EV-ADF4159EB1Z/EV-ADF4159EB3Z User Guide
UG-383

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Evaluating the ADF4159 Frequency Synthesizer for Phase-Locked Loops

FEATURES

- Self-contained board, including synthesizer, 100 MHz reference, USB interface, and voltage regulators
- Accompanying software allows control of synthesizer functions from a PC (via USB interface)
- Externally powered by 5.5 V and 15 V supplies

EVALUATION KIT CONTENTS

- EV-ADF4159EB1Z or EV-ADF4159EB3Z evaluation board
- CD with evaluation software
- USB cable

REQUIRED ADDITIONAL EQUIPMENT

- VCO (for EV-ADF4159EB3Z)
- Loop filter components (for EV-ADF4159EB3Z)
- Soldering equipment
- Spectrum analyzer
- Power supplies (5.5 V and 15 V)
- Windows®-based PC with USB port for evaluation software

REQUIRED DOCUMENTS

- ADF4159 data sheet
- UG-383 user guide

REQUIRED SOFTWARE

- Analog Devices ADF4158-9 evaluation software, Version 4.x or higher (included on the CD in the evaluation board kit or available for download at www.analog.com)

GENERAL DESCRIPTION

The EV-ADF4159EB1Z/ EV-ADF4159EB3Z evaluates the performance of the ADF4159 frequency synthesizer for phase-locked loops (PLL). A photograph of the evaluation board is shown in Figure 1. The evaluation board involves the ADF4159 synthesizer, a USB connector, SMA connectors, a reference oscillator, and power supply connectors. There are also footprints for active filter components and a voltage controlled oscillator (VCO); if used, these components must be soldered to the board to complete the loop. An on-board temperature compensated crystal oscillator (TCXO) provides the 100 MHz reference frequency, and a USB cable is included to connect the board to a PC USB port.

In addition, the evaluation kit contains Windows-based software to allow easy programming of the synthesizer.

EVALUATION BOARD PHOTOGRAPH

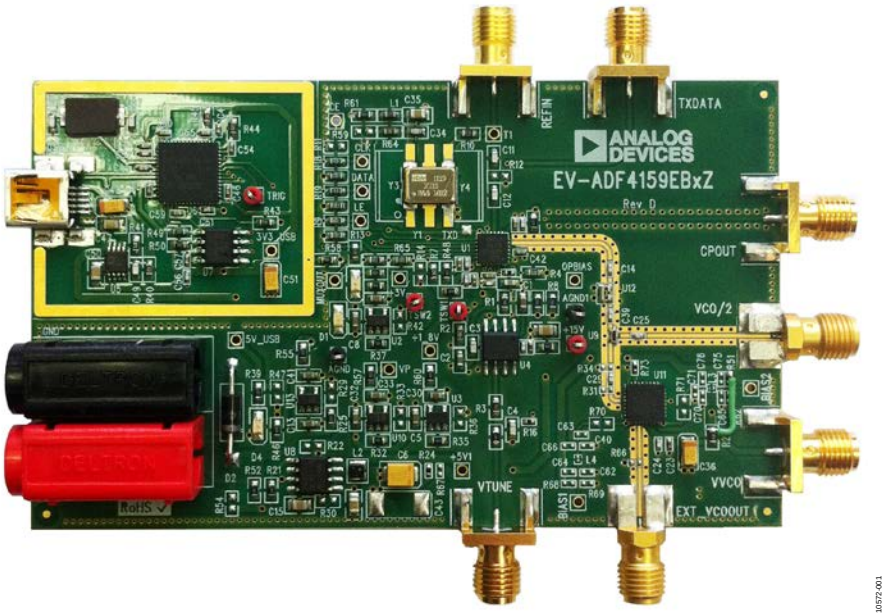


Figure 1.

TABLE OF CONTENTS

Features 1
Evaluation Kit Contents 1
Required Additional Equipment 1
Required Documents 1
Required Software 1
General Description 1
Evaluation Board Photograph 1
Revision History 2
Evaluation Board Hardware 3
Overview 3
Power Supplies 3
Local Oscillator 3
VCO 3
Output Signals 3
Loop Filter 4
VCO Configuration 5
EV-ADF4159EB1Z 5
EV-ADF4159EB3Z 5
Evaluation Setup 6
Getting Started 7
Installing the Software 7
Configuring and Setting up the Board 7
Using the Software—Main Controls 8
Using the Software—Ramp and Shift-Key Controls 9
Evaluation Board Schematics 11

REVISION HISTORY

7/14—Rev. A to Rev. B

Changes to Sample Loop Filter Section 4

11/13—Rev. 0 to Rev. A

Deleted EV-ADF4159EB2Z ..... Universal
Changes to Figure 7 8
Changes to Figure 8 9
Changes to Figure 9 10

8/13—Revision 0: Initial Version

EVALUATION BOARD HARDWARE

OVERVIEW

The evaluation board kit includes a cable for connecting the evaluation board to the USB port of a PC. The silkscreen for the evaluation board is show in Figure 2, and the schematics for the evaluation board are shown in Figure 10 to Figure 13.

POWER SUPPLIES

The evaluation board is powered by a 5.5 V power supply connected to the red and black banana connectors. Connect the red connector to a 5.5 V power supply and the black connector to ground.

The op amp is powered by a 15 V power supply.

Optionally, the VCO can be powered independently by connecting a 5 V supply to the VVCO SMA and removing R27. When this option is used, reduce the voltage on the banana connectors to 5 V.

The USB section of the evaluation board (see the area bounded by the gold box in Figure 1) is powered by the USB host.

LOCAL OSCILLATOR

The 100 MHz TXCO provides the reference frequency. To ensure that the PFD frequency is also 100 MHz, set the on-chip R-divider to 1.

Alternatively, an external reference can be used by connecting the reference to the REFIN SMA and removing R10 and L1.

VCO

The VCO configuration is different for each evaluation board model: EV-ADF4159EB1Z and EV-ADF4159EB3Z. See the VCO Configuration section for more information.

OUTPUT SIGNALS

With a VCO connected, the evaluation board outputs the VCO output on the EXT_VCOOUT SMA and the VCO output is divided by 2 on the VCO/2 SMA.

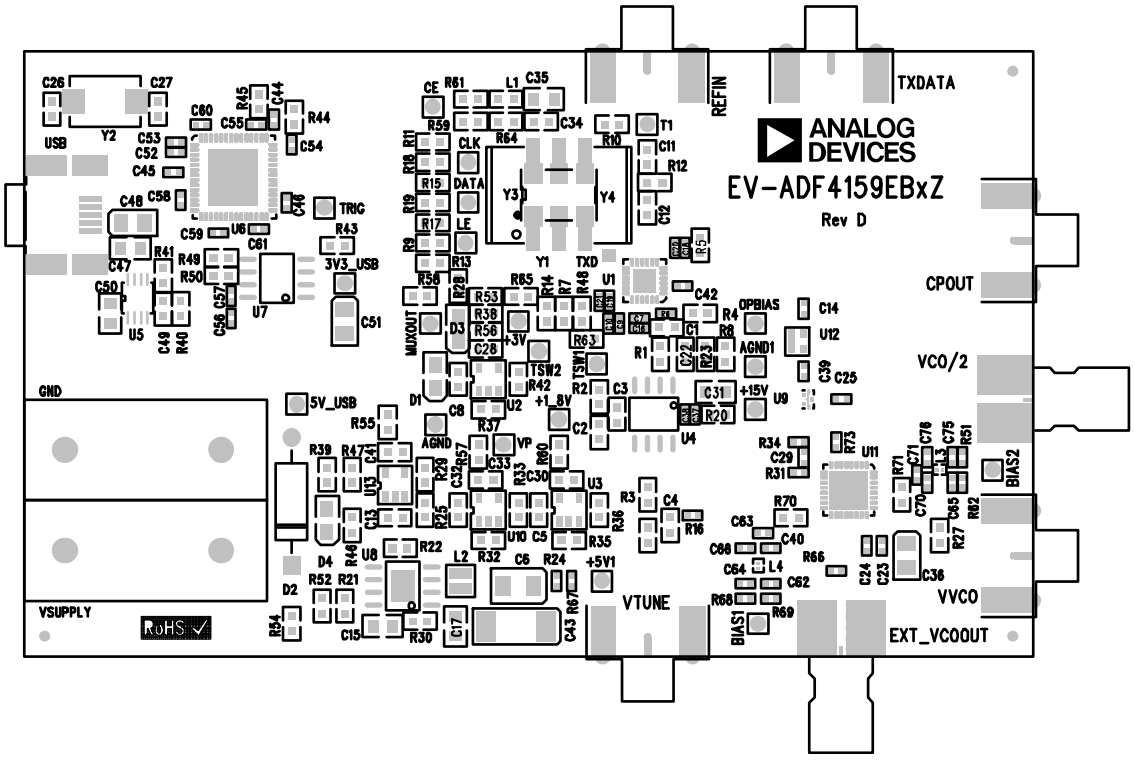


Figure 2. Evaluation Board Silkscreen

LOOP FILTER

The loop filter schematic is included in Figure 13. The general placement of loop filter components is shown in Figure 3. When using a loop filter, calculate the values of the necessary components and solder them to the board. The ADIsimPLL software, which is available on the CD included in the evaluation board kit or from www.analog.com/adisimpll, provides tools for designing loop filters and calculating component values.

After soldering the loop filter components to the evaluation board, connect a 15 V supply to the op amp power supplies, a 15 V supply to the red 15 V test point, and the ground to the black AGND test point (see Figure 1). See the Sample Loop Filter section for an example configuration.

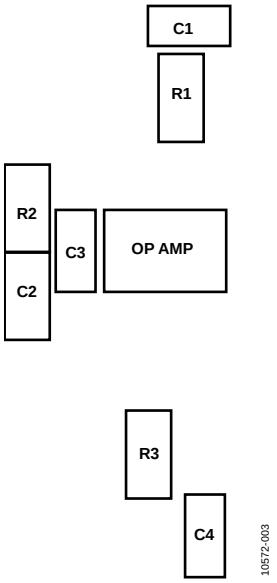


Figure 3. Placement of Loop Filter Components

Sample Loop Filter

Use the parameters of the sample loop filter described in this section as a guide for adding a loop filter onto the evaluation board.

Refer to Figure 3 for proper placement of components and to Table 1 for recommended component values.

The sample loop filter is designed for

- VCO kV = 150 MHz/V
- PFD frequency = 100 MHz
- Charge pump current = 2.5 mA
- Loop bandwidth = 282 kHz
- Phase margin = 48.1°

Table 1. Sample Loop Filter Components Values

Component	Value
R1	100 Ω
C1	220 pF
R2	360 Ω
C2	5.6 nF
R3	1 kΩ
C3	180 pF
C4	180 pF

VCO CONFIGURATION

EV-ADF4159EB1Z

The EV-ADF4159EB1Z evaluation board has a MACOM VCO (MAOC-009269) with a range of 11.4 GHz to 12.8 GHz installed. The RFOUT signal is connected to the EXT_VCOOUT SMA. The RFOUT/2 signal of the VCO is fed back to the ADF4159 PLL; therefore, when the VCO outputs 12 GHz, the ADF4159 is locked at 6 GHz.

For optimum performance, ensure that the components values are as described in Table 2.

Table 2. Component Values for EV-ADF4159EB1Z

Component	Value[1]
R73	0 Ω
C29	100 pF
R31, R34, R51, R62, R68, R70, R71, R72 (Bottom Layer)	DNP
C40, C62, C63, C64, C65, C66, C70, C71, C75, C76	DNP
L3, L4	DNP

[1] DNP is do not populate.

Terminate the VCO/2 SMA with 50 Ω..

EV-ADF4159EB3Z

The EV-ADF4159EB3Z evaluation board does not have a VCO installed. The board is configured for use with an external VCO board. Connect an external VCO to the evaluation board using SMA cables. There are two configuration options:

- The VCO control voltage can be connected to the VTUNE SMA, and the VCO RFOUT signal can be connected to the VCO/2 SMA. This configuration uses the on-board loop filter.
- The CPOUT SMA can be used to connect the ADF4159 charge pump output to an external loop filter. Connect the VCO RFOUT signal to the VCO/2 SMA to feed the signal back into the ADF4159.

For optimum performance, ensure that the component values are as shown in Table 3.

Table 3. Component Values for EV-ADF4159EB3Z

Component	Value[1]
R34	50 Ω
R31	DNP
C29	DNP

[1] DNP is do not populate.

EVALUATION SETUP

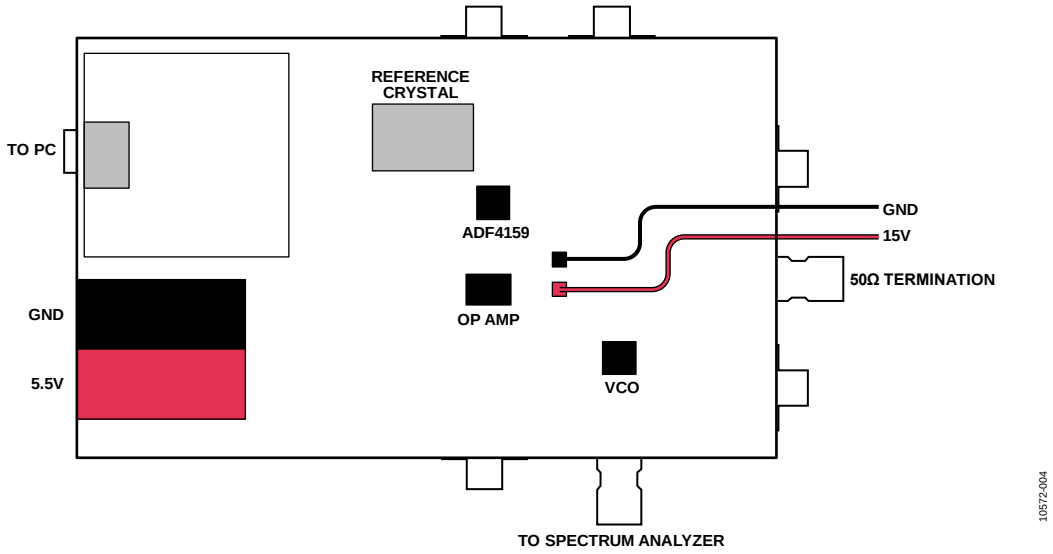


Figure 4. Evaluation Setup Block Diagram

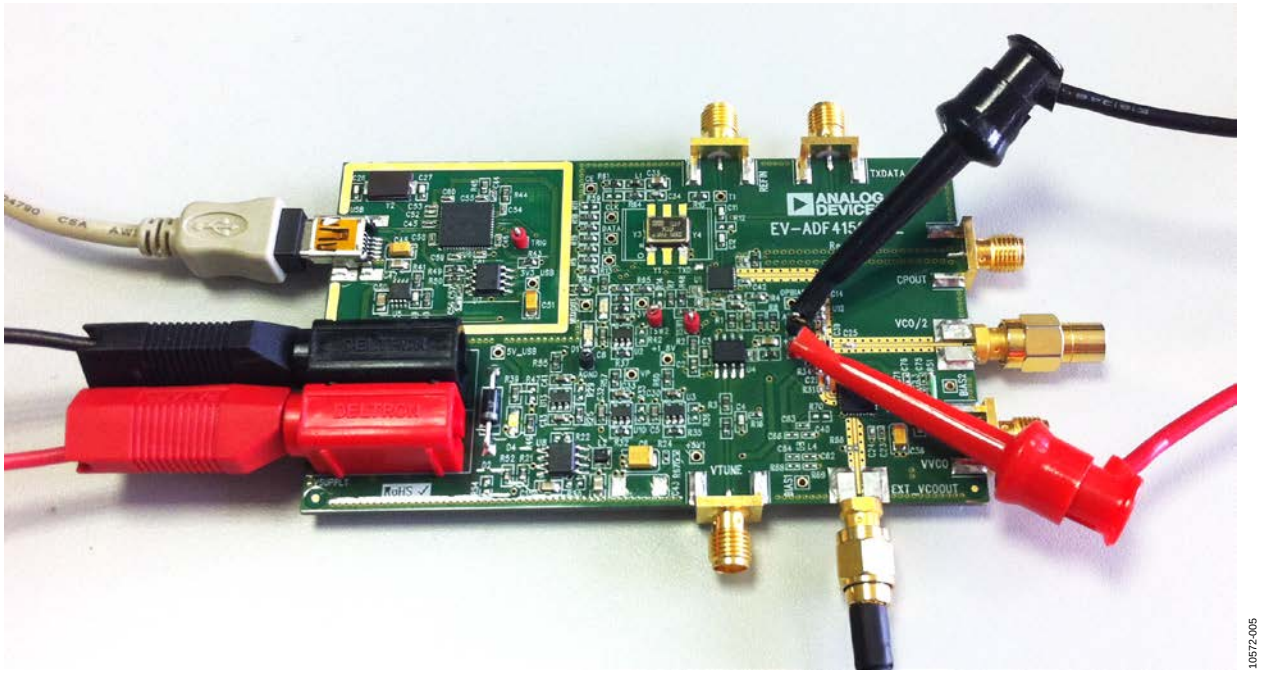


Figure 5. Evaluation Setup

GETTING STARTED

INSTALLING THE SOFTWARE

For the software installation procedure, see the UG-476 user guide. The control software for the EV-ADF4159EB1Z and EV-ADF4159EB3Z is provided on the CD included in the evaluation board kit.

CONFIGURING AND SETTING UP THE BOARD

1. Set up the circuit as shown in Figure 4.
2. Run the ADF4158-9 software.
3. Select **ADF4159** and **USB board (green)**, and then click **Connect** (see Figure 6).
4. Click the **Main Controls** tab to view the main controls (see Figure 7). The default values are set to lock a VCO at 12 GHz.
5. Click **Write All Registers (7, 6, 6, 5, 5, 4, 4, 3, 2, 1, 0)** or manually write to each register (**Write R7**, **Write R6 - Ramp 1**, **Write R6 - Ramp 2**, **Write R5 - Ramp 1**, **Write R5 - Ramp 2**, **Write R4 - Ramp 1**, **Write R4 - Ramp 2**, **Write R3**, **Write R2**, **Write R1**, and **Write R0**).
6. On the spectrum analyzer, confirm that the output signal is locked at 12 GHz.

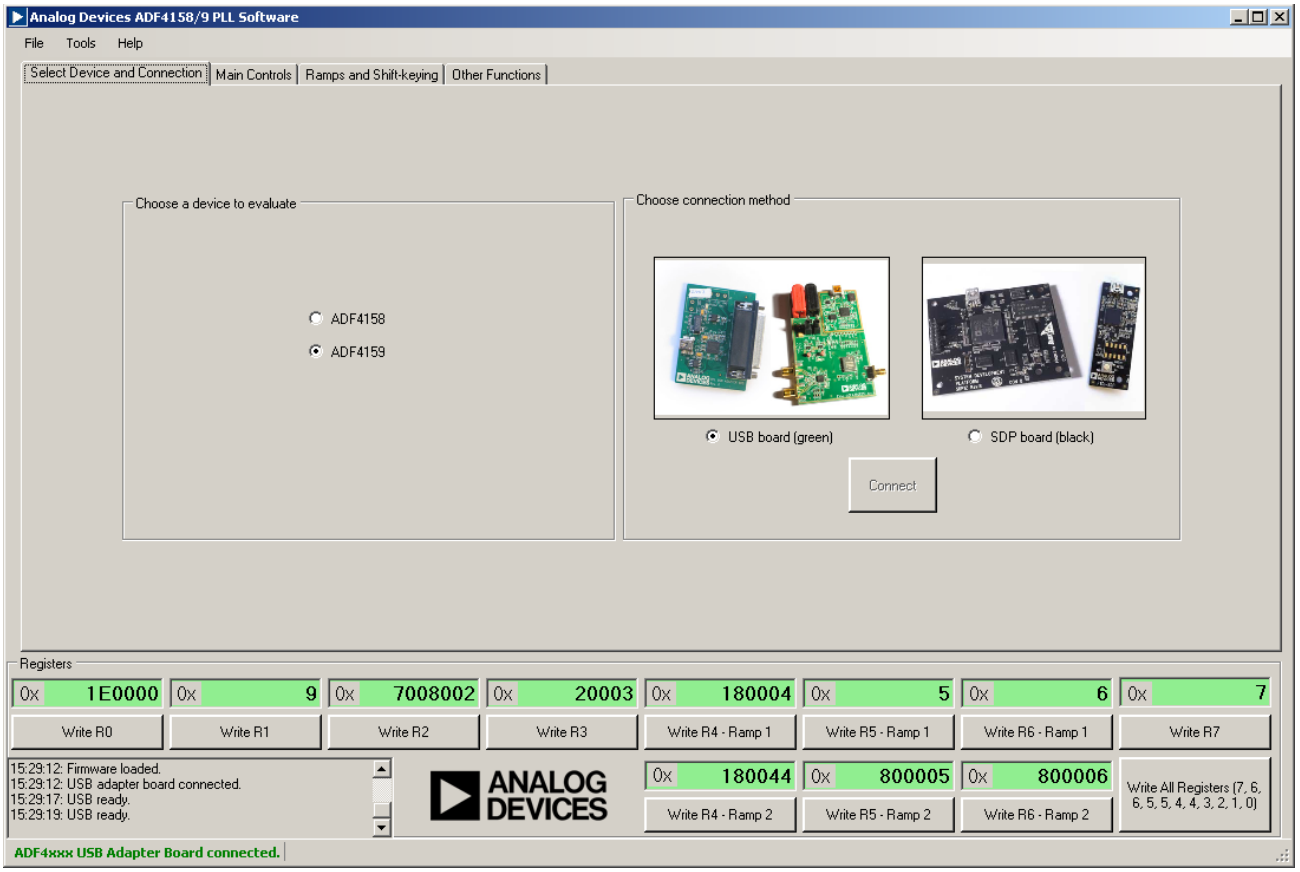


Figure 6. Software—Device Selection

USING THE SOFTWARE—MAIN CONTROLS

Use the **Main Controls** tab to select the RL and PLL settings. Because the evaluation board is set up to feedback the VCO/2 output to the ADF4159, in the **RF Settings** area, set the **RF VCO Output Frequency** to half the VCO output. Set the **Reference Frequency** to be the same as the applied reference signal. The PFD frequency is calculated from the reference frequency, the R-counter, the reference doubler, and the reference-divide-by-2. Ensure that the value in the **PFD Frequency** box matches the value specified in the loop filter design.

In the **PLL Settings** area, program the **Charge Pump Setting** to the value for which the loop filter was designed. Program the **Phase Detector Polarity** to negative when using an inverting active loop filter configuration (as is on this evaluation board).

The **Muxout** drop-down box allows you to choose the signal that is connected to the output of the MUXOUT pin.

Clicking **Pulse TXdata** triggers a pulse on the TXDATA pin. This pulse starts low and then stays high for approximately 4 µs.

The register values are shown at the bottom of the window. When the background of a register value is green, this indicates that the value has been changed and needs to be written to the part. Clicking the button below each register value writes that value to the part.

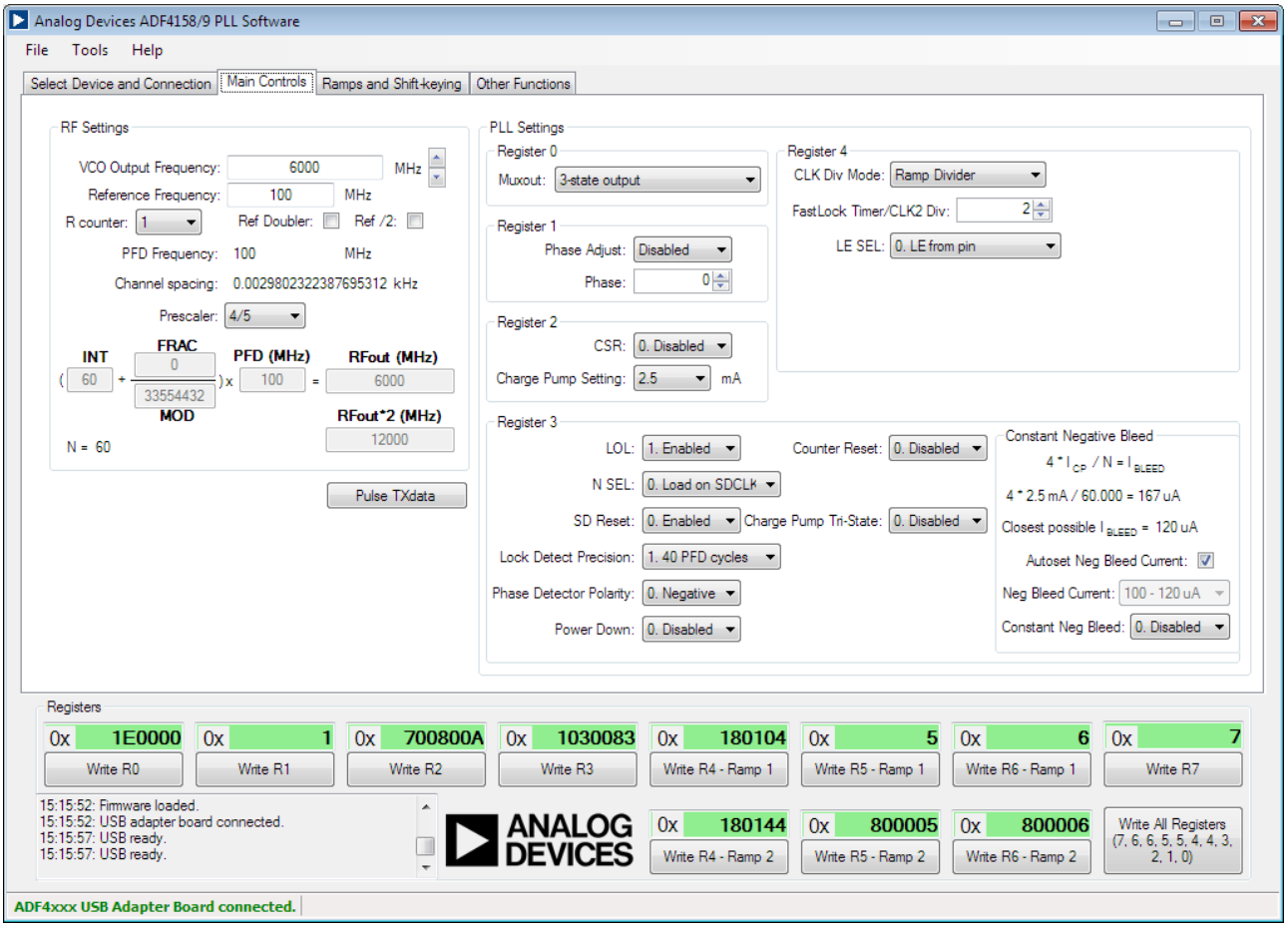


Figure 7. Software—Main Controls

USING THE SOFTWARE—RAMP AND SHIFT-KEY CONTROLS

In the **Ramps and Shift-keying** tab, you can configure the ramping and shift-keying functionality of the ADF4159.

The ramp type can be selected in the **Ramp mode** drop-down box, and the various ramp parameters can be set in **CLK1** and **Up Ramp** boxes.

Example

Figure 8 shows the ramping and shift-keying settings for an example of a continuous triangular ramp of 128 up ramp steps over 50 MHz with an up ramp time of 96 µs. (Up ramp refers to the ramp from the initial frequency to the end frequency, whereas down ramp refers to the ramp/jump from the end frequency back to the initial frequency.) For 50 MHz, the PLL is programmed for a 25 MHz ramp because the evaluation board uses the RFOUT/2 signal. After each parameter is set in the software, it needs to be written to the part.

The other options in this tab allow configuring the various ramps and shift-keying controls of the ADF4159.

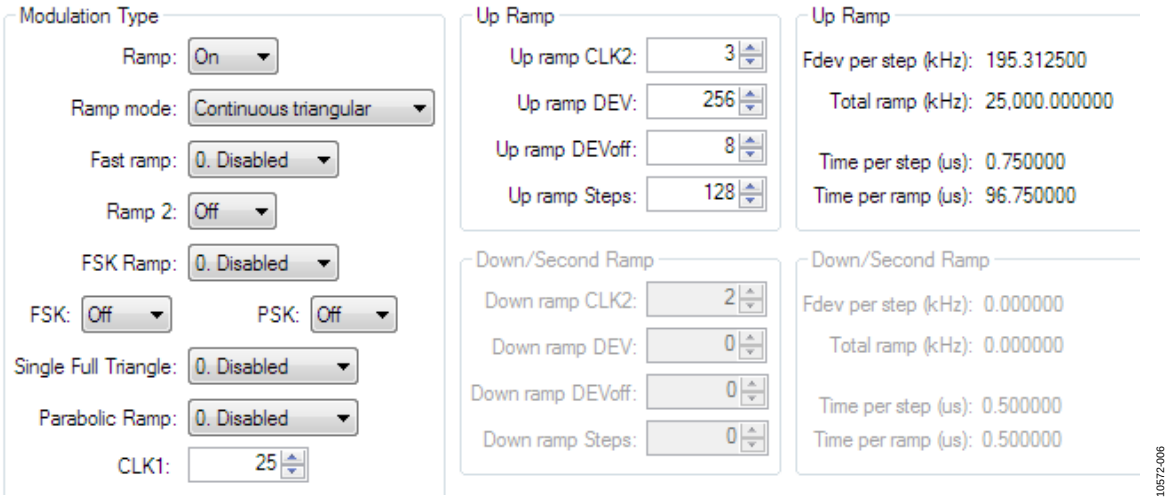


Figure 8. Example of Ramp

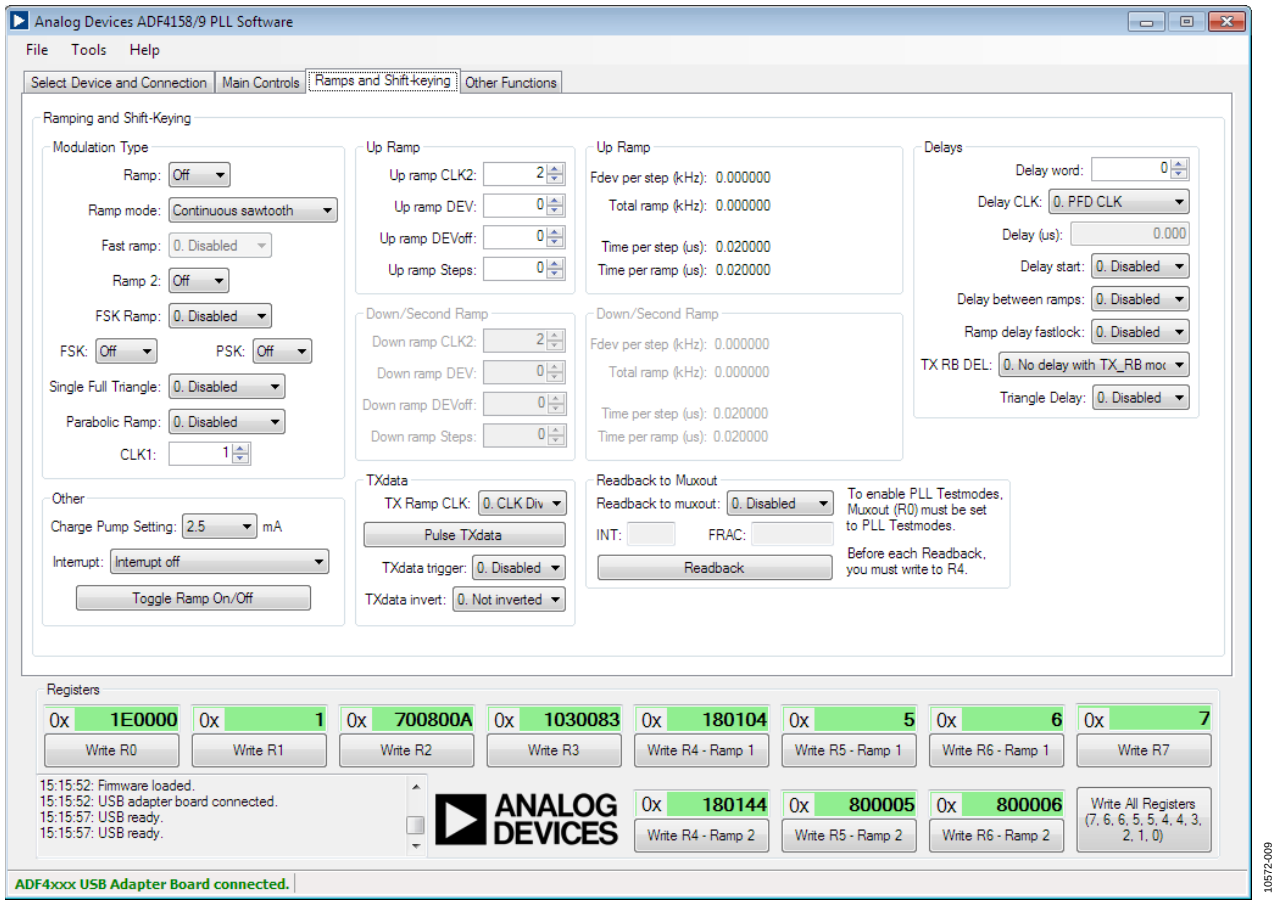


Figure 9. Software—Ramp Controls

EVALUATION BOARD SCHEMATICS

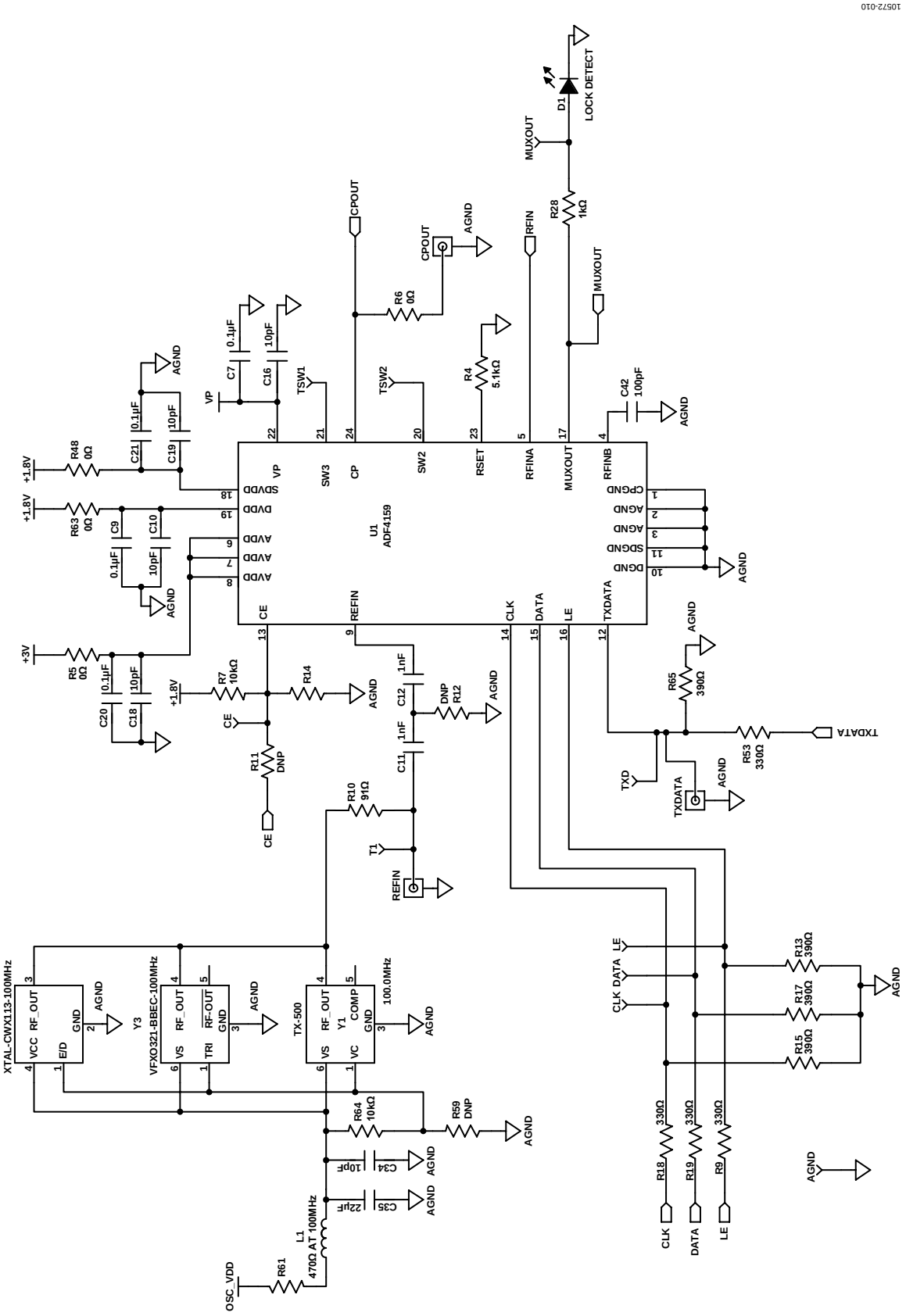


Figure 10. Evaluation Board Schematic (Page 1)

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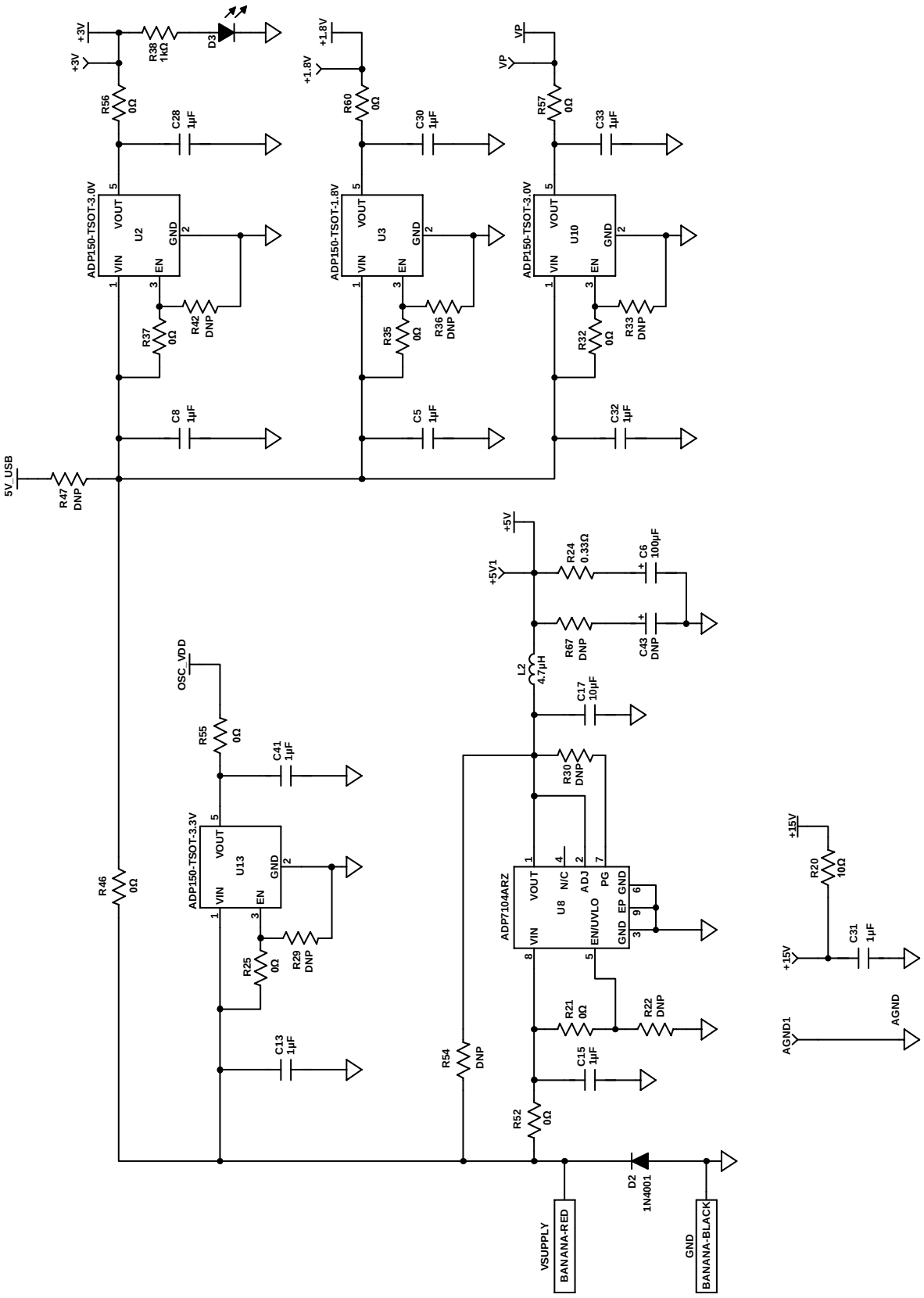


Figure 11. Evaluation Board Schematic (Page 2)

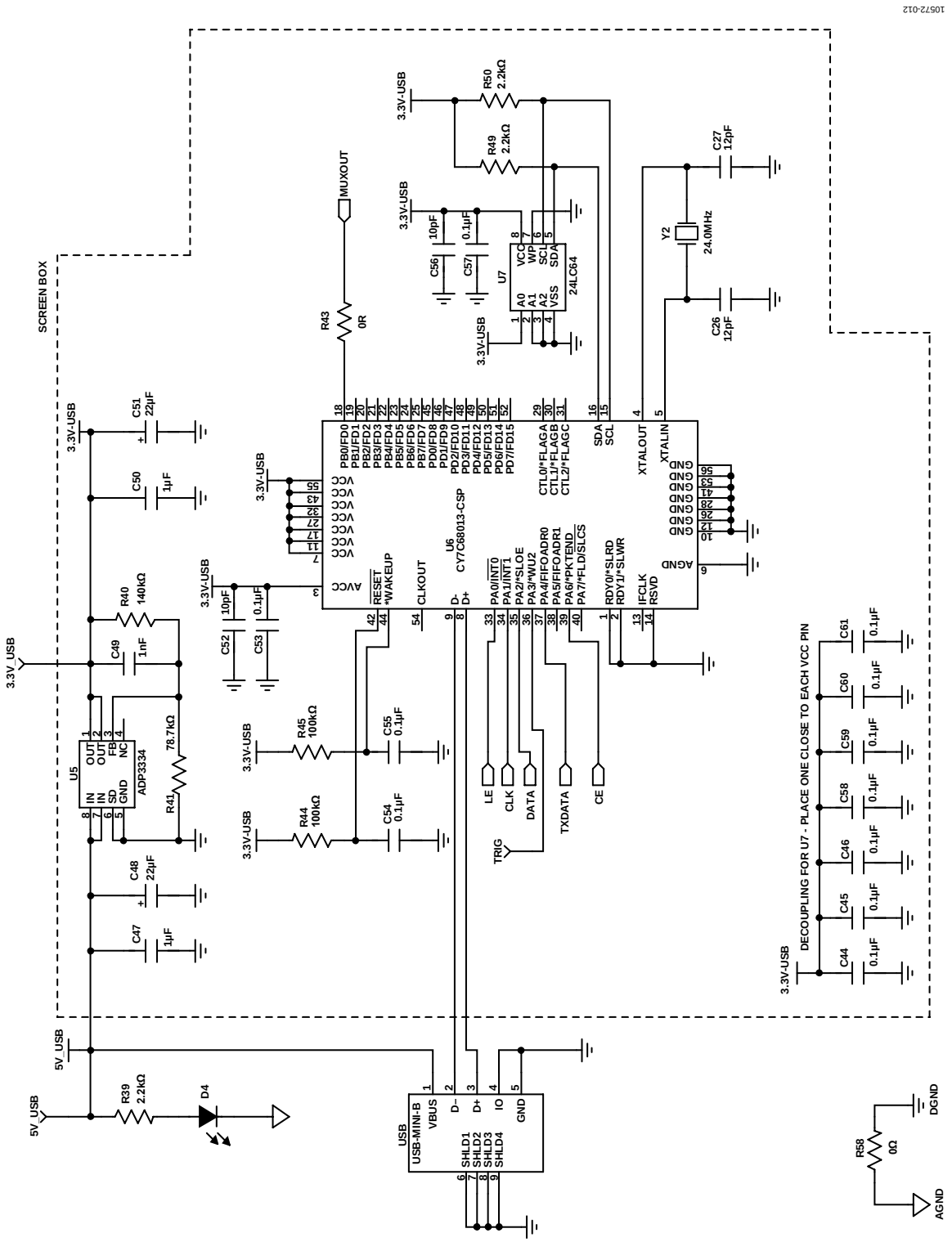


Figure 12. Evaluation Board Schematic (Page 3)

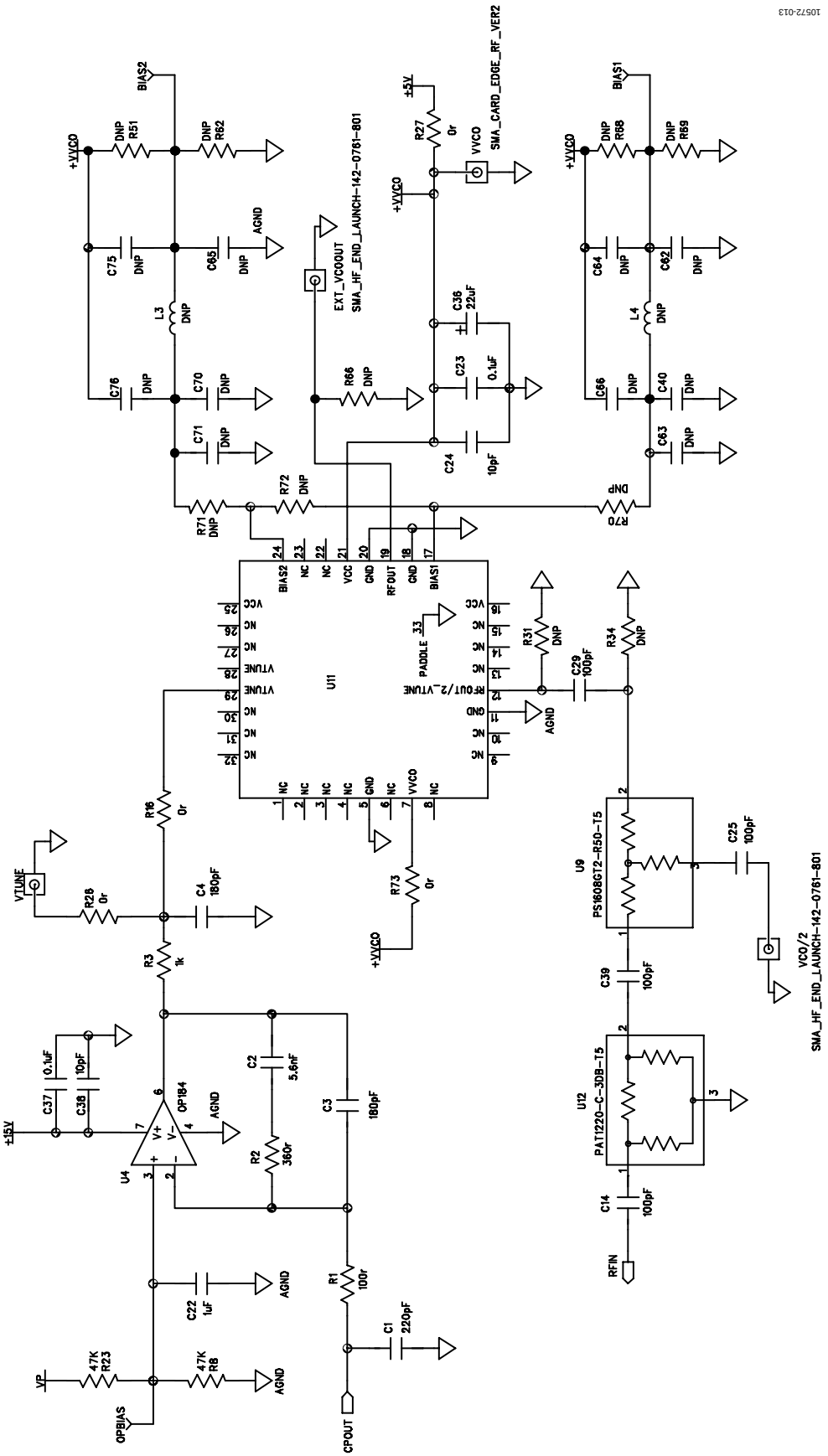


Figure 13. Evaluation Board Schematic (Page 4)

NOTES

NOTES



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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