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**MCP16301**  
**300 mA D<sup>2</sup>PAK**  
**Demo Board**  
**User's Guide**

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# MCP16301 300 mA D<sup>2</sup>PAK 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](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<sup>®</sup> 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 300 mA D<sup>2</sup>PAK 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 300 mA D<sup>2</sup>PAK 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 300 mA D<sup>2</sup>PAK Demo Board.
- **Chapter 2. "Installation and Operation"** – Includes instructions on how to get started with MCP16301 300 mA D<sup>2</sup>PAK Demo Board and a description of the user's guide.
- **Appendix A. "Schematics and Layouts"** – Shows the schematic and layout diagrams for the MCP16301 300 mA D<sup>2</sup>PAK Demo Board.
- **Appendix B. "Bill of Materials (BOM)"** – Lists the parts used to build the MCP16301 300 mA D<sup>2</sup>PAK Demo Board.

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## 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 MCP16301 300 mA D<sup>2</sup>PAK 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)
- **AN1385 Application Note** – *“Dynamic Analysis of the MCP16301 Switch-mode Power Converter Utilizing the MCP16301 Design Analyzer”* (DS01385)
- **MCP16301 User’s Guide** – *“MCP16301 600 mA Demo Board User’s Guide”* (DS51978)

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- Distributor or Representative
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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 (May 2011)

- Initial Release of this Document.

# MCP16301 300 mA D<sup>2</sup>PAK Demo Board User's Guide

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NOTES:



## Chapter 1. Product Overview

### 1.1 INTRODUCTION

This chapter provides an overview of the MCP16301 300 mA D<sup>2</sup>PAK Demo Board, and covers the following topics:

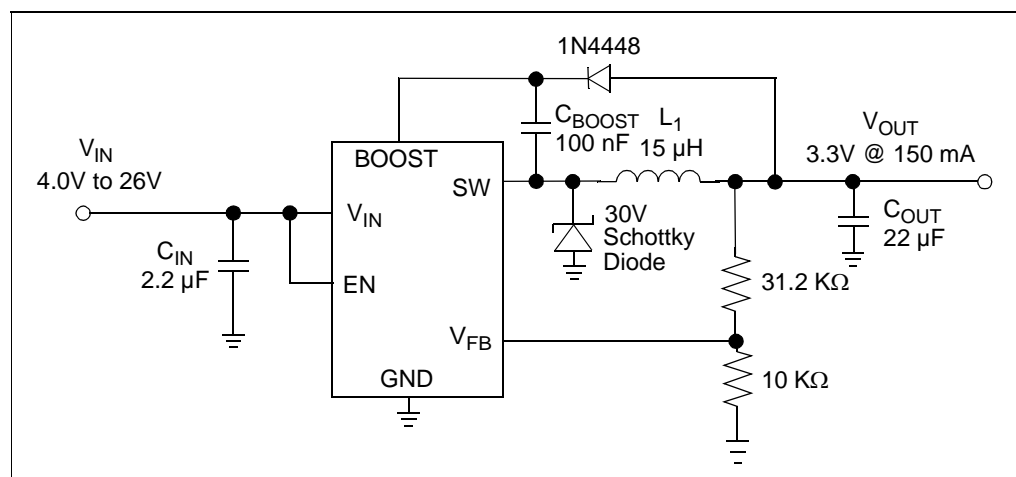
- MCP16301 Short Overview
- What is the MCP16301 300 mA D<sup>2</sup>PAK Demo Board?
- What Does the MCP16301 300 mA D<sup>2</sup>PAK Demo Board Kit Contain?

### 1.2 MCP16301 SHORT OVERVIEW

The MCP16301 device is a highly integrated, high-efficiency, fixed frequency, step-down DC-DC converter in a popular 6-pin SOT-23 package, that operates from input voltage sources up to 30V. The integrated features include a high-side switch, fixed frequency peak current mode control, internal compensation, peak current limit and overtemperature protection. Minimal external components are needed to develop a high-efficiency power supply, operating from a high-voltage input.

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 the external filtering components, resulting in a small solution size.

The MCP16301 300 mA D<sup>2</sup>PAK Demo Board can supply 300 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. For this evaluation board, the external components are sized such that they can fit into a smaller space than a D<sup>2</sup>PAK linear regulator. The external components, namely the Schottky diode and the inductor, limit the maximum output current for this application to less than 300 mA.



**FIGURE 1-1:** 300 mA Typical, MCP16301 Step-Down Application.

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## 1.3 WHAT IS THE MCP16301 300 MA D<sup>2</sup>PAK DEMO BOARD?

The MCP16301 300 mA D<sup>2</sup>PAK Demo Board is designed to operate from a 4V to 26V input and regulate the output to 3.3V while delivering 300 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 board was designed using small surface mount components, to show the small board area necessary for a high-input voltage, 300 mA design, that fits into less board area than the popular D<sup>2</sup>PAK, commonly used for linear regulators.

## 1.4 WHAT DOES THE MCP16301 300 MA D<sup>2</sup>PAK DEMO BOARD KIT CONTAIN?

The MCP16301 300 mA D<sup>2</sup>PAK Demo Board kit includes:

- MCP16301 300 mA D<sup>2</sup>PAK Demo Board (102-00360)
- Important Information Sheet.

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## Chapter 2. Installation and Operation

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### 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: SOT-23 -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 300 mA D<sup>2</sup>PAK Demo Board Features

The MCP16301 300 mA D<sup>2</sup>PAK Demo Board is developed to demonstrate how the MCP16301 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.

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## 2.2 GETTING STARTED

The MCP16301 300 mA D<sup>2</sup>PAK Demo Board is fully assembled and tested to evaluate and demonstrate the MCP16301 capability.

### 2.2.1 Power Input and Output Connection

#### 2.2.1.1 POWERING THE MCP16301 300 MA D<sup>2</sup>PAK DEMO BOARD

The MCP16301 300 mA D<sup>2</sup>PAK Demo Board is fully assembled, tested and ready for evaluation. Apply positive input voltage to the  $V_{IN}$  terminal and the corresponding return to the GND terminal. The maximum input voltage should not exceed 26V. An electronic load or resistive load can be used for evaluation or the intended system load can be connected. The 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 the 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 begins to switch. Apply greater than 4V supply to the input for proper operation. A minimum load is required to regulate the output to 3.3V. For minimum load requirements (light load conditions), detailed information is provided in the data sheet.
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 300 mA D<sup>2</sup>PAK Demo Board Boost Strap 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 start up, 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 small time to recharge the boost capacitor.



# MCP16301 300 mA D<sup>2</sup>PAK DEMO BOARD USER'S GUIDE

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## Appendix A. Schematics and Layouts

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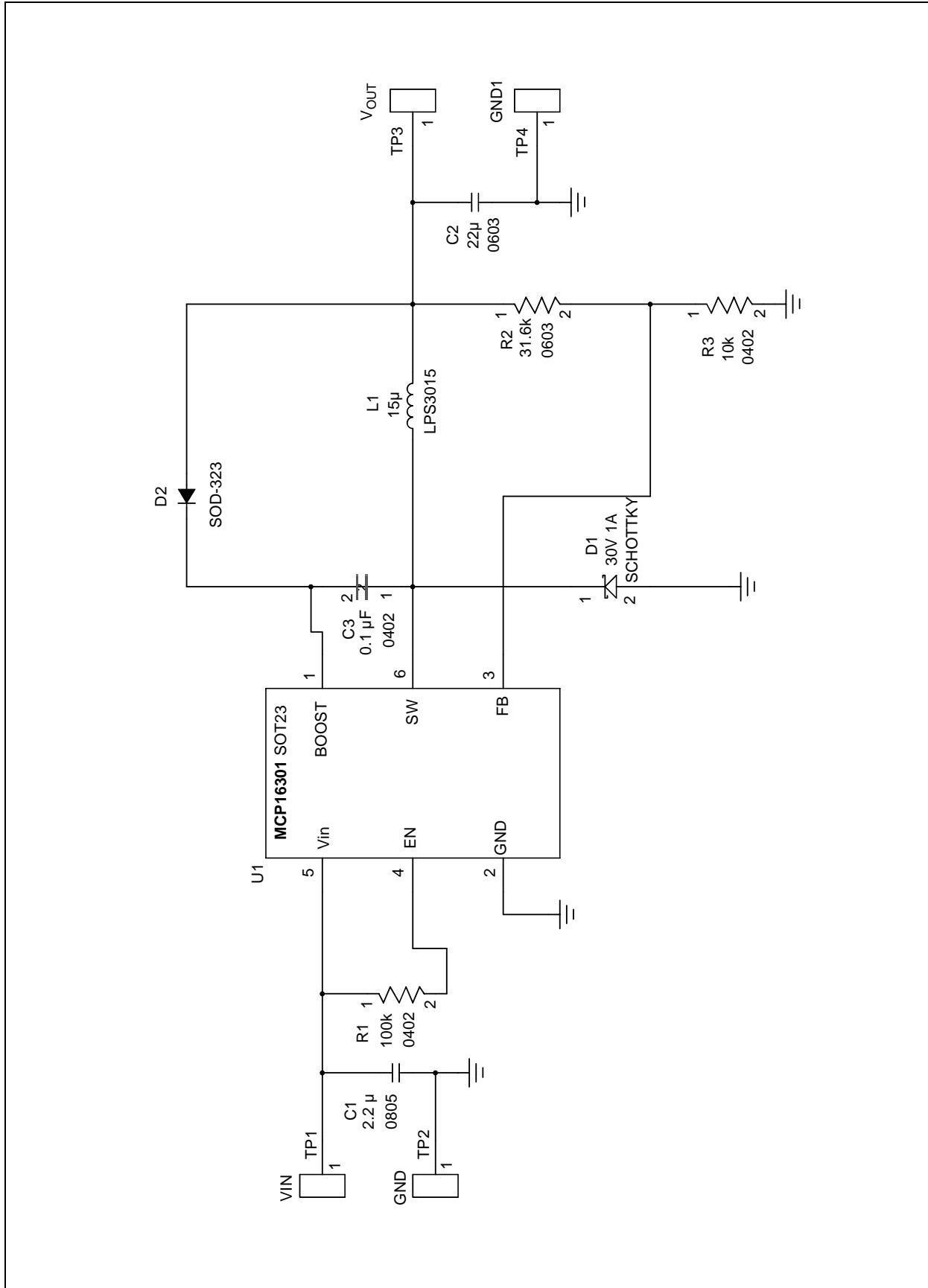
### A.1 INTRODUCTION

This appendix contains the following schematics and layouts for the MCP16301 300 mA D<sup>2</sup>PAK Demo Board:

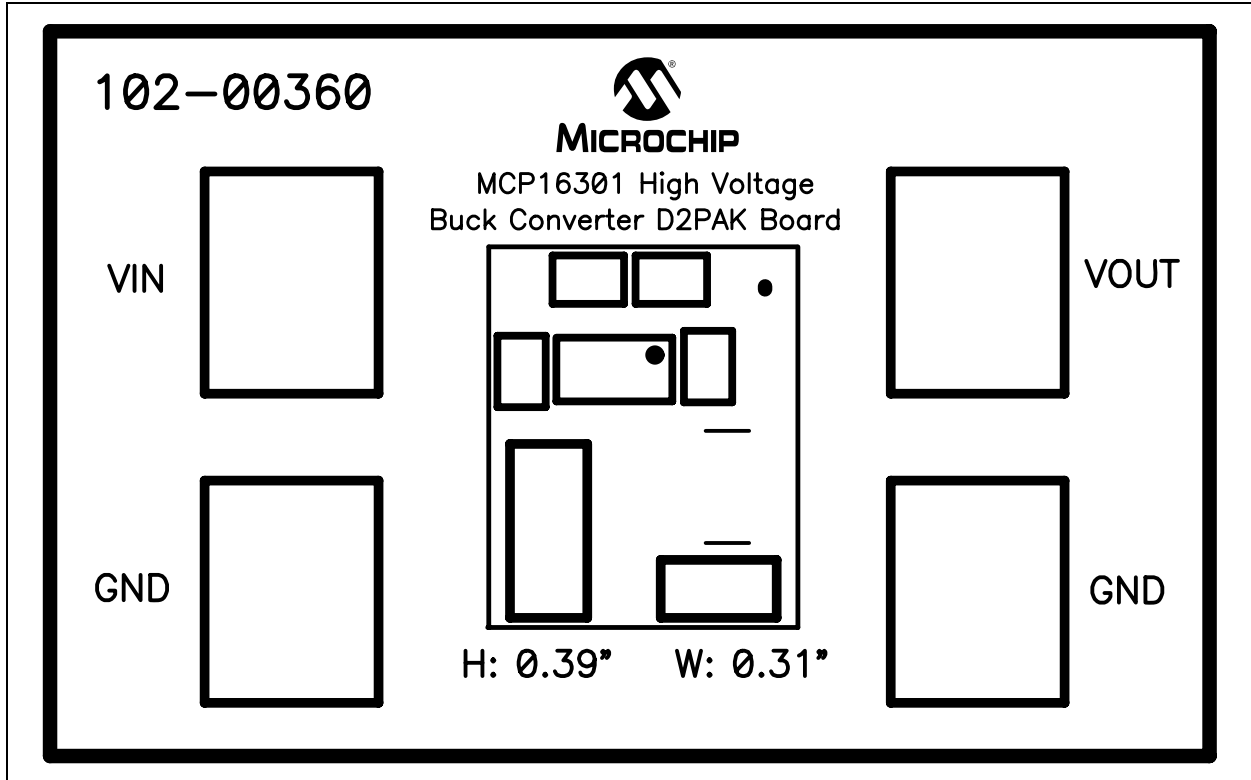
- Board – Schematic
- Board – Top Silk and Pads
- Board – Top Copper Layer
- Board – Bottom Copper Layer

# MCP16301 300 mA D<sup>2</sup>PAK Demo Board User's Guide

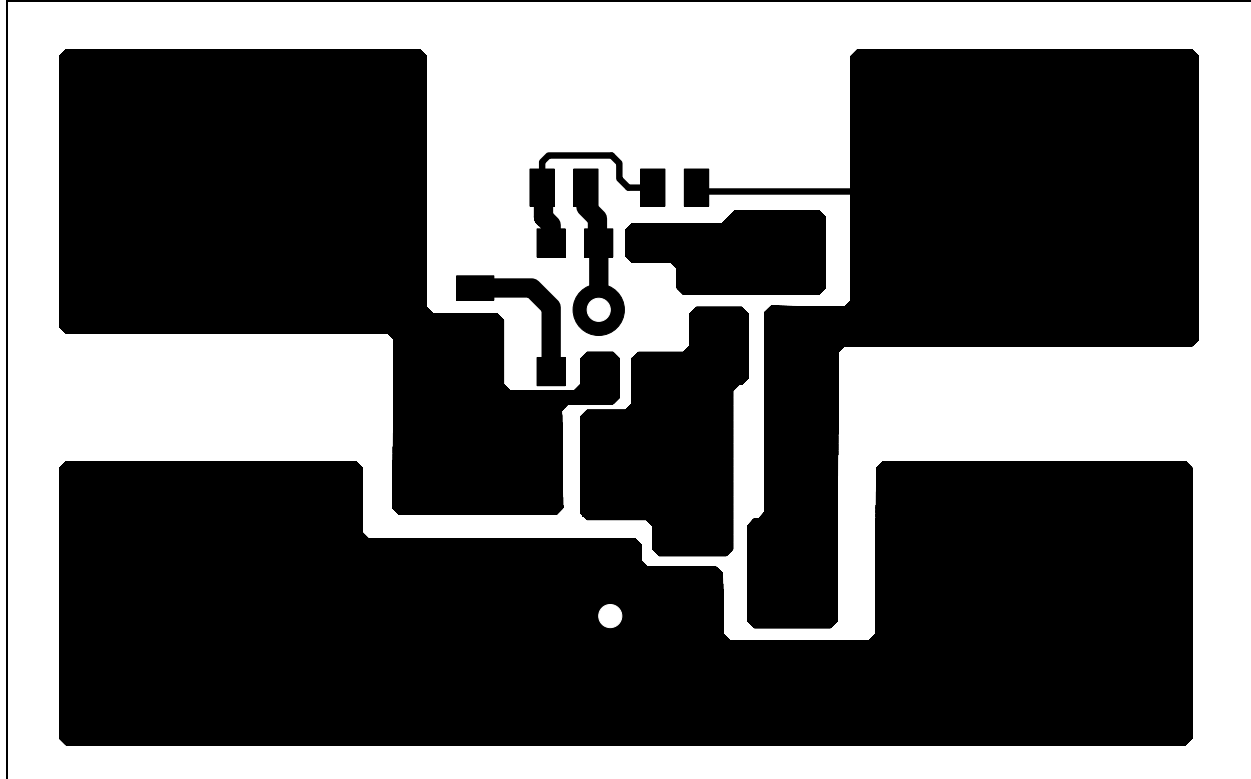
## A.2 BOARD – SCHEMATIC



## A.3 BOARD – TOP SILK AND PADS



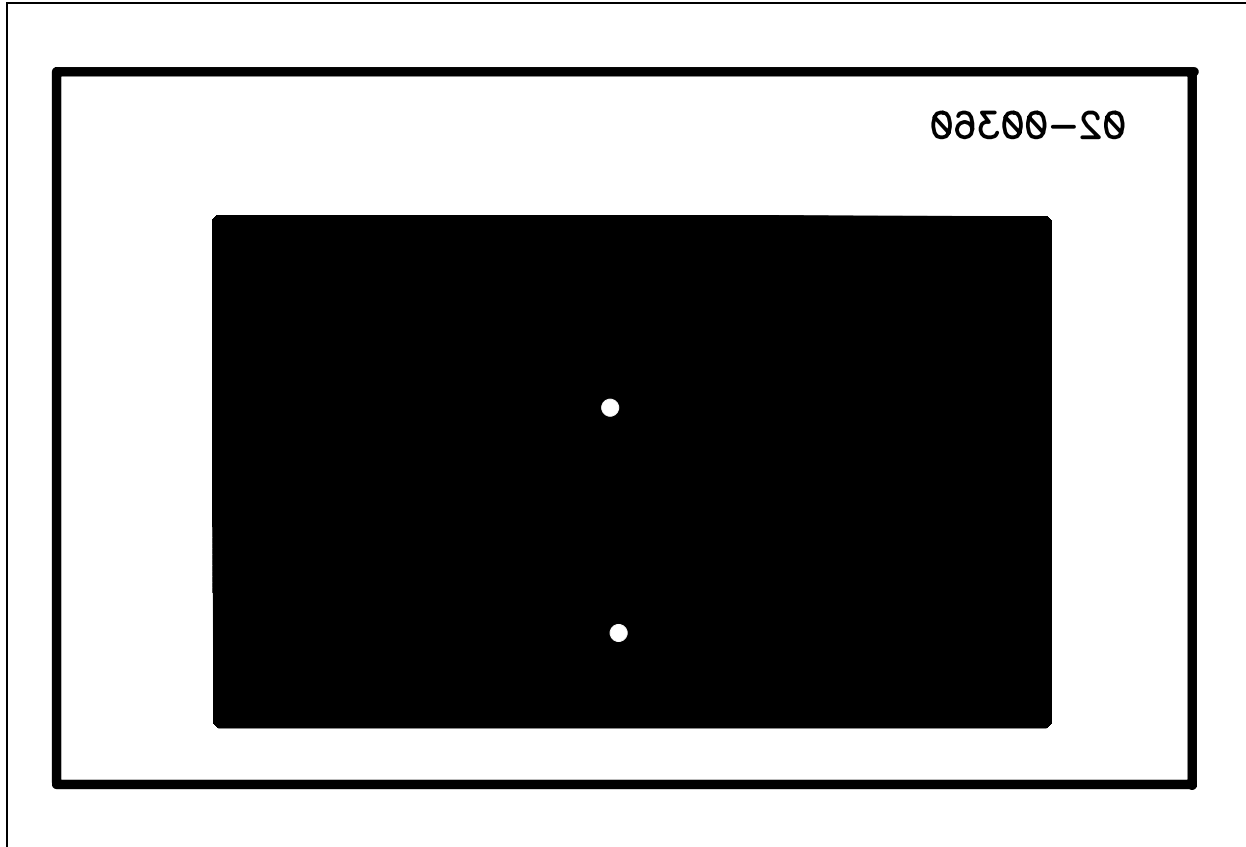
## A.4 BOARD – TOP COPPER LAYER



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## A.5 BOARD – BOTTOM COPPER LAYER





**Appendix B. Bill of Materials (BOM)**

**TABLE B-1: BILL OF MATERIALS (BOM)**

Qty	Reference	Description	Manufacturer	Part Number
1	C1	CAP CER 2.2 $\mu$ F 50V X5R 0805	TDK <sup>®</sup> Corporation	C2012X5R1H225K
1	C2	CAP CER 10 $\mu$ F 6.3V X5R 0603	Taiyo Yuden <sup>®</sup>	JMK107BJ106MA-T
1	C3	CAP CER 0.10 $\mu$ F 6.3V X5R 0402	TDK Corporation	C1005X5R0J104M
1	D1	DIODE SCHOTTKY 30V 1A PWRDI-323	Diodes <sup>®</sup> Incorporated	PD3S130HDICT-ND
1	D2	DIODE SWITCH 75V 200mW SOD-323	Diodes Incorporated	1N4448WS-7-F
1	L1	Shielded Power Inductor 15 $\mu$ H	Coilcraft <sup>®</sup> Inc.	LPS3015-153MLB
1	PCB	RoHS Compliant Bare PCB MCP16301 D <sup>2</sup> PAK Board	—	104-00360
1	R1	RES 1.00M OHM 1/10W 1% 0402 SMD	Panasonic <sup>®</sup> -ECG	ERJ-2RKF1004X
1	R2	RES 31.6K OHM 1/10W 1% 0402 SMD	Panasonic-ECG	ERJ-2RKF3162X
1	R3	RES 10.0K OHM 1/10W 1% 0402 SMD	Panasonic-ECG	ERJ-2RKF1002X
4	TP1, TP2, TP3, TP4	PC TEST POINT TIN SMD	Harwin Inc	S1751-46R
1	U1	MCP16301 High Input Buck Converter SOT-23	Microchip Technology Inc.	<b>MCP16301T-I/CHY</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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