MIC21LV32 Evaluation Board User's Guide

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Preface

NOTICE TO CUSTOMERS

All documentation becomes dated, and this manual is no exception. Microchip tools and documentation are constantly evolving to meet customer needs, so some actual dialogs and/or tool descriptions may differ from those in this document. Please refer to our website (www.microchip.com) to obtain the latest documentation available.

Documents are identified with a "DS" number. This number is located on the bottom of each page, in front of the page number. The numbering convention for the DS number is "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 MIC21LV32 Evaluation Board. Items discussed in this chapter include:

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

DOCUMENT LAYOUT

This document describes how to use the MIC21LV32 Evaluation Board as a development tool. The manual layout is as follows:

- **Chapter 1. "Product Overview"** – Important information about the MIC21LV32 Evaluation Board.
- **Chapter 2. "Installation and Operation"** – Includes instructions on installing and using the MIC21LV32 Evaluation Board.
- **Appendix A. "Schematics and Layouts"** – Shows the schematic and layout diagrams for the MIC21LV32 Evaluation Board.
- **Appendix B. "Bill of Materials (BOM)"** – Lists the parts used to build the MIC21LV32 Evaluation Board.
- **Appendix C. "Board Waveforms and Performance Curves"** – Shows the behavior and performance of the MIC21LV32 Evaluation Board in numbers.

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 MIC21LV32 Evaluation Board (EV71S00A). Other useful documents are listed below. The following Microchip document is available and recommended as a supplemental reference resource.

- **MIC21LV32 Data Sheet – *"36V Dual Phase, Advanced COT Buck Controller Stackable for Multiphase Operation"* (DS20006513A).**

THE MICROCHIP WEBSITE

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

- **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

CUSTOMER SUPPORT

Users of Microchip products can receive assistance through several channels:

- Distributor or Representative
- 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 website at:
http://www.microchip.com/support.

DOCUMENT REVISION HISTORY

Revision A (October 2021)

- Initial release of this document.

NOTES:

Chapter 1. Product Overview

1.1 INTRODUCTION

This chapter provides an overview of the MIC21LV32 Evaluation Board and covers the following:

- MIC21LV32 Device Overview
- MIC21LV32 Device Key Features
- MIC21LV32 Evaluation Board Kit Contents

1.2 MIC21LV32 DEVICE OVERVIEW

The MIC21LV32 is a constant on-time, dual phase synchronous buck controller, featuring a unique adaptive on-time control architecture with a stackable feature of up to eight phases. The MIC21LV32 operates over an input supply range from 4.5V to 36V and can be used to supply up to 50A of output current/phase. The output voltage is adjustable down to 0.6V with an ensured accuracy of ±1%. The device operates with a programmable switching frequency from 100 kHz to 1 MHz per phase.

The MIC21LV32 is available in a 32-pin 5 mm x 5 mm VQFN package, with a -40°C to +125°C junction operating temperature range.

1.3 MIC21LV32 DEVICE KEY FEATURES

- Input Voltage Range: 4.5V to 36V
- Adjustable Output from 0.6V to 28V
- Adaptive Constant On-Time Control:
  - High Delta V Operation
  - Any Capacitor™ Stable
- 0.6V Internal Reference with ±1% Accuracy
- Operates in CCM, Stackable for Multiphase Operation Up to Eight Phases
- Ripple Injection from Third Node which Allows Greater than 50% Duty Cycles
- HyperLight Load® and Phase Shedding
- Automatic Phase Shedding with User-Settable Thresholds or Externally Controlled Phase Shedding
- Accurate Current Balancing Between Phases
- Accurate Phasing Between Phases which are Always 180° Out of Phase
- 100 kHz to 800 kHz Switching Frequency per Phase
- High-Voltage Internal 5V LDO for Single-Supply Operation
- Secondary LDO to Improve System Efficiency
- Supports Start-up to Pre-Bias Output
- Remote Sense Amplifier for Tight Output Regulation
- Supports Adaptive Voltage Positioning (AVP) or Droop
- Precision Enable Function for Low Standby Current
- External Programmable Soft Start to Reduce Inrush Current
- Programmable Current Limit and Hiccup Short-Circuit Protection
- Thermal Shutdown with Hysteresis
- Die Temperature Sense on MIC21LV32
- Compact Size: 5 mm x 5 mm 32-Pin QFN
- -40°C to +125°C Junction Temperature Range

1.4 MIC21LV32 EVALUATION BOARD KIT CONTENTS

The MIC21LV32 Evaluation Board kit includes the following items:

- MIC21LV32 Evaluation Board PCB
- Important Information Sheet
- China RoHS Declaration

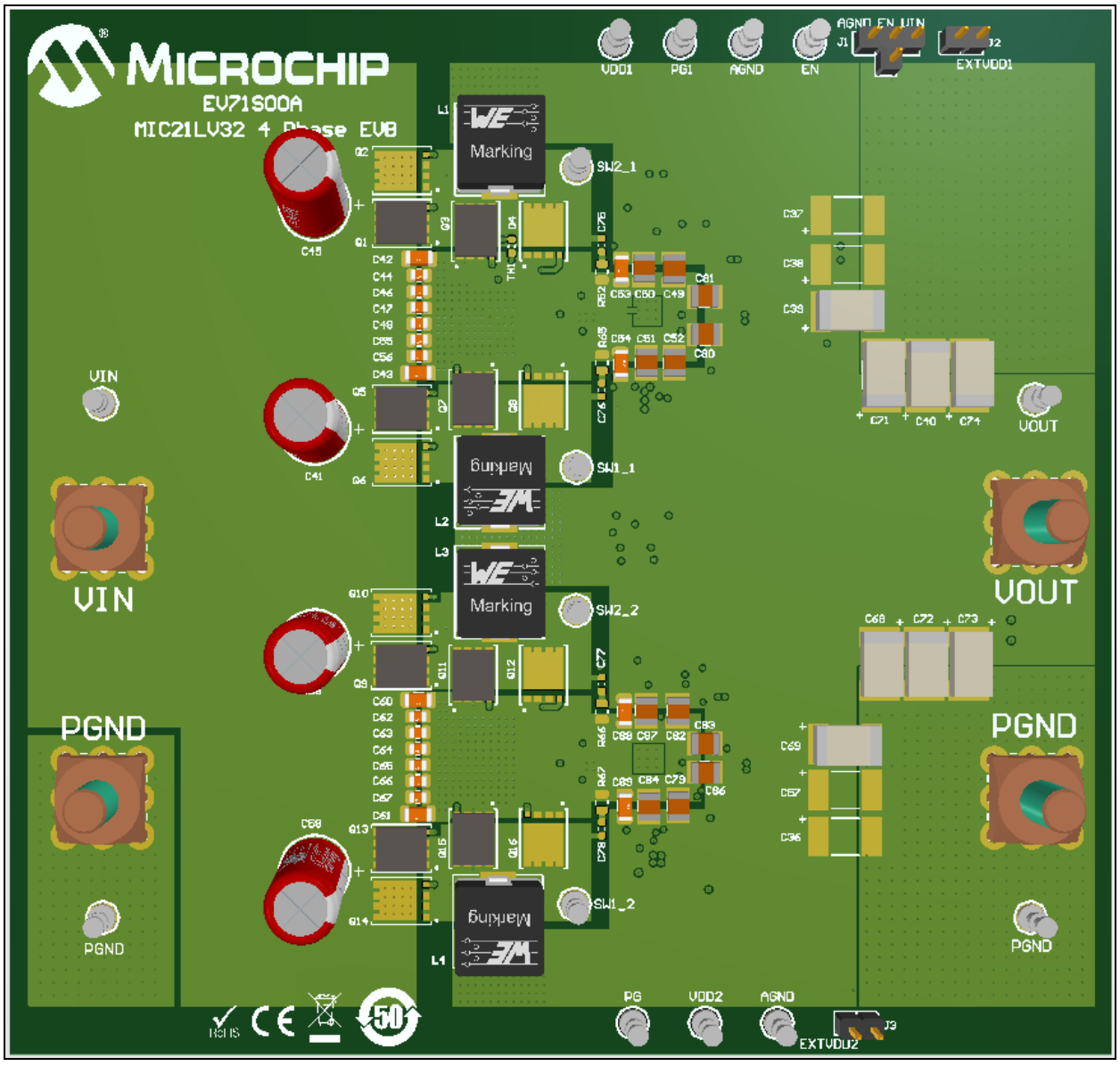

FIGURE 1-1: *Typical MIC21LV32 Evaluation Board, EV71S00A (Top 3D View).*

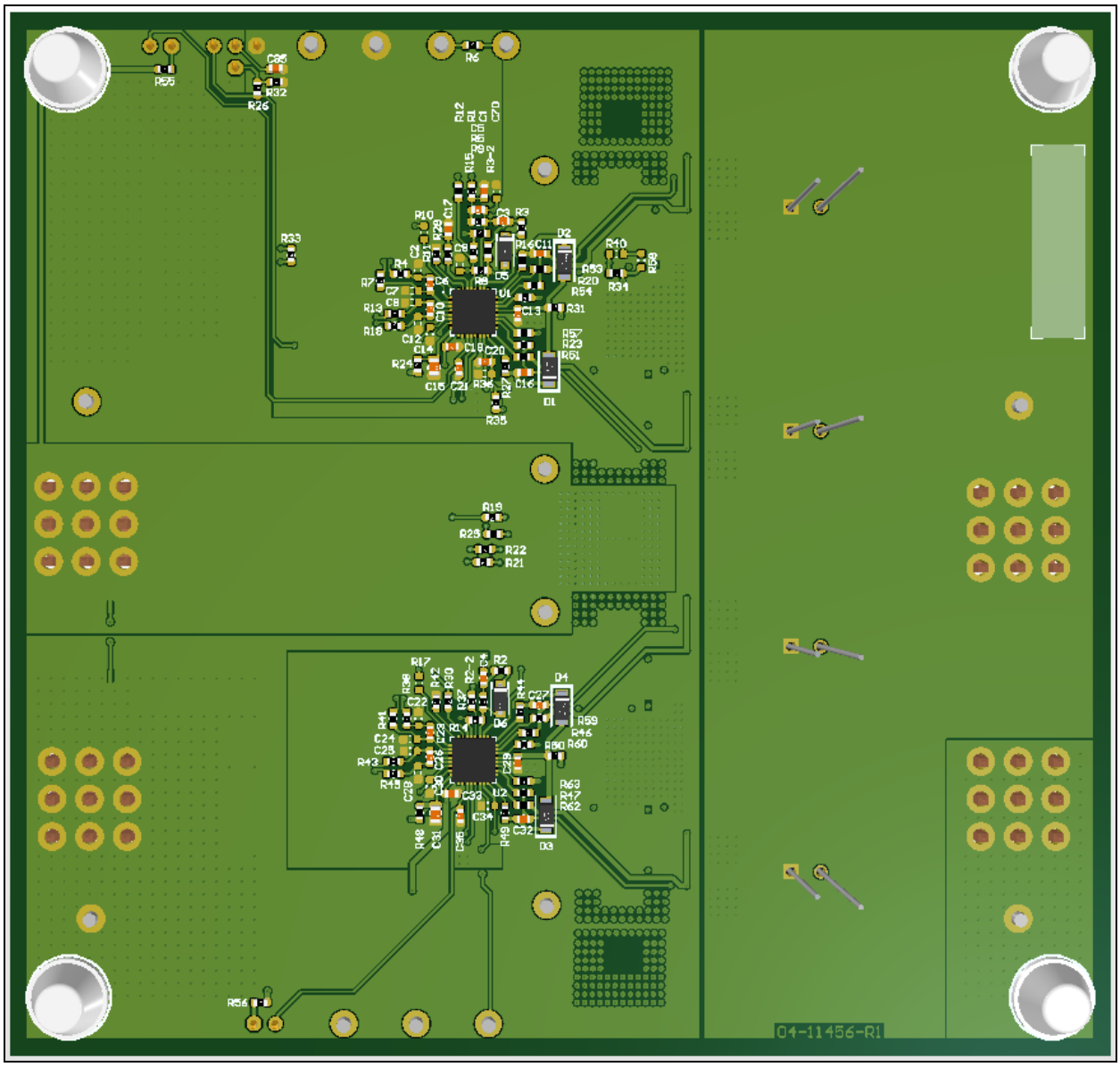

FIGURE 1-2: *Typical MIC21LV32 Evaluation Board, EV71S00A (Bottom 3D View).*

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Chapter 2. Installation and Operation

2.1 INTRODUCTION

The MIC21LV32 Evaluation Board is fully assembled and tested to evaluate and demonstrate the MIC21LV32 capabilities. The board is based on a buck topology and can deliver an adjustable output voltage between 0.6V and 28V, with a maximum current of 80A when it's supplied with 4.5-36V input voltage. However, the board is tuned and optimized for 12V input (±20%) and 0.82V/80A output.

2.1.1 Powering the MIC21LV32 Evaluation Board

The board is connected directly to a variable DC power supply that can deliver 4.5V to 30V DC (input capacitors rated at 35V) and an output capability of at least 4A. The load could either be a power resistor or an electronic load. In the case of an electronic load, the maximum current that can be drawn is reduced due to the low output voltage.

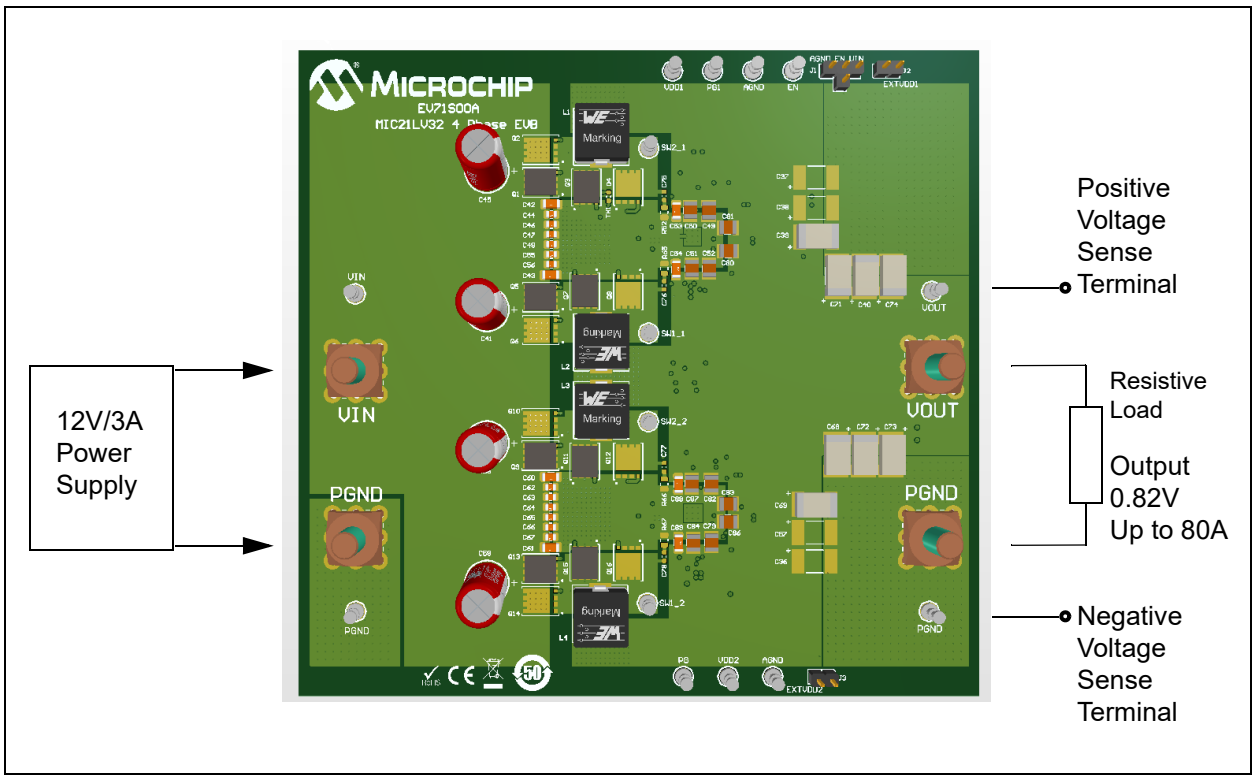


FIGURE 2-1: *MIC21LV32 Evaluation Board Connection Diagram.*

2.2 SETUP AND CONFIGURATION

The output voltage delivered by the MIC21LV32 Evaluation Board is set to 0.82V. To enable the IC, a jumper on J1 must be placed vertically between J1-2 and J1-3 (to pull the enable to V_{IN}), or between J1-2 and J4 (in order to pull the enable to the voltage divider, in this case ½ V_{IN}). MIC21LV32 also features an internal high-voltage LDO. To bypass this LDO, a jumper can be plugged in to J2-1 (V_{OUT}) and J2-2 (EXTVDD), but only if the board output voltage is greater than 4.7V. If the internal high-voltage LDO is to be used, the jumper should be placed on J2-2 (EXTVDD) and J2-3 (AGND) or left unconnected. EXTVDD can also be connected to an external voltage through the test pin provided.

EXAMPLE 2-1: CALCULATION OF R_{ILIM} FOR BOTTOM MOSFET R_{dson} CURRENT SENSING

$$I_{LIM} = \frac{0.3V - (0.25 \times V_{ILIM})}{R_{dson}} \quad (1)$$

$$V_{ILIM} = 1.2V - (4 \times R_{dson} \times I_{LIM}) \quad (2)$$

For I_{LIM} = 20A per phase, R_{dson} = 1 mΩ at +25°C, using equation (2)
V_{ILIM} = 1.2V – (4 × 1 mΩ × 20A) = 1.12V.
To obtain 1.12V on the I_{LIM} pin, which has a 10 µA constant-current source over a constant temperature, a programming equivalent resistor, R_{ILIM} = 1.12V/10 µA = 112 kΩ is required.

EXAMPLE 2-2: CALCULATION OF THE FEEDBACK DIVIDER FOR 0.82V

$$R_{FB(BOT)} = \frac{R_{FB(TOP)}}{\frac{V_{OUT}}{V_{REF}} - 1} \quad (3)$$

For V_{OUT} = 0.82V having $R_{FB(TOP)}$ = 20 kΩ and V_{REF} = 0.6V, using equation (3)
$R_{FB(BOT)}$ = 20 kΩ/(0.82V/0.6V – 1) = 54.5 kΩ. Due to tolerances, a 56 kΩ and 300Ω resistor in series give a calculated output voltage of 0.82V.

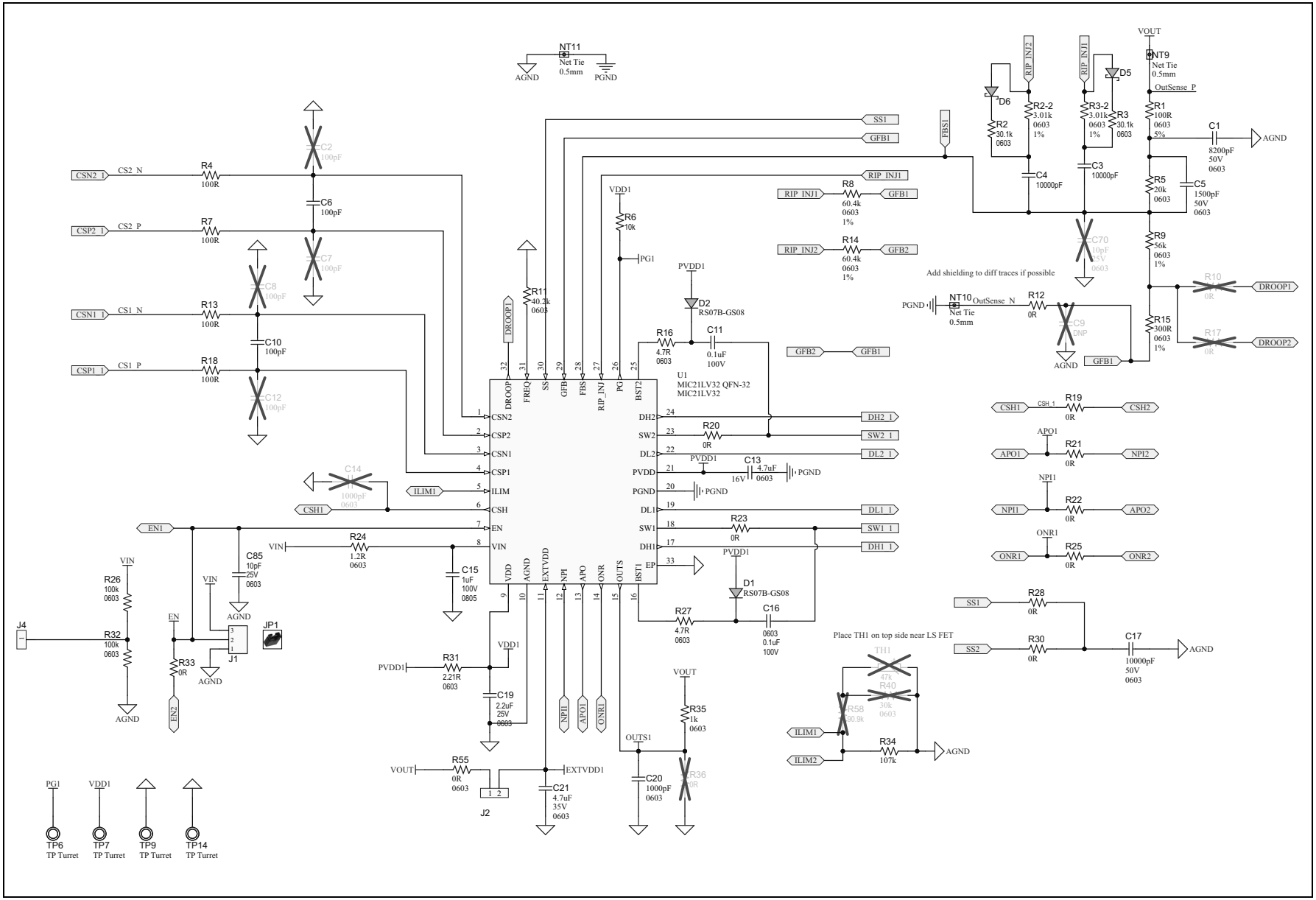
Appendix A. Schematics and Layouts

A.1 INTRODUCTION

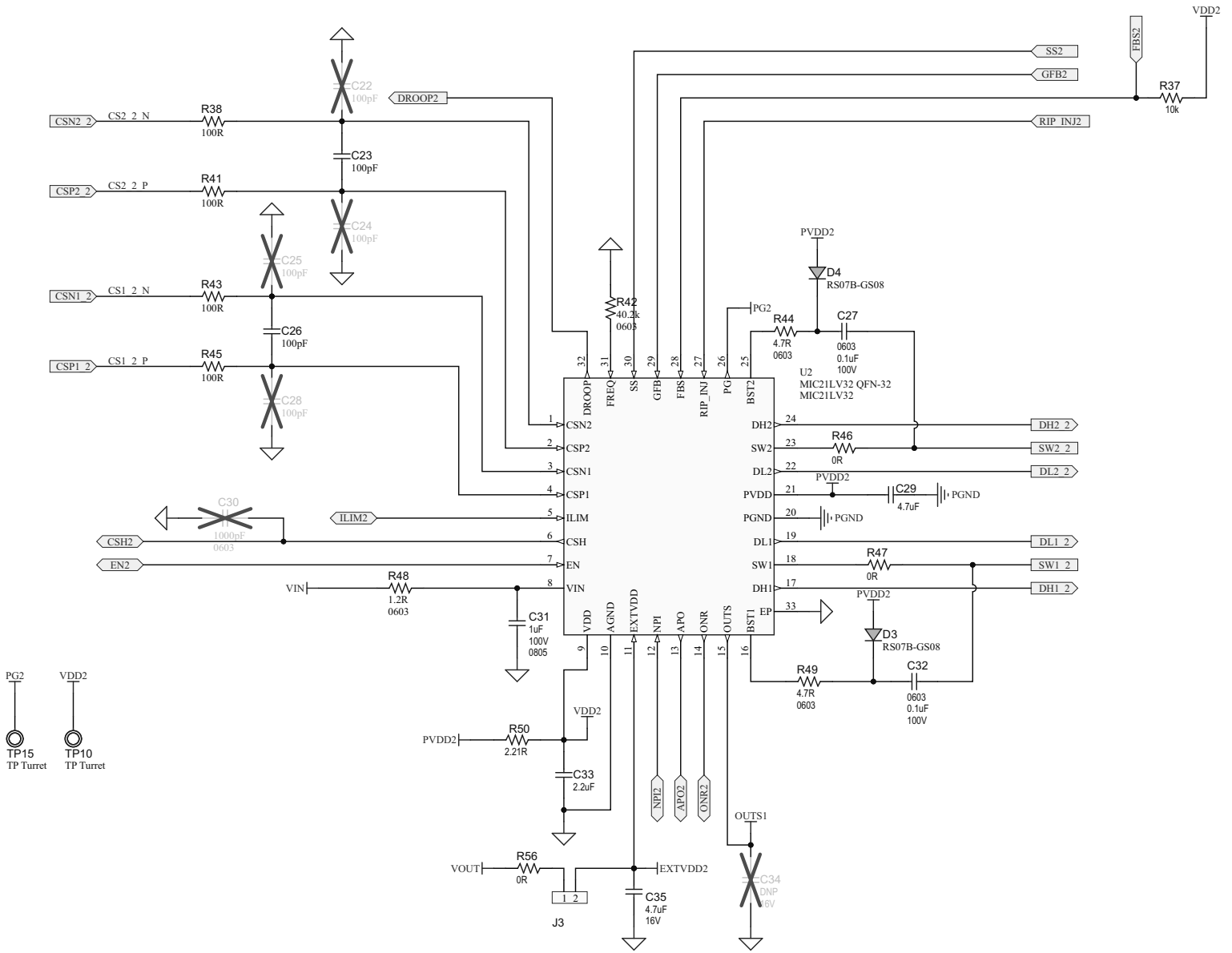
This appendix contains the schematics and layouts of the MIC21LV32 Evaluation Board:

- EV71S00A Board – Schematic 1: Primary Controller
- EV71S00A Board – Schematic 2: Secondary Controller
- EV71S00A Board – Schematic 3: Power Phases 1-2
- EV71S00A Board – Schematic 4: Power Phases 3-4
- EV71S00A Board – Top Silk
- EV71S00A Board – Top Copper and Silk
- EV71S00A Board – Top Copper
- EV71S00A Board – Inner 1 Copper
- EV71S00A Board – Inner 2 Copper
- EV71S00A Board – Inner 3 Copper
- EV71S00A Board – Inner 4 Copper
- EV71S00A Board – Bottom Silk
- EV71S00A Board – Bottom Copper and Silk
- EV71S00A Board – Bottom Copper

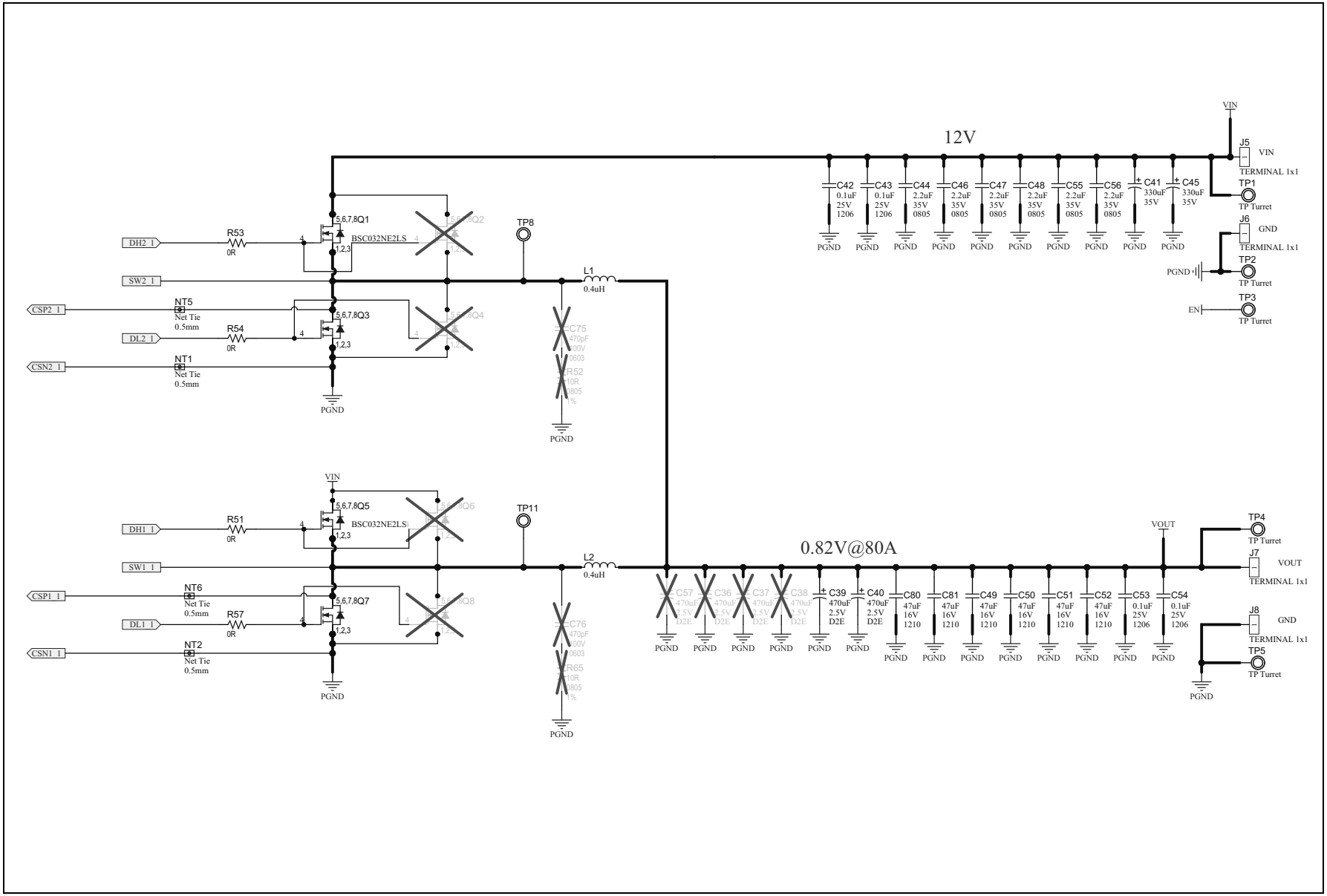
A.2 EV71S00A BOARD – SCHEMATIC 1: PRIMARY CONTROLLER



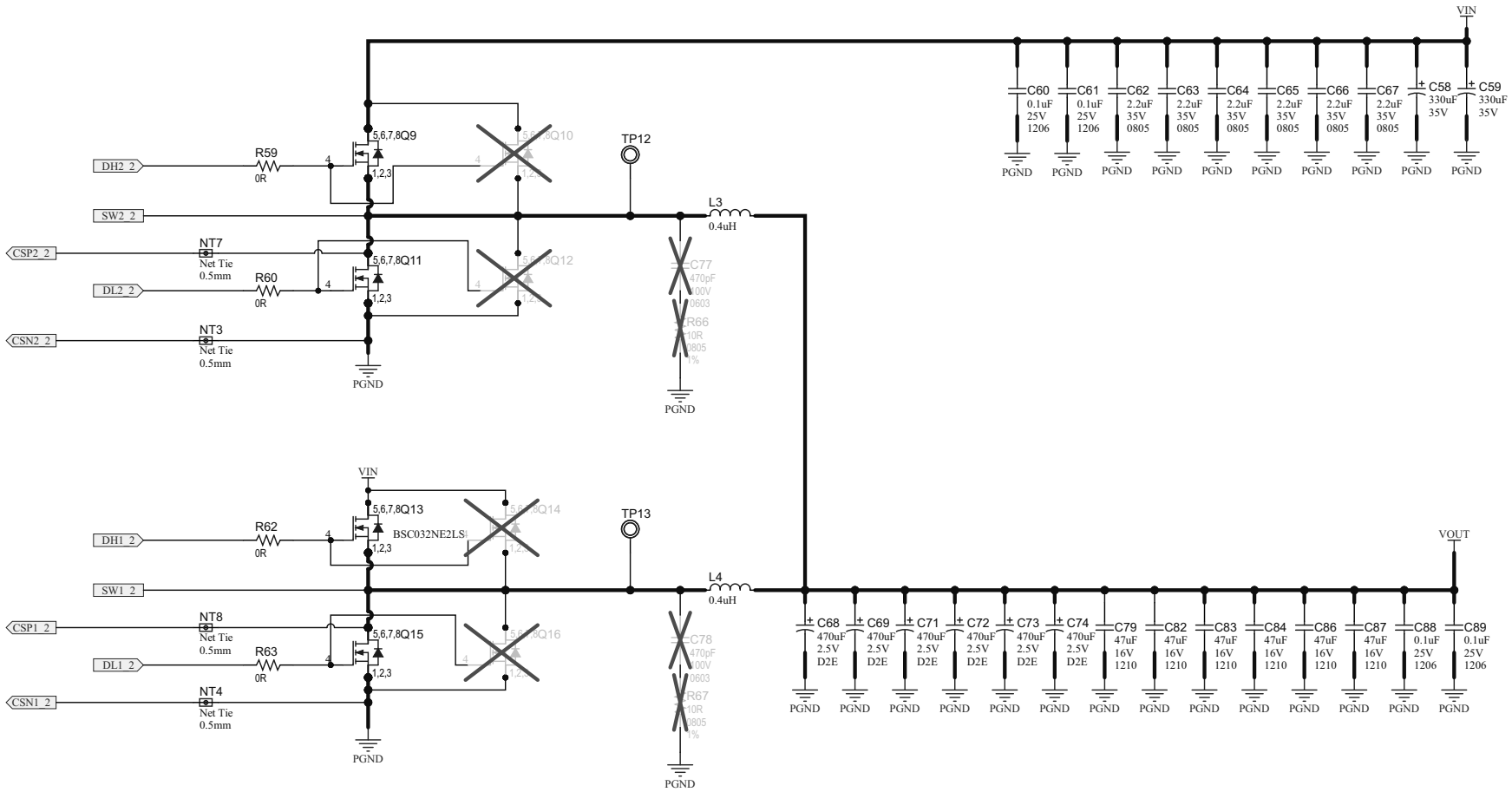
A.3 EV71S00A BOARD – SCHEMATIC 2: SECONDARY CONTROLLER



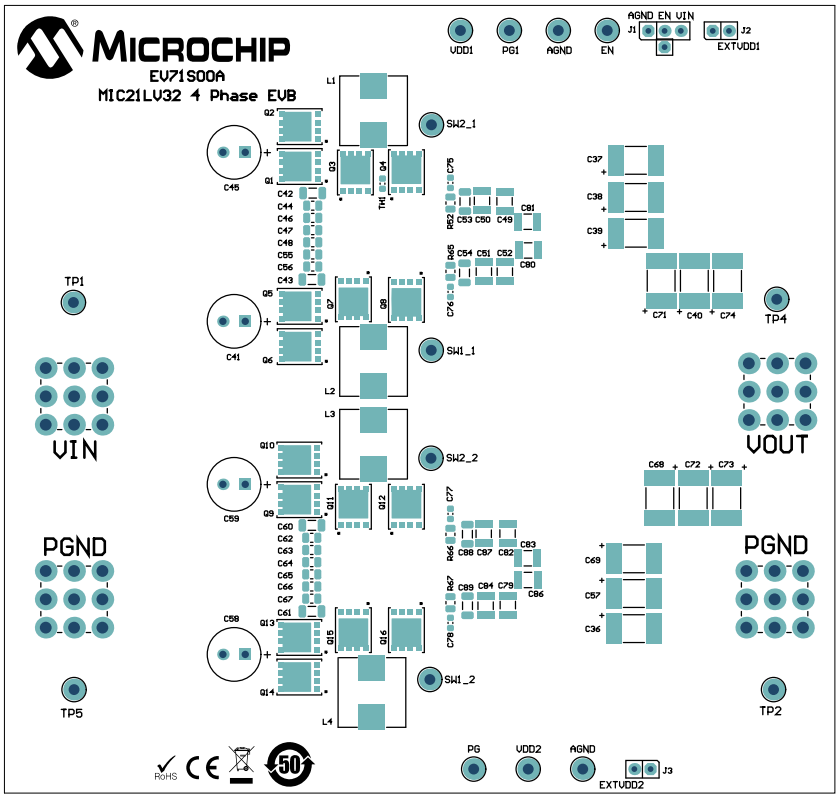
A.4 EV71S00A BOARD – SCHEMATIC 3: POWER PHASES 1-2



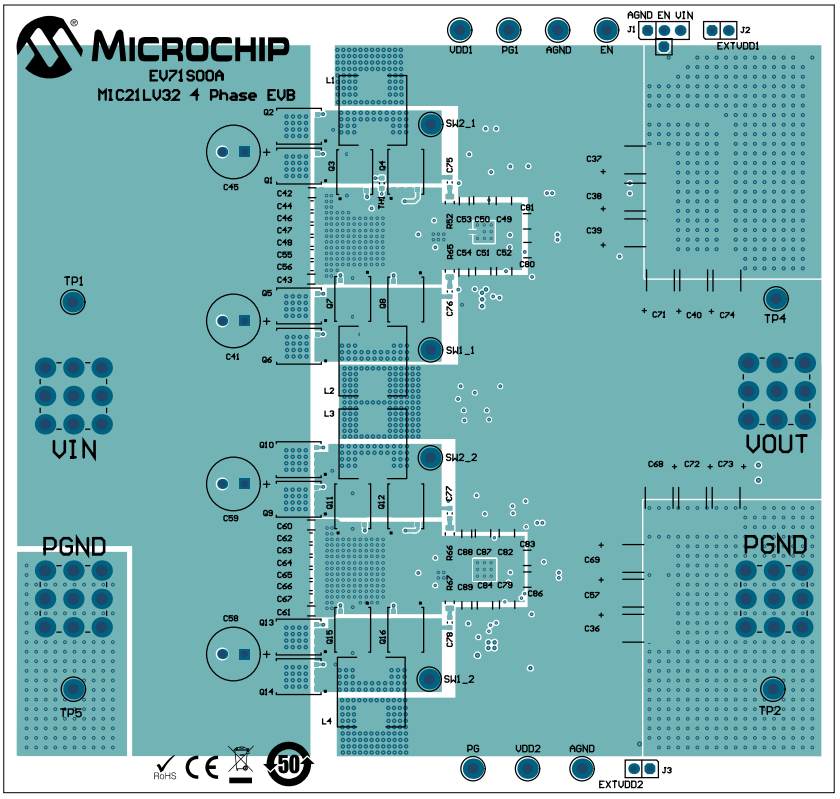
A.5 EV71S00A BOARD – SCHEMATIC 4: POWER PHASES 3-4



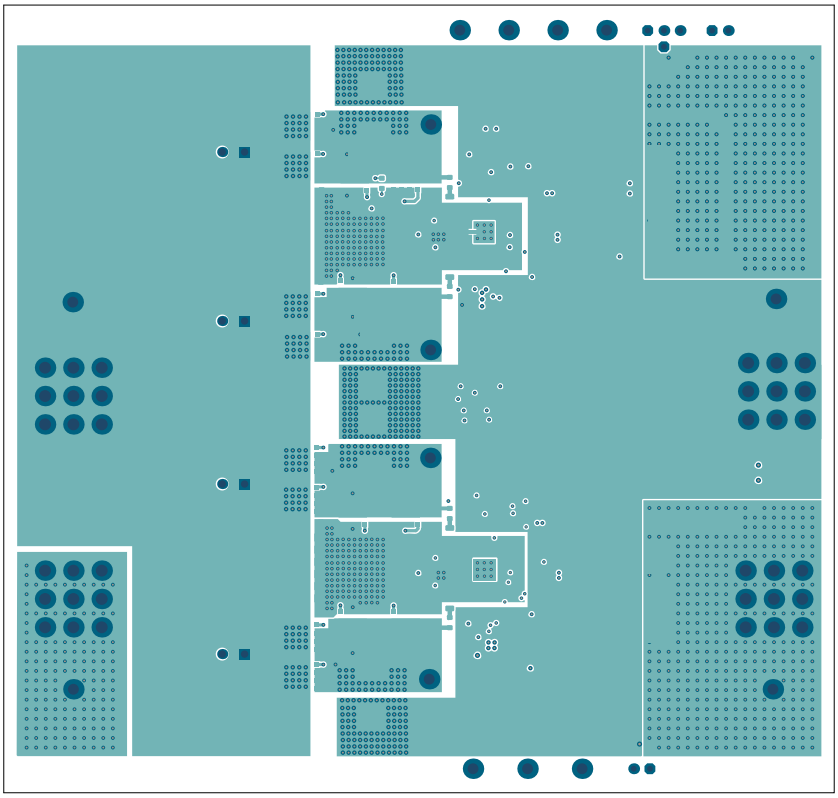
A.6 EV71S00A BOARD – TOP SILK



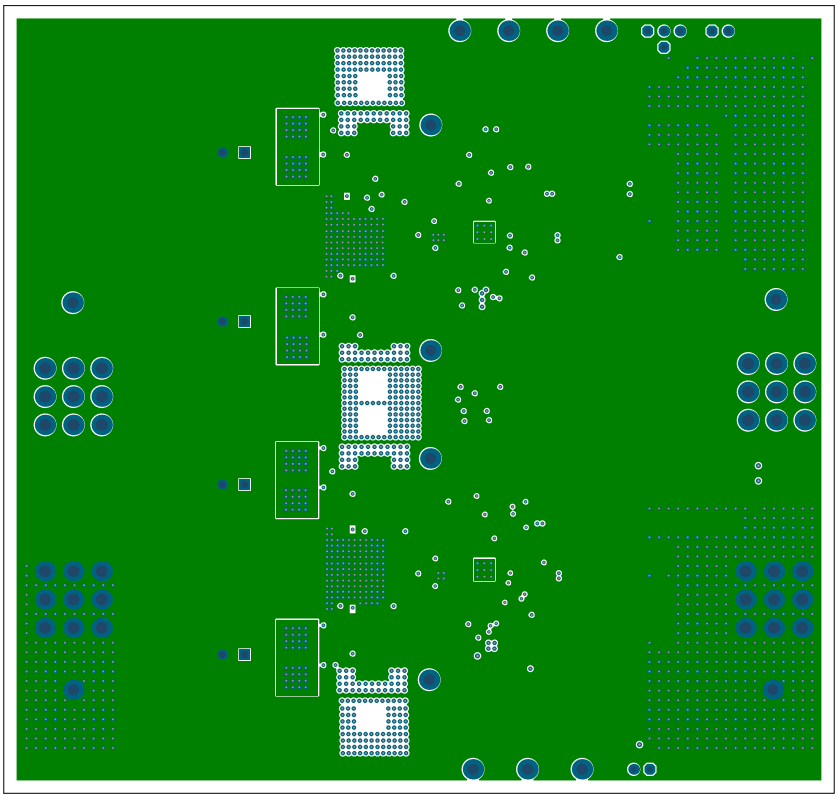
A.7 EV71S00A BOARD – TOP COPPER AND SILK



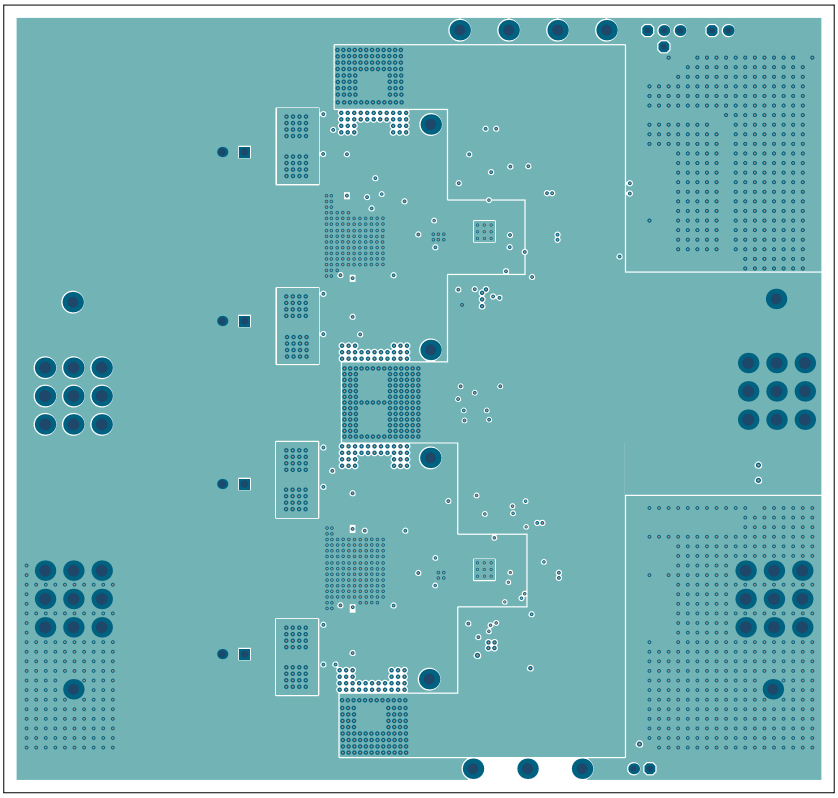
A.8 EV71S00A BOARD – TOP COPPER



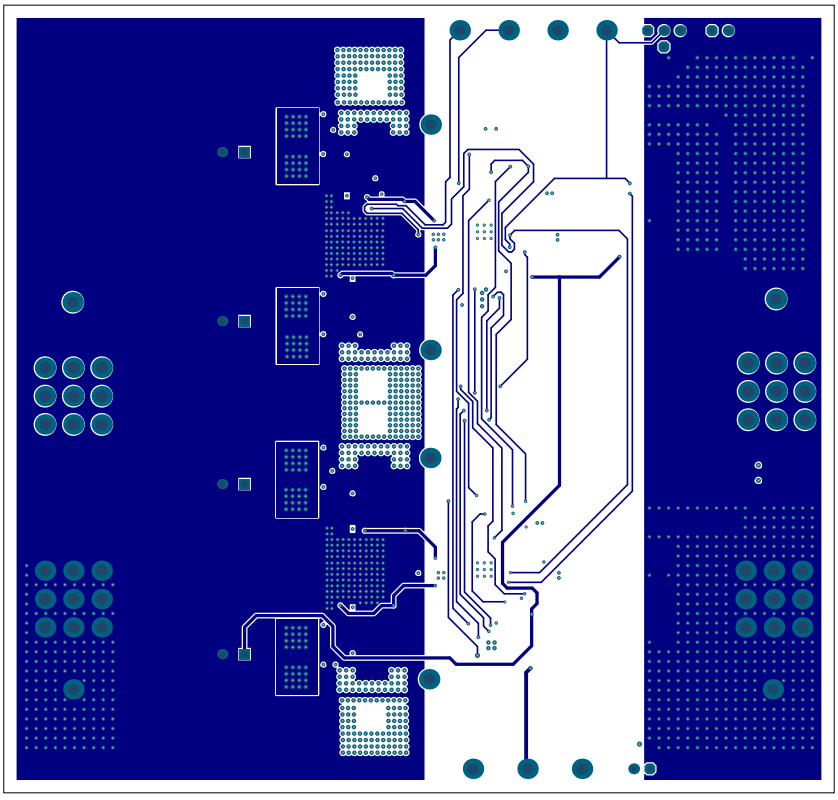
A.9 EV71S00A BOARD – INNER 1 COPPER



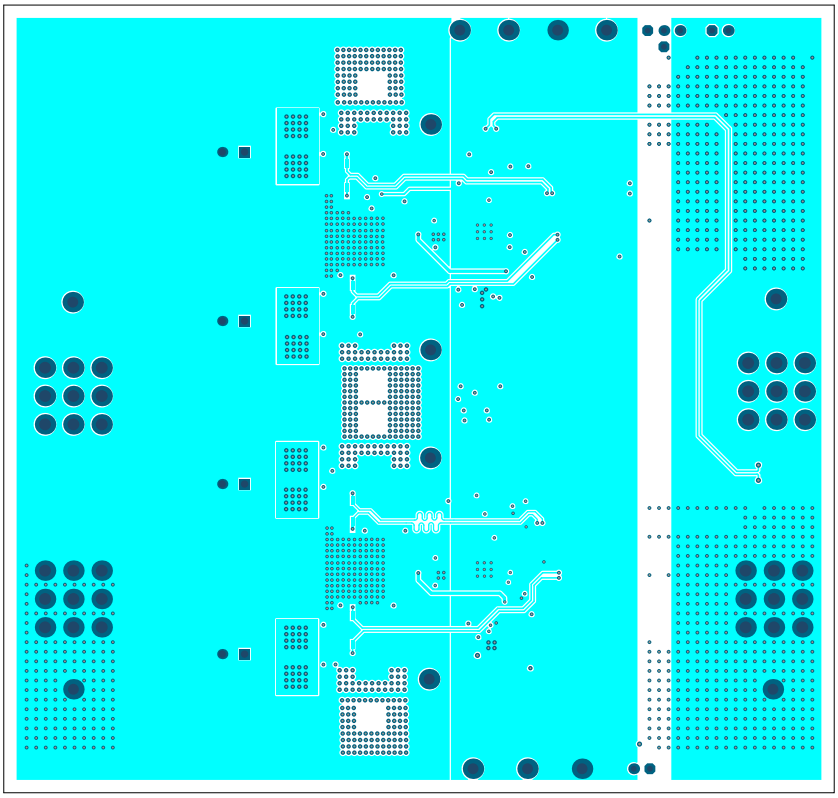
A.10 EV71S00A BOARD – INNER 2 COPPER



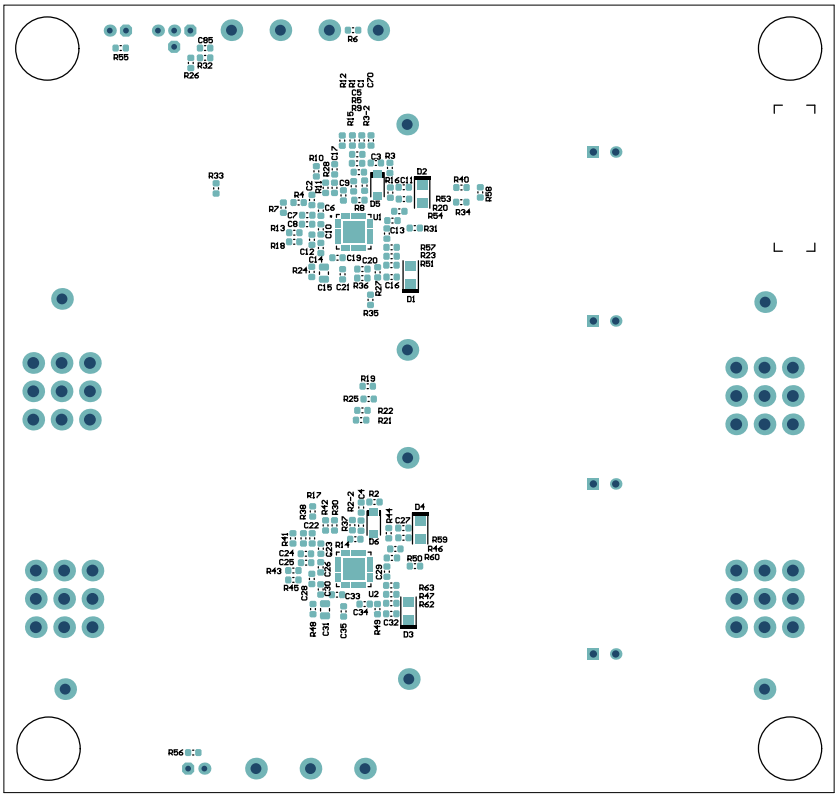
A.11 EV71S00A BOARD – INNER 3 COPPER



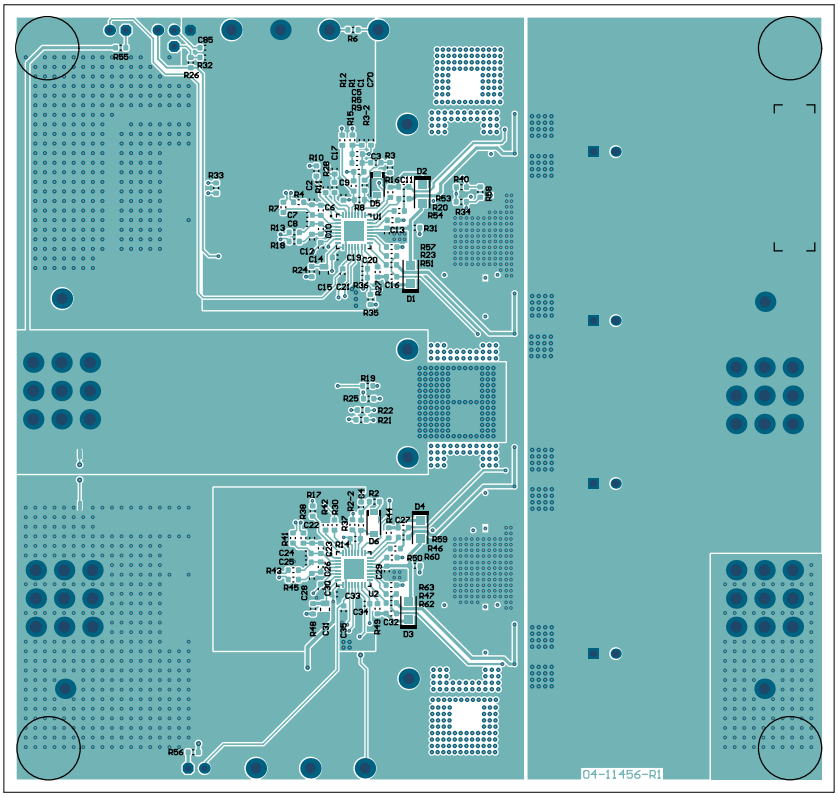
A.12 EV71S00A BOARD – INNER 4 COPPER



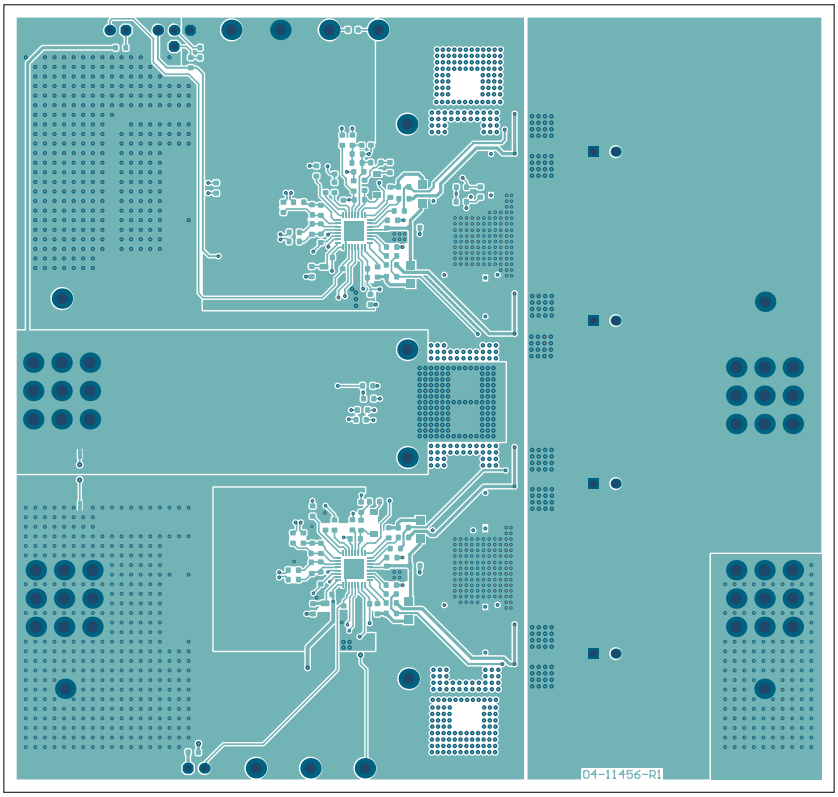
A.13 EV71S00A BOARD – BOTTOM SILK



A.14 EV71S00A BOARD – BOTTOM COPPER AND SILK



A.15 EV71S00A BOARD – BOTTOM COPPER



Appendix B. Bill of Materials (BOM)

TABLE B-1: BILL OF MATERIALS (BOM)

Qty.	Reference	Description	Manufacturer	Part Number
1	C1	Capacitor Ceramic, 8200 pF, 50V, 5%, X7R, SMD, 0603	Yageo Corporation	CC0603JRX7R9BB822
2	C3, C4	Capacitor Ceramic, 10000 pF, 25V, 5%, C0G, SMD, 0603	TDK Corporation	C1608C0G1E103J080AA
1	C5	Capacitor Ceramic, 1500 pF, 50V, 10%, X7R, SMD, 0603, AEC-Q200	TDK Corporation	CGA3E2X7R1H152K080AA
4	C6, C10, C23, C26	Capacitor Ceramic, 100 pF, 50V, 10%, X7R, SMD, 0603	Würth Elektronik	885012206077
4	C11, C16, C27, C32	Capacitor Ceramic, 0.1 µF, 100V, 10%, X7R, SMD, 0603	Murata Manufacturing Co., Ltd.	GRM188R72A104KA35D
3	C13, C29, C35	Capacitor Ceramic, 4.7 µF, 16V, 10%, X5R, SMD, 0603	TDK Corporation	C1608X5R1C475K080AC
2	C15, C31	Capacitor Ceramic, 1 µF, 100V, 10%, X7S, SMD, 0805	TDK Corporation	C2012X7S2A105K125AB
1	C17	Capacitor Ceramic, 10000 pF, 50V, 10%, X7R, SMD, 0603	KEMET	C0603C103K5RACTU
2	C19, C33	Capacitor Ceramic, 2.2 µF, 25V, 10%, X5R, SMD, 0603	Murata Manufacturing Co., Ltd.	GRM188R61E225KA12D
1	C20	Capacitor Ceramic, 1000 pF, 50V, 10%, X7R, SMD, 0603	Wurth Electronik	885012206083
1	C21	Capacitor Ceramic, 4.7 µF, 35V, 10%, X5R, SMD, 0603	Murata Manufacturing Co., Ltd.	GRM188R6YA475KE15D
8	C39, C40, C68, C69, C71, C72, C73, C74	Capacitor Tantalum, 470 µF, 2.5V, 20%, 0.007 Ohm, SMD, D2E	Panasonic® - ECG	2R5TPE470M7
4	C41, C45, C58, C59	Capacitor Aluminum, 330 µF, 35V, 20%, RAD, P3.5D8H20	Würth Electronik	860080574014
4	C42, C43, C60, C61	Capacitor Ceramic, 0.1 µF, 25V, 10%, X7R, SMD, 1206	Würth Electronik	885012208058
12	C44, C46, C47, C48, C55, C56, C62, C63, C64, C65, C66, C67	Capacitor Ceramic, 2.2 µF, 35V, 10%, X7R, SMD, 0805	TDK Corporation	CGA4J1X7R1V225K125AE
12	C49, C50, C51, C52, C79, C80, C81, C82, C83, C84, C86, C87	Capacitor Ceramic, 47 µF, 16V, 20%, X5R, SMD, 1210	Würth Electronik	885012109011
4	C53, C54, C88, C89	Capacitor Ceramic, 0.1 µF, 25V, 10%, X7R, SMD, 1206	KEMET	C1206F104K3RACTU
1	C85	Capacitor Ceramic, 10 pF, 25V, 10%, NP0, SMD, 0603	AVX Corporation (Kyocera)	06033A100KAT2A
4	D1, D2, D3, D4	Diode Rectifier, 100V, 500 mA, SMD, DO-219AB	Vishay Intertechnology, Inc.	RS07B-GS08

Note: The components listed in this Bill of Materials are representative of the PCB assembly. The released BOM used in manufacturing uses all RoHS-compliant components.

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

Qty.	Reference	Description	Manufacturer	Part Number
2	D5, D6	Diode Schottky, MBR0530T1G, 430 mV, 500 mA, 30V, SOD-123	Diodes Incorporated®	B0530W-7-F
1	J1	Connector Header-2.54, Male, 1x3, Gold, 5.84 MH, Through-Hole, Vertical	Amphenol ICC (FCI)	68000-103HLF
2	J2, J3	Connector Header-2.54, Male, 1x2, Gold, 5.84 MH, Through-Hole, Vertical	Amphenol ICC (FCI)	77311-118-02LF
1	J4	Connector Header-2.54, Male, 1x1, Gold, 5.84 MH, Through-Hole, Vertical	Samtec, Inc.	TSW-101-07-S-S
4	J5, J6, J7, J8	Connector Terminal, 85A, Male, 1x1, Shank Terminal, Through-Hole, Vertical	Würth Electronik	74651195R
4	L1, L2, L3, L4	Inductor, 0.4 µH, 24A, 20%, SMD, L10.5W10.2H4.7, AEC-Q200	Würth Electronik	74651195R
4	Q1, Q5, Q9, Q13	Transistor, FET, N-CH, BSC032NE2LS, 25V, 84A, 37W, TDSON-8	Infineon Technologies AG	BSC032NE2LSATMA1
4	Q3, Q7, Q11, Q15	Transistor, FET, N-CH, BSC010NE2LSIATMA1, 25V, 38A, 96W, TDSON-8	Infineon Technologies AG	BSC010NE2LSIATMA1
1	R1	Resistor, Thick Film, 100R, 5%, 1/10W, SMD, 0603	Panasonic® - ECG	ERJ-3GEYJ101V
2	R2-2, R3-2	Resistor, Thick Film, 3.01k, 1%, 1/3W, SMD, 0603	Bourns®, Inc.	CHP0603-FX-3011ELF
2	R2, R3	Resistor, Thick Film, 30.1k, 0.1%, 1/10W, SMD, 0603	Susumu Co., LTD.	RG1608P-3012-B-T5
8	R4, R7, R13, R18, R38, R41, R43, R45	Resistor, Thick Film, 100R, 1%, 1/10W, SMD, 0603	Panasonic - ECG	ERJ3EKF1000V
1	R5	Resistor, Thick Film, 20k, 1%, 1/10W, SMD, 0603	Panasonic - ECG	ERJ3EKF2002V
2	R6, R37	Resistor, Thick Film, 10k, 1%, 1/16W, SMD, 0603	TE Connectivity, Ltd. (previously Tyco Electronics, Ltd.)	CPF0603F10KC1
2	R8, R14	Resistor, Thick Film, 60.4k, 1%, 1/10W, SMD, 0603	Panasonic - ECG	ERJ-3EKF6042V
1	R9	Resistor, Thick Film, 56k, 1%, 1/10W, SMD, 0603	Stackpole Electronics, Inc.	RMCF0603FT56K0
2	R11, R42	Resistor, Thick Film, 40.2k, 1%, 1/10W, SMD, 0603	Yageo Corporation	RC0603FR-0740K2L
22	R12, R19, R20, R21, R22, R23, R25, R28, R30, R33, R46, R47, R51, R53, R54, R55, R56, R57, R59, R60, R62, R63	Resistor, Thick Film, 0R, 1/10W, SMD, 0603	Panasonic® - ECG	ERJ-3GEY0R00V
1	R15	Resistor, Thick Film, 300R, 1%, 1/10W, SMD, 0603	Yageo Corporation	RC0603FR-07300RL

Note: The components listed in this Bill of Materials are representative of the PCB assembly. The released BOM used in manufacturing uses all RoHS-compliant components.

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

Qty.	Reference	Description	Manufacturer	Part Number
4	R16, R27, R44, R49	Resistor, Thick Film, 4.7R, 1%, 1/10W, SMD, 0603	Panasonic - ECG	ERJ-3RQF4R7V
2	R24, R48	Resistor, Thick Film, 1.2R, 1%, 1/10W, AEC-Q200, SMD, 0603	Panasonic - ECG	ERJ-3RQF1R2V
2	R26, R32	Resistor, Thick Film, 100k, 1%, 1/8W, SMD, 0603	Vishay Beyschlag	MCT06030C1003FP500
2	R31, R50	Resistor, Thick Film, 2.21R, 0.1%, 1/16W, SMD, 0603	Stackpole Electronics, Inc.	RNCF0603BKC2R21
1	R34	Resistor, Thick Film, 107k, 1%, 1/10W, SMD, 0603	Panasonic - ECG	ERJ-3EKF1073V
1	R35	Resistor, Thick Film, 1k, 1%, 1/10W, SMD, 0603, AEC-Q200	Panasonic - ECG	ERJ3EKF1001V
15	TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP8, TP9, TP10, TP11, TP12, TP13, TP14, TP15	Connector, Test Point, Pin, Tin, Through-Hole	Harwin Plc.	H2121-01

Note: The components listed in this Bill of Materials are representative of the PCB assembly. The released BOM used in manufacturing uses all RoHS-compliant components.

TABLE B-2: BILL OF MATERIALS (BOM) – MICROCHIP PARTS

Qty.	Reference	Description	Manufacturer	Part Number
2	U1, U2	Microchip Analog, 75V, COT, Switching Buck Controller, MIC21LV32 QFN-32	Microchip Technology Inc.	MIC21LV32YML-TR

Note: The components listed in this Bill of Materials are representative of the PCB assembly. The released BOM used in manufacturing uses all RoHS-compliant components.

TABLE B-3: BILL OF MATERIALS (BOM) – MECHANICAL PARTS

Qty.	Reference	Description	Manufacturer	Part Number
1	JP1	Mechanical Hardware Jumper, 2.54 mm, 1x2	3M®	969102-0000-DA
1	LABEL1	Label, Assembly w/Revision Level (Small Modules) per MTS-0002	—	—
4	PAD1, PAD2, PAD3, PAD4	Mechanical Hardware Rubber Pad, Cylindrical, 0.374" x 0.189", Clear	Essentra Components	RBS-35
1	PCB1	Printed Circuit Board	—	04-11456-R1

Note: The components listed in this Bill of Materials are representative of the PCB assembly. The released BOM used in manufacturing uses all RoHS-compliant components.

TABLE B-4: BILL OF MATERIALS (BOM) – DO NOT POPULATE PARTS

Qty.	Reference	Description	Manufacturer	Part Number
0	C2, C7, C8, C12, C22, C24, C25, C28	Capacitor Ceramic, 100 pF, 50V, 10%, X7R, SMD, 0603	Würth Electronik	885012206077
0	C9	Capacitor Ceramic, 0.1 µF, 100V, 10%, X7R, SMD, 0603	Murata Manufacturing Co., Ltd.	GRM188R72A104KA35D
0	C14, C30	Capacitor Ceramic, 1000 pF, 50V, 10%, X7R, SMD, 0603	Würth Electronik	885012206083
0	C34	Capacitor Ceramic, 4.7 µF, 16V, 10%, X5R, SMD, 0603	TDK Corporation	C1608X5R1C475K080AC
0	C36, C37, C38, C57	Capacitor Tantalum, 470 µF, 2.5V, 20%, 0.007 Ohm, SMD, D2E	Panasonic® - ECG	2R5TPE470M7
0	C70	Capacitor Ceramic, 10 pF, 25V, 5%, NP0, SMD, 0603	Würth Electronik	885012006032
0	C75, C76, C77, C78	Capacitor Ceramic, 470 pF, 100V, 5%, C0G, SMD, 0603	TDK Corporation	CGA3E2C0G2A471J080AA
0	Q2, Q6, Q10, Q14	Transistor, FET, N-CH, BSC032NE2LS, 25V, 84A, 37W, TDSON-8	Infineon Technologies AG	BSC032NE2LSATMA1
0	Q4, Q8, Q12, Q16	Transistor, FET, N-CH, BSC010NE2LSIATMA1, 25V, 38A, 96W, TDSON-8	Infineon Technologies AG	BSC010NE2LSIATMA1
0	R10, R17, R36	Resistor, Thick Film, 0R, 1/10W, SMD, 0603	Panasonic - ECG	ERJ-3GEY0R00V
0	R40	Resistor, Thick Film, 30k, 5%, 1/10W, SMD, 0603	Panasonic - ECG	ERJ3GEYJ303V
0	R52, R65, R66, R67	Resistor, Thick Film, 10R, 1%, 1/8W, SMD, 0805	Vishay/Dale	CRCW080510R0FKEAC
0	R58	Resistor, Thick Film, 90.9k, 1%, 1/10W, SMD, 0603	Panasonic - ECG	ERJ-3EKF9092V
0	TH1	Resistor, Thermistor, 47k, 1%, 100 mW, SMD, 0603	Murata Manufacturing Co., Ltd.	NCU18WB473F60RB

Note: 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. Board Waveforms and Performance Curves

C.1 MAIN WAVEFORMS

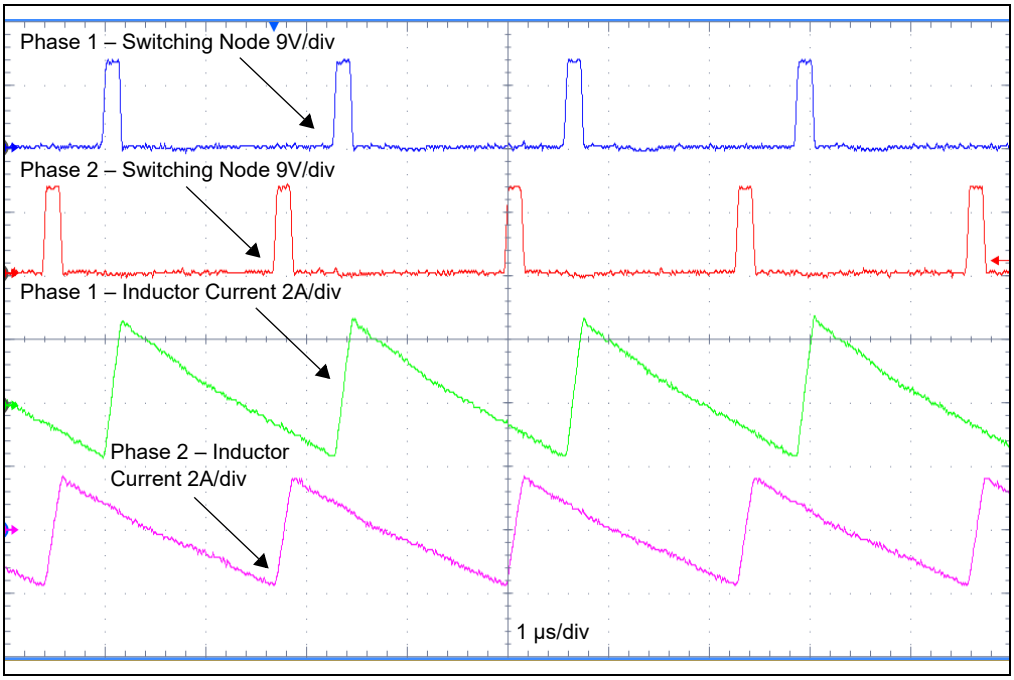


FIGURE C-1: *Switching Node Waveforms for V_{IN} 12V, V_{OUT} 0.82V, Phase 1 + 2, No Load.*

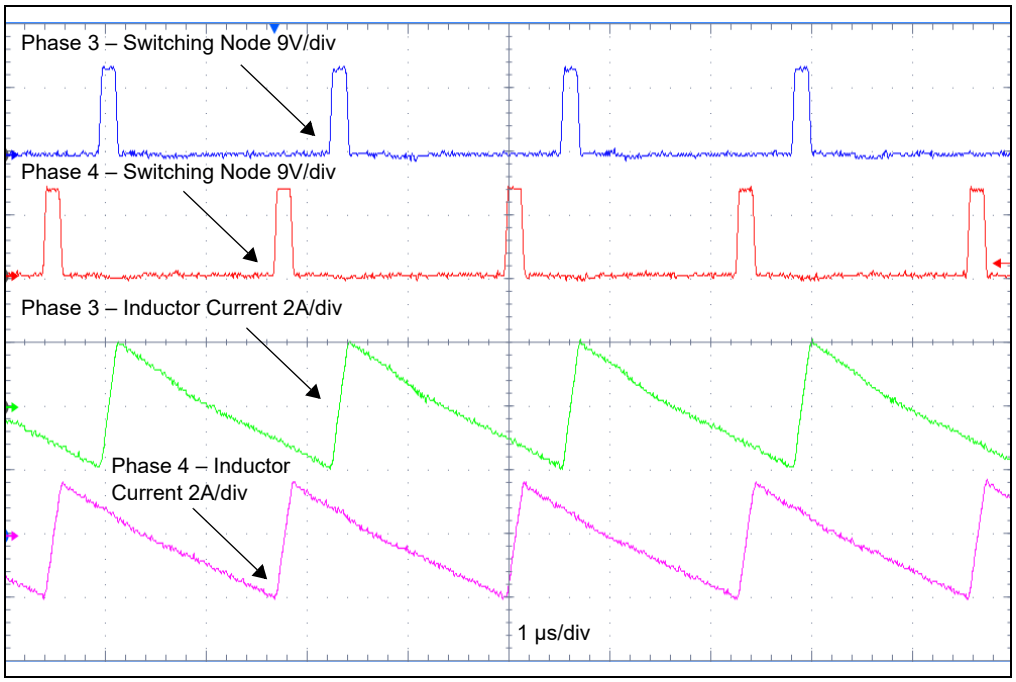


FIGURE C-2: *Switching Node Waveforms for V_{IN} 12V, V_{OUT} 0.82V, Phase 3 + 4, No Load.*

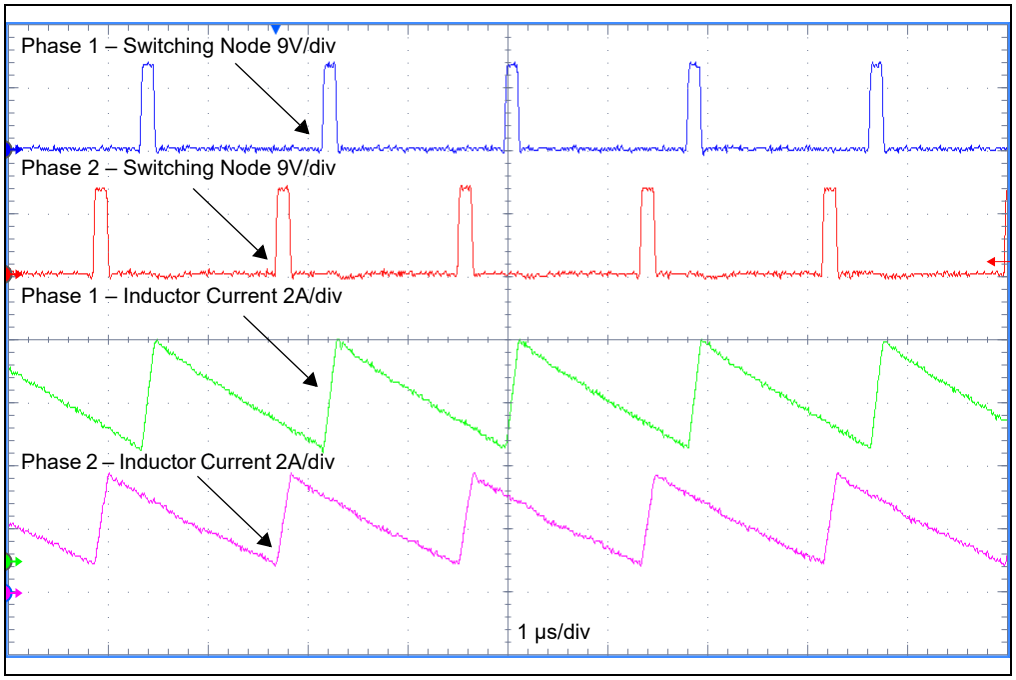


FIGURE C-3: *Switching Node Waveforms for V_{IN} 12V, V_{OUT} 0.82V, Phase 1 + 2, I_{OUT} 12.5A.*

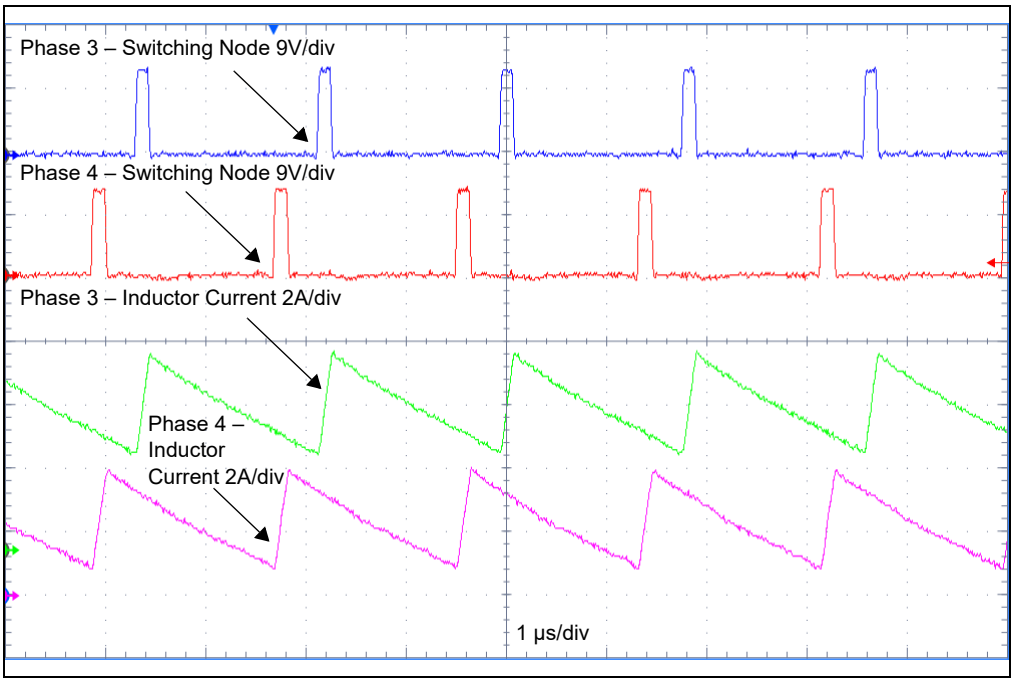


FIGURE C-4: *Switching Node Waveforms for V_{IN} 12V, V_{OUT} 0.82V, Phase 3 + 4, I_{OUT} 12.5A.*

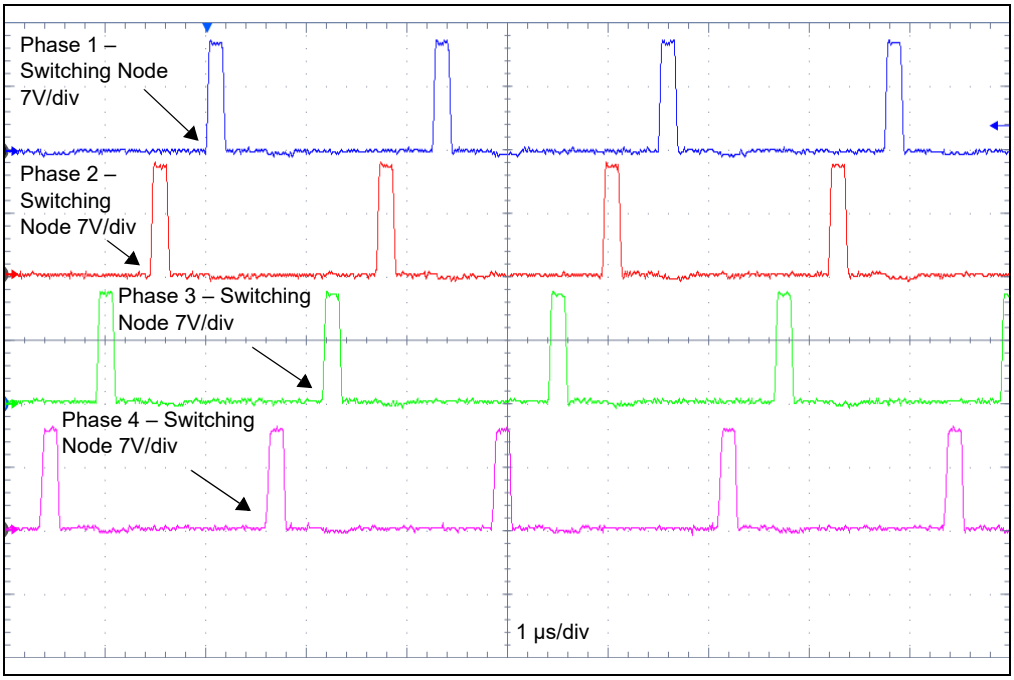


FIGURE C-5: *Switching Node Waveforms for V_{IN} 12V, V_{OUT} 0.82V, Phase 1 + 2 + 3 + 4, No Load.*

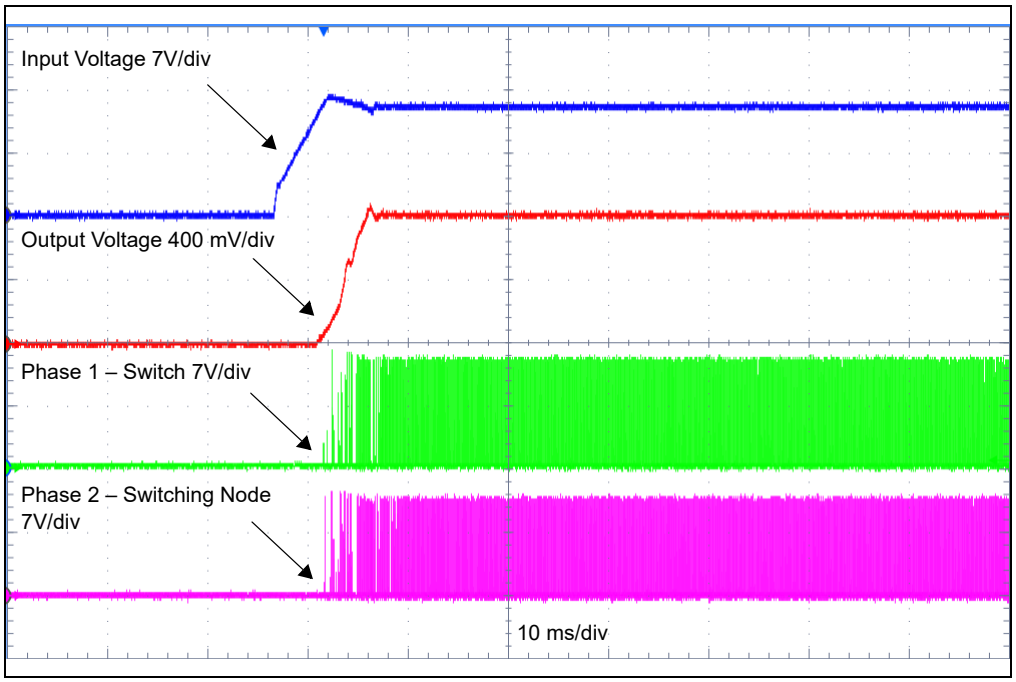


FIGURE C-6: *Soft Start Under No Load.*

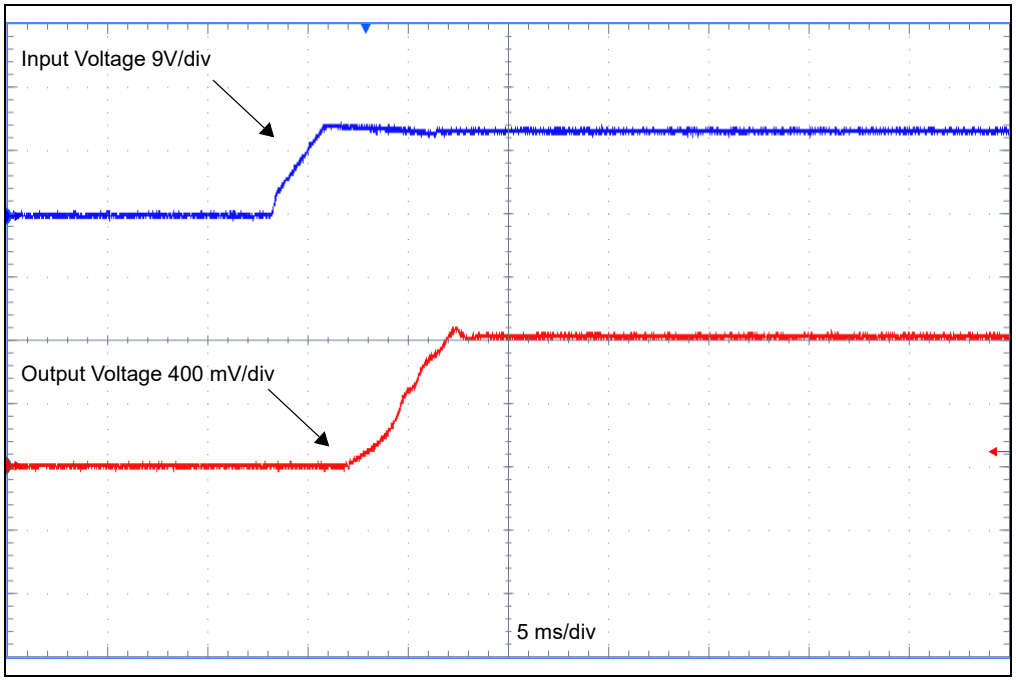


FIGURE C-7: *Start-up Under 12.5A Load.*

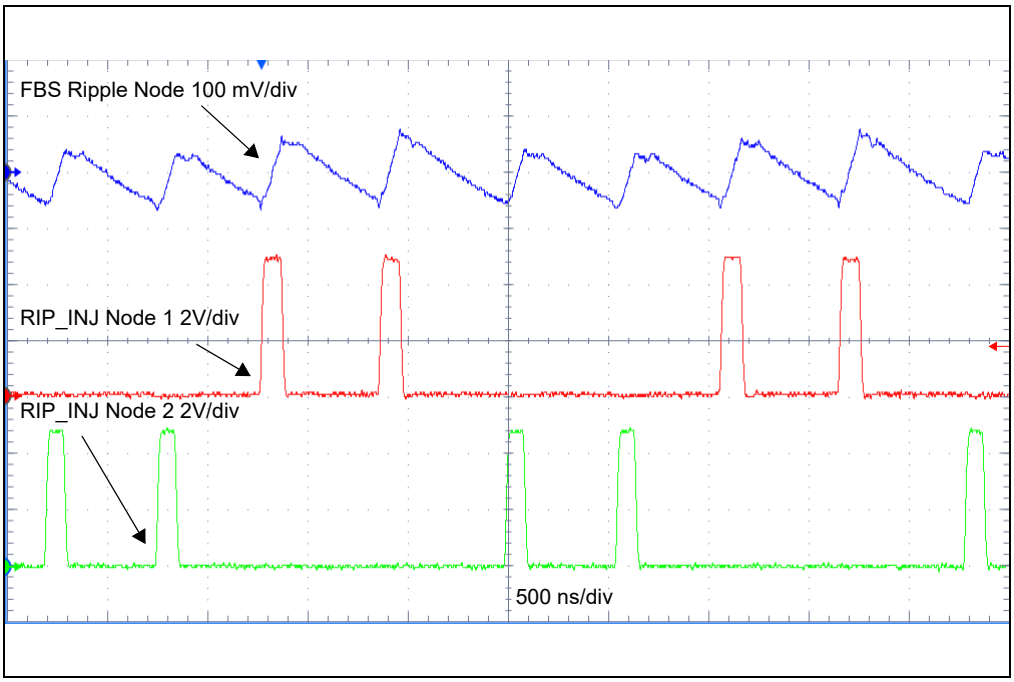


FIGURE C-8: *Ripple Injection 12V In, 0.82V, No Load.*

C.2 PERFORMANCE CURVES

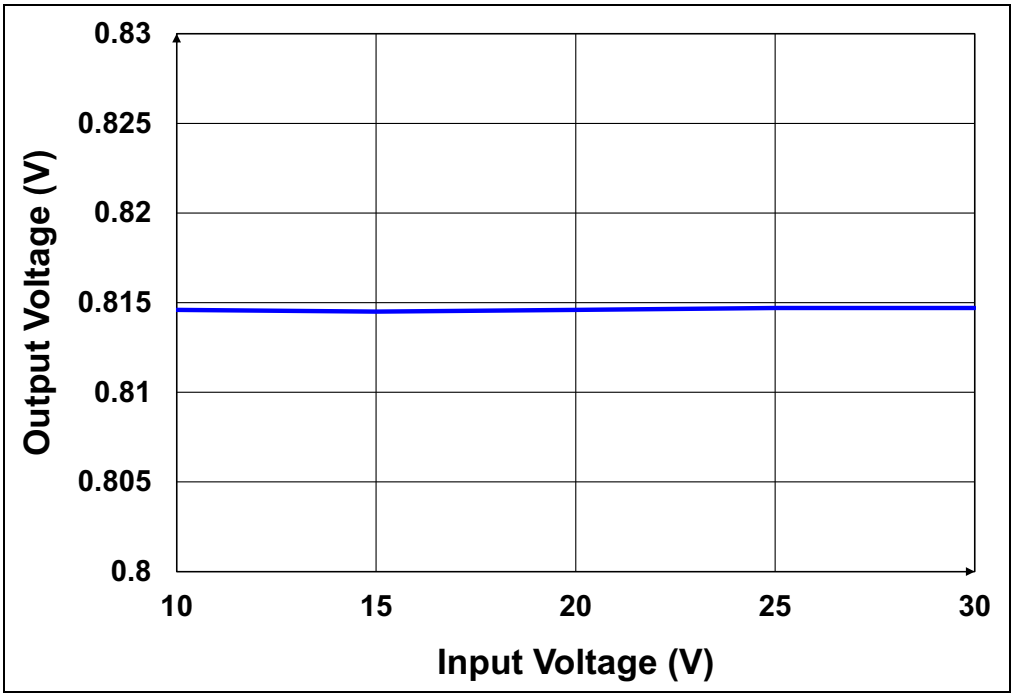


FIGURE C-9: *Output Voltage vs. Input Voltage with No Load.*

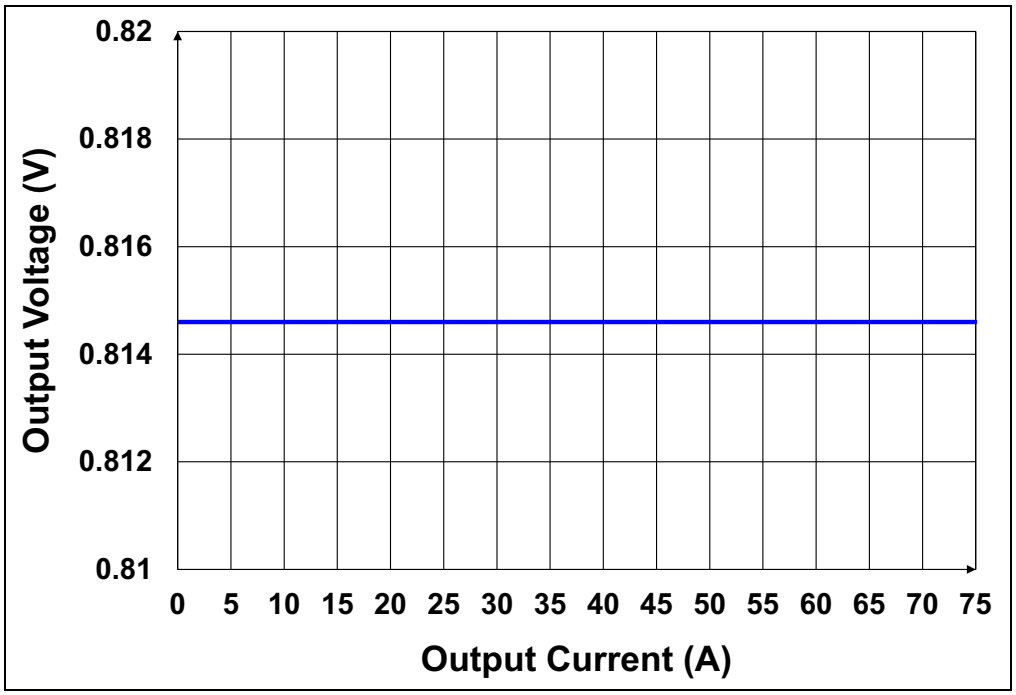


FIGURE C-10: *Output Voltage vs. Output Current (V_{IN} = 12V).*

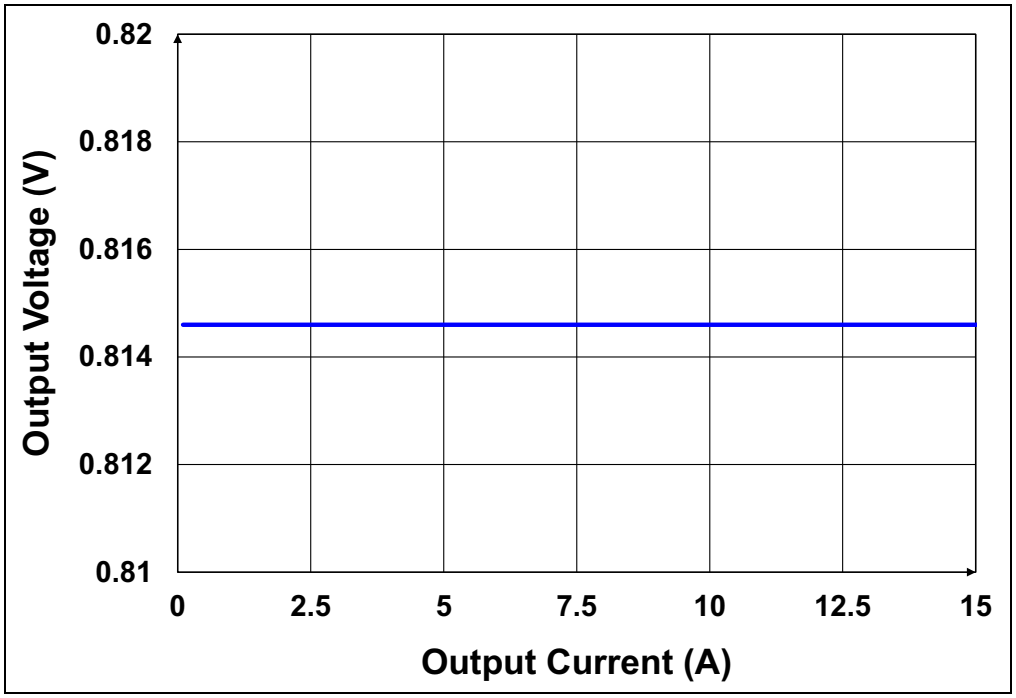


FIGURE C-11: *Output Voltage vs. Output Current (V_{IN} = 20V).*

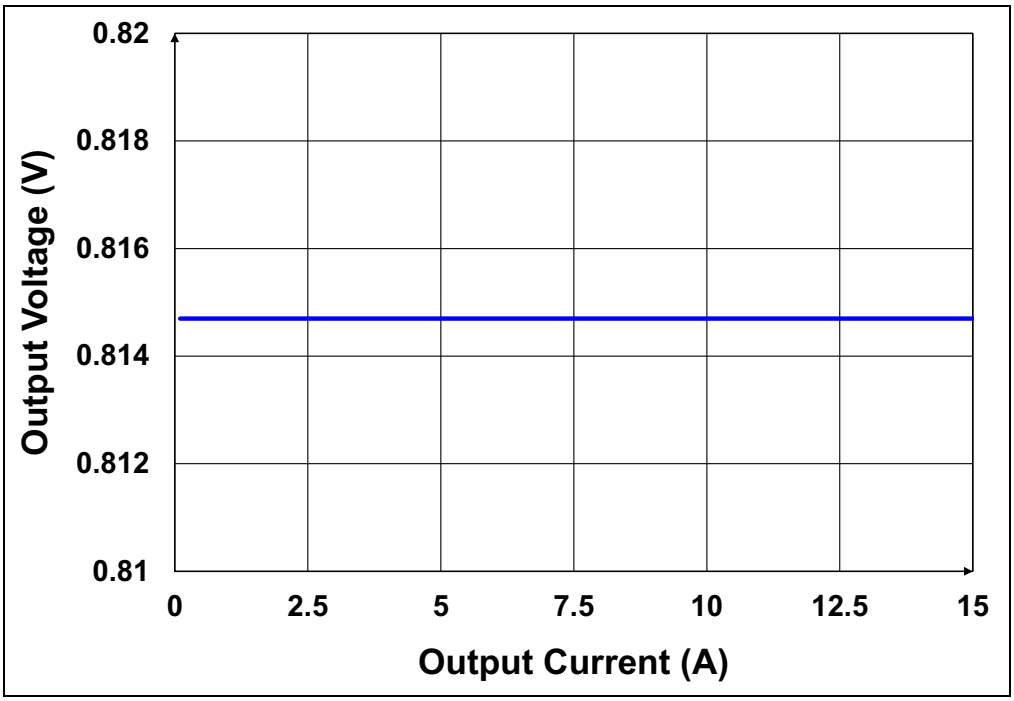


FIGURE C-12: *Output Voltage vs. Output Current (V_{IN} = 30V).*

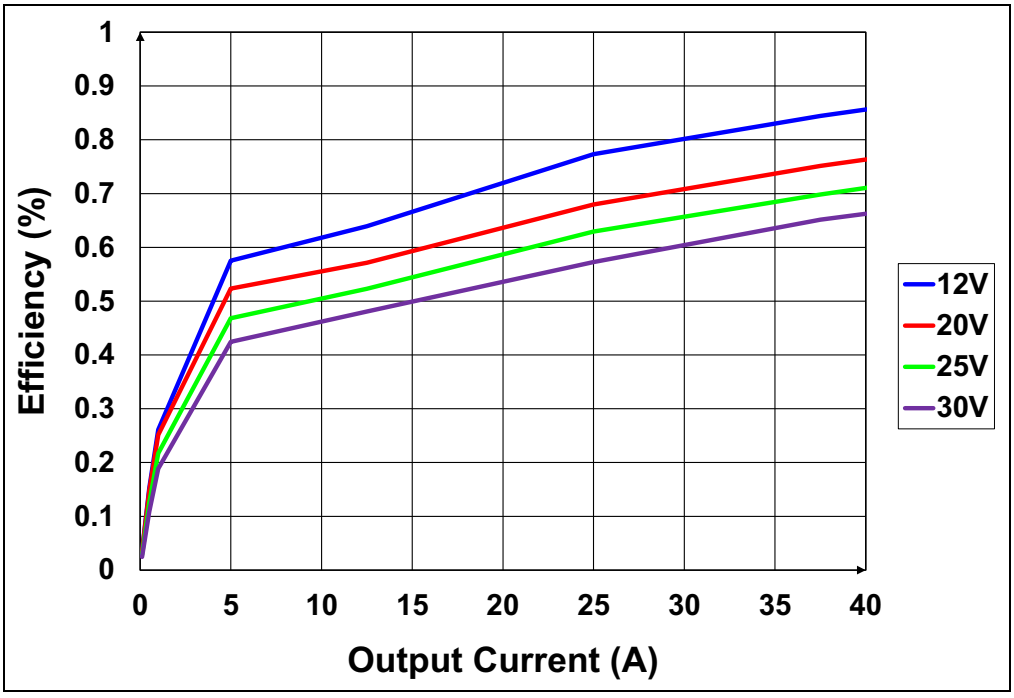


FIGURE C-13: *Efficiency vs. Output Current.*

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