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MCP19111
Evaluation Board
User's Guide

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Object of Declaration: MCP19111 Evaluation Board

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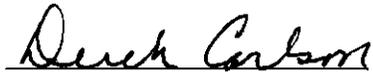
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Signed for and on behalf of Microchip Technology Inc. at Chandler, Arizona, USA



Derek Carlson
VP Development Tools

02-MAY-12
Date

NOTES:



MCP19111 EVALUATION BOARD USER'S GUIDE

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MCP19111 EVALUATION BOARD USER'S GUIDE

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 "DSXXXXA", where "XXXX" 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 on-line help. Select the Help menu, and then Topics to open a list of available on-line help files.

INTRODUCTION

This chapter contains general information that will be useful to know before using the MCP19111 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 MCP19111 Evaluation Board. The manual layout is as follows:

- **Chapter 1. "Product Overview"** – Important information about the MCP19111 Evaluation Board.
- **Chapter 2. "Installation and Operation"** – Includes instructions on how to get started with the MCP19111 Evaluation Board and a description of the user's guide.
- **Appendix A. "Schematic and Layouts"** – Shows the schematic and layout diagrams for the MCP19111 Evaluation Board.
- **Appendix B. "Bill of Materials"** – Lists the parts used to build the MCP19111 Evaluation Board.

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 MCP19111 Evaluation Board. Other useful documents are listed below. The following Microchip documents are available and recommended as supplemental reference resources.

- **MCP19111 Data Sheet – “Digitally Enhanced Power Analog Controller with Integrated Synchronous Driver” (DS22331)**
- **“MCP19111 Buck Power Supply, Graphical User Interface User’s Guide” (DS52113)**

THE MICROCHIP WEB SITE

Microchip provides online 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, 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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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 web site at:
<http://www.microchip.com/support>.

DOCUMENT REVISION HISTORY

Revision A (January 2013)

- Initial Release of this Document.

NOTES:

Chapter 1. Product Overview

1.1 INTRODUCTION

This chapter provides an overview of the MCP19111 Evaluation Board and covers the following topics:

- MCP19111 Short Overview
- What is the MCP19111 Evaluation Board
- MCP19111 Evaluation Board Kit Contents

1.2 MCP19111 SHORT OVERVIEW

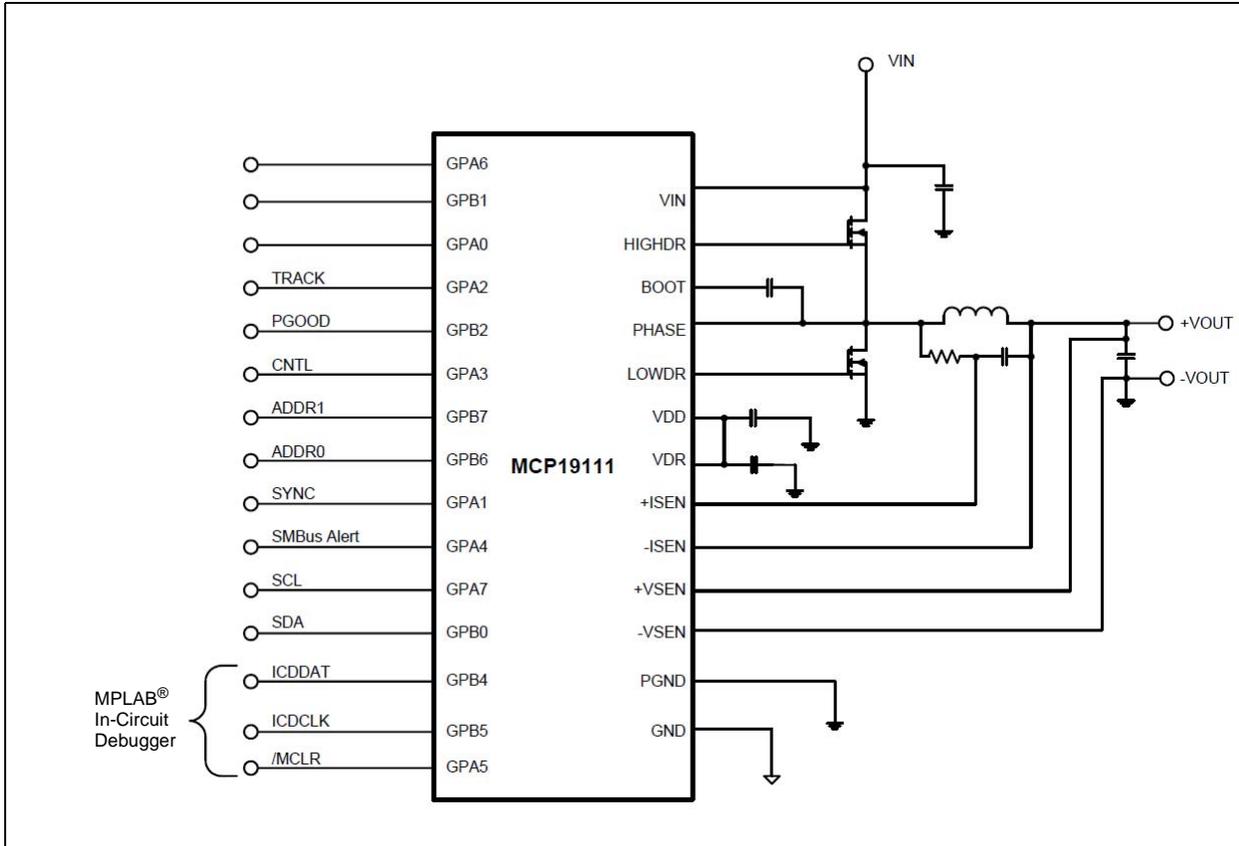
The MCP19111 is a highly integrated, mixed signal, analog Pulse Width Modulation (PWM) current mode controller with an integrated microcontroller core for synchronous DC/DC step down applications. Since the MCP19111 uses traditional analog control circuitry to regulate the output of the DC/DC converter, the integration of the PIC[®] microcontroller mid-range core is used to provide complete customization of device operating parameters, start-up and shut down profiles, protection levels, and fault handling procedures.

The MCP19111 is designed to efficiently operate from a single 4.5V to 32V supply. It features integrated synchronous drivers, bootstrap device, internal linear regulator, and 4K word nonvolatile memory all in a space-saving 28-pin 5 mm X 5 mm QFN package.

After initial device configuration by using Microchip's MPLAB X Integrated Development Environment (IDE) software, PMBus[™] or I²C communication can be used by a host to communicate with or modify the operation of the MCP19111. A subset of the PMBus 1.1 specification commands are supported by the MCP19111.

An internal 5V rail provides power to the PIC MCU and is also present on the V_{DD} pin. It is recommended that a 1 μF capacitor be placed between V_{DD} and PGND. The V_{DD} pin may also be directly connected to the V_{DR} pin or connected through a low pass RC filter. The V_{DS} pin provides power to the internal synchronous driver.

FIGURE 1-1: TYPICAL MCP19111 BUCK APPLICATION



1.3 WHAT IS THE MCP19111 EVALUATION BOARD

The MCP19111 Evaluation Board demonstrates how the MCP19111 device operates in a synchronous buck topology over a wide input voltage and load range. Nearly all operational and control system parameters are programmable by utilizing the integrated PIC microcontroller core (See **Section 2.1.1 “MCP19111 Features”** for a full list of programmable parameters). MPLAB X IDE can be used in conjunction with a Graphical User Interface (GUI) plug-in to easily configure the MCP19111. For more information regarding the GUI plug-in, refer to the “MCP19111 MPLAB® X Integrated Development Environment Plug-in User’s Guide” (DS52113). Alternatively, the user can program the MCP19111 using their own firmware, tailoring it to their application. The evaluation board contains headers for ICSP™ (In-Circuit Serial Programming™) as well as I²C communication, pull-up and pull-down resistor pads and test point pads on each GPIO pin, and two push buttons for system development. The MCP19111 Evaluation Board is also intended to demonstrate an optimized Printed Circuit Board (PCB) layout that minimizes parasitics while increasing efficiency and power density. Proper PCB layout is critical to achieve optimum MCP19111 operation, as well as power train efficiency and noise minimization. MPLAB X IDE, the MCP19111 GUI plug-in, and example firmware is available for download from the Microchip website.

1.4 MCP19111 EVALUATION BOARD KIT CONTENTS

This MCP19111 Evaluation Board kit includes the following items:

- MCP19111 Evaluation Board (ADM00397)
- Important Information Sheet

Chapter 2. Installation and Operation

2.1 INTRODUCTION

2.1.1 MCP19111 Features

The MCP19111 device was developed to provide high input voltage, high current applications with a precisely regulated rail while operating at high efficiency.

The key analog features of the MCP19111 include:

- Input Voltage Range: 4.5V to 32V
- Output Voltage Range: 0.5V to 3.6V
- Switching Frequency: 100 kHz to 1.6 MHz
- High Drive:
 - +5V Gate Drive
 - 1A/2A Source Current
 - 1A/2A Sink Current
- Low Drive:
 - +5V Gate Drive
 - 2A Source Current
 - 4A Sink Current
- Peak Current Mode Control
- Differential Remote Output Sense
- Multi-Phase Systems:
 - Master or Slave
 - Frequency Synchronized
 - Common Error Signal
- Multiple Output Systems:
 - Master or Slave
 - Frequency Synchronized
- Configurable Parameters:
 - Overcurrent Limit
 - Input Undervoltage Lockout
 - Output Overvoltage
 - Output Undervoltage
 - Internal Analog Compensation
 - Soft Start Profile
 - Synchronous Driver Dead Time
 - Switching Frequency
- Thermal Shutdown

The key microcontroller features of the MCP19111 include:

- Precision 8 MHz Internal Oscillator Block:
 - Factory Calibrated
- Interrupt Capable:
 - Firmware
 - Interrupt-on-Change Pins
- Only 35 Instruction Words to Learn
- 4096 Words On-Chip Program Memory
- High Endurance Flash:
 - 100,000 Write Flash Endurance
 - Flash Retention: >40 Years
- Watchdog Timer (WDT) with Independent Oscillator for Reliable Operation
- Programmable Code Protection
- In-Circuit Debug (ICD) via Two Pins
- In-Circuit Serial Programming (ICSP) via Two Pins
- 14 I/O Pins and 1 Input-Only Pin:
 - 3 Open Drain Pins
- Analog-to-Digital Converter (ADC):
 - 10-bit Resolution
 - 12 Internal Channels
 - 8 External Channels
- Timer0: 8-bit Timer/Counter with 8-bit Prescaler
- Enhanced Timer1:
 - 16-bit Timer/Counter with Prescaler
 - 2 Selectable Clock Sources
- Timer2: 8-bit Timer/Counter with Prescaler:
 - 8-bit Period Register
- I²C Communication:
 - 7-bit Address Masking
 - 2 Dedicated Address Registers
 - SMBus/PMBus Compatibility

2.1.2 MCP19111 Evaluation Board Features

The MCP19111 Evaluation Board is designed to operate within an input voltage range of 5 to 12V, and an output voltage range of 0.5V to 3.6V. The MCP19111 is paired with Microchip's low capacitance, low resistance MOSFETs to provide an efficient and robust power train solution, allowing operation to be assessed at load currents of up to 20A with proper airflow. Adequate ceramic and bulk capacitors are supplied on the input to reduce RMS ripple current and tame input voltage deviation caused by load transients. A mix of ceramic and bulk capacitors is also provided on the output to reduce voltage ripple and provide fast response to load transients.

The MCP19111 Evaluation Board provides the user with an example of an optimized PCB layout which reduces parasitics and increases power density. Some features of this board design include:

- Wide, short traces used to connect power components
- Ceramic V_{IN} capacitors placed as close to the drain of the high-side MOSFET as possible, and as close to the source of the low-side MOSFET as possible
- Split ground plane to decouple the digital and power ground signals
- Careful placement of current sense components to reduce PCB induced noise

The MCP19111 Evaluation Board also provides test points for easy access to power train signals such as high-side gate drive, low-side gate drive and phase node. The V_{OUT} signal, which is fed back into the MCP19111 through resistor R26, provides a convenient injection point for stability analysis. Eight of the MCP19111's GPIO pins are brought out to test points and pads are provided for optional pull-up and pull-down resistors. Two of the GPIO pins are connected to push buttons, and pads are provided for switch debouncing. Finally, headers are provided for ICSP and I²C, allowing the user to program and communicate with the MCP19111.

2.2 GETTING STARTED

The MCP19111 Evaluation Board is fully assembled, programmed and tested to evaluate and demonstrate the MCP19111 operational capabilities.

2.2.1 Power Input and Output Connection

2.2.1.1 POWERING THE MCP19111 EVALUATION BOARD

The MCP19111 Evaluation Board is fully assembled, programmed, tested and ready to begin evaluation. Apply positive input voltage to the V_{IN} terminal and its return to the PGND terminal. The maximum input voltage should not exceed 12V. An electronic load or resistive load can be used for evaluation, or the intended system load can be connected. Electronic loads attempt to sink current at 0V during startup; a resistive load or constant resistance is recommended for start-up evaluation. Connect the positive voltage terminal of the load to the V_{OUT} terminal on the MCP19111 Evaluation Board and connect the negative or return side of the load to the PGND terminal.

2.2.1.2 BOARD TESTING

To test the board:

1. Apply greater than 5V to the input for proper operation, no minimum load is required to regulate the output to 1.8V.
2. Press push button BT1. This button enables the internal synchronous drivers of the MCP19111. This button can be pressed at any time to enable/disable the internal synchronous drivers of the MCP19111.
3. The measured output voltage should be 1.8V typical. Adjusting the input voltage and load should not cause the output to vary significantly over the operating range of the converter.

NOTES:



MCP19111 EVALUATION BOARD USER'S GUIDE

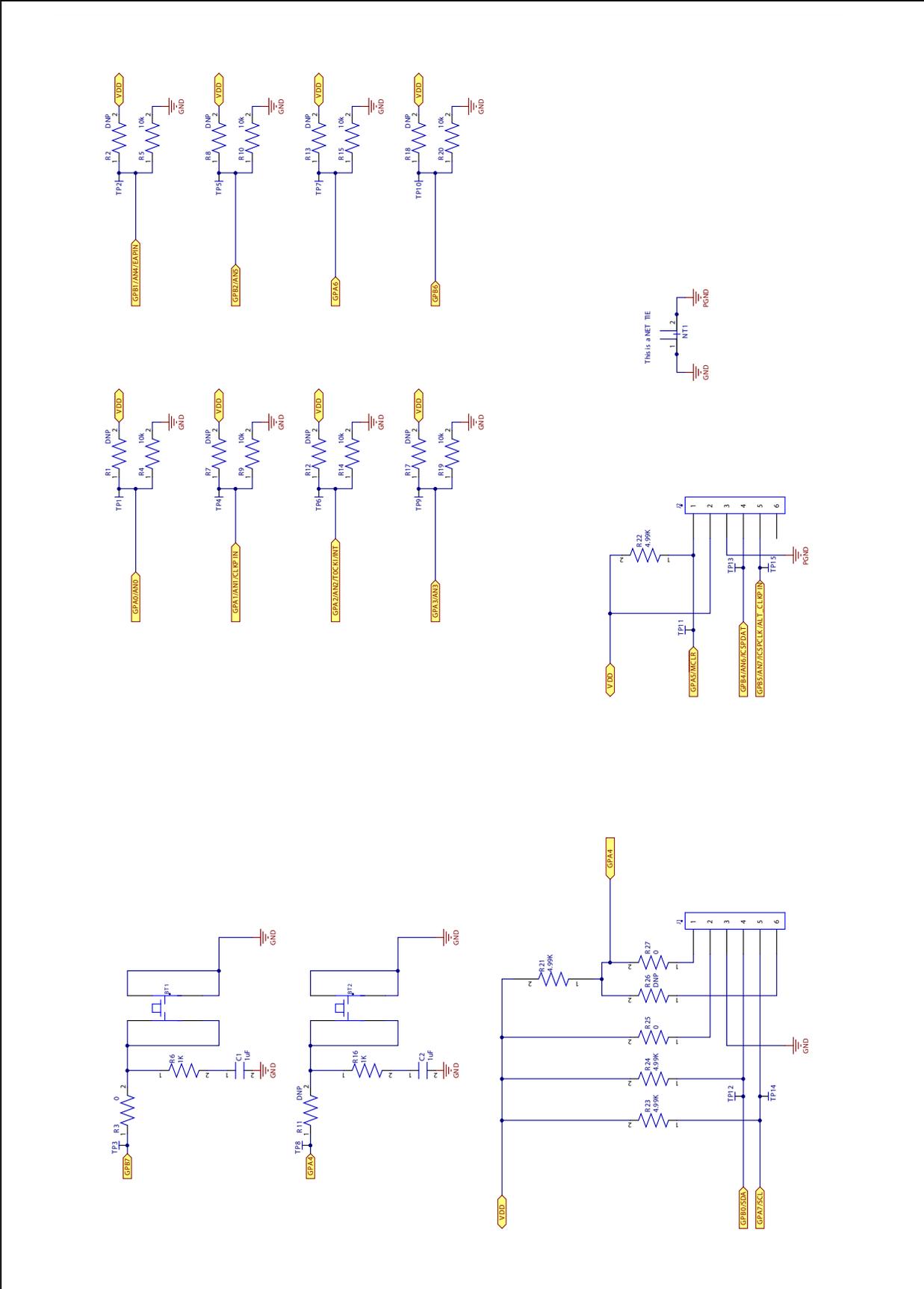
Appendix A. Schematic and Layouts

A.1 INTRODUCTION

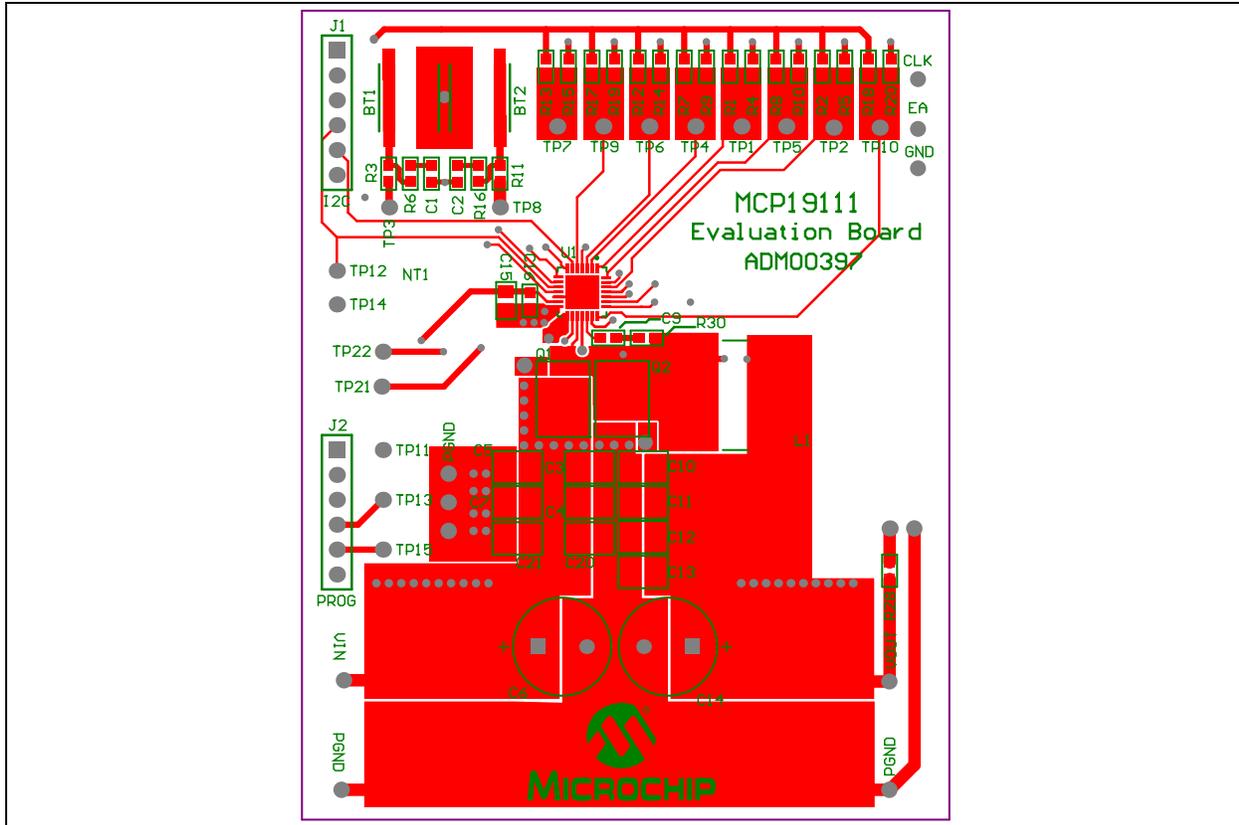
This appendix contains the following schematics and layouts for the MCP19111 Evaluation Board:

- Board – Schematic 1
- Board – Schematic 2
- Board – Top Layer
- Board – Top Copper
- Board – Mid Layer 1
- Board – Mid Layer 2
- Board – Bottom Layer
- Board – Bottom Copper

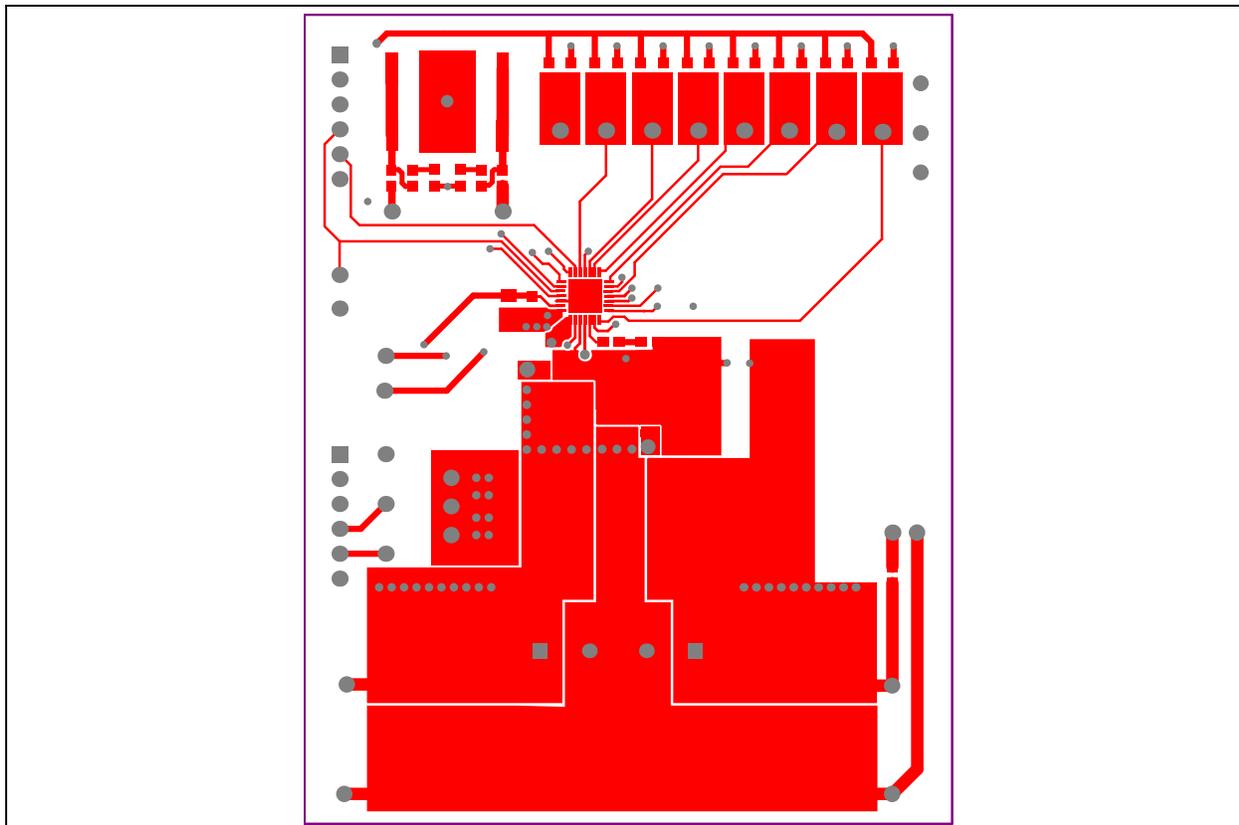
A.2 BOARD – SCHEMATIC 1



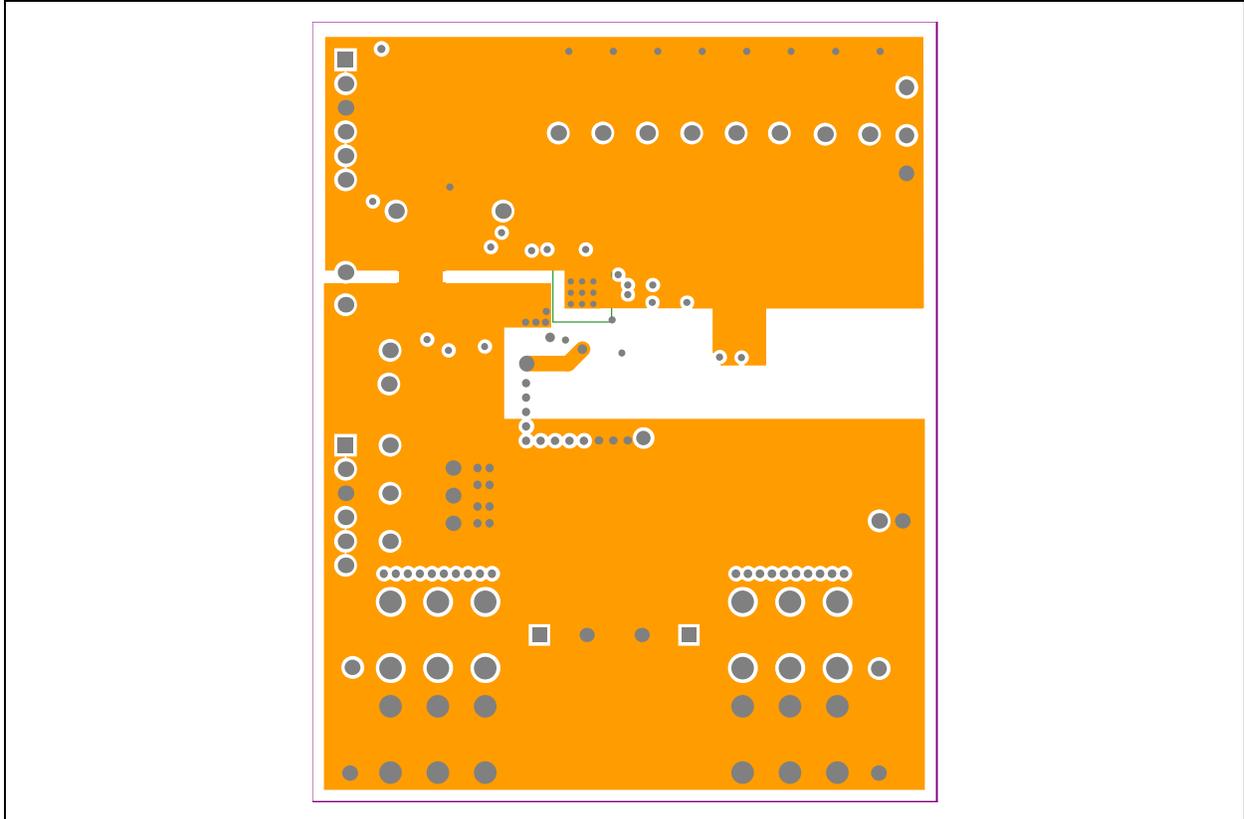
A.4 BOARD – TOP LAYER



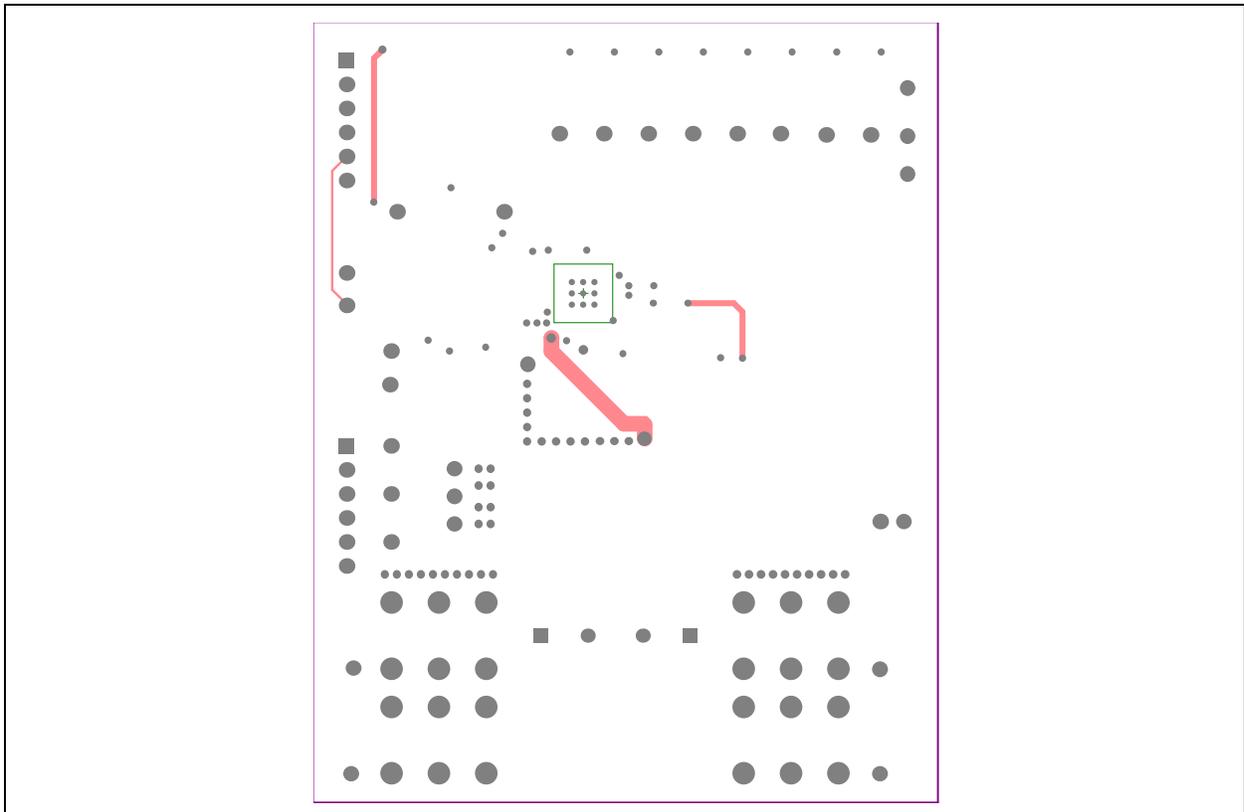
A.5 BOARD – TOP COPPER



A.6 BOARD – MID LAYER 1



A.7 BOARD – MID LAYER 2



Appendix B. Bill of Materials

TABLE B-1: BILL OF MATERIALS (BOM)

Qty	Reference	Description	Manufacturer	Part Number
2	BT1, BT2	SWITCH TACTILE SPST-NO 0.05A 12V	E-Switch	TL3301NF260QG
3	C1, C2, C18, C19	CAP CER 1UF 10V 10% X5R 0603	Murata Electronics North America	GRM188R61A105KA61D
4	C10, C11, C12, C13	CAP CER 100UF 6.3V 20% X5R 1210	TDK Corporation	C3225X5R0J107M250AC
1	C14	Do Not Populate	—	—
1	C15	CAP CER 4.7UF 25V 10% X5R 0805	Murata Electronics North America	GRM21BR61E475KA12L
1	C16	CAP CER 0.1UF 25V 10% X7R 0603	Murata Electronics North America	GRM188R71E104KA01D
4	C17	Do Not Populate	—	—
6	C3, C4, C5, C7, C20, C21	CAP CER 22UF 25V 20% X5R 1210	Taiyo Yuden	TMK325BJ226MM-T
1	C6	Do Not Populate	—	—
1	C8	CAP CER 0.47UF 25V 10% X7R 0603	Murata Electronics North America	GRM188R71E474KA12D
1	C9	CAP CER 0.47UF 10V 10% X5R 0603	Murata Electronics North America	GRM188R61A474KA61D
2	J1, J2	CONN HEADER R/A SGL 6POS GOLD	3M	961106-5604-AR
1	L1	1.0uH Power Inductor	Coilcraft	XAL1010-102ME
1	Q1	High-Speed N-Channel Power MOSFET	Microchip Technology, Inc.	MCP87050T-U/MF
1	Q2	High-Speed N-Channel Power MOSFET	Microchip Technology, Inc.	MCP87018-U/MF
11	R1, R2, R7, R8, R12, R13, R17, R18, R11, R26, R31	Do Not Populate	—	—
4	R21, R22, R23, R24	RES 4.99K OHM 1/10W 1% 0603 SMD	Vishay Dale	CRCW060318K0JNEA
7	R3, R11, R25, R27, R32, R30, R28	RES 0.0 OHM 1/10W 0603 SMD	Vishay Dale	CRCW06030000Z0EA
1	R29	RES 220 OHM 1/10W 5% 0603 SMD	Vishay Dale	CRCW0603220RJNEA
8	R4, R5, R9, R10, R14, R15, R19, R20	RES 10K OHM 1/10W 5% 0603 SMD	Vishay Dale	CRCW060310K0JNEA
2	R6, R16	RES 1.0K OHM 1/10W 5% 0603 SMD	Vishay Dale	CRCW06031K00JNEA

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
8	TP1, TP2, TP4, TP5, TP6, TP7, TP9, TP10	TEST POINT PC MINI .040"D BLACK	Keystone Electronics	5001
4	TP16, TP17, TP19, TP20	TERMINAL SCREW PC HEAVY DUTY	Keystone Electronics	8197
10	TP3, TP8, TP12, TP14, TP11, TP13, TP15, TP18, TP21, TP22	Do Not Populate	—	—
1	U1	Digitally Enhanced Power Analog Sync Buck Controller	Microchip Technology, Inc.	MCP19111-E/MQ

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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