MCP6421 Electromagnetic Interference Rejection Ratio Evaluation Board User's Guide

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Object of Declaration: MCP6421 EMIRR Evaluation Board

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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 a Finished Appliance, nor is it intended for incorporation into Finished Appliances that are made commercially available as single functional units to end users under 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

16-July-2013
Date

NOTES:

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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 "DSXXXXXA", where "XXXXX" 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 MCP6421 EMIRR 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 MCP6421 EMIRR 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 MCP6421 EMIRR Evaluation Board.
- **Chapter 2. "Installation and Operation"** – Includes instructions on how to set up and operate the MCP6421 EMIRR Evaluation Board.
- **Appendix A. "Schematic and Layouts"** – Shows the schematic and layout diagrams for the MCP6421 EMIRR Evaluation Board.
- **Appendix B. "Bill of Materials (BOM)"** – Lists the parts used to build the MCP6421 EMIRR 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 MCP6421 EMIRR Evaluation Board. Other useful documents are listed below. The following Microchip document is available and recommended as a supplemental reference resource.

- **MCP6421 Data Sheet – *"4.4 µA, 90 kHz Op Amp"* (DS25165)**

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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 (August 2013)

- Initial Release of this Document.

NOTES:

Chapter 1. Product Overview

1.1 INTRODUCTION

The MCP6421 EMIRR Evaluation Board is described as follows:

- Assembly #: ADM00443
- Order #: MCP6421EV-EMIRR
- Name: MCP6421 EMIRR Evaluation Board

Items discussed in this chapter include:

- MCP6421 EMIRR Evaluation Board Description
- MCP6421 EMIRR Evaluation Board Kit Contents

1.2 MCP6421 EMIRR EVALUATION BOARD DESCRIPTION

The MCP6421 EMIRR Evaluation Board is intended to support the electromagnetic interference rejection ratio (EMIRR) measurement and to show the electromagnetic interference (EMI) rejection capability of the MCP6421 operational amplifier.

The MCP6421 EMIRR Evaluation Board has the following features:

- All of the component labels on the board are consistent with those on the schematic
- Supports the MCP6421 single op amp SC70-5 package from Microchip Technology, Inc.
- Test points for connection to lab equipment
- Single supply or dual-supply configuration

Figure 1-1 shows the block diagram of the MCP6421 EMIRR Evaluation Board. Lab equipment can be attached (via test points) to measure the EMIRR response.

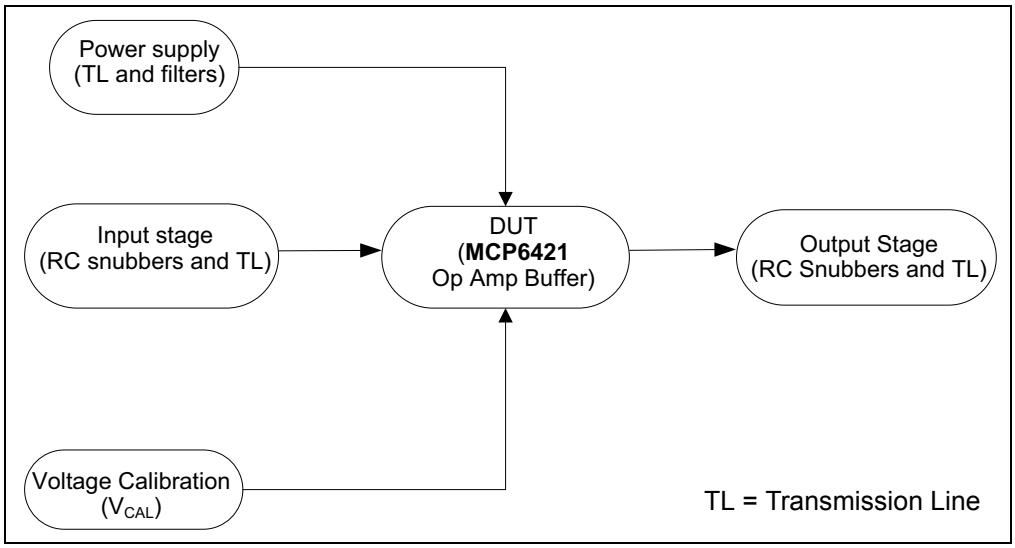


FIGURE 1-1: *MCP6421 EMIRR Evaluation Board – Block Diagram.*

1.3 MCP6421 EMIRR EVALUATION BOARD KIT CONTENTS

This MCP6421 EMIRR Evaluation Board kit includes:

- MCP6421 EMIRR Evaluation Board (ADM00443)
- Important Information Sheet

FIGURE 1-2: *MCP6421 EMIRR Evaluation Board.*

Chapter 2. Installation and Operation

2.1 INTRODUCTION

This chapter shows how to set up the MCP6421EMIRR Evaluation Board. Topics discussed in this chapter include:

- Required Tools
- MCP6421 EMIRR Evaluation Board Setup
- MCP6421 EMIRR Evaluation Board Operation

2.2 REQUIRED TOOLS

The following tools are required for testing the functionality of the board:

- Lab power supply
- High-frequency function generator
- Lab measurement equipment (e.g., network analyzer)

2.3 MCP6421 EMIRR EVALUATION BOARD SETUP

The MCP6421 EMIRR Evaluation Board uses a single op amp in buffer configuration with RC snubbers as terminations. Figure 2-1 shows the circuit diagram for the board.

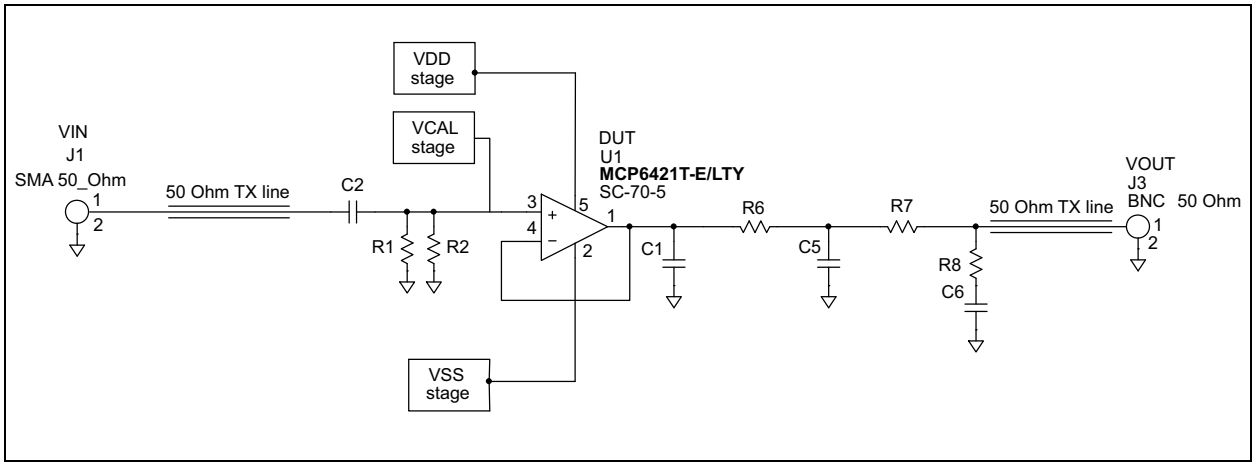


FIGURE 2-1: *MCP6421 EMIRR Evaluation Board Circuit Diagram.*

The power supply voltage needs to be within the allowed range for the op amp. The MCP6421 op amp supports a maximum of 5.5V power supply. Power supply is ensured by a 50Ω transmission line and by LC filters to minimize noise injection (see Figure 2-3).

All component labels on the board are consistent with those on the schematic. The op amp uses the SC70-5 package.

The BNC and SMA connectors for the power supply, ground, input signals, output signals, and voltage calibration allow the lab equipment to be connected to the board. The MCP6421 EMIRR Evaluation Board top view is shown in Figure 2-2.

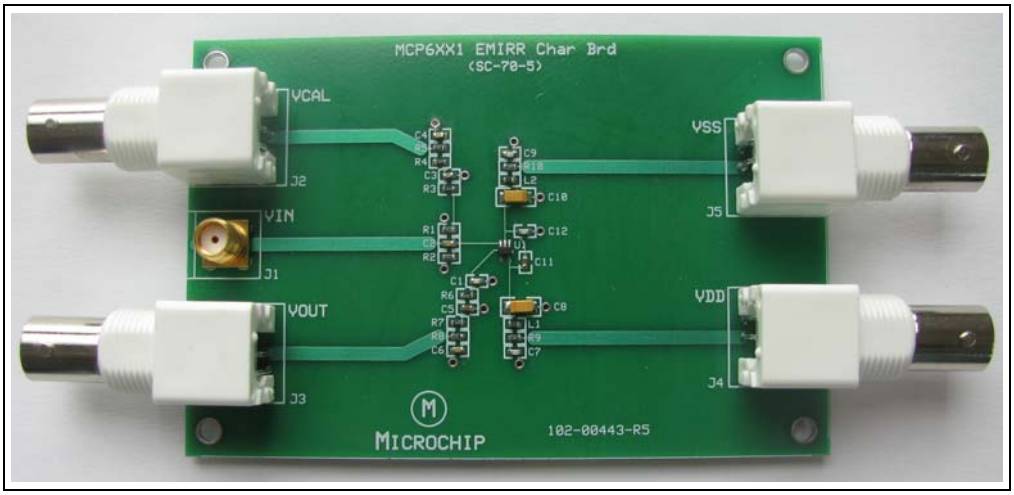


FIGURE 2-2: *MCP6421 EMIRR Evaluation Board Top View.*

2.3.1 Top Level Amplifier Circuit Diagram

2.3.1.1 POWER SUPPLY BLOCK

The op amp is biased by a 50Ω transmission line, RC snubbers and LC low-pass filter to reject high-frequency power supply noise. Figure 2-3 shows the circuit diagram for the power supply, where R9 = R10 = 49.9Ω, C7 = C9 = C12 = 100 pF, C8 = C10 = 10 uF, C11 = 100 nF and L1 = L2 = 470Ω ferrite.

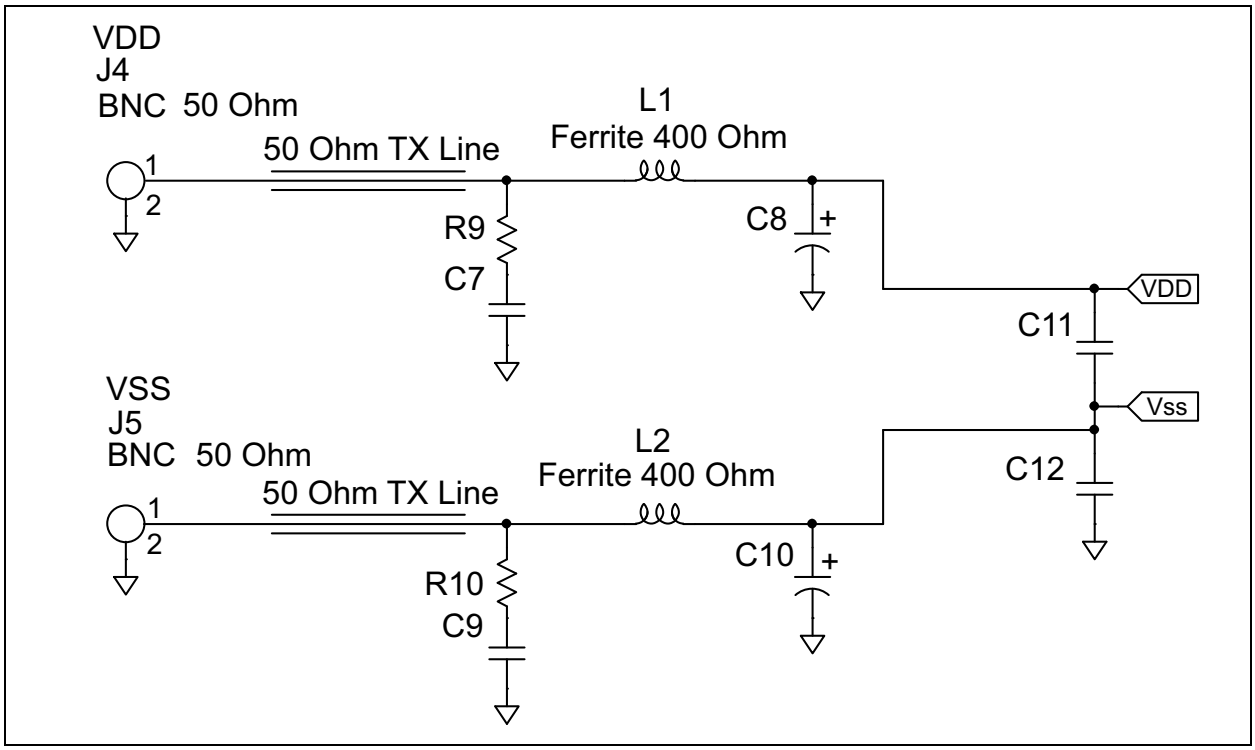


FIGURE 2-3: *Circuit Diagram for Power Supply.*

2.3.1.2 INPUT STAGE

The input section consists of a 50Ω transmission line to match the output impedance of the signal generator and a capacitor to couple AC signal and two parallel resistors that give 50Ω input impedance at the op amp input. The AC coupled input signal minimizes changes in the DC input offset. Figure 2-4 shows the circuit diagram for the input section (R1 = R2 = 100Ω, C2 = 10 nF).

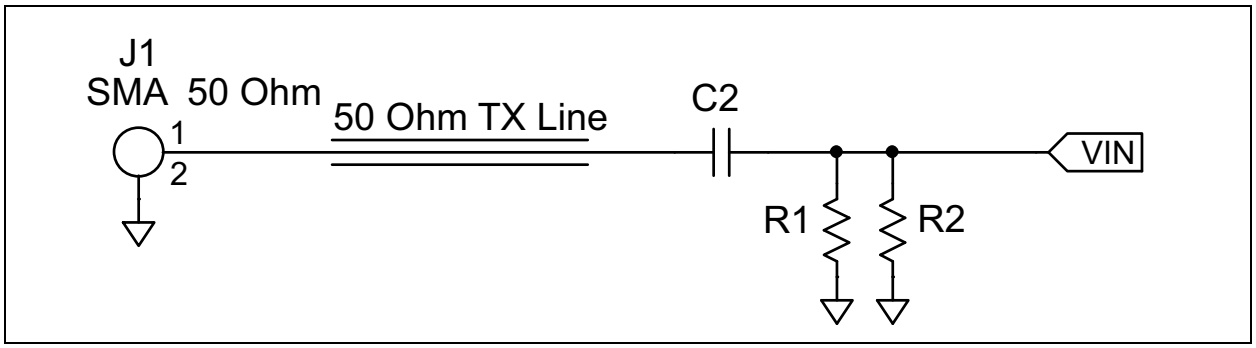


FIGURE 2-4: *Input Stage Block.*

2.3.1.3 OUTPUT STAGE

The output section consists of a 50Ω transmission line to match the input of the network analyzer and to minimize the inductance, antenna effects and disturbance effects, and a double pole RC low-pass filter to minimize DC loading and crosstalk. Figure 2-5 shows the circuit diagram of the output section (R6 = R7 = 10 kΩ, R8 = 49.9Ω, C5 = 100 nF, C6 = 10 nF).

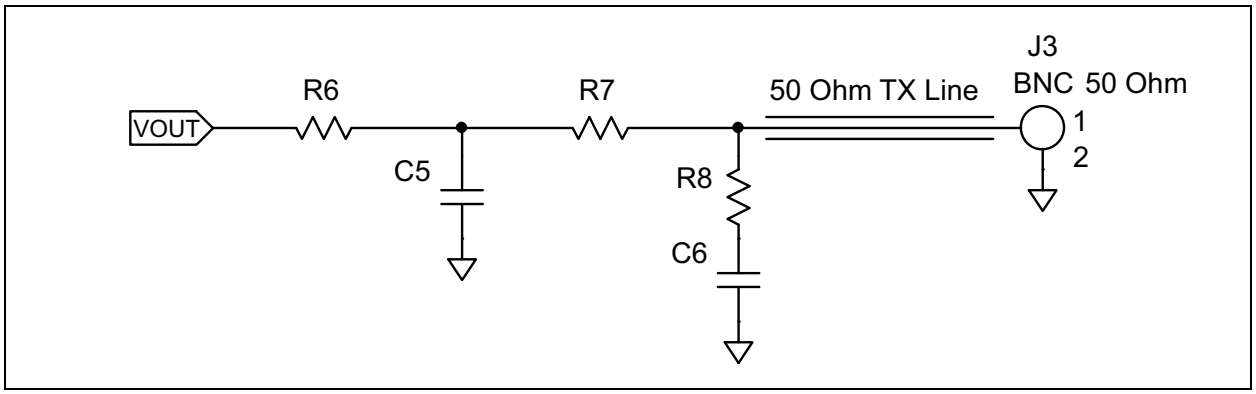


FIGURE 2-5: *Output Stage Block.*

2.3.1.4 CALIBRATION STAGE

The calibration stage consists of a 50Ω transmission line and a double pole RC low-pass filter, and is the same as the output stage. The calibration stage provides a DC output from V_{IN}, after the coupling capacitor, measuring the op amp offset without input signal. Measure the 2nd harmonic distortion (HD2) for the AC source to offset conversion versus frequency and power without populating the op amp, and correct the DC output from V_{OUT} using both calibration measurements. Figure 2-6 shows the circuit diagram of the calibration stage (C4 = 10 nF, C3 = 100 nF, R5 = 49.9Ω and R3 = R4 = 10 kΩ).

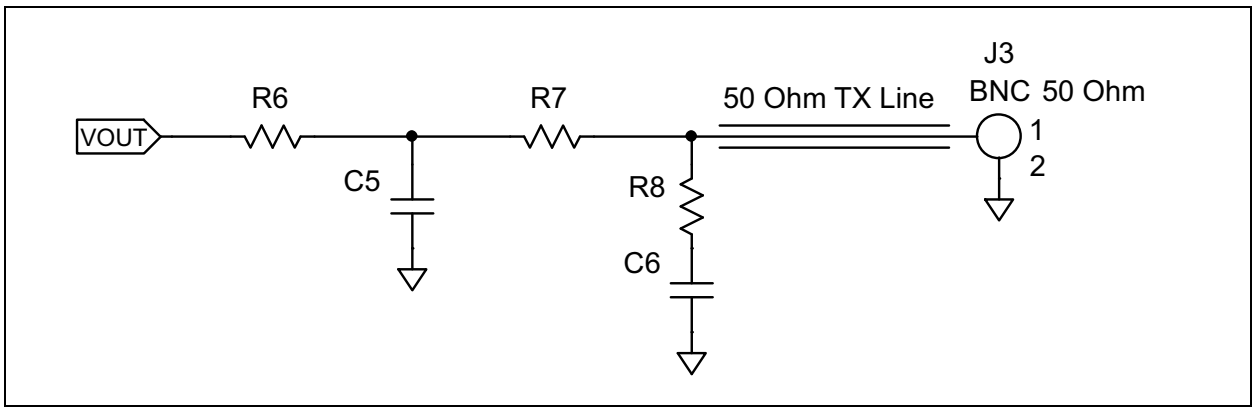


FIGURE 2-6: *Circuit Diagram for Calibration Stage.*

2.3.1.5 DEVICE UNDER TEST (DUT) STAGE

The DUT block consists of an op amp in buffer configuration with one capacitor on the output. Figure 2-7 shows the circuit diagram of the DUT buffer block. The output capacitor (C1 = 22 pF) and parasitic layout capacitance present an output capacitive load of about 30 pF (standard condition for the data sheet specs).

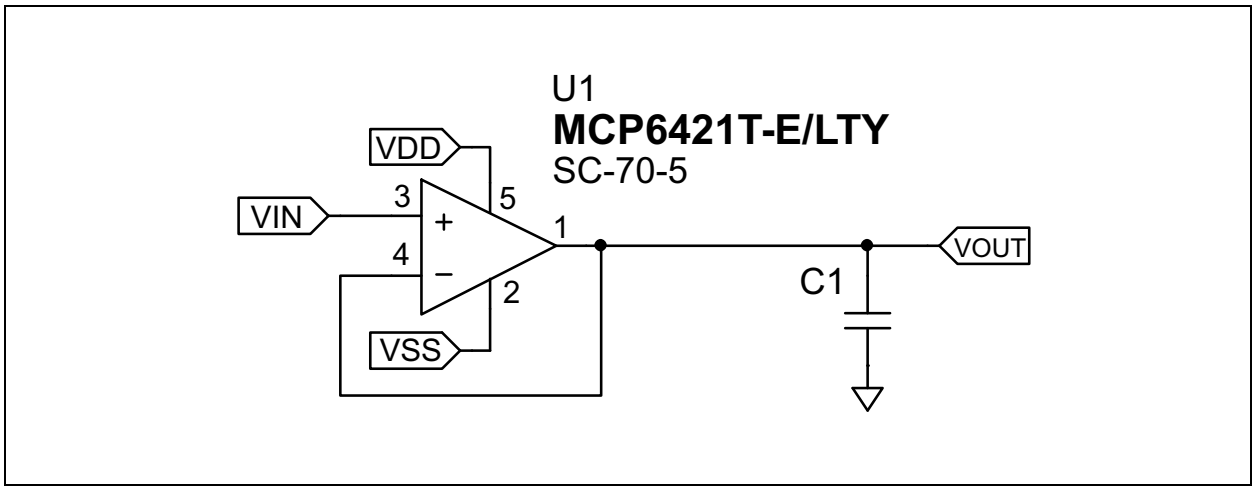


FIGURE 2-7: *Circuit Diagram for Device Under Test Buffer Block.*

2.4 MCP6421 EMIRR EVALUATION BOARD OPERATION

2.4.1 Testing the Amplifier

2.4.1.1 CHECKING THE COAX CONNECTORS

The coax connectors for the power supply, ground, input signals and output signals allow lab equipment to be connected to the board. Figure 2-8 shows the coax connectors to be checked.

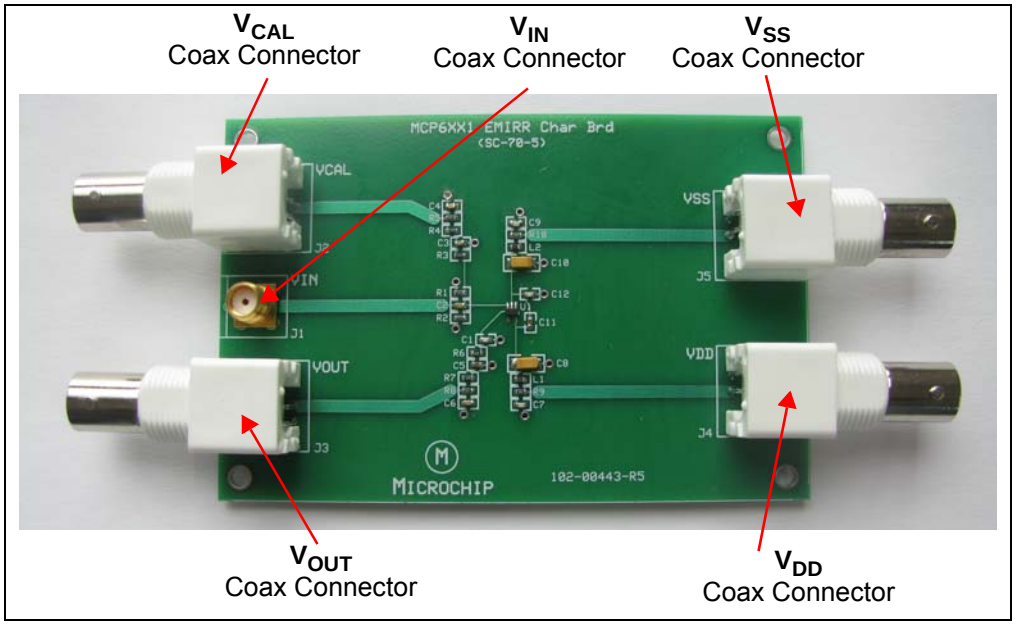


FIGURE 2-8: *Check-in Coax Connectors.*

2.4.1.2 BOARD VALIDATION

This board was built, and its responses were measured. All resistors have 1% tolerance. The capacitors have 5% and 10% tolerance.

2.4.1.2.1 Measurements Results

In Bench Measurement:

- V_{DD} = 5.5V
- V_{CAL}
- The amplifier's gain is 1 V/V

Measure the EMIRR versus frequency. The level of the input signal is 100 mVpp.

Measure the EMIRR as function of the level of the input signal. The frequency of the input signal needs to have the following values: 400 MHz, 900 MHz, 1800 MHz, 2400 MHz.

The EMIRR definition is:

EQUATION 2-1:

$$EMIRR(dB) = 20 \bullet log\left(\frac{V_{RF}}{\Delta V_{OS}}\right)$$

Where:

V_{RF} = Peak Amplitude of RF Interfering signal (V_{PK})

ΔV_{OS} = Input Offset Voltage Shift (V)

Figure 2-9 shows the result of EMIRR versus frequency.

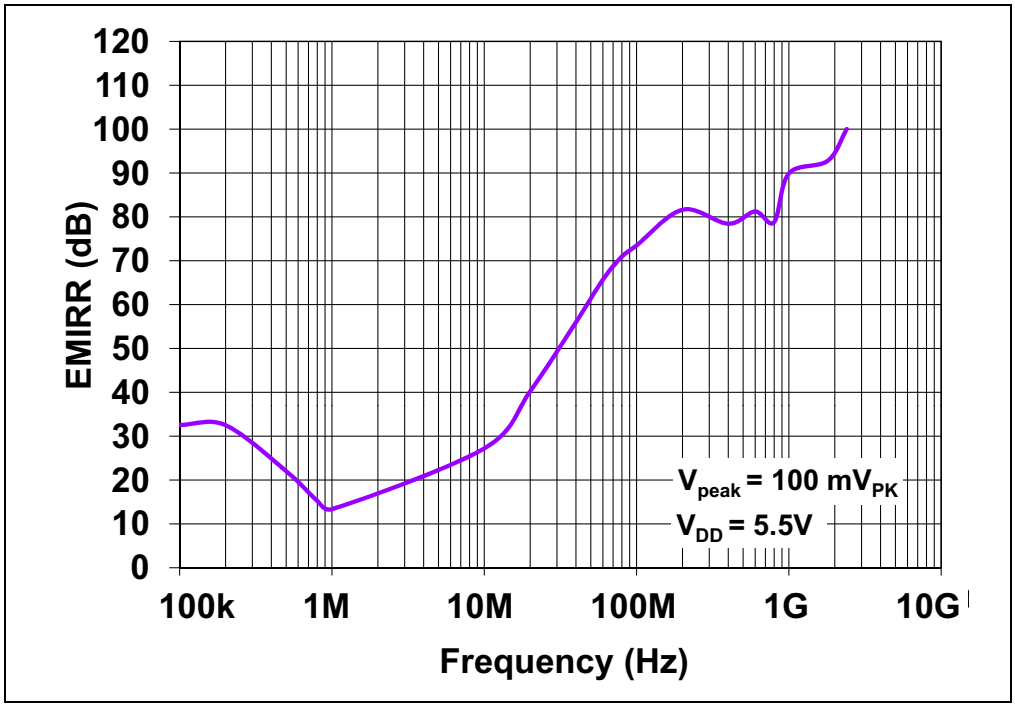


FIGURE 2-9: *Measurement of EMIRR versus Frequency.*

Figure 2-10 shows the result of EMIRR versus RF input peak voltage.

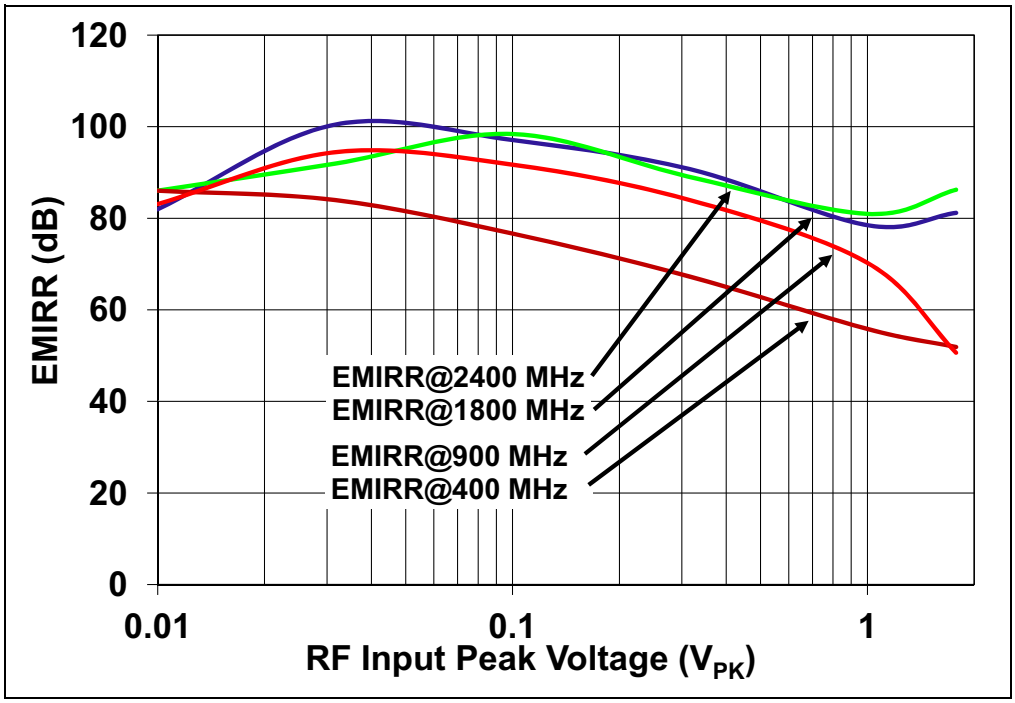


FIGURE 2-10: *Measurement of EMIRR versus RF Input Peak Voltage.*

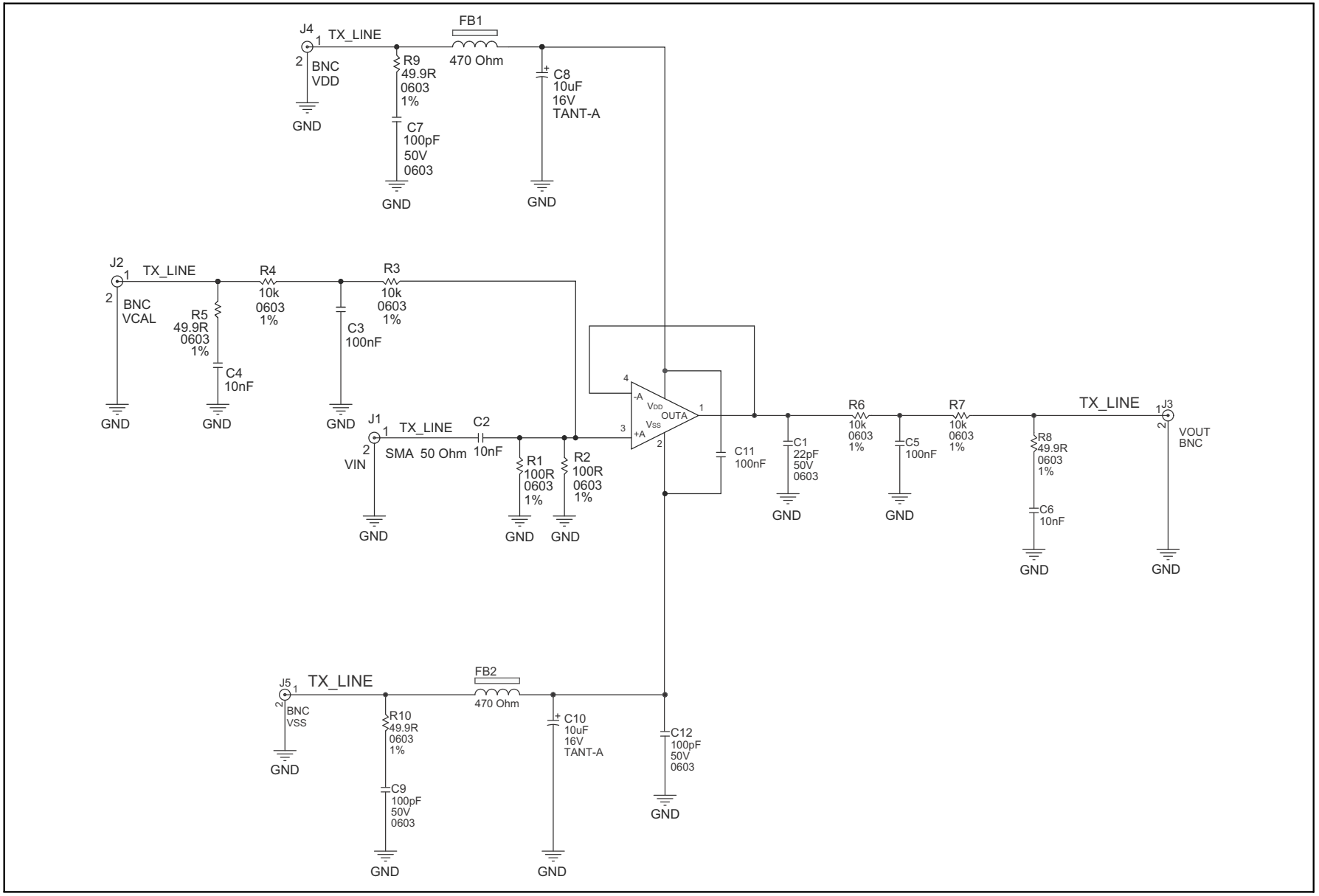
Appendix A. Schematic and Layouts

A.1 INTRODUCTION

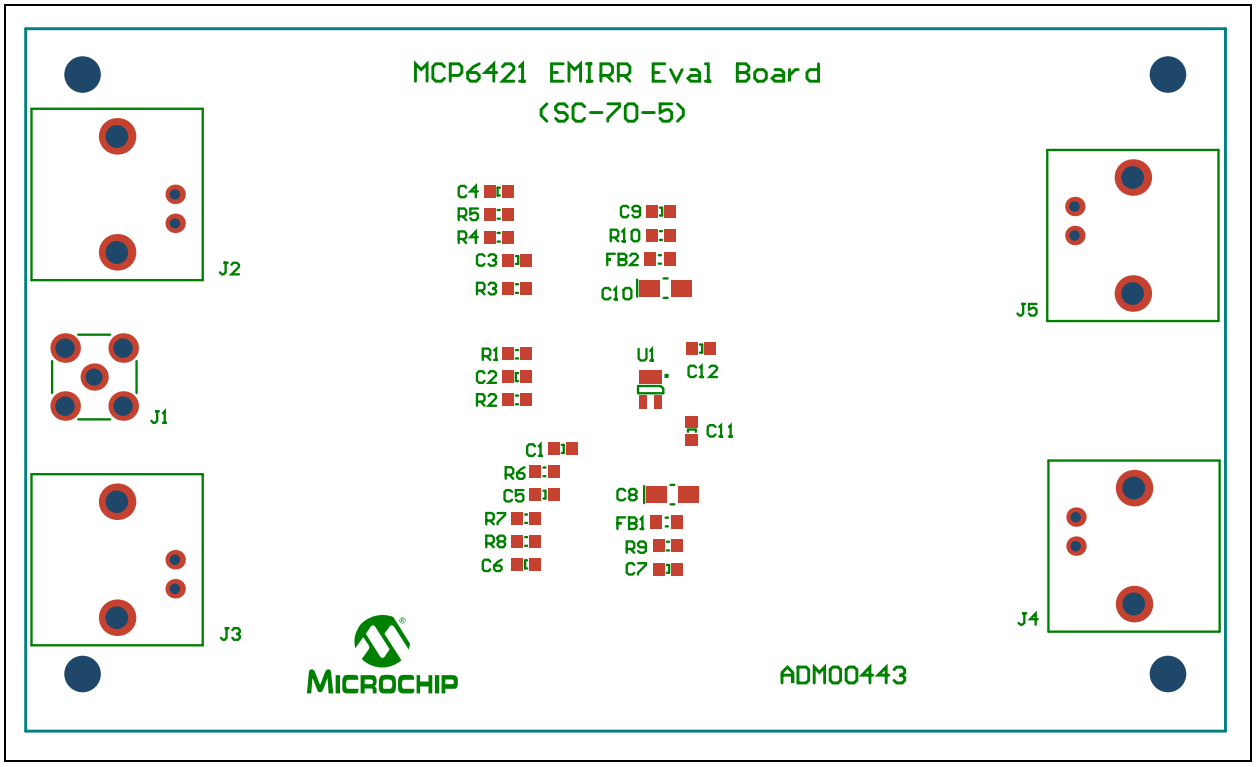
This appendix contains the following schematics and layouts for the MCP6421 EMIRR Evaluation Board:

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

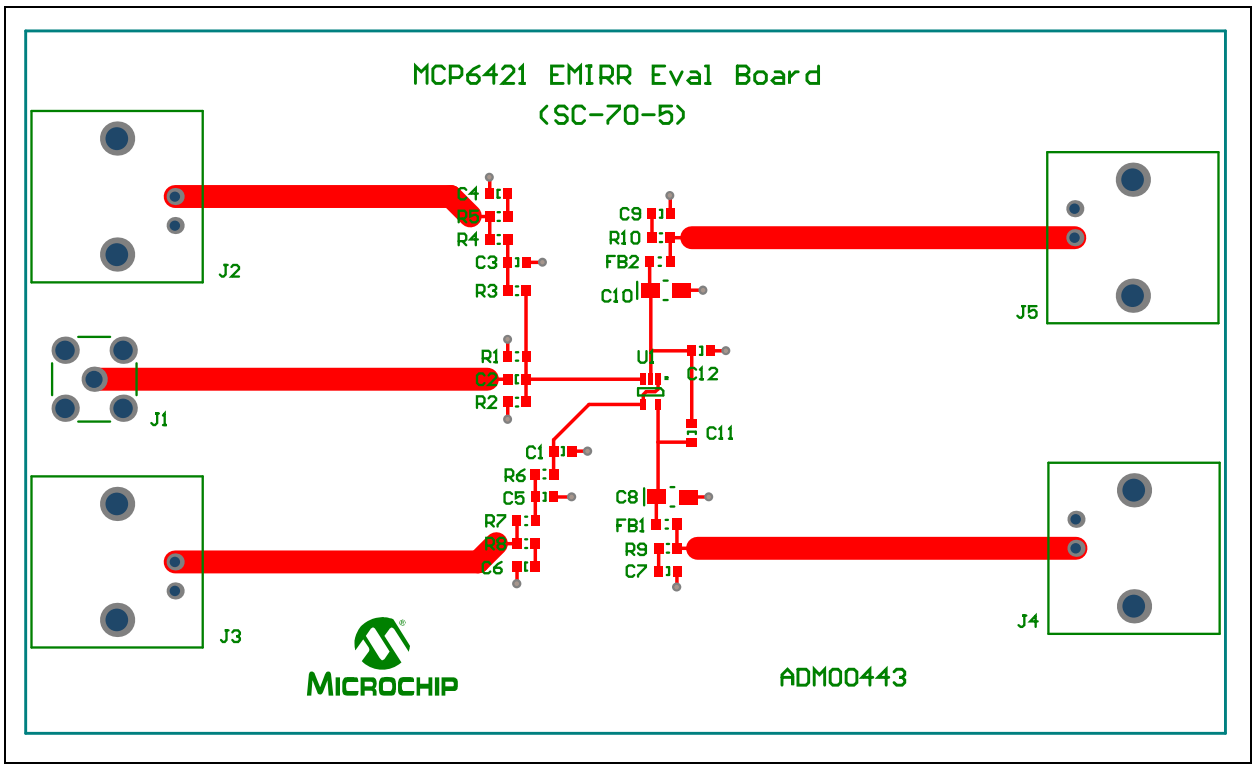
A.2 BOARD – SCHEMATIC



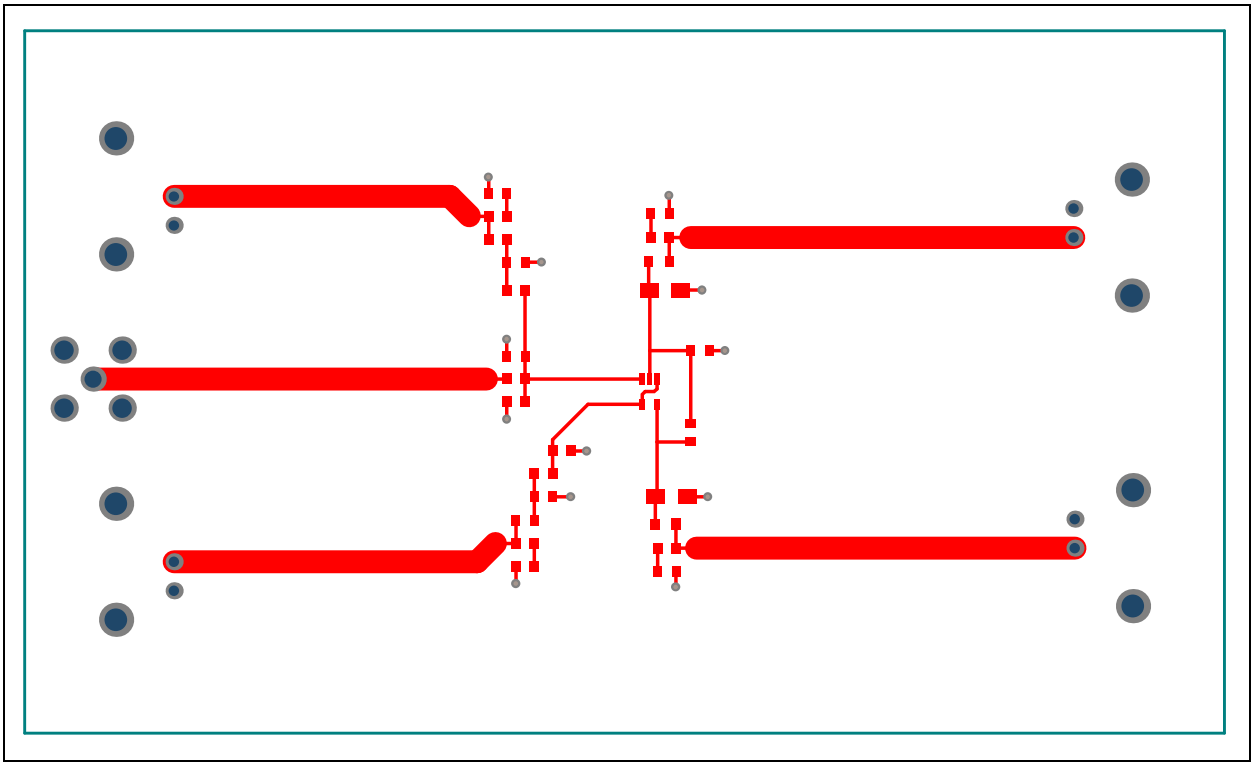
A.3 BOARD – TOP SILK



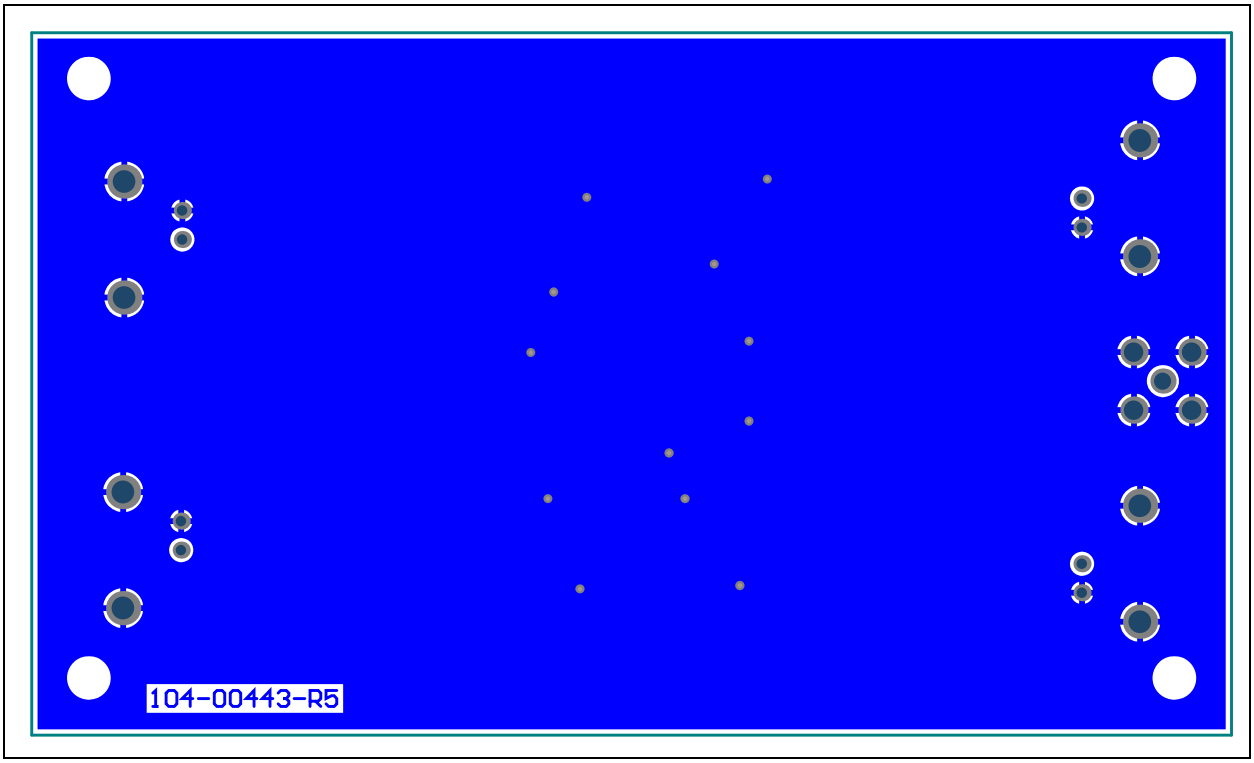
A.4 BOARD – TOP COPPER AND SILK



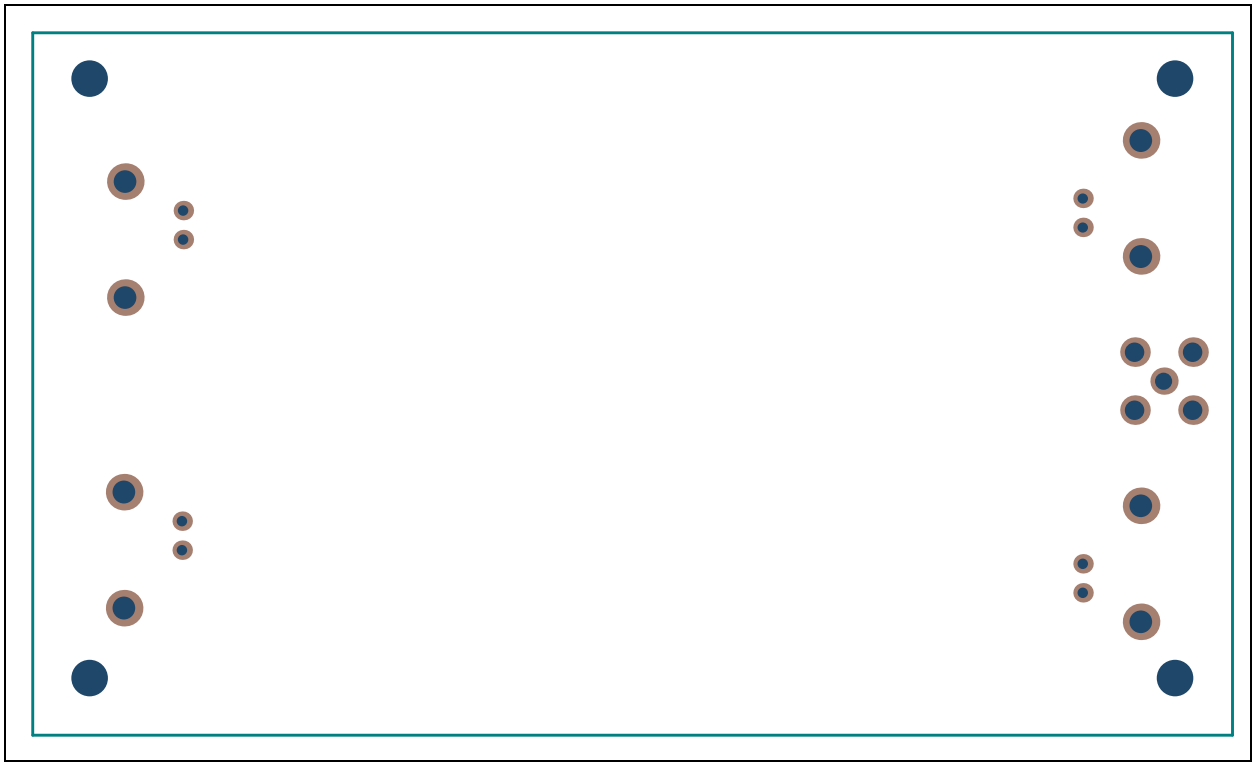
A.5 BOARD – TOP COPPER



A.6 BOARD – BOTTOM COPPER AND SILK



A.7 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	Cap. cer. 22 pF 50V 5% NP0 SMD 0603	Panasonic® - ECG	ECU-V1H220JCV
3	C2, C4, C6	Cap. cer. 10000 pF 50V 10% X7R 0603	AVX Corporation	06035C103KAT2A
3	C3, C5, C11	Cap. cer. 0.1 µF 50V 10% X7R 0603	AVX Corporation	06035C104KAT2A
3	C7, C9, C12	Cap. cer. 100 pF 50V 5% NP0 SMD 0603	Panasonic	ECU-V1H101JCV
2	C8, C10	Cap. Tant. 10 µF 16V 10% 3Ohm SMD A	KEMET®	B45196H3106K109
2	FB1, FB2	Ferrite CHIP 470 OHM 300 mA 0603	Murata Electronics®	BLM18BB471SN1D
1	J1	Conn. SMA jack str. 50 Ohm PCB	Amphenol Commercial	901-144-8RFX
4	J2, J3, J4, J5	Conn. BNC jack str. 50 Ohm PCB	Amphenol Commercial	31-5431-2010
0	PCB	MCP6421 EMIRR Evaluation Board – RoHS compliant Printed Circuit Board	—	104-00443
2	R1, R2	Res. TKF 100R 1% 1/10W SMD 0603	Panasonic	ERJ-3EKF1000V
4	R3, R4, R6, R7	Res. TKF 10k 1% 1/10W SMD 0603	NIC Components Corp.	NRC06F1002TRF
4	R5, R8, R9, R10	Res. TKF 49.9R 1% 1/10W SMD 0603	Panasonic	ERJ-3EKF49R9V
1	U1	MCP6421, SC70-5, single op amp, 90 kHz	Microchip Technology, Inc.	**MCP6421T-E/LTY**

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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