MIC22950 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 MIC22950 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 MIC22950 Evaluation 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 MIC22950 Evaluation Board.
- **Chapter 2. "Installation and Operation"** – Includes details about the MIC22950 Evaluation Board features, as well as instructions on powering up the board.
- **Appendix A. "Schematic and Layouts"** – Shows the schematic and layout diagrams for the MIC22950 Evaluation Board.
- **Appendix B. "Bill of Materials (BOM)"** – Lists the parts used to build the MIC22950 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	*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 MIC22950 Evaluation Board. Other useful documents are listed below. The following Microchip document is available and recommended as a supplemental reference resource:

MIC22950 Data Sheet – *"10A Integrated Switch Synchronous Buck Regulator with Freq Programmable to 2 MHz"*

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:

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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://www.microchip.com/support.

DOCUMENT REVISION HISTORY

Revision A (May 2018)

- Initial Release of this Document.

NOTES:

Chapter 1. Product Overview

1.1 INTRODUCTION

This chapter provides information on the MIC22950 Evaluation Board by covering the following topics:

- MIC22950 Short Overview
- What Is the MIC22950 Evaluation Board?
- Content of the MIC22950 Evaluation Board kit

1.2 MIC22950 SHORT OVERVIEW

MIC22950 is a high-efficiency, 10A integrated switch, synchronous buck (step-down) regulator. The switching frequency of the MIC22950 device is programmable from 400 kHz to 2 MHz, allowing the customer to optimize the design, either for efficiency or for the smallest footprint. MIC22950 is optimized for the highest power density and achieves up to 95% efficiency, while switching at 400 kHz to 2 MHz.

The ultra-high-speed control loop keeps the output voltage within regulation, even under extreme transient load swings, commonly found in FPGAs and in low-voltage ASICs.

The output voltage can be adjusted down to 0.7V, in order to address all the low-voltage power needs. The high side MOSFET is a P-Channel, allowing duty cycle control up to 100%.

MIC22950 features a full range of sequencing and tracking options. Multiple outputs are allowed to be sequenced in several ways during turn-on and turn-off, by using the EN pin, the EN/DLY and the DELAY pins, combined with the POR/PG pin. The Ramp Control (RC) pin allows the device to be connected to any other device in the MIC22X00 family of products, to keep the output voltages within a certain delta V during start-up.

MIC22950 is available in a 32-Lead 5 x 5 x 0.9 mm VQFN package, with a junction operating range from –40ºC to +125ºC.

The key features of the MIC22950 Evaluation Board include:

- 2.6V to 5.5V supply voltage
- Fully integrated MOSFET switches
- Adjustable output voltage option, up to 0.7V
- Output load current, up to 10A
- Full sequencing and tracking capability
- Power-on reset
- Up to 95% efficiency
- Operating frequency programmable from 400 kHz to 2 MHz
- Ultra-fast transient response
- 100% maximum duty cycle
- Micro-power shutdown
- Thermal-shutdown and current-limit protection
- Available in a 32-Lead 5 x 5 x 0.9 mm VQFN package
- -40ºC to +125ºC junction temperature range

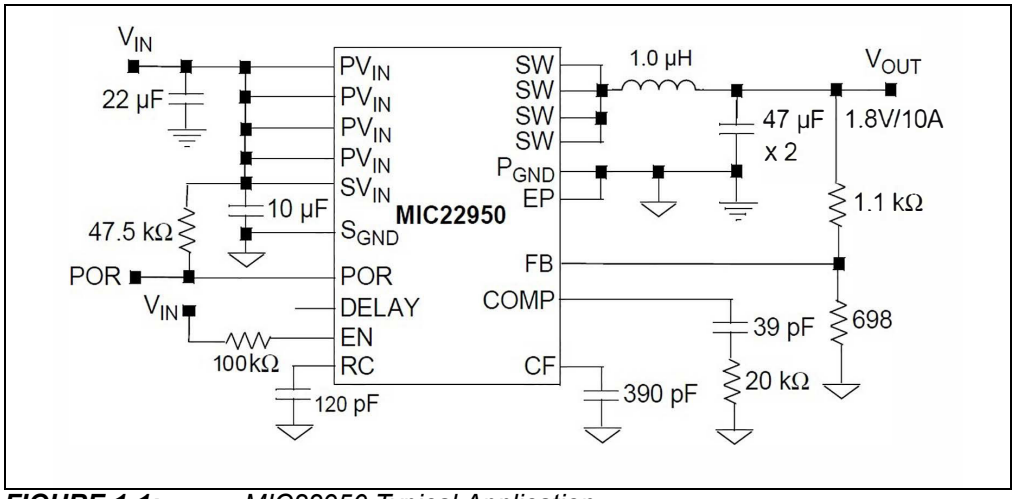


FIGURE 1-1: *MIC22950 Typical Application.*

1.3 WHAT IS THE MIC22950 EVALUATION BOARD?

The MIC22950 Evaluation Board is developed to evaluate a typical application, where V_{IN} is between 2.6V - 5.5V and V_{OUT} is set to 1.8V. The application can run up to 10A continuous output current loading.

The MIC22950 Evaluation Board is optimized for the highest power density and achieves over 90% efficiency when the switching frequency is around 1 MHz.

The power supply and load are connected to the MIC22950 Evaluation Board trough four high-power terminals (turrets type). For the input and output voltage measurements, the dedicated pin headers can be used, allowing a clean measurement with low noise. Dedicated test pins allow monitoring and stimulating all the key features of the device, including Enable, Delay, Power-Good and Ramp Control.

The voltage mode feedback loop is designed to allow high bandwidth, with just two external compensation components.

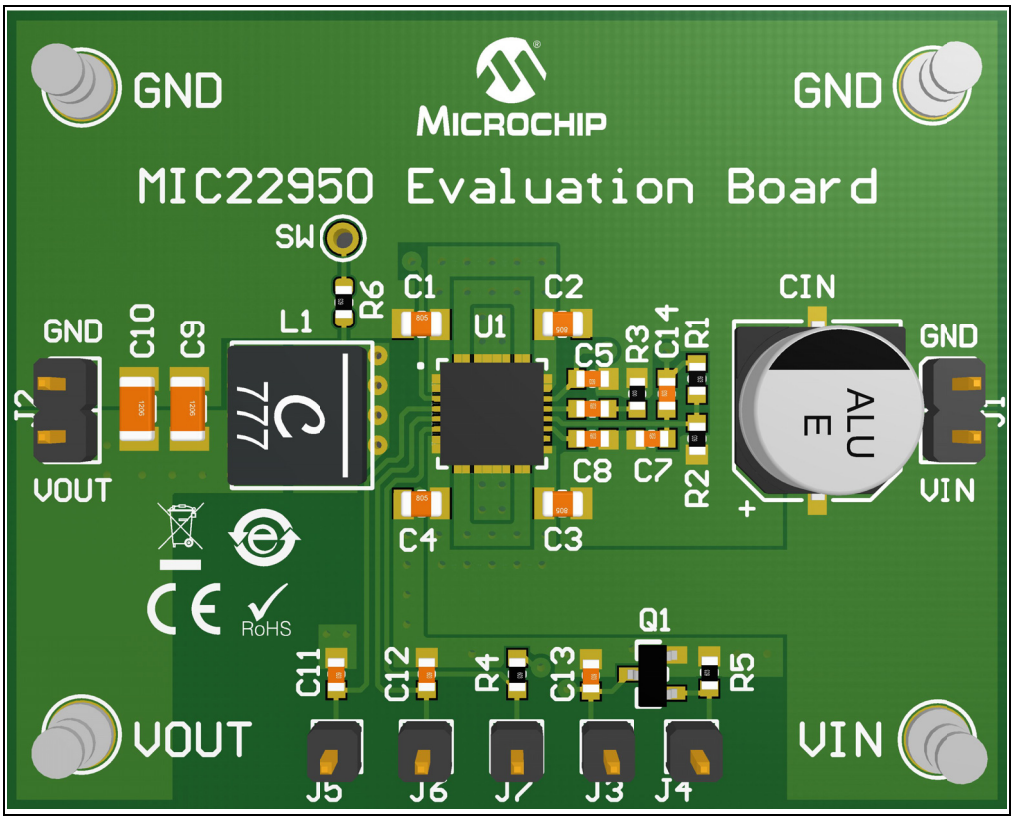


FIGURE 1-2: *MIC22950 Evaluation Board - Top View.*

1.4 MIC22950 EVALUATION BOARD KIT CONTENTS

The MIC22950 Evaluation Board Kit includes:

- One MIC22950 Evaluation Board, 10A, DC/DC unit (ADM00823)
- Important information sheet

Chapter 2. Installation and Operation

2.1 INTRODUCTION

The MIC22950 Evaluation Board can be powered from a single voltage range, from 2.6V to 5.5V, making it compatible with 5V rails and USB power.

2.2 FEATURES

The key features of the MIC22950 include:

- 2.6V to 5.5V supply voltage
- Output continuous load current up to 10A
- Switching frequency programmed at 524kHz
- 84us programmed output voltage ramp time
- POR delay of 1.24ms
- Accessible test points for SW node, Ramp Control, POR delay and Enable

2.3 GETTING STARTED

Follow the next steps to power-up the MIC22950 Evaluation Board:

1. Connect the external supply between the V_{IN} terminal and the GND terminal. Pay particular attention to the polarity.
2. With the output of the power supply disabled, set its voltage to the desired input test voltage ($2.6V \leq V_{IN} \leq 5.5V$). An ammeter may be placed between the input supply and the V_{IN} terminals. Be sure to monitor the supply voltage at V_{IN} terminal, as the ammeter and/or power lead resistance can reduce the voltage supplied to the device.
3. Connect a load between the V_{OUT} and GND terminals. The load can be either passive (resistive) or active (electronic). An ammeter may be placed between the load and the output. Ensure that the output voltage is monitored at the V_{OUT} terminals. To obtain the best output voltage regulation and low noise, please use the local GND terminal.
4. The MIC22950 Evaluation Board has a pull-down resistor (R7) on the EN pin. By default, the output voltage will be disabled. To enable the device, connect the EN pin at V_{IN} potential. The MIC22950 Evaluation Board also has an $\overline{SHDN}$ pin, which is used to put the device in shutdown mode when the V_{IN} potential is applied on this pin. Applying a voltage to both EN and $\overline{SHDN}$ pins will cause the Q1 transistor to short the EN potential to GND; depending on the power supply used, this may cause damage to Q1. In order to use both EN and $\overline{SHDN}$ pins simultaneously, a pull-up resistor can be used on the EN pin (10k or higher).
5. A power-on reset output is provided to monitor the power-on reset function (J7). The Power-on Reset (POR) output will go higher after the output voltage reaches 90% of the nominal set voltage and after the delay set by C_{DELAY}. POR/PG is asserted low without delay, when the enable pin (EN) is set to low (GND) or when the output goes below the 10% threshold. For the Power-Good (PG) function, the delay must be set to a minimum. This can be done by removing the DELAY pin capacitor (C11).

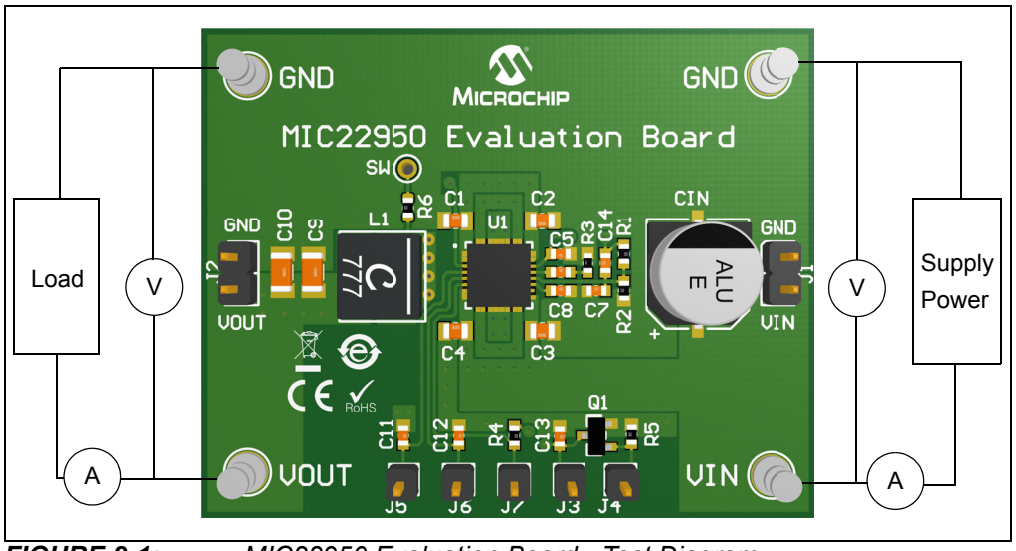


FIGURE 2-1: *MIC22950 Evaluation Board - Test Diagram.*

2.4 EVALUATION BOARD DESCRIPTION

2.4.1 Frequency set capacitor (CF)

This pin allows the setting of the switching frequency. A 200 µA source current charges the capacitor (C8) on this pin up to a voltage of 1V. The CF capacitor is then discharged with an internal N-Channel MOSFET, marking the end of the switching period. The capacitor should be connected very close to the IC and grounded directly to the SGND pin.

2.4.2 Ramp control pin (RC)

The J6 (RC) pin allows the slew rate of the output voltage to be programmed by the addition of a capacitor from J6 (RC) pin to ground (C12). RC pin is internally fed with a 1 µA current source and V_{OUT} slew rate is proportional to the capacitor and the 1 µA source. The RC pin cannot be left floating. Use a minimum capacitor value of 120 pF or larger.

2.4.3 Delay pin (DELAY)

Adding a capacitor to the J5 (DELAY) pin allows the delay of the POR signal.

When V_{OUT} reaches 90% of its nominal voltage, the DELAY pin current source (1 µA) starts to charge the external capacitor. At 1.24V, the POR pin is asserted high. On the MIC22950 Evaluation Board, C11 accomplishes this functionality.

2.4.4 Output noise and ripple measurements

The MIC22950 Evaluation Board is populated with headers, which are used for measuring output noise and ripple (J1 and J2). Each connector is designed to probe the output, using the local ground as reference. This is the proper way of measuring low-amplitude ripple signals, as it eliminates any noise caused by long oscilloscope ground or ground plane noise.

2.4.5 Board layout considerations

It is recommended that the switching trace (from the switching node) is kept as short as possible. This will decrease the noise generated by the MIC22950 device and improve performance. The output capacitors (C9 and C10) must be placed as close as possible to the inductor.

It is also recommended that a copper plane is placed immediately under the MIC22950 device; it must be connected to the ground copper plane using a via under the device. The MIC22950 device's exposed pad must be connected at ground plane, in order to conduct the heat away from the device and to improve thermal performance. Doing so will also shield the device and improve output ripple performance.

NOTES:

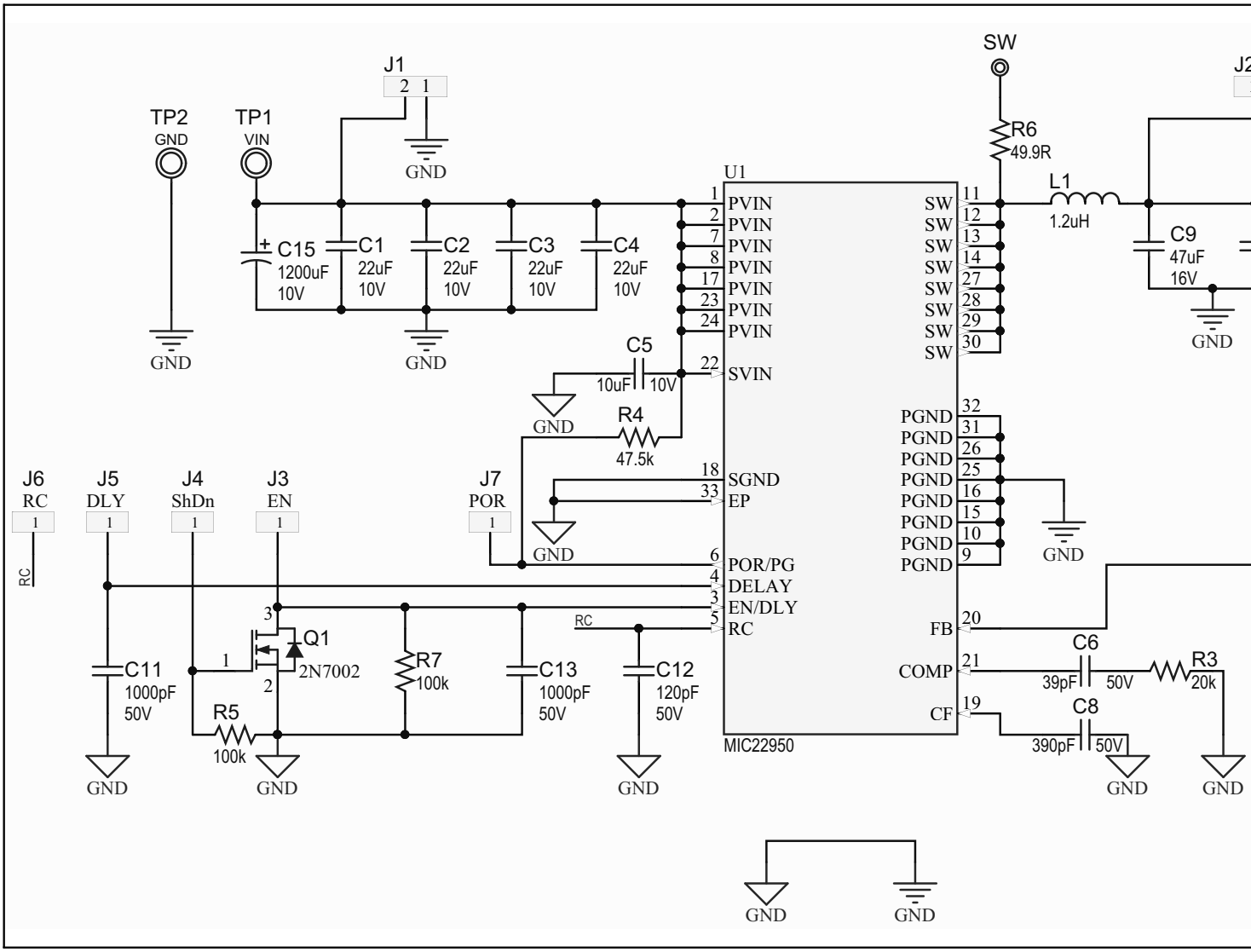
Appendix A. Schematic and Layouts

A.1 INTRODUCTION

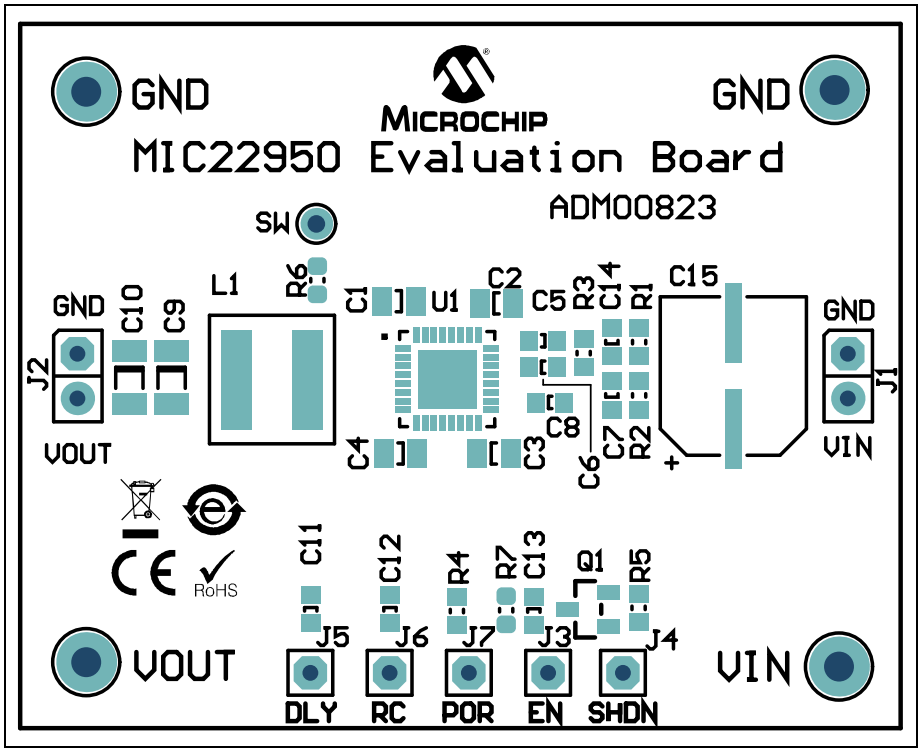
This appendix contains the following schematics and layouts for the MIC22950 Evaluation Board (ADM00823).

- Board - Schematic
- Board - Top Silk
- Board - Top Copper and Silk
- Board - Top Copper
- Board - Mid-Layer 1
- Board - Mid-Layer 2
- Board - Bottom Copper
- Board - Bottom Copper and Silk
- Board - Bottom Silk

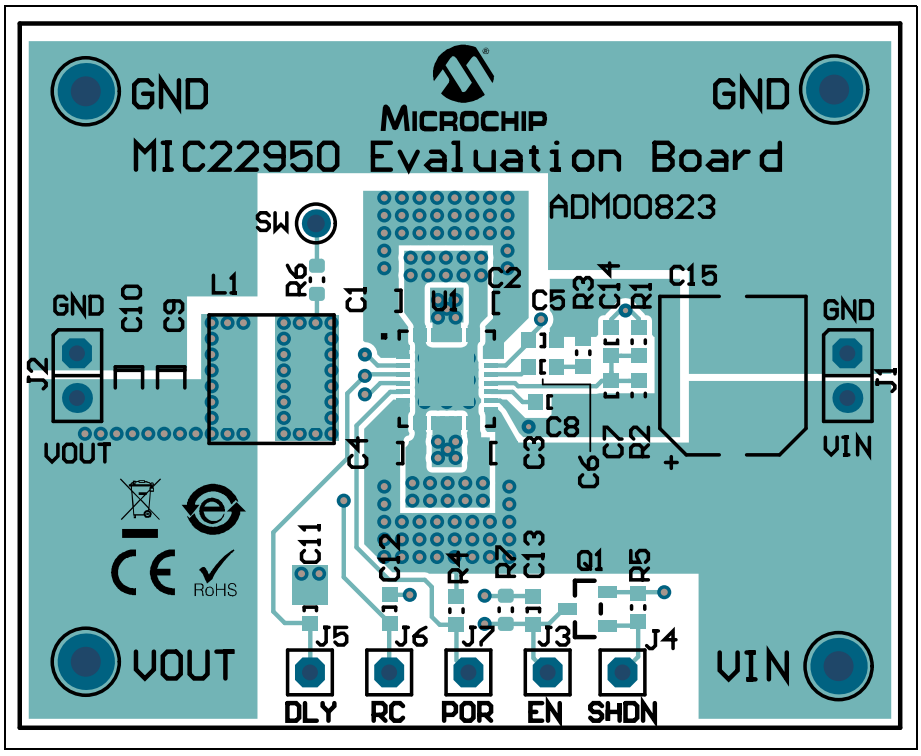
A.2 BOARD - SCHEMATIC



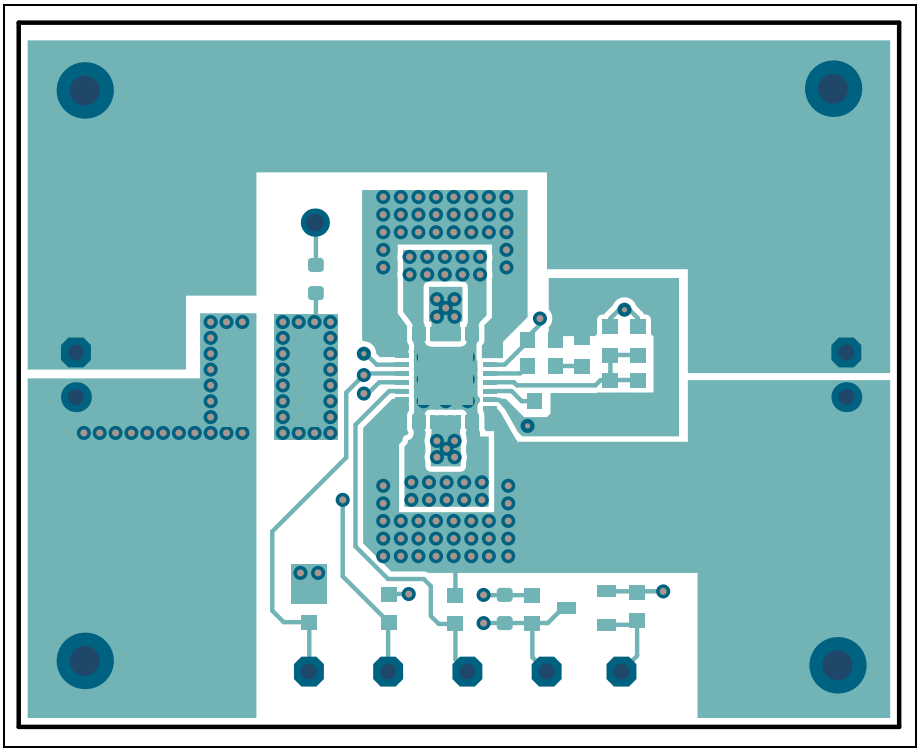
A.3 BOARD - TOP SILK



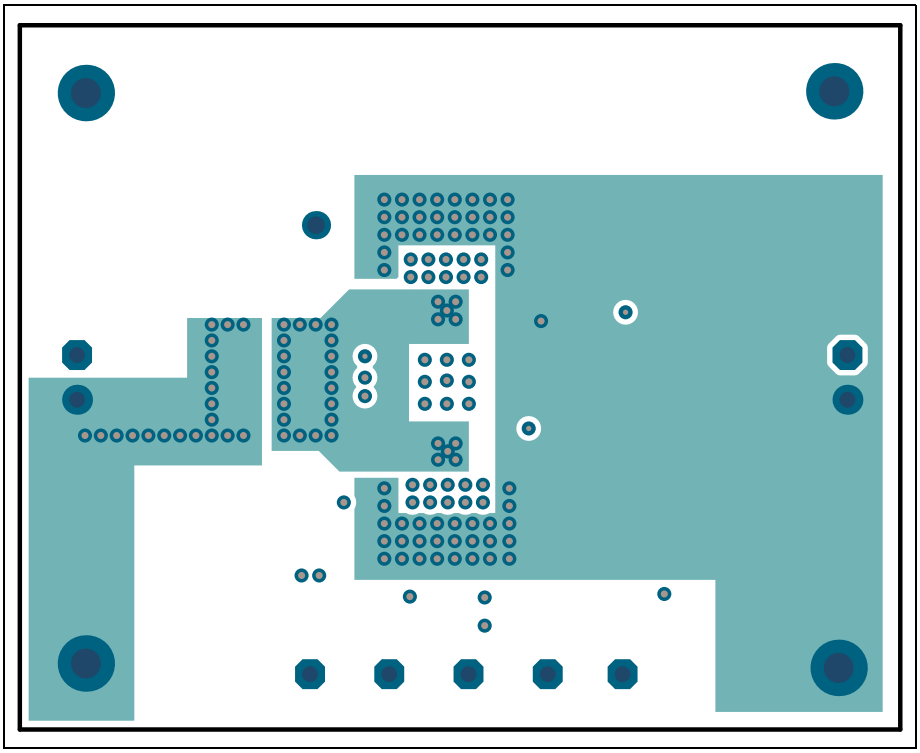
A.4 BOARD - TOP COPPER AND SILK



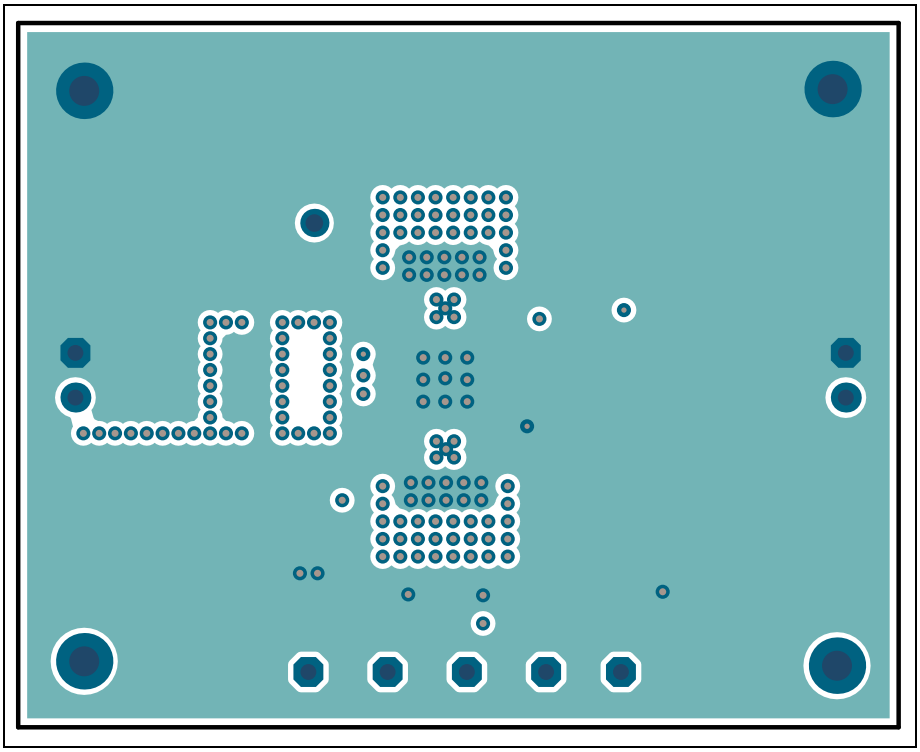
A.5 BOARD - TOP COPPER



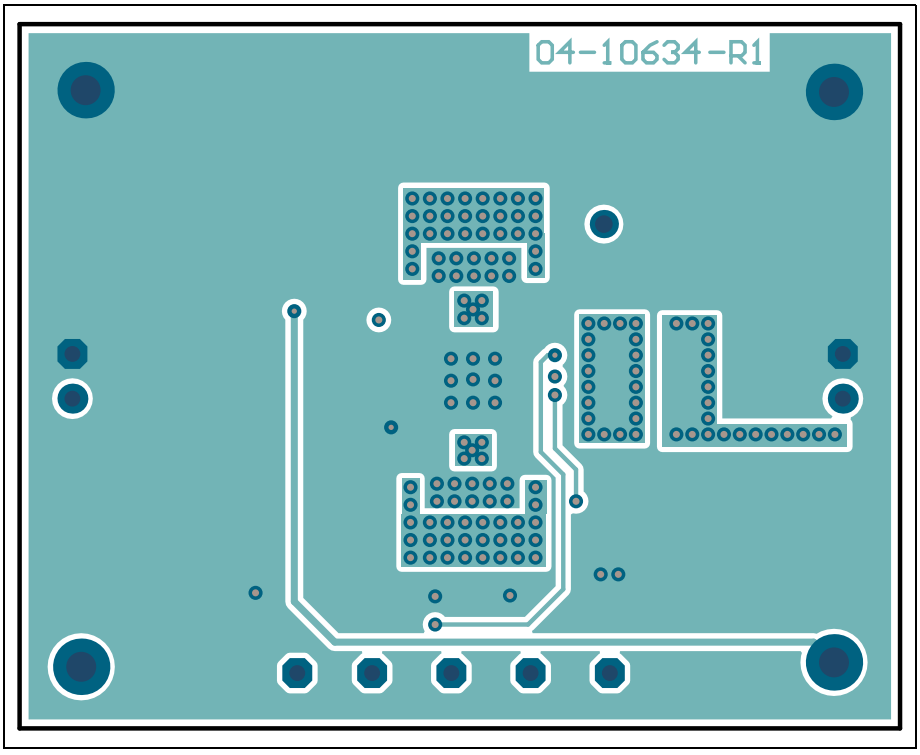
A.6 BOARD - MID-LAYER 1



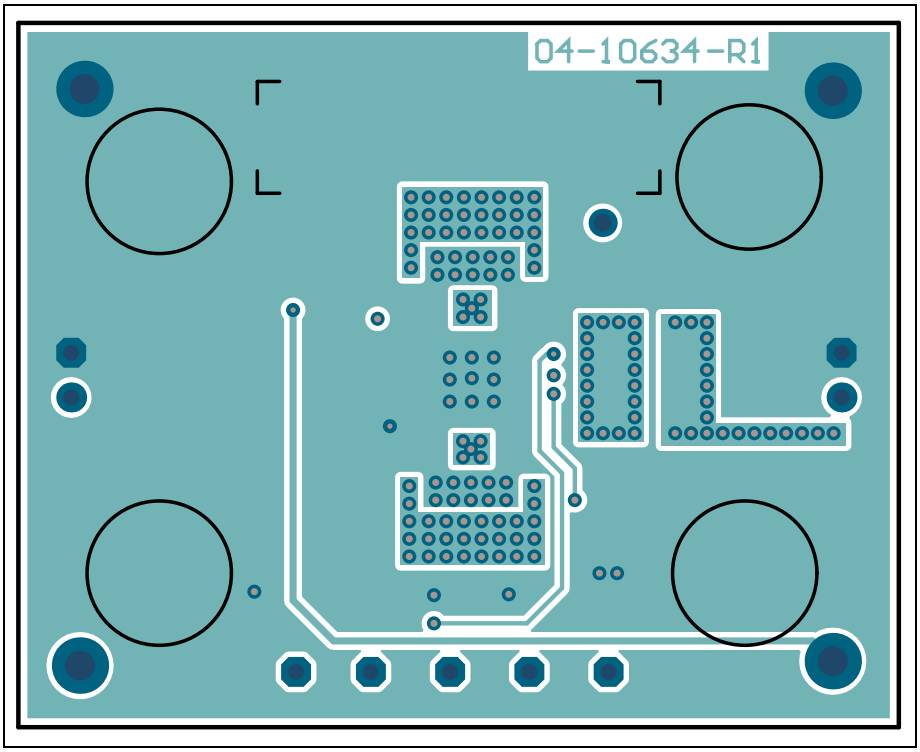
A.7 BOARD - MID-LAYER 2



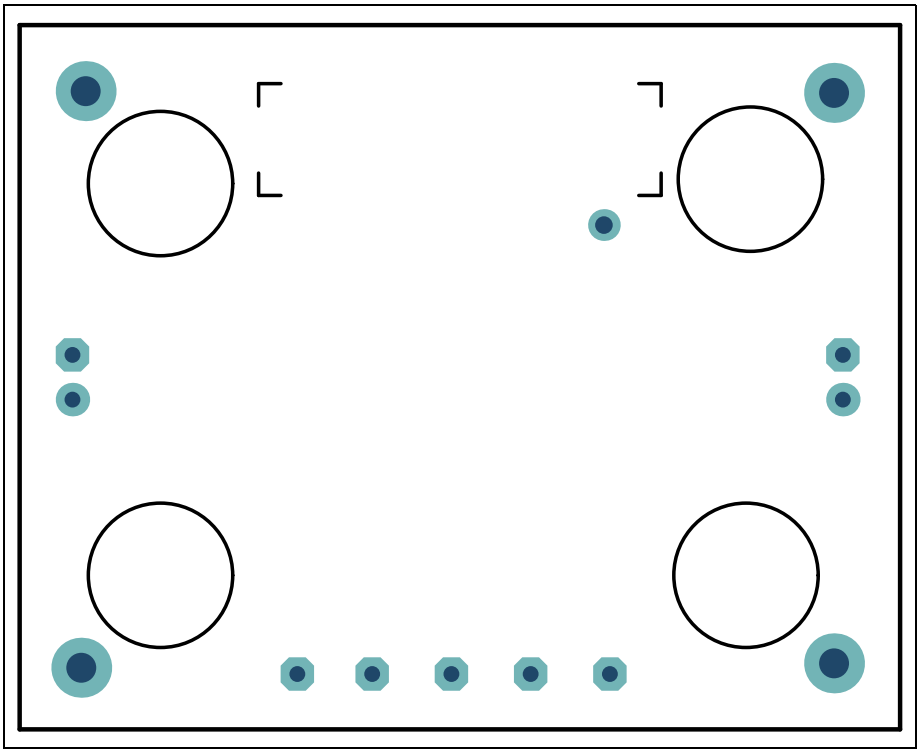
A.8 BOARD - BOTTOM COPPER



A.9 BOARD - BOTTOM COPPER AND SILK



A.10 BOARD - BOTTOM SILK



Appendix B. Bill of Materials (BOM)

TABLE B-1: MIC22950 EVALUATION BOARD BILL OF MATERIALS (BOM)

Qty.	Reference	Description	Manufacturer	Part Number
4	C1, C2, C3, C4	Capacitor Ceramic, 22 µF, 10v, 20%, X7S, SMD, 0805	TDK Corporation	C2012X7S1A226M125AC
2	C11, C13	Capacitor Ceramic, 1000 pF, 50V, 20%, X7R, SMD, 0603	TDK Corporation	C1608X7R2A102K080AA
1	C12	Capacitor Ceramic, 120 pF, 50V, 5%, C0G, SMD, 0603	TDK Corporation	C1608C0G1H121J080AA
1	C15	Capacitor Aluminum, 1200 µF, 10V, SMD, E	Panasonic® - ECG	EEEFPA122UAP
1	C5	Capacitor Ceramic, 10 µF, 10V, 20%, X5R, SMD, 0603	Samsung Electro-Mechanics America, Inc.	CL10A106MP8NNNC
1	C6	Capacitor Ceramic, 39 pF, 50V, 5%, C0G, SMD, 0603	TDK Corporation	CGA3E2C0G1H390J080AA
1	C8	Capacitor Ceramic, 390 pF, 50V, 5%, C0G, SMD, 0603	TDK Corporation	C1608C0G1H391J080AA
2	C9, C10	Capacitor Ceramic, 47 µF, 16V, 20%, X5R, SMD, 1206	TDK Corporation	C3216X5R1C476M160AB
2	J1, J2	CON HDR-2.54, Male, 1x2, Tin, 6.10 MH, TH, VERT	Molex®	0022284020
5	J3, J4, J5, J6, J7	CON HDR-2.54, Male, 1x1, Gold, 5.84 MH, TH, VERT	TE Connectivity, Ltd.	5-146280-1
1	L1	Inductor, 1.2 µH, 16A, 20%, SMD, L6.56W6.36H3.1	Coilcraft	XAL6030-122MEB
1	LABEL1	Label, Assy W/rev Level (Small Modules) Per Mts-0002	—	—
4	PAD1, PAD2, PAD3, PAD4	Mechanical HW Rubber Pad, Cylindrical, D7.9, H5.3, Black	3M	SJ61A11
1	PCB1	MIC22950 Evaluation Board - Printed Circuit Board	Microchip Technology Inc.	**04-10634-R1**
1	Q1	TRANS FET N-CH 2N7002, 215 60V 300 mA 830 mW SOT-23-3	NXP Semiconductors	2N7002,215
1	R1	Resistor, SMD, 1.1 kΩ, 1%, 1/10W, 0603	Stackpole Electronics, Inc.	RMCF0603FT1K10
1	R2	Resistor, TKF, 698R, 1%, 1/10W, SMD, 0603	Panasonic - ECG	ERJ-3EKF6980V
1	R3	Resistor, TKF, 20 kΩ, 1%, 1/10W, SMD, 0603	Panasonic - ECG	ERJ-3EKF2002V
1	R4	Resistor, TKF, 47.5 kΩ, 1%, 1/10W, SMD, 0603	Vishay/Dale	CRCW060347K5FKEA

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: MIC22950 EVALUATION BOARD BILL OF MATERIALS (BOM) (CONTINUED)

Qty.	Reference	Description	Manufacturer	Part Number
2	R5, R7	Resistor, TF, 100 kΩ, 1%, 1/8W, SMD, 0603	Vishay Beyschlag	MCT06030C1003FP500
1	R6	Resistor, TKF, 49.9R, 1%, 1/4W, SMD, 0603	Vishay/Dale	CRCW060349R9FKEAHP
4	TP1, TP2, TP3, TP4	CON TP, Pin, Tin, TH	Harwin Plc.	H2121-01
1	U1	MCHP Analog Switcher, Buck, 0.7V to 5.5V, MIC22950YML-TR QFN-32	Microchip Technology Inc.	**MIC22950YML-TR**

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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