonstrate the MCP16311/2 products. This board requires the use of external lab supplies and load.

2.3.1 Power Input and Output Connection

2.3.1.1 POWERING THE MCP16311/2 SYNCHRONOUS BUCK CONVERTER EVALUATION BOARD

The evaluation board has two independent circuit applications. One uses the MCP16311 in the 8LD MSOP package, the other uses the MCP16312 device in the 8LD TDFN package. The 8LD MSOP package has an output voltage setting of 3.3V. The 8LD TDFN package has an output voltage setting of 5.0V.

The switch peak current limit will provide a safe maximum current value. The maximum output current for the converters will vary with input and output voltages. Refer to the MCP16311/2 data sheet for more information on the maximum output current.

2.3.1.2 BOARD POWER-UP PROCEDURE

1. Connect power supply at input. Input voltage should be higher than V_{OUT}. Connect system load to V_{OUT} and GND terminals; maximum load varies with input and output voltage (see the MCP16311/2 data sheet for more information on the maximum load). Connect the (+) side of the load to V_{OUT} and the (–) load to GND terminals.
2. By default, the EN pin is pulled high through a resistor, so the converter is enabled and V_{OUT} can be measured between V_{OUT} and GND terminals. When EN is pulled low, the converter is disabled and V_{OUT} is floating and disconnected from the input.
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.

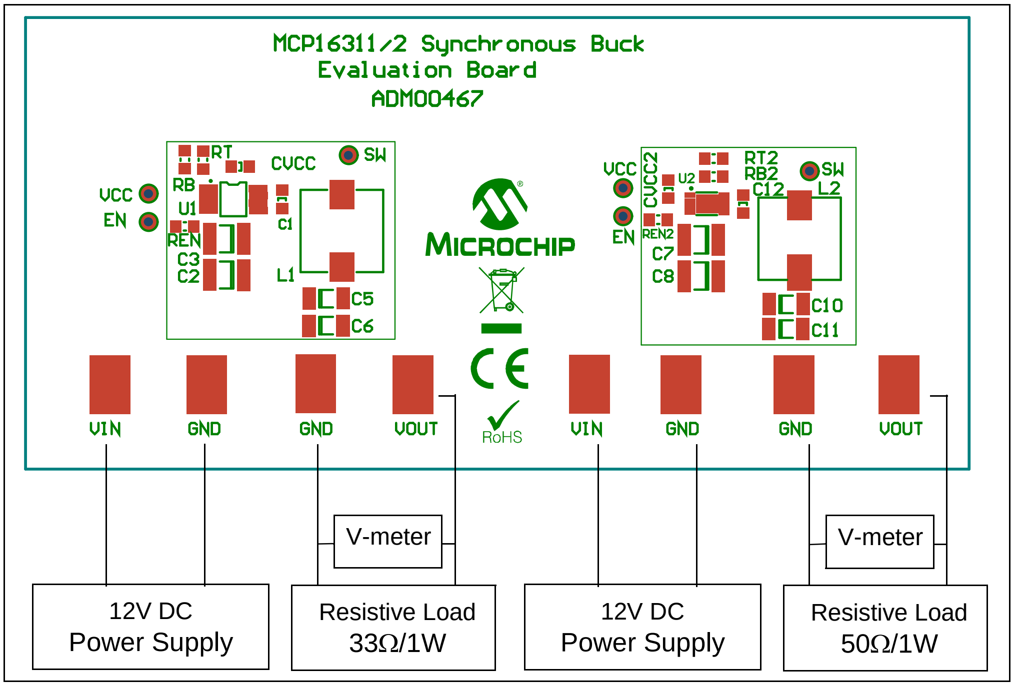


FIGURE 2-2: *MCP16311/2 Synchronous Buck Converter Evaluation Board Setup.*

2.3.1.3 ADJUSTABLE V_{OUT} SETTING

The resistor divider RT and RB are used to set the converter output voltage. If the output voltage is modified by changing the feedback resistors, the inductor should also be changed. Check Table 2-1 for the value of the inductor or the MCP16311/2 data sheet for more information. The output voltage can be calculated using the following equation:

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

Where:
$V_{FB} = 0.8V$

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

NOTES:

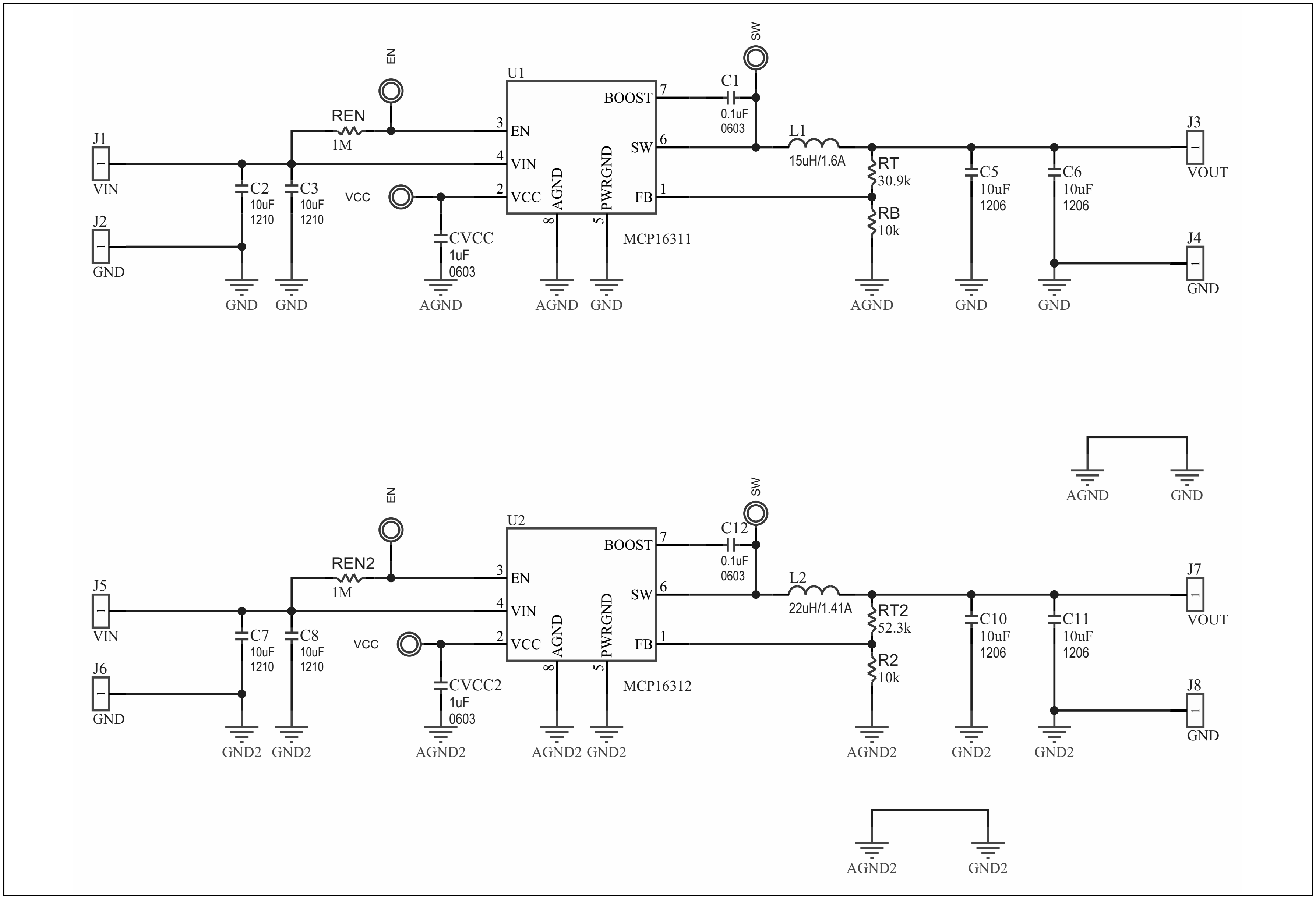
Appendix A. Schematic and Layouts

A.1 INTRODUCTION

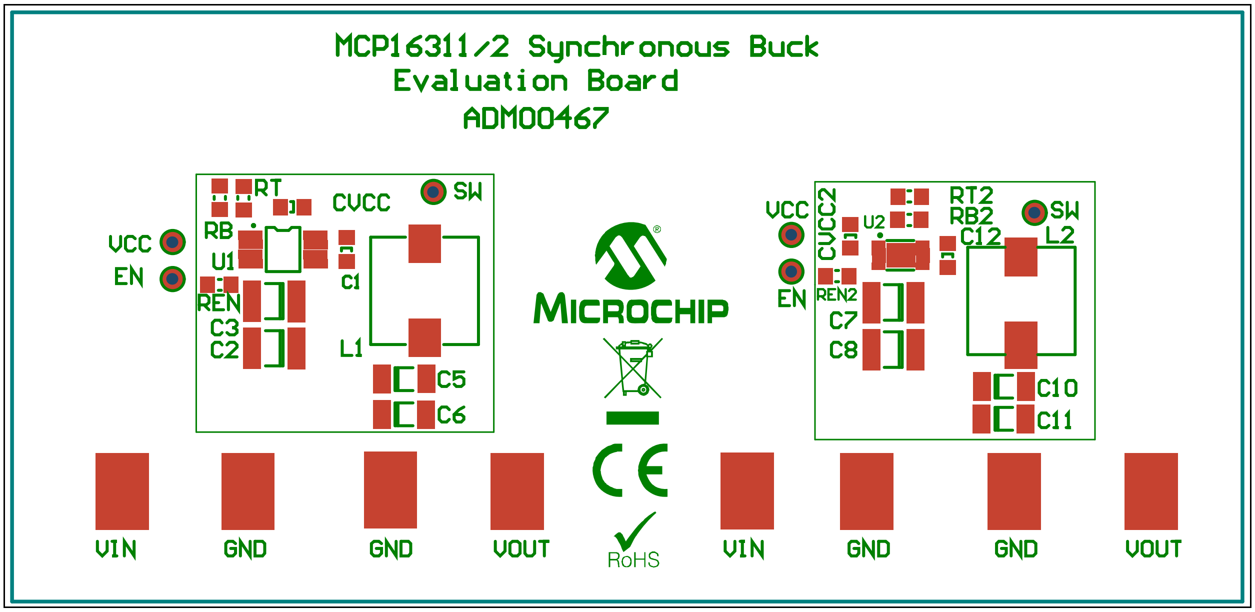
This appendix contains the following schematics and layouts for the MCP16311/2 Synchronous Buck Converter Evaluation Board:

- Board – Schematic
- Board – Top Silk
- Board – Top Copper
- Board – Top Copper and Silk
- Board – Bottom Copper

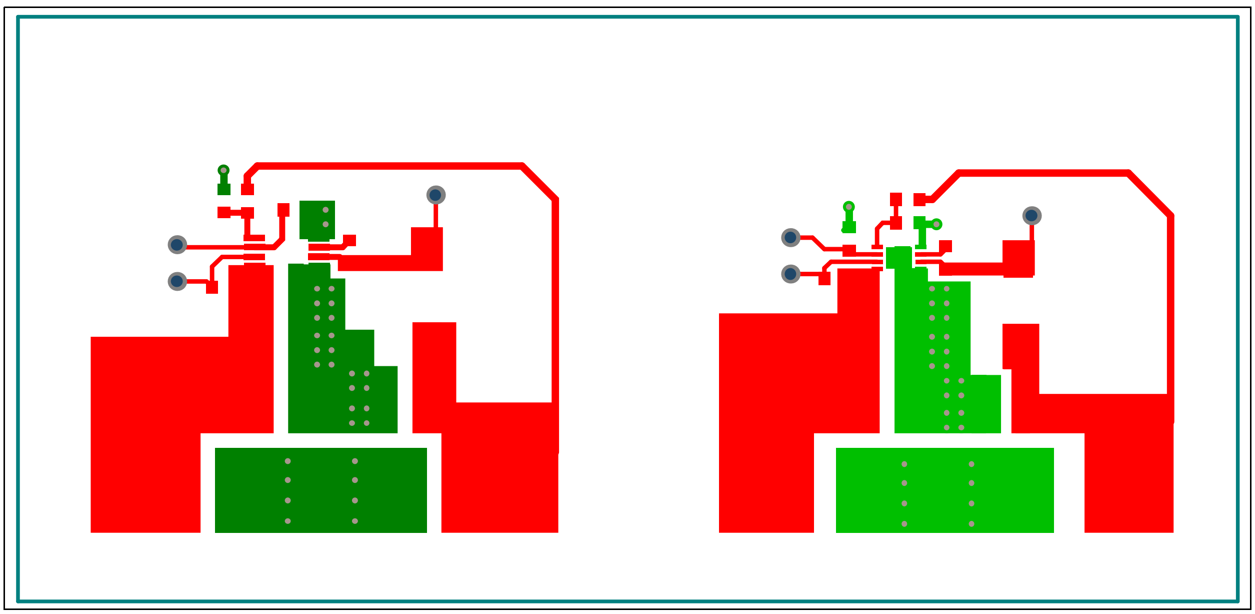
A.2 BOARD – SCHEMATIC



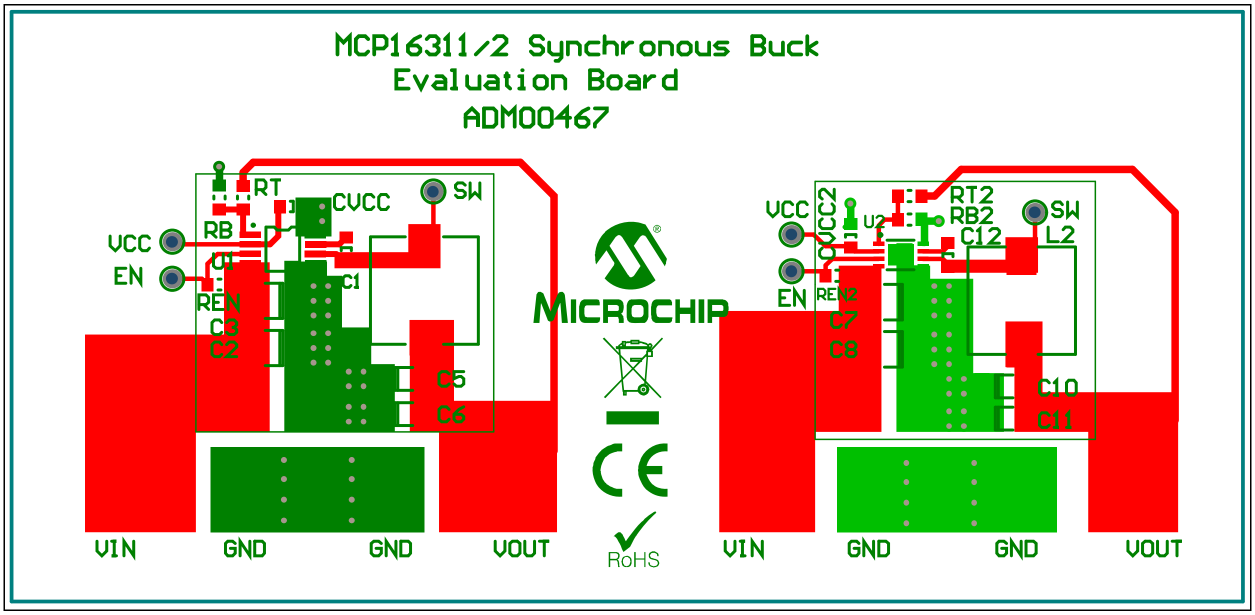
A.3 BOARD – TOP SILK



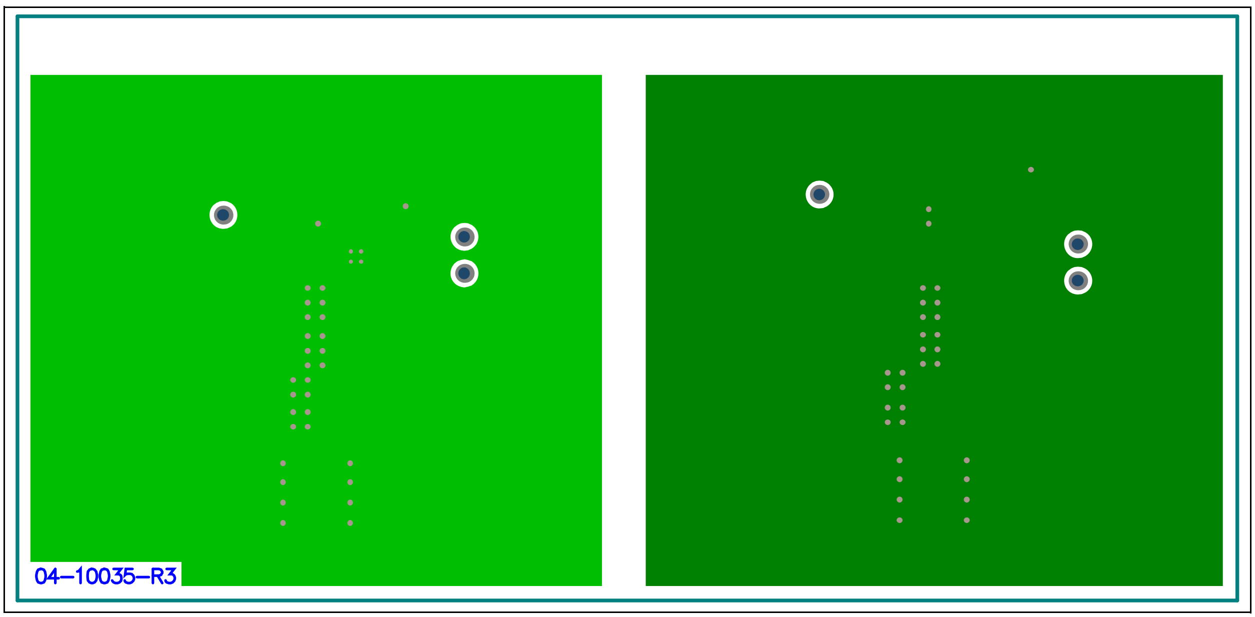
A.4 BOARD – TOP COPPER



A.5 BOARD – TOP COPPER AND SILK



A.6 BOARD – BOTTOM COPPER



Appendix B. Bill of Materials (BOM)

TABLE B-1: BILL OF MATERIALS (BOM)

Qty	Reference	Description	Manufacturer	Part Number
2	C1, C12	CAP CER 0.1 µF 50V X7R 10% 0603	TDK Corporation	C1608X7R1H104K
4	C2, C3, C7, C8	CAP CER 10 µF 50V X7S 1210	TDK Corporation	C3225X7S1H106M
4	C5, C6, C10, C11	CAPACITOR, 1206, X7R, 16V, 10 µF	TDK Corporation	C3216X7R1C106K
2	CVCC, CVCC2	CAP CER 1 µF 16V 10% X7R 0603	TDK Corporation	C1608X7R1C105K
8	J1, J2, J3, J4, J5, J6, J7, J8	PC TEST POINT TIN SMD	Harwin Plc.	S1751-46R
1	L1	CHOKE, SMD, 15 µH	Wurth Group	7447779115
1	L2	CHOKE, SMD, 22 µH	Wurth Group	7447779122
1	PCB	Printed Circuit Board – MCP16311/2 Synchronous Buck Converter Evaluation Board	—	104-00467
2	RB, RB2	RES 10k Ohm 1/10W 1% 0603 SMD	Panasonic® – ECG	ERJ-3EKF1002V
2	REN, REN2	RES 1M Ohm 1/10W 5% 0603 SMD	Panasonic – ECG	ERJ-3GEYJ105V
1	RT	RESISTOR, 0603 30K9	Multicomp®	MC 0.063W 0603 1% 30K9
1	RT2	RES 52.3k OHM 1/10W 1% 0603 SMD	Panasonic – ECG	ERJ-3EKF5232V
1	U1	30V SYNCHRONOUS BUCK VOLTAGE REGULATOR	Microchip Technology Inc.	**MCP16311-E/MS**
1	U2	30V SYNCHRONOUS BUCK VOLTAGE REGULATOR	Microchip Technology Inc.	**MCP16312T-E/MNY**

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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