Evaluating the ADF41510 10 GHz, Integer-N/Fractional-N PLL Synthesizer

FEATURES

- EV-ADF41510SD1Z
  - ADF41510 frequency synthesizer, 100 MHz crystal oscillator, loop filter, USB interface, and voltage regulators
- EV-ADF41510SD2Z
  - All features of EV-ADF41510SD1Z plus HMC587 5 GHz to 10 GHz voltage-controlled oscillator (VCO)
- Windows®-based software allows control of synthesizer functions from a PC
- Externally powered by 6 V and 25 V

EVALUATION KIT CONTENTS

- EV-ADF41510SD1Z or EV-ADF41510SD2Z evaluation board

EQUIPMENT NEEDED

- Windows-based PC with USB port for evaluation software
- System demonstration platform, SDP-S
- EVAL-SDP-CS1Z controller board
- Dual power supply (6 V, 25 V)
- Spectrum analyzer

DOCUMENTS NEEDED

- ADF41510 data sheet

SOFTWARE NEEDED

- ADF41510 software, Version 0.1.0 or higher

GENERAL DESCRIPTION

The EV-ADF41510SD1Z and EV-ADF41510SD2Z are evaluation boards that can be used to evaluate all the features of the ADF41510. The EV-ADF41510SD1Z requires an external VCO. The EV-ADF41510SD2Z includes an on-board 5 GHz to 10 GHz HMC587 VCO.

The EV-ADF41510SD1Z has Subminiature Version A (SMA) connectors to connect the charge pump output (VTUNE) to the tuning input of the VCO and the phase-locked loop (PLL) radio frequency (RF) input (RFIN) to the VCO output.

Both variants of the evaluation board include the ADF41510 frequency synthesizer, 100 MHz reference (crystal oscillator (XO)), loop filter, USB interface, low noise voltage regulators.

For easy programming of the synthesizer, download the Windows-based software from the ADF41510 product page ADF41510. The file transfer program (FTP) user name and password are printed on the label inside the lid of the evaluation board box.

The evaluation board requires an SDP-S, which is not included with the kit. The SDP-S allows software programming of the ADF41510 device through a USB interface.

Full specifications on the ADF41510 are available in the ADF41510 data sheet available from Analog Devices, Inc., and must be consulted with this user guide when using the EVAL-ADF41510 evaluation board.

EVALUATION BOARD PHOTOGRAPH

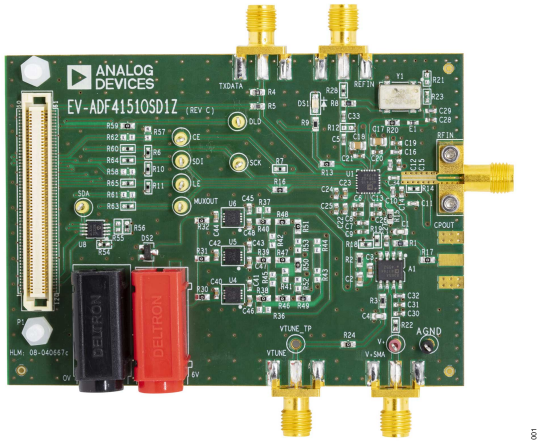

Figure 1. Evaluation Board Photograph

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REVISION HISTORY

2/2024—Revision 0: Initial Version

GETTING STARTED

SOFTWARE INSTALLATION PROCEDURES

Download the EV-ADF41510SD1Z and EV-ADF41510SD2Z control software from the product page ADF41510. The FTP user name and password are printed on a label inside the evaluation kit box. For the software installation procedure, refer to the PLL Software Installation Guide.

EVALUATION BOARD SETUP PROCEDURES

To run the software, perform the following steps:

1. After installation, click the **ADF41510** icon on the desktop or select **Analog Devices > ADF41510** from the **Start** menu.
2. In the **Select Device and Connection** tab, click **Connect** (see Figure 2).
3. Approximately 5 sec to 10 sec after connecting the board, the connection status in the bottom left corner changes from **No device connected** to **Connected**.

Under **File**, the current settings can be saved to or loaded from a text file.

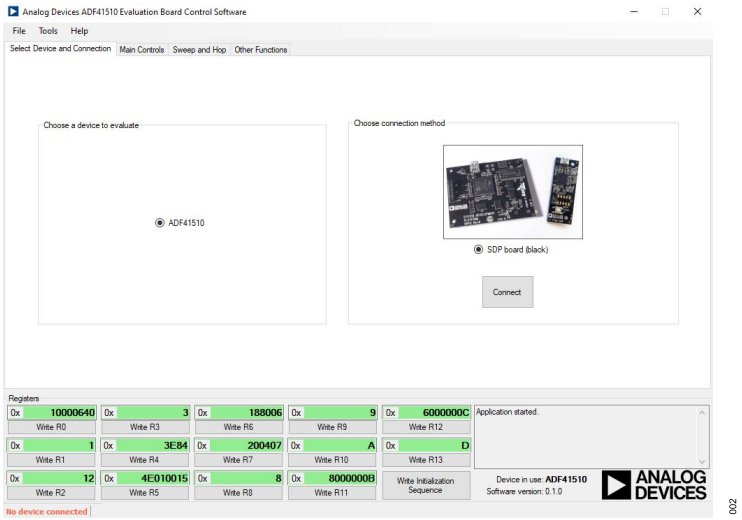

Figure 2. Software Front Panel Display, Select Device and Connection Tab

EVALUATION BOARD HARDWARE

The EV-ADF41510SD1Z and EV-ADF41510SD2Z require the SDP-S platform that uses the EVAL-SDP-CS1Z.

The evaluation board schematics, assembly, silkscreen, and bill of materials are available in the Evaluation Board Schematics and Artwork and Ordering Information sections, respectively.

POWER SUPPLIES

The board is powered by a 6 V (300 mA) power supply connected to the red and black banana connectors. Connect the red connector to a 6 V power supply and the black connector to ground. Connect a 25 V (20 mA) power supply to either the V+SMA SMA connector or the test point labeled V+. These connectors power the loop filter op amp.

The power supply circuitry provides a network of 0 Ω resistors to configure the power supply connections to the ADF41510. Using fewer low-dropout (LDO) regulators increases the risk of spur contaminated DC feeds, but provides a more cost-efficient design. By default, three LDO regulators provide power. The EV-ADF41510SD2Z includes a dedicated 5 V LDO powering the HMC587 VCO.

SMA CONNECTIONS

The EV-ADF41510SD1Z evaluation board requires two VCO connections labeled RFIN and VTUNE. Connect RFIN to the VCO RF output and VTUNE to the VCO V_{TUNE} input.

LOOP FILTER

The loop filter is shown in Figure 9 and EV-ADF41510SD1Z Board in Evaluation Board Schematics and Artwork. Figure 3 shows the loop filter component placement. For the best in-band phase noise at 10 GHz, use the following components with a 3.3 mA charge pump current and narrow anti-backlash pulse (ABP) setting. These components are the default on the evaluation boards.

- C1 = 470 pF, C2 = 10 nF, C3 = 220 pF, C4 = 470 pF
- R1 = 68 Ω, R2 = 220 , R3 = 150 Ω

Narrower loop filter bandwidths have lower spurious signals.

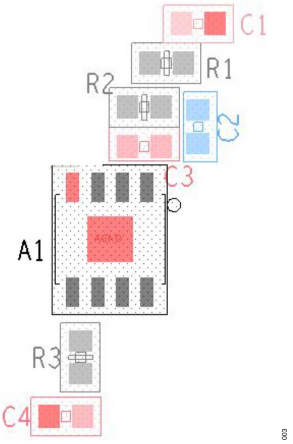

Figure 3. Loop Filter Placement

REFERENCE SOURCE

The evaluation boards contain a 100 MHz single-ended output XO from Crystek Corporation. When using an external reference, remove R8 to disconnect the XO stub and remove R20 to power down the XO. Connect the external reference to the SMA connector labeled REFIN.

DEFAULT CONFIGURATION

All components necessary for local oscillator (LO) generation are installed on the EV-ADF41510SD2Z board. This board is shipped with the ADF41510 synthesizer, HMC587 VCO, 100 MHz reference XO, and a 312 kHz loop filter (assuming charge pump current (I_{CP}) = 3.3 mA and RF VCO frequency (RF_{OUT}) = 10 GHz).

On both the EV-ADF41510SD1Z and the EV-ADF41510SD2Z, R_{SET} = 2.7 kΩ

EVALUATION BOARD HARDWARE

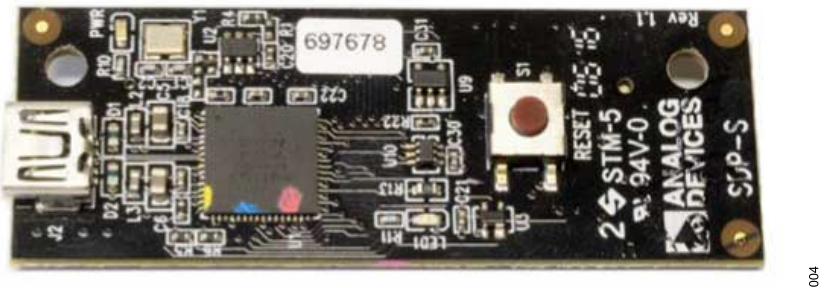

Figure 4. SDP-S USB Interface

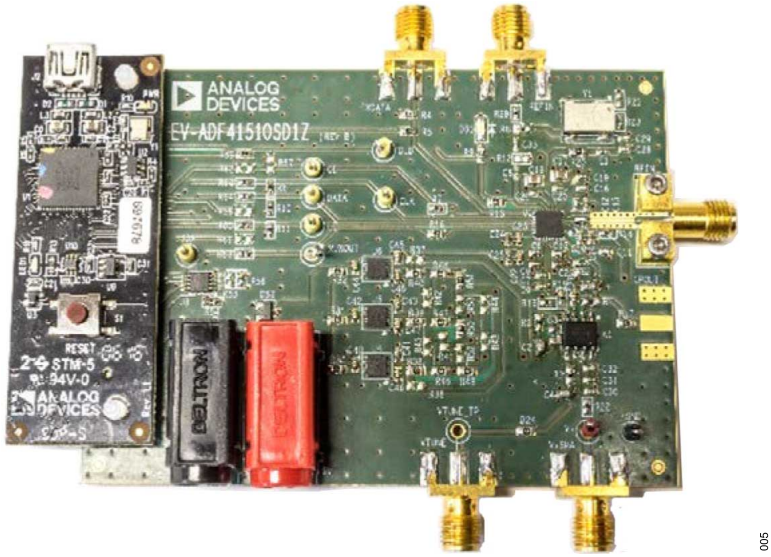

Figure 5. Hardware Connection Photograph

EVALUATION BOARD SOFTWARE

MAIN CONTROLS

The **Main Controls** tab (see Figure 6) selects the RF and user configurable register settings. Consult the register descriptions of the ADF41510 data sheet for details. The default setting is recommended for most registers.

In the **RF Settings** area, ensure that the **VCOout (MHz)** box equals the VCO frequency fed back to the PLL.

Ensure that the value in the **Reference freq.** box equals the applied reference signal. The phase frequency detector (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 (MHz)** box matches the value specified in the loop filter design.

In the **Register 5** area, select the value in the **CP Current** drop-down box that matches the value used for the loop filter design.

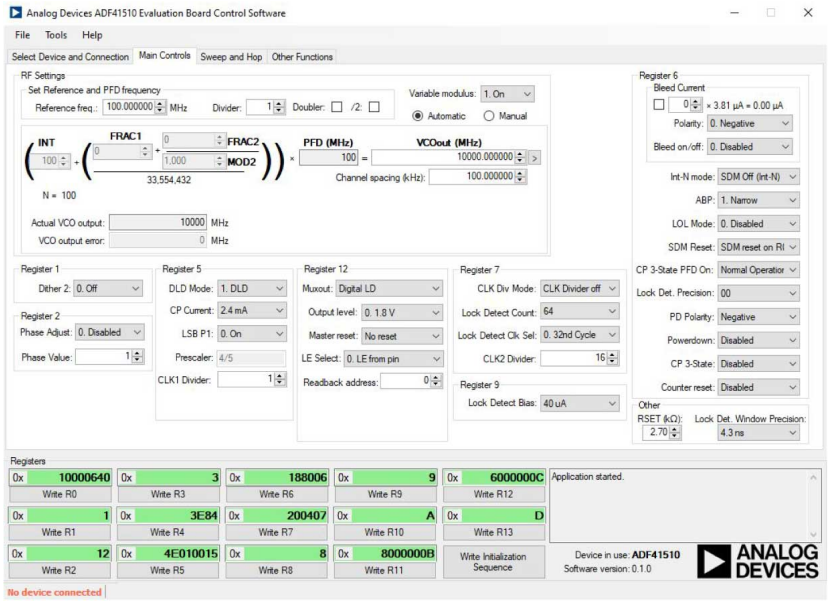

Figure 6. Software Front Panel Display, Main Controls Tab

EVALUATION AND TEST

To evaluate and test the performance of the EV-ADF41510SD1Z and EV-ADF41510SD2Z, use the following procedure:

1. Install the ADF41510 software (refer to the PLL Software Installation Guide).
2. If using a PC with Windows XP, follow the hardware driver installation procedure.
3. Connect the evaluation board to the SDP-S board.
4. Connect the 6 V power supply to the banana connectors.
5. Connect the 25 V power supply to the V+SMA connector.
6. Power on the 6 V and 25 V supplies. There is no sequencing requirement.
7. Connect the USB cable from the SDP-S board to the PC.
8. Run the ADF41510 software.
9. Select **ADF41510** and **SDP board (black)** in the **Select Device and Connection** tab (see Figure 2).
10. Click the **Main Controls** tab, and set the **VCOout (MHz)** box to a frequency of 10,000 MHz (see Figure 6).
11. Click **Write Initialization Sequence** in the **Registers** area.
12. Connect the spectrum analyzer to SMA Connector RFOUT.
13. Measure the output spectrum and single sideband phase noise.

Figure 7 shows a phase noise plot of the SMA RFOUT at 10 GHz.

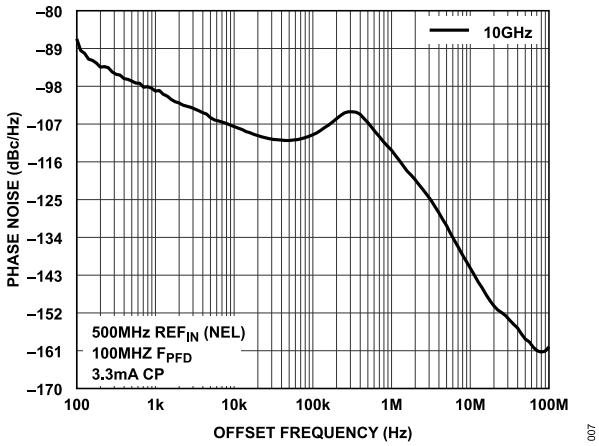

Figure 7. Single Sideband Phase Noise

EVALUATION BOARD SCHEMATICS AND ARTWORK

EV-ADF41510SD1Z BOARD

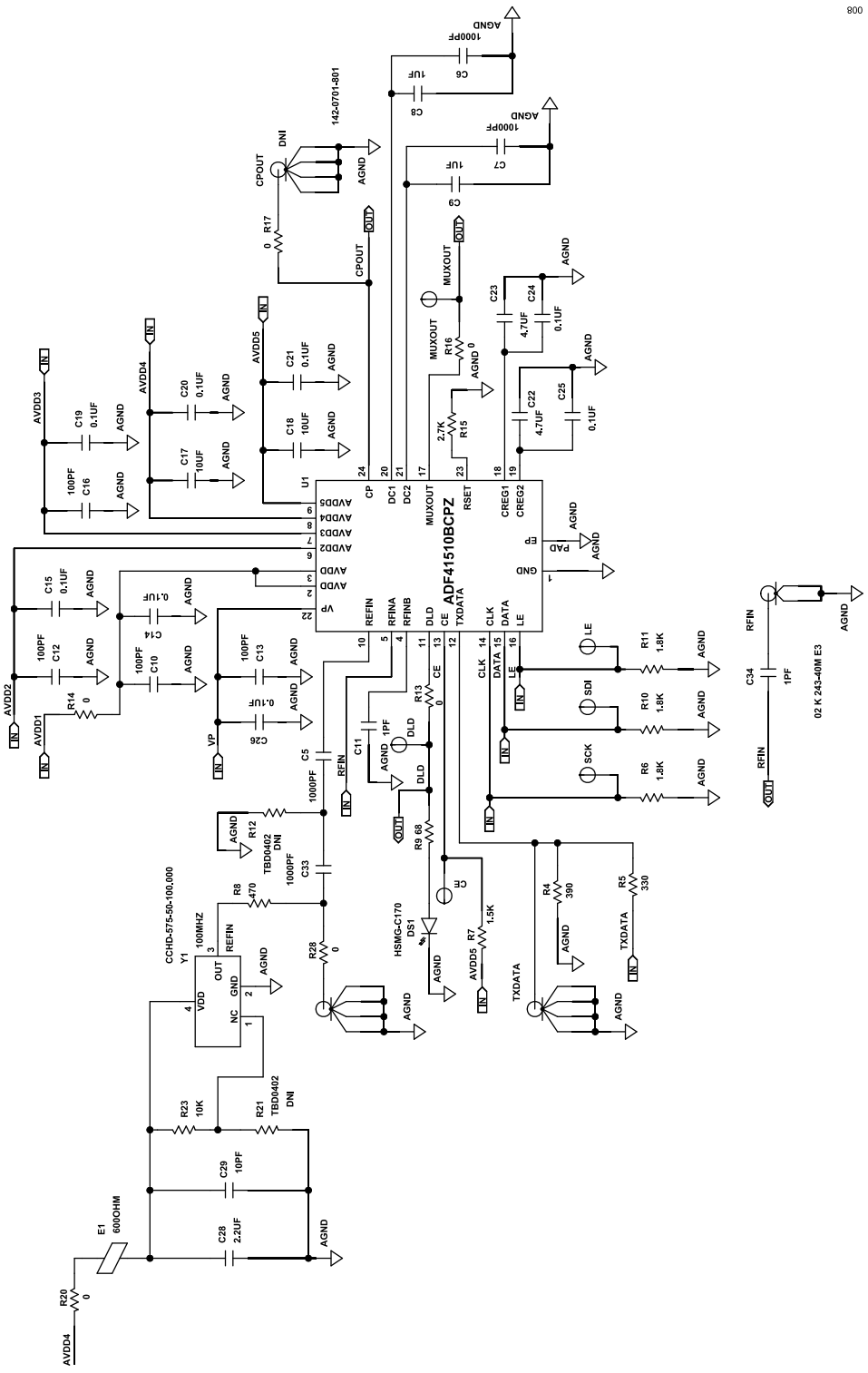

Figure 8. EV-ADF41510SD1Z Schematic

EVALUATION BOARD SCHEMATICS AND ARTWORK

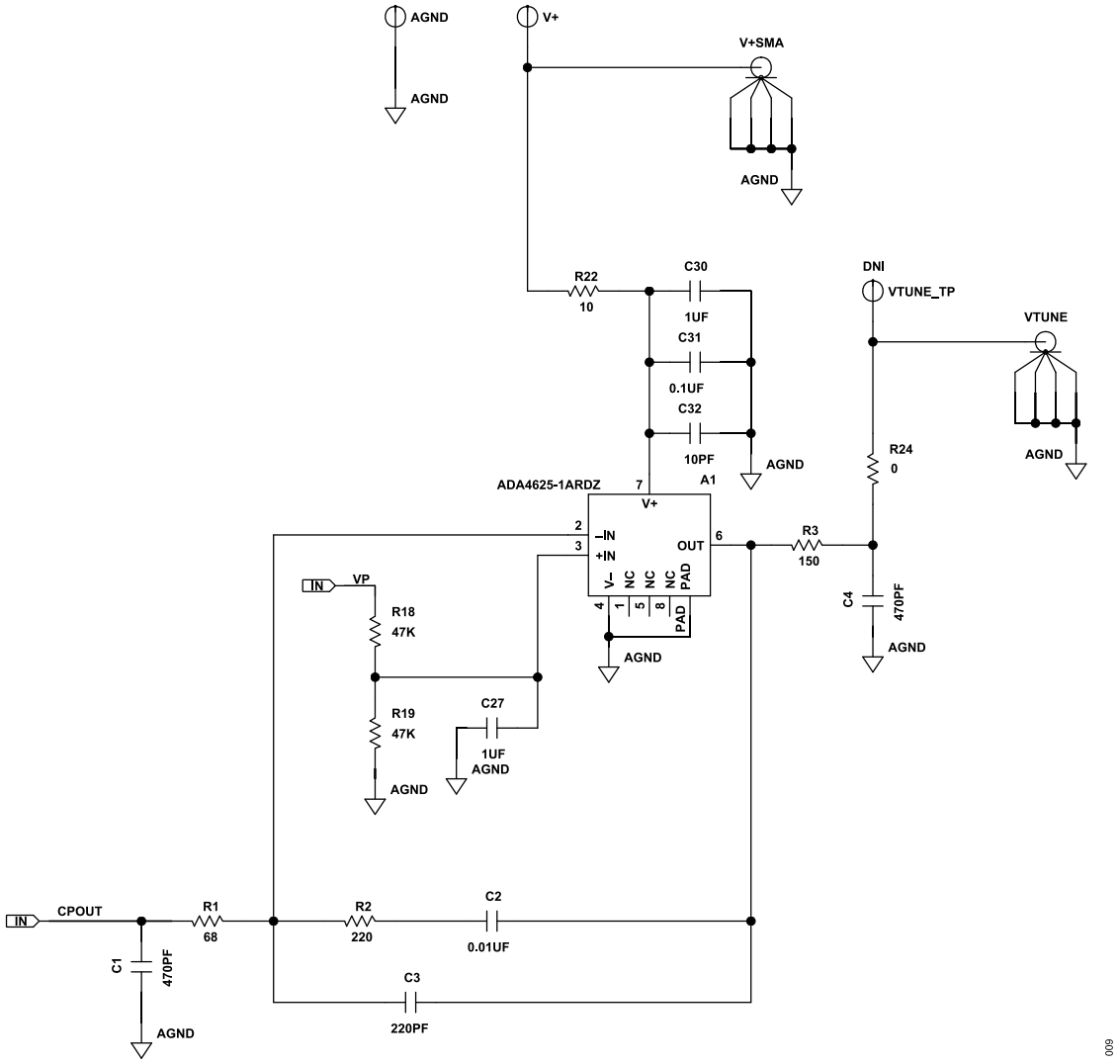

Figure 9. EV-ADF41510SD1Z Schematic, Loop Filter

EVALUATION BOARD SCHEMATICS AND ARTWORK

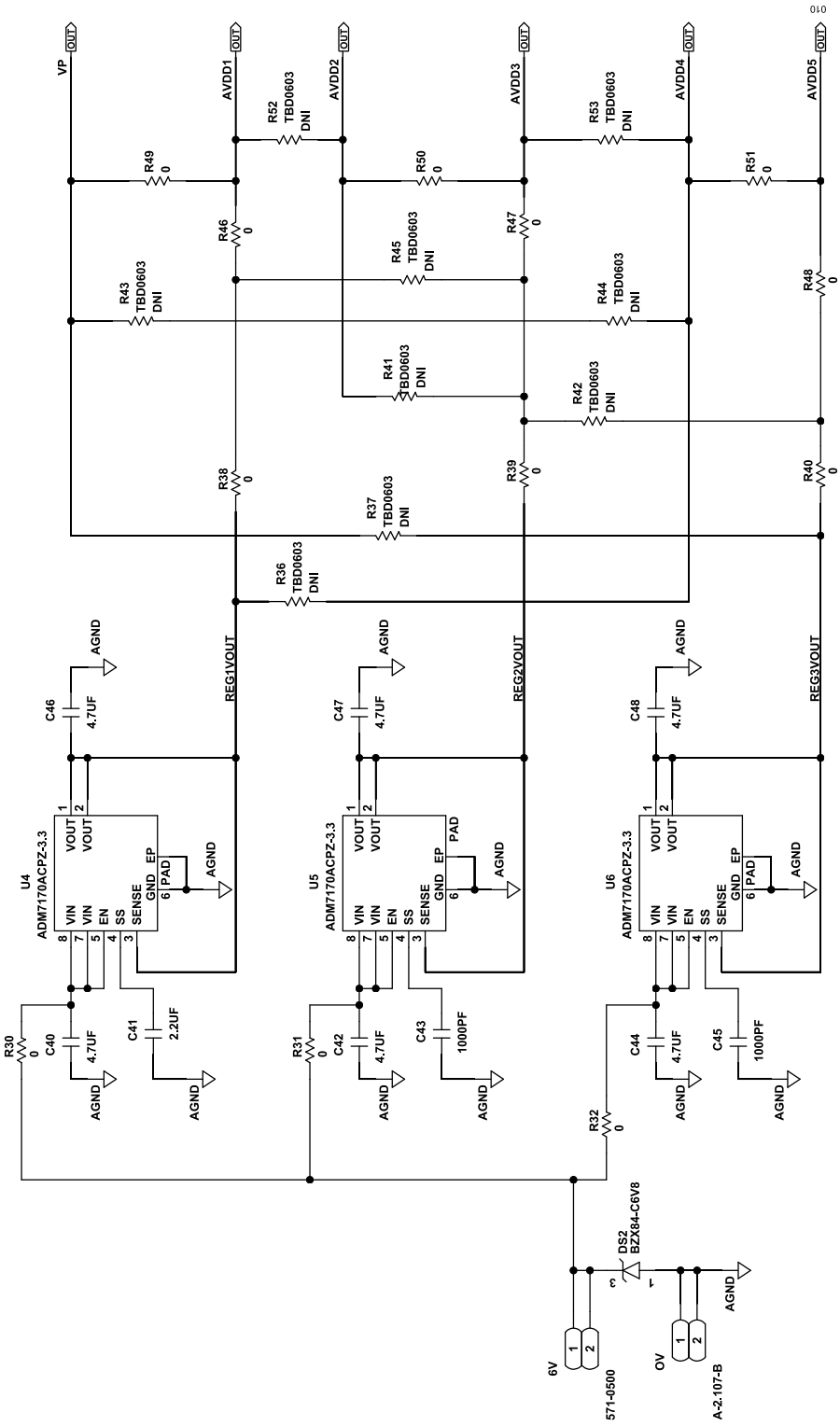

Figure 10. EV-ADF41510SD1Z Schematic, Power

EVALUATION BOARD SCHEMATICS AND ARTWORK

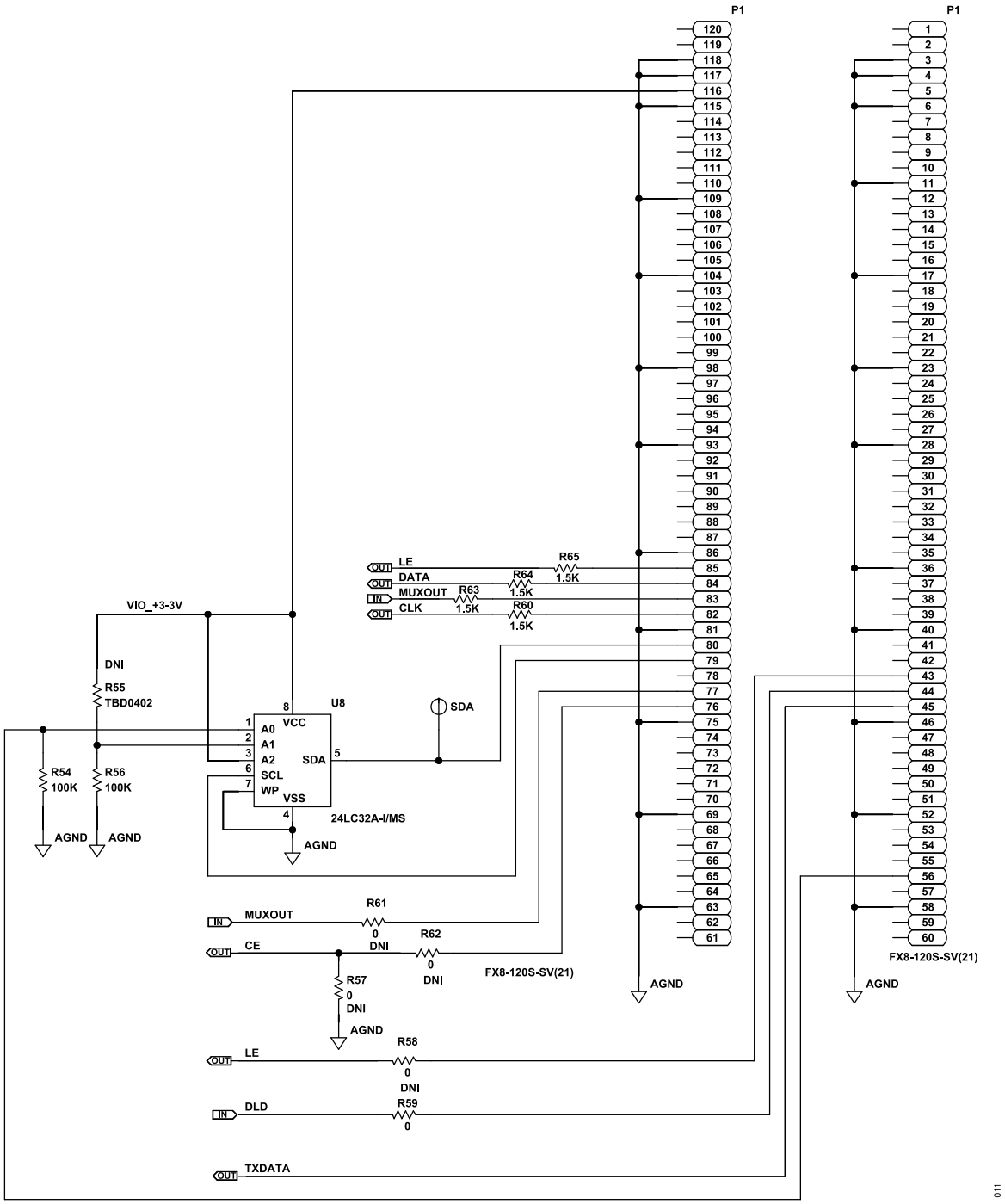

Figure 11. EV-ADF41510SD1Z Schematic, System Demonstration Platform (SDP) Connector

EVALUATION BOARD SCHEMATICS AND ARTWORK

EV-ADF41510SD2Z BOARD

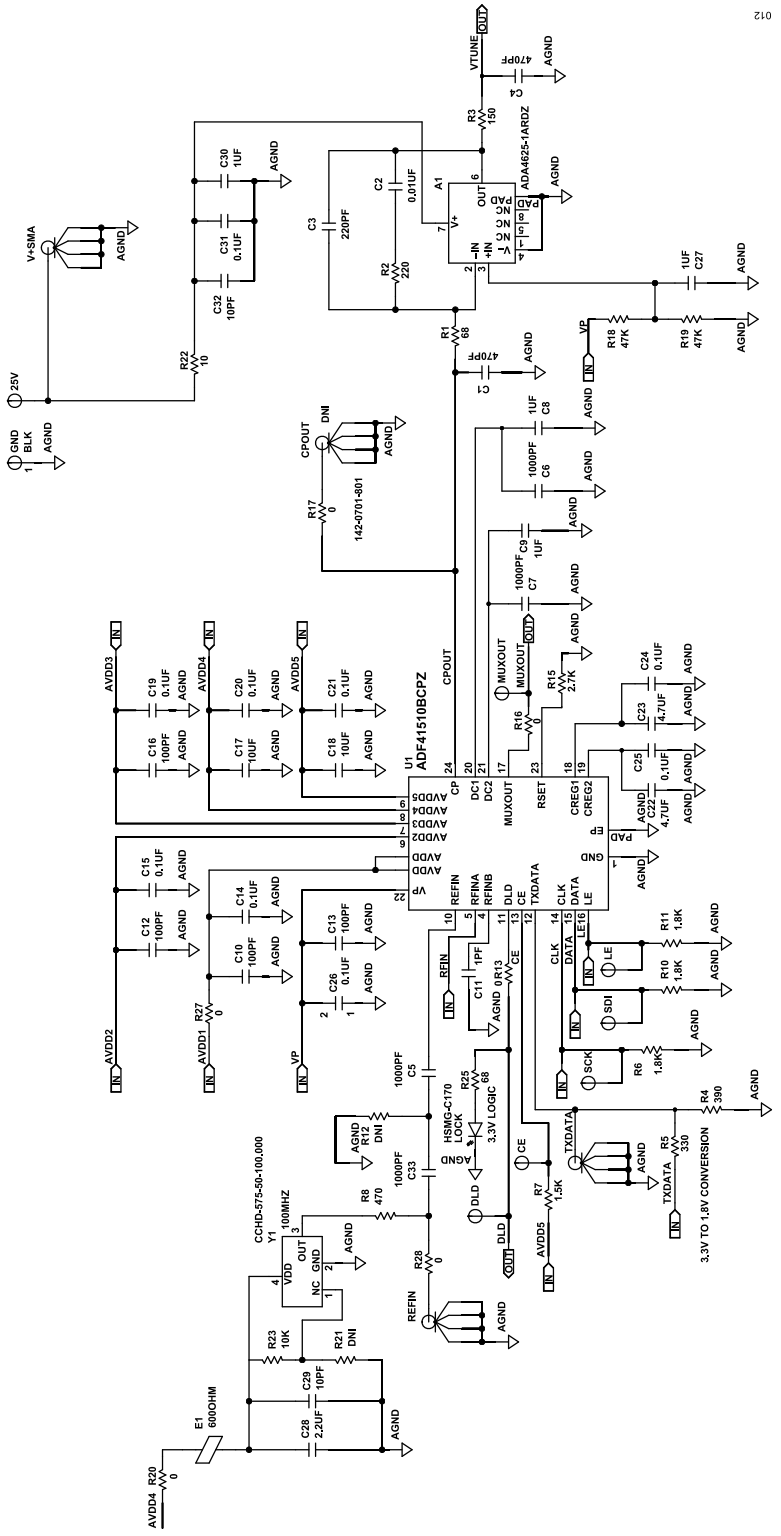

Figure 12. EV-ADF41510SD2Z with HMC587 VCO Schematic

EVALUATION BOARD SCHEMATICS AND ARTWORK

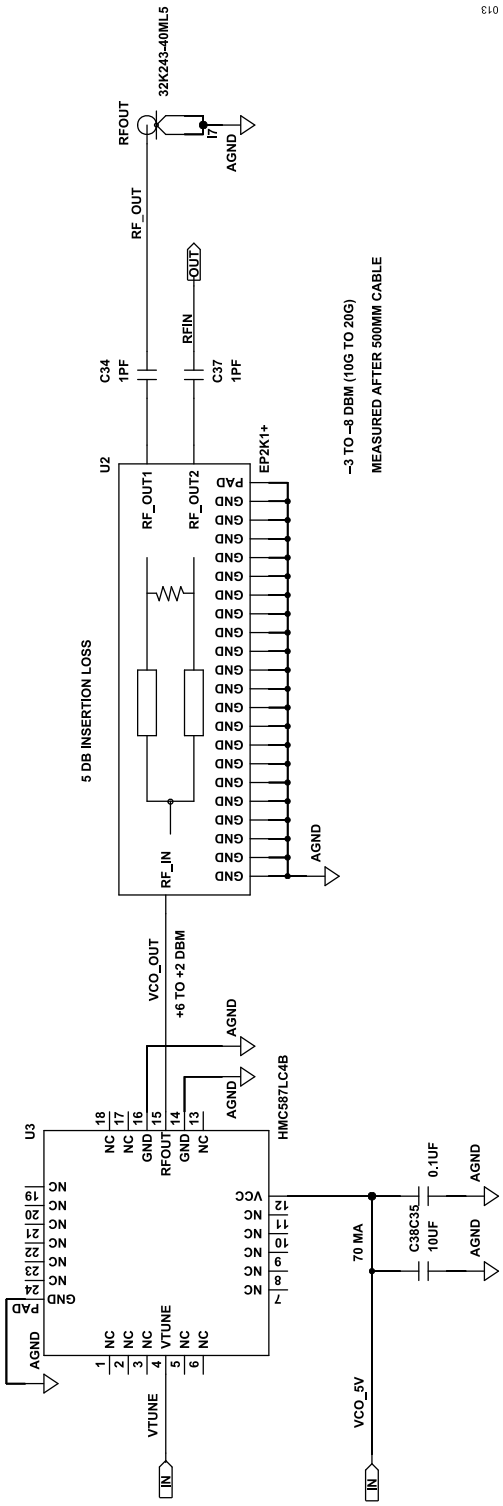

Figure 13. EV-ADF41510SD2Z Schematic, VCO

EVALUATION BOARD SCHEMATICS AND ARTWORK

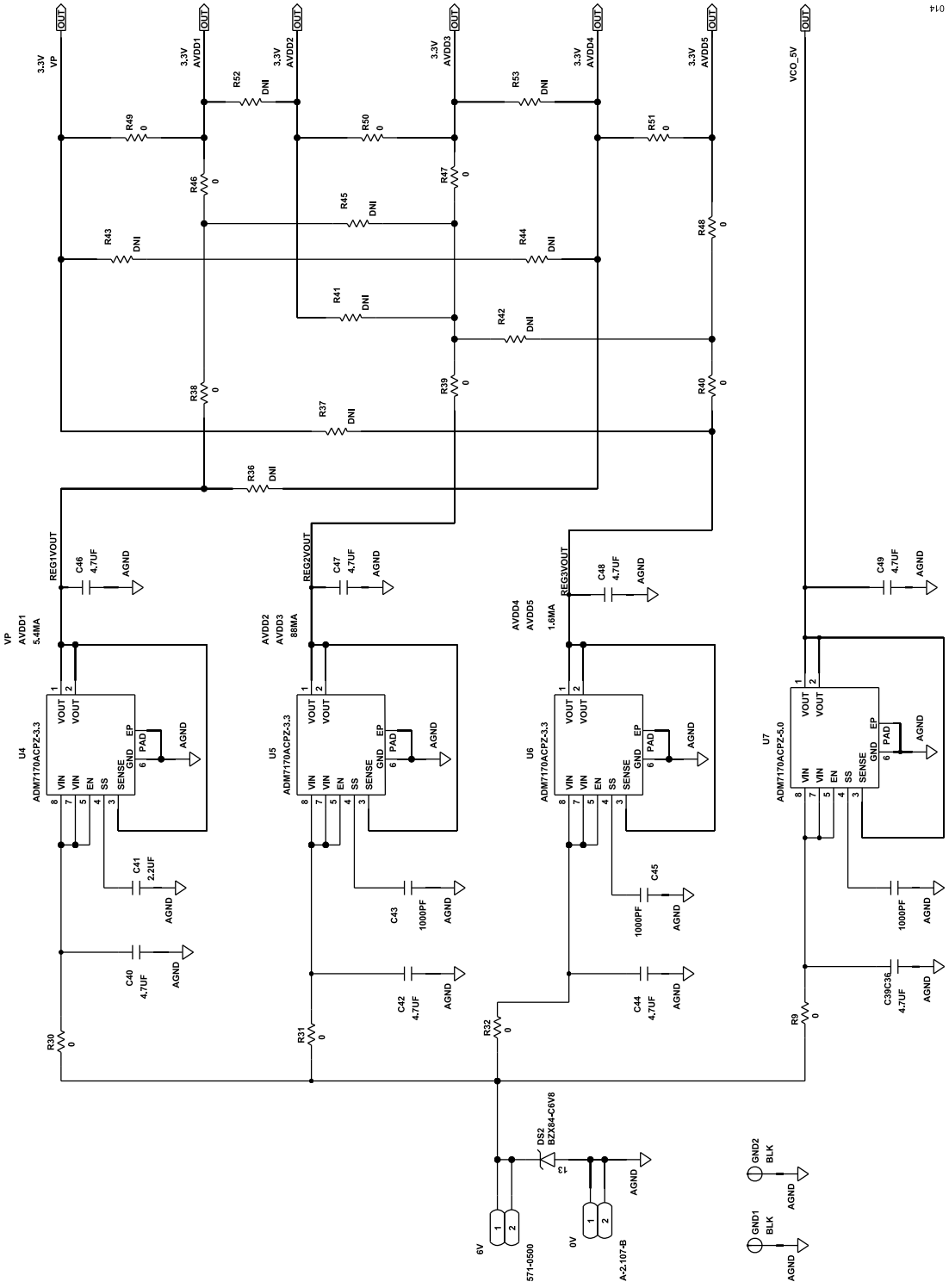

Figure 14. EV-ADF41510SD2Z Schematic, Power

EVALUATION BOARD SCHEMATICS AND ARTWORK

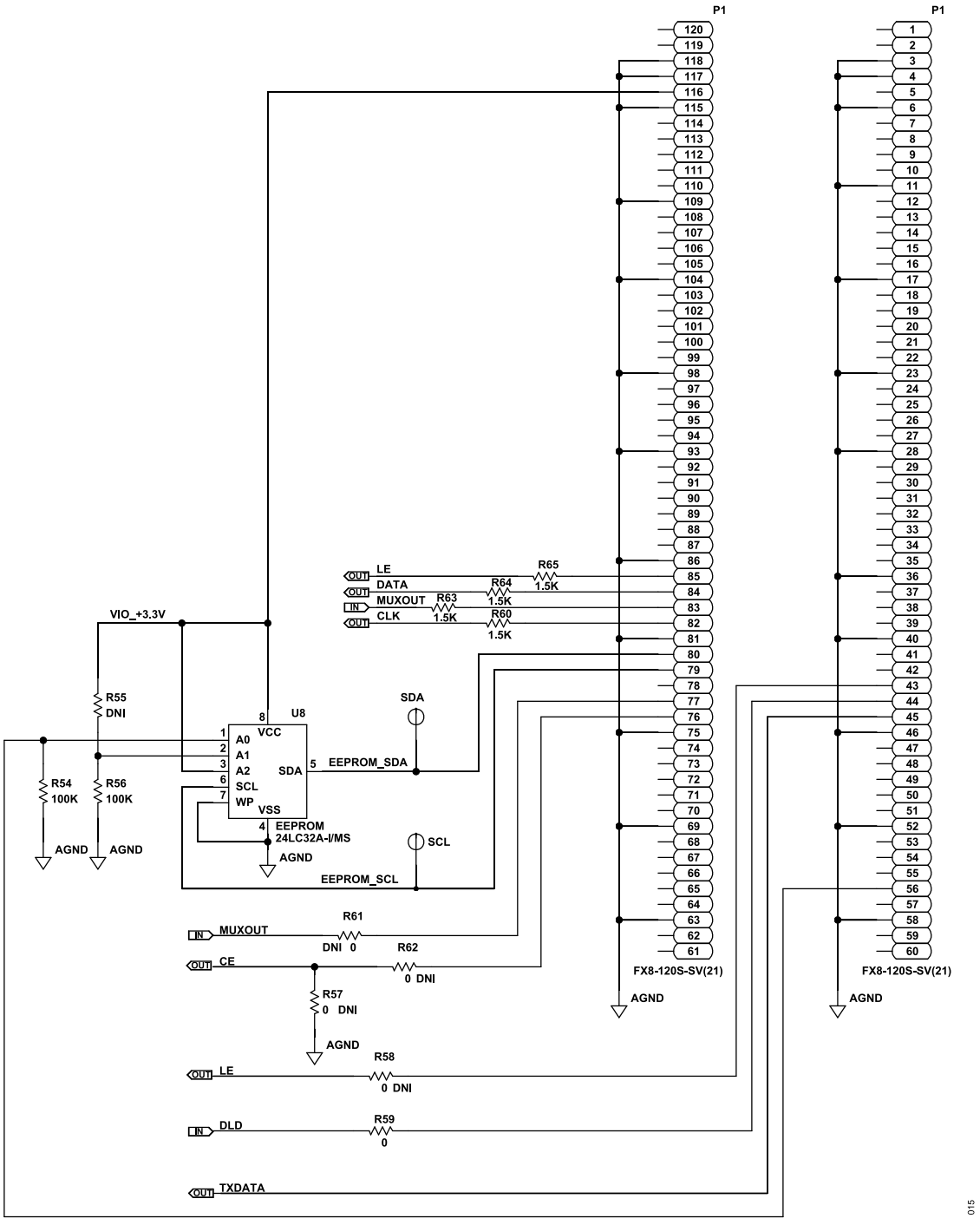

Figure 15. EV-ADF41510SD2Z Schematic, SDP Connector

EVALUATION BOARD SCHEMATICS AND ARTWORK

SILKSCREEN LAYERS

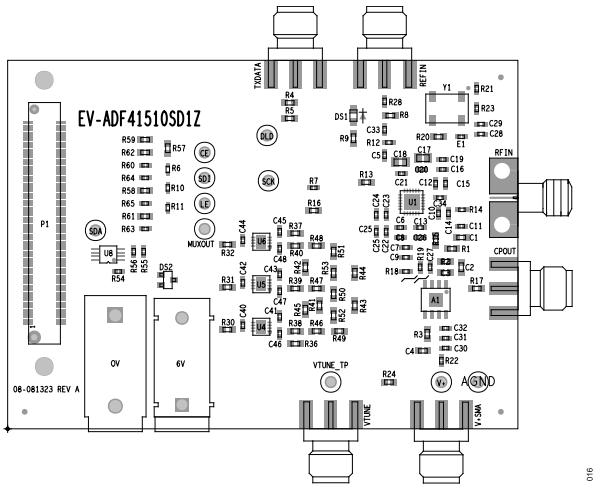

Figure 16. EV-ADF41510SD1Z Silkscreen

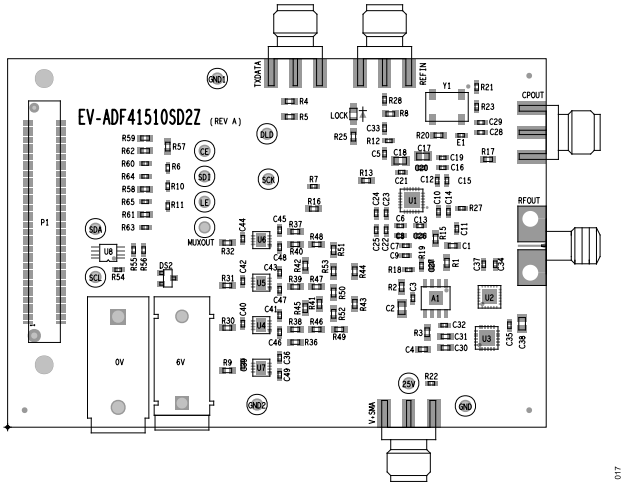

Figure 17. EV-ADF41510SD2Z Silkscreen

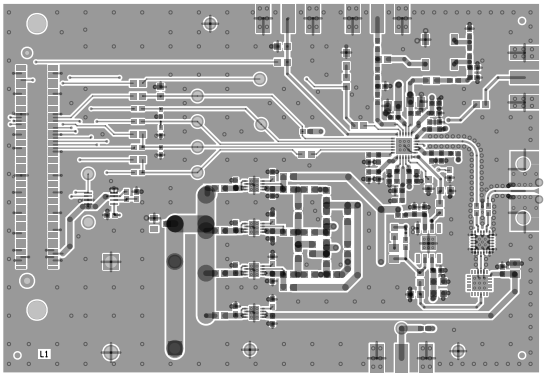

Figure 18. Layer 1 (EV-ADF41510SD2Z)

EVALUATION BOARD SCHEMATICS AND ARTWORK

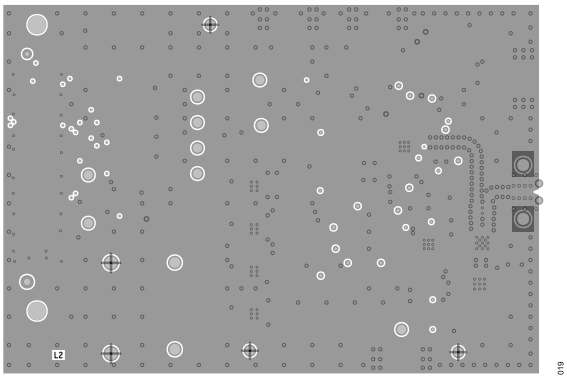

Figure 19. Layer 2 (Ground)

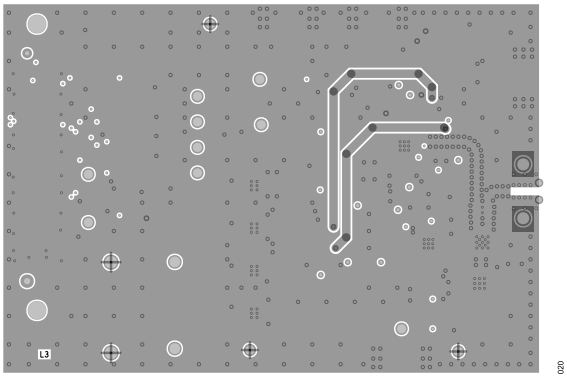

Figure 20. Layer 3

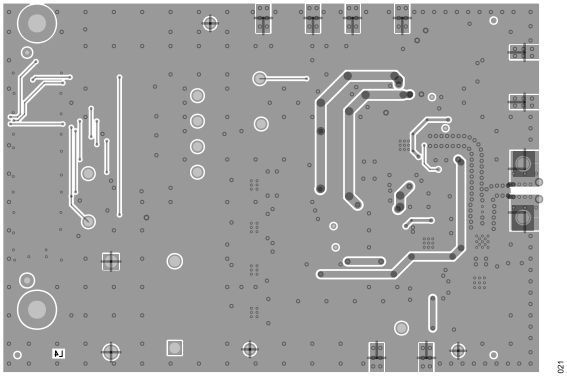

Figure 21. Layer 4

ORDERING INFORMATION

BILL OF MATERIALS

Table 1. Bill of Materials

Component	Description	Part Number	Manufacturer
Not applicable	Printed circuit board (PCB)	08-040667C	Analog Devices, Inc. (supplied)
A1	IC, 36 V, 18 MHz, Low Noise, Fast Settling Single Supply, RRO, JFET Op Amp	ADA4625-1	Analog Devices
AGND	Connected PCB test point block	TP-104-01-00	Components Corporation
C1, C4	Capacitor, ceramic, 470 pF 50 V 5% C0G 0603	CC0603JRNPO9BN471	PHYCOMP (YAGEO)
C10, C12, C13, C16	Capacitor, ceramic, C0G, NP0, general-purpose, 100 pF, 5%, 50 V	GRM1555C1H101JA01D	Murata
C11, C34	Capacitor, ceramic, C0G NP0, 0402, 1 pF, 10%, 25 V	04023A1R0BAT2A	AVX
C14, C26, C31	Capacitor, ceramic, X7R, general-purpose, 0.1 pF, 10%, 16 V	GRM155R71C104KA88D	Murata
C15, C19, C20, C21, C24, C25	Capacitor, ceramic, X7R, 0.1 µF, 10%, 16 V	C0402C104K4RACTU	KEMET
C17, C18	Capacitor, ceramic, multilayer X5R, for SM-TH combo footprint use ALT_SYMBOLS, 10 µF, 10%, 25 V	C2012X5R1E106K085AC	TDK
C2	Capacitor, ceramic, 0.01 µF 50 V 5% C0G 0603	GRM1885C1H103JA01D	Murata
C22, C23, C40, C42, C44, C46, C47, C48	Capacitor, ceramic, X5R, general-purpose, 4.7 µF, 20%, 6.3 V	GRM155R60J475ME87D	Murata
C8, C9, C27, C30	Capacitor, ceramic, X5R, general-purpose, 1 µF, 10%, 6.3 V	GRM155R60J105KE19D	Murata
C28, C41	Capacitor ceramic, X5R, 2.2 µF, 10%, 6.3 V	C1005X5R0J225K050BC	TDK
C29, C32	Capacitor, multilayer, NP0 0402, 10 pF, 5%, 50 V	CC0402JRNP09BN100	Yageo
C3	Capacitor, ceramic, 220 pF 50 V 5% C0G 0603	CC0603JRNPO9BN221	Yageo
C5, C6, C7, C33, C43, C45	Capacitor, ceramic, chip, 0.001 µF, 5%, 25 V	C0402C102J3GACTU	KEMET
CE, DLD, LE, MUXOUT, SCK, SDA, SDI	Connected PCB test point, yellow	TP-104-01-04	Components Corporation
DS1	Light emitting diode (LED) 570 nm surface mount device (SMD), green, 0%, 2.2 V	HSMG-C170	Broadcom
DS2	Diode BZX84C 6.8 V Zener SOT-23, 5%, 6.8 V	BZX84-C6V8	Philips
E1	Inductor chip, ferrite bead, 600 Ω, 25%	BLM15AX601SN1D	Murata
OV	Connected PCB socket banana jack, black	A-2.107-B	Multicomp
P1	Connected PCB, vertical type receptacle SMD used in UG-291	FX8-120S-SV(21)	Hirose Electric
R1	Resistor, film, SMD 68 Ω 0.1% 1/10W 0603	RT0603BRD0768RL	Yageo
R6, R10, R11	Resistor, thick film, chip, 1.8 kΩ, 1%	CRCW04021K80FKED	Vishay Intertechnology
R13, R16, R17, R20, R24, R30, R31, R32, R38, R39, R40, R46, R47, R48, R49, R50, R51, R59	Resistor, film, SMD 0603, 1%	MC0603WG00000T5E-TC	Multicomp
R14	Resistor, thick film, chip, 1%, 50 V	MC00625W040210R	Multicomp
R15	Resistor, film, SMD 0603, 2.7 kΩ, 1%	MC 0.063 w 0603 1% 2K7	Multicomp
R18, R19	Resistor, precision thick film, chip, 47 kΩ, 1%, 50 V	ERJ-2RKF4702X	Panasonic
R2	Resistor, SMD 220 Ω 0.1% 1/10W 0603	ERA-3AEB221V	Panasonic
R22	Resistor, precision thick film, chip, 10 Ω, 1% {Found missing unit in schematic}	ERJ-2RKF10R0X	Panasonic
R23	Resistor, high stab, flat chip, 10 kΩ, 0.1%, 50 V	TNPW040210K0BEED	Vishay Intertechnology
R28	Resistor, chip, SMD jumper, 0, N/R	ERJ-2GE0R00X	Panasonic
R3	Resistor, SMD 150 Ω 1% 1/10W 0603	ERJ-3EKF1500V	Panasonic
R4	Resistor, film, SMD 0603, 390R, 1%	MC 0.063 w 0603 1% 390R	Multicomp
R5	Resistor, film, SMD 0603, 330R, 1%	MC 0.063 W 0603 1% 330R	Multicomp
R54, R56	Resistor, precision thick film, chip, 100 kΩ, 1%	ERJ-2RKF1003X	Panasonic
R7, R60, R63, R64, R65	Resistor, general-purpose, thick film, chip, 1.5 kΩ, 1%, 50 V	RMCF0402FT1K50	Stackpole Electronics
R8	Resistor, film, SMD 0603, 470R, 1%	MC 0.063 W 0603 1% 470R	Multicomp
R9	Resistor, film, SMD 0603, 68R, 1%	MC 0.063 W 0603 1% 68R	Multicomp
REIN, TXDATA, V+SMA, VTUNE	Connected PCB, coaxial SMA, end launch	142-0701-801	Cinch Connectivity Solutions

ORDERING INFORMATION

Table 1. Bill of Materials (Continued)

Component	Description	Part Number	Manufacturer
RFIN	Connected PCB, SMA, right angle (RA) jack, ALT_SYMBOLS is for nonplated mounting hole	32K243-40ML5	Rosenberger Hochfrequenz-technik Gmbh & Co. KG
U1	IC10 GHz, Integer-N or Fractional-N, PLL synthesizer, preliminary	ADF41510BCPZ	Analog Devices
U4, U5, U6	IC ultra-low noise, high power supply rejection ratio (PSRR), fast transient response, complementary metal-oxide semiconductor (CMOS), LDO, 3.3 V	ADM7170ACPZ-3.3-R7	Analog Devices
U8	IC 32 kB, serial electronically erasable programmable read only memory (EEPROM), 0 V	23LC32A-I/MS	Microchip Technology
V+	Connected PCB, test point, red	TP-104-01-02	Components Corporation
Y1	100 MHz, 0%, 3.3 V	CCHD-575-50-1000.000	Crystek
CPOUT	Connected PCB, coaxial SMA, end launch	142-0701-801	Cinch Connectivity Solutions
R12, R21, R55	Do not install (TBD_R0402), use SYM_3 or SYM_4	TBD0402	TBD0402
R36, R37, R41, R42, R43, R44, R45, R52, R53	Do not install (TBD_R0603), use SYM_3 or SYM_4	TBD0603	TBD0603
R57, R58, R61, R62	Resistor, film, SMD 0603, 1%	MC0603WG00000T5E-TC	Multicomp
VTUNE_TP	Connected PCB, test point, yellow	TP-104-01-04	Components Corporation

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.