ANALOG DEVICES

Evaluating the ADF5355 Frequency Synthesizer for Phase-Locked Loops

FEATURES

Self contained board, including ADF5355 frequency synthesizer with integrated voltage controlled oscillator (VCO), differential 122.88 MHz temperature controlled crystal oscillator (TCXO), loop filter (5 kHz), USB interface, and voltage regulators
Windows-based software allows control of synthesizer functions from a PC
Externally powered by 6 V

EQUIPMENT NEEDED

Windows-based PC with USB port for evaluation software
System demonstration platform, serial only (SDP-S)
    EVAL-SDP-CS1Z controller board
Power supply (6 V)
Spectrum analyzer
50 Ω terminators

EVALUATION KIT CONTENTS

EV-ADF5355SD1Z
USB cable

ONLINE RESOURCES

Documents Needed
    ADF5355 data sheet
    EV-ADF5355SD1Z user guide
    PLL Software Installation Guide
Required Software
    Analog Devices, Inc., ADF5355 software, Version 0.46.1 or higher (available for download at www.analog.com/ADF5355)

GENERAL DESCRIPTION

The EV-ADF5355SD1Z evaluates the performance of the ADF5355 frequency synthesizer with integrated VCO for phase-locked loops (PLLs). A photograph of the evaluation board is shown in Figure 1. The evaluation board contains the ADF5355 synthesizer with integrated VCO, a differential 122.88 MHz reference TCXO, a loop filter, a USB interface, power supply connectors, and sub-miniature Version A (SMA) connectors. A USB cable is included to connect the board to a PC USB port.

For easy programming of the synthesizer, download the Windows®-based software from www.analog.com/ADF5355.

This board requires an SDP-S (shown in Figure 1, but not supplied with the kit). The SDP-S allows software programming of the ADF5355 device.

EVALUATION BOARD PHOTOGRAPH

Figure 1. EV-ADF5355SD1Z

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REVISION HISTORY

GETTING STARTED

SOFTWARE INSTALLATION PROCEDURES

See the ADF5355 product page for the EV-ADF5355SD1Z control software. For the software installation procedure, see the PLL Software Installation Guide.

EVALUATION BOARD SETUP PROCEDURES

To run the software,

1. Click the **ADF5355** file on the desktop or from the **Start** menu.
2. On the **Select Device and Connection** tab, choose **ADF5355** and **SDP board (black)**, and then click **Connect** (see Figure 2).
3. When connecting the board, allow 5 sec to 10 sec for the label on the status bar to change.

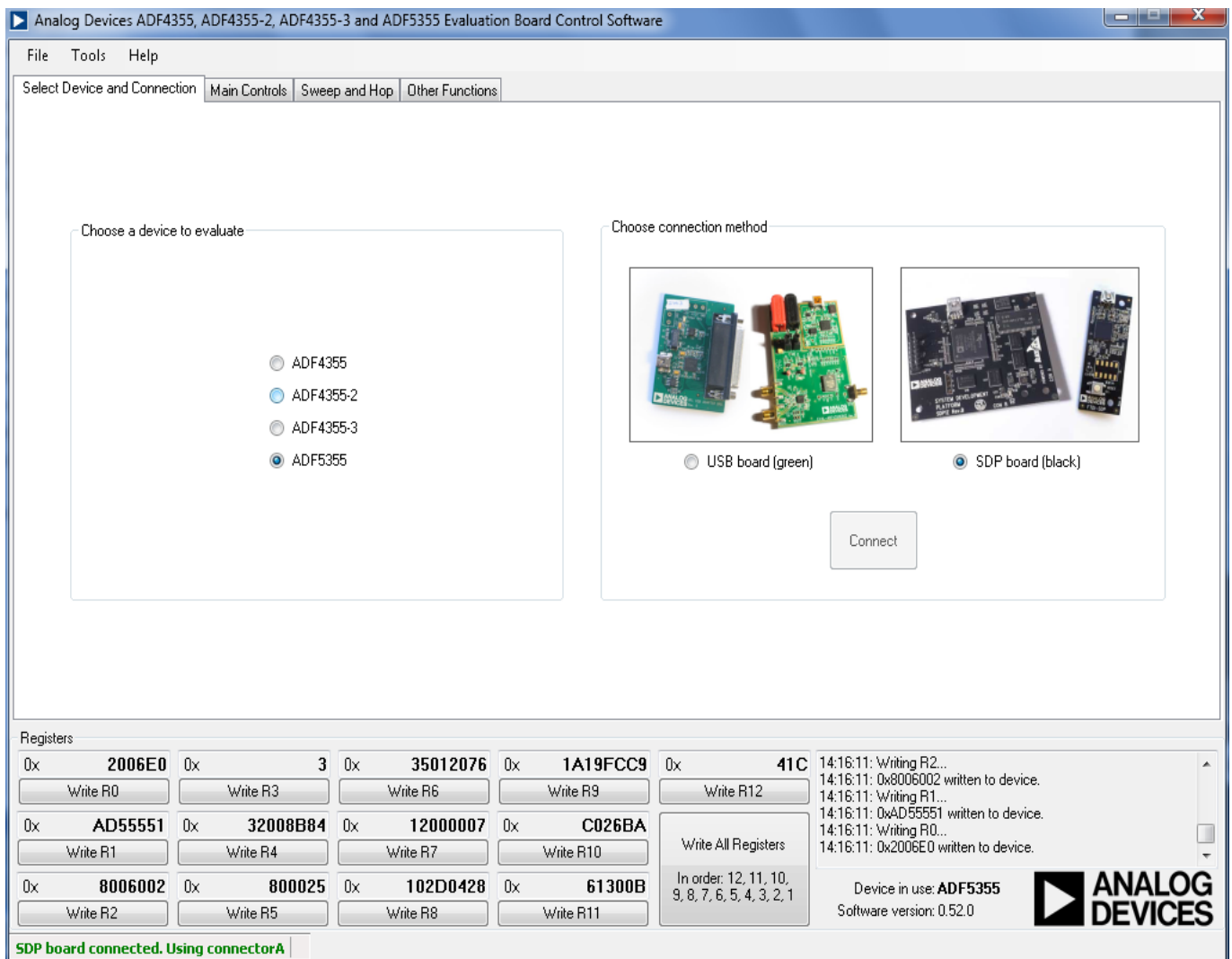Under the **File** menu, the current settings can be saved to, and loaded from, a text file.

Figure 2. Software Front Panel Display—Select Device and Connection

EVALUATION BOARD HARDWARE

The EV-ADF5355SD1Z requires an SDP-S platform that uses the EVAL-SDP-CS1Z (SDP-B is not recommended).

The EV-ADF5355SD1Z schematics are shown in Figure 7, Figure 8, and Figure 9. The silkscreens for the evaluation board are shown in Figure 10 and Figure 11.

POWER SUPPLIES

The board is powered by a 6 V 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.

The power supply circuitry allows the user two or three separate low dropout (LDO) regulators to feed the ADF5355 (using fewer LDO regulators increases the risk of spur contaminated dc feeds).

The charge pump and VCO supply pins are powered from a 5 V ADM7150 high performance, low noise regulator. The remaining supplies are powered from a 3.3 V ADM7150 high performance, low noise regulator.

LED1 indicates when the ADF5355 is powered on. Use Switch S1 to switch the 6 V power to the board on and off.

RF OUTPUT

The EV-ADF5355SD1Z has one pair of SMA output connectors: RFOUTA+ and RFOUTA− (differential outputs). Because they are sensitive to impedance mismatch, connect the RF outputs to equal load impedances. If only one port of a differential pair is used, terminate the complementary port with an equal load terminator (in general, a 50 Ω terminator).

SMA RFOUTB is a single-ended RF output that operates from 6.8 GHz to 13.6 GHz. If only RFOUTB is used, power off RFOUTA+ and RFOUTA−. If left on, terminate both RFOUTA+ and RFOUTA− SMA connectors with 50 Ω terminators.

LOOP FILTER

The loop filter schematic is included in the board schematic in Figure 7. Figure 3 shows the loop filter component placements. For lowest noise at 100 kHz offset, use the following components (that are inserted on the evaluation board) with a 0.9 mA charge pump current:

- C60 = 22 nF, C59 = 0.47 μF, C61 = 10 nF, C73 = 10 pF
- R14 = 220 Ω, R1 = 470 Ω

For lowest rms phase noise, use the following components with 0.9 mA charge pump current:

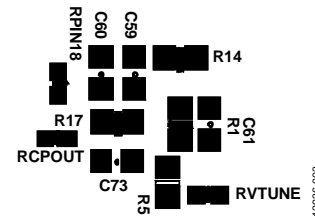- C60 = 1.2 nF, C59 = 33 nF, C61 = 390 pF, C73 = 10 pF
- R14 = 1 kΩ, R17 = 3.3 kΩ

Figure 3. Loop Filter Placement

REFERENCE SOURCE

The evaluation board contains a 122.88 MHz differential output TCXO from Vectron International. If preferred, the user may supply either a single-ended or differential reference input to the REFINA/REFINB SMA connectors. When using an external reference, remove R12 to disconnect the power rail from the TCXO.

To use a single-ended REFINx, connect a low noise 122.88 MHz reference source to SMA REFINB, and connect a 50 Ω terminator to SMA REFINA. Remove Resistor R27 (100 Ω). To use a differential REFINx, connect the differential signal to SMA REFINA and SMA REFINB. The differential REFINA/REFINB SMA connectors can operate to a 500 MHz input frequency.

In the schematic shown in Figure 7, the $REF_{IN}A$ pin of U1 (ADF5355) is connected to SMA REFINB, and the $REF_{IN}B$ pin of U1 (ADF5355) is connected to SMA REFINA. This schematic matches the evaluation board connections.

DEFAULT CONFIGURATION

All components necessary for local oscillator generation are inserted on the board. This board is shipped with the ADF5355 synthesizer with an integrated VCO, a differential 122.88 MHz reference TCXO, and a 5 kHz loop filter (I_{CP} = 0.9 mA).
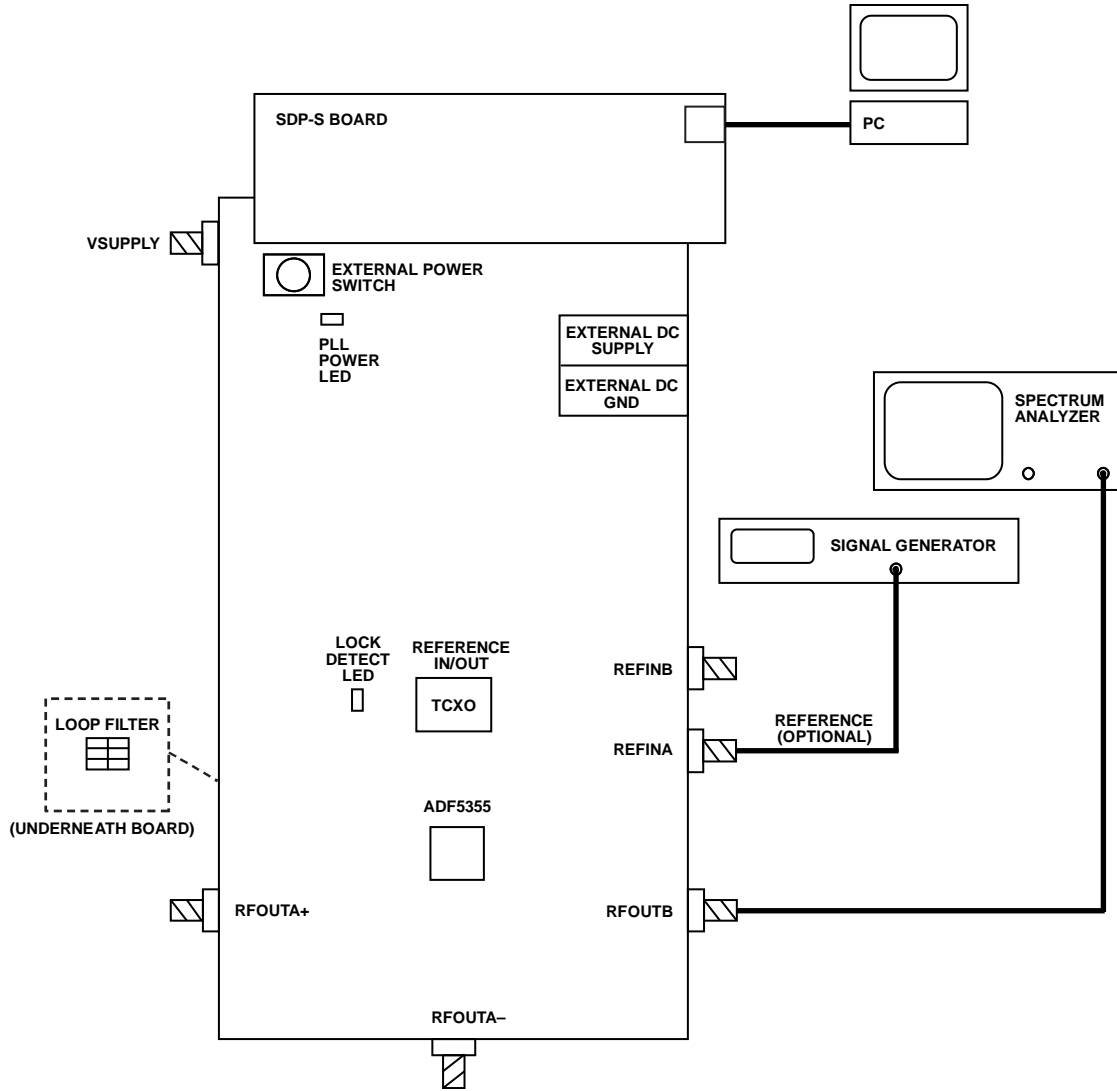
EVALUATION BOARD SETUP

Figure 4. Evaluation Setup Block Diagram

EVALUATION BOARD SOFTWARE

MAIN CONTROLS

The **Main Controls** tab (see Figure 5) selects the RF and user configurable register settings. Consult the register descriptions in the ADF5355 data sheet for details. Default settings are recommended for most registers.

In **RF Settings**, ensure that **VCOout (MHz)** equals the VCO frequency. Set **Output divider** to give the required **RFoutA± (MHz)**.

Ensure that **Reference freq** equals 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 **PFD (MHz)** matches the value specified in the loop filter design.

In **Register 4**, program **CP current** to match the value used for the loop filter design.
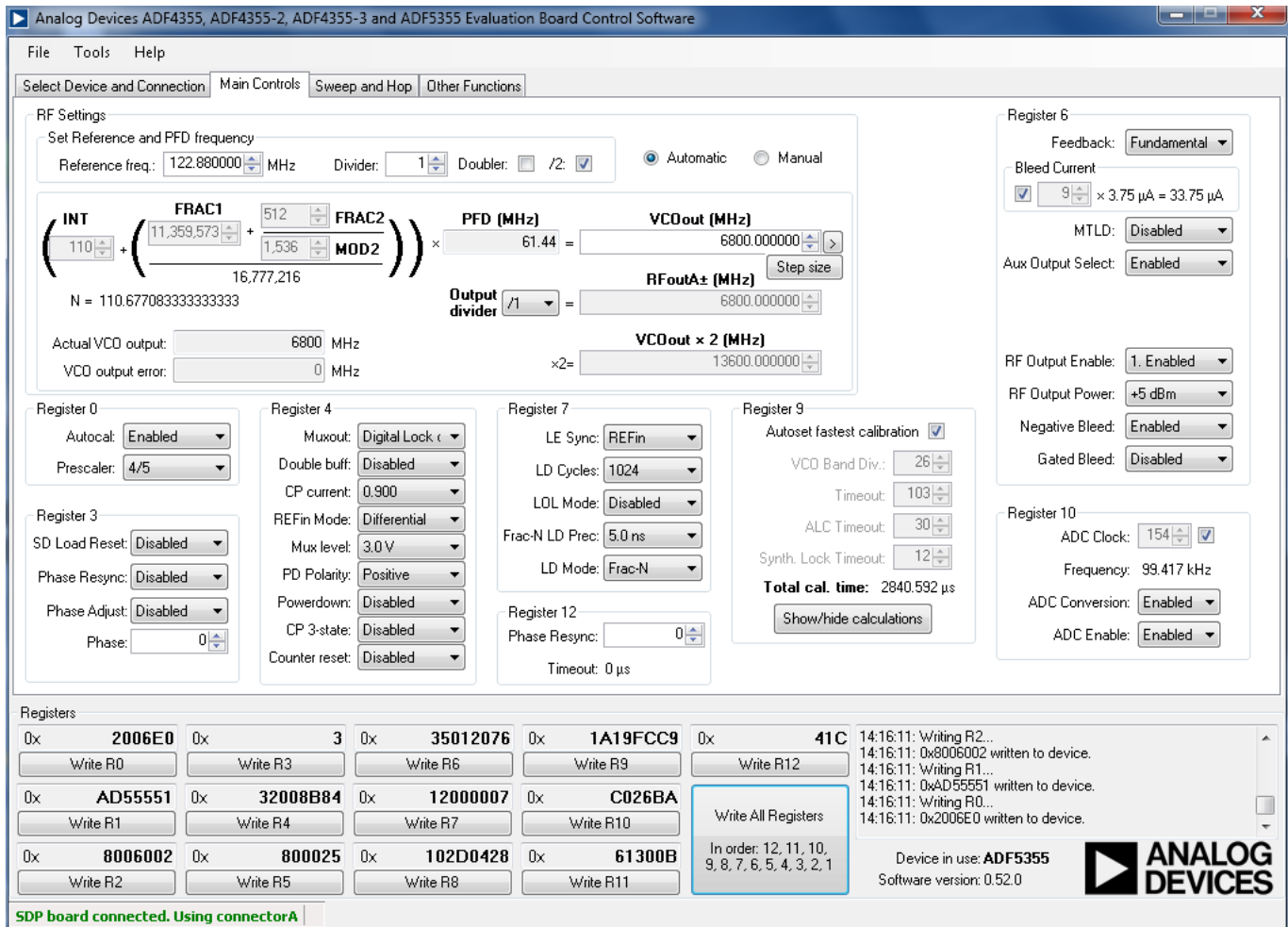

Figure 5. Software Front Panel Display—Main Controls

EVALUATION AND TEST

To evaluate and test the performance of the ADF5355, use the following procedure:

1. Install the ADF5355 software (see the PLL Software Installation Guide).
2. Follow the hardware driver installation procedure (Windows XP only).
3. Connect a 50 Ω terminator to RFOUTA−.
4. Connect the EV-ADF5355SD1Z board to the SDP-S board.
5. Connect the 6 V power supply to the banana connectors and power up the board using S1 (check that LED1 is on).
6. Connect the USB cable from the SDP-S board to the PC.
7. Run the ADF5355 software.
8. Select **ADF5355** and **SDP board (black)** in the **Select Device and Connection** tab of the software front panel display window (see Figure 2).
9. Click the **Main Controls** tab, and set the **VCOout (MHz)** to a frequency of 6800 MHz and then click **Write All Registers**.
10. Connect the spectrum analyzer to SMA Connector RFOUTA+. See Figure 4 for a typical evaluation setup.
11. Measure the output spectrum and single sideband phase noise.

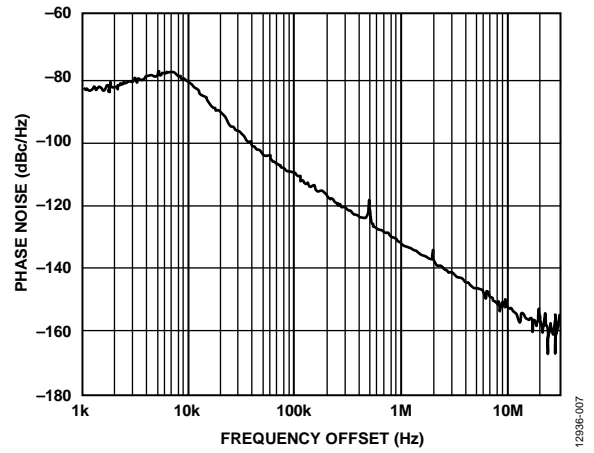Figure 6 shows a phase noise plot of the SMA RFOUTA+ equal to 6.8 GHz.

Figure 6. Single Sideband Phase Noise
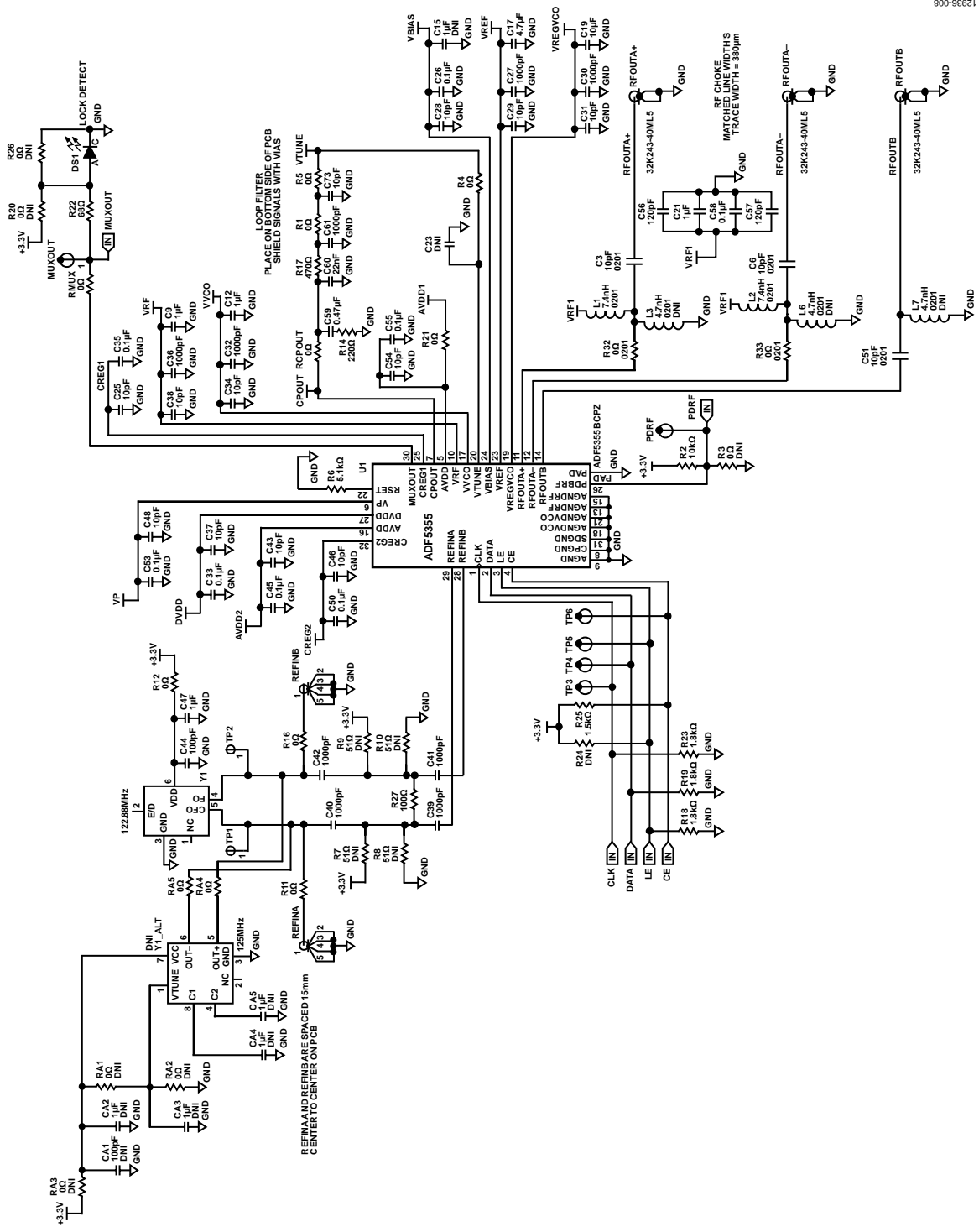
EVALUATION BOARD SCHEMATICS AND ARTWORK

Figure 7. Evaluation Board Schematic—Page 1

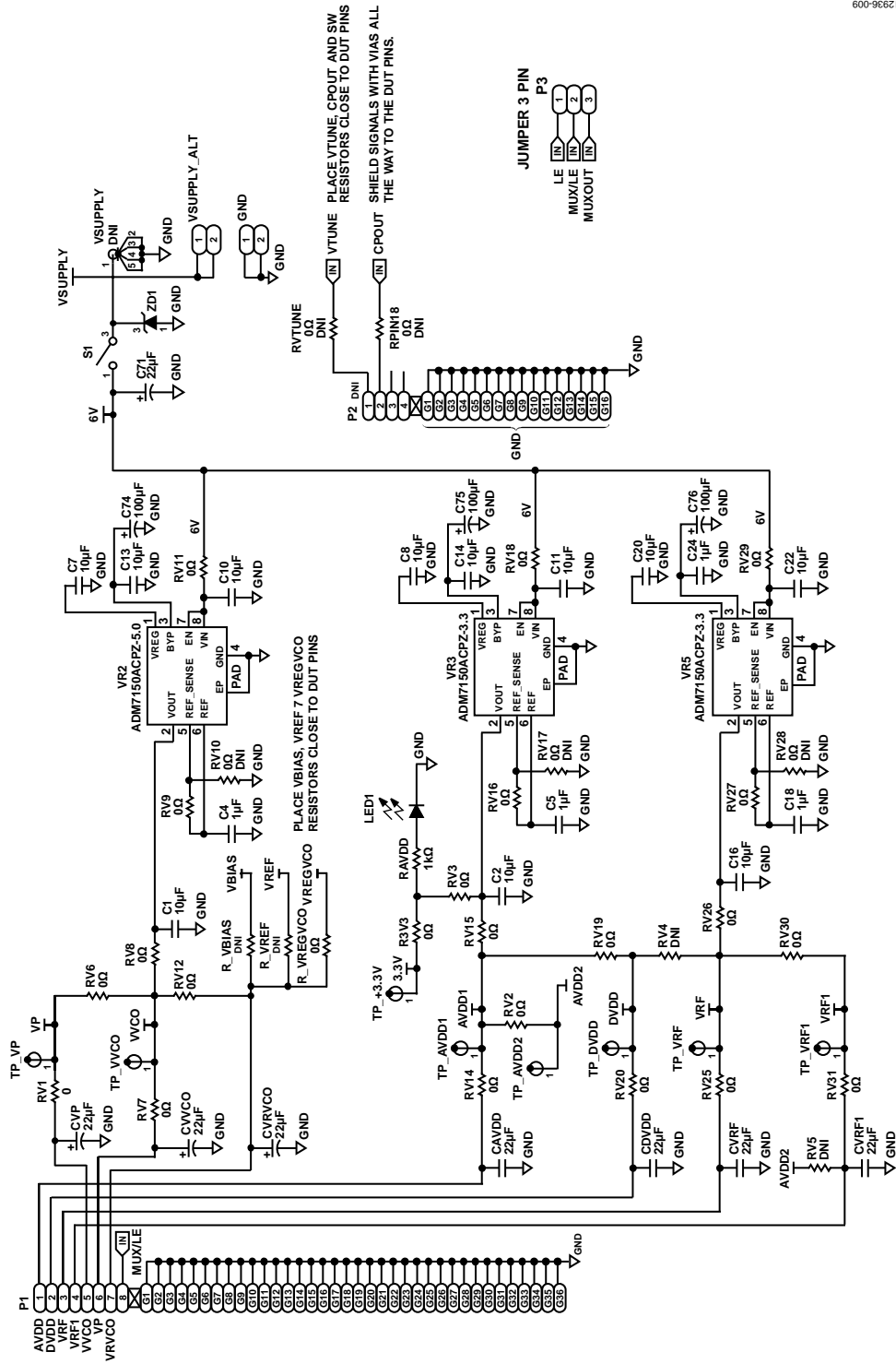Figure 8. Evaluation Board Schematic—Page 2
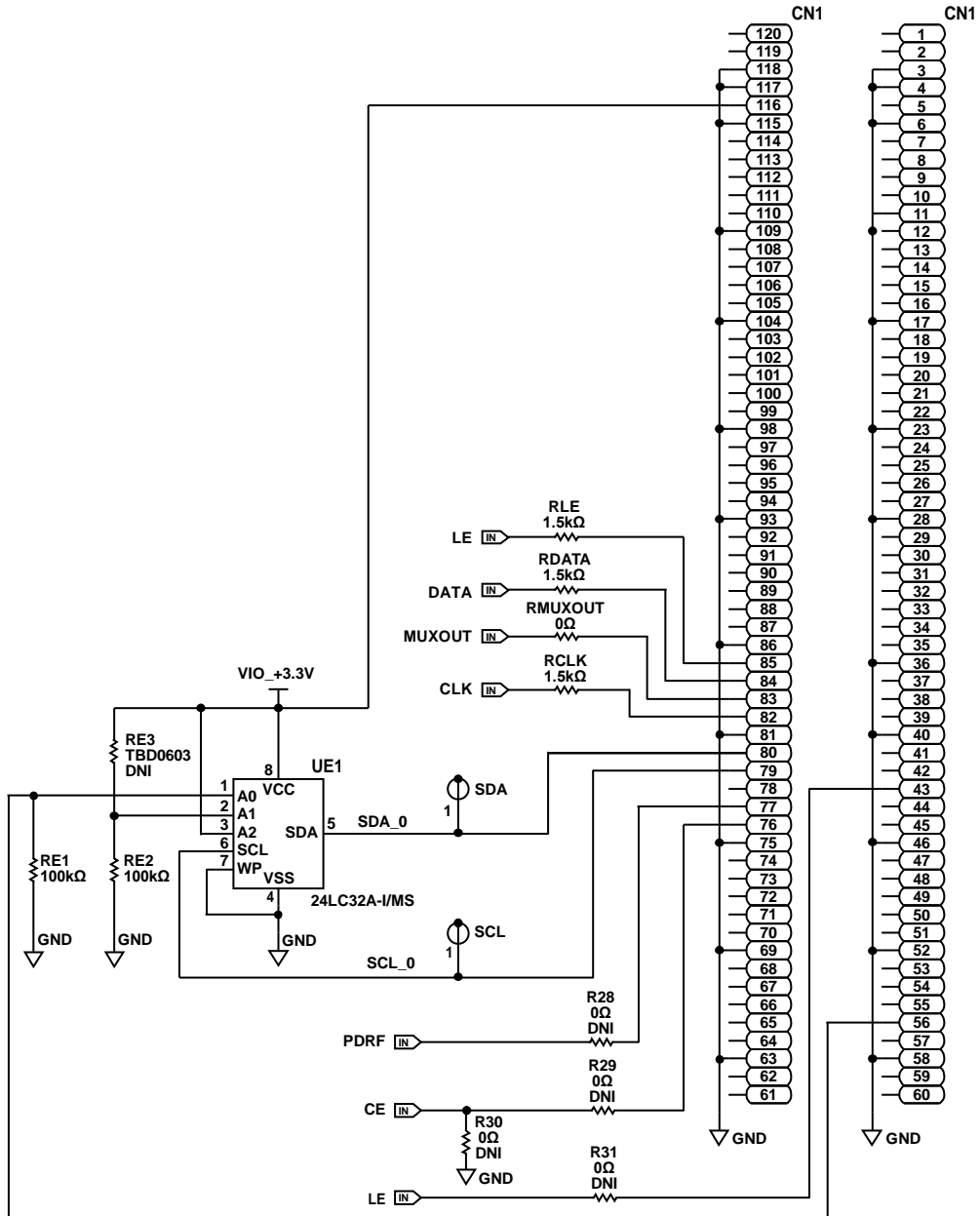
Figure 9. Evaluation Board Schematic—Page 3
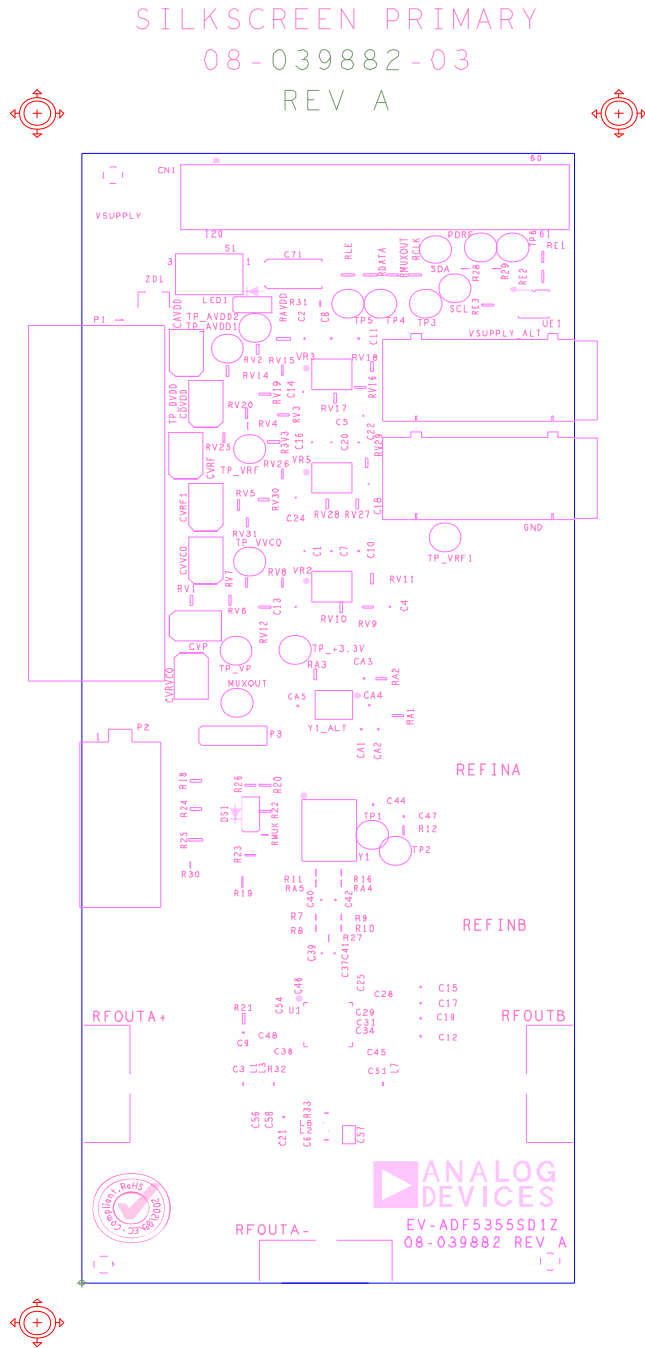
Figure 10. Evaluation Board Silkscreen—Top Side

SILKSCREEN SECONDARY
08-039882-05
REV A
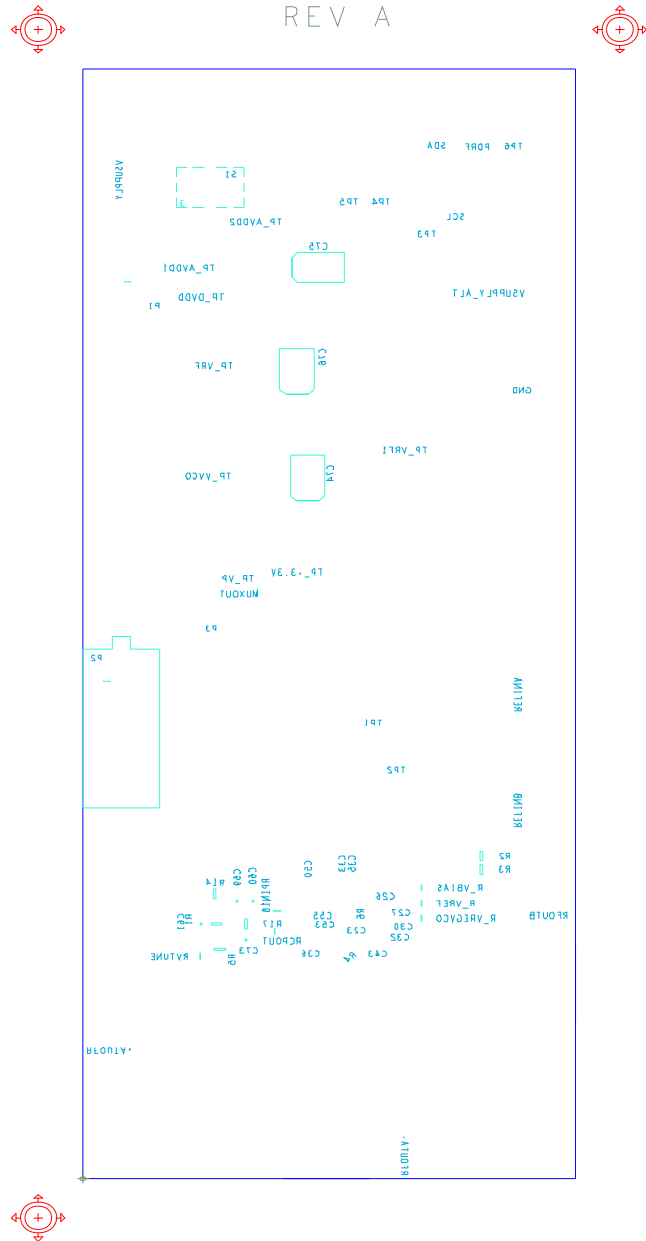
Figure 11. Evaluation Board Silkscreen—Reverse Side

12936-012

Figure 12. Evaluation Board Layer 1—Primary
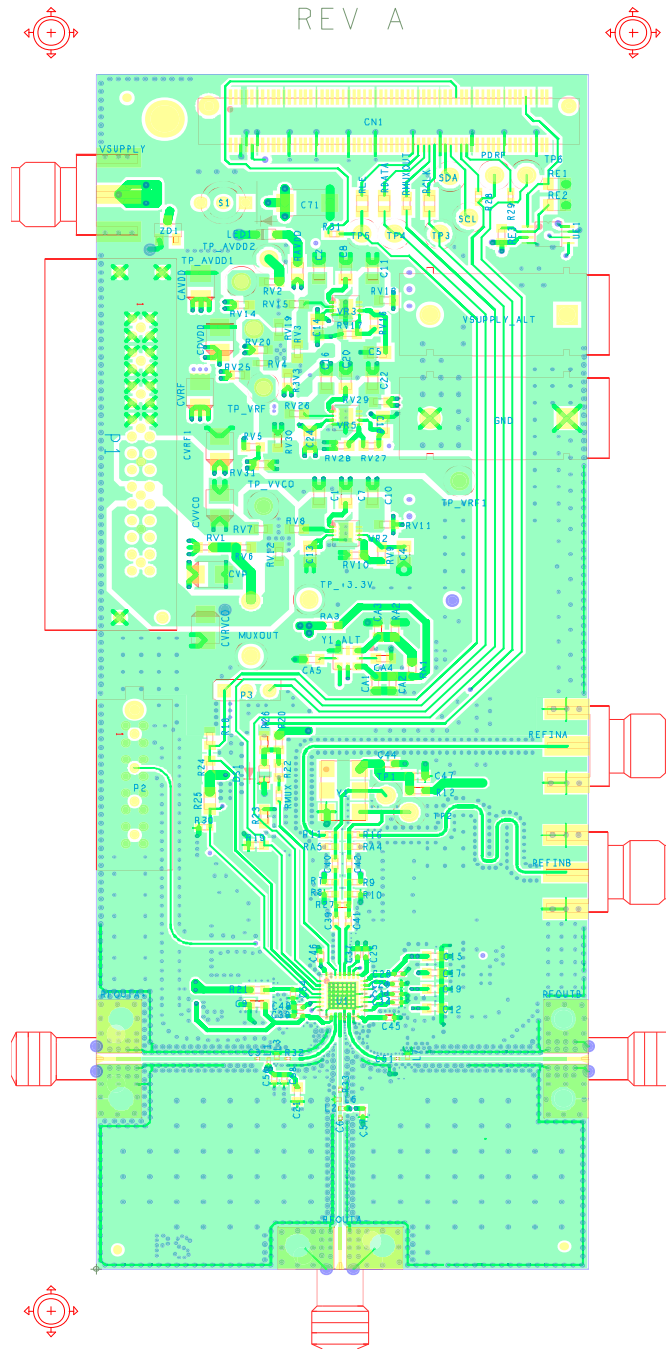
L2 GROUND
08-039882-08
REV A
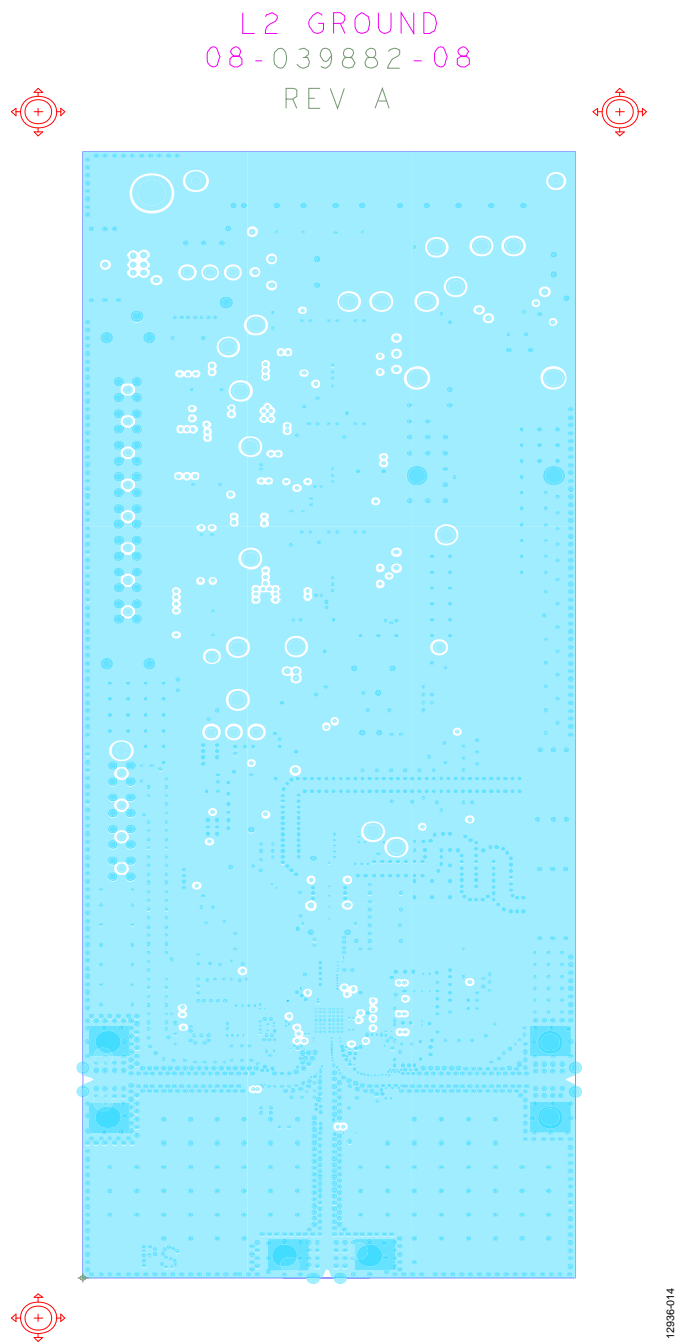
Figure 13. Evaluation Board Layer 2—Ground

L3 POWER
08-039882-09
REV A
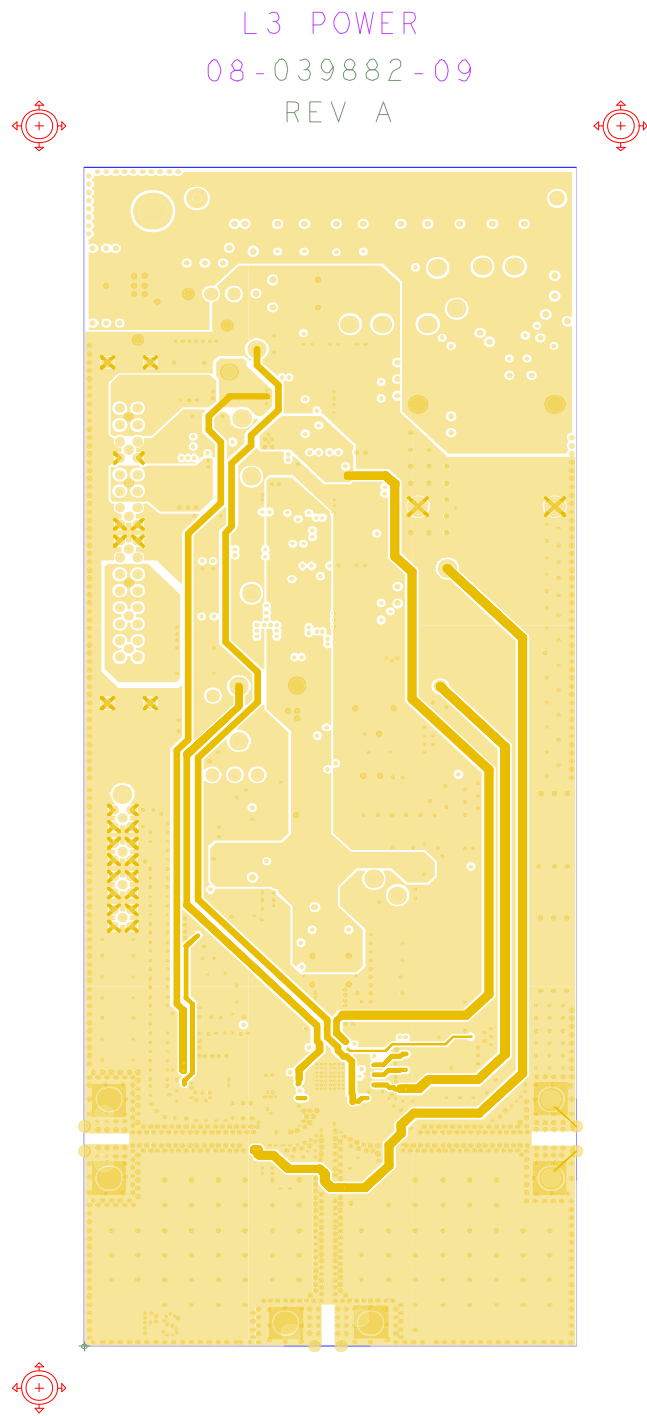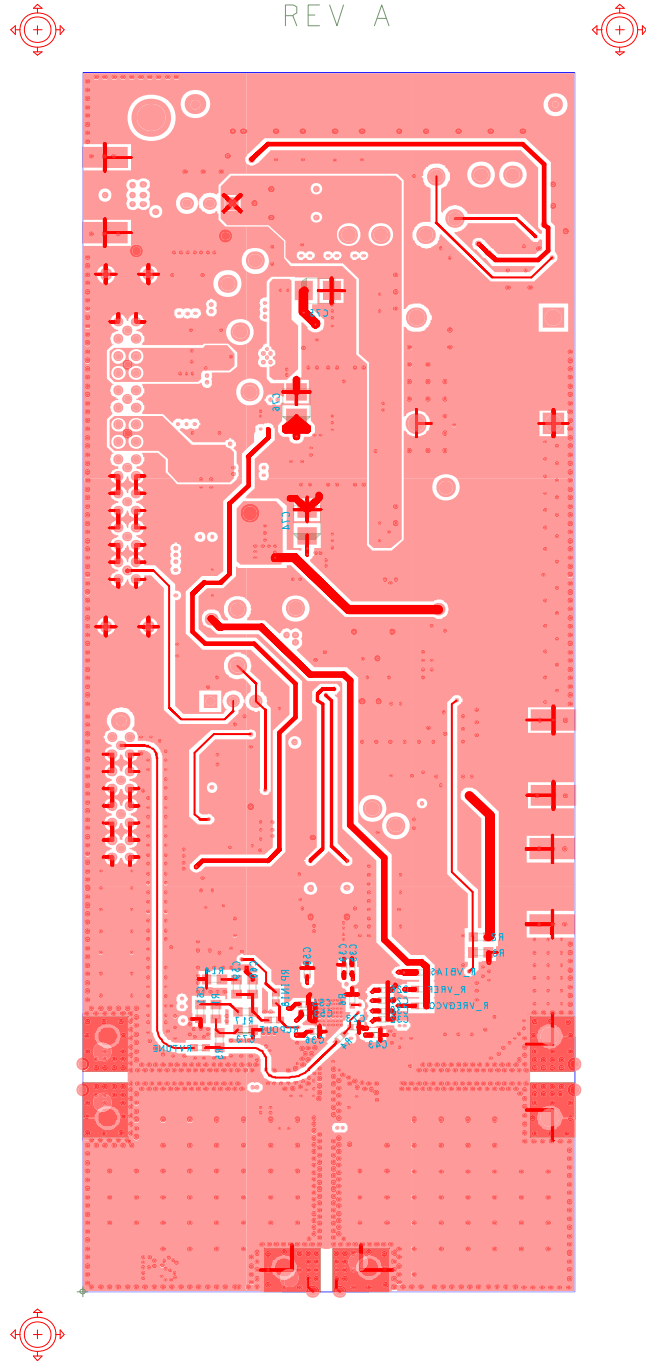

Figure 14. Evaluation Board Layer 3—Power

Figure 15. Evaluation Board Layer 4—Secondary

ORDERING INFORMATION

BILL OF MATERIALS

Table 1.

Reference Designator	Description	Value	Manufacturer	Part Number
C1, C2, C7, C8, C10, C11, C16, C20, C22	Ceramic multilayer capacitor, X5R	10 µF	TDK	C2012X5R1E106K085AC
C9, C12, C21, C47	Ceramic capacitor, X7R	1 µF	Allied Electronics	0603YC105KAT2A
C4, C5, C13, C14, C18, C24	Ceramic capacitor, X8R	1 µF	TDK	C2012X8R1C105K125AB
C17	Ceramic capacitor, X5R	4.7 µF	TDK	C1608X5R1C475K080AC
C19	Ceramic capacitor, X5R	10 µF	TDK	C1608X5R1A106M080AC
C25, C28, C29, C31, C34, C37, C38, C43, C46, C48, C54	RF/microwave capacitor, C0G	10 pF	Allied Electronics	04025U100GAT2A
C27, C30, C32, C36, C39 to C42	Ceramic capacitor, C0G, 0402	1000 pF	Murata	GRM1555C1H102JA01
C3, C6, C51	Ceramic chip capacitor, RF	10 pF	Allied Electronics	0201ZK100GBSTR
C26, C33, C35, C45, C50, C53, C55, C58	Ceramic capacitor, X7R	0.1 µF	KEMET	C0402C104K4RACTU
C44	Ceramic capacitor, NP0	100 pF	Yageo	2238 867 15101
C56, C57	Ceramic capacitor, C0G, 0402	120 pF	Murata	GRM1555C1H121JA01
C59	Ceramic capacitor, Y5V	0.47 µF	Murata	GRM188F51C474ZA01D
C60	Ceramic capacitor	22 nF	Allied Electronics	0603YC223KAT2A
C61	Ceramic capacitor, X7R	10,000 pF	Yageo	CC0603KRX7R9BB103
C71	Solid tantalum electrolytic capacitor	22 µF	Allied Electronics	TCJC226M025R0100
C73	Chip capacitor, C0G, 0603	10 pF	Murata	GRM1885C1H100JA01D
C74 to C76	Tantalum chip capacitor	100 µF	Allied Electronics	TAJB107K006R
CVP, CVRF, CAVDD, CDVDD, CVRF1, CVVCO, CVRVCO	Tantalum capacitor surface-mount device (SMD)	22 µF	Allied Electronics	TAJB226K016R
CN1	Connector printed circuit board (PCB), vertical type receptacle SMD		HIROSE	FX8-120S-SV(21)
DS1, LED1	LED, 570 nm, SMD (green)		Avago Technologies	HSMG-C170
GND	Connector PCB, single socket (black)		Del-Tron Precision, Inc.	571-0100
L1, L2	Inductor chip	7.4 nH	Coilcraft	0302CS-7N4XJLU
SCL, SDA, TP1 to TP6, PDRF, TP_VP, MUXOUT, TP_VRF, TP_DVDD, TP_VRF1, TP_VVCO, TP_+3.3V, TP_AVDD1, TP_AVDD2	Connector PCB, test point (yellow)		Components Corporation	TP-104-01-04
P3	Connector PCB, Header 3		Molex	22-28-4033
R1, R4, R5, R12, R21, RV1 to RV3, RV6 to RV9, R3V3, RV11, RV12, RV14 to RV16, RV18 to RV20, RV25 to RV27, RV29 to RV31, RMUXOUT	Film SMD resistor, 0603	0 Ω	Multicomp	MC0603WG00000T5E-TC
R11, R16, RMUX, RCPOUT, R_VREGVCO	Resistor thick film chip	0 Ω	Multicomp	0402WGF0000TCE
R14	Film SMD resistor, 0603	220 Ω	Multicomp	MC 0.063W 0603 1% 220R
R17	Film SMD resistor, 0603	470 Ω	Multicomp	MC 0.063W 0603 1% 470R

Reference Designator	Description	Value	Manufacturer	Part Number
R18, R19, R23	Film SMD resistor, 0603	1.8 kΩ	Multicomp	MC 0.063W 0603 1% 1K8
R2	Precision thick film chip, resistor R0603	10 kΩ	Panasonic	ERJ-3EKF1002V
R22	Film SMD resistor, 0603	68 Ω	Multicomp	MC 0.063W 0603 1% 68R
R25, RLE, RCLK, RDATA	Precision thick film chip resistor, R0805	1.5 kΩ	Panasonic	ERJ-6ENF1501V
R27	High-frequency thin film chip resistor	100 Ω	Vishay	FC0402E1000BST1
R32, R33	Chip SMD resistor, 0201	0 Ω	Panasonic	ERJ-1GE0R00C
R6	Standard thick film chip resistor	5.1 kΩ	Vishay	CRCW04025K10FKED
RAVDD	Precision thick film chip resistor, R0805	1 kΩ	Panasonic	ERJ-6ENF1001V
RE1, RE2	Precision thick film chip resistor, R0805	100 kΩ	Panasonic	ERJ-6ENF1003V
RE3	Do not install (TBD0603)[1]			Do not install
REFINA, REFINB	PCB, coaxial SMA, end launch connector		Johnson	142-0701-801
RFOUTB, RFOUTA+, RFOUTA−	PCB, SMA right angle jack connector		Rosenberger	32K243-40ML5
S1	Momentary single pole single throw switch		Alcoswitch	TT11AGPC-1
U1	IC, Analog Devices microwave wideband synthesizer with integrated VCO		Analog Devices	ADF5355BCPZ
UE1	IC, 32 kB serial EEPROM		Microchip Technology, Inc.	24LC32A-I/MS
VR2	IC, 800 mA, ultralow noise/high power supply rejection ratio (PSRR), RF linear regulator, 5.0 V output		Analog Devices	ADM7150ACPZ-5.0
VR3, VR5	IC, 800 mA, ultralow noise/high PSRR, RF linear regulator, 3.3 V output		Analog Devices	ADM7150ACPZ-3.3
VSUPPLY	Connector PCB, coaxial SMA, end launch (do not install)			Do not install
VSUPPLY_ALT	PCB, single socket (red) connector		Del-Tron Precision, Inc.	571-0500
Y1	IC, crystal low voltage positive emitter coupled logic (LVPECL)		Vectron International	VCC6-LAB-122M880000
ZD1	Zener diode, 6.8 V, SOT-23		Philips	BZX84-C6V8

[1] TBD means no value assigned; component not inserted.

NOTES

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