ANALOG DEVICES

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Evaluating the ADF5901 24 GHz Voltage Controlled Oscillator (VCO) and Programmable Gain Amplifier (PGA) with a 2-Channel Power Amplifier (PA) Output

FEATURES

Contains ADF5901 24 GHz VCO and PGA with a 2-channel PA output
Contains ADF4159 13 GHz fractional-N frequency synthesizer
Accompanying software allows control of the ADF5901 and the ADF4159 functions from a PC

EVALUATION KIT CONTENTS

EV-ADF5901SD2Z evaluation board

ADDITIONAL EQUIPMENT

PC running Windows® XP or more recent version
Analog Devices, Inc., EVAL-SDP-CS1Z system demonstration platform serial (SDP-S) board
Spectrum analyzer
Oscilloscope (optional)
5 V power supply

DOCUMENTS NEEDED

ADF5901 data sheet

REQUIRED SOFTWARE

Analog Devices ADF5901 software

GENERAL DESCRIPTION

The EV-ADF5901SD2Z evaluation board allows the user to evaluate the performance of the ADF5901 24 GHz VCO and PGA with a 2-channel PA output. Figure 1 shows the EV-ADF5901SD2Z, which contains the ADF5901, the ADF4159, three high frequency, K-type SMA connectors for the local oscillator (LO) output and two transceiver (Tx) outputs, two high frequency SMA connectors for the AUX and the $\overline{AUX}$ outputs, banana connectors for power supply, and a connector for the serial interface.

The EV-ADF5901SD2Z evaluation kit also contains software that is compatible with Windows XP and later versions to allow easy programming of the device.

The EV-ADF5901SD2Z evaluation board requires an EVAL-SDP-CS1Z (SDP-S) controller board, which is not supplied with the kit. The EVAL-SDP-CS1Z allows software programming of the ADF5901 device.

Full specifications on the ADF5901 are available in the ADF5901 data sheet, which should be consulted in conjunction with this user guide when working with the evaluation board.

EV-ADF5901SD2Z EVALUATION BOARD PICTURE

Figure 1.

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REVISION HISTORY

12/15—Revision 0: Initial Version

EVALUATION BOARD HARDWARE

The EV-ADF5901SD2Z evaluation board requires the use of an EVAL-SDP-CS1Z (SDP-S) controller board to program the device. The EVAL-SDP-CS1Z is not included and must be purchased separately. The EV-ADF5901SD2Z schematics are shown in Figure 7 to Figure 14. The EV-ADF5901SD2Z evaluation board layout is shown in Figure 15 and Figure 16.

POWER SUPPLIES

The EV-ADF5901SD2Z board is powered via a 5 V external supply that must be connected as described in the Evaluation Board Quick Start Procedures section.

INPUT SIGNALS

The 100 MHz temperature controlled crystal oscillator (TCXO) provides the necessary reference signal. An external REF_{IN} can be used, if desired.

Control V_{TUNE} from the ADF4159. Alternatively, control V_{TUNE} externally via J7 by removing R20 and powering down the ADF4159.

OUTPUT SIGNALS

The Tx and LO outputs from the ADF5901 contain dc bias voltage and are available on the J8 (TXOUT1), J9 (TXOUT2) and J4 (LOOUT) output SMAs.

DEFAULT OPERATION

All the necessary components to operate the ADF5901 are included on the EV-ADF5901SD2Z.

EVALUATION BOARD QUICK START PROCEDURES

Take the following steps to evaluate the ADF5901:

1. Connect the power supply to the EV-ADF5901SD2Z:
   a. 5 V to the Banana Connector P3
   b. GND to the Banana Connector P2.
2. Install the ADF5901 software by following the on-screen instructions.
3. Connect the EVAL-SDP-CS1Z controller board to the PC and to the EV-ADF5901SD2Z.
4. Install the hardware driver; follow the on-screen instructions.
5. Run the ADF5901 software.
6. Choose **ADF5901 and ADF4159** and **SDP board (black)** in the **Select Device and Connection** tab of the software front panel window (see Figure 2).
7. Ensure that a **SDP board connected** message appears on the front panel (see Figure 2).
8. Connect an ac-coupled signal source analyzer to the TX2 output SMA, J9.
9. Click the **ADF5901 Controls** tab and click **Write All Registers** (see Figure 4).
10. Click the **ADF5901 Controls** tab and click **Initialize ADF5901** (see Figure 3).
11. Measure the result on TXOUT2 (J9).

EV-ADF5901SD2Z CONTROL SOFTWARE

The control software for the EV-ADF5901SD2Z accompanies the EV-ADF5901SD2Z on a CD. For software installation procedures, follow the on-screen instructions.

To run the EV-ADF5901SD2Z control software, take the following steps:

1. Choose the **ADF5901 and ADF4159** file on the desktop or in the **Start** menu.
2. Within the **Select Device and Connection** tab, choose your device and your connection method, and click **Connect**.
3. Confirm that **Analog Devices Eval Board connected** displays at the bottom left of the window. Otherwise, the software has no connection to the EV-ADF5901SD2Z evaluation board.

   Note that when connecting the EV-ADF5901SD2Z, it takes approximately 5 sec to 10 sec for the status label to change.
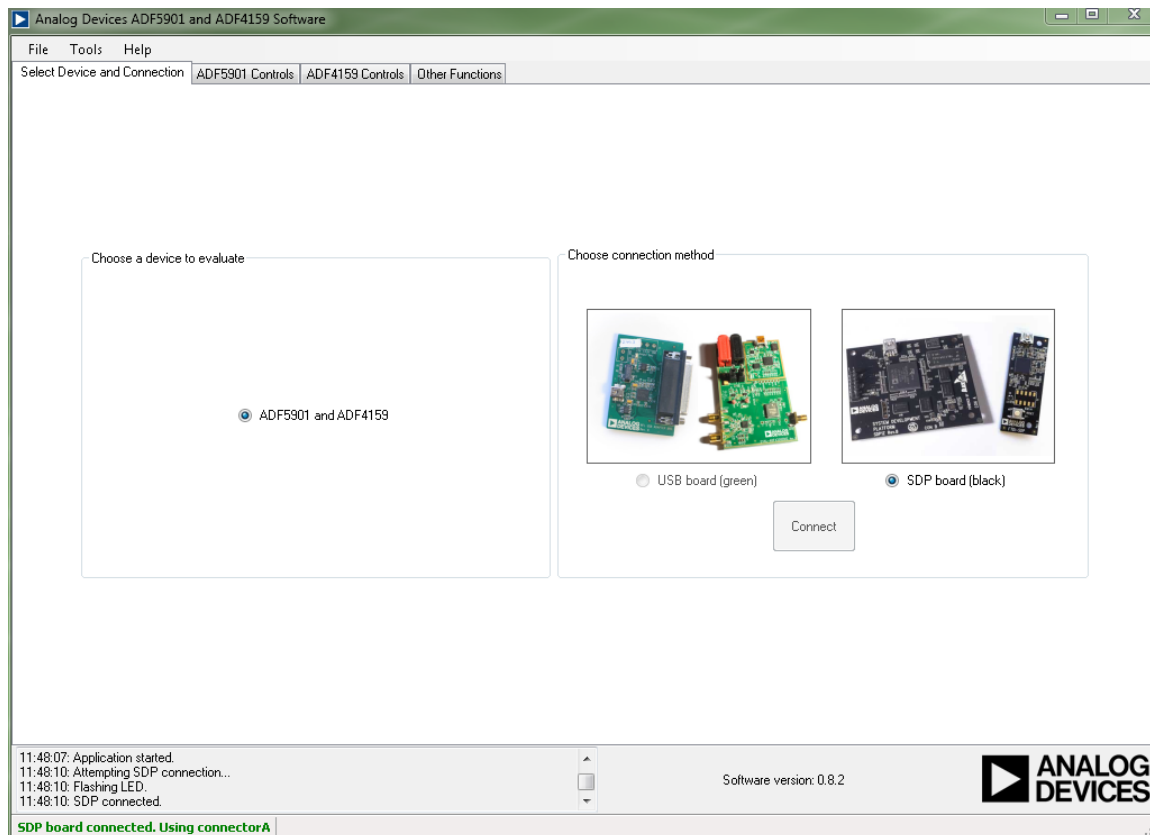
*Figure 2. Software Front Panel Display—**Select Device and Connection***

To control the ADF5901 settings (see Figure 3), select the **ADF5901 Controls** tab.

To set the calibration frequency for the ADF5901, go to the **RF Settings** section shown in Figure 3 under the **ADF5901 Controls** tab. Set the frequency to the center of the frequency band. Type the desired output frequency in the **VCO Frequency** text box (in MHz).

Use the register section within the **ADF5901 Controls** tab to select from the general options available for the ADF5901, including calibration control and register read back.

At initial power-up of the device, click **Initialize ADF5901** to perform the initialization sequence as described in the ADF5901 data sheet.

Following the sequence, the ADF5901 powers up, and all the ADF5901 blocks calibrate.
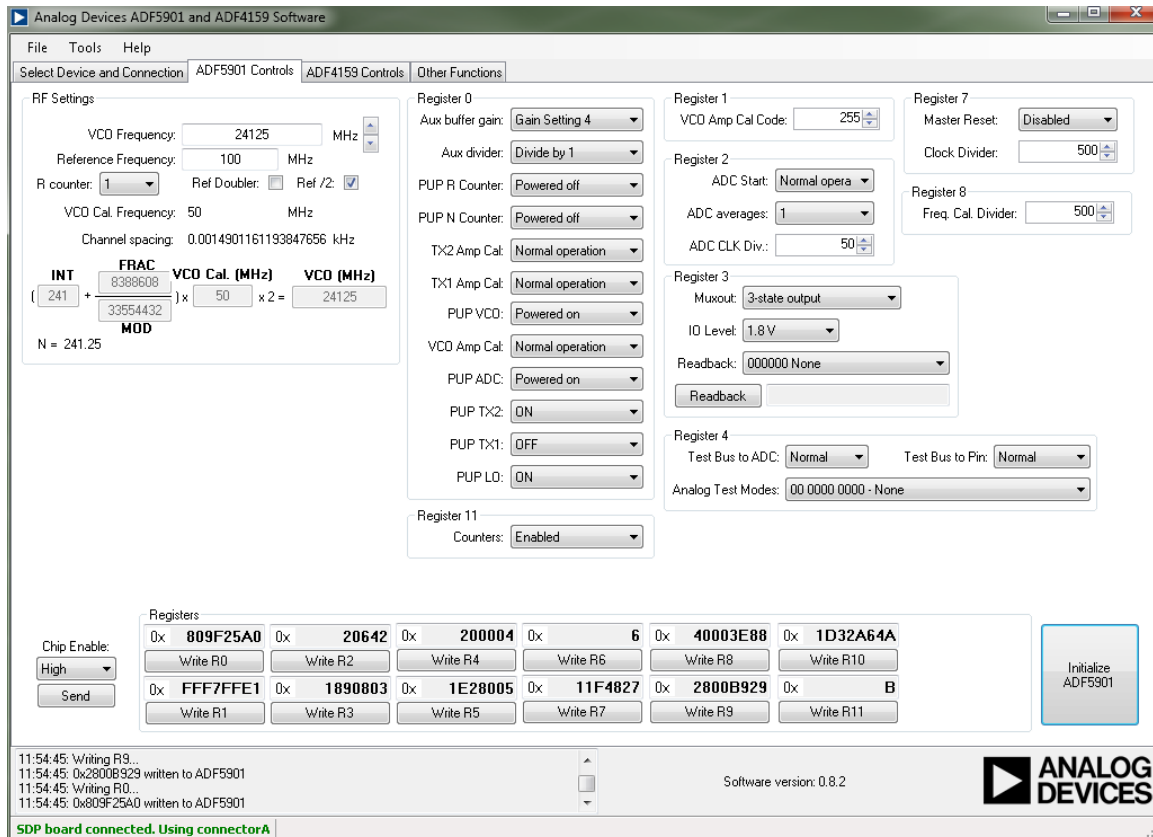
Figure 3. Software Front Panel Display—**ADF5901 Controls**

To control the ADF4159 settings (see Figure 4), select the **ADF4159 Controls** tab.

Within the **ADF4159 Controls** tab, select the **Main Controls** tab to set the **RF Settings** and **PLL Settings**. In the **RF Settings** area, set the **RF VCO Output Frequency** to half the ADF5901 VCO output. In addition, set the **Reference Frequency** the same as the applied reference signal. Calculate the PFD frequency 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. (Note that a passive loop filter was used on this evaluation board).

Use the **Muxout** drop-down box within the **Main Controls** tab to choose the signal connected to the output of the MUXOUT pin.

Click the button under each register value within the **Main Controls** tab to write that value to the device. The register values are shown in Figure 4 at the bottom of the window. When the background of a register value is green, this indicates that the value was changed and needs to be written to the device.
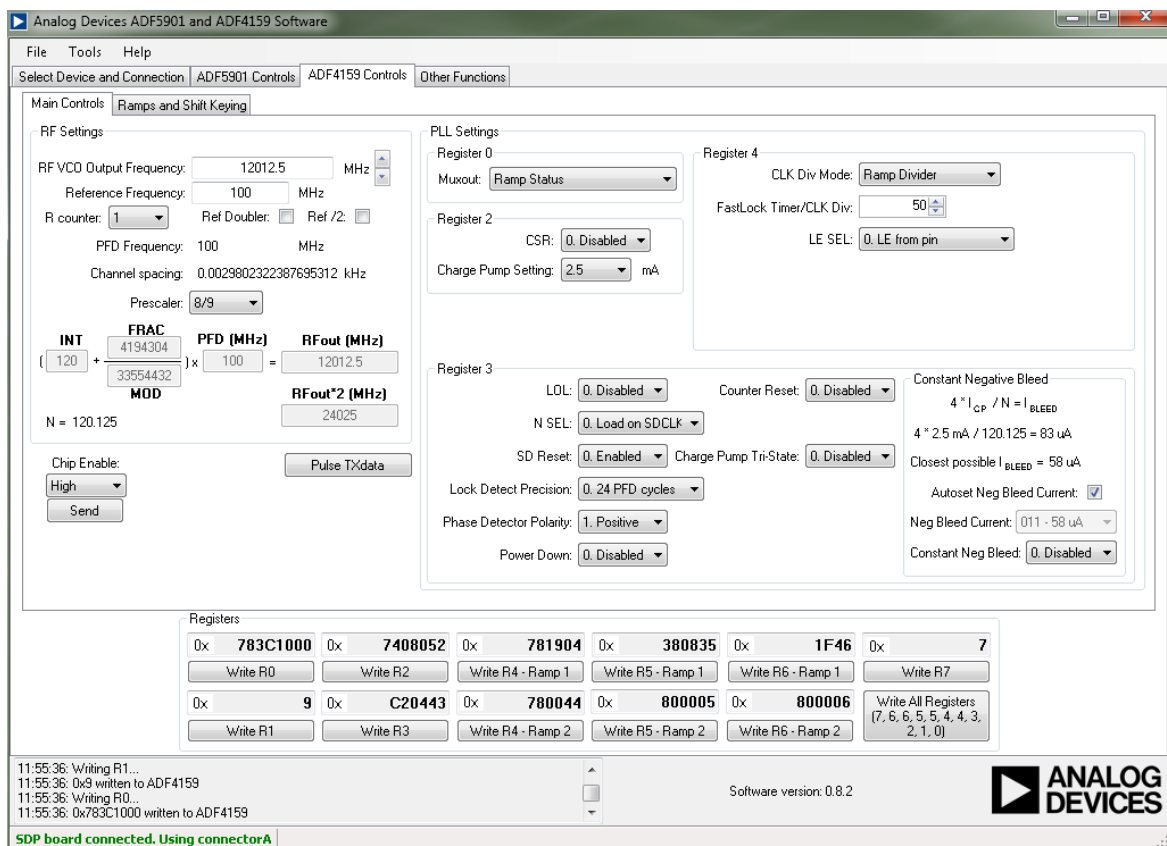
Figure 4. Software Front Panel Display—ADF4159 Controls

To configure the ramp functionality of the ADF4159, select the **Ramps and Shift Keying** tab.

To select the ramp type, go to the **Ramp mode** drop-down box within the **Ramps and Shift Keying** tab, and set the various ramp parameters in the **CLK1** box and **Up Ramp** boxes.

Example

Figure 5 shows the ramping settings for an example of a continuous triangular ramp of 1000 up ramp steps over 200 MHz at the

ADF5901 Tx output with a ramp time of 5 ms. For 200 MHz, the PLL is programmed for a 100 MHz ramp because the EV-ADF5901SD2Z uses the ADF5901 auxilary output with a 12 GHz output signal. After each parameter is set in the software, it must be written to the device.

To configure the other options in the **Ramps and Shift Keying** tab, set the various **Ramp and Shift Keying** controls of the ADF4159.
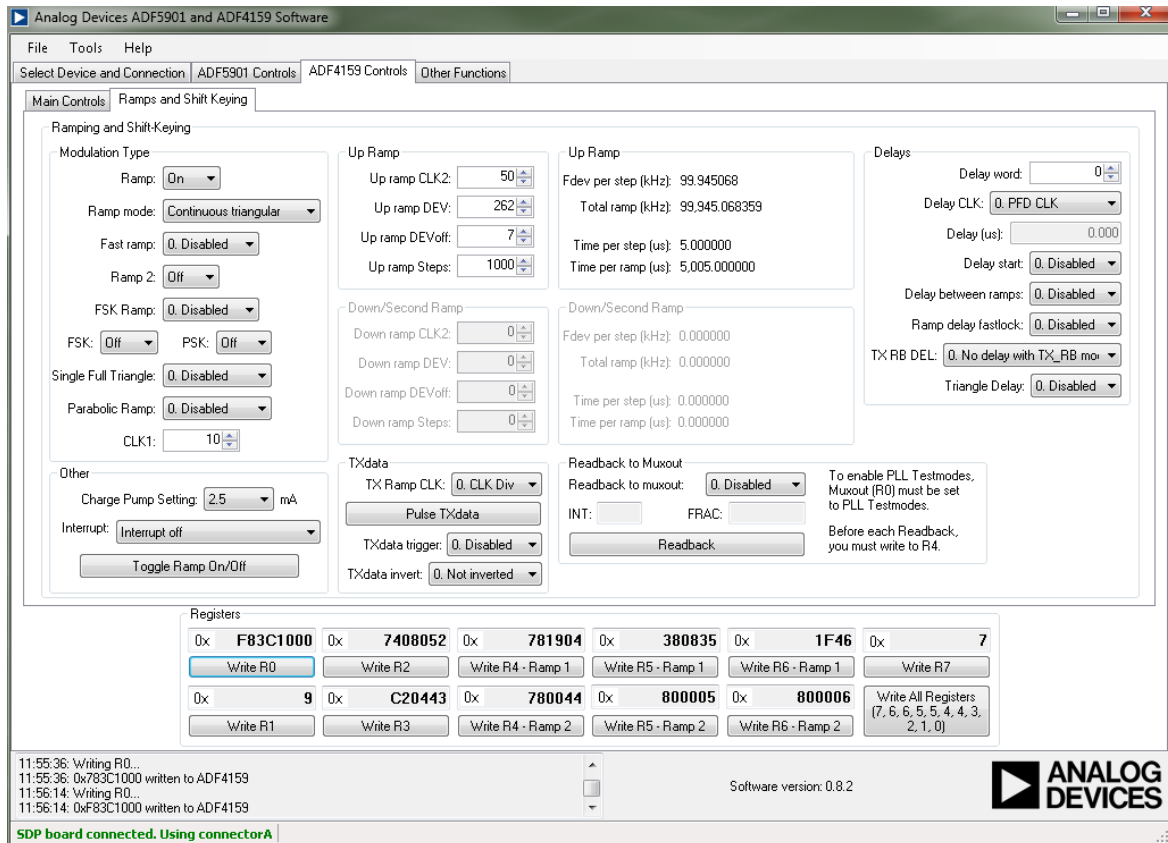
Figure 5. Software Front Panel Display—ADF4159 **Ramps and Shift Keying**

EVALUATION AND TESTING

To evaluate and test the performance of the ADF5901, take the following steps:

1. Follow the on-screen instructions to install the ADF5901 evaluation software.
2. Connect the EVAL-SDP-CS1Z controller board to the EV-ADF5901SD2Z.
1. Connect dc blocked J9 (TXOUT2) to the spectrum analyzer.
3. Click the **ADF5901** icon to run the ADF5901 software.

4. Select the USB board and the ADF5901 device in the **Select Device and Connection** tab of the software front panel window (see Figure 2).
5. In the ADF4159 **Main Controls** tab, click **Write All Registers** to power up the ADF4159.
6. In the **ADF5901 Controls** tab, click **Initialize ADF5901** to power up and calibrate the ADF5901. See Figure 6 for the suggested setup.
7. Measure the TXOUT2 output signal on the J9 SMA.
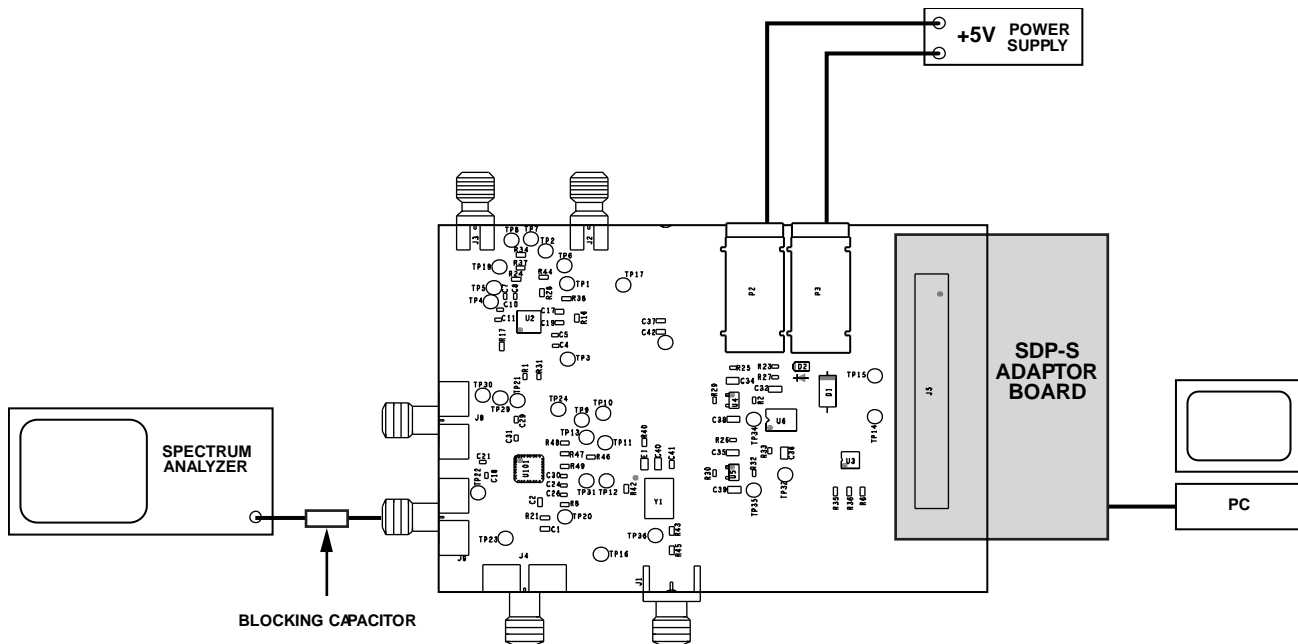
Figure 6. Typical EV-ADF5901SD2Z Evaluation Board Setup

EVALUATION BOARD SCHEMATICS AND ARTWORK
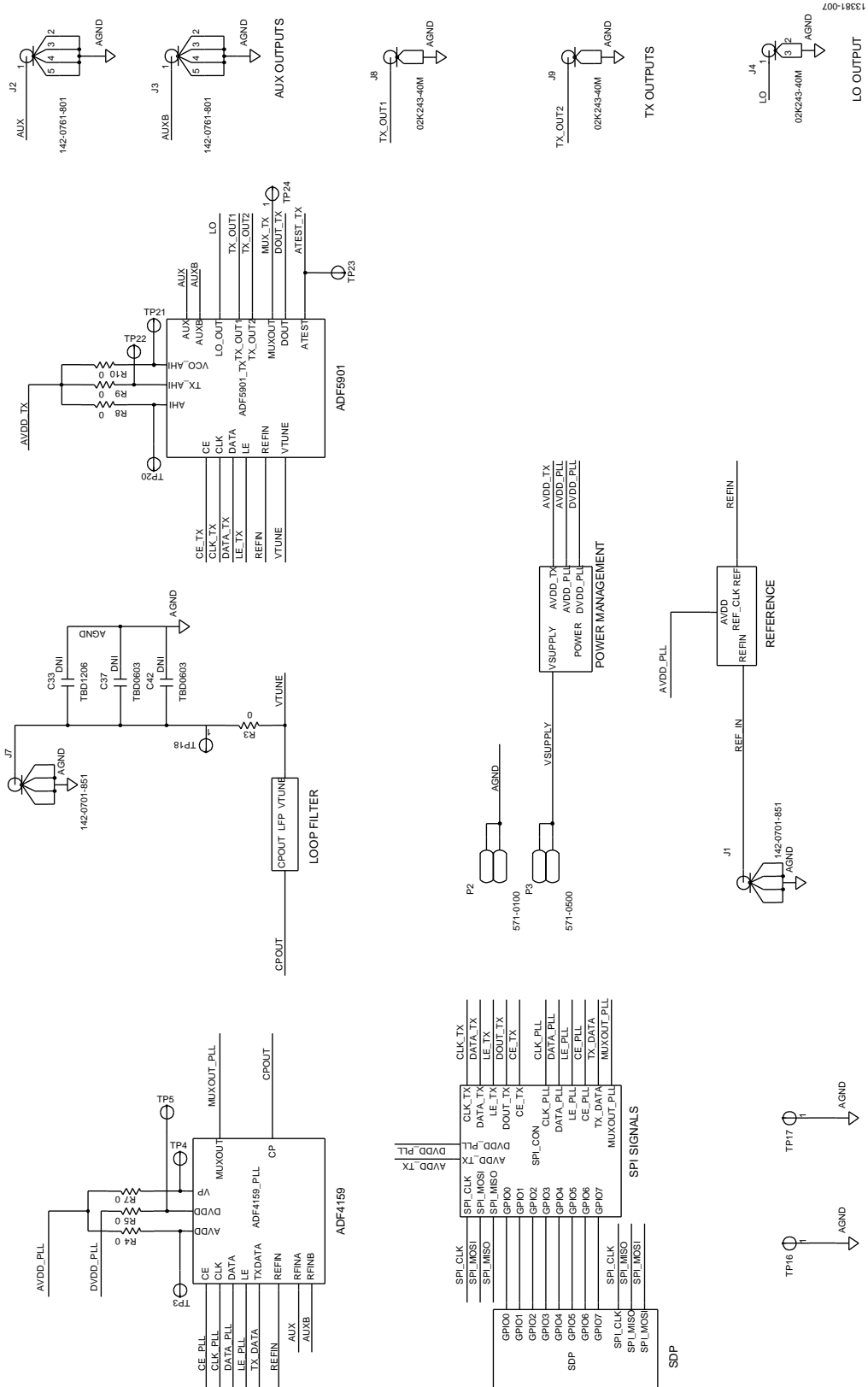
Figure 7. EV-ADF5901SD2Z Schematic (Page 1)
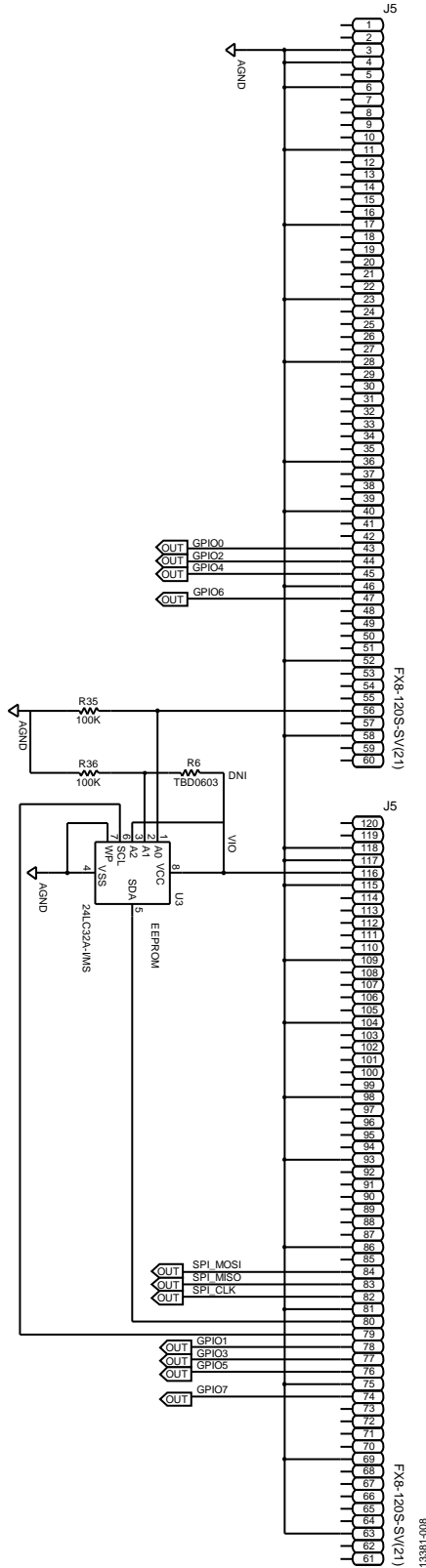
Figure 8. EV-ADF5901SD2Z Schematic (Page 2)
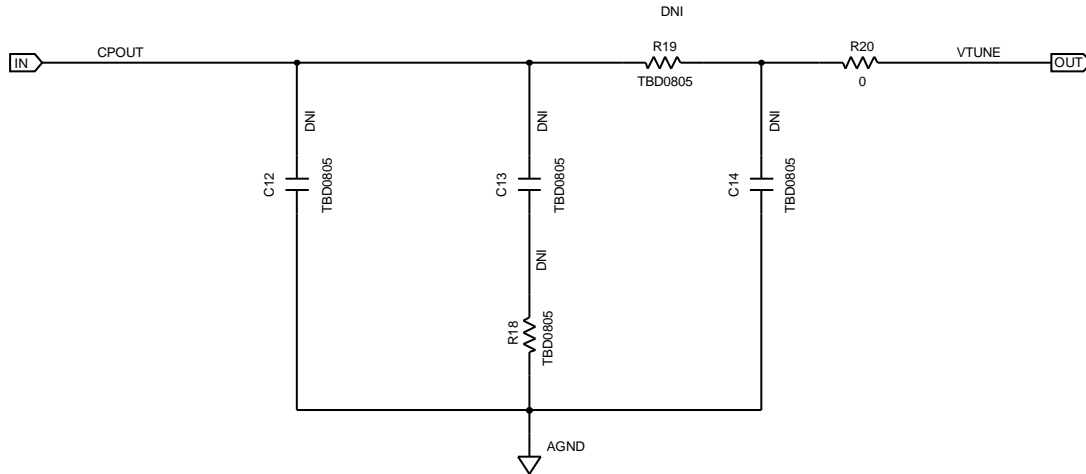
Figure 9. *EV-ADF5901SD2Z* Schematic (Page 3)
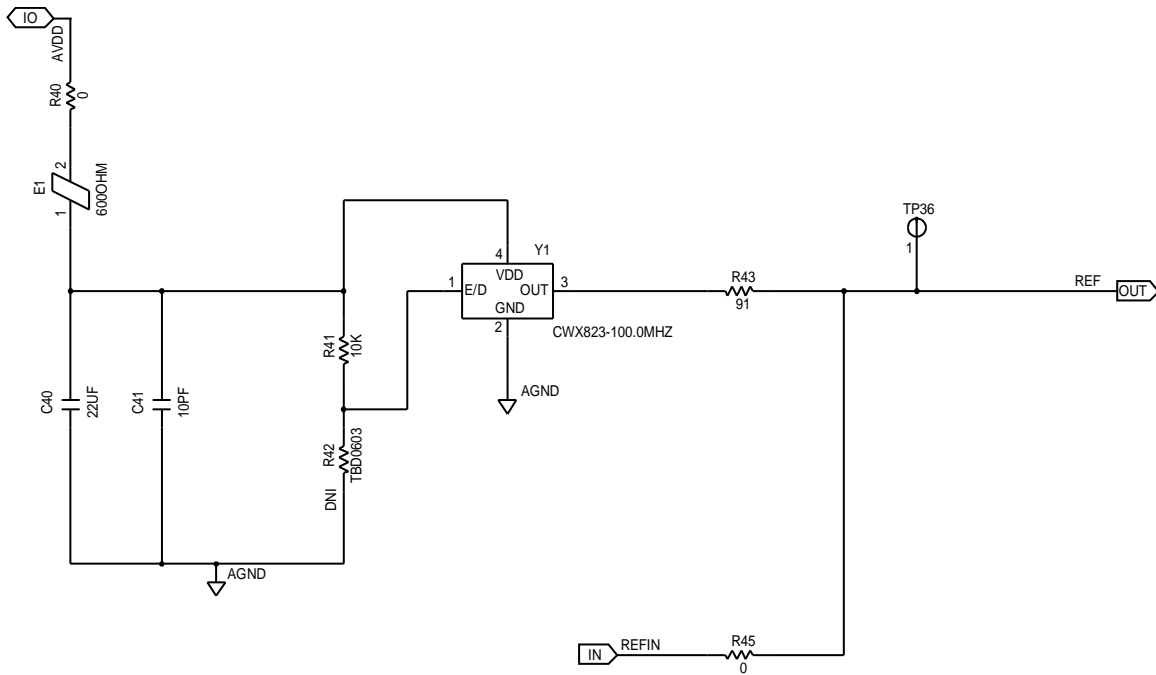
Figure 10. *EV-ADF5901SD2Z* Schematic (Page 4)
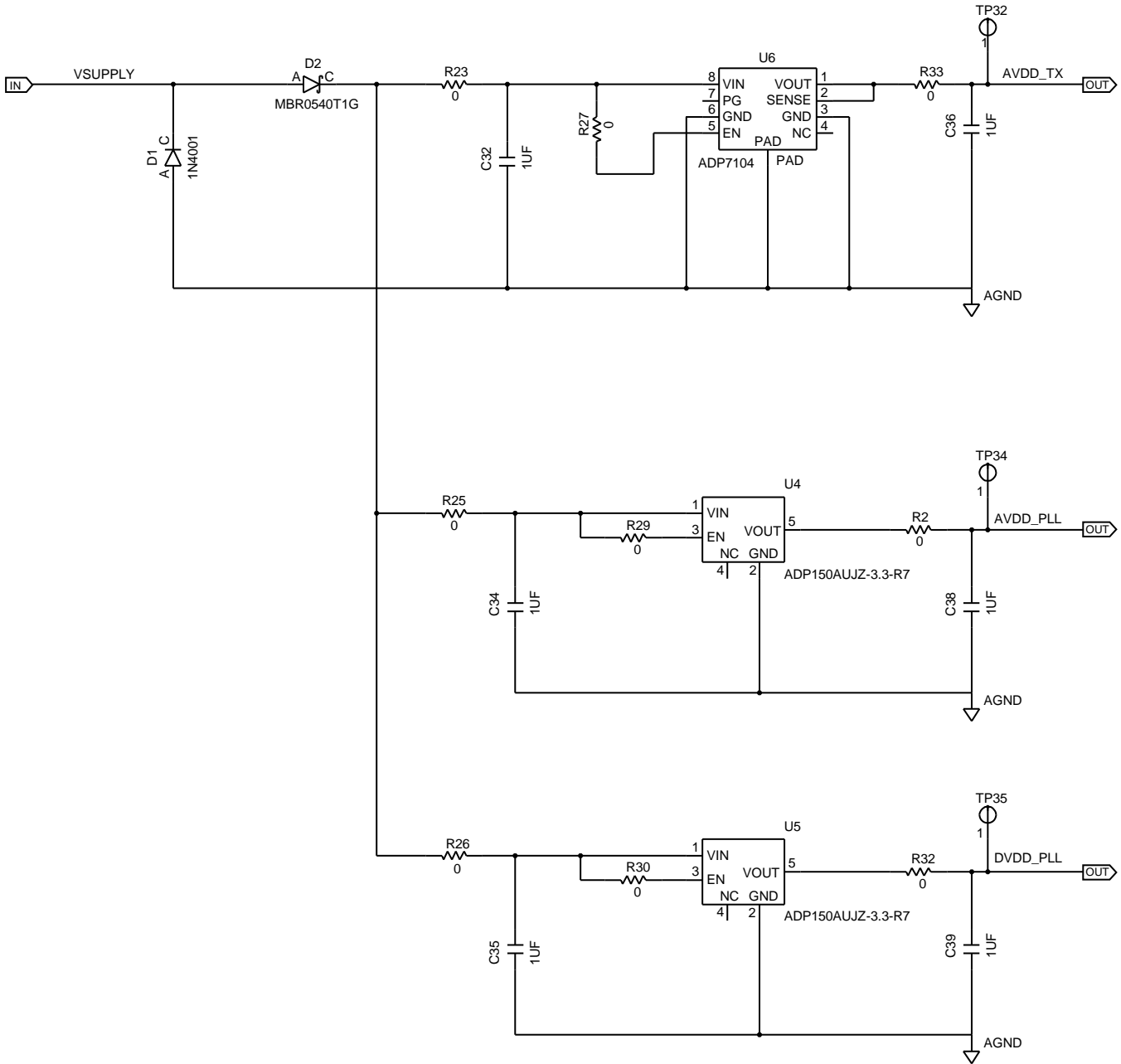
Figure 11. EV-ADF5901SD2Z Schematic (Page 5)
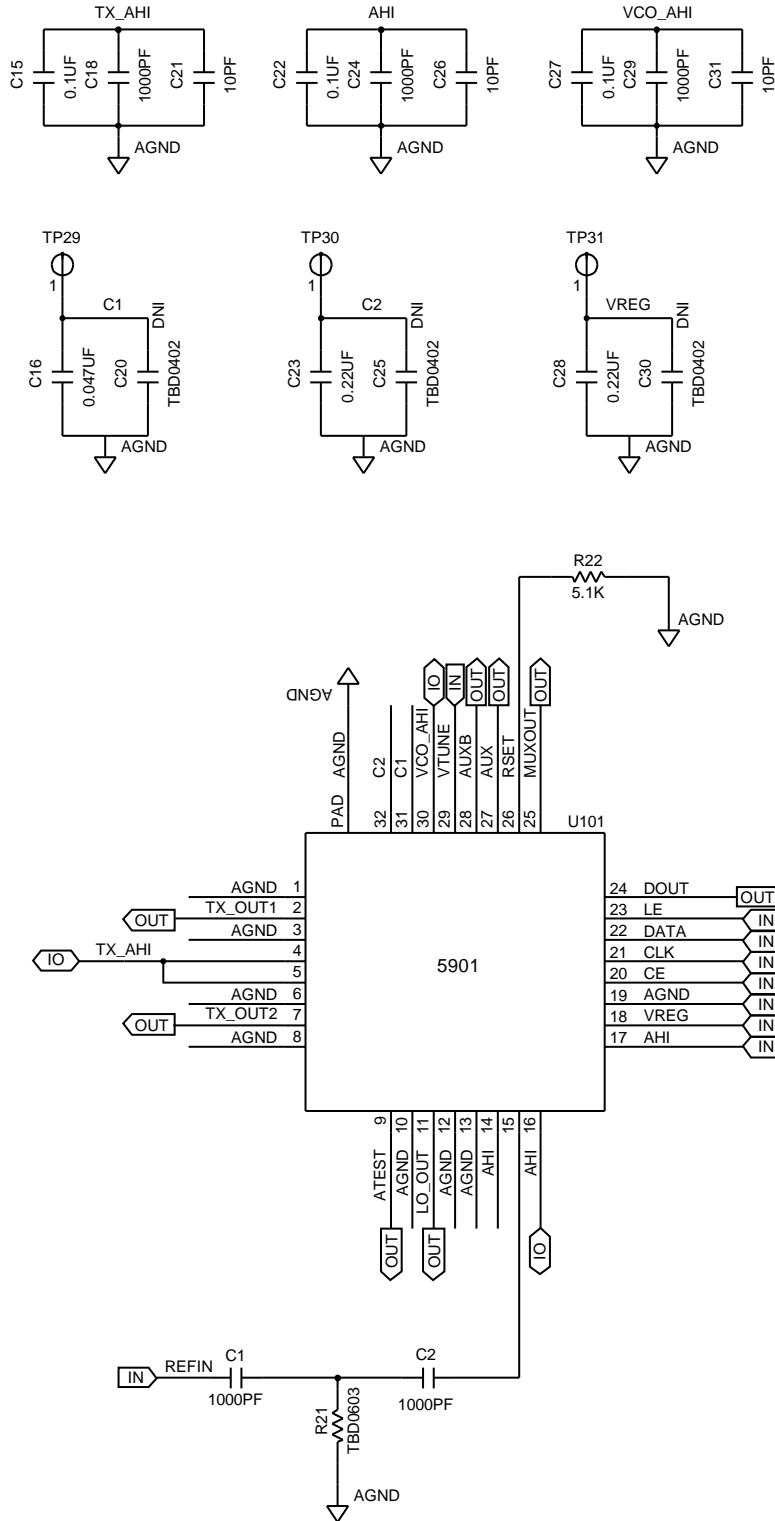
Figure 12. *EV-ADF5901SD2Z* Schematic (Page 6)
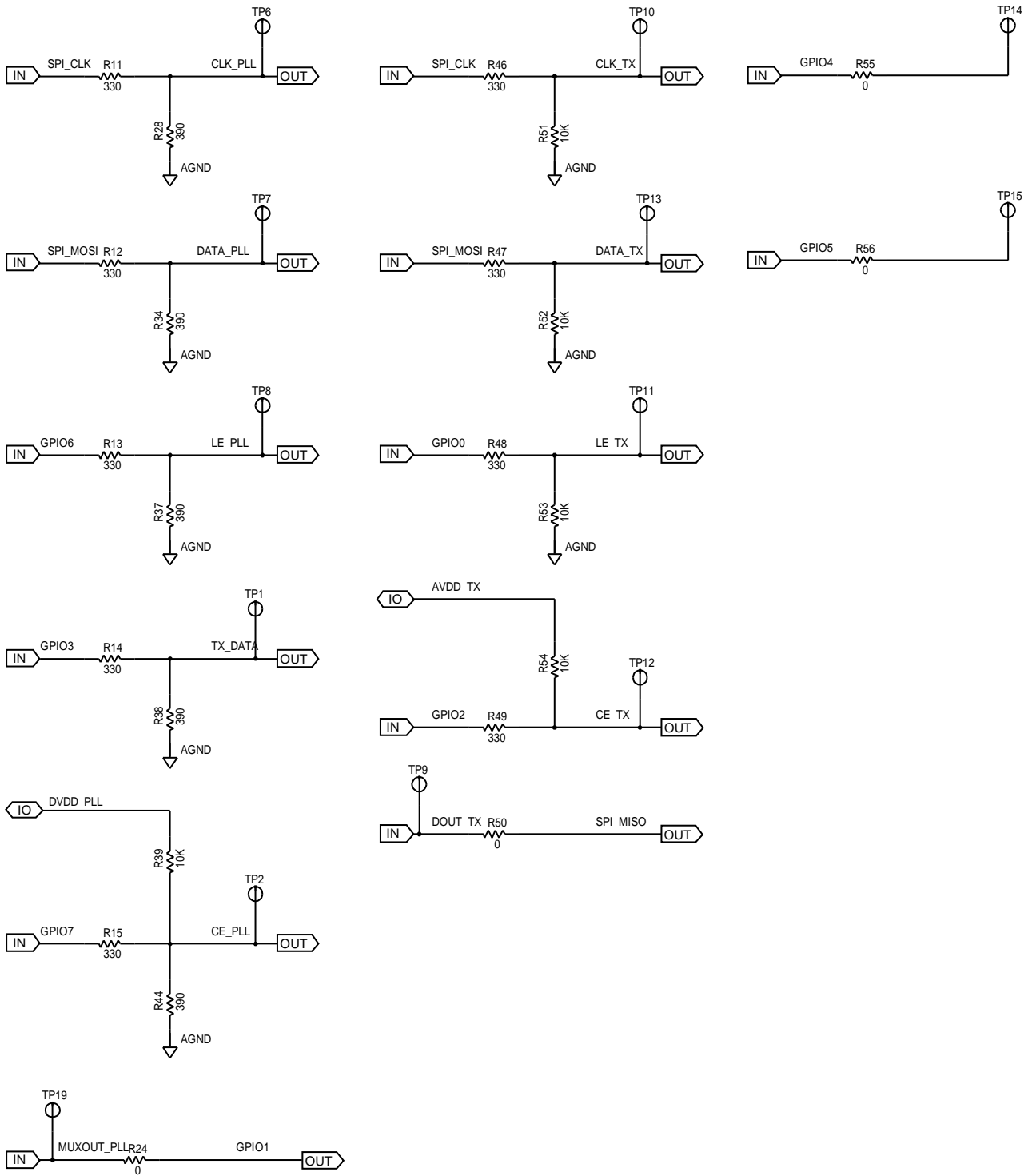
Figure 13. EV-ADF5901SD2Z Schematic (Page 7)
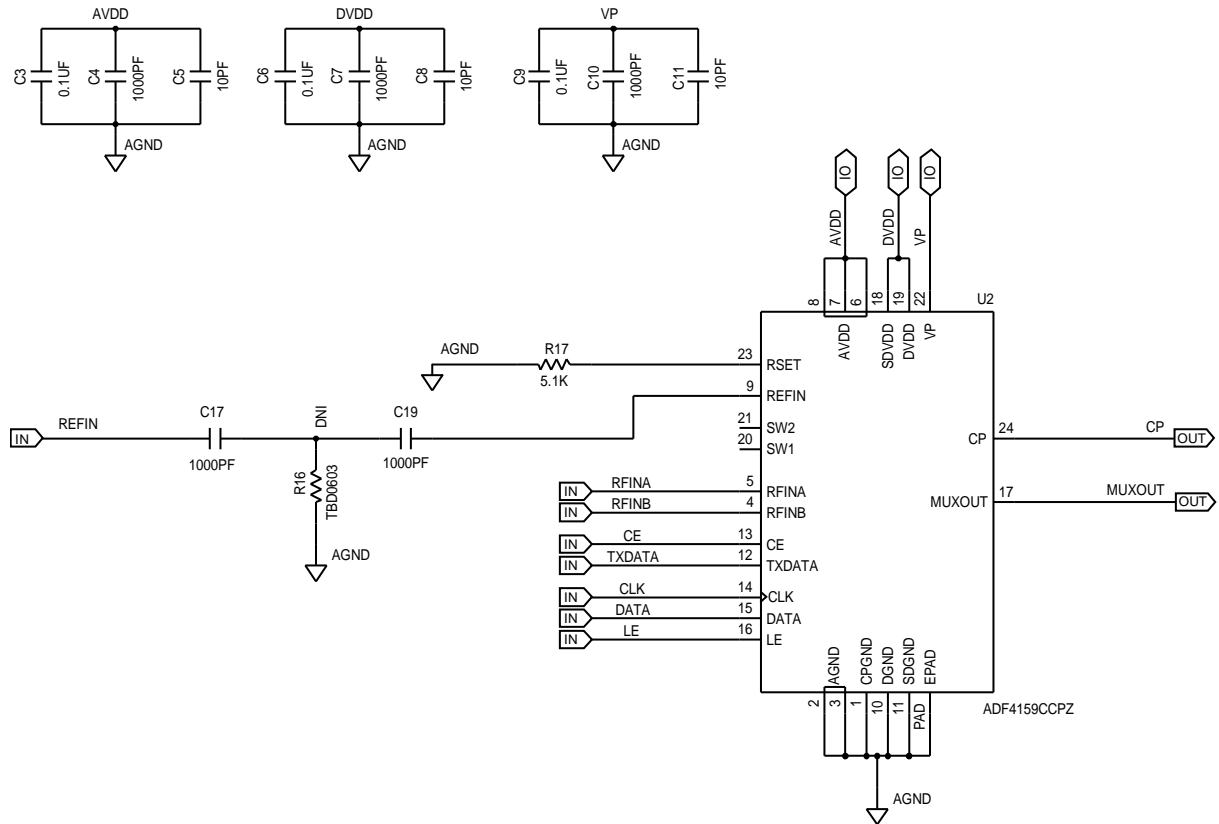
Figure 14. *EV-ADF5901SD2Z* Schematic (Page 8)
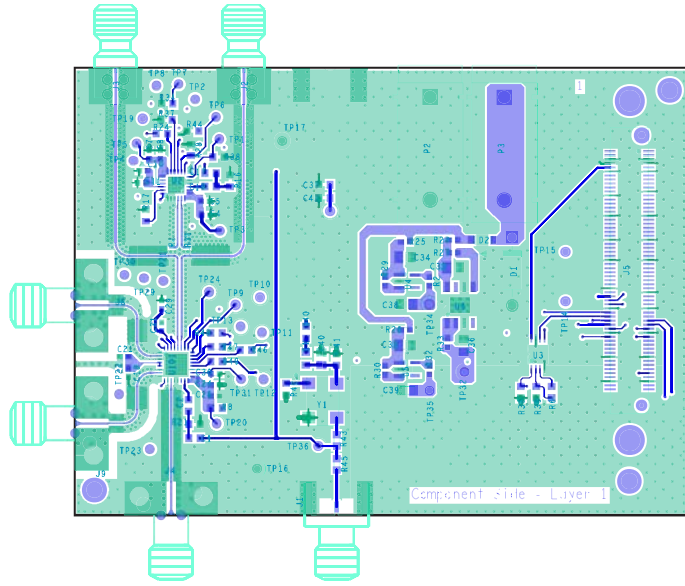
Figure 15. EV-ADF5901SD2Z Layer 1 (Component Side)
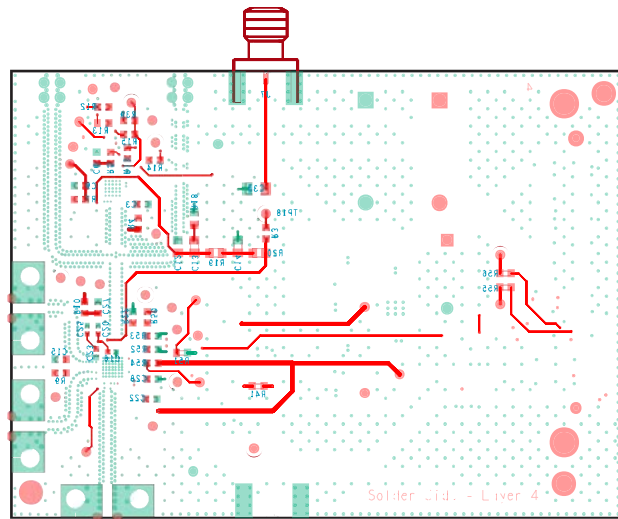
Figure 16. EV-ADF5901SD2Z Layer 4 (Bottom Plane)

ORDERING INFORMATION

BILL OF MATERIALS

Table 1.

Quantity	Reference Designator	Part Description	Manufacturer	Part Number
4	C1, C2, C17, C19	1 nF, 0603 capacitors	AVX	06035A102JAT2A
6	C4, C7, C10, C18, C24, C29	1 nF, 0402 capacitors	AVX	04023C102KAT2A
6	C5, C8, C11, C21, C26, C31	10 pF, 0402 capacitors	AVX	04023A100JAT2A
6	C3, C6, C9, C15, C22, C27	100 nF, 0603 capacitors	AVX	06033C104JAT2A
1	C16	47 nF, 0402 capacitor	Kemet	C0402C473K3RACTU
1	C23	220 nF, 0402 capacitor	Taiyo Yuden	JMK105B7224KV-F
1	C28	220 nF, 0603 capacitor	AVX	06033C224KAT2A
6	C32, C34 to C36, C38, C39	1 µF, 0805 capacitors	AVX	08053C105KAZ2A
1	C40	22 µF, 0805 capacitor	Murata	GRM21BE70G226ME51L
1	C41	10 pF, 0603 capacitor	AVX	06035A100JAT2A
1	C12	220 pF, 0805 capacitor	Multicomp	MCCA001042
1	C13	3.3 nF, 0805 capacitor	Kemet	C0805C332J5GACTU
1	C14	100 pF, 0805 capacitor	Multicomp	MCCA001040
1	D1	Diode, standard, 1 A, 50 V	Multicomp	1N4001
1	D2	Diode, Schottky, 0.5 A, 20 V	ON Semiconductor	MBR0520LT1G
1	E1	Ferrite bead	Wuerth Elektronik	7427-92642
2	J1, J7	CONN-PCB end launch jack	Emerson	142-0701-851
2	J2, J3	CONN-PCB high frequency SMA	Emerson (Johnson)	142-0761-801
3	J4, J8, J9	CONN-PCB SMA RA jack	Rosenberger	02K243-40M
1	J5	CONN-PCB vertical type RCPT SMD	Hirose	FX8-120S-SV(21)
1	P2	CONN-PCB single SKT black	Deltron	571-0100
1	P3	CONN-PCB single SKT red	Deltron	571-0500
11	R1, R2, R23, R25 to R27, R29 to R33	0 Ω, 0402 resistors	Multicomp	MC 0.0625W 0402 1% 0R
13	R3 to R5, R7 to R10, R24, R40, R45, R50, R55, R56	0 Ω, 0603 resistors	Multicomp	MC 0.063W 0603 0R
9	R11 to R15, R46 to R49	330 Ω, 0603 resistors	Multicomp	MC 0.063W 0603 330R
2	R17, R22	5.1 kΩ, 0603 resistors	Multicomp	MC 0.063W 0603 5k1
1	R20	0 Ω, 0805 resistor	Multicomp	MC 0.1W 0805 0R
5	R28, R34, R37, R38, R44	390 Ω, 0603 resistors	Multicomp	MC 0.063W 0603 390R
2	R35, R36	100 kΩ ,0603 resistor	Multicomp	MC 0.063W 0603 5% 100K
1	R41	10 kΩ, 0603 resistor	Multicomp	MC 0.063W 0603 10K
1	R43	91 Ω, 0603 resistor	Multicomp	MC 0.063W 0603 1% 91R
1	R18	510 Ω, 0805 resistor	Multicomp	MC 0.1W 0805 1% 510R
1	R19	1 kΩ, 0805 resistor	Multicomp	MC 0.1W 0805 1% 1K
1	U2	ADF4159 13 GHz Fractional-N frequency synthesizer	Analog Devices, Inc.	ADF4159CCPZ
1	U3	IC 32 Kbit serial EEPROM	Microchip	24LC32A-I/MS
2	U4	3.0 V CMOS linear regulator	Analog Devices	ADP150AUJZ-3.0
2	U5	1.8 V CMOS linear regulator	Analog Devices	ADP150AUJZ-1.8
1	U6	3.3 V CMOS linear regulator	Analog Devices	ADP7104ARDZ-3.3
1	Y1	100 MHz crystal clock oscillator	Connor-Winfield	CWX113-100.0M
1	U101	ADF5901 24 GHz TX MMIC	Analog Devices	ADF5901WCCPZ-U6
2	TP16, TP17	Black test point	Vero	20-2137
1	TP23	Red test point	Vero	20-313137

Quantity	Reference Designator	Part Description	Manufacturer	Part Number
3	C20, C25, C30	Do not install	Not applicable	Not applicable
1	C33	Do not install	Not applicable	Not applicable
2	C37, C42	Do not install	Not applicable	Not applicable
4	R6, R16, R21, R42	Do not install	Not applicable	Not applicable
5	R39, R51 to R54	Do not install	Not applicable	Not applicable
28	TP1 to TP15, TP18 to TP22, TP24, TP29 to TP32, TP34 to TP36	Do not install	Not applicable	Not applicable
4	C1, C2, C17, C19	1 nF, 0603 capacitors	AVX	06035A102JAT2A
2	SCREW1, SCREW2	Screw, cheese, nylon, M3X10, PK100	ALLTHREAD Plastics Limited	119030010
2	NUT1, NUT2	Nut/washer, nylon, M3, PK100	DURATOOL	1140030

RELATED LINKS

Resource	Description
ADF5901	Product Page, 24 GHz VCO and PGA with 2-Channel PA Output
ADF4159	Product Page, Direct Modulation/Fast Waveform Generating, 13 GHz, Fractional-N Frequency Synthesizer
ADP7104	Product Page, 20 V, 500 mA, Low Noise, CMOS LDO

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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