Note the following details of the code protection feature on Microchip devices:

- Microchip products meet the specification contained in their particular Microchip Data Sheet.
- Microchip believes that its family of products is one of the most secure families of its kind on the market today, when used in the intended manner and under normal conditions.
- There are dishonest and possibly illegal methods used to breach the code protection feature. All of these methods, to our knowledge, require using the Microchip products in a manner outside the operating specifications contained in Microchip’s Data Sheets. Most likely, the person doing so is engaged in theft of intellectual property.
- Microchip is willing to work with the customer who is concerned about the integrity of their code.
- Neither Microchip nor any other semiconductor manufacturer can guarantee the security of their code. Code protection does not mean that we are guaranteeing the product as “unbreakable.”

Code protection is constantly evolving. We at Microchip are committed to continuously improving the code protection features of our products. Attempts to break Microchip’s code protection feature may be a violation of the Digital Millennium Copyright Act. If such acts allow unauthorized access to your software or other copyrighted work, you may have a right to sue for relief under that Act.

Trademarks

The Microchip name and logo, the Microchip logo, dsPIC, FlashFlex, KEEL0O, KEEL0O logo, MPLAB, PIC, PICmicro, PICSTART, PIC32 logo, rPIC, SST, SST Logo, SuperFlash and UNI/O are registered trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

FilterLab, Hampshire, HI-TECH C, Linear Active Thermistor, MTP, SEEVAL and The Embedded Control Solutions Company are registered trademarks of Microchip Technology Incorporated in the U.S.A.

Silicon Storage Technology is a registered trademark of Microchip Technology Inc. in other countries.

Analog-for-the-Digital Age, Application Maestro, BodyCom, chipKIT, chipKIT logo, CodeGuard, dsPICDEM, dsPICDEM.net, dsPICWorks, dsSPEAK, ECAN, ECONOMONITOR, FanSense, HI-TIDE, In-Circuit Serial Programming, ICSP, Mindi, MIWI, MPASM, MPF, MPLAB Certified logo, MPLIB, MPLINK, mTouch, Omniscent Code Generation, PICC, PICC-18, PICDEM, PICDEM.net, PICkit, PICtail, REAL ICE, rFLAB, Select Mode, SQI, Serial Quad I/O, Total Endurance, TSHARC, UniWinDriver, WiperLock, ZENA and Z-Scale are trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

SQTP is a service mark of Microchip Technology Incorporated in the U.S.A.

GestiC and ULPP are registered trademarks of Microchip Technology Germany II GmbH & Co. KG, a subsidiary of Microchip Technology Inc., in other countries.

All other trademarks mentioned herein are property of their respective companies.

© 2013, Microchip Technology Incorporated, Printed in the U.S.A., All Rights Reserved.

Printed on recycled paper.

ISBN: 978-1-62077-381-9

QUALITY MANAGEMENT SYSTEM CERTIFIED BY DNV

== ISO/TS 16949 ==

Microchip received ISO/TS-16949:2009 certification for its worldwide headquarters, design and wafer fabrication facilities in Chandler and Tempe, Arizona; Gresham, Oregon and design centers in California and India. The Company’s quality system processes and procedures are for its PIC® MCUs and dsPIC® DSCs, KeeloQ® code hopping devices, Serial EEPROMs, microperipherals, nonvolatile memory and analog products. In addition, Microchip’s quality system for the design and manufacture of development systems is ISO 9001:2000 certified.
Object of Declaration: MCP6421 EMIRR Evaluation Board

EU Declaration of Conformity

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). This development/evaluation tool complies with EU RoHS2 Directive 2011/65/EU.

For information regarding the exclusive, limited warranties applicable to Microchip products, please see Microchip’s standard terms and conditions of sale, which are printed on our sales documentation and available at www.microchip.com.
Signed for and on behalf of Microchip Technology Inc. at Chandler, Arizona, USA

Derek Carlson
VP Development Tools

16 - July - 2013
Date
Table of Contents

Preface ..................................................................................................................................... 7
  Introduction.............................................................................................................................. 7
  Document Layout .................................................................................................................. 7
  Conventions Used in this Guide .......................................................................................... 8
  Recommended Reading ......................................................................................................... 9
  The Microchip Web Site ....................................................................................................... 9
  Customer Support ............................................................................................................... 9
  Document Revision History ............................................................................................... 9

Chapter 1. Product Overview
  1.1 Introduction ................................................................................................................... 11
  1.2 MCP6421 EMIRR Evaluation Board Description ...................................................... 11
  1.3 MCP6421 EMIRR Evaluation Board Kit Contents .................................................... 12

Chapter 2. Installation and Operation
  2.1 Introduction ................................................................................................................... 13
  2.2 Required Tools .............................................................................................................. 13
  2.3 MCP6421 EMIRR Evaluation Board Setup ................................................................ 13
  2.4 MCP6421 EMIRR Evaluation Board Operation ......................................................... 17

Appendix A. Schematic and Layouts
  A.1 Introduction .................................................................................................................. 19
  A.2 Board – Schematic ........................................................................................................ 20
  A.3 Board – Top Silk ............................................................................................................ 21
  A.4 Board – Top Copper and Silk ....................................................................................... 21
  A.5 Board – Top Copper ....................................................................................................... 22
  A.6 Board – Bottom Copper and Silk ................................................................................. 22
  A.7 Board – Bottom Silk ...................................................................................................... 23

Appendix B. Bill of Materials (BOM)

Worldwide Sales and Service ................................................................................................. 26
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

<table>
<thead>
<tr>
<th>Description</th>
<th>Represents</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Arial font:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Italic characters</td>
<td>Referenced books</td>
<td>MPLAB® IDE User’s Guide</td>
</tr>
<tr>
<td>Emphasized text</td>
<td>...is the only compiler...</td>
<td></td>
</tr>
<tr>
<td>Initial caps</td>
<td>A window</td>
<td>the Output window</td>
</tr>
<tr>
<td>A dialog</td>
<td>the Settings dialog</td>
<td></td>
</tr>
<tr>
<td>A menu selection</td>
<td>select Enable Programmer</td>
<td></td>
</tr>
<tr>
<td>Quotes</td>
<td>A field name in a window or dialog</td>
<td>“Save project before build”</td>
</tr>
<tr>
<td>Underlined, italic text with right angle bracket</td>
<td>A menu path</td>
<td>File&gt;Save</td>
</tr>
<tr>
<td>Bold characters</td>
<td>A dialog button</td>
<td>Click OK</td>
</tr>
<tr>
<td>A tab</td>
<td>Click the Power tab</td>
<td></td>
</tr>
<tr>
<td>N'Rnnnn</td>
<td>A number in verilog format, where N is the total number of digits, R is the radix and n is a digit.</td>
<td>4'b0010, 2'hF1</td>
</tr>
<tr>
<td>Text in angle brackets &lt; &gt;</td>
<td>A key on the keyboard</td>
<td>Press &lt;Enter&gt;, &lt;F1&gt;</td>
</tr>
</tbody>
</table>

### Courier New font:

<table>
<thead>
<tr>
<th>Description</th>
<th>Represents</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plain Courier New</td>
<td>Sample source code</td>
<td>#define START</td>
</tr>
<tr>
<td>Filenames</td>
<td>autoexec.bat</td>
<td></td>
</tr>
<tr>
<td>File paths</td>
<td>c:\mcc18\h</td>
<td></td>
</tr>
<tr>
<td>Keywords</td>
<td>.asm, .endasm, static</td>
<td></td>
</tr>
<tr>
<td>Command-line options</td>
<td>-Opa+, -Opa-</td>
<td></td>
</tr>
<tr>
<td>Bit values</td>
<td>0, 1</td>
<td></td>
</tr>
<tr>
<td>Constants</td>
<td>0xFF, ‘A’</td>
<td></td>
</tr>
<tr>
<td>Italic Courier New</td>
<td>A variable argument</td>
<td>file.o, where file can be any valid filename</td>
</tr>
<tr>
<td>Optional arguments</td>
<td>mcc18 [options] file [options]</td>
<td></td>
</tr>
<tr>
<td>Choice of mutually exclusive arguments; an OR selection</td>
<td>errorlevel {0</td>
<td>1}</td>
</tr>
<tr>
<td>Ellipses...</td>
<td>Replaces repeated text</td>
<td>var_name [, var_name...]</td>
</tr>
<tr>
<td>Represents code supplied by user</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>void main (void) { ... }</td>
<td></td>
</tr>
</tbody>
</table>
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)

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

CUSTOMER SUPPORT

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 (August 2013)

- Initial Release of this Document.
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.

![Block Diagram](image-url)

**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.

![Circuit Diagram](image)

**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 $R9 = R10 = 49.9Ω$, $C7 = C9 = C12 = 100 \text{ pF}$, $C8 = C10 = 10 \text{ uF}$, $C11 = 100 \text{ nF}$ 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).

![Input Stage Block](image)

**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).

![Output Stage Block](image)

**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 ($C_4 = 10\, \text{nF}$, $C_3 = 100\, \text{nF}$, $R_5 = 49.9\, \Omega$ and $R_3 = R_4 = 10\, \text{k}\, \Omega$).

![Figure 2-6: Circuit Diagram for Calibration Stage.](image)

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 ($C_1 = 22\, \text{pF}$) 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.](image)
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.

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:

- \( V_{DD} = 5.5 \text{V} \)
- \( V_{CAL} \)
- 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:**

\[
EMIRR(dB) = 20 \cdot \log \left( \frac{V_{RF}}{\Delta V_{OS}} \right)
\]

Where:

- \( V_{RF} = \) Peak Amplitude of RF Interfering signal (V\text{PK})
- \( \Delta V_{OS} = \) Input Offset Voltage Shift (V)
Figure 2-9 shows the result of EMIRR versus frequency.

![Figure 2-9](image.png)

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

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

![Figure 2-10](image.png)

**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.3 BOARD – TOP SILK

A.4 BOARD – TOP COPPER AND SILK
A.5 BOARD – TOP COPPER

A.6 BOARD – BOTTOM COPPER AND SILK
### Appendix B. Bill of Materials (BOM)

<table>
<thead>
<tr>
<th>Qty</th>
<th>Reference</th>
<th>Description</th>
<th>Manufacturer</th>
<th>Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>C1</td>
<td>Cap. cer. 22 pF 50V 5% NP0 SMD 0603</td>
<td>Panasonic® - ECG</td>
<td>ECU-V1H220.JCV</td>
</tr>
<tr>
<td>3</td>
<td>C2, C4, C6</td>
<td>Cap. cer. 10000 pF 50V 10% X7R 0603</td>
<td>AVX Corporation</td>
<td>06035C103KAT2A</td>
</tr>
<tr>
<td>3</td>
<td>C3, C5, C11</td>
<td>Cap. cer. 0.1 µF 50V 10% X7R 0603</td>
<td>AVX Corporation</td>
<td>06035C104KAT2A</td>
</tr>
<tr>
<td>3</td>
<td>C7, C9, C12</td>
<td>Cap. cer. 100 pF 50V 5% NP0 SMD 0603</td>
<td>Panasonic</td>
<td>ECU-V1H101JCV</td>
</tr>
<tr>
<td>2</td>
<td>C8, C10</td>
<td>Cap. Tant. 10 µF 16V 10% 3Ohm SMD</td>
<td>KEMET®</td>
<td>B45196H3106K109</td>
</tr>
<tr>
<td>2</td>
<td>FB1, FB2</td>
<td>Ferrite CHIP 470 OHM 300 mA 0603</td>
<td>Murata Electronics®</td>
<td>BLM18BB471SN1D</td>
</tr>
<tr>
<td>1</td>
<td>J1</td>
<td>Conn. SMA jack str. 50 Ohm PCB</td>
<td>Amphenol Commercial</td>
<td>901-144-8RFX</td>
</tr>
<tr>
<td>4</td>
<td>J2, J3, J4, J5</td>
<td>Conn. BNC jack str. 50 Ohm PCB</td>
<td>Amphenol Commercial</td>
<td>31-5431-2010</td>
</tr>
<tr>
<td>0</td>
<td>PCB</td>
<td>MCP6421 EMIRR Evaluation Board – RoHS compliant Printed Circuit Board</td>
<td>—</td>
<td>104-00443</td>
</tr>
<tr>
<td>2</td>
<td>R1, R2</td>
<td>Res. TKF 100R 1% 1/10W SMD 0603</td>
<td>Panasonic</td>
<td>ERJ-3EFK1000V</td>
</tr>
<tr>
<td>4</td>
<td>R3, R4, R6, R7</td>
<td>Res. TKF 10k 1% 1/10W SMD 0603</td>
<td>NIC Components Corp.</td>
<td>NRC06F1002TRF</td>
</tr>
<tr>
<td>4</td>
<td>R5, R8, R9, R10</td>
<td>Res. TKF 49.9R 1% 1/10W SMD 0603</td>
<td>Panasonic</td>
<td>ERJ-3EFK49R9V</td>
</tr>
<tr>
<td>1</td>
<td>U1</td>
<td>MCP6421, SC70-5, single op amp, 90 kHz</td>
<td>Microchip Technology, Inc.</td>
<td>MCP6421T-E/LTY</td>
</tr>
</tbody>
</table>

**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.