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MCP1632
300 kHz Boost Converter
Demo Board
User's Guide

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Derek Carlson
VP Development Tools

16-July-2013
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 “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 MCP1632 300 kHz Boost Converter 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 MCP1632 300 kHz Boost Converter 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”** – Shows a brief description of the MCP1632 300 kHz Boost Converter Demo Board.
- **Chapter 2. “Installation and Operation”** – Includes instructions on how to get started with the MCP1632 300 kHz Boost Converter Demo Board.
- **Appendix A. “Schematic and Layouts”** – Shows the schematic and layout diagrams for the MCP1632 300 kHz Boost Converter Demo Board.
- **Appendix B. “Bill of Materials”** – Lists the parts used to build the MCP1632 300 kHz Boost Converter Demo Board.
- **Appendix C. “Typical Performance Data, Curves and Waveforms”** – Shows the typical performance graphs.

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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 MCP1632 300 kHz Boost Converter Demo Board. Other useful documents are listed below. The following Microchip documents are available and recommended as supplemental reference resources.

- **MCP1632 Data Sheet – “High-Speed Low-Side PWM Controller” (DS20005254)**

THE MICROCHIP WEB SITE

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

- **Product Support** – Data sheets and errata, application notes and sample programs, design resources, user's guides and hardware support documents, latest software releases and archived software
- **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

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- 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 (January 2014)

- Initial Release of this Document.

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Chapter 1. Product Overview

1.1 INTRODUCTION

This chapter provides an overview of the MCP1632 300 kHz Boost Converter Demo Board and covers the following topics:

- Short Overview: MCP1632 PWM Controller
- What is the MCP1632 300 kHz Boost Converter Demo Board?
- What is Contained In the MCP1632 300 kHz Boost Converter Demo Board Kit?

1.2 SHORT OVERVIEW: MCP1632 PWM CONTROLLER

The MCP1632 is a high-speed, Current Mode PWM controller intended for applications that require low-side MOSFET control, such as the Boost, Flyback or SEPIC converters. The MCP1632 converter integrates all the blocks necessary to develop a standalone switch-mode power supply. The MCP1632 PWM controller offers great flexibility to designers, as the power train can be tailored for various applications and power levels. The MCP1632 converter includes: internal oscillator with two options for switching frequency (300 kHz and 600 kHz), adjustable reference voltage generator and adjustable soft-start time, internal ramp generator for slope compensation and blanking circuit for current sense (CS) signal, and an Undervoltage Lockout circuit (UVLO). The MCP1632 PWM converter can be easily interfaced with PIC[®] microcontrollers in order to develop intelligent solutions. The MCP1632 converter accepts input bias voltages between 3V and 5.5V. For larger input voltages, a linear voltage regulator can be used to provide the necessary bias voltage.

Typical applications include: general purpose DC-DC converters, LED drivers, batteries chargers and bias generators.

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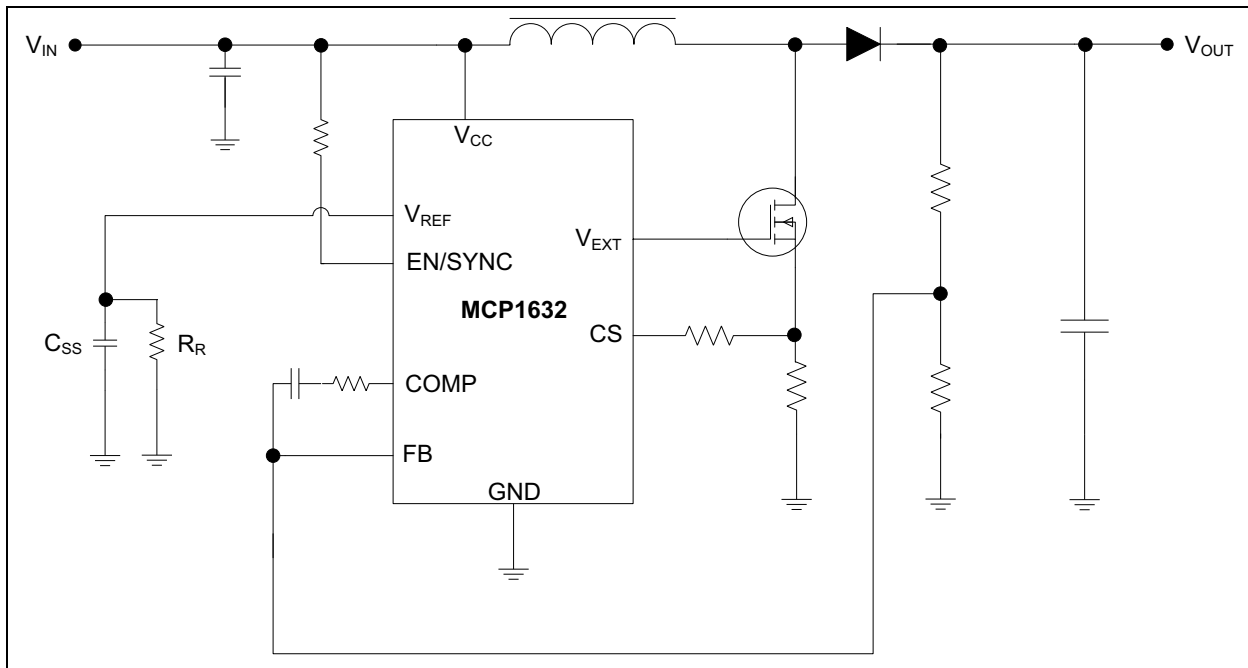


FIGURE 1-1: MCP1632 Typical Application for Peak Current Mode Control.

1.3 WHAT IS THE MCP1632 300 KHZ BOOST CONVERTER DEMO BOARD?

The MCP1632 300 kHz Boost Converter Demo Board is a compact, highly efficient, step-up voltage converter that will convert the input voltage rail (typically 5V) to a regulated 12V output voltage. The maximum output current for this demo board is 0.9A. The board demonstrates the capabilities of the MCP1632 PWM controller. Test points for various signals are provided for measuring different parameters of the converter. The demo board can be modified to support output voltages from 9V to 15V by changing a single resistor.

1.4 WHAT IS CONTAINED IN THE MCP1632 300 KHZ BOOST CONVERTER DEMO BOARD KIT?

This MCP1632 300 kHz Boost Converter Demo Board kit includes the following items:

- MCP1632 300 kHz Boost Converter Demo Board (ADM00530)
- Important Information Sheet

Chapter 2. Installation and Operation

2.1 INTRODUCTION

The MCP1632 300 kHz Boost Converter Demo Board was developed to provide a compact, low-cost and highly efficient step-up conversion for low output currents.

The key features of this board include:

- Input Voltage Range: 3.6V to 5.5V
- Output Voltage: 12V (can be adjusted between 9V and 15V by changing a single resistor)
- Maximum Output Current: 0.9A
- 90% typical efficiency at 12V/0.8A output and 5V input
- 300 kHz fixed switching frequency
- Overcurrent Protection for MOSFETs
- Shutdown input for placing the converter in low-power Standby mode
- Undervoltage Lockout (UVLO) with 2.7V (Off) and 2.8V (On) typical thresholds

2.2 GETTING STARTED

The MCP1632 300 kHz Boost Converter Demo Board is fully assembled and tested to evaluate and demonstrate the capabilities of the MCP1632 PWM controller.

2.2.1 Necessary Instruments and Tools

- Adjustable DC Power Supply with 0V-6V/5 A_{DC} range output capability
- Electronic load with at least 1A current capability and load stepping capability
- Digital Oscilloscope with a minimum bandwidth of 50MHz
- Digital voltmeter/ammeter
- Optionally, a Network Analyzer/Bode Plot Analyzer for loop analysis
- Wires for connections; these wires must sustain high current, 4A for the connection between adjustable DC power supply and board, 1A for the connection between the board and the electronic load

2.2.2 Setup procedure

To power up the MCP1632 300 kHz Boost Converter Demo Board, the following steps must be completed:

1. Connect the Electronic Load to J3 connector of the demo board; the "Positive" (+) and "Negative" (-) connector pins are marked on the board silkscreen.
2. Connect the Adjustable DC Power Supply to J1 connector of the demo board; the "Positive" (+) and "Negative" (-) connector pins are marked on the board silkscreen.
3. The DC voltage supplied by the Adjustable DC Power Supply must be between 3.6V and 5.5V.

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2.2.3 Board Testing

The typical testing setup is depicted in Figure 2-1. Table 2-1 shows all the available test points on the board.

The user can connect various instruments at the listed test points to evaluate the parameters of the converter. The typical performance data, curves and waveforms are presented in [Appendix C. "Typical Performance Data, Curves and Waveforms"](#). Note that some parameters vary with the input voltage (e.g., the maximum output current should not exceed 0.8A if the input voltage is below 4 V).

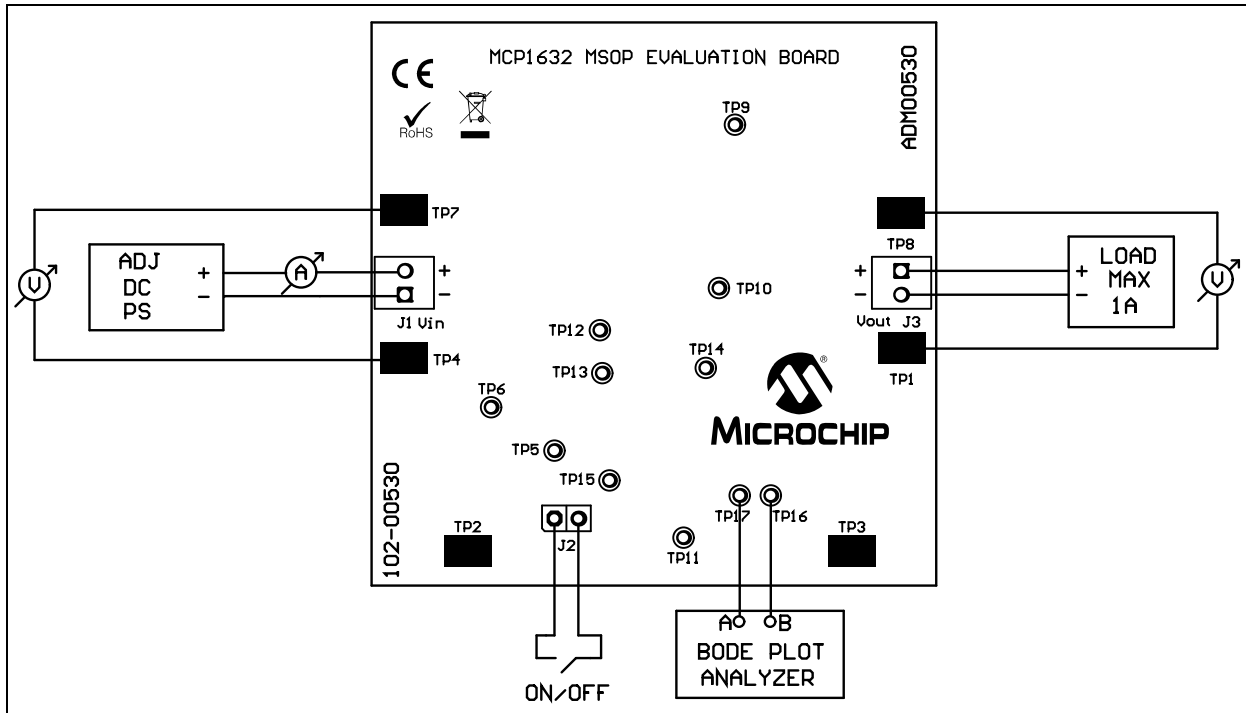


FIGURE 2-1: Typical Test Setup.

TABLE 2-1: TEST POINTS DESCRIPTION

Test Point	Label	Description
TP1, TP2, TP3, TP4	GND	Board GND
TP6, TP7	V_{IN}	Input voltage
TP5	SHDN	Shutdown input (EN pin of MCP1632)
TP14	CS	CS pin of MCP1632
TP12	MCS	MOSFET current sense resistor (R9)
TP10	DR	MOSFET drive signal (pin 6 of MCP1632)
TP9	SW	Main switch node (drain of Q1 MOSFET)
TP13	V_{REF}	Reference voltage (pin 8 of MCP1632)
TP8	V_{OUT}	Converter's output voltage
TP11	FB	Feedback voltage (pin 2 of MCP1632)
TP15	COMP	Output of the error amplifier (pin 2 of MCP1632)
TP16, TP17	CH B, CH A	Signal injection points for loop measurement

2.2.3.1 ADJUSTING THE OUTPUT VOLTAGE

The output voltage can be modified by changing the value of R8 from the feedback divider. The output voltage is set according to Equation 2-1.

EQUATION 2-1: OUTPUT VOLTAGE

$$V_{OUT} = V_{REF} \times \frac{R3 + R8}{R8}$$

Where:

$$V_{REF}(V) = R5(\Omega) \times 50 \times 10^{-6}$$

$$R3 = 20 \text{ k}\Omega$$

Do not modify the value of the R3 resistor (20 kΩ) because this will affect the loop compensation of the system.

Some parameters, such as efficiency, the overcurrent protection thresholds and the input and output voltage ripple, can be affected by the modification of the output voltage.

Table 2-2 shows the standard value of the R8 resistor for several common output voltages.

TABLE 2-2: OUTPUT VOLTAGE VERSUS R8 VALUE (R3 = 20 kΩ)

V _{OUT} (V)	R8 (kΩ)	V _{REF} (V)
9	5.71	2
12	4.02	2
15	3.08	2

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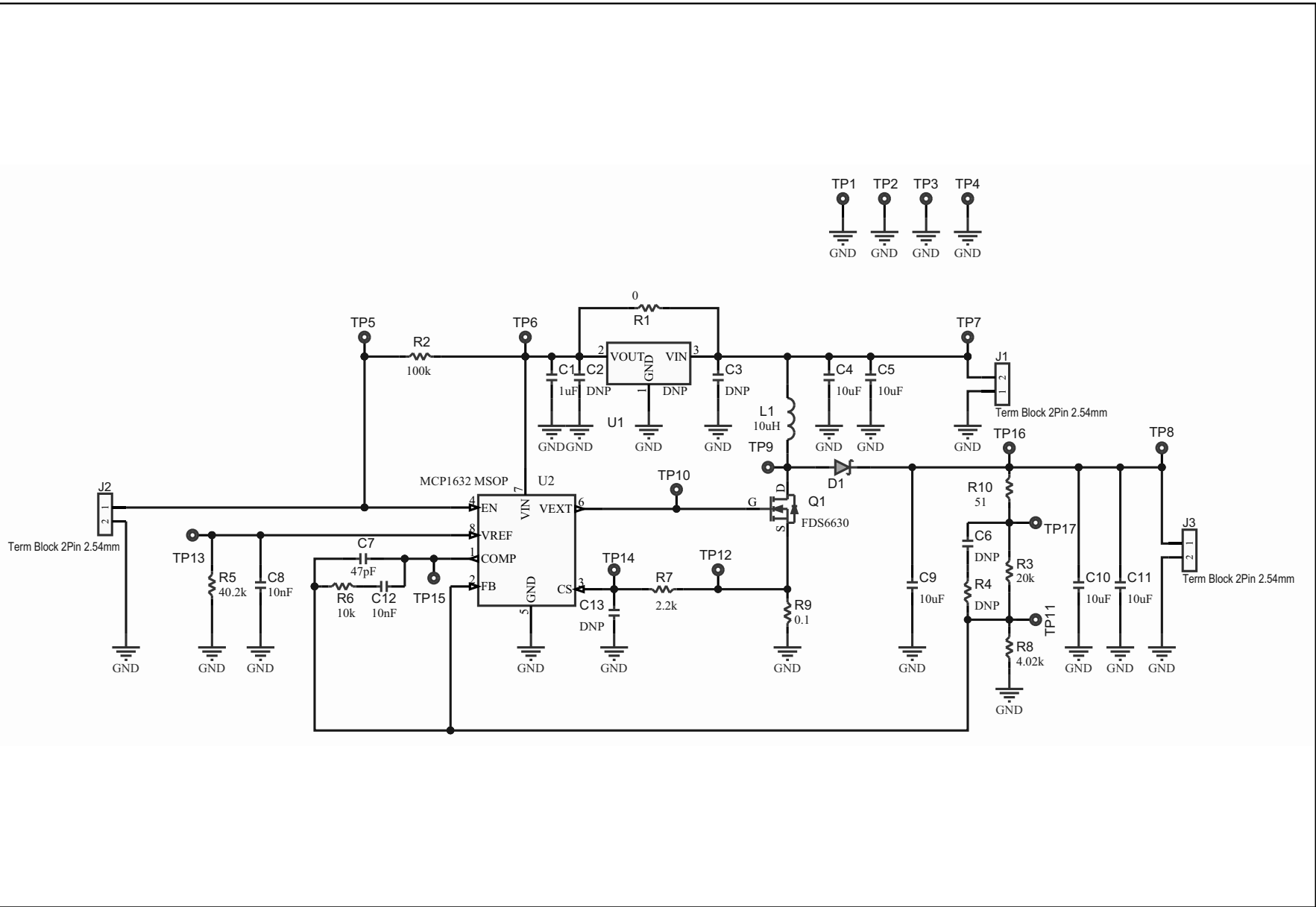
Appendix A. Schematic and Layouts

A.1 INTRODUCTION

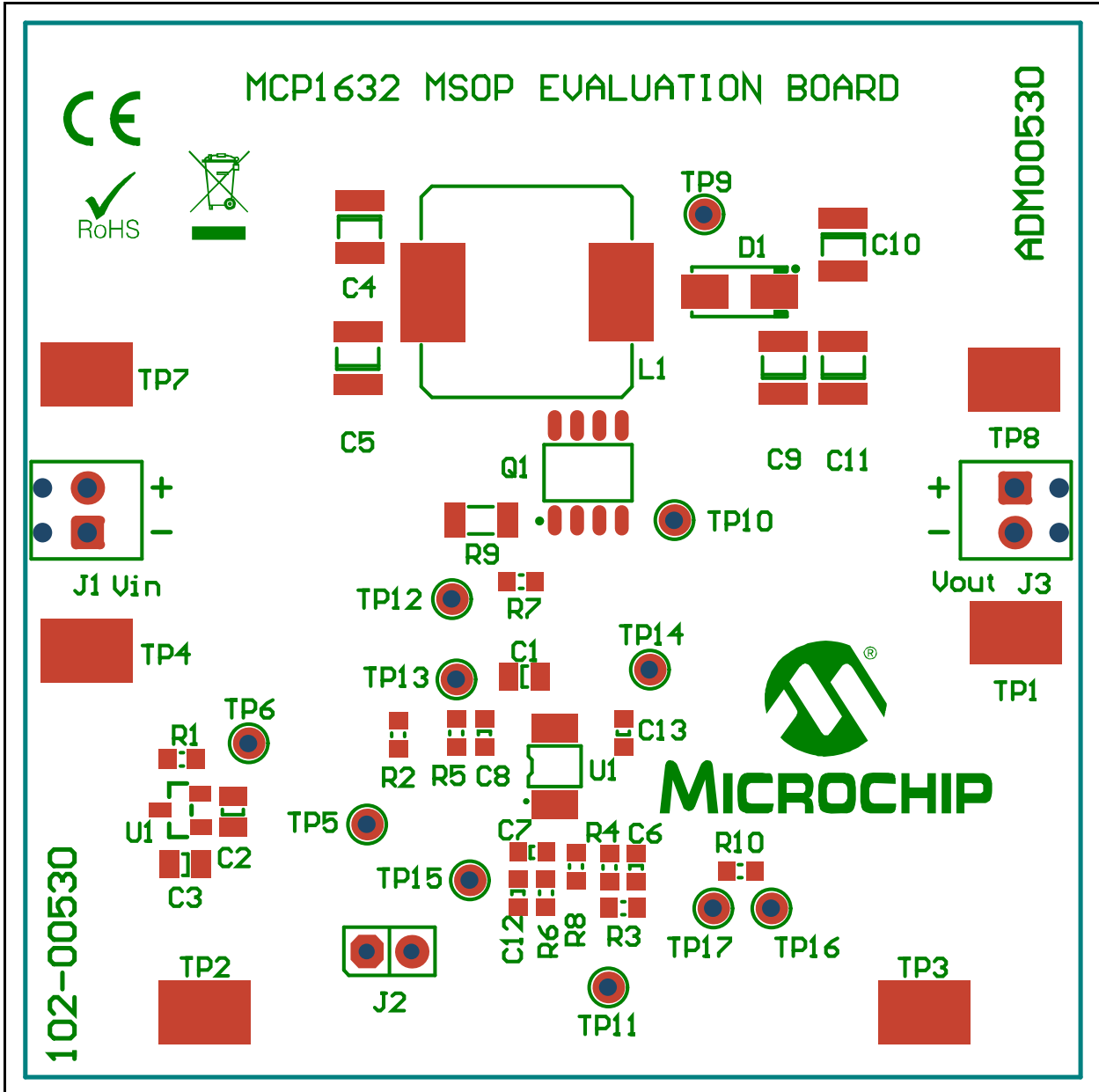
This appendix contains the following schematics and layouts for the MCP1632 300 kHz Boost Converter Demo Board:

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

A.2 BOARD – SCHEMATIC

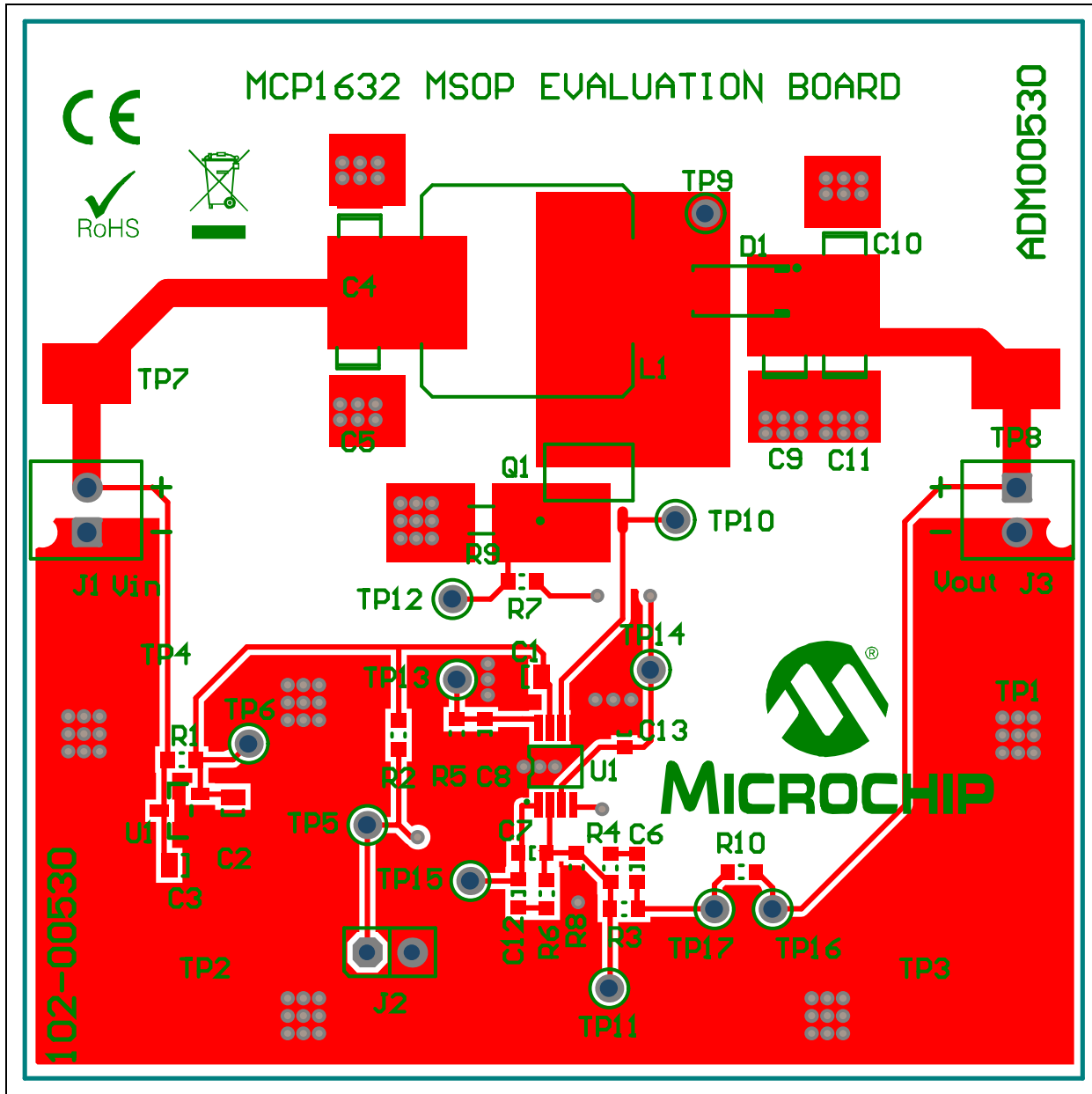


A.3 BOARD – TOP SILK

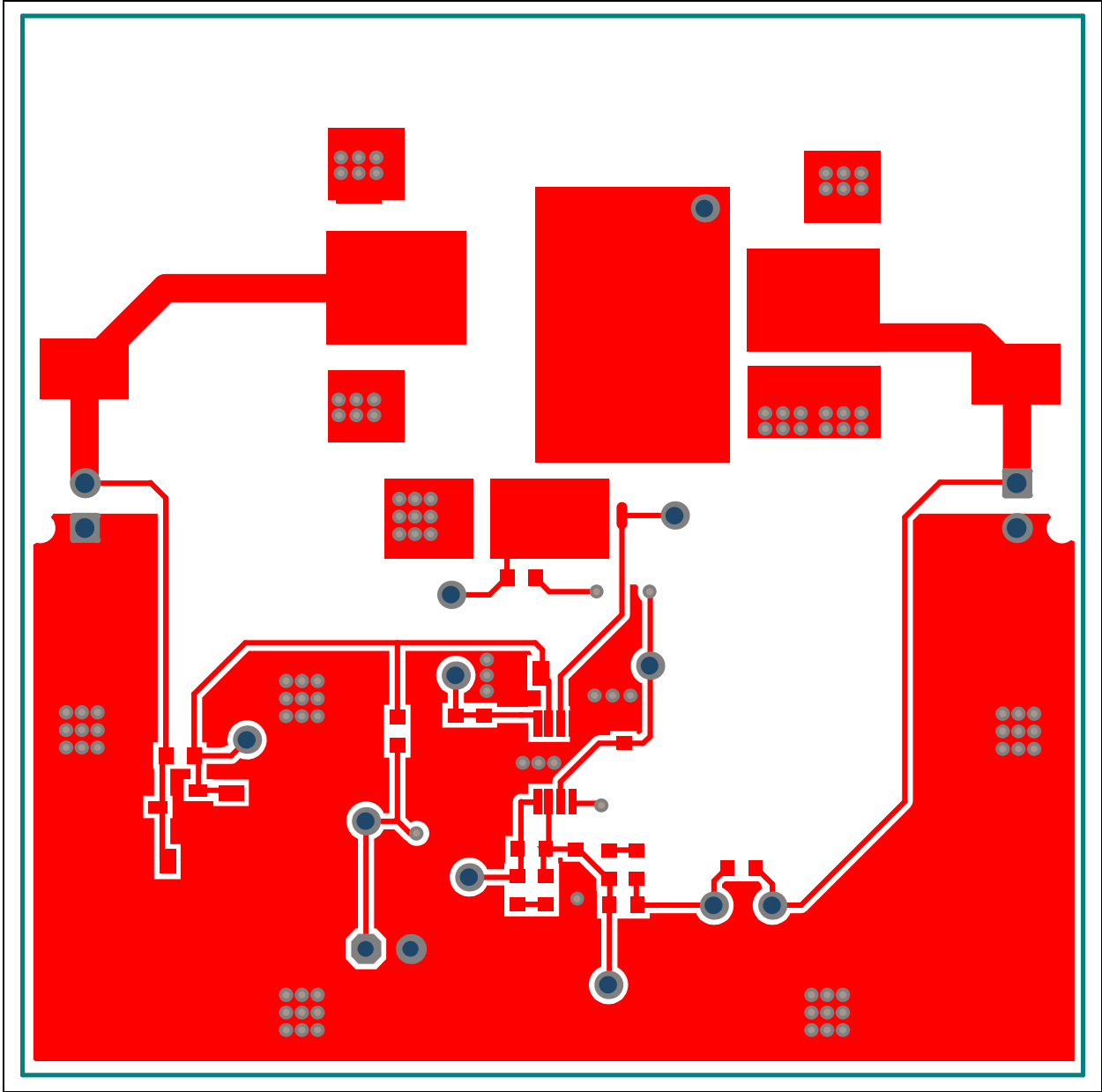


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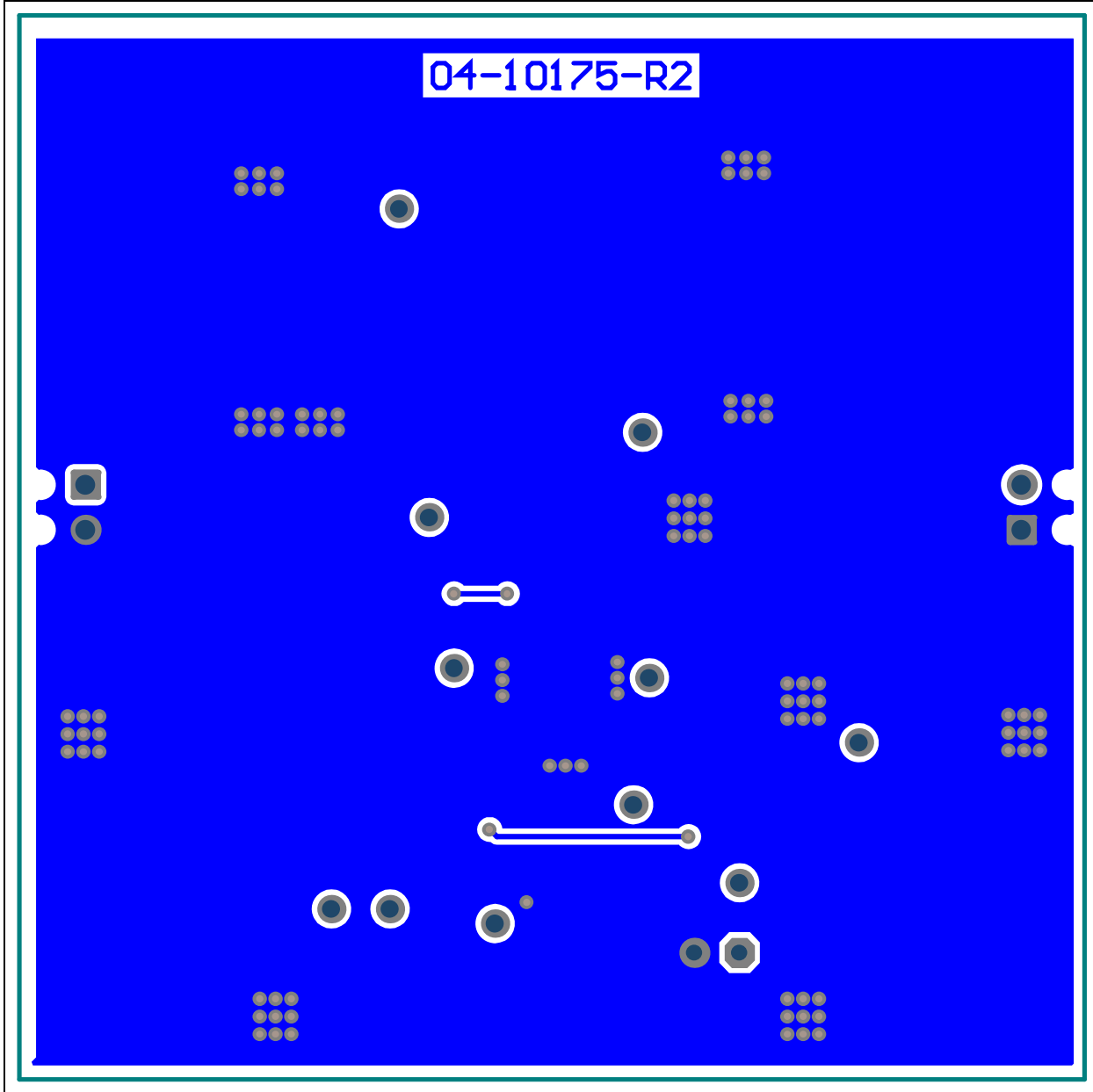
A.4 BOARD – TOP COPPER AND SILK



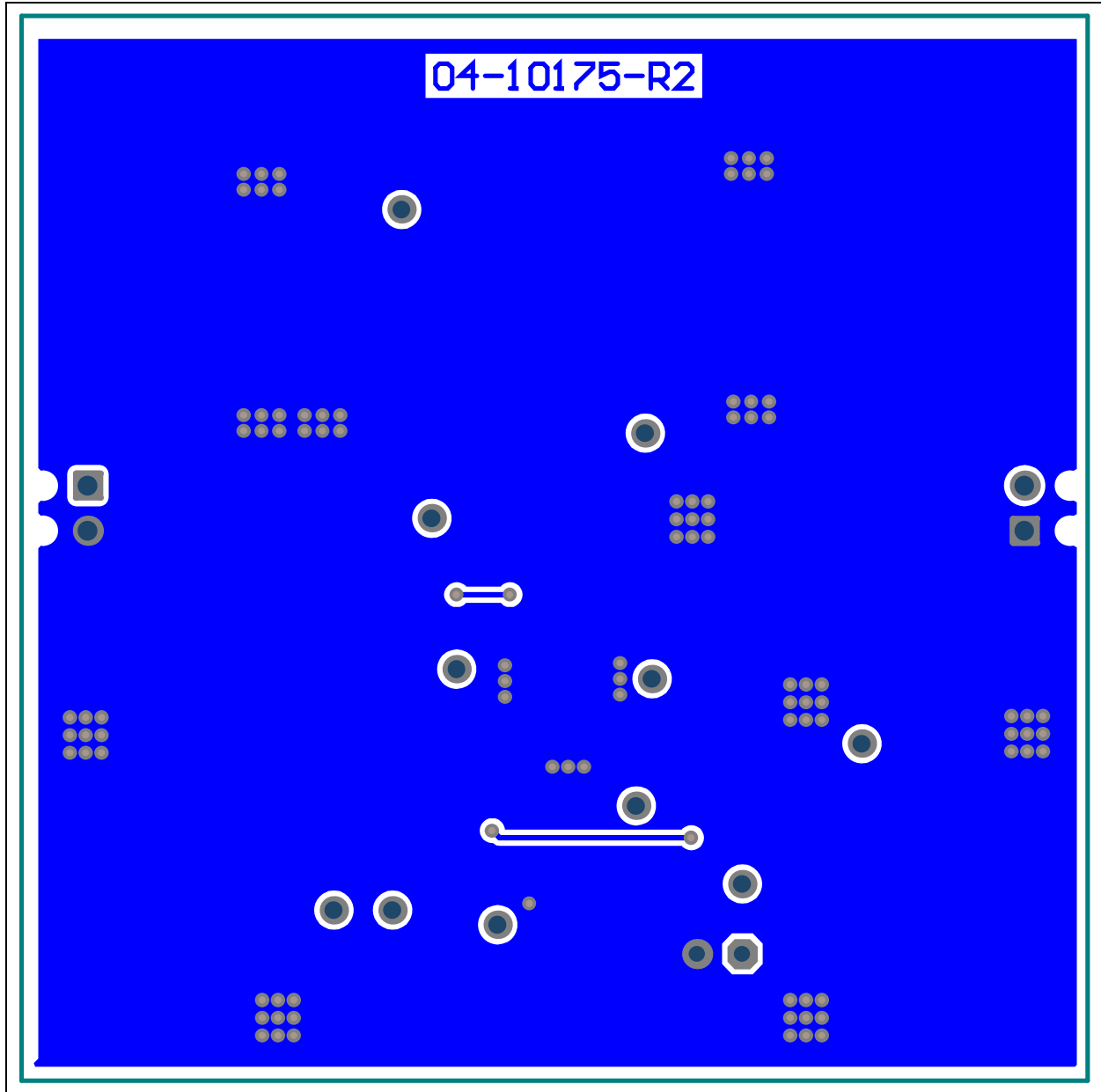
A.5 BOARD – TOP COPPER



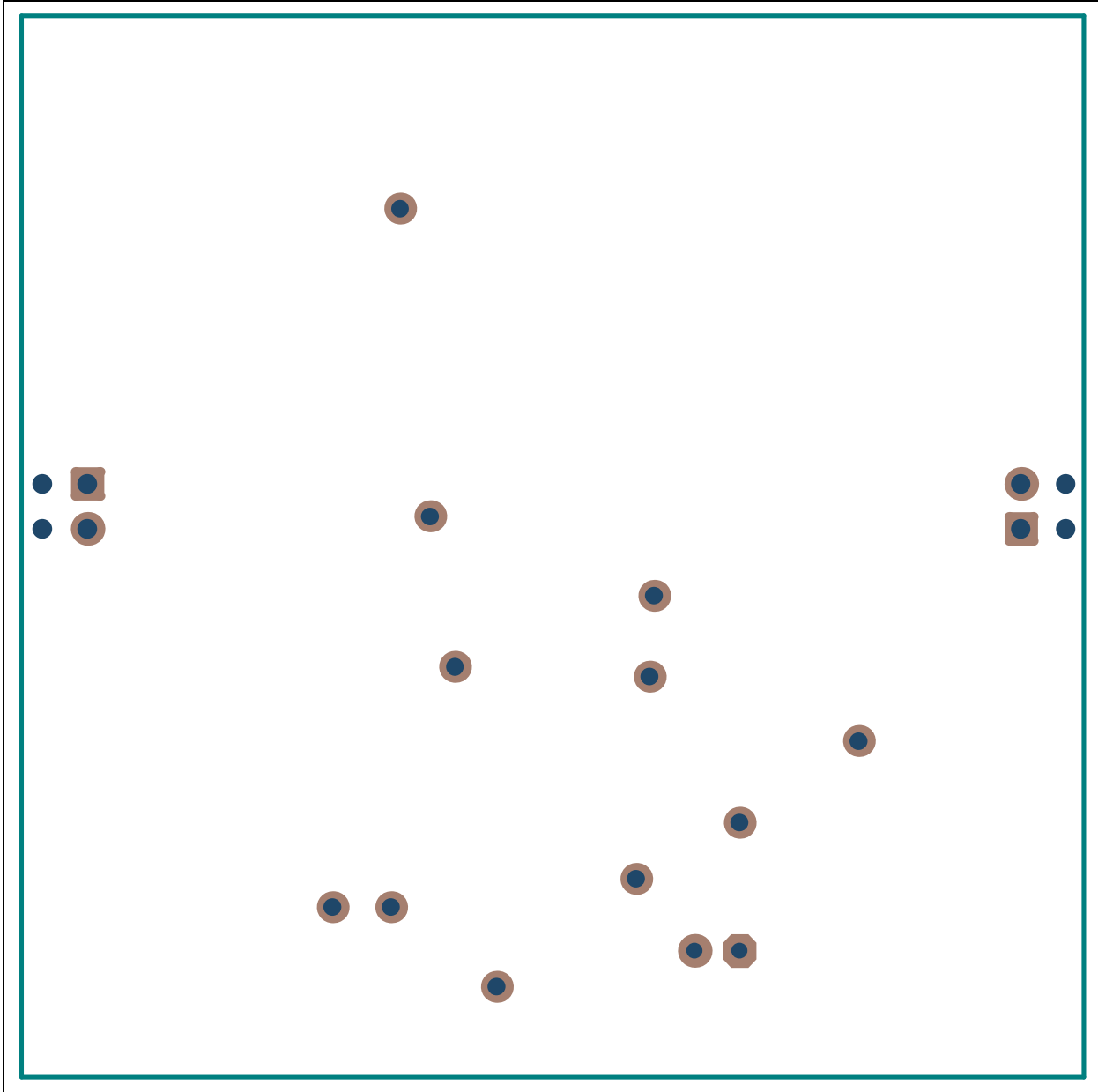
A.6 BOARD – BOTTOM COOPER



A.7 BOARD – BOTTOM COPPER AND SILK



A.8 BOARD – BOTTOM SILK





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Appendix B. Bill of Materials

TABLE B-1: BILL OF MATERIALS (BOM)

Qty	Reference	Description	Manufacturer	Part Number
1	C1	Cap. ceramic 1 μ F 16V 10% X7R 0805	Yageo Corporation	CC0805KKX7R7BB105
0	C2 – C3, C6, C13	DO NOT POPULATE	—	—
2	C4 – C5	Cap. ceramic 10 μ F 16V 10% X7R 1210	Samsung Electro-Mechanics America, Inc.	CL32B106KOULNNE
1	C7	Cap. ceramic 47 pF 100V 5% COG 0603	AVX Corporation	06031A470JAT2A
2	C8, C12	Cap. ceramic 10000 pF 25V 5% NP0 0603	TDK Corporation	C1608C0G1E103J080AA
3	C9 – C11	Cap. ceramic 10 μ F 25V 10% X7R 1210	TDK Corporation	C3225X7R1E106K
1	D1	Diode Schottky 40V 2A DO214AC	Vishay	SSA24-E3/61T
2	J1, J3	Conn. term. block 2.54 MM 2 POS	Phoenix Contact GmbH & Co.	1725656
2	J2	Conn. header Vert. 0.100" Gold	TE Connectivity, Ltd.	5-146868-1
1	L1	Inductor power 10 UH 4.00A SMD	EPCOS AG	B82477G2103M
	PCB	Printed Circuit Board - MCP1632 300 kHz Boost Converter Demo Board	—	104-00530
1	Q1	MOSFET N-Ch. 30V 6.5A 8 SOIC	Fairchild Semiconductor®	FDS6630A
1	R1	Res. 0 Ω 1/10W 0603 SMD	Panasonic® - ECG	ERJ-3GEY0R00V
1	R2	Res. 100 k Ω 1/10W 1% 0603 SMD	Panasonic - ECG	ERJ-3EKF1003V
1	R3	Res. 20.0 k Ω 1/10W 1% 0603 SMD	Panasonic - ECG	ERJ-3EKF2002V
0	R4	DO NOT POPULATE	—	—
1	R5	Res. 40.2 k Ω 1/10W 1% 0603 SMD	Yageo Corporation	RC0603FR-0740K2L
1	R6	Res. 10.0 k Ω 1/8W 1% SMD 0603	Vishay	MCT06030C1002FP500
1	R7	Res. 2.20 k Ω 1/8W 1% SMD 0603	Vishay	MCT06030C2201FP500
1	R8	Res. 4.02 k Ω 1/10W 1% 0603 SMD	Yageo Corporation	RC0603FR-074K02L
1	R9	Res. 0.1 Ω 1/2W 1% 1206 SMD	Bourns®, Inc.	CRM1206-FX-R100ELF
1	R10	Res. 51.0 Ω 1/10W 1% 0603 SMD	Yageo Corporation	RC0603FR-0751RL
5	TP1, TP3 – TP4, TP7 – TP8	PC test point compact SMT	Keystone Electronics Corp.	5016
0	TP5 – TP6, TP9 – TP17	DO NOT POPULATE	—	—
0	U1	DO NOT POPULATE	—	—
1	U2	High-Speed Boost Controller	Microchip Technology Inc.	MCP1632-AAE/MS

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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Appendix C. Typical Performance Data, Curves and Waveforms

C.1 PERFORMANCE OVERVIEW

This chapter shows some of the typical performance parameters and curves of the MCP1632 300 kHz Boost Converter Demo Board.

TABLE C-1: CONVERTER PARAMETERS

Parameter	Value	Comments
Input Voltage Range (V)	3.6 – 5.5	
Output Voltage (V)	12	±2.5% Tolerance
Maximum Output Current (A)	0.9	Steady State output current
Output Voltage Ripple (mV)	< 120	$V_{IN} = 5V, I_{OUT} = 0.85A$
Input Voltage Ripple (mV)	< 30	$V_{IN} = 5V, I_{OUT} = 0.85A$
Output Voltage Overshoot during Step Load (mV)	< 600	Step Load 0.3A to 0.8A
Switching Frequency (kHz)	250 – 350	Typical 300 kHz

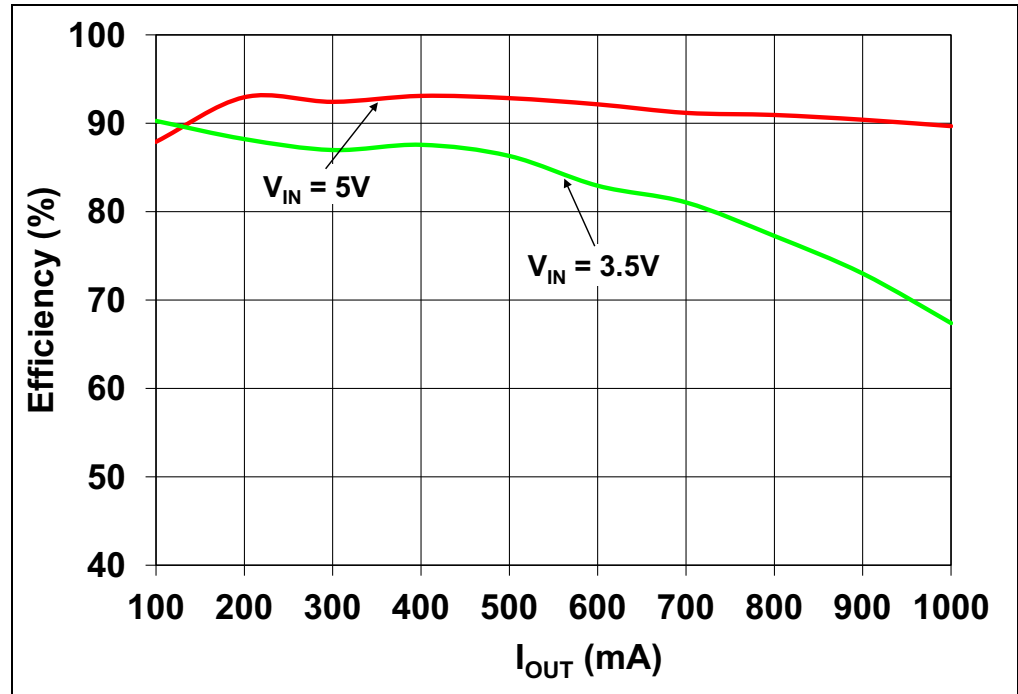


FIGURE C-1: Efficiency.

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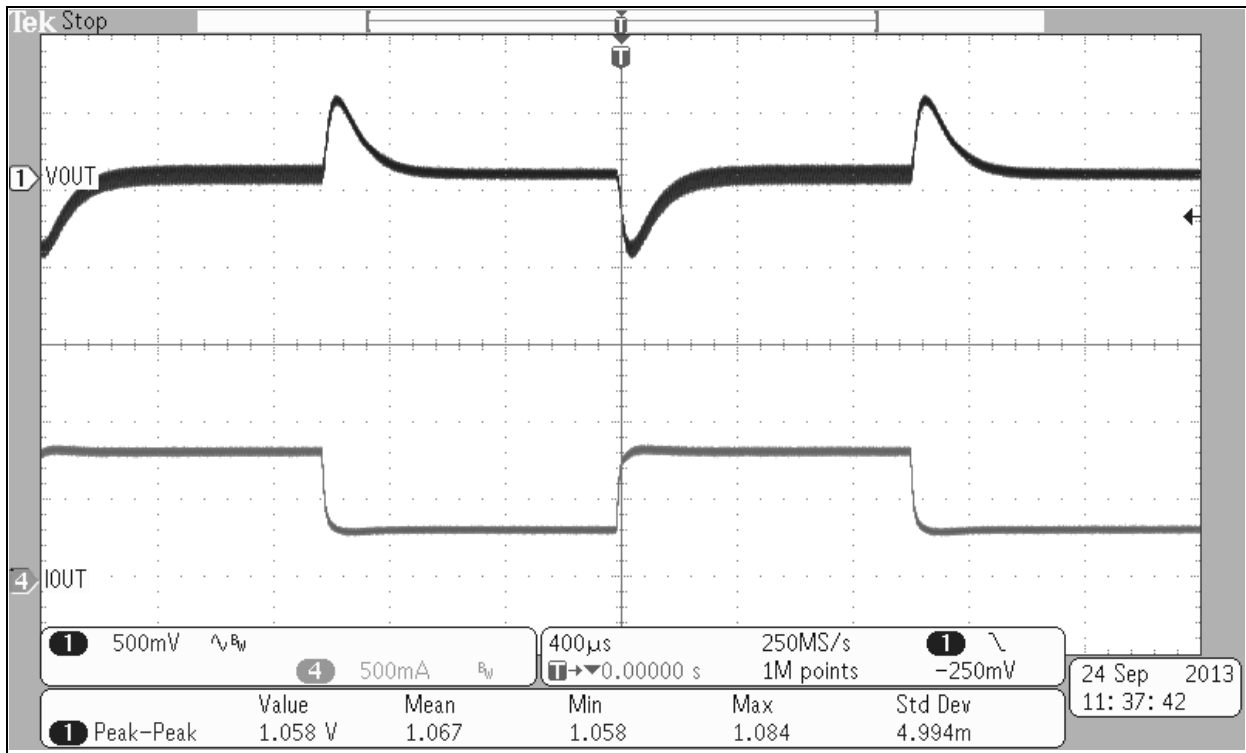


FIGURE C-2: Step Load ($V_{IN} = 5V$).

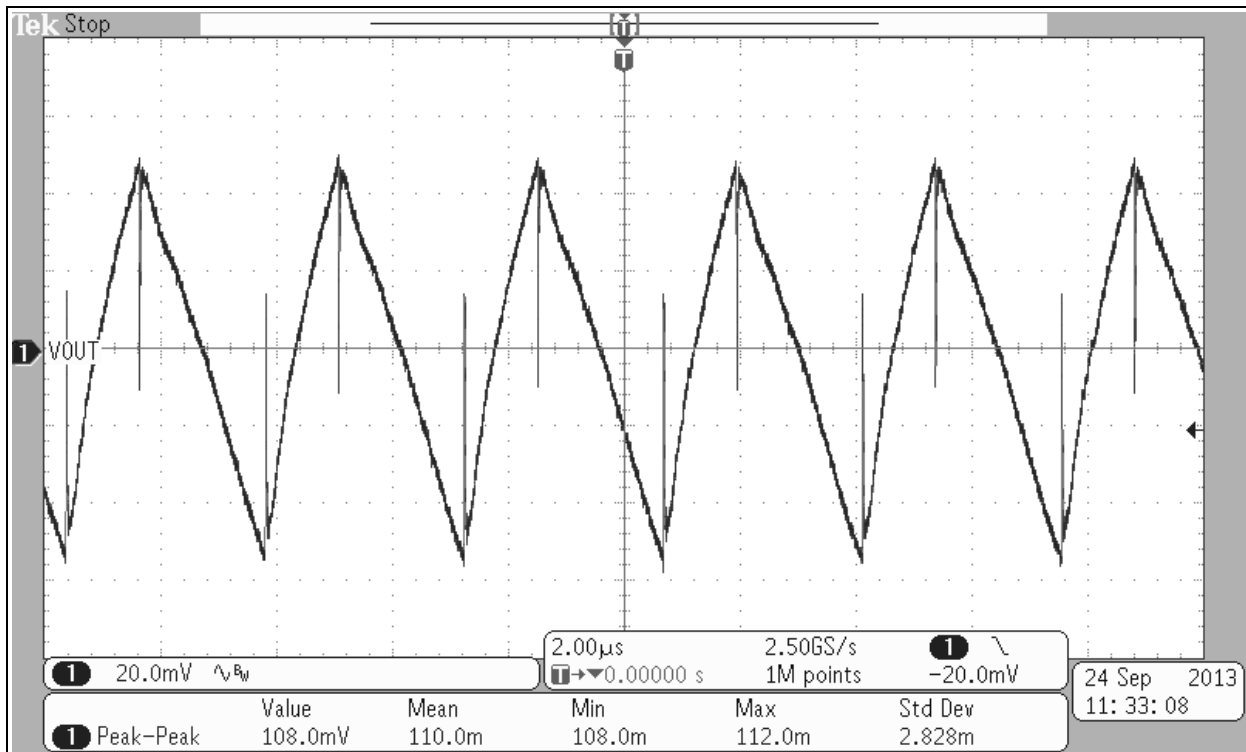


FIGURE C-3: Output Voltage Ripple/Noise ($V_{IN} = 5V$, $I_{OUT} = 0.85A$, $BW = 200\text{ MHz}$).

Typical Performance Data, Curves and Waveforms

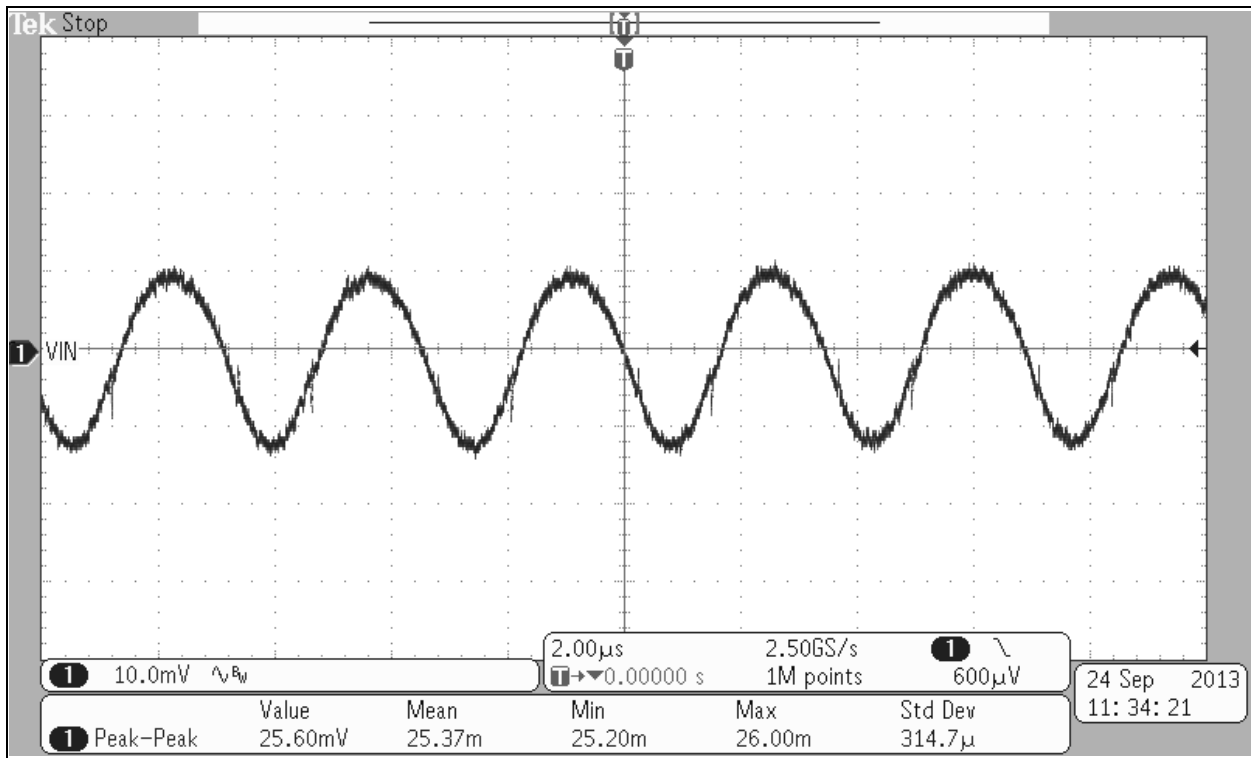


FIGURE C-4: Input Voltage Ripple/Noise ($V_{IN} = 5V$, $I_{OUT} = 0.85A$, $BW = 200\text{ MHz}$).

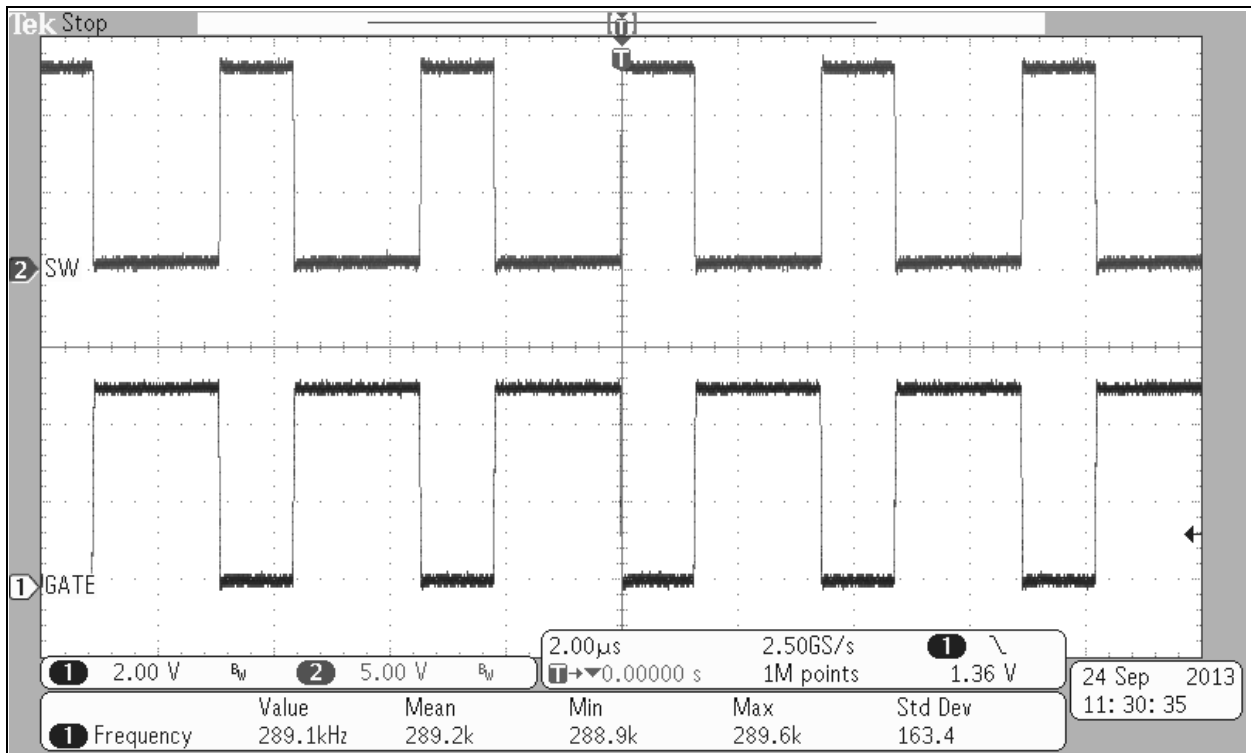


FIGURE C-5: SW and Gate Signals ($V_{IN} = 5V$, $I_{OUT} = 0.85A$, $BW = 300\text{ MHz}$).

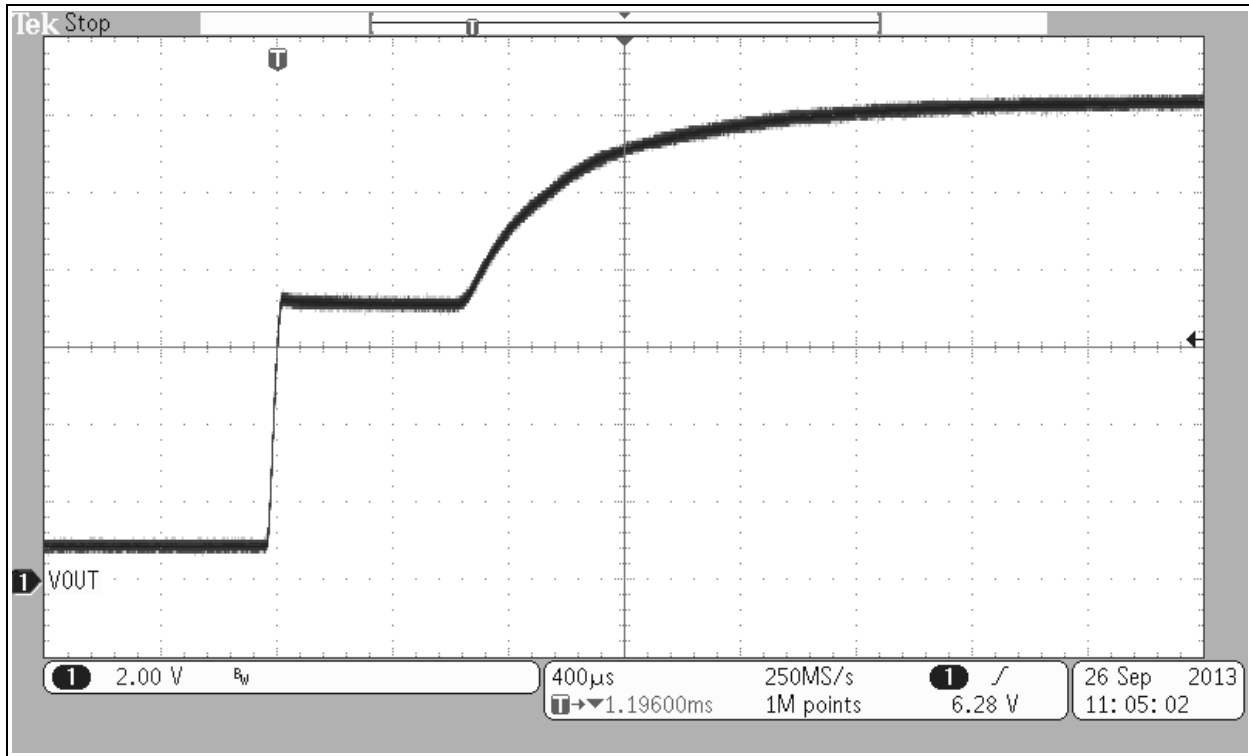


FIGURE C-6: Soft Start.

Typical Performance Data, Curves and Waveforms

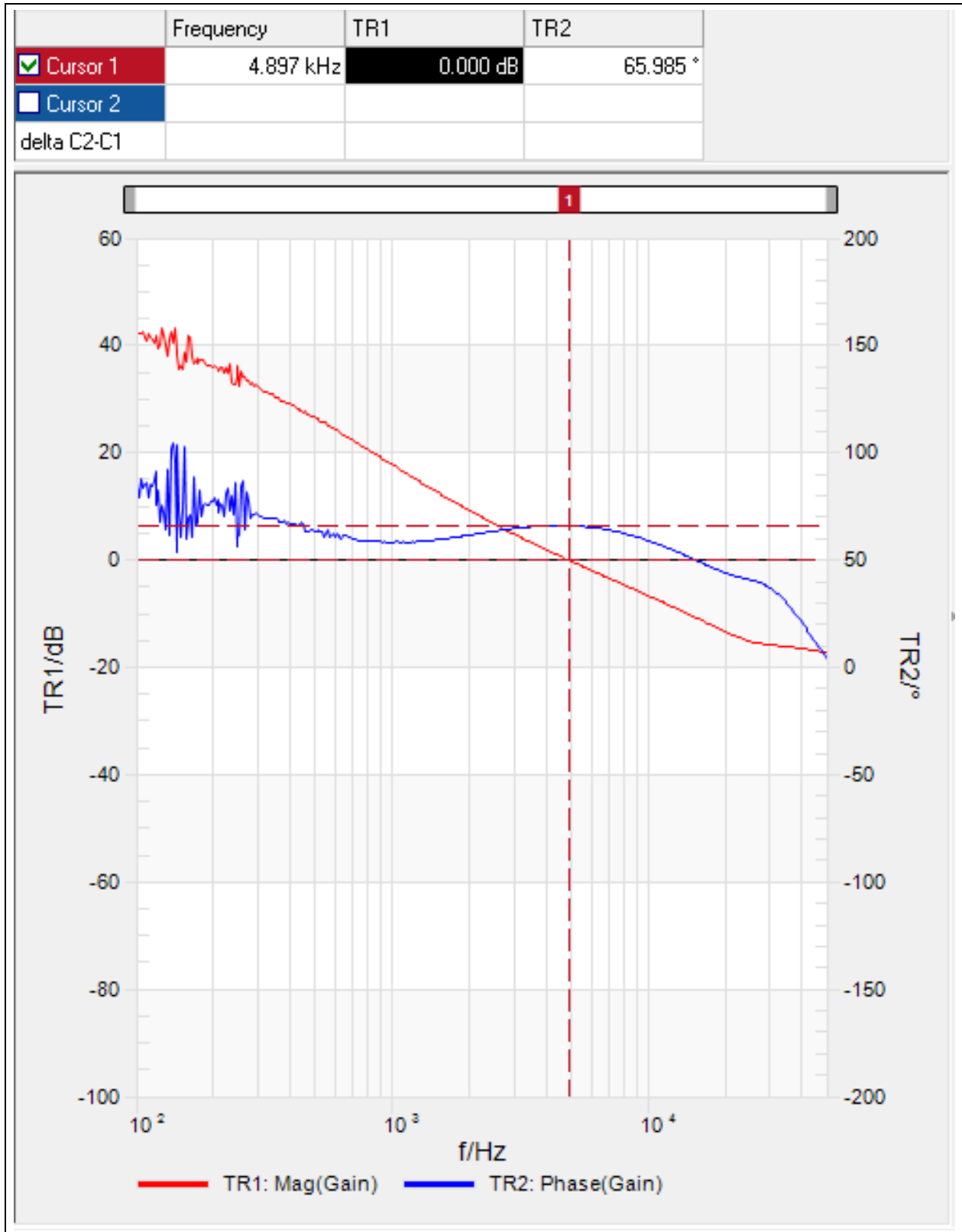


FIGURE C-7: Bode Plots (Red-Gain, Blue-Phase) ($V_{IN} = 5V$, $V_{OUT} = 12V$, $I_{OUT} = 0.5A$).



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