

MIC2877 High-Current Synchronous Boost Regulator 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 MIC2877 Evaluation Board. Items discussed in this chapter include:

- Document Layout
- Conventions Used in this Guide
- Recommended Reading
- Recommended Reading
- The Microchip Web Site
- Customer Support
- Document Revision History

DOCUMENT LAYOUT

This document describes how to use the MIC2877 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 MIC2877 Evaluation Board.
- **Chapter 2. "Installation and Operation"** – Includes instructions on installing and starting the MIC2877 Evaluation Board.
- **Appendix A. "Schematic and Layouts"** – Shows the schematic and layout diagrams for the MIC2877 Evaluation Board.
- **Appendix B. "Bill of Materials (BOM)"** – Lists the parts used to build the MIC2877 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) { ... }`

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RECOMMENDED READING

This user's guide describes how to use the MIC2877 Evaluation Board. Another useful document is listed below. The following Microchip document is available and recommended as a supplemental reference resource:

MIC2877 Data Sheet – *"2MHz Synchronous Low Voltage Step-Up Regulator with 6.5A Switch and Bidirectional Load Disconnect"* (DS20005873A)

THE MICROCHIP WEB SITE

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- **General Technical Support** – Frequently Asked Questions (FAQs), technical support requests, online discussion groups, Microchip consultant program member listing
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- Technical Support

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Technical support is available through the web site at:
http://www.microchip.com/support.

DOCUMENT REVISION HISTORY

Revision A (November 2017)

- Initial Release of this Document.

NOTES:

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Chapter 1. Product Overview

1.1 INTRODUCTION

The MIC2877 Evaluation Board demonstrates a compact and highly efficient 2 MHz synchronous boost regulator with a 6.5 switch. It also features a bidirectional true-load disconnect function, which prevents any leakage current between the input and the output when the device is disabled.

MIC2877 automatically operates in bypass mode when the input voltage is higher than the target output voltage. At light loads, the boost converter automatically jumps to PFM mode to improve the efficiency.

In shutdown mode, the regulator typically consumes less than 2 µA. The MIC2877 Evaluation Board also features an integrated anti-ringing switch, in order to minimize EMI, overvoltage and overcurrent protection, UVLO and thermal shutdown.

Figure 1-1 shows the top view of the MIC2877 High-Current Synchronous Boost Regulator Evaluation Board (ADM00831).

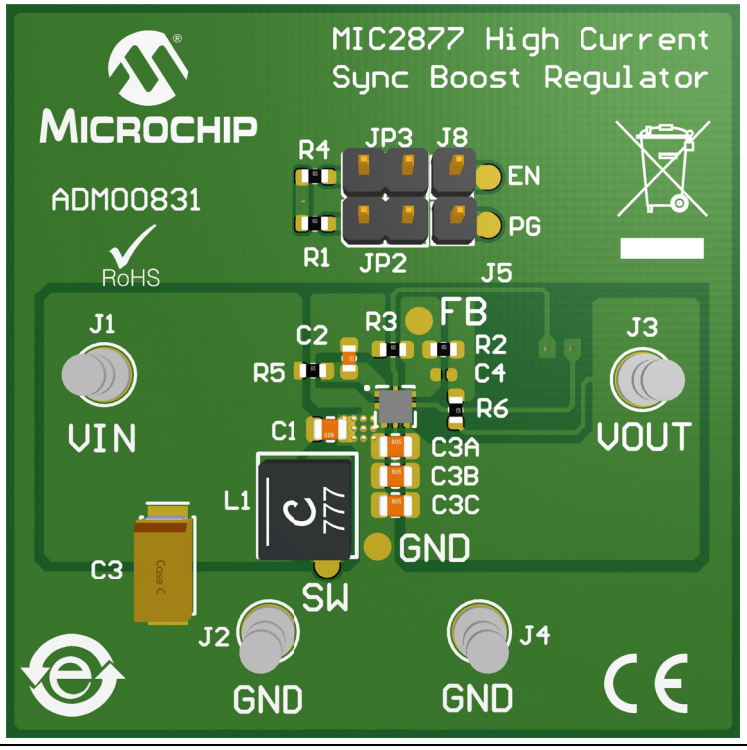


FIGURE 1-1: *MIC2877 Evaluation Board Top View.*

1.2 MIC2877 EVALUATION BOARD FEATURES

The MIC2877 Evaluation Board has the following features:

- 2.5V to 5.5V input voltage
- Up to 1.5A continuous-load current for 2.5V<V_{IN}<3.0V
- Up to 2A continuous-load current for V_{IN}>3.0V
- Up to 95% efficiency
- 2 MHz switching frequency
- Configurable for all four fixed-output voltage versions (4.75V, 5.0V, 5.25V, 5.5V) and for the adjustable version
- Bidirectional true load disconnect
- Automatic bypass mode (when V_{IN} > V_{OUT})
- Soft-start
- Programmable output voltage

1.3 WHAT DOES THE MIC2877 EVALUATION BOARD KIT INCLUDE?

The MIC2877 High-Current Synchronous Boost Regulator Evaluation Board kit includes the following items:

- MIC2877 Evaluation Board (ADM00831)
- Important Information Sheet

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Chapter 2. Installation and Operation

2.1 SYSTEM CONFIGURATION AND REQUIREMENTS

The MIC2877 Evaluation Board requires a bench power supply, adjustable from 2.5V to 5.5V, with at least 6.5 current capability, in order to handle the input peak current at heavy load.

CAUTION

The MIC2877 Evaluation Board does not have reverse polarity protection. Applying a negative voltage between the V_{IN} terminal and the ground (GND) terminal can damage the device. The input voltage should not exceed 5.5V.

The input power leads should be as short as possible in order to minimize the inductance and limit the power loss. Input voltage measurements should be made at the V_{IN} and GND terminals to make sure that the voltage-drop on the input power leads are not included.

2.2 GETTING STARTED

2.2.1 Connecting an External Supply to the V_{IN} Terminals

Apply the desired input voltage to the V_{IN} and GND terminals of the MIC2877 Evaluation Board, paying careful attention to polarity and the supply range (2.5V to 5.5V). An ammeter can be placed between the power supply and the input terminal of the MIC2877 Evaluation Board to monitor the input current. Make sure that the supply voltage is monitored at the V_{IN} terminal as the ammeter and/or the power-lead resistance can reduce the voltage supplied to the input.

2.2.2 Connecting a Load to V_{OUT} and GND Terminals

The load connected between the V_{OUT} and GND terminals of the MIC2877 Evaluation Board can be either passive (resistive) or active (electronic load). In case of electronic load, keep the load disabled until the MIC2877 Evaluation Board has been powered up. An ammeter may be placed between the load and the output terminal to monitor the current load. Ensure that the output voltage is monitored across the V_{OUT} and GND terminals.

2.2.3 Enabling and Disabling the MIC2877

The MIC2877 Evaluation Board has an enable (EN) pin (JP3 pin 2).The MIC2877 Evaluation Board is in normal regulation mode when the EN pin is asserted high. Placing a jumper on JP3 connects the EN pin to V_{IN} through a 10 kΩ pull-up resistor. If this pin is driven low, the IC is in shut-down state. This pin has an internal weak pull-down (2.5 MΩ resistor) and should never be left open.

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2.2.4 Power-Good (PG) Monitoring Function

A power-good (PG) test pin (JP2 pin 2) is provided for monitoring the power-good function. It is an open drain active high output power-good output. Placing the jumper on JP2 connects the PG pin to V_{IN} through a 1 MΩ pull-up resistor. This pin is asserted high when the output is above the PG threshold (91% of the nominal V_{OUT}).

2.3 CIRCUIT DESCRIPTION

2.3.1 Bidirectional Output Disconnect

The power stage of the MIC2877 consists of an NMOS transistor as the main switch and a PMOS transistor as the synchronous rectifier. A control circuit turns off the back gate diode of the PMOS in order to isolate the output from the input supply when the chip is disabled (V_{EN} = 0V).

2.3.2 Transient Response

A 150 µF tantalum capacitor is placed on the MIC2877 Evaluation Board in order to prevent the false UVLO trigger during load transient evaluation (caused by the input voltage dropping under UVLO threshold), especially for low-input voltages and high-load current steps.

2.3.3 Integrated Anti-Ringing Switch

MIC2877 includes an anti-ringing switch, which eliminates the ringing on the SW node of a conventional boost converter operating in the discontinuous conduction mode (DCM). At the end of a switching cycle, during DCM operation, both the NMOS and the PMOS are turned off. The anti-ringing switch in the MIC2877 clamps the SW pin voltage to the input, to dissipate the remaining energy stored in the inductor and the parasitic elements of the power switches.

2.3.4 Automatic Bypass Mode (when V_{IN}>V_{OUT})

The MIC2877 automatically operates in bypass mode when the input voltage is higher than the target output voltage. In bypass mode, the NMOS is turned off while the PMOS is fully turned on to provide a very low impedance path from the input to the output.

2.3.5 Soft-Start

The MIC2877 device integrates an internal soft-start circuit to limit the inrush current during start-up. When the device is enabled, the PMOS is slowly turned on to charge the output capacitor to a voltage close to the input voltage. Then the device starts the boost switching cycles in order to gradually charge up the output voltage to the target V_{OUT}.

2.3.6 Output Voltage Programming

The MIC2877 Evaluation Board supports both the adjustable and the fixed output voltage versions of the device. For the adjustable version, the output voltage can be set by an external resistor divider (R2 and R3). The typical feedback voltage is 900 mV and the recommended maximum output voltage is 5.5V. The current through the resistor divider should be significantly larger than the current into the FB pin (0.01 µA typical). It is recommended that the total resistance of R2 and R3 should be in the order of 1 MΩ or less, for accurate output voltage setting. The appropriate R2 and R3 values for the desired output voltage are calculated as Equation 2-1 shows.

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EQUATION 2-1:

$$R2 = R3 \times \left(\frac{V_{OUT}}{0.9V} - 1\right)$$

Note: If a MIC2877 fixed output voltage version is used, R2 must be shorted and R3 must be removed from the board.

2.3.7 Testing with Inductive or Active Loads

The MIC2877 is designed for on-board power conversion and with on-board loads in mind, where stray inductance is very small. This allows for a very compact solution, with a small amount of input and output capacitance. When testing the MIC2877 remotely, active loads or inductive loads (for instance, load boards with long leads or large rheostats), a Schottky diode (20V, 0.5A-1A ratings) should be added with the anode connected to ground and cathode connected to the output of the MIC2877 Evaluation Board. This is done to prevent the output from being pulled below ground, which can damage the part.

This precaution is particularly important when exercising protections, for example, the thermal shutdown or when exercising any other condition that may trigger protections and shutdown the part. When the protection triggers, the current delivered by the MIC2877 will exhibit a sudden change. If significant inductance is present on the load side or if the current sink capability of the load is maintained down to very low voltages, the output may be pulled below ground by more than 0.3V, exceeding the absolute maximum ratings of the device.

2.3.8 Input Bulk Capacitor

A similar phenomenon may also endanger the part from the input side, especially when testing with high-input voltages. Long power-supply leads are inductive. When the protection triggers, or when the load drops very rapidly in normal conditions, the current consumption of the MIC2877 will also exhibit a sudden change. The lead inductance will discharge into the input capacitor, causing the input voltage to rise. If the input capacitance at the MIC2877 is too small, the input voltage spike may rise to a point where the device is damaged. This is the reason why some extra bulk capacitance is provided at the input side of the MIC2877 Evaluation Board. If the input supply to the MIC2877 has some significant stray inductance and it is close to the maximum rating, the input bulk capacitor is mandatory. Its value can be increased as needed to keep the overvoltage within the safe limits. Since the current change through the MIC2877 is instantaneous, the ESR of the input bulk capacitor should also be small.

NOTES:

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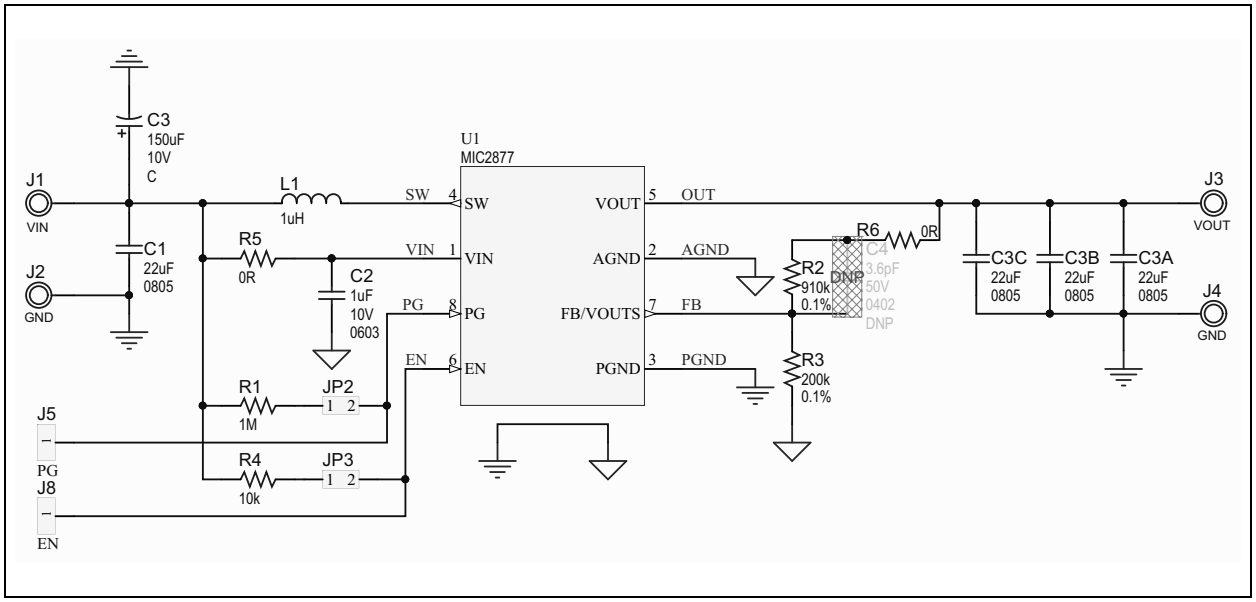
Appendix A. Schematic and Layouts

This appendix contains the following schematics and layouts for the MIC2877 Evaluation Board (ADM00831).

- Board - Schematic
- Board - Top Silk
- Board - Top Copper and Silk
- Board - Top Copper
- Board - Bottom Copper
- Board - Bottom Copper and Silk
- Board - Bottom Silk

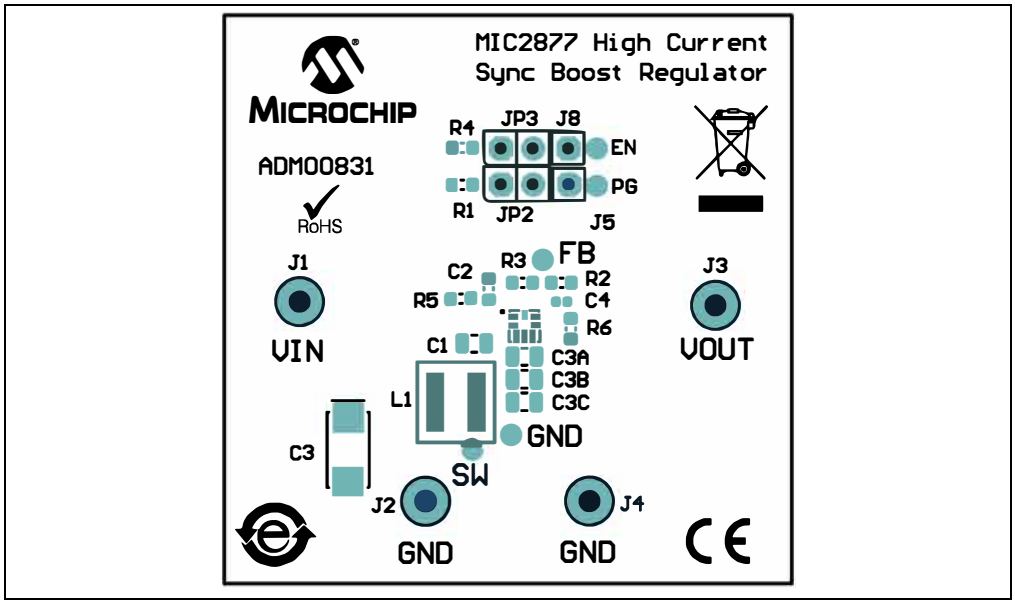
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A.1 BOARD - SCHEMATIC

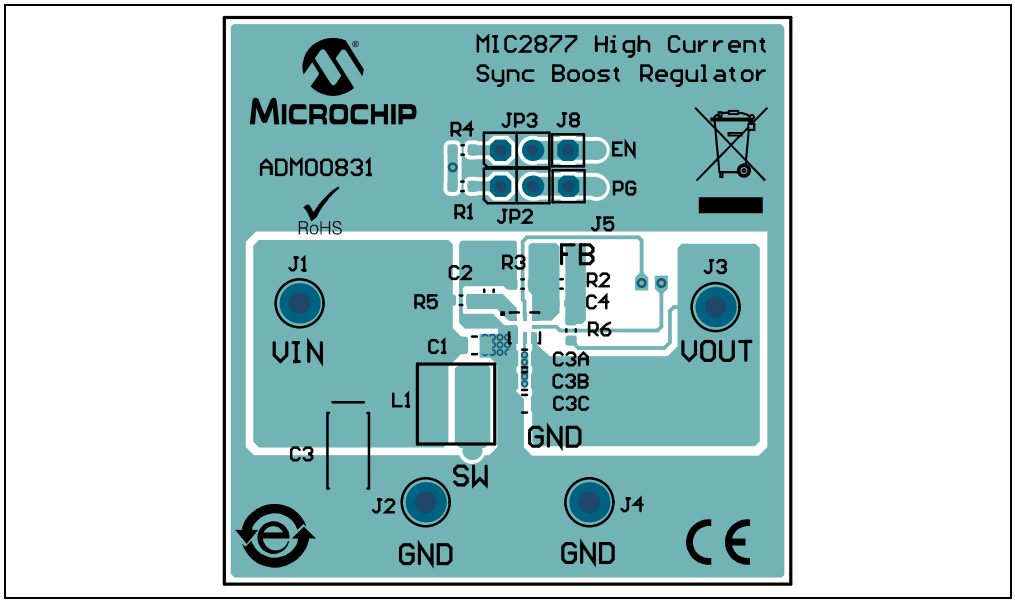


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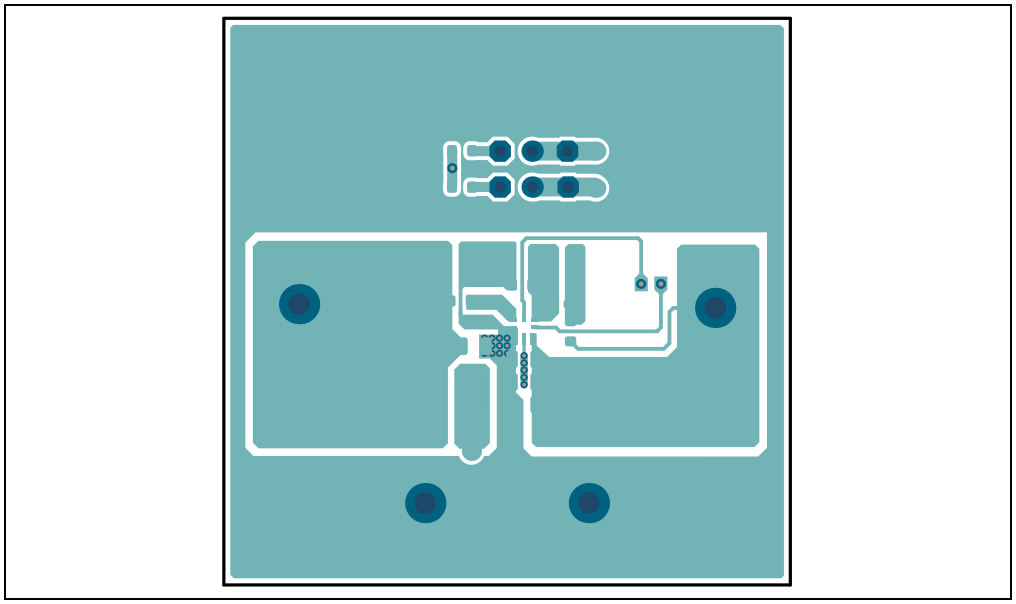
A.2 BOARD - TOP SILK



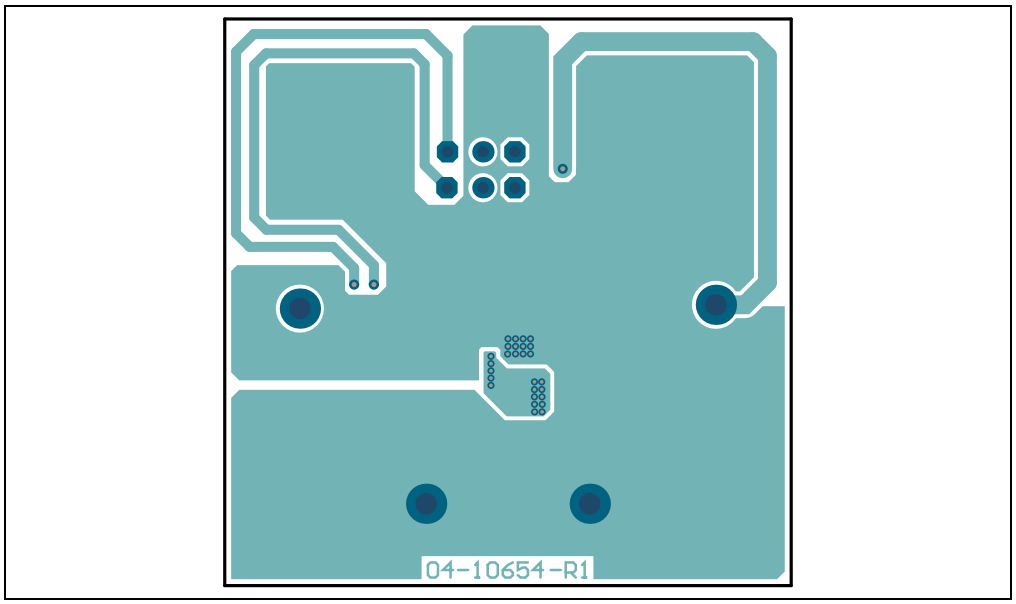
A.3 BOARD - TOP COPPER AND SILK



A.4 BOARD - TOP COPPER

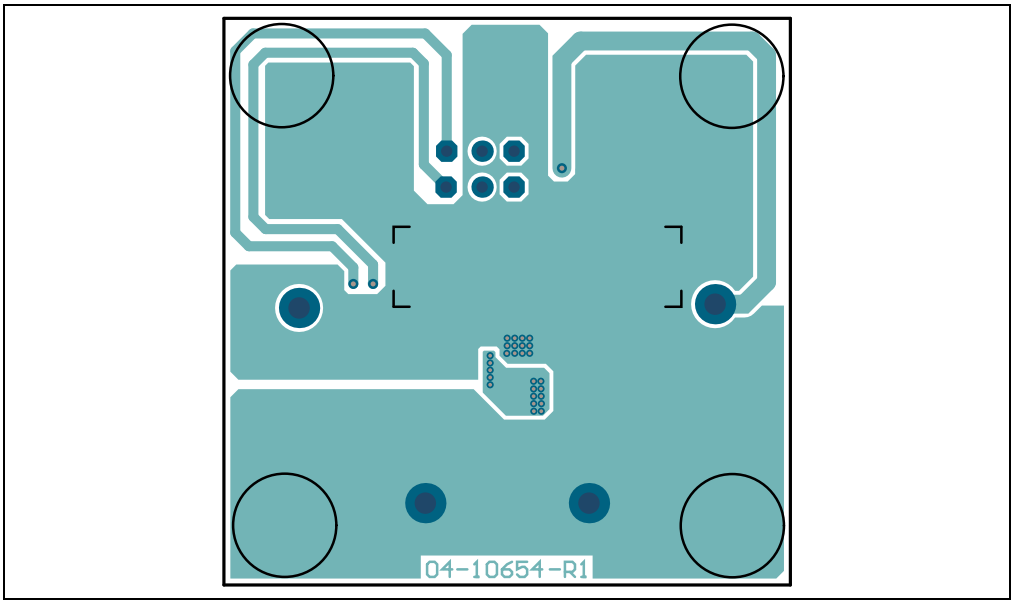


A.5 BOARD - BOTTOM COPPER

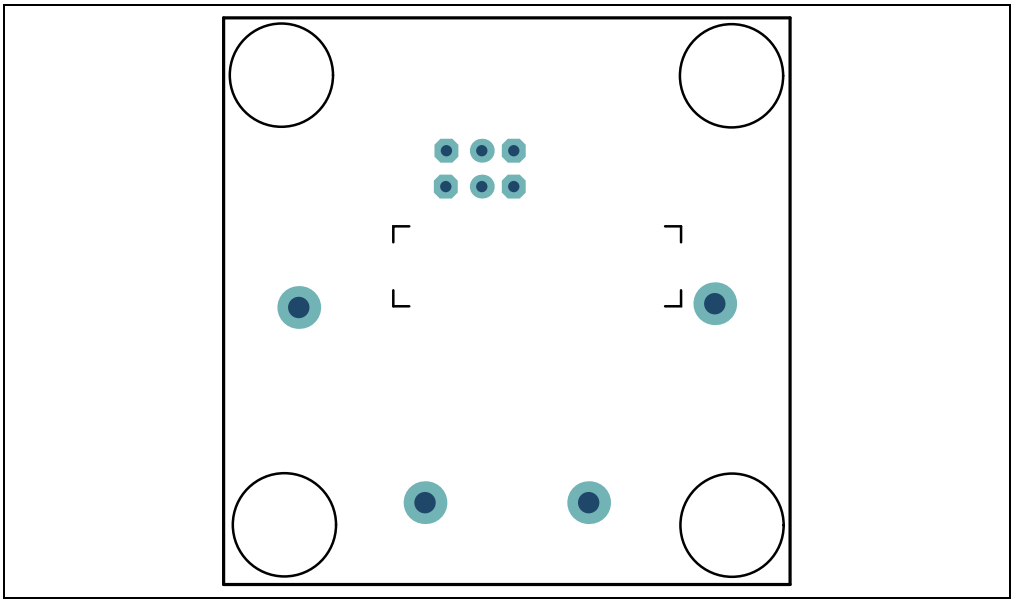


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A.6 BOARD - BOTTOM COPPER AND SILK



A.7 BOARD - BOTTOM SILK



NOTES:

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Appendix B. Bill of Materials (BOM)

TABLE B-1: MIC2877 HIGH-CURRENT SYNCHRONOUS BOOST REGULATOR EVALUATION BOARD - BILL OF MATERIALS (BOM)

Qty.	Reference	Description	Manufacturer	Part Number
4	C1, C3A, C3B, C3C	Capacitor Ceramic, 22 µF, 10V, 20%, X5R, SMD, 0805	Taiyo Yuden Co., Ltd.	LMK212BJ226MG-T
1	C2	Capacitor Ceramic, 1 µF, 10V, 10%, X5R, SMD, 0603	Murata Manufacturing Co., Ltd.	GRM188R61A105KA61D
1	C3	Capacitor Tantalum, 150 µF, 20%, 10V, SMD, C	KEMET	T520C157M010ATE055
2	JP2, JP3	CON, HDR-2.54, Male, 1x2, Tin, 6.10 MH, TH, VERT	Molex®	0022284020
2	JP2, JP3	Mechanical HW Jumper, 2.54 mm, 1x2, Phosphor Bronze, with Handle	Jameco® Electronics	2012JH-R
1	L1	Inductor, 1 µH, 11.1A, 20%, SMD, L5.28, W5.48, H3.1	Coilcraft	XAL5030-102MEC
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	Printed Circuit Board - MIC2877 Evaluation Board	Microchip Technology Inc.	**04-10654-R1**
1	R1	Resistor TKF, 1M, 5%, 1/10W, SMD, 0603	Panasonic® - ECG	ERJ-3GEYJ105V
2	R5, R6	Resistor TKF, 0R, 1/10W, SMD, 0603	Panasonic® - ECG	ERJ-3GSY0R00V
1	R4	Resistor TKF, 10k, 5%, 1/10W, SMD, 0603	Panasonic® - ECG	ERJ-3GEYJ103V
1	R2	Resistor TF, 910k, 0.1%, 1/16W, SMD, 0603	TE Connectivity, Ltd.	CPF0603B910KE1
1	R3	Resistor TF, 200k, 0.1%, 1/10W, SMD, 0603	Panasonic® - ECG	ERA-3AEB204V
8	J1, J2, J3, J4	CON TP, Pin, Tin, TH	Harwin Plc.	H2121-01
1	U1	MCHP Analog Switcher Boost, 3V, to 5.5V, MIC2877AYFT, FTQFN-8	Microchip Technology Inc.	**MIC2877AYFT**
0	C4	Capacitor Ceramic, 10 pF, 25V, 10%, NP0, SMD, 0603	AVX Corporation	06033A100KAT2A

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.

2: MIC2877 Evaluation Board is populated by default with the adjustable output voltage chip version (MIC2877-AYFT-TR). If one of the four fixed output voltage chip versions (MIC2877-4.75YFT-TR, MIC2877-5.0YFT-TR, MIC2877-5.25YFT-TR, MIC2877-5.5YFT-TR) is used, R5 must be replaced with a 0Ω resistor, while R6 must be removed from the MIC2877 Evaluation Board.

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TABLE B-2: DO NOT POPULATE

Qty.	Reference	Description	Manufacturer	Part Number
1	C4	Capacitor Ceramic, 10 pF, 25V, 10%, NP0, SMD, 0603	AVX Corporation	06033A100KAT2A

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.

2: MIC2877 Evaluation Board is populated by default with the adjustable output voltage chip version (MIC2877-AYFT-TR). If one of the four fixed output voltage chip versions (MIC2877-4.75YFT-TR, MIC2877-5.0YFT-TR, MIC2877-5.25YFT-TR, MIC2877-5.5YFT-TR) is used, R5 must be replaced with a 0Ω resist or, while R6 must be removed from the MIC2877 Evaluation Board.

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