

## Evaluation Board for the Integer-N PLL Frequency Synthesizer

### FEATURES

Self-contained board for generating RF frequencies  
Contains the **ADF4108**—an 8 GHz frequency synthesizer IC  
Accompanying software allows complete control of synthesizer functions from a PC

### EVALUATION KIT CONTENTS

**EV-ADF4108EB1Z** board

CD that includes

- Self-installing software that allows users to control the board and exercise all functions of the device
- Electronic version of the **ADF4108** data sheet
- Electronic version of the **UG-160** user guide
- Electronic version of the **UG-476** user guide

### ADDITIONAL EQUIPMENT

PC running Windows XP or more recent version  
Spectrum analyzer  
Oscilloscope (optional)  
Power supplies of 5.5 V and 15 V

### DOCUMENTS NEEDED

**ADF4108** data sheet

### REQUIRED SOFTWARE

Analog Devices Int-N software (Version 7 or higher)  
**ADIsimPLL**

### GENERAL DESCRIPTION

The **EV-ADF4108EB1Z** evaluation board allows the user to evaluate the performance of the **ADF4108** frequency synthesizer for phase-locked loops (PLLs). Figure 1 shows the board, which contains the **ADF4108** synthesizer, an SMA connector for the reference input, the power supplies, a USB interface, and the RF outputs. There is also an active loop filter and a VCO on board. The user has the option of using an alternate loop filter and VCO by connecting the board to the following SMA connectors: VTUNE and CPOUT. The evaluation kit contains software that is compatible with Windows® XP and more recent versions to allow easy programming of the synthesizer.

The USB interface allows software programming of the **ADF4108** device. A USB cable is included in the evaluation board kit to allow software programmability.

### EVALUATION BOARD

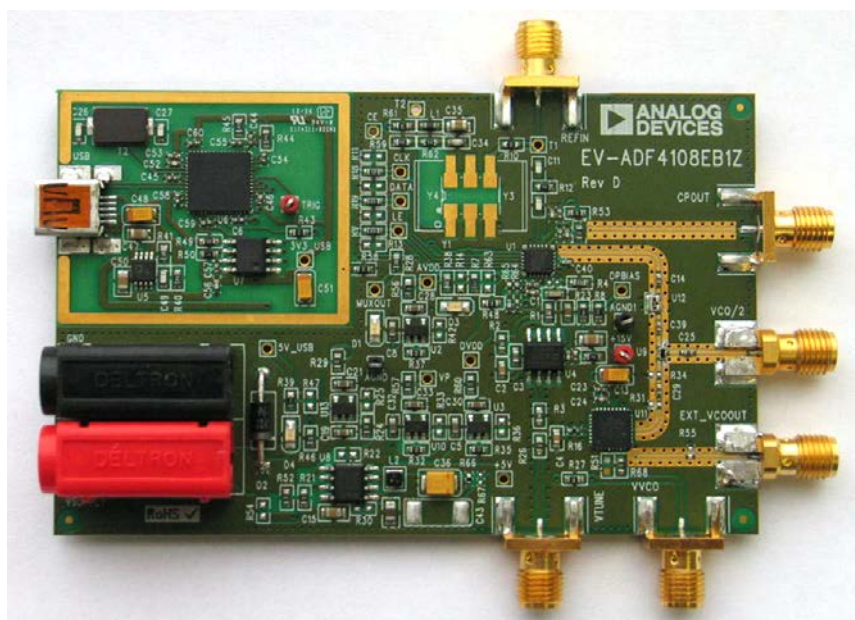


Figure 1. **EV-ADF4108EB1Z**

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## REVISION HISTORY

### 12/12—Rev. A to Rev. B

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### 7/11—Revision 0: Initial Version

## QUICK START GUIDE

Use the following steps to evaluate the [ADF4108](#) device:

1. Install the Int-N software (see the [UG-476](#) user guide, *PLL Software Installation Guide*).
2. Follow the hardware driver installation procedure.
3. Connect the power supplies to the [EV-ADF4108EB1Z](#):
  - a. Connect the 5.5 V power supply to the on-board banana connectors.
  - b. Connect the 15 V power supply to the test points labeled +15 V and AGND1.
4. Connect the USB cable to the PC and to the [EV-ADF4108EB1Z](#).
5. Run the Int-N software.
6. Select the [ADF4108](#) device and the USB board in the **Select Device and Connection** tab of the main window.
7. Ensure that **Analog Devices RFG.L Eval Board connected** is displayed at the bottom left of the main window.
8. Connect the reference frequency to REFIN (SMA).
9. Click the **Main Controls** tab to input the RF and other settings.
10. Note that the **Phase Detector Polarity** drop-down box in the **Settings** section should be set to **Negative** to suit the active loop filter in inverting mode.
11. Update all registers.
12. Connect the output to a signal source analyzer. The board offers two outputs.
  - a. VCO/2 via the SMA labeled VCO/2.
  - b. VCO via the SMA labeled EXT\_VCOOUT.
13. Measure the results.

## EVALUATION BOARD HARDWARE

The evaluation board comes with a mini-USB cable to connect the evaluation board to the USB port of a PC. The evaluation board silkscreen is shown in Figure 2. The [EV-ADF4108EB1Z](#) schematics are shown in Figure 7 to Figure 10.

### POWER SUPPLIES

The board is powered via two external supplies, 5.5 V and 15 V, and connected as described in the Quick Start Guide section.

### INPUT SIGNALS

The necessary reference input can be supplied from an external generator. A low noise, high slew rate reference source is best for achieving the stated performance of the [ADF4108](#). This reference source is connected to the REFIN SMA connector. A second option is to solder a footprint-compatible TCXO to Footprint Y1.

### OUTPUT SIGNALS

The VCO output is available at EXT\_VCOOUT through a standard SMA connector. A divide-by-2 option is also available

at the VCO/2 SMA connector. To use an alternate loop filter and VCO, the charge pump output (CPOUT) and the VCO tune voltage (VTUNE) are available as outputs via standard SMA connectors.

### DEFAULT OPERATION

All components necessary for local oscillation (LO) generation can be inserted on the board. The board is shipped with the [ADF4108](#) synthesizer, an active loop filter, and the VCO.

An active loop filter using standard feedback is inserted between the charge pump output and the VCO input. The design parameters for the loop filter are for a center frequency of 6400 MHz, a PFD frequency of 2500 kHz, and an active loop filter bandwidth of 15 kHz. To design a filter for different frequency setups, use the [ADIsimPLL](#) simulation software to generate filter component values and evaluate results.

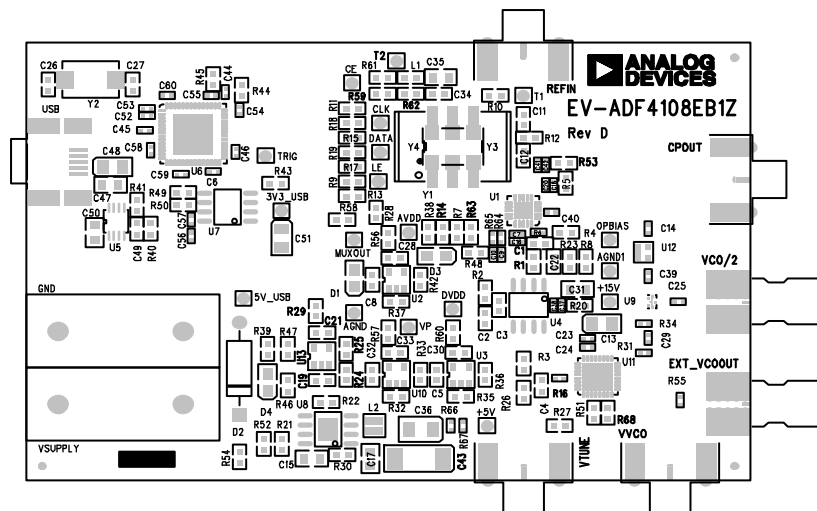


Figure 2. Evaluation Board Silkscreen

## EVALUATION BOARD SOFTWARE

The control software for the [EV-ADF4108EB1Z](#) is provided on the CD included in the evaluation board kit. To install the software, see the [UG-476](#) user guide, *PLL Software Installation Guide*.

To run the software, click the **Int-N v7** file on the desktop or select the file from the **Start** menu.

On the **Select Device and Connection** tab, choose the device and connection method, and then click **Connect**.

Confirm that **Analog Devices RFG.L Eval Board connected** is displayed at the bottom left of the window (see Figure 3). If this message is not displayed, the software cannot connect to the evaluation board.

Note that when the board is connected, there is about a 5 sec to 10 sec delay before the status label changes.

From the **File** menu, the current settings can be saved as and loaded from a text file.

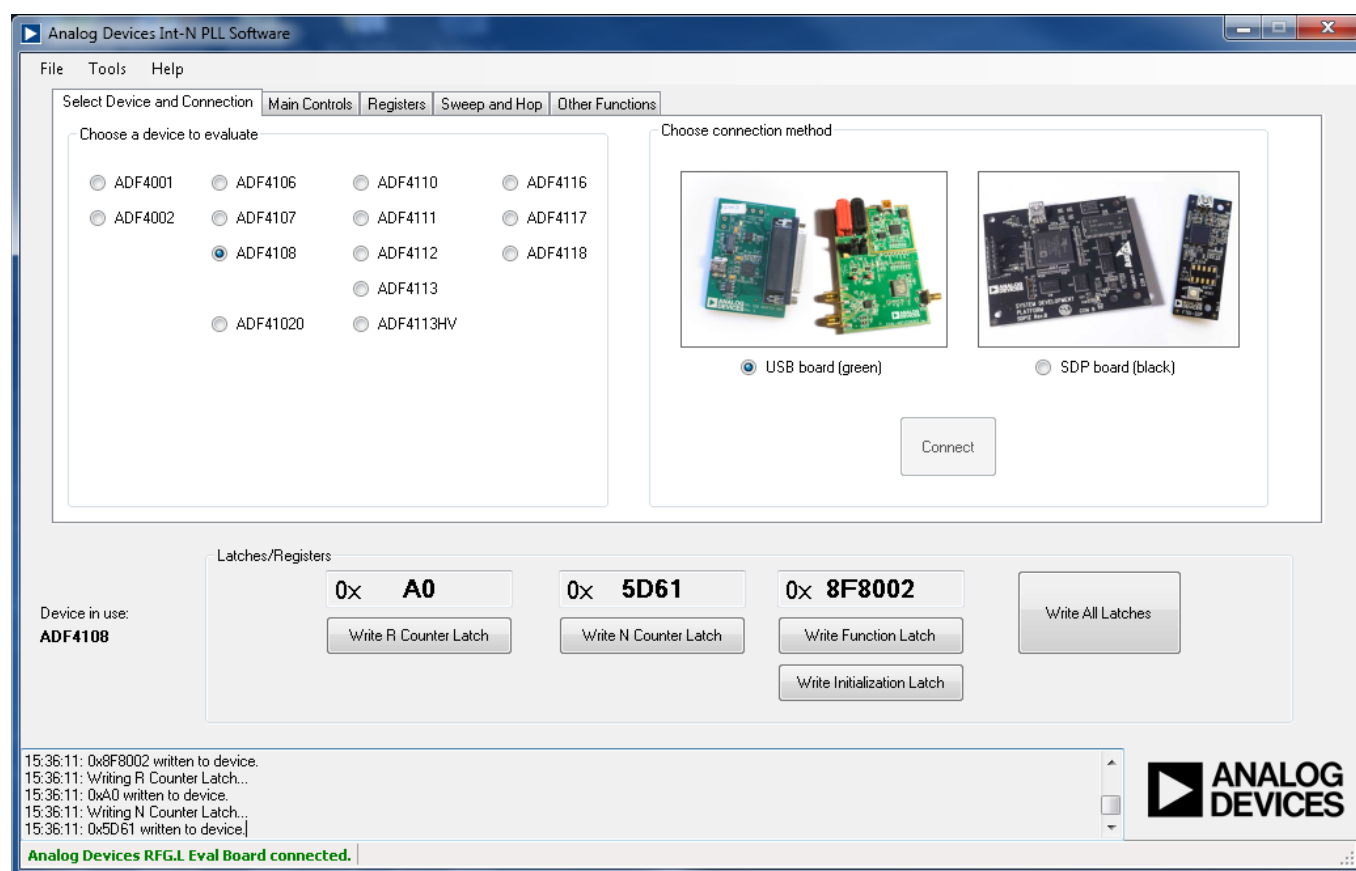


Figure 3. Int-N Software, Main Window—Select Device and Connection

The **Main Controls** tab controls the PLL settings (see Figure 4).

Use the **RF Settings** section to control the output frequency. You can type the desired output frequency in the **RF VCO Output Frequency** text box (in megahertz).

Use the **Reference Frequency** text box to set the correct reference frequency and the reference frequency divider. The default reference on the software window is 100 MHz.

The **Settings** section lets you select general options available for the PLL, including the charge pump current settings and phase detector polarity. The **EV-ADF4108EB1Z** uses a charge pump setting of 5 mA and a negative phase detector polarity.

In the **Registers** tab, you can manually input the desired value to be written to the registers.

In the **Sweep and Hop** tab, you can make the device sweep a range of frequencies or hop between two set frequencies.

In the **Latches/Registers** section at the bottom of the **Main Controls** tab of the main window, the values to be written to each register are displayed. If the background on the text box is green, the value displayed is different from the value actually on the device. Click **Write R Counter Latch** or **Write N Counter Latch** to write the value displayed to the device. To update all Latches in the correct order, click **Write All Latches**.

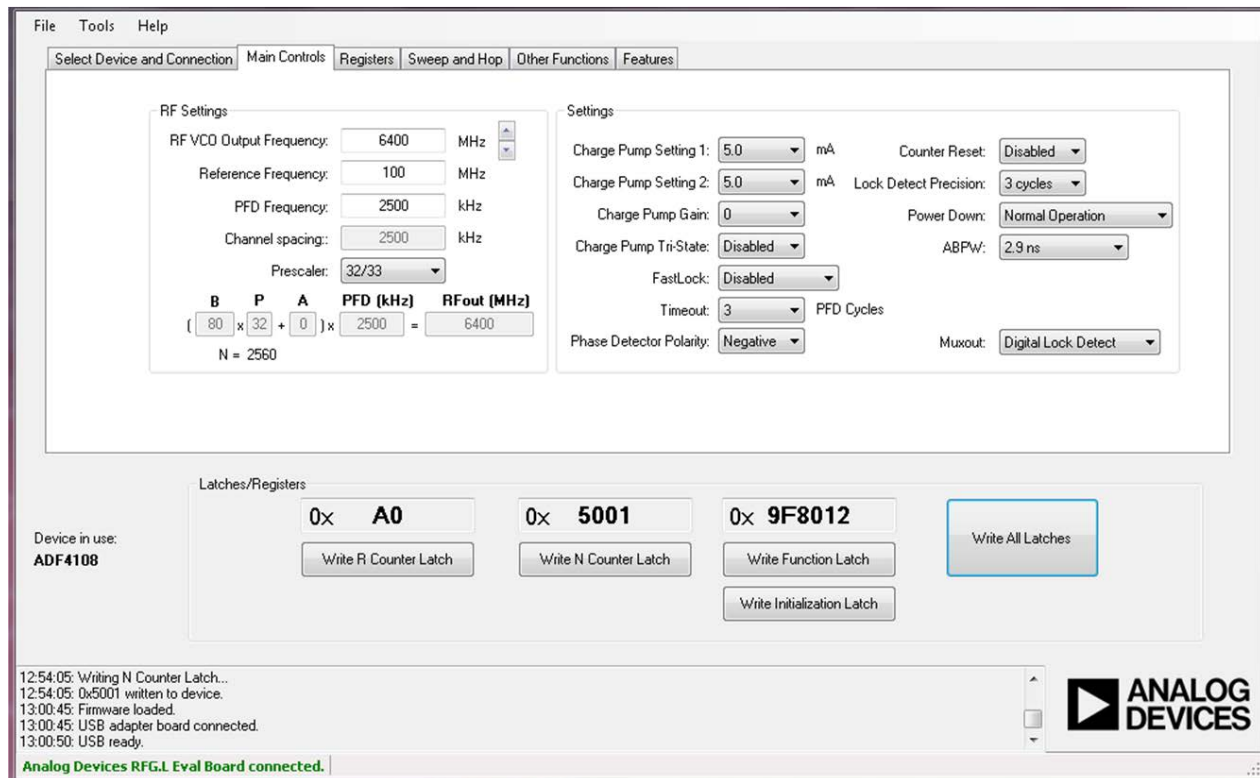


Figure 4. Int-N Software, Main Window—Main Controls

## EVALUATION AND TEST

To evaluate and test the performance of the [ADF4108](#), use the following procedure:

1. Install the Analog Devices Int-N software (see the [UG-476](#) user guide, *PLL Software Installation Guide*).
2. Use [ADIsimPLL](#) to generate the loop filter component values if a different loop filter is required.
3. Solder new filter components specified by [ADIsimPLL](#).
4. Install the USB software drivers. Connect the evaluation board to a PC using the supplied USB cable. Follow the hardware driver installation procedure that appears.
5. Connect the USB connector to the [EV-ADF4108EB1Z](#).
6. Connect a reference signal to REFIN.
7. Connect a spectrum analyzer to EXT\_VCOOUT or VCO/2.
8. Run the Int-N software.
9. Select the USB board and the [ADF4108](#) device in the **Select Device and Connection** tab of the main window of the evaluation board software.
10. In the **Main Controls** tab in the main window of the evaluation board software, set the VCO center frequency in the **RF VCO Output Frequency** text box (the example in Figure 5 uses a 6.4 GHz VCO). Set the **PFD Frequency** text box as specified in [ADIsimPLL](#), and program the **Reference Frequency** value to equal the reference connected to the REFIN SMA Connector (or the TCXO). See Figure 6 for the suggested setup.
11. Measure the output spectrum. Figure 5 shows 6.4 GHz phase noise output.

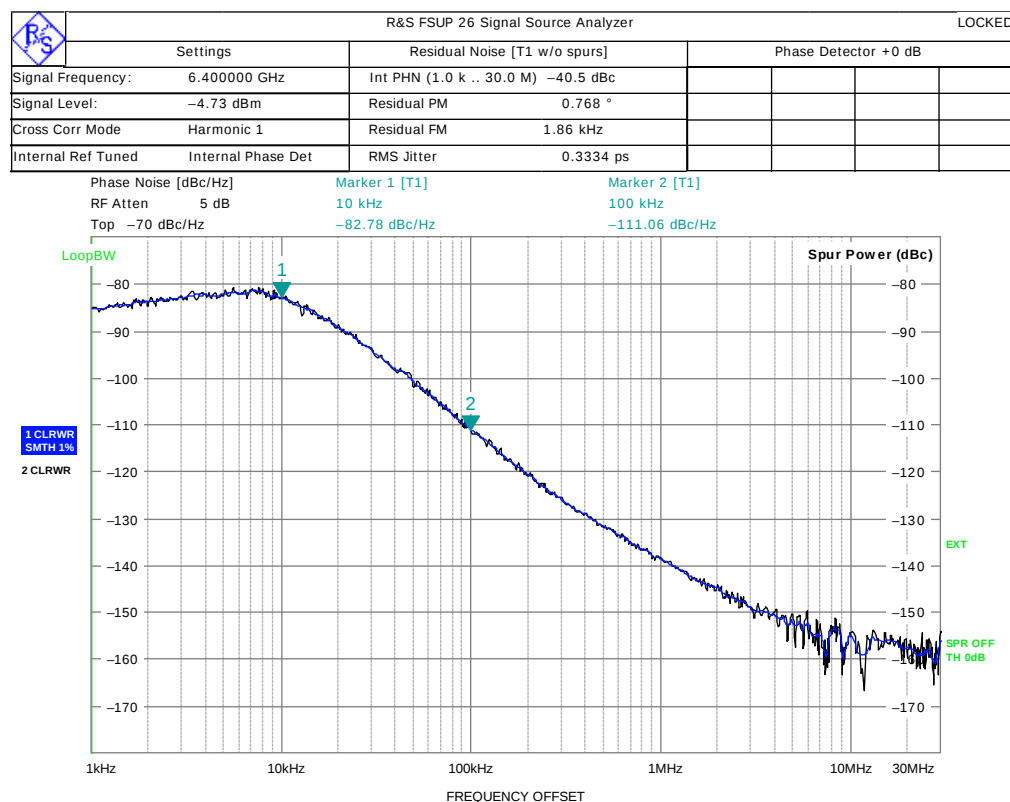


Figure 5. Spectrum Analyzer Display

09145-019



Figure 6. Typical Evaluation Setup

## EVALUATION BOARD SCHEMATICS AND ARTWORK

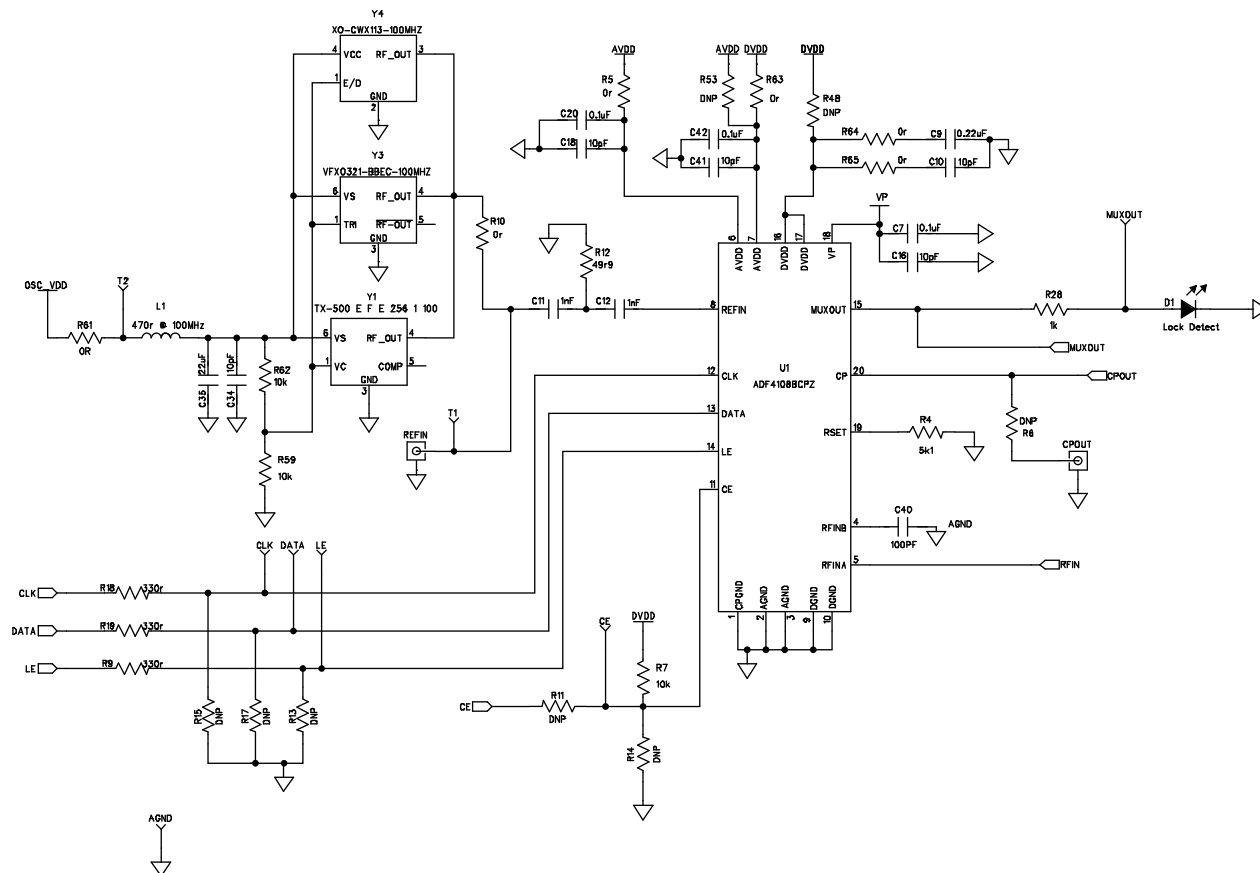


Figure 7. Evaluation Board Schematic (Page 1)

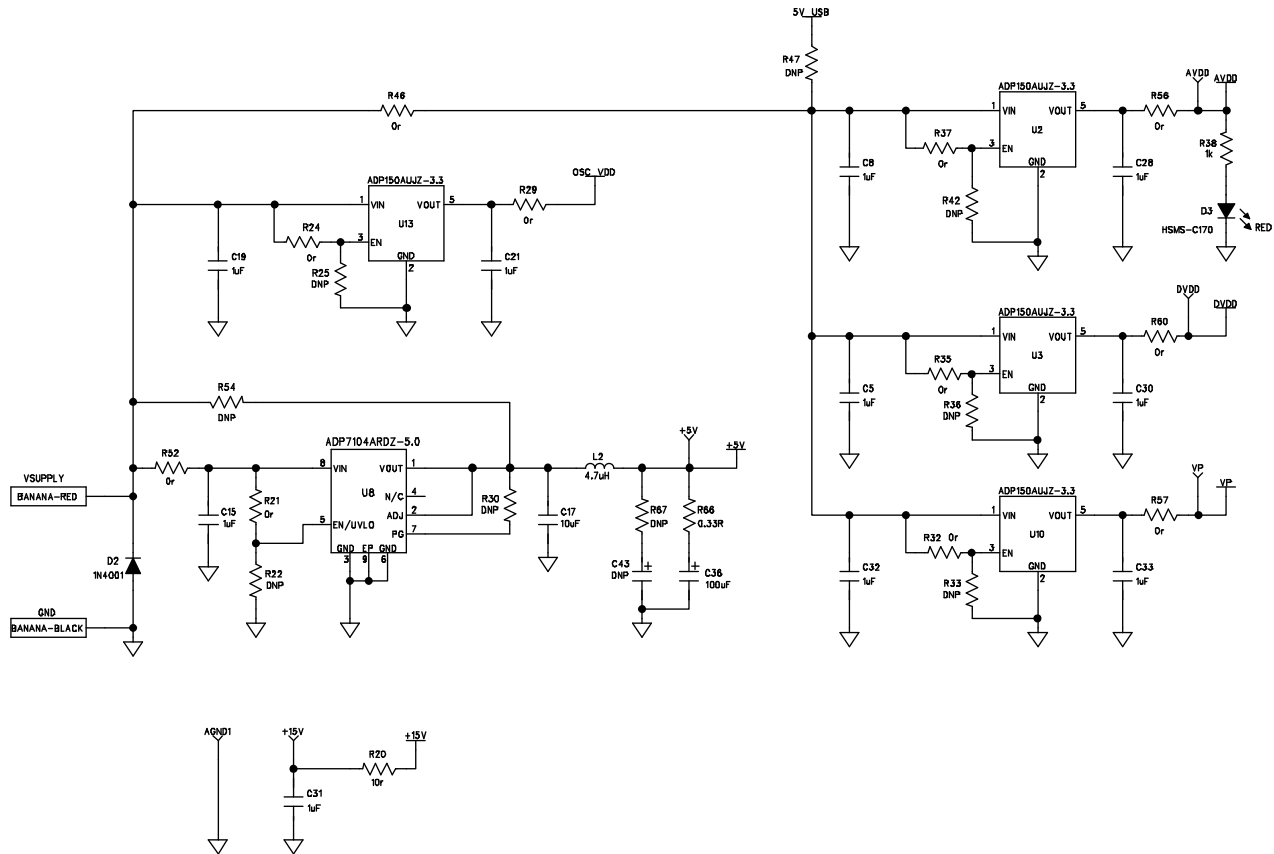


Figure 8. Evaluation Board Schematic (Page 2)

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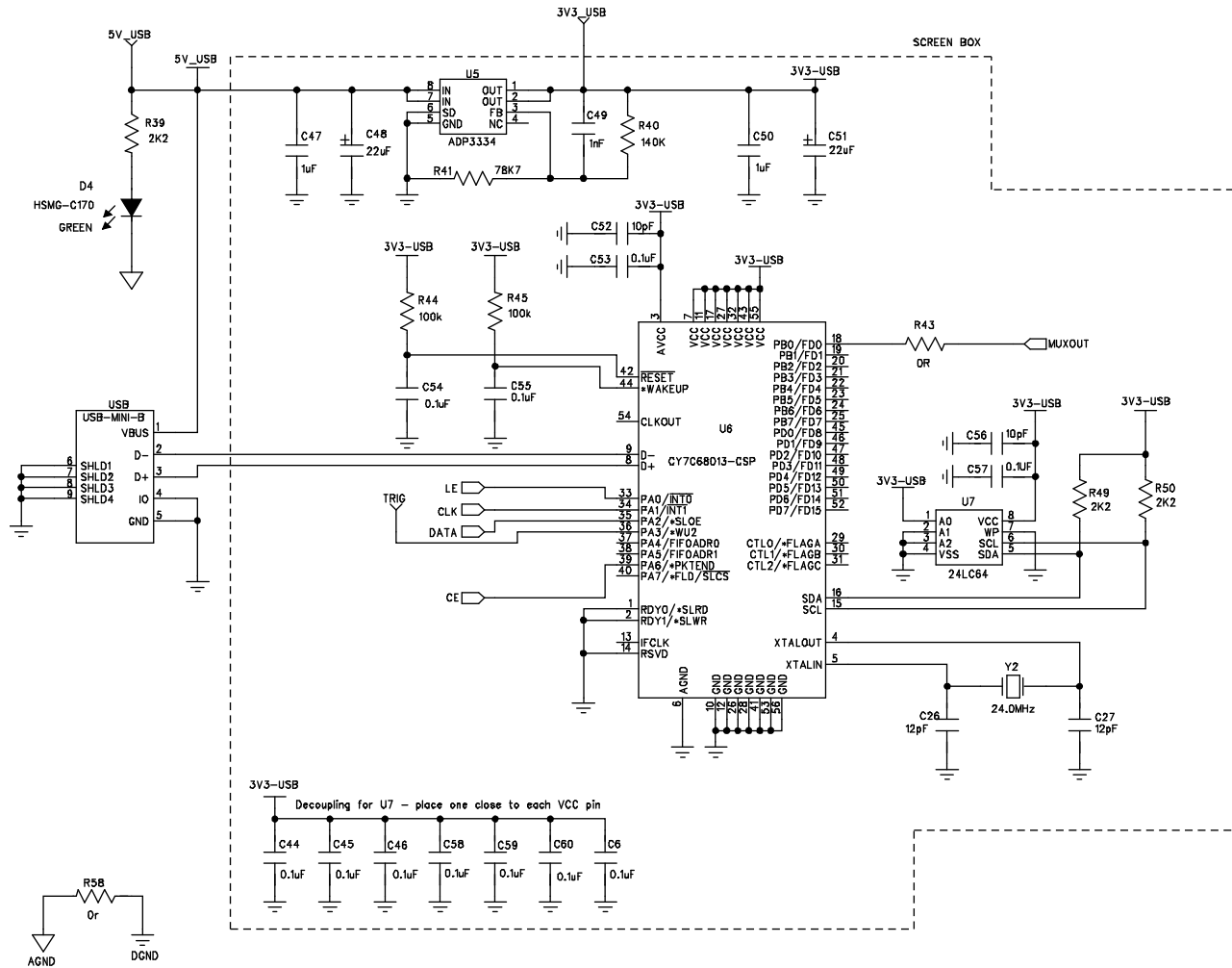


Figure 9. Evaluation Board Schematic (Page 3)

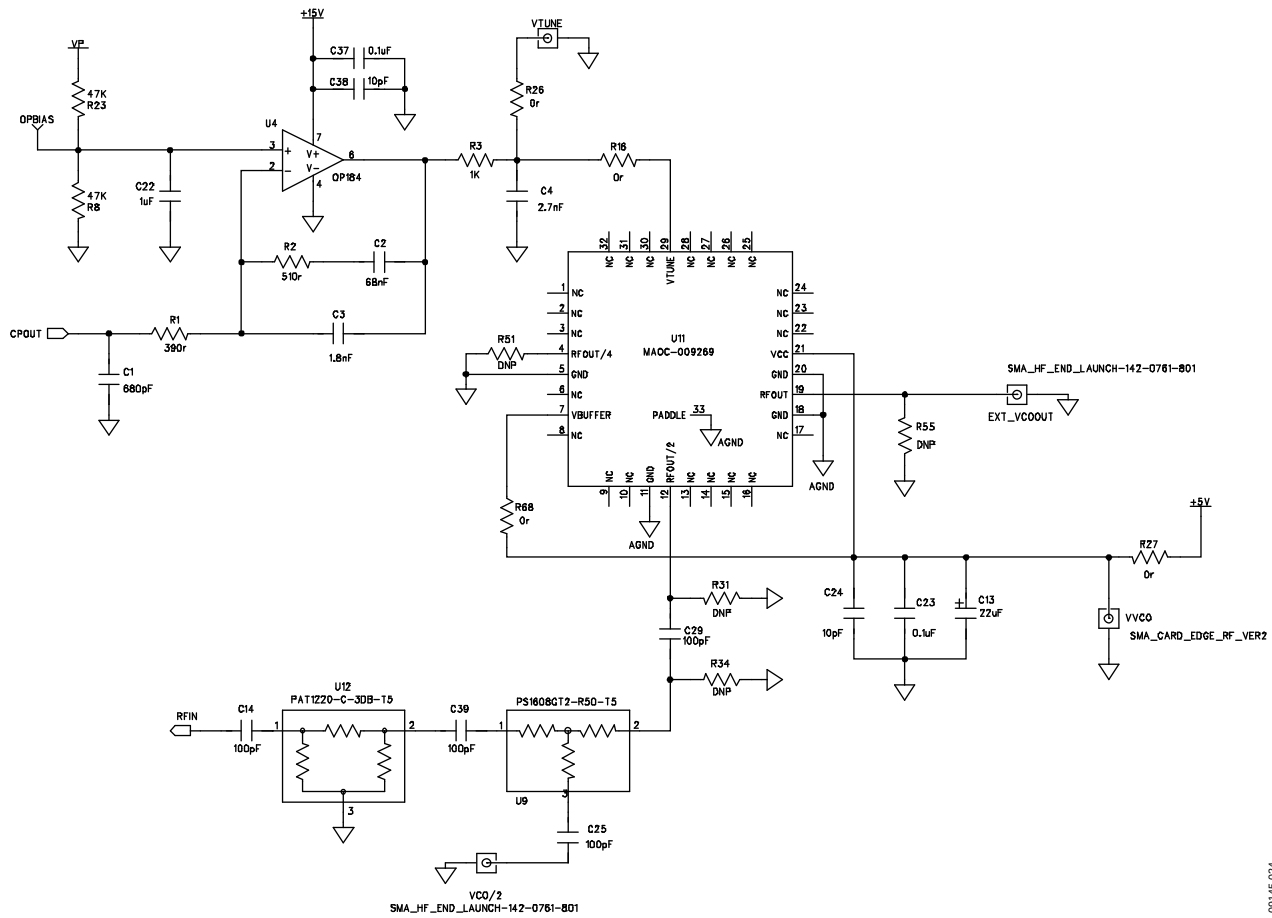


Figure 10. Evaluation Board Schematic (Page 4)

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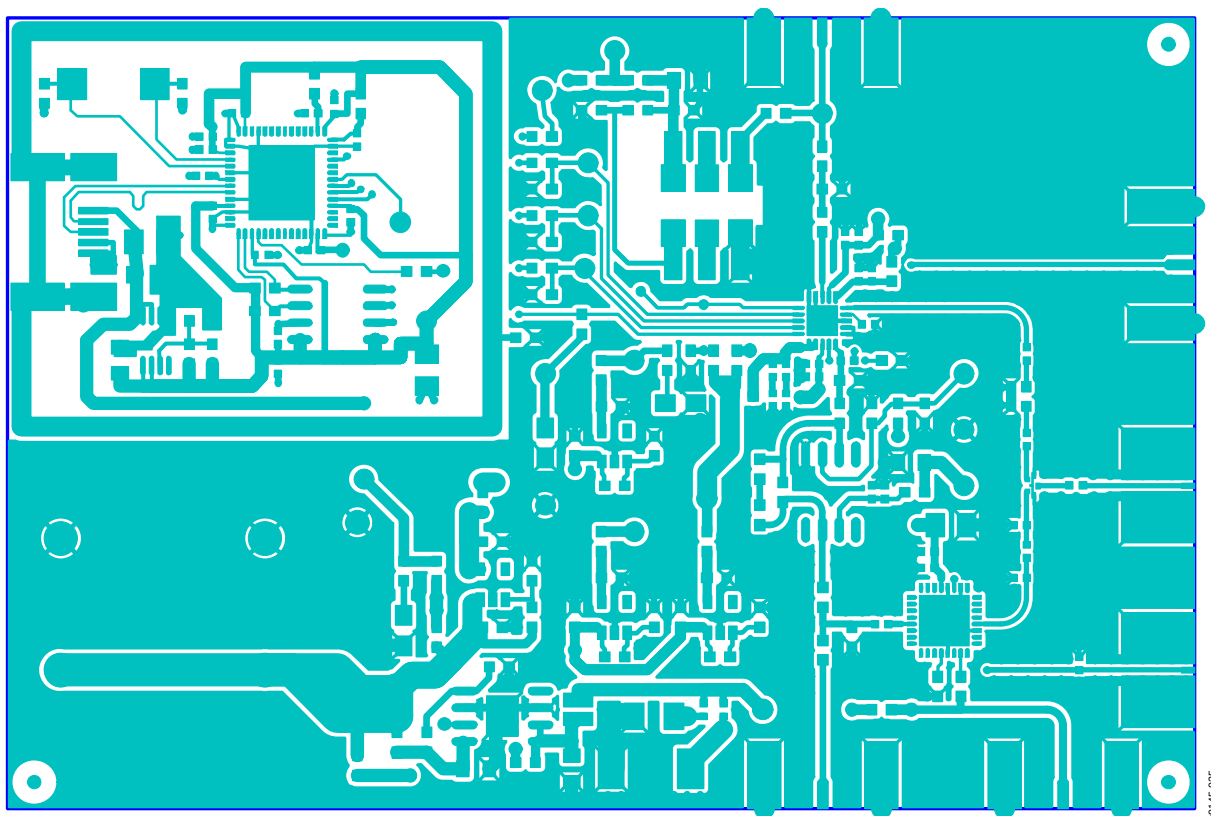


Figure 11. Layer 1 (Component Side)

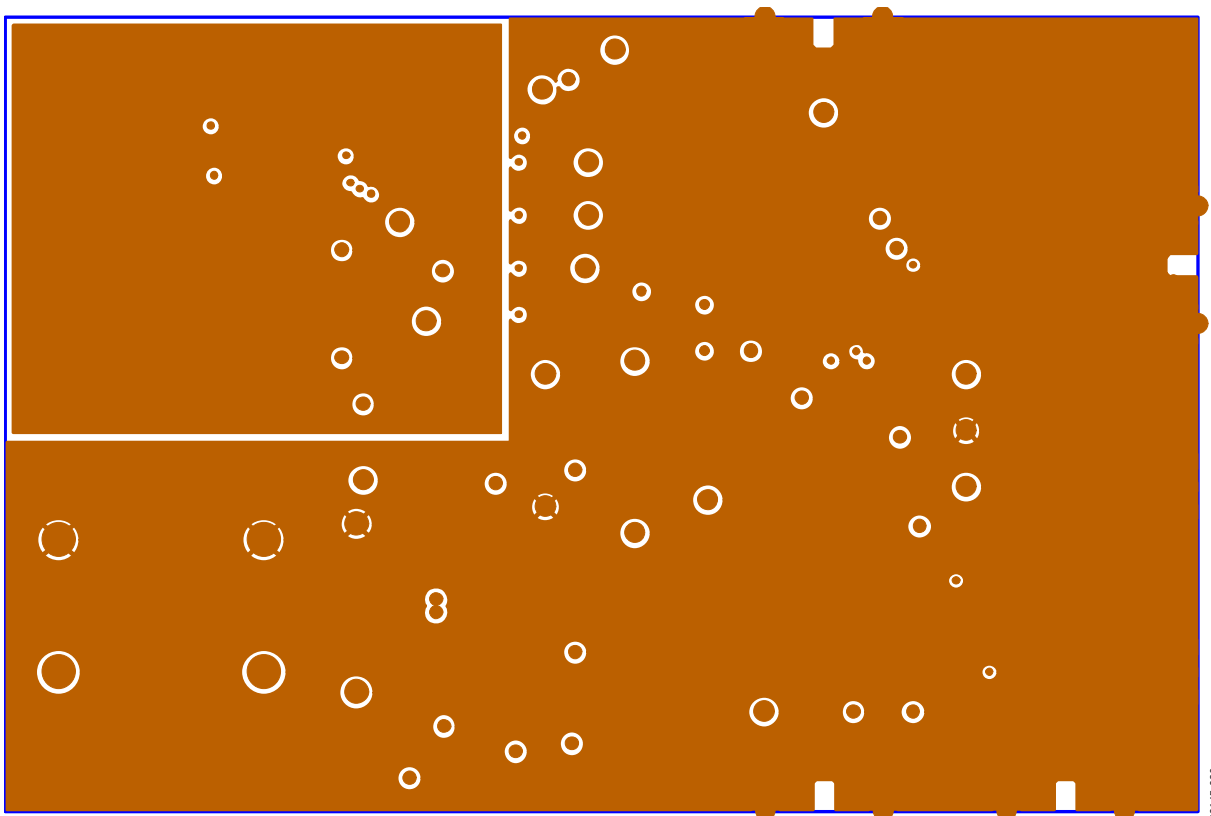


Figure 12. Layer 2 (Ground Plane)

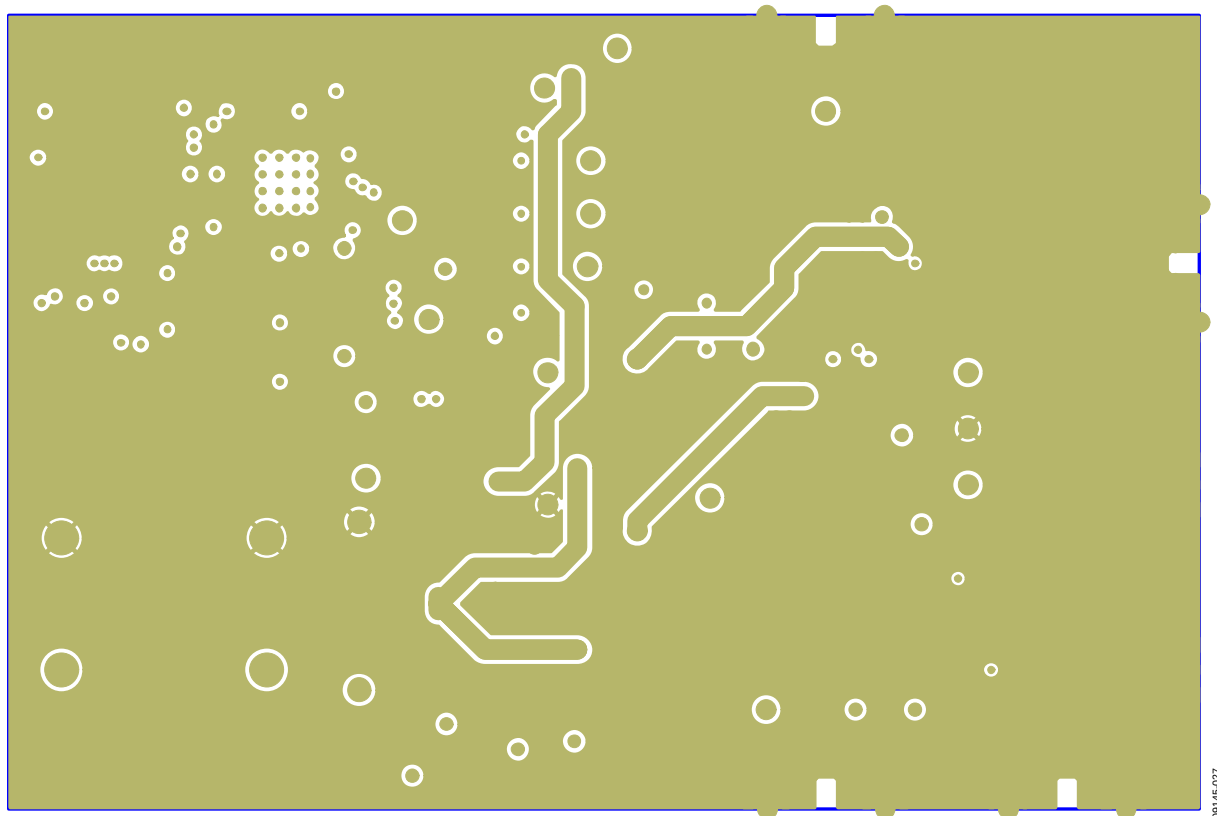


Figure 13. Layer 3 (Power/Ground Plane)

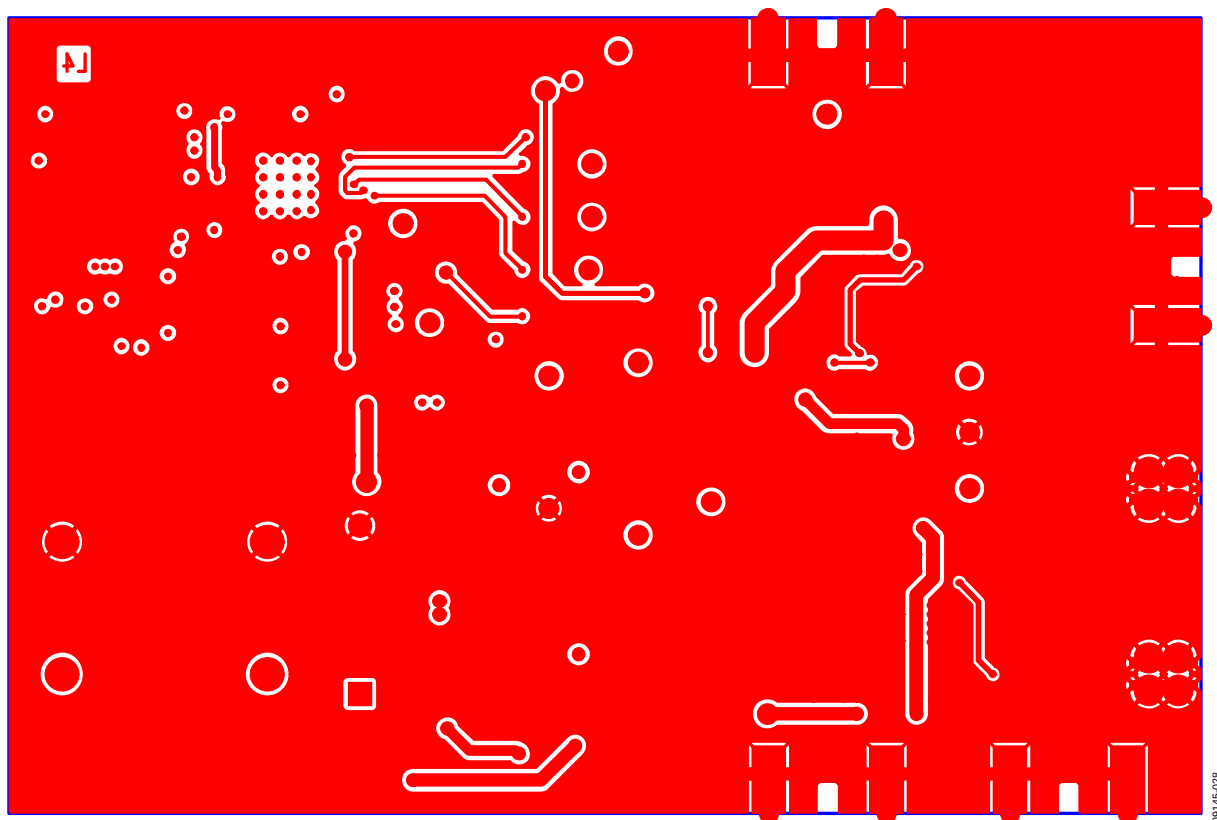


Figure 14. Layer 4 (Solder Side)

## BILL OF MATERIALS

Table 1.

| Reference Designator                                                                                                                                                                                                                                                         | Part Description                                           |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|
| +5V, +15V, 3V3_USB, <sup>1</sup> 5V_USB, <sup>1</sup> AVDD, <sup>1</sup> CE, <sup>1</sup> CLK, <sup>1</sup> DATA, <sup>1</sup> DVDD, <sup>1</sup> LE, <sup>1</sup> MUXOUT, <sup>1</sup> OPBIAS, <sup>1</sup> T1, <sup>1</sup> T2, <sup>1</sup> RIG, VP <sup>1</sup>          | Red test point                                             |
| AGND, AGND1                                                                                                                                                                                                                                                                  | Black test point                                           |
| C1                                                                                                                                                                                                                                                                           | Capacitor, 0603, 50 V, 680 pF, COG/NPO                     |
| C2                                                                                                                                                                                                                                                                           | Capacitor, 0603, X7R, 50 V, 68 nF                          |
| C3                                                                                                                                                                                                                                                                           | Capacitor, 0603, X7R, 50 V, 1.8 nF                         |
| C4                                                                                                                                                                                                                                                                           | Capacitor, 0603, X7R, 50 V, 2.7 nF                         |
| C5, C8, C19, C21, C22, C28, C30, C32, C33                                                                                                                                                                                                                                    | Capacitor, 0603, 1 $\mu$ F, 10 V, X5R                      |
| C6, C7, C20, C42, C44, C45, C46, C53, C54, C55, C57, C58, C59, C60                                                                                                                                                                                                           | X7R ceramic capacitor, 0402, 16 V, 0.1 $\mu$ F             |
| C9                                                                                                                                                                                                                                                                           | X5R ceramic capacitor, 0402, 6.3 V, 0.22 $\mu$ F           |
| C10, C16, C18, C24, C38, C41, C52, C56                                                                                                                                                                                                                                       | NPO ceramic capacitor, 0402, 50 V, 10 pF                   |
| C11, C12, C49                                                                                                                                                                                                                                                                | NPO ceramic capacitor, 0603, 50 V, 1 nF                    |
| C13, C48, C51                                                                                                                                                                                                                                                                | Tantalum capacitor (TAJ-A case), RTAJ_A, 6.3 V, 22 $\mu$ F |
| C14, C25, C29, C39                                                                                                                                                                                                                                                           | COG ceramic capacitor, 0402, 50 V, 100 pF                  |
| C15, C31, C47, C50                                                                                                                                                                                                                                                           | Capacitor, X5R, 0805, 1.0 $\mu$ F, 50 V                    |
| C17                                                                                                                                                                                                                                                                          | Capacitor, X5R, 0805, 10 V, 10 $\mu$ F, 10%                |
| C23, C37                                                                                                                                                                                                                                                                     | X5R ceramic capacitor, 0402, 25 V, 0.1 $\mu$ F             |
| C26, C27                                                                                                                                                                                                                                                                     | NPO SMD ceramic capacitor, 0603, 50 V, 10 pF               |
| C34                                                                                                                                                                                                                                                                          | Multilayer ceramic capacitor, 0603, 10 pF                  |
| C35                                                                                                                                                                                                                                                                          | X5R ceramic capacitor, 0805, 6.3 V, 22 $\mu$ F             |
| C36                                                                                                                                                                                                                                                                          | Capacitor, CASE B, 100 $\mu$ F, 6.3 V, RTAJ_B              |
| C40                                                                                                                                                                                                                                                                          | Capacitor, 0402, 100 pF, 50 V, NPO                         |
| C43 <sup>1</sup>                                                                                                                                                                                                                                                             | Capacitor, RTAJ_D                                          |
| CPOUT, REFIN, VTUNE, VVCO                                                                                                                                                                                                                                                    | Conn jack end launch PC gold SMA                           |
| D1, D4                                                                                                                                                                                                                                                                       | LED, green                                                 |
| D2                                                                                                                                                                                                                                                                           | Diode, standard, 1 A, 50 V                                 |
| D3                                                                                                                                                                                                                                                                           | LED, red                                                   |
| EXT_VCOOUT, VCO/2                                                                                                                                                                                                                                                            | High frequency SMA end launch connector—142-0761-801       |
| GND                                                                                                                                                                                                                                                                          | Black 4 mm banana socket                                   |
| L1                                                                                                                                                                                                                                                                           | Ferrite bead, 470 $\Omega$ at 100 MHz                      |
| L2                                                                                                                                                                                                                                                                           | Inductor, SMT Power EPL2014 Series, 4.7 $\mu$ H            |
| R1                                                                                                                                                                                                                                                                           | Resistor, 0603, 390 $\Omega$                               |
| R2                                                                                                                                                                                                                                                                           | Resistor, 0603, 510 $\Omega$                               |
| R3, R28, R38                                                                                                                                                                                                                                                                 | Resistor, 0603, 1 k $\Omega$                               |
| R4                                                                                                                                                                                                                                                                           | Resistor, 0603, 5.1 k $\Omega$                             |
| R5, R10, R21, R24, R26, R27, R29, R32, R35, R37, R43, R46, R48, R52, R53, R56, R57, R58, R60, R61, R68                                                                                                                                                                       | Resistor, 0603, 0 $\Omega$                                 |
| R6, <sup>1</sup> R31, <sup>1</sup> R34, <sup>1</sup> R55, <sup>1</sup> R67 <sup>1</sup>                                                                                                                                                                                      | Resistor, 0402                                             |
| R7, R59, R62                                                                                                                                                                                                                                                                 | Resistor, 0603, 10 k $\Omega$                              |
| R8, R23                                                                                                                                                                                                                                                                      | Resistor, 0603, 47 k $\Omega$                              |
| R9, R18, R19                                                                                                                                                                                                                                                                 | Resistor, 0603, 330 $\Omega$                               |
| R11, <sup>1</sup> R13, <sup>1</sup> R14, <sup>1</sup> R15, <sup>1</sup> R17, <sup>1</sup> R22, <sup>1</sup> R25, <sup>1</sup> R30, <sup>1</sup> R33, <sup>1</sup> R36, <sup>1</sup> R42, <sup>1</sup> R47, <sup>1</sup> R51, <sup>1</sup> R54, <sup>1</sup> R63 <sup>1</sup> | Resistor, 0603                                             |
| R12                                                                                                                                                                                                                                                                          | Resistor, 0603, 49.9 $\Omega$                              |
| R16, R64, R65                                                                                                                                                                                                                                                                | Resistor, 0402, 0 $\Omega$                                 |
| R20                                                                                                                                                                                                                                                                          | Resistor, 0603, 10 $\Omega$                                |
| R39, R49, R50                                                                                                                                                                                                                                                                | Resistor, 0603, 2.2 k $\Omega$                             |
| R40                                                                                                                                                                                                                                                                          | Resistor, 0603, 140 k $\Omega$                             |

| Reference Designator | Part Description                                             |
|----------------------|--------------------------------------------------------------|
| R41                  | Resistor, 0603, 78.7 k $\Omega$                              |
| R44, R45             | Resistor, 0603, 100 k $\Omega$                               |
| R66                  | Resistor, 0402, 0.33 $\Omega$                                |
| U1                   | <a href="#">ADF4108</a> , PLL frequency synthesizer          |
| U2, U3, U10, U13     | <a href="#">ADP150AUJZ-3.3</a> , 3.3 V linear regulator      |
| U4                   | <a href="#">OP184</a> , single op amp                        |
| U5                   | <a href="#">ADP3334</a> , adjustable LDO regulator           |
| U6                   | USB microcontroller                                          |
| U7                   | 64k, I <sup>2</sup> C serial EEPROM                          |
| U8                   | <a href="#">ADP7104ARDZ-5.0</a> , linear regulator           |
| U9                   | Power divider, 6 dB, 1 W, 0603 SMD                           |
| U11                  | VCO, dual output and divide-by-2 prescaler                   |
| U12                  | Attenuator, 3 dB, 50 $\Omega$ , 0805 SMD                     |
| VSUPPLY              | Red 4 mm banana socket                                       |
| Y1 <sup>1</sup>      | TX-500 temperature compensated crystal oscillator, 100.0 MHz |
| Y2                   | SMD crystal, 24.0 MHz                                        |

<sup>1</sup> Do not insert.

## RELATED LINKS

| Resource                | Description                                                                                                  |
|-------------------------|--------------------------------------------------------------------------------------------------------------|
| <a href="#">ADF4108</a> | Product Page: PLL Frequency Synthesizer                                                                      |
| <a href="#">ADP150</a>  | Product Page: Ultralow Noise, 150 mA CMOS Linear Regulator                                                   |
| <a href="#">OP184</a>   | Product Page: Single-Supply Rail-to-Rail Input/Output Operational Amplifier                                  |
| <a href="#">ADP3334</a> | Product Page: High Accuracy Low I <sub>Q</sub> , 500 mA anyCAP <sup>®</sup> Adjustable Low Dropout Regulator |
| <a href="#">ADP7104</a> | Product Page: 20 V, 500 mA, Low Noise, CMOS LDO                                                              |
| <a href="#">UG-476</a>  | User Guide: PLL Software Installation Guide                                                                  |

I<sup>2</sup>C refers to a communications protocol originally developed by Philips Semiconductors (now NXP Semiconductors).



### EEB Caution

**EEB (electrostatic discharge) sensitive device.** Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy EEB. Therefore, proper EEB precautions should be taken to avoid performance degradation or loss of functionality.

### Legal Terms and Conditions

By using the evaluation board discussed herein (together with any tools, components documentation or support materials, the "Evaluation Board"), you are agreeing to be bound by the terms and conditions set forth below ("Agreement") unless you have purchased the Evaluation Board, in which case the Analog Devices Standard Terms and Conditions of Sale shall govern. Do not use the Evaluation Board until you have read and agreed to the Agreement. Your use of the Evaluation Board shall signify your acceptance of the Agreement. This Agreement is made by and between you ("Customer") and Analog Devices, Inc. ("ADI"), with its principal place of business at One Technology Way, Norwood, MA 02062, USA. Subject to the terms and conditions of the Agreement, ADI hereby grants to Customer a free, limited, personal, temporary, non-exclusive, non-sublicensable, non-transferable license to use the Evaluation Board FOR EVALUATION PURPOSES ONLY. Customer understands and agrees that the Evaluation Board is provided for the sole and exclusive purpose referenced above, and agrees not to use the Evaluation Board for any other purpose. Furthermore, the license granted is expressly made subject to the following additional limitations: Customer shall not (i) rent, lease, display, sell, transfer, assign, sublicense, or distribute the Evaluation Board; and (ii) permit any Third Party to access the Evaluation Board. As used herein, the term "Third Party" includes any entity other than ADI, Customer, their employees, affiliates and in-house consultants. The Evaluation Board is NOT sold to Customer; all rights not expressly granted herein, including ownership of the Evaluation Board, are reserved by ADI. CONFIDENTIALITY. This Agreement and the Evaluation Board shall all be considered the confidential and proprietary information of ADI. Customer may not disclose or transfer any portion of the Evaluation Board to any other party for any reason. Upon discontinuation of use of the Evaluation Board or termination of this Agreement, Customer agrees to promptly return the Evaluation Board to ADI. ADDITIONAL RESTRICTIONS. Customer may not disassemble, decompile or reverse engineer chips on the Evaluation Board. Customer shall inform ADI of any occurred damages or any modifications or alterations it makes to the Evaluation Board, including but not limited to soldering or any other activity that affects the material content of the Evaluation Board. Modifications to the Evaluation Board must comply with applicable law, including but not limited to the RoHS Directive. TERMINATION. ADI may terminate this Agreement at any time upon giving written notice to Customer. Customer agrees to return to ADI the Evaluation Board at that time. LIMITATION OF LIABILITY. THE EVALUATION BOARD PROVIDED HEREUNDER IS PROVIDED "AS IS" AND ADI MAKES NO WARRANTIES OR REPRESENTATIONS OF ANY KIND WITH RESPECT TO IT. ADI SPECIFICALLY DISCLAIMS ANY REPRESENTATIONS, ENDORSEMENTS, GUARANTEES, OR WARRANTIES, EXPRESS OR IMPLIED, RELATED TO THE EVALUATION BOARD INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTY OF MERCHANTABILITY, TITLE, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF INTELLECTUAL PROPERTY RIGHTS. IN NO EVENT WILL ADI AND ITS LICENSORS BE LIABLE FOR ANY INCIDENTAL, SPECIAL, INDIRECT, OR CONSEQUENTIAL DAMAGES RESULTING FROM CUSTOMER'S POSSESSION OR USE OF THE EVALUATION BOARD, INCLUDING BUT NOT LIMITED TO LOST PROFITS, DELAY COSTS, LABOR COSTS OR LOSS OF GOODWILL. ADI'S TOTAL LIABILITY FROM ANY AND ALL CAUSES SHALL BE LIMITED TO THE AMOUNT OF ONE HUNDRED US DOLLARS (\$100.00). EXPORT. Customer agrees that it will not directly or indirectly export the Evaluation Board to another country, and that it will comply with all applicable United States federal laws and regulations relating to exports. GOVERNING LAW. This Agreement shall be governed by and construed in accordance with the substantive laws of the Commonwealth of Massachusetts (excluding conflict of law rules). Any legal action regarding this Agreement will be heard in the state or federal courts having jurisdiction in Suffolk County, Massachusetts, and Customer hereby submits to the personal jurisdiction and venue of such courts. The United Nations Convention on Contracts for the International Sale of Goods shall not apply to this Agreement and is expressly disclaimed.