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

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**Object of Declaration: MCP16311/2 Synchronous Buck Converter Evaluation Board  
User's Guide**

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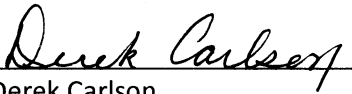
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Derek Carlson

VP Development Tools

16-July-2013

Date

NOTES:



# MCP16311/2 SYNCHRONOUS BUCK CONVERTER EVALUATION BOARD USER'S GUIDE

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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](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 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

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 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.

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- Field Application Engineer (FAE)
- Technical Support

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

## 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.

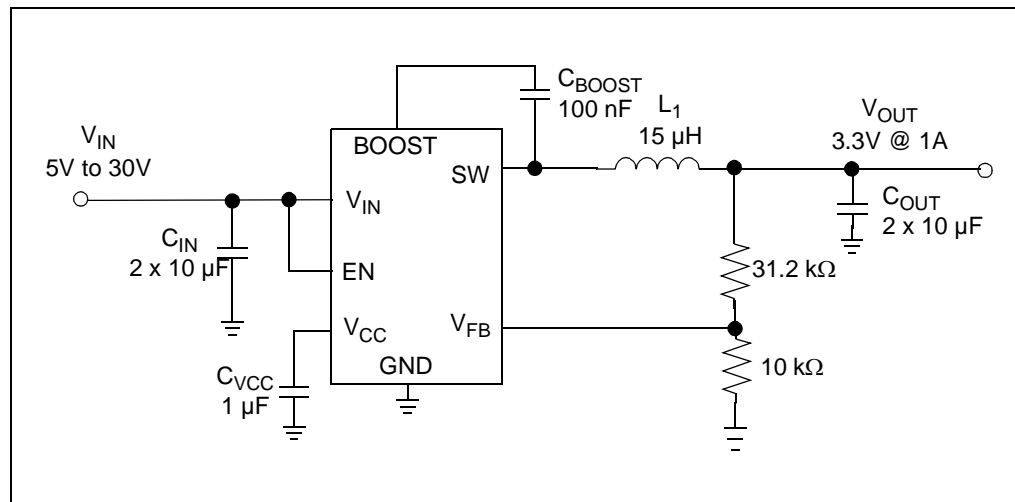
The MCP16311 automatically selects the best operating mode for efficiency, Pulse-Width Modulation (PWM) or Pulse Frequency Modulation (PFM), while the MCP16312 is a PWM-only device. The MCP16311/2 family of devices have a wide input voltage range (4V to 30V) and a wide output voltage range (2V – 15V). 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

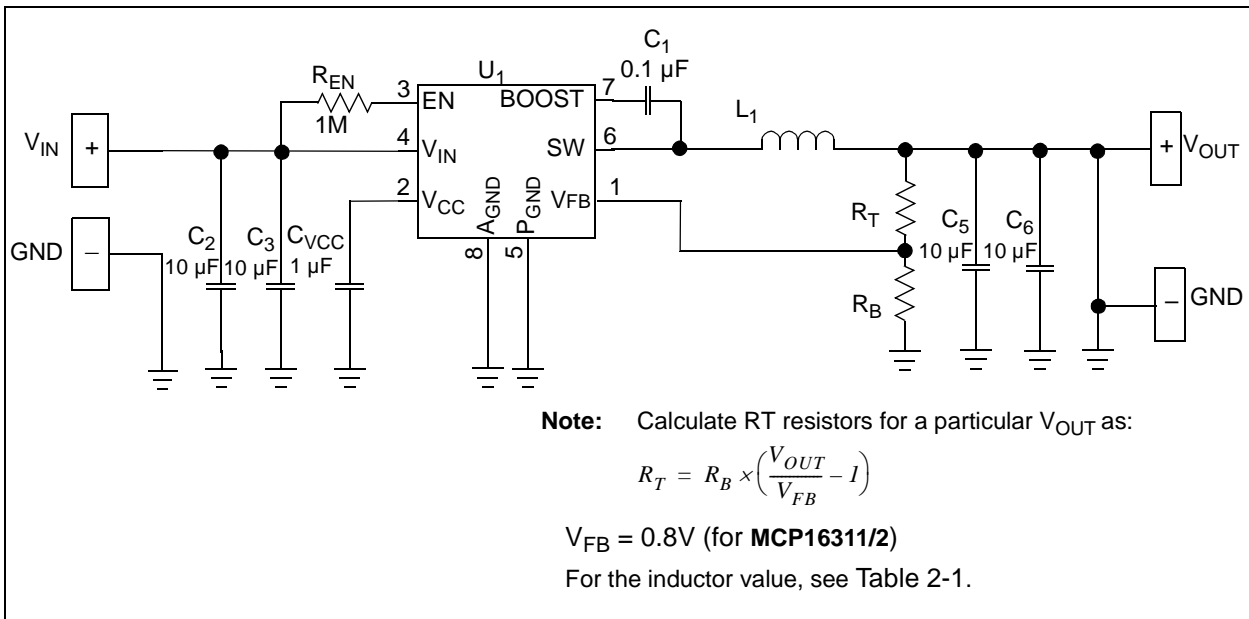
The MCP16311/2 Synchronous Buck Converter Evaluation Board kit includes:

- 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 ( $V_{IN}$ ).



**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

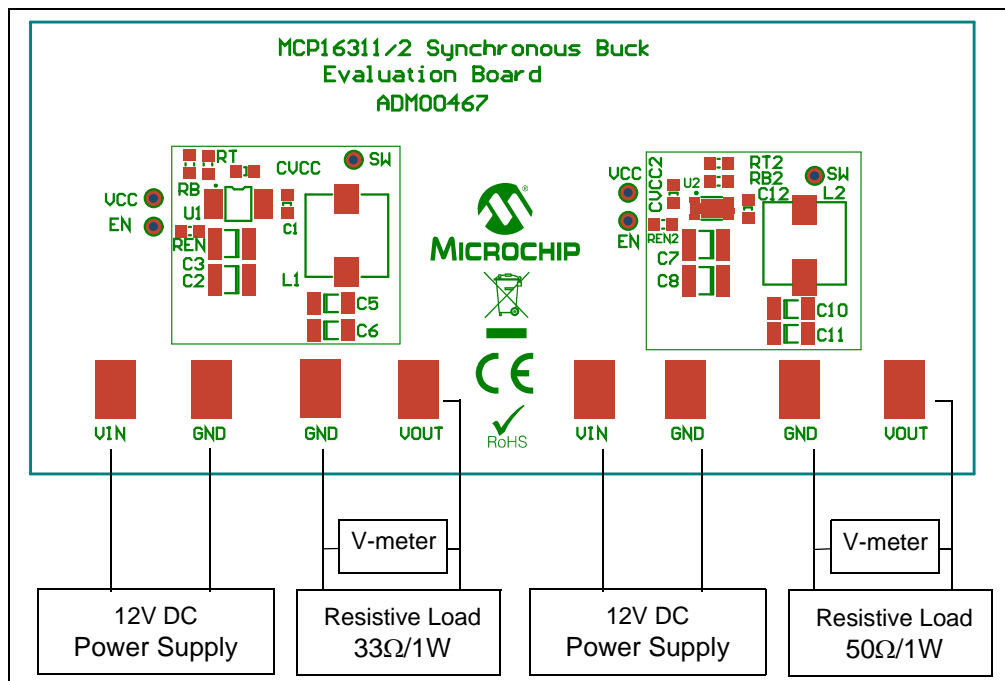
#### 2.3.1.1 POWERING THE MCP16311/2 SYNCHRONOUS BUCK CONVERTER EVALUATION BOARD

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 $\mu H$
3.3V	15 $\mu H$
5.0V	22 $\mu H$
12V	56 $\mu H$
15V	68 $\mu H$

NOTES:





# MCP16311/2 SYNCHRONOUS BUCK CONVERTER EVALUATION BOARD USER'S GUIDE

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## Appendix A. Schematic and Layouts

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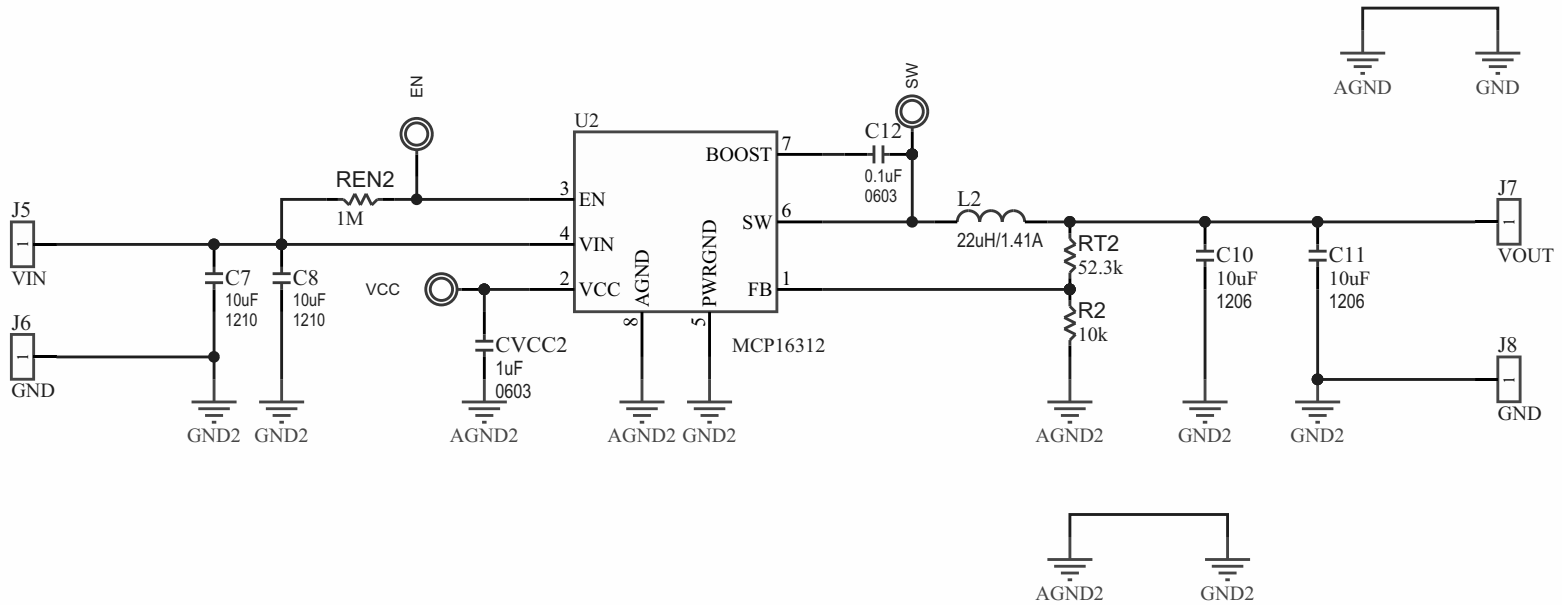
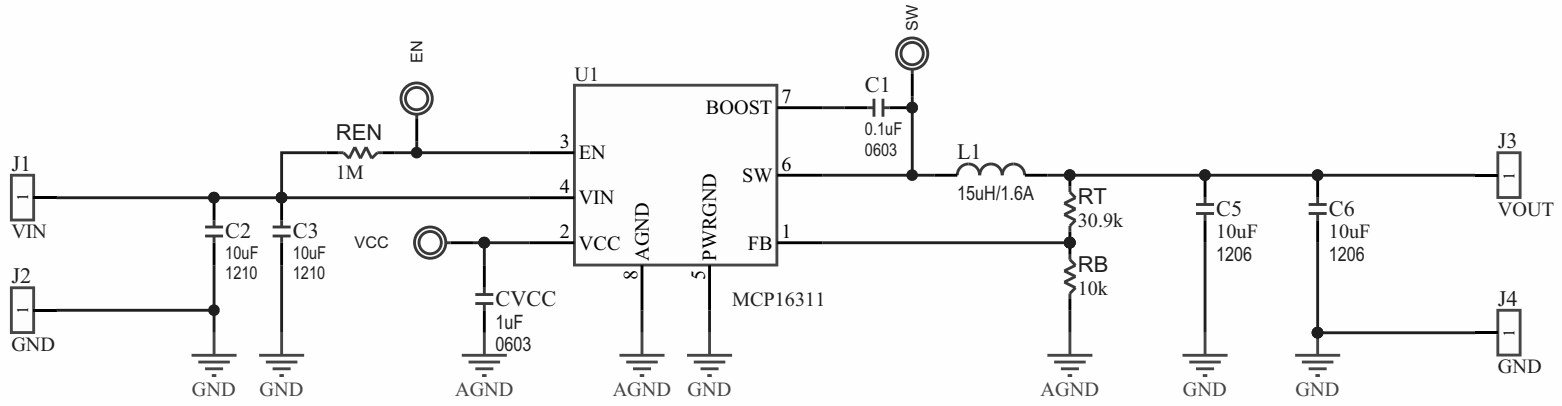
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### A.1 INTRODUCTION

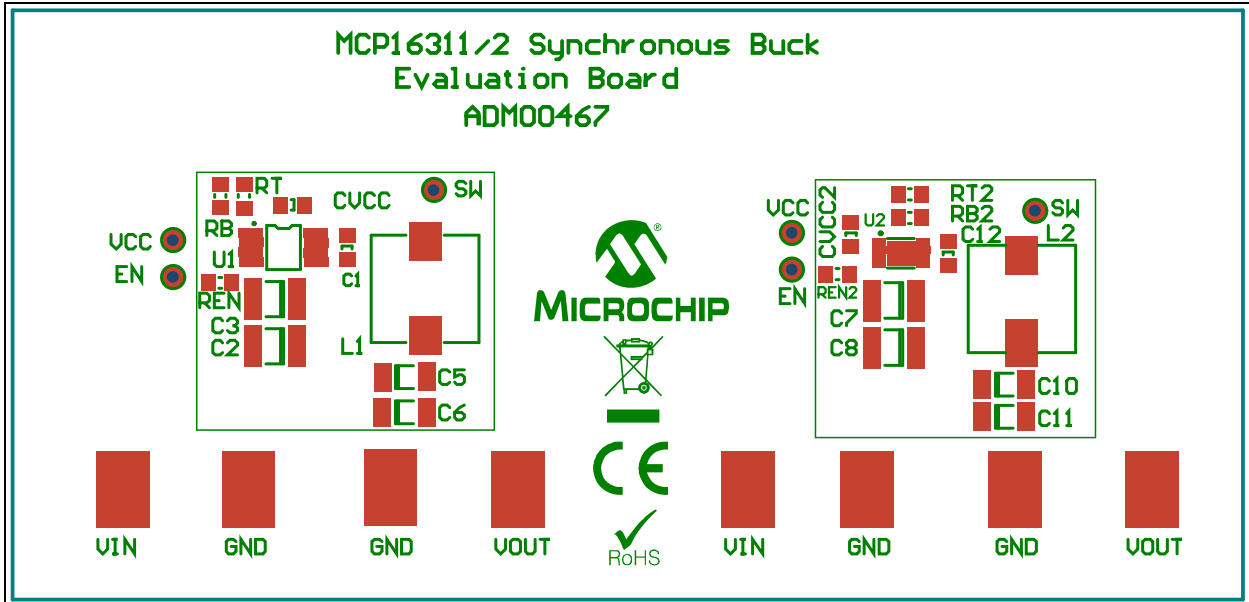
This appendix contains the following schematics and layouts for the MCP16311/2 Synchronous Buck Converter Evaluation Board:

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

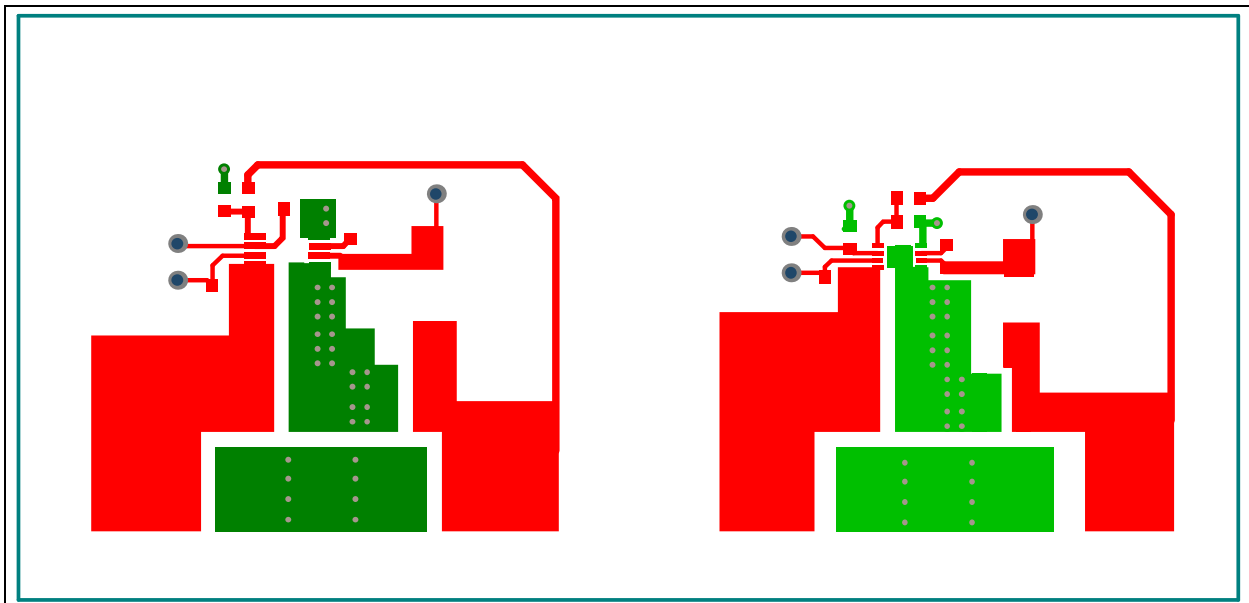
## A.2 BOARD – SCHEMATIC



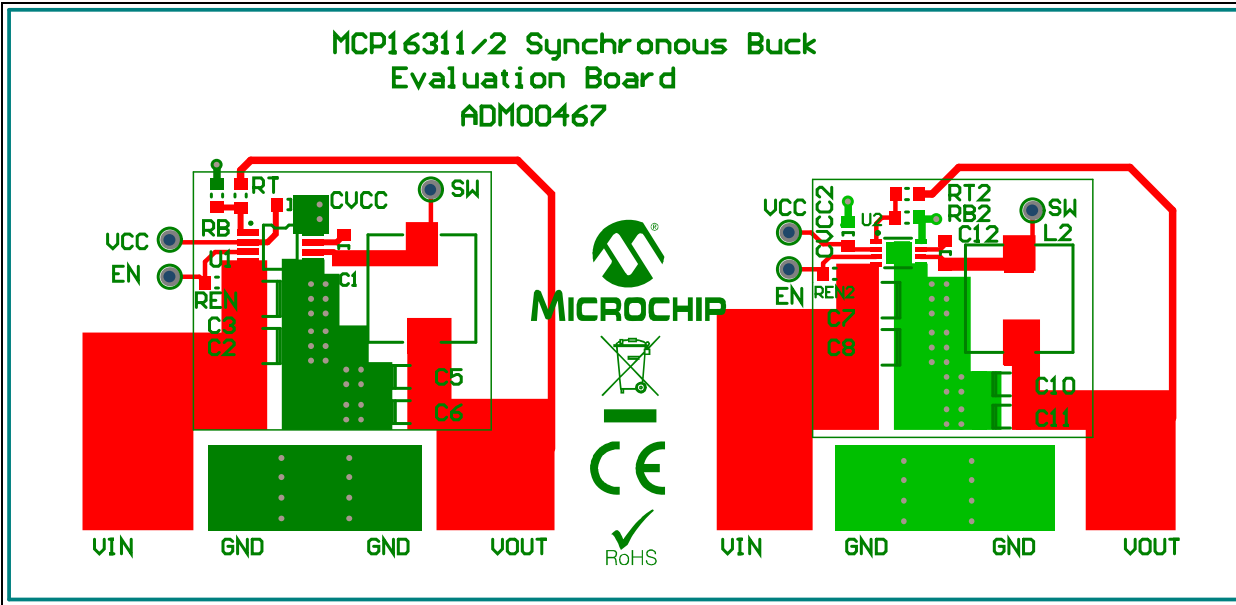
## A.3 BOARD – TOP SILK



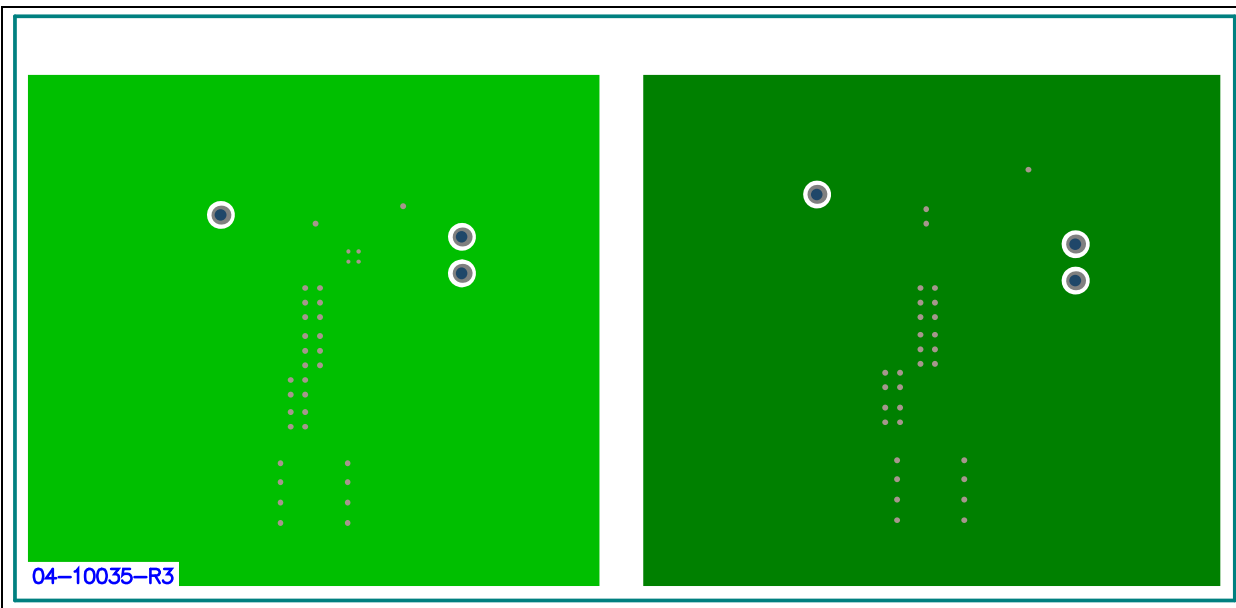
## A.4 BOARD – TOP COPPER



A.5 BOARD – TOP COPPER AND SILK



A.6 BOARD – BOTTOM COPPER





# MCP16311/2 SYNCHRONOUS BUCK CONVERTER EVALUATION BOARD USER'S GUIDE

## 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 $\mu$ F 50V X7R 10% 0603	TDK Corporation	C1608X7R1H104K
4	C2, C3, C7, C8	CAP CER 10 $\mu$ F 50V X7S 1210	TDK Corporation	C3225X7S1H106M
4	C5, C6, C10, C11	CAPACITOR, 1206, X7R, 16V, 10 $\mu$ F	TDK Corporation	C3216X7R1C106K
2	CVCC, CVCC2	CAP CER 1 $\mu$ F 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 $\mu$ H	Würth Group	7447779115
1	L2	CHOKE, SMD, 22 $\mu$ H	Würth 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.	<b>MCP16311-E/MS</b>
1	U2	30V SYNCHRONOUS BUCK VOLTAGE REGULATOR	Microchip Technology Inc.	<b>MCP16312T-E/MNY</b>

**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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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

#### France - Paris

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

#### Germany - Dusseldorf

Tel: 49-2129-3766400

#### Germany - Munich

Tel: 49-89-627-144-0  
Fax: 49-89-627-144-44

#### Germany - Pforzheim

Tel: 49-7231-424750

#### Italy - Milan

Tel: 39-0331-742611  
Fax: 39-0331-466781

#### Italy - Venice

Tel: 39-049-7625286

#### Netherlands - Drunen

Tel: 31-416-690399  
Fax: 31-416-690340

#### Poland - Warsaw

Tel: 48-22-3325737

#### Spain - Madrid

Tel: 34-91-708-08-90  
Fax: 34-91-708-08-91

#### Sweden - Stockholm

Tel: 46-8-5090-4654

#### UK - Wokingham

Tel: 44-118-921-5800  
Fax: 44-118-921-5820

10/28/13



Компания «ЭлектроПласт» предлагает заключение долгосрочных отношений при поставках импортных электронных компонентов на взаимовыгодных условиях!

Наши преимущества:

- Оперативные поставки широкого спектра электронных компонентов отечественного и импортного производства напрямую от производителей и с крупнейших мировых складов;
- Поставка более 17-ти миллионов наименований электронных компонентов;
- Поставка сложных, дефицитных, либо снятых с производства позиций;
- Оперативные сроки поставки под заказ (от 5 рабочих дней);
- Экспресс доставка в любую точку России;
- Техническая поддержка проекта, помощь в подборе аналогов, поставка прототипов;
- Система менеджмента качества сертифицирована по Международному стандарту ISO 9001;
- Лицензия ФСБ на осуществление работ с использованием сведений, составляющих государственную тайну;
- Поставка специализированных компонентов (Xilinx, Altera, Analog Devices, Intersil, Interpoint, Microsemi, Aeroflex, Peregrine, Syfer, Eurofarad, Texas Instrument, Miteq, Cobham, E2V, MA-COM, Hittite, Mini-Circuits, General Dynamics и др.);

Помимо этого, одним из направлений компании «ЭлектроПласт» является направление «Источники питания». Мы предлагаем Вам помощь Конструкторского отдела:

- Подбор оптимального решения, техническое обоснование при выборе компонента;
- Подбор аналогов;
- Консультации по применению компонента;
- Поставка образцов и прототипов;
- Техническая поддержка проекта;
- Защита от снятия компонента с производства.



#### Как с нами связаться

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**Факс:** 8 (812) 320-02-42

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