

Evaluation Board for the **ADF4151** PLL Frequency Synthesizer

FEATURES

- General-purpose evaluation board for the **ADF4151**, including VCO, loop filter, and TCXO
- Contains the ADF4151 frequency synthesizer (500 MHz to 3.5 GHz)
- Accompanying software allows complete control of synthesizer functions from a PC

EVALUATION KIT CONTENTS

EVAL-ADF4151EB1Z 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 **ADF4151** data sheet
- Electronic version of the UG-369 user guide

ADDITIONAL EQUIPMENT

- PC running Windows XP or more recent version
- Power supply
- Spectrum analyzer
- Oscilloscope (optional)

DOCUMENTS NEEDED

ADF4151 data sheet

REQUIRED SOFTWARE

Analog Devices, Inc., ADF4151 software (Version 2 or higher)
ADIsimPLL

GENERAL DESCRIPTION

This board is designed to allow the user to evaluate the performance of the **ADF4151** frequency synthesizer for phase-locked loops (PLLs). Figure 1 shows the board, which contains the **ADF4151** synthesizer, loop filter, voltage control oscillator (VCO), reference oscillator (TCXO) of frequency 25 MHz for the reference input, power supply connectors, and an RF output.

The evaluation kit also contains software that is compatible with Windows® XP and later versions to allow easy programming of the synthesizer.

A USB port in the PC is required to program the part.

EVALUATION BOARD

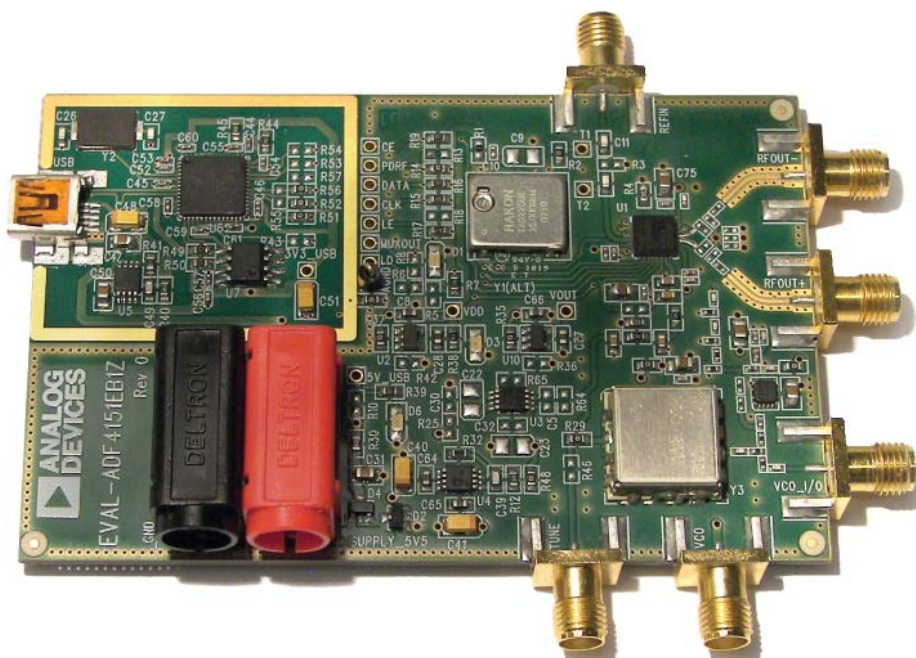


Figure 1. EVAL-ADF4151EB1Z

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REVISION HISTORY

2/12—Rev. 0 to Rev. A

Changes to Quick Start Guide Section	3
Changes to Power Supply Section	4

1/12—Revision 0: Initial Version

QUICK START GUIDE

Follow these steps to quickly evaluate the [ADF4151](#) device:

1. Install the [ADF4151](#) software.
2. Connect the [EVAL-ADF4151EB1Z](#) board to the PC.
3. Follow the hardware driver installation procedure.
4. Connect the power supplies to banana connectors (5.5 V).
5. Run the [ADF4151](#) software.
6. Connect the spectrum analyzer to SMA connector VCO_I/O.
7. Measure the results.

EVALUATION BOARD HARDWARE

The [EVAL-ADF4151EB1Z](#) schematics are shown in Figure 22, Figure 23, Figure 24, and Figure 25. The silkscreen of the evaluation board is shown in Figure 2.

POWER SUPPLIES

The board is powered from external banana connectors. The supplied voltage should be 5.5 V. The power supply circuit uses high precision, low noise [ADP150AUJZ-3.3](#) linear regulators and [ADP3334ARMZ](#) adjustable LDO regulators to provide 3.3 V to V_{DD} on the board (which supplies the [ADF4151](#) AV_{DDX} , DV_{DD} , and SDV_{DD} pins) to the [ADF4151](#) V_{DD} and 5 V to the [ADF4151](#) V_P .

INPUT SIGNALS

The reference signal is necessary for proper operation of the synthesizer. It can be sourced from a provided TCXO or an external generator, which can be connected to the REFIN edge mount connector. To use an external reference generator, it is necessary to remove R1 and R2 to disconnect TCXO from the reference input and from the supply.

Digital SPI signals are supplied from the Cypress microcontroller, U6, which is used for communication with the USB port of the PC.

OUTPUT SIGNALS

All components necessary for LO generation are inserted on the board. The PLL is made up of the [ADF4151](#) synthesizer, a fourth-order passive loop filter, and the VCO. The loop filter must be inserted between the charge pump output and the VCO input, as shown in Figure 25. If replacing the VCO, a VCO in a T-package (or similar) must be used. The RF output is available at the edge mount SMA connector, VCO_I/O.

DEFAULT OPERATION SETTINGS

This board is shipped with a TCXO that provides a reference frequency of 25 MHz, a fourth-order low-pass filter with 30 kHz bandwidth at $I_{CP} = 2.25$ mA, and a VCO with a 1.7 GHz to 1.8 GHz frequency range. To test the performance of the part for a different frequency range and different loop filter, the relevant components on the board must be changed.

ADDITIONAL OPTIONS

The VVCO connector can be used as a test point to measure the supply voltage of the VCO in its default configuration. It can also be used to provide an external supply for the on-board VCO; however, if an external supply for VCO is used, Resistor R31 must be removed to disconnect the connector from the output of the on-board voltage regulator.

Optionally, an external VCO can be used. In this case, it is necessary to remove R29 and insert a $0\ \Omega$ link at R46 to form a connection between the loop filter output and the VTUNE SMA edge mount connector. Remove R31 to disconnect the on-board VCO from the power supply. Remove Resistor R26 to disconnect the output of the on-board VCO from the RF signal path, and replace Resistors R27 and R28 with $0\ \Omega$ links to ensure operation of the VCO_I/O connector as an input from an external VCO.

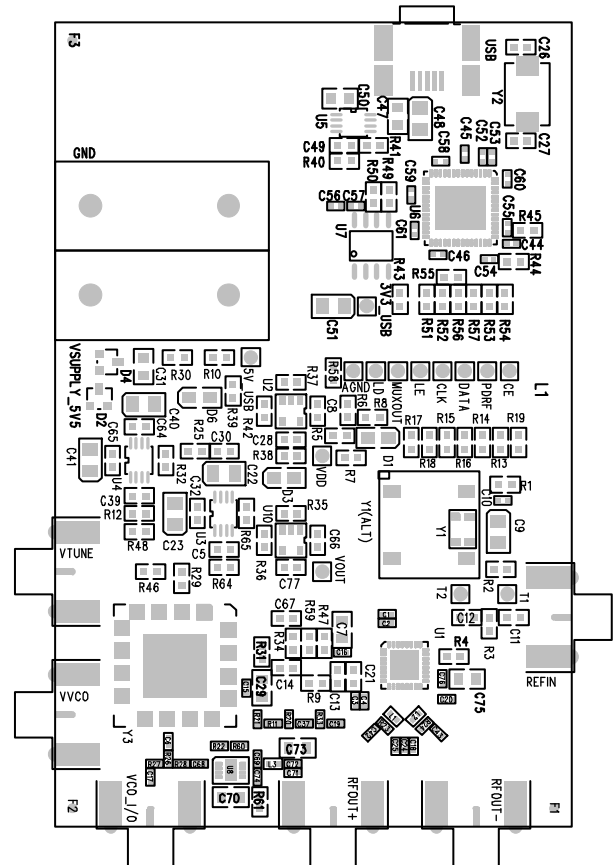


Figure 2. Evaluation Board Silkscreen

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EVALUATION BOARD SETUP PROCEDURE

SOFTWARE INSTALLATION

Use the following steps to install the software.

1. Install the Analog Devices **ADF4151** software by double-clicking **ADF4151 Setup.msi**.
If you are using Windows XP, follow the instructions in the Windows XP Software Installation Guide section (see Figure 3 to Figure 7).
If you are using Windows Vista or Windows 7, follow the instructions in the Windows Vista and Windows 7 Software Installation Guide section (see Figure 8 to Figure 12).
Note that the software requires Microsoft Windows Installer and Microsoft .NET Framework 3.5 (or higher).
The installer connects to the Internet and downloads Microsoft .NET Framework automatically. Alternatively, before running the **ADF4151 Setup.msi**, both the installer and .NET Framework can be installed from the CD that is provided.
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2. Connect your board by USB.
If you are using Windows XP, follow the steps in the Windows XP Driver Installation Guide section (see Figure 13 to Figure 16).
On Windows Vista or Windows 7, the drivers install automatically.

Windows XP Software Installation Guide

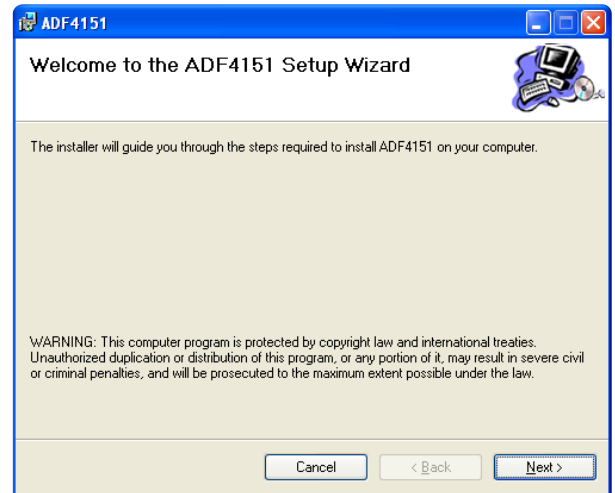


Figure 3. Windows XP **ADF4151** Software Installation, Setup Wizard

1. Click **Next >**.

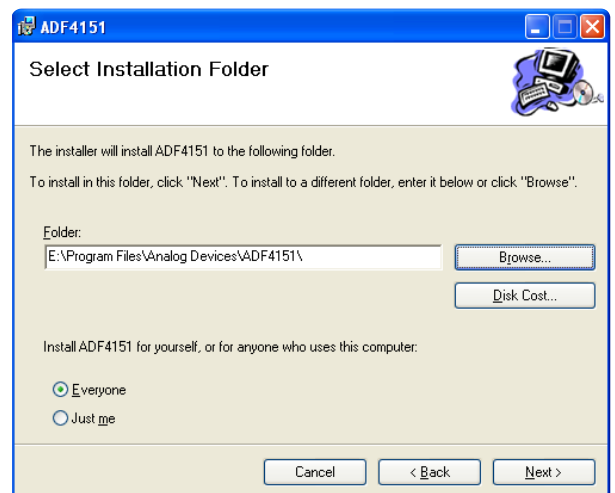


Figure 4. Windows XP **ADF4151** Software Installation, Select Installation Folder

2. Choose an installation directory and click **Next >**.

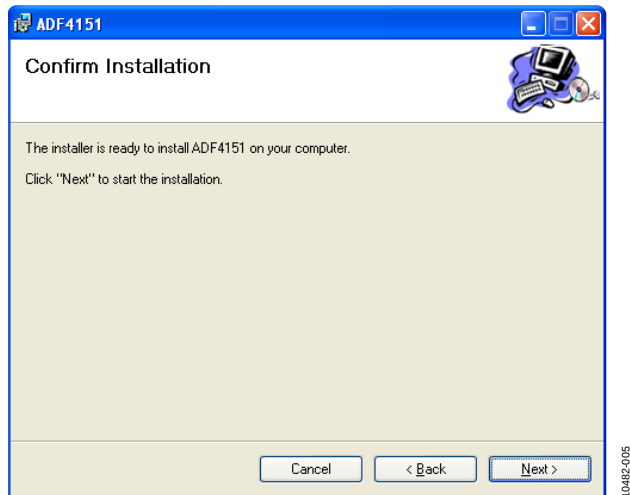


Figure 5. Windows XP ADF4151 Software Installation, Confirm Installation

3. Click **Next >**.



Figure 6. Windows XP ADF4151 Software Installation, Logo Testing

4. Click **Continue Anyway**.

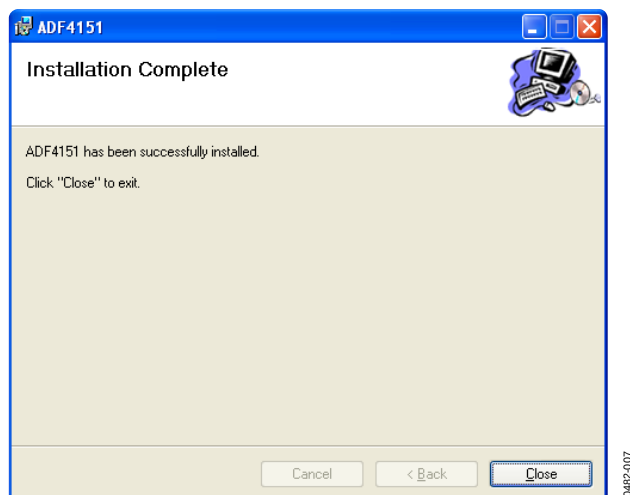


Figure 7. Windows XP ADF4151 Software Installation, Installation Complete

5. Click **Close**.

Windows Vista and Windows 7 Software Installation Guide



Figure 8. Windows Vista/7 ADF4151 Software Installation, Setup Wizard

1. Click **Next >**.



Figure 9. Windows Vista/7 ADF4151 Software Installation, Select Installation Folder

2. Choose an installation directory and click **Next >**.

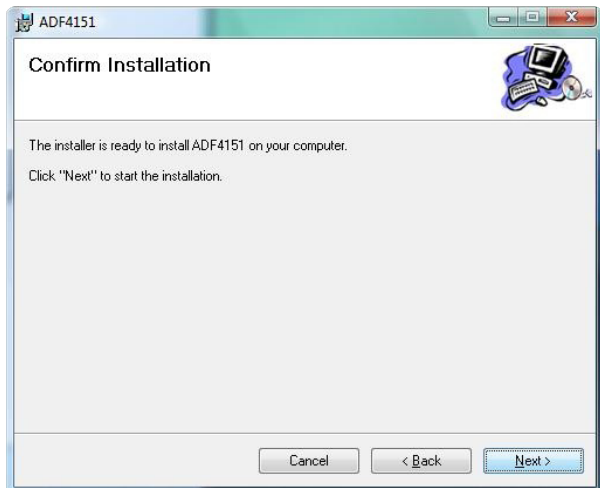


Figure 10. Windows Vista/7 ADF4151 Software Installation, Confirm Installation

3. Click **Next >**.



Figure 11. Windows Vista/7 ADF4151 Software Installation, Start Installation

4. Click **Install**.

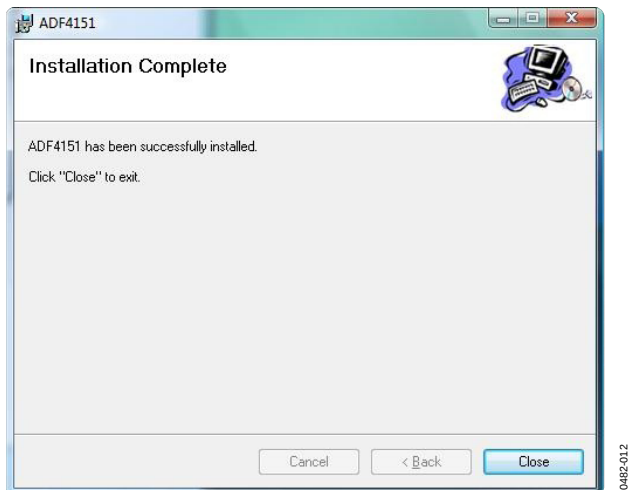


Figure 12. Windows Vista/7 ADF4151 Software Installation, Install Complete

5. Click **Close**.

Windows XP Driver Installation Guide



Figure 13. Windows XP USB Driver Installation, Found New Hardware Wizard

1. Choose **Yes, this time only** and click **Next >**.

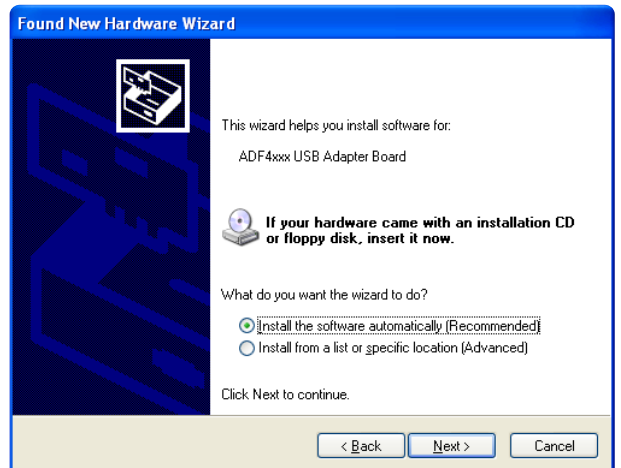


Figure 14. Windows XP USB Driver Installation, Install Options

2. Click **Next >**.

Note that Figure 14 may list **Analog Devices RFG.L Eval Board** instead of **ADF4xxx USB Adapter Board**.

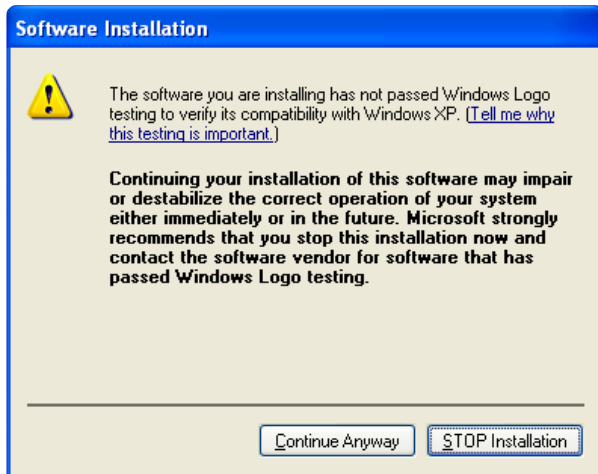


Figure 15. Windows XP USB Driver Installation, Logo Testing

3. Click **Continue Anyway**.

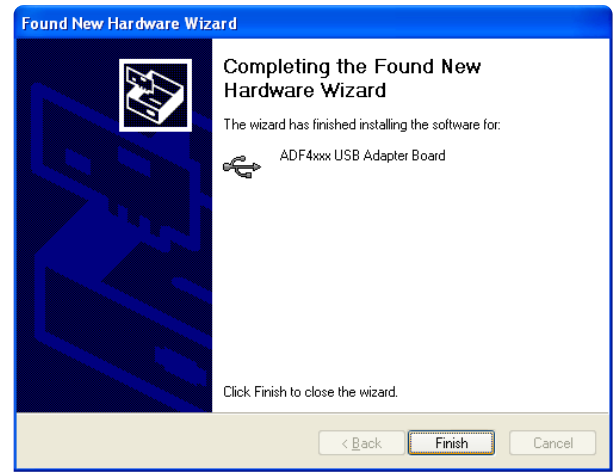


Figure 16. Windows XP USB Driver Installation, Complete Installation

4. Click **Finish**.

EVALUATION BOARD SOFTWARE

The control software for the [EVAL-ADF4151EB1Z](#) is available on the CD included in the evaluation kit. To install the software, see the Software Installation section.

To run the software, first connect the board to the USB port of the PC and then click the **ADF4151** file on the desktop or in the **Start** menu. Confirm that **USB OK** is displayed at the top right corner of the software front panel display window (see Figure 17). Otherwise, the software has no connection to the evaluation board.

Note that, when connecting the board, it takes about 5 sec to 10 sec for the status label to change.

If the software is started before the board is connected to USB port, an error window opens, informing that the USB device was not found, and the **No USB** message is displayed in the top right corner of the software front panel window. In this case, connect the board to the USB port and click the **Connect USB** button.

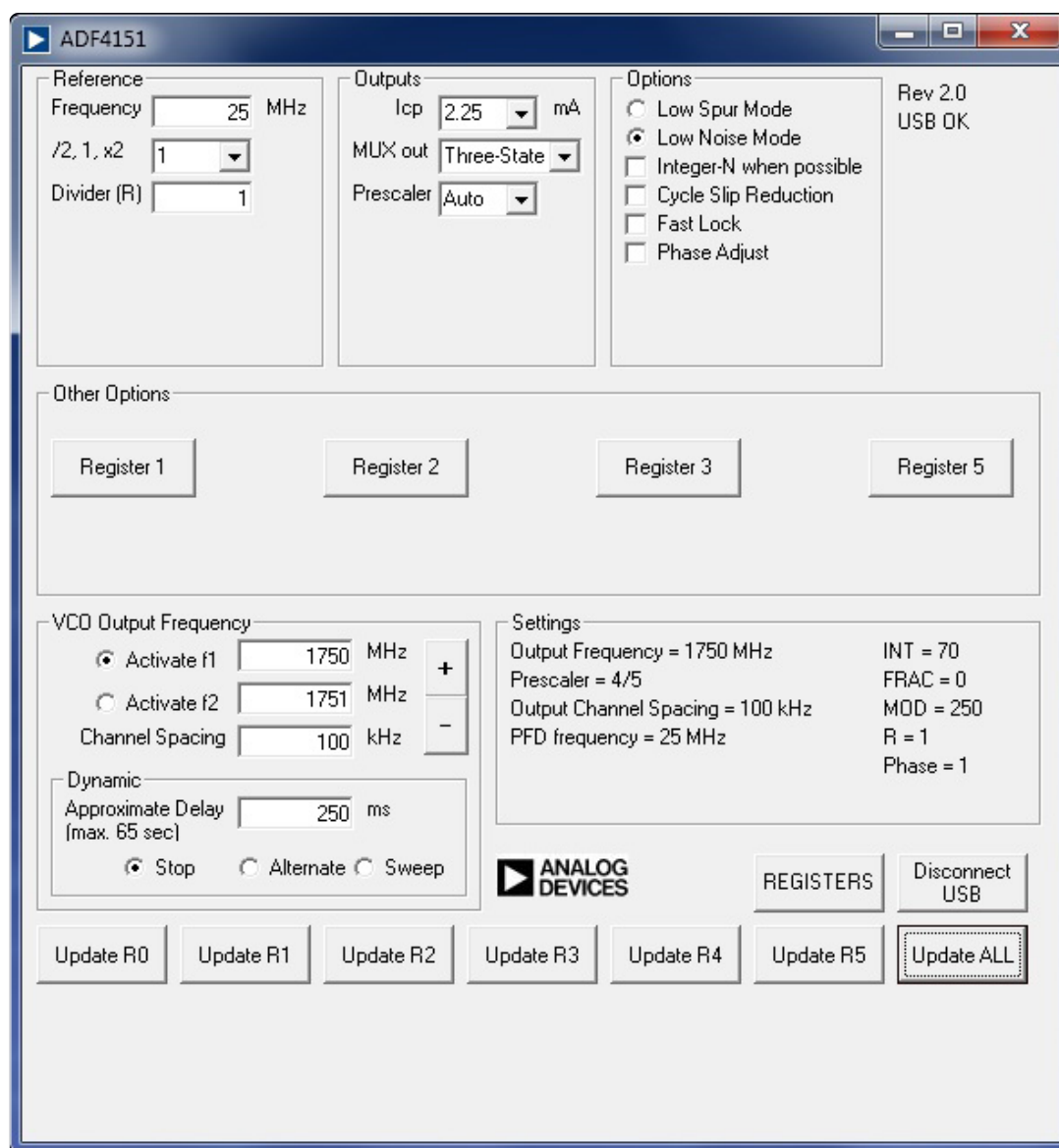


Figure 17. Software Front Panel Display—Select Device and Connection

Use the **Frequency** text box in the **Reference** section to set the correct reference frequency. The default reference on the software window is at 25 MHz and matches the frequency of the TCXO present on the board.

Use the **VCO Output Frequency** section to control the output frequency. To achieve single-tone on the VCO output, type the desired output frequency in the **Activate f1** text box (in megahertz) and ensure that **Stop** is selected in the **Dynamic** section under **VCO Output Frequency**. Selecting the **Alternate** option causes the frequency on the VCO output to switch between the **Activate f1** and **Activate f2** values. The delay time between frequency switches is controlled by the **Approximate Delay** option. The third option of the **Dynamic** section, **Sweep**, allows the output frequency to constantly change with the frequency step set by **Channel Spacing**, starting from **Activate f1** until it reaches **Activate f2**. After the **Active f2** frequency is reached, the sweep is repeated.

Some register settings may need to be set manually. Click the **Register 1** to **Register 5** buttons to open the register settings windows, as shown in Figure 18.

Click the **REGISTERS** button to display the binary and hexadecimal values for all registers, as shown in Figure 19.

When a new register setting value is entered (see Figure 18), the relevant **Update Rx** (where x = 0 to 5) button becomes red, indicating that it must be clicked to program the part with the new value. Clicking the **Update ALL** button programs all register values simultaneously.

Click the **OK** button to confirm the new value in the **Register x Settings** (where x = 1, 2, 3, or 5) window (see Figure 18). Click **Update Rx** to program the part with the new value. The new value is retained in the **Register x Settings** window if it is opened again.

If the value entered is outside of the range specified in the [ADF4151](#) data sheet, an error message appears and the field is automatically updated to the lowest or highest value within the allowed range. Some limits are changed dynamically based on the values of other registers; that is, the highest allowed value for **Phase** in the **Register 1 Settings** window depends on the current value of the modulus (**MOD** in the **Settings** section), which is calculated based on the data from the **Reference** section and the **Channel Spacing** field (under the **VCO Output Frequency** section).

Click the **Cancel** button to abandon a register value change, and the new value is not retained in the **Register x Settings** window if it is opened again.

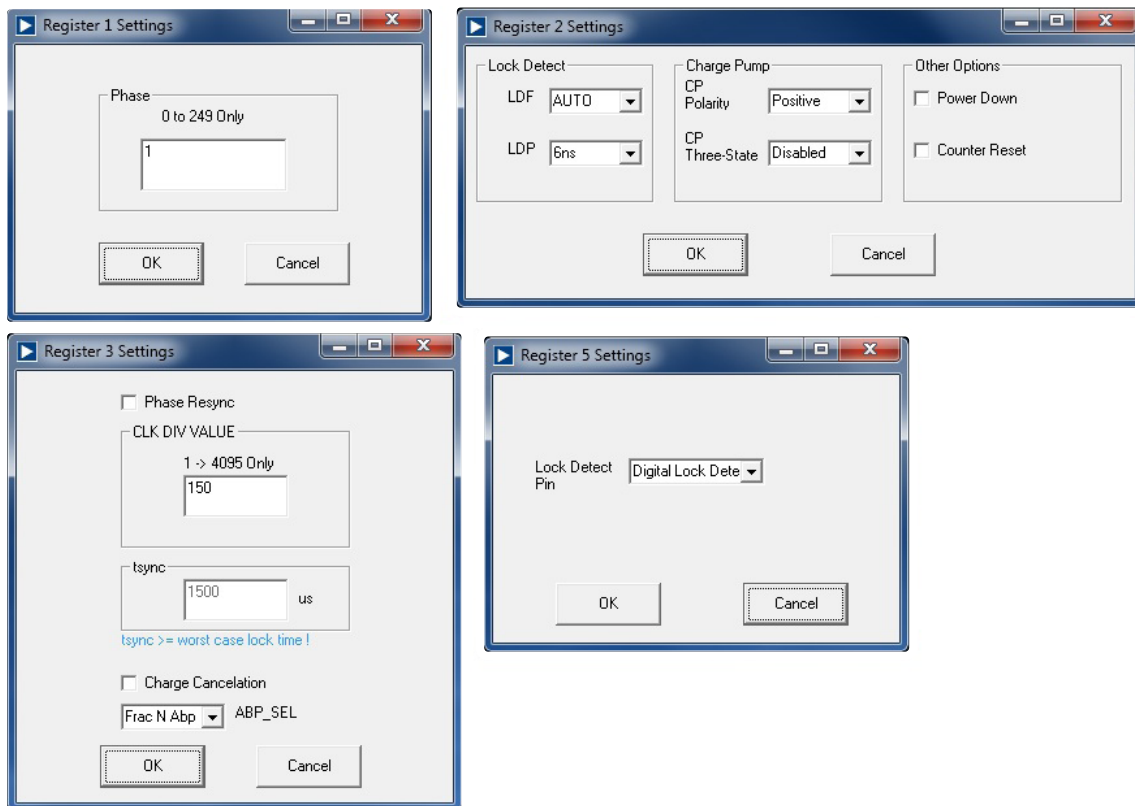
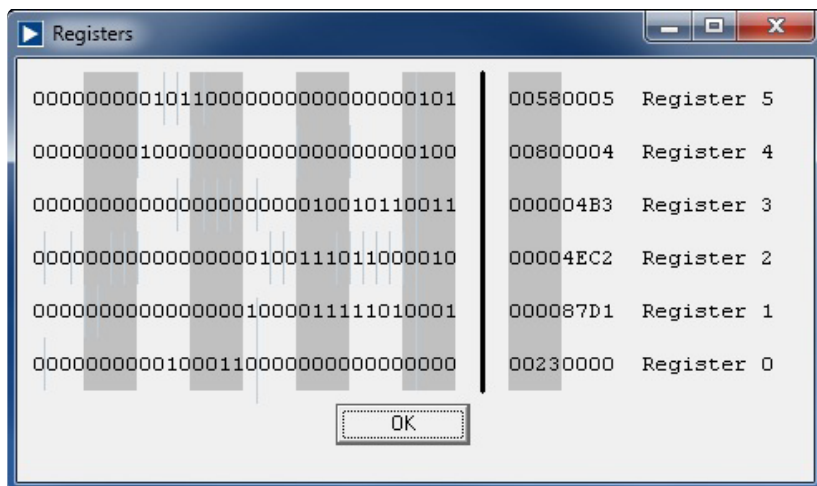


Figure 18. Register Settings Windows for Register 1, Register 2, Register 3, and Register 5

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Figure 19. Registers Window for Register 1, Register 2, Register 3, and Register 5

EVALUATION AND TEST

To evaluate and test the performance of the [ADF4151](#), use the following procedure:

1. If using a different VCO and loop filter than provided on the board, ensure that a VCO and loop filter are properly inserted on the board. Use ADIsimPLL to generate the loop filter component values.
2. Install the [ADF4151](#) software. Connect the evaluation board to a PC using the supplied USB cable. Follow the hardware driver installation procedure that appears.
3. If the on-board crystal oscillator is used, skip this step. If an external reference is necessary, connect a reference signal to the REFIN edge mount connector.
4. Connect the power supply to the board.
5. Connect a spectrum analyzer to Connector VCO_I/O.
6. Run the [ADF4151](#) software.
7. In the software window, set the VCO center frequency (Figure 20 shows a screenshot of a spectrum analyzer taken at a frequency of 1750 MHz, which is in the middle range of the provided VCO). Set the PFD frequency as defined in ADIsimPLL, and program the reference frequency to 25 MHz if the on-board TCXO is used or to the frequency that has been supplied to the REFIN connector. See Figure 21 for the suggested setup.
8. Measure the output spectrum. Figure 20 shows a 1750 MHz output.

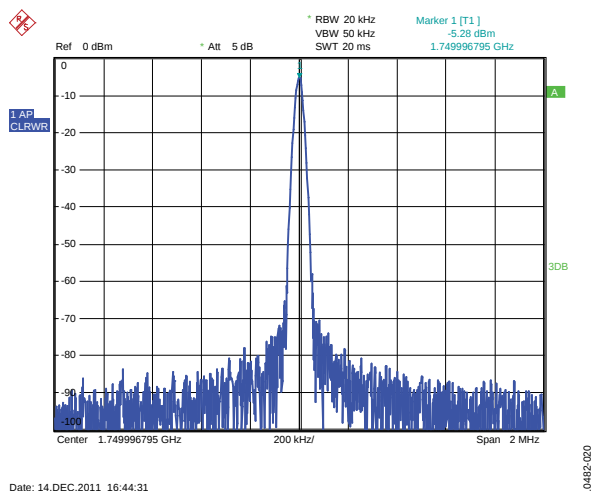


Figure 20. Spectrum Analyzer Display

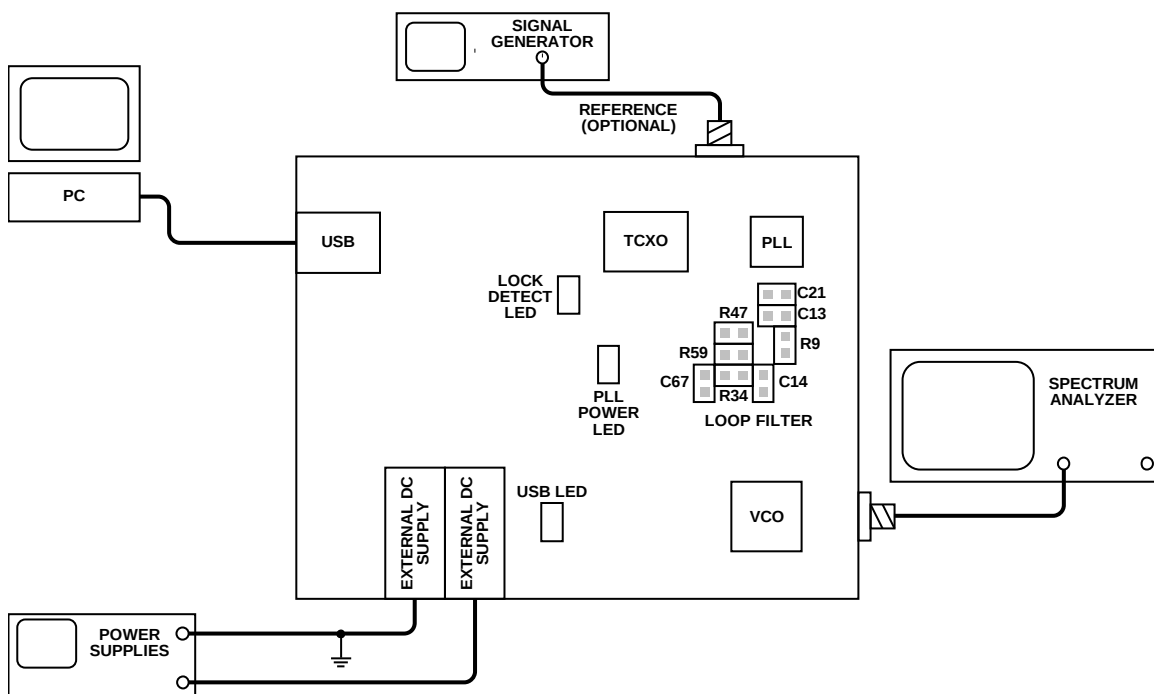


Figure 21. Typical Evaluation Setup

EVALUATION BOARD SCHEMATICS AND ARTWORK

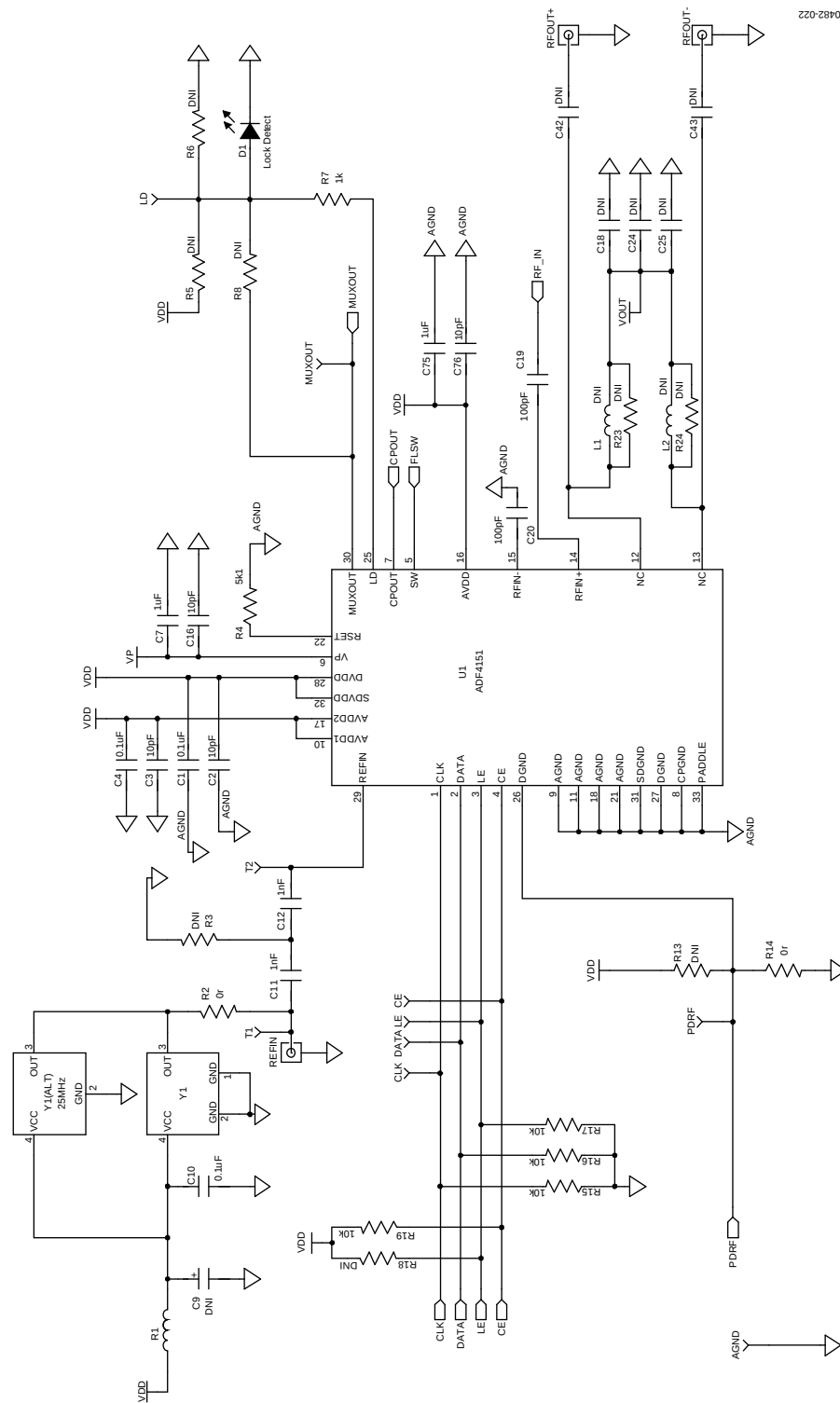


Figure 22. Evaluation Board Schematic (Page 1)

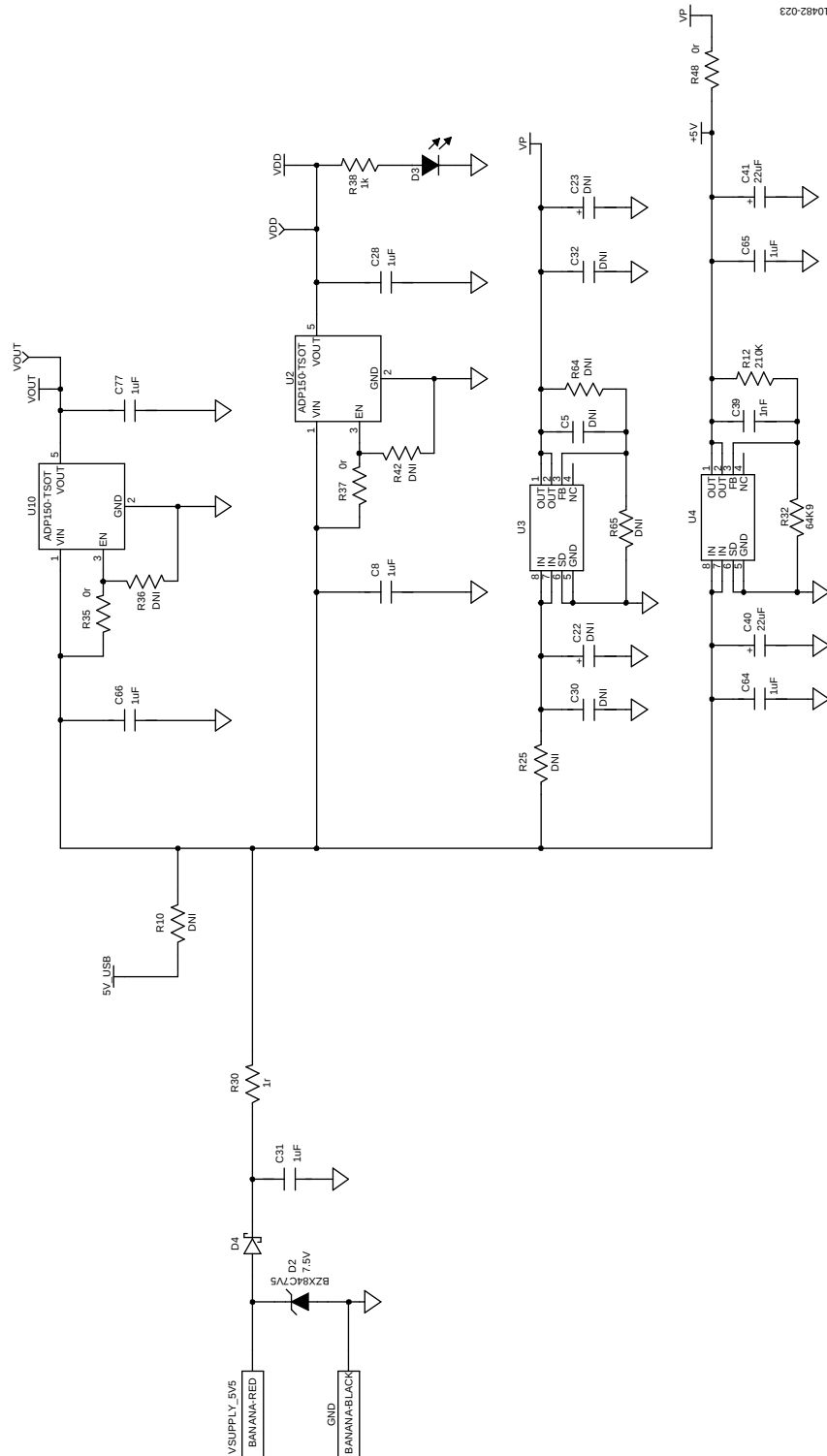


Figure 23. Evaluation Board Schematic (Page 2)

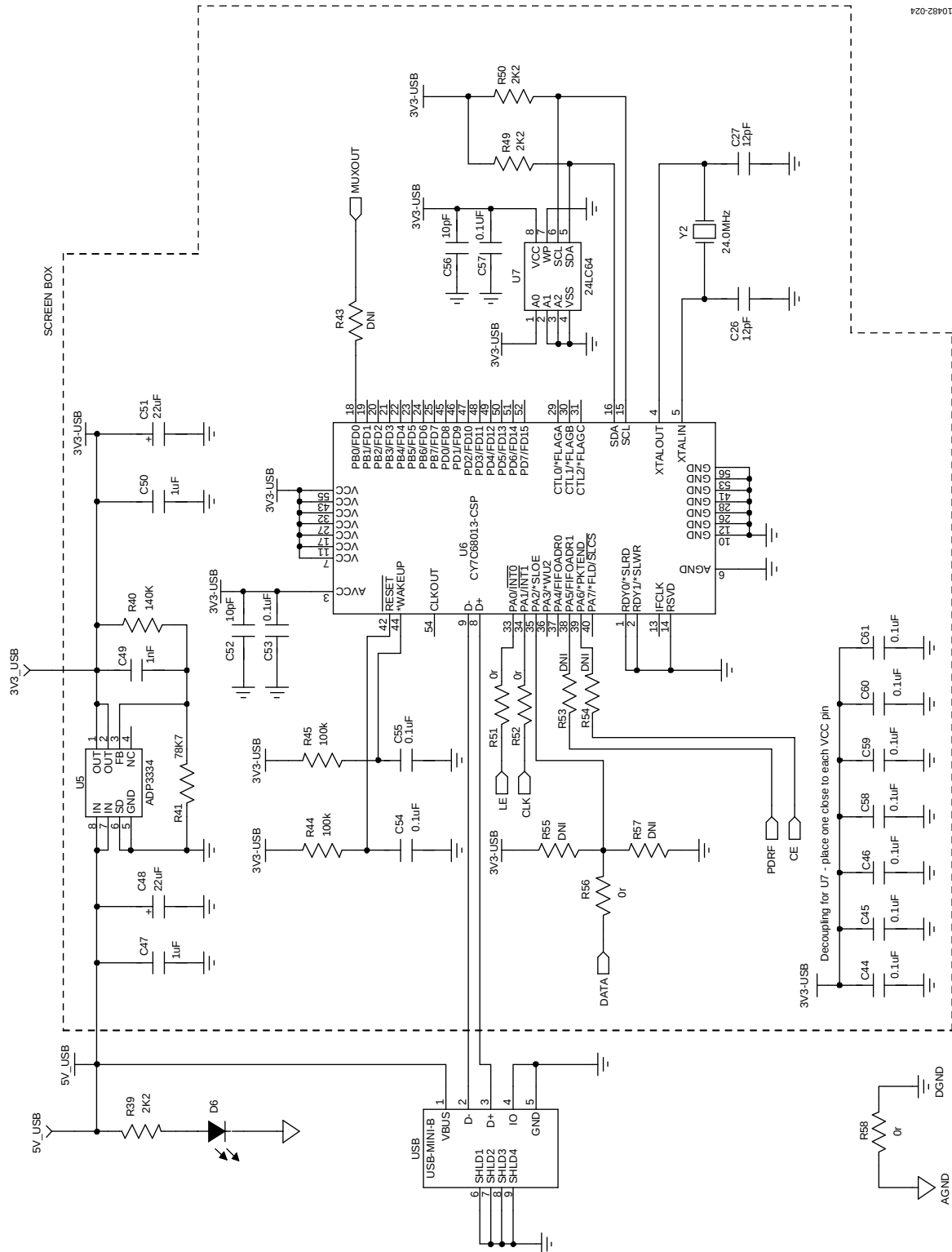


Figure 24. Evaluation Board Schematic (Page 3)

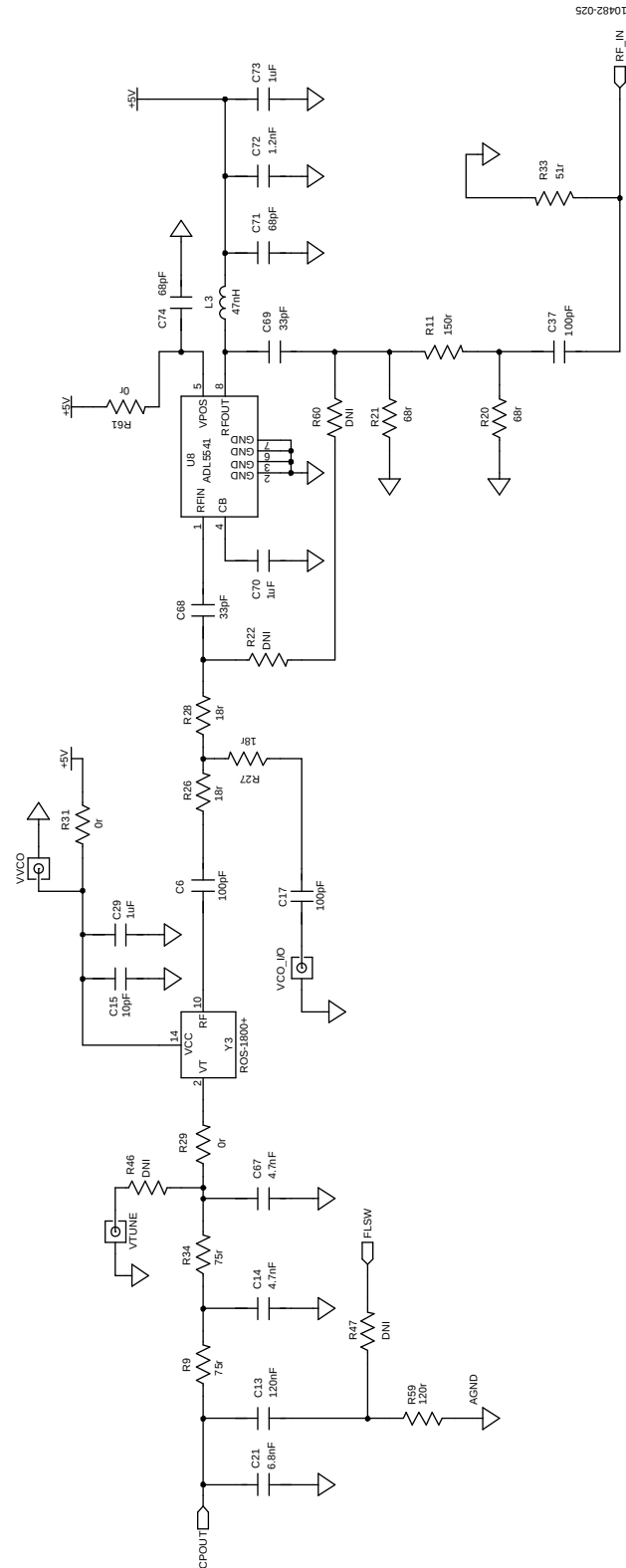


Figure 25. Evaluation Board Schematic (Page 4)

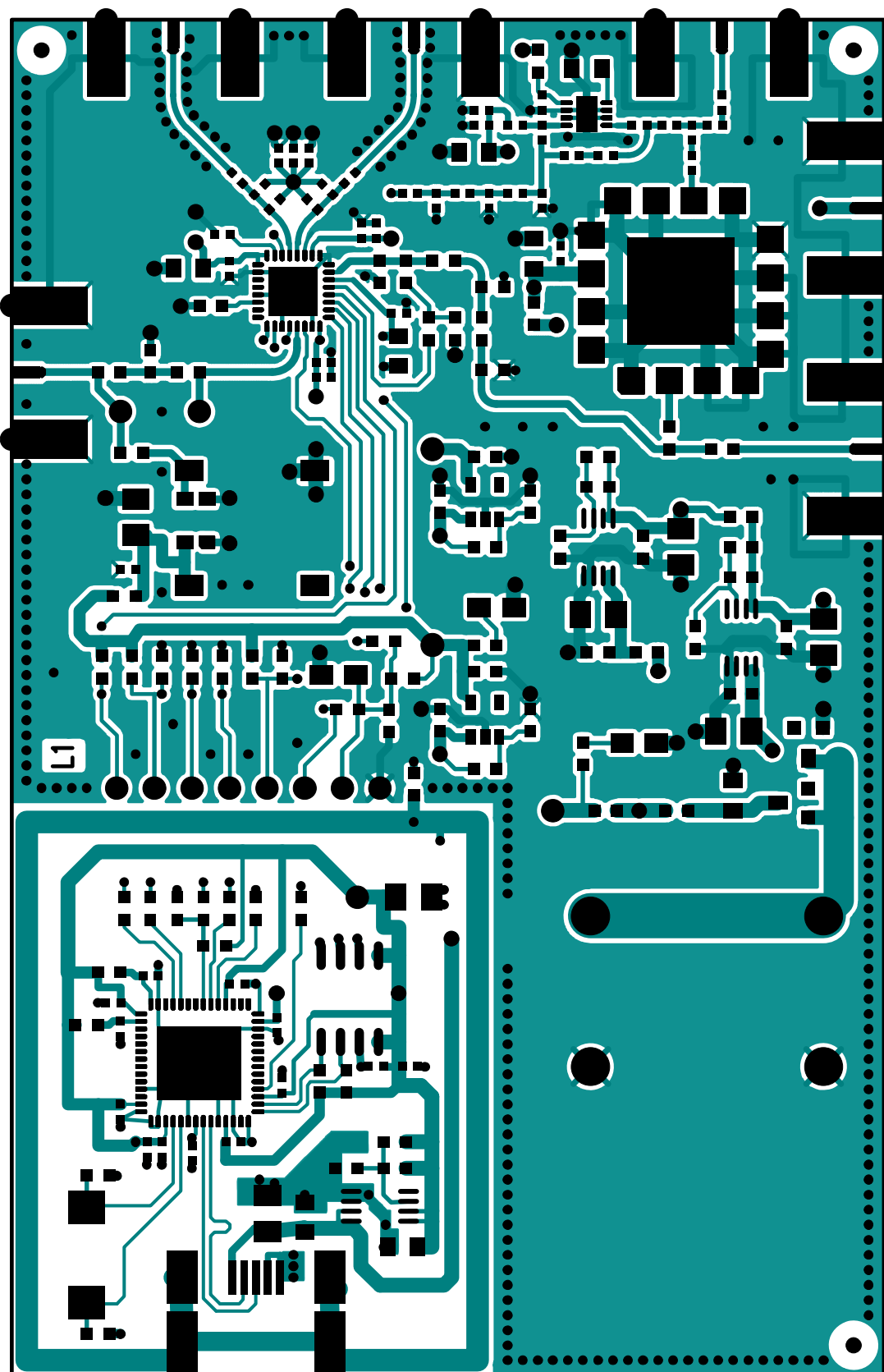
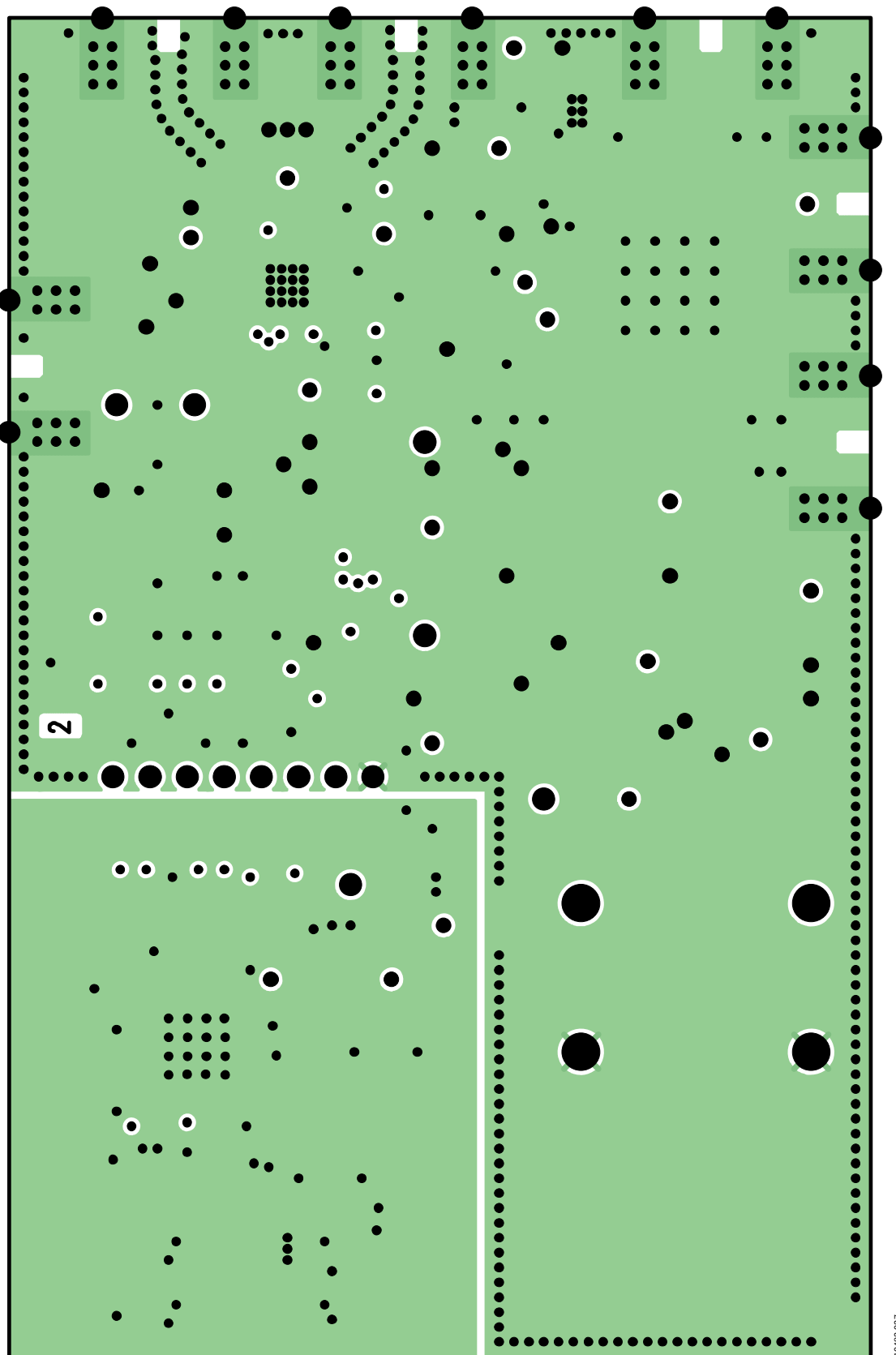


Figure 26. Layer 1 (Component Side)

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Figure 27. Layer 2 (Ground Plane)

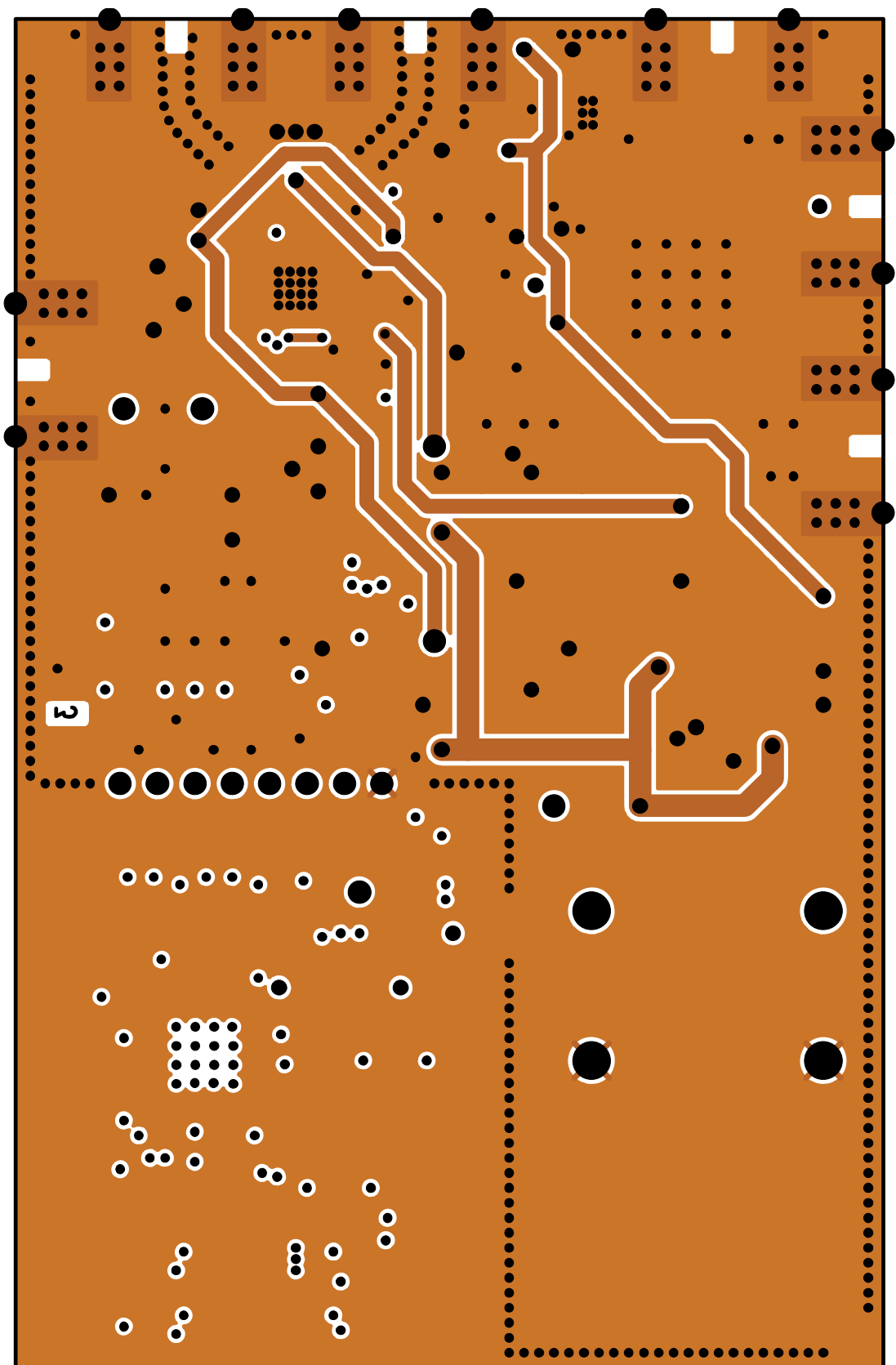
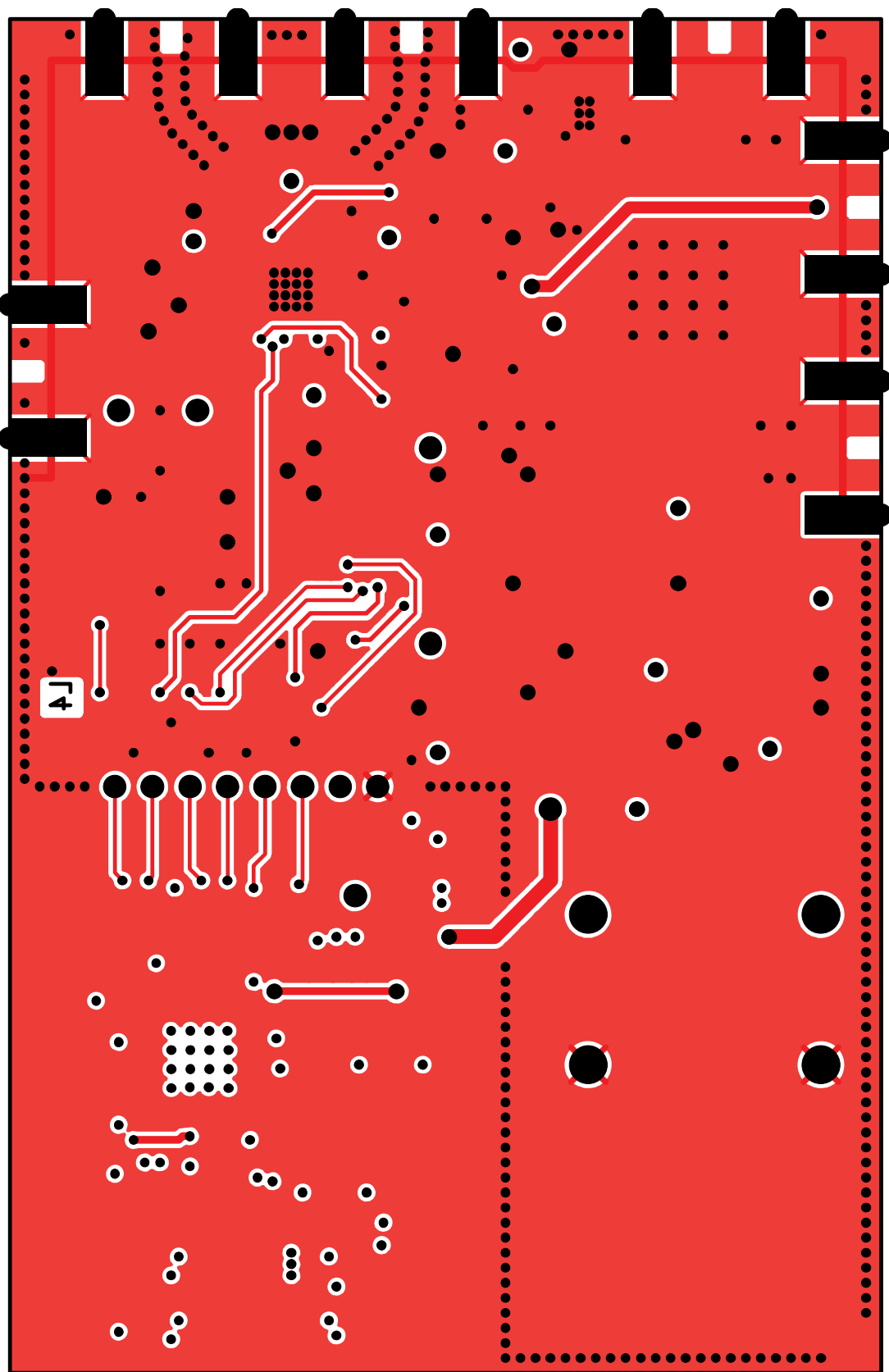


Figure 28. Layer 3 (Power Plane)



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Figure 29. Layer 4 (Solder Side)

ORDERING INFORMATION

BILL OF MATERIALS

Table 1.

Reference Designator	Value	Description	Manufacturer/Part Number
AGND		Black test point	Vero 20-2137
C1, C4, C10, C44, C45, C46, C53, C54, C55, C57, C58, C59, C60, C61	0.1 μ F	16 V, X7R ceramic capacitor	Kemet C0402C104K4RAC
C2, C3, C15, C16, C52, C56, C76	10 pF	50 V NP0 ceramic capacitor	AVX 04025U100GAT2A
C5, C24	Do not insert	50 V NP0 ceramic capacitor	Not applicable
C6, C17, C19, C20, C37	100 pF	50 V C0G ceramic capacitor	Murata GRM1555C1H101JD01D
C7, C29, C31	1 μ F	Ceramic capacitor 1.0 μ F, 50 V, X5R, 0805	Taiyo/Yuden GRM32RR71H105KA01L
C8, C28, C66, C77	1 μ F	Capacitor, 0603, 1 μ F, 10 V, X5R	Murata GRM188R61A105KA61D
C9	Do not insert	TAJ-A capacitor location, not inserted	Not applicable
C11, C12, C39, C49	1 nF	50 V NP0 ceramic capacitor	AVX 06035A102JAT2A
C13	120 nF	50 V X7R SMD ceramic capacitor	Kemet C0603C124K5RACTU
C14, C67	4.7 nF	50 V X7R SMD ceramic capacitor	Kemet C0603C472K5RAC
C18, C25, C30, C32	Do not insert	16 V X5R ceramic capacitor	Not applicable
C21	6.8 nF	50 V NP0 SMD ceramic capacitor	Kemet C0603C682J5GACTU
C22, C23	Do not insert	6.3 V tantalum capacitor (TAJ-A case)	Not applicable
C26, C27	12 pF	50 V NP0 SMD ceramic capacitor	Phycomp 2238 867 15129
C40, C41, C48, C51	22 μ F	6.3 V tantalum capacitor (TAJ-A case)	AVX TAJA226K006R
C42, C43	Do not insert	Ceramic capacitor, 1000 pF 50 V C0G 0402	Not applicable
C47, C50	1.0 μ F	Ceramic capacitor, 1.0 μ F, 25 V, X5R, 0805	Taiyo/Yuden TMK107BJ105KA-T
C64, C65	1 μ F	16 V X5R ceramic capacitor	Kemet C0603C105K4PAC-TU
C68, C69	33 pF	50 V C0G ceramic capacitor	Murata GRM1555C1H330JZ01D
C70, C73, C75	1.0 μ F	Ceramic capacitor 1.0 μ F, 50 V, X5R, 0805	Taiyo/Yuden GRM32RR71H105KA01L
C71, C74	68 pF	50 V C0G ceramic capacitor	Murata GRM1555C1H680JZ01D
C72	1.2 nF	50 V X7R ceramic capacitor	Murata GRM155R71H122KA01D
D1, D6		Green LED	Avago Technologies, HSMG-C170
D2	7.5 V	Zener diode, 7.5 V, 300 mW	Fairchild BZX84C7V5
D3		Red LED	Avago Technologies HSMS-C170
D4		Schottky diode, 1 A forward	Avago Technologies HSMS-280C-BLKG
GND		Black 4 mm banana socket	Deltron 571-0100-01
L1, L2	Do not insert	0402 inductor location, not inserted	Not applicable
L3	47 nH	Coilcraft 0402CS SMD inductor	Coilcraft 0402CS-47NX-LU
R1, R2, R14, R29, R31, R35, R37, R48, R51, R52, R56, R58, R61	0 Ω	SMD resistor	Multicomp MC 0.063W 0603 0R
R3, R5, R6, R8, R10, R13, R18, R22, R23, R24, R25, R36, R42, R43, R46, R47, R53, R54, R55, R57, R60, R64, R65	Do not insert	0603 resistor location, not inserted	Not applicable
R4	5.1 k Ω	SMD resistor	Multicomp MC 0.063W 0603 5k1
R7, R38	1 k Ω	SMD resistor	Multicomp MC 0.063W 0603 1K
R9, R34	75 Ω	SMD resistor	CRCW060375R0FKEA
R11	150 Ω	0402 SMD resistor	Multicomp MC 0.0625W 0402 1% 150R
R12	210 k Ω	SMD resistor	Multicomp MC 0.063W 0603 210k
R15, R16, R17, R19	10 k Ω	SMD resistor	Multicomp MC 0.063W 0603 10K
R20, R21	68 Ω	0402 SMD resistor	Multicomp MC 0.0625W 0402 1% 68R
R33	51 Ω	0402 SMD resistor	Multicomp MC 0.063W 0402 51R
R26, R27, R28	18 Ω	0402 SMD resistor	Multicomp MC 0.0625W 0402 1% 18R
R30	1 Ω	SMD resistor	Yageo (PHYCOMP) RC0603FR-071RL
R32	64.9 k Ω	SMD resistor	Multicomp MC 0.063W 0603 68k
R39, R49, R50	2.2 k Ω	SMD resistor	Multicomp MC 0.063W 0603 2k2

Reference Designator	Value	Description	Manufacturer/Part Number
R40	140 k Ω	SMD resistor	Multicomp MC 0.063W 0603 1% 140K
R41	78.7 k Ω	SMD resistor	Multicomp MC 0.063W 0603 1% 78K7
R44, R45	100 k Ω	SMD resistor	Multicomp MC 0.063W 0603 100K
R59	120 Ω	SMD resistor	Multicomp MC 0.063W 0603 1% 120R
REFIN, RFOUT+, RFOUT–		End-launch 50 Ω SMA jack	Emerson Network 142-0701-851
U1		PLL	Analog Devices ADF4151
U2, U10		3.3 V linear regulator	Analog Devices ADP150AUJZ-3.3
U3, U4, U5		Adjustable LDO regulator	Analog Devices ADP3334ARMZ
U6		USB microcontroller	Cypress Semiconductor CY7C68013A-56LFXC
U7		64 k I ² C serial EEPROM	Microchip Technology 24LC64-ISN
U8		50 MHz to 6 GHz RF/IF gain block	Analog Devices ADF4151 ACPZ
USB		USB Mini-B connector (USB-OTG)	Molex 54819-0578
VCO_I/O, VTUNE, VVCO		End-launch 50 Ω SMA jack	Emerson Network 142-0701-851
VSUPPLY_5V5		Red 4 mm banana socket	Deltron 571-0500-01
Y1 (ALT)	25 MHz	SMD temperature compensated crystal oscillator	Rakon TXO225B
Y2	24 MHz	SMD crystal	ECS International ECS-240-12-20A-TR
Y3	1700 MHz to 1800 MHz	VCO	Mini-Circuits ROS-1800+

RELATED LINKS

Resource	Description
ADF4151	Product Page, Fractional-N/Integer-N PLL Synthesizer
ADP150	Product Page, Ultralow Noise, 150 mA CMOS Linear Regulator
ADP3334	Product Page, High Accuracy Low IQ, 500 mA anyCAP® Adjustable Low Dropout Regulator

NOTES

NOTES

I²C refers to a communications protocol originally developed by Philips Semiconductors (now NXP Semiconductors).

**ESD Caution**

ESD (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 ESD. Therefore, proper ESD 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 NONINFRINGEMENT 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.