MCP16361 Evaluation Board User's Guide

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MCP16361 EVALUATION 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 website (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 MCP16361 Evaluation Board. Items discussed in this chapter include:

- Document Layout
- Conventions Used in this Guide
- Recommended Reading
- The Microchip Website
- Customer Support
- Document Revision History

DOCUMENT LAYOUT

This document describes how to use the MCP16361 Evaluation Board as a development tool. The manual layout is as follows:

- **Chapter 1. "Product Overview"** – Important information about the MCP16361 Evaluation Board.
- **Chapter 2. "Installation and Operation"** – Includes instructions on how to get started with the MCP16361 Evaluation Board and a description of each function.
- **Appendix A. "Schematic and Layouts"** – Shows the schematic and PCB layout for the MCP16361 Evaluation Board.
- **Appendix B. "Bill of Materials (BOM)"** – Lists the parts used to build the MCP16361 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 MCP16361 Evaluation Board. Another useful document is the following Microchip document listed below, which is available and recommended as a supplemental reference resource:

- **MCP16361/2/3 Data Sheet — *"48V Input, 3A Output, 2.2 MHz Switching Frequency, Integrated Switch Step-Down Regulator" (DS20006481)***

THE MICROCHIP WEBSITE

Microchip provides online support via our website at www.microchip.com. This website is used as a means to make files and information easily available to customers. Accessible by using your favorite Internet browser, the website contains the following information:

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- **General Technical Support** – Frequently Asked Questions (FAQs), technical support requests, online discussion groups, Microchip consultant program member listing
- **Business of Microchip** – Product selector and ordering guides, latest Microchip press releases, listing of seminars and events, listings of Microchip sales offices, distributors and factory representatives

CUSTOMER SUPPORT

Users of Microchip products can receive assistance through several channels:

- Distributor or Representative
- Local Sales Office
- Field Application Engineer (FAE)
- Subject Matter Expert Engineers (SMEs)
- Technical Support

Customers should contact their distributor, representative, field application engineer (FAE) or Subject Matter Expert Engineers (SME) 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 website at:
http://www.microchip.com/support.

DOCUMENT REVISION HISTORY

Revision A (December 2020)

- Initial release of this document.

NOTES:

Chapter 1. Product Overview

1.1 INTRODUCTION

This chapter provides an overview of the MCP16361 Evaluation Board and covers the following topics:

- MCP16361 Short Overview
- What is the MCP16361 Evaluation Board?
- Contents of the MCP16361 Evaluation Board Kit

1.2 MCP16361 SHORT OVERVIEW

The MCP16361/2/3 is a highly integrated, high-efficiency, fixed-frequency, step-down DC-DC converter in an 8-lead 3 mm x 3 mm VDFN package that operates from input voltage sources up to 48V. Integrated features include a high-side switch, fixed-frequency Peak Current Mode Control, Internal Compensation, Power Good, Peak Current Limit and Overtemperature Protection. The MCP16361/2/3 provides all the active functions for local DC-DC conversion, with fast transient response and accurate regulation.

High efficiency power conversion is achieved by integrating the current-limited, low-resistance, high-speed N-channel MOSFET together with its driving circuitry. High switching frequency minimizes the size of the external filtering components, resulting in a small size solution.

The MCP16361/2/3 can supply 3A of continuous current while regulating the output voltage from 2.0V to 24V. 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.

The MCP16361 is capable of running in PFM/PWM mode; it switches in PFM mode for light load conditions and for large buck conversion ratios. This results in a higher efficiency over all load ranges.

By comparison, the MCP16362 runs in PWM-only mode and is recommended for applications in which the low-frequency component associated with the PFM mode of operation is not desirable.

Besides the two aforementioned options, the MCP16363 is designed for EMI constrained applications where reduced peak emissions are required. This is achieved by sweeping the switching frequency over a 10% range above the 2.2 MHz nominal value.

The EN input is used to turn the device on and off; while off, only a few microamps (µA) of current are consumed from the input.

The Power Good output pin will go from logic low to logic high (through an external pull-up resistor) once the output voltage is within 93% of the nominal set point. The output voltage is set with an external resistive divider. The MCP16361/2/3 is offered in a space-saving 8-lead 3 mm x 3 mm VDFN wettable flanks surface mount package.

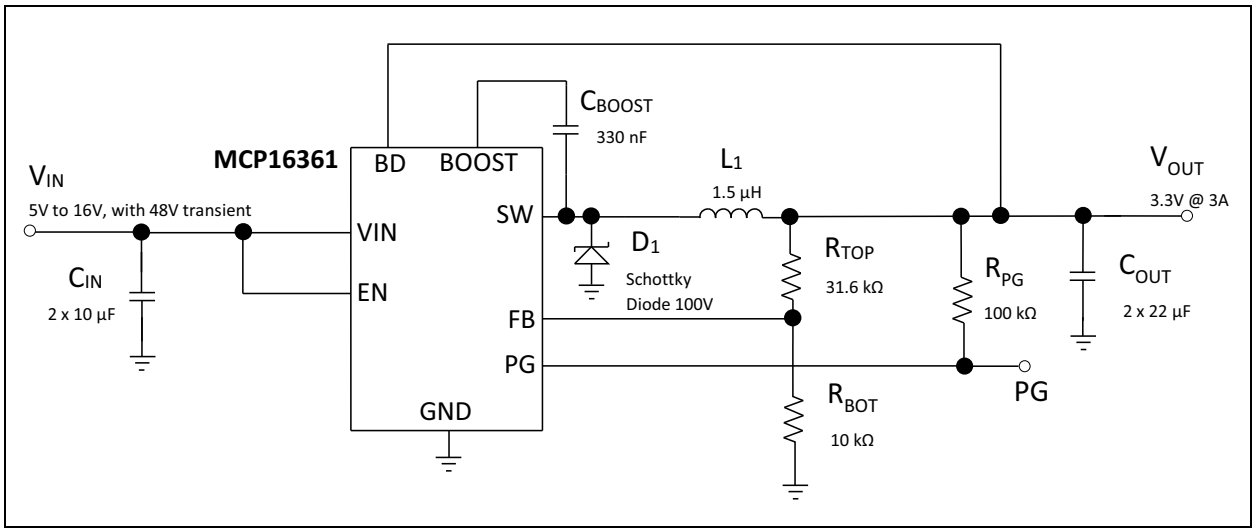


FIGURE 1-1: *Typical MCP16361 Buck Converter Application @ 3.3V Output.*

1.3 WHAT IS THE MCP16361 EVALUATION BOARD?

The MCP16361 Evaluation Board is used to evaluate and demonstrate Microchip Technology's MCP16361 product. This evaluation board is compatible with the two other products in the family: MCP16362 and MCP16363. The input voltage range for a typical 3.3V output application is 5V-16V (transient up to 48V) and the load current can go up to 3A.

1.4 CONTENTS OF THE MCP16361 EVALUATION BOARD KIT

The MCP16361 Evaluation Board kit includes:

- MCP16361 Evaluation Board (EV27C97A)
- Important Information Sheet

Chapter 2. Installation and Operation

2.1 INTRODUCTION

The MCP16361 device can regulate the output voltage over a 2V-24V wide range and typically deliver over 3A of load current at 3.3V output, when supplied from a 12V input source. The maximum input voltage range is 4V-48V and the regulated voltage (V_{OUT}) should be lower than the input voltage (V_{IN}).

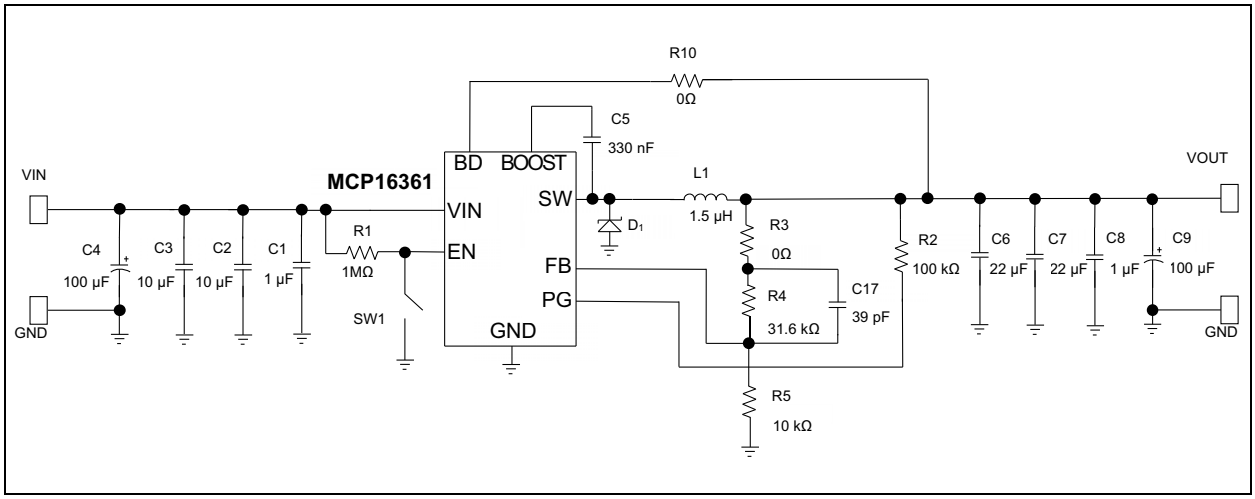


FIGURE 2-1: *MCP16361 Evaluation Board Application @ 3.3V Output.*

2.2 FEATURES

The MCP16361 Evaluation Board has the following features:

- Input Voltage Range (V_{IN}): 4V – transient up to 48V
- Output Voltage: 3.3V
- Output Current: 3A @ 3.3V Output (typical), 12V Input
- Automatic PFM/PWM Operation for MCP16361
- PWM Switching Frequency: 2.2 MHz
- Low Device Shutdown Current: 3 µA, typical
- Low Device Quiescent Current: 18 µA, typical (not switching)
- Integrated N-Channel Buck Switch ON State Resistance: 100 mΩ
- Internal Compensation
- Internal Soft Start
- Internal Bootstrap Diode
- Internal Current Limit
- Power Good Output
- Overtemperature Protection (if the die temperature exceeds +155°C, with 25°C hysteresis)

2.3 GETTING STARTED

The MCP16361 Evaluation Board is fully assembled and tested to evaluate and demonstrate the features of the MCP16361 switching regulator. This board requires the use of external laboratory power supply and load.

2.3.1 Power Input and Output Connection

2.3.1.1 POWERING THE MCP16361 EVALUATION BOARD

The Evaluation Board has two circuit applications:

- The first one is a typical application for a 3.3V output, used to evaluate the MCP16361 product.
- For the second application circuit, the components are not populated; it shows an example of routing a 5V output typical application, but using smaller packages for components, in order to estimate the minimum area required on the PCB. The components are detailed in Table B-3.

2.3.1.2 BOARD POWER-UP PROCEDURE

For the power-up procedure, follow the steps below:

1. Connect the power supply to the input terminals of the evaluation board; the input voltage should be higher than V_{OUT}.
   Connect the load to the VOUT and GND terminals; maximum load varies with input and output voltage (see the MCP16361/2/3 Data Sheet for more information on the maximum load). Connect the positive (+) side of the load to VOUT and the negative (–) side of the load to the GND terminal.
2. By default, the EN pin is pulled high through a resistor. SW1 must be in the OFF position so that V_{OUT} can be measured between the VOUT and GND terminals. When SW1 is ON, the EN pin is pulled to GND and the converter is disabled, while V_{OUT} is floating and disconnected from the input.
3. When SW1 is in the OFF position, the measured output voltage should be approximately 3.3V (± 200 mV) in PFM mode and 3.3V (± 20 mV) in PWM mode respectively. Adjusting the input voltage and the load should not cause the output to vary more than a few millivolts over the operating range of the converter.

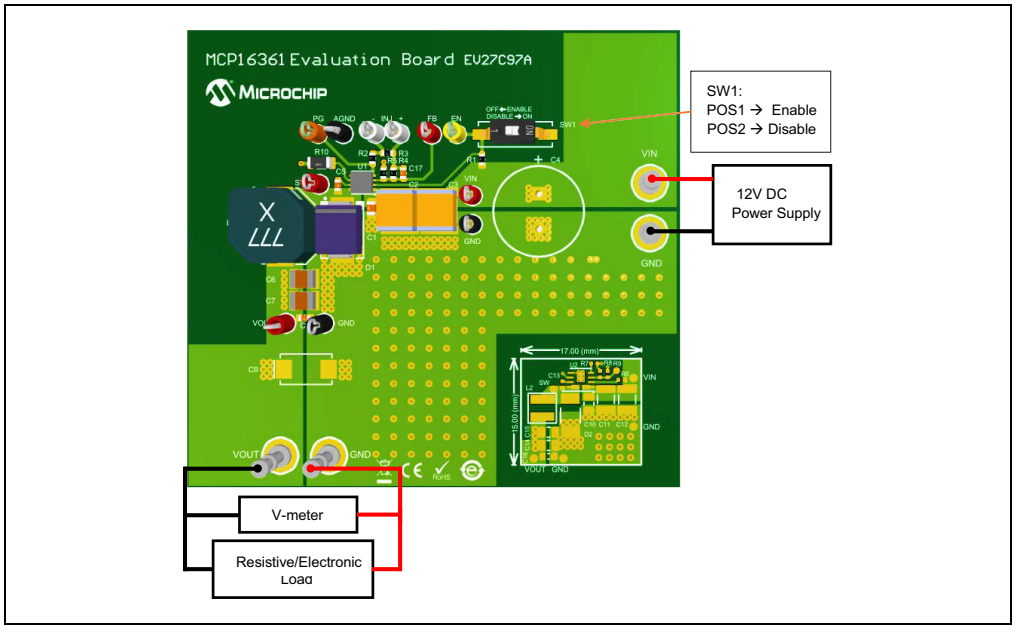


FIGURE 2-2: *MCP16361 Evaluation Board Test Setup.*

2.3.1.3 ADJUSTABLE V_{OUT} SETTING

The resistive divider consisting of RTOP and RBOT is used to set the converter's 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 inductor value or the MCP16361/2/3 Data Sheet for more information. The output voltage can be calculated using the following equation:

EQUATION 2-1:

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

Where:

V_{FB} = 0.8V

TABLE 2-1: RECOMMENDED INDUCTOR VALUES

V_{OUT}	Inductor Value
2	1 µH
3.3	1.5 µH
5	2.2 µH
9	3.8 µH
12	5.6 µH
15	6.8 µH
18	6.8 µH
24	7 µH

2.3.1.4 PERFORMANCE EVALUATION

This section provides specific operation waveforms and graphs. Refer to the MCP16361/2/3 Data Sheet (DS20006481) for more information.

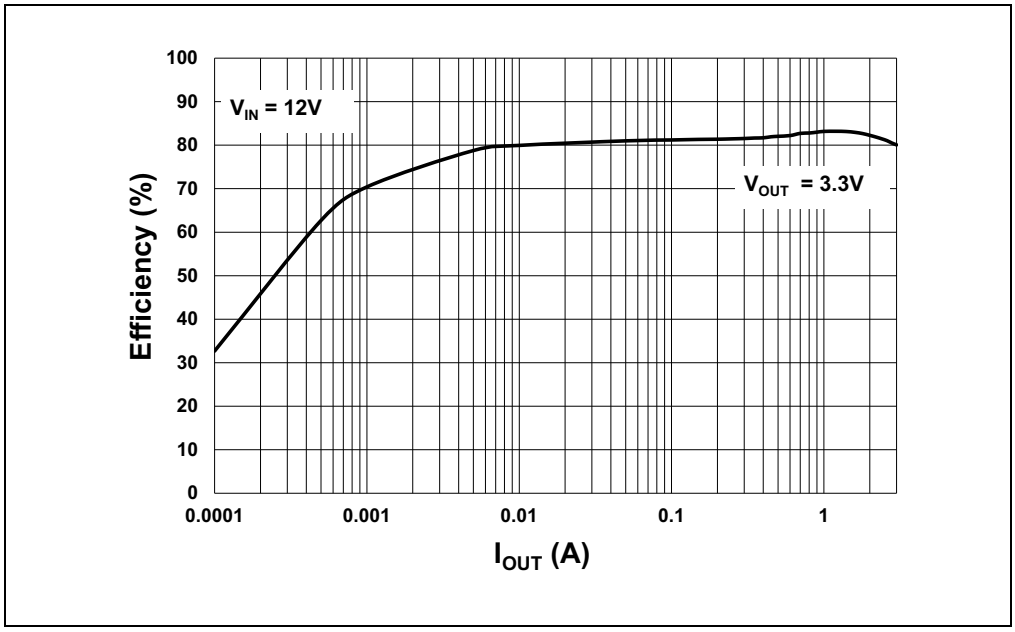


FIGURE 2-3: *MCP16361/2/3, Efficiency vs. I_{OUT} @ V_{OUT} = 3.3V, V_{IN} = 12V.*

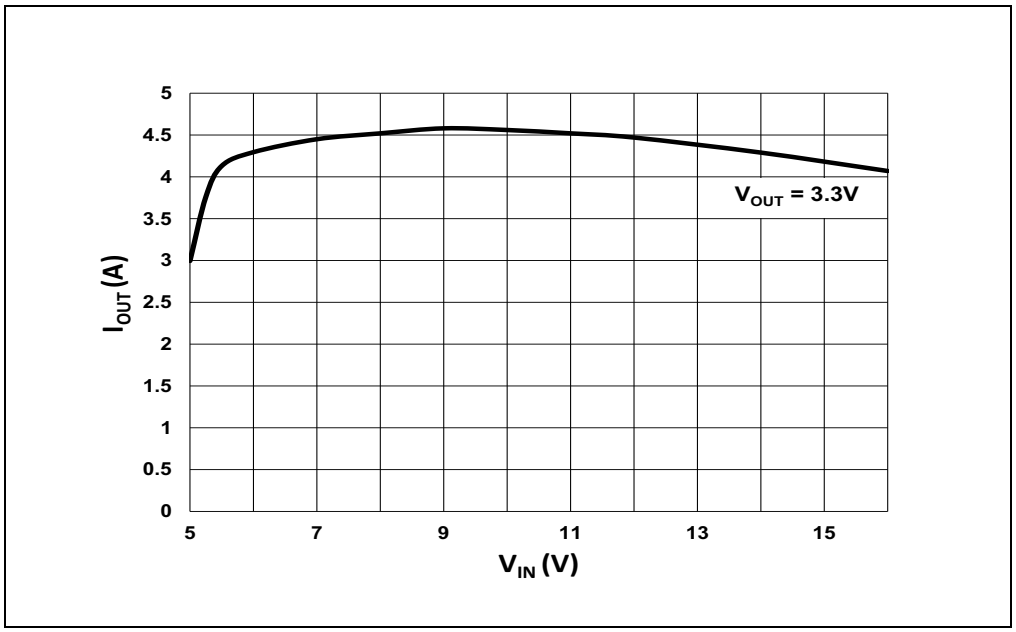


FIGURE 2-4: *MCP16361/2/3, Maximum I_{OUT} vs. V_{IN} with Maximum 5% Output Drop.*

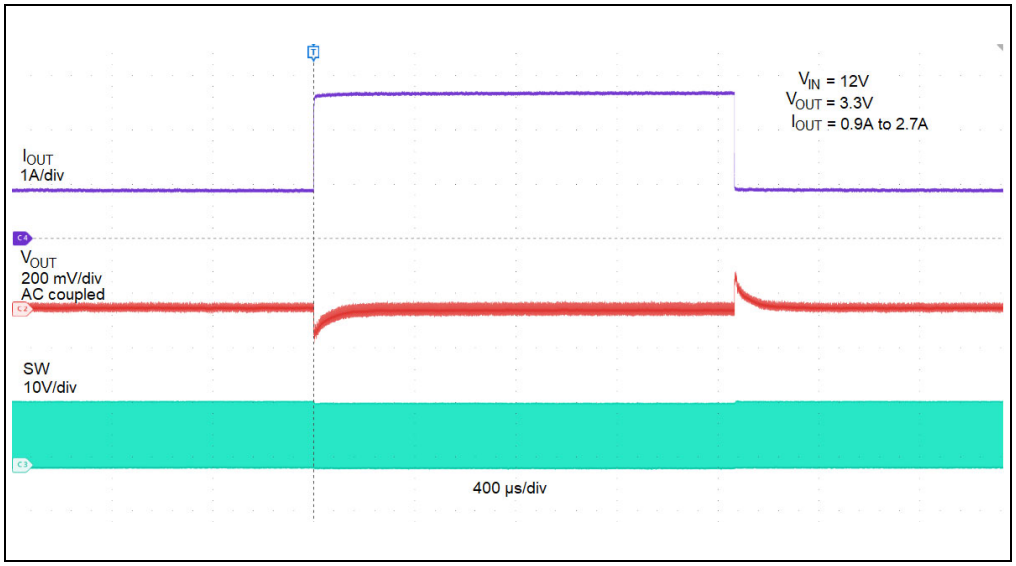


FIGURE 2-5: *MCP16361/2/3, Load Step Response.*

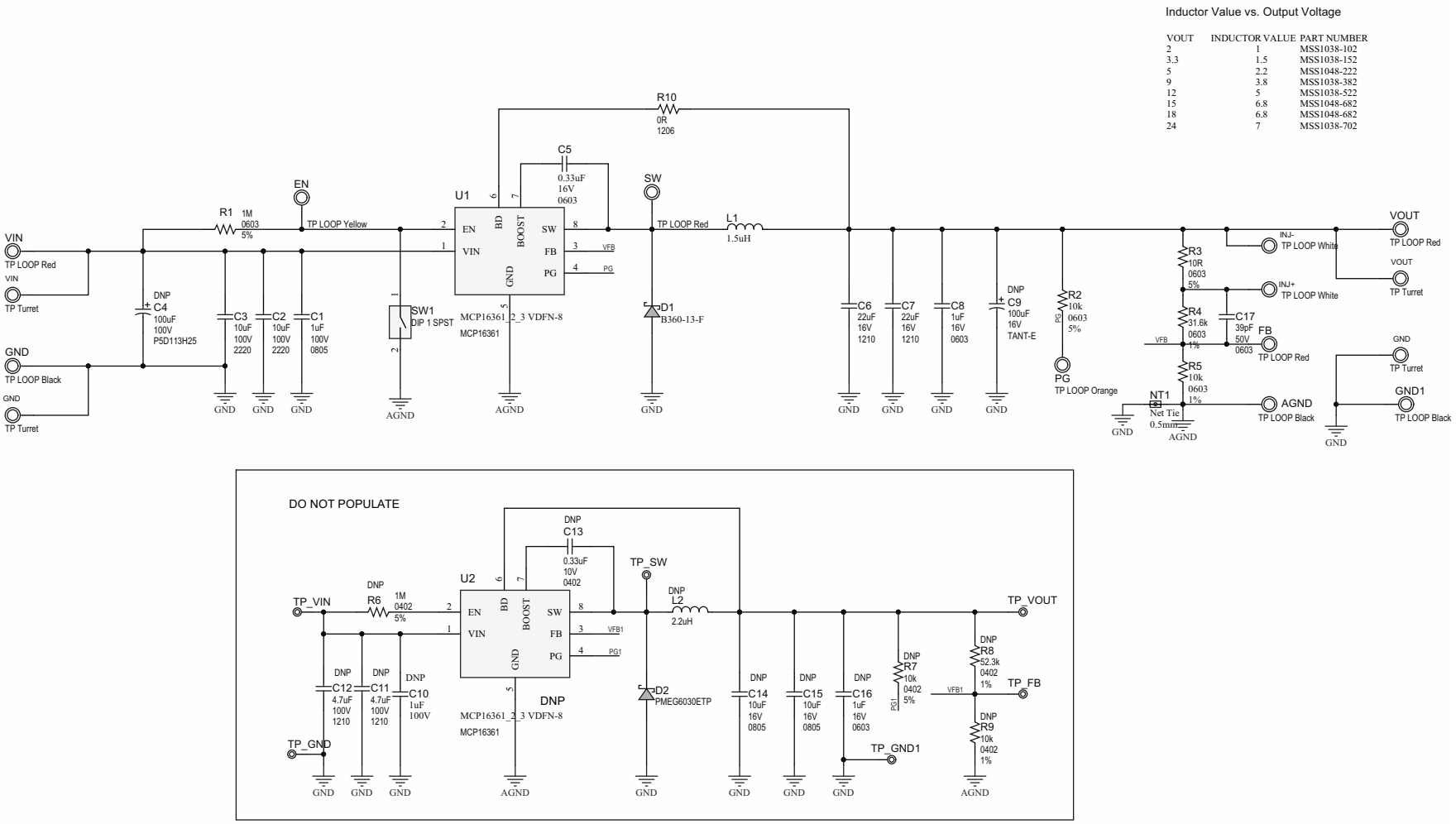
Appendix A. Schematic and Layouts

A.1 INTRODUCTION

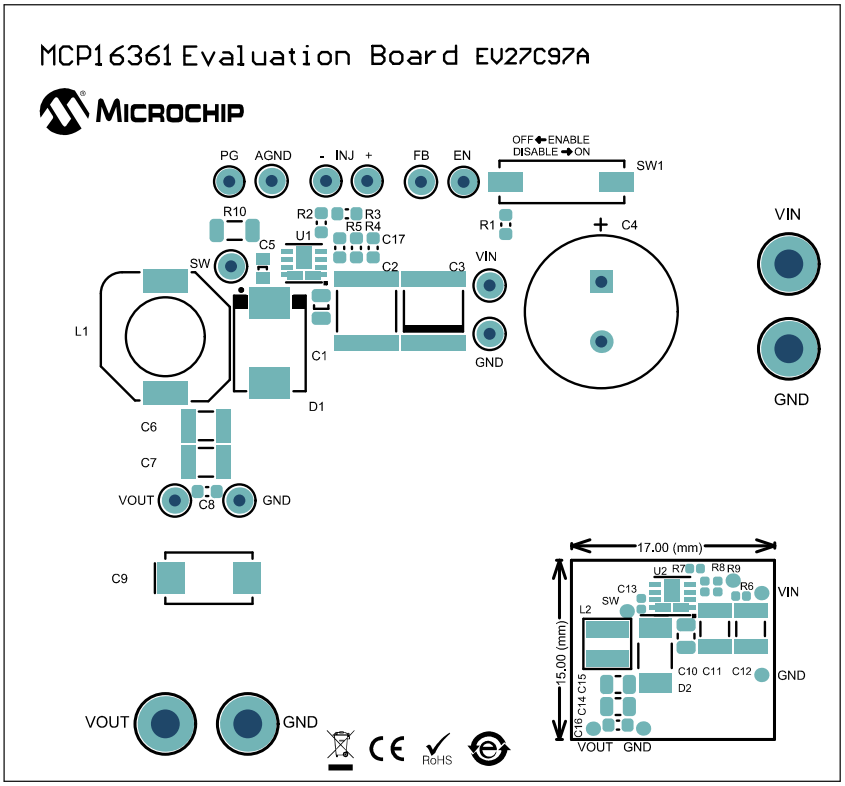
This appendix contains the following schematic and layouts for the MCP16361 Evaluation Board:

- Board – Schematic
- Board – Top Silk
- Board – Top Copper and Silk
- Board – Top Copper
- Board – Mid-Layer 1
- Board – Mid-Layer 2
- Board – Bottom Copper
- Board – Bottom Copper and Silk
- Board – Bottom Silk

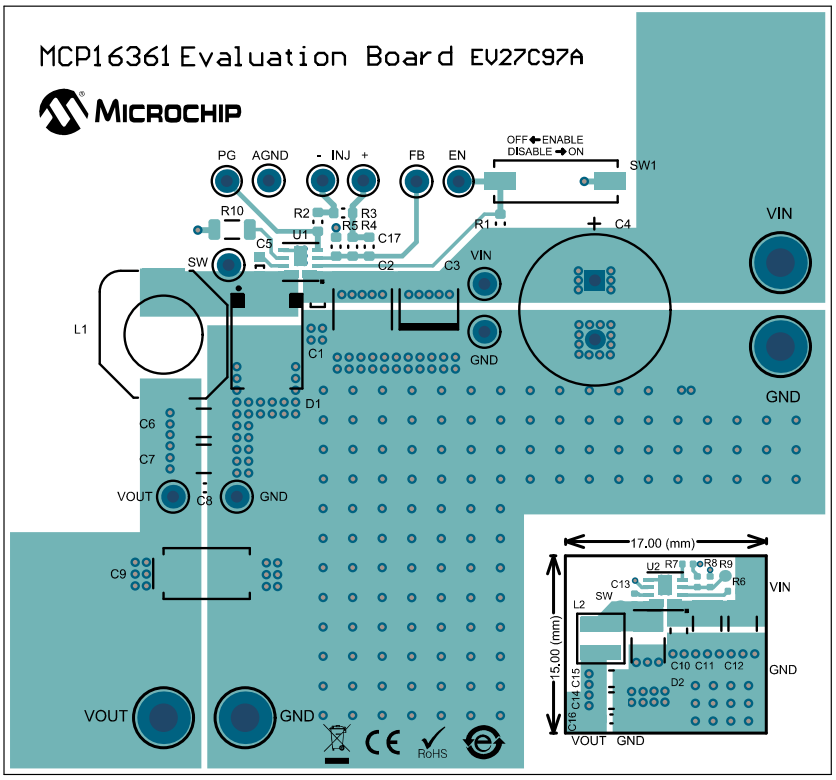
A.2 BOARD – SCHEMATIC



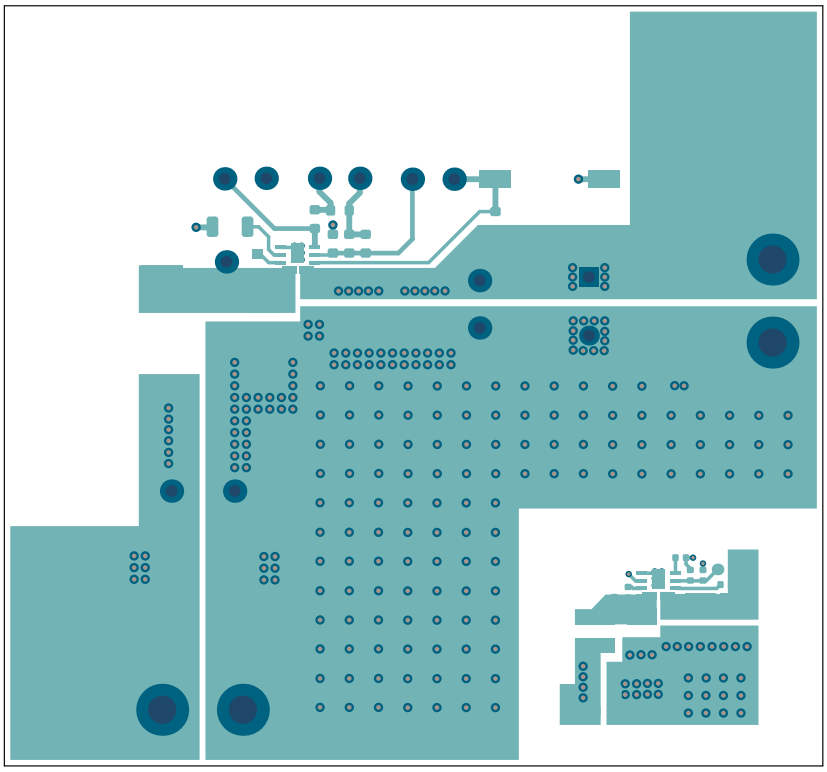
A.3 BOARD – TOP SILK



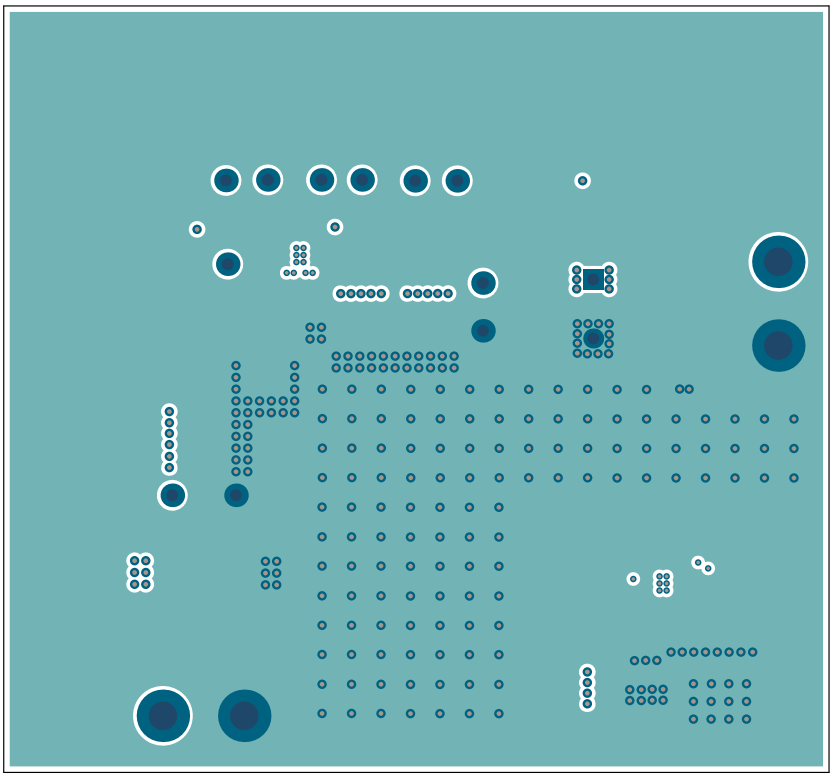
A.4 BOARD – TOP COPPER AND SILK



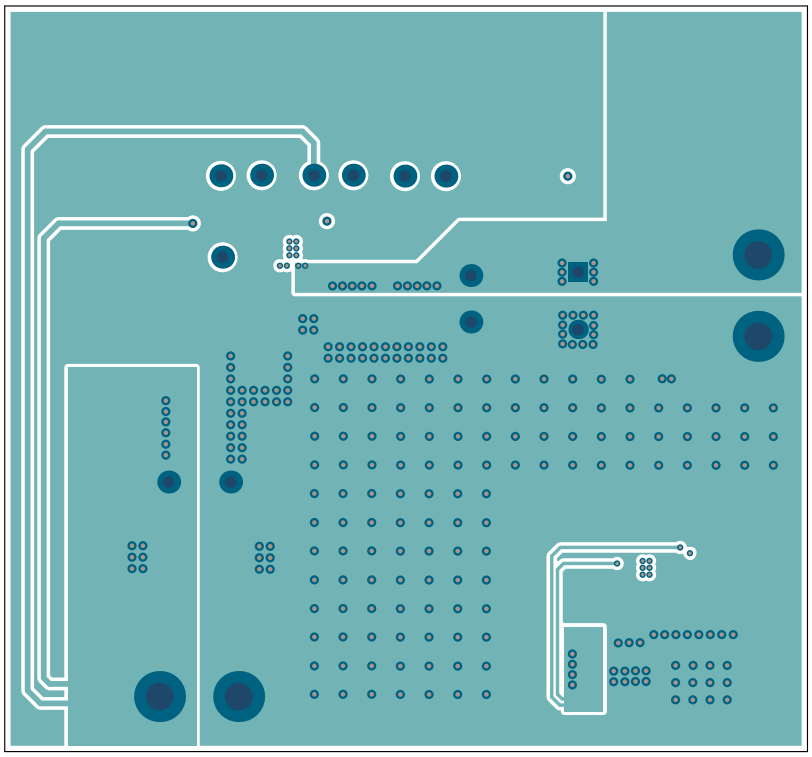
A.5 BOARD – TOP COPPER



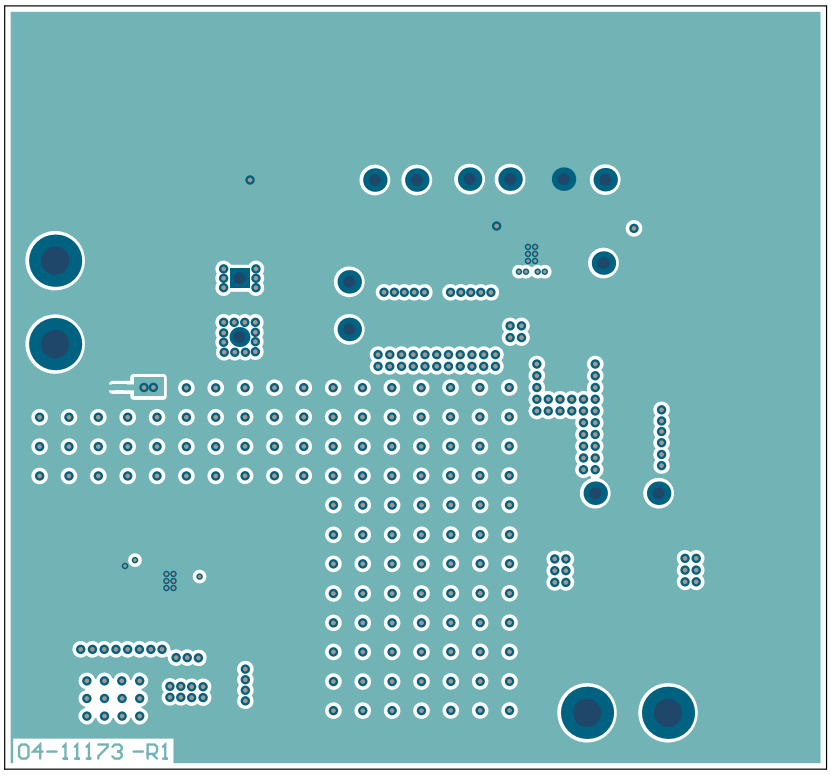
A.6 BOARD – MID-LAYER 1



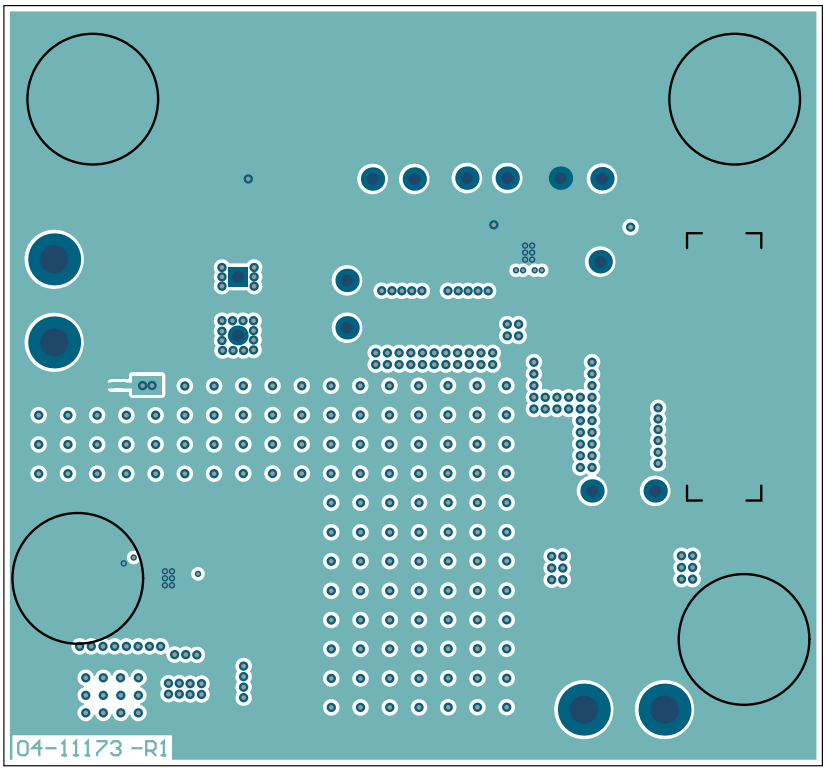
A.7 BOARD – MID-LAYER 2



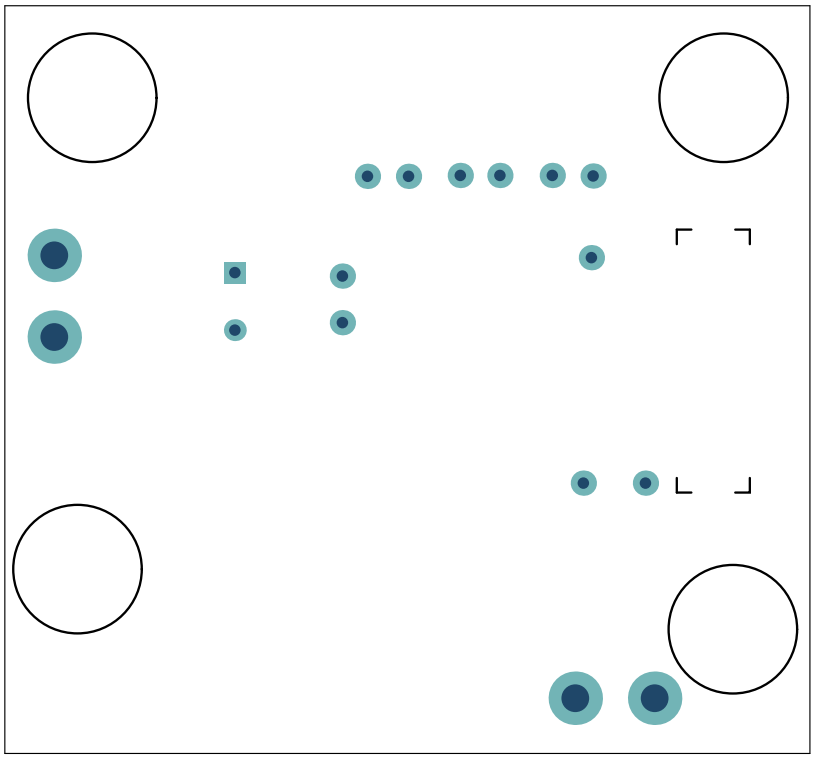
A.8 BOARD – BOTTOM COPPER



A.9 BOARD – BOTTOM COPPER AND SILK



A.10 BOARD – BOTTOM SILK



Appendix B. Bill of Materials (BOM)

TABLE B-1: BILL OF MATERIALS (BOM)

Qty.	Reference	Description	Manufacturer	Part Number
3	AGND, GND, GND1	Test Point, Mini, Black	Keystone® Electronics Corp.	5001
1	C1	Capacitor, Ceramic, 1 µF, 100V, 10%, X7S, SMD, 0805	TDK Corporation	C2012X7S2A105K125A
2	C2, C3	Capacitor, Ceramic, 10 µF, 100V, 20%, X7S, SMD, 2220	TDK Corporation	C5750X7S2A106M
1	C5	Capacitor, Ceramic, 0.33 µF, 16V, 10%, X7R, SMD, 0603	Murata Manufacturing Co., Ltd.	GRM188R71C334KA01D
2	C6, C7	Capacitor, Ceramic, 22 µF, 16V, 10%, X7R, SMD, 1210, AEC-Q200	TDK Corporation	CGA6P1X7R1C226M25
1	C8	Capacitor, Ceramic, 1 µF, 16V, 5%, SMD, 0603	Yageo	CC0603KRX7R7BB105
1	C17	Capacitor, Ceramic, 39 pF, 50V, 20%, X5R, SMD, 0603	TDK Corporation	CGA3E2C0G1H390J080
1	D1	Diode, Schottky, 700 mV, 3A, 60V, DO-214AB, SMC	Diodes Incorporated	B360-13-F
1	EN	Test Point, Mini, Yellow	Keystone Electronics Corp.	5004
4	FB, SW, VIN, VOUT	Test Point, Mini, Red	Keystone Electronics Corp.	5000
1	L1	Inductor, 1.5 µH, 7.85A, 30%, SMD	Coilcraft	MSS1038-152NLC
1	PCB1	Printed Circuit Board	Microchip Technology Inc.	**02-00058**
1	PG	Test Point, Loop Type, Orange	Keystone Electronics Corp.	5003
1	R1	Resistor, TKF, 1 MΩ, 5%, 1/10W, SMD, 0603	Yageo Corporation	9C06031A1004JLHFT
1	R2	Resistor, TKF, 10 kΩ, 5%, 1/10W, SMD, 0603	Panasonic®	ERJ-3GEYJ103V
1	R3	Resistor, TKF, 10Ω, 5%, 1/10W, SMD, 0603	Panasonic	ERJ-3GEYJ100V
1	R4	Resistor, TKF, 31.6 kΩ, 1%, 1/10W, SMD, 0603	Panasonic	ERJ-3EKF3162V
1	R5	Resistor, TKF, 10 kΩ, 1%, 1/16W, SMD, 0603	TE Connectivity	CPF0603F10KC1
1	R10	Resistor, TKF 0 Ω, SMD, 1206	Yageo	RC1206JR-070RL
1	SW1	Switch, DIP 1 SPST 24V 25 mA, SMD	Wurth Elektronik	418121160801
4	TP1, TP2, TP3, TP4	Connector, Turret, Single, Tin, Through Hole	Keystone Electronics Corp.	1502-2
	TP6, TP7	Test Point, Mini, White	Keystone Electronics Corp.	5002

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.

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

Qty.	Reference	Description	Manufacturer	Part Number
1	U1	Microchip Analog Switching Regulator, 4V to 48V, VDFN-8	Microchip Technology Inc.	**MCP16361T-E/NMX**

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.

TABLE B-2: BILL OF MATERIALS (BOM) — MECHANICAL PARTS

Qty.	Reference	Description	Manufacturer	Part Number
4	PAD1, PAD2, PAD3, PAD4	Mechanical HW Rubber Pad, Bumpon™ Hemisphere, 0.44" x 0.20", Black	3M	SJ-5003-BLACK

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.

TABLE B-3: BILL OF MATERIALS (BOM) — DO NOT POPULATE PARTS

Qty.	Reference	Description	Manufacturer	Part Number
1	C4	Capacitor, Aluminum, 100 µF, 100V, 20%	Wurth Elektronik	860130878011
1	C9	Capacitor, Tantalum, 100 µF, 16V, 20%, X7S, SMD, 2197	KEMET	T491X107M016AT
1	C10	Capacitor, Ceramic, 1 µF, 100V, 20%3, X7S, SMD, 0805	TDK Corporation	C2012X7S2A105M125AB
2	C11, C12	Capacitor, Ceramic, 4.7 µF, 16V, 10%, X7R, SMD, 0805, 1210, AEC-Q200	Taiyo Yuden	HMK325C7475KMHPE
1	C13	Capacitor, Ceramic, 0.33 µF, 10V, 10%, C0G, SMD	Samsung Electro-Mechanics America, Inc.	CL05A334KP5NNNC
2	C14, C15	Capacitor, Ceramic, 10 µF, 16V, 20%, X7R, SMD, 0805	Taiyo Yuden Co., Ltd.	EMK212BB7106MG-T
1	C16	Capacitor, Ceramic, 1 µF, 16V, 10%, X7R, SMD, 0603	Yageo	CC0603KRX7R7BB105
1	D2	Diode, Schottky, 60V, 3A, SMD, SOD-128	Nexperia USA Inc.	PMEG6030ETPX
1	L2	Inductor, 2.2 µH, 5.5A, 20%, SMD	Coilcraft	XAL4020-222MEC
1	R6	Resistor, TKF, 1 MΩ, 5%, 1/16W, SMD, 0402	Yageo	RC0402JR-071ML
1	R7	Resistor, TKF, 10 kΩ, 5%, 1/10W, SMD, 0402	Panasonic	ERJ-2GEJ103X
1	R8	Resistor, TKF, 52.3 kΩ, 1%, 1/10W, SMD, 0402	Panasonic	ERJ-2RKF5232X
1	R9	Resistor, TKF, 10 kΩ, 1%, 1/10W, SMD, 0402	Panasonic	ERJ-2RKF1002X
1	U2	Microchip Analog Switching Regulator, 4V to 48V, VDFN-8	Microchip Technology Inc.	**MCP16361T-E/NMX**

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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