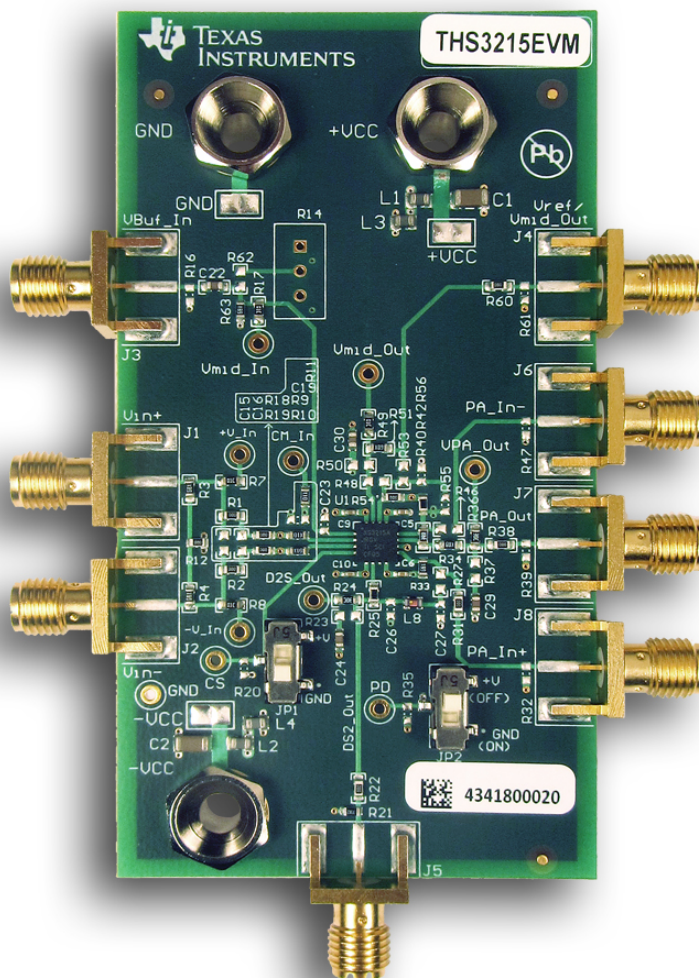


THS3215EVM and THS3217EVM



This user guide describes the characteristics, operation, and use of the THS3215EVM and THS3217EVM (THS321xEVM). This evaluation module (EVM) is a demonstration fixture for the [THS3215](#) and [THS3217](#) family of wideband, differential DAC to single-ended line drivers. The EVM provides 50-Ω input and output termination for easy evaluation with common 50-Ω test equipment. A complete circuit description, schematic diagram, printed circuit board (PCB) layout, and bill of materials are included.

Throughout this document, the terms demonstration kit, evaluation board, evaluation module, and EVM are synonymous with the THS321xEVM.

Contents

1	Introduction	3
2	Design Considerations	4
3	Schematic, PCB Layout, and Bill of Materials	8

List of Figures

1	THS321x Power-Supply Schematic	4
2	Logic Control Switches.....	4
3	Midscale Buffer Configuration Options.....	5
4	D2S Input Connection Options.....	6
5	200-MHz Butterworth Filter Before D2S Inputs	7
6	OPS Input and Output Connection Options	8
7	EVM Schematic	9
8	Layer 1: Top Signal Layer.....	10
9	Layer 2: GND Plane	10
10	Layer 3: Power Plane, $\pm V_{CC}$	10
11	Layer 4: Power Plane, $\pm V_{CC}$	10
12	Layer 5: GND Plane	11
13	Layer 6: Bottom Signal Layer.....	11

List of Tables

1	Bidirectional Switch Settings	4
2	Bill of Materials, THS321x EVM	13

1 Introduction

This section provides a general description of the THS3215 and THS3217 devices and the EVM.

1.1 THS3215 and THS3217 Description

The [THS3215](#) and [THS3217](#) (THS321x) combine the key signal-chain components required to interface with a complementary-current output, digital-to-analog converter (DAC). These two-stage devices deliver the low-distortion, dc-coupled, single-ended signal required by a wide range of applications. The input stage buffers the DAC resistive termination, and converts the signal from differential to single-ended with a fixed gain of 2 V/V. The differential to single-ended output is available externally for direct use, and can also be connected through an RLC filter or attenuator to the input of an internal output power stage (OPS). The wideband, current-feedback, OPS provides all pins externally for flexible gain setting.

An internal 2×1 multiplexer (mux) to the OPS noninverting input provides an easy means to select between the internal differential-to-single ended stage (D2S) output or an external input. More information on the THS3215 and THS3217 can be found in their respective product data sheets, [SBOS780](#) and [SBOS766](#).

1.2 EVM Description

The THS321xEVM enables performance evaluation of each individual subblock within these devices. The PCB provides various flexible options to also test either the THS3215 or THS3217 as a complete system. The EVM provides placeholders to insert filters at different points within the system to allow for more realistic end-application evaluation.

The following list describes key EVM components:

- Power input: ± 6 VDC (typical) at $+V_{CC}$ (P3, TP1) and $-V_{CC}$ (P1, TP2)
- Common reference: GND (P2, TP3 and TP13)
- Interface to the midscale buffer input pin, VMID_IN, through J3 (TP8).
- Interface to the midscale buffer output pin, VMID_OUT, through J4 (TP9).
- Interface to the D2S noninverting signal input pin, IN+, through J1 (TP4).
- Interface to the D2S inverting signal input pin, IN–, through J2 (TP5).
- Interface to the D2S output pin, VO1, through J5 (TP14)
- Interface to the D2S reference input, VREF, through J4. SMA connector J4 is shared with the midscale buffer output. Depending on the components populated on the board, the appropriate signal is available at the SMA connector.
- PATHSEL control through switch CS_SW (TP12). [Section 2.2](#) describes the operation of the switch logic.
- Interface to the OPS external, noninverting input pin, VIN+, through J8.
- DISABLE control through switch PD_SW (TP11). [Section 2.2](#) describes the operation of the switch logic.
- Interface to the OPS output pin, VOUT, through J7 (TP10).
- Interface to the OPS inverting input pin, VIN–, through J6.

2 Design Considerations

This section discusses general design considerations and options when setting up and configuring the various blocks in THS321xEVM.

2.1 Power Supplies

Power is applied to the board through connectors P1, P2, and P3, as shown in Figure 1. Both bipolar and single-sided supplies can be used. The typical supplies are ± 6 V.

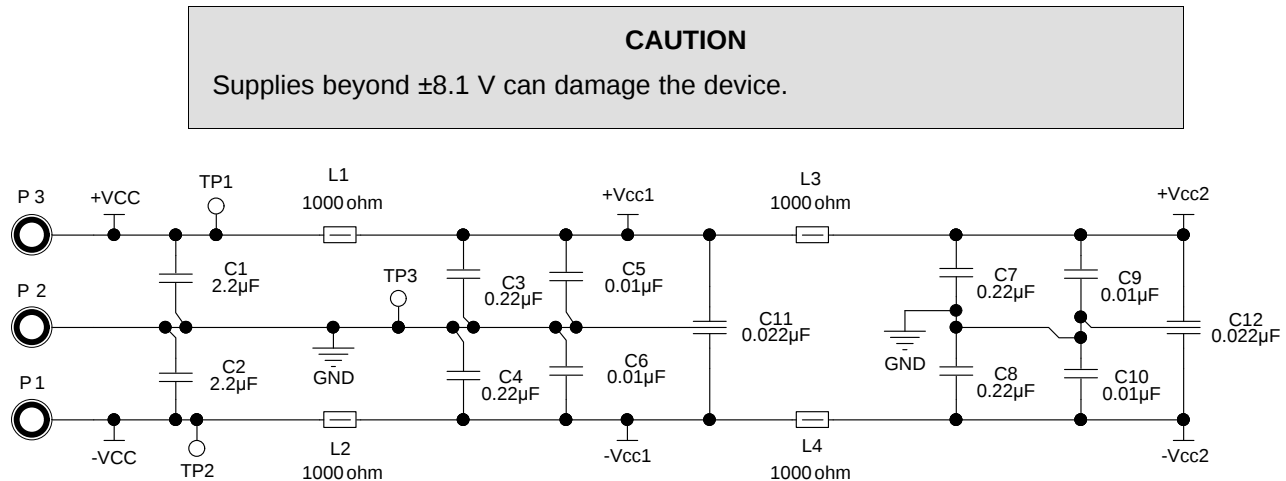


Figure 1. THS321x Power-Supply Schematic

2.2 Digital Logic Control

There are two bidirectional switches on the THS321xEVM that control the status of the PATHSEL and DISABLE control pins. Figure 2 shows the control logic with respect to the switch position. For brevity, the PATHSEL control is shown as CS and the DISABLE control is shown as PD on the PCB. The full switch settings are listed in Table 1.

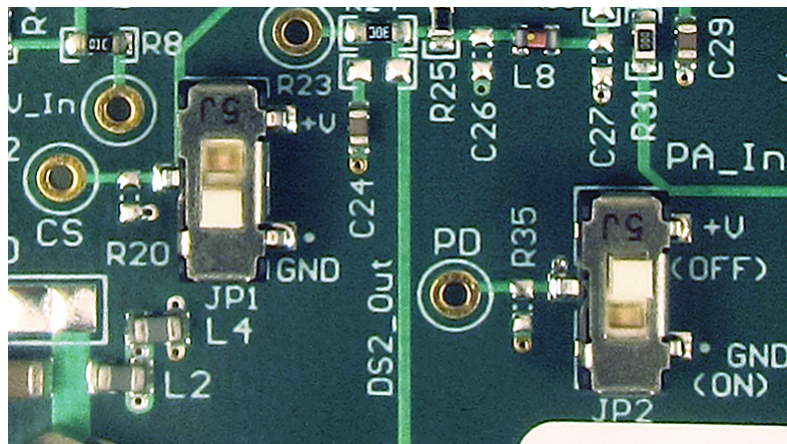


Figure 2. Logic Control Switches

Table 1. Bidirectional Switch Settings

Switch	Set to +VCC	Set to GND
CS_SW (PATHSEL control)	OPS external, noninverting path	Internal path from D2S to OPS
PD_SW (DISABLE control)	OPS off	OPS on

2.3 Midscale or Reference Buffer

The EVM is configured by default to drive a ground-centered signal. In cases where a different output common-mode voltage is required, use the midscale buffer to provide a low impedance path. This buffer is also used in applications where a servo loop is required to set the dc offset of the system to a desired value. Alternatively, the buffer can also be used to set the reference voltage in single-supply applications where the inputs to the D2S are ac-coupled. The midscale buffer input defaults to the midsupply voltage. In cases where a different input voltage is required, adjust the R14 potentiometer (uninstalled by default) to achieve the desired offset voltage. Resistor R62 must be appropriately sized, and resistor R63 uninstalled in order to set the correct voltage at the input of the midscale buffer. The EVM allows for connecting the output of the midscale buffer to various nodes of the THS321x. The different options are:

1. In single-supply and ac-coupled applications, the common-mode input of the D2S is configured in one of two ways. The first way is by installing $R56 = 0 \Omega$. This setting connects the output of the buffer to the Junc_Vocm node on the board. Components R5, R6, R11, and C19 must be appropriately sized and installed. The second way is by applying an external common-mode voltage through test-point TP7.
2. If the output common-mode voltage of the D2S must be set to any voltage other than GND, uninstall resistors R54 and R51, and install R48 instead. This configuration connects the output of the midscale buffer to VREF (pin 14).
3. If the OPS is configured in the noninverting mode with a common-mode dc offset voltage from the D2S, then the D2S provides the necessary dc bias to the noninverting pin of the OPS. However, if the OPS R_G is grounded, the dc common-mode offset voltage from the D2S is amplified by $(1 + R_F / R_G)$, and may result in limited output headroom from the OPS. To prevent this limitation, connect R_G to the midscale buffer output so that the common-mode gain is 0 dB by setting R55 to the desired value of the gain resistor and uninstalling R42. Installing R55 connects the output of the midscale buffer to Junc_Vneg enabling configuration of the OPS in a level-shifted, common-mode, noninverting configuration. Make sure that R54 and R60 are uninstalled, and $R51 = R53 = 0 \Omega$ in this configuration.

The areas within the dashed boxes in [Figure 3](#) show the described configurations.

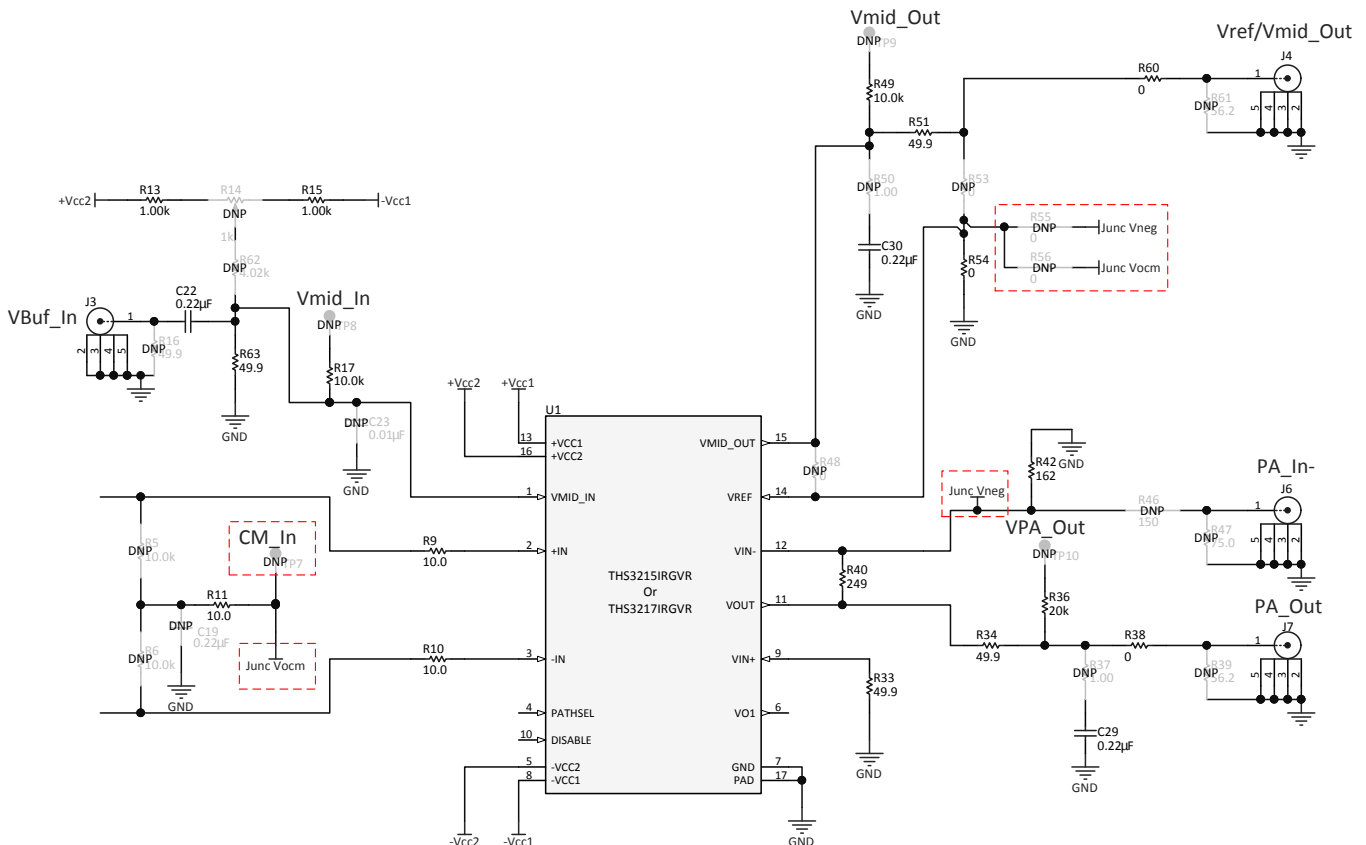


Figure 3. Midscale Buffer Configuration Options

2.4 Differential to Single-Ended Stage (D2S)

The D2S inputs are driven by an external differential signal through SMA connectors J1 and J2. Standard lab equipment usually provides only a single-ended output. The [LMH3401](#), a very wideband, single-ended to differential amplifier, was used during product evaluation to drive a differential signal into the D2S. The spacing of the SMA connectors on the THS321xEVM is designed to interface directly with the output of the [LMH3401EVM](#) through standard SMA barrel connectors. The THS321xEVM provides a standard 100- Ω differentially-terminated resistive network to GND, dc-coupled to the D2S input pins. [Figure 4](#) shows the EVM schematic of the D2S input/output network with the default passive components installed. The output of the D2S can also be measured externally at J5.

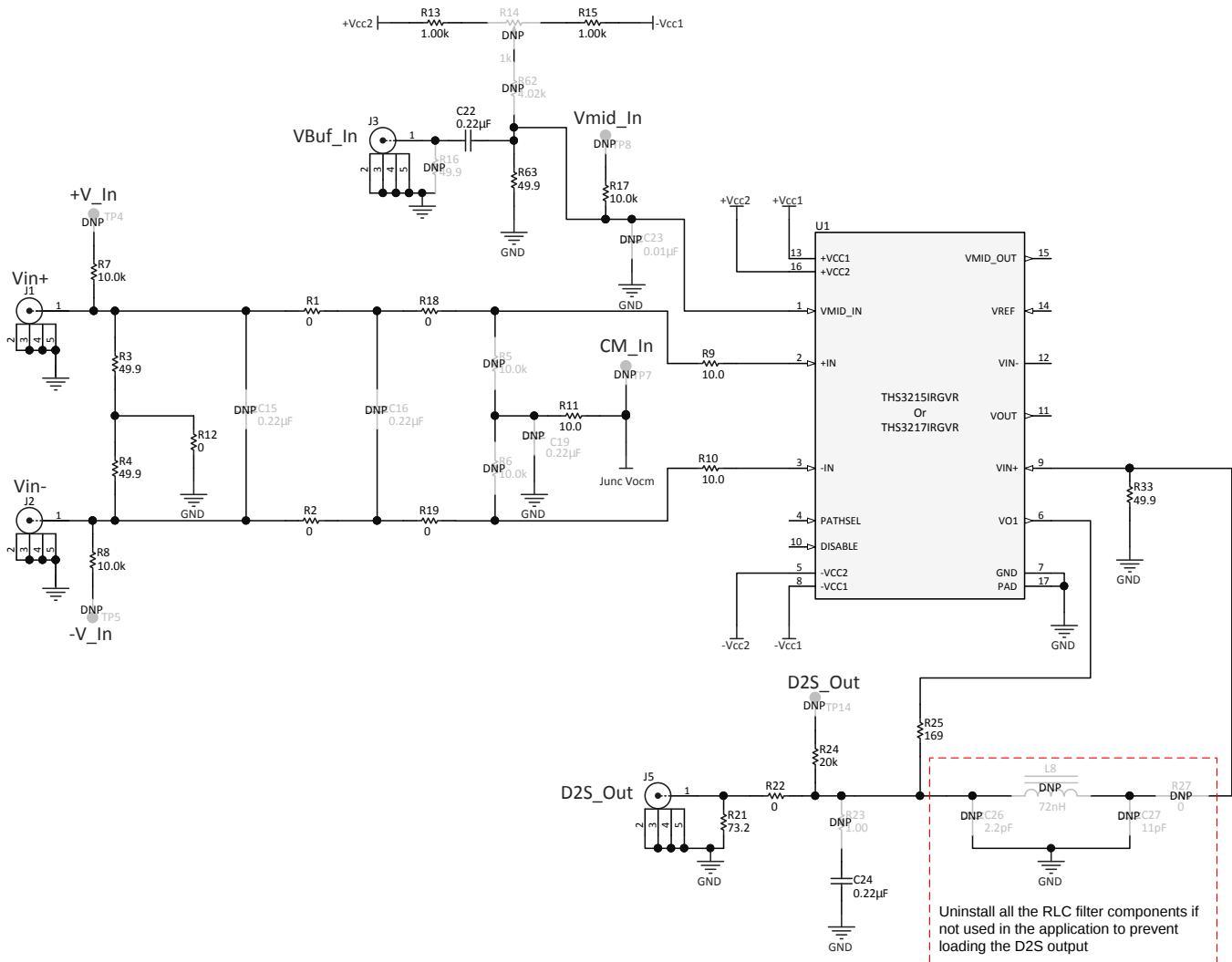


Figure 4. D2S Input Connection Options

The EVM allows for flexibility in the D2S input network configuration. The different options are:

1. In order to reduce the high-frequency noise and distortion components from the previous stage driving the D2S, a passive RLC filter can be inserted prior to the D2S inputs. [Figure 5](#) shows an example of a third-order, 200-MHz, Butterworth filter placed between the DAC output and D2S input. The THS321xEVM is able to evaluate system performance with similar RLC-filter architectures installed on the board.

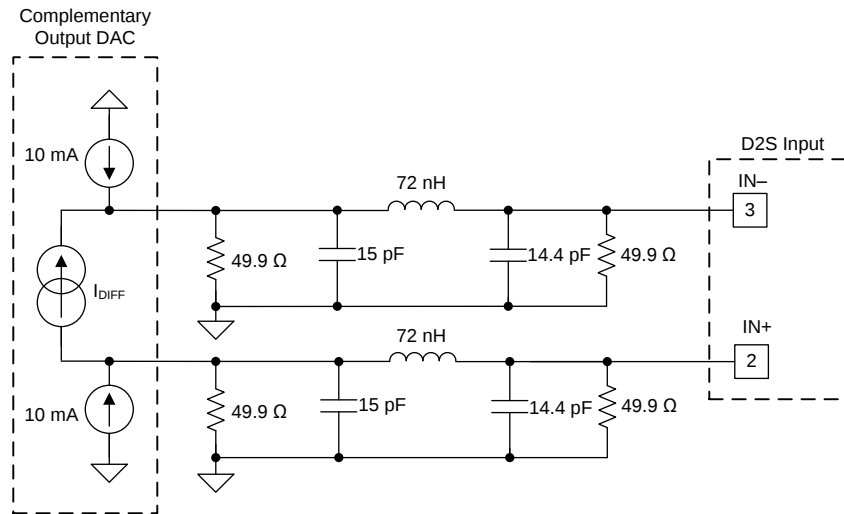


Figure 5. 200-MHz Butterworth Filter Before D2S Inputs

2. In single-supply and ac-coupled applications, use R18 and R19 to install the appropriately-sized, ac-blocking capacitors (see [Figure 4](#)). Use the midscale buffer output in conjunction with R56, R11, R5, and R6 to set the desired dc common-mode voltage for the D2S input.
3. The output of the D2S is fed into the internal, noninverting input pin of the OPS by driving PATHSEL low through switch CS_SW.
4. Certain applications may require an interstage filter inserted between the D2S and OPS to reduce overall system noise, and prevent high-frequency harmonics from previous stages propagating to the OPS output. In such situations, use C26, L8, and C27 to insert a third-order, RLC filter into the signal path of the THS321x (see [Figure 4](#)). The output of the filter then drives the external noninverting input of the OPS, VIN+ (pin 9).

2.5 Output Power Stage (OPS)

As described in [option 3](#) and [option 4](#) of [Section 2.4](#), the OPS can be driven internally or externally. The OPS can be also used as a standalone amplifier in an inverting or noninverting configuration. The output of the OPS is available at SMA connector J7. [Figure 6](#) shows the EVM schematic of the OPS input/output network with the default passive components installed. The different options are:

1. When configuring the OPS as a standalone-noninverting amplifier, apply the external input at J8. Set termination resistor R33 = 49.9 Ω .
2. When configuring the OPS as a standalone-inverting amplifier, apply the external input at J6. Set R46 as the R_G resistor, and R47 as the termination resistor. R42 must be uninstalled in this configuration.
3. To conserve power, disable the OPS by setting the DISABLE control low through switch PD_SW.

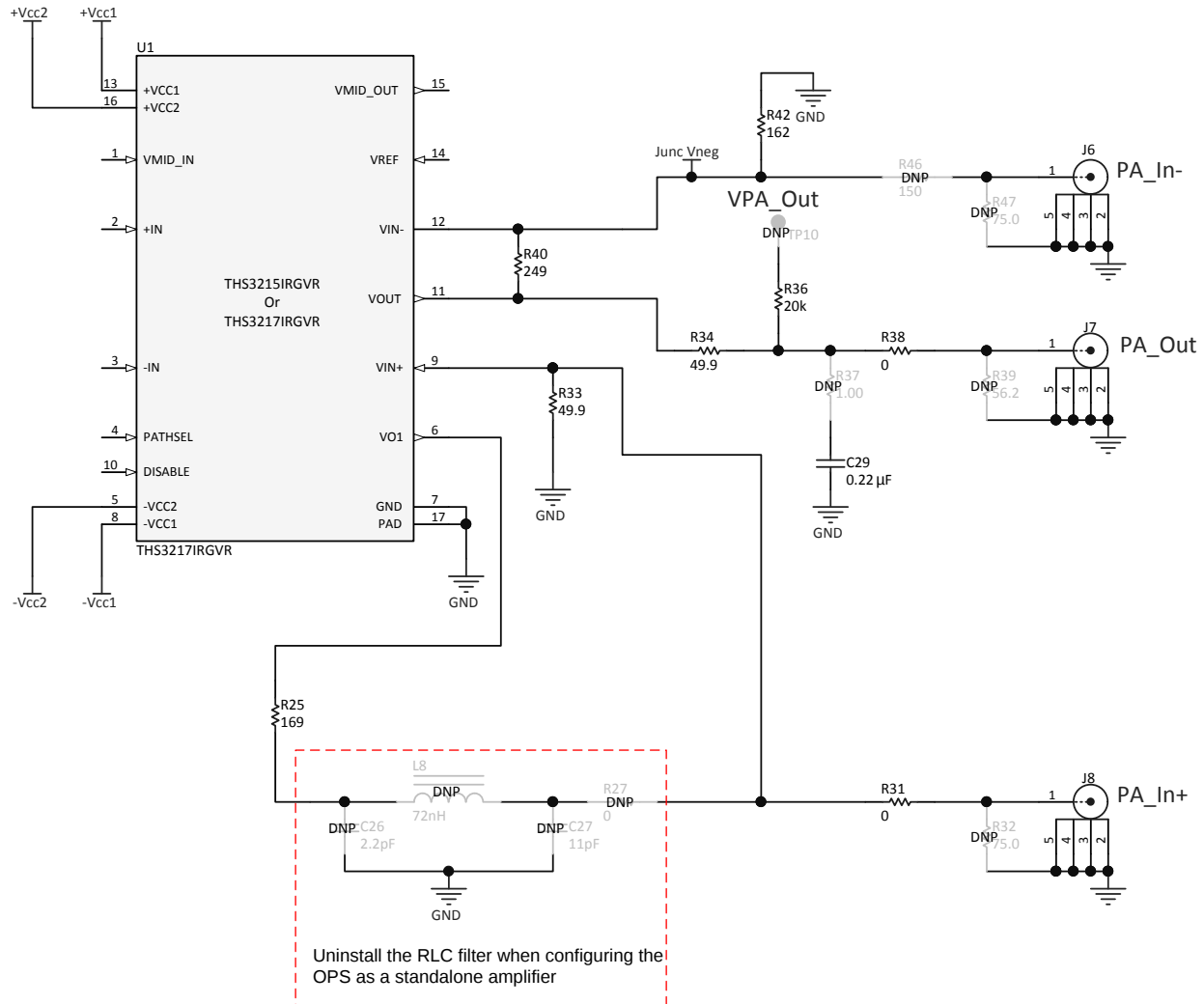


Figure 6. OPS Input and Output Connection Options

3 Schematic, PCB Layout, and Bill of Materials

This section provides a complete schematic diagram, PCB layout, and bill of materials (BOM) for the THS321xEVM.

3.1 Schematic

[Figure 7](#) shows the schematic.

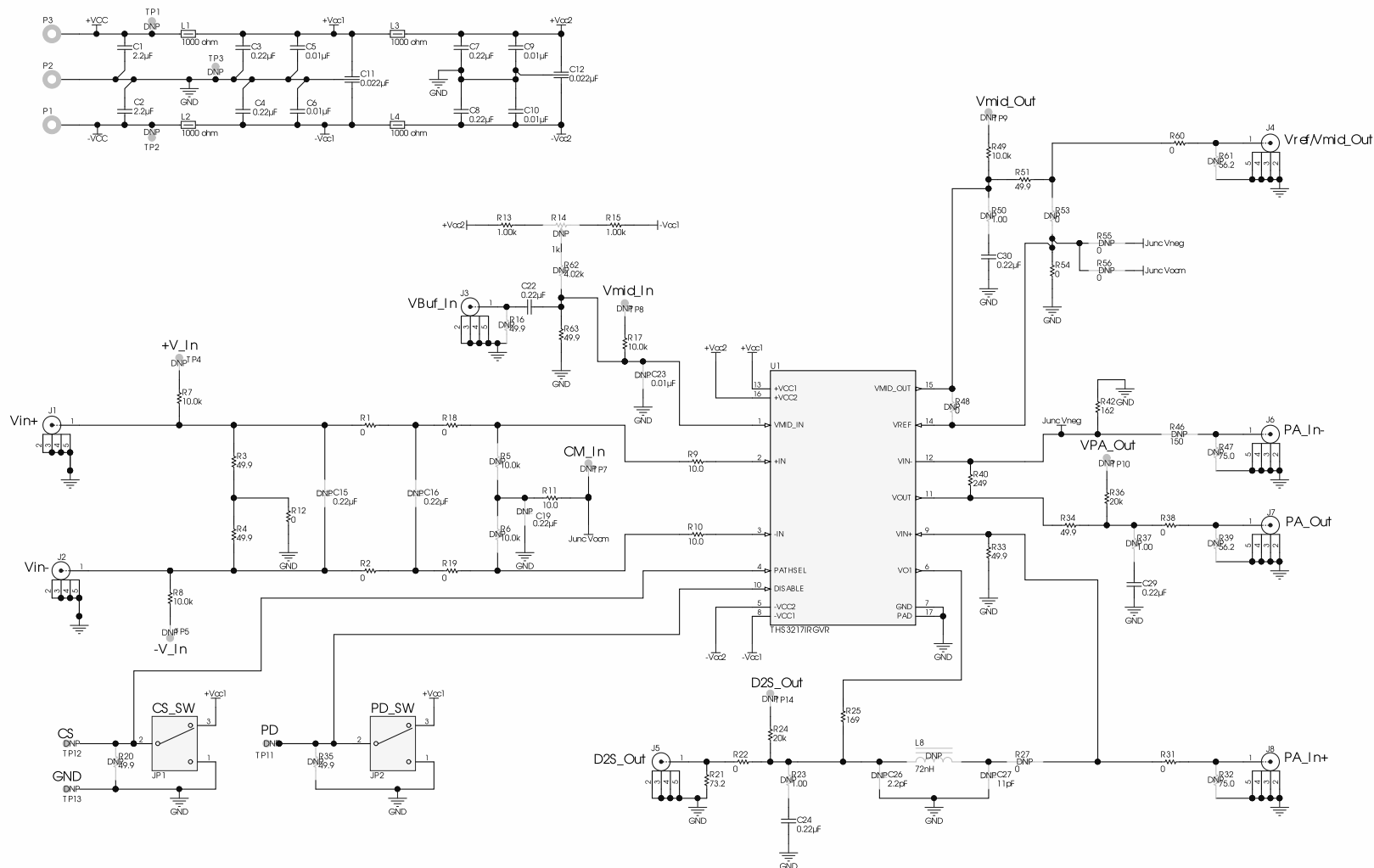


Figure 7. EVM Schematic

3.2 PCB Layout

The PCB layers are shown in Figure 8 through Figure 13.

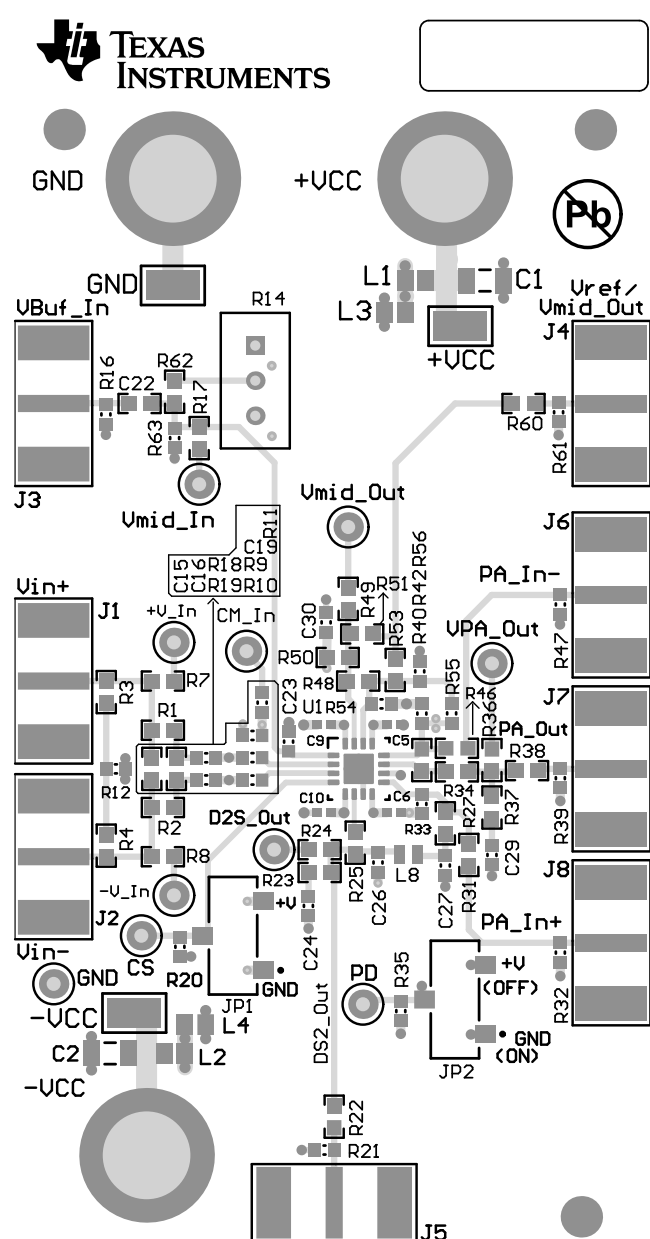


Figure 8. Layer 1: Top Signal Layer

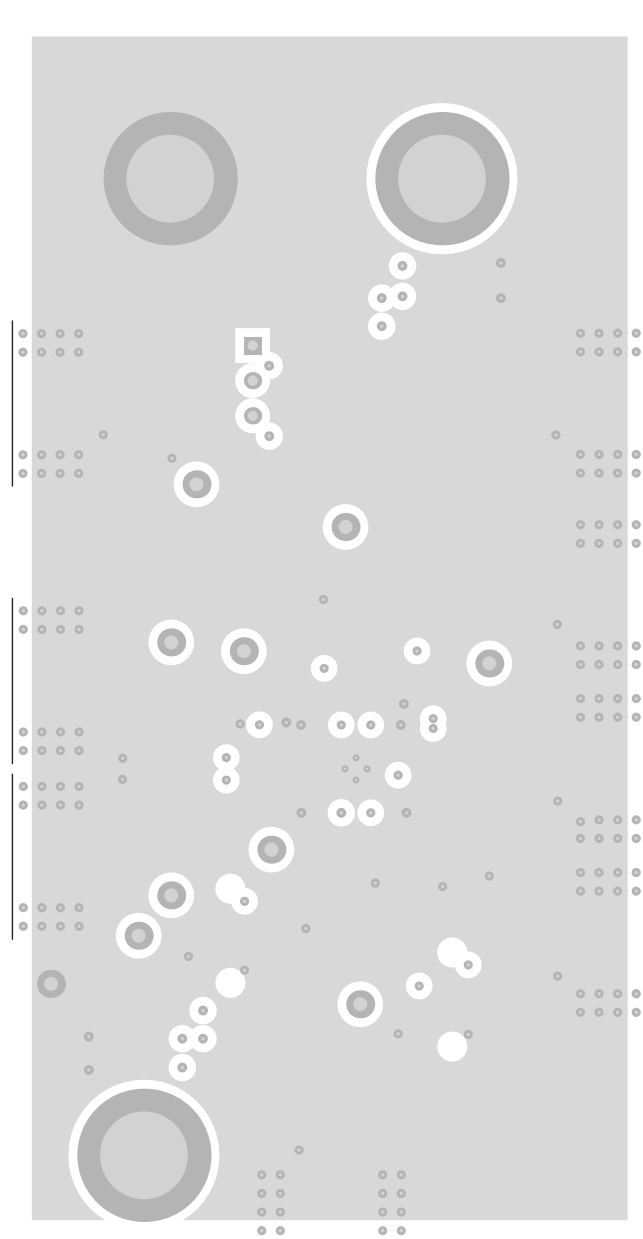


Figure 9. Layer 2: GND Plane

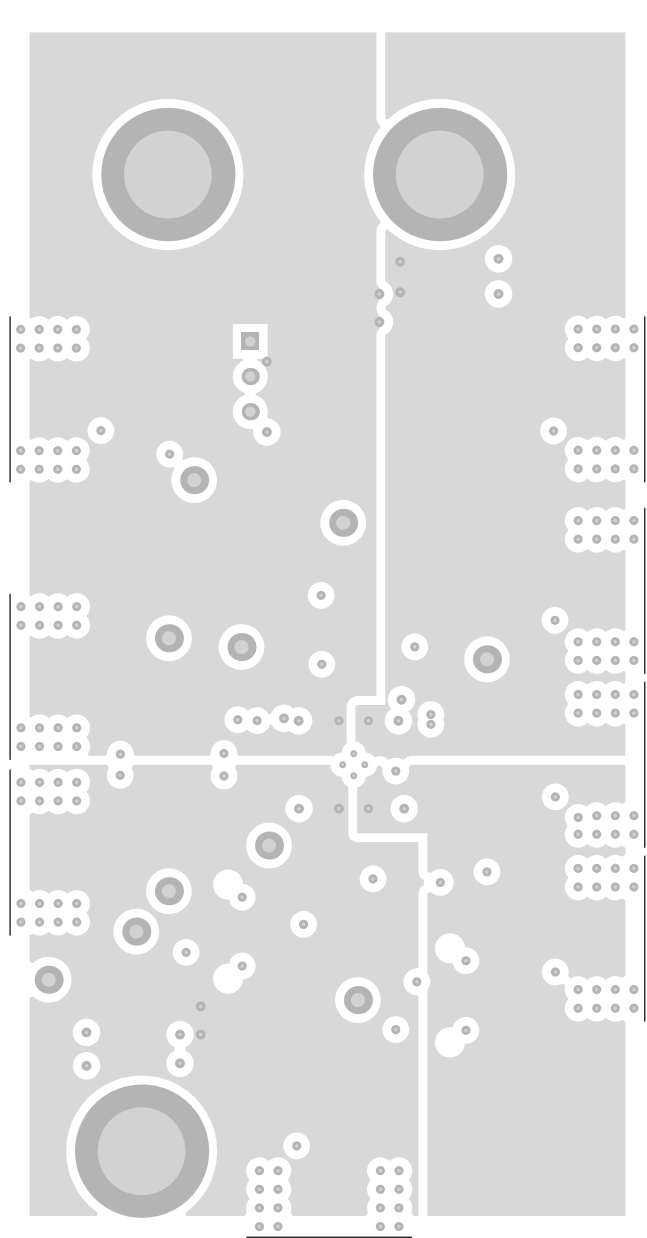


Figure 10. Layer 3: Power Plane, $\pm V_{CC}$

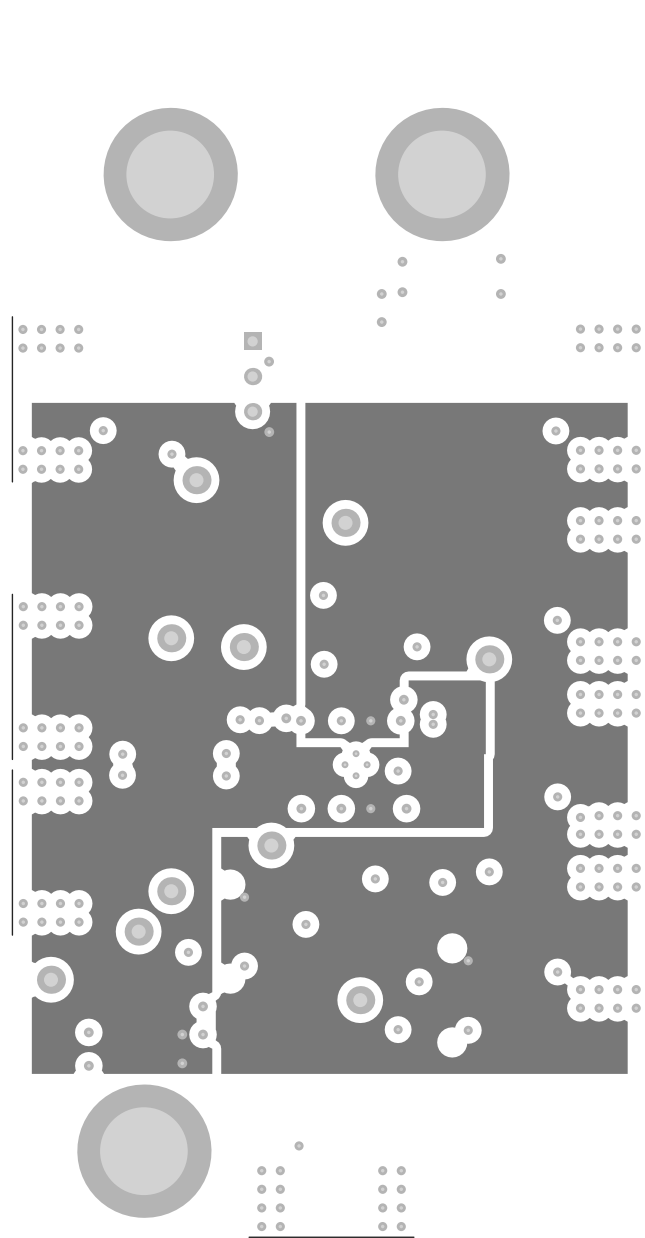


Figure 11. Layer 4: Power Plane, $\pm V_{CC}$

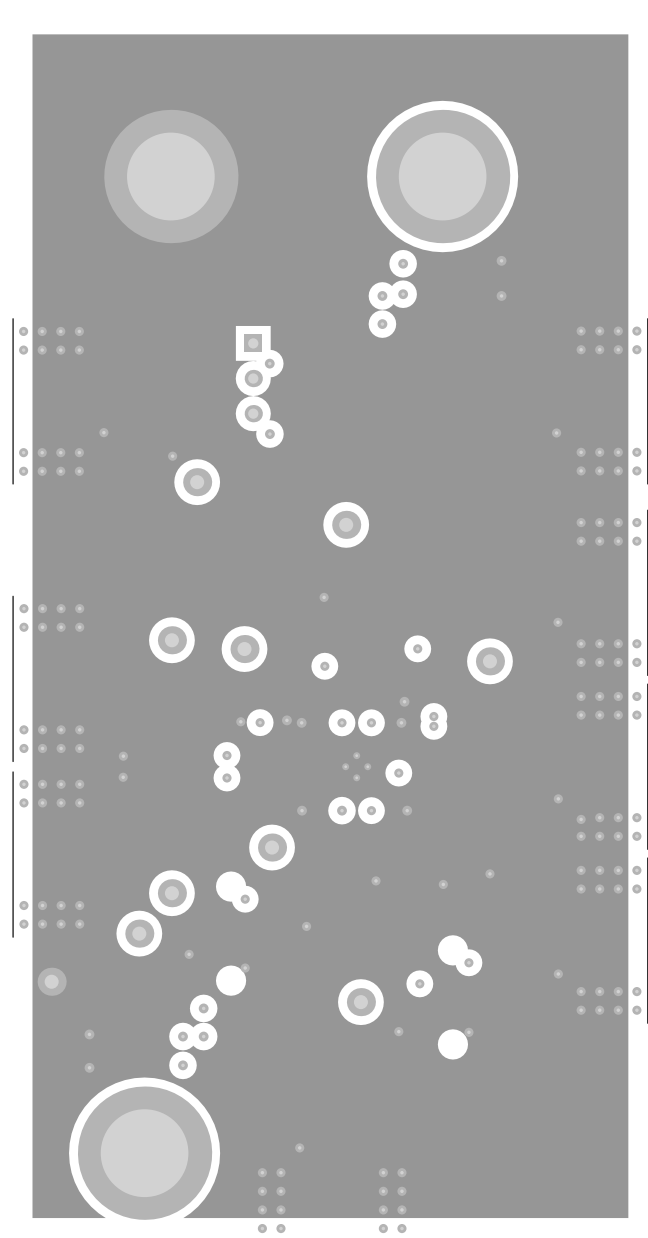


Figure 12. Layer 5: GND Plane

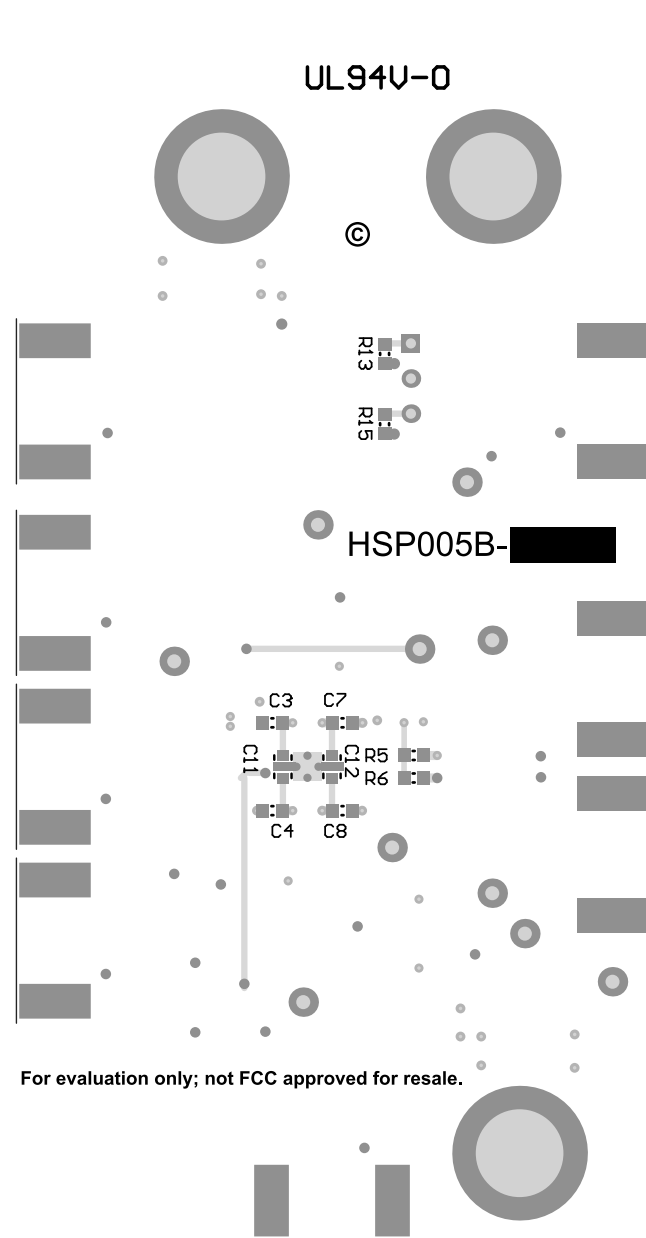


Figure 13. Layer 6: Bottom Signal Layer

3.3 Bill of Materials

Table 2 lists the bill of materials for the THS321xEVM. The BOMs for the THS3215EVM and THS3217EVM are identical except for the line item corresponding to the DUT model populated on the EVM.

Table 2. Bill of Materials, THS321x EVM

Item #	Reference Designator	Quantity	Part Number	Value	Description
1	C1, C2	2	GRM31MR71E225KA93L	MuRata	CAP, CERM, 2.2 μ F, 25 V, +/- 10%, X7R, 1206
2	C3, C4, C7, C8, C22, C24, C29, C30	8	GRM188R71E224KA88D	MuRata	CAP, CERM, 0.22 μ F, 25 V, +/- 10%, X7R, 0603
3	C5, C6, C9, C10	4	GRM155R71E103KA01D	MuRata	CAP, CERM, 0.01 μ F, 25 V, +/- 10%, X7R, 0402
4	C11, C12	2	250X14W223MV4T	Johanson Technology	CAP, CERM, 0.022 μ F, 25 V, +/- 20%, X7R, 0603
5	J1, J2, J3, J4, J5, J6, J7, J8	8	142-0701-851	Emerson Network Power	Connector, End launch SMA, 50 ohm, SMT
6	JP1, JP2	2	CL-SB-12B-01T	Copal Electronics	Switch, Slide, SPDT, 0.2A, GULL, 12V, SMD
7	L1, L2, L3, L4	4	BLM21AG102SN1D	MuRata	Ferrite Bead, 1000 ohm @ 100 MHz, 0.5 A, 0805
8	L8	1	AISC-0603HP-72NJ-T	Abracon Corporation	Inductor, Wirewound, 72 nH, 0.58 A, 0.35 ohm, SMD
9	P1, P2, P3	3	6095	Keystone	Standard Banana Jack, Uninsulated
10	R1, R2, R12, R18, R19, R22, R31, R38, R54, R60	10	ERJ-3GEY0R00V	Panasonic	RES, 0, 5%, 0.1 W, 0603
11	R3, R4, R33, R34, R51, R63	6	ERJ-3EKF49R9V	Panasonic	RES, 49.9, 1%, 0.1 W, AEC-Q200 Grade 0, 0603
12	R5, R6, R7, R8, R17, R49	6	ERJ-3EKF1002V	Panasonic	RES, 10.0 k, 1%, 0.1 W, 0603
13	R9, R10, R11	3	RC0603FR-0710RL	Yageo America	RES, 10.0, 1%, 0.1 W, 0603
14	R13, R15	2	ERJ-3EKF1001V	Panasonic	RES, 1.00 k, 1%, 0.1 W, 0603
15	R21	1	CRCW060373R2FKEA	Vishay-Dale	RES, 73.2, 1%, 0.1 W, 0603
16	R24, R36	2	CRCW060320K0JNEA	Vishay-Dale	RES, 20 k, 5%, 0.1 W, 0603
17	R25	1	CRCW0603169RFKEA	Vishay-Dale	RES, 169, 1%, 0.1 W, 0603
18	R40	1	CRCW0603249RFKEA	Vishay-Dale	RES, 249, 1%, 0.1 W, 0603
19	R42	1	CRCW0603162RFKEA	Vishay-Dale	RES, 162, 1%, 0.1 W, 0603
20	U1	1	THS3215IRGVR OR THS3217IRGVR	Texas Instruments	Wideband Differential DAC to Single Ended Line Driver, RGV0016A
21	C15, C16, C19	0	GRM188R71E224KA88D	MuRata	CAP, CERM, 0.22 μ F, 25 V, +/- 10%, X7R, 0603
22	C23	0	GRM188R71E103KA01D	MuRata	CAP, CERM, 0.01 μ F, 25 V, +/- 10%, X7R, 0603
23	C26	0	06035A2R2CAT2A	AVX	CAP, CERM, 2.2 pF, 50 V, +/- 11%, C0G/NP0, 0603
24	C27	0	GRM1885C1H110JA01D	MuRata	CAP, CERM, 11 pF, 50 V, +/- 5%, C0G/NP0, 0603
25	R14	0	3296W-1-102LF	Bourns	TRIMMER, 1k ohm, 0.5W, TH
26	R16, R20, R35	0	ERJ-3EKF49R9V	Panasonic	RES, 49.9, 1%, 0.1 W, AEC-Q200 Grade 0, 0603
27	R23, R37, R50	0	CRCW06031R00FKEA	Vishay-Dale	RES, 1.00, 1%, 0.1 W, 0603
28	R27, R48, R53, R55, R56	0	ERJ-3GEY0R00V	Panasonic	RES, 0, 5%, 0.1 W, 0603
29	R32, R47	0	CRCW060375R0FKEA	Vishay-Dale	RES, 75.0, 1%, 0.1 W, 0603
30	R39, R61	0	RC0603FR-0756R2L	Yageo America	RES, 56.2, 1%, 0.1 W, 0603
31	R46	0	RC0603FR-07150RL	Yageo America	RES, 150, 1%, 0.1 W, 0603
32	R62	0	RC0603FR-074K02L	Yageo America	RES, 4.02 k, 1%, 0.1 W, 0603
33	TP1, TP2, TP3	0	5019	Keystone	Test Point, Miniature, SMT
34	TP4, TP5, TP7, TP8, TP9, TP10, TP11, TP12, TP13, TP14	0	5003	Keystone	Test Point, Miniature, Orange, TH

Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Original (February 2016) to A Revision	Page
• Added THS3215EVM and related information to this user's guide	1
• Changed front page EVM photo.....	1
• Changed Figure 3 to match new Figure 7 schematic	5
• Changed Figure 4 to match new Figure 7 schematic	6
• Changed Figure 7	9
• Changed PCB layout, Figure 8 to Figure 13	10
• Changed BOM	13

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as "components") are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI's terms and conditions of sale of semiconductor products. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

TI assumes no liability for applications assistance or the design of Buyers' products. Buyers are responsible for their products and applications using TI components. To minimize the risks associated with Buyers' products and applications, Buyers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of significant portions of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI components or services with statements different from or beyond the parameters stated by TI for that component or service voids all express and any implied warranties for the associated TI component or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI's goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or "enhanced plastic" are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have **not** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

Products

Audio	www.ti.com/audio
Amplifiers	amplifier.ti.com
Data Converters	dataconverter.ti.com
DLP® Products	www.dlp.com
DSP	dsp.ti.com
Clocks and Timers	www.ti.com/clocks
Interface	interface.ti.com
Logic	logic.ti.com
Power Mgmt	power.ti.com
Microcontrollers	microcontroller.ti.com
RFID	www.ti-rfid.com
OMAP Applications Processors	www.ti.com/omap
Wireless Connectivity	www.ti.com/wirelessconnectivity

Applications

Automotive and Transportation	www.ti.com/automotive
Communications and Telecom	www.ti.com/communications
Computers and Peripherals	www.ti.com/computers
Consumer Electronics	www.ti.com/consumer-apps
Energy and Lighting	www.ti.com/energy
Industrial	www.ti.com/industrial
Medical	www.ti.com/medical
Security	www.ti.com/security
Space, Avionics and Defense	www.ti.com/space-avionics-defense
Video and Imaging	www.ti.com/video

TI E2E Community

e2e.ti.com