One Technology Way • P.O. Box 9106 • Norwood, MA 02062-9106, U.S.A. • Tel: 781.329.4700 • Fax: 781.461.3113 • www.analog.com

Evaluating the AD5750 Industrial Current/Voltage Output Driver

FEATURES

Current output ranges: 4 mA to 20 mA, 0 mA to 20 mA, 0 mA to 24 mA, ±20 mA, ±24 mA
Voltage output ranges: 0 V to 5 V, 0 V to 10 V, ±5 V, ±10 V
20% overrange
Flexible serial digital interface
On-chip output fault detection
Asynchronous CLEAR pin function
Power supply
AV_{DD} range: +12 V to +20 V
AV_{SS} range: −12 V to −20 V
Output loop compliance to AV_{DD} − 2.0 V
Temperature range: −40°C to +105°C
LFCSP package

APPLICATIONS

Process control
Actuator control
PLC

GENERAL DESCRIPTION

The AD5750 is a single-channel, low cost, precision current/voltage output driver with hardware- or software-programmable output ranges. The software ranges are configured via an SPI-/MICROWIRE®-compatible serial interface.

The output current range is programmable across five current ranges: 4 mA to 20 mA, 0 mA to 20 mA, 0 mA to 24 mA, ±20 mA, and ±24 mA.

Voltage output is provided from a separate pin that can be configured to provide 0 V to 5 V, 0 V to 10 V, ±5 V, or ±10 V output ranges. An overrange of 20% is available on the voltage ranges.

The input to the AD5750 is an analog input ranging from 0 V to 4.096 V. After the range is selected, 0 V outputs the low end of the selected range, and 4.096 V outputs the high end of the selected range. This evaluation board is configured to allow the AD5750 to be driven with an on-board DAC (AD5662 16-bit, 0 V to 4.096 V output). Alternatively, the user can configure an external 0 V to 4.096 V input. The evaluation board can operate the AD5750 in software mode only.

The evaluation board is powered via terminal blocks and requires a sense resistor (R38) of 15 kΩ with less than 15 ppm/°C; there is no load resistor provided on this evaluation board.

EVALUATION BOARD BLOCK DIAGRAM

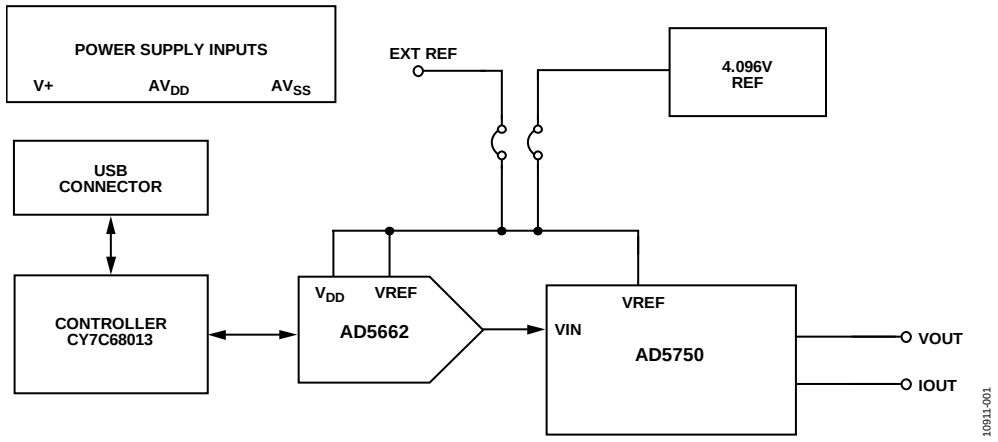

Figure 1.

TABLE OF CONTENTS

REVISION HISTORY

9/12—Revision 0: Initial Version

EVALUATION BOARD HARDWARE

POWER SUPPLIES

The digital section of the AD5750 evaluation board can be powered from the USB port. This is the default setup. It can also be powered by an external supply using the J7 power connector. Both AGND and DGND inputs are provided on the board. The AGND and DGND planes are connected at one location close to the AD5750. Each supply is decoupled to the relevant ground plane using 10 µF and 0.1 µF capacitors. Each device supply pin is also decoupled using a 10 µF and 0.1 µF capacitor pair to the relevant ground plane.

The AV_{DD} and AV_{SS} pins can be operated from ±12 V to ±20 V, respectively (Connector J17). The supply for the on-board reference can be supplied from AV_{DD} or V+ (LK27). The maximum supply for this reference is 18 V. If using AV_{DD} to supply the ADR434, AV_{DD} must be limited to +18 V. The external reference can be overdriven via Connector J2.

LINK OPTIONS

Several link and switch options on the evaluation board should be set for the required operating setup before using the board.

Table 1 lists the default link options. The functions of these link options are described in detail in Table 2. The default setup is for control by the PC via the USB port. The default setting also configures the on-board reference and DAC to provide the analog input to the AD5750.

Table 1. Link Options Default

Link No.	Option (Default)
LK1	B
LK2	Inserted
LK6	A
LK8	A
LK10	B
LK16	Inserted
LK17	Inserted
LK21	Inserted
LK22	Removed
LK23	Inserted
LK25	A
LK27	A

Table 2. Link Options

Link No.	Function
LK1	This link is used to select whether the on-board DAC or an external analog input is used to generate the 0 V to 4.096 V input. Position A: the external source is used. Position B: the on-board DAC is used.
LK2	This link is used to disconnect the on-board DAC to allow connection of an external analog input.
LK6	This link is used to select the power supply source for the ADP3303. Position A: the USB 5 V power supply source is the power supply source for the ADP3303. Position B: J7 is the power supply source for the ADP3303.
LK8	This link is used to select the power supply source for the digital circuitry DV_{CC}. Position A: the USB 5 V power supply source or J7 is the power supply source for the digital circuitry DV_{CC}. Position B: the ADP3303 output is used to supply the digital circuitry DV_{CC}.
LK10	This link is used to determine the connection to the AV_{SS} pin. Position A: the AV_{SS} pin is tied to the J14 connector. Position B: the AV_{SS} pin is tied to GND.
LK16	This link is used to connect the voltage output to a positive sense feedback.
LK17	This link is used to connect the voltage output to a negative sense feedback.
LK21	This link is used to connect the AV_{DD} supply to the AV_{DD} pin of the AD5750. The link should always be inserted.
LK22	This link is used to select an external reference source to be used as the reference/supply to the AD5662 and the reference for the AD5750.
LK23	This link is used to select the on-board ADR434 reference to be used as the reference/supply to the AD5662 and the reference for the AD5750.
LK25	This link is used to determine the connection to Pin 32 (the NC/IFAULT pin). Position A: In software mode, Pin 32 is a no connect (NC) and must be tied to GND. Position B: In hardware mode, Pin 32 is the open-circuit fault alert (IFAULT) and must be tied to a pull-up resistor.
LK27	This link is used to determine the supply to the on-board reference. The maximum supply for this reference is 18 V. If AV_{DD} is used to supply the ADR434, AV_{DD} must be limited to +18 V. Position A: the reference is tied to AV_{DD}. Position B: the reference is tied to V+.

EVALUATION BOARD SOFTWARE

INSTALLING THE SOFTWARE

The AD5750EBZ evaluation kit includes self-installing software on a CD-ROM. The software is compatible with Windows® 2000 and Windows XP and must be install before connecting the evaluation board to the USB port to ensure that the evaluation board is correctly recognized when it is connected to the PC.

1. Insert the CD-ROM into the disc drive. The installation process should automatically begin. If the setup file does not run automatically when you insert the CD-ROM, run the **setup.exe** file directly from the CD-ROM.
2. After the installation from the CD-ROM has completed, connect the AD5750 evaluation board to the USB port using the cable supplied in the evaluation board kit.
3. The software should automatically detect the evaluation board. Follow the on-screen instructions to complete the installation.

USING THE SOFTWARE

To run the software,

1. From the **Analog Devices** menu, select **Start** > **All Programs** > **Analog Devices** > **AD5750** > **AD5750 Evaluation Software**. The window shown in Figure 2 should appear.

Programming the AD5750 Analog Input (Section 1)

The analog input to the AD5750 is provided from the on-board AD5662 16-bit DAC. The AD5662 is a 16-bit, 5 V DAC. Both the power supply and the reference to the DAC are supplied from an on-board reference ADR434 (4.096 V). This reference can be overdriven and an external reference supply can be connected via Connector J2.

To program the AD5662 DAC,

1. Type the data-word in hexadecimal format in the **Enter Data Word** box within Section 1 of the main window.
2. Click **OK** to program the DAC.

The **AD5662 programmed word** should then display the programmed word to the DAC. If you are using an external DAC, there is no need to program the on-board DAC.

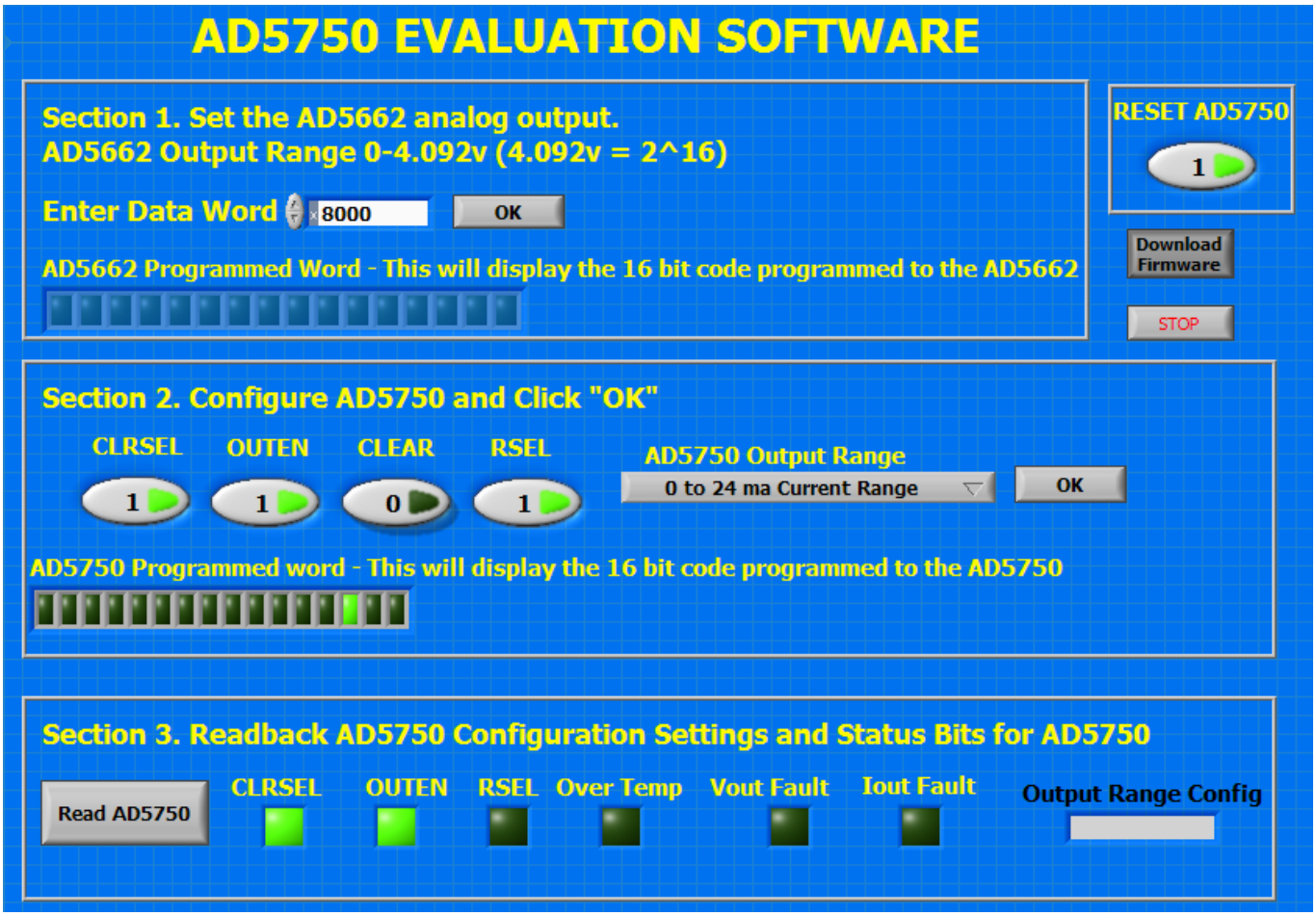

Figure 2. Main Window

Configuring the AD5750 Range and Settings (Section 2)

Using Section 2 of the evaluation board software's main window allows various functions of the AD5750 to be configured.

CLRSEL

The **CLRSEL** box selects the CLEAR condition—either zero scale or full scale of the selected range. Setting CLRSEL to 1 selects the midscale of the selected range. Clearing CLRSEL to 0 selects the full scale of the selected range.

CLEAR

The **CLEAR** box implements a clear condition. Setting CLEAR to 1 sets the CLEAR bit in the register and clears the output. Clearing CLEAR to 0 enables the output with the last code programmed.

OUTEN

The **OUTEN** box enables and disables the output. Setting OUTEN to 1 enables the output. Clearing OUTEN to 0 disables the output.

RSEL and AD5750 Output Range

The AD5750 output range is selected using a combination of the **AD5750 Output Range** pull-down menu and the **RSEL** box. The RSEL bit nominally selects whether the internal or external sense resistor is enabled but is also used as a decode bit to allow for extra ranges (for example, current-mode overranges and an extra voltage range). Table 3 shows the implementation and settings for choosing all the available ranges.

To set the AD5750 output range,

1. Using Table 3, determine the output range required.
2. Set the **RSEL** and **AD5750 Output Range** as detailed in Table 3.

Table 3. Configuring the AD5750 Output Range

	Settings in Section 2 of Main Window	
Output Range Required	**RSEL**	**AD5750 Output Range**
4 mA to 20 mA output using external current sense resistor option	0	4 mA to 20 mA current range
0 mA to 20 mA output using external current sense resistor option	0	0 mA to 20 mA current range
0 mA to 24 mA output using external current sense resistor option	0	0 mA to 24 mA current range
±20 mA output using external current sense resistor option	0	±20 mA current range
±24 mA output using external current sense resistor option	0	±24 mA current range
0 V to 5 V voltage range	0 or 1	0 V to 5 V voltage range
0 V to 10 V voltage range	0 or 1	0 V to 10 V voltage range
±5 V voltage range	0 or 1	±5 V voltage range
±10 V voltage range	0 or 1	±10 V voltage range
0 V to 6 V voltage range	0 or 1	0 V to 6 V voltage range
0 V to 12 V voltage range	0 or 1	0 V to 12 V voltage range
±6 V voltage range	0 or 1	±6 V voltage range
±12 V voltage range	0 or 1	±12 V voltage range
±2.5 V voltage range	0	Range 1101
0 V	0	Range 1110
0 V	0	Range 1111
4 mA to 20 mA output using internal current sense resistor option	1	4 mA to 20 mA current range
0 mA to 20 mA output using internal current sense resistor option	1	0 mA to 20 mA current range
0 mA to 24 mA output using internal current sense resistor option	1	0 mA to 24 mA current range
±20 mA output using internal current sense resistor option	1	±20 mA current range
±24 mA output using internal current sense resistor option	1	±24 mA current range
3.92 mA to 20.4 mA using internal current sense resistor option	1	Range 1101
0 mA to 20.4 mA using internal current sense resistor option	1	Range 1110
0 mA to 24.5 mA using internal current sense resistor option	1	Range 1111

Reading Back from the AD5750 (Section 3)

The main window also allows you to read back the status of various AD5750 bits. Within Section 3 in the main window of the evaluation board software, click **READ AD5750** to read back from the AD5750.

CLRSEL

The **CLRSEL** box displays the condition of the CLRSEL bit in the control register. Reading back a CLRSEL setting of 1 indicates that the midscale of the range is selected. Reading back a CLRSEL setting of 0 indicates that the full-scale of the range is selected.

OUTEN

The **OUTEN** box displays whether the output is enabled or disabled. Reading back a OUTEN setting of 1 indicates that the output is enabled. Reading back a OUTEN setting of 0 indicates that the output is disabled.

RSEL

The **RSEL** box displays the condition of the RSEL bit internally. Reading back a RSEL setting of 0 indicates that the external sense resistor is selected. Reading back a RSEL setting of 1 indicates that the internal sense resistor is selected.

Over Temp

The **Over Temp** box indicates when the core temperature exceeds 150°C. Reading back an Over Temp setting of 1 indicates that the core temperature has exceeded 150°C.

Iout Fault

The **Iout Fault** box indicates when there is an open-circuit condition on the current output channel. Reading back an Iout Fault setting of 1 indicates that there is an open-circuit condition on the current output channel.

Vout Fault

The **Vout Fault** box indicates when there is a short-circuit condition on the voltage output channel. Reading back a Vout Fault setting of 1 indicates that there is a short-circuit condition on the voltage output channel.

Output Range Config

The **Output Range Config** box shows the selected output range configuration.

Resetting the AD5750

Click **RESET AD5750** to reset the AD5750. Setting **RESET AD5750** to 1 resets the part. Clearing **RESET AD5750** to 0 puts the part back in normal mode.

TESTING THE OUTPUTS

Voltage Output

The voltage output is available on the VOUT channel. Connect this channel to a digital volt meter (DVM) to monitor the output voltage.

Current Output

The current output is available on the IOUT channel. On the AD5750 evaluation board, the IOUT output is terminated with a ±2.0 ppm/°C, 250 Ω load resistor. This resistor is rated at 0.6 W. The maximum output in current mode from the AD5750 is 24.5 mA; therefore, the maximum power dissipation using this resistor is 0.15 W. Using the setup provided, you can connect the IOUT channel to a DVM to monitor the output voltage and calculate the output current.

EVALUATION BOARD SCHEMATICS AND ARTWORK

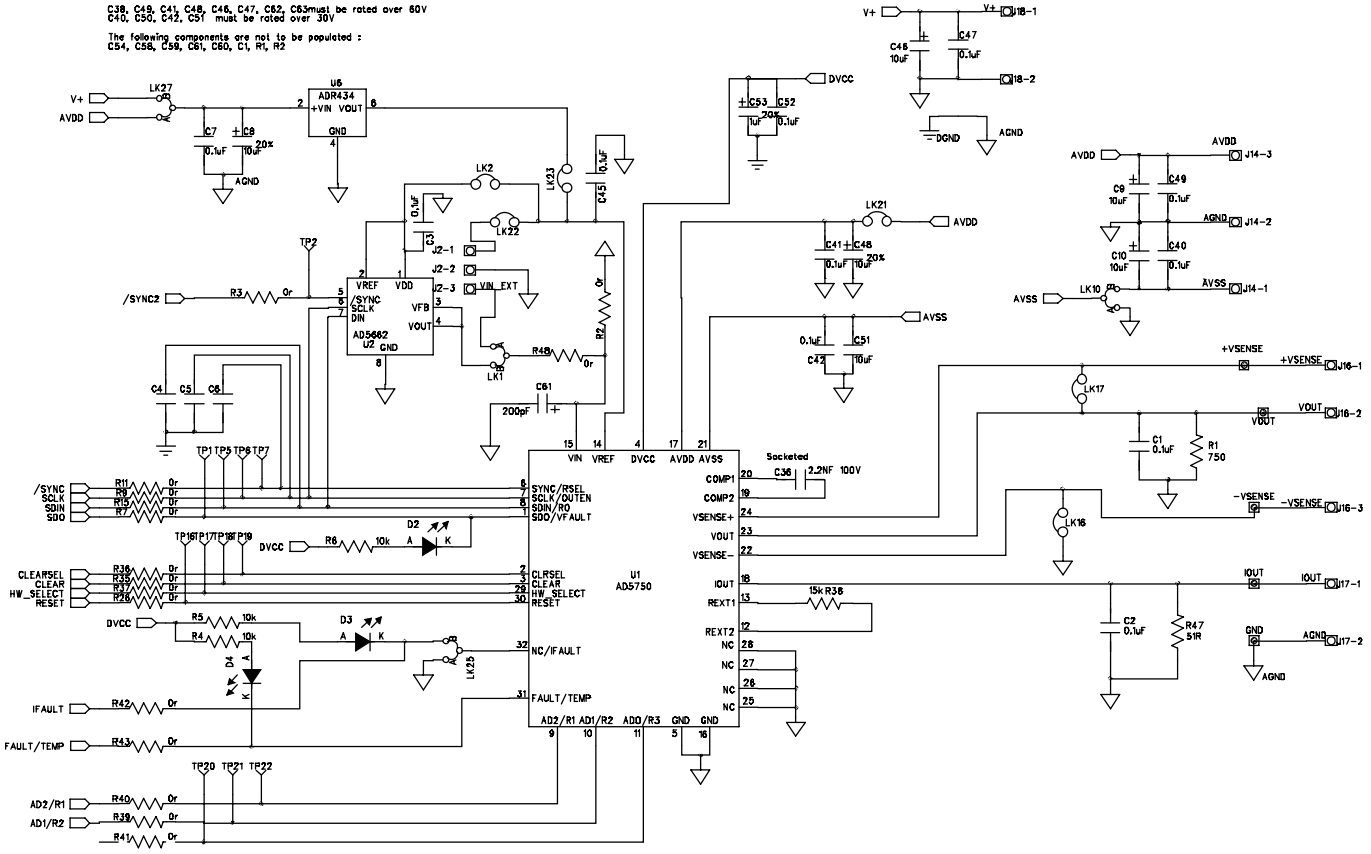

Figure 3. Main Device Circuitry

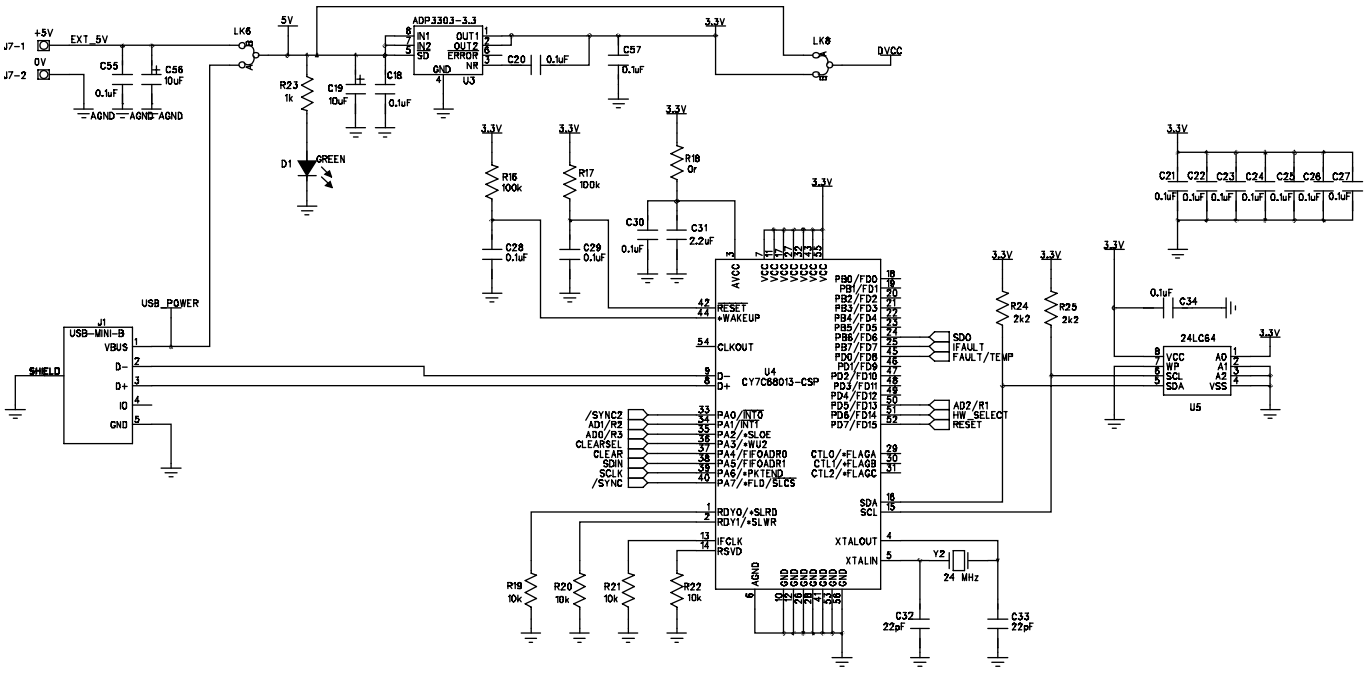

Figure 4. USB Controller Circuitry

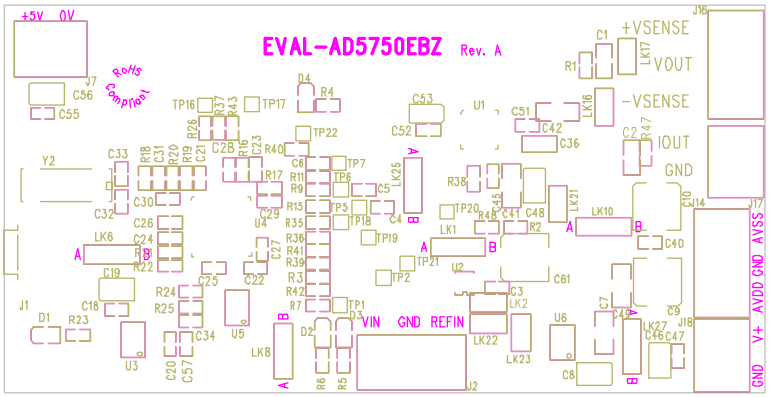

Figure 5. Component Placement

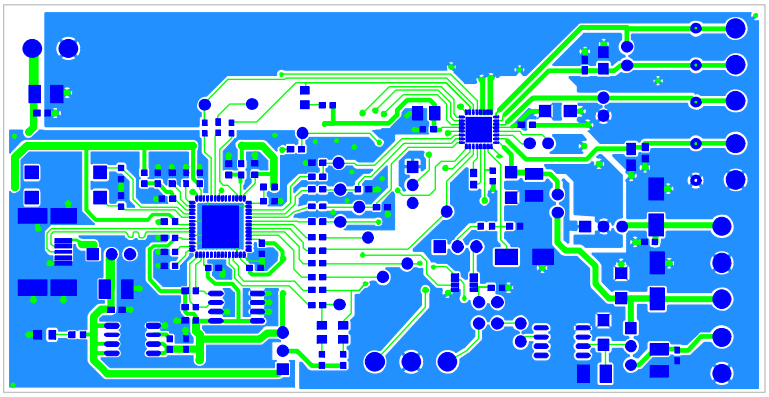

Figure 6. Top PCB Layer

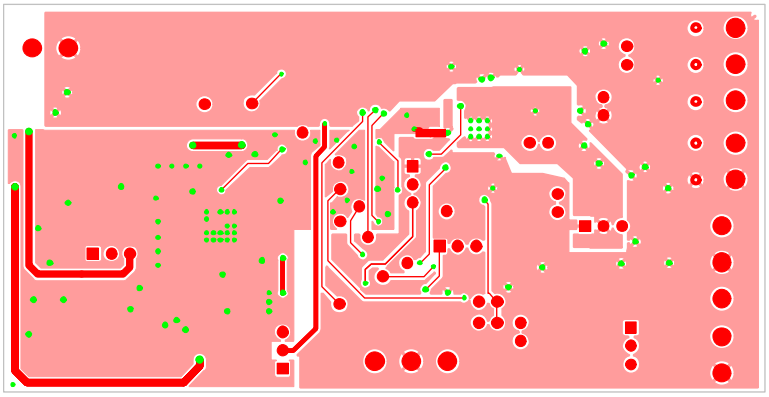

Figure 7. Bottom PCB Layer

BILL OF MATERIALS

Table 4.

Name	Part Description	Part Number	Stock Code
C1, C3, C18, C20, C21, C22, C23, C24, C25, C26, C27, C28, C29, C30, C34, C45, C47, C52, C55, C57	0.1 µF, 16 V, X7R, ceramic capacitor	CM105X7R104K16AT	FEC 1216538
C2, C4, C5, C6, C61			DNP
C7, C40, C41, C42, C49	0.1 µF, 100 V, ceramic capacitor	C1206F104K1RAC	FEC 1288275
C8, C19, C46, C56	10 µF, 10 V, SMD, tantalum capacitor	MCCTB106M010	FEC 1190113
C9, C10, C48	10 µF, 63 V, electrolytic capacitor	EEEFK1J100P	FEC 9696008
C31	2.2 µF, 10 V, Y5V, ceramic capacitor	9402098	FEC 9402098
C32, C33	22 pF, 50 V, NPO, ceramic capacitor	2238 867 15229	FEC 722005
C51	10 µF, 35 V, Y5V, ceramic capacitor	GMK316F106ZL-T	Digikey 587-1352-1-ND
C53	1 µF, 10 V, SMD, tantalum capacitor	TAJR105K010R	FEC 197099
D1, D2, D3, D4	Red, SMD LED	HSMH-C170	FEC 5790840
J1	USB Mini-B connector (USB-OTG)	565790576	FEC 9786490
J2, J7, J14, J16, J17, J18	3-pin terminal block (5 mm pitch)	CTB5000/3	FEC 151790
LK1, LK2, LK6, LK8, LK10, LK16, LK17, LK21, LK22, LK23, LK25, LK27	3-pin (0.1 inch pitch) header and shorting shunt	M20-9990246	FEC 1022249 & 150-411
R1, R2, R47			DNP
R3, R7, R9, R11, R15, R18, R26, R35, R36, R37, R39, R40, R41, R42, R43, R48	0 Ω, SMD resistor	MC 0.063W 0603	FEC 9331662
R4, R5, R6, R19, R20, R21, R22	10 kΩ, SMD resistor	MC 0.063W 0603	FEC 9330399
R16, R17	100 kΩ, SMD resistor	MC 0.063W 0603	FEC 9330402
R23	1 kΩ, SMD resistor	MC 0.063W 0603	FEC 9330380
R24, R25	2.2 kΩ, SMD resistor	MC 0.063W 0603	FEC 9330810
R38	15 kΩ, precision SMD resistor	RN73C2A15KBTG	FEC 1140932
U1	8 × 12 analog switch array	AD5750YCPZ	AD5750YCPZ
U2	16-bit *nano*DAC® with reference	AD5662BRJZ-2500RL7	AD5662BRJZ-2500RL7
U3	Precision low dropout voltage regulator	ADP3303ARZ-3.3	ADP3303ARZ-3.3
U4	USB microcontroller	CY7C68013-56LFC	CY7C68013-56LFC
U5	64k EEPROM	24LC64-I/SN	Digikey 24LC64-I/SN-ND
U6	Reference	ADR434ARMZ	ADR434ARZ/ADR434BRZ
Y2	24 MHz , plastic SMD crystal	X24M000000S244	FEC 9509658

RELATED LINKS

Resource	Description
AD5750	Product Page: Industrial Current/Voltage Output Driver with Programmable Ranges
AD5662	Product Page: 2.7 V to 5.5 V, 250 µA, Rail-to-Rail Output 16-Bit *nano*DAC in a SOT-23
ADR434	Product Page: Ultralow Noise XFET® 4.096 V Voltage Reference with Current Sink and Source Capability
ADP3303	Product Page: High Accuracy anyCAP® 200 mA Low Dropout Linear Regulator

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.

UG10911-0-9/12(0)

www.analog.com