MCP39F511A Power Monitor Demonstration Board User's Guide

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MCP39F511A POWER MONITOR DEMONSTRATION 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 MCP39F511A Power Monitor Demonstration 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 MCP39F511A Power Monitor Demonstration Board 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 MCP39F511A Power Monitor Demonstration Board.
- **Chapter 2. "Installation and Operation"** – Provides information on using the MCP39F511A Power Monitor Demonstration Board.
- **Appendix A. "Schematic and Layouts"** – Shows the schematic and layout diagrams for the MCP39F511A Power Monitor Demonstration Board.
- **Appendix B. "Bill of Materials (BOM)"** – Lists the parts used to build the MCP39F511A Power Monitor Demonstration Board.

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) { ... }`

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RECOMMENDED READING

This user's guide describes how to use the MCP39F511A Power Monitor Demonstration Board. Another useful document is listed below. The following Microchip document is available and recommended as a supplemental reference resource:

MCP39F511A Data Sheet – *"AC/DC Dual-Mode Power-Monitoring IC with Calculation and Energy Accumulation" (DS20006044)*

THE MICROCHIP WEBSITE

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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 website at:
http://www.microchip.com/support.

DOCUMENT REVISION HISTORY

Revision A (June 2018)

- Initial release of this document.

NOTES:

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Chapter 1. Product Overview

1.1 INTRODUCTION

The MCP39F511A Power Monitor Demonstration Board is a fully-functional, single-phase power and energy monitor. The system calculates active power, reactive power, RMS current, RMS voltage, active energy (both import and export), reactive energy and other typical power quantities, as defined in the MCP39F511A data sheet.

The MCP39F511A Power Monitor Demonstration Board uses the Power Monitor Utility software for evaluation through a USB connection to the board. The Power Monitor Utility software is used to calibrate and monitor the system, and can be used to create custom calibration setups. For most accuracy requirements, only a single-point calibration is needed. The software offers an automated step-by-step calibration process that can be used to quickly calibrate power meters.

A download link for this software can be found on the demonstration board's web page. For instructions on how to use the software, refer to the software's supporting documentation included within the application installation package.

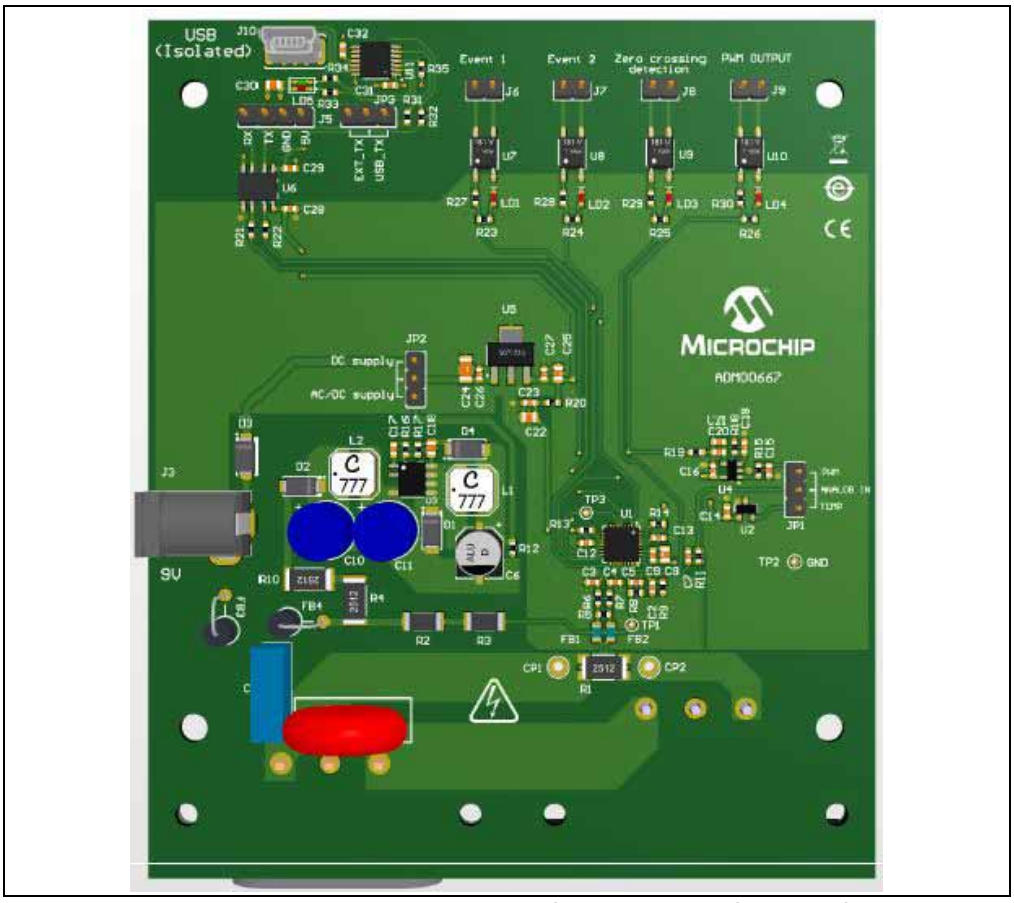

FIGURE 1-1: *MCP39F511A Power Monitor Demonstration Board.*

1.2 WHAT DOES THE MCP39F511A POWER MONITOR DEMONSTRATION BOARD KIT INCLUDE?

This MCP39F511A Power Monitor Demonstration Board kit includes:

- MCP39F511A Power Monitor Demonstration Board (ADM00667)
- AC Line Cable
- IEC to Female AC Load Cable
- Mini-USB Cable
- Important Information Sheet

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Chapter 2. Installation and Operation

2.1 GETTING STARTED

To use the MCP39F511A Power Monitor Demonstration Board, follow the steps described in the sections below. The meter is calibrated at a load current of 5A [rms] and the maximum current (I_{MAX}) is 15A [rms].

It is not recommended to put more than 15A [rms] through the AC plugs mounted on the Printed Circuit Board (PCB).

2.1.1 Wiring Connections

Figure 2-1 identifies the line and the load connections of the MCP39F511A Power Monitor Demonstration Board.

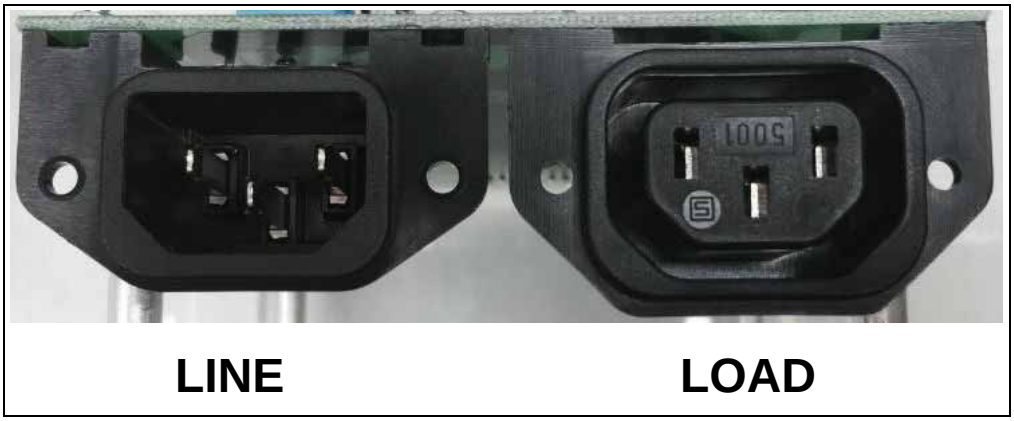

FIGURE 2-1: *Connecting the MCP39F511A Power Monitor Demonstration Board.*

2.1.2 Powering the Meter

The meter turns on when the line input voltage is between 90V [rms] and 230V [rms].

2.1.3 Connecting the USB Cable to a PC

1. The Power Monitor Utility software needs to be installed in order to proceed.
2. Select the appropriate COM port. The connection status in the bottom-left corner of the software displays "Meter Connected", when the meter is connected correctly. The status "Meter Disconnected" is displayed when no meter is found. Check that the correct COM port was selected and try again.
3. Click the **Start** button in order to begin showing output data and UART transmitted/received packets of data exchanged between the PC and the MCP39F511A device.

Note:	For instructions on using the software GUI, refer to the help file located in the program installation directory.

NOTES:

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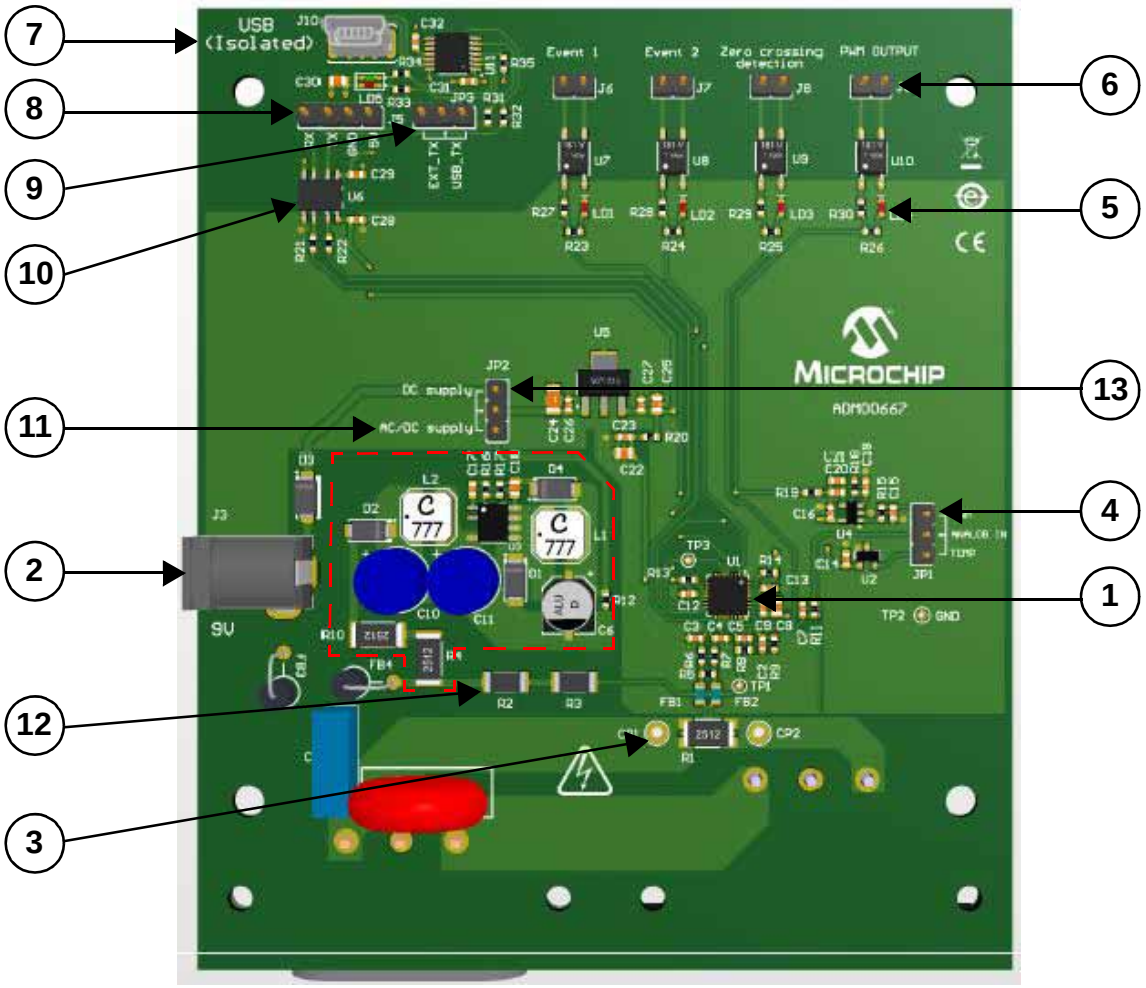
Chapter 3. Hardware Description



Legend:

1 = MCP39F511A

2 = +9V DC Input (non-isolated)

3 = Connections to external shunt current sensing resistor (CP1 and CP2)

4 = Configuration jumper for analog input

5 = Output LEDs for digital I/O

6 = Headers for digital testing (isolated)

7 = USB Connection (isolated)

8 = Header for connection to external master MCU (isolated)

9 = Jumper selection for external MCU or USB (GUI) operation

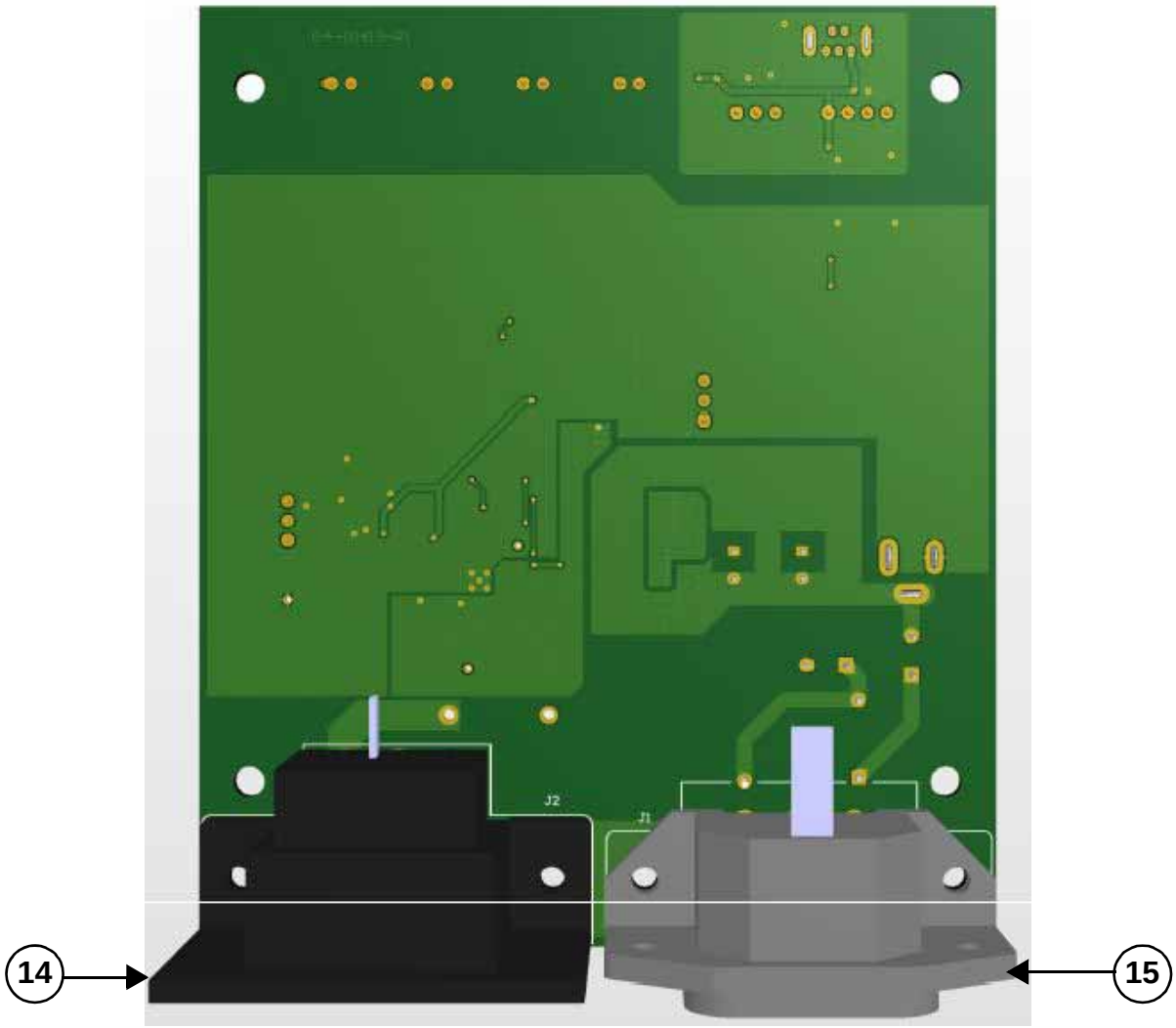
10 = Isolation IC

11 = AC/DC Power Supply

12 = 1000:1 Voltage Divider for Voltage Input

13 = Jumper for DC or AC/DC Supply

FIGURE 3-1: *MCP39F511A Power Monitor Demonstration Board Top View.*



Legend:

14 = Line connection AC supply (90 – 230V)

15 = Load connection (15A maximum recommended current)

FIGURE 3-2: *MCP39F511A Power Monitor Demonstration Board Bottom View.*

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3.1 INPUT AND ANALOG FRONT END

The MCP39F511A Power Monitor Demonstration Board operates from 90V [rms] to 230V [rms]. The high-voltage line and neutral connections are located at the bottom of the board. The shunt sits on the neutral or the low side of a two-wire system. The MCP39F511A Power Monitor Demonstration Board comes populated with a surface mount 2 mΩ shunt. When using a lower value external shunt, twist together the wires going from the external shunt to the CP1 and CP2 connections.

The neutral side of the two-wire system goes into a resistor divider on the voltage channel input. Anti-aliasing low-pass filters are inserted on the input pins. The voltage channel uses two 499 kΩ resistors to achieve a divider ratio of 1000:1. For a line voltage of 220 V_{RMS}, the channel 1 input signal size is 220 mV_{RMS}.

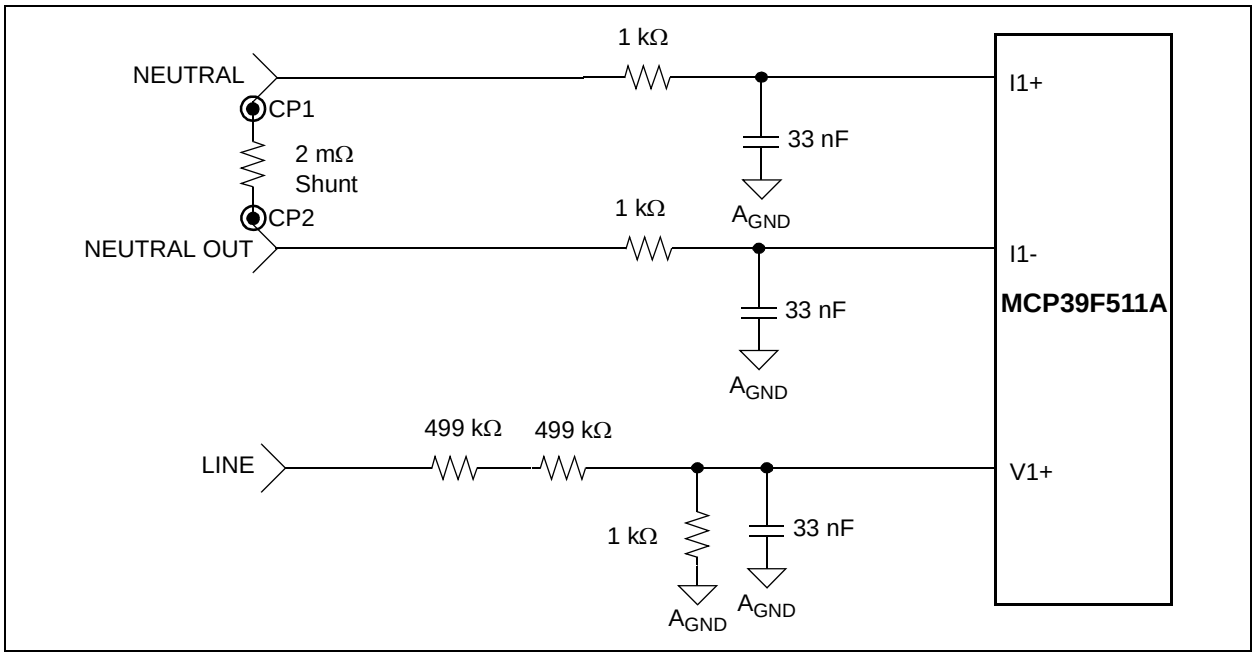

FIGURE 3-3: *Analog Front-End Circuitry.*

Note:	All of the analog circuitry associated with this part of the circuit is connected to the analog ground plane (AGND).

3.2 POWER SUPPLY CIRCUIT

The power supply circuit for the MCP39F511A Power Monitor Demonstration Board is shown in Figure 3-4.

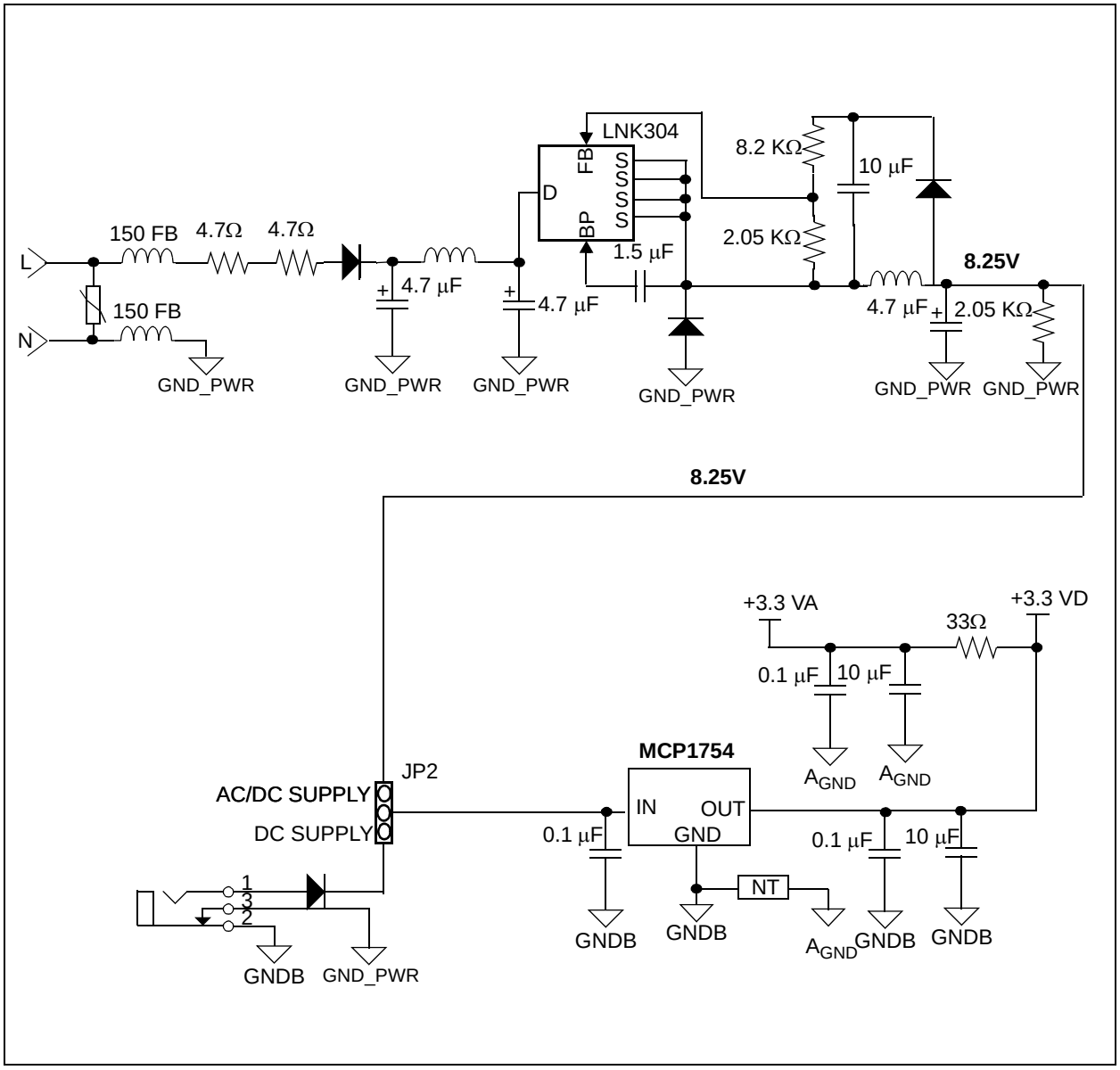

FIGURE 3-4: *Power Supply Circuit with Option for AC/DC Switching Supply from Mains or DC Supply.*

> **Note:** When using an external power supply, the jumper needs to be moved on DC SUPPLY position. When the power plug is inserted into the input jack, the ground of the meter is disconnected from the NEUTRAL, so no measurements can be taken. The external power supply is useful for serial communication purposes only.

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Appendix A. Schematic and Layouts

A.1 INTRODUCTION

This appendix contains the following schematics and layouts for the MCP39F511A Power Monitor Demonstration Board:

Board – Schematic

Board – Schematic (Continued)

Board – Top Silk

Board – Top Copper and Silk

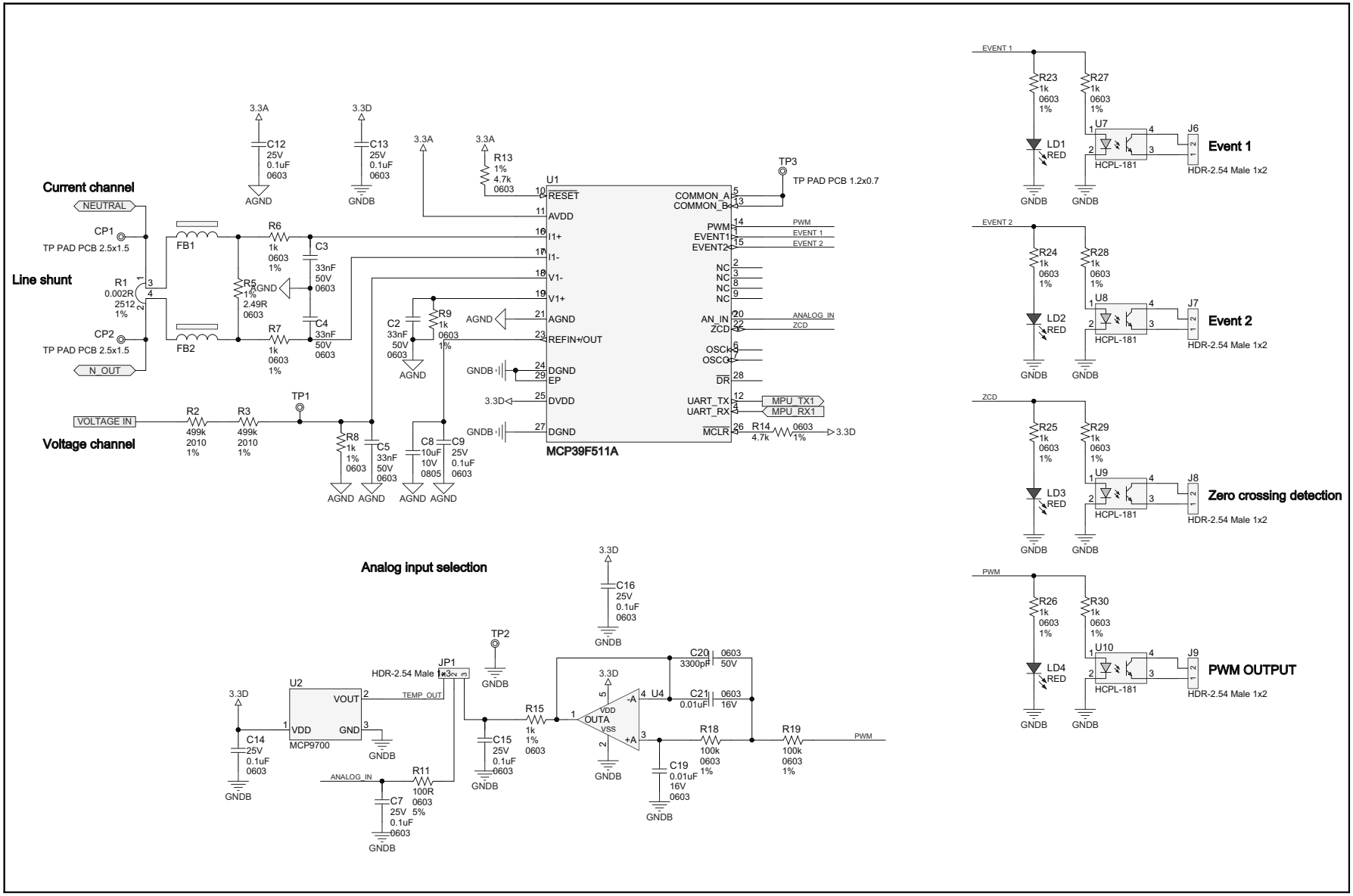
Board – Top Copper

Board – Bottom Copper

Board – Bottom Copper and Silk

Board – Bottom Silk

A.2 BOARD – SCHEMATIC



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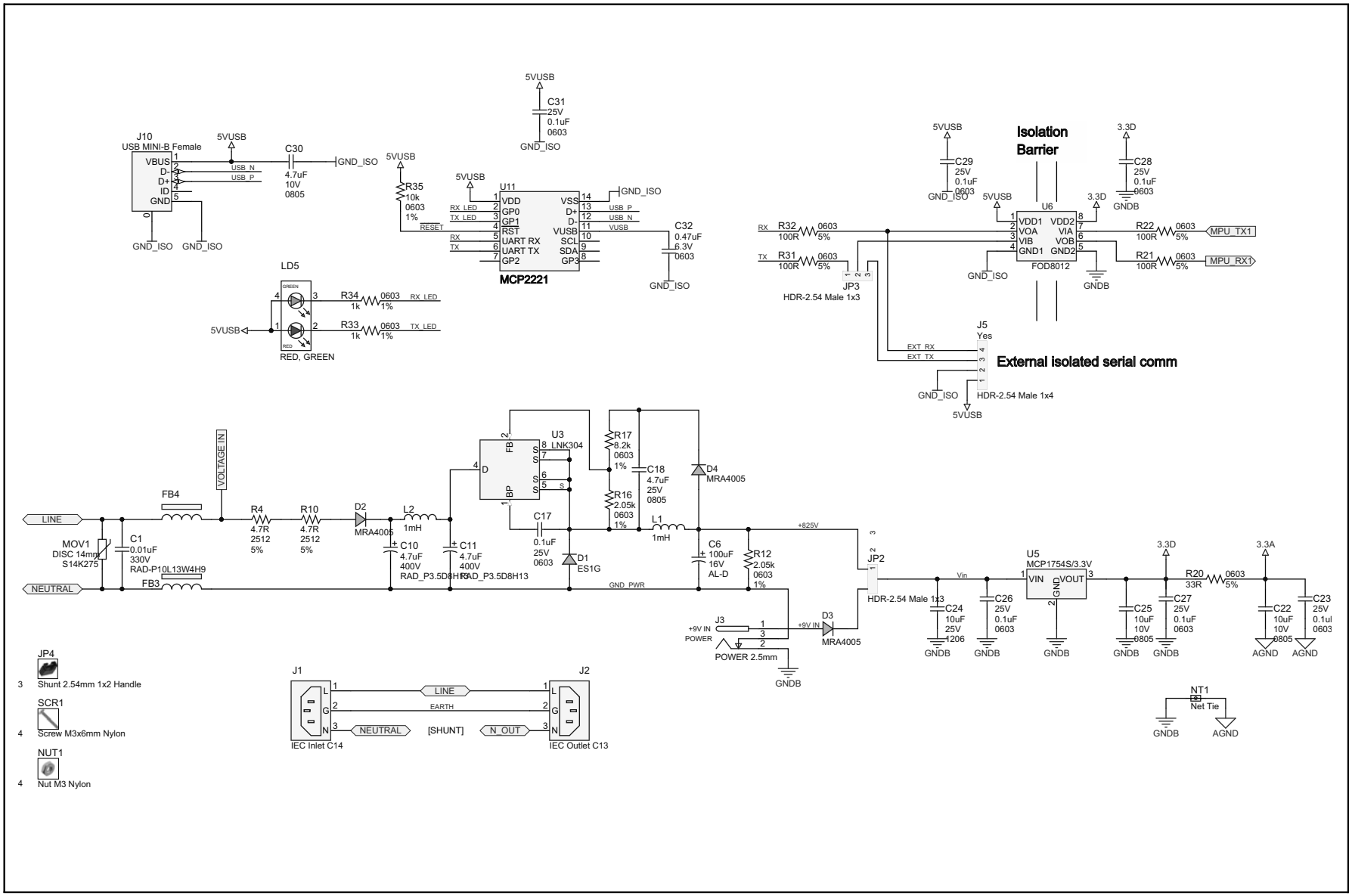
A.3 BOARD – SCHEMATIC (CONTINUED)



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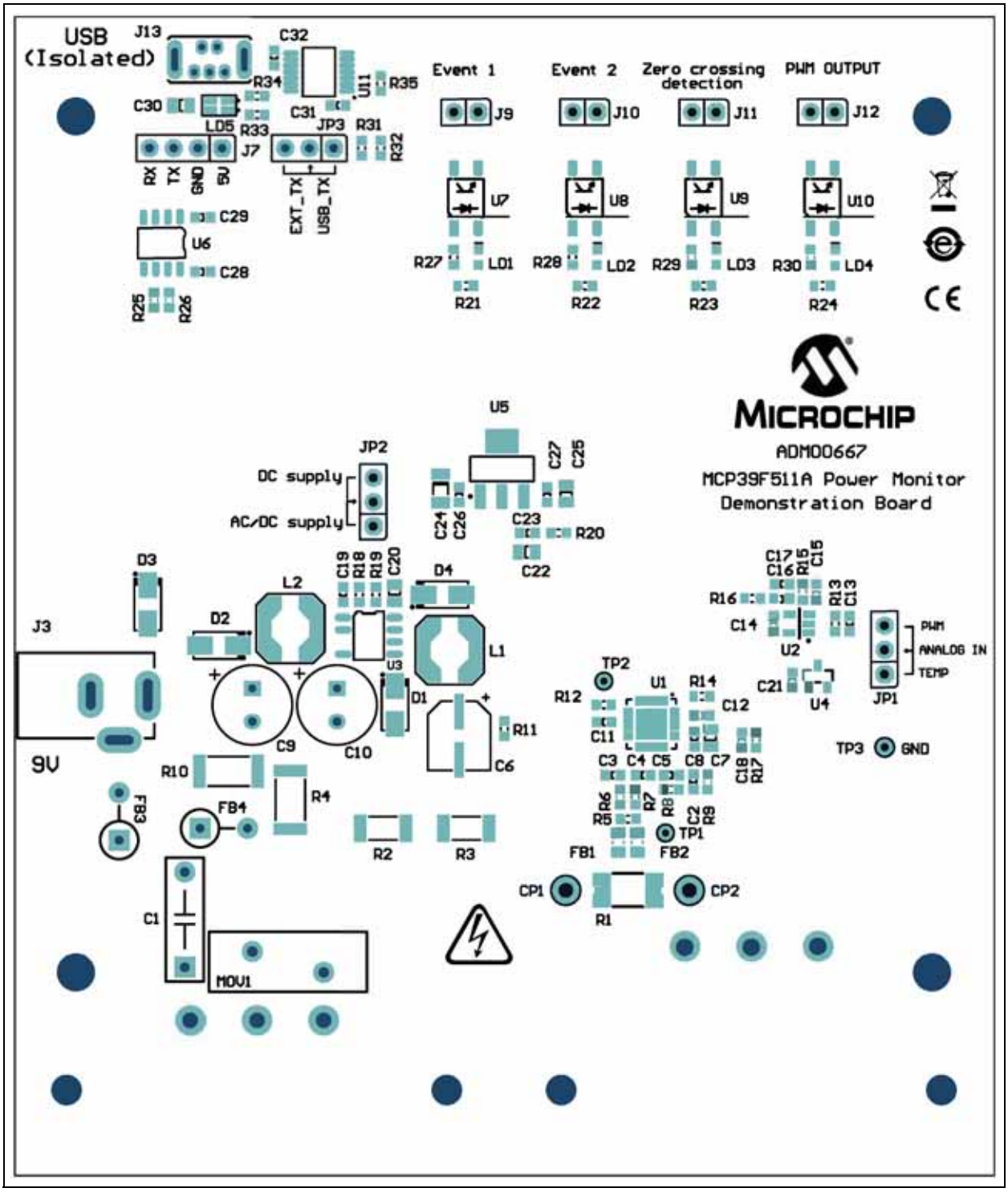
A.4 BOARD – SILK



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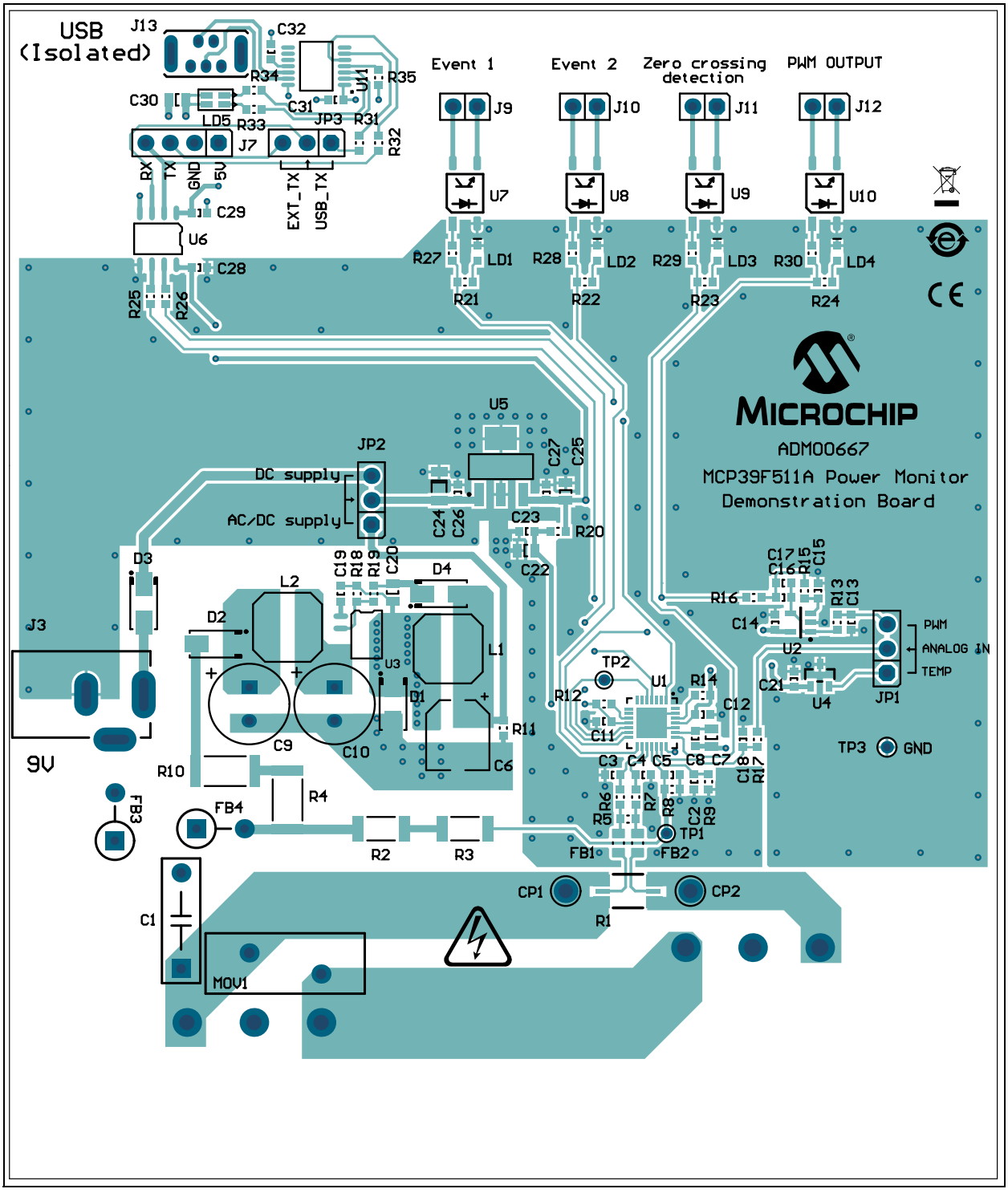
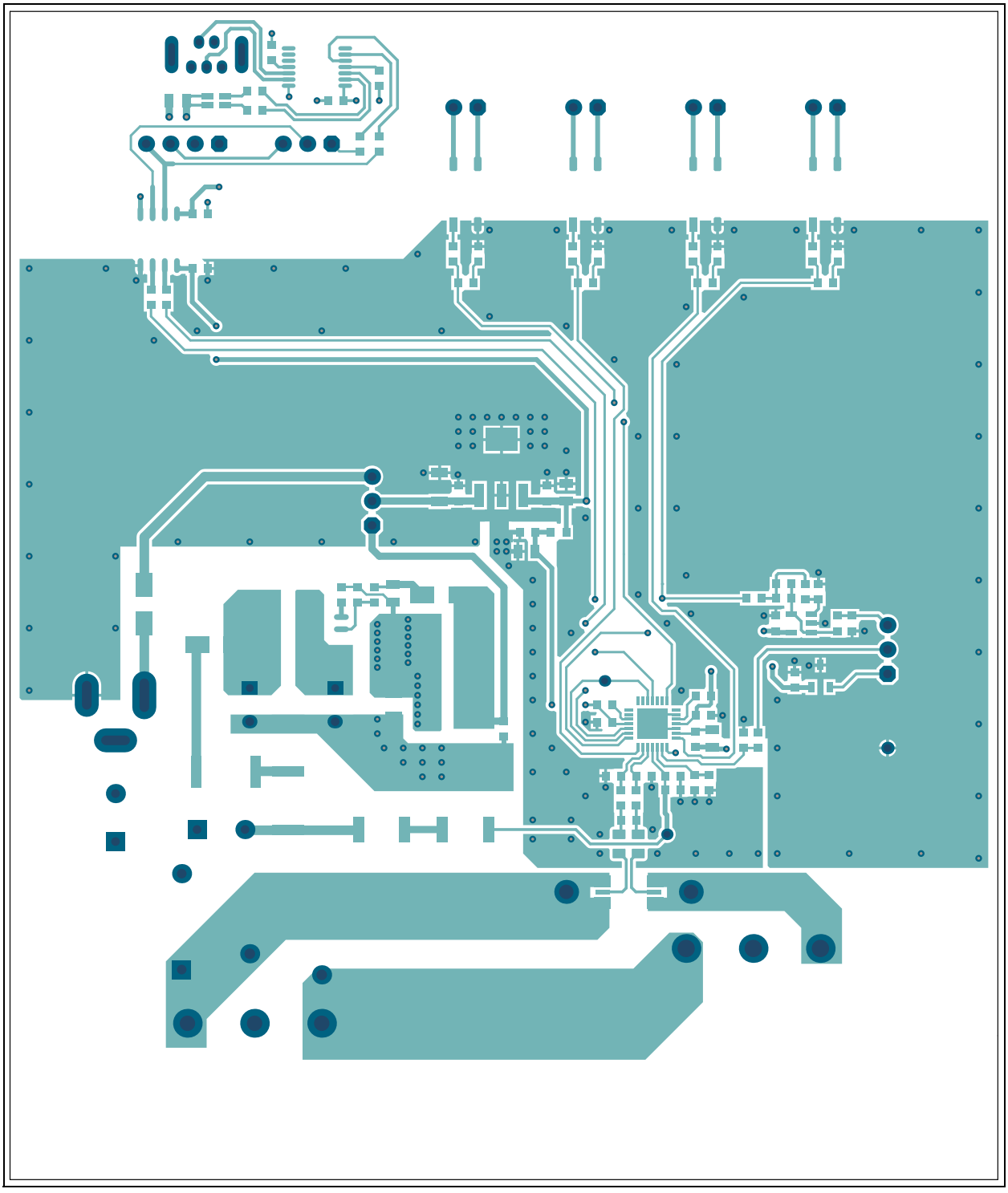
A.5 BOARD – TOP COPPER AND SILK



A.6 BOARD – TOP COPPER



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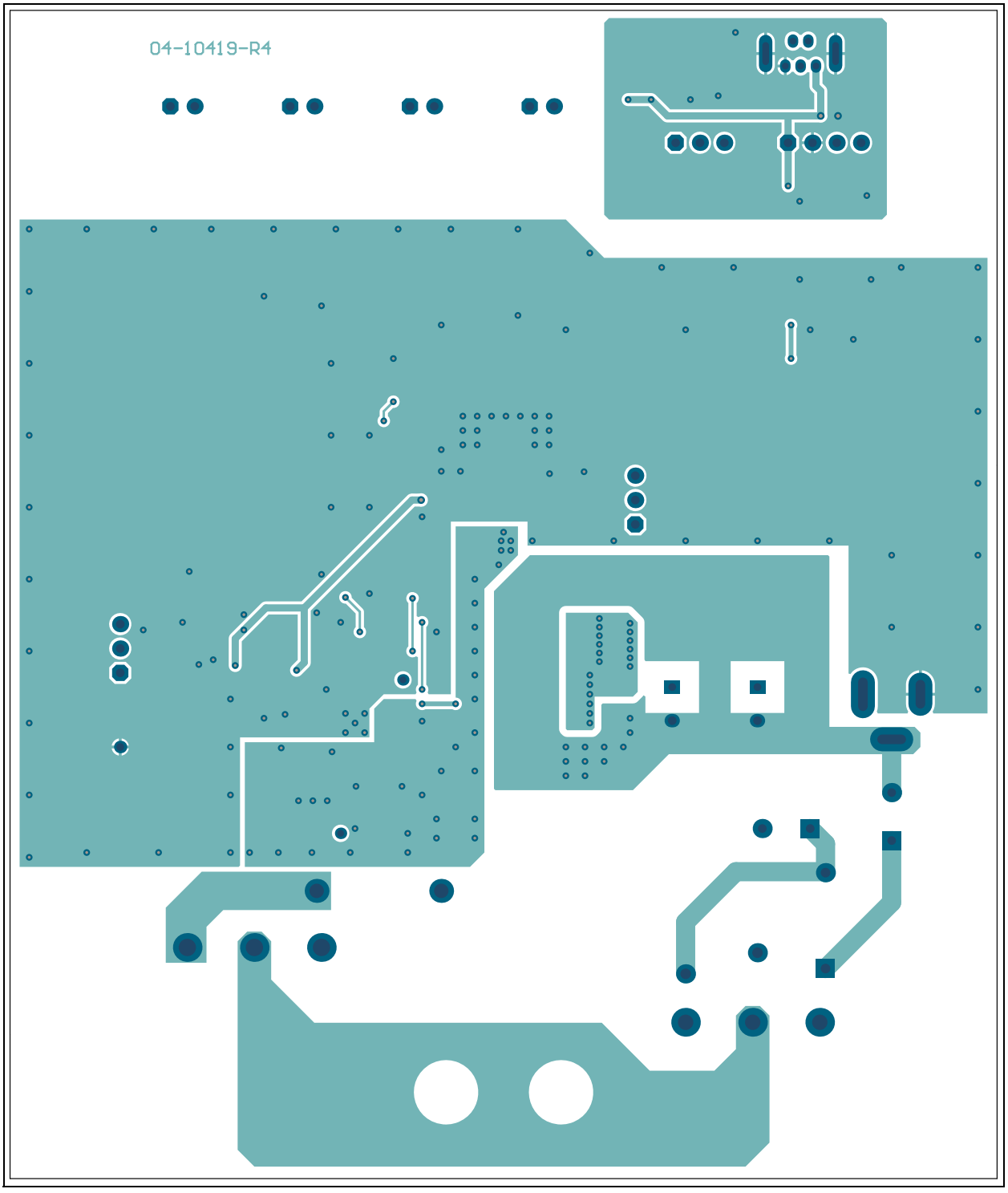
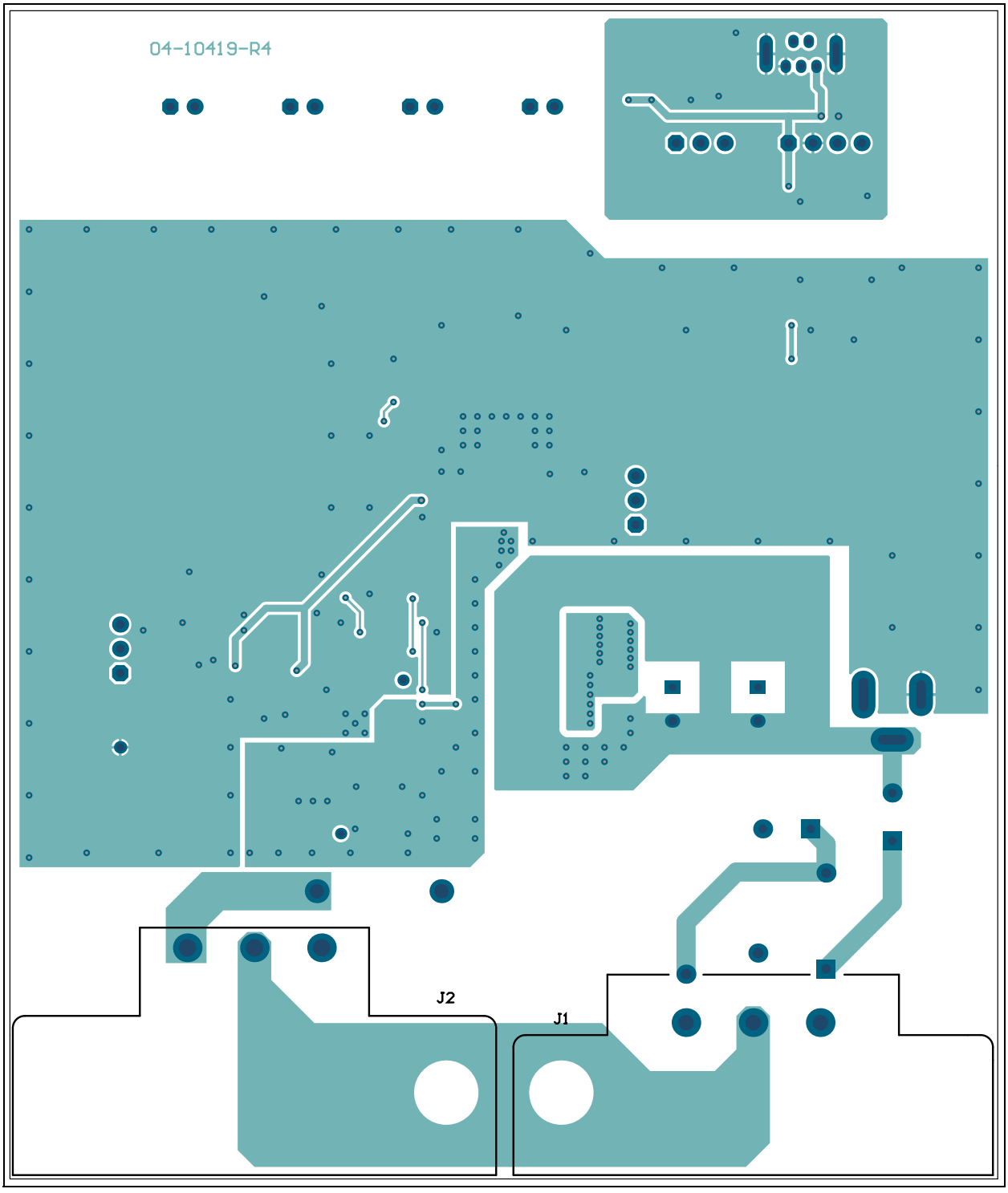
A.7 BOARD – BOTTOM COPPER



A.8 BOARD – BOTTOM COPPER AND SILK



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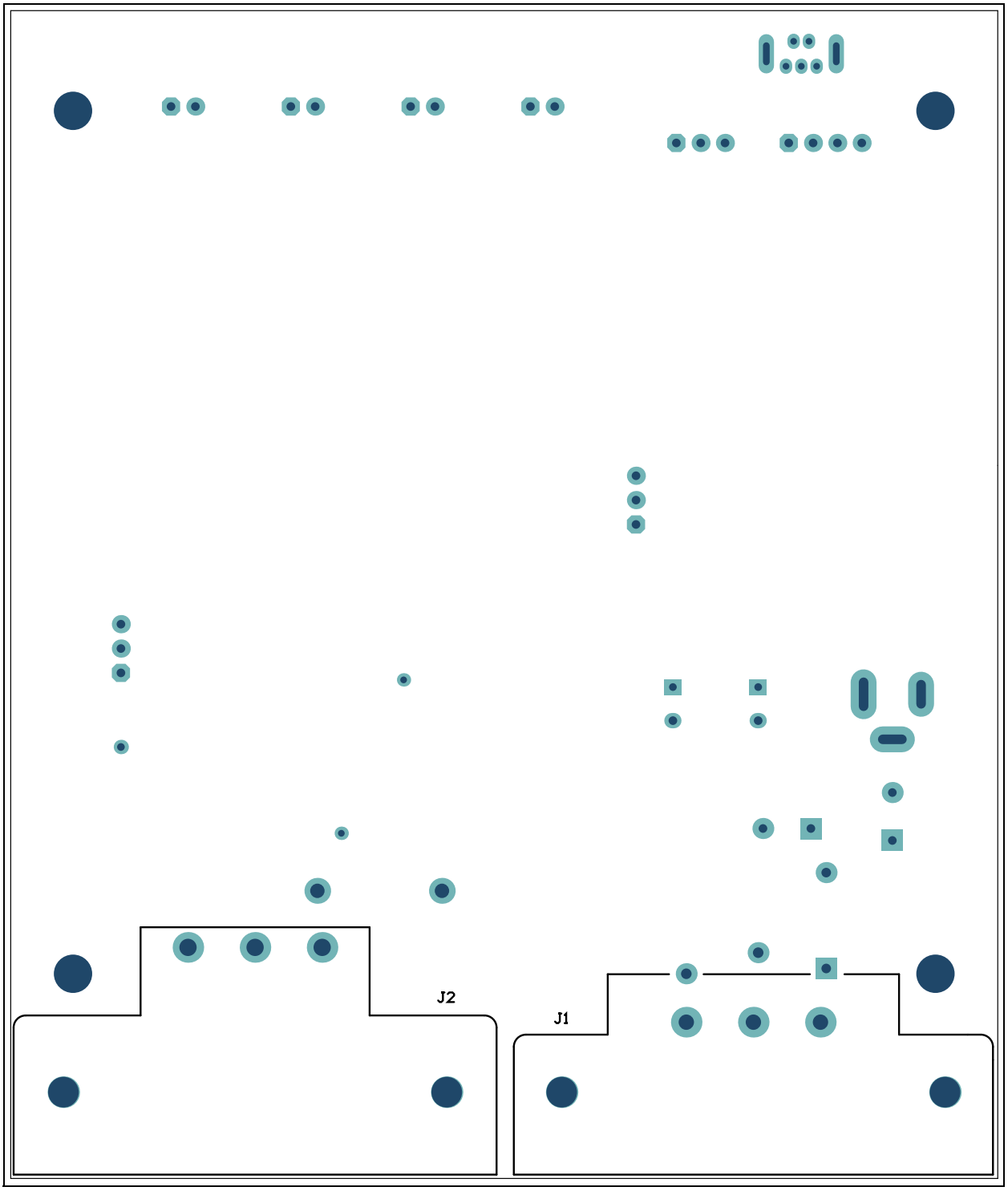
A.9 BOARD – BOTTOM SILK



NOTES:

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Appendix B. Bill of Materials (BOM)

TABLE B-1: MCP39F511A POWER MONITOR DEMONSTRATION BOARD - BOM

Qty.	Reference	Description	Manufacturer	Part Number
1	C1	Cap. Film 0.01 µF 330V 20% RAD P10L13W4H9	EPCOS AG	B32911A3103M
2	C10, C11	Cap. Alu. 4.7 µF 400V 20% RAD_P3.5D8H13	Nichicon Corporation	UVC2G4R7MPD1TD
1	C18	Cap. Ceramic 4.7 µF 25V 10% X7R SMD 0805	TDK Corporation	C2012X7R1E475K125AB
2	C19, C21	Cap. Ceramic 0.01 µF 16V 5% SMD 0603	Taiyo Yuden Co., Ltd.	EMK107SD103JA-T
4	C2, C3, C4, C5	Cap. Ceramic 33 nF 50V 10% X7R SMD 0603	TDK Corporation	C1608X7R1H333K
1	C20	Cap. Ceramic 3300 pF 50V 10% X7R SMD 0603	ROHM	C0603C332K5RACTU
1	C24	Cap. Ceramic 10 µF 25V 10% X7R SMD 1206	Taiyo Yuden Co., Ltd.	TMK316B7106KL-TD
1	C30	Cap. Ceramic 4.7 µF 10V 10% X5R SMD 0805	Taiyo Yuden Co., Ltd.	LMK212BJ475KD-T
1	C32	Cap. Ceramic 0.47 µF 6.3V 10% X5R SMD 0603	Murata Electronics North America, Inc.	GRM188R60J474KA01D
1	C6	Cap. Alu.100 µF 16V 20% SMD D	Nichicon Corporation	UWX1C101MCL1GB
14	C7, C9, C12, C13, C14, C15, C16, C17, C23, C26, C27, C28, C29, C31	Cap. Ceramic 0.1 µF 25V 10% X7R SMD 0603	Murata Electronics North America, Inc.	GRM188R71E104KA01D
3	C8, C22, C25	Cap. Ceramic 10 µF 10V 10% X7R SMD 0805	TDK Corporation	C2012X7R1A106K125AC
1	D1	Diode Rectifier ES1G 1.25V 1A 400V SMD DO-214AC_SMA	Diodes Incorporated®	ES1G-13-F
3	D2, D3, D4	Diode Rectifier MRA4005 1.1V 1A 600V DO-214AC_SMA	ON Semiconductor®	MRA4005T3G
2	FB1, FB2	Ferrite 800 mA 0.15R SMD 0805	Laird Technologies®	LI0805H151R-10
2	FB3, FB4	Ferrite 7A 0.01R RAD P5L5.3D3.8	Panasonic® - ECG	EXC-ELSR35S
1	J1	Conn, IEC 250V 15A Inlet C14 TH. R/A	SCHURTER Inc.	GSP1.9103.1
1	J10	Conn. USB MINI-B Female TH. Vert.	Molex Connector Corporation	500075-1517
1	J2	Conn. IEC 250V 15A Outlet C13 TH. R/A	SCHURTER Inc.	6182.0033
1	J3	Conn. Power 2.5 mm 5.5 mm Switch TH. R/A	CUI Inc.	PJ-002B

TABLE B-1: MCP39F511A POWER MONITOR DEMONSTRATION BOARD - BOM (CONTINUED)

Qty.	Reference	Description	Manufacturer	Part Number
1	J5	Conn. HDR-2.54 Male 1x4 Tin 5.84 MH TH. Vertical	FCI	68002-404HLF
4	J6, J7, J8, J9	Conn. Header-2.54 Male 1x2 Tin 6.10 MH TH. Vertical	Molex®	0022284020
3	JP1, JP2, JP3	Conn. Header-2.54 Male 1x3 Gold 5.84 MH TH. Vertical	FCI	68000-103HLF
2	L1, L2	Inductor 1 mH 240 mA 20% SMD L6W6H2.4	Coilcraft	LPS6225-105MLB
4	LD1, LD2, LD3, LD4	Diode LED Red 1.95V 30 mA 700 mcd Clear SMD 0603	Kingbright Electronic Co., Ltd.	APTD1608SURCK
1	LD5	Diode LED BI Red, Green 1.95V, 2.1V 30 mA 0805	Kingbright Electronic Co., Ltd.	APHBM2012SURKCGKC
1	MOV1	Res. Varistor 275V 130J TH. Disc. 14 mm	EPCOS AG	S14K275E2K1
1	PCB1	MCP39F511A Power Monitor Demonstration Board - Printed Circuit Board	Microchip Technology Inc.	04-10419-R4
1	R1	Res. Shunt MF 0.002R 1% 2W 2512	Stackpole Electronics, Inc.	CSNL2512FT2L00
5	R11, R21, R22, R31, R32	Res. TKF. 100R 5% 1/10W SMD 0603	Vishay/Dale	CRCW0603100RJNEA
2	R12, R16	Res. TKF. 2.05k 1% 1/10W SMD 0603	Yageo Corporation	RC0603FR-072K05L
2	R13, R14	Res. TKF. 4.7 kΩ 1% 1/10W SMD 0603	Panasonic® - BSG	ERJ-3EKF4701V
1	R17	Res. TKF. 8.2 kΩ 1% 1/10W SMD 0603	Panasonic - BSG	ERJ-3EKF8201V
2	R18, R19	Res. TF. 100 kΩ 1% 1/8W SMD 0603	Vishay/Beyschlag	MCT06030C1003FP500
2	R2, R3	Res. TKF. 499 kΩ 1% 3/4W SMD 2010	Vishay/Dale	CRCW2010499KFKEF
1	R20	Res. TKF. 33R 5% 1/10W SMD 0603	Yageo Corporation	9C06031A33R0JLHFT
1	R35	Res. TKF. 10 kΩ 1% 1/10W SMD 0603	Panasonic - BSG	ERJ-3EKF1002V
2	R4, R10	Res. TKF. 4.7R 5% 1W SMD 2512	Stackpole Electronics, Inc.	RPC2512JT4R70
1	R5	Res. TKF 2.49R 1% 1/10W SMD 0603	Vishay/Dale	CRCW06032R49FKEA
15	R6, R7, R8, R9, R15, R23, R24, R25, R26, R27, R28, R29, R30, R33, R34	Res. TKF. 1 kΩ 1% 1/10W SMD 0603	Panasonic - BSG	ERJ-3EKF1001V
1	U1	Microchip Analog Energy Measurement 4000:1 MCP39F511A-E/MQ QFN-28	Microchip Technology Inc.	**MCP39F511A-E/MQ**
1	U11	Microchip Interface USB I2C UART MCP2221-I/ST TSSOP-14	Microchip Technology Inc.	**MCP2221-I/ST**
1	U2	Microchip Analog Temp. Sensor -40C to +150C MCP9700T-E/TT SOT-23-3	Microchip Technology Inc.	**MCP9700T-E/TT**
1	U3	IC Switcher LNK304 SO-8C	Power Integrations™	LNK304DG-TL

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TABLE B-1: MCP39F511A POWER MONITOR DEMONSTRATION BOARD - BOM (CONTINUED)

Qty.	Reference	Description	Manufacturer	Part Number
1	U4	Microchip Analog OpAmp 1-Ch 10 MHz MCP6021T-E/OT SOT-23-5	Microchip Technology Inc.	**MCP6021T-E/OT**
1	U5	Microchip Analog LDO 3.3V MCP1754ST-3302E/DB SOT-223-3	Microchip Technology Inc.	**MCP1754ST-3302E/DB**
1	U6	IC Photo FOD8012 Bi-Dir 3.3V and 5V SOIC-8	Fairchild Semiconductor®	FOD8012
4	U7, U8, U9, U10	IC Photo HCPL-181 4-SMD	Avago Technologies	HCPL-181-00CE

TABLE B-2: BILL OF MATERIALS - MECHANICAL PARTS

Qty.	Reference	Description	Manufacturer	Part Number
3	JP4	Mech. HW. Jumper 2.54 mm 1x2 Handle Gold	TE Connectivity, Ltd.	881545-2
4	NUT1	Mech. HW. Nut M3 Nylon	Keystone Electronics Corp.	4688
4	SCR1	MECH HW. Screw M3 x 6 mm Pan Slotted Nylon	Keystone Electronics Corp.	29341

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