

ADS522xEVM User's Guide

This document provides the information needed to set up and operate the ADS522xEVM evaluation module (EVM). For a more detailed description of the ADS5220 and the ADS5221, please refer to the product datasheets available from the Texas Instruments web site at <http://www.ti.com>. Additional support documents are listed in the section of this guide entitled **Related Documentation from Texas Instruments**. Throughout this document, the acronym *EVM* and the phrase *evaluation module* are synonymous with the ADS522xEVM. This user's guide includes setup and configuration instructions, information regarding operating procedures and input/output connections, an electrical schematic, PCB layout drawings, and a parts list for the EVM.

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1 Overview

This User's Guide gives a general overview of the ADS522xEVM, and provides a general description of the features and functions to be considered while using this module. Unless otherwise specified, the abbreviation *ADS522x* refers to the ADS5220 and ADS5221 family of devices.

1.1 Purpose

The ADS522x EVM provides a platform for evaluating the ADS5220 and ADS5221, 12-bit analog-to-digital converters (ADCs) under various signal, reference, and supply conditions. This document should be used in combination with the EVM schematic diagram (see [Figure 6](#)).

1.2 EVM Basic Functions

Analog input to the ADC is provided via on-board SMA connectors. The single-ended input at SMA can be converted into a differential signal at the input of the ADS522x. The EVM provides two analog input paths. One input path uses a differential amplifier, while the other input is transformer-coupled.

The EVM also provides an on-board SMA connector for input of the ADC clock. The clock input path uses a TTL translator, and allows the user to apply a single-ended sine wave clock to the EVM.

Digital output from the EVM is performed via a 40-pin connector. The digital outputs from the ADC are buffered before going to the connector.

Power connections to the EVM are via the CON 3TERM SCREW and the CON 6TERM SCREW connectors. Separate connectors are provided for the ADC analog and driver supplies, the external buffer supply, the clock driver supply and the differential amplifier supply.

1.3 Power Requirements

The ADS522xEVM can be powered with only a single +3.3V supply if it is used in the transformer-coupled input configuration and internal reference mode. An additional $\pm 5V$ supply is required when using the differential amplifier input configuration. Provision has also been made to allow the EVM to be powered with independent supplies in order to provide higher performance.

1.4 Voltage Limits Warning

CAUTION
Exceeding the maximum input voltages can damage EVM components.
Undervoltage conditions may cause improper operation of some or all of the EVM components.

1.5 ADS522xEVM Operating Procedure

The ADS522xEVM provides a flexible means of evaluating the ADS5220 and ADS5221 in a number of operating modes. The following list shows a basic set-up procedure that can be used as a board confidence check.

1. Verify that all jumper settings match those listed in [Table 1](#), [Table 2](#) and [Table 3](#).

Table 1. ADS522xEVM Connectors

Connector ID	Function	Default Configuration
J1	SMA, Analog input of DUT through transformer	Installed
J2	SMA, Analog input of DUT through OPA	Installed
J3	SMA, Clock input of DUT through TTL translator	Installed
J4	SMA, optional external clock input of SN74LVTH16374	Installed
J5	40-Pin Terminal Strip, EVM digital output data bus	Installed
P1	3-pin Terminal block, OPA power supply	Installed
P2	6-pin Terminal block, DUT power supply	Installed
TP1	Optional connector for external reference voltage	Installed
TP2	Optional connector for input common-mode voltage	Installed

Table 2. ADS522xEVM Three-Pin Jumper

Jumper ID	Function	Default Configuration
JP1	Pin 2 is connected with MSB (pin 1 of ADS522x), pin 1 is GND, and pin 3 is +3.3V.	Installed 1-2
JP2	Pin 2 is connected with CE (pin 2 of ADS522x), pin 1 is GND, and pin 3 is +3.3V.	Installed 1-2
JP3	Pin 2 is connected with MSEL (pin 3 of ADS522x), pin 1 is GND and pin 3 is +3.3V.	Installed 1-2
JP4	Pin 2 is connected with STPD (pin 4 of ADS522x), pin 1 is GND and pin 3 is +3.3V.	Installed 1-2
JP5	Pin 2 is connected with QPD (pin 5 of ADS522x), pin 1 is GND and pin 3 is +3.3V.	Installed 1-2
JP6	Pin 2 is connected with RSEL (pin 31 of ADS522x), pin 1 is GND and pin 3 is +3.3V.	Installed 1-2

Table 3. 0Ω Resistor Connection (Jumper) for Three Analog Input Options

Option ID	Configuration	Default
Option 1 – Differential input through transformer	R11 and R16 are on. R12 and R15 are off. R22, R54, R55, R69 are on. R8, R14, R7, R56 are off. C13, C54 and C55 are off. C39 is on.	Yes
Option 2 - Single-ended input through transformer	R11 and R16 are on. R12 and R15 are off. R7, R8, R56 and R57 are on. R14, R22, R54, R55 and R69 are off. C13, C54, C55 are on. C39 is off.	No
Option 3 - Differential input through OPA	R12 and R15 are on. R11 and R16 are off. R13 and R14 are on. R56, R57, R7 and R8 are off. C13 is off, and C39 is on.	No
R* are not installed in the default case	R12, R15, R21, R19, R36, R61, R60, R52, R58, R23, R18 and R70 are not installed for default mode.	No

2. Connect supplies to the EVM in this sequence:
 - External buffer supply (V_{DD_Buf}) to J7(1) and return to J7(3)
 - +2.5v to 3.3V ADC output buffer supply (VDRV) to J7(2) and return to J7(3)
 - Supply ground to J7(3)
 - +3.3V ADC analog supply (DUTA) to J7(5) and return to J7(3)
 - +3.3V ADC digital supply (DUTD) to J7(4) and return to J7(3)
 - +3.3V clock driver supply (V_{DD_CLK}) to J7(6) and return to J7(3)
 - When R51 and R9 are installed (default configuration), J7(5) and J7(6) should not be connected to the supply.
3. Switch power supplies on.
4. Use a function generator with a 50Ω output to input a 65MHz signal for the ADS5221 (40MHz for the ADS5220); for both devices, use a 0V offset, $0.7V_{RMS}$ sine wave signal into J3 (clock input). The frequency and amplitude of the clock must be within the specification for the device speed grade.
5. Use a function generator with a 50Ω output to provide a 10MHz, 0V offset and -1dBFS amplitude sine wave signal into J1 (analog input). This will provide a transformer-coupled differential input signal to the ADC.
6. The digital pattern on the output connector J5 should now represent a sine wave and can be monitored using a logic analyzer.

1.6 Installation Note

The default operational mode on the ADS522xEVM is mode one: differential input through a transformer. The following components should not be installed when the EVM is in default mode.

1. Components that have the symbol “*”
2. Components that have the symbol “(2)”
3. Components that have the symbol “(3)”

All other components in the schematic should be installed when using the EVM in default mode. Be sure that the following components are also installed:

1. Components that have the symbol “(1)(2)”
2. SN74LVTH16374 should be installed for U4

1.6.1 Related Documentation from Texas Instruments

The following documents provide information regarding Texas Instrument integrated circuits used in the assembly of the ADS522xEVM. The latest revisions of these documents are available from the TI web site at <http://www.ti.com>.

Data Sheet

ADS5220 Datasheet

ADS5221 Datasheet

Literature Number

[SBAS261](#)

[SBOS262](#)

2 Circuit Description

2.1 Schematic Diagram

The schematic diagram for the EVM is shown in [Figure 6](#).

2.2 Circuit Function

The following sections describe the function and placement of individual circuits. Refer to the relevant product datasheet for device-specific operating characteristics.

2.2.1 Analog Input

The EVM can be configured to provide the ADC with either transformer-coupled input or differential amplifier input driven to a single-ended source. The inputs are provided via SMA connectors J1 for transformer-coupled input and J2 for differential amplifier input. To set up one of these options, the EVM must be configured in the following manner:

1. Differential input through transformer.

This option provides a differential input to the ADS522x by converting a single-ended input signal into a differential signal using an RF transformer. The single-ended signal source is connected to J1, the primary side of the RF transformer (ADT1-1WT). The differential inputs, pin 41 and pin 42 of the ADS522x, are connected to the secondary side of the transformer through a 0Ω resistor connection (R11, R16). The secondary CT (center point) of the transformer is connected to the common-mode voltage of 1.5V (1.17V when the clock input is on) through a 0Ω resistor connection (see [Table 3](#)). Note that the analog input common-mode voltage is from a simple resistor network (not a buffer) on the EVM, so it is changed when the clock is on. This common-mode voltage can be adjusted in the range of 0.8V to 1.5V on the EVM for best performance by using TP2 (with R58 installed and R5 removed). The default value is 1.5V. A 50Ω termination resistor (R21) is optional for flexible applications, and is not installed in the default mode. The transformer has an impedance ratio of 1 with an approximate bandwidth of 400kHz to 800MHz.

2. Single-ended input through transformer.

This option provides single-ended input to the ADS522x through an external transformer. The single-ended signal source is connected to J1, the primary side of the transformer. The secondary side of the transformer is connected to +IN through R11, and –IN pin of the ADS522x is connected to the common-mode voltage through the 0Ω resistor. The EVM provides a 1.25V common-mode voltage (default value) for both the –IN pin and IN+ through the 0Ω resistor connection (see [Table 3](#)). Note that the common-mode voltage for the single-ended configuration can be adjusted for optimum performance from 0.8V to 1.25V on the EVM by using TP2 (R58 is on and R5 is off). The ADS522x provides the best performance at differential input configuration.

3. Differential input through OPA.

This option provides a differential input to the ADS522x by an external differential operational amplifier (OPA). A single-ended signal source is connected to J2, the non-inverting input of the OPA (THS4503, wideband, low-distortion fully differential amplifier). The differential output of the OPA with common-mode voltage is connected to the differential input, pin 41 and pin 42 of ADS522x, through a 0Ω resistor connection (R12, R15). The 1.5V common-mode voltage is provided through the 0Ω resistor connection (see [Table 3](#)). A DC or AC signal can be connected to the OPA through the 0Ω resistor connection (R13, R17) or by replacing it with a 0.1μF capacitor. The THS4503 operates on a ±5V power supply from J6, and is configured for a gain of 1 on the EVM. Additional details of the THS4503 are included in the [THS4503 product datasheet](#), available for download at www.ti.com.

2.2.2 Clock Input

The EVM provides a PECL-to-TTL translator on the clock input path. A low jitter sine wave with 0.7V_{RMS} is commonly applied to J3.

2.2.3 Power

The EVM requires 3.3V analog supply, 3.3V digital supply, and 2.5V to 3.3V for the digital driver supply (VDRV). When operating the onboard amplifier, the EVM requires an additional $\pm 5V$ supply for the OPA. The analog supply (V_{DDA}) and digital supply (V_{DDD}) of the ADS522x have separate supply decoupling. The digital driver supply should be provided separately from the analog supply for high performance. When VDRV is 2.5V, the ADS522x has better performance than when VDRV is 3.3V.

2.2.4 Reference

The default reference mode on the EVM is internal reference. The EVM layout enables all the reference modes, including an internal programmable REF through connectors R18 and R23. The external reference voltage can be applied at TP1. Additional details regarding the reference mode configuration are included in the ADS522x datasheets.

2.2.5 Data Outputs/Digital Control

Data outputs from the ADC are buffered using an SN74LVTH16374 (or SN74AVC16244 with the installation of R60 and R61). The output data connector J5 is a standard 40-pin header that allows easy connection to a logic analyzer. The connector pinout is listed in [Table 4](#). The digital input control pins of the ADS522x are controlled through jumpers JP1 to JP6. The EVM provides an extra SMA connector (J4) for an alternate external clock.

Table 4. Output Connector J5 (IDC-40, 40-pin Terminal Strip)

J5 Pin	Description	J5 Pin	Description
1	Clk	2	GND
3	NC	4	GND
5	D11 (MSB)	6	GND
7	D10	8	GND
9	D9	10	GND
11	D8	12	GND
13	D7	14	GND
15	D6	16	GND
17	D5	18	GND
19	D4	20	GND
21	D3	22	GND
23	D2	24	GND
25	D1	26	GND
27	D0 (LSB)	28	GND
29	OVR	30	GND
31	NC	32	GND
33	NC	34	GND
35	NC	36	GND
37	NC	38	GND
39	NC	40	GND

3 Physical Description

This section describes the physical characteristics and PCB layout of the evaluation module, and lists the components used in the ADS522xEVM.

3.1 PCB Layout and Schematic

The EVM is constructed on a 5-layer, 2.5in x 3in, 0.0625in-thick PCB using FR-4 material. The DUT and external digital buffer are on the top layer. The clock driver and OPA are on the bottom layer. The individual layers are shown in [Figure 1](#) through [Figure 5](#). The ADS522xEVM schematic is shown in [Figure 6](#).

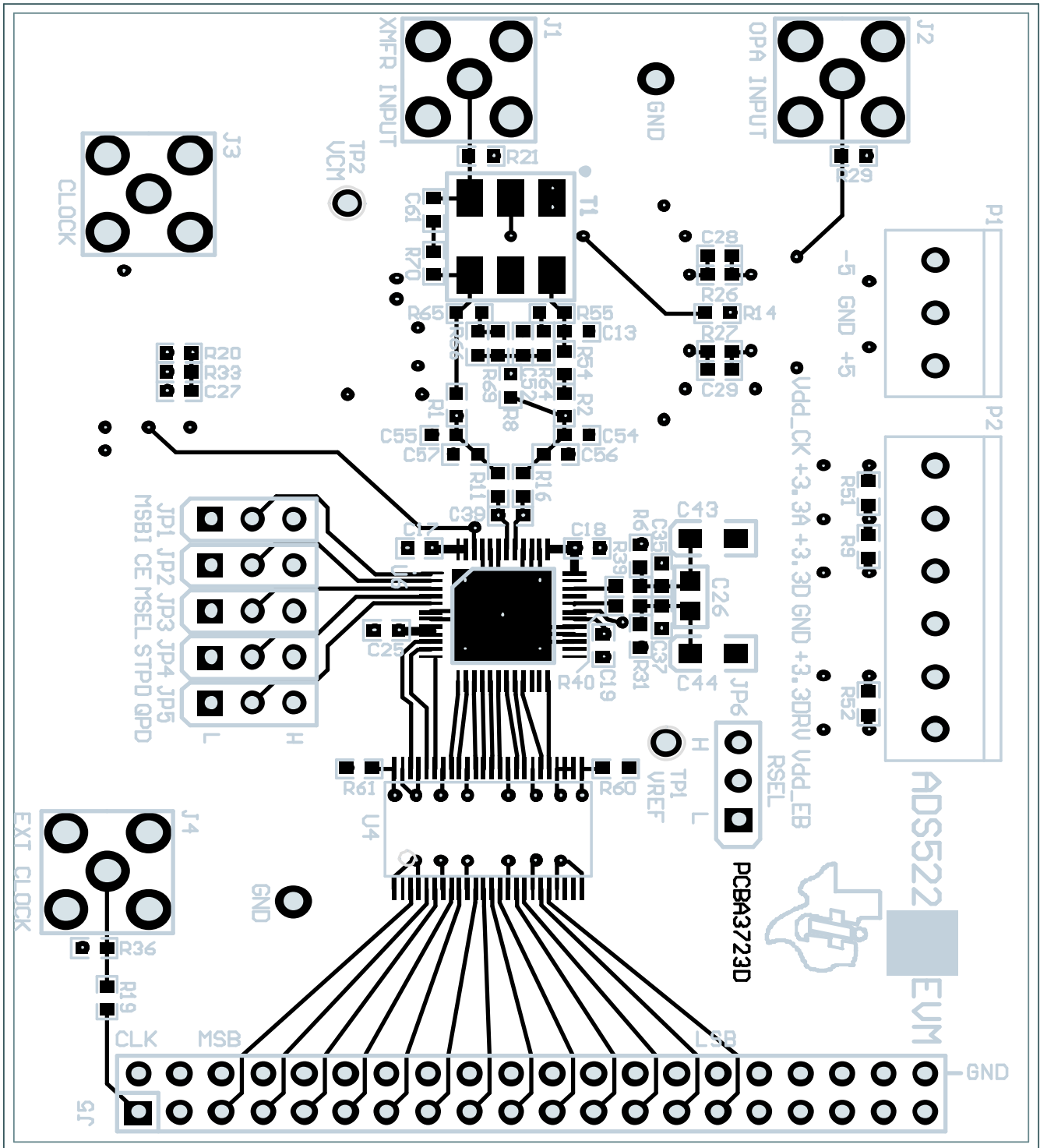


Figure 1. ADS522xEVM Top Layer

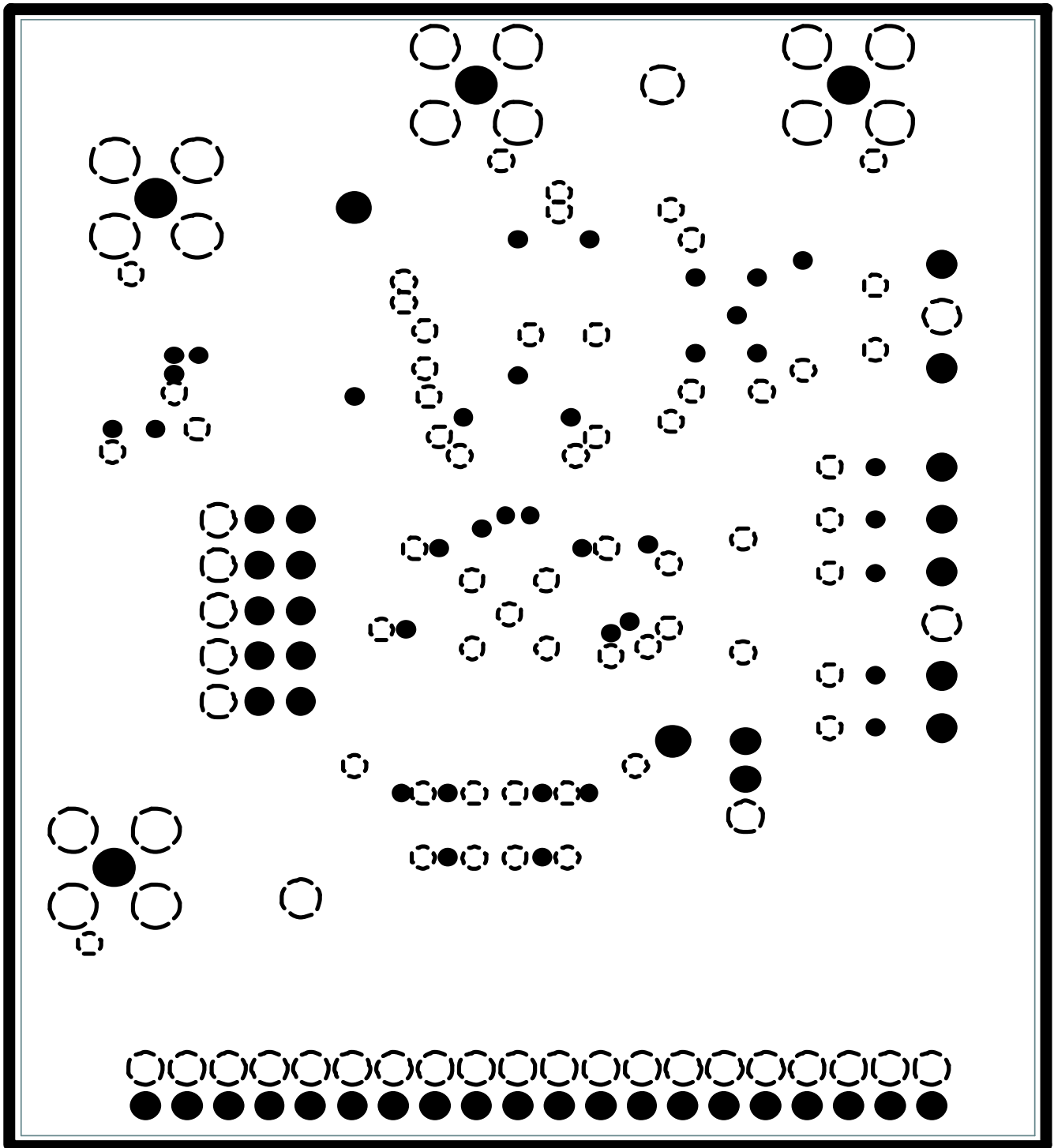


Figure 2. ADS522xEVM Ground Layer

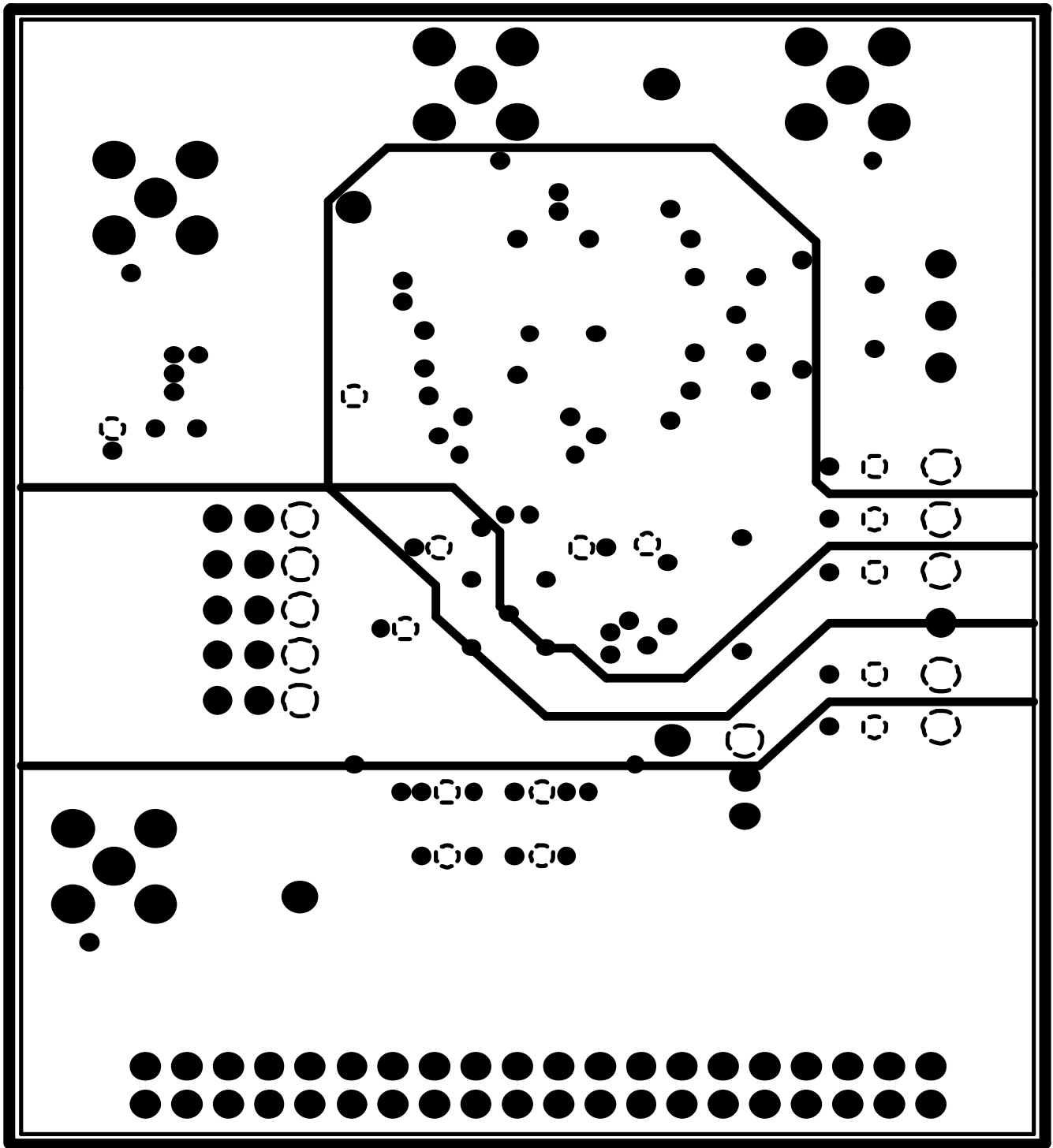


Figure 3. ADS522xEVM Power Layer

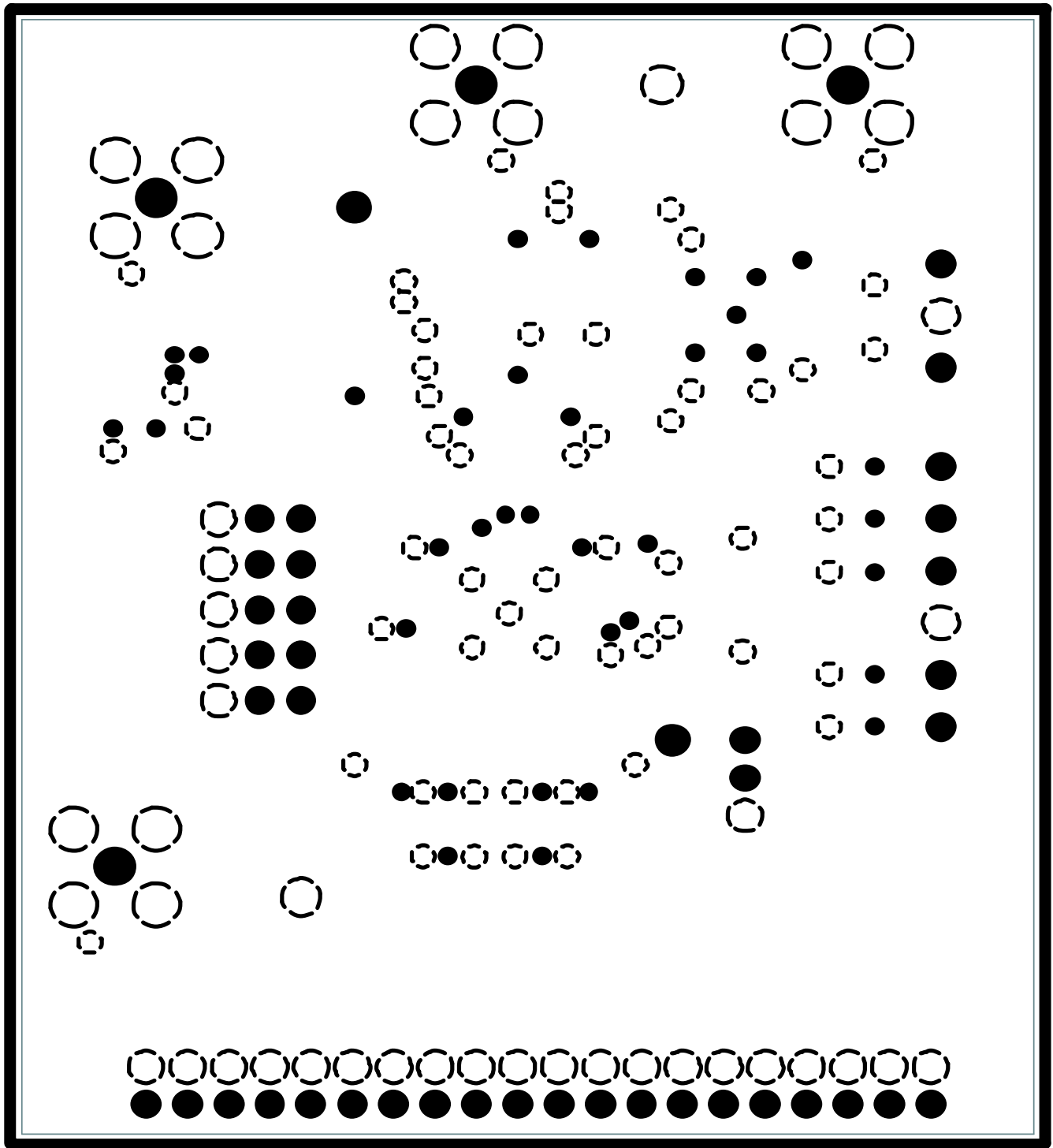


Figure 4. ADS522xEVM Ground Layer

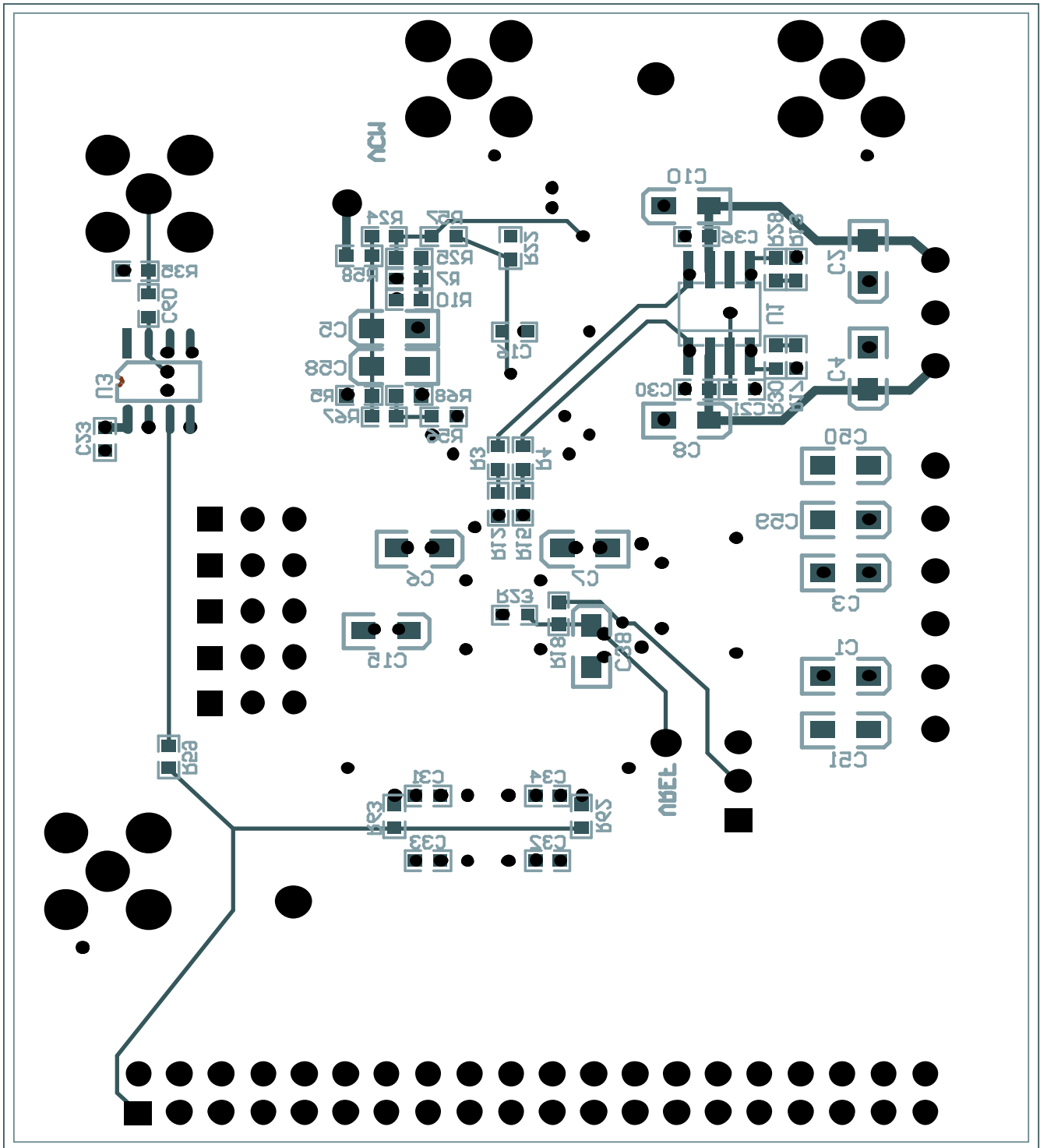


Figure 5. ADS522xEVM Bottom Layer

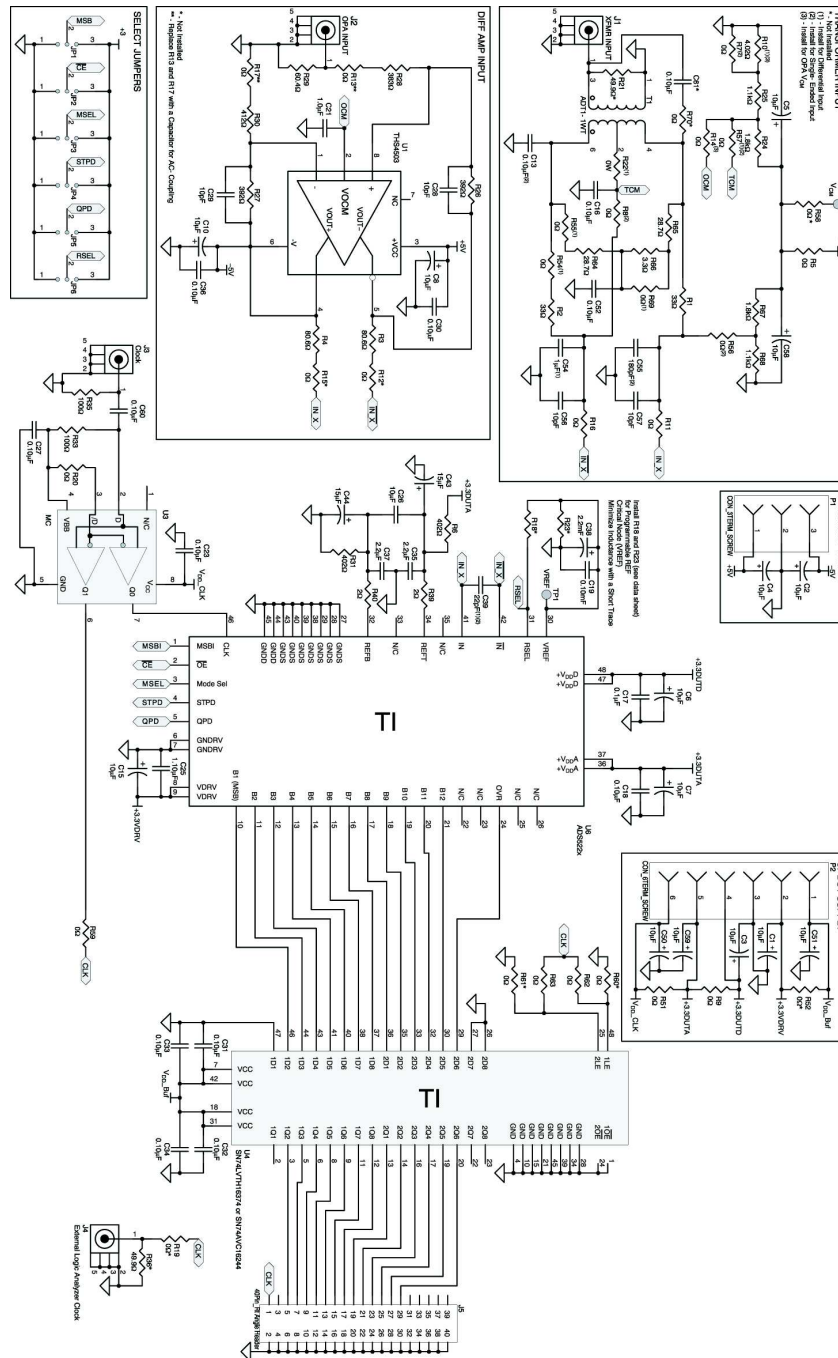


Figure 6. ADS522xEVM Schematic

Physical Description
3.2 Parts List

The Parts List, showing the components used in the assembly of the ADS522xEVM, is given in [Table 5](#).

Table 5. ADS522xEVM Parts List

QTY PER BOARD	VALUE	MFR PART NUMBER	Ref Des	VENDOR	DESCRIPTION	FOOTPRINT	NOT INSTALLED
28	0Ω	P0.0GCT	R5, R8-R11, R13, R16, R17, R20	Digi-Key	1/10W 5% 0603 SMD Resistor	0603	R7, R12, R14, R15, R19, R52, R58, R60, R61, R70
2	2Ω	P2.0GCT	R39, R40	Digi-Key	1/10W 5% 0603 SMD Resistor	0603	
2	28.7Ω	P28.7HCT-ND	R64, R65	Digi-Key	1/10W 10% 0603 SMD Resistor	0603	
3	33Ω	P33.2HCT-ND	R1, R2, R66	Digi-Key	1/10W 10% 0603 SMD Resistor	0603	
2	49.9Ω	P49.9HCT-ND		Digi-Key	1/10W 10% 0603 SMD Resistor	0603	R21, R36
1	60.4Ω	P60.4HCT-ND	R29	Digi-Key	1/10W 10% 0603 SMD Resistor	0603	
2	80.6Ω	P80.6HCT-ND	R3, R4	Digi-Key	1/10W 10% 0603 SMD Resistor	0603	
2	100Ω	P100HCT-ND	R33, R35	Digi-Key	1/10W 10% 0603 SMD Resistor	0603	
1	383Ω	P383HCT-ND	R28	Digi-Key	1/10W 10% 0603 SMD Resistor	0603	
2	392Ω	P392HCT-ND	R26, R27	Digi-Key	1/10W 10% 0603 SMD Resistor	0603	
3	402Ω	P402HCT-ND	R6, R10, R31	Digi-Key	1/10W 10% 0603 SMD Resistor	0603	
1	412Ω	P412HCT-ND	R30	Digi-Key	1/10W 10% 0603 SMD Resistor	0603	
2	1.1kΩ	P1.10KHCT-ND	R25, R68	Digi-Key	1/10W 10% 0603 SMD Resistor	0603	
2	1.8kΩ	P1.8KHCT-ND	R24, R67	Digi-Key	1/10W 10% 0603 SMD Resistor	0603	
1				Digi-Key	1/10W 10% 0603 SMD Resistor	0603	R18
1				Digi-Key	1/10W 10% 0603 SMD Resistor	0603	R23
2	15μF	P11303CT-ND	C43, C44	Digi-Key	6.3V 20% Low-Profile Tantalum Capacitor	3216	
14	10μF	399-1563-1-ND	C1-C8, C10, C15, C50, C51, C58, C59	Digi-Key	10V 10% Low-Profile Tantalum Capacitor	3216	
1	10μF	PCC2327CT-ND	C26	Digi-Key	6.3V 20% X5R 0805 Multilayer Ceramic	805	
3	2.2μF	PCC2273CT-ND	C35, C37, C38	Digi-Key	6.3V 10% X5R 0603 Multilayer Ceramic	0603	
2	1.0μF	PCC2224CT-ND	C21	Digi-Key	16V 10% X5R 0603 Multilayer Ceramic	0603	C54

Table 5. ADS522xEVM Parts List (continued)

QTY PER BOARD	VALUE	MFR PART NUMBER	Ref Des	VENDOR	DESCRIPTION	FOOTPRINT	NOT INSTALLED
17	0.1 μ F	BC1254CT-ND	C16-C19, C23, C25, C27, C30-C34, C36, C52, C60	Digi-Key	16V 10% X7R Multilayer Ceramic	0603	C13, C61
1	180pF	PCC181ACVCT-ND		Digi-Key	50V 10% 0603 SMD Multilayer Ceramic	0603	C55
1	22pF	PCC220ACVCT-NT	C39	Digi-Key	50V 10% 0603 SMD Multilayer Ceramic	0603	
4	10pF	PCC100CVCT-ND	C28, C29, C56, C57	Digi-Key	50V 10% 0603 SMD Multilayer Ceramic	0603	
4	SMA	142-0701-201	J1-J4	Johnson Components	Straight F SMA Jack	SMA_JACK	
1	40-Pin Rt-Angle Terminal Strip	TSW-120-08-G-D-RA	J5	Samtec	20x2-Pin 0.025in ² Terminal Strip, Right Angle	IDC40RT	
6	3-Pos Jumper	A26545-ND	JP1-JP6	Digi-Key	3-Pin 0.025in ² St. Post, 0.10in Header	3POS_JUMP	
6	Shunt	SNT-100-BK-T-H	JP1-JP6	Samtec	Shorting Jumper with Handle		
1	CON_3TERM_SCREW	ED1514-ND	P1	Digi-Key	3-Position Terminal Block, 3.5mm	3P-TERM	
1	CON_6TERM_SCREW0	ED1518-ND	P2	Digi-Key	6-Position Terminal Block, 3.5mm	6P-TERM	
1	ADT1-WT	ADT1-1WT	T1	Mini-Circuits	1:1 RF Transformer	TTWB	
1	Test_Hook	5007K	TP1, TP2	Digi-Key	White PC Test Point 0.063in D	TP	
1	THS45036	THS4503ID	U1	Texas Instruments	Wideband, Low Distortion Differential Operational Amplifier	SO-8	
1	MC100EPT26	MC100EPT26 DOS-ND	U3	Motorola	XLATOR 1:2 FNO PECL-TTL	SO-8	
1	SN74LVTH16374	SN74LVTH16374 DGGR	U4	Texas Instruments	3.3V 16-Bit D Flip-Flop	48-TSSOP (DGGR)	
1	ADS5220	ADS5220PFBT	U6 ⁽¹⁾	Texas Instruments	12-Bit, 40MSPS, 3V A/D Converter	48-TQFP (PFB)	
or	ADS5221	ADS5211PFBT	U6 ⁽¹⁾	Texas Instruments	12-Bit, 65MSPS, 3V A/D Converter	48-TQFP (PFB)	

(1) Populate U6 based on specified order.

FCC Warnings

This equipment is intended for use in a laboratory test environment only. It generates, uses, and can radiate radio frequency energy and has not been tested for compliance with the limits of computing devices pursuant to subpart J of part 15 of FCC rules, which are designed to provide reasonable protection against radio frequency interference. Operation of this equipment in other environments may cause interference with radio communications, in which case the user at his own expense will be required to take whatever measures may be required to correct this interference.

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EVM WARNINGS AND RESTRICTIONS

It is important to operate this EVM within the input voltage range of -0.3V to 3.6V and the output voltage range of -0.3V to 3.6V.

Exceeding the specified input range may cause unexpected operation and/or irreversible damage to the EVM. If there are questions concerning the input range, please contact a TI field representative prior to connecting the input power.

Applying loads outside of the specified output range may result in unintended operation and/or possible permanent damage to the EVM. Please consult the EVM User's Guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative.

During normal operation, some circuit components may have case temperatures greater than 60°C. The EVM is designed to operate properly with certain components above 60°C as long as the input and output ranges are maintained. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors. These types of devices can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during operation, please be aware that these devices may be very warm to the touch.

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