MCP16251 and MCP1640B Synchronous Boost Converters Evaluation Board User's Guide

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

Derek Carlson
VP Development Tools

02-May-12
Date

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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 MCP16251 and MCP1640B Synchronous Boost Converters 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 MCP16251 and MCP1640B Synchronous Boost Converters Evaluation Board as a development tool. The manual layout is as follows:

- **Chapter 1. "Product Overview"** – Important information about the MCP16251 and MCP1640B Synchronous Boost Converters Evaluation Board.
- **Chapter 2. "Installation and Operation"** – Includes instructions on how to get started with this user's guide and a description of the board.
- **Appendix A. "Schematic and Layouts"** – Shows the schematic and layout diagrams for the MCP16251 and MCP1640B Synchronous Boost Converters Evaluation Board.
- **Appendix B. "Bill of Materials (BOM)"** – Lists the parts used to build the MCP16251 and MCP1640B Synchronous Boost Converters 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 the MCP16251 and MCP1640B Synchronous Boost Converters Evaluation Board. Other useful documents are listed below. The following Microchip documents are available and recommended as supplemental reference resources.

- **MCP16251/2 Data Sheet – Low Quiescent Current, PFM/PWM Synchronous Boost Regulator with True Output Disconnect or Input/Output Bypass Option (DS25173)**

This data sheet provides detailed information regarding the MCP16251/2 device.

- **MCP1640/B/C/D Data Sheet – *"0.65V Start-up Synchronous Boost Regulator with True Output Disconnect or Input/Output Bypass Option"* (DS22234)**

This data sheet provides detailed information regarding the MCP1640B device.

- **MCP1623/24 Data Sheet – *"Low-Voltage Input Boost Regulator for PIC® Microcontrollers"* (DS41420)**

This data sheet provides detailed information regarding the MCP1623/4device.

- **AN1311 – *"Single Cell Input Boost Converter Design"* (DS01311)**

This application note details how to use the MCP1640 device in specific applications.

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

DOCUMENT REVISION HISTORY

Revision B (July 2013)

- Updated **Appendix B. "Bill of Materials (BOM)"**.

Revision A (April 2013)

- Initial Release of this Document.

Chapter 1. Product Overview

1.1 INTRODUCTION

The MCP16251 and MCP1640B devices are compact, high-efficiency, fixed frequency, step-up DC-DC converters. These products provide an easy-to-use power supply solution, with a minimum number of external components for applications powered by one-cell, two-cell, or three-cell alkaline, NiCd, NiMH, one-cell Li-Ion or Li-Polymer batteries.

The MCP16251 automatically selects the best operating mode for efficiency, pulse-width modulation (PWM) or pulse frequency (PFM). The device has a very low quiescent current 4 µA (not switching, measured at output), a wide input voltage range (0.35 to 5.5V) and a low start-up voltage (0.82V) at 1 mA load current.

The MCP1640B is a PWM-only controller, with a typical of 19 µA quiescent current (not switching, measured at output), a wide input voltage range (0.35V to 5.5V) and a start-up voltage of 0.65V at 1 mA load current.

The major differences between the two device families (MCP16251/2 and MCP1640/B/C/D) are the very low quiescent current for the MCP16251/2, and the voltage reference (1.21V for the MCP1640/B/C/D, 1.23V for the MCP16251/2, respectively).

The available package types for these devices are: SOT-23-6 and 2x3 mm (T)DFN-8.

The scope of this evaluation board is to demonstrate the low quiescent current for the PWM/PFM MCP16251 device, and the low-noise output for the MCP1640B PWM-only option.

This chapter provides an overview of the MCP16251 and MCP1640B Synchronous Boost Converters Evaluation Board, and covers the following topics:

- What is the MCP16251 and MCP1640B Synchronous Boost Converters Evaluation Board?
- What the MCP16251 and MCP1640B Synchronous Boost Converters Evaluation Board Contains

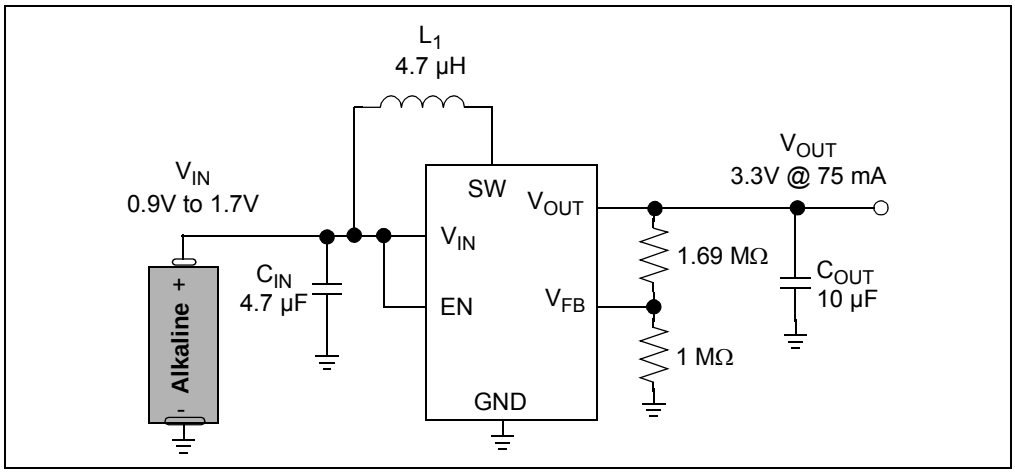


FIGURE 1-1: *Typical MCP16251 Boost Converter Single-Cell Battery Input.*

1.2 WHAT IS THE MCP16251 AND MCP1640B SYNCHRONOUS BOOST CONVERTERS EVALUATION BOARD?

The MCP16251 and MCP1640B Synchronous Boost Converters Evaluation Board is used to evaluate and demonstrate Microchip Technology's MCP16251 and MCP1640B products. This board demonstrates the MCP16251/MCP1640B in two boost-converter applications with multiple output voltages. It can be used to evaluate both package options (SOT-23-6 and 2x3 mm 8-(T)DFN). The MCP16251 and MCP1640B Synchronous Boost Converters Evaluation Board was developed to help engineers reduce the product design cycle time.

Three common output voltages can be selected: 2.0V, 3.3V and 5.0V. The output voltage can be changed with a mini-dip switch that changes the external resistor divider.

A switch connected to the EN pin is used to enable and disable the converters. When enabled, the MCP16251/MCP1640B will regulate the output voltage; when disabled, the MCP16251/MCP1640B disconnects the path from input to output for "true-disconnect".

1.3 WHAT THE MCP16251 AND MCP1640B SYNCHRONOUS BOOST CONVERTERS EVALUATION BOARD CONTAINS

This MCP16251 and MCP1640B Synchronous Boost Converters Evaluation Board kit includes:

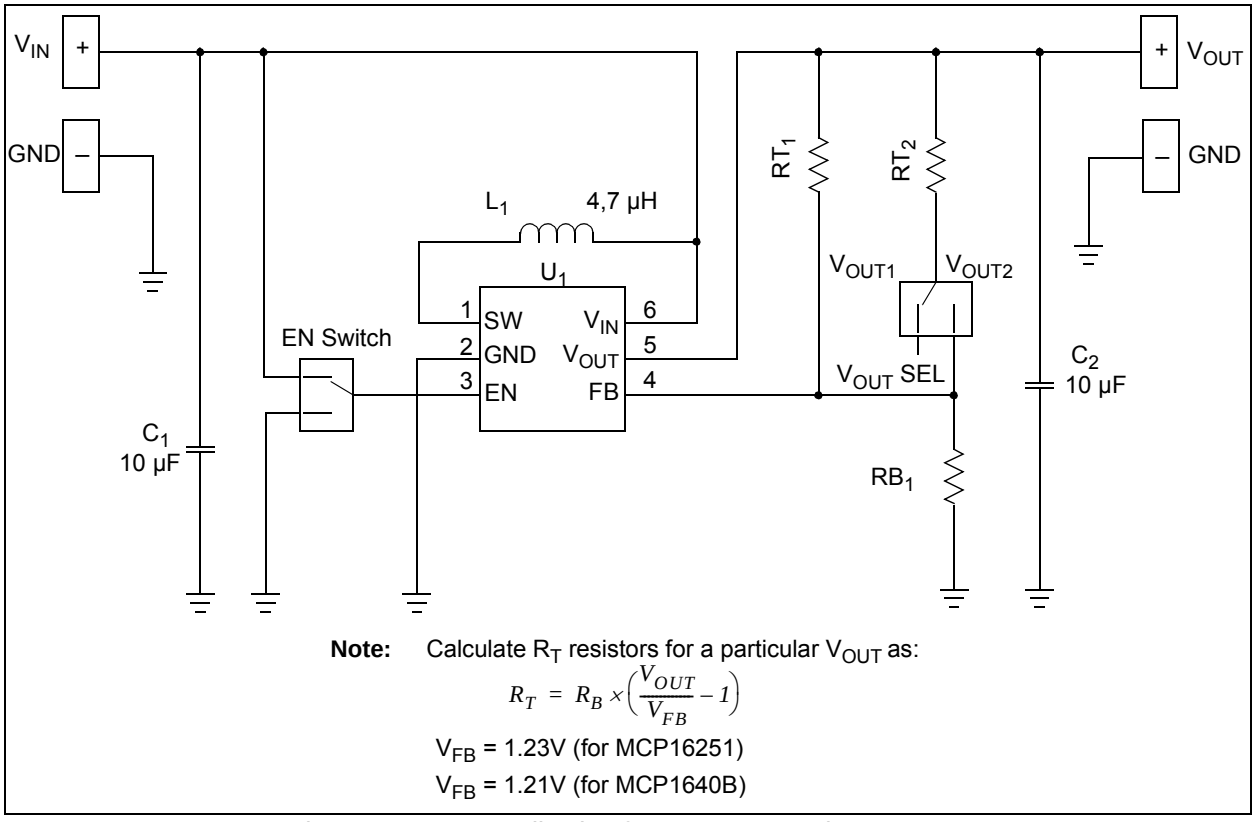
- MCP16251 and MCP1640B Synchronous Boost Converters Evaluation Board (ADM00458)
- Important information sheet

Chapter 2. Installation and Operation

2.1 INTRODUCTION

The MCP1640B is capable of regulating the output voltage over a wide 2.0V to 5.5V range, and typically can deliver over 100 mA of load current at 3.3V output when supplied from a single 1.2V cell. The input voltage range is 0.35V to 5.5V with a low 0.65V start-up voltage. The regulated output voltage (V_{OUT}) should be greater than or equal to the input voltage (V_{IN}). In particular, the MCP1640B is PWM-only with True Disconnect shutdown option.

The MCP16251 can regulate the output voltage over a 1.8V to 5.5V range, and can deliver a minimum of 75 mA of load current at 3.3V V_{OUT} when supplied from a one alkaline battery. Compared to the MCP1640B, the MCP16251 has both pulse-width modulation (PWM) and pulse frequency modulation (PFM) operating modes, and automatically selects the best operating mode for efficiency.



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

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

V_{FB} = 1.23V (for MCP16251)

V_{FB} = 1.21V (for MCP1640B)

FIGURE 2-1: *Synchronous Boost Application for SOT-23-6 package type.*

When disabled, the True Disconnect option removes the normal boost topology path from input to output by opening the diode path, using a P-Channel synchronous switch with a reversible body diode.

The MCP16251 and MCP1640B Synchronous Boost Converters Evaluation Board offers both package types in two boost-converter applications for 2.0V, 3.3V and 5.0V output voltage options that can be selected using a mini-dip switch. The enable input is controlled in both boost converter applications using a mini-dip switch.

2.2 BOARD FEATURES

The MCP16251 and MCP1640B Synchronous Boost Converters Evaluation Board has the following features:

- It can be powered by one-cell, two-cell, or three-cell alkaline, NiCd, NiMH, one-cell Li-Ion or Li-Polymer batteries
- Input voltage range (V_{IN}): 0.35V to 5.5V, with $V_{IN} \leq V_{OUT}$
- Fixed output voltage: 2.0V or 3.3V and 3.3V or 5.0V, selected using a mini-dip switch on board
- Output current: typical 125 mA @ 3.3V Output, 1.5V Input or 200 mA @ 5.0V Output, 3V Input
- Start-up voltage: 0.82V (for MCP16251's Converter) or 0.65V (for MCP1640B's Converter) at V_{OUT} = 3.3V and I_{OUT} = 1mA, resistive load
- Automatic PFM/PWM Operation for the MCP16251 Converter
- PWM Switching Frequency = 500 kHz
- Enable state, selectable using the mini-dip switch on board
- Peak Input Current Limit (800mA for MCP1640 or 650mA for MCP16251)
- Overtemperature Protection

2.3 GETTING STARTED

The MCP16251 and MCP1640B Synchronous Boost Converters Evaluation Board is fully assembled and tested to evaluate and demonstrate the MCP16251 and the MCP1640B 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 MCP16251 AND MCP1640B SYNCHRONOUS BOOST CONVERTERS EVALUATION BOARD

Soldered test points are available for input voltage connections. The maximum input voltage should not exceed 6.0V. The output voltage will not remain in regulation for input voltages that are greater than or equal to the output voltage.

The MCP16251 and MCP1640B Synchronous Boost Converters Evaluation Board has two independent circuit applications, one using the MCP16251 SOT-23-6 package, while the other uses the MCP1640B DFN-8 package. The SOT-23-6 package has two output voltage settings (2.0V and 3.3V) selectable by an on-board mini-dip switch. The DFN-8 package has two output voltage settings (3.3V and 5.0V), also selectable by an on-board mini-dip switch.

Soldered test points are available to connect a load. 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 MCP16251/2 and MCP1640/B/C/D data sheets for more information on the maximum output current.

2.3.1.2 BOARD POWER-UP PROCEDURE

1. Connect system load to V_{OUT} and GND terminals; maximum load varies with input and output voltage (see the MCP16251/2 and MCP1640/B/C/D data sheets for more information on the maximum load). Connect the (+) side of the load to V_{OUT} and the negative (-) load to ground (GND).
2. Set the desired output voltage using the V_{OUT} SEL mini-dip switch.
3. Turn the device ON/OFF using the EN mini-dip switch.
4. When EN is set ON or high, the converter is enabled and V_{OUT} can be measured on the V_{OUT} and GND terminals. When EN is low, the converter is disabled and V_{OUT} is floating, and disconnected from the input.

Capacitors C_3, C_4, C_6 and C_7 are not populated. The component pads are provided for experimental use.

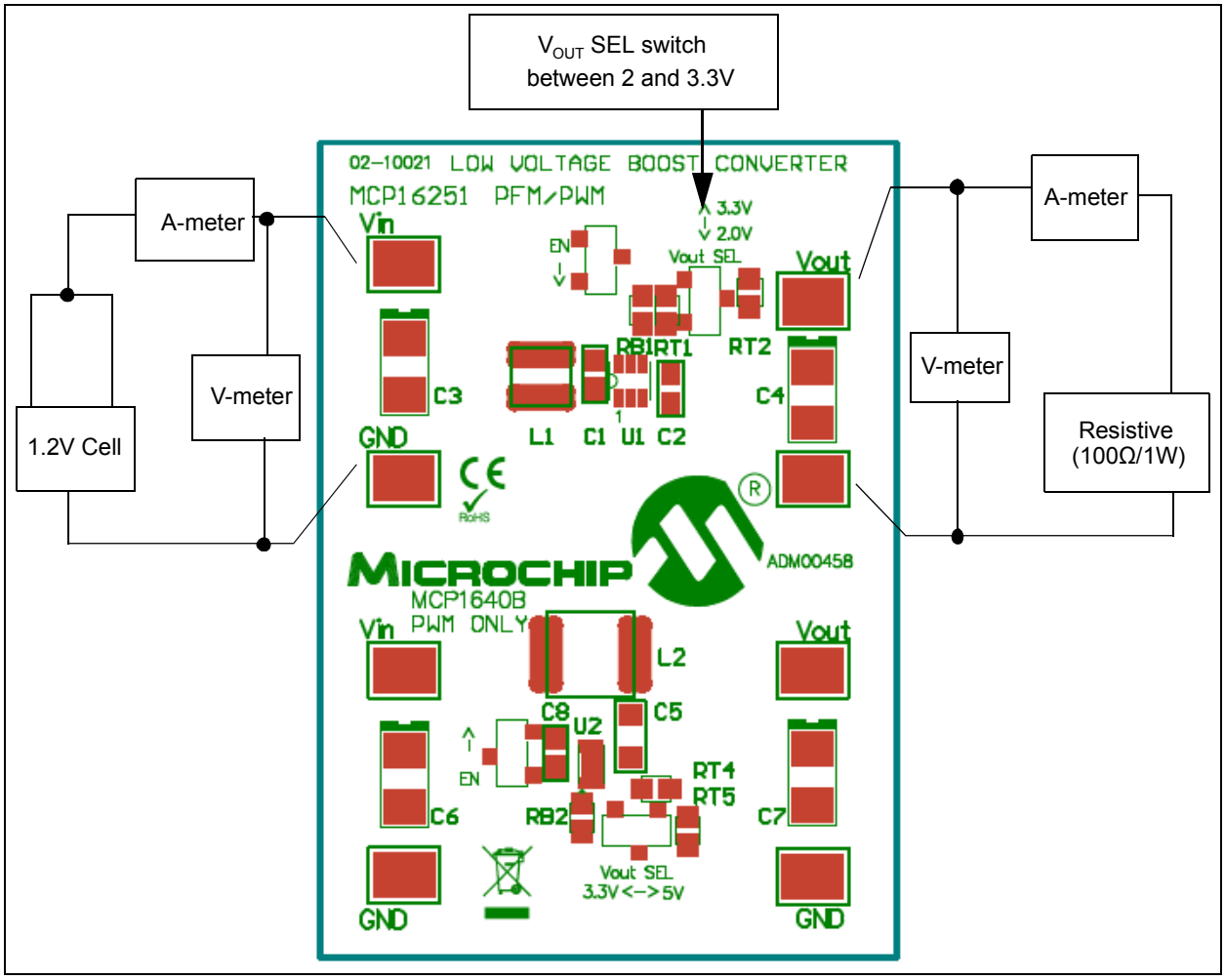


FIGURE 2-2: *MCP16251 and MCP1640B Synchronous Boost Converters Evaluation Board Setup.*

2.3.1.3 EN AND V_{OUT} SEL SWITCHES FUNCTION

Table 2-1 shows how the switches affect the functionality of the evaluation board.

TABLE 2-1: FUNCTION OF BOARD SWITCHES

State of Switches		V_{OUT} [V] for	
SW3 or SW4 EN Switch	**SW1 or SW2 V_{OUT} SEL Switch**	**MCP16251T-E/CH SOT-23-6 Converter**	**MCP1640BT-I/MC 2x3 mm DFN Converter**
ON	ON	2	3.3
ON	OFF	3.3	5
OFF	ON	0	0
OFF	OFF	0	0

Note that SW2 (V_{OUT} SEL) and SW4 (EN) are used for the SOT-23-6 circuit. Switches SW1 (V_{OUT} SEL) and SW3 (EN) are used for the 2x3 mm DFN-8 circuit.

2.3.1.4 ADJUSTABLE V_{OUT} SETTING

The resistor divider RT and RB are used to set the converter output voltage. By setting the V_{OUT} SEL switch in ON or OFF position, the output voltage can be calculated using the following equation:

EQUATION 2-1:

$$RT_1 = RB_1 \times \left[\left(\frac{V_{OUT}}{V_{FB}}\right) - 1\right]$$

or

$$RT_4 = RB_2 \times \left[\left(\frac{V_{OUT}}{V_{FB}}\right) - 1\right]$$

Where: V_{FB} = 1.21V for MCP1640B

V_{FB} = 1.23V for MCP16251

Note: If the feedback loop is recalculated, the V_{OUT} SEL switch will not be used, as it will add a resistor in parallel with the calculated component.

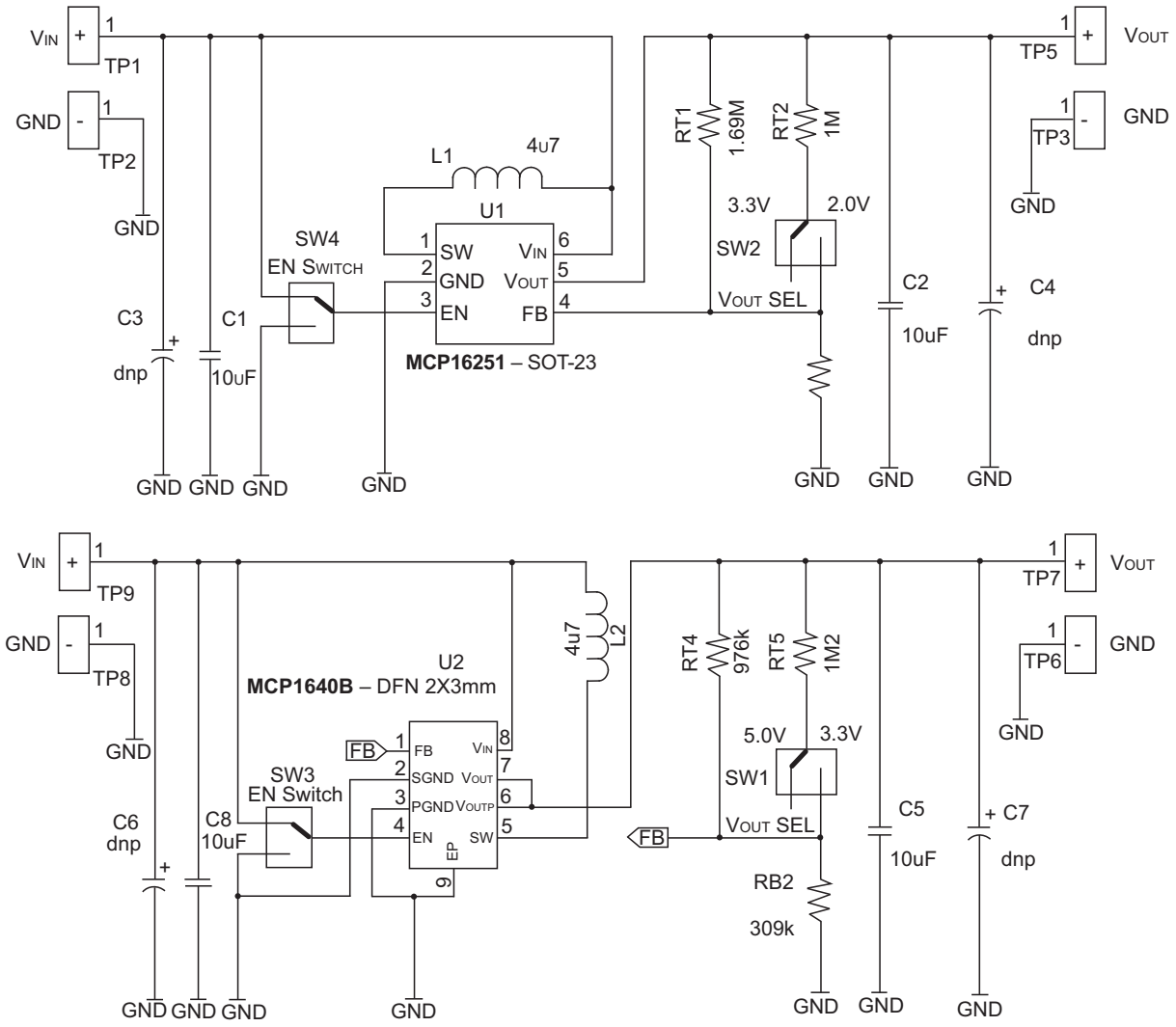
Appendix A. Schematic and Layouts

A.1 INTRODUCTION

This appendix contains the following schematics and layouts for the MCP16251 and MCP1640B Synchronous Boost Converters Evaluation Board:

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

A.2 BOARD – SCHEMATIC

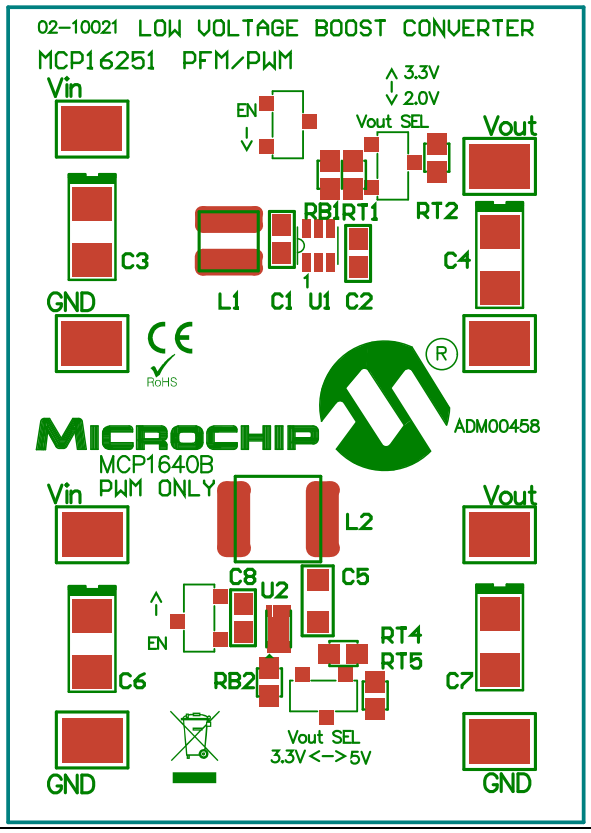


Note:
Calculate RT resistors for a particular VOUT as:

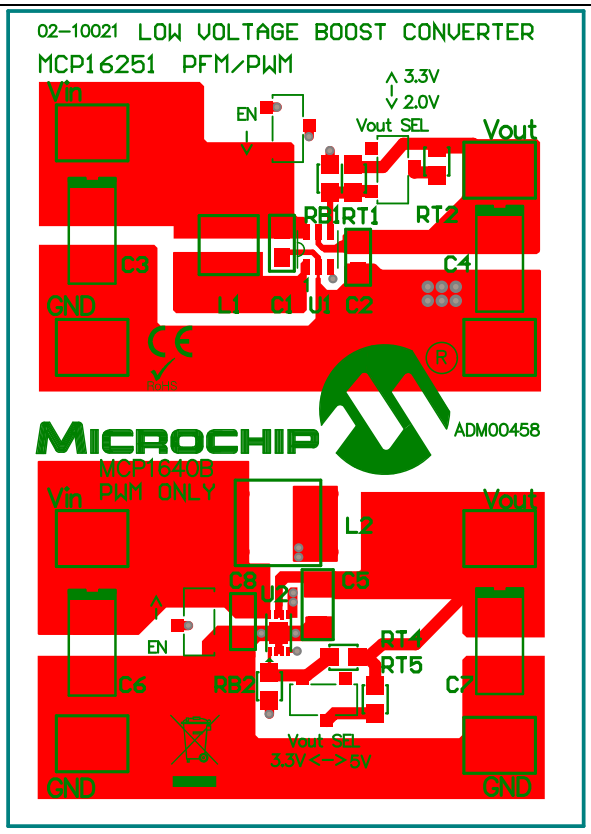
RT = RB *((Vout/VFB) - 1)

VFB = 1.23V - MCP16251
VFB = 1.21V - MCP1640B

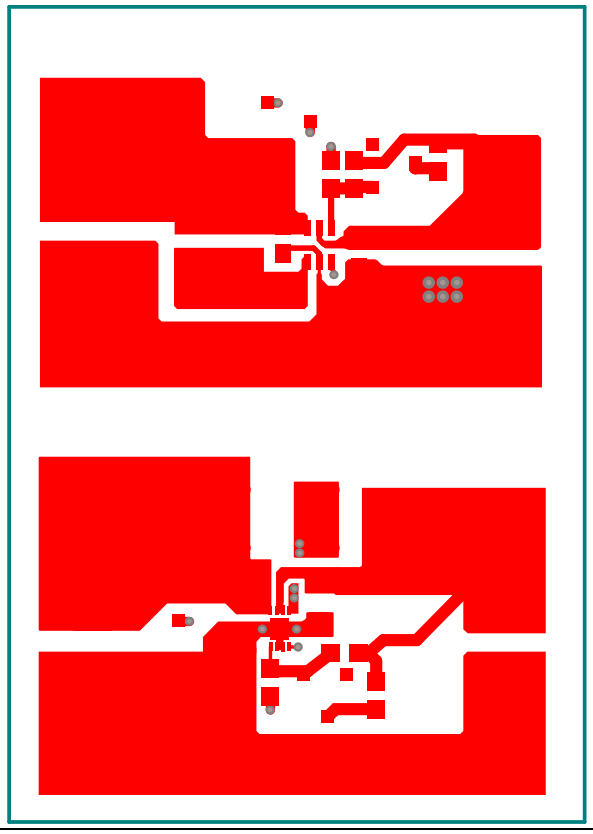
A.3 BOARD – TOP SILK



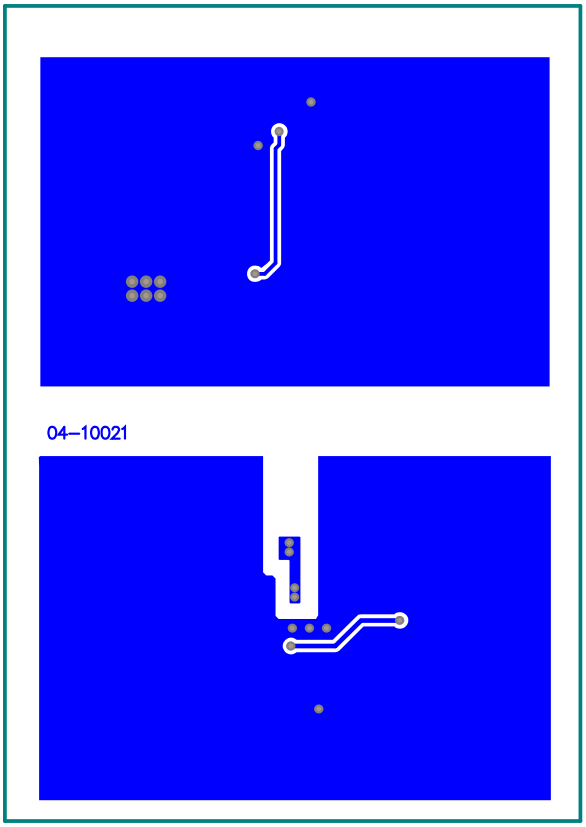
A.4 BOARD – TOP COPPER AND SILK



A.5 BOARD – TOP COPPER



A.6 BOARD – BOTTOM COPPER



Appendix B. Bill of Materials (BOM)

TABLE B-1: BILL OF MATERIALS (BOM)

Qty	Reference	Description	Manufacturer	Part Number
4	Bump	Bumpon Hemisphere 44X.20 white	3M	SJ-5003 (WHITE)
3	C1, C2, C8	Cap. ceramic 10 µF 10V X7R 0805	Murata Electronics®	GRM21BR71A106KE51L
1	C5	Cap. ceramic 10 µF 10V X7R 1206	Murata Electronics	GRM31CR71A106KA01L
1	L1	Inductor Power 4.7 µH 1.55A SMD	Wurth Electronics	744043004
1	L2	Inductor Power 4.7 µH 2.0A SMD	EPCOS AG	B82462G4472M
	PCB	Printed Circuit Board – MCP16251 and MCP1640B Synchronous Boost Converters Evaluation Board	—	104-00458
2	RB1, RT2	Res. 1000 kOhm 1/8W 1% 0805 SMD	Panasonic®-ECG	ERJ-6ENF1004V
1	RB2	Res. 309 kOhm 1/8W 1% 0805 SMD	Panasonic-ECG	ERJ-6ENF3093V
1	RT1	Res. 1690 kOhm 1/8W 1% 0805 SMD	Yageo Corporation	RC0805FR-071M69L
1	RT4	Res. 976 kOhm 1/8W 1% 0805 SMD	Panasonic-ECG	ERJ-6ENF9763V
1	RT5	Res. 1.20 MOhm 1/8W 1% 0805 SMD	Rohm Semiconductor	MCR10EZHF1204
4	SW1, SW2, SW3, SW4	Switch slide SPDT SMD Gull	Nidec Copal Electronics Inc.	CJS-1200TB
8	TP1, TP2, TP3, TP5, TP6, TP7, TP8, TP9	PC test point compact SMT	Keystone Electronics Corp.	5016
1	U1	MCP16251 Synchronous Step-up DC-DC Converter, SOT-23	Microchip Technology inc.	**MCP16251T-I/CH**
1	U2	MCP1640B Synchronous Boost Converter, DFN 2x3 mm	Microchip Technology inc.	**MCP1640BT-I/MC**

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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