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Evaluation Board for a 18-Bit Serial Input, Voltage Output DAC with Integrated Precision Reference Buffer Amplifiers

FEATURES

Full-featured evaluation board for the AD5780
Link options
PC control in conjunction with Analog Devices, Inc., system development platform
PC software for control

EVALUATION BOARD DESCRIPTION

The EVAL-AD5780 is a full-featured evaluation board, designed to allow the user to easily evaluate all features of the AD5780 voltage output, 18-bit digital-to-analog converter (DAC). The AD5780 pins are accessible at on-board connectors for external connection. The board can be controlled by two means: via the on-board connector (J3), or via the system development platform connector (J4). The SDP board allows the evaluation board to be controlled through the USB port of a Windows® XP- (SP2 or later) or Vista-based (32-bit) PC using the AD5780 evaluation software.

DEVICE DESCRIPTION

The AD5780 is a high precision, 18-bit DAC with integrated precision reference buffer amplifiers designed to meet the requirements of precision control applications. The output range of the AD5780 is configured by two reference voltage inputs. The device is specified to operate with a dual power supply of up to 33 V.

Complete specifications for the AD5780 are provided in the AD5780 data sheet, available from Analog Devices, and should be consulted in conjunction with this user guide when using the evaluation board.

FUNCTIONAL BLOCK DIAGRAM

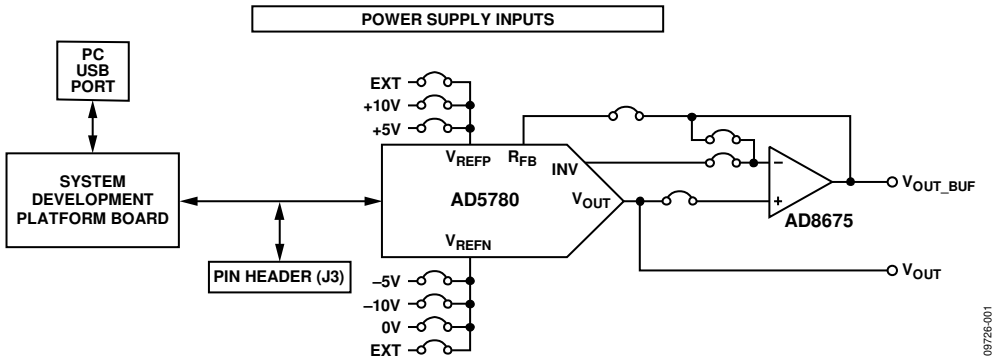

Figure 1.

TABLE OF CONTENTS

Features 1
Evaluation Board Description 1
Device Description 1
Functional Block Diagram 1
Revision History 2
Evaluation Board Hardware 3
Power Supplies 3
Link Options 3
On-Board Connectors 3
Evaluation Board Software 5
Software Installation 5
Software Operation 5
Main Window 6
Evaluation Board Performance 8
Evaluation Board Schematics and Artwork 9
Ordering Information 15
Bill of Materials 15

REVISION HISTORY

7/12—Rev. 0 to Rev. A

Changed ADR445 to ADR4550 (Throughout) 3
Changes to Evaluation Board Schematics and Artwork Section . 9

11/11—Revision 0: Initial Version

EVALUATION BOARD HARDWARE

POWER SUPPLIES

The following external supplies must be provided:

- 5 V between the V_{CC} and DGND inputs for the digital supply of the AD5780. Alternatively, place Link 1 in Position A to power the digital circuitry from the USB port via the SDP board (default).
- 7.5 V to 16.5 V between the V_{DD} and AGND inputs for the positive analog supply of the AD5780.
- −2.5 V to −16.5 V between the V_{SS} and AGND inputs for the negative analog supply of the AD5780.

The analog and digital planes are connected at one location, close to the AD5780. To avoid ground loop problems, it is recommended not to connect AGND and DGND elsewhere in the system.

Each supply is decoupled to the relevant ground plane with 10 µF and 0.1 µF capacitors. Each device supply pin is again decoupled with a 10 µF and 0.1 µF capacitor pair to the relevant ground plane.

LINK OPTIONS

The link options on the evaluation board should be set for the required operating setup before using the board. The functions of the link options are described in Table 5.

Default Link Option Setup

The default link options are listed in Table 1. By default, the board is configured with V_{REFP} = +10 V and V_{REFN} = −10 V for a ±10 V output range.

Table 1. Default Link Options

Link No.	Option
LK1	A
LK2	B
LK3	A
LK4	Removed
LK5	Removed
LK6	Removed
LK7	Removed
LK8	C
LK9	Inserted
LK11	Inserted

Connector J3 Pin Descriptions

Table 2. Connector J3 Pin Configuration

9	7	5	3	1
10	8	6	4	2

Table 3. Connector J3 Pin Descriptions

Pin No.	Description
1	SDO
2	$\overline{\text{RESET}}$
3	DGND
4	$\overline{\text{CLR}}$
5	DGND
6	$\overline{\text{LDAC}}$
7	SDIN
8	DGND
9	SCLK
10	$\overline{\text{SYNC}}$

ON-BOARD CONNECTORS

There are nine connectors on the AD5780 evaluation board PCB as outlined in Table 4.

Table 4. On-Board Connectors

Connector	Function
J1	Digital power supply connector
J2	Analog power supply connector
J3	Digital interface pin header connector
J4	SDP board connector
VOUT	DAC output connector
VOUT_BUF	Buffered DAC output connector
VREF	+5 V external reference voltage input connector (+10 V, +5 V, −10 V, and −5 V reference voltages are generated from this +5 V input or on-board ADR4550)
VREFN	DAC negative reference input connector
VREFP	DAC positive reference input connector

Table 5. Link Options

Link No.	Description
LK1	This link selects the source of the digital power supply. Position A selects the source from the SDP board. Position B selects the source from Connector J1.
LK2	This link selects the positive reference voltage source. Position A selects an on-board generated +5 V. Position B selects an on-board generated +10 V. Position C selects an external voltage applied at Connector VREFP.
LK3	This link is used in conjunction with LK4 to configure the mode of operation of the output amplifier. Position A configures the amplifier in unity gain. LK4 should be removed.[1] Position B configures the amplifier for a gain of 2. Lk4 should be inserted.[2]
LK4	This link is used in conjunction with LK3 to configure the mode of operation of the output amplifier. When this link is inserted, LK3 should be in Position B to configure the amplifier for a gain of 2.[2] When this link is removed, LK3 should be in Position A to configure the amplifier for unity gain.[1]
LK5	This link selects the state of the $\overline{\text{RESET}}$ pin. When this link is inserted, $\overline{\text{RESET}}$ is at logic low. When this link is removed, $\overline{\text{RESET}}$ is at logic high.
LK6	This link selects the state of the $\overline{\text{CLR}}$ pin. When this link is inserted, $\overline{\text{CLR}}$ is at logic low. When this link is removed, $\overline{\text{CLR}}$ is at logic high.
LK7	This link selects the state of the $\overline{\text{LDAC}}$ pin. When this link is inserted, $\overline{\text{LDAC}}$ is at logic low. When this link is removed, $\overline{\text{LDAC}}$ is at logic high.
LK8	This link selects the negative reference voltage source. Position A selects an on-board generated −5 V. Position B selects AGND. Position C selects an on-board generated −10 V. Position D selects an external voltage applied at Connector VREFN.
LK9	This link connects the output of Voltage Reference U5 to the reference scaling circuitry.
LK11	This link connects the DAC output to the noninverting input of the output buffer amplifier. When this link is inserted, the DAC output is connected to the noninverting input of the output amplifier. When this link is removed, the DAC output is disconnected from the noninverting input of the output buffer amplifier and the DAC output voltage is accessible at the VOUT connector.

[1] The RBUF bit of the control register must be set to high to enable the unity gain mode of operation.
[2] The RBUF bit of the control register must be cleared to low to enable the gain of 2 mode of operation.

EVALUATION BOARD SOFTWARE

SOFTWARE INSTALLATION

The AD5780 evaluation kit includes self-installing software on a CD. The software is compatible with Windows XP (SP2) and Vista (32-bit). If the setup file does not run automatically, you can run the **setup.exe** file from the CD.

Install the evaluation software before connecting the evaluation board and SDP board to the USB port of the PC to ensure that the evaluation system is correctly recognized when connected to the PC.

1. After installation from the CD is complete, power up the AD5780 evaluation board as described in the Power Supplies section. Connect the SDP board (via either Connector A or Connector B) to the AD5780 evaluation board and then to the USB port of your PC using the supplied cable.
2. When the evaluation system is detected, proceed through any dialog boxes that appear. This completes the installation.

SOFTWARE OPERATION

To launch the software, complete the following steps:

1. From the **Start** menu, select **Analog Devices – AD5780** > **AD5780 Evaluation Software**. The main window of the software then displays (see Figure 3).
2. If the evaluation system is not connected to the USB port when the software is launched, a connectivity error displays (see Figure 2). Connect the evaluation board to the USB port of the PC, wait a few seconds, click **Rescan**, and follow the instructions.

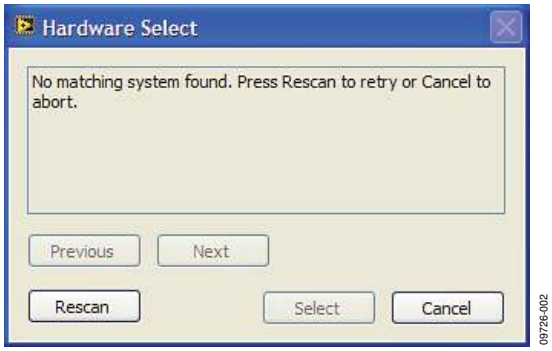

Figure 2. Connectivity Error Alert

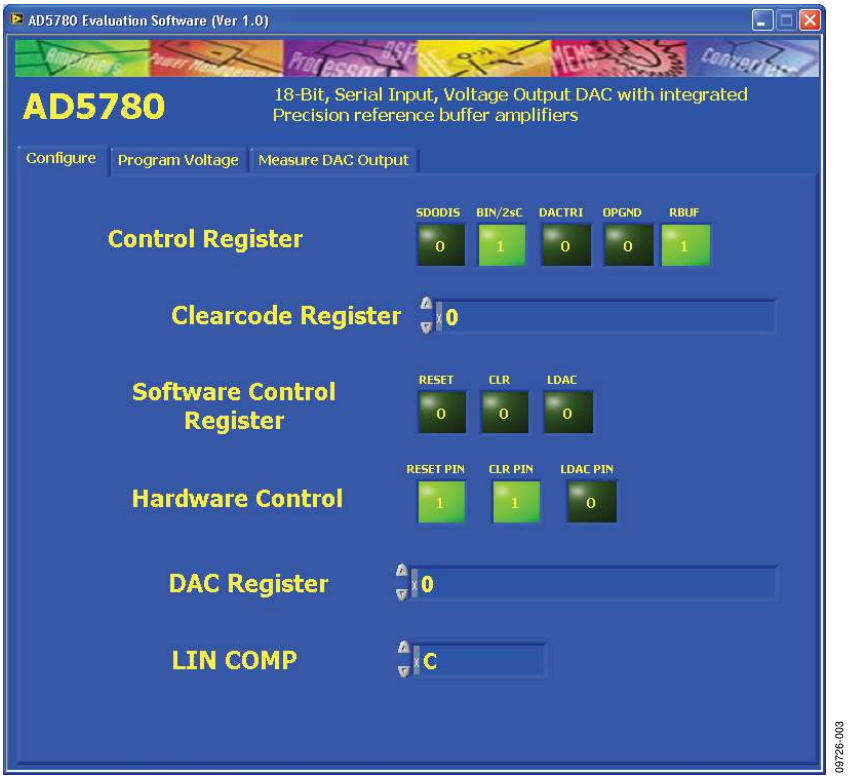

Figure 3. Main Window

MAIN WINDOW

The main window is divided into three tabs: **Configure**, **Program Voltage**, and **Measure DAC Output**.

Configure

The **Configure** section allows access to the control register, clearcode register, software control register, and DAC register and also allows control of the RESET, CLR, and LDAC pins.

Program Voltage

The **Program Voltage** section programs the DAC register with a value calculated from the entered values: the positive voltage reference (VREFP), the negative voltage reference (VREFN), and the desired output voltage (see Figure 4).

Figure 4. Program Voltage Window

Measure DAC Output

The **Measure DAC Output** section allows the PC to control an Agilent 3458A multimeter to measure and log the DAC output voltage.

The multimeter is controlled over a general-purpose interface bus (GPIB). Once connected to the PC, first configure the multimeter via its front panel before taking a measurement. Figure 6 shows the measurement options. The software runs through a sequence of steps, programming the DAC register and measuring the DAC output voltage. The sequence begins with the software programming the DAC with the **Start Code** value, incrementing the programmed value at each step by the **Code Step** value, and finishing when the programmed value reaches the **Stop Code** value. A delay between measurements can be inserted, if required. The GPIB address of the multimeter must be specified.

To begin the measurement, click **START**. The measurement can be halted at any time by clicking **STOP**. When the measurement is completed, a dialog box appears to allow the data to be saved as a spreadsheet file with three columns of data. The first column is the DAC code, the second column is the DAC voltage in volts, and the third column is the INL error in LSBs, as shown in Figure 5. A graph of both the DAC output voltage vs. the DAC code and the INL error vs. the DAC code is displayed on-screen (see Figure 6). In the measurement example shown in Figure 6, measurements are taken in 1024 code steps beginning at Code 0 and finishing at Code 262,143 in total 256 measurements. With the number of power line cycles (NPLC) setting on the multimeter set to 1, the measurement takes ~18 sec to complete. To complete an all codes measurement requiring 262,144 measurement points takes ~6 hours to complete.

	A	B	C
1	0	-9.9983	0
2	1024	-9.92018	-0.01316
3	2048	-9.84206	-0.01866
4	3072	-9.76394	0.010392
5	4096	-9.68582	-0.02197
6	5120	-9.6077	0.007083
7	6144	-9.52958	0.016931
8	7168	-9.45146	0.013356
9	8192	-9.37334	0.028971
10	9216	-9.29522	0.040746
11	10240	-9.2171	0.058275
12	11264	-9.13898	0.043191
13	12288	-9.06086	0.066475
14	13312	-8.98274	0.060986

09726-005

Figure 5. Saved Data Format

If an Agilent 3458A multimeter is not connected to the PC, the software steps through the codes without taking any measurements.

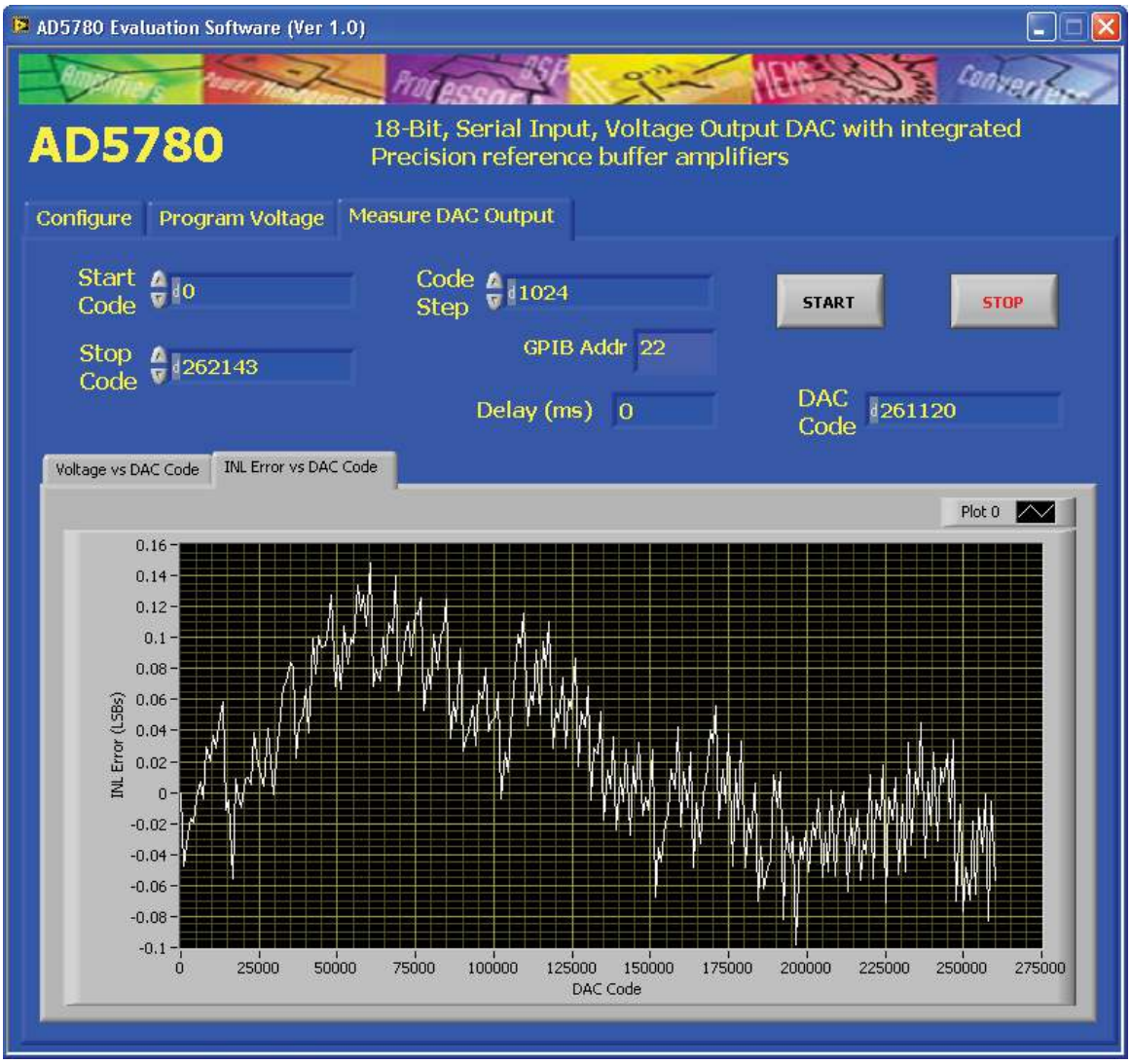

Figure 6. Measure DAC Output Window

EVALUATION BOARD PERFORMANCE

The following data demonstrates the measured linearity performance of the AD5780 evaluation board circuit. The board is powered from V_{DD} = +15 V and V_{SS} = −15 V. V_{REFP} = +10 V and V_{REFN} = −10 V are both generated from the on-board voltage reference.

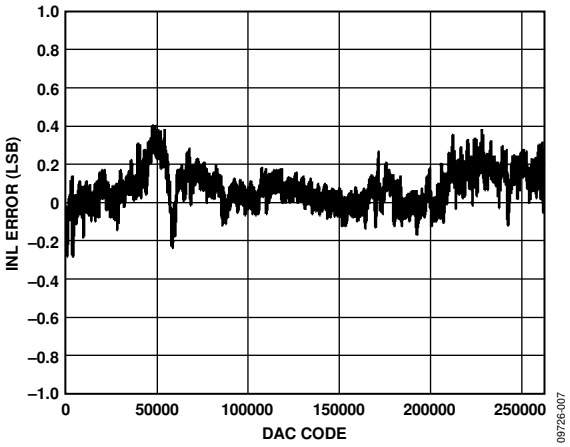

Figure 7. INL Error vs. DAC Code

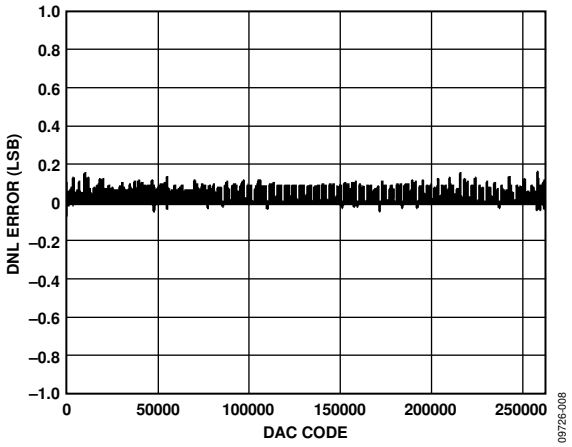

Figure 8. DNL Error vs. DAC Code

EVALUATION BOARD SCHEMATICS AND ARTWORK

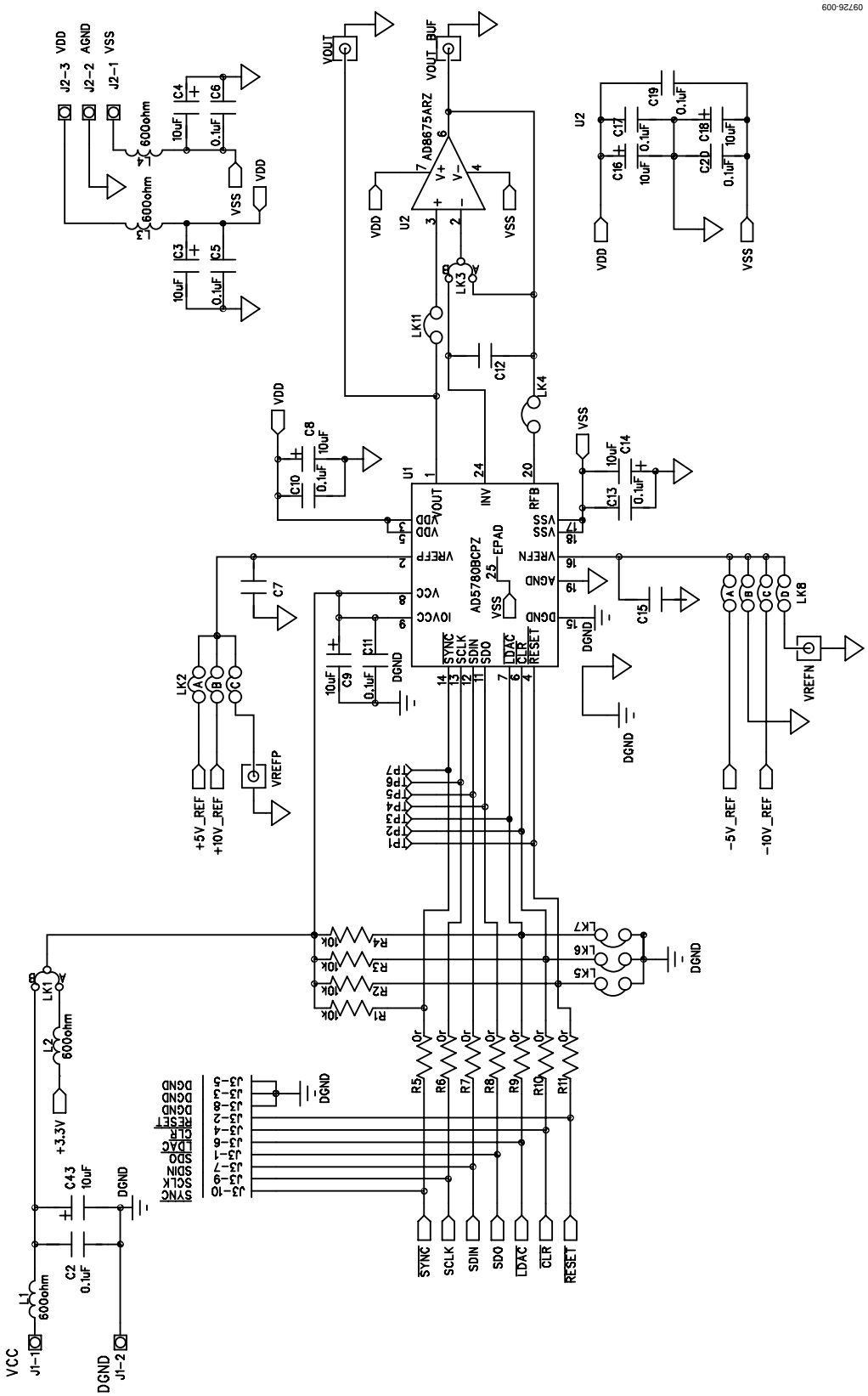

Figure 9. Schematic of the AD5780 Circuitry

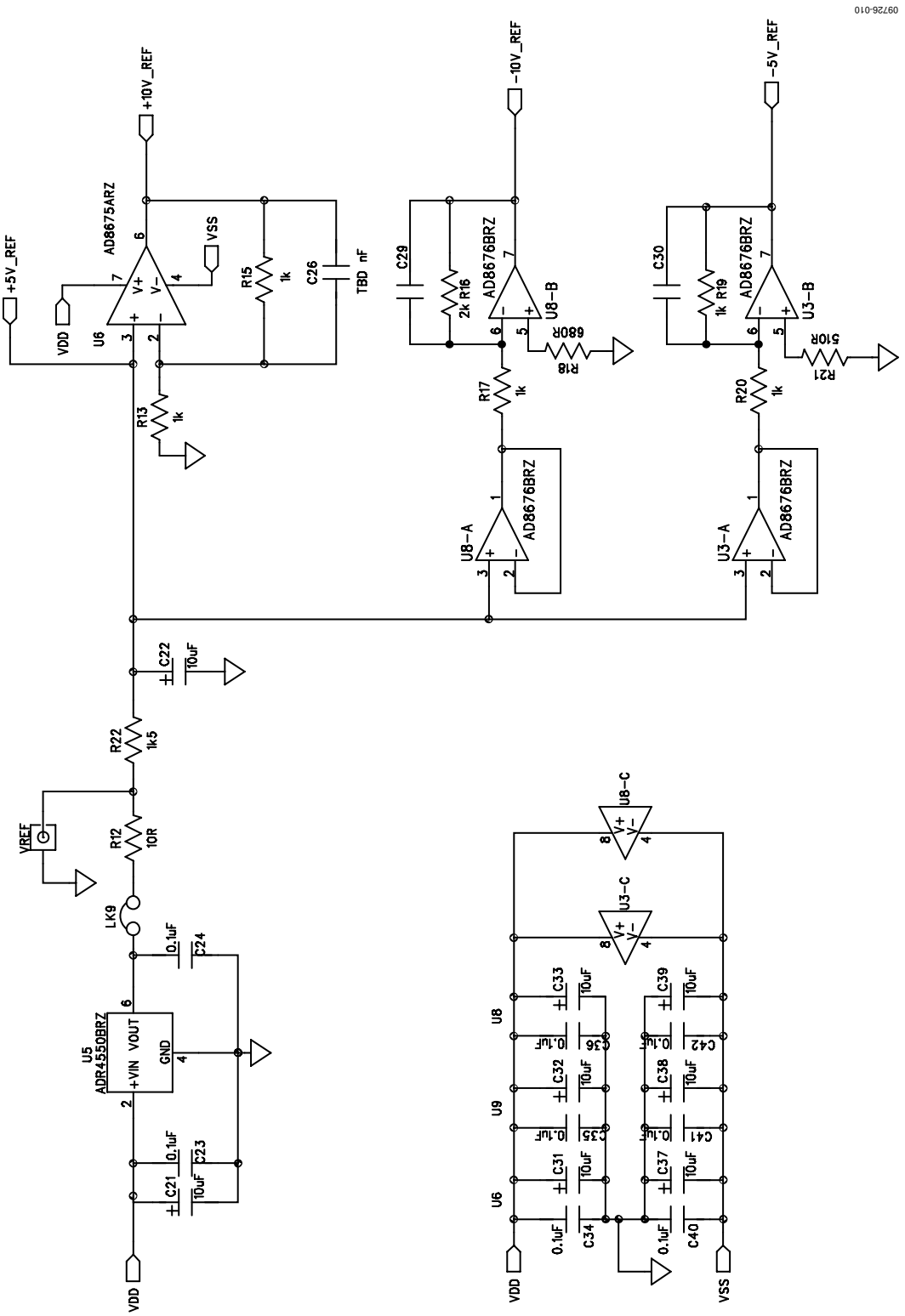

Figure 10. Schematic of the Voltage Reference Circuitry

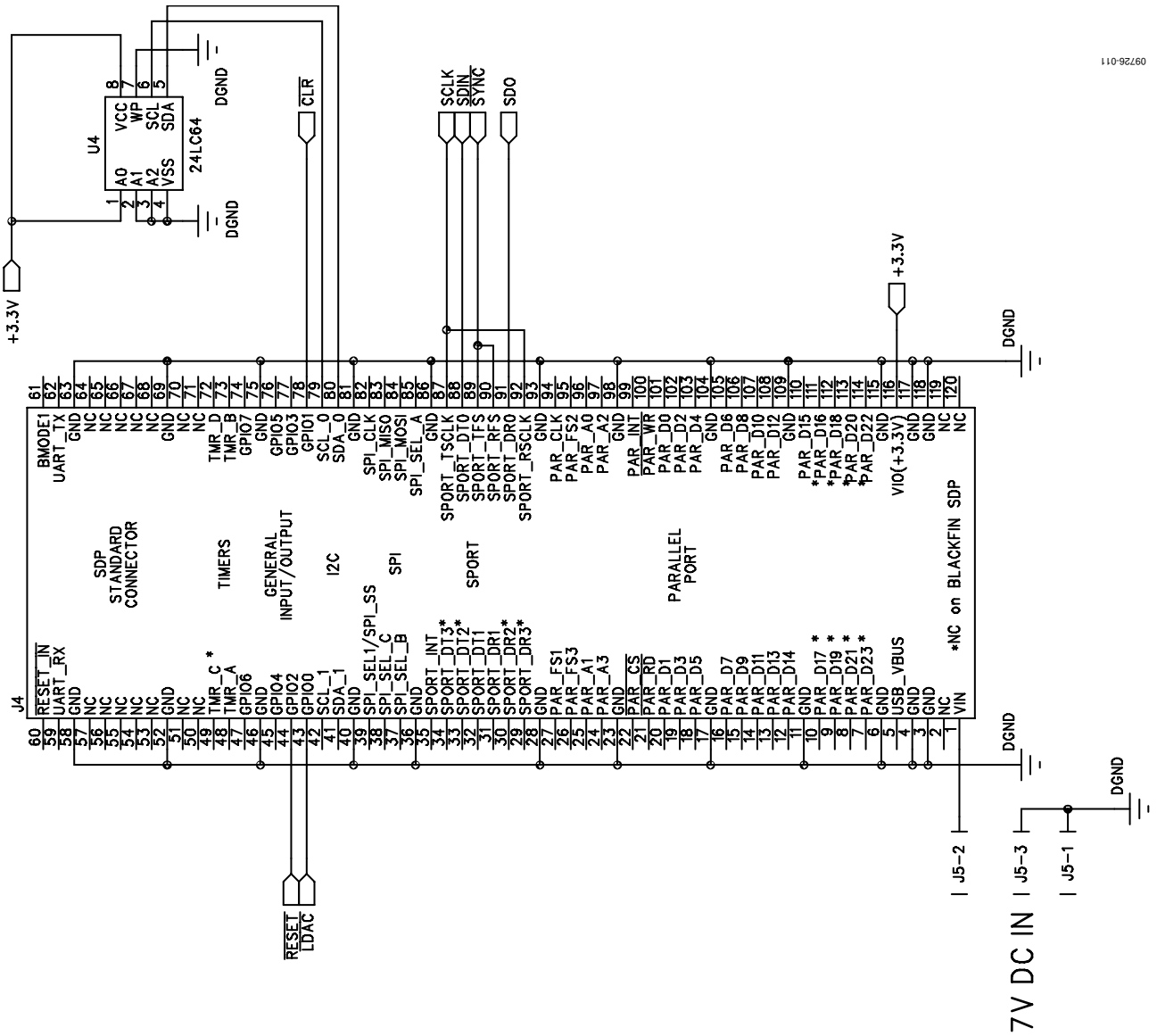

Figure 11. Schematic of the SDP Board Connector

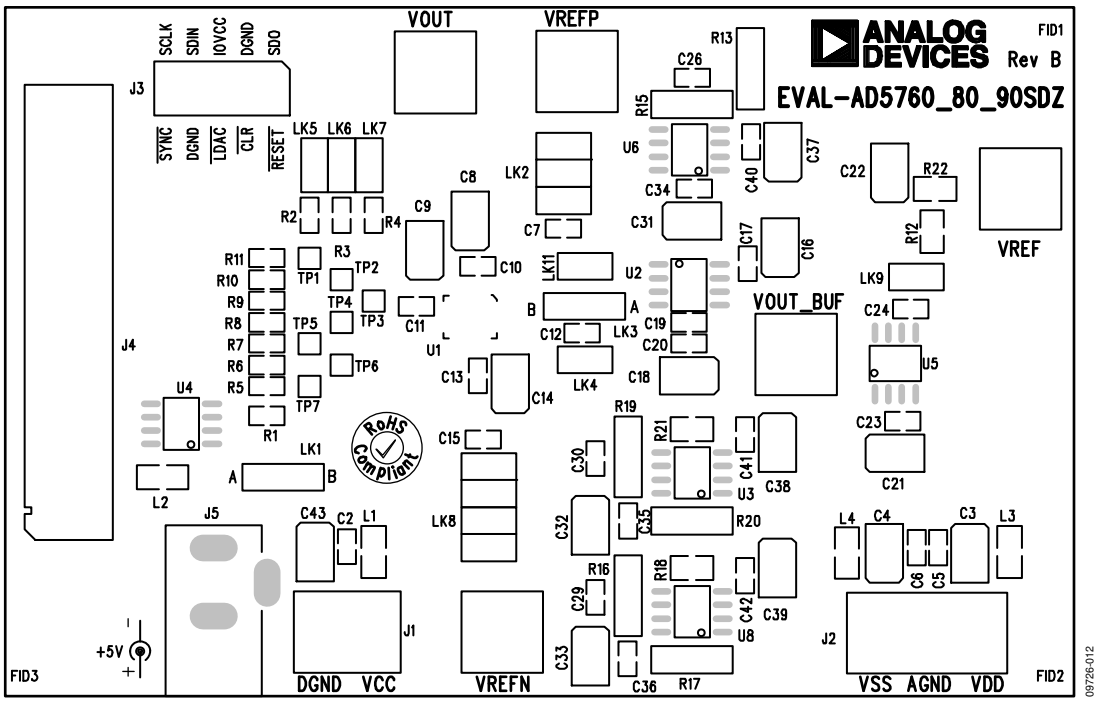

Figure 12. Component Placement Schematic

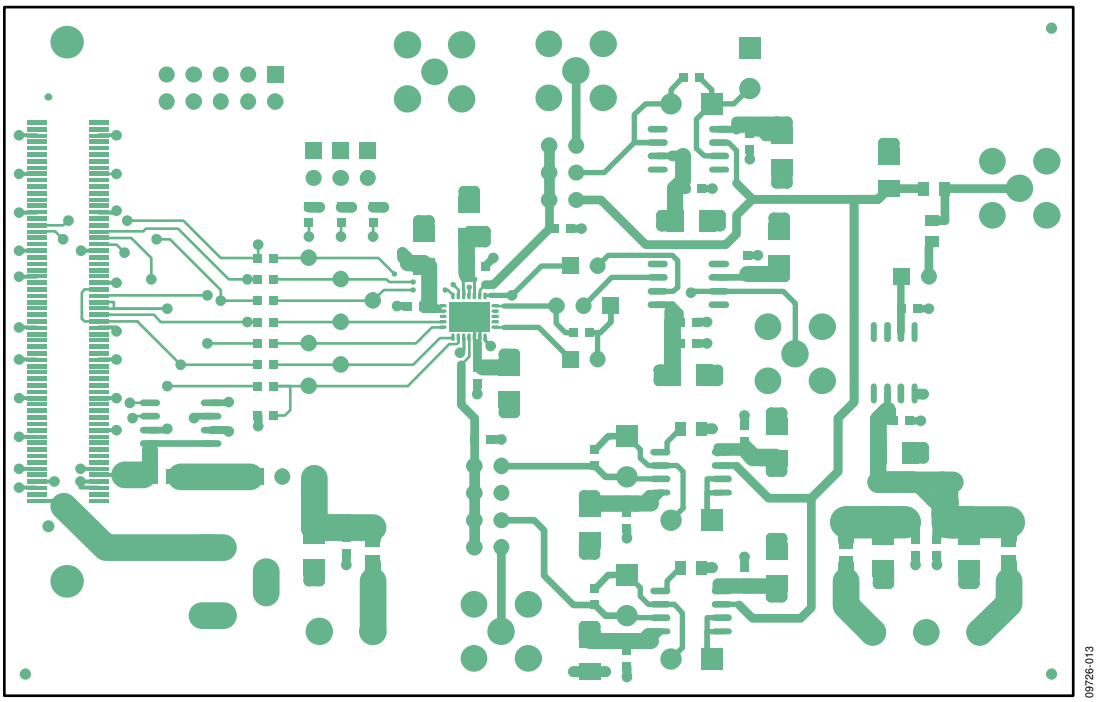

Figure 13. Top Printed Circuit Board (PCB) Layer Schematic

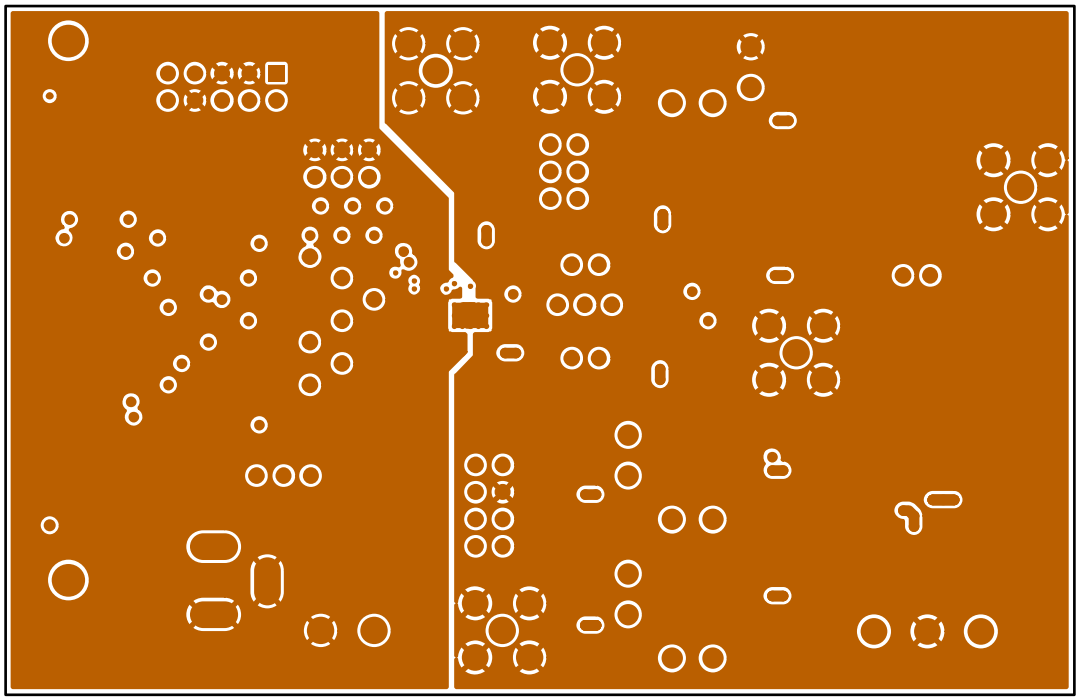

Figure 14. Inner First PCB Layer Schematic

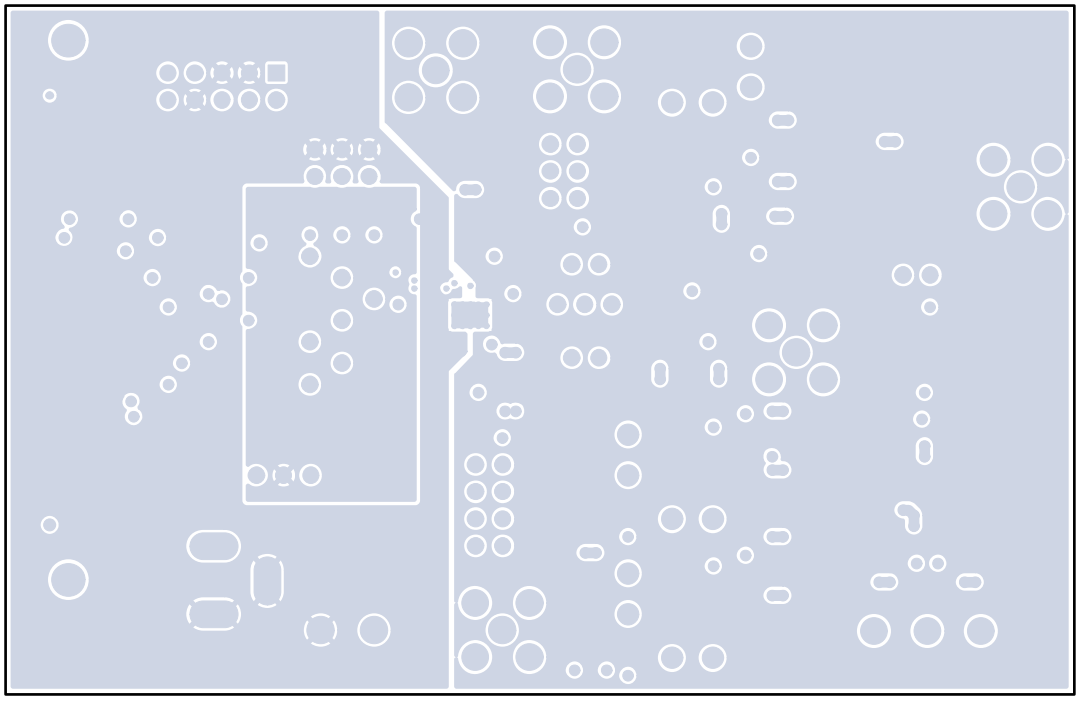

Figure 15. Inner Second PCB Layer Schematic

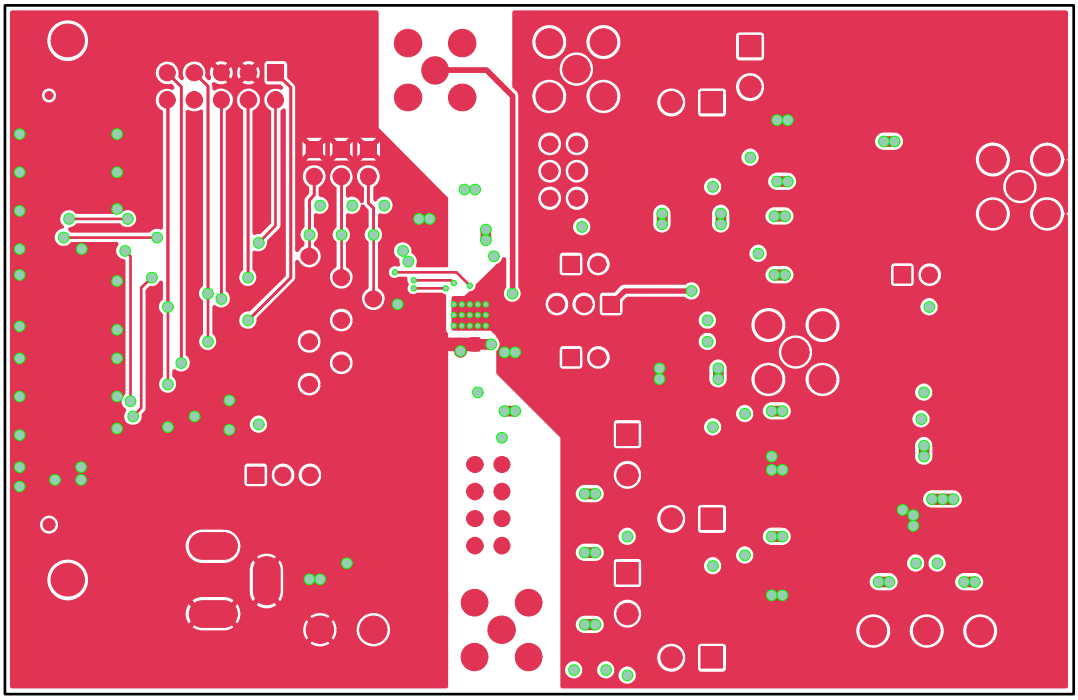

Figure 16. Bottom PCB Layer Schematic

ORDERING INFORMATION

BILL OF MATERIALS

Table 6.

Reference Designator	Part Description	Part Number	Stock Code
C2	Capacitor, 0603, 0.1 µF, 16 V	CM105X7R104K16AT	FEC 9406140
C3	Capacitor+, 10 µF, 16 V, 10%, Case B	TAJB106K016R	FEC 498737
C4	Capacitor+, 10 µF, 16 V, 10%, Case B	TAJB106K016R	FEC 498737
C5	Capacitor, 0603, 0.1 µF, 16V	CM105X7R104K16AT	FEC 9406140
C6	Capacitor, 0603, 0.1 µF, 16 V	CM105X7R104K16AT	FEC 9406140
C8	Capacitor+, 10 µF, 16 V, 10%, Case B	TAJB106K016R	FEC 498737
C9	Capacitor+, 10 µF, 16 V, 10%, Case B	TAJB106K016R	FEC 498737
C10	Capacitor, 0603, 0.1 µF, 16 V	CM105X7R104K16AT	FEC 9406140
C11	Capacitor, 0603, 0.1 µF, 16 V	CM105X7R104K16AT	FEC 9406140
C13	Capacitor, 0603, 0.1 µF, 16 V	CM105X7R104K16AT	FEC 9406140
C14	Capacitor+, 10 µF, 16 V, 10%, Case B	TAJB106K016R	FEC 498737
C16	Capacitor+, 10 µF, 16 V, 10%, Case B	TAJB106K016R	FEC 498737
C17	Capacitor, 0603, 0.1 µF, 16 V	CM105X7R104K16AT	FEC 9406140
C18	Capacitor+, 10 µF, 16 V, 10%, Case B	TAJB106K016R	FEC 498737
C19	Capacitor, 0603, 0.1 µF, 16 V	CM105X7R104K16AT	FEC 9406140
C20	Capacitor, 0603, 0.1 µF, 16 V	CM105X7R104K16AT	FEC 9406140
C21	Capacitor+, 10 µF, 16 V, 10%, Case B	TAJB106K016R	FEC 498737
C22	Capacitor+, 10 µF, 16 V, 10%, Case B	TAJB106K016R	FEC 498737
C23	Capacitor, 0603, 0.1 µF, 16 V	CM105X7R104K16AT	FEC 9406140
C24	Capacitor, 0603, 0.1 µF, 16 V	CM105X7R104K16AT	FEC 9406140
C31	Capacitor+, 10 µF, 16 V, 10%, Case B	TAJB106K016R	FEC 498737
C32	Capacitor+, 10 µF, 16 V, 10%, Case B	TAJB106K016R	FEC 498737
C33	Capacitor+, 10 µF, 16 V, 10%, Case B	TAJB106K016R	FEC 498737
C34	Capacitor, 0603, 0.1 µF, 16 V	CM105X7R104K16AT	FEC 9406140
C35	Capacitor, 0603, 0.1 µF, 16 V	CM105X7R104K16AT	FEC 9406140
C36	Capacitor, 0603, 0.1 µF, 16 V	CM105X7R104K16AT	FEC 9406140
C37	Capacitor+, 10 µF, 16 V, 10%, Case B	TAJB106K016R	FEC 498737
C38	Capacitor+, 10 µF, 16 V, 10%, Case B	TAJB106K016R	FEC 498737
C39	Capacitor+, 10 µF, 16 V, 10%, Case B	TAJB106K016R	FEC 498737
C40	Capacitor, 0603, 0.1 µF, 16 V	CM105X7R104K16AT	FEC 9406140
C41	Capacitor, 0603, 0.1 µF, 16 V	CM105X7R104K16AT	FEC 9406140
C42	Capacitor, 0603, 0.1 µF, 16 V	CM105X7R104K16AT	FEC 9406140
C43	Capacitor+, 10 µF, 16 V, 10%, Case B	TAJB106K016R	FEC 498737
J1	2-pin terminal block (5 mm pitch) CON\POWER	CTB5000/2	FEC 151789
J2	3-pin terminal block (5 mm pitch) CON\POWER3	CTB5000/3	FEC 151790
J3	20-pin (2 × 10) header	Not applicable	FEC 1022244 (36 + 36 pin strip)
J4	120-way connector, 0.6 mm pitch, SDP-STANDARD-CONN	FX8-120S-SV(21)	FEC 1324660
L1	Ferrite Bead IND	74279204	FEC 1635719
L2	Ferrite Bead IND	74279204	FEC 1635719
L3	Ferrite Bead IND	74279204	FEC 1635719
L4	Ferrite Bead IND	74279204	FEC 1635719
LK1	3-pin SIL header and shorting link	M20-9990345 and M7567-05	FEC 1022248 and 150410
LK2	6-pin (3 × 2) 0.1" header and shorting block	M20-9983646 and M7566-05	FEC 148-535 and 150-411 (36-pin strip)
LK3	3-pin SIL header and shorting link	M20-9990345 and M7567-05	FEC 1022248 and 150410
LK4	2-pin (0.1" pitch) header and shorting shunt	M20-9990246	FEC 1022247 and 150-411

Reference Designator	Part Description	Part Number	Stock Code
LK5	2-pin (0.1" pitch) header and shorting shunt	M20-9990246	FEC 1022247 and 150-411
LK6	2-pin (0.1" pitch) header and shorting shunt	M20-9990246	FEC 1022247 and 150-411
LK7	2-pin (0.1" pitch) header and shorting shunt	M20-9990246	FEC 1022247 and 150-411
LK8	8-pin (4 × 2) 0.1" header and shorting block	M20-9983646 and M7566-05	FEC 1022244 and 150-411 (36-pin strip)
LK9	2-pin (0.1" pitch) header and shorting shunt	M20-9990246	FEC 1022247 and 150-411
LK11	2-pin (0.1" pitch) header and shorting shunt	M20-9990246	FEC 1022247 and 150-411
R1	SMD resistor	MC 0.063W 0603 10k	FEC 9331700
R2	SMD resistor	MC 0.063W 0603 10k	FEC 9331700
R3	SMD resistor	MC 0.063W 0603 10k	FEC 9331700
R4	SMD resistor	MC 0.063W 0603 10k	FEC 9331700
R5	SMD resistor	MC 0.063W 0603 0R	FEC 9331662
R6	SMD resistor	MC 0.063W 0603 0R	FEC 9331662
R7	SMD resistor	MC 0.063W 0603 0R	FEC 9331662
R8	SMD resistor	MC 0.063W 0603 0R	FEC 9331662
R9	SMD resistor	MC 0.063W 0603 0R	FEC 9331662
R10	SMD resistor	MC 0.063W 0603 0R	FEC 9331662
R11	SMD resistor	MC 0.063W 0603 0R	FEC 9331662
R12	SMD resistor	MC 0.063W 0603 0R	FEC 9331662
R13	Resistor, 1 kΩ, 0805, 5 ppm	PCF0805-13-1K-B-T1	FEC 31108863
R15	Resistor, 1 kΩ, 0805, 5 ppm	PCF0805-13-1K-B-T1	FEC 31108863
R16	Resistor, 2 kΩ, 0805, 5 ppm	PCF0805-13-2K-B-T1	FEC 1108872
R17	Resistor, 1 kΩ, 0805, 5 ppm	PCF0805-13-1K-B-T1	FEC 31108863
R18	Resistor, 0805, 680 Ω	MC 0.1W 0805 5% 680R	FEC 9334785
R19	Resistor, 1 kΩ, 0805, 5 ppm	PCF0805-13-1K-B-T1	FEC 31108863
R20	Resistor, 1 kΩ, 0805, 5 ppm	PCF0805-13-1K-B-T1	FEC 31108863
R21	Resistor, 0805, 510 Ω	MC 0.1W 0805 5% 510R	FEC 9334637
R22	Resistor, 0805, 1.5 kΩ	MC 0.1W 0805 5% 1K5	FEC 9333924
TP1	Red test point	20-2137	FEC 240-333
TP2	Red test point	20-2137	FEC 240-333
TP3	Red test point	20-2137	FEC 240-333
TP4	Red test point	20-2137	FEC 240-333
TP5	Red test point	20-2137	FEC 240-333
TP6	Red test point	20-2137	FEC 240-333
TP7	Red test point	20-2137	FEC 240-333
U1	18-bit DAC	AD5780BCPZ	AD5780BCPZ
U2	Single op amp	AD8675ARZ	AD8675ARZ
U9	Dual op amp	AD8676BRZ	AD8676BRZ
U4	64k I^2C serial EEPROM	24LC64-ISN	FEC 9758070
U5	5 V reference	ADR4550BRZ	ADR4550BRZ
U6	Single, 8-pin op amp	AD8675ARZ	AD8675ARZ
U8	Dual op amp	AD8676BRZ	AD8676BRZ
VOUT	Straight PCB mount SMB jack, 50 Ω	1-1337482-0	FEC 1206013
VOUT_BUF	Straight PCB mount SMB jack, 50 Ω	1-1337482-0	FEC 1206013
VREF	Straight PCB mount SMB jack, 50 Ω	1-1337482-0	FEC 1206013
VREFN	Straight PCB mount SMB jack, 50 Ω	1-1337482-0	FEC 1206013
VREFP	Straight PCB mount SMB jack, 50 Ω	1-1337482-0	FEC 1206013

NOTES

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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.

UG09726-0-7/12(A)

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