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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
Electronic version of the UG-476 user guide

ADDITIONAL EQUIPMENT

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

DOCUMENTS NEEDED

ADF4151 data sheet
UG-369 user guide
UG-476 user guide

REQUIRED SOFTWARE

Analog Devices ADF4150 family software (Version 4.2.2 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 25 MHz frequency 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.

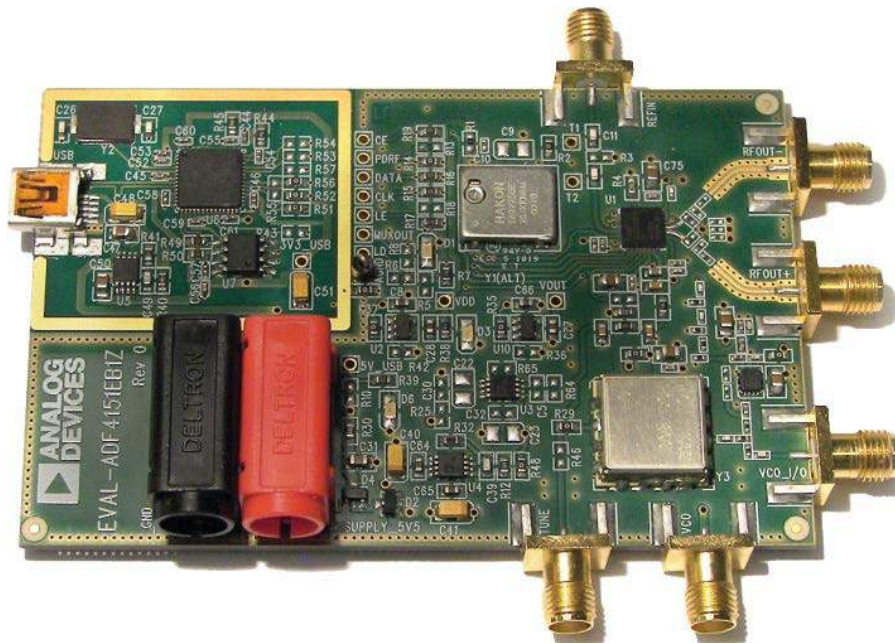The PC must have a USB port to program the part.

EVALUATION BOARD PHOTOGRAPH

Figure 1. EVAL-ADF4151EB1Z

TABLE OF CONTENTS

REVISION HISTORY

QUICK START GUIDE

Follow these steps to quickly evaluate the ADF4151 device:

1. Install the Analog Devices ADF4150 family software (see UG-476, *PLL Software Installation Guide*).
2. Connect the EVAL-ADF4151EB1Z board to the PC.
3. Follow the hardware driver installation procedure when it appears (Windows XP only).
4. Connect the power supplies to banana connectors (5.5 V).
5. Run the ADF4150 family software.

6. Select **USB board (green)** and **ADF4151** in the **Select Device and Connection** tab of the software front panel display window.
7. Click the **Main Controls** tab.
8. Update all registers.
9. Connect the spectrum analyzer to SMA connector VCO_I/O.
10. Measure the results.

EVALUATION BOARD HARDWARE

The EVAL-ADF4151EB1Z schematics are shown in Figure 7, Figure 8, Figure 9, and Figure 10. 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_{DD}, DV_{DD}, and SDV_{DD} pins) 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 from 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 the 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 local oscillator (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 10. 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 a 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 Ω 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 Ω links to ensure operation of the VCO_I/O connector as an input from an external VCO.

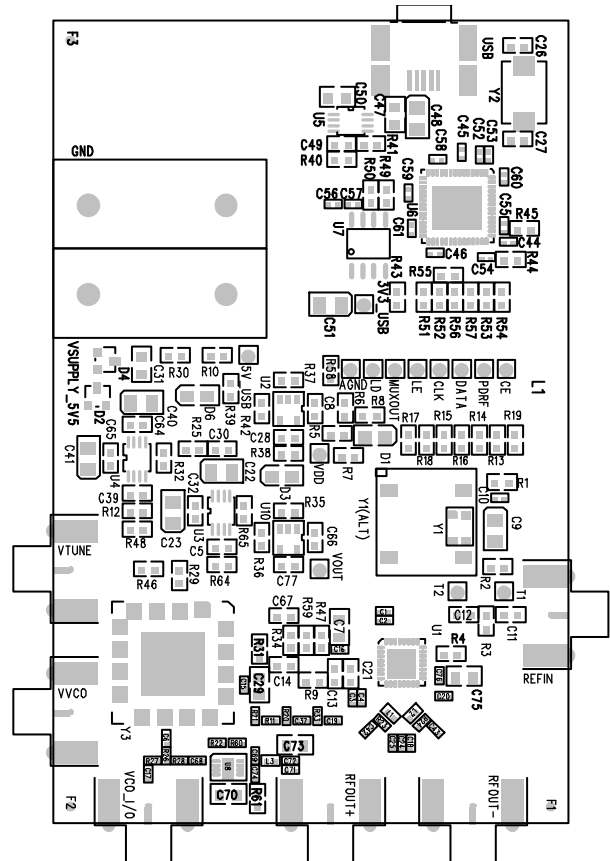Figure 2. Evaluation Board Silkscreen

EVALUATION BOARD SOFTWARE

The control software for the EVAL-ADF4151EB1Z accompanies the board on the CD included in the evaluation kit. To install the software, see UG-476, *PLL Software Installation Guide*.

To run the software,

1. Click the **ADF4150 Family** file on the desktop or from the **Start** menu.
2. On the **Select Device and Connection** tab, choose **ADF4151** and **USB board (green)**, and then click **Connect** (see Figure 3).

3. Confirm that **ADF4xxx USB Adapter Board connected** is displayed at the bottom left of the window (see Figure 3). 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.
4. Under the **File** menu, the current settings can be saved to and loaded from a text file.
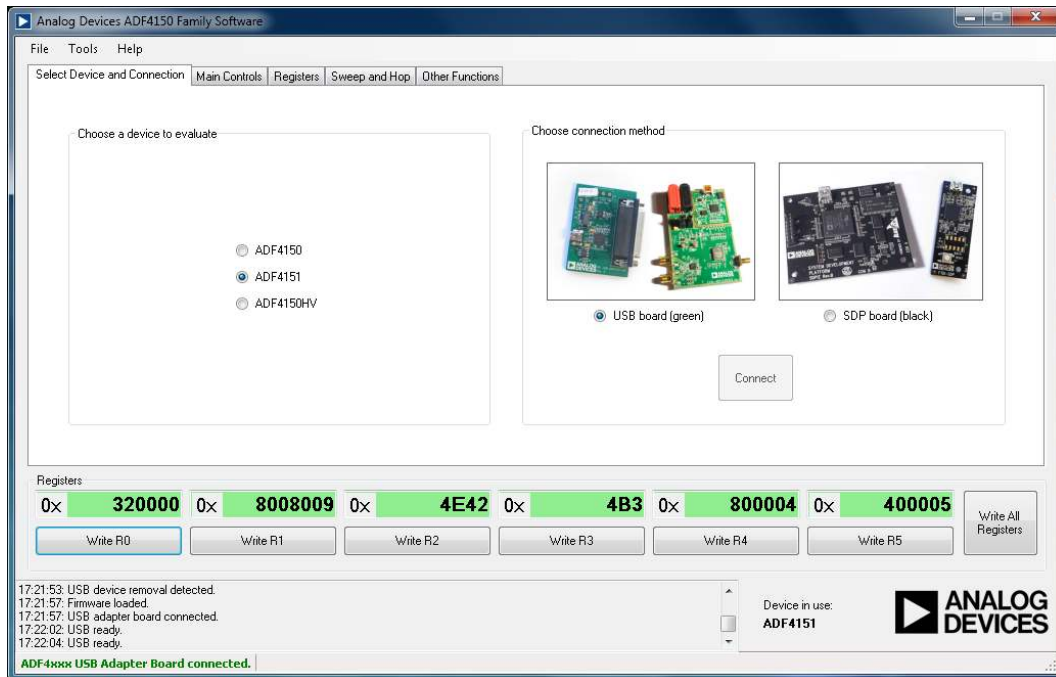
Figure 3. Software Front Panel Display—Select Device and Connection

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

Use the **Reference Frequency** text box to set the correct reference frequency and the reference frequency divider. If the on-board TCXO is used, the reference frequency should be set to 25 MHz.

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

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.

The **Registers** section near the bottom of each window displays the value to be written to each register. If the background of a text box is green, the value displayed is different from the value actually on the device. Click **Write Rx** (where x = 0 to 5) to write that value to the device.
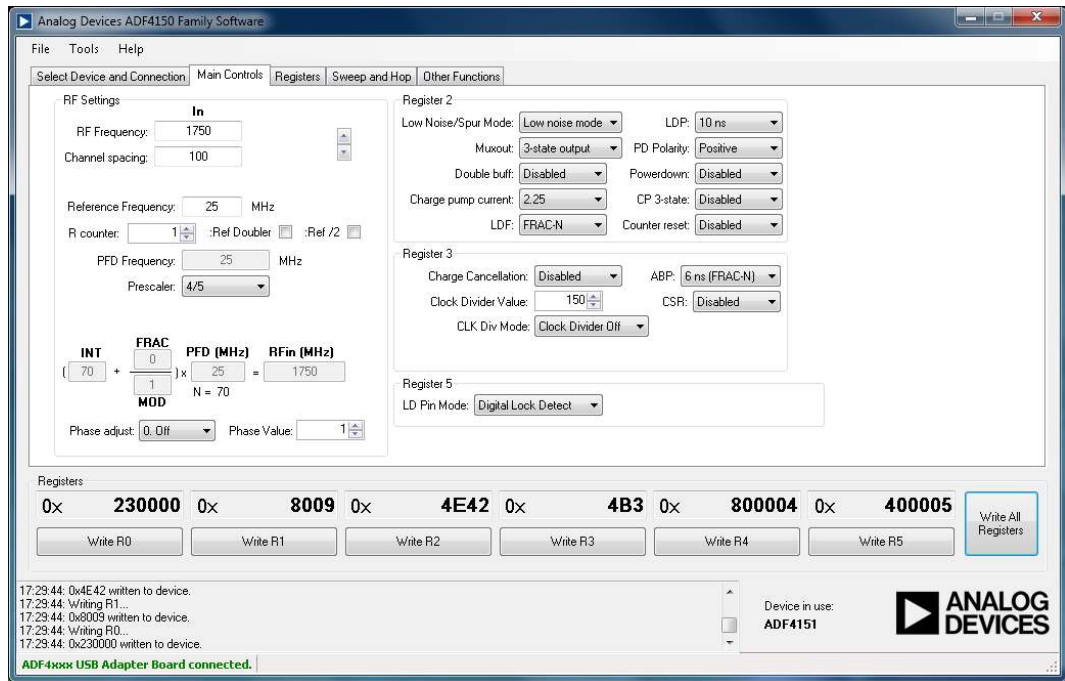
Figure 4. Software Front Panel Display—Main Controls

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 Analog Devices ADF4150 family software. Connect the evaluation board to a PC using the supplied USB cable. Follow the hardware driver installation procedure when it 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 Analog Devices ADF4150 family software.

7. In the software window, set the RF frequency (Figure 5 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 6 for the suggested setup.

8. Measure the output spectrum. Figure 5 shows a 1750 MHz output.
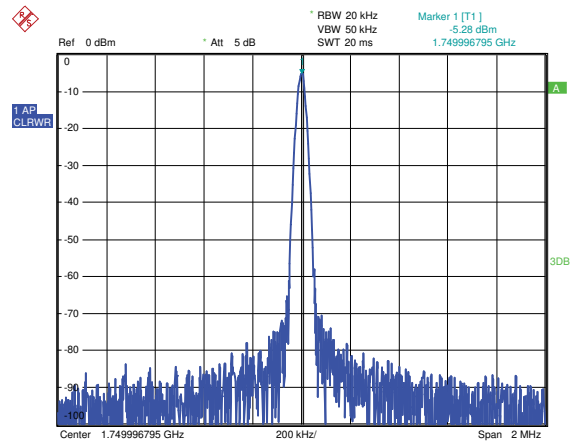
Figure 5. Spectrum Analyzer Display
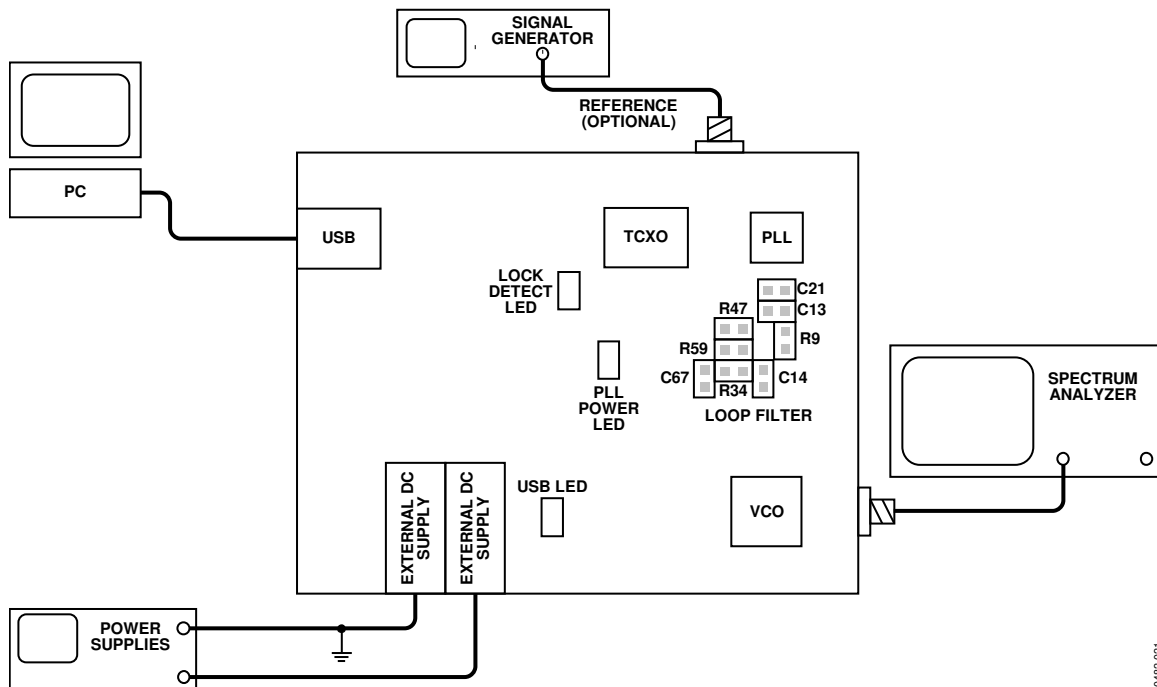
Figure 6. Typical Evaluation Setup

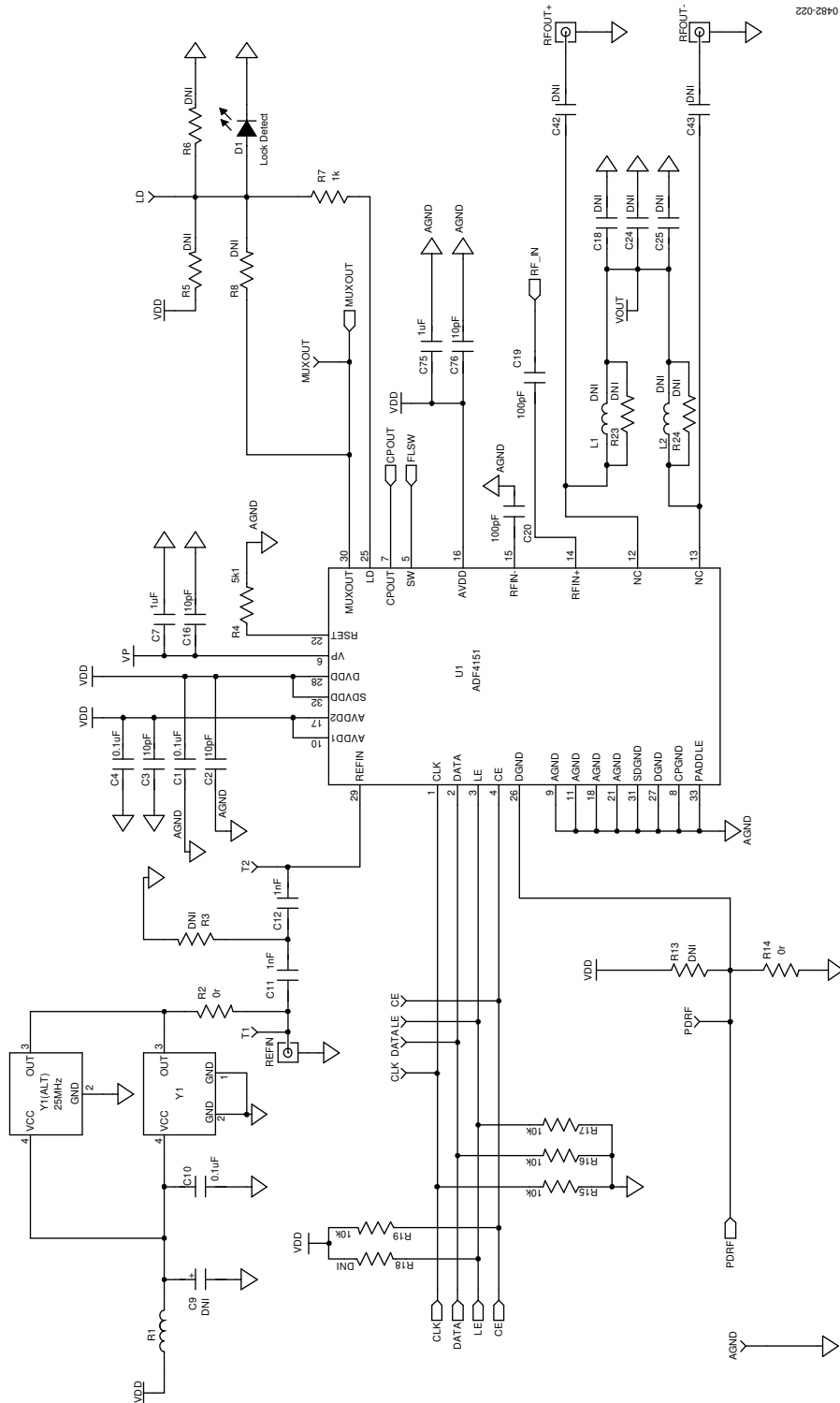# EVALUATION BOARD SCHEMATICS AND ARTWORK
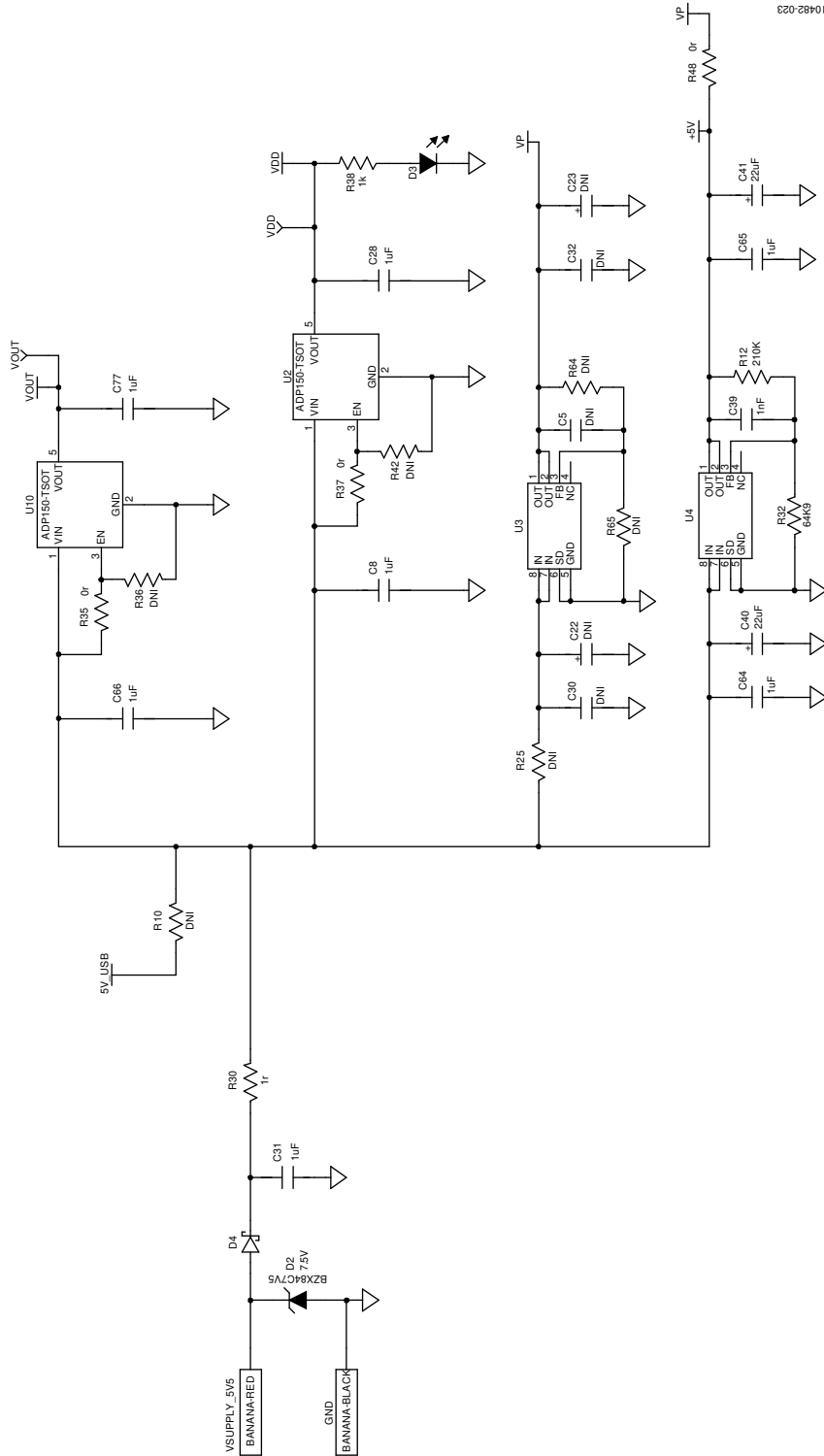

Figure 7. Evaluation Board Schematic (Page 1)
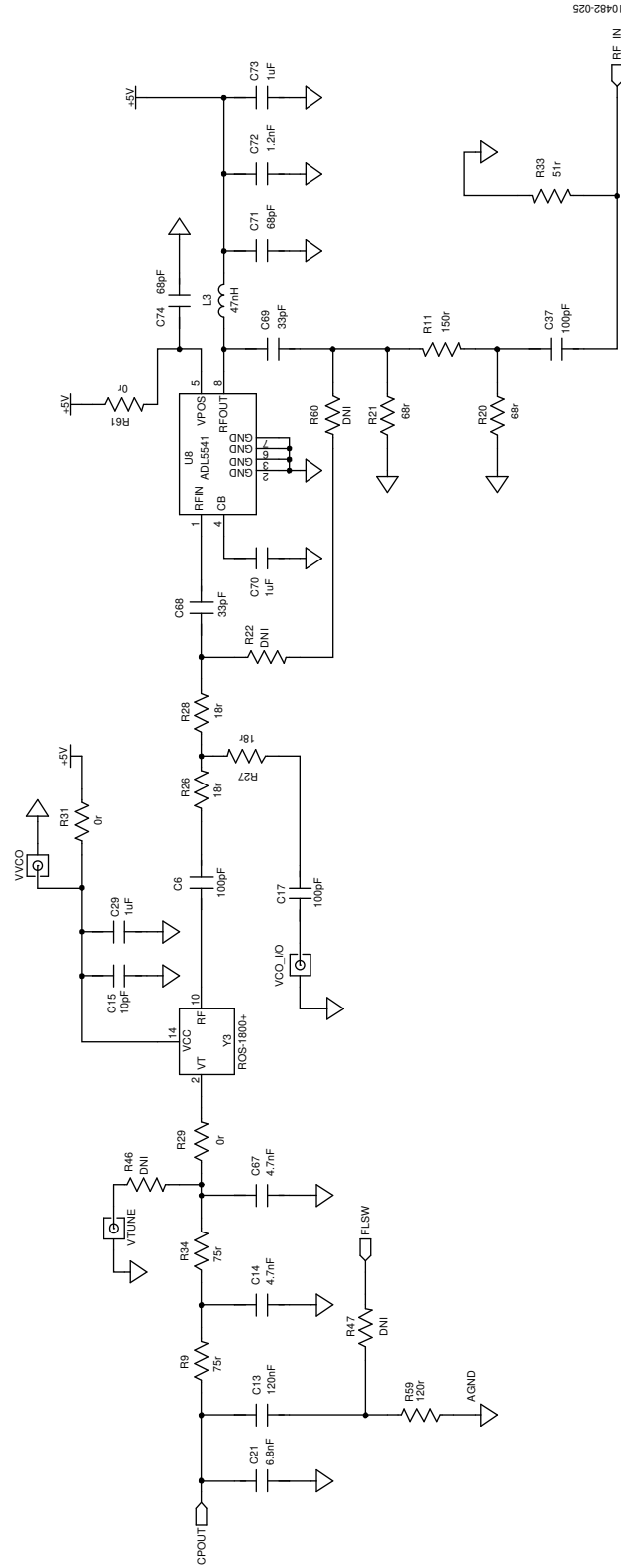
Figure 8. Evaluation Board Schematic (Page 2)

Figure 9. Evaluation Board Schematic (Page 3)

Figure 10. Evaluation Board Schematic (Page 4)

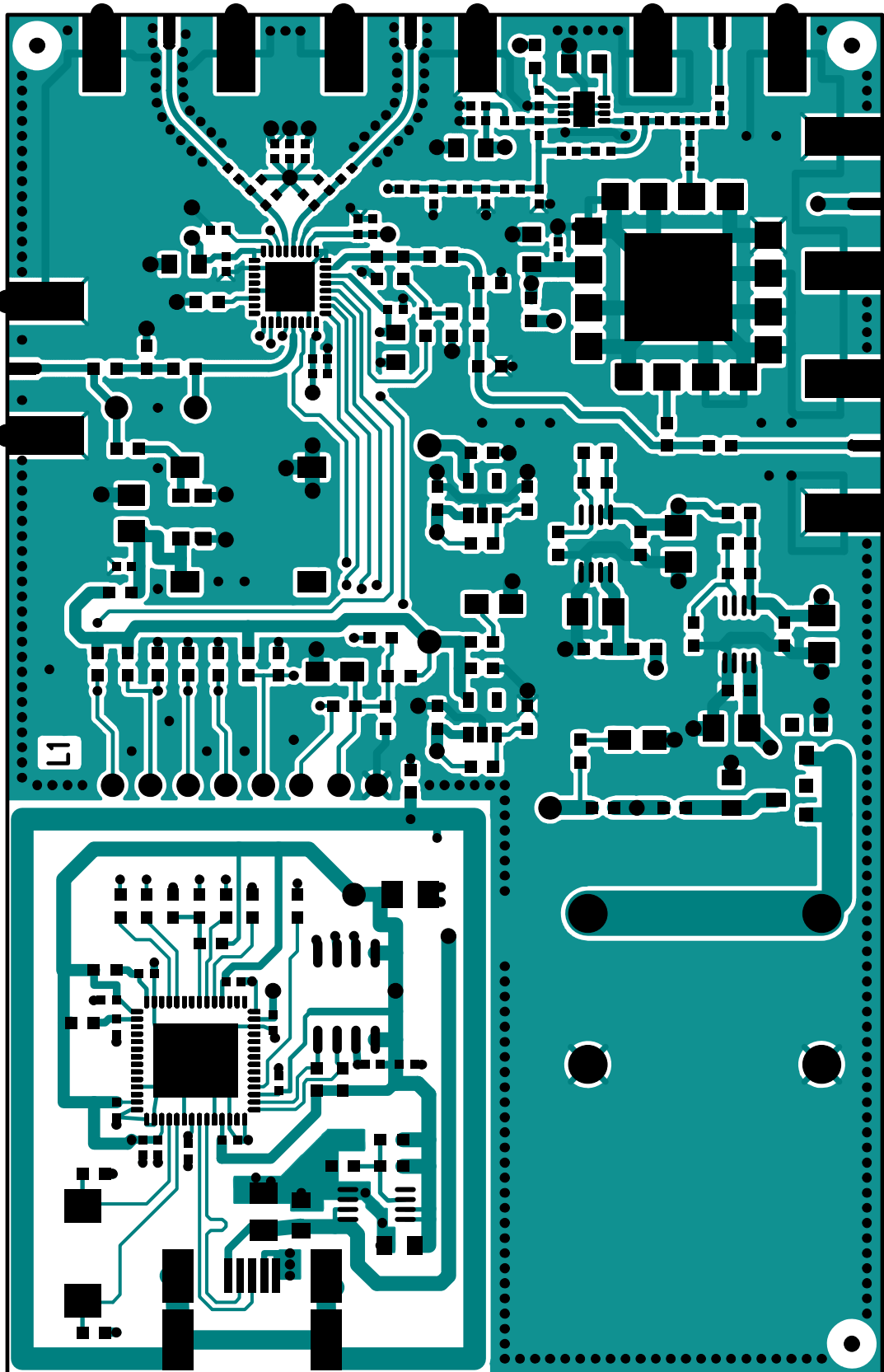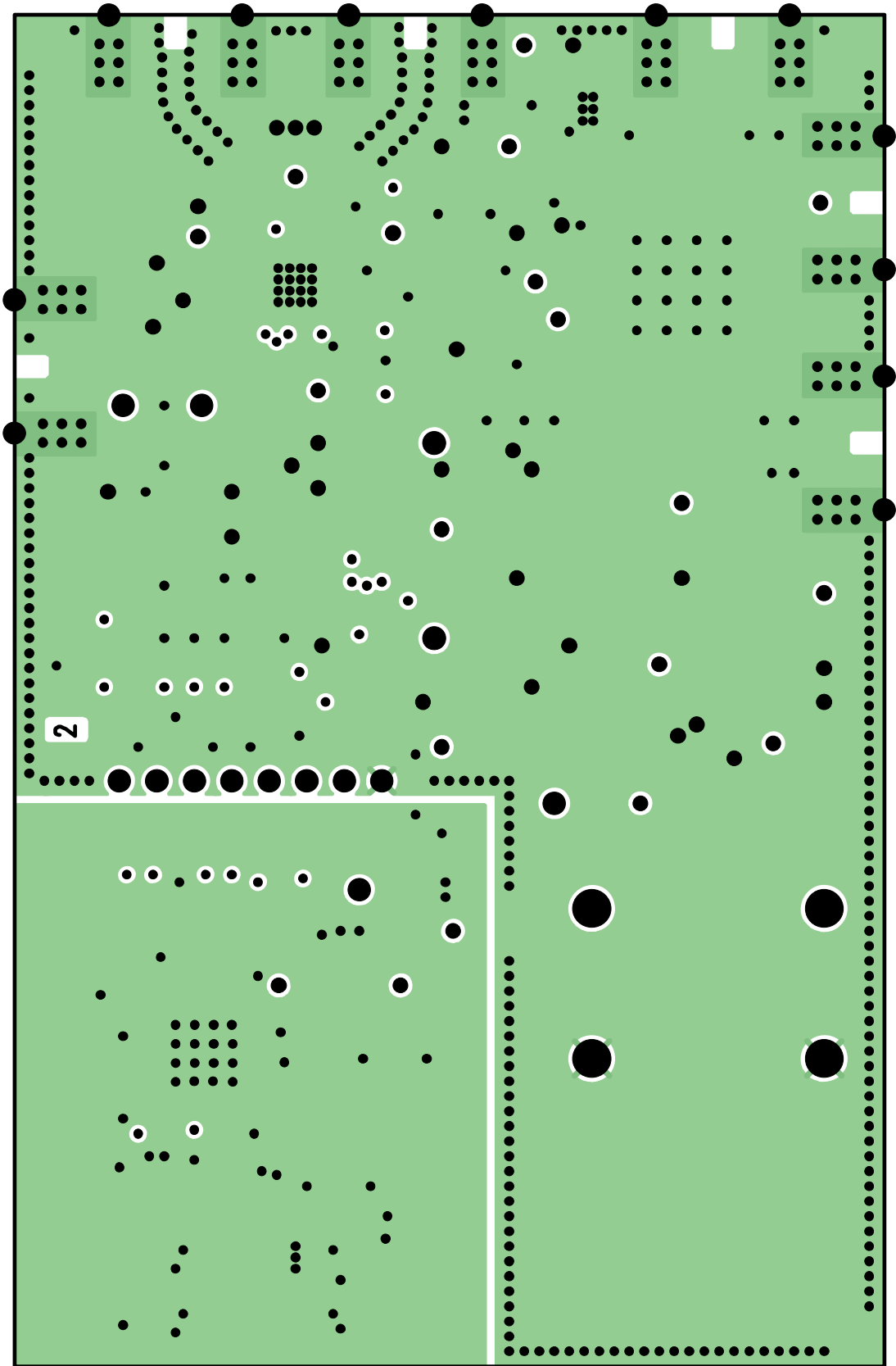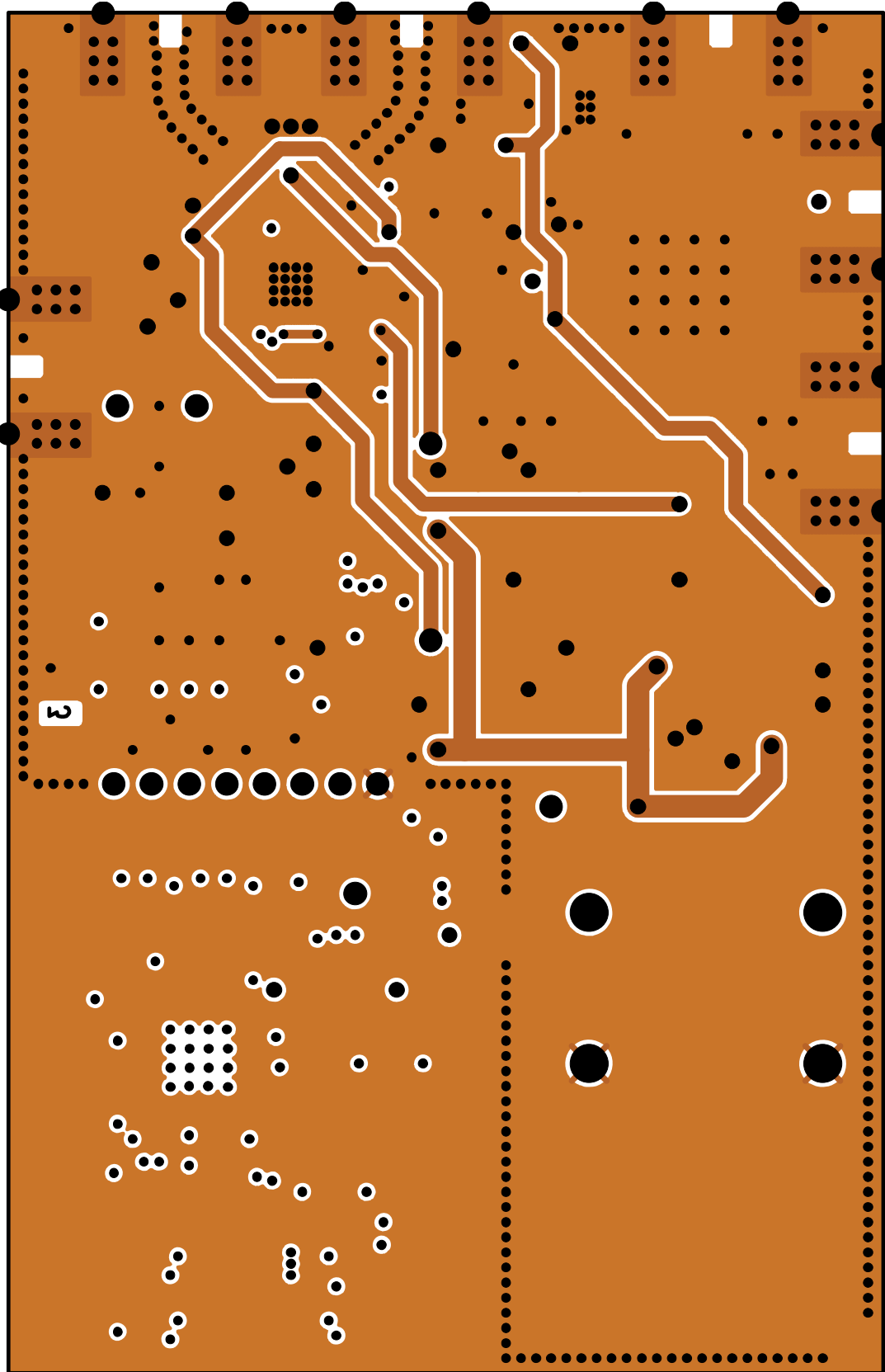*Figure 11. Layer 1 (Component Side)*

Figure 12. Layer 2 (Ground Plane)

Figure 13. Layer 3 (Power Plane)

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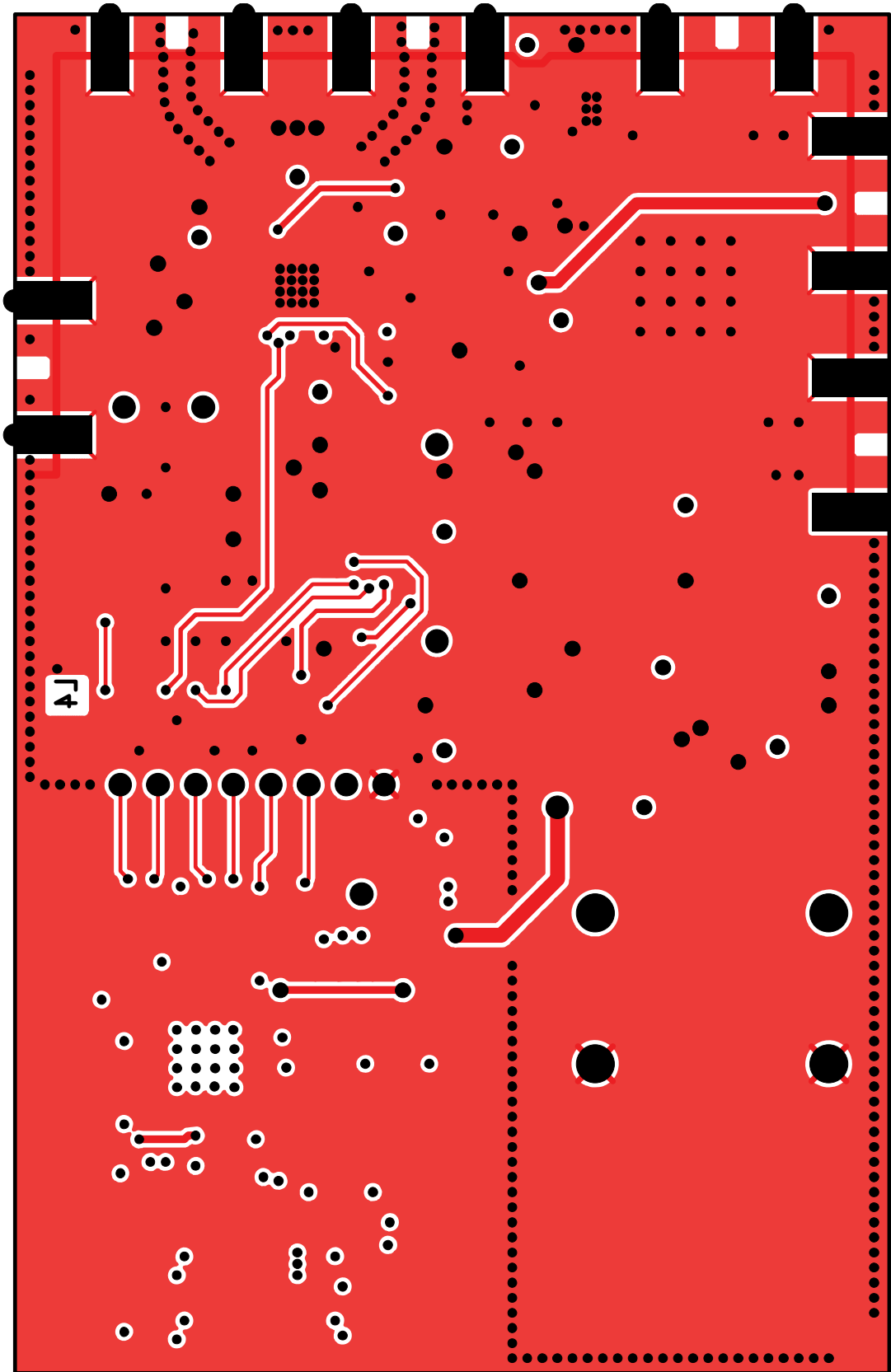
Figure 14. Layer 4 (Solder Side)

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 µF	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 µF	Ceramic capacitor 1.0 µF, 50 V, X5R, 0805	Taiyo/Yuden GRM32RR71H105KA01L
C8, C28, C66, C77	1 µF	Capacitor, 0603, 1 µF, 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 µF	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 µF	Ceramic capacitor, 1.0 µF, 25 V, X5R, 0805	Taiyo/Yuden TMK107BJ105KA-T
C64, C65	1 µF	16 V X5R ceramic capacitor	Kemet C0603C105K4PAC-TU
C68, C69	33 pF	50 V C0G ceramic capacitor	Murata GRM1555C1H330JZ01D
C70, C73, C75	1.0 µF	Ceramic capacitor 1.0 µF, 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 kΩ	SMD resistor	Multicomp MC 0.063W 0603 5k1
R7, R38	1 kΩ	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 kΩ	SMD resistor	Multicomp MC 0.063W 0603 210k
R15, R16, R17, R19	10 kΩ	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 kΩ	SMD resistor	Multicomp MC 0.063W 0603 68k
R39, R49, R50	2.2 kΩ	SMD resistor	Multicomp MC 0.063W 0603 2k2

Reference Designator	Value	Description	Manufacturer/Part Number
R40	140 kΩ	SMD resistor	Multicomp MC 0.063W 0603 1% 140K
R41	78.7 kΩ	SMD resistor	Multicomp MC 0.063W 0603 1% 78K7
R44, R45	100 kΩ	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 ADF4151BCPZ
U2, U10		3.3 V linear regulator	Analog Devices ADP150AUJZ-3.3-R7
U3, U4, U5		Adjustable LDO regulator	Analog Devices ADP3334ARMZ-REEL7
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 ADL5541ACPZ-R7
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 I$_Q$, 500 mA anyCAP® Adjustable Low Dropout Regulator
ADL5541	Product Page, Fractional-N/Integer-N PLL Synthesizer

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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.

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