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MCP19035
600 kHz High-Voltage
Synchronous Buck Controller
Reference Design
User's Guide

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Object of Declaration: MCP19035 600 kHz High-Voltage Synchronous Buck Controller Reference Design User's Guide

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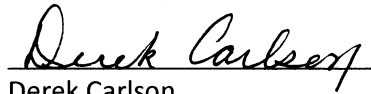
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VP Development Tools

16-July-2013
Date

MCP19035 600 kHz HIGH-VOLTAGE SYNCHRONOUS BUCK CONTROLLER REFERENCE DESIGN USER'S GUIDE

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MCP19035 600 kHz HIGH-VOLTAGE SYNCHRONOUS BUCK CONTROLLER REFERENCE DESIGN USER'S GUIDE

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 "DSXXXXXXXXA", where "XXXXXXXX" 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 MCP19035 600 kHz High-Voltage Synchronous Buck Controller Reference Design. 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 MCP19035 600 kHz High-Voltage Synchronous Buck Controller Reference Design 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 MCP19035 600 kHz High-Voltage Synchronous Buck Controller Reference Design.
• **Chapter 2. "Installation and Operation"** – Includes instructions on how to get started with the MCP19035 600 kHz High-Voltage Synchronous Buck Controller Reference Design and a description of the user's guide.
• **Appendix A. "Schematic and Layouts"** – Shows the schematic and layout diagrams for the MCP19035 600 kHz High-Voltage Synchronous Buck Controller Reference Design.
• **Appendix B. "Bill of Materials (BOM)"** – Lists the parts used to build the MCP19035 600 kHz High-Voltage Synchronous Buck Controller Reference Design.
• **Appendix C. "Typical Performance Data, Curves and Waveforms"** – Lists the typical performance data, curves and waveforms.

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 MCP19035 600 kHz High-Voltage Synchronous Buck Controller Reference Design. Other useful documents are listed below. The following Microchip documents are available and recommended as supplemental reference resources.

- **MCP19035 Data Sheet – "*High-Speed Synchronous Buck Controller*" (DS22326)**
- **AN1452 – "*Using the MCP19035 Synchronous Buck Converter Design Tool*" (DS01452)**
- **MCP19035 Excel-based Design Analyzer**

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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 (July 2014)

- Initial Release of this Document.

MCP19035 600 kHz HIGH-VOLTAGE SYNCHRONOUS BUCK CONTROLLER REFERENCE DESIGN USER'S GUIDE

Chapter 1. Product Overview

1.1 INTRODUCTION

This chapter provides an overview of the MCP19035 600 kHz High-Voltage Synchronous Buck Controller Reference Design and covers the following topics:

• MCP19035 Short Overview
• What Is the MCP19035 600 kHz High-Voltage Synchronous Buck Controller Reference Design?
• What the MCP19035 600 kHz High-Voltage Synchronous Buck Controller Reference Design Kit Contains

1.2 MCP19035 SHORT OVERVIEW

The MCP19035 is a highly-featured, highly-integrated, synchronous buck controller in a space-saving 10-pin DFN 3x3 package that operates from input voltage sources up to 30V. Integrated features include high and low-side MOSFET drivers, fixed-frequency voltage mode control, internal oscillator and reference voltage generator, overcurrent protection circuit for both sides, Power Good circuit and overtemperature protection. A minimal number of external components are necessary to develop a complete, high-performance Synchronous Buck Converter power supply.

The MCP19035 Synchronous Buck Controller is intended to be used for applications requiring medium to high-output currents (up to 20A) and input voltages up to 30V.

Typical applications includes:

• Medium currents Point-of-Load converters
• FPGA/DSP power supplies
• USB power ports
• Digital Set-Top boxes
• Industrial 24V rail converters
• High-power LED drivers

The internal linear voltage regulator (LDO) allows low current loads (i.e., PIC® microcontrollers) to be powered directly from the controller without any additional components.
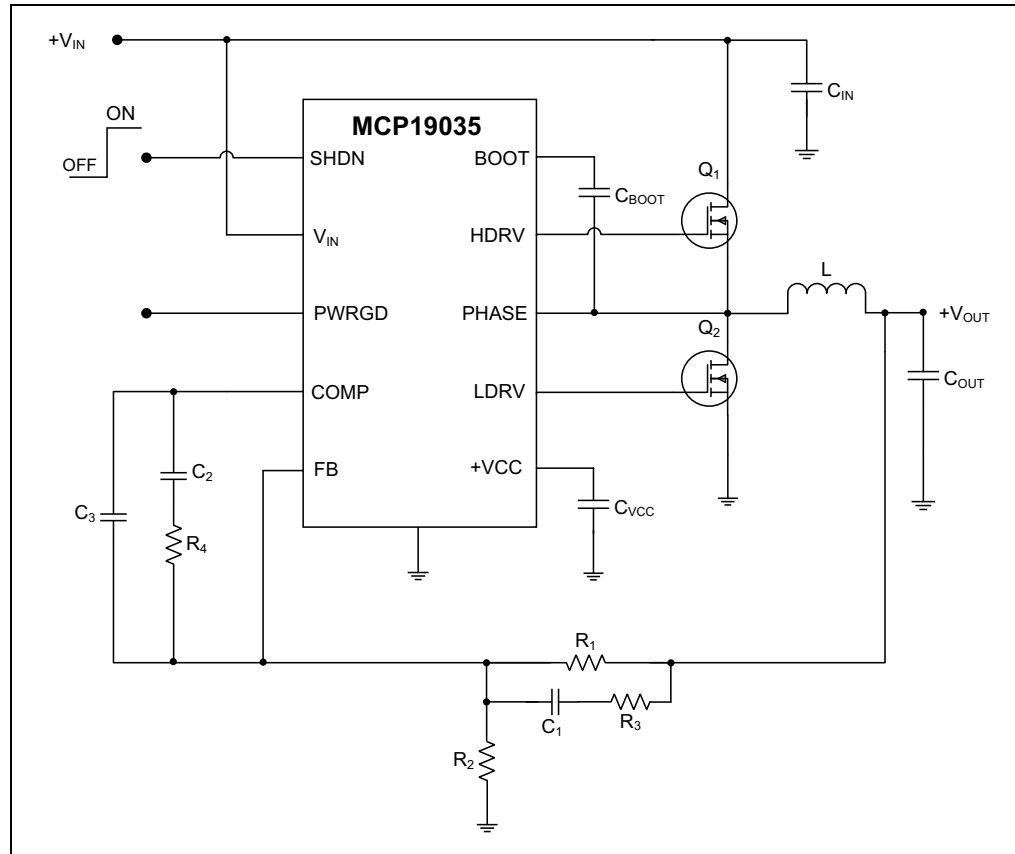
FIGURE 1-1: *MCP19035 – Typical Application.*

1.3 WHAT IS THE MCP19035 600 kHz HIGH-VOLTAGE SYNCHRONOUS BUCK CONTROLLER REFERENCE DESIGN?

The MCP19035 600 kHz Synchronous Buck Converter Controller is a compact, highly efficient, step-down voltage converter that will convert the input voltage rail (typically 24V) to 5V regulated output voltage. The maximum output current for this step-down converter is 5A. The board demonstrates the capabilities of the MCP19035 600 kHz Synchronous Buck Converter Controller in a typical high-voltage input step-down application. Test points for various signals are provided for measuring different parameters of the converter. The reference design can be modified to support output voltages from 3.3V to 5V by changing a single resistor.

1.4 WHAT THE MCP19035 600 kHz HIGH-VOLTAGE SYNCHRONOUS BUCK CONTROLLER REFERENCE DESIGN KIT CONTAINS

The MCP19035 600 kHz High-Voltage Synchronous Buck Controller Reference Design kit includes:

• MCP19035 600 kHz High-Voltage Synchronous Buck Controller Reference Design (ARD00514)
• Important Information Sheet

Chapter 2. Installation and Operation

2.1   INTRODUCTION

The MCP19035 600 kHz High-Voltage Synchronous Buck Controller Reference Design was developed to provide a compact, low-cost and highly efficient step-down conversion for low to medium output currents.

2.1.1   MCP19035 600 kHz High-Voltage Synchronous Buck Controller Reference Design Features

The MCP19035 600 kHz High-Voltage Synchronous Buck Controller Reference Design has the following key features:

• Input Voltage Range: 8V to 26V
• Output Voltage: 5V (can be adjusted by changing one resistor between 3.3V and 5V)
• Maximum output current: 5A
• 93% typical efficiency at 5V/5A output and 24V input
• 600 kHz fixed switching frequency
• Overcurrent protection for high and low-side MOSFETs
• Power Good (PGOOD) output for monitoring the output voltage quality
• Shutdown input for placing the converter in low-power Standby mode
• Undervoltage Lockout (UVLO) with 4.5V and 3.9V typical thresholds

2.2   GETTING STARTED

The MCP19035 600 kHz High-Voltage Synchronous Buck Controller Reference Design is fully assembled and tested to evaluate and demonstrate the MCP19035 capabilities.

2.2.1   Instruments and Tools Required

• Adjustable DC power supply with 0V-30V/5A$_{DC}$ range output capability
• Electronic load with at least 5A current capability and load stepping capability
• Digital oscilloscope with a minimum bandwidth of 50 MHz
• Digital voltmeter/ammeter
• Optionally, a network analyzer/Bode plot analyzer for loop analysis
• Wires for connections; these wires must sustain high currents (5A for the connection between adjustable DC power supply and board, 5A for the connection between board and the electronic load)

2.2.2 Setup Procedure

To power up the MCP19035 600 kHz High-Voltage Synchronous Buck Controller Reference Design, the following steps must be completed:

1. Connect the electronic load to J2 connector of the reference design; the "positive" (+) and "negative" (-) connector pins are marked on the board silkscreen.

2. Connect the adjustable DC power supply to J1 connector of the reference design; 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 24V.

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"**.
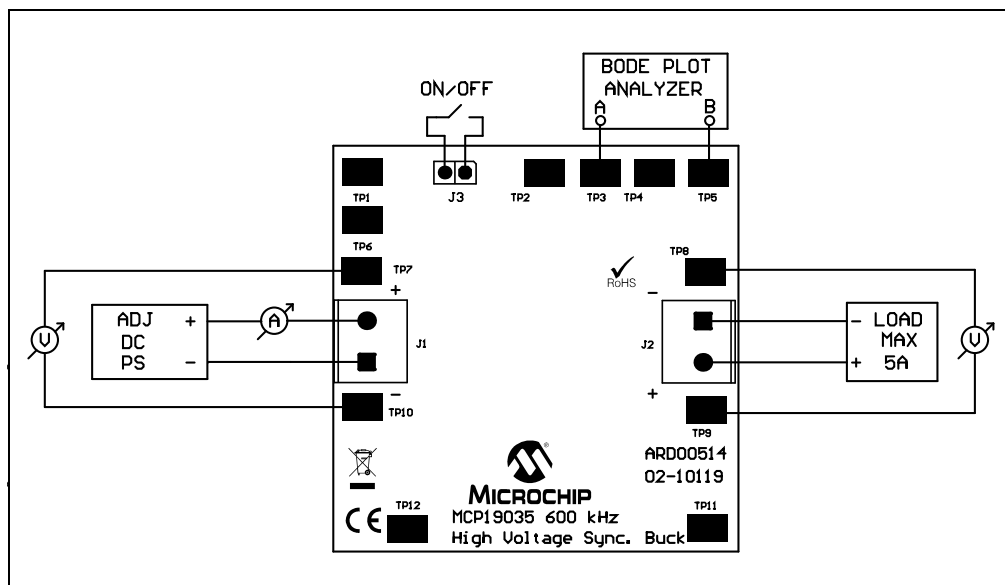
FIGURE 2-1:   *Typical Test Setup.*

TABLE 2-1:   TEST POINTS DESCRIPTION

Test Point	Label	Description
TP2, TP4, TP6, TP8, TP10, TP11, TP12	GND	Power GND
TP7	V_{IN}	Input voltage
TP1	PGOOD	Power Good output
TP9	V_{OUT}	Output voltage
TP3, TP5	CH A, CH B	Signal injection points for loop measurement

2.2.4 Adjusting the Output Voltage

The output voltage can be modified by changing the value of R12 from the feedback divider. The output voltage is set according to Equation 2-1.

EQUATION 2-1: EQUATION OUTPUT VOLTAGE

$$V_{OUT} = V_{REF} \times \frac{R10 + R12}{R12}$$

Where:

V_{REF} = 0.6V

R10 = 20 kΩ

Do not modify the value of the R10 resistor (20 kΩ) because this will affect the loop compensation of the system.

Some parameters like efficiency, the overcurrent protection thresholds and the input and output voltage ripples can be affected by the modification of the output voltage. Do not exceed 6V for the output voltage or permanent damage of the board can occur.

Table 2-2 shows the standard values of R12 resistor for some usual output voltages.

TABLE 2-2: OUTPUT VOLTAGE VERSUS R12 VALUE

V_{OUT}(V)	R12(kΩ)
3.3	4.42
5	2.74

Appendix A. Schematic and Layouts

A.1 INTRODUCTION

This appendix contains the following schematics and layouts for the MCP19035 600 kHz High Voltage Synchronous Buck Controller Reference Design:

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

Schematic and Layouts
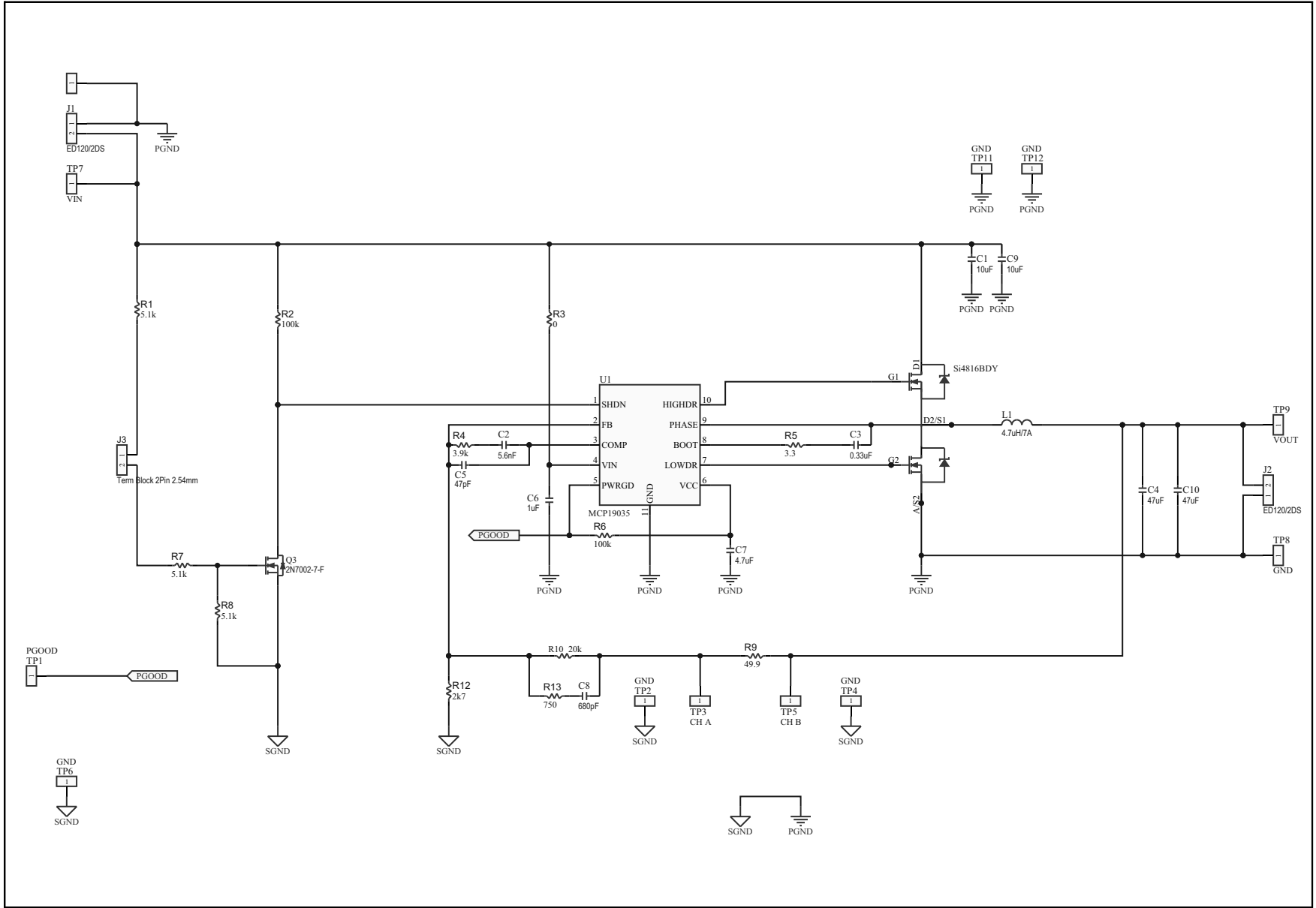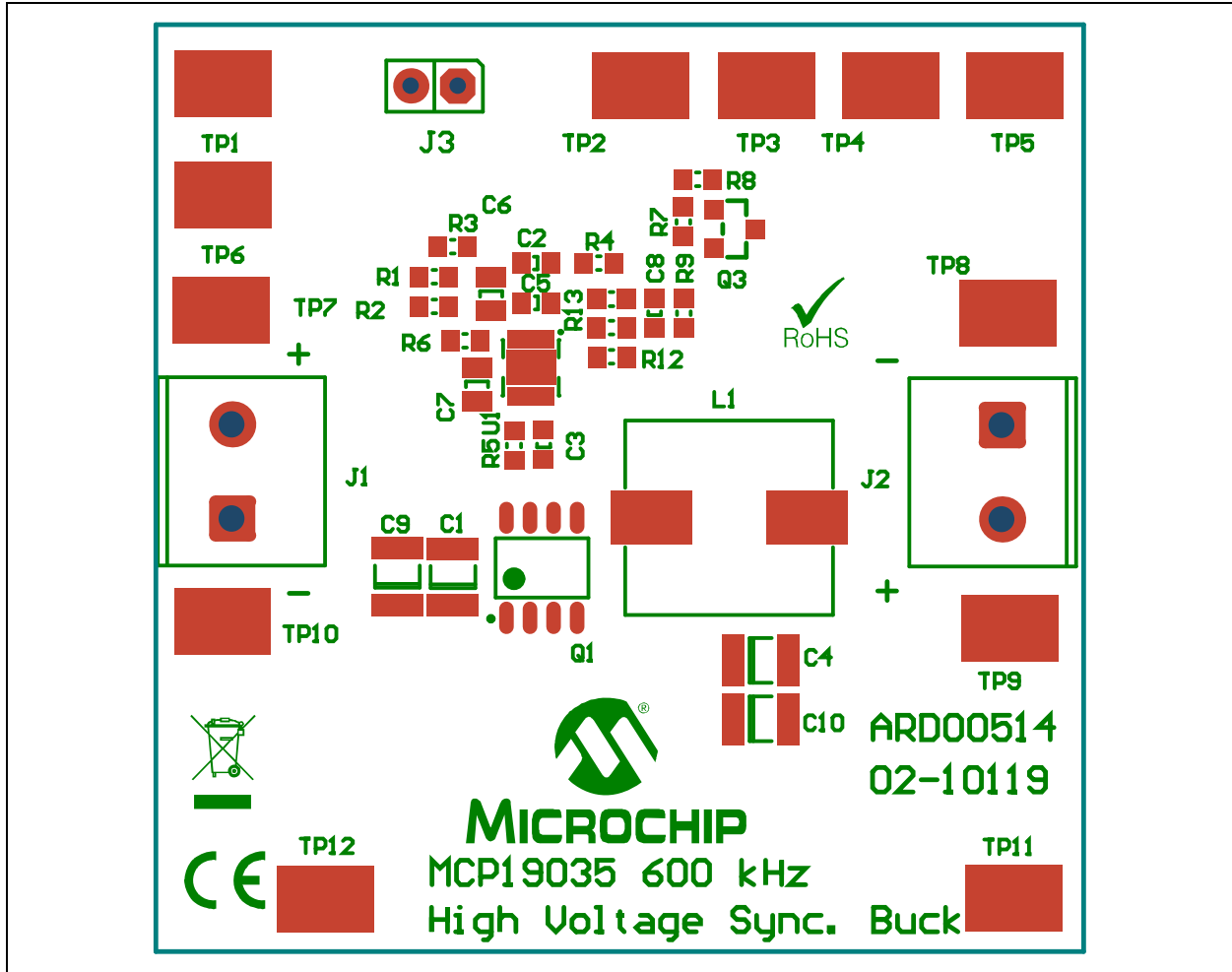
A.3   BOARD – TOP SILK

A.4   BOARD – TOP SILK AND COPPER

A.5   BOARD – BOTTOM COPPER

04-10119

A.6   BOARD – BOTTOM COPPER AND SILK

04-10119

Appendix B. Bill of Materials (BOM)

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

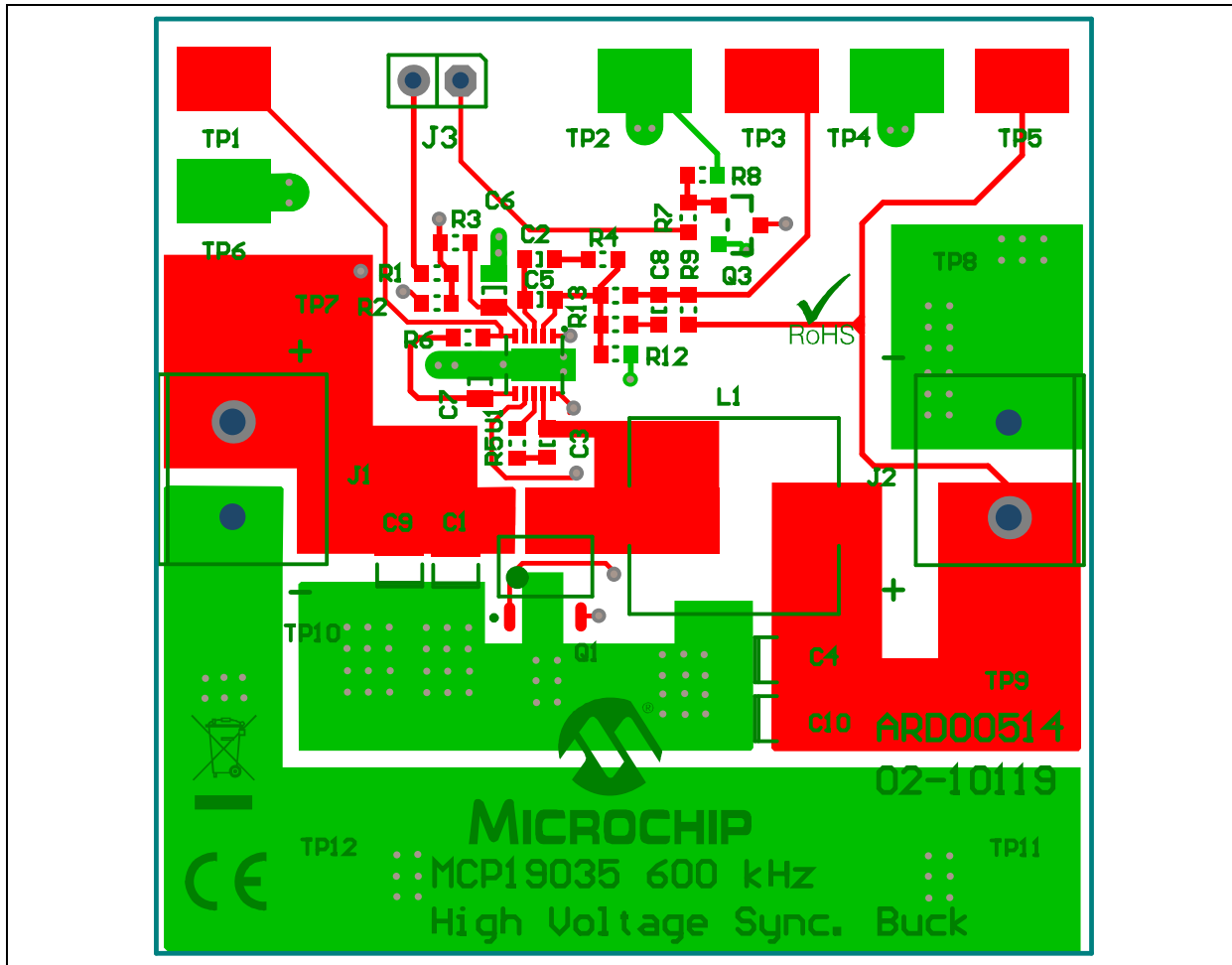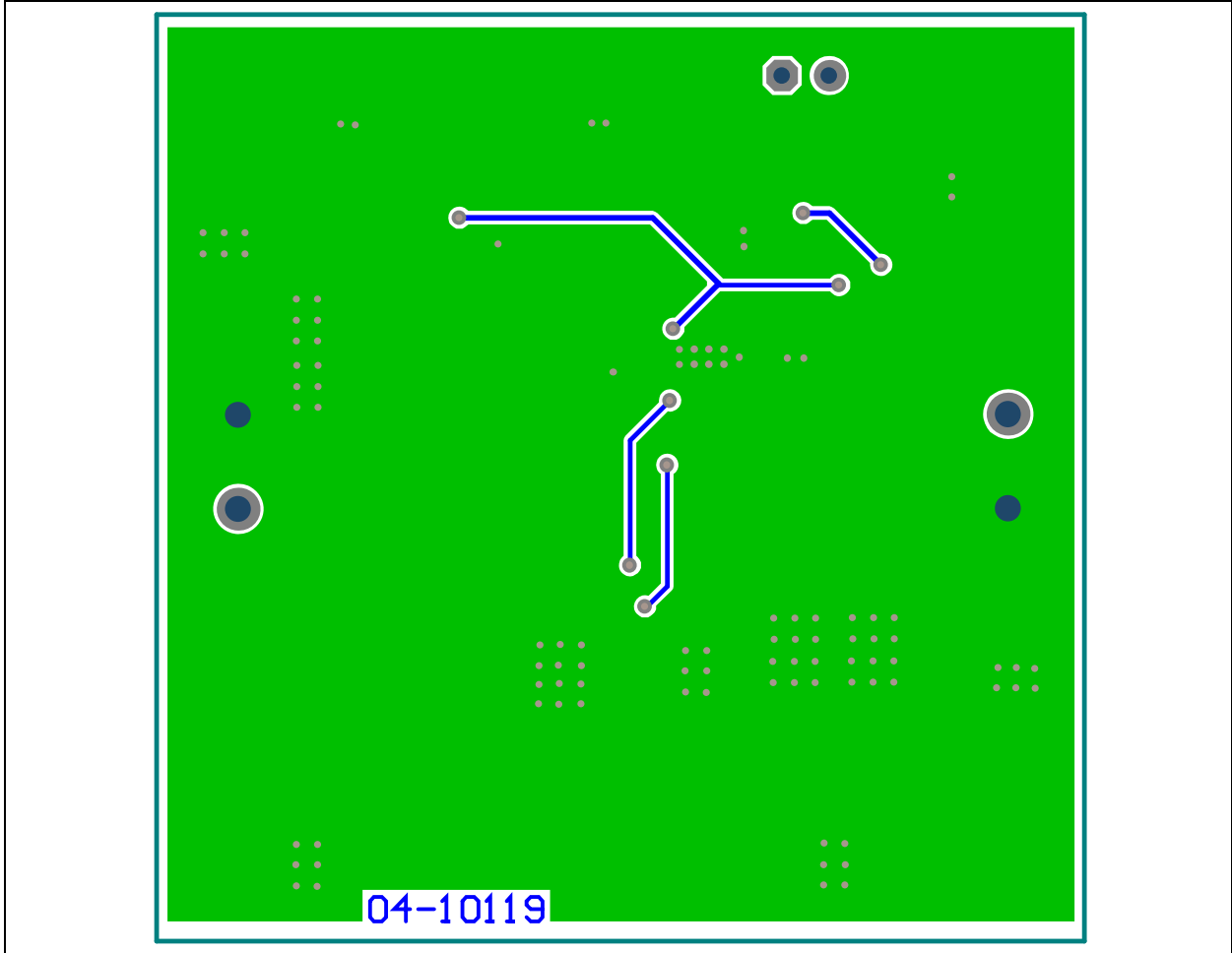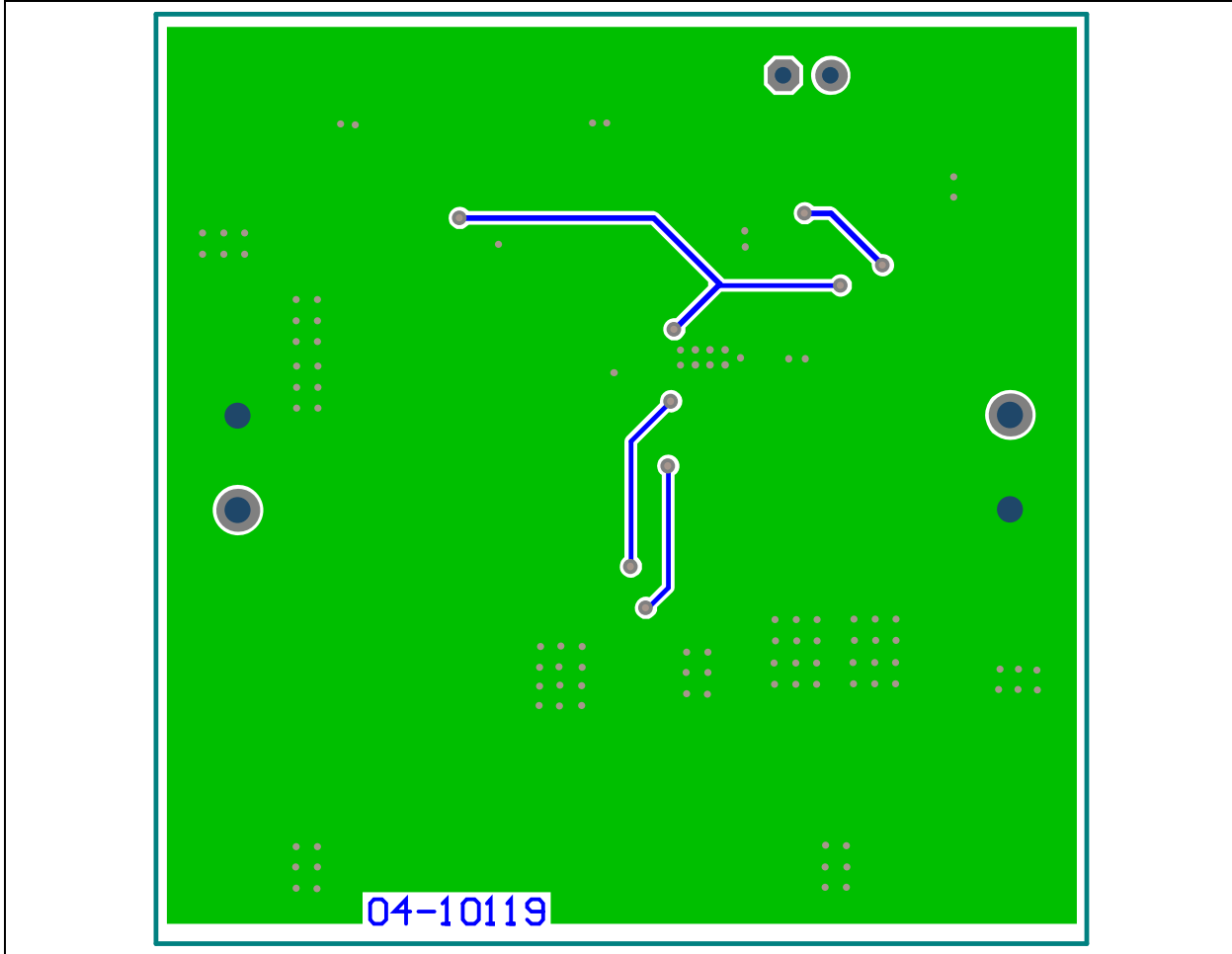| Qty.	Reference	Description	Manufacturer	Part Number
2	C1, C9	Cap. ceramic 10 UF 35V 20% X7R 1210	Taiyo Yuden Co., Ltd.	GMK325AB7106MM-T
1	C2	Cap. ceramic 5600 PF 25V 5% NP0 0603	TDK Corporation	C1608C0G1E562J080AA
1	C3	Cap. ceramic 0.33 UF 16V 10% X7R 0603	Murata Americas	GRM188R71C334KA01D
2	C4, C10	Cap. ceramic 47 UF 10V 20% X7R 1210	Taiyo Yuden Co., Ltd.	LMK325B7476MM-TR
1	C5	Cap. ceramic 47 PF 50V 5% NP0 0603	AVX Corporation	C1608C0G1H470J080AA
1	C6	Cap. ceramic 1 UF 35V 10% X7R 0805	TDK Corporation	CGA4J3X7R1V105K
1	C7	Cap. ceramic 4.7 UF 35V 10% X7R 0805	TDK Corporation	C2012X7R1V475K125AC
1	C8	Cap. ceramic 680 PF 50V 5% NP0 0603	TDK Corporation	C1608C0G1H681J080AA
2	J1, J2	Terminal Block 5.08 MM vert. 2 POS	On-Shore Technology, Inc.	ED120/2DS
1	J3	Conn. header vert. 100" gold	TE Connectivity, Ltd.	5-146868-1
1	L1	Inductor power 4.7 UH 8.5A SMD	Wurth® Electronik Group	74477004
0	PCB	MCP19035 600 kHz High-Voltage Synchronous Buck Controller Reference Design Printed Circuit Board	–	104-00514
1	Q1	Dual N-Channel 30-V (D-S) MOSFET with Schottky Diode	Vishay	SI4816BDY-T1-E3
1	Q3	MOSFET N-Channel 60V 115 MA SOT-23-3	Diodes® Incorporated	2N7002-7-F
3	R1, R7, R8	Res. 5.1k Ohm 1/10W 1% 0603 SMD	Panasonic® – ECG	ERJ-3EKF5101V
2	R2, R6	Res. 100k Ohm 1/10W 1% 0603 SMD	Panasonic – ECG	ERJ-3EKF1003V
1	R3	Res. 0 Ohm 1/10W 0603 SMD	Panasonic – ECG	ERJ-3GEY0R00V
1	R4	Res. 3.9K Ohm 1/10W 5% 0603 SMD	Panasonic – ECG	ERJ-3GEYJ392V
1	R5	Res. 3.3 Ohm 1/10W 1% 0603	Panasonic – ECG	ERJ-3RQF3R3V
1	R9	Res. 49.9 Ohm .25W 1% 0603 SMD	Vishay/Dale	CRCW060349R9FKEAHP
1	R10	Res. 20k Ohm 1/10W 1% 0603 SMD	Panasonic – ECG	ERJ-3EKF2002V
1	R12	Res. 2.70K Ohm 1/10W 1% 0603 SMD	Panasonic – ECG	ERJ-3EKF2701V
1	R13	Res. 750 Ohm 1/10W 1% 0603 SMD	Vishay/Dale	CRCW0603750RFKEA
12	TP1 - TP12	PC test point compact SMT	Keystone Electronics Corp.	5016
1	U1	High-Speed Synchronous Buck Controller	Microchip Technology Inc.	MCP19035-BAAAE/MF

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.

Appendix C. Typical Performance Data, Curves and Waveforms

C.1   INTRODUCTION

This chapter shows some of the typical performance parameters and curves of the MCP19035 600 kHz High-Voltage Synchronous Buck Controller Reference Design.

TABLE C-1:   CONVERTER PARAMETERS

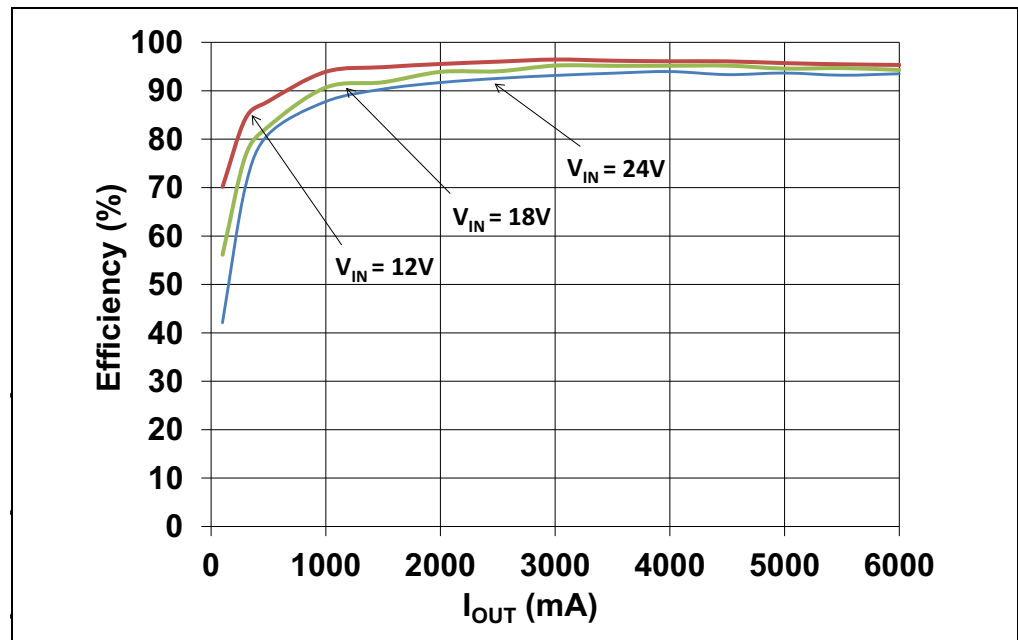| Parameter	Value	Comments
Input Voltage Range (V)	8 - 26	
Output Voltage (V)	5	±2.5% Tolerance
Maximum Output Current (A)	5	Steady state output current
Output Voltage Ripple (mV)	< 50	V_{IN} = 24V, I_{OUT} = 4A
Input Voltage Ripple (mV)	< 200	V_{IN} = 24V, I_{OUT} = 4A
Output Voltage Overshoot during Step Load (mV)	< 200	Step Load 1A to 4A
Switching Frequency (kHz)	550 - 650	Typical 600 kHz

FIGURE C-1:   *Efficiency.*

Typical Performance Data, Curves and Waveforms

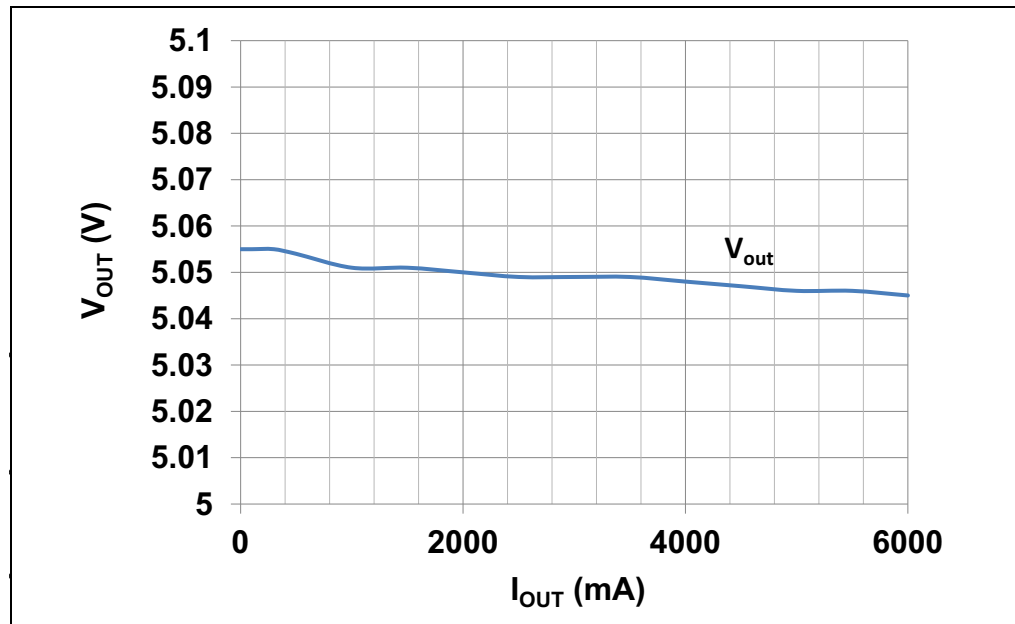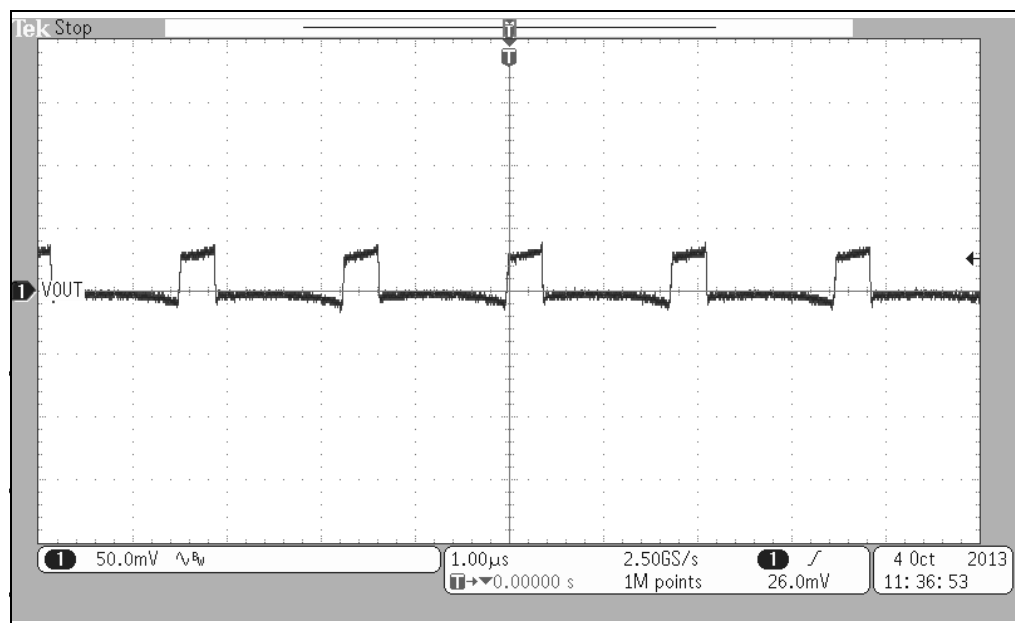**FIGURE C-2:** *Load Regulation (V_{IN} = 24V).*

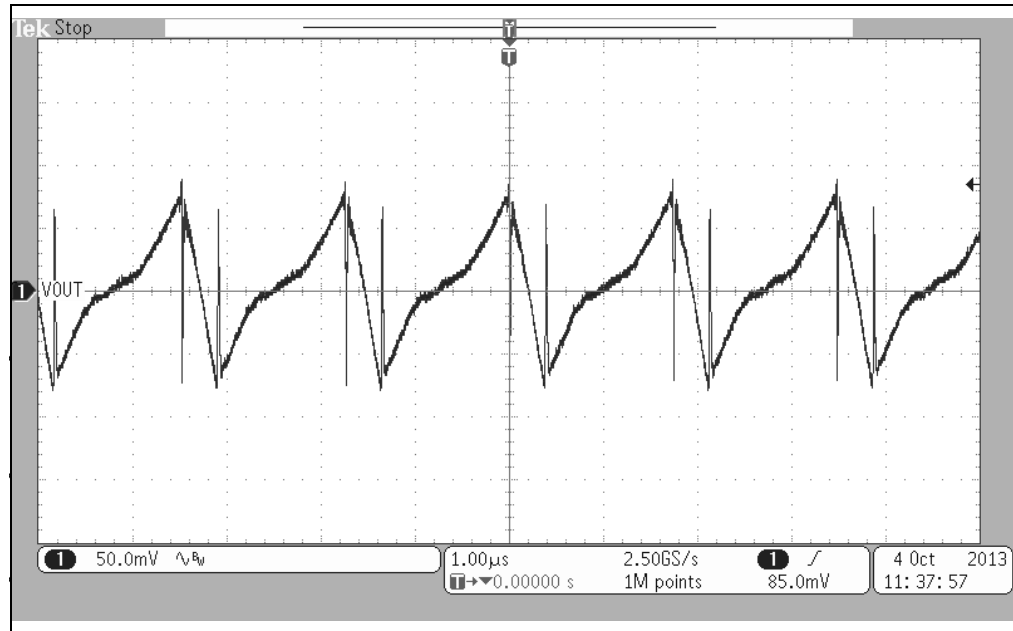**FIGURE C-3:** *Output Voltage Ripple/Noise (V_{IN} = 24V, I_{OUT} = 4A, BW = 20 MHz).*

FIGURE C-4: *Input Voltage Ripple/Noise (V_{IN} = 24V, I_{OUT} = 4A, BW = 20 MHz).*
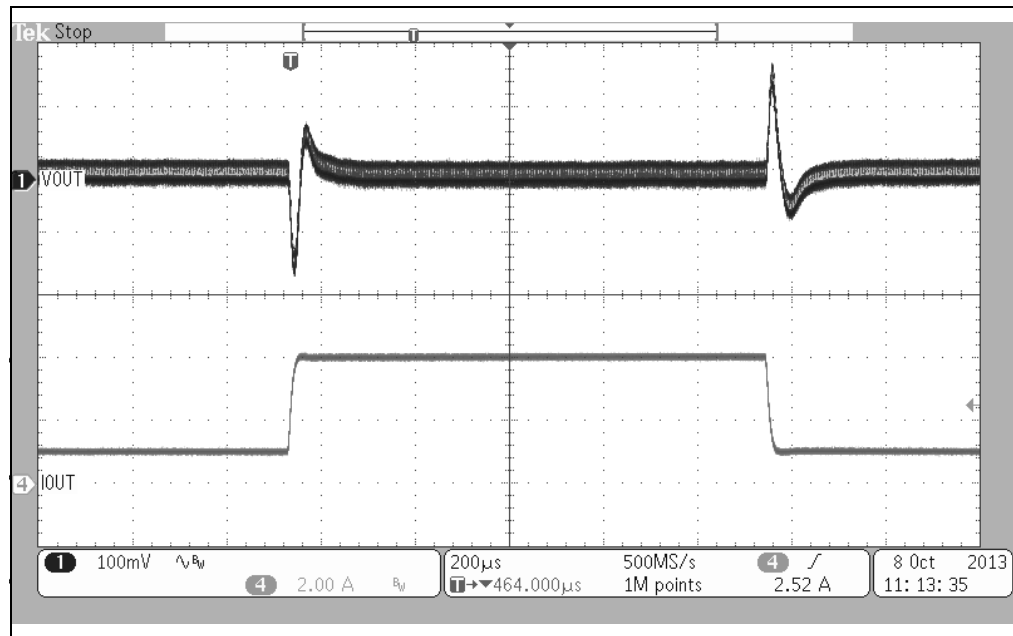

FIGURE C-5: *Step Load (V_{IN} = 24V).*
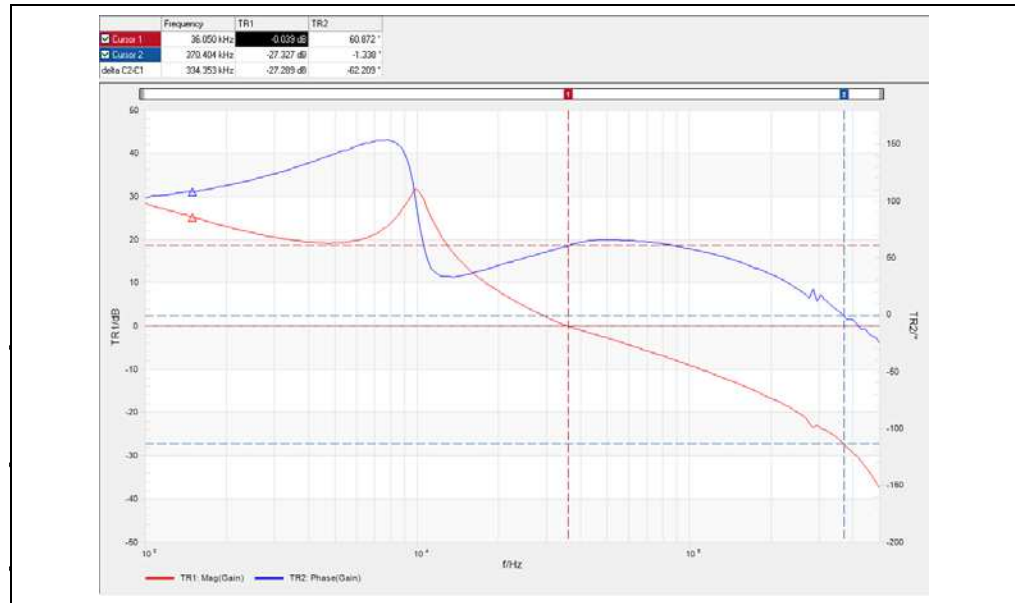
Typical Performance Data, Curves and Waveforms

FIGURE C-6: Bode Plots (V_{IN} = 24V, V_{OUT} = 5V; I_{OUT} = 5A).

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