MCP39F511N Power Monitor Demonstration Board User's Guide

24-Bit, Dual-Channel, Single-Phase AC/DC Power Monitoring IC

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MCP39F511N 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 (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 "DSXXXXXXXA", where "XXXXXXX" 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 MCP39F511N Power Monitor Demonstration Board. Items discussed in this chapter include:

- **Document Layout**
- **Conventions Used in this Guide**
- **Recommended Reading**
- **The Microchip Website**
- **Product Change Notification Service**
- **Customer Support**
- **Document Revision History**

DOCUMENT LAYOUT

This document describes how to use the MCP39F511N Power Monitor Demonstration Board as a demonstration board to evaluate the MCP39F511N device.

The manual layout is as follows:

- **Chapter 1. "Product Overview"** – Provides important information about the MCP39F511N Power Monitor Demonstration Board.
- **Chapter 2. "Installation and Operation"** – Provides information on using the MCP39F511N Power Monitor Demonstration Board, including **Wiring Connections** that describes wiring the line and load connections.
- **Chapter 3. "Hardware Description"** – Provides details on the functional blocks of the power monitor, including the analog front-end design and power supply design.
- **Appendix A. "Schematic and Layouts"** – Shows the schematic and layout diagrams for the MCP39F511N Power Monitor Demonstration Board.
- **Appendix B. "Bill of Materials (BOM)"** – Lists the parts used to build the MCP39F511N 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) { ... }`

RECOMMENDED READING

This user's guide describes how to use MCP39F511N. Another useful document is listed below. The following Microchip document is available and recommended as a supplemental reference resource:

MCP39F511N Data Sheet – *"Dual-Channel, Single-Phase Power-Monitoring IC with Calculation"* (DS20005473)

This data sheet provides detailed information regarding the MCP39F511N device.

THE MICROCHIP WEBSITE

Microchip provides online support via our web site at **www.microchip.com**. where files and information easily available to customers. The web site contains the following:

- **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, on-line 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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- Distributor or Representative
- Local Sales Office
- Field Application Engineer (FAE)
- Technical Support

Customers can 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 at https://www.microchip.com/support.

DOCUMENT REVISION HISTORY

Revision B (July 2024)

- Updated **Section 1.2 "MCP39F511N Power Monitor Demonstration Board Kit Contents"**.
- Updated **Section 2.1.1 "Wiring Connections"**.
- Updated **A.3 "Board – Schematic"**.
- Updated **Appendix B. "Bill of Materials (BOM)"**.

Revision A (December 2015)

- Initial release of this document.

Chapter 1. Product Overview

1.1 INTRODUCTION

MCP39F511N is a fully functional dual-channel single-phase power and energy monitor. For each channel, MCP39F511N calculates active power, reactive power, RMS current, RMS voltage, active energy (both import and export), reactive energy and other typical power quantities for two separate loads, as defined in the MCP39F511N Data Sheet.

The MCP39F511N Power Monitor Utility 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 energy meter software offers an automated step-by-step calibration process that can be used to quickly calibrate energy meters.

The MCP39F511N Power Monitor Demonstration Board uses the MCP39F511N Power Monitor Utility for evaluation via a USB connection to the board. A download link for this software can be found on the MCP39F511N Power Monitor Demonstration Board's product page. For instructions on the use of the MCP39F511N Power Monitor Utility, refer to the software's supporting documentation included within the install package.

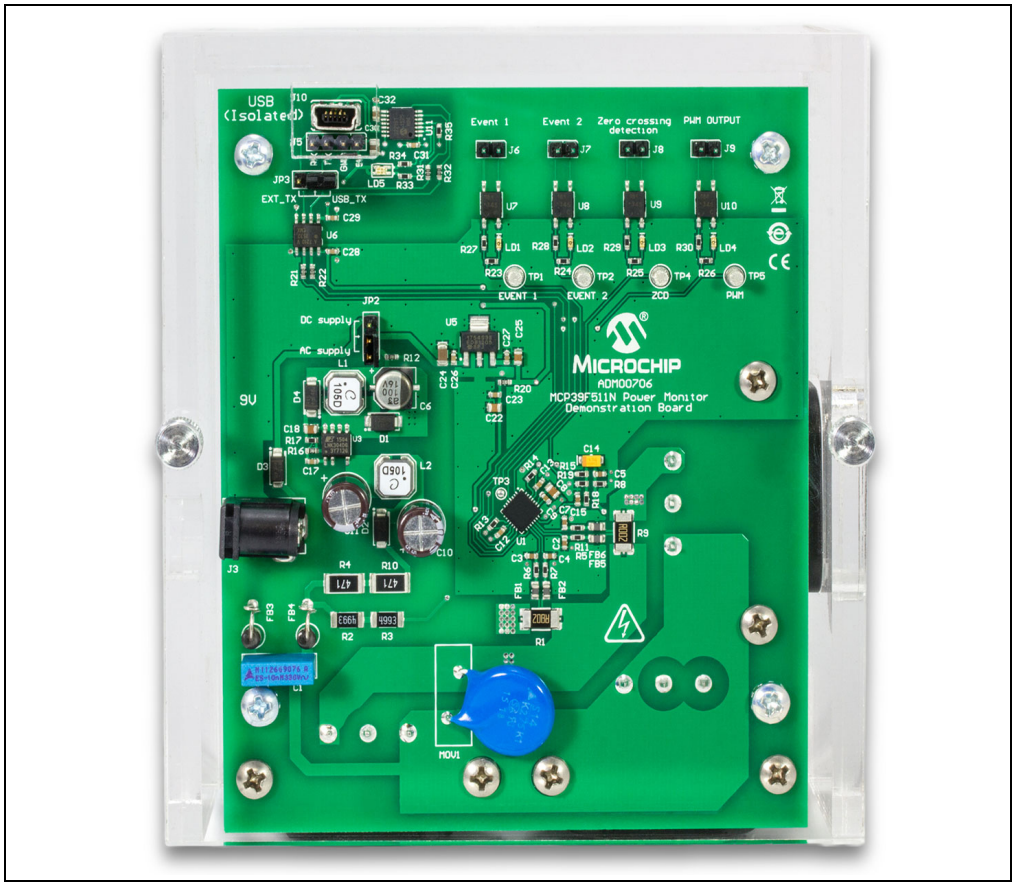


FIGURE 1-1: *MCP39F511N Power Monitor Demonstration Board.*

1.2 MCP39F511N POWER MONITOR DEMONSTRATION BOARD KIT CONTENTS

This MCP39F511N Power Monitor Demonstration Board kit includes:

- MCP39F511N Power Monitor Demonstration Board (ADM00706)
- Mini-USB Cable
- Important Information Sheet

Note: IEC cables are required to connect to the MCP39F511N Power Monitor Demonstration Board. These cables are not included in the board kit and must be purchased separately. The required cables are:

- 1 x P/N: Mechanical Headers & Wires, 6ft 16 American Wire Gauge (AWG) Universal Power Cord (IEC320C13 to NEMA 5-15P)
- 2 x P/N: Mechanical Headers & Wires, 1ft 18 AWG Monitor Power Adapter Cord (NEMA 5-15R to IEC320C14).

Chapter 2. Installation and Operation

2.1 GETTING STARTED

To use the MCP39F511N Power Monitor Demonstration Board, follow the steps described in the sections below. The meter design uses a 5A load for calibration current and a maximum current (I_{MAX}) of 15A.

Note: Microchip does not recommended putting more than 15A through the AC plugs mounted on the Printed Circuit Board (PCB).

To test the calibrated meter, follow these steps:

2.1.1 Wiring Connections

Figure 2-1 identifies the line and the two load connections of the MCP39F511N Power Monitor Demonstration Board.

Note: Figure 2-1 shows an example of how to connect the MCP39F511N Power Monitor Demonstration Board. The IEC cables shown in Figure 2-1 are not included in the board kit and must be purchased separately. For information on what cables to purchase, see **Section 1.2 "MCP39F511N Power Monitor Demonstration Board Kit Contents"**.

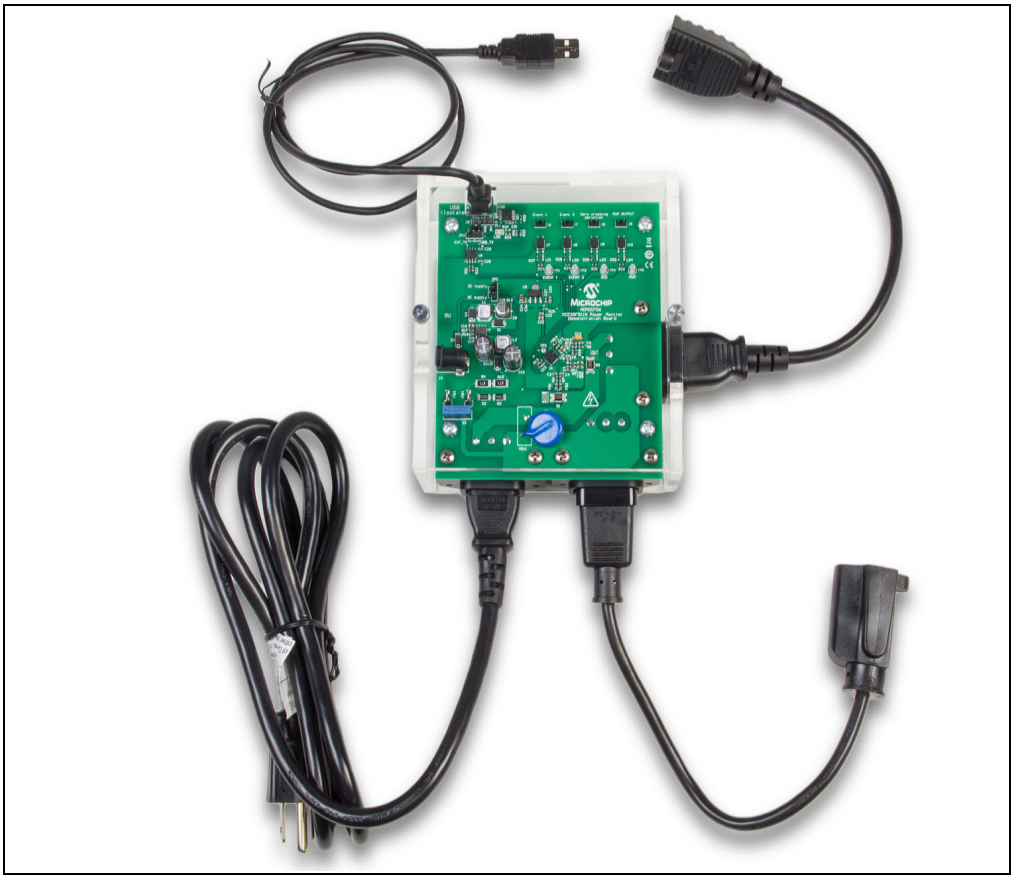


FIGURE 2-1: *Connecting the MCP39F511N Power Monitor Demonstration Board.*

2.1.2 Connect line/load power to the meter (power the meter)

The meter turns on when the line connection has between 90V to 220V connected. One or two loads can be connected to the meter.

2.1.3 Connect the USB cable to a PC with the installed MCP39F511N Power Monitor Utility software

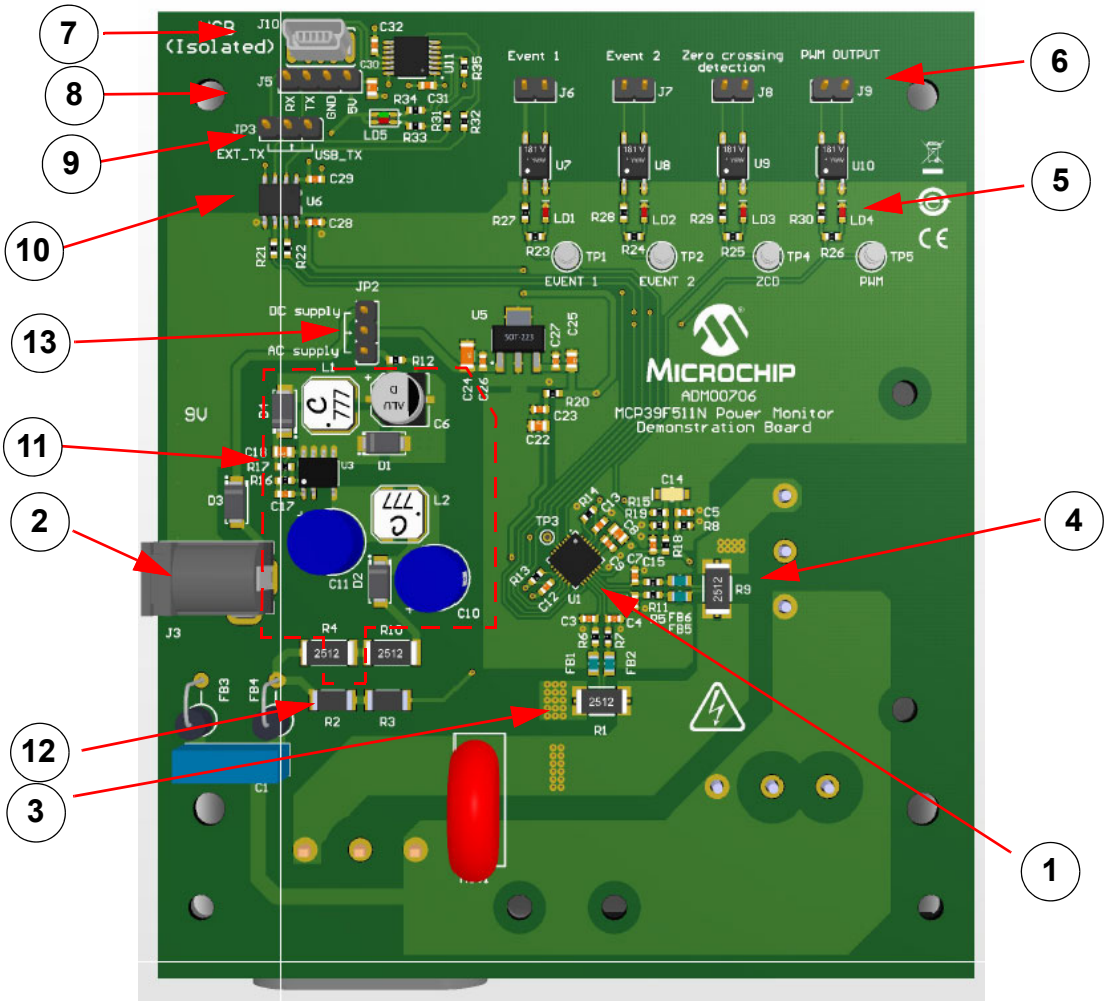
Select the appropriate COM port.

If the meter is connected correctly, the connection status in the bottom left corner of the MCP39F511N Power Monitor Utility displays "Meter Connected".

If no meter is found, the status is "Meter Disconnected". Check that the correct COM port was selected and try again.

Press the **Start** icon to begin showing output data and UART transmission between the PC and MCP39F511N.

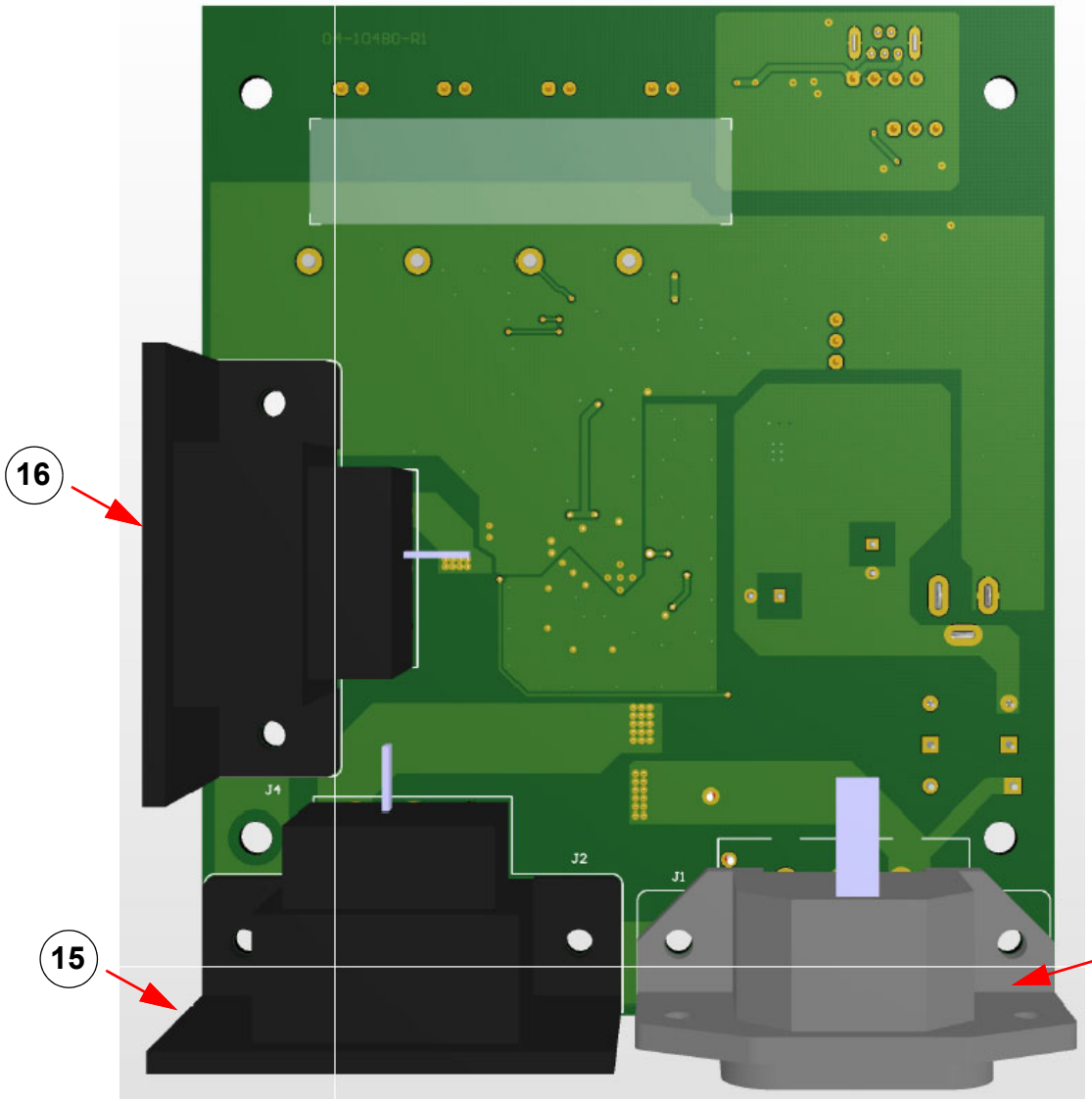
Chapter 3. Hardware Description



Legend:

1 = MCP39F511N
2 = +9V DC Input (nonisolated)
3 = Current Sensing Shunt - Channel 1
4 = Current Sensing Shunt - Channel 2
5 = Output LEDs for digital I/O
6 = Headers for digital I/O 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 = Switching AC/DC Power Supply
12 = 200:1 Voltage Divider for Voltage Input
13 = Jumper for DC or Switching AC/DC Supply

FIGURE 3-1: *MCP39F511N Power Monitor Demonstration Board Top View.*



Legend:

14	=	Line connection AC supply (80-230V)
15	=	Load connection for Channel 1 (15 A maximum recommended current)
16	=	Load connection for Channel 2 (15 A maximum recommended current)

FIGURE 3-2: *MCP39F511N Power Monitor Demonstration Board Bottom View.*

3.1 INPUT AND ANALOG FRONT END

The MCP39F511N Power Monitor Demonstration Board operates from 80V to 230V. At the bottom of the main board, there are the high voltage line and neutral connections. The shunts sit on the neutral or low-side of a two-wire system. The board comes populated with two surface mounted 2 mΩ shunts.

The line side of the two-wire system goes into a resistive divider on the voltage channel input, along with a DC offset added from V_{DD}. Anti-aliasing low-pass filters are included. The voltage channel uses two 499 kΩ resistors and additional components to achieve a divider ratio of approximately 236:1. For a line voltage of 236 V_{RMS}, the channel 1 input signal size is 1 V_{RMS} with a DC offset voltage of $DV_{DD}/2$ per the schematic snippet below.

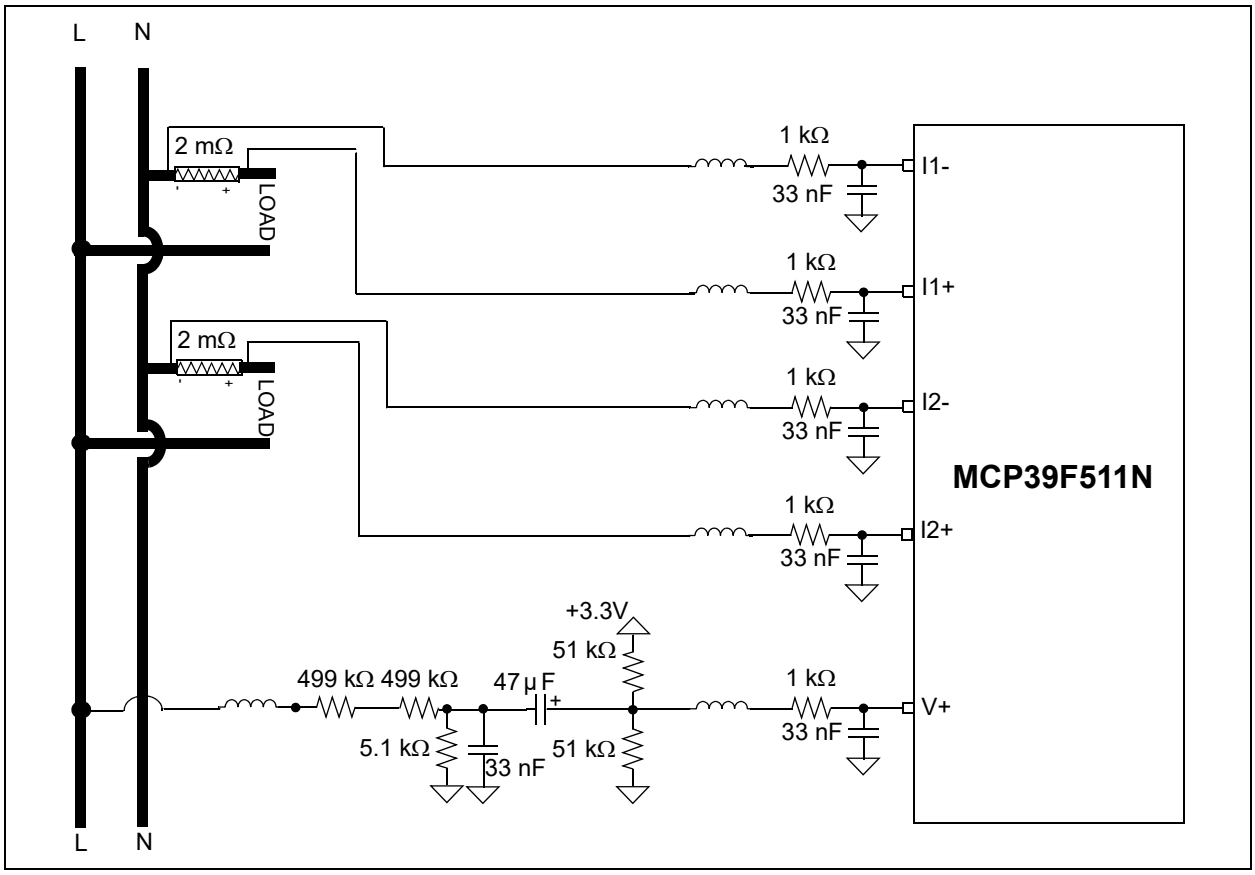


FIGURE 3-3: *Analog Front-End Circuitry.*

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

3.2 POWER SUPPLY CIRCUIT

The power supply circuit for the MCP39F511N Power Monitor Demonstration Board is shown in Figure 3-4.

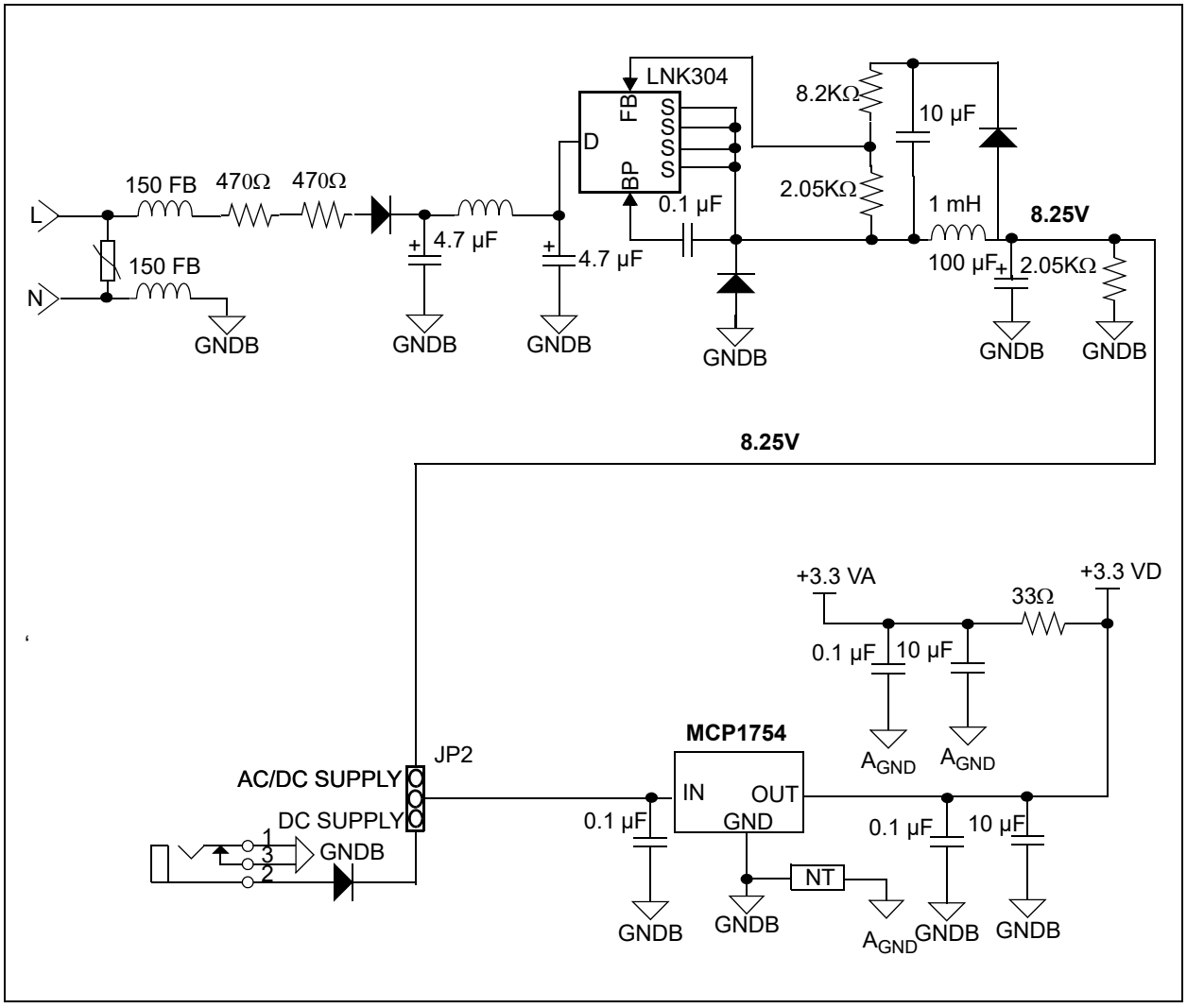


FIGURE 3-4: *Power Supply Circuit with Option for AC/DC Switching Supply from Mains or DC Supply.*

Appendix A. Schematic and Layouts

A.1 INTRODUCTION

This appendix contains the following schematics and layouts for of the MCP39F511N 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 SCHEMATICS AND PCB LAYOUT

The layer order is shown in Figure A-1.

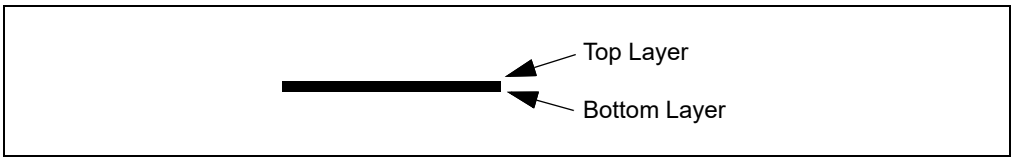
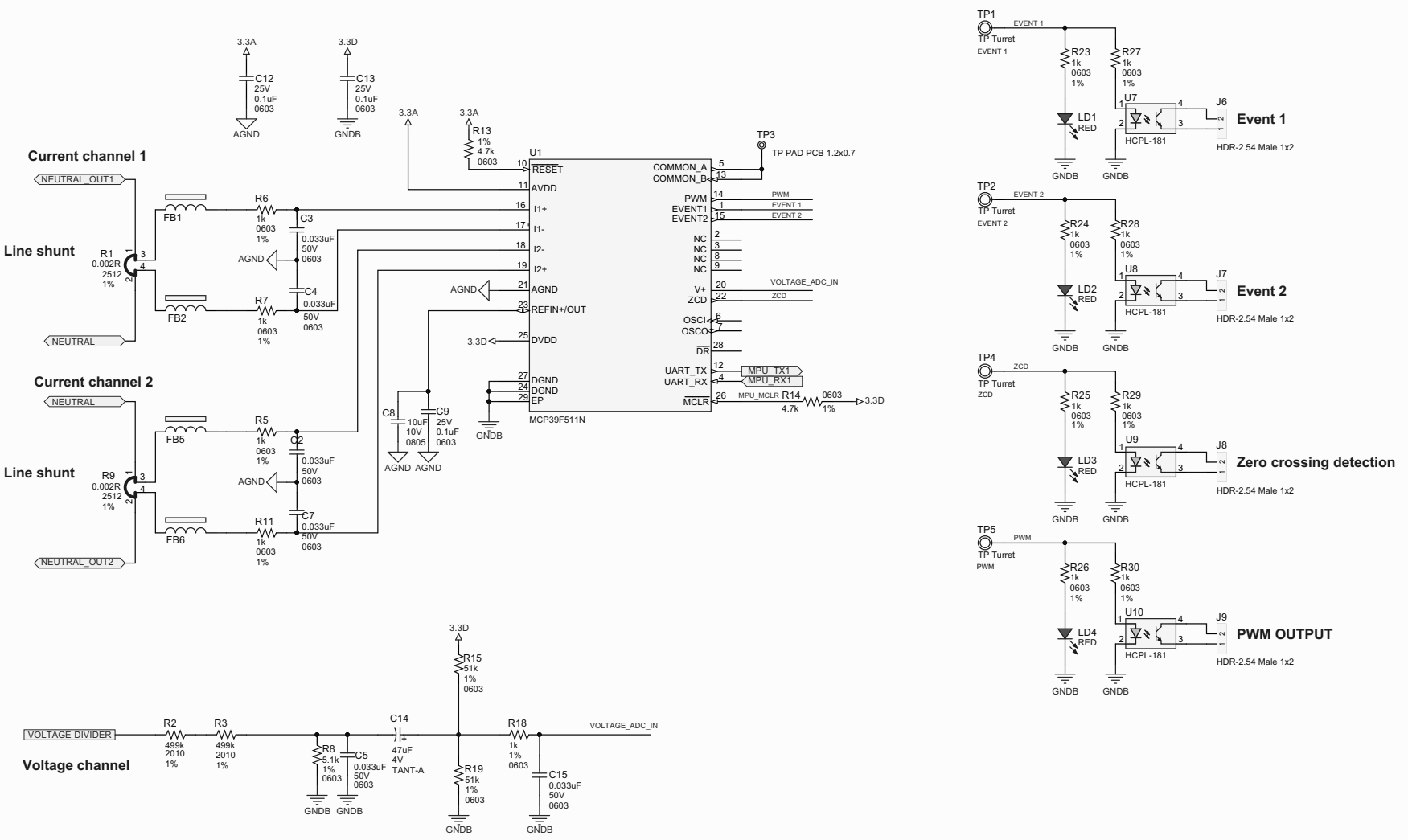
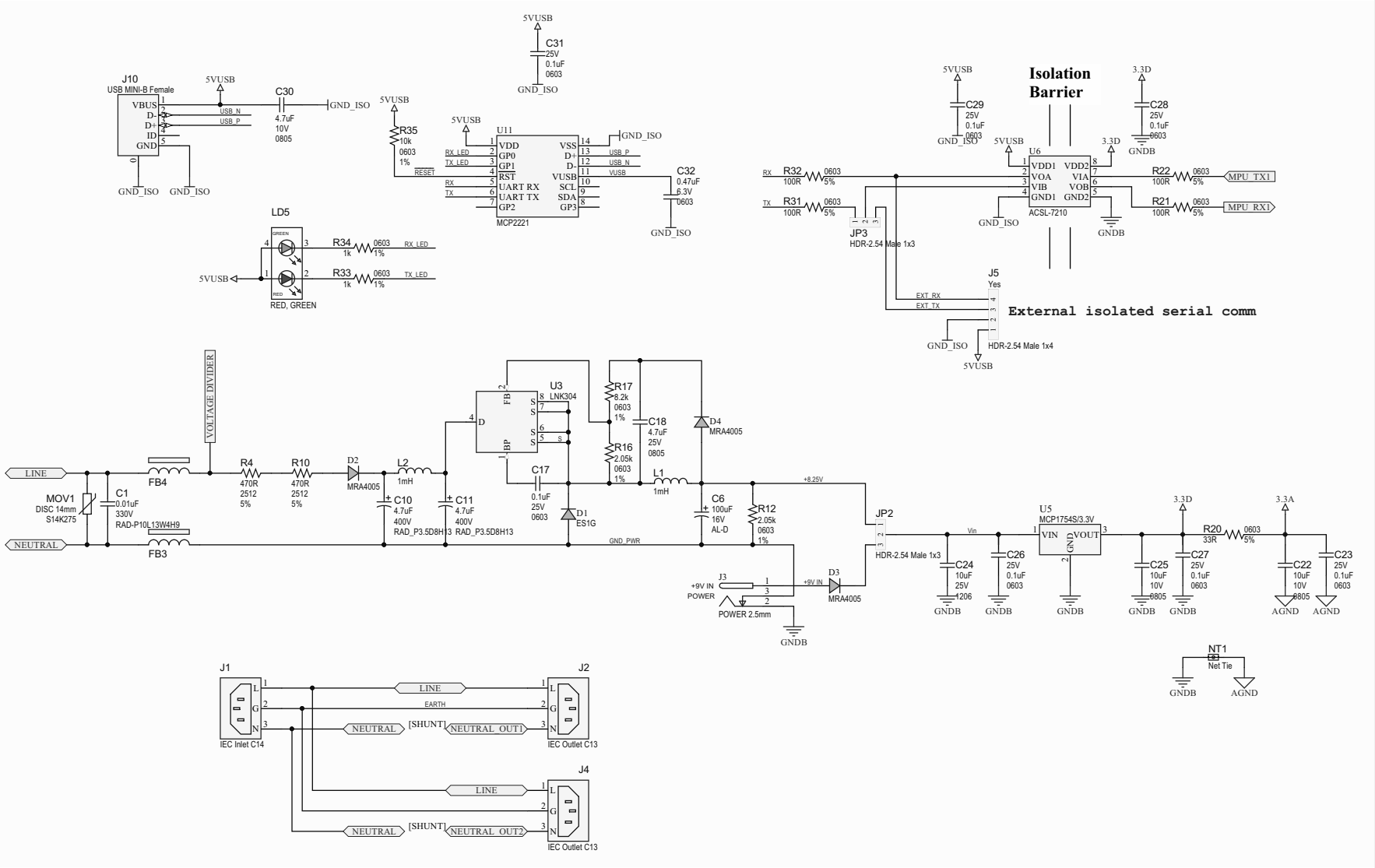


FIGURE A-1: *Layer Order.*

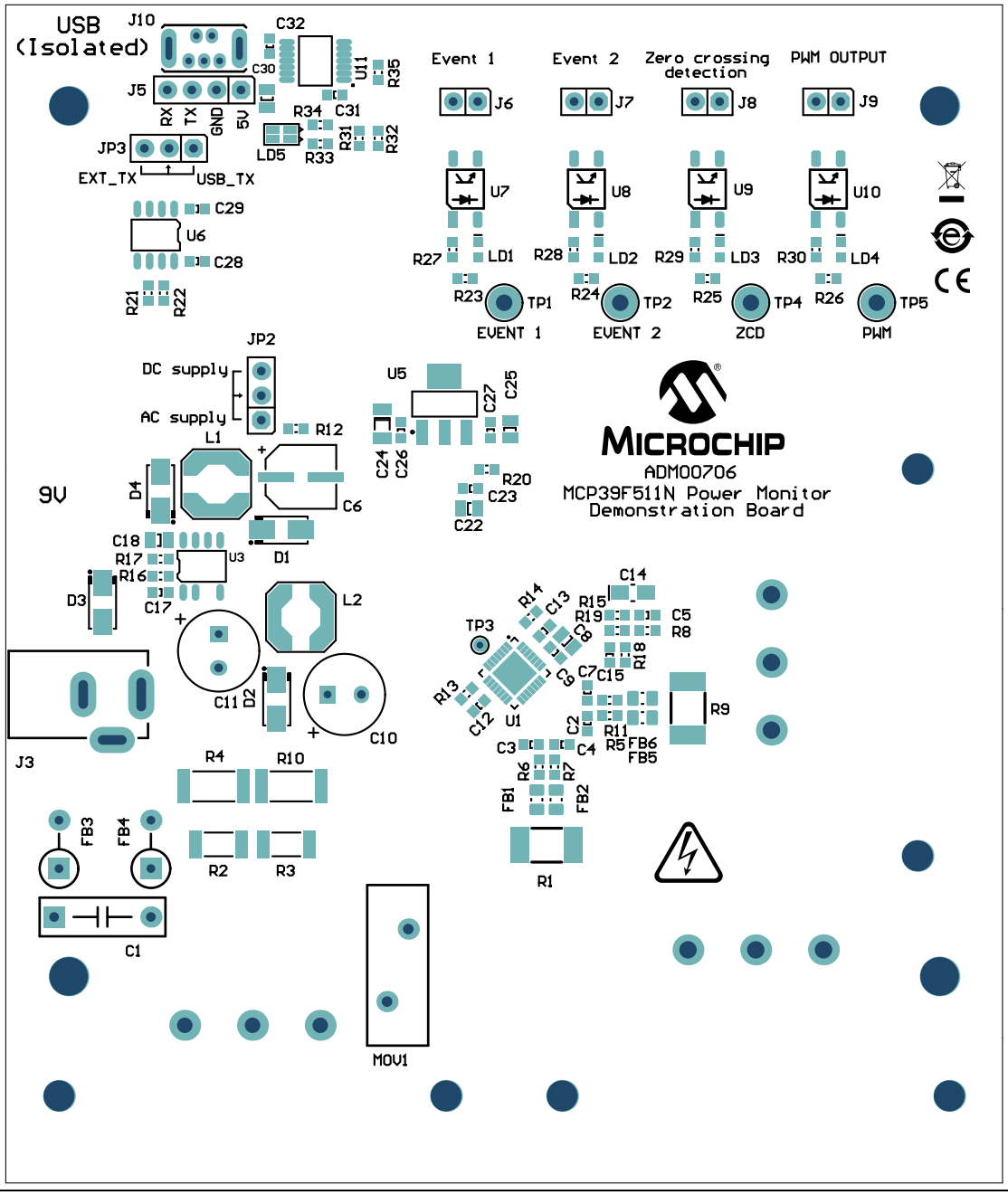
A.3 BOARD – SCHEMATIC



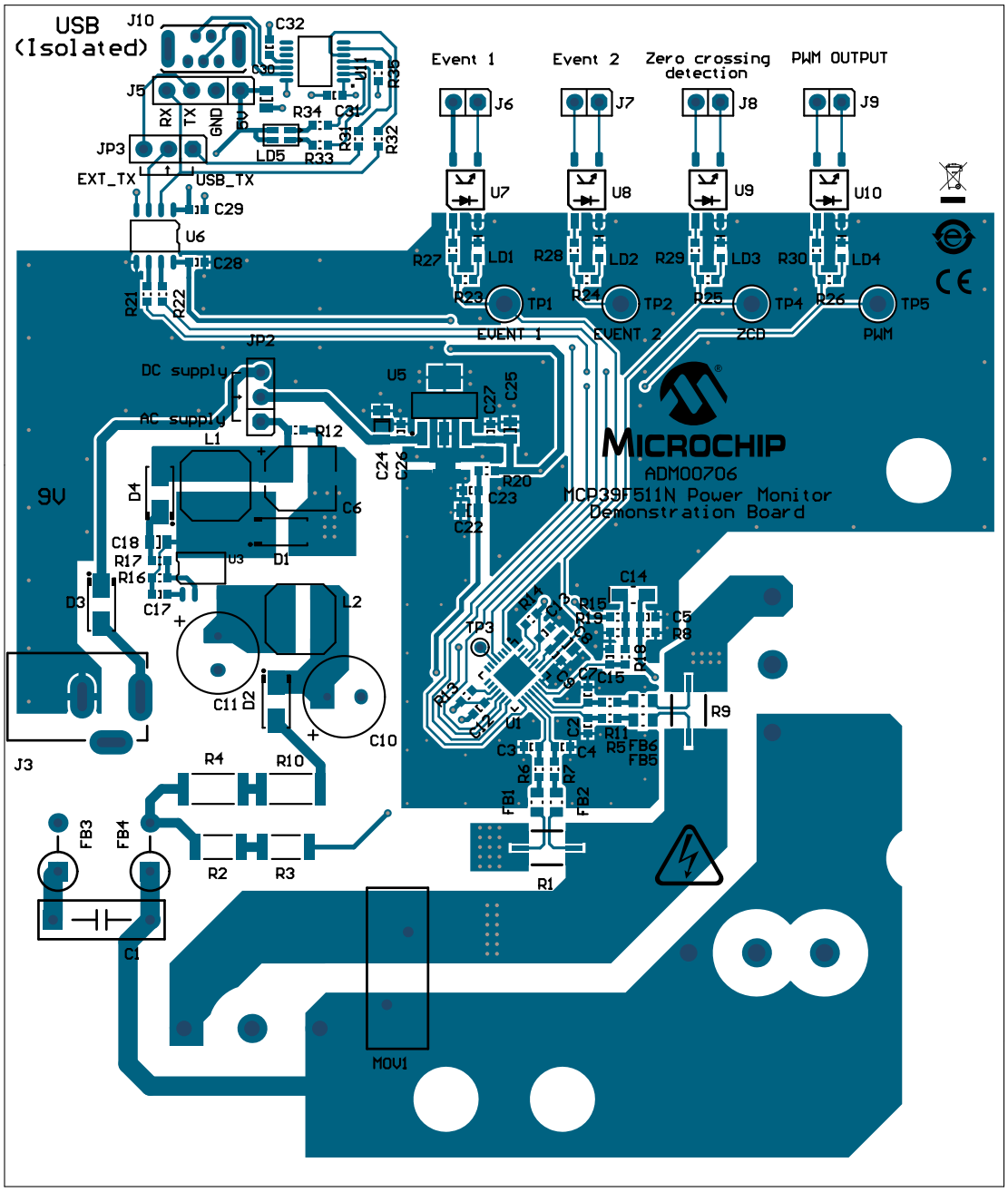
A.4 BOARD – SCHEMATIC (CONTINUED)



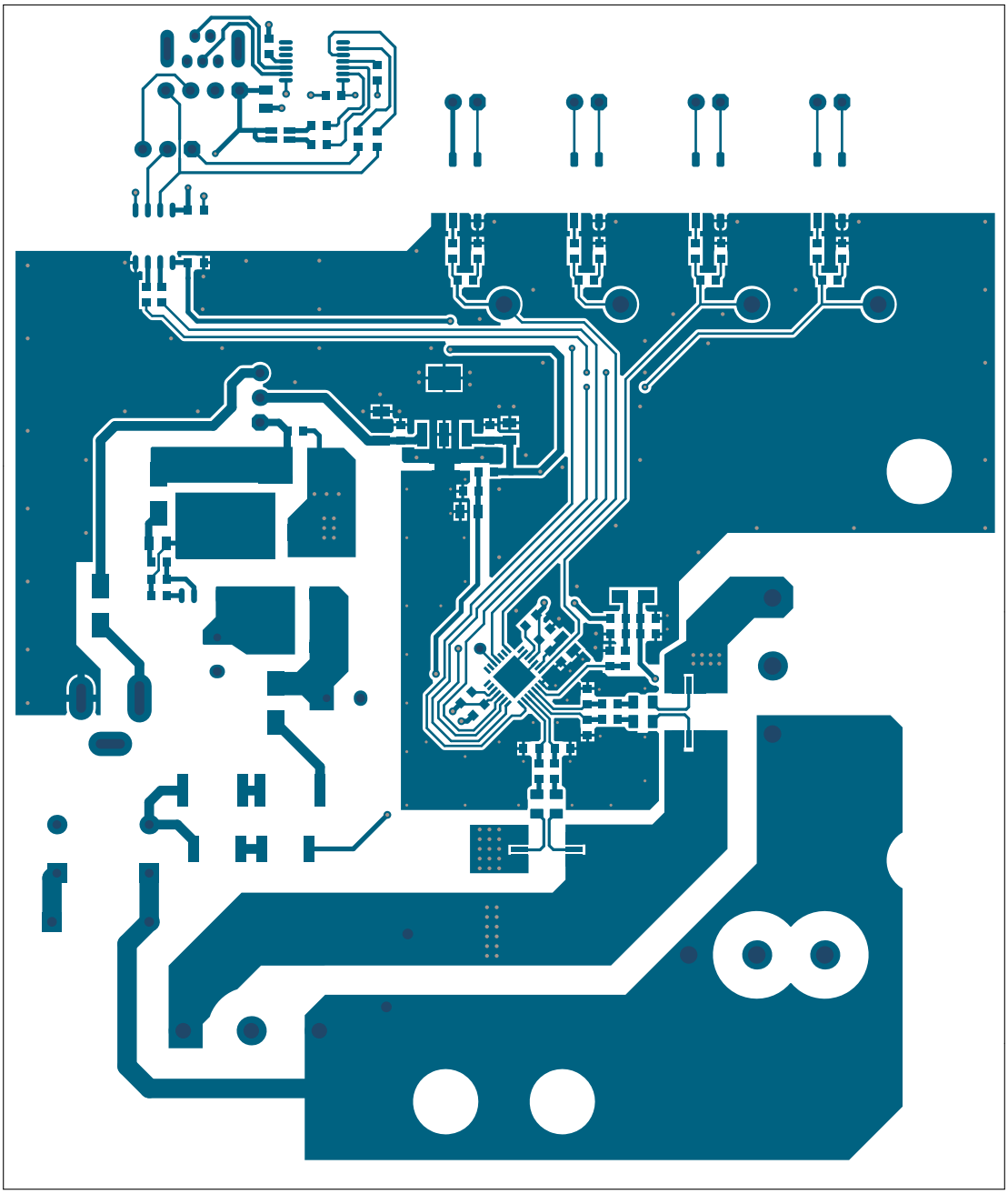
A.5 BOARD – TOP SILK



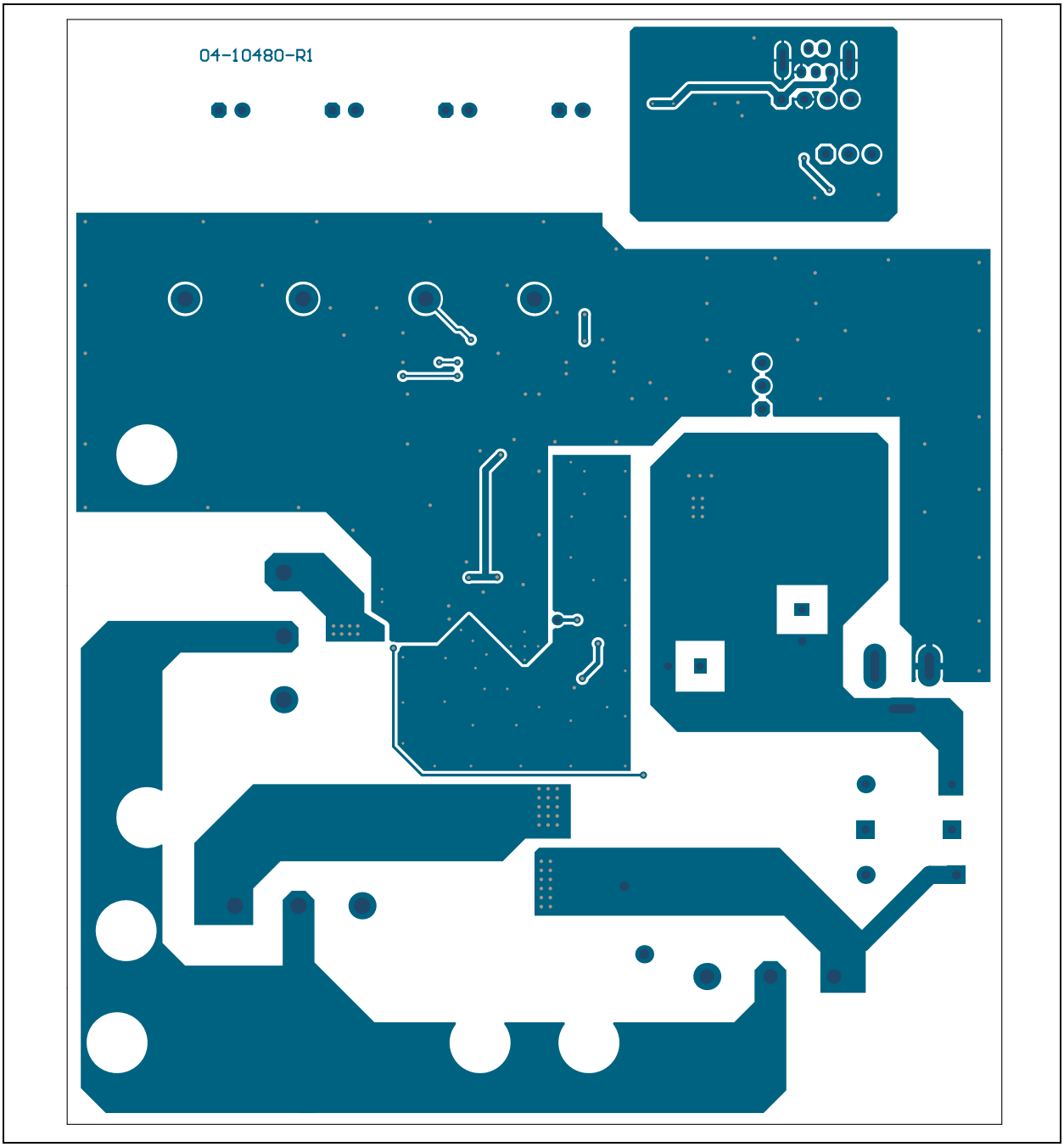
A.6 BOARD – TOP COPPER AND SILK



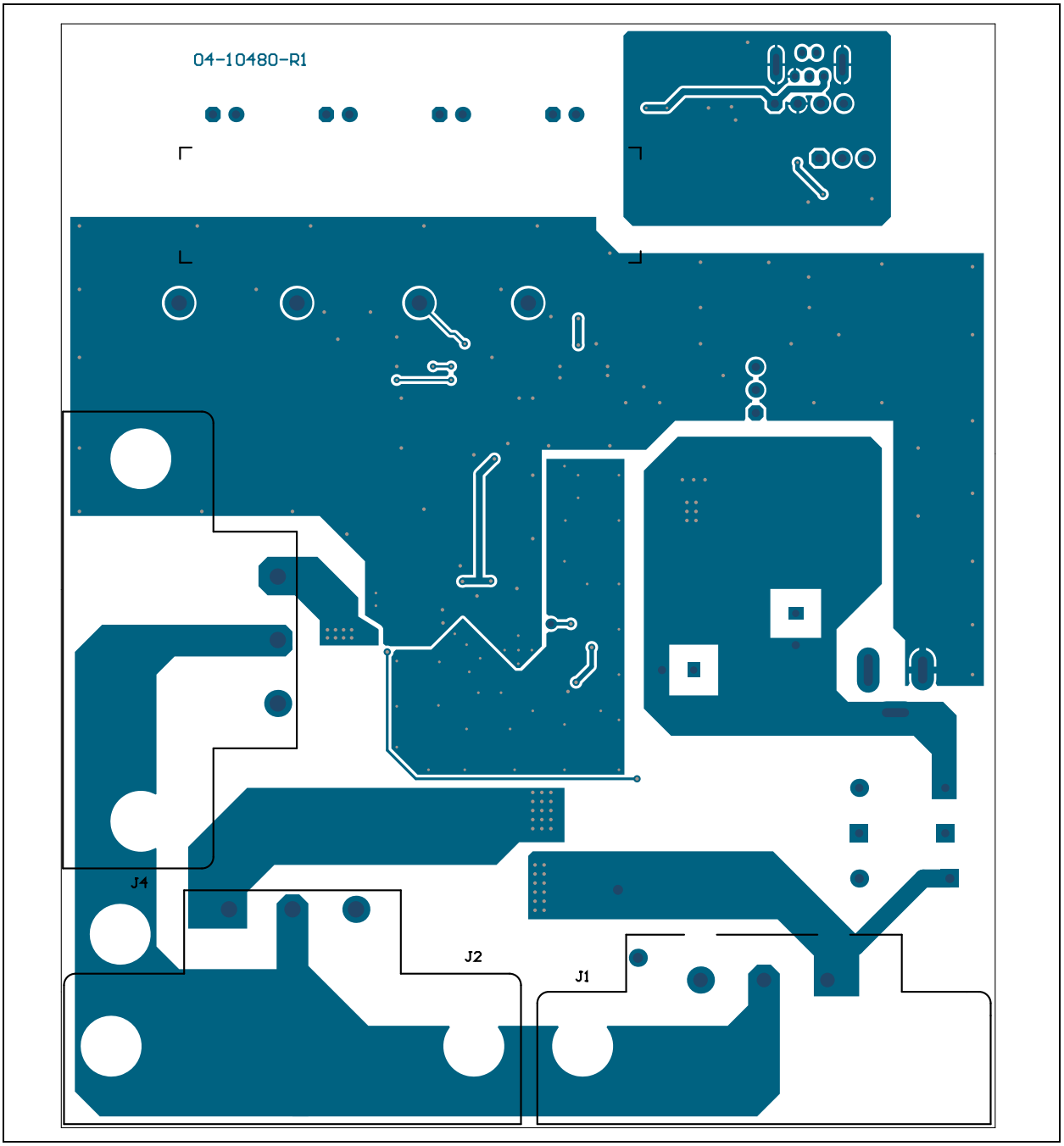
A.7 BOARD – TOP COPPER



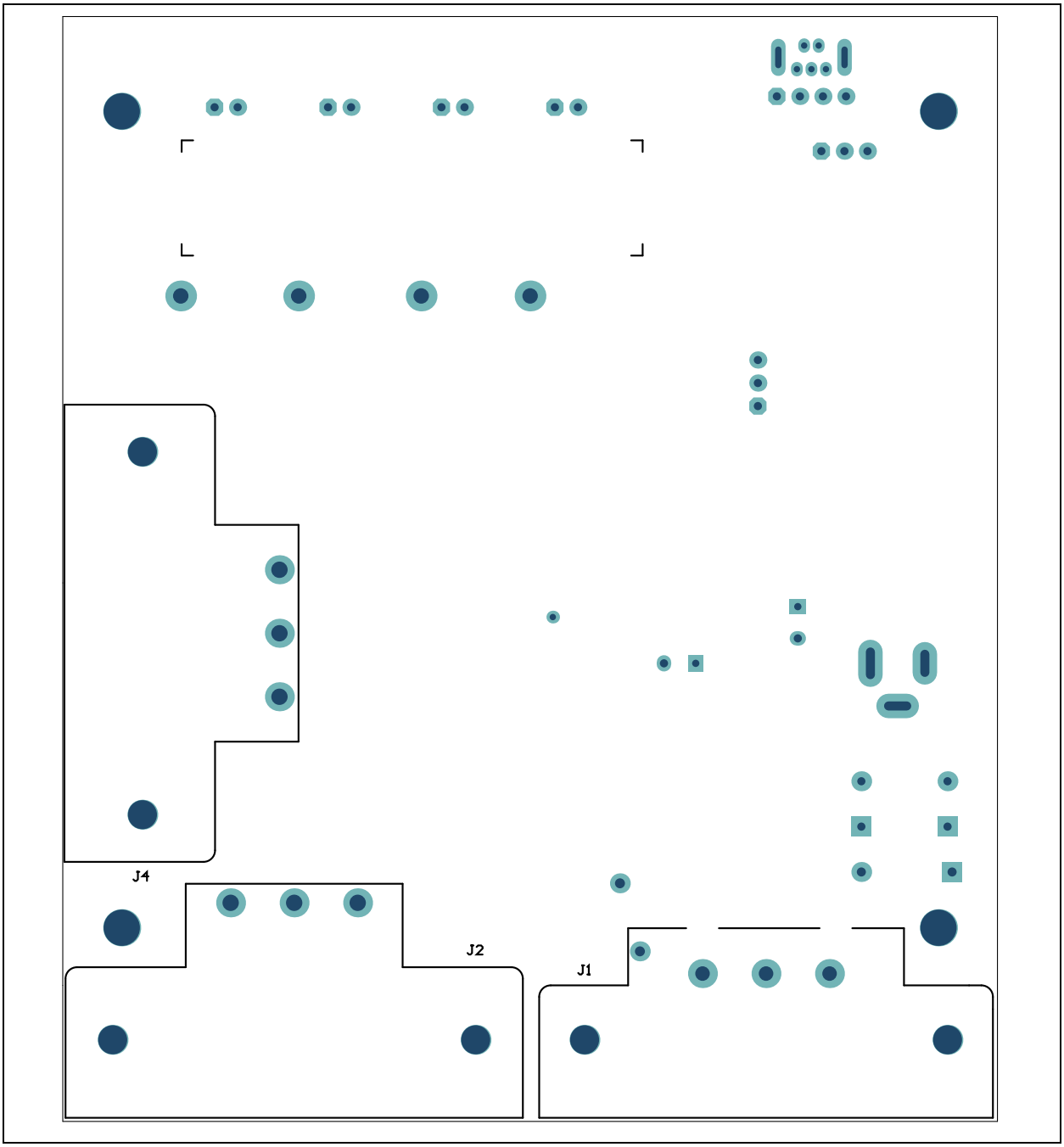
A.8 BOARD – BOTTOM COPPER



A.9 BOARD – BOTTOM COPPER AND SILK



A.10 BOARD – BOTTOM SILK



NOTES:

Appendix B. Bill of Materials (BOM)

TABLE B-1: BILL OF MATERIALS (BOM)

Qty.	Reference	Description	Manufacturer	Part Number
1	C1	Capacitor, film, 0.01 µF, 330V, 20%, RAD, P10L13W4H9	TDK Electronics	B32911A3103M
6	C2, C3, C4, C5, C7, C15	Capacitor, ceramic, 0.033 µF, 50V, 10%, X7R, SMD, 0603	TDK Corporation	C1608X7R1H333K
1	C6	Capacitor, aluminum, 100 µF, 16V, 20%, SMD, D	Nichicon Corporation	UWX1C101MCL1GB
3	C8, C22, C25	Capacitor, ceramic, 10 µF, 10V, 10%, X7R, SMD, 0805	TDK Corporation	C2012X7R1A106K125AC
10	C9, C12, C13, C17, C23, C26, C27, C28, C29, C31	Capacitor, ceramic, 0.1 µF, 25V, 10%, X7R, SMD, 0603	Murata Electronics®	GRM188R71E104KA01D
2	C10, C11	Capacitor, aluminum, 4.7 µF, 400V, 20%, RAD_P3,.5D8H13	Nichicon Corporation	UVC2G4R7MPD1TD
1	C14	Capacitor, tantalum, 47 µF, 4V, 10%, 2.6Ohm, SMD A	AVX Corporation	TAJA476K004RNJ
1	C18	Capacitor, ceramic, 4.7 µF, 25V, 10%, X7R, SMD, 0805	TDK Corporation	C2012X7R1E475K125AB
1	C24	Capacitor, ceramic, 10 µF, 25V, 10%, X7R, SMD, 1206	Taiyo Yuden Co., Ltd.	TMK316B7106KL-TD
1	C30	Capacitor, ceramic, 4.7 µF, 10V, 10%, X5R, SMD, 0805	Taiyo Yuden Co., Ltd.	LMK212BJ475KD-T
1	C32	Capacitor, ceramic, 0.47 µF, 6.3V, 10%, X5R, SMD, 0603	Murata Electronics	GRM188R60J474KA01D
1	CBL1	Mech., hardware, cable, USB-A male-to-mini, USB-B, male, 3 ft, black	Katerno	10UM-02103BK
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	onsemi	MRA4005T3G
1	ENCLOSURE1	Mech., enclosure, slim ref. side port meter	Tech-Demos.com	TD03-0102R0
4	FB1, FB2, FB5, FB6	Ferrite, 800mA, 0.15R, SMD, 0805	Laird Technologies®	LI0805H151R-10
2	FB3, FB4	Ferrite, 7A, RAD, P5L5.3D3.8	Murata Electronics North America, Inc.	BL02RN1R2M2B
1	J1	Connector, IEC, 250V, 15A, inlet, C14, TH, R/A	SCHURTER Inc.	GSP1.9103.1
2	J2, J4	Connector, IEC, 250V, 15A, outlet, C13, TH, R/A	SCHURTER Inc.	6182.0033

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.

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

Qty.	Reference	Description	Manufacturer	Part Number
1	J3	Connector, power, 2.5mm, 5.5mm, switch, TH, R/A	CUI Devices	PJ-002B
1	J5	Connector, header-2.54, male, 1x4, tin, 5.84, MH, TH, vertical	FCI	68002-404HLF
4	J6, J7, J8, J9	Connector, header-2.54, male, 1x2, tin, 6.10, MH, TH, vertical	Molex®	0022284020
1	J10	Connector, USB, mini-B, female, TH, vertical	Molex® Connector Corporation	500075-1517
2	JP2, JP3	Connector, header-2.54, male, 1x3, gold, 5.84, MH, TH, vertical	FCI	68000-103HLF
2	JP4, JP5	Mech., hardware, jumper, 2.54 mm, 1x2, handle, gold	TE Connectivity, Ltd.	881545-2
2	L1, L2	Inductor, 1 mH, 240 mA, 20%, SMD, L6W6H2.4	Coilcraft®	LPS6225-105MRB
1	LABEL1	Label, **NEED HELP WITH ASSY/SERIAL**		
1	LABEL2	Mech., hardware, label, high voltage	Panduit Corp.	PLD-56
4	LD1, LD2, LD3, LD4	Diode, LED, red, 1.95V, 30 mA, 700, MCD, clear, SMD, 0603	Kingbright Company, LLC	APTD1608SURCK
1	LD5	Diode, LED, bi., red, green, 1.95V, 2.1V, 30 mA, 0805	Kingbright Company, LLC	APHBM2012SURKCGKC
1	MOV1	Resistor, varistor, 275V, 130J, TH, disc, 14 mm	TDK Electronics	S14K275E2K1
6	NUT1, NUT2, NUT3, NUT4, NUT5, NUT6	Hex. nut, 0.217", steel, M3	Keystone Electronics Corp.	4708
1	PCB1	Printed Circuit Board – MCP39F501 Power Monitor Demonstration Board	Microchip Technology Inc.	04-10480-1
2	R1, R9	Resistor, shunt, MF, 0.002R, 1%, 2W, 2512	Stackpole Electronics, Inc.	CSNL2512FT2L00
2	R2, R3	Resistor, TKF, 499k, 1%, 3/4W, SMD, 2010	Vishay® Dale	CRCW2010499KFKEF
2	R4, R10	Resistor, TKF, 470R, 5%, 1W, SMD, 2512	Panasonic® - ECG	ERJ-1TYJ471U
15	R5, R6, R7, R11, R18, R23, R24, R25, R26, R27, R28, R29, R30, R33, R34	Resistor, TKF, 1k, 1%, 1/10W, SMD, 0603	Panasonic - ECG	ERJ-3EKF1001V
1	R8	Resistor, TKF, 5.1k, 1%, 1/10W, SMD, 0603	Panasonic - ECG	ERJ-3EKF5101V
2	R12, R16	Resistor, TKF, 2.05k, 1%, 1/10W, SMD, 0603	Yageo Corporation	RC0603FR-072K05L
2	R13, R14	Resistor, TKF, 4.7k, 1%, 1/10W, SMD, 0603	Panasonic - ECG	ERJ-3EKF4701V
2	R15, R19	Resistor, TKF, 51k, 1%, 1/10W, SMD, 0603	Panasonic - ECG	ERJ-3EKF5102V
1	R17	Resistor, TKF, 8.2k, 1%, 1/10W, SMD, 0603	Panasonic - ECG	ERJ-3EKF8201V

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.

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

Qty.	Reference	Description	Manufacturer	Part Number
1	R20	Resistor, TKF, 33R, 5%,1/10W, SMD, 0603	Yageo Corporation	9C06031A33R0JLHFT
4	R21, R22, R31, R32	Resistor, TKF, 100R, 5%, 1/10W, SMD, 0603	Vishay® Dale	CRCW0603100RJNEA
1	R35	Resistor, TKF, 10k, 1%, 1/10W, SMD 0603	Panasonic - ECG	ERJ-3EKF1002V
6	SCR1, SCR2, SCR3, SCR4, SCR5, SCR6	Machine screw, pan, Phillips, M3	Digi-Key® Electronics	335-1156-ND
4	TP1, TP2, TP4, TP5	Connector, TP pin, tin, TH	Harwin Plc.	H2121-01
1	U1	Microchip Analog Energy Measurement 4000:1 MCP39F511N-E/MQ QFN-28	Microchip Technology Inc.	**MCP39F511N-E/MQ**
1	U3	IC, switcher, LNK304, SO-8C	Power Integrations	LNK304DG-TL
1	U5	Microchip Analog LDO 3.3V MCP1754ST-3302E/DB SOT-223-3	Microchip Technology Inc.	**MCP1754ST-3302E/DB**
1	U6	IC, photo, ACSL-7210-06RE, Bi-Dir., 3.3V, and 5V SOIC-8	Avago Technologies	ACSL-7210-06RE
4	U7, U8, U9, U10	IC, Photo, HCPL-181, 4-SMD	Avago Technologies	HCPL-181-00CE
1	U11	Microchip interface USB I2C UART MCP2221-I/ST TSSOP-14	Microchip Technology Inc.	**MCP2221-I/ST**

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.

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