MCP19035
300 kHz Synchronous Buck Controller Evaluation Board User's Guide

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Object of Declaration: MCP19035 300 kHz Synchronous Buck Controller Evaluation Board

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The development/evaluation tool is designed to be used for research and development in a laboratory environment. This development/evaluation tool is not a Finished Appliance, nor is it intended for incorporation into Finished Appliances that are made commercially available as single functional units to end users under EU EMC Directive 2004/108/EC and as supported by the European Commission's Guide for the EMC Directive 2004/108/EC (8th February 2010).
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Derek Carlson
VP Development Tools

02-May-12
Date

NOTES:

MCP19035 300 KHZ SYNCHRONOUS BUCK CONTROLLER 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 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 "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 MCP19035 300 kHz Synchronous Buck Controller Evaluation 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 MCP19035 300 kHz Synchronous Buck Controller Evaluation 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 MCP19035 300 kHz Synchronous Buck Controller Evaluation Board
- **Chapter 2. "Installation and Operation"** – Includes instructions on how to get started with the MCP19035 300 kHz Synchronous Buck Controller Evaluation Board
- **Appendix A. "Schematic and Layouts"** – Shows the schematic and layout diagrams for the MCP19035 300 kHz Synchronous Buck Controller Evaluation Board
- **Appendix B. "Bill of Materials"** – Lists the parts used to build the MCP19035 300 kHz Synchronous Buck Controller Evaluation Board
- **Appendix C. "Typical Performance Data, Curves and Waveforms"** – Shows the typical performance graphs

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 MCP19035 300 kHz Synchronous Buck Controller Evaluation Board. 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)**

THE MICROCHIP WEB SITE

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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

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- Local Sales Office
- 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://www.microchip.com/support

DOCUMENT REVISION HISTORY

Revision A (November 2012)

- Initial Release of this Document.

NOTES:

Chapter 1. Product Overview

1.1 INTRODUCTION

This chapter provides an overview of the MCP19035 300 kHz Synchronous Buck Controller Evaluation Board, and covers the following topics:

- Short Overview: MCP19035
- What Is the MCP19035 300 kHz Synchronous Buck Controller Evaluation Board?
- What the MCP19035 300 kHz Synchronous Buck Controller Evaluation Board Kit Contains

1.2 SHORT OVERVIEW: MCP19035

The MCP19035 is a highly-featured, highly-integrated, Synchronous Buck Controller in a space-saving 10-pin DFN 3 x 3 mm 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 on both the high- and low-side devices, 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 include:

- Medium current Point-of-Load converters
- FPGA/DSP power supplies
- Digital Set-Top boxes
- Industrial 24V rails converters

The internal linear voltage regulator (LDO) allows low current loads (for example, PIC microcontrollers) to be powered directly from this controller without any additional components.

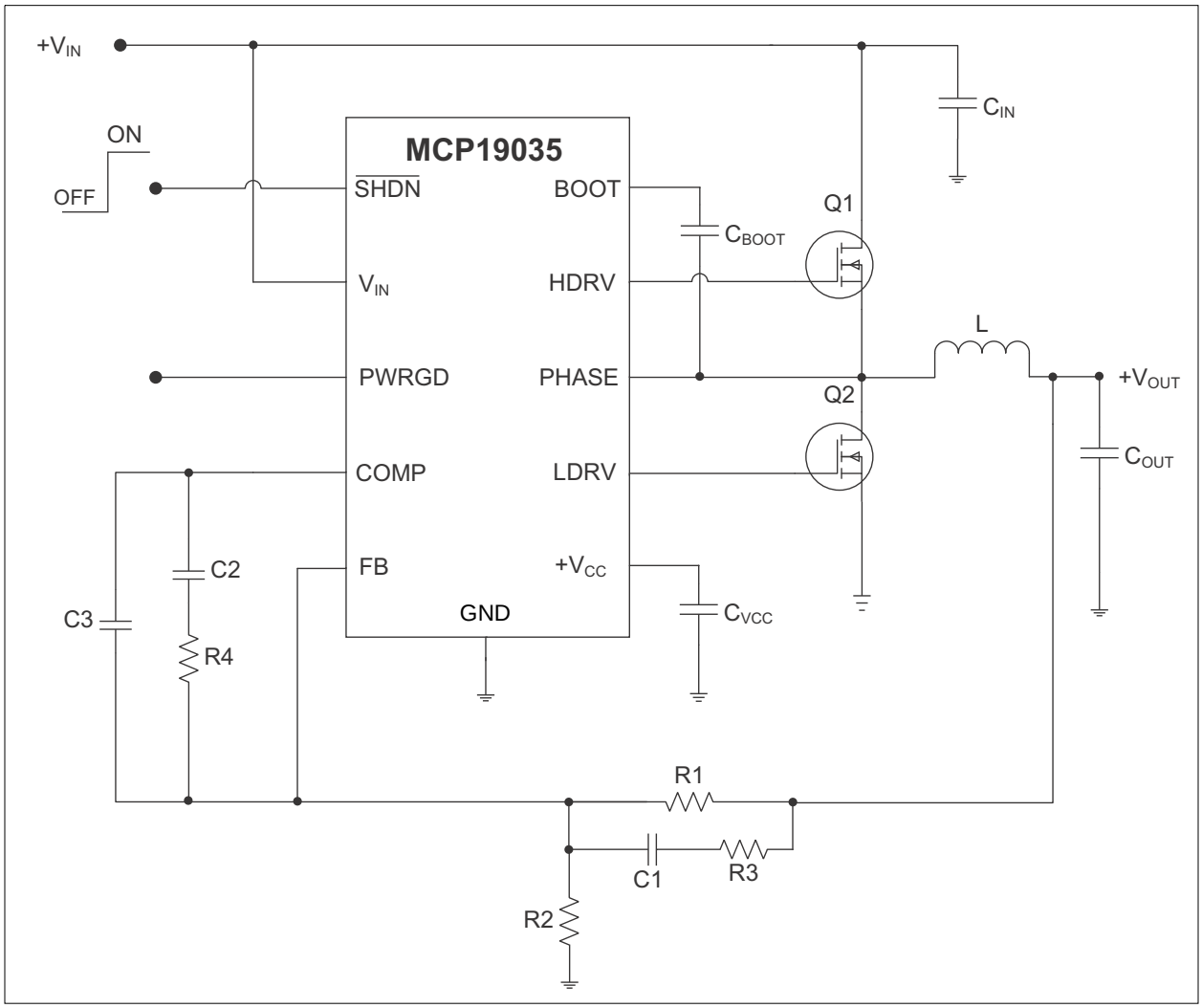


FIGURE 1-1: *Typical Application.*

1.3 WHAT IS THE MCP19035 300 KHZ SYNCHRONOUS BUCK CONTROLLER EVALUATION BOARD?

The MCP19035 300 kHz Synchronous Buck Controller Evaluation Board is a compact, highly efficient, step-down voltage regulator that will convert the input voltage rail (typically 12V) to 1.8V regulated output voltage. The maximum output current for this step-down converter is 15A. The board demonstrates the capabilities of the MCP19035 300 kHz synchronous buck converter, as well as Microchip's high-performance power MOSFET transistors. Test points for various signals are provided for measuring different parameters of the converter. The evaluation board can be modified to support output voltages from 0.9V to 3.3V by changing a single resistor.

1.4 WHAT THE MCP19035 300 KHZ SYNCHRONOUS BUCK CONTROLLER EVALUATION BOARD KIT CONTAINS

The MCP19035 300 kHz Synchronous Buck Controller Evaluation Board kit includes:

- MCP19035 300 kHz Synchronous Buck Controller Evaluation Board (ADM00434)
- Important Information Sheet

Chapter 2. Installation and Operation

2.1 INTRODUCTION

The MCP19035 300 kHz Synchronous Buck Controller Evaluation Board was developed to provide a compact, low-cost and highly efficient step-down conversion for low to medium output currents.

The key features of this board include:

- Input Voltage Range: 8V to 14V
- Output Voltage: 1.8V (can be adjusted by changing one resistor between 0.9V and 3.3V)
- Maximum Output Current: 15A
- 91% typical efficiency at 1.8V/15A output and 12V input
- 300 kHz fixed switching frequency
- On-board High Performance Power MOSFET Transistors
- 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 a low-power Standby mode
- Under Voltage Lockout (UVLO) with 4.2V and 3.6V (typical) thresholds

2.2 GETTING STARTED

The MCP19035 300 kHz Synchronous Buck Controller Evaluation Board is fully assembled and tested to evaluate and demonstrate the MCP19035 capabilities.

2.2.1 Necessary Instruments and Tools

The list of required instruments and tools include:

- Adjustable DC power supply with 0V – 15V/5 A_{DC} range output capability
- Electronic load with at least 25A 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: they must sustain high current, 5A for the connection between adjustable DC power supply and board, 15A for the connection between board and the electronic load

2.2.2 Setup Procedure

To power-up the MCP19035 300 kHz Synchronous Buck Controller Evaluation Board, the following steps must be completed:

1. Connect the Electronic Load to J2 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 on 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 should be 12V.

2.2.3 Board Testing

The typical test 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 shown in **Appendix C. "Typical Performance Data, Curves and Waveforms"**.

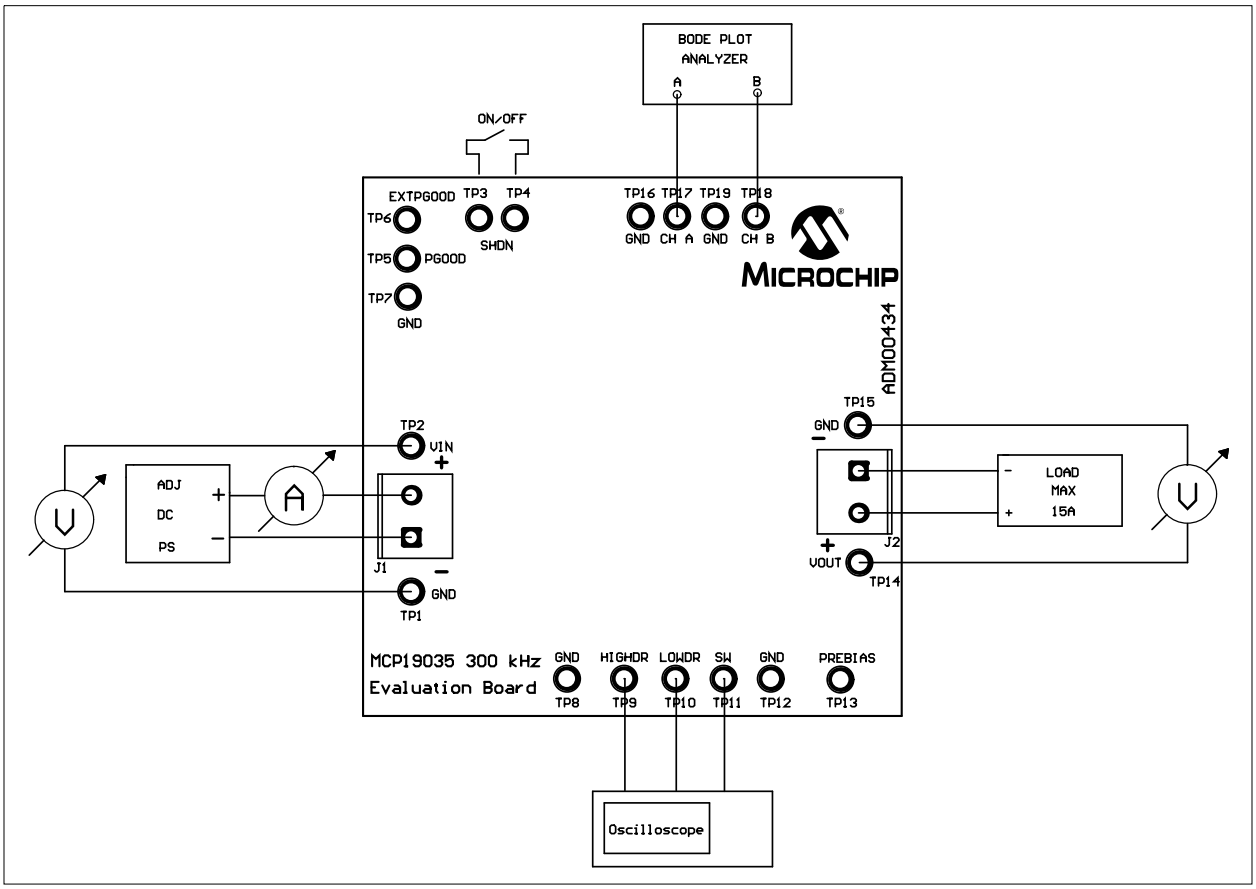


FIGURE 2-1: *Typical Test Setup.*

TABLE 2-1: TEST POINTS DESCRIPTION

Test Point	Label	Description
TP1, TP8, TP12, TP15	GND	Power GND
TP7, TP16, TP19	SGND	Signal GND
TP2	V_{IN}	Input voltage
TP3	SHDN	Shutdown input pull-up resistor
TP4	SHDN	Shutdown input
TP5	PGOOD	Power Good output
TP6	EXTPGOOD	External Pull-up for PGOOD signal
TP9	HIGHDR	High-Side MOSFET drive signal
TP10	LOWDR	Low-Side MOSFET drive signal
TP11	SW	Main switch node
TP13	PREBIAS	Pre-bias load point
TP14	V_{OUT}	Output Voltage
TP17, TP18	CH A, CH B	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 R12 from the feedback divider. The output voltage is set according to Equation 2-1.

EQUATION 2-1: OUTPUT VOLTAGE

$$V_{OUT} = V_{REF} \times \frac{R11 + R12}{R12}$$

Where:

V_{REF} = 0.6V
R11 = 20 kΩ

Do not modify the value of the R11 resistor (20 kΩ), as this will affect the system's loop compensation.

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

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)
0.9	40.2
1	30
1.2	20
1.5	13.3
1.8	10
2	8.45
2.25	7.32
2.5	6.34
3.3	4.42

NOTES:

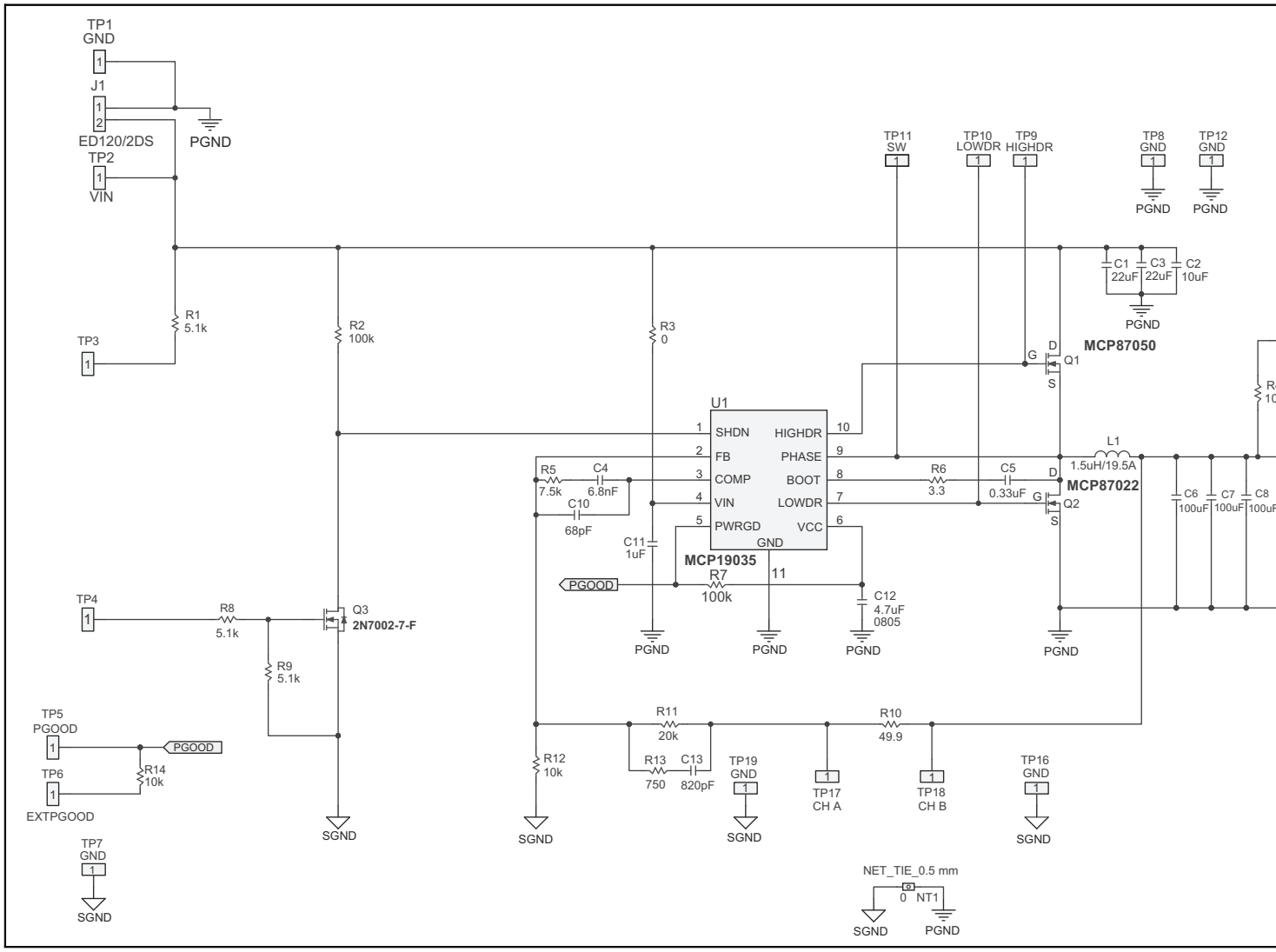
Appendix A. Schematic and Layouts

A.1 INTRODUCTION

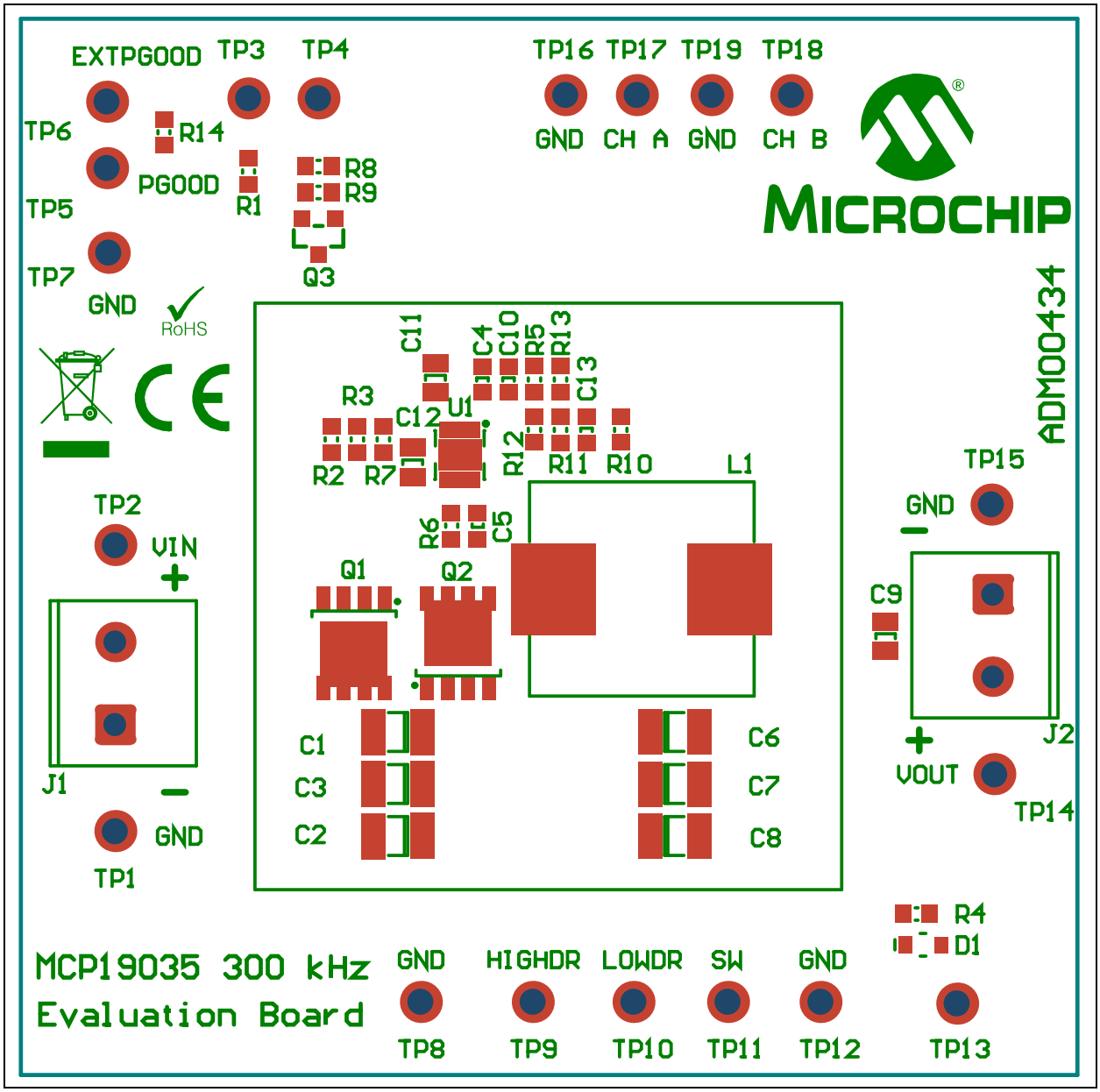
This appendix contains the following schematics and layouts for the MCP19035 300 kHz Synchronous Buck Controller Evaluation Board:

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

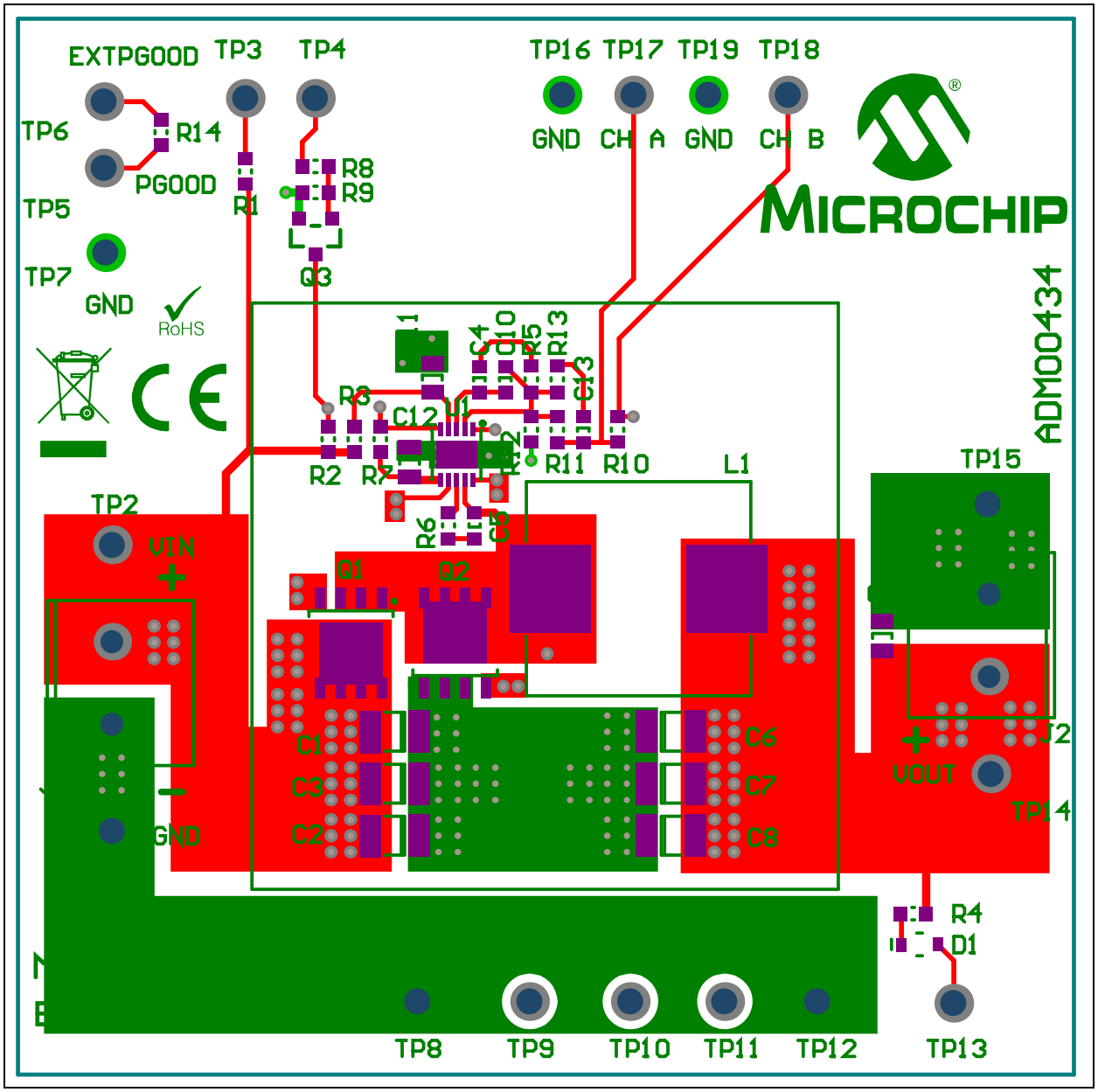
A.2 BOARD – SCHEMATIC



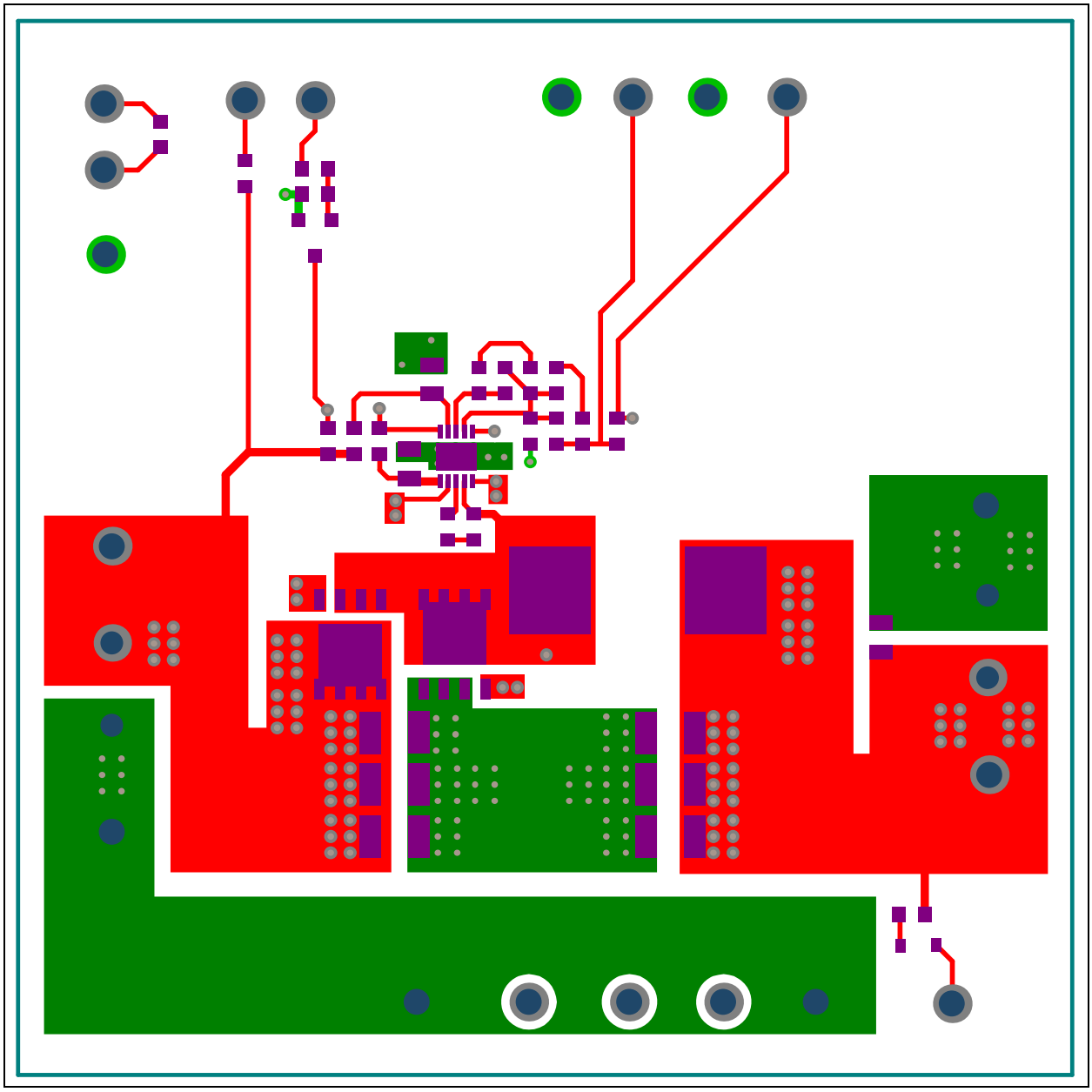
A.3 BOARD – TOP SILK AND PADS



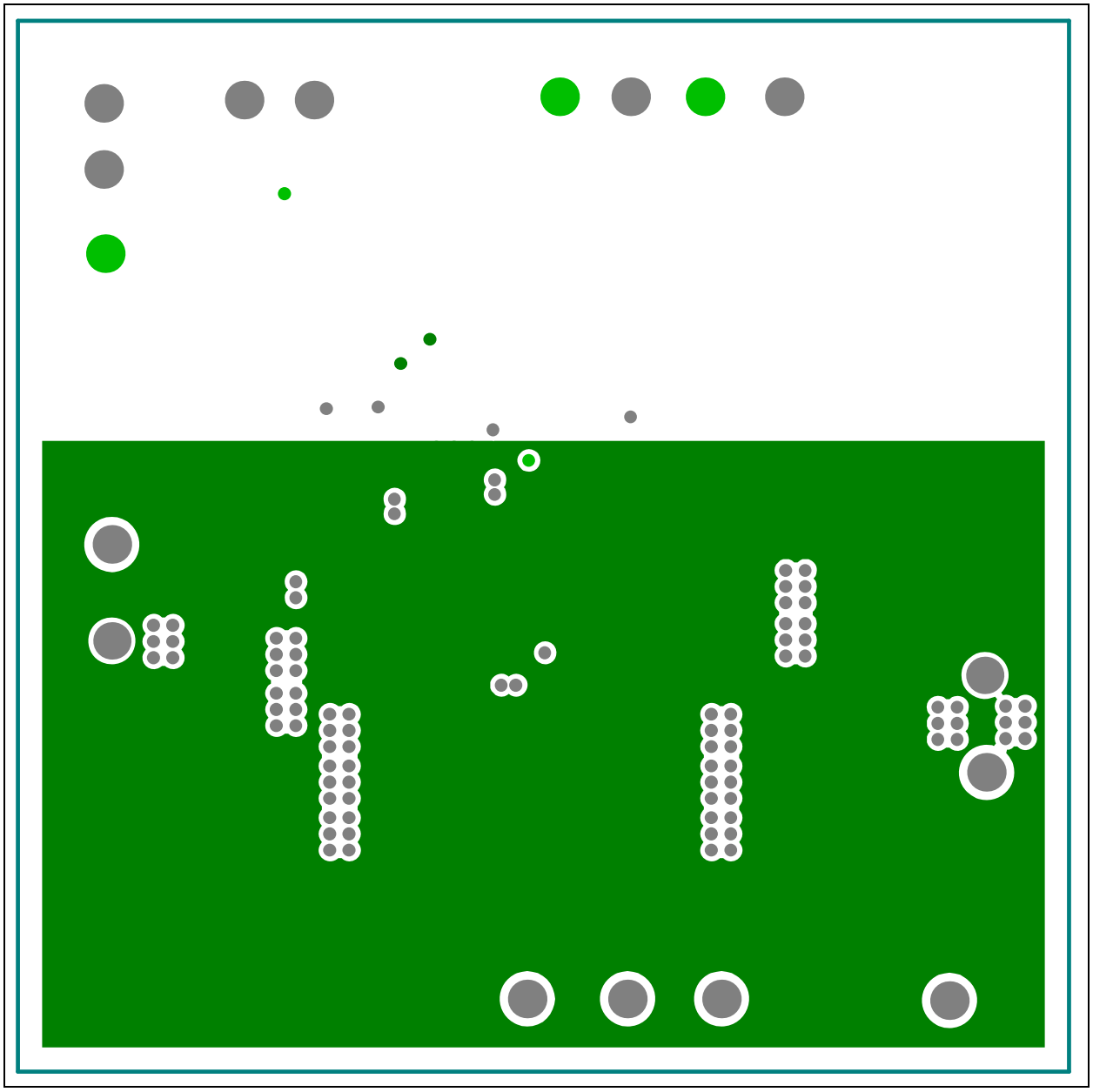
A.4 BOARD – TOP COPPER AND SILK



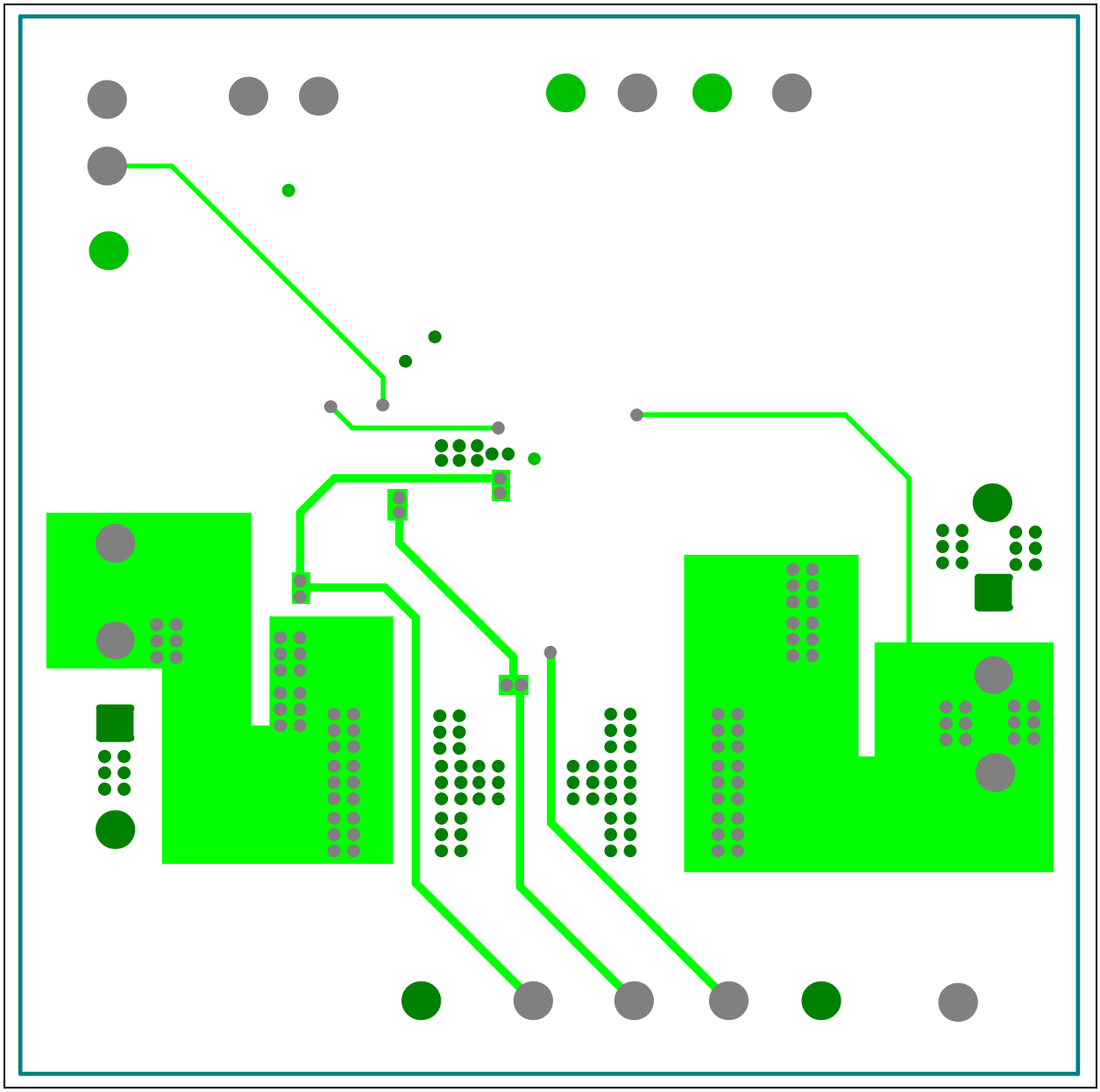
A.5 BOARD – TOP COPPER



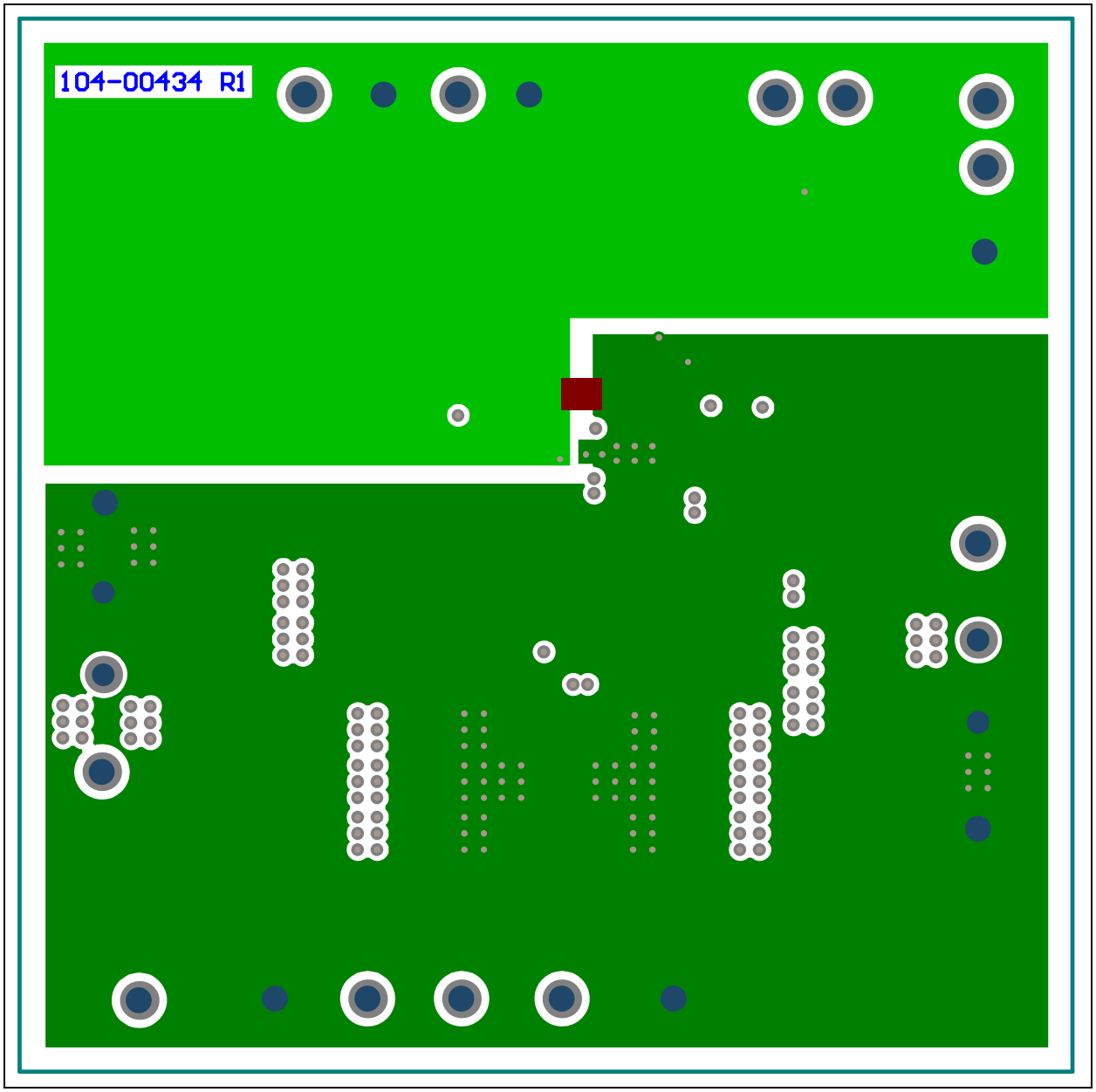
A.6 BOARD – MID LAYER 1



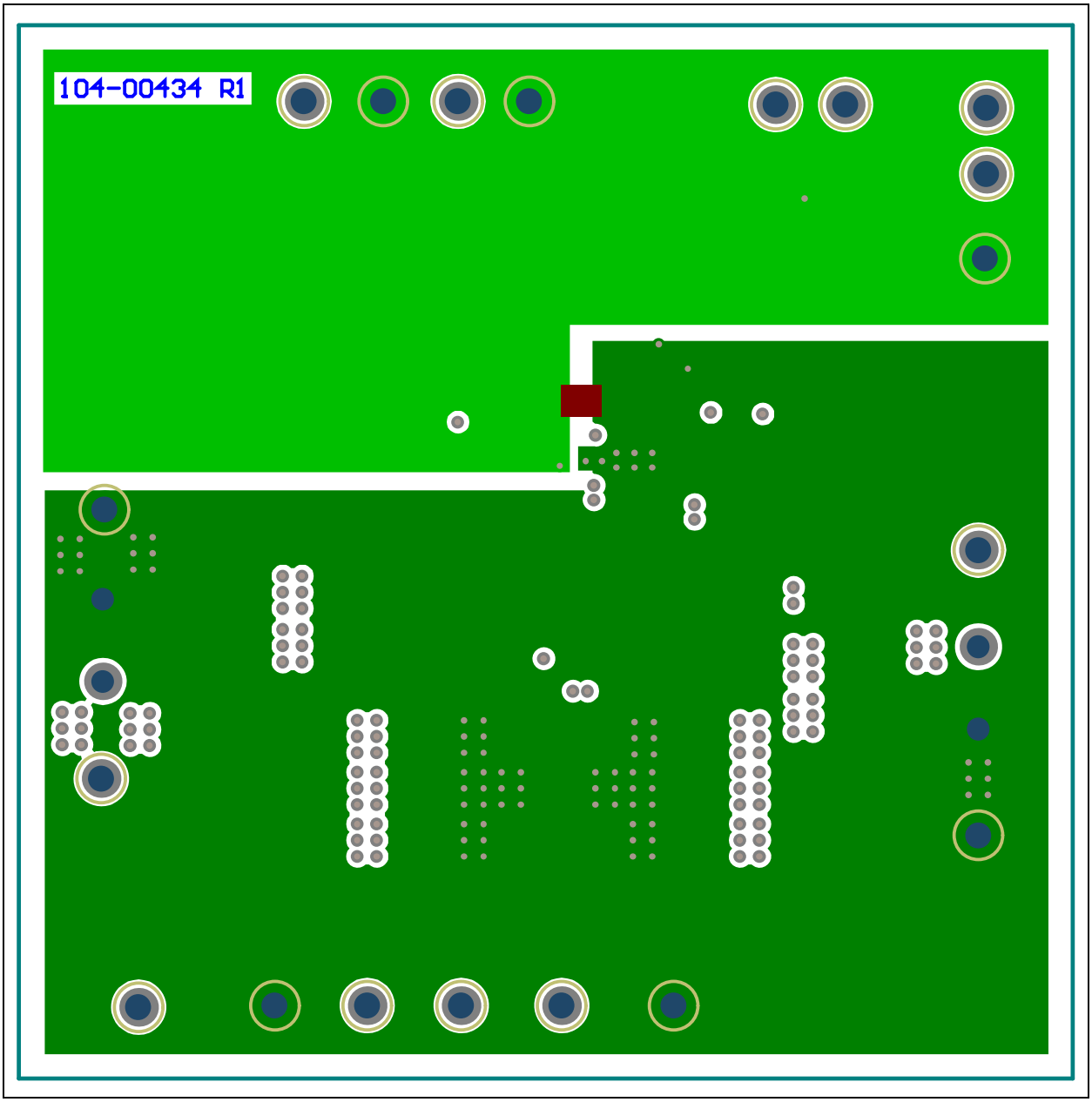
A.7 BOARD – MID LAYER 2



A.8 BOARD – BOTTOM COPPER AND PADS



A.9 BOARD – BOTTOM COPPER, SILK AND PADS



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Appendix B. Bill of Materials

TABLE B-1: BILL OF MATERIALS (BOM)

Qty	Reference	Description	Manufacturer	Part Number
4	BUMP	Bumpon Hemisphere .44X.20 White	3M	SJ-5003 (WHITE)
2	C1, C3	Cap. Cer. 22 µF 25V 10% X7R 1210	Murata Electronics®	GRM32ER71E226KE15L
1	C2	Cap. Cer. 10 µF 25V 10% X7R 121	TDK Corporation	C3225X7R1E106K
1	C4	Cap. Cer. 6800 PF 50V 5% NP0 0603	KEMET®	C0603C682J5GACTU
1	C5	Cap. Cer. 0.33 µF 16V 10% X7R 0603	Murata Electronics	GRM188R71C334KA01D
3	C6, C7, C8	Cap. Cer. 100 µF 6.3V 20% X5R 1210	TDK Corporation	C3225X5R0J107M
2	C9, C11	Cap. Cer. 1 µF 35V 10% X7R 0805	TDK Corporation	CGA4J3X7R1V105K
1	C10	Cap. Cer. 68 PF 100V 5% NP0 0603	KEMET	C0603C680J1GACTU
1	C12	Cap. Cer. 4.7 µF 25V X5R 0805	TDK Corporation	C2012X5R1E475K
1	C13	Cap. Cer. 820 PF 50V 5% NP0 0603	KEMET	C0603C821J5GACTU
1	D1	Diode Schottky 0.5A 30V SOD 323	Diodes® Incorporated	B0530WS-7-F
2	J1, J2	Terminal Block 5.08 MM vert. two pos.	On-Shore Technology, Inc.	ED120/2DS
1	L1	Inductor Power 1.5µH 19.5A SMD	Wurth® Elektronik Group	7443320150
	PCB	Printed Circuit Board - MCP19035 300 kHz Synchronous Buck Controller Evaluation Board	—	104-00434
1	Q1	High Performance MOSFET Transistor	Microchip Technology Inc.	**MCP87050-U/MF**
1	Q2	High Performance MOSFET Transistor	Microchip Technology Inc.	**MCP87022-U/MF**
1	Q3	MOSFET N-Ch. 60V 115 MA SOT-23-3	Diodes Incorporated	2N7002-7-F
3	R1, R8, R9	Res. 5.1kOhm 1/10W 1% 0603 SMD	Panasonic® - ECG	ERJ-3EKF5101V
2	R2, R7	Res. 100kOhm 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. 100 Ohm 1/10W 1% 0603 SMD	Panasonic - ECG	ERJ-3EKF1000V
1	R5	Res. 7.50kOHMhm 1/10W 1% 0603 SMD	Panasonic - ECG	ERJ-3EKF7501V
1	R6	Res. 3.3 Ohm 1/10W 1% 0603	Panasonic - ECG	ERJ-3RQF3R3V
1	R10	Res. 49.9 Ohm .25W 1% 0603 SMD	Vishay/Dale	CRCW060349R9FKEAHP
1	R11	Res. 20k Ohm 1/10W 1% 0603 SMD	Panasonic - ECG	ERJ-3EKF2002V
2	R12, R14	Res. 10k Ohm 1/10W 1% 0603 SMD	Panasonic - ECG	ERJ-3EKF1002V
1	R13	Res. 750 Ohm 1/10W 1% 0603 SMD	Vishay/Dale	CRCW0603750RFKEA
19	TP1 – TP19	Test Point PC Multi Purpose Black	Keystone Electronics Corp.	5011
1	U1	High Speed Synchronous Buck Controller	Microchip Technology Inc.	**MCP19035-AAABE/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.

NOTES:

Appendix C. Typical Performance Data, Curves and Waveforms

C.1 INTRODUCTION

This chapter shows some of the typical performace parameters and curves of the MCP19035 300 kHz Synchronous Buck Controller Evaluation Board.

TABLE C-1: CONVERTER PARAMETERS

Parameter	Value	Comments
Input Voltage Range (V)	8 - 14	
Output Voltage (V)	1.8	±2.5% tolerance
Maximum Output Current (A)	15	Steady State output current
Output Voltage Ripple (mV)	<30	V_{IN} = 12V, I_{OUT} = 15A
Input Voltage Ripple (mV)	<300	V_{IN} = 12V, I_{OUT} = 15A
Output Voltage Overshoot during Step Load (mV)	<100	Step Load 0A to 5A
Switching Frequency (kHz)	250 – 350	Typical 300 kHz

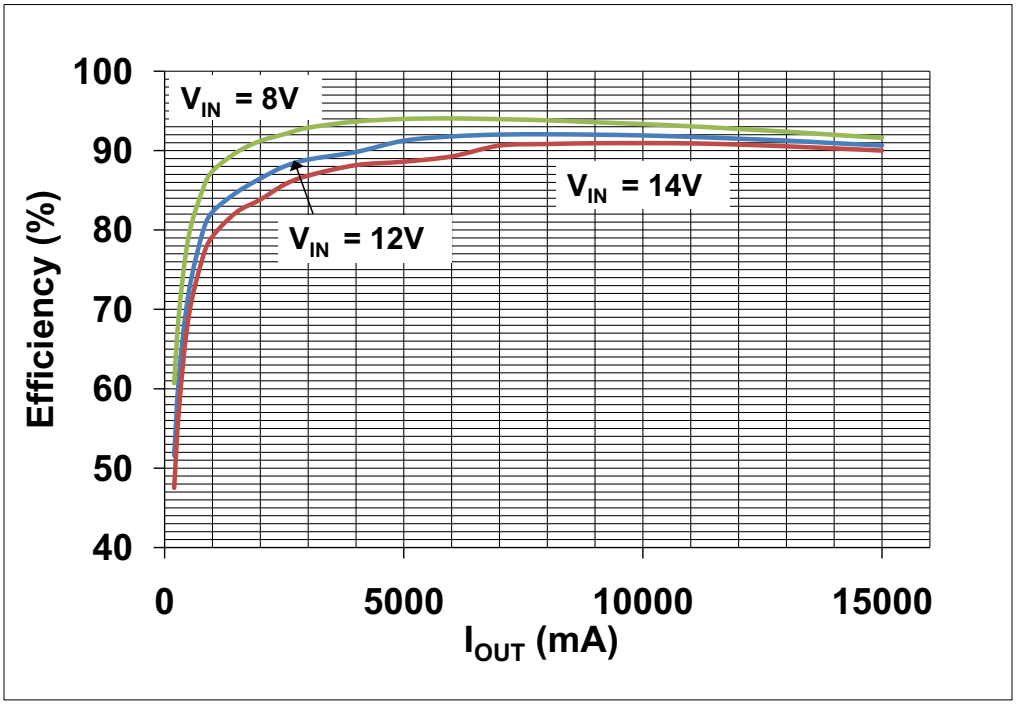

FIGURE C-1: *Efficiency.*

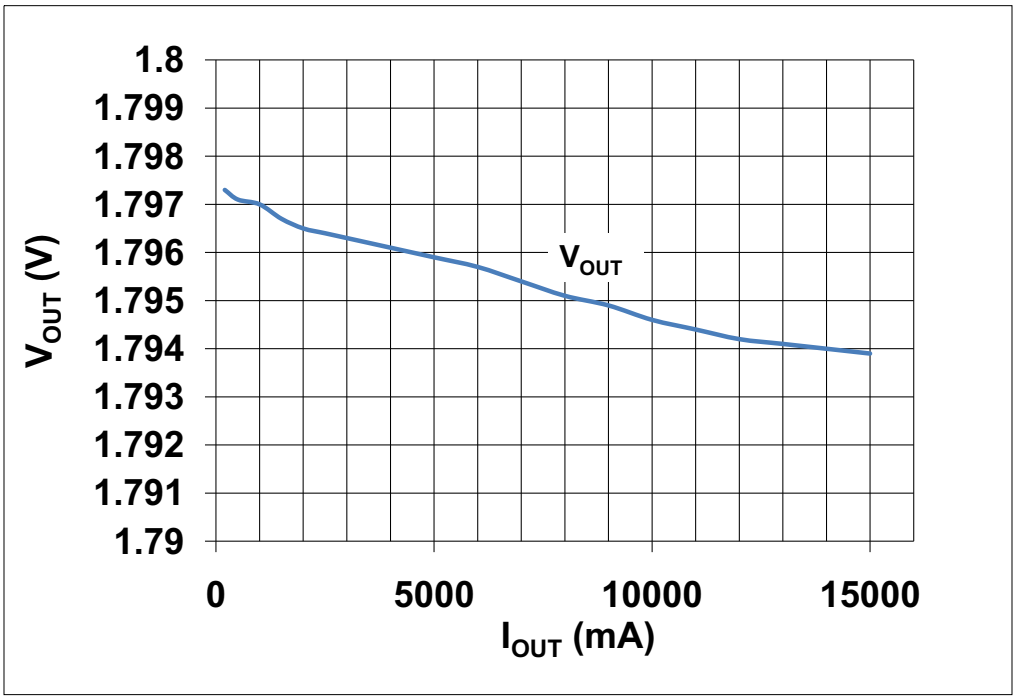

FIGURE C-2: *Load Regulation (V_{IN} = 12V).*

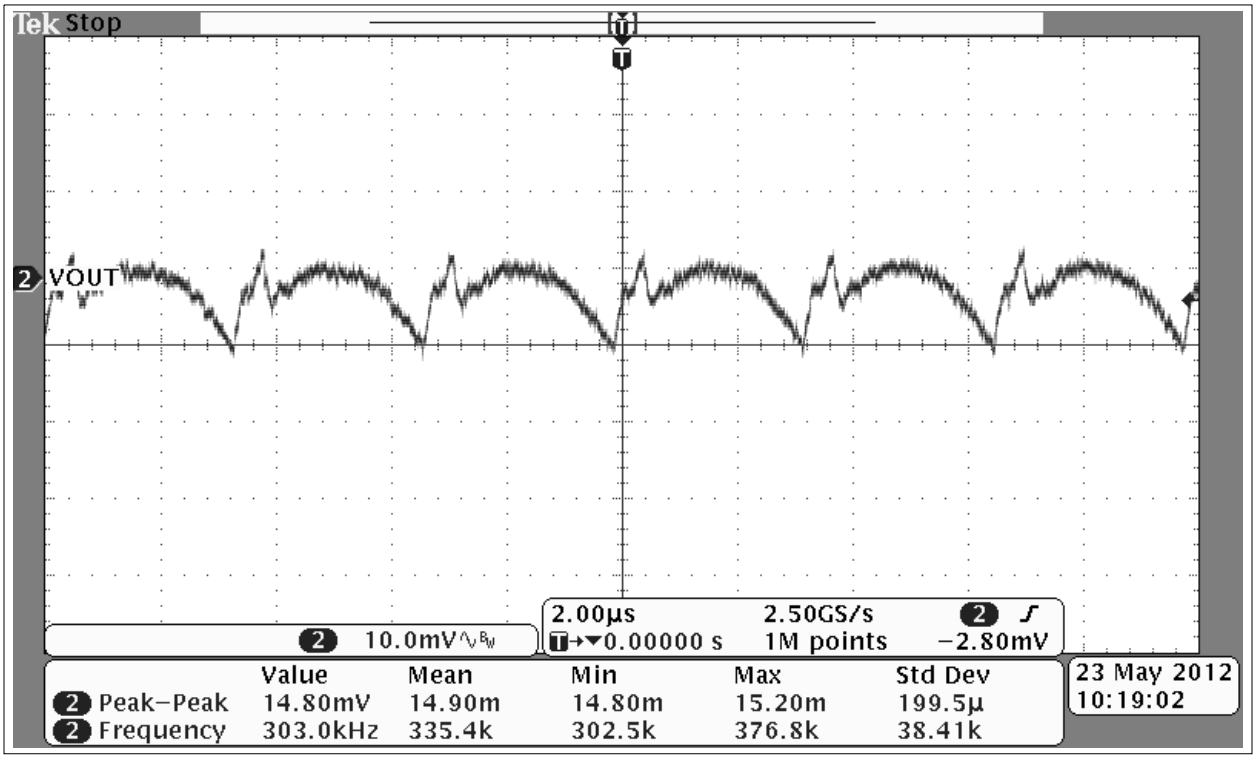

FIGURE C-3: *Output Voltage Ripple/Noise (V_{IN} = 12V, I_{OUT} = 10A, BW = 20 MHz).*

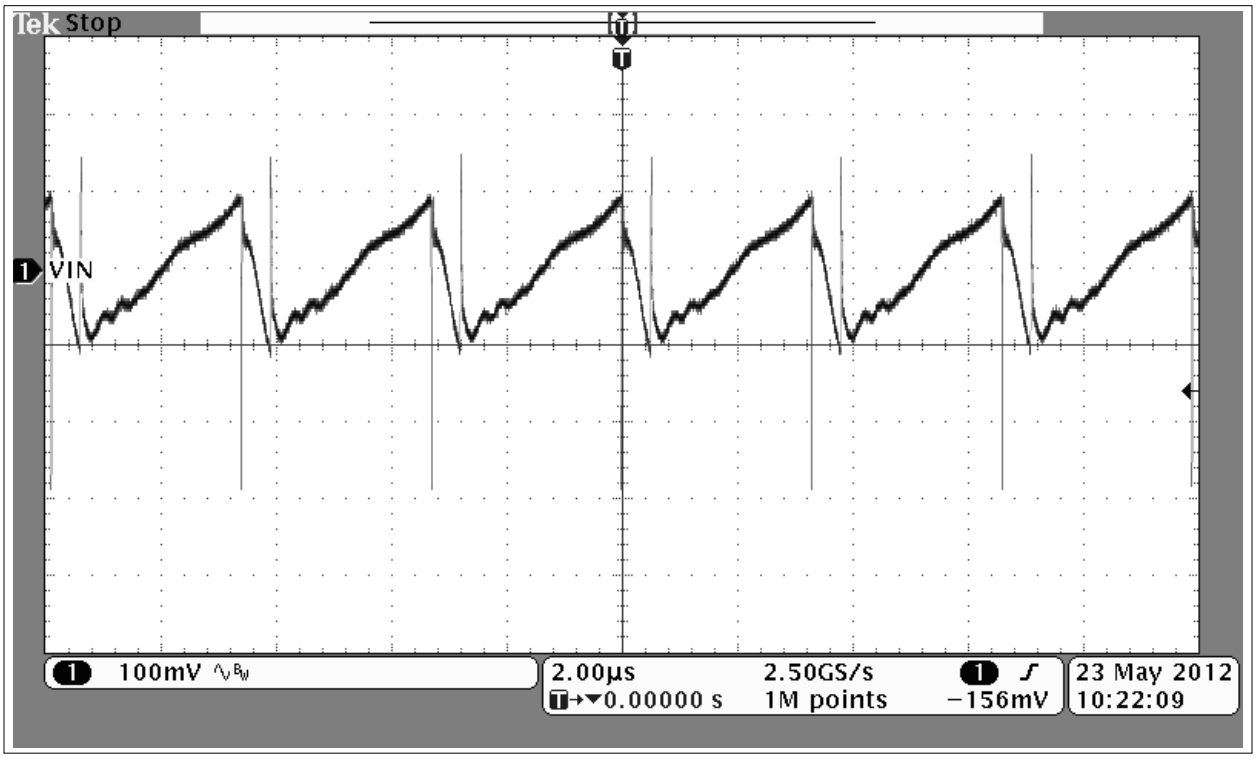

FIGURE C-4: *Input Voltage Ripple/Noise (V_{IN} = 12V, I_{OUT} = 10A, BW = 20 MHz).*

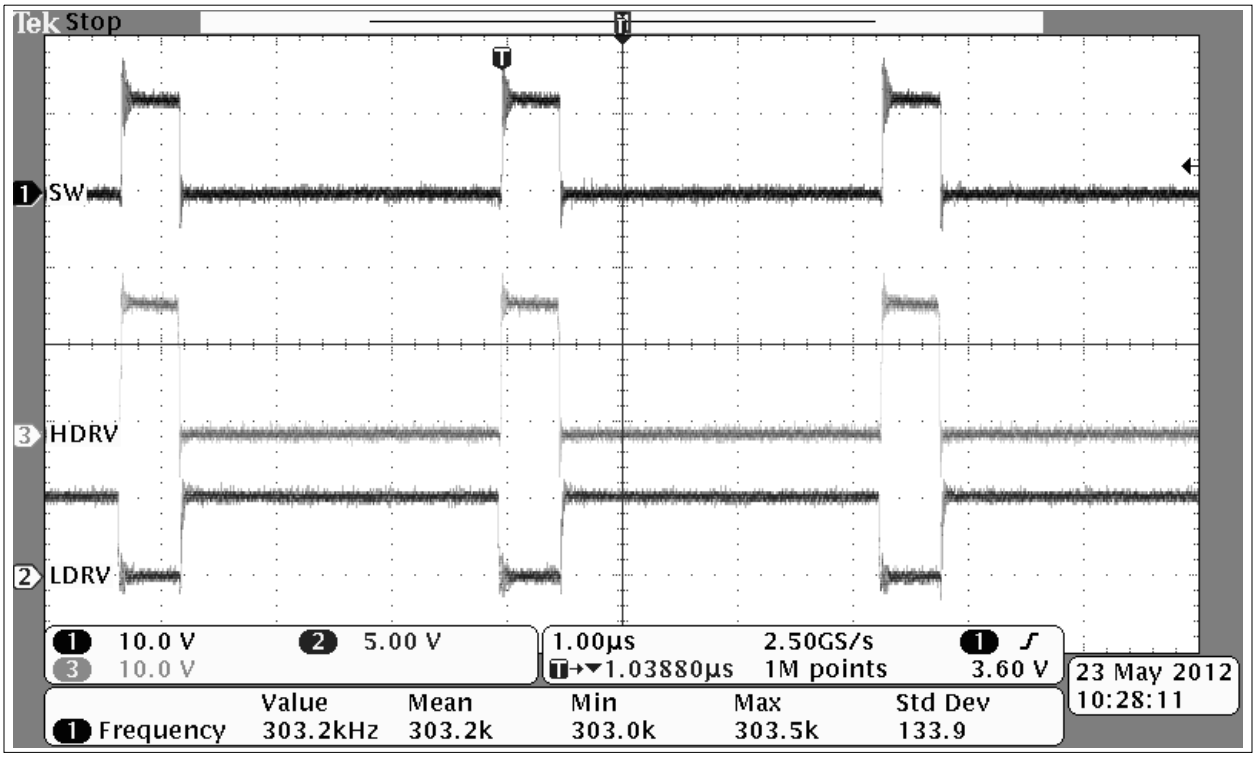

FIGURE C-5: *SW (TP11), LDRV (TP10) and HDRV (TP9) signals (V_{IN} = 12V, I_{OUT} = 10A, BW = 300 MHz).*

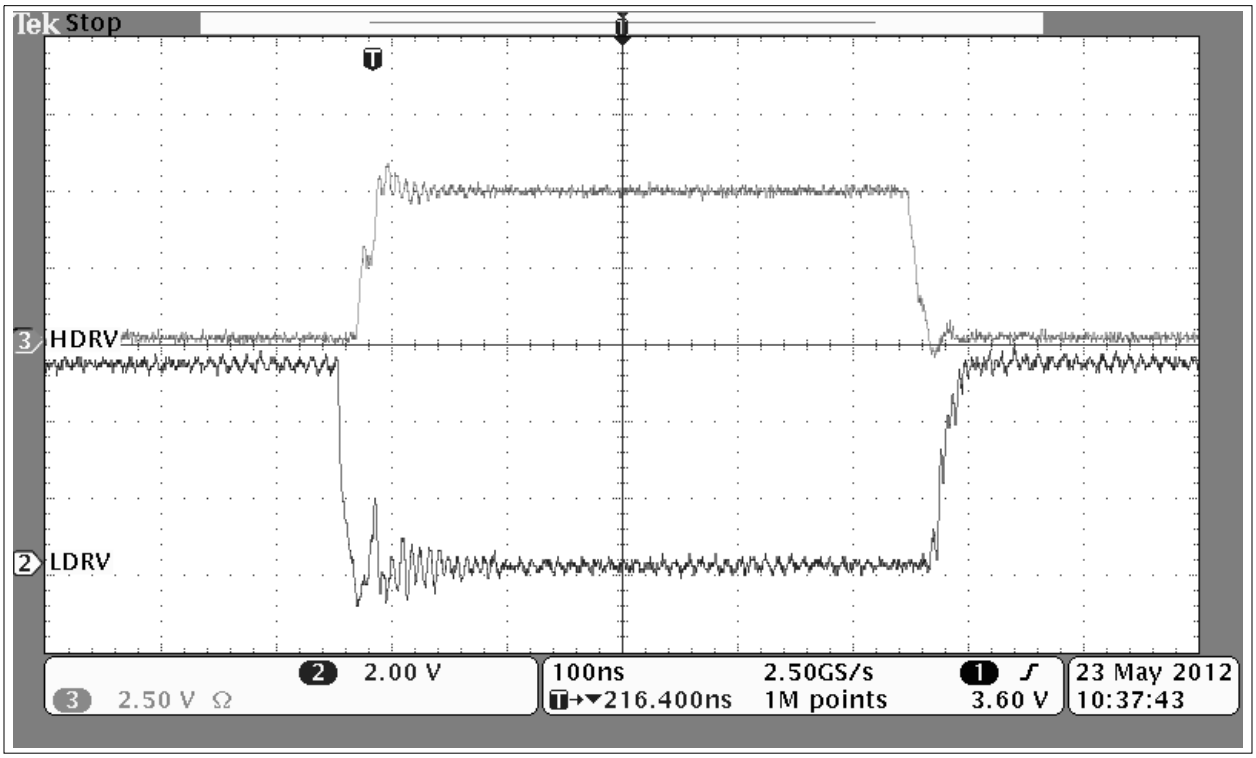

FIGURE C-6: *LDRV (TP10) and HDRV (TP9) signals (V_{IN} = 12V, I_{OUT} = 10A, BW = 300 MHz).*

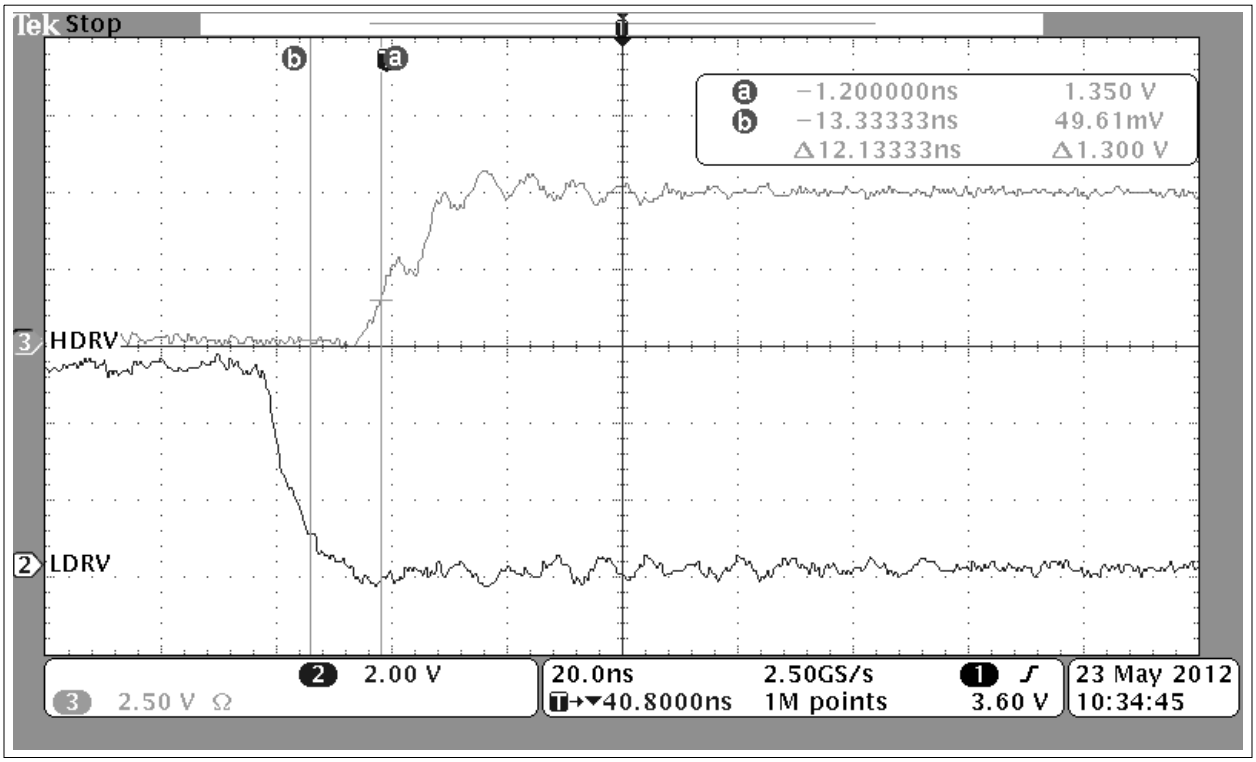

FIGURE C-7: *Dead Times 1 (V_{IN} = 12V, I_{OUT} = 1A, BW = 300 MHz).*

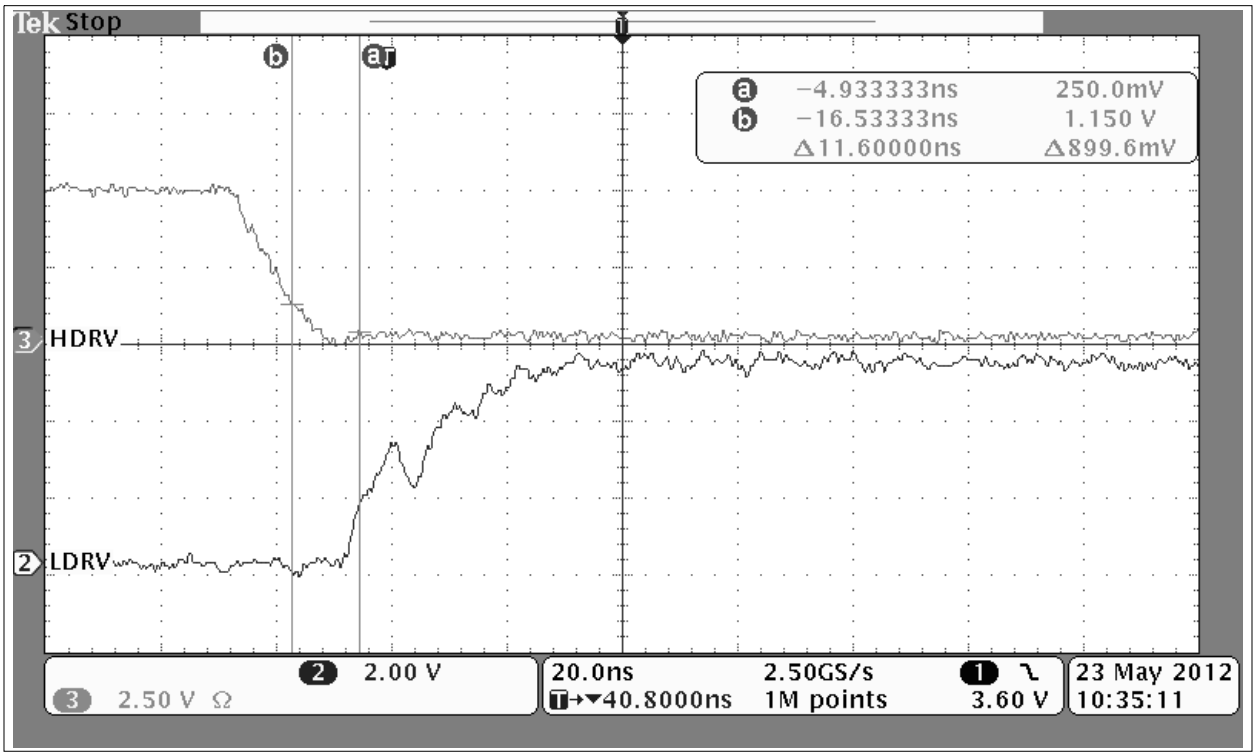

FIGURE C-8: *Dead Times 2 (V_{IN} = 12V, I_{OUT} = 1A, BW = 300 MHz).*

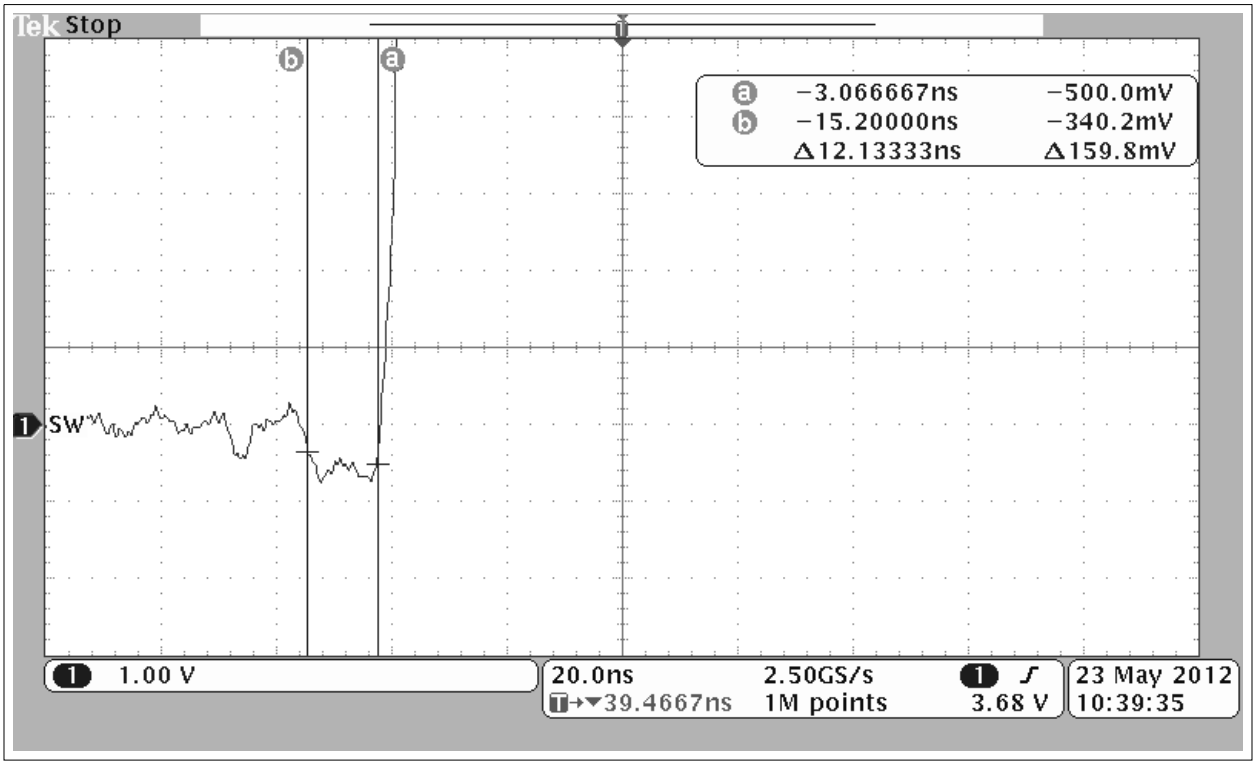

FIGURE C-9: *The Body Diode Conduction Time (V_{IN} = 12V, I_{OUT} = 10A, BW = 300 MHz).*

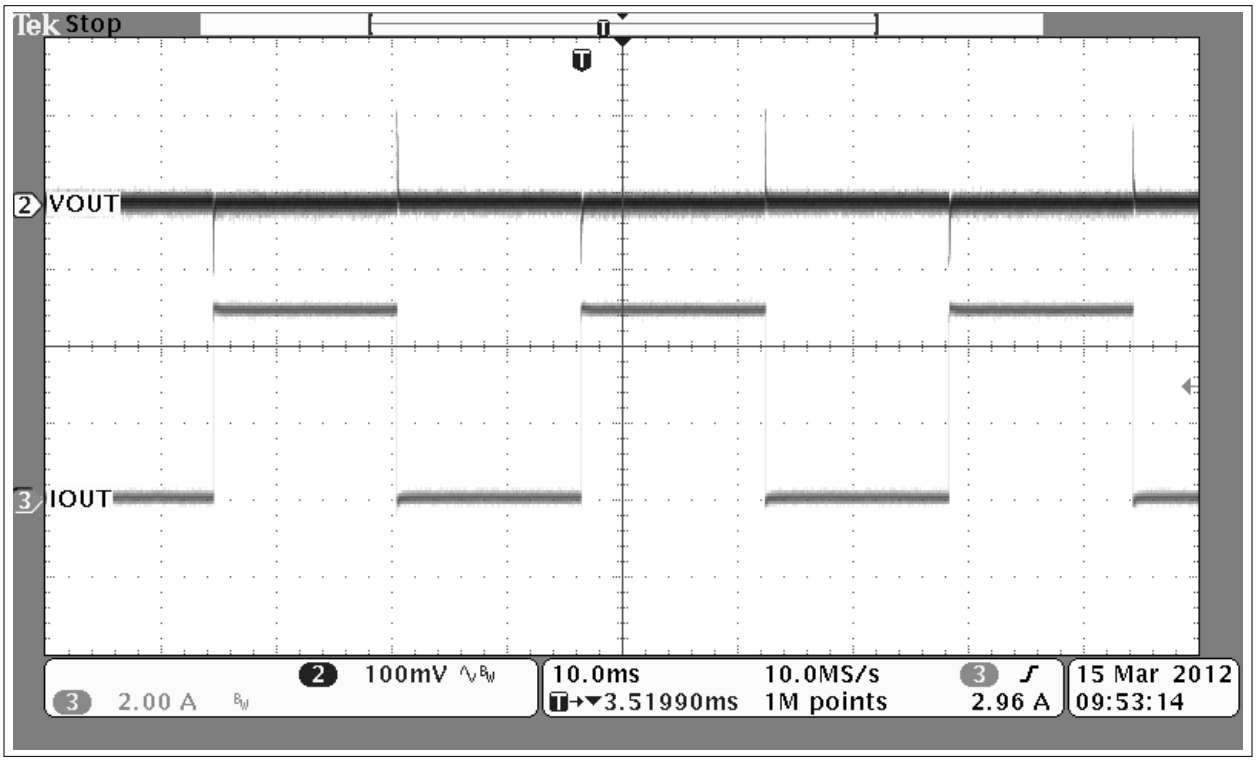

FIGURE C-10: *Step Load 1 (V_{IN} = 12V).*

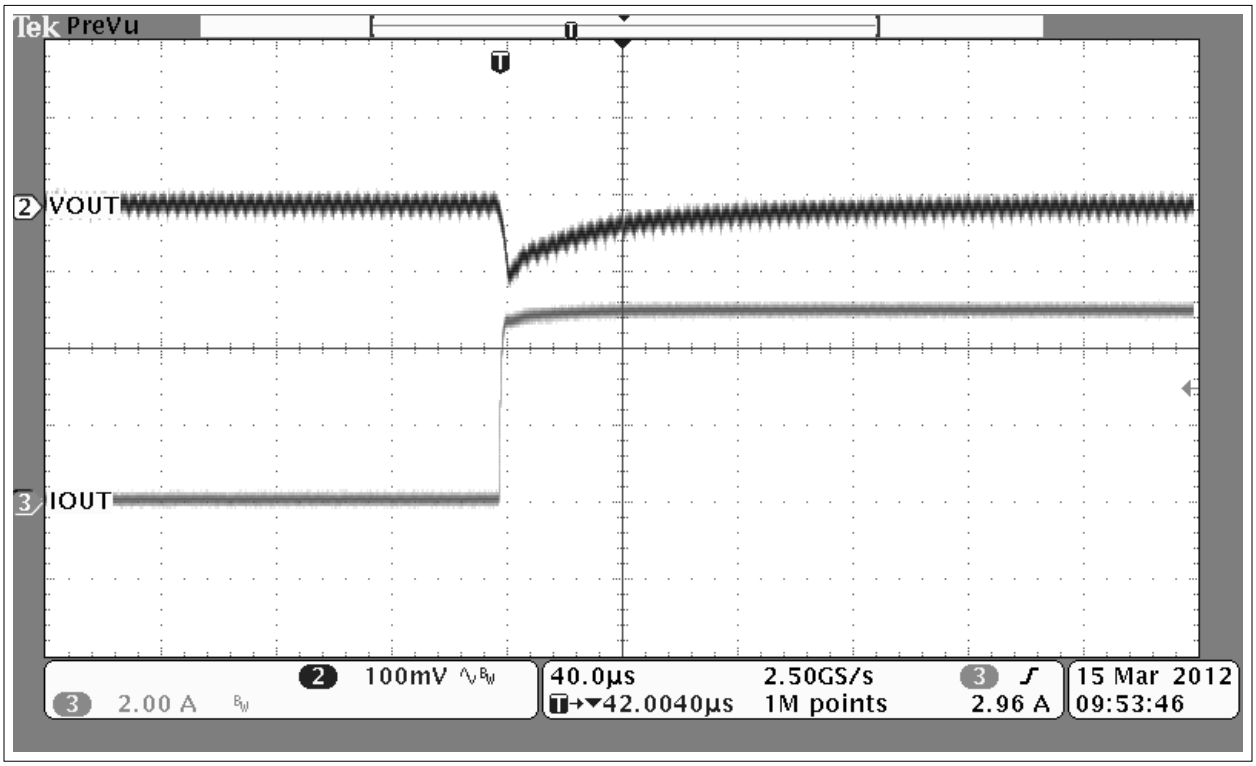

FIGURE C-11: *Step Load 2 (V_{IN} = 12V).*

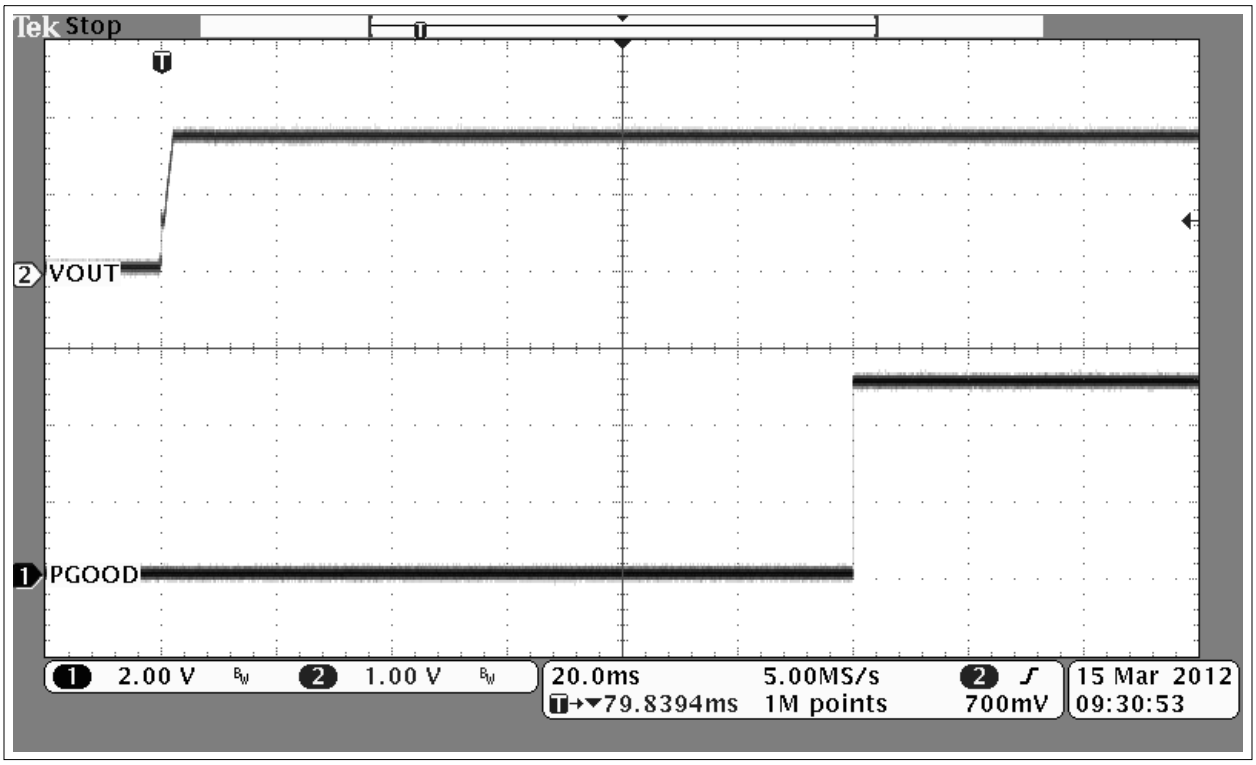

FIGURE C-12: *Power Good Signal (PGOOD).*

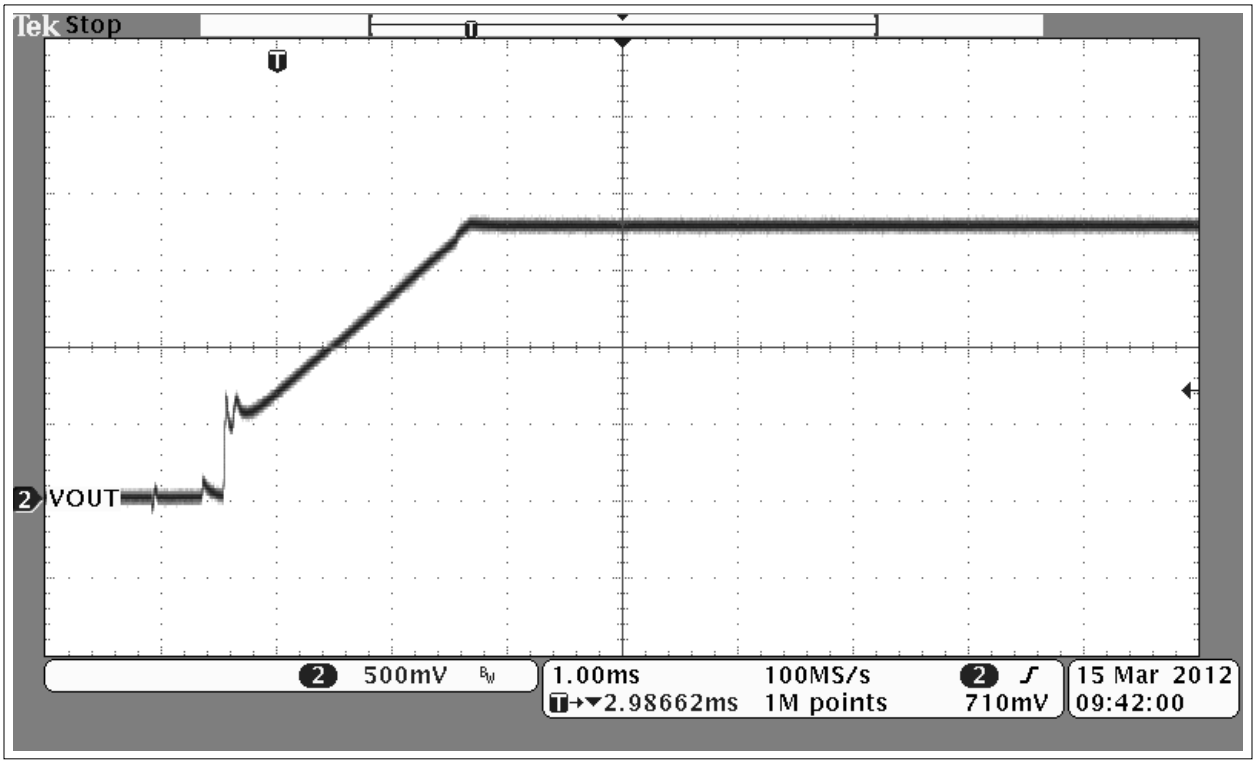

FIGURE C-13: *Soft Start.*

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