One Technology Way • P.O. Box 9106 • Norwood, MA 02062-9106, U.S.A. • Tel: 781.329.4700 • Fax: 781.461.3113 • www.analog.com

# Evaluation Board for the ADF4150 PLL Frequency Synthesizer

## FEATURES

General-purpose evaluation board for ADF4150, including VCO, loop filter, and TCXO
Contains the ADF4150 frequency synthesizer (500 MHz to 5 GHz)
Accompanying software allows complete control of synthesizer functions from a PC

## EVALUATION KIT CONTENTS

EVAL-ADF4150EB1Z 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 ADF4150 data sheet
- Electronic version of the UG-380 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

ADF4150 data sheet
UG-380 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 ADF4150 frequency synthesizer for phase-locked loops (PLLs). Figure 1 shows the board, which contains the ADF4150 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

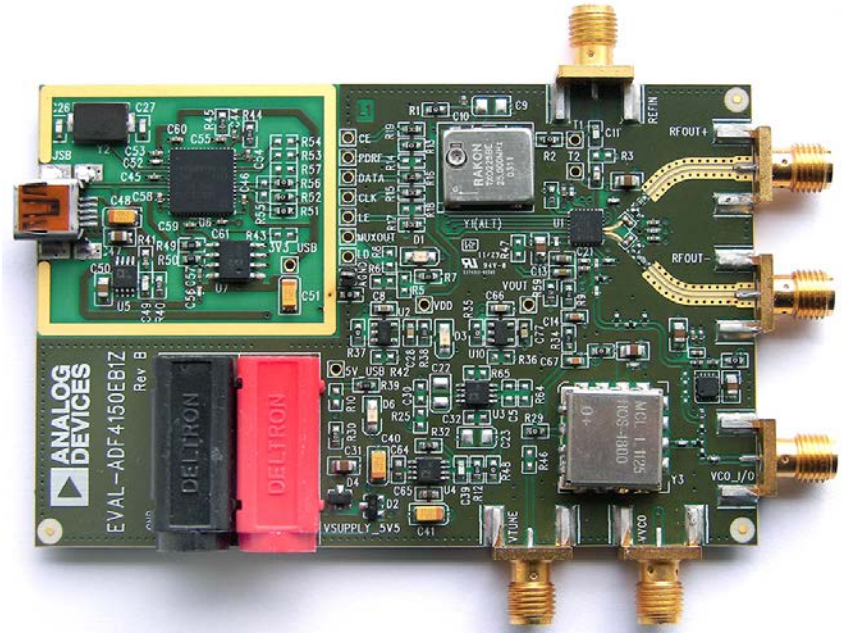


*Figure 1. EVAL-ADF4150EB1Z*

# TABLE OF CONTENTS



## REVISION HISTORY

**4/13—Rev. 0 to Rev. A**

Changes to Evaluation Kit Contents Section, Documents Needed Section, and Required Software Section ..... 1
Changes to Quick Start Guide Section ..... 3
Changes to Power Supplies Section ..... 4
Deleted Evaluation Board Setup Procedure Section, Deleted Figure 3 to Figure 16; Renumbered Sequentially ..... 5
Changes to Evaluation Board Software Section ..... 5
Added Figure 3; Renumbered Sequentially ..... 5
Replaced Figure 4 ..... 6
Changes to Evaluation and Test Section ..... 7
Deleted Figure 18 to Figure 20; Renumbered Sequentially ..... 11

**3/12—Revision 0: Initial Version**

# QUICK START GUIDE

Follow these steps to quickly evaluate the ADF4150 device:

1. Install the Analog Devices ADF4150 family software (see UG-476, *PLL Software Installation Guide*).
2. Connect the EVAL-ADF4150EB1Z 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 **ADF4150** in the **Select Device and Connection** tab of the software front panel display window and then click **Connect**.
7. Click the **Main Controls** tab.
8. Update all registers.
9. Connect the spectrum analyzer to the RFOUT+ SMA connector.
10. Terminate the RFOUT− and VCO_I/O SMA connectors with 50 Ω termination resistors.
11. Measure the results.

# EVALUATION BOARD HARDWARE

The EVAL-ADF4150EB1Z 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 supply 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 ADF4150 $AV_{DD}$, $DV_{DD}$, and $SDV_{DD}$ pins) and 5 V to the ADF4150 $V_P$ pin.

## 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. R3 can be populated with a 50 Ω resistor to adjust the impedance matching of the evaluation board to the external reference source.

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 ADF4150 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, and the differential RF output of the part is connected to the RFOUT+ and RFOUT– edge mount SMA connectors.

## 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 $I_{CP}$ = 2.325 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.

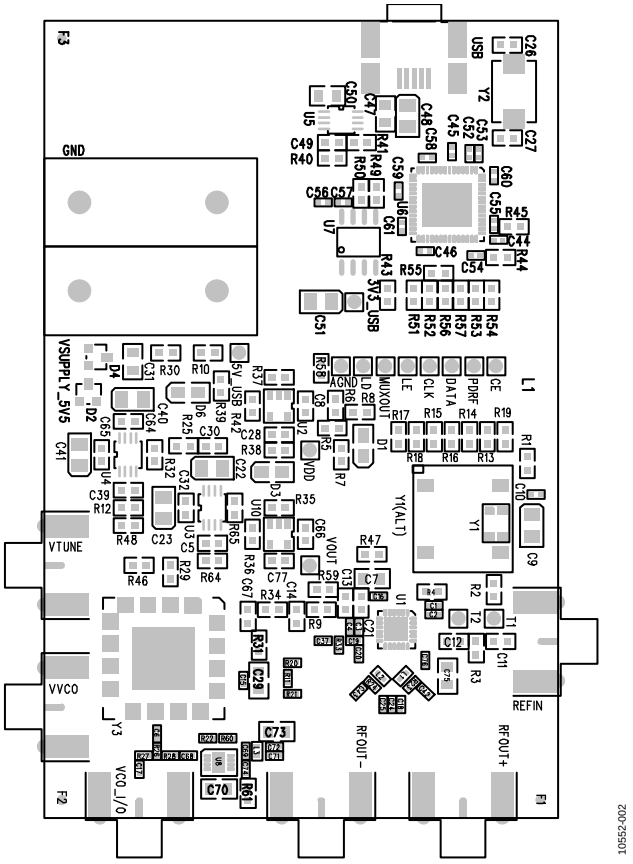


*Figure 2. Evaluation Board Silkscreen*

# EVALUATION BOARD SOFTWARE

The control software for the EVAL-ADF4150EB1Z 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 **ADF4150** 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.

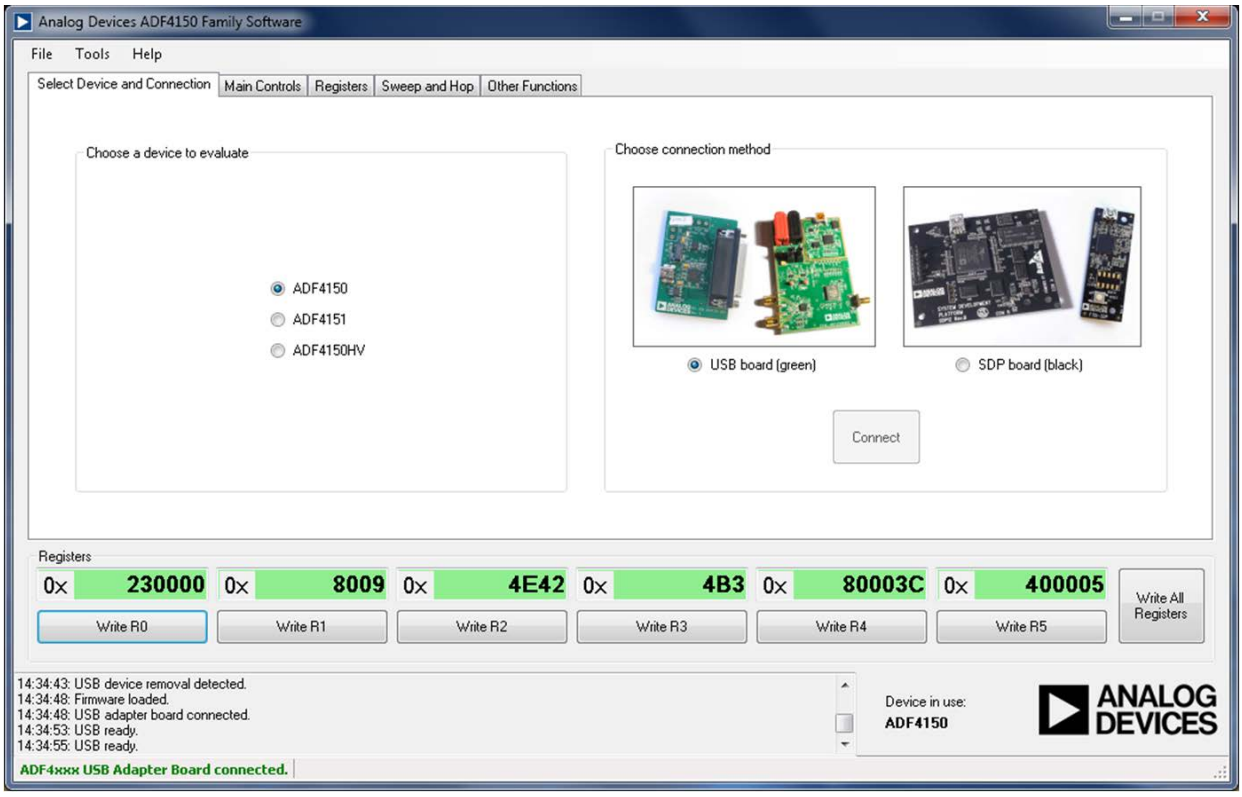


*Figure 3. Software Front Panel Display—Select Device and Connection*

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.

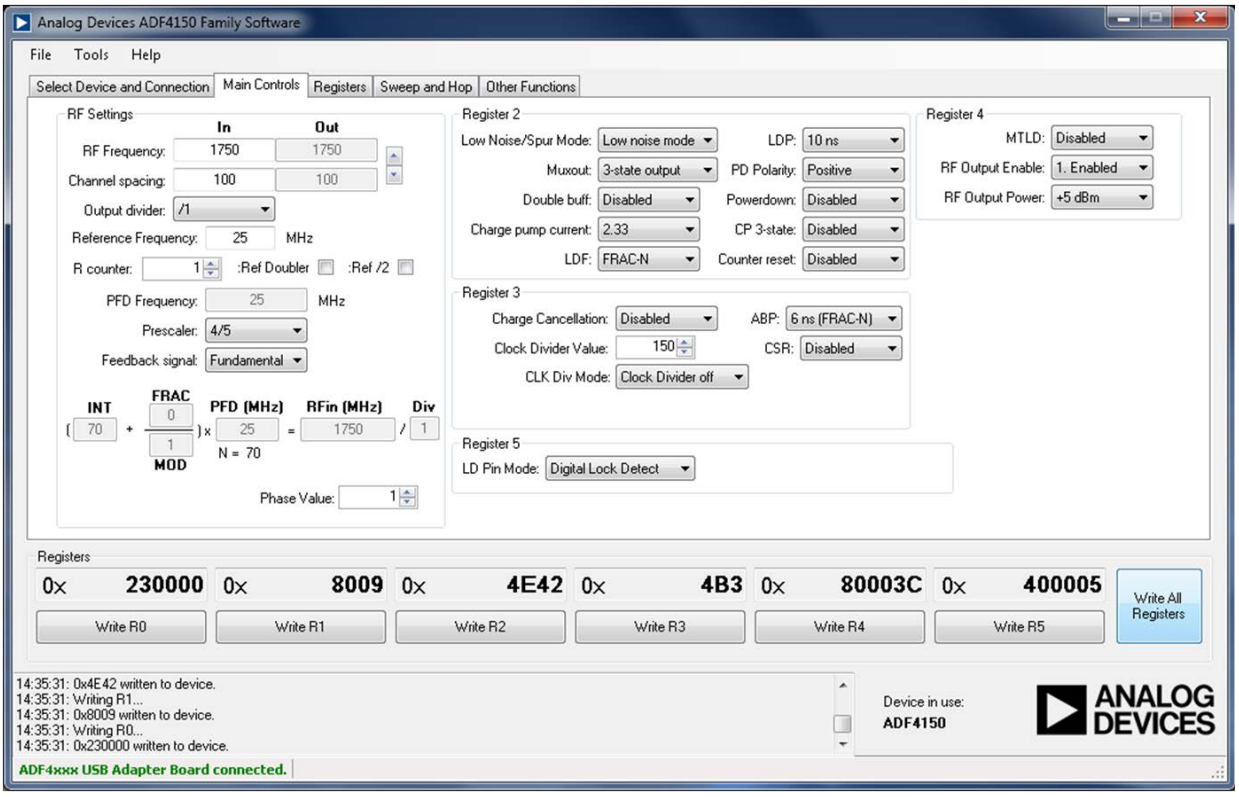


*Figure 4. Software Front Panel Display—Main Controls*

# EVALUATION AND TEST

To evaluate and test the performance of the ADF4150, use the following procedure:

1. If using a different VCO and loop filter than provided on the board, ensure that the VCO and loop filter are properly inserted on the board. Use ADIsimPLL to generate the loop filter component values.
2. Install the 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 50 Ω termination resistors to the RFOUT+ and RFOUT− connectors.
6. Connect a spectrum analyzer to Connector VCO_IO.
7. Run the ADF4150 family software.
8. On the **Select Device and Connection** tab of the software front panel display window, select **ADF4150** and **USB board (green)**, and then click **Connect**.
9. Click the **Main Controls** tab.
10. In the software window, set the RF output center frequency (Figure 5 shows a screenshot of a spectrum analyzer taken at a frequency of 1750 MHz, which is in the midrange 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.
11. Measure the output spectrum. Figure 5 shows a 1750 MHz output.

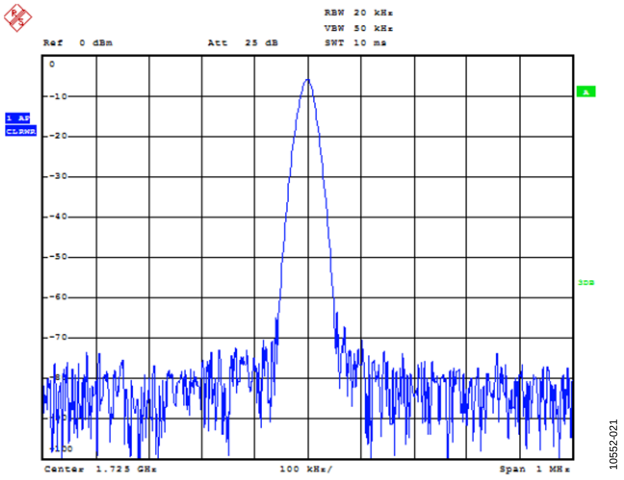


*Figure 5. Spectrum Analyzer Display*

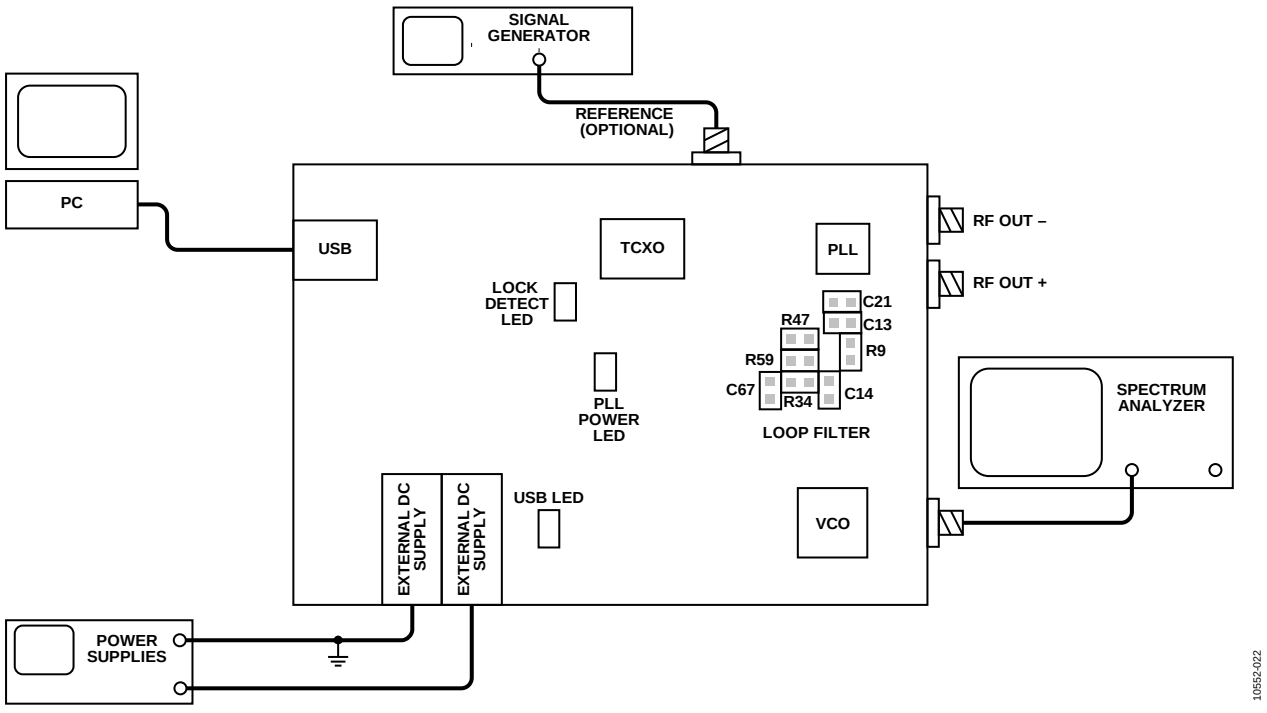


*Figure 6. Typical Evaluation Setup*

# EVALUATION BOARD SCHEMATICS AND ARTWORK

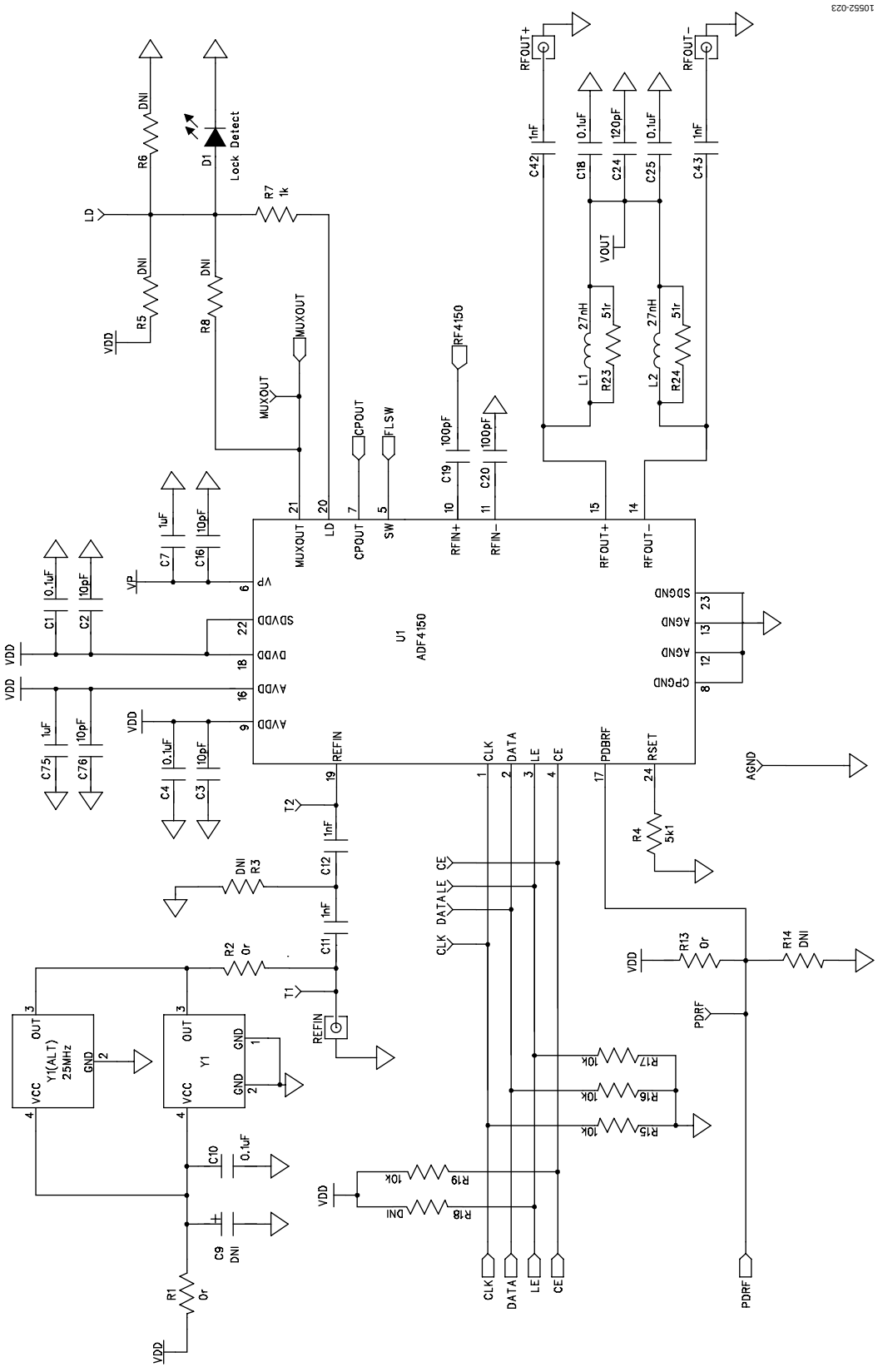


*Figure 7. Evaluation Board Schematic (Page 1)*

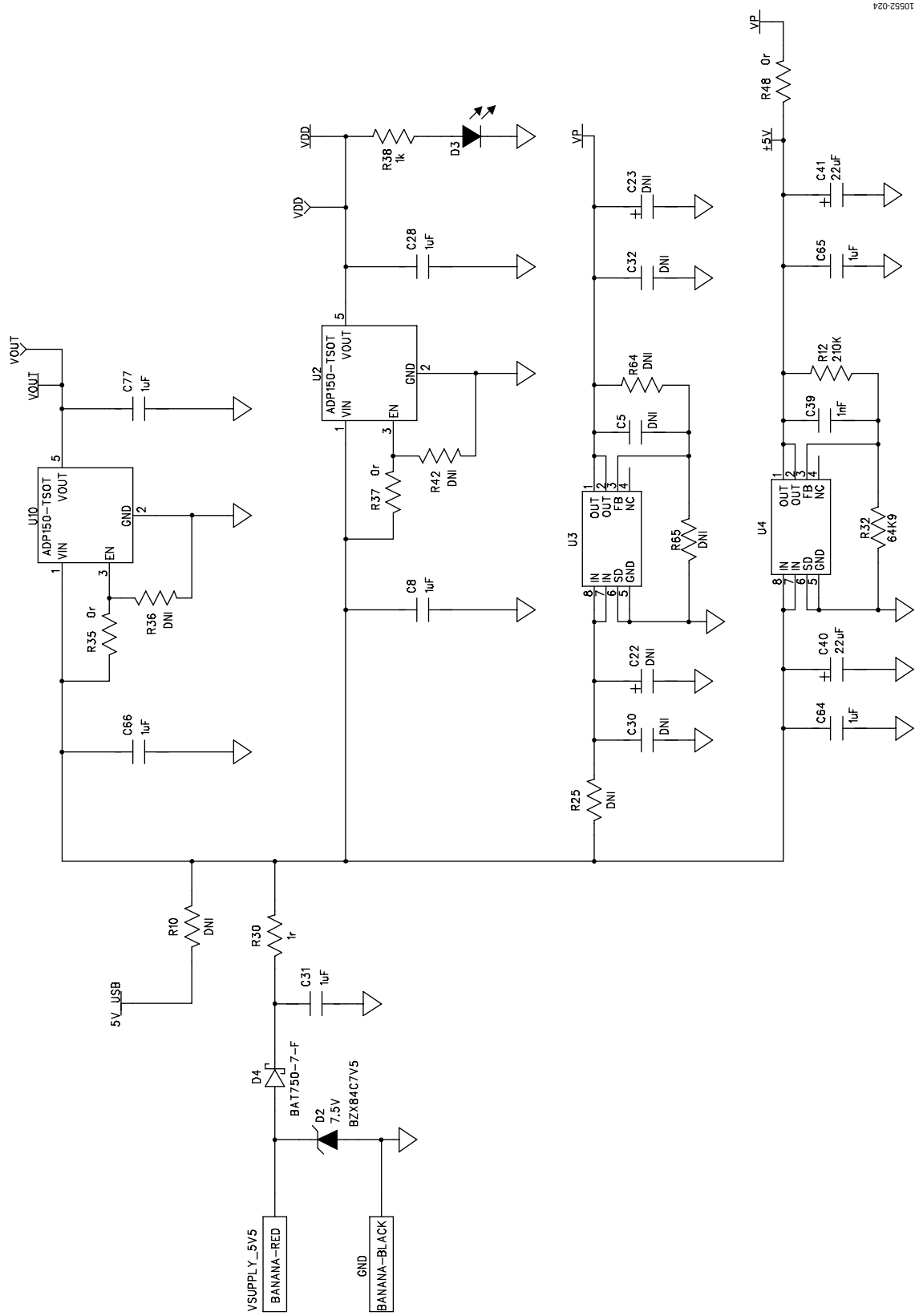


*Figure 8. Evaluation Board Schematic (Page 2)*

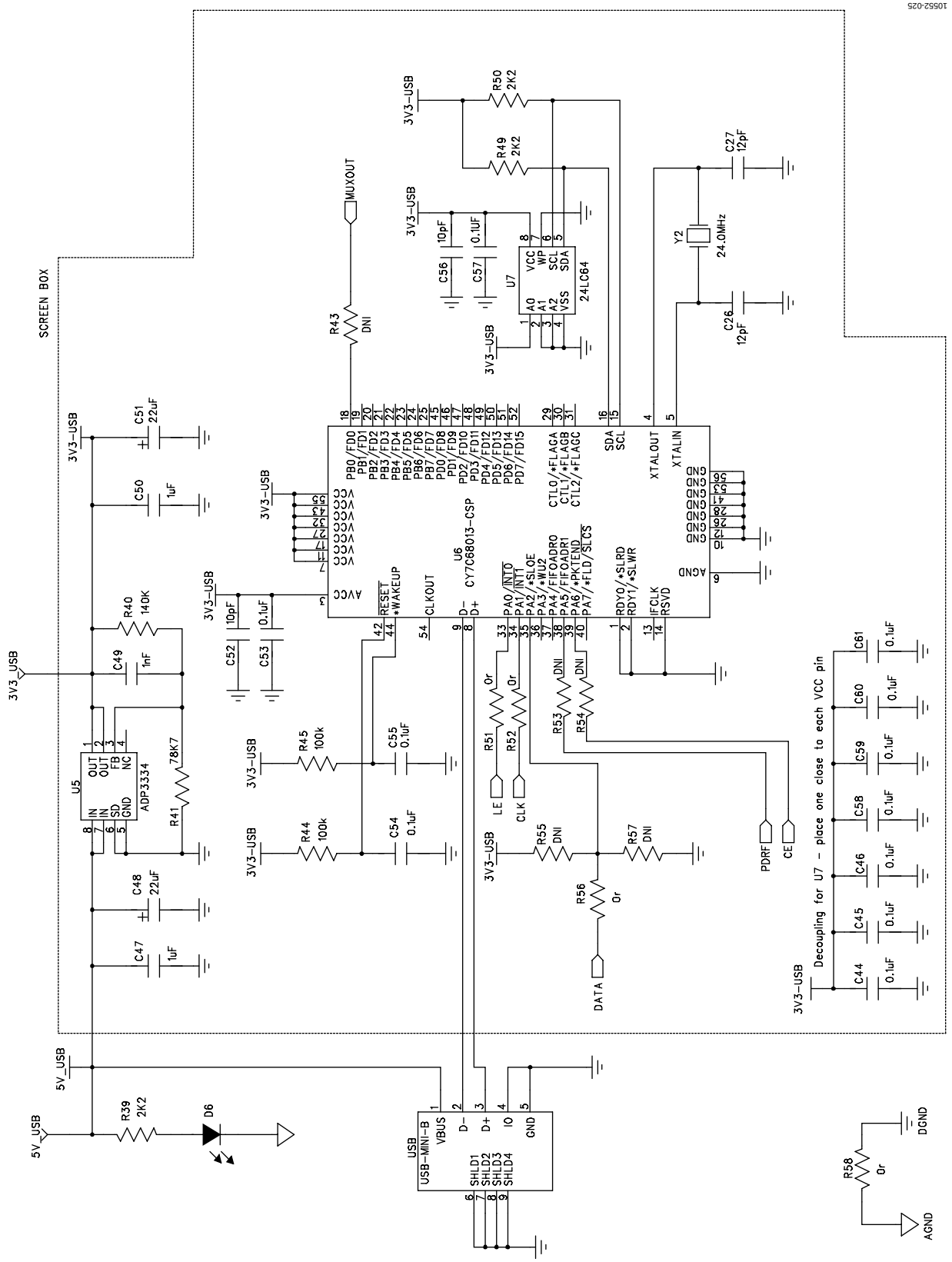


*Figure 9. Evaluation Board Schematic (Page 3)*

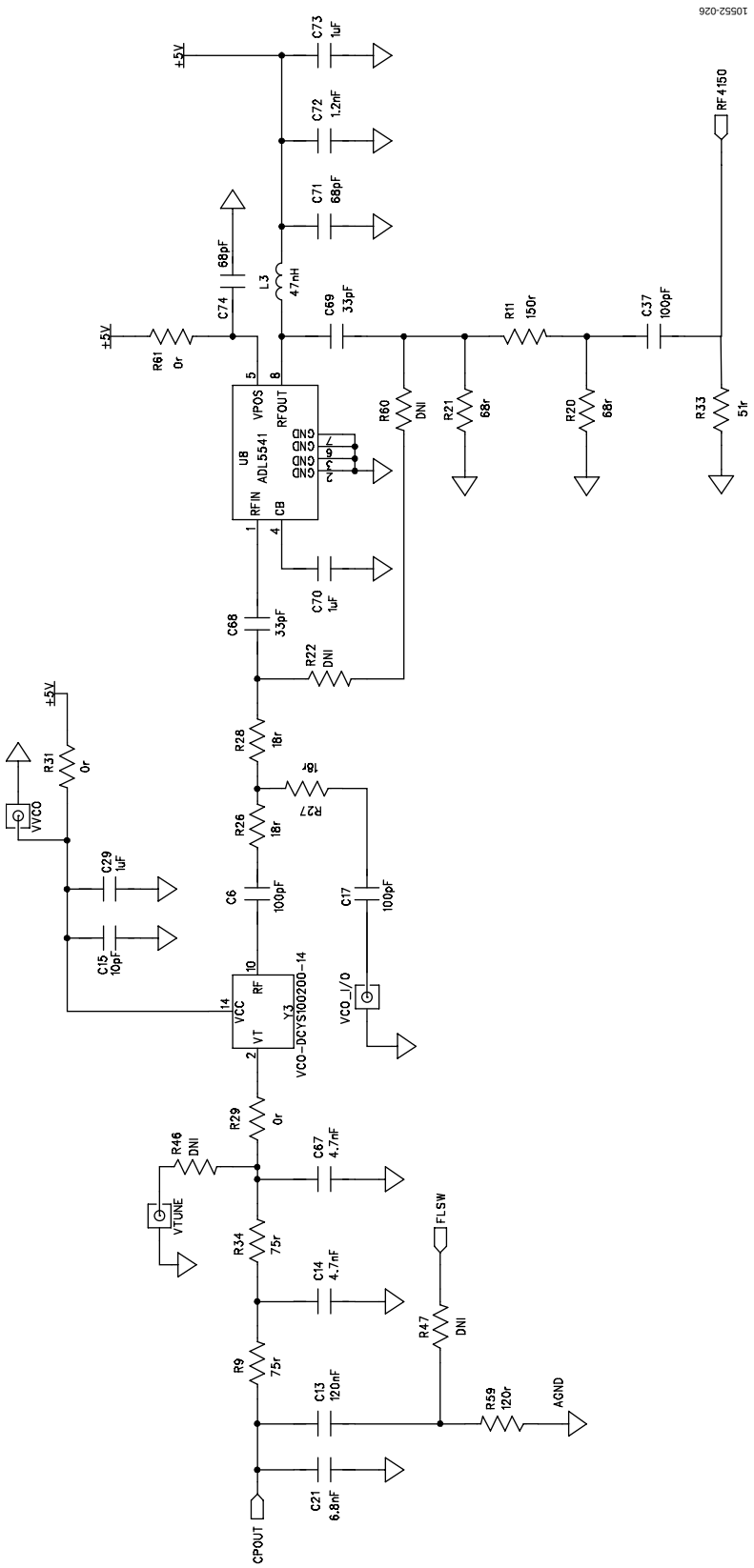


*Figure 10. Evaluation Board Schematic (Page 4)*

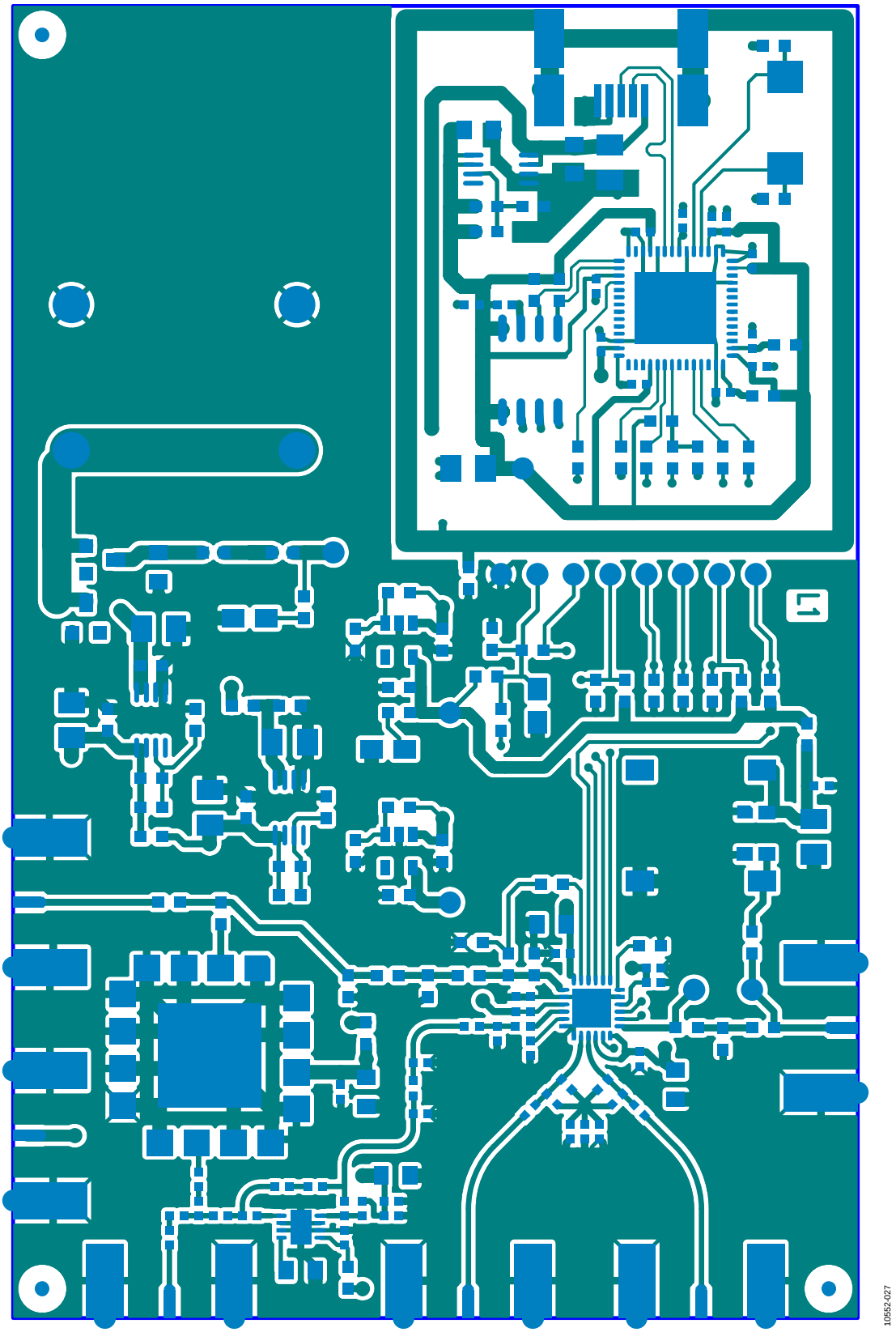


*Figure 11. Layer 1 (Component Side)*

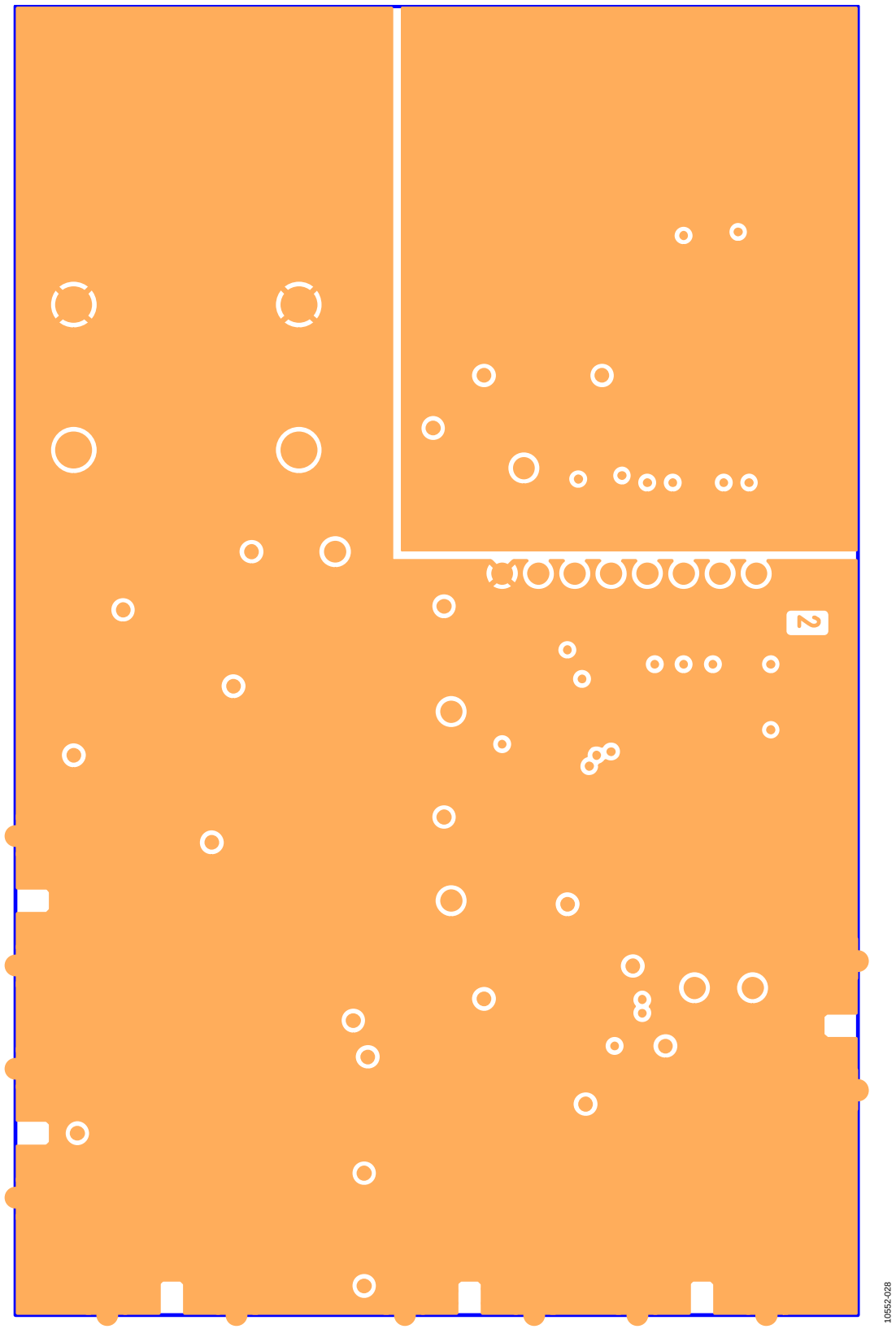


*Figure 12. Layer 2 (Ground Plane)*

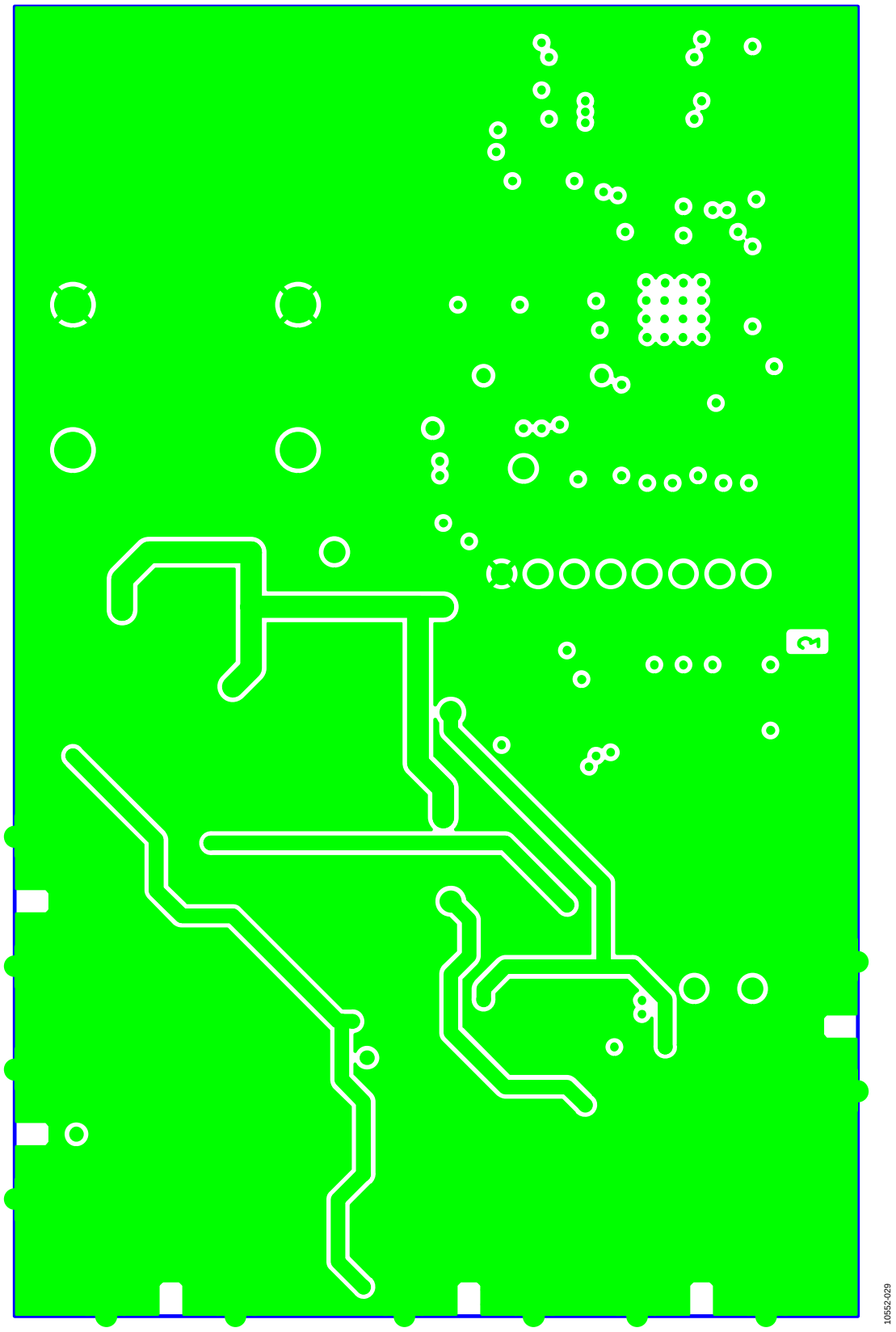


*Figure 13. Layer 3 (Power Plane)*

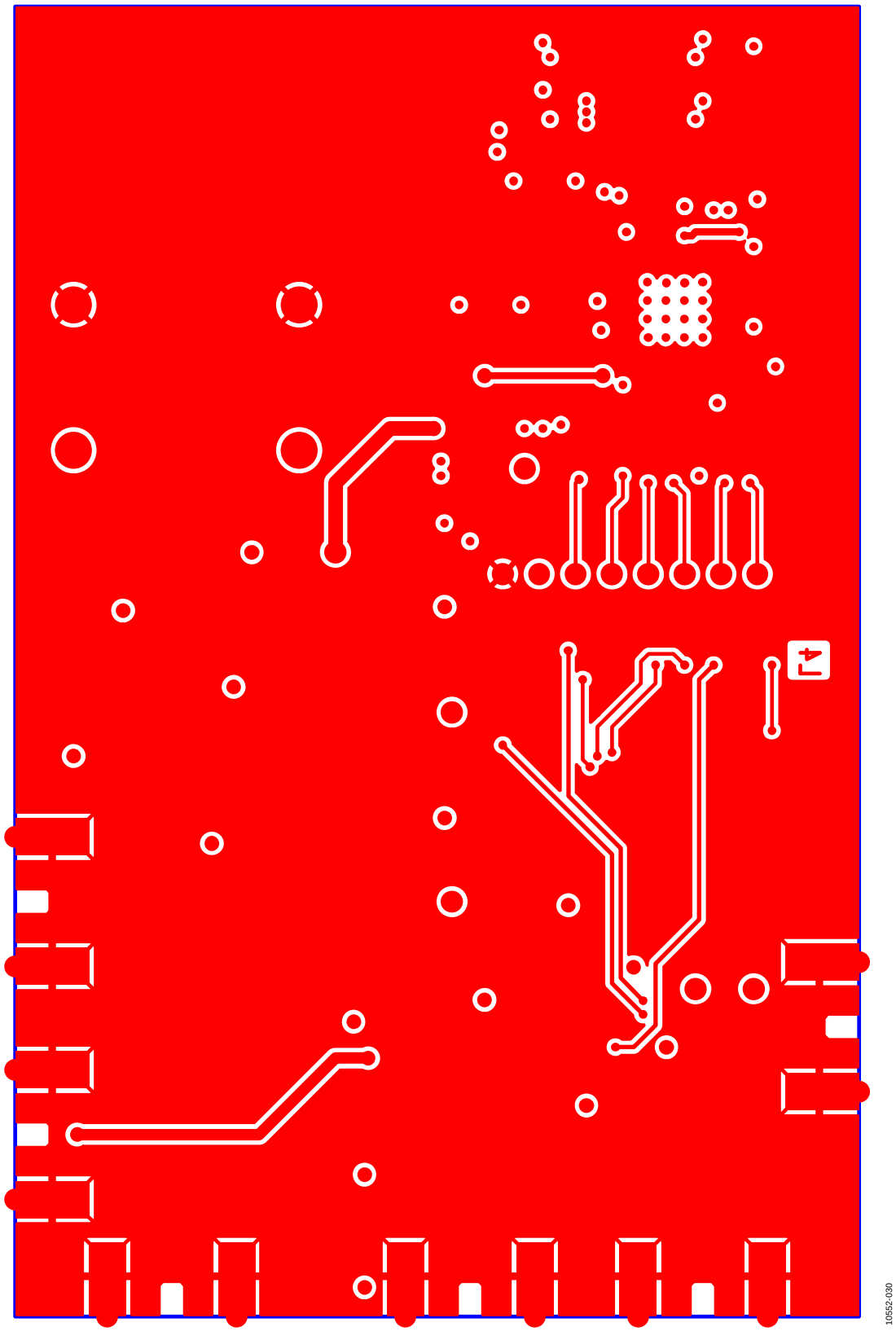


*Figure 14. Layer 4 (Solder Side)*

# BILL OF MATERIALS

**Table 1.**

| Reference Designator | Value | Description | Manufacturer/Part Number |
|---|---|---|---|
| AGND | | Black test point | Vero 20-2137 |
| C1, C4, C10, C18, C25, 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 | Do not insert | 50 V NP0 ceramic capacitor | N/A |
| C6, C17, C19, C20, C37 | 100 pF | 50 V C0G ceramic capacitor | Murata GRM1555C1H101JD01D |
| C7, C29, C31, C70, C73, C75 | 1 µF | Capacitor, ceramic, 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 | N/A |
| 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 |
| C30, C32 | Do not insert | 16 V X5R ceramic capacitor | N/A |
| C21 | 6.8 nF | 50 V NPO SMD ceramic capacitor | Kemet C0603C682J5GACTU |
| C22, C23 | Do not insert | 6.3 V tantalum capacitor (TAJ-A case) | N/A |
| C24 | 120 pF | 50 V NP0 ceramic capacitor | AVX 04025A121JAT2A |
| C26, C27 | 12 pF | 50 V NPO 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 | 1 nF | Ceramic capacitor, 1000 pF, 50 V, C0G 0402 | Murata GRM1555C1H102JA01D |
| C47, C50 | 1 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 |
| 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, 0.75 A forward | Diodes Inc. BAT750-7-F |
| GND | | Black 4 mm banana socket | Deltron 571-0100-01 |
| L1, L2 | 27 nH | Coilcraft 0402CS SMD inductor | Coilcraft 0402CS-27NX-LU |
| L3 | 47 nH | Coilcraft 0402CS SMD inductor | Coilcraft 0402CS-47NX-LU |
| R1, R2, R13, 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, R14, R18, R22, R25, R36, R42, R43, R46, R47, R53, R54, R55, R57, R60, R64, R65 | Do not insert | 0603 resistor location | N/A |
| 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 |
| R23, R24, 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 ADF4150 |
| 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 | | 64k $I^2C$ serial EEPROM | Microchip Technology 24LC64-ISN |
| U8 | | 50 MHz to 6 GHz RF/IF gain block | Analog Devices ADL5541ACPZ |
| 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 |
|---|---|
| ADF4150 | 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 |
| ADL5541 | Product Page, 50 MHz to 6 GHz RF/IF Gain Block, Gain of 15 dB |

## NOTES

## 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.



**UG10552-0-4/12(A)**


www.analog.com