



**MCP19035  
600 kHz Synchronous  
Buck Controller  
Evaluation Board  
User's Guide**

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ISBN: 978-1-62077-176-1

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**Object of Declaration: MCP19035 600 kHz Synchronous Buck Controller Evaluation Board**

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Signed for and on behalf of Microchip Technology Inc. at Chandler, Arizona, USA



Derek Carlson  
VP Development Tools

02-May-12  
Date

NOTES:

## Table of Contents

|                                                                                            |          |
|--------------------------------------------------------------------------------------------|----------|
| <b>Preface</b>                                                                             | <b>7</b> |
| Introduction                                                                               | 7        |
| Document Layout                                                                            | 7        |
| Conventions Used in this Guide                                                             | 8        |
| Recommended Reading                                                                        | 9        |
| The Microchip Web Site                                                                     | 9        |
| Customer Support                                                                           | 9        |
| Document Revision History                                                                  | 9        |
| <b>Chapter 1. Product Overview</b>                                                         |          |
| 1.1 Introduction                                                                           | 11       |
| 1.2 Short Overview: MCP19035                                                               | 11       |
| 1.3 What is the MCP19035 600 kHz Synchronous Buck Controller<br>Evaluation Board?          | 12       |
| 1.4 What the MCP19035 600 kHz Synchronous Buck Controller<br>Evaluation Board Kit Contains | 12       |
| <b>Chapter 2. Installation and Operation</b>                                               |          |
| 2.1 Introduction                                                                           | 13       |
| 2.1.1 MCP19035 600 kHz Synchronous Buck Controller<br>Evaluation Board Features            | 13       |
| 2.2 Getting Started                                                                        | 13       |
| 2.2.1 Necessary Instruments and Tools                                                      | 13       |
| 2.2.2 Setup Procedure                                                                      | 13       |
| 2.2.3 Board Testing                                                                        | 14       |
| <b>Appendix A. Schematic and Layouts</b>                                                   |          |
| A.1 Introduction                                                                           | 17       |
| A.2 Board – Schematic                                                                      | 18       |
| A.3 Board – Top Silk                                                                       | 19       |
| A.4 Board – Top Copper and Silk                                                            | 20       |
| A.5 Board – Top Copper                                                                     | 21       |
| A.6 Board – Mid Layer 1                                                                    | 22       |
| A.7 Board – Mid Layer 2                                                                    | 23       |
| A.8 Board – Bottom Copper                                                                  | 24       |
| A.9 Board – Bottom Copper and Silk                                                         | 25       |

Appendix B. Bill of Materials

Appendix C. Typical Performance Data, Curves and Waveforms

C.1 Introduction ..... 29

Worldwide Sales and Service .....38

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## Preface

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### 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 “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 600 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 600 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 600 kHz Synchronous Buck Controller Evaluation Board
- **Chapter 2. “Installation and Operation”** – Includes instructions on how to get started with the MCP19035 600 kHz Synchronous Buck Controller Evaluation Board
- **Appendix A. “Schematic and Layouts”** – Shows the schematic and layout diagrams for the MCP19035 600 kHz Synchronous Buck Controller Evaluation Board
- **Appendix B. “Bill of Materials”** – Lists the parts used to build the MCP19035 600 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                                                    |
|--------------------------------------------------|-----------------------------------------------------------------------------------------------------|-------------------------------------------------------------|
| <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)<br>{ ...<br>}                              |



## RECOMMENDED READING

This user's guide describes how to use the MCP19035 600 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)**

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- 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 (April 2013)

- Initial Release of this Document.

NOTES:

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## **Chapter 1. Product Overview**

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### **1.1 INTRODUCTION**

This chapter provides an overview of the MCP19035 600 kHz Synchronous Buck Controller Evaluation Board and covers the following topics:

- Short Overview: MCP19035
- What is the MCP19035 600 kHz Synchronous Buck Controller Evaluation Board?
- What the MCP19035 600 kHz Synchronous Buck Controller Evaluation Board Kit Contains

### **1.2 SHORT OVERVIEW: MCP19035**

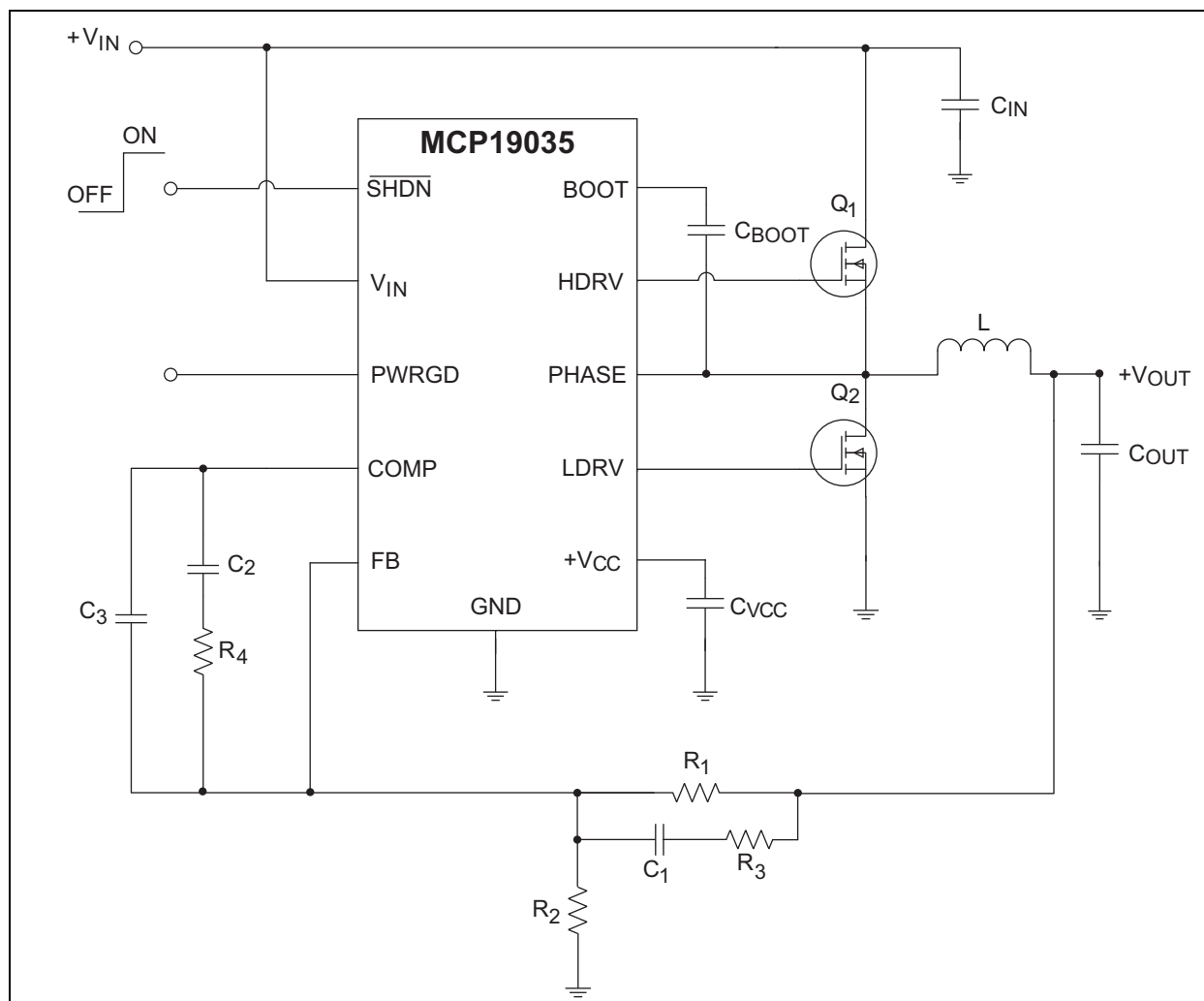
The MCP19035 is a highly-featured, highly integrated, synchronous buck controller in a space-saving 10-pin DFN 3 x 3 mm package that operates from input voltage sources up to 30V. Integrated features include high and low-side MOSFET drivers, fixed-frequency voltage mode control, internal oscillator and reference voltage generator, overcurrent protection circuit for both sides, Power Good circuit and overtemperature protection. A minimal number of external components is 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<sup>®</sup> microcontrollers) to be powered directly from this controller without any additional components.



**FIGURE 1-1:** MCP19035 - Typical Application.

## 1.3 WHAT IS THE MCP19035 600 KHZ SYNCHRONOUS BUCK CONTROLLER EVALUATION BOARD?

The MCP19035 600 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 10A. The board demonstrates the capabilities of the MCP19035 600 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 ranging from 0.9V to 3.3V by changing a single resistor.

## 1.4 WHAT THE MCP19035 600 KHZ SYNCHRONOUS BUCK CONTROLLER EVALUATION BOARD KIT CONTAINS

The MCP19035 600 kHz Synchronous Buck Controller Evaluation Board kit includes:

- MCP19035 600 kHz Synchronous Buck Controller Evaluation Board (ADM00445)
- Important Information Sheet

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## Chapter 2. Installation and Operation

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### 2.1 INTRODUCTION

#### 2.1.1 MCP19035 600 kHz Synchronous Buck Controller Evaluation Board Features

The MCP19035 600 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: 10A
- 88% typical efficiency at 1.8V/10A output and 12V input
- 600 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 low-power Standby mode
- Under Voltage Lockout (UVLO) with 4.2V and 3.6V typical thresholds

### 2.2 GETTING STARTED

The MCP19035 600 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

- Adjustable DC Power Supply with 0V – 15V/5 A<sub>DC</sub> range output capability
- Electronic load with at least 20A 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 the board and the electronic load

#### 2.2.2 Setup Procedure

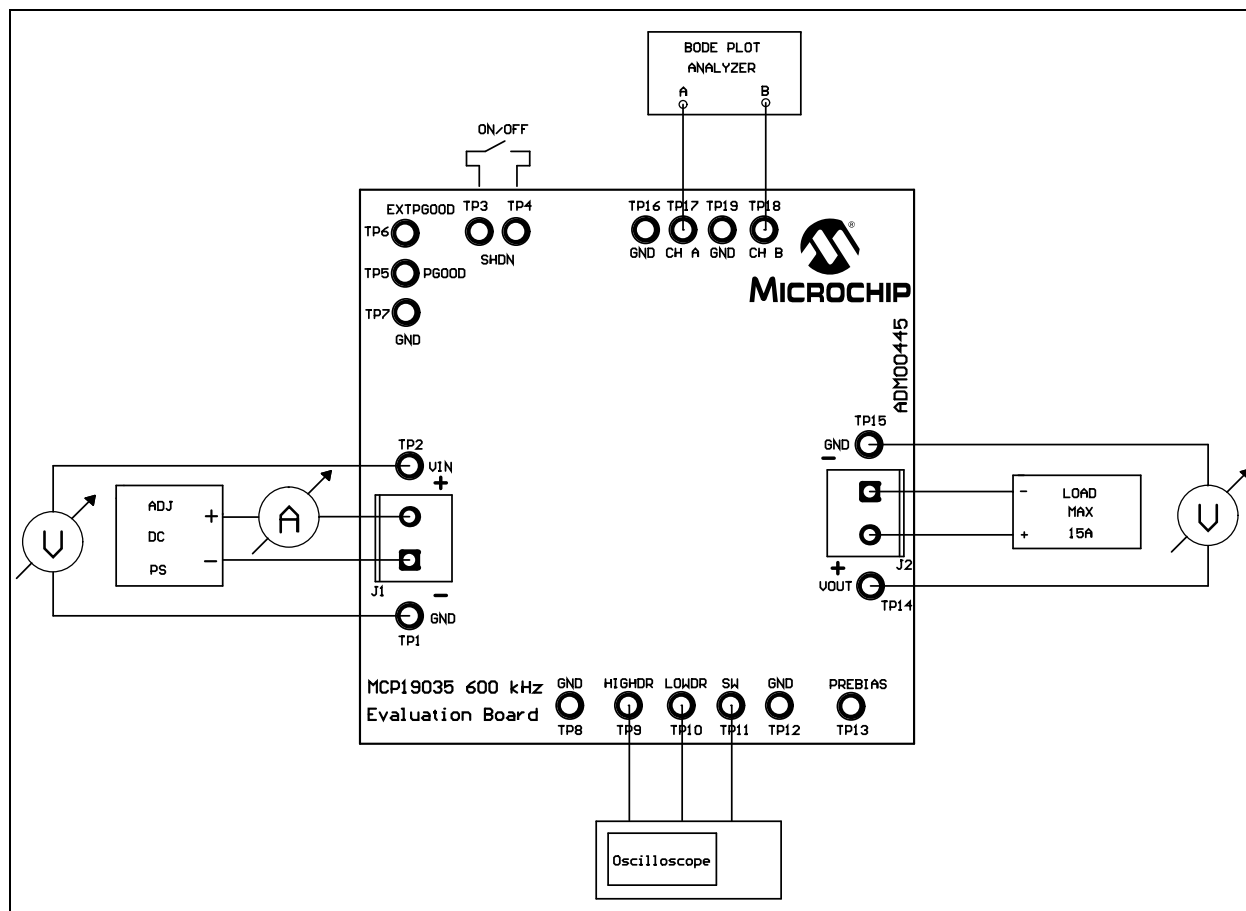
To power up the MCP19035 600 kHz Synchronous Buck Controller Evaluation Board, the following steps must be completed:

1. Connect the Electronic Load to J2 connector of the evaluation 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 evaluation 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 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 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                                  |
|----------------------|------------|----------------------------------------------|
| 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

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

Where:

$$\begin{aligned} V_{REF} &= 0.6V \\ R11 &= 20 \text{ k}\Omega \end{aligned}$$

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 <sub>OUT</sub> (V) | R <sub>12</sub> (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:





# MCP19035 600 KHZ SYNCHRONOUS BUCK CONTROLLER EVALUATION BOARD USER'S GUIDE

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## Appendix A. Schematic and Layouts

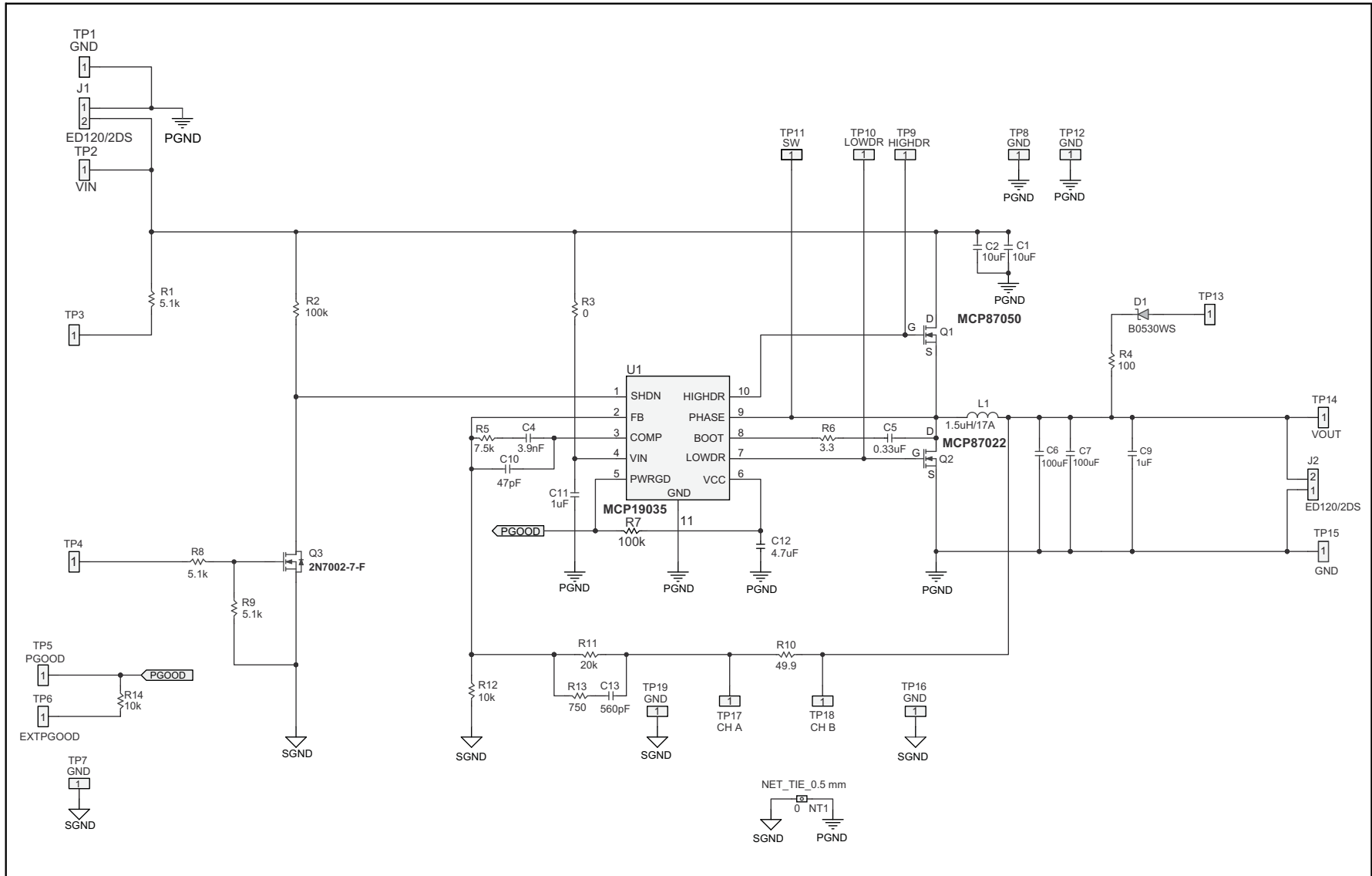
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### A.1 INTRODUCTION

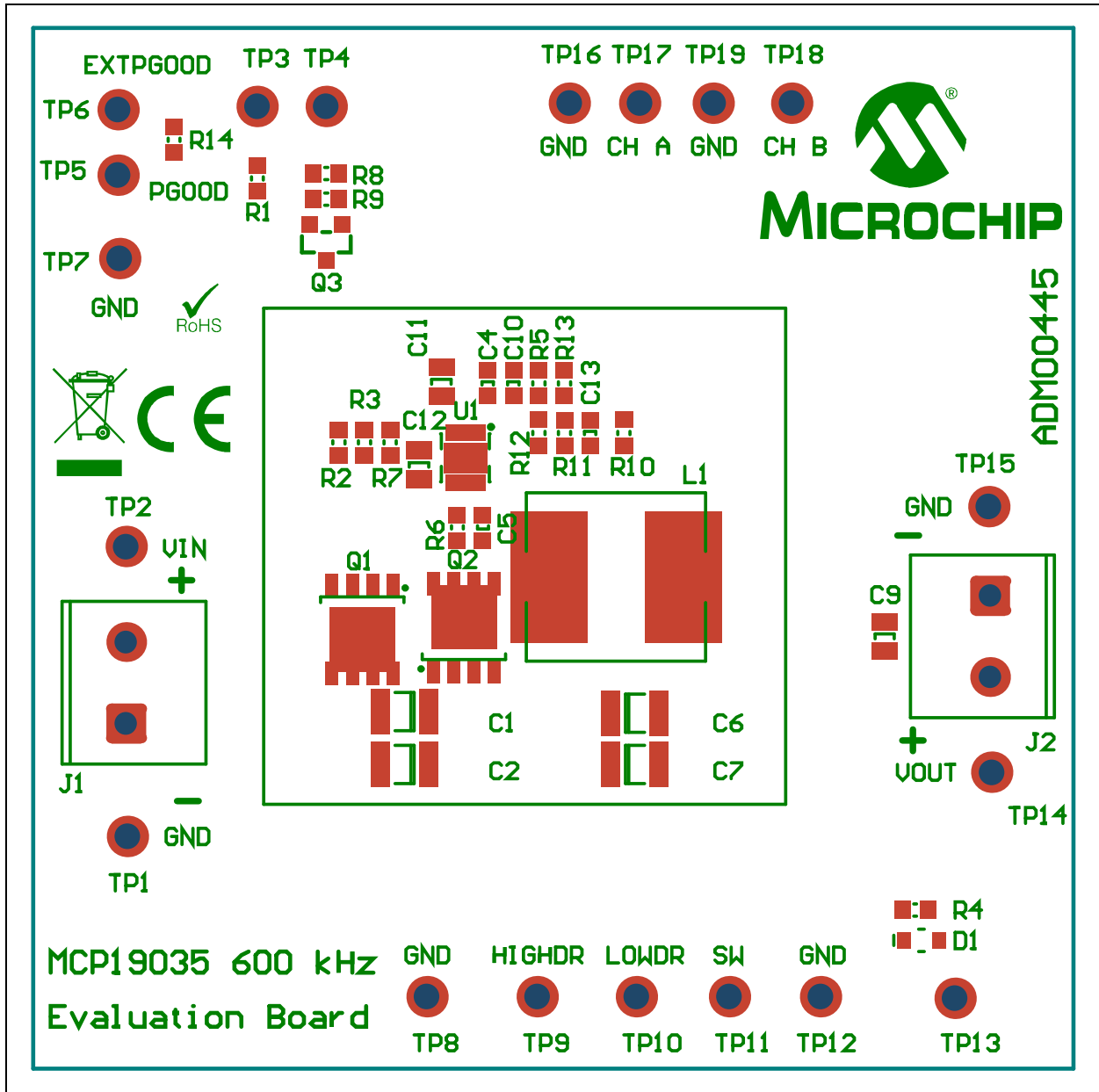
This appendix contains the following schematics and layouts for the MCP19035 600 kHz Synchronous Buck Controller Evaluation Board:

- 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

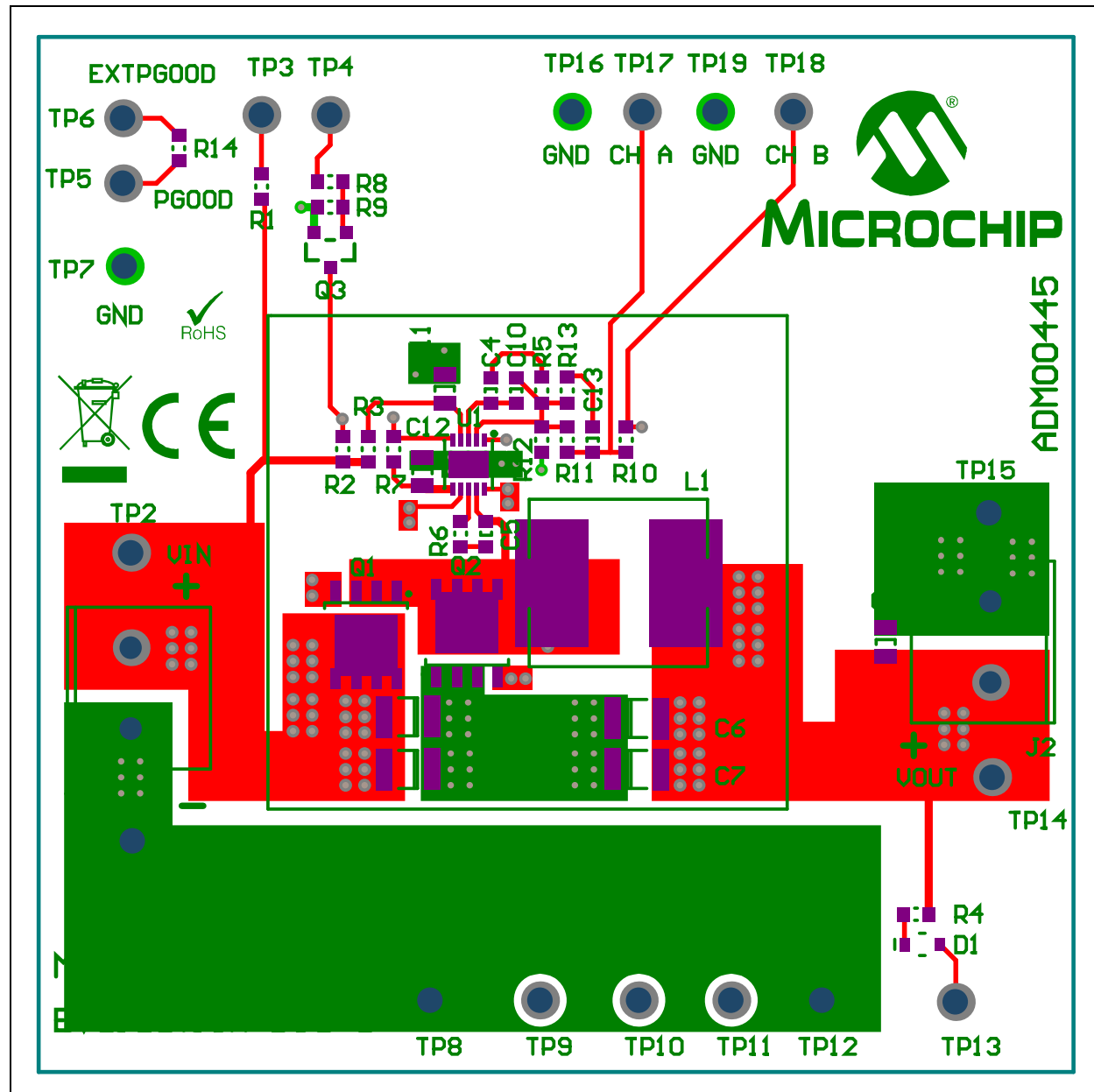
## A.2 BOARD - SCHEMATIC



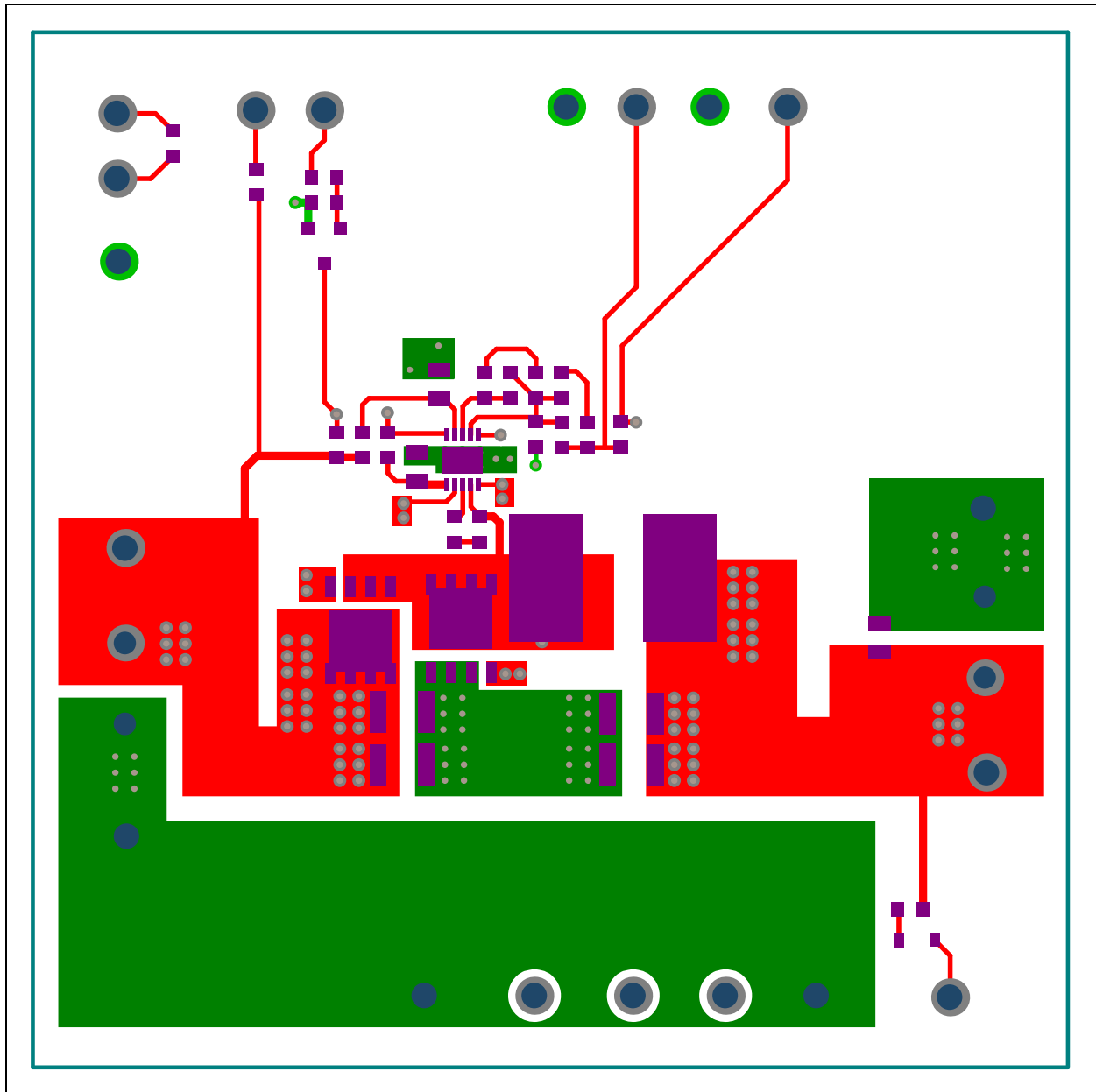
## A.3 BOARD – TOP SILK



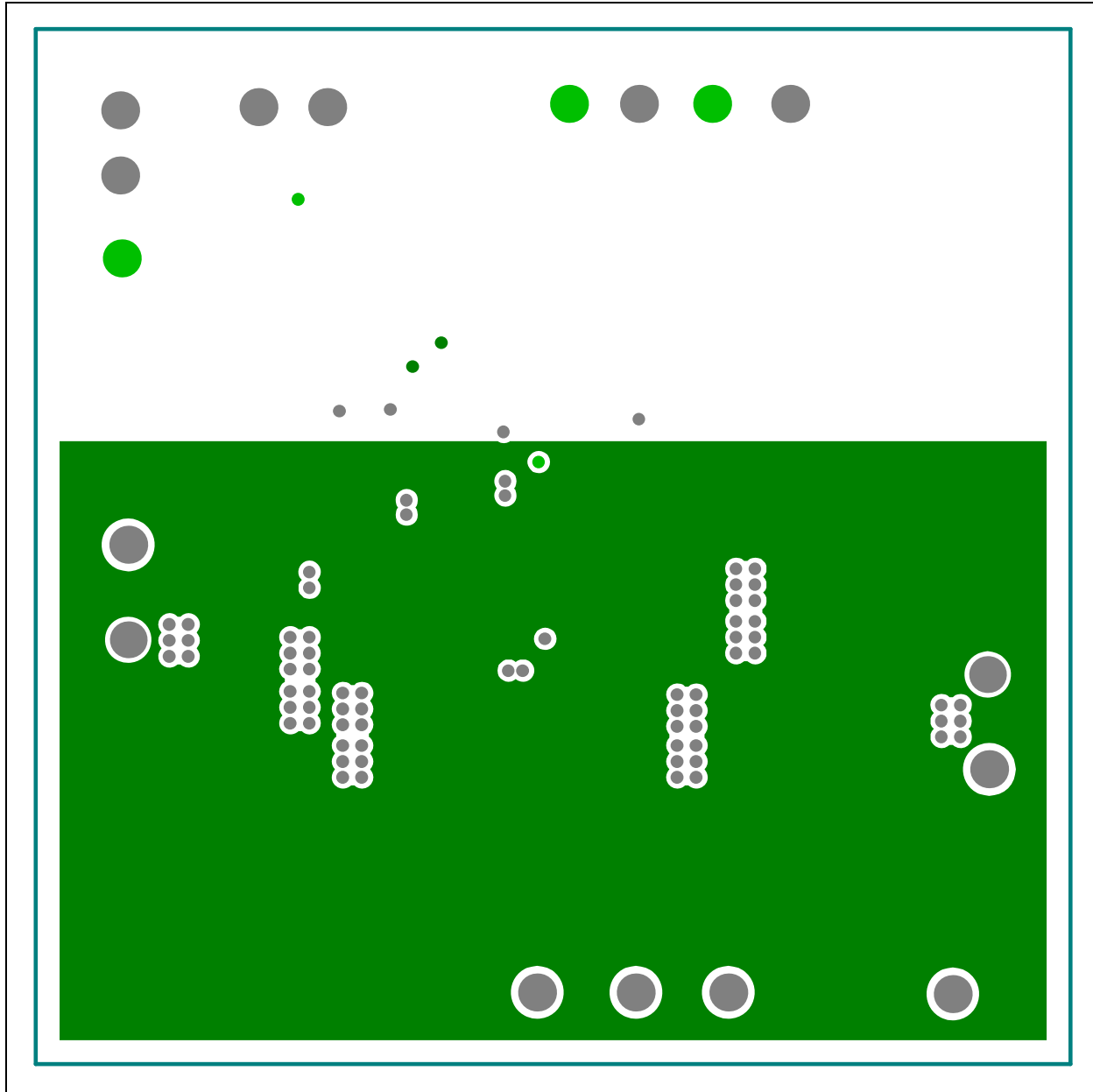
# A.4 BOARD – TOP COPPER AND SILK



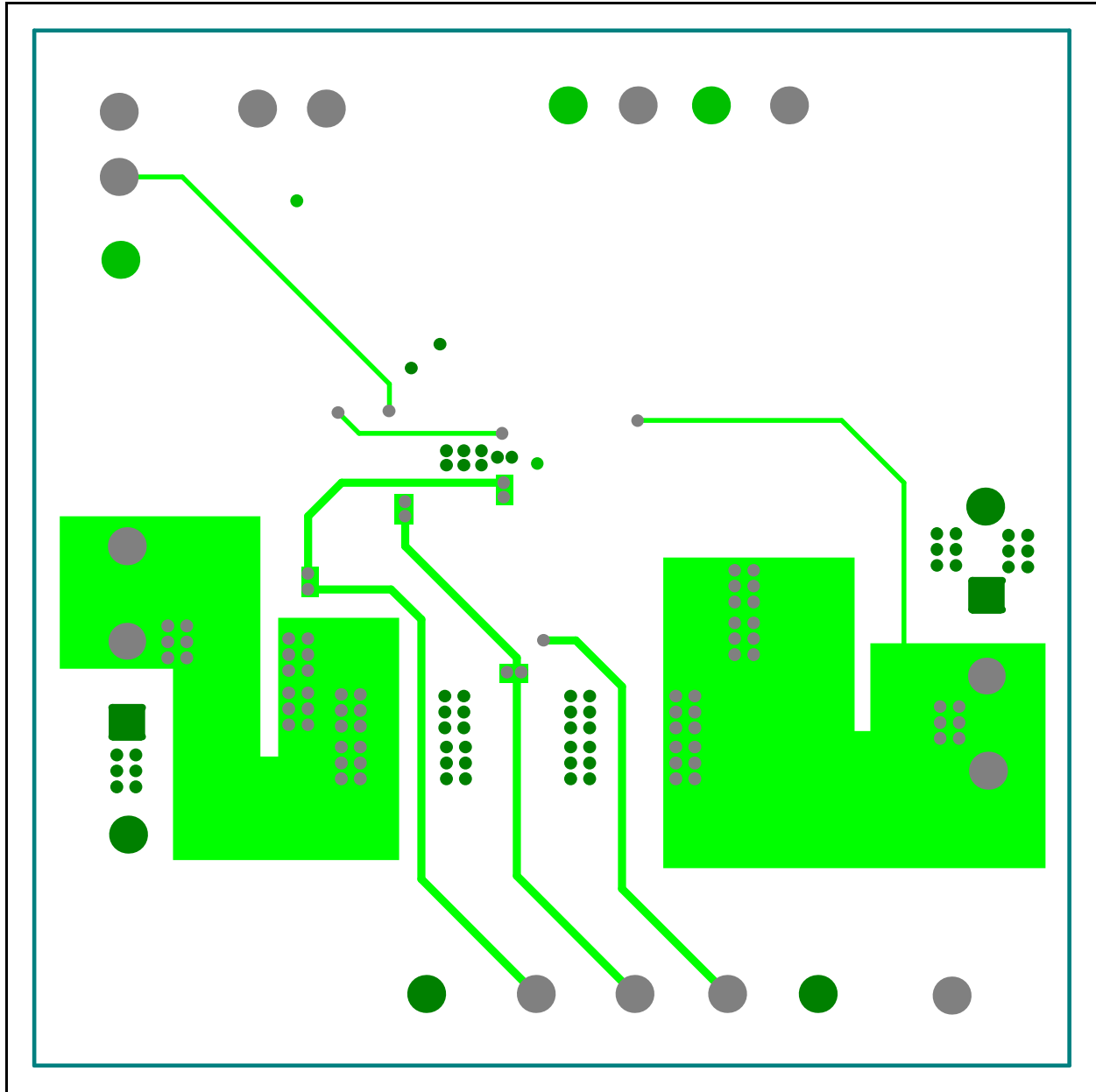
## A.5 BOARD – TOP COPPER



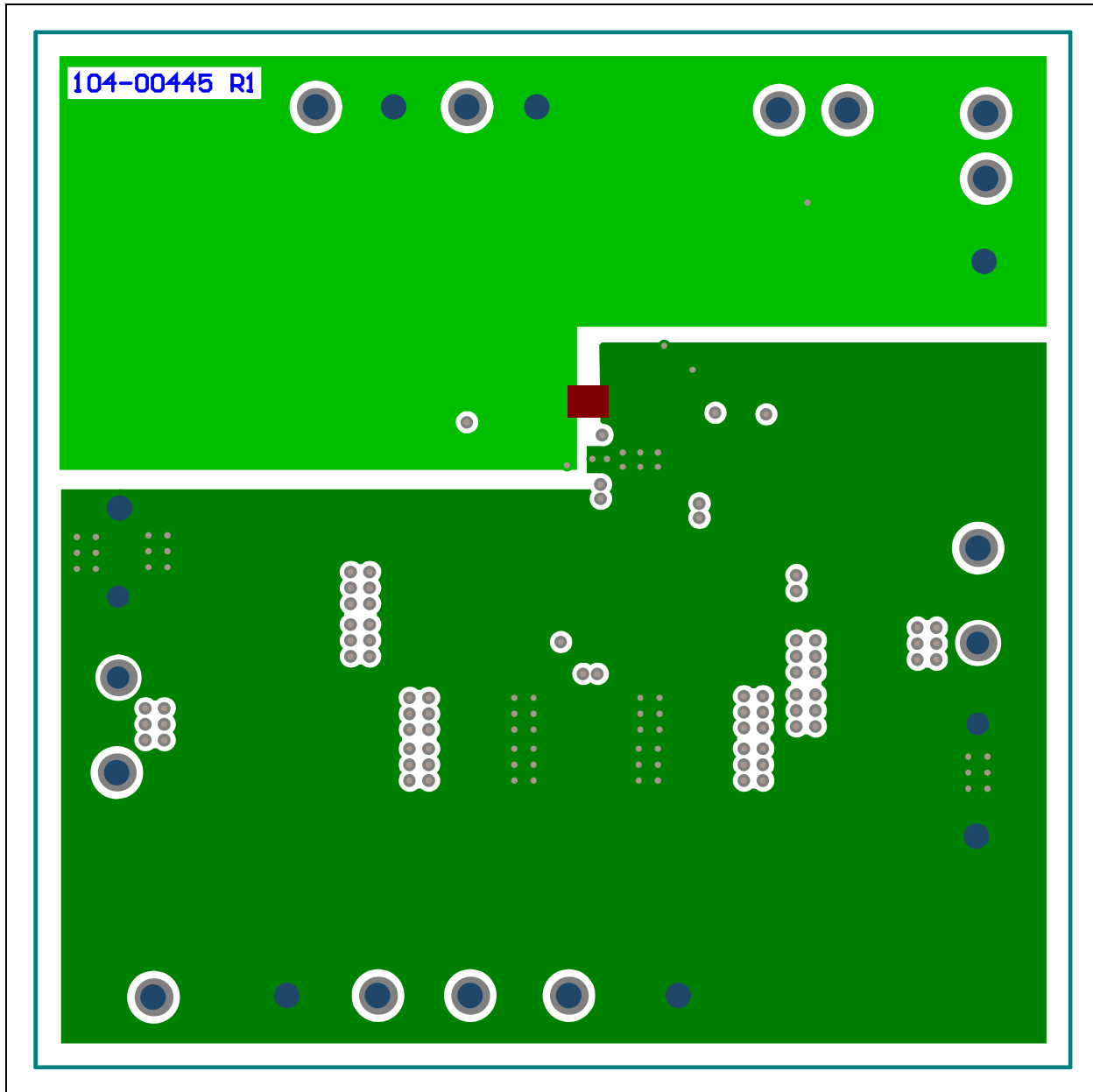
## A.6 BOARD – MID LAYER 1



## A.7 BOARD – MID LAYER 2

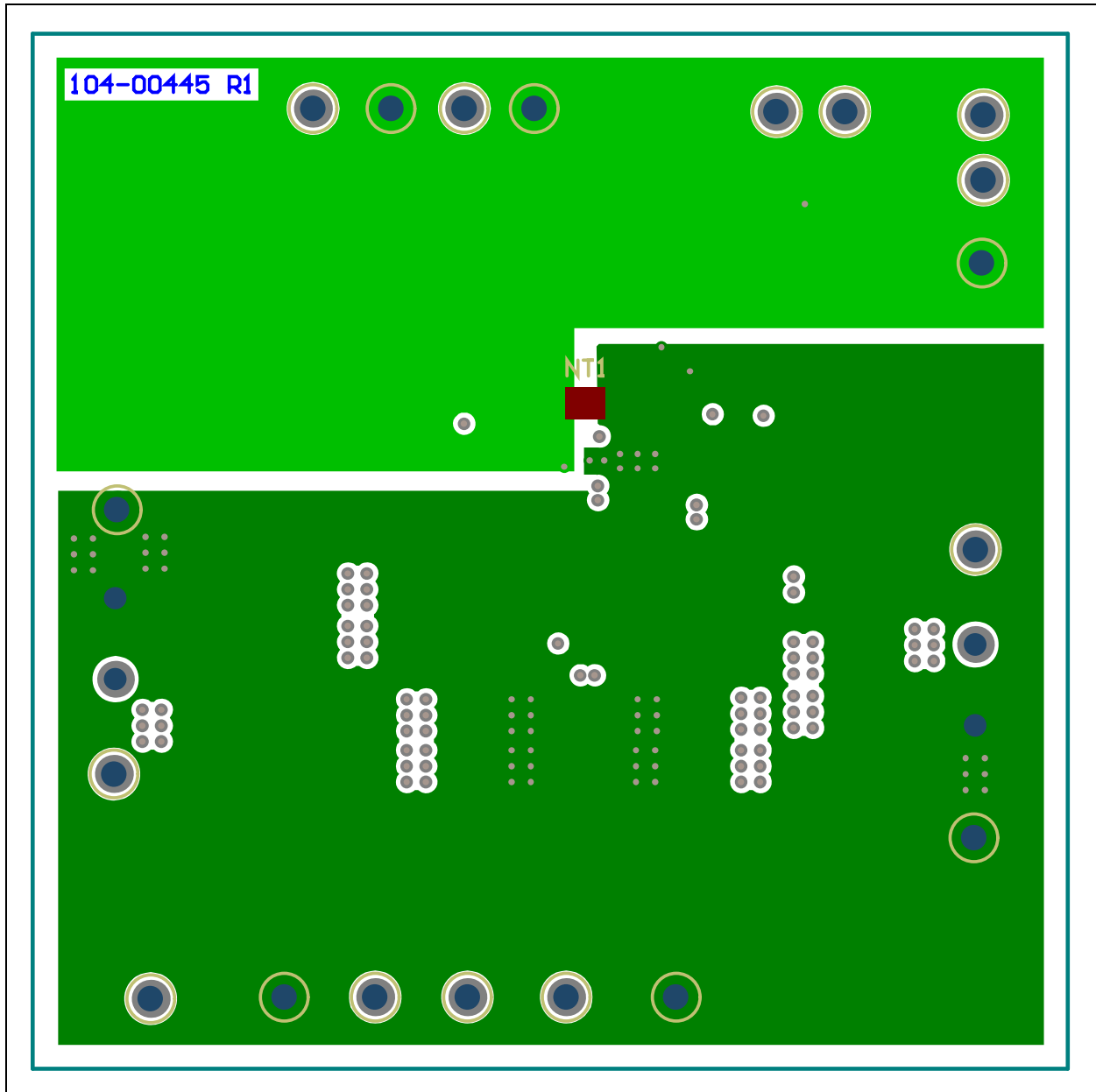


## A.8 BOARD – BOTTOM COPPER





## A.9 BOARD – BOTTOM COPPER AND SILK



NOTES:

## Appendix B. Bill of Materials

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

| Qty | Reference  | Description                                                                           | Manufacturer               | Part Number              |
|-----|------------|---------------------------------------------------------------------------------------|----------------------------|--------------------------|
| 4   | BUMP       | Bumpon Hemisphere .44 X .20 White                                                     | 3M                         | SJ-5003 (WHITE)          |
| 2   | C1, C2     | Cap. Cer. 10 $\mu$ F 25V 10% X 7R 1210                                                | TDK Corporation            | C3225X7R1E106K           |
| 1   | C4         | Cap. Cer. 3900PF 50V 5% NP0 0603                                                      | TDK Corporation            | C1608C0G1H392J           |
| 1   | C5         | Cap. Cer. 0.33 $\mu$ F 16V 10% X7R 0603                                               | Murata Electronics®        | GRM188R71C334KA01D       |
| 2   | C6, C7     | Cap. Cer. 100 $\mu$ F 6.3V 20% X5R 1210                                               | TDK Corporation            | C3225X5R0J107M           |
| 2   | C9, C11    | Cap. Cer. 1 $\mu$ F 35V 10% X7R 0805                                                  | TDK Corporation            | CGA4J3X7R1V105K          |
| 1   | C10        | Cap. Cer. 47pF 100V 5% COG 0603                                                       | AVX Corporation            | 06031A470JAT2A           |
| 1   | C12        | Cap. Cer. 4.7 $\mu$ F 25V X5R 0805                                                    | TDK Corporation            | C2012X5R1E475K           |
| 1   | C13        | Cap. Cer. 560PF 50V 5% NP0 0603                                                       | KEMET®                     | C0603C561J5GACTU         |
| 1   | D1         | Diode Schottky 0.5A 30V SOD323                                                        | Diodes® Incorporated       | B0530WS-7-F              |
| 2   | J1, J2     | Terminal Block 5.08MM Vert. 2 POS.                                                    | On-Shore Technology, Inc.  | ED120/2DS                |
| 1   | L1         | Inductor Power 1.0 $\mu$ H 17A SMD                                                    | Würth Elektronik Group     | 7443340100               |
|     | PCB        | Printed Circuit Board - MCP19035 600 kHz Synchronous Buck Controller Evaluation Board | —                          | 104-00445                |
| 1   | Q1         | High Performance MOSFET Transistor                                                    | Microchip Technology Inc.  | <b>MCP87050-U/MF</b>     |
| 1   | Q2         | High Performance MOSFET Transistor                                                    | Microchip Technology Inc.  | <b>MCP87022-U/MF</b>     |
| 1   | Q3         | MOSFET N-Ch 60V 115MA SOT-23-3                                                        | Diodes Incorporated        | 2N7002-7-F               |
| 3   | R1, R8, R9 | Res. 5.1 kOhm 1/10W 1% 0603 SMD                                                       | Panasonic® - ECG           | ERJ-3EKF5101V            |
| 2   | R2, R7     | Res. 100 kOhm 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. 7.50 kOhm 1/10W 1% 0603 SMD                                                      | Panasonic - ECG            | ERJ-3EKF7501V            |
| 1   | R6         | Res. 3.3 Ohm 1/10W 1% 0603                                                            | Panasonic - ECG            | ERJ-3RQF3R3V             |
| 2   | R12, R14   | Res. 10 kOhm 1/10W 1% 0603 SMD                                                        | Panasonic - ECG            | ERJ-3EKF1002V            |
| 1   | R10        | Res. 49.9 Ohm .25W 1% 0603 SMD                                                        | Vishay/Dale                | CRCW060349R9FKEAHP       |
| 1   | R11        | Res. 20 kOhm 1/10W 5% 0603 SMD                                                        | Panasonic - ECG            | ERJ-3GEYJ203V            |
| 1   | R13        | Res. 750 Ohm 1/10W 1% 0603 SMD                                                        | Vishay/Dale                | CRCW0603750RFKEA         |
| 19  | TP1 – TP19 | Test Point PC Multi Purpose Blk                                                       | Keystone Electronics Corp. | 5011                     |
| 1   | U1         | MCP19035 High Speed Synchronous Buck Controller                                       | Microchip Technology Inc.  | <b>MCP19035-BAABE/MF</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.

NOTES:

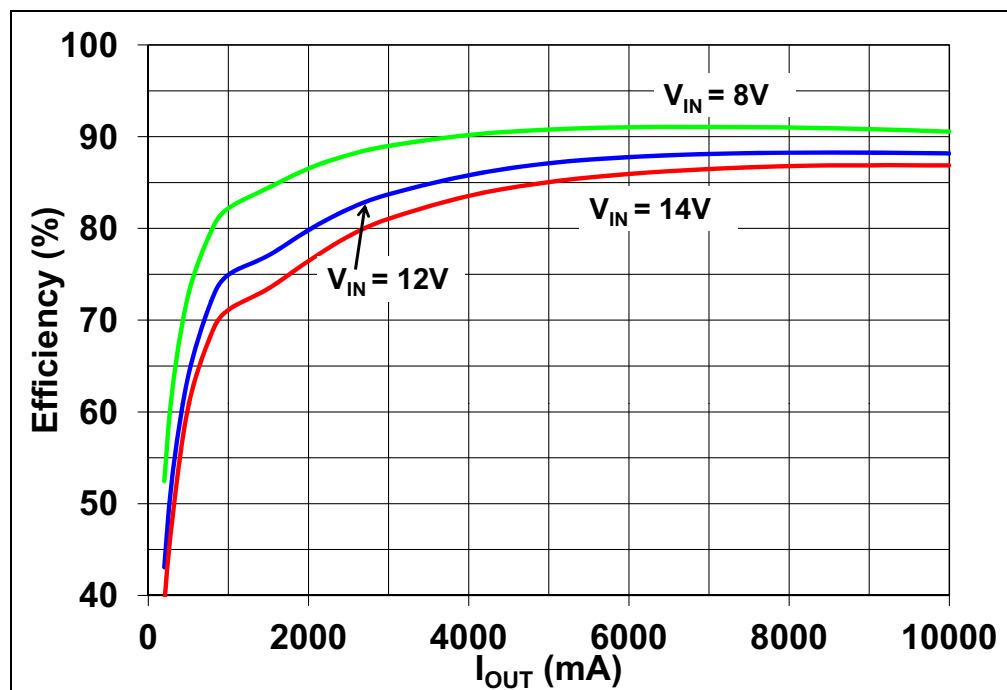
## Appendix C. Typical Performance Data, Curves and Waveforms

### C.1 INTRODUCTION

This chapter shows some of the typical performance parameters and curves of the MCP19035 600 kHz 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)                     | 10        | Steady State output current      |
| Output Voltage Ripple (mV)                     | <30       | $V_{IN} = 12V$ , $I_{OUT} = 10A$ |
| Input Voltage Ripple (mV)                      | <300      | $V_{IN} = 12V$ , $I_{OUT} = 10A$ |
| Output Voltage Overshoot during Step Load (mV) | <100      | Step Load 0A to 5A               |
| Switching Frequency (kHz)                      | 510 – 690 | Typical 600 kHz                  |



**FIGURE C-1:** Efficiency.

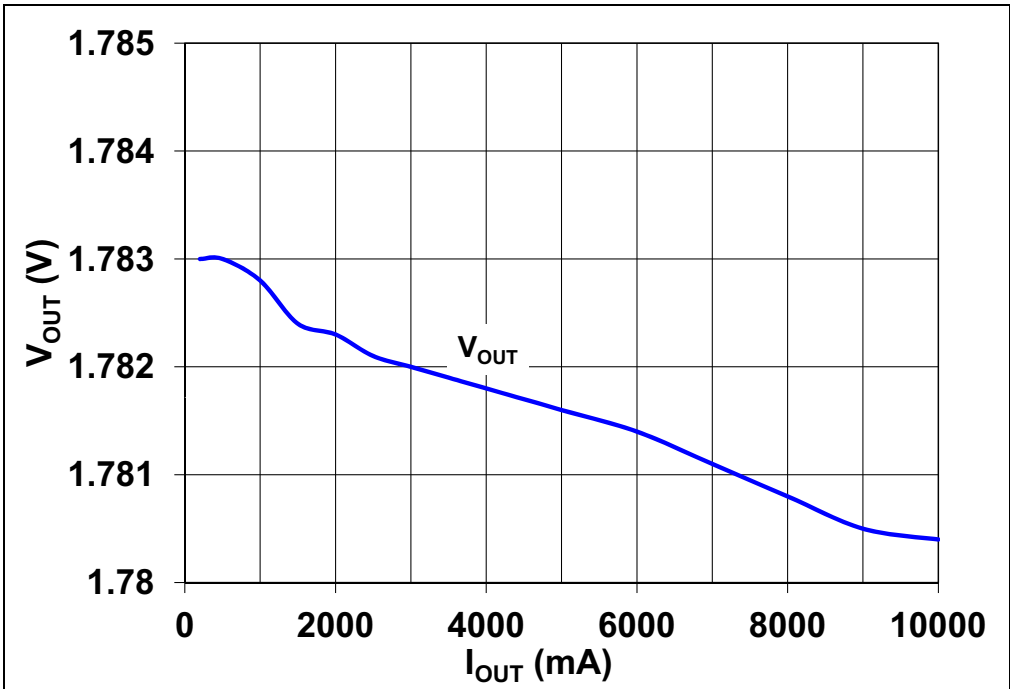


FIGURE C-2: Load Regulation ( $V_{IN} = 12V$ ).

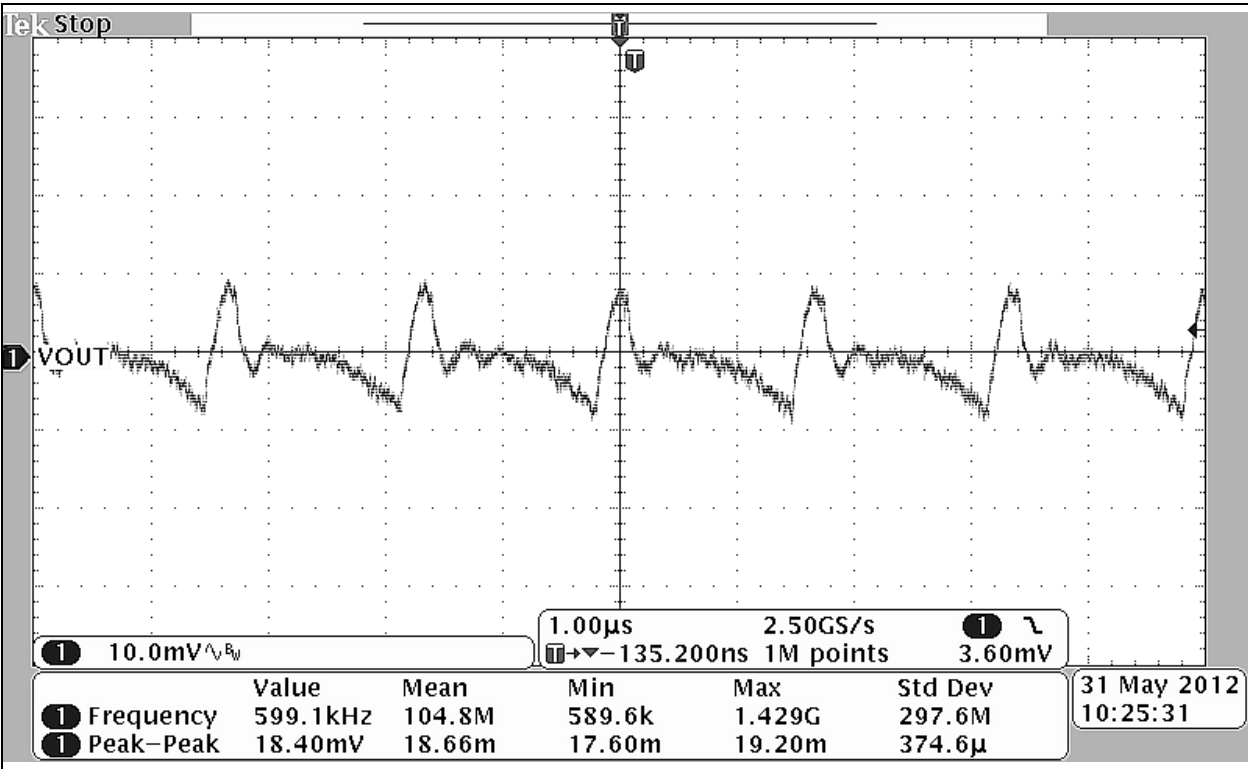
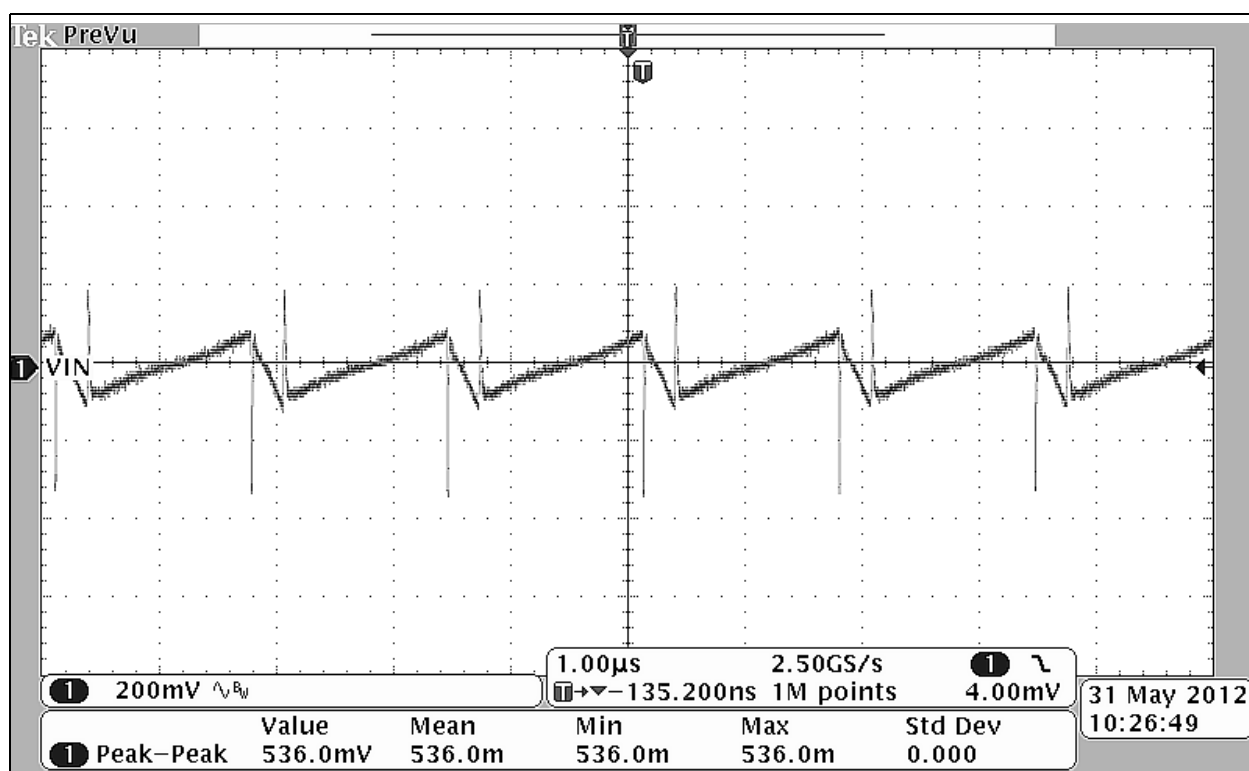
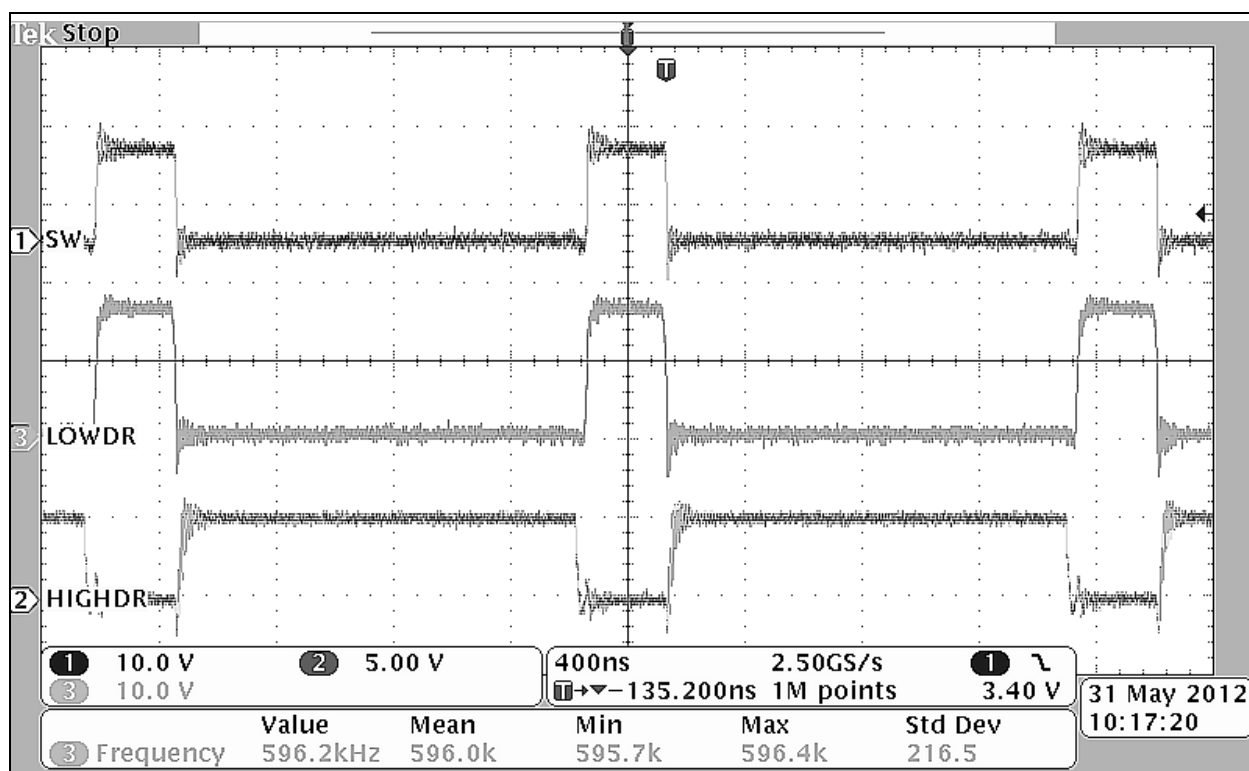


FIGURE C-3: Output Voltage Ripple/Noise ( $V_{IN} = 12V$ ,  $I_{OUT} = 10A$ ,  $BW = 20\text{ MHz}$ ).

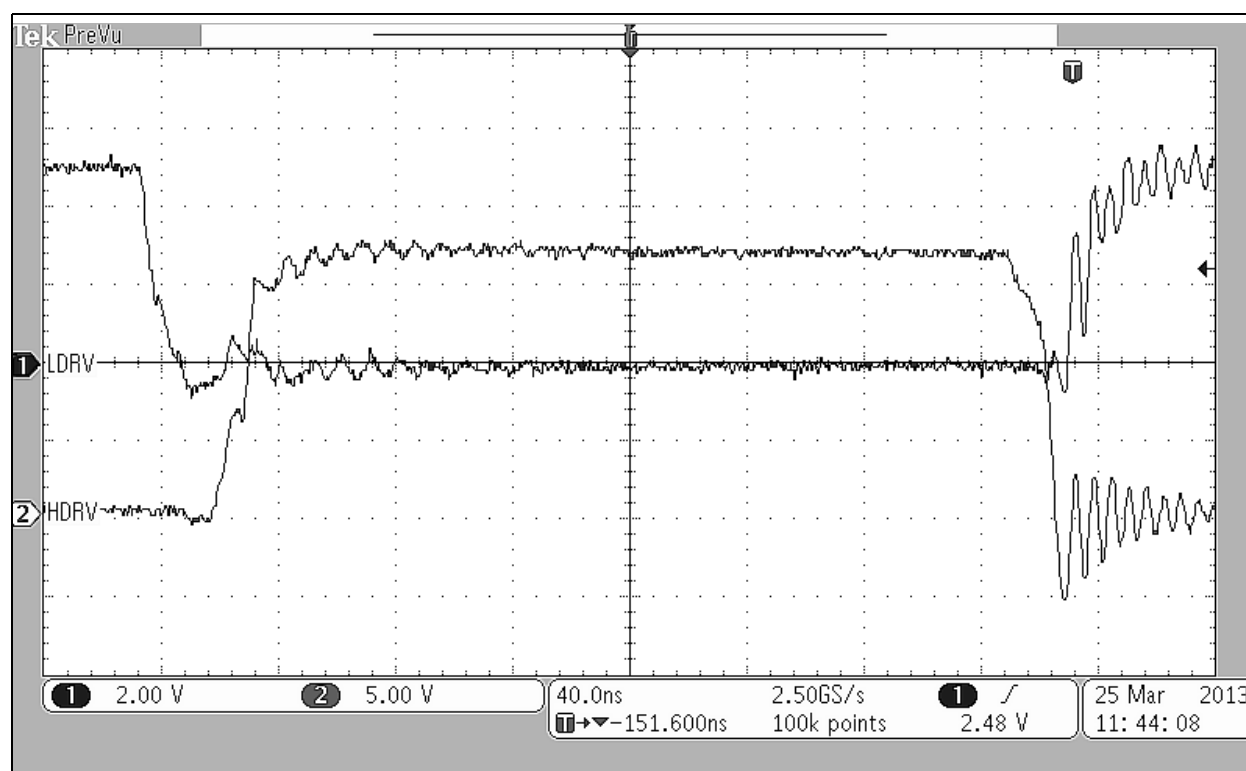
# Typical Performance Data, Curves and Waveforms



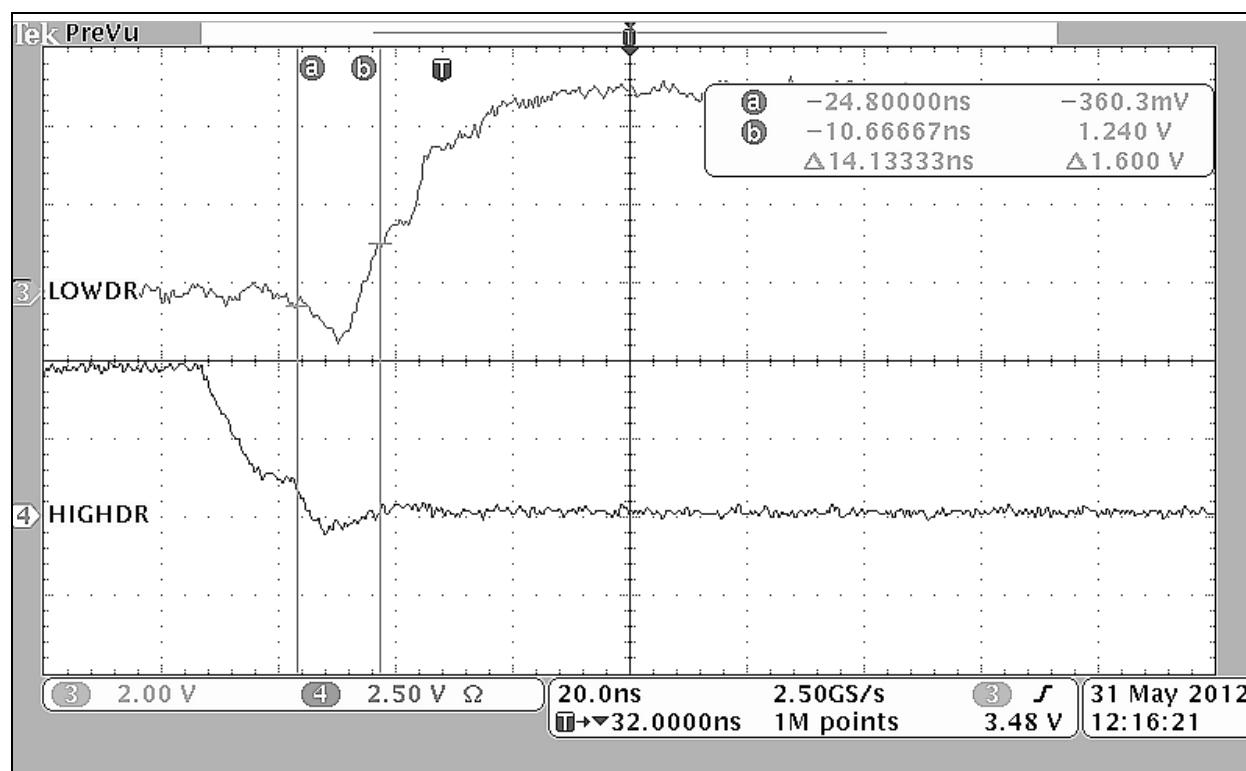
**FIGURE C-4:** Input Voltage Ripple/Noise ( $V_{IN} = 12V$ ,  $I_{OUT} = 10A$ ,  $BW = 20\text{ MHz}$ ).



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



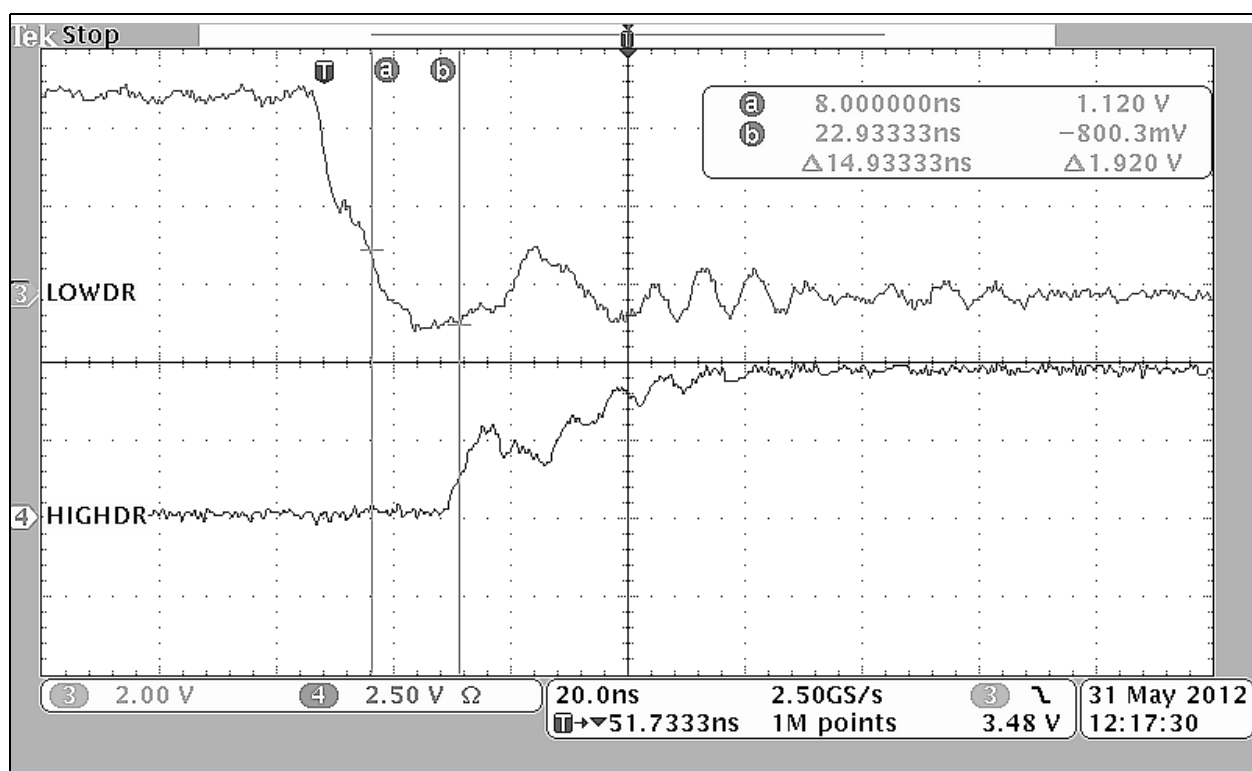
**FIGURE C-6:** LDRV (TP10) and HDRV (TP9) Signals ( $V_{IN} = 12V$ ,  $I_{OUT} = 10A$ ,  $BW = 300\text{ MHz}$ ).



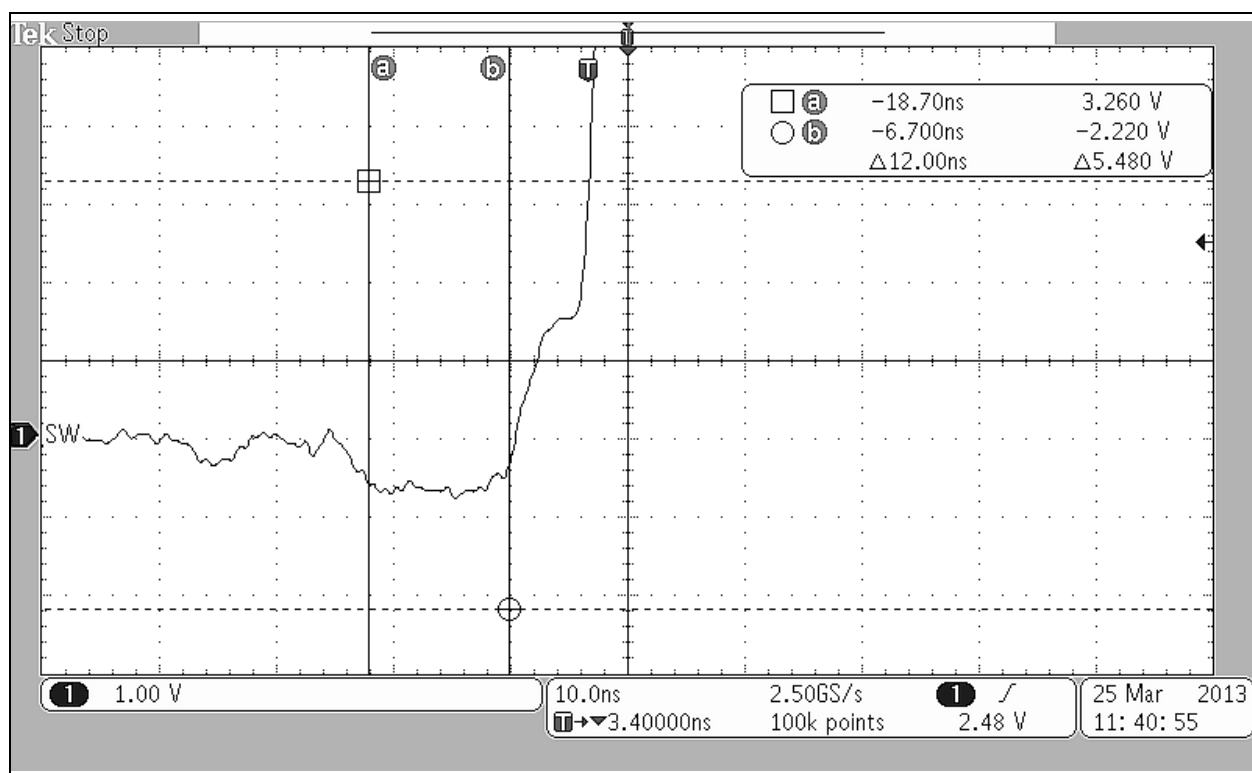
**FIGURE C-7:** Dead Times 1 ( $V_{IN} = 12V$ ,  $I_{OUT} = 10A$ ,  $BW = 300\text{ MHz}$ ).



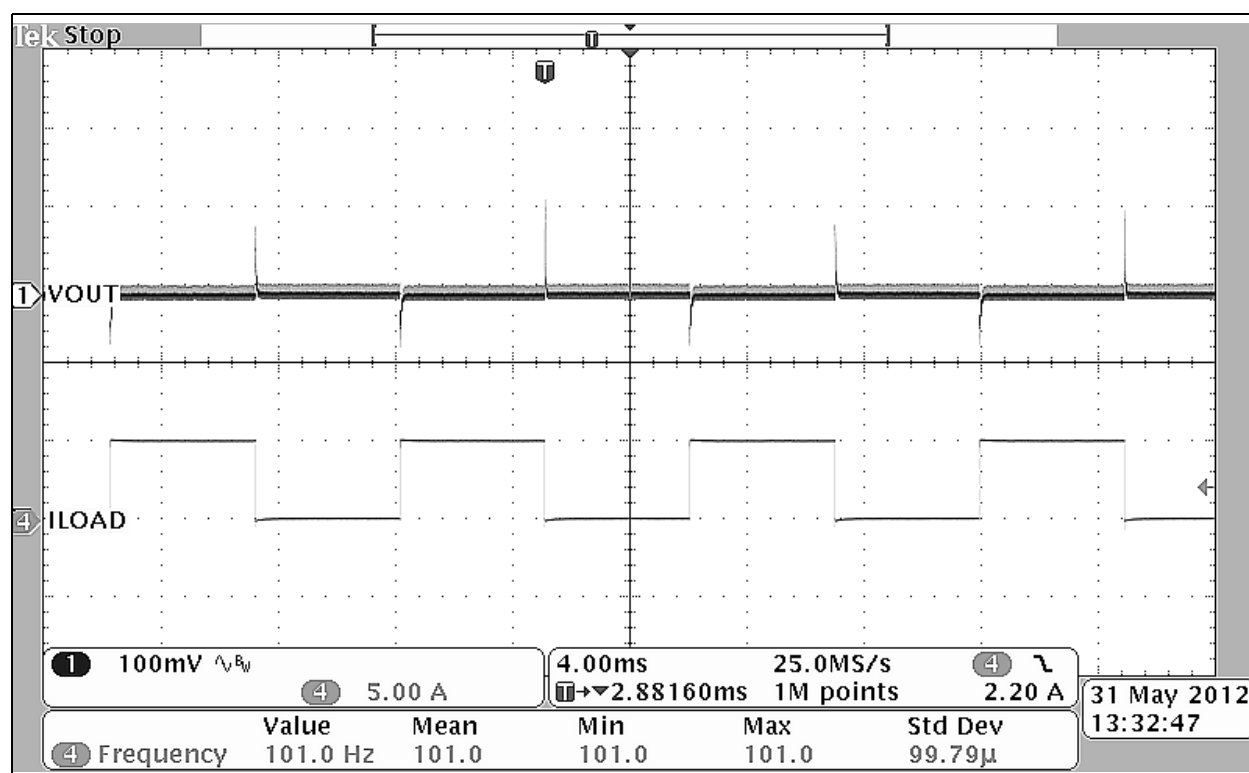
# Typical Performance Data, Curves and Waveforms



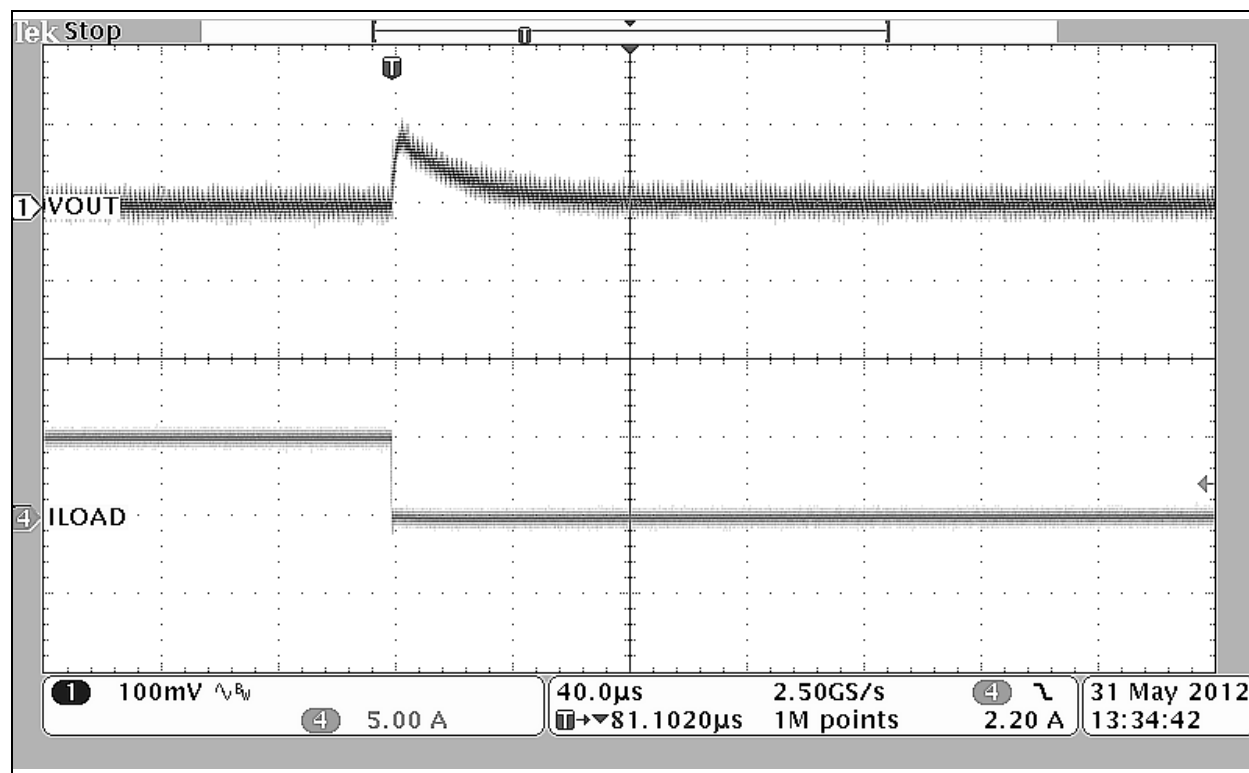
**FIGURE C-8:** Dead Times 2 ( $V_{IN} = 12V$ ,  $I_{OUT} = 10A$ ,  $BW = 300\text{ MHz}$ ).



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

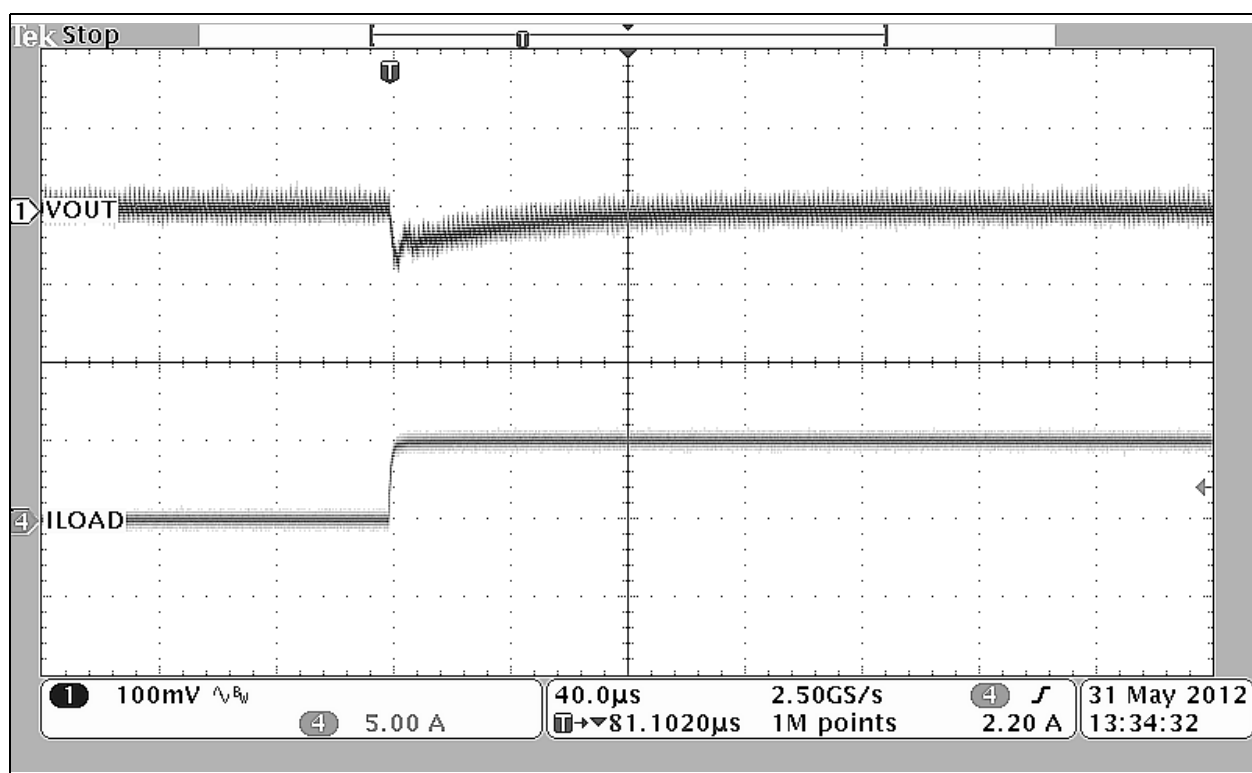


**FIGURE C-10:** Step Load 1 ( $V_{IN} = 12V$ ).

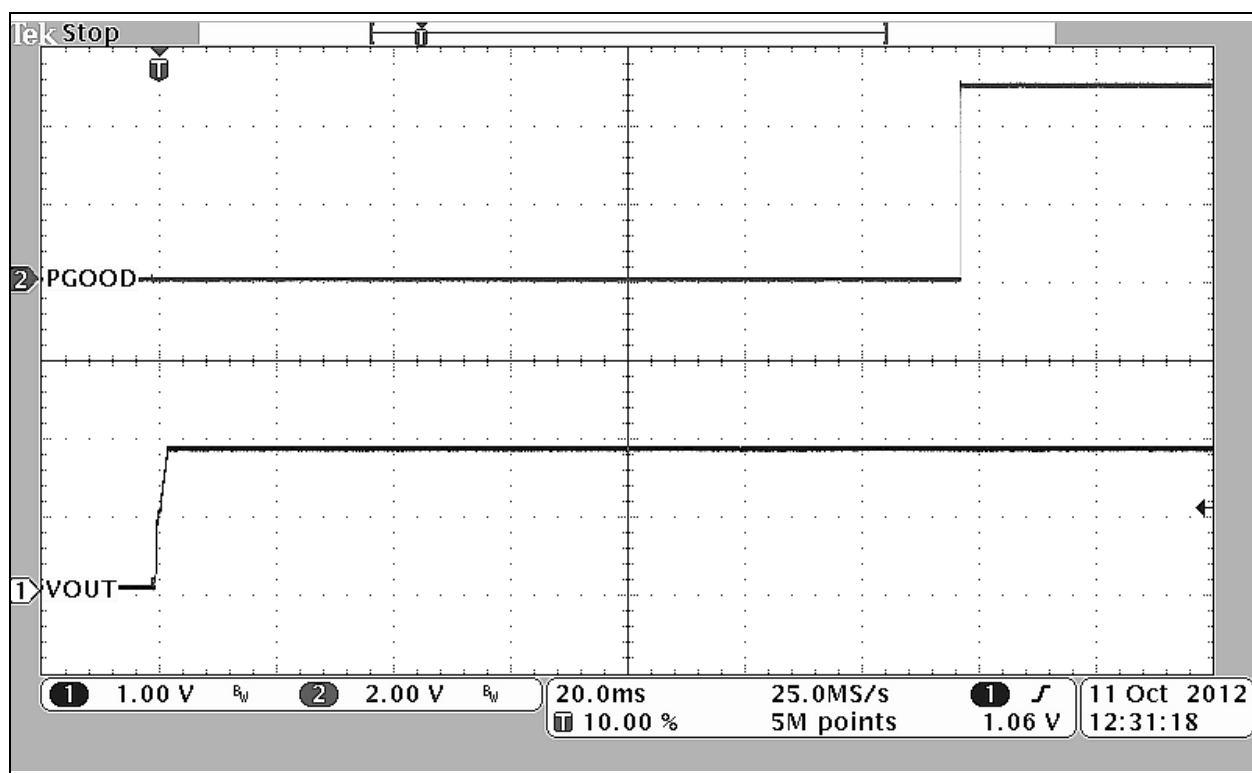


**FIGURE C-11:** Step Load 2 ( $V_{IN} = 12V$ ).

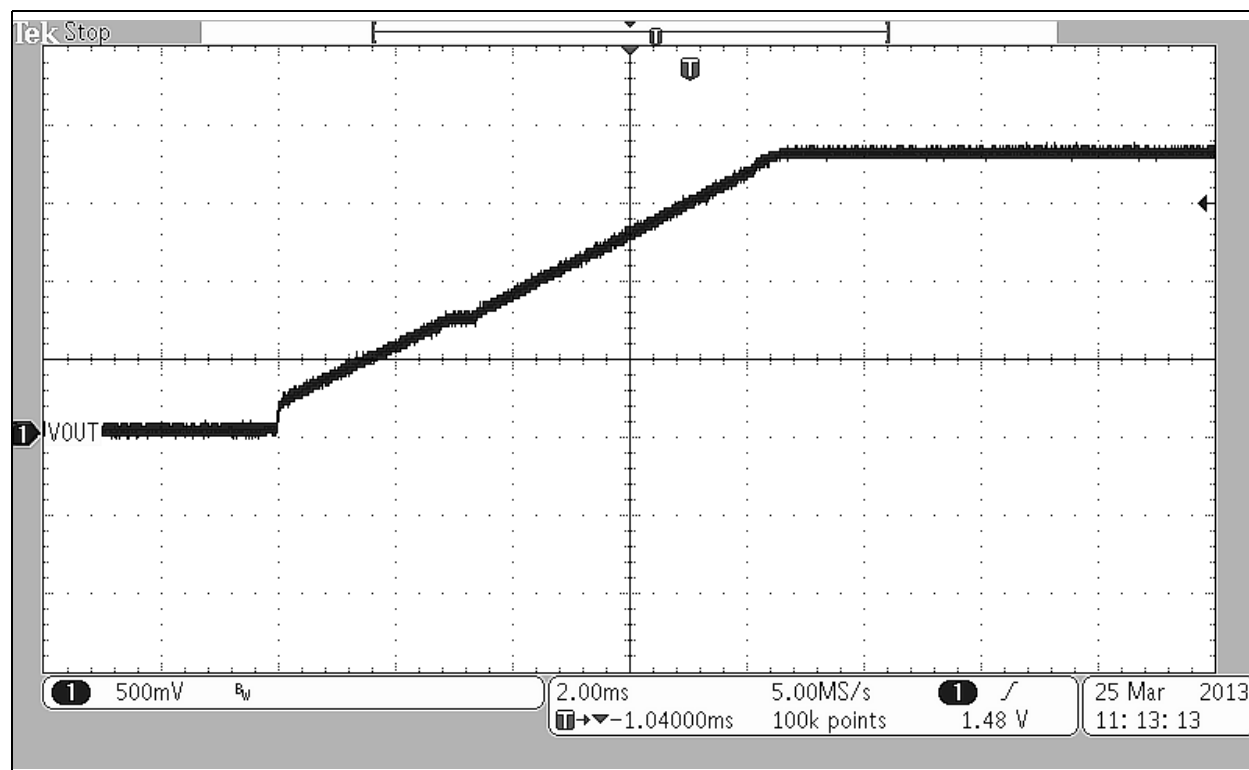
# Typical Performance Data, Curves and Waveforms



**FIGURE C-12:** Step Load 3 ( $V_{IN} = 12V$ ).



**FIGURE C-13:** Power Good Signal (PGOOD).



**FIGURE C-14:** Soft Start.

# Typical Performance Data, Curves and Waveforms

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NOTES:



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