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MCP16301 High Voltage Buck Converter 600 mA Demo Board User's Guide

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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 “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 on-line help. Select the Help menu, and then Topics to open a list of available on-line help files.

INTRODUCTION

This chapter contains general information that will be useful to know before using the MCP16301 600 mA Demo 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 MCP16301 600 mA Demo Board as a development tool to emulate and debug firmware on a target board. The manual layout is as follows:

- **Chapter 1. “Product Overview”** – Important information about the MCP16301 600 mA Demo Board.
- **Chapter 2. “Installation and Operation”** – Includes instructions on how to get started with MCP16301 600 mA Demo Board and a description of the user's guide.
- **Appendix A. “Schematic and Layouts”** – Shows the schematic and layout diagrams for the MCP16301 600 mA Demo Board.
- **Appendix B. “Bill of Materials”** – Lists the parts used to build the MCP16301 600 mA Demo Board.

CONVENTIONS USED IN THIS GUIDE

This manual uses the following documentation conventions:

DOCUMENTATION CONVENTIONS

Description	Represents	Examples
Arial font:		
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>Save</i></u>
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	<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 MCP16301 600 mA Demo Board. Other useful documents are listed below. The following Microchip documents are available and recommended as supplemental reference resources.

MCP16301 Data Sheet – “*High Voltage Input Integrated Switch Step-Down Regulator*” (DS25004)

MCP16301 300 mA D2PAK Demo Board User's Guide (DS51983)

AN1385, Dynamic Analysis of the MCP16301 Switch Mode Power Converter Utilizing the MCP16301 Design Analyzer (DS01385)

THE MICROCHIP WEB SITE

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- Distributor or Representative
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- 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 (May 2011)

Initial release of this document.

NOTES:

Chapter 1. Product Overview

1.1 INTRODUCTION

This chapter provides an overview of the MCP16301 600 mA Demo Board and covers the following topics:

- MCP16301 Short Overview
- What is the MCP16301 600 mA Demo Board?
- MCP16301 600 mA Demo Board Kit Contents

1.2 MCP16301 SHORT OVERVIEW

The MCP16301 is a highly integrated, high-efficiency, fixed frequency, step-down DC-DC converter in a popular 6-pin SOT23 package that operates from input voltage sources up to 30V. Integrated features include a high-side switch, fixed-frequency peak-current mode control, internal compensation, peak current limit and over-temperature protection. Minimal external components are necessary to develop a complete step-down DC-DC converter power supply.

High converter efficiency is achieved by integrating the current limited, low resistance, high-speed N-Channel MOSFET and associated drive circuitry. High switching frequency minimizes the size of external filtering components resulting in a small solution size.

The MCP16301 can supply 600 mA of continuous current while regulating the output voltage from 2.0V to 15V. An integrated high performance peak-current mode architecture keeps the output voltage tightly regulated, even during input voltage steps and output current transient conditions that are common in power systems.

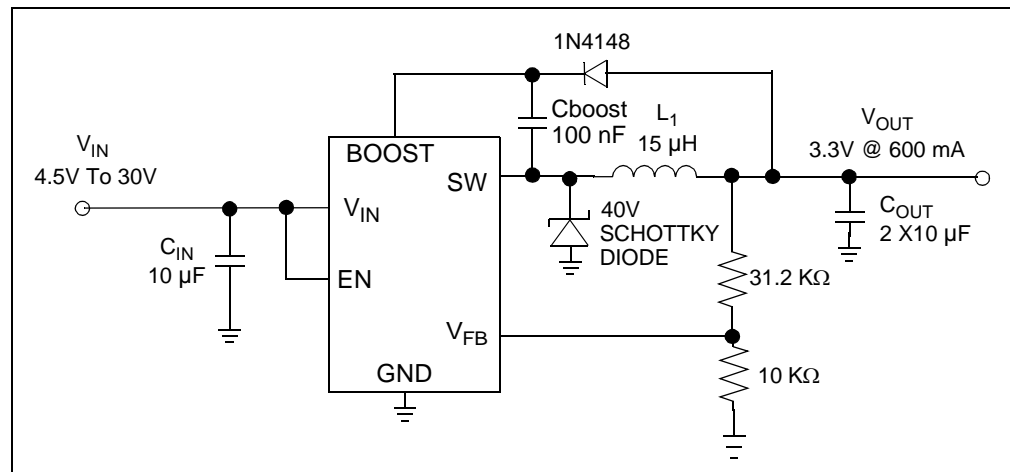


FIGURE 1-1: Typical MCP16301 Step Down Application.

1.3 WHAT IS THE MCP16301 600 mA DEMO BOARD?

The MCP16301 600 mA Demo Board is designed to operate from a 4V to 30V input and regulate the output to 3.3V while delivering 600 mA of load current. Test points for input power and load are provided to demonstrate the capability of the demo board over the entire range. The MCP16301 600 mA Demo Board was designed using small surface-mount components to show application size for a high voltage 600 mA design.

1.4 MCP16301 600 mA DEMO BOARD KIT CONTENTS

This MCP16301 600 mA Demo Board kit includes the following items:

- MCP16301 600 mA Demo Board, 102-00352
- Important Information Sheet

Chapter 2. Installation and Operation

2.1 INTRODUCTION

2.1.1 MCP16301 Features

The MCP16301 device has been developed to provide high input voltage applications with a precise low voltage regulated rail while operating at high efficiency.

The key features of the MCP16301 include:

- Up to 96% Typical Efficiency
- Input Voltage Range: 4.0V to 30V
- Output Voltage Range: 2.0V to 15V
- 2% Output Voltage Accuracy
- Integrated N-Channel Buck Switch: 460 mΩ
- 600 mA Output Current
- 500 kHz Fixed Frequency
- Adjustable Output Voltage
- Low Device Shutdown Current
- Peak Current Mode Control
- Internal Compensation
- Stable with Ceramic Capacitors
- Internal Soft-Start
- Cycle by Cycle Peak Current Limit
- Under Voltage Lockout (UVLO): 3.5V
- Overtemperature Protection
- Available Package: SOT23 - 6

A high performance peak-current mode control system is used to deliver fast response to sudden line and load changes.

2.1.2 MCP16301 600 mA Demo Board Features

The MCP16301 600 mA Demo Board is developed to demonstrate how the MCP16301 device operates over a wide input voltage and load range. Test points are provided for input and output, allowing the demo board to be connected directly to a system.

A copper via connected to the EN input can be used to turn the MCP16301 on and off – turning the device on (EN > 1.4V) when the undervoltage lockout threshold is met (VIN > 3.5V), will enable the device.

2.2 GETTING STARTED

The MCP16301 600 mA Demo Board is fully assembled and tested to evaluate and demonstrate the MCP16301.

2.2.1 Power Input and Output Connection

2.2.1.1 POWERING THE MCP16301 600 mA DEMO BOARD

The MCP16301 600 mA Demo Board is fully assembled, tested and ready to begin evaluation. Apply positive input voltage to the V_{IN} terminal and its return to the GND terminal. The maximum input voltage should not exceed 30V. An electronic load or resistive load can be used for evaluation or the intended system load can be connected. Electronic loads attempt to sink current at 0V during startup, a resistive load or constant resistance is recommended for startup evaluation. Connect the positive voltage terminal of the load to the V_{OUT} terminal on the demo board and connect the negative or return side of the load to the GND terminal.

2.2.1.2 BOARD TESTING

To test the board, follow the next steps:

1. Apply input voltage.
2. An internal pull up resistor is connected from V_{IN} to the EN input of the MCP16301, once the input voltage is greater than 3.5V the device will begin to switch. Apply greater than 4V to the input for proper operation, a minimum load is required to regulate the output to 3.3V. Detailed information is provided in the MCP16301 data sheet (DS25004) for minimum load requirements for light load conditions.
3. The measured output voltage should be 3.3V typical, 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.

2.2.2 How the MCP16301 High Side Drive Boost Circuit Operates

The MCP16301 integrates a low resistance N-Channel MOSFET. A high side or floating supply is needed to drive the gate of the N-Channel MOSFET above the input voltage to turn it on. The demo board uses the output voltage, 3.3V, to charge the boost cap while inductor current flows clamping the SW node to a diode drop below ground. Prior to startup, there is no inductor current, so an internal pre-charge circuit charges the boost cap up to a minimum threshold. Once charged, the N-Channel can be turned on, ramping current into the inductor.

The worst case operating conditions for charging the boost capacitor occur at minimum V_{IN} and no load. At minimum V_{IN} (4V), there is not enough head room to pre-charge the boost cap to a high value. At no load, the converter is operating at a minimum, or very low duty cycle, putting a small amount of current into the inductor. When the switch turns off, the inductor current decays very quickly, resulting in a short time to recharge the boost capacitor.



MCP16301 600 mA DEMO BOARD USER'S GUIDE

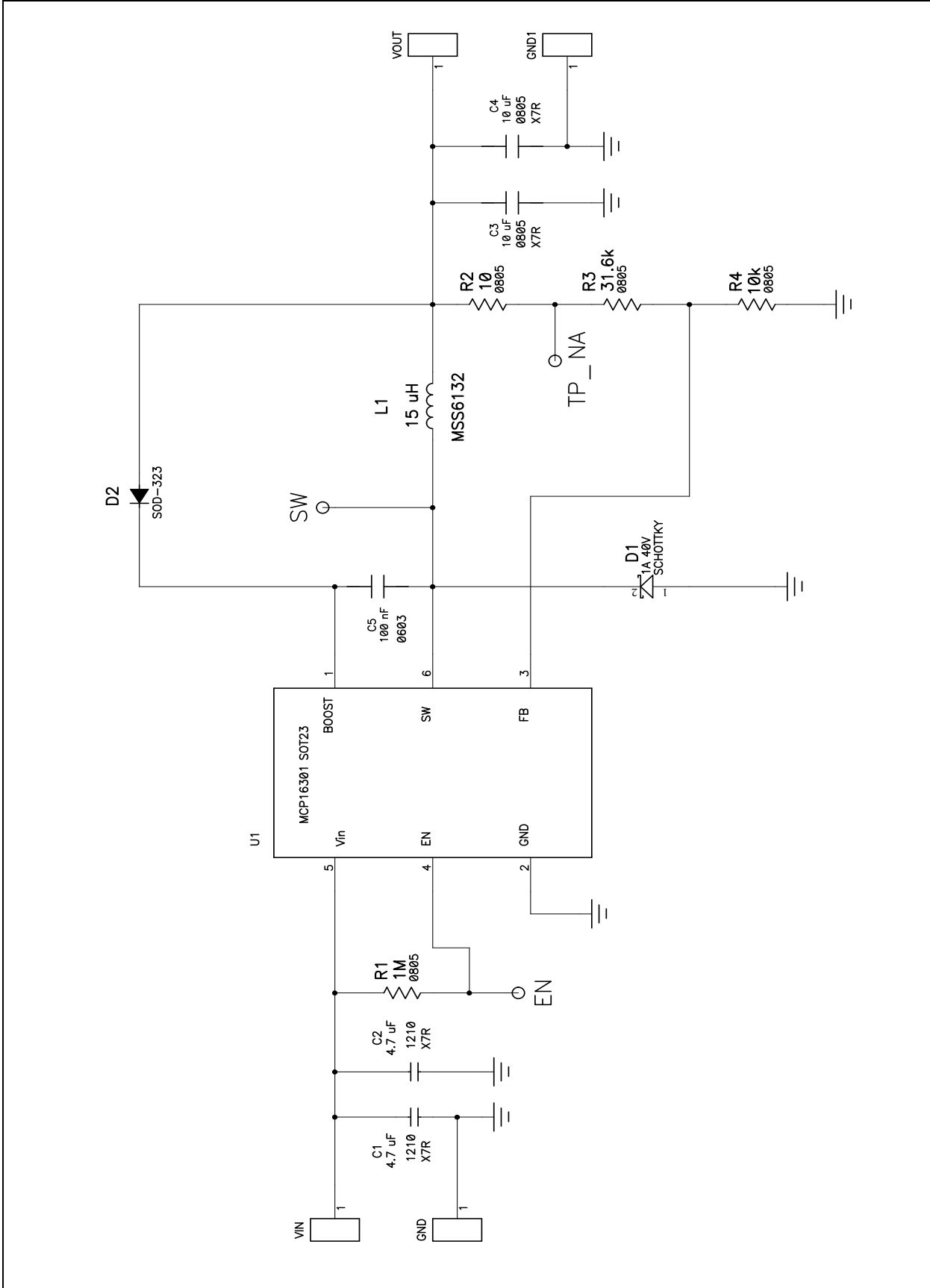
Appendix A. Schematic and Layouts

A.1 INTRODUCTION

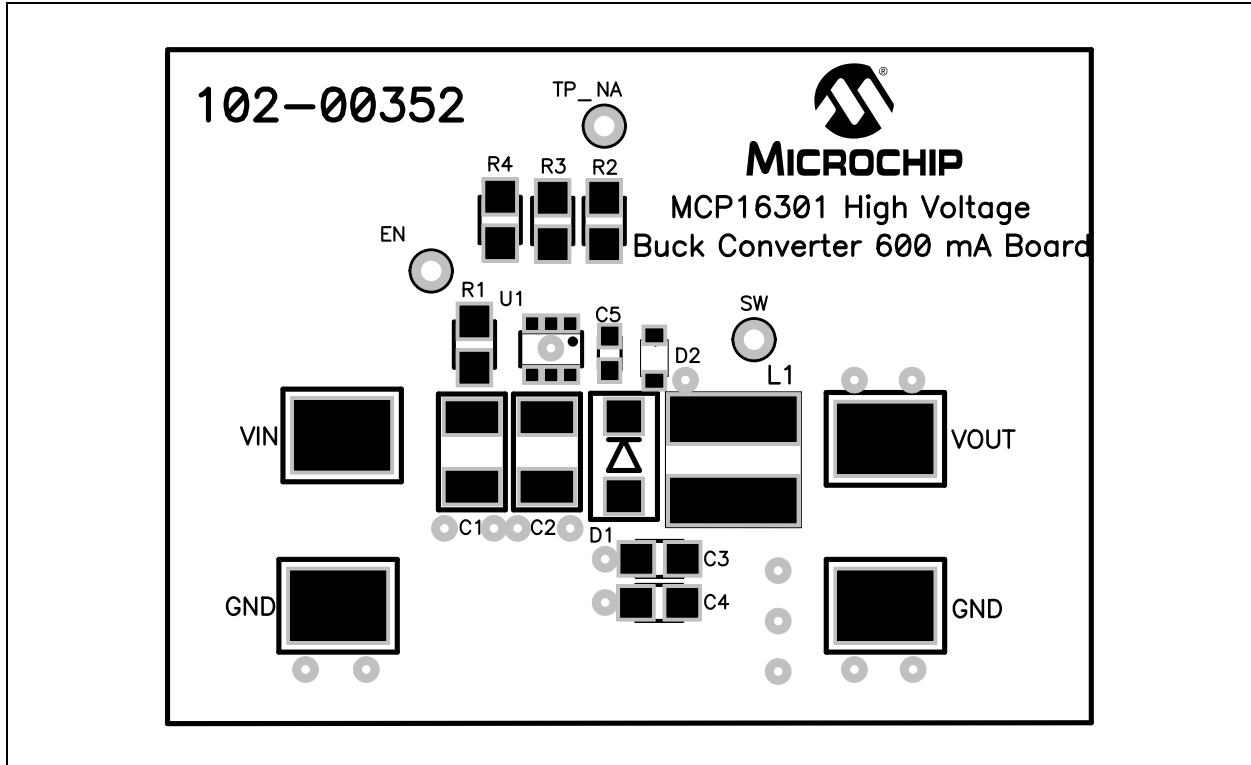
This appendix contains the following schematics and layouts for the MCP16301 600 mA Demo Board:

- Board – Schematic
- Board – Top Silk And Pads
- Board – Top Copper And Pads
- Board – Bottom Copper

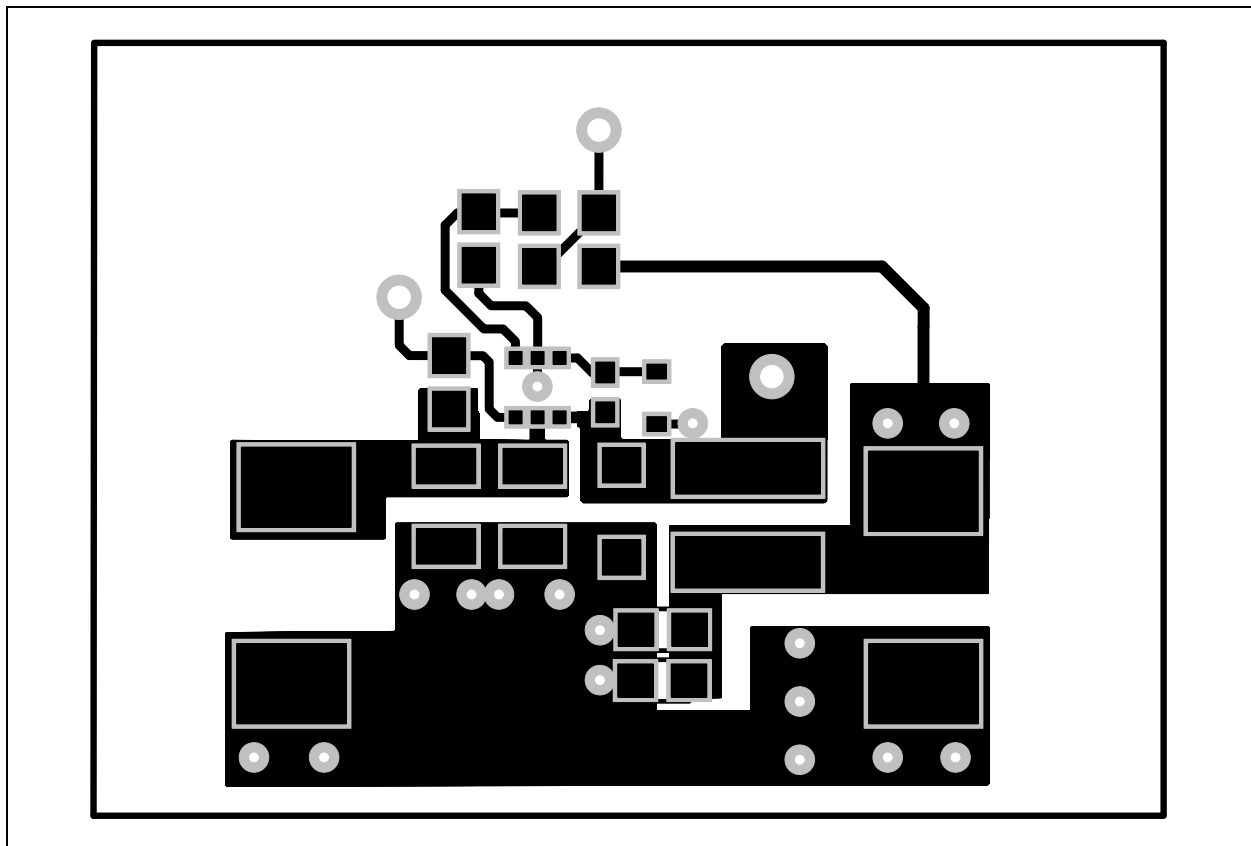
A.2 BOARD – SCHEMATIC



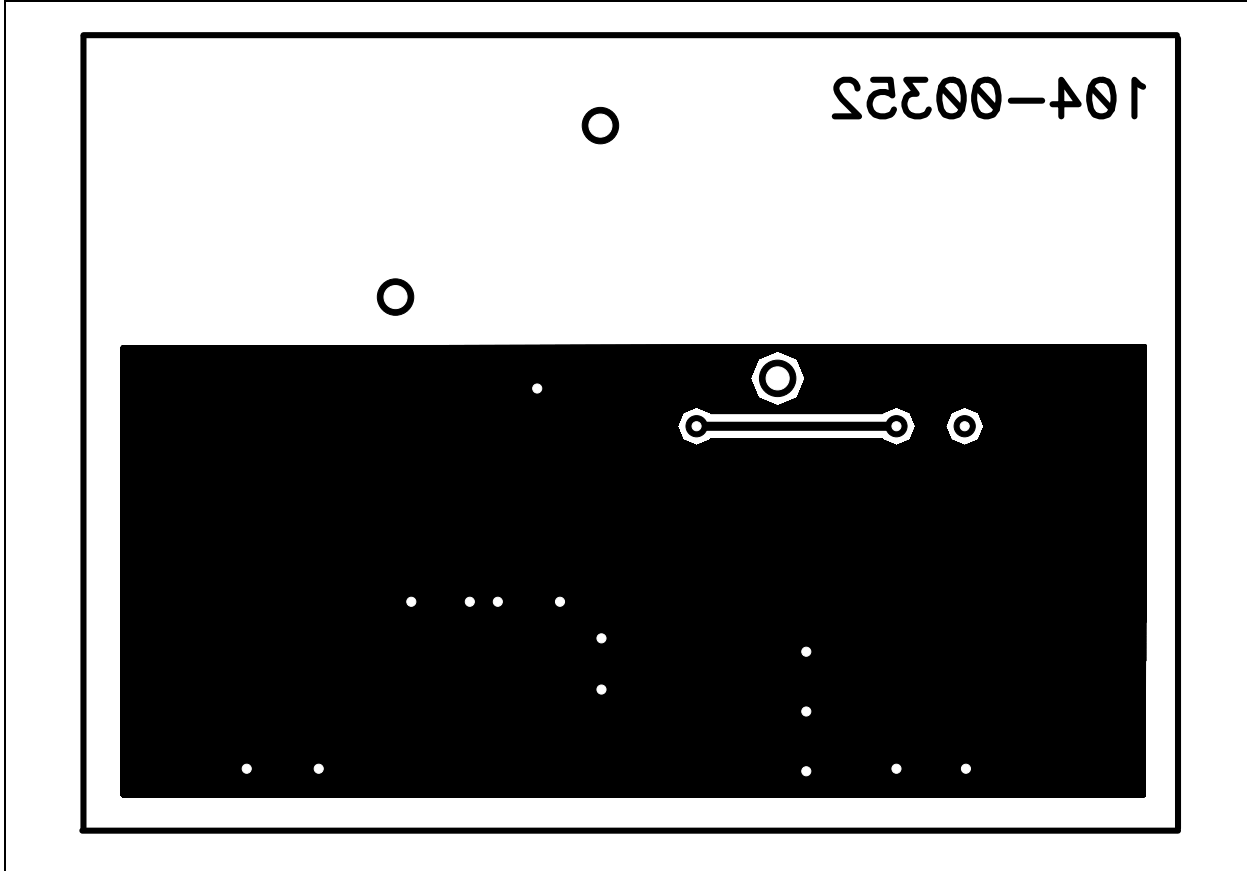
A.3 BOARD – TOP SILK AND PADS



A.4 BOARD – TOP COPPER AND PADS



A.5 BOARD – BOTTOM COPPER



Appendix B. Bill of Materials

TABLE B-1: BILL OF MATERIALS (BOM)

Qty	Reference	Description	Manufacturer	Part Number
4	BUMP	BUMPON Square 0.40" x 0.1" Black	3M™	SJ-5007 (Black)
2	C1, C2	CAP 4.7uF 50V CERAMIC X7R 1210 10%	Taiyo Yuden®	UMK325B7475KM-T
2	C3, C4	CAP 10uF 6.3V CERAMIC X7R 0805 10%	Taiyo Yuden	JMK212B7106KG-T
1	C5	CAP 0.1uF 16V CERAMIC X7R 0603 10%	AVX Corporation	0603YC104KAT2A
1	D1	DIODE SCHOTTKY 40V 1A SMA	Diodes Incorporated®	B140-13-F
1	D2	DIODE SWITCH 75V 200 mW SOD-323	Diodes Incorporated	1N4448WS-7-F
1	L1	MSS6132 15 µH Shielded Power Inductor	Coilcraft®	MSS6132-153ML
1	PCB	MCP16301 4V to 30V V _{IN} , 3.3V 600 mA I _{OUT} Printed Circuit Board	Microchip Technology Inc.	104-00352
1	R1	RES 1.00M OHM 1/8W 1% 0805 SMD	Panasonic® ECG	ERJ-6ENF1004V
1	R2	RES 10 OHM 1/8W 1% 0805 SMD	Panasonic ECG	ERJ-6ENF10R0V
1	R3	RES 31.6K OHM 1/8W 1% 0805 SMD	Panasonic ECG	ERJ-6ENF3162V
1	R4	RES 10.0K OHM 1/8W 1% 0805 SMD	Panasonic ECG	ERJ-6ENF1002V
1	U1	MCP16301 High Input Voltage Buck Converter SOT23	Microchip Technology Inc.	MCP16301
4	VIN, VOUT, GND, GND	PC TEST POINT TIN SMD	Harwin	S1751-46R

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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