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**MCP39F511N
Power Monitor
Demonstration Board
User's Guide**

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Object of Declaration: MCP39F511N Power Monitor Demonstration Board

EU Declaration of Conformity

Manufacturer: Microchip Technology Inc.
2355 W. Chandler Blvd.
Chandler, Arizona, 85224-6199
USA

This declaration of conformity is issued by the manufacturer.

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

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


Derek Carlson
VP Development Tools

12-Sep-14
Date

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Preface

NOTICE TO CUSTOMERS

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

Documents are identified with a “DS” number. This number is located on the bottom of each page, in front of the page number. The numbering convention for the DS number is “DSXXXXXXA”, where “XXXXXX” 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 Web Site
- 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 **Section 2.1.1 “Step 1: 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
- **Appendix B. “Bill of Materials (BOM)”** – Lists the parts used to build the MCP39F511N Power Monitor Demonstration Board

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CONVENTIONS USED IN THIS GUIDE

This manual uses the following documentation conventions:

DOCUMENTATION CONVENTIONS

Description	Represents	Examples
Arial font:		
Italic characters	Referenced books	<i>MPLAB[®] 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>Save</i></u>
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	<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) { ... }

RECOMMENDED READING

This user's guide describes how to use MCP39F511N Power Monitor Demonstration Board. 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 WEB SITE

Microchip provides on-line support via our web site at www.microchip.com. This web site is used as a means to make files and information easily available to customers. Accessible by using your favorite Internet browser, the web site 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, 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 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://support.microchip.com>

DOCUMENT REVISION HISTORY

Revision A (December 2015)

- Initial Release of this Document.

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Chapter 1. Product Overview

1.1 INTRODUCTION

The MCP39F511N Power Monitor Demonstration Board is a fully functional dual-channel single-phase power and energy monitor. For each channel, the system 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 MCP39F511 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 energy meter software offers an automated step-by-step calibration process that can be used to quickly calibrate energy meters.

This demonstration board uses the Power Monitor Utility Software for evaluation via a USB connection to the board. A download link for this software can be found on the evaluation board's web page. For instructions on the use of this software, refer to the software's supporting documentation included within the application install package.



FIGURE 1-1: MCP39F511N Power Monitor Demonstration Board.

1.2 WHAT THE MCP39F511N POWER MONITOR DEMONSTRATION BOARD KIT INCLUDES

This MCP39F511N Power Monitor Demonstration Board kit includes:

- MCP39F511N Power Monitor Demonstration Board (ADM00706)
- AC Line Cable
- Two IEC-to-Female AC Load Cables
- Mini-USB Cable
- Important Information Sheet

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.

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

To test the calibrated meter, the following connections can be made:

2.1.1 Step 1: Wiring connections

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

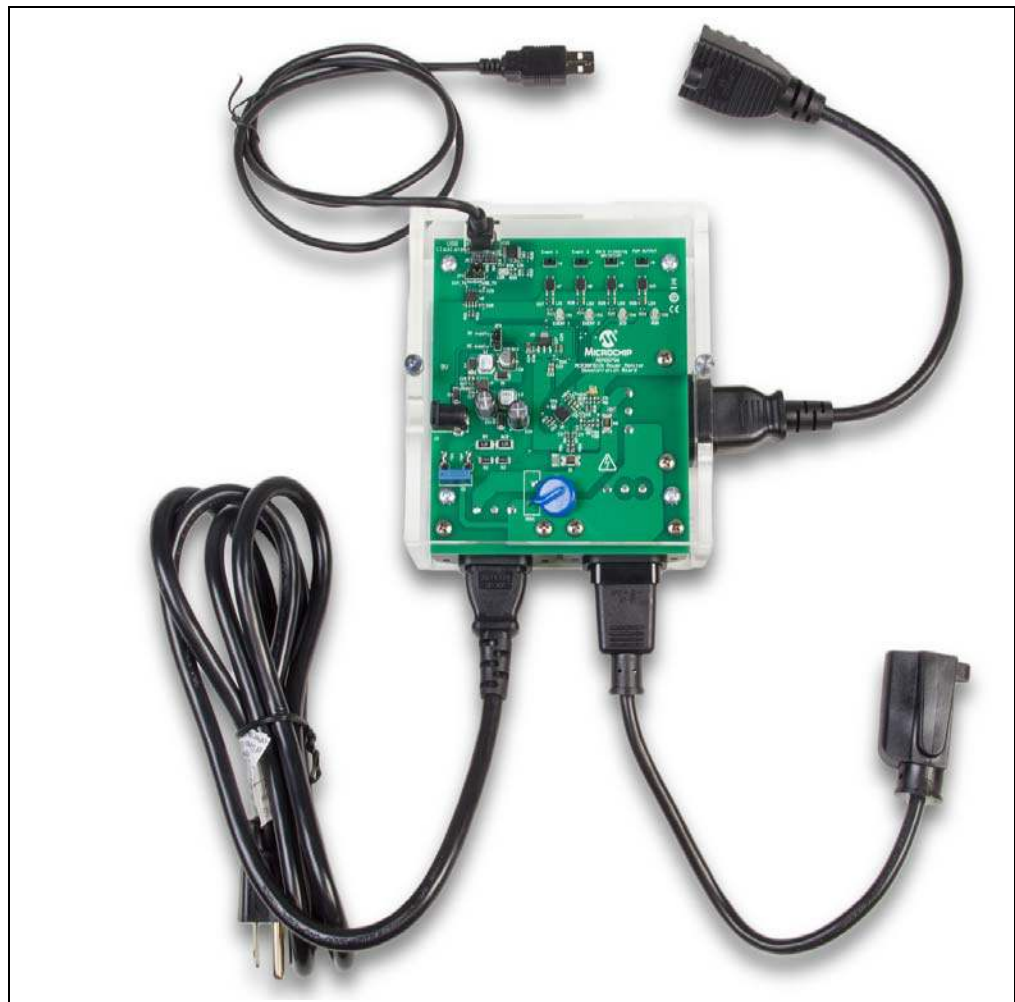


FIGURE 2-1: *Connecting the MCP39F511N Power Monitor Demonstration Board.*

2.1.2 Step 2: Connect line/load power to the meter (power the meter)

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

2.1.3 Step 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 software will display "Meter Connected". If no meter is found, the status will be "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 the MCP39F511N.

Chapter 3. Hardware Description

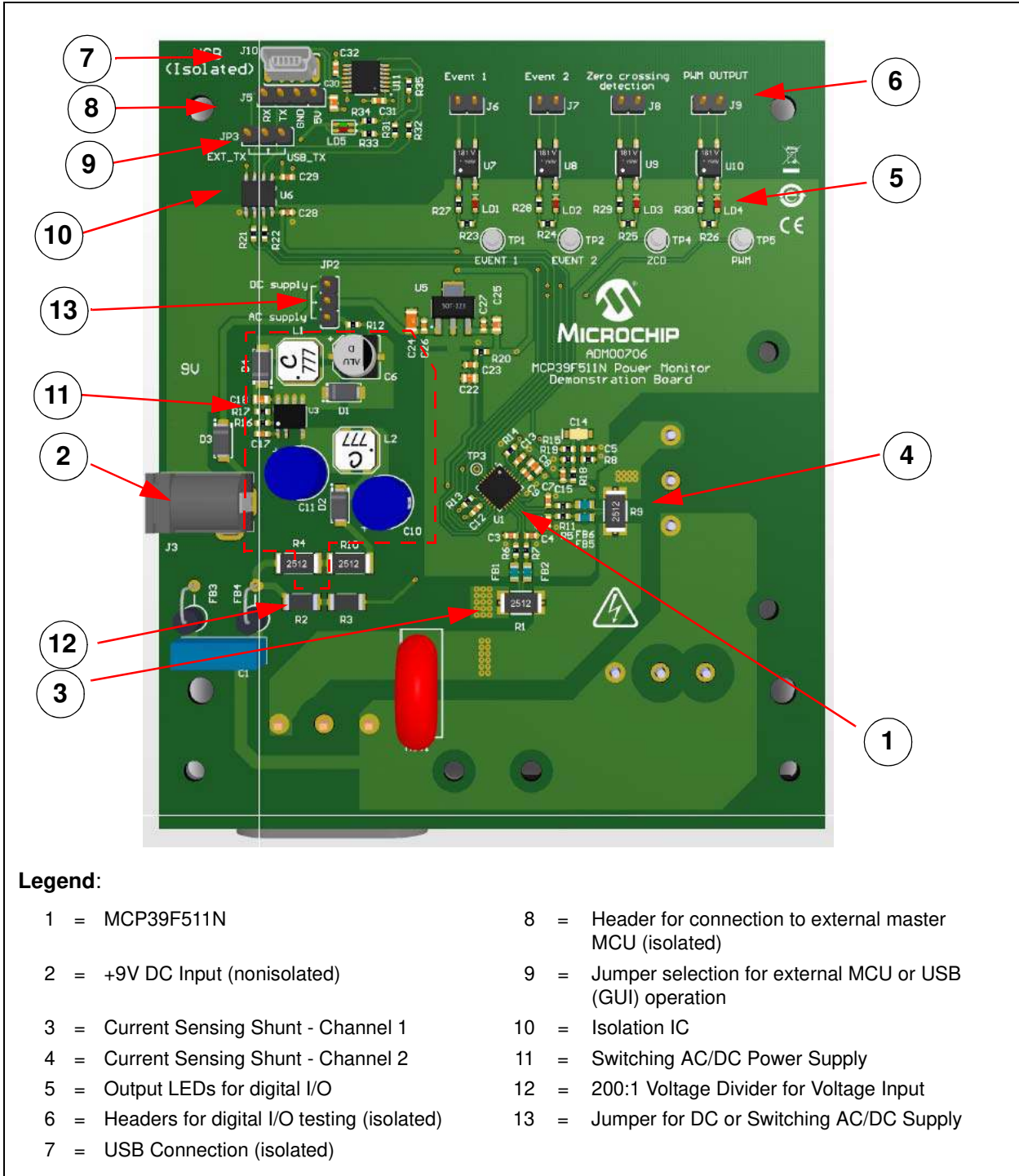


FIGURE 3-1: MCP39F511N Power Monitor Demonstration Board Top View.

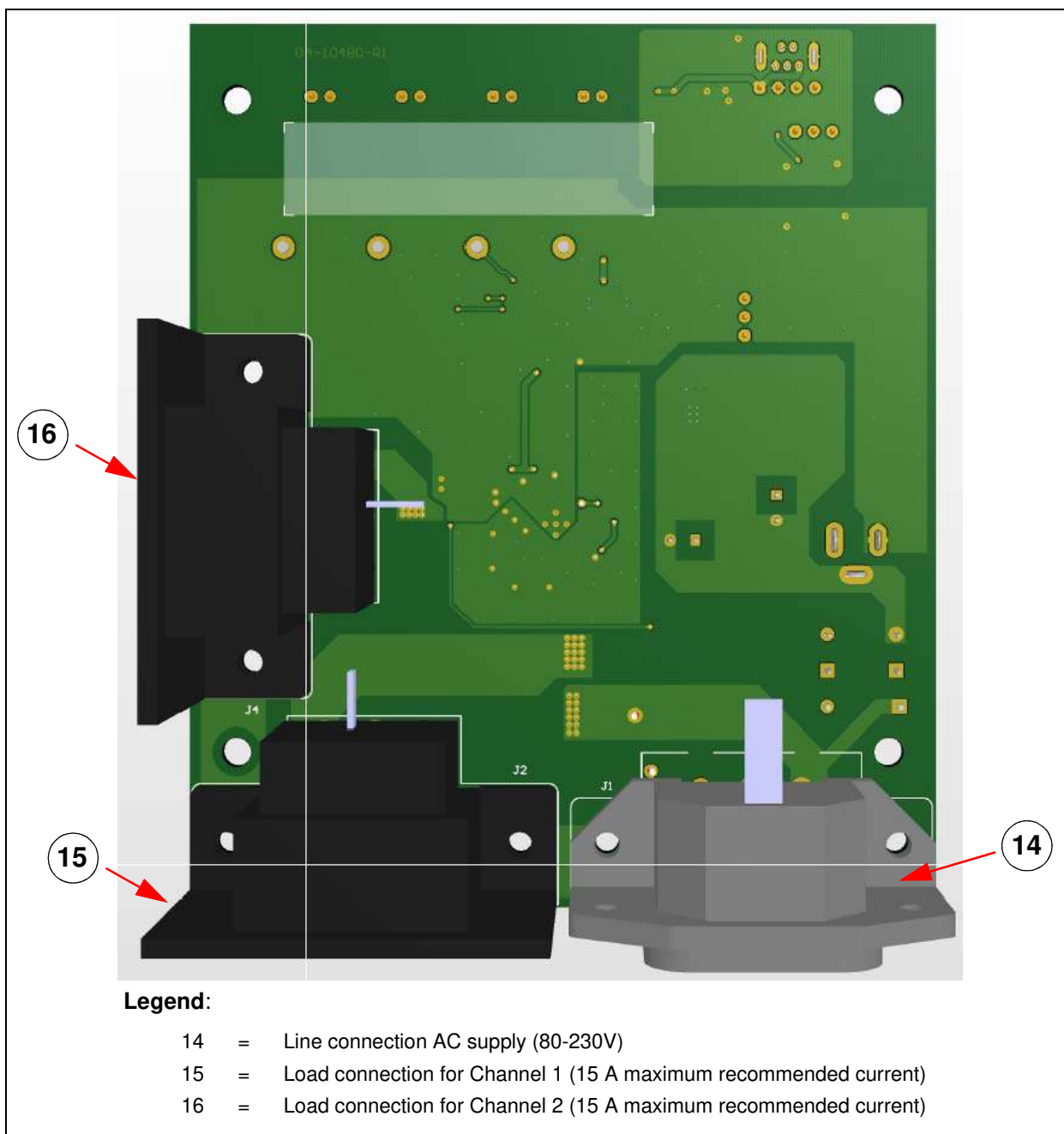


FIGURE 3-2: MCP39F511N Power Monitor Demonstration Board Bottom View.

3.1 INPUT AND ANALOG FRONT END

The MCP39F511N Power Monitor Demonstration Board will operate 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 mount 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 the 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 will be 1V_{RMS} with a DC offset voltage of DV_{DD}/2 per the schematic snippet below.

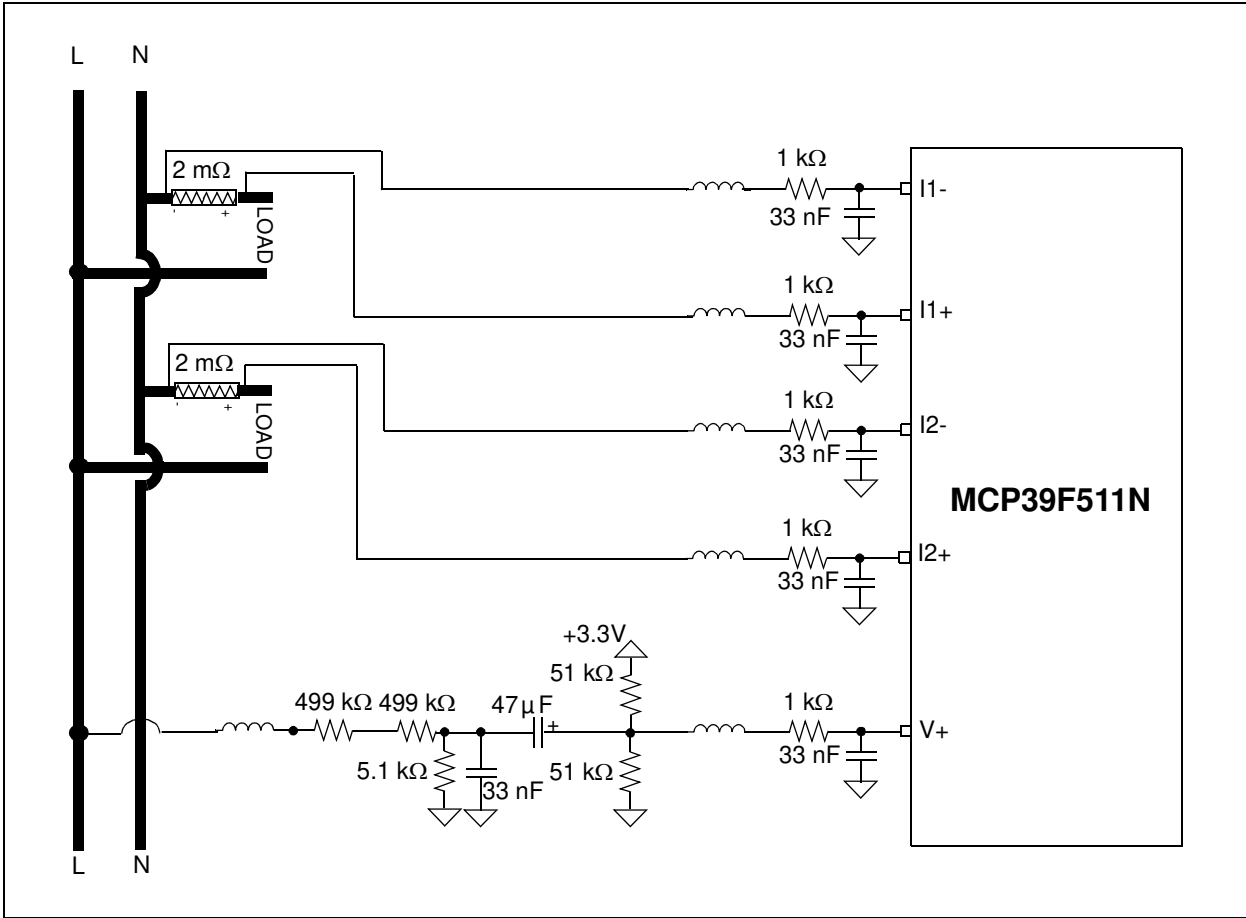


FIGURE 3-3: Analog Front-End Circuitry.

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

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3.2 POWER SUPPLY CIRCUIT

The power supply circuit for the MCP39F511N Power Monitor Demonstration Board is shown in [Figure 3-4](#).

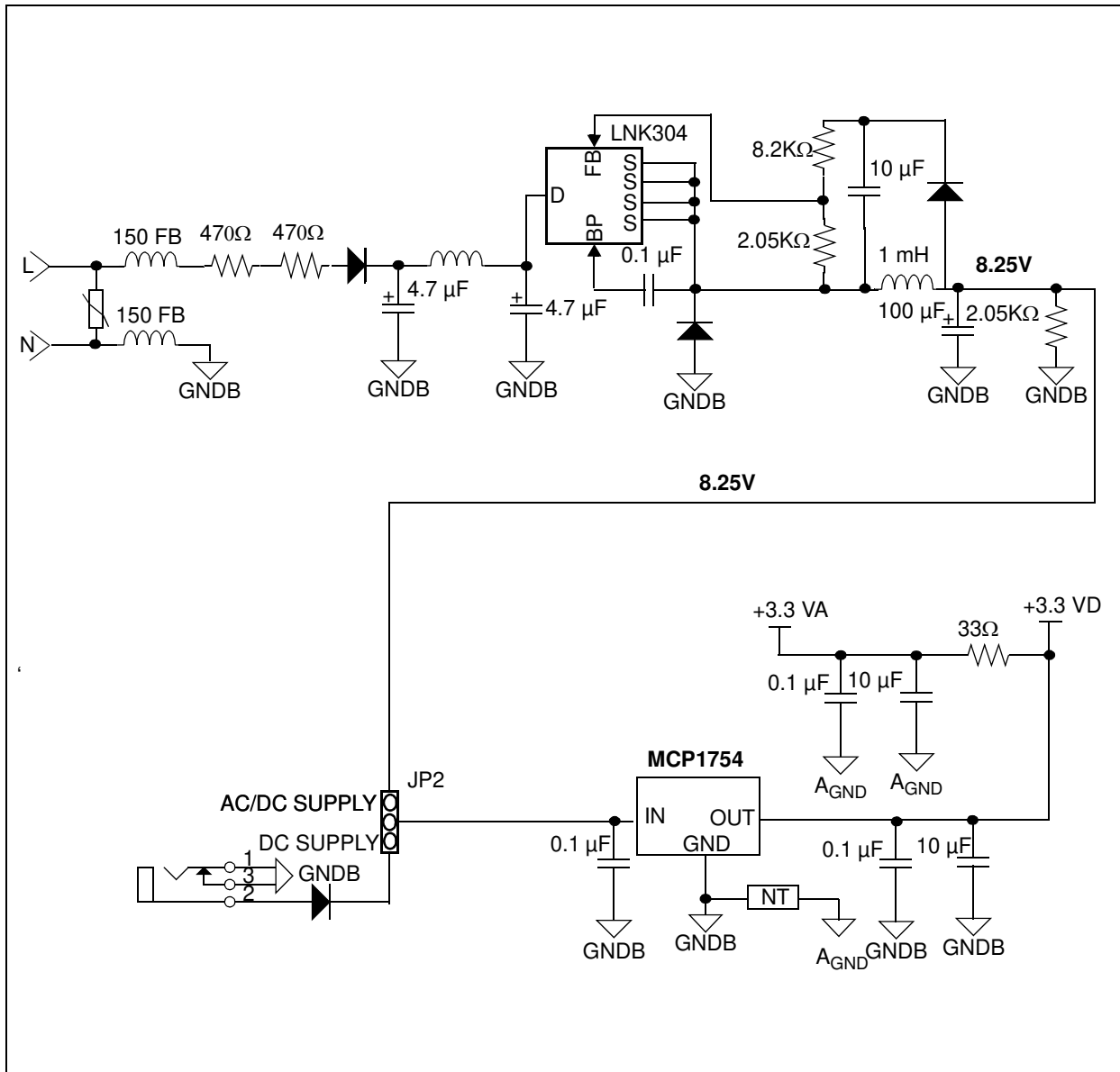


FIGURE 3-4: Power Supply Circuit with Option for AC/DC Switching Supply from Mains or DC Supply.

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](#).

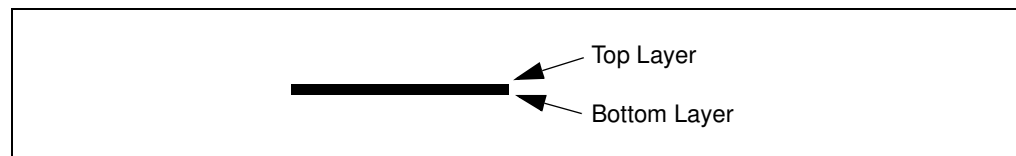
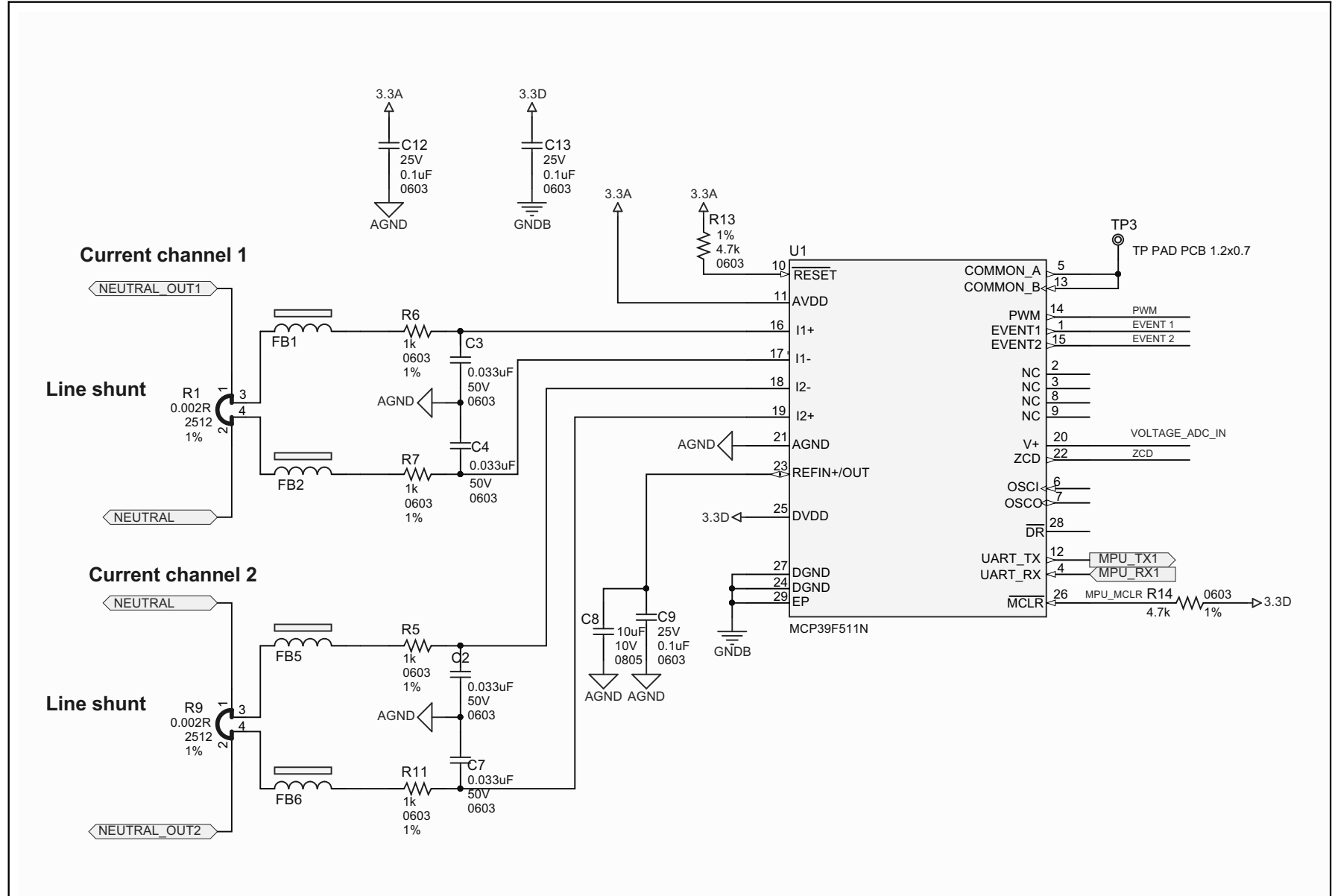
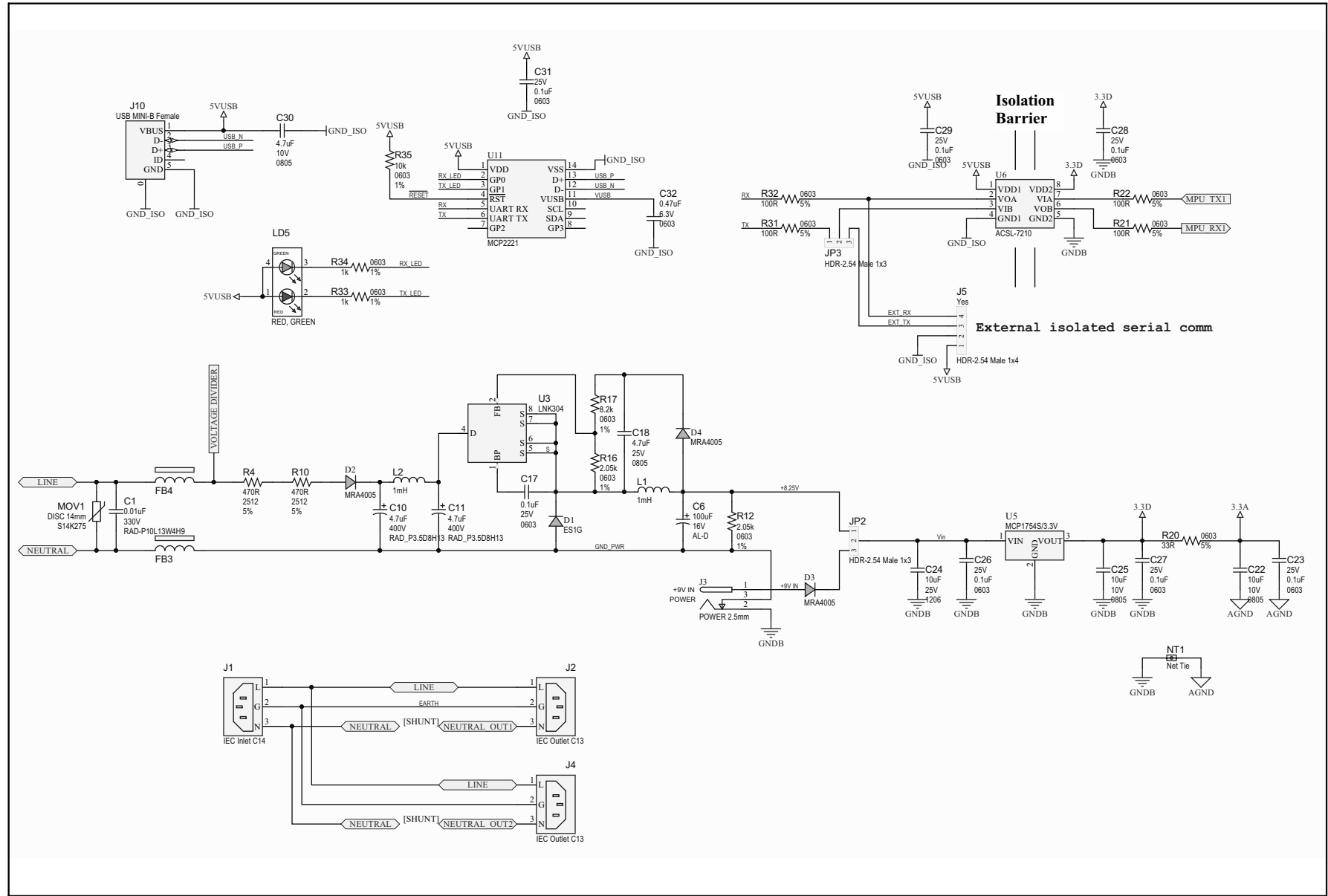


FIGURE A-1: *Layer Order.*

A.3 BOARD – SCHEMATIC

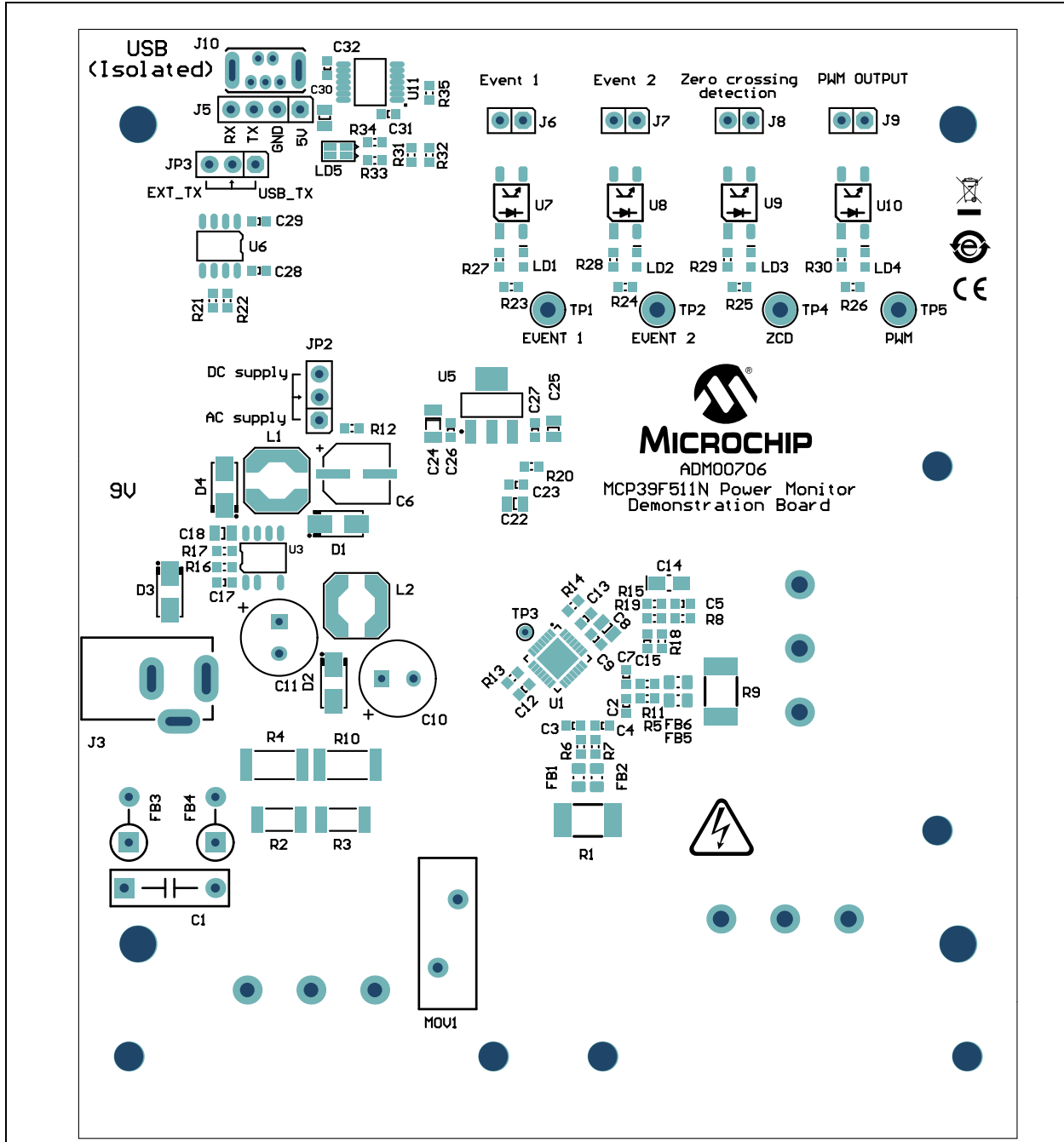


A.4 BOARD – SCHEMATIC (CONTINUED)

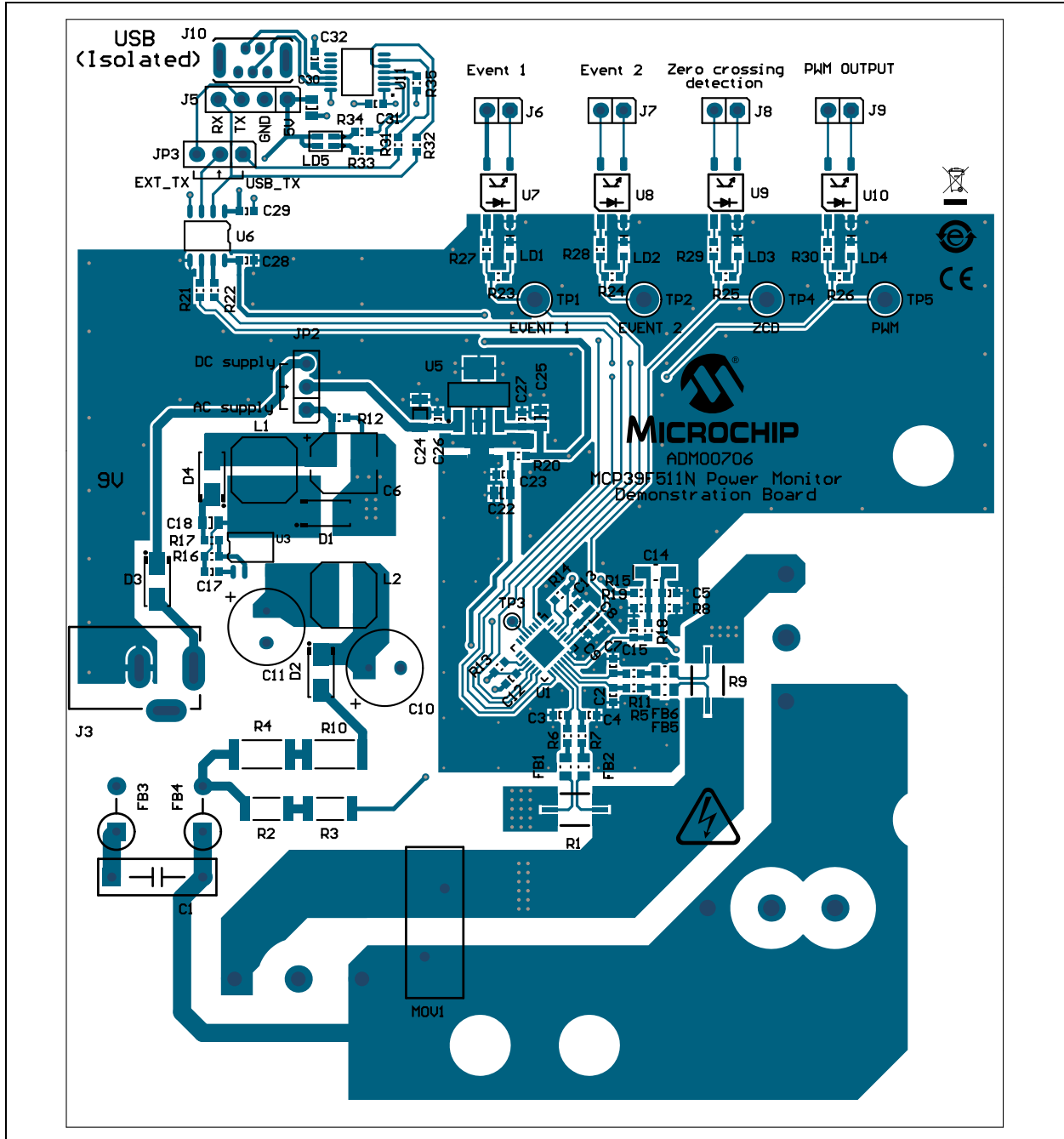


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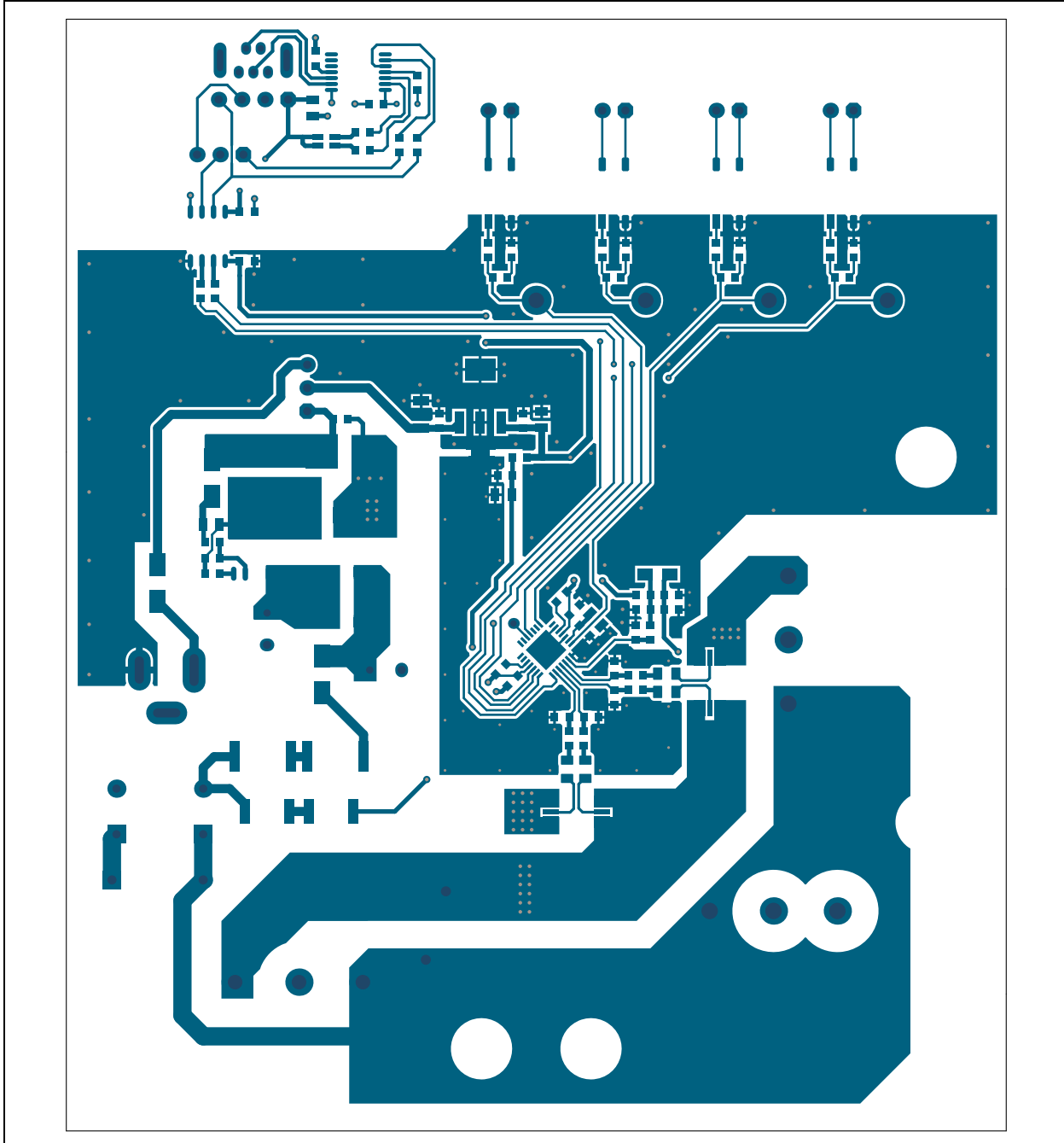
A.5 BOARD – TOP SILK



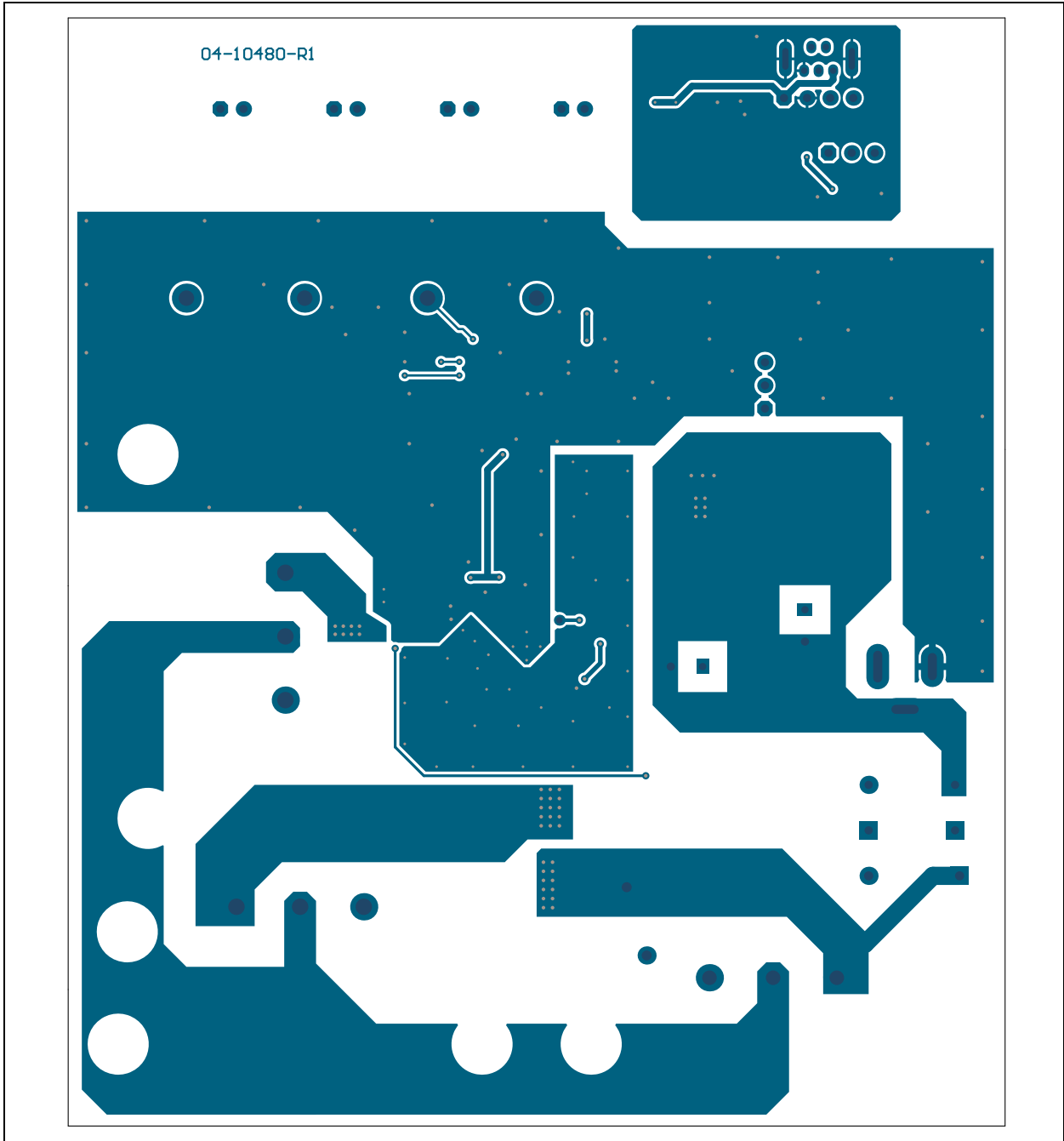
A.6 BOARD – TOP COPPER AND SILK



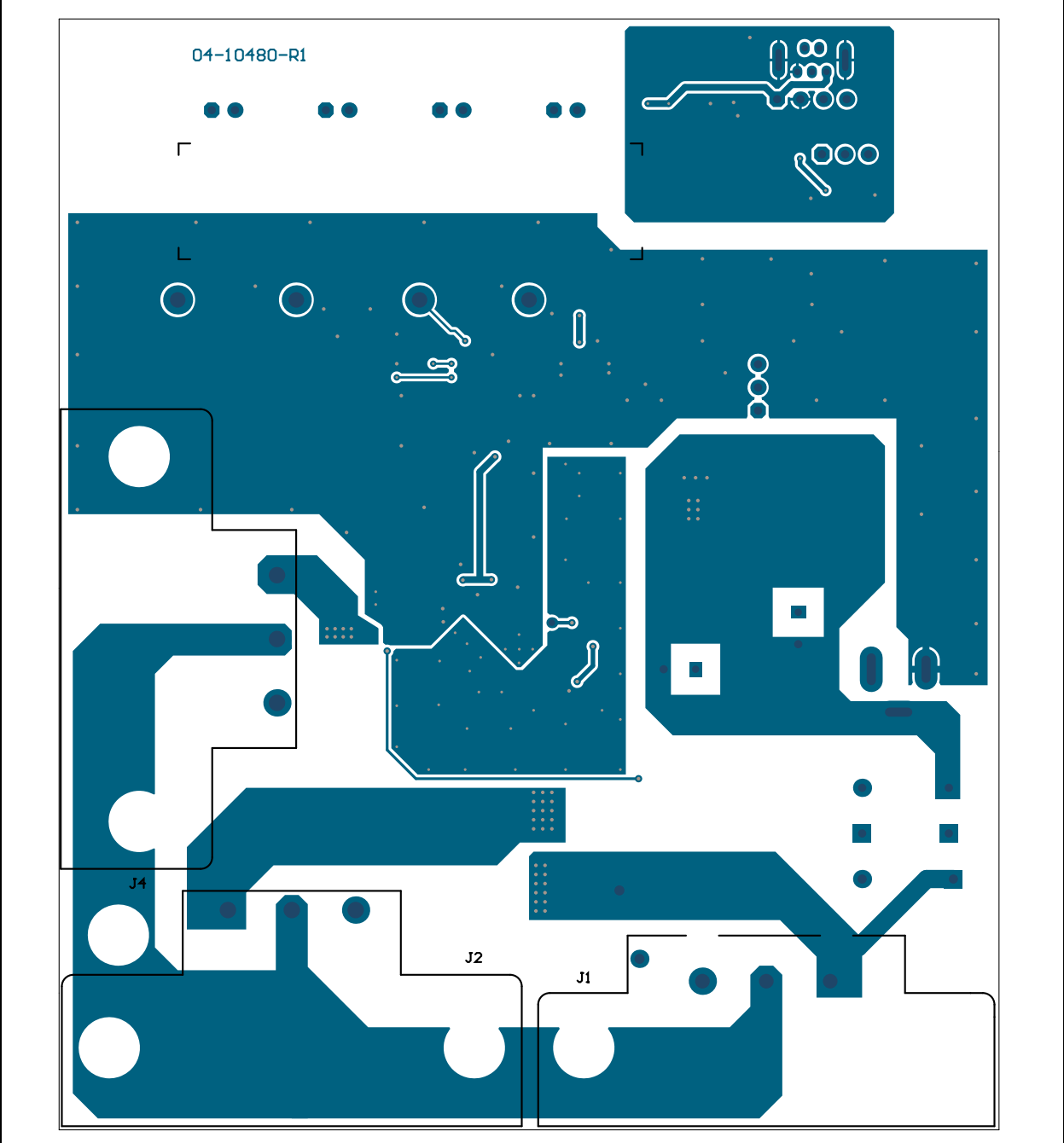
A.7 BOARD – TOP COPPER



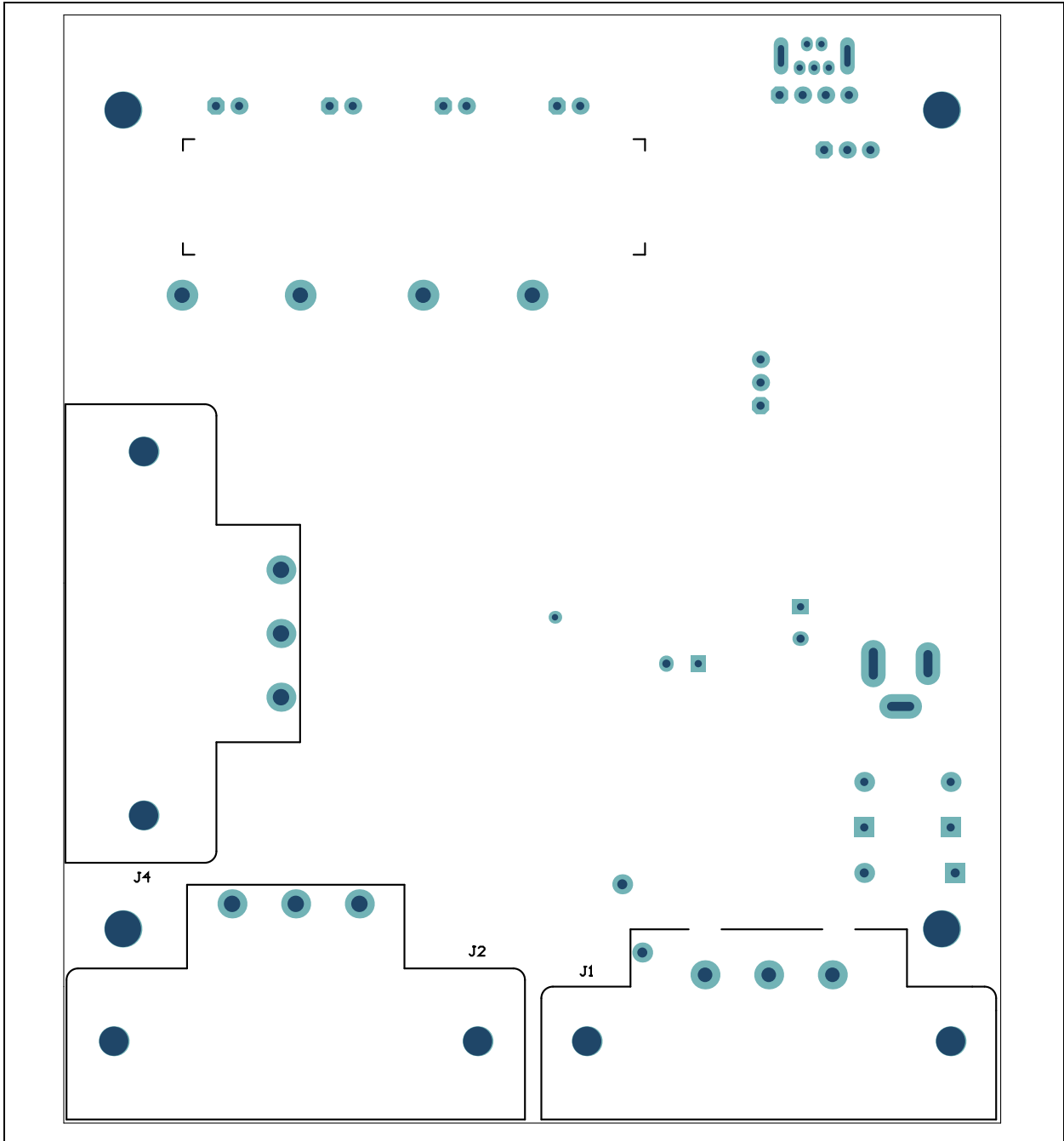
A.8 BOARD – BOTTOM COPPER



A.9 BOARD – BOTTOM COPPER AND SILK



A.10 BOARD – BOTTOM SILK



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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 μ F 330V 20% RAD P10L13W4H9	EPCOS AG	B32911A3103M
6	C2, C3, C4, C5, C7, C15	Capacitor ceramic 0.033 μ F 50V 10% X7R SMD 0603	TDK Corporation	C1608X7R1H333K
1	C6	Capacitor alum. 100 μ F 16V 20% SMD D	Nichicon Corporation	UWX1C101MCL1GB
3	C8, C22, C25	Capacitor ceramic 10 μ F 10V 10% X7R SMD 0805	TDK Corporation	C2012X7R1A106K125AC
10	C9, C12, C13, C17, C23, C26, C27, C28, C29, C31	Capacitor ceramic 0.1 μ F 25V 10% X7R SMD 0603	Murata Electronics	GRM188R71E104KA01D
2	C10, C11	Capacitor alum. 4.7 μ F 400V 20% RAD_P3.5D8H13	Nichicon Corporation	UVC2G4R7MPD1TD
1	C14	Capacitor tantalum 47 μ F 4V 10% 2.6Ohm SMD A	AVX Corporation	TAJA476K004RNJ
1	C18	Capacitor ceramic 4.7 μ F 25V 10% X7R SMD 0805	TDK Corporation	C2012X7R1E475K125AB
1	C24	Capacitor ceramic 10 μ F 25V 10% X7R SMD 1206	Taiyo Yuden Co., Ltd.	TMK316B7106KL-TD
1	C30	Capacitor ceramic 4.7 μ F 10V 10% X5R SMD 0805	Taiyo Yuden Co., Ltd.	LMK212BJ475KD-T
1	C32	Capacitor ceramic 0.47 μ F 6.3V 10% X5R SMD 0603	Murata Electronics [®]	GRM188R60J474KA01D
1	CBL1	Mech. HW cable USB-A male-to-mini USB-B male 3 ft black	Katerno	10UM-02103BK
2	CBL2, CBL3	Mech. HW 1ft 18 AWG monitor power adapter cord (NEMA 5-15R to IEC320C14)	Katerno	152360
1	CBL4	Mech. HW 6 ft 16 AWG universal power cord (IEC320C13 to NEMA 5-15P)	Katerno	153879
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
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

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.

Bill of Materials (BOM)

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

Qty.	Reference	Description	Manufacturer	Part Number
1	J1	Conn. IEC 250V 15A inlet C14 TH R/A	SCHURTER Inc.	GSP1.9103.1
2	J2, J4	Conn. IEC 250V 15A outlet C13 TH R/A	SCHURTER Inc.	6182.0033
1	J3	Conn. pwr. 2.5mm 5.5mm switch TH R/A	CUI Inc.	PJ-002B
1	J5	Conn. header-2.54 male 1x4 tin 5.84 MH TH vert.	FCI	68002-404HLF
4	J6, J7, J8, J9	Conn. header-2.54 male 1x2 tin 6.10 MH TH vert.	Molex®	0022284020
1	J10	Conn. USB mini-B female TH vert.	Molex® Connector Corporation	500075-1517
2	JP2, JP3	Conn. header-2.54 male 1x3 gold 5.84 MH TH vert.	FCI	68000-103HLF
2	JP4, JP5	Mech. HW 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. HW 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 Electronic Co., Ltd.	APTD1608SURCK
1	LD5	Diode LED bi. red, green 1.95V, 2.1V 30 mA 0805	Kingbright Corp.	APHBM2012SURKCGKC
1	MOV1	Resistor varistor 275V 130J TH disc 14 mm	EPCOS AG	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	Res. TKF 499k 1% 3/4W SMD 2010	Vishay/Dale	CRCW2010499KFKEF
2	R4, R10	Res. 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	Res. TKF 1k 1% 1/10W SMD 0603	Panasonic - ECG	ERJ-3EKF1001V
1	R8	Res. TKF 5.1k 1% 1/10W SMD 0603	Panasonic - ECG	ERJ-3EKF5101V
2	R12, R16	Res. TKF 2.05k 1% 1/10W SMD 0603	Yageo Corporation	RC0603FR-072K05L
2	R13, R14	Res. TKF 4.7k 1% 1/10W SMD 0603	Panasonic - ECG	ERJ-3EKF4701V
2	R15, R19	Res. TKF 51k 1% 1/10W SMD 0603	Panasonic - ECG	ERJ-3EKF5102V
1	R17	Res. TKF 8.2k 1% 1/10W SMD 0603	Panasonic - ECG	ERJ-3EKF8201V
1	R20	Res. TKF 33R 5% 1/10W SMD 0603	Yageo Corporation	9C06031A33R0JLHFT
4	R21, R22, R31, R32	Res. TKF 100R 5% 1/10W SMD 0603	Vishay/Dale	CRCW0603100RJNEA

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.

Bill of Materials (BOM)

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

Qty.	Reference	Description	Manufacturer	Part Number
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	Conn. 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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