

# EVM User's Guide: TAS67524Q1EVM

## TAS67524Q1EVM Evaluation Module



### Description

The TAS67524Q1EVM showcases the TAS67524-Q1 four channel, digital input closed-loop class-D automotive audio amplifier with 1L modulation that removes 1x inductor per channel and reduces inductor costs by 50% for four channels.. The EVM uses the PurePath™ Console (PPC3) graphical user interface in the programming and I2C configuration to evaluate features, functionality, and performance of the TAS67524-Q1 device.

### Get Started

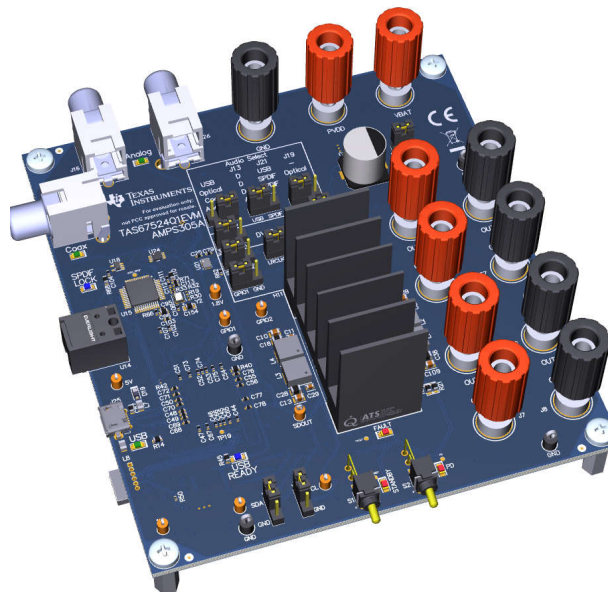
1. Request access to datasheet and EVM through the TAS67524Q1EVM product page on ti.com.
2. Request access to PurePath Console 3
3. Request access to the TAS67524-Q1 software
4. Refer to the TAS67524-Q1 datasheet for detailed information on the device and use the E2E™ forums for any additional technical support needed

### Features

- On-board USB to I<sup>2</sup>C controller to use the PPC3 GUI for device evaluation and configuration of features like real-time load diagnostics, thermal gain and PVDD foldback, and low latency signal path
- New 1L modulation requiring only one inductor per channel for cost-savings and smaller PCB footprint compared to traditional designs
- Global temperature, channel temperature, and PVDD values through I2C read out for easy system level thermal management
- Optical, SPDIF, USB, and PSIA (external I2S/TDM) input options

### Applications

- [Automotive head unit](#)
- Automotive external amplifier
- [Acoustic vehicle alerting system \(AVAS\)](#)



# 1 Evaluation Module Overview

## 1.1 Introduction

This manual describes the operations of the TAS67524Q1EVM. The TAS67524Q1EVM is a stand-alone EVM. The PurePath™ Control Console 3 GUI (PPC3) initializes and operates the EVM. The main topics of this document are:

- Hardware implementation and descriptions
- Software implementation and descriptions
- TAS67524Q1EVM operations, both hardware and software

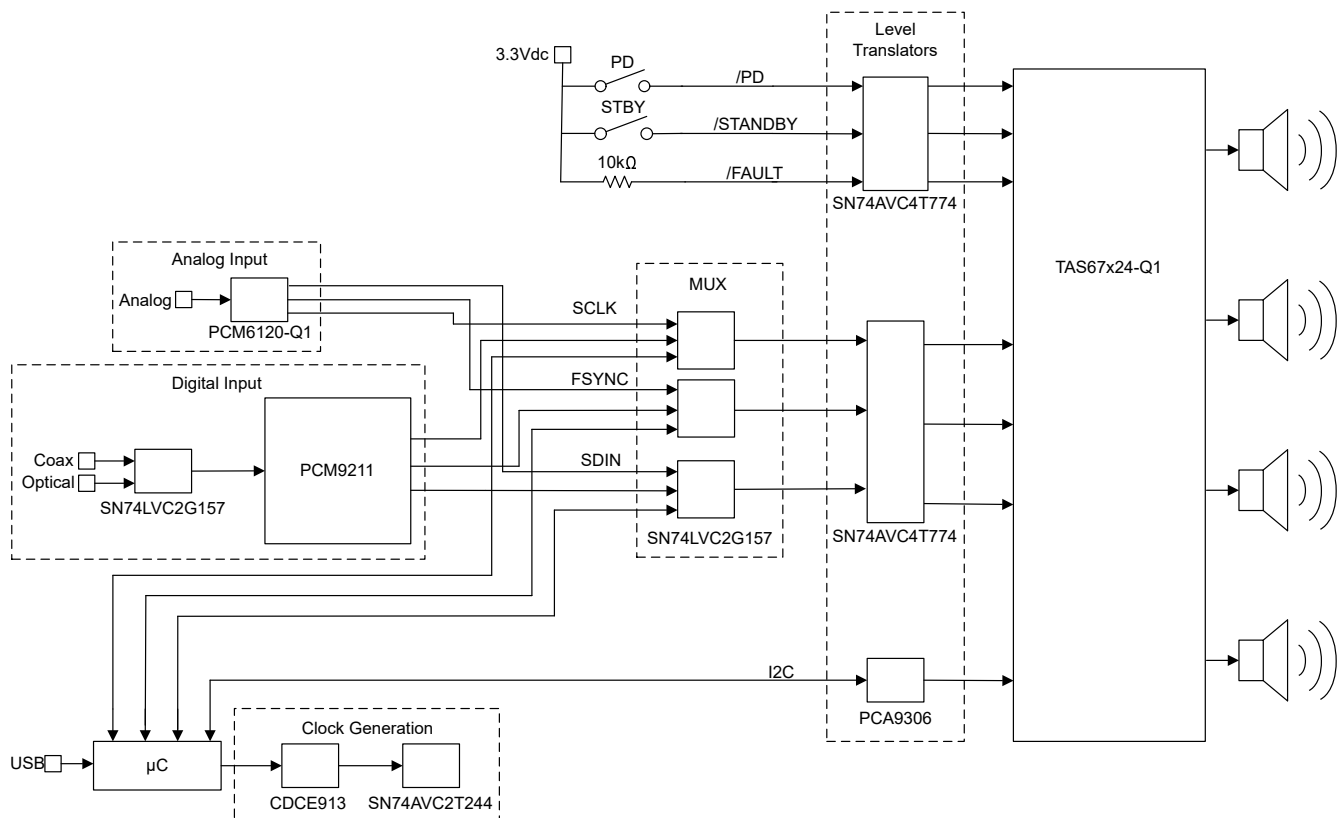
### Required equipment and accessories:

1. TAS67524Q1EVM
2. USB A male to micro B male cable
3. Power Supply Unit (PSU) up to 18V, > 10A capable
4. 1-4 resistive loads or speaker loads
5. 2-6 pair of wires stripped both ends
6. Optical audio source (optional)
7. Optical SPDIF cable (optional)
8. Desktop or laptop PC with Microsoft® Windows® 10 or above operating system

## 1.2 Kit Contents

This EVM kit contains one TAS67524Q1EVM.

## 1.3 Specification



**Figure 1-1. Specification**

## 1.4 Device Information

TI devices used in this EVM

- TAS67524-Q1: four channel automotive audio amplifier with 1L modulation
- SN74LVC1GU04: Single 1.65V to 5.5V inverter
- TPSM82903: High-efficiency buck converter module with integrated inductor
- TPS76833QDR: Low-dropout voltage regulator
- TCA9406: 2-bit bidirectional 1MHz I2C/SMBus voltage level translator
- CDCE913: Programmable 1-PLL VCXO clock synthesizer
- SN74AVC2T244: Dual-Bit Dual-Supply Bus Transceiver
- SN74LVC2G07: 2-ch, 1.65V to 5.5V buffers with open-drain outputs
- TPS3897: Single-channel, adjustable supervisor
- SN74LVC2G157: Single 2-Line to 1-Line Data Selector/Multiplexer
- PCM9211: 216kHz Digital Audio Interface Transceiver
- SN74LVC1G14: Single 1.65V to 5.5V inverter with Schmitt-Trigger inputs
- SN74AVC4T774: Four-bit dual-supply bus transceiver
- PCM6120-Q1: Automotive, stereo, 123dB SNR, 768kHz audio ADC
- LMK6C: Fixed-frequency LVCMOS oscillator
- LMR51450: 36V, 5A synchronous buck converter

## 2 Hardware

### 2.1 Description

The TAS67524Q1 EVM is a stand-alone EVM. This requires three power supplies, USB control via Purepath Control Console 3 (PPC3), and a digital audio input. The digital audio input can be provided through the USB, the optical input, the coaxial input, or directly through the I2S/TDM headers.

### 2.2 Setup

This section describes the TAS67524Q1EVM start-up procedure. Have the equipment and accessories listed on the first page of this document available.

Hardware Connections:

1. Connect speakers or resistive loads to J1/J5, J18/J27, J28/J29, J7/J8
2. Connect the USB micro cable from the PC to the EVM
3. Connect the Power supplies PVDD and VBAT
4. Set the switches S1 and S2, to pull low STANDBY and PD, the red LED turns on
5. Select Audio Source, and provide the clock
6. Turn on VBAT and PVDD power supplies
7. Launch the TAS67524 EVM PPC3 plugin on the PC
8. Set up the device appropriately and follow the screens

### 2.3 Header and Jumper Information

#### Power Supply:

- The PVDD and VBAT voltage working range are all between 4.5V and 19V. J3 jumper can be used to connect PVDD and VBAT together on the EVM, this allows both rails to be driven from a single car battery or voltage supply
- By default the IOVDD is generated based on the 3.3V or 1.8V LDOs driven by the 5V USB input but alternatively can drive the IOVDD pin directly on J10 using pin 2, or if the DVDD current draw wants to be monitored can drive the TAS67524-Q1 DVDD rail directly by J30 pin 2
- Refer to [Table 2-1](#) on descriptions of connectors, jumpers, and headers:

**Table 2-1. Power Supply Connectors**

Number	Name	Description
J2	IC PVDD	Connects the IC PVDD voltage to the voltage supplied by the connectors
J3	PVDD to VBAT	Used to connect PVDD and VBAT together on the EVM, therefore only needing one power supply to operate the EVM.
J10	IOVDD	Selects the IOVDD/DVDD voltage between 3.3V or 1.8V. Default: 3.3V
J12	VBAT	Battery Voltage Input
J17	PVDD	PVDD voltage input
J20	GND	Power ground
J25	USB	USB connector for the device, the 5V USB rail is used to drive the 1.8V and 3.3V LDO's on the EVM
J30	DVDD_IO	Connects the IOVDD rail to the DVDD of the TAS67524-Q1 IC

#### Audio Port:

- USB connector could be used as the audio port, Window Media Player or equivalent can be used to stream audio from your PC
- Coax and Optical input connector could accept SPDIF (Sony/Philips Digital Interface) audio format, a source such as a DVD player or AP can be used to stream audio
- Analog input connector can accept audio input from a media player or Audio Precision equipment. The full-scale input voltage is 0.5Vrms.
- J11/J14/J15 is used to interface an external PSIA (Programmable Serial Interface Adapter) to drive I2S or TDM inputs.

Refer to [Table 2-2](#) for selecting the different types of audio inputs:

**Table 2-2. Audio Select**

J13	J21	J19	J11/J14/J15	
USB	D	USB	-	IN
Optical	D	SPDIF	Optical	IN
Coax	D	SPDIF	Coax	IN
Analog	A	-	-	IN
PSIA	-	-	-	OUT

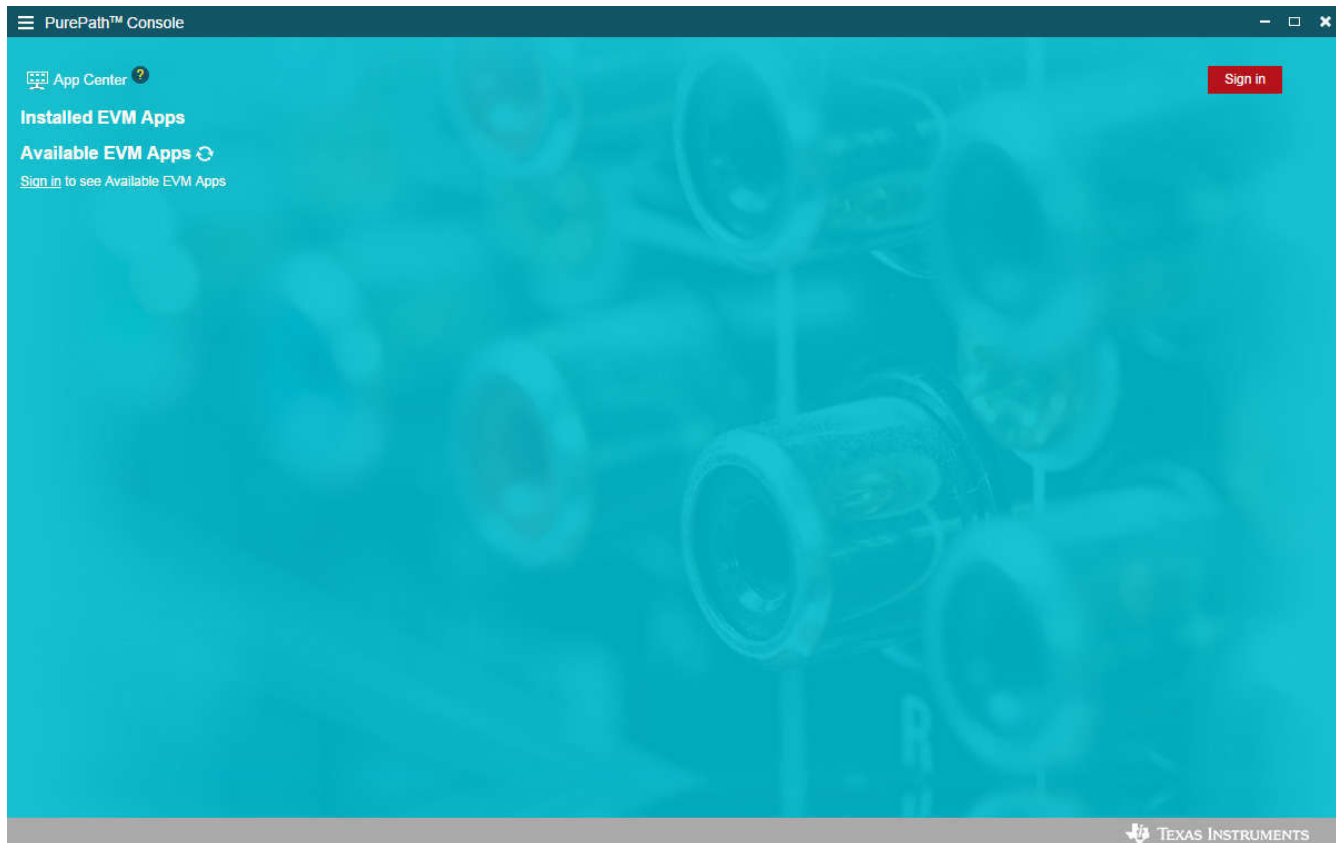
## 3 Software

### 3.1 PurePath Console 3 (PPC3) Access and Description

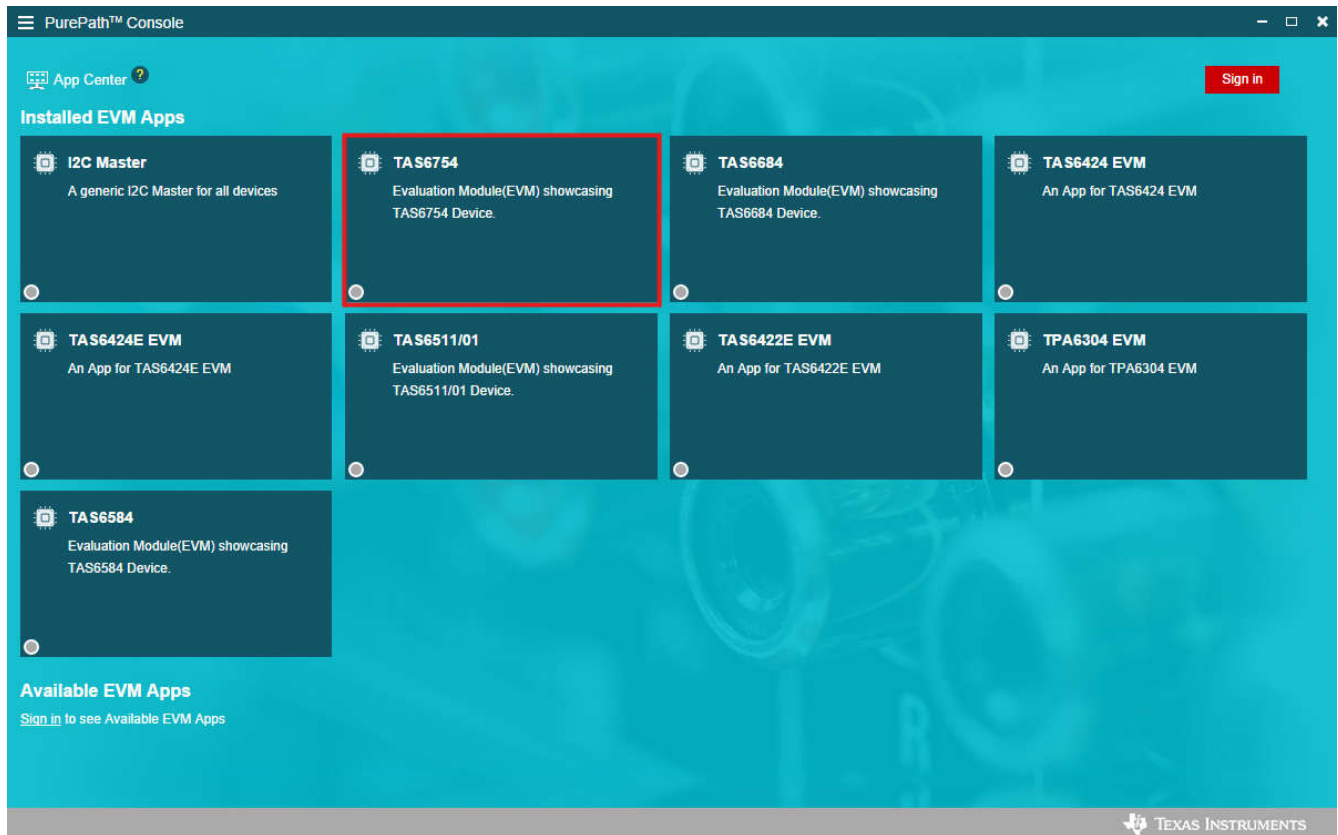
The PPC3 is a server-based tool. Access must be requested for both the PPC3 software and TAS67524 App. Once approval is given, your approved PPC3 apps can be located at [ti.com/secureresources](https://ti.com/secureresources).

Open the URL in the approval email or go to the device secure resource folder. Click and download the tar.gz file under the "Downloads".

Once the download is complete, open the PPC3 GUI. Click on "Open" from the side menu and open the downloaded tar.gz file. (Choose "All Files" in the Open file dialog). For any additional details refer to the install FAQ on E2E found [here](#).

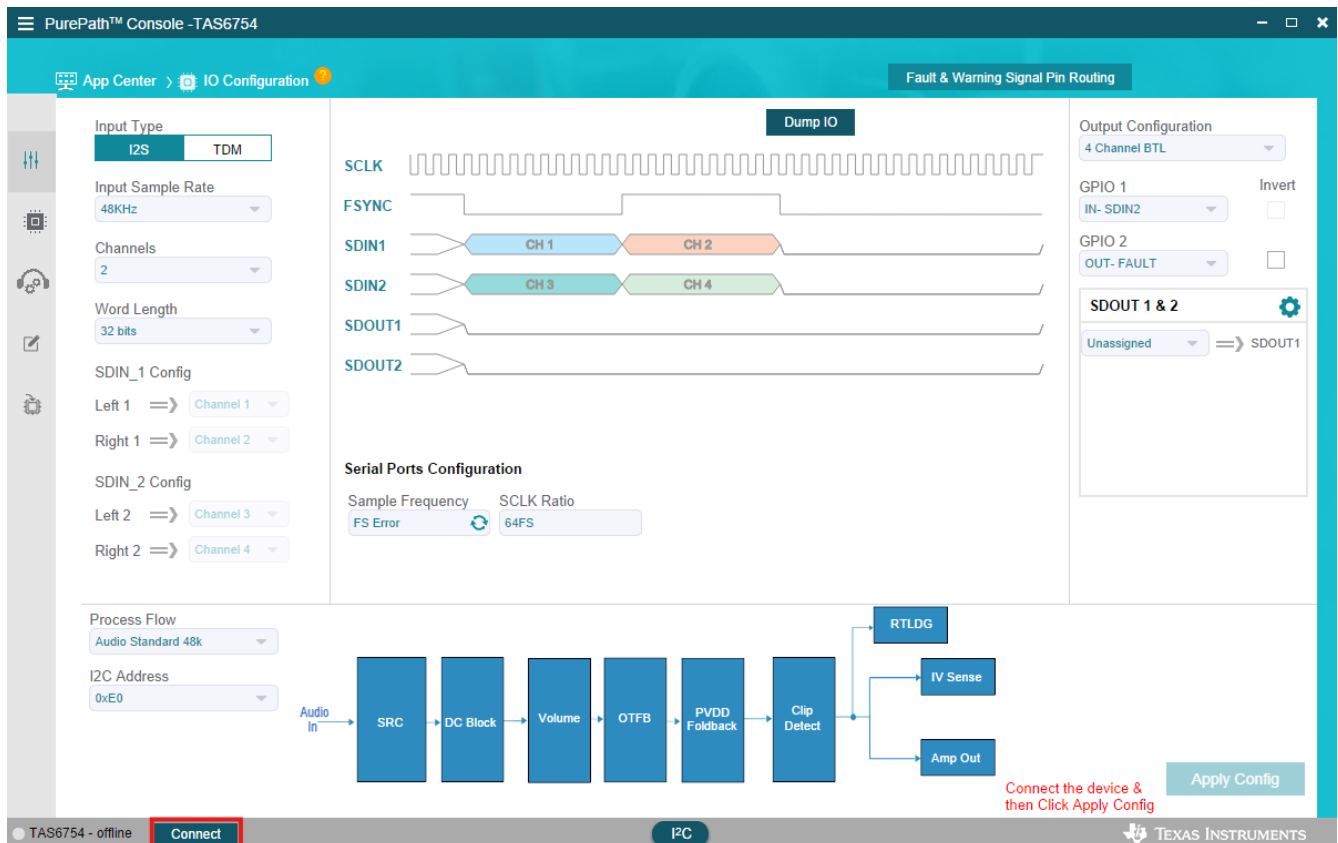


Click on TAS67524 Application box to download application. An installation window pops-up. Click the Install button. The TAS67524 EVM box appears in installed EVM apps section. Click the TAS67524 box to start the TAS67524 app.



### 3.2 PurePath Console – TAS67524 EVM Entry Window

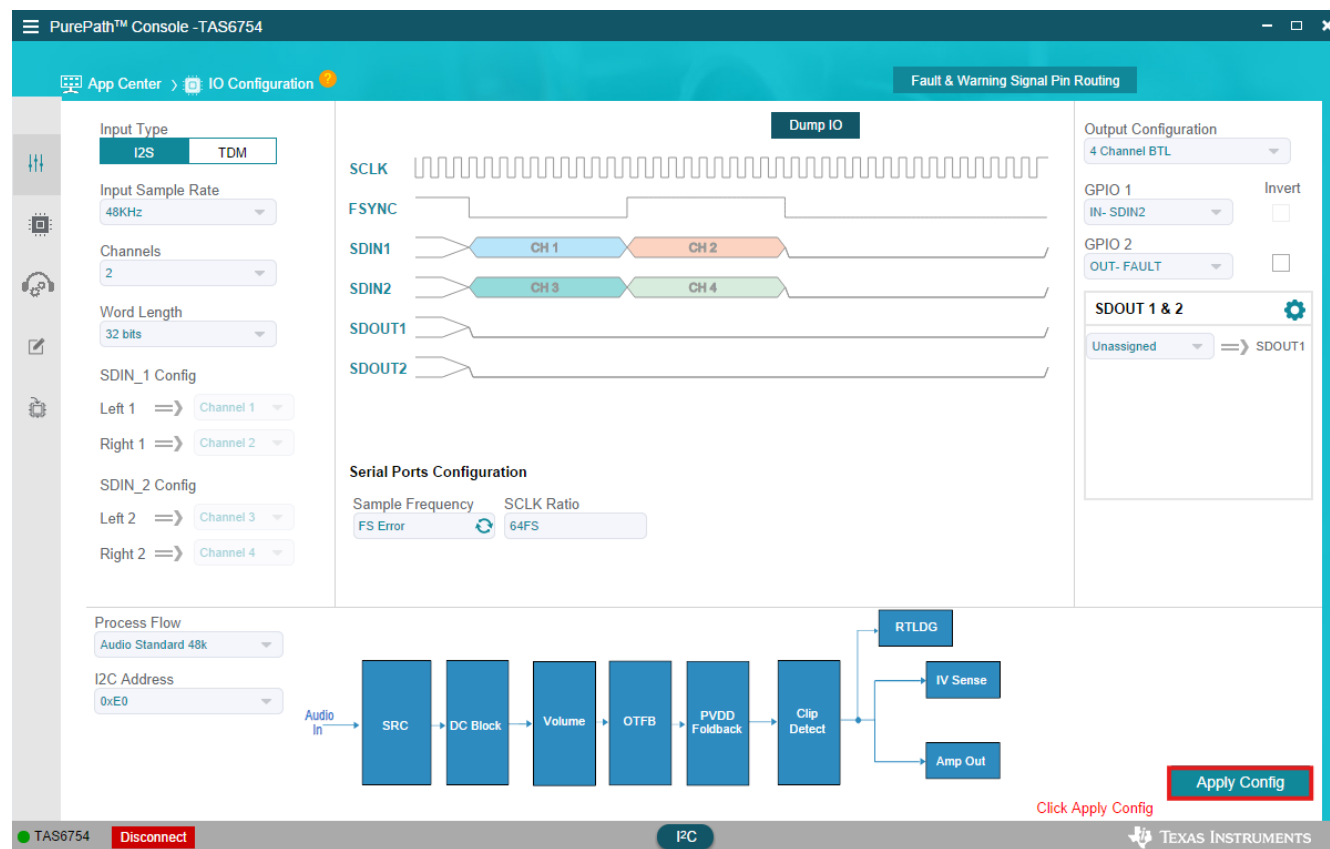
Launch the TAS67524 EVM app and IO configuration window is shown with the default device selection.



When the EVM is connected to your PC and the EVM is powered, a Connect button is found in the lower left corner of the PPC3 window. Click this button with your mouse to connect the EVM. Upon a successful connection the button changes to red and the gray circle becomes green. To disconnect, click the button again.

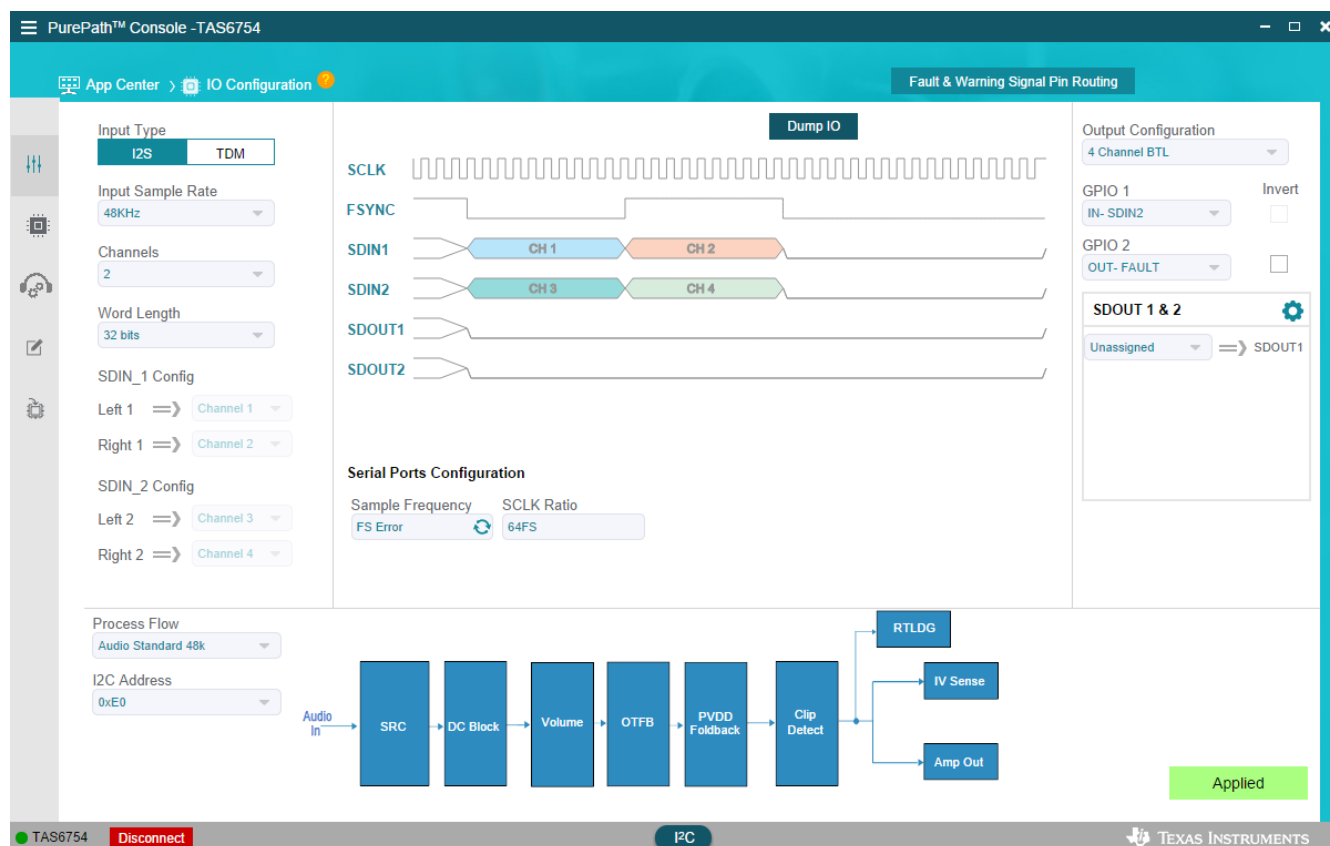


The default device address 0xE0. Select the proper values for the set up. Click on the *Apply Config* button when selections are complete.



After clicking on Apply Config, the IO configuration writes the selected configuration via I2C on the device and the button changes to Applied.



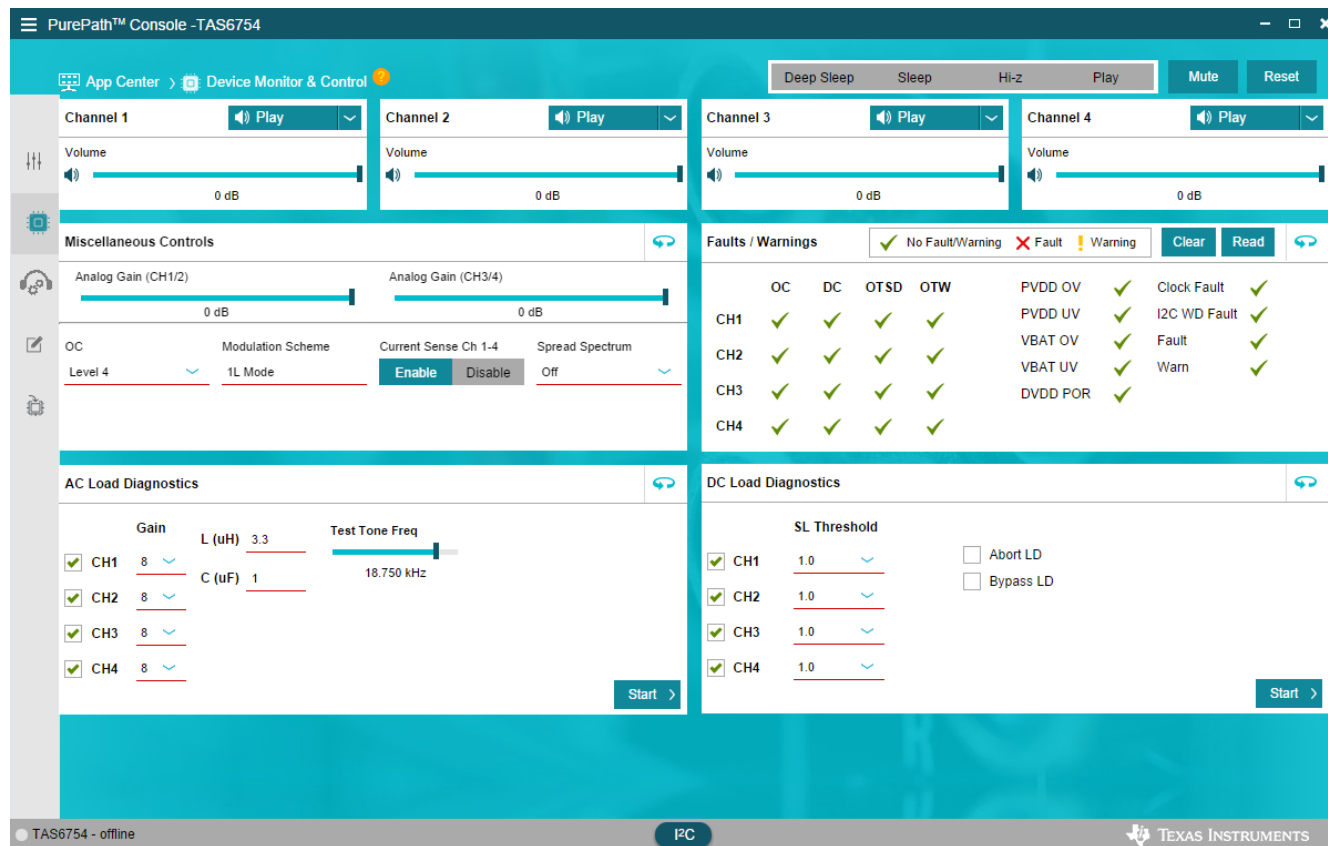


There are four control windows used to control and configure the TAS67524-Q1.

- Device Monitor and Control
- Audio Processing Options
- IO Configuration
- Register Map

### 3.3 Device Monitor and Control Window

The TAS67524 Device and Control Window provides the operational register controls after the device is set up. Click on the *Device Monitor & Control* icon in the left side column of the window and the following window is displayed.

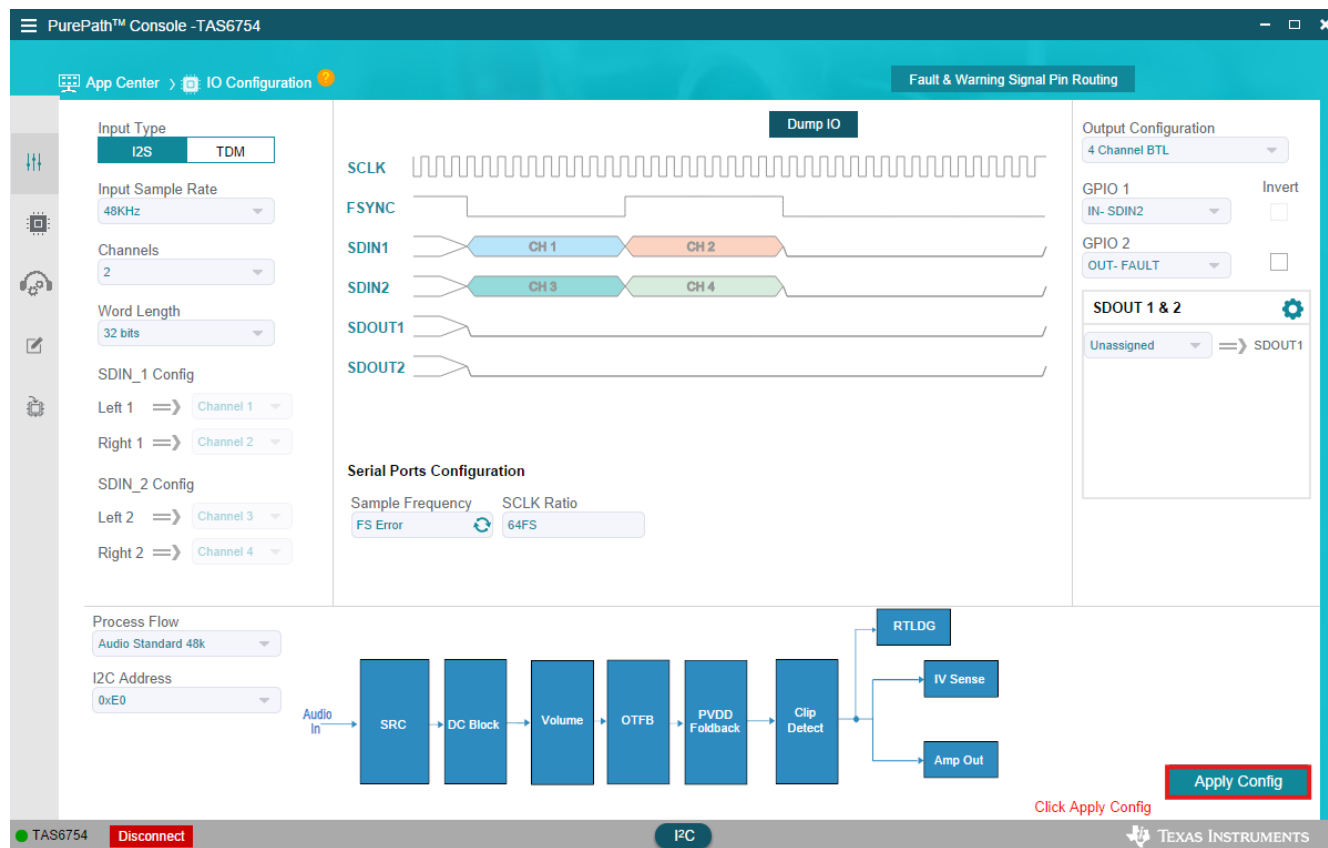


This window can be used to control multiple features of the TAS67524/64-Q1.

- Individual channel state and volume.
- Global channel state.
- Miscellaneous Controls
  - Over Current level: It is recommended to change the level as needed.
  - Current Sense
  - Spread Spectrum control
  - Analog Gain
  - Digital Volume ramp rates
- Fault and Warning Monitor
- AC Load Diagnostics
- DC Load Diagnostics

### 3.4 IO Configuration

Click on the *IO Configuration* icon in the left side column of the window and the following window is displayed.



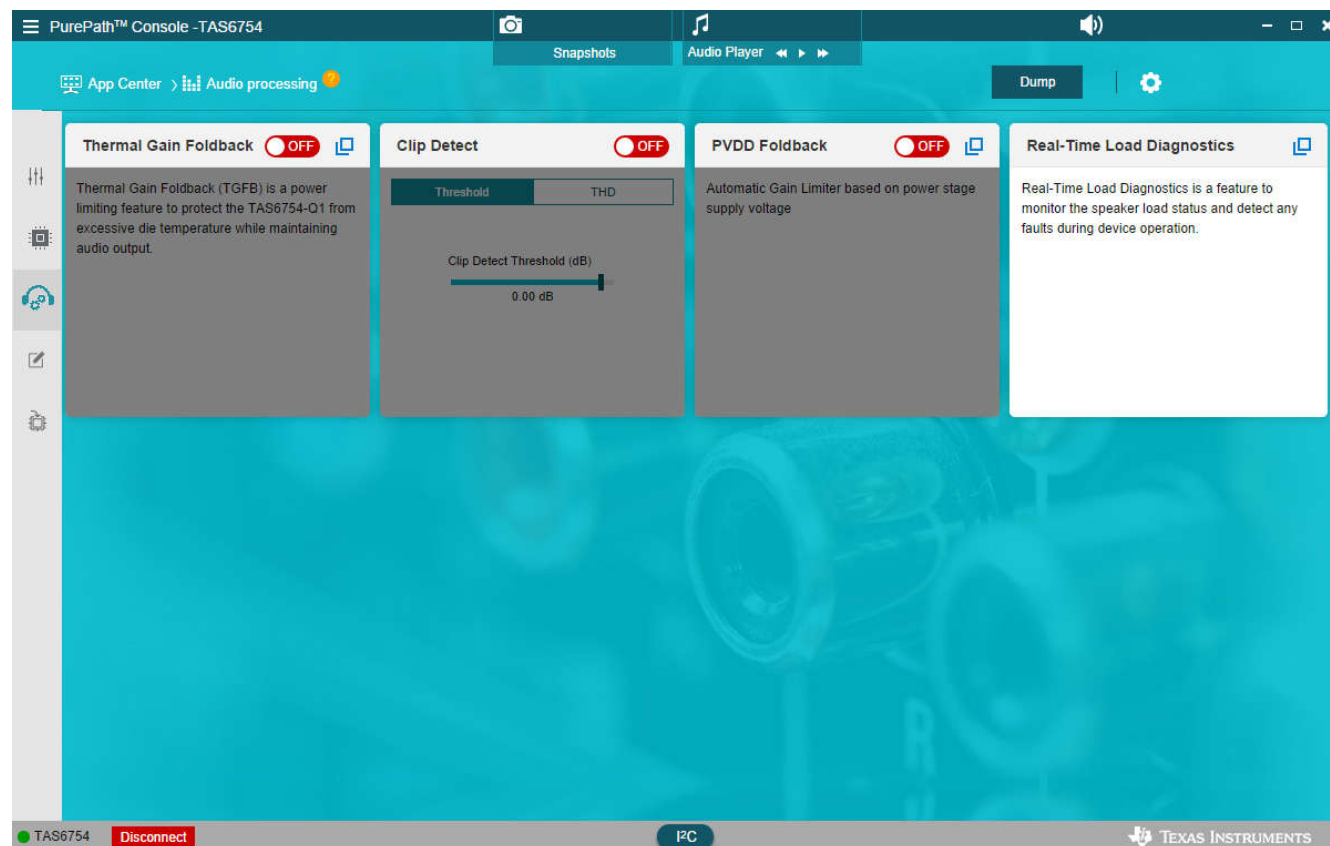
The IO configuration window is setup with the default settings. Both SPDIF inputs and the USB inputs need the I2S inputs.

If an external I2S or TDM signal is provided the inputs and outputs are configured in this window.

The Serial Port configuration is set when PPC3 connects to the EVM.

### 3.5 Audio Processing Window

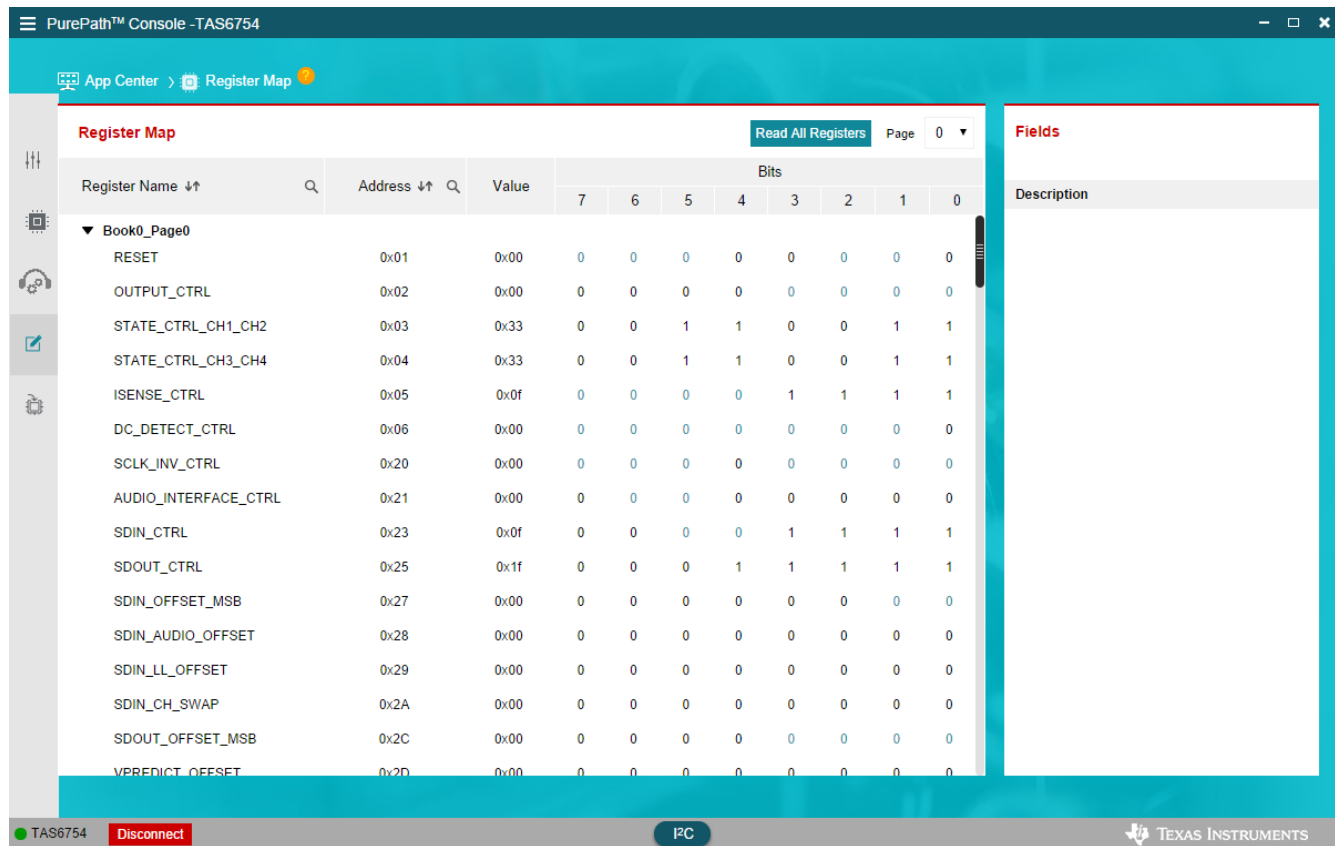
Click on the *Audio Processing Options* icon in the left side column of the window and the following window is displayed.



Each box has a defined process. Click on the *on/off* slider to turn a process. Each box can be opened to modify the process. The Clip Detect box is modified at the Audio Processing Window level.

### 3.6 Register Map

Click on the *Register Map* icon in the left side column of the window and the following window is displayed.




**Register Map** Read All Registers Page 0

Register Name	Address	Value	Bits								
			7	6	5	4	3	2	1	0	
Book0_Page0											
RESET	0x01	0x00	0	0	0	0	0	0	0	0	0
OUTPUT_CTRL	0x02	0x00	0	0	0	0	0	0	0	0	0
STATE_CTRL_CH1_CH2	0x03	0x33	0	0	1	1	0	0	1	1	
STATE_CTRL_CH3_CH4	0x04	0x33	0	0	1	1	0	0	1	1	
ISENSE_CTRL	0x05	0x0f	0	0	0	0	1	1	1	1	
DC_DETECT_CTRL	0x06	0x00	0	0	0	0	0	0	0	0	0
SCLK_INV_CTRL	0x20	0x00	0	0	0	0	0	0	0	0	0
AUDIO_INTERFACE_CTRL	0x21	0x00	0	0	0	0	0	0	0	0	0
SDIN_CTRL	0x23	0x0f	0	0	0	0	1	1	1	1	
SDOUT_CTRL	0x25	0x1f	0	0	0	1	1	1	1	1	
SDIN_OFFSET_MSB	0x27	0x00	0	0	0	0	0	0	0	0	0
SDIN_AUDIO_OFFSET	0x28	0x00	0	0	0	0	0	0	0	0	0
SDIN_LL_OFFSET	0x29	0x00	0	0	0	0	0	0	0	0	0
SDIN_CH_SWAP	0x2A	0x00	0	0	0	0	0	0	0	0	0
SDOUT_OFFSET_MSB	0x2C	0x00	0	0	0	0	0	0	0	0	0
VPREDICT_OFFSET	0x2D	0x00	0	0	0	0	0	0	0	0	0

**Fields**

Description

TAS6754 Disconnect I2C 

The register map can be sorted either alphabetically or numerically (register number). When a register is selected, the hex value and the individual bit value is displayed. The name and description for each bit is shown to the right in the Fields box. A bit changes state when double clicked. The state change is sent to the EVM at the end of the second click.

### 3.7 I2C Monitor Window

The register map can be sorted either alphabetically or numerically (register number). When a register is selected, the hex value and the individual bit value is displayed. The name and description for each bit is shown to the right in the Fields box. A bit changes state when double clicked. The state change is sent to the EVM at the end of the second click.

### 3.8 End System Integration

Click on the *End System Integration* icon in the left side column of the window and the following window is displayed.

PurePath™ Console -TAS6754

App Center > TAS6754 Home > End System Integration

## Summary

Choose the settings with which to create header/cfg file.

Base Sample Rate : 48 kHz      Selected Sample Rate : 48 kHz


Selected Audio Mode : Audio Standard 48k(2.2 48k)      Destination : Output Window

End System I2C Address : 0xE0      Format : .h

Burst : 1      Dump Mode : Current State

☒ Include Comments

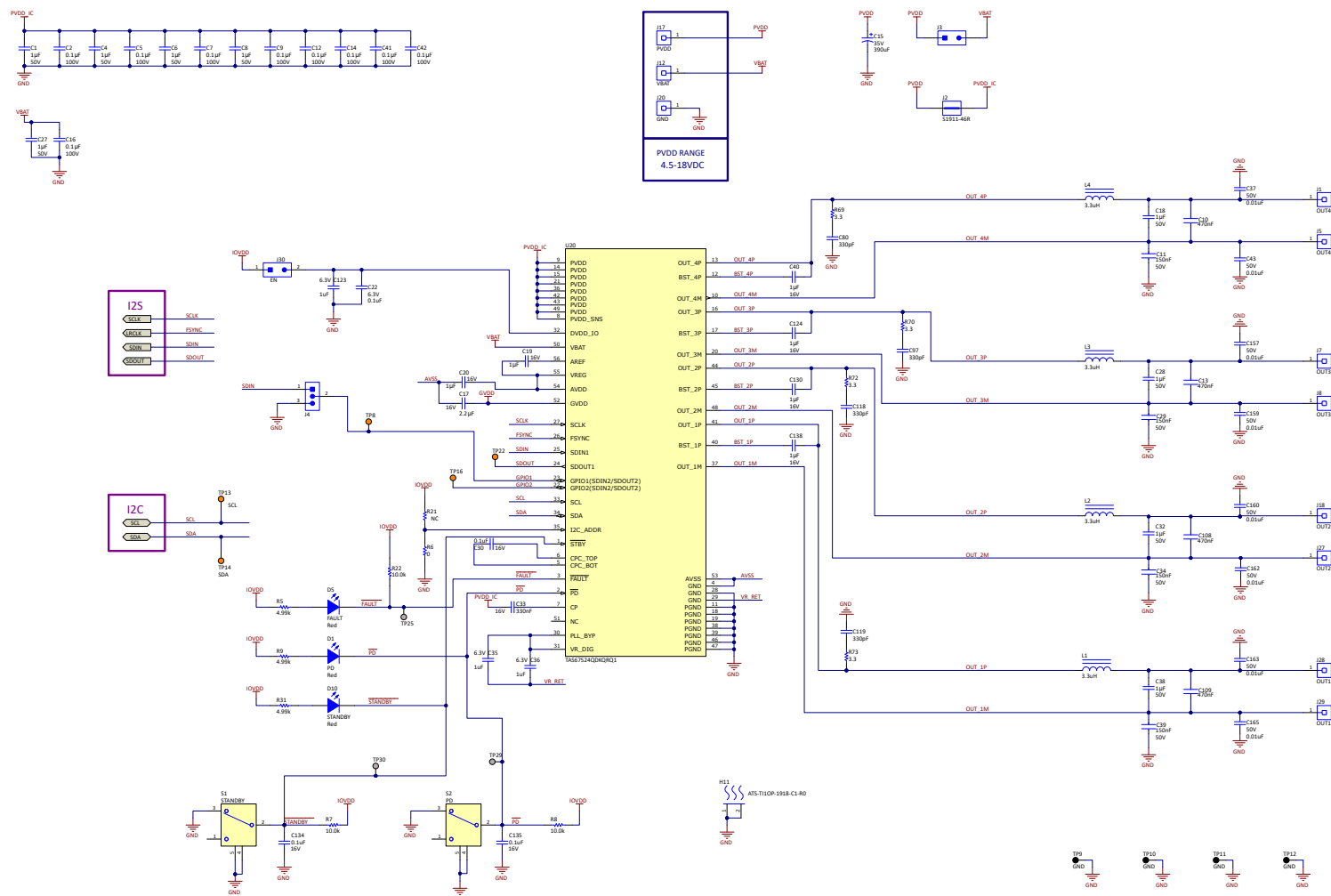
**Dump to Output Window** **Finish**

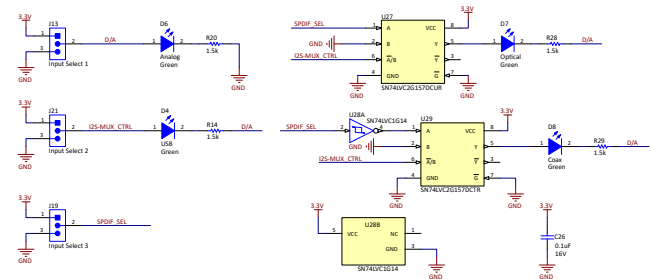
TAS6754 **Disconnect** **I2C**  **TEXAS INSTRUMENTS**

To generate the end system integration configuration files, configure the drop down menu options then click the Dump to Output Window button. Review the output file information and when satisfied click the Finish button.

## 4 Hardware Design Files

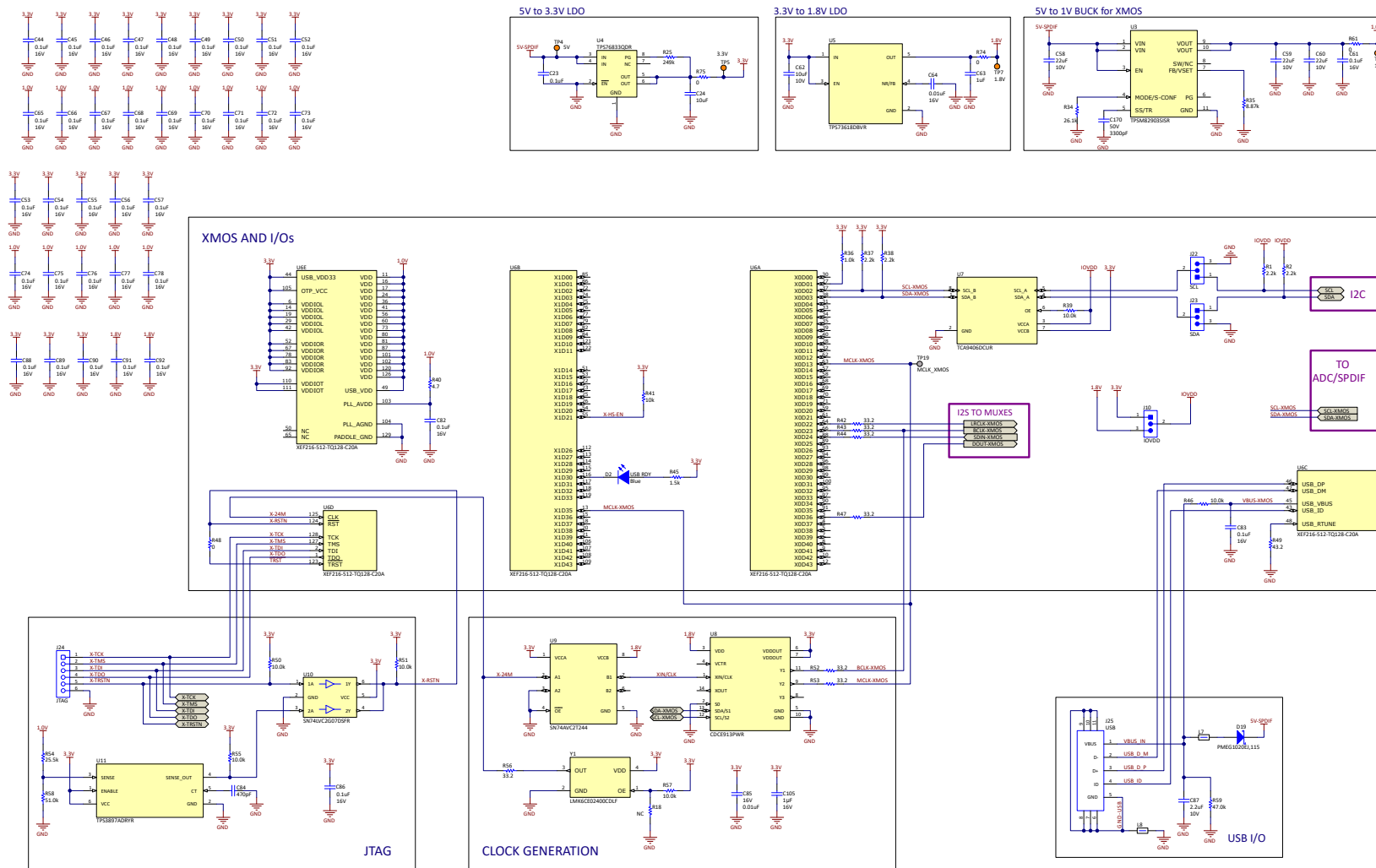
### 4.1 Schematics











## 4.2 PCB Layouts

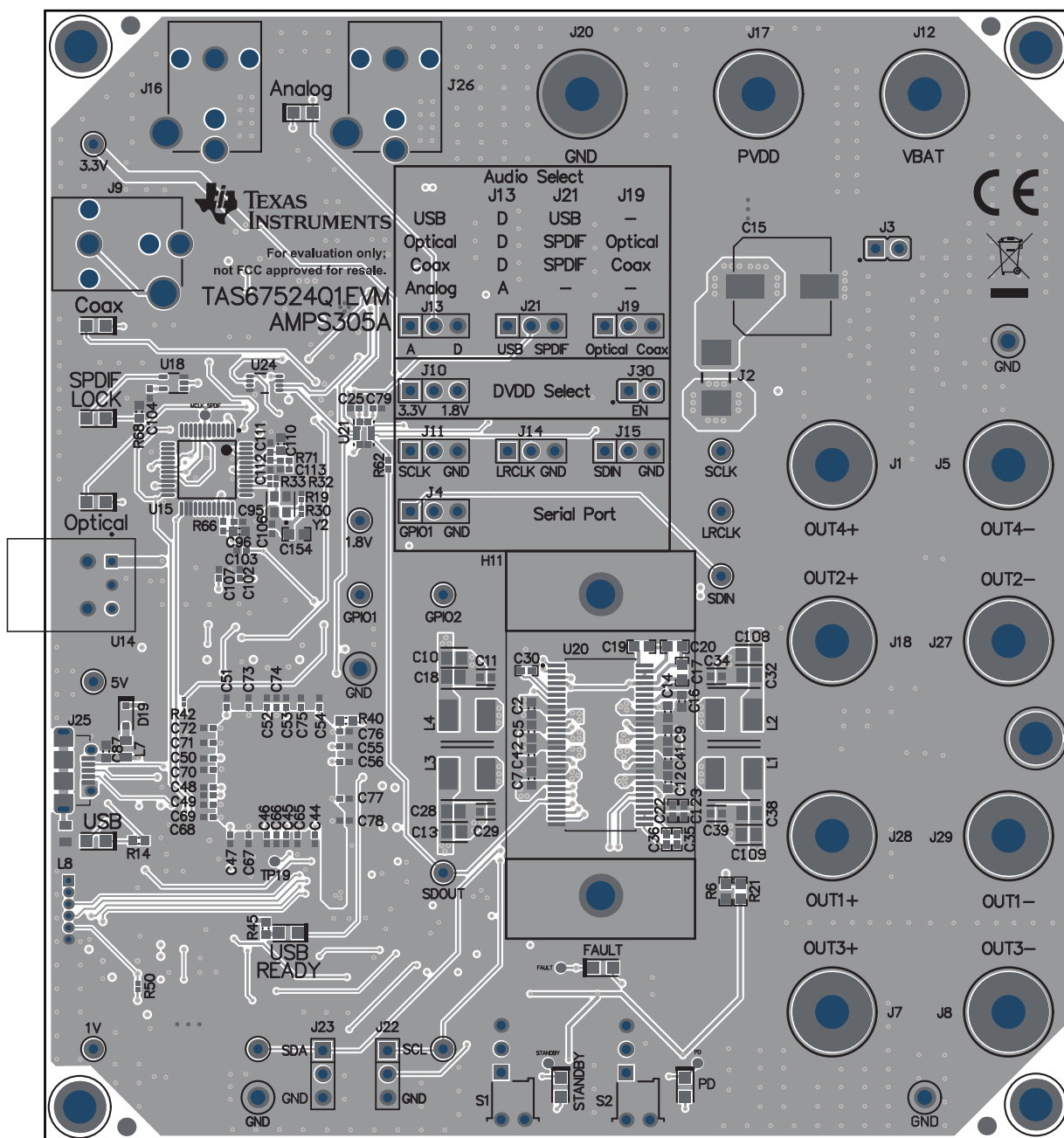
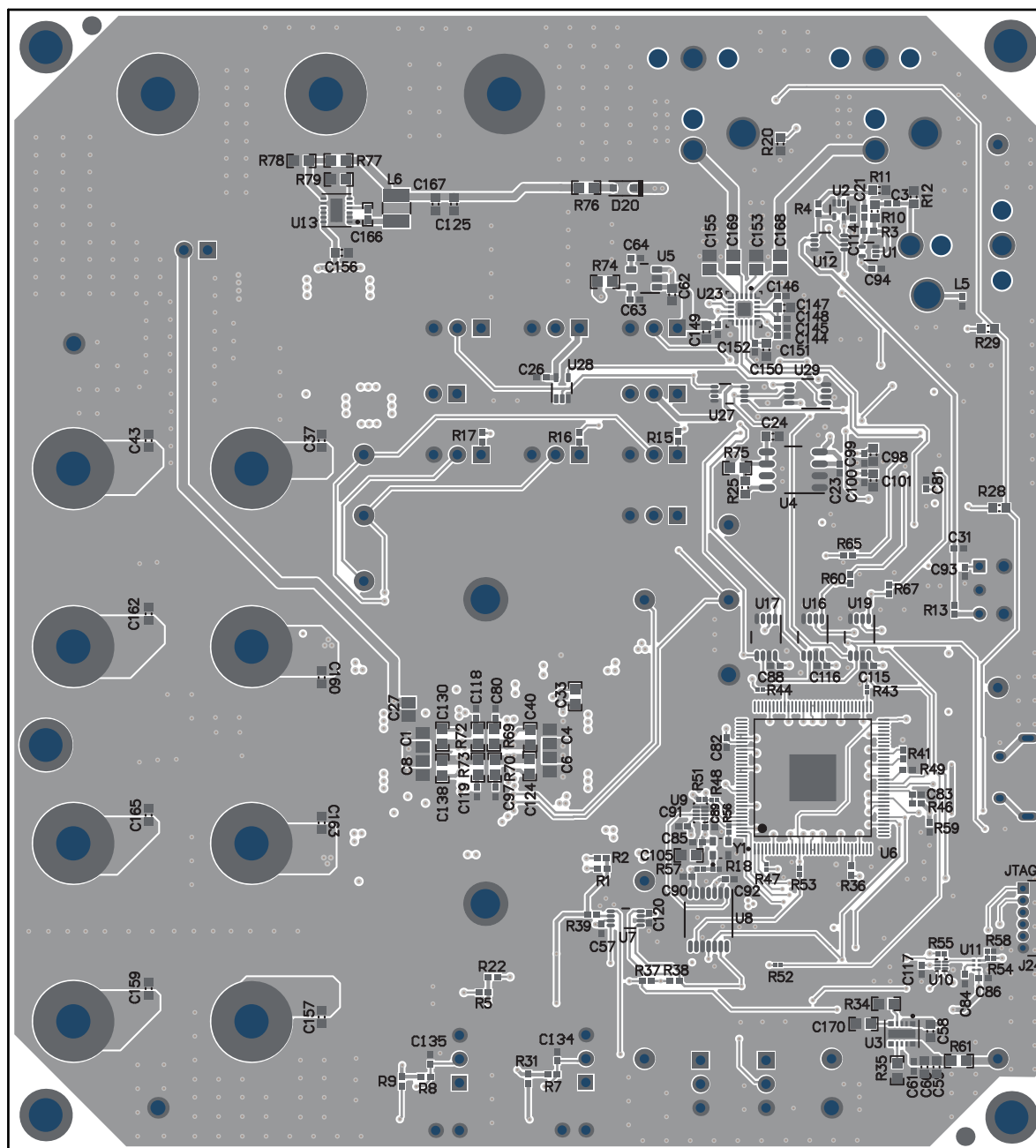
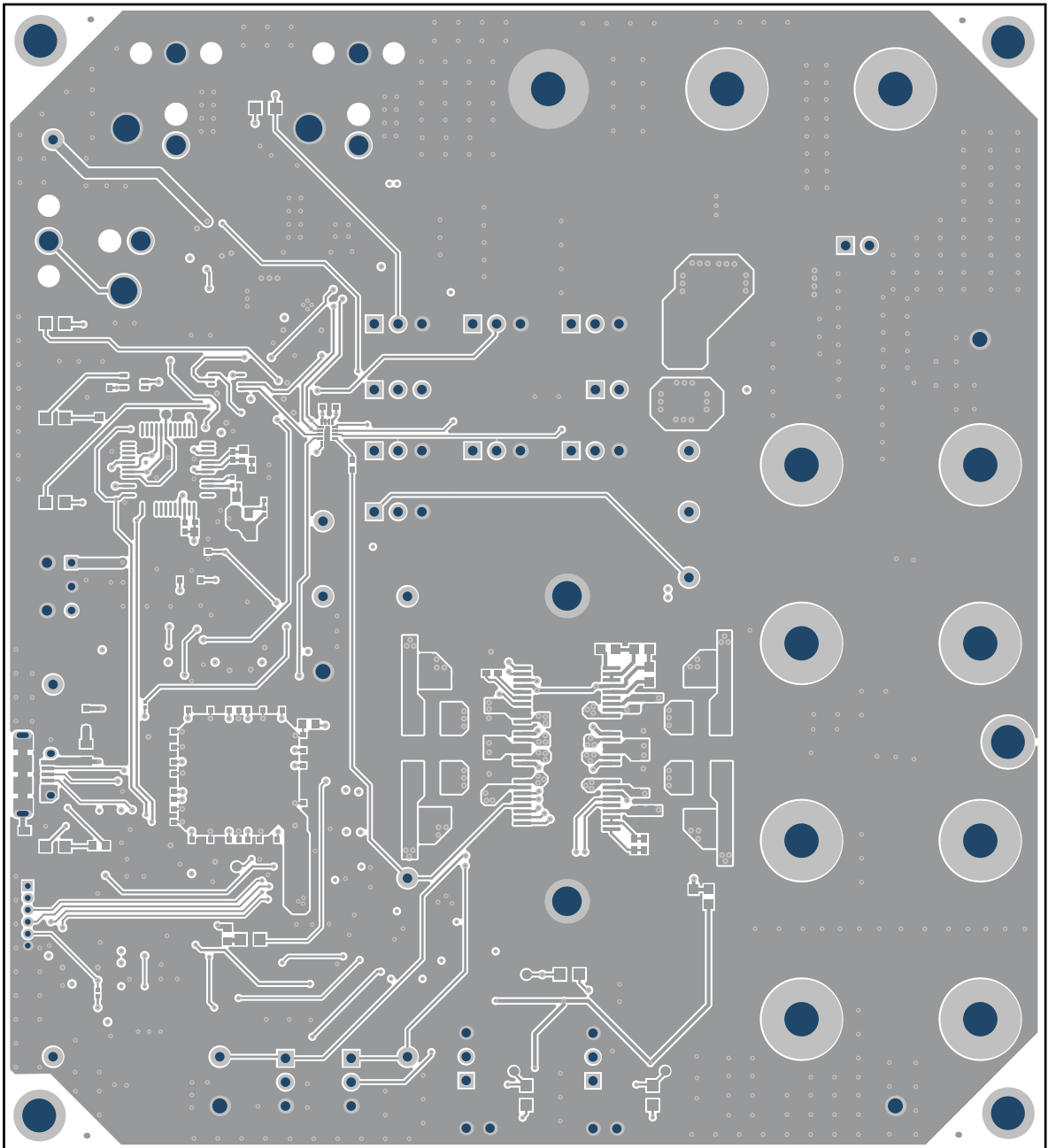


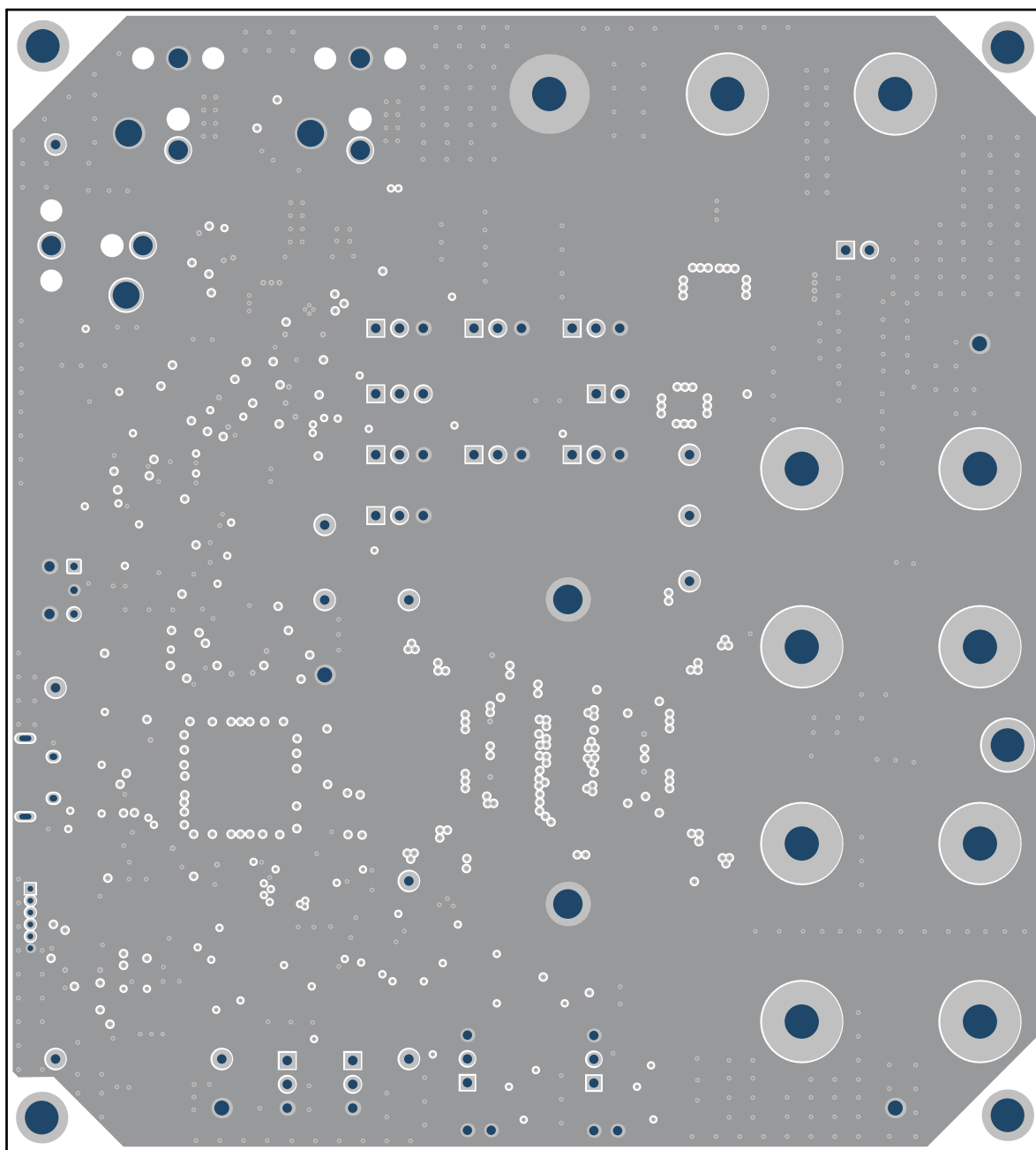
Figure 4-1. Top Composite



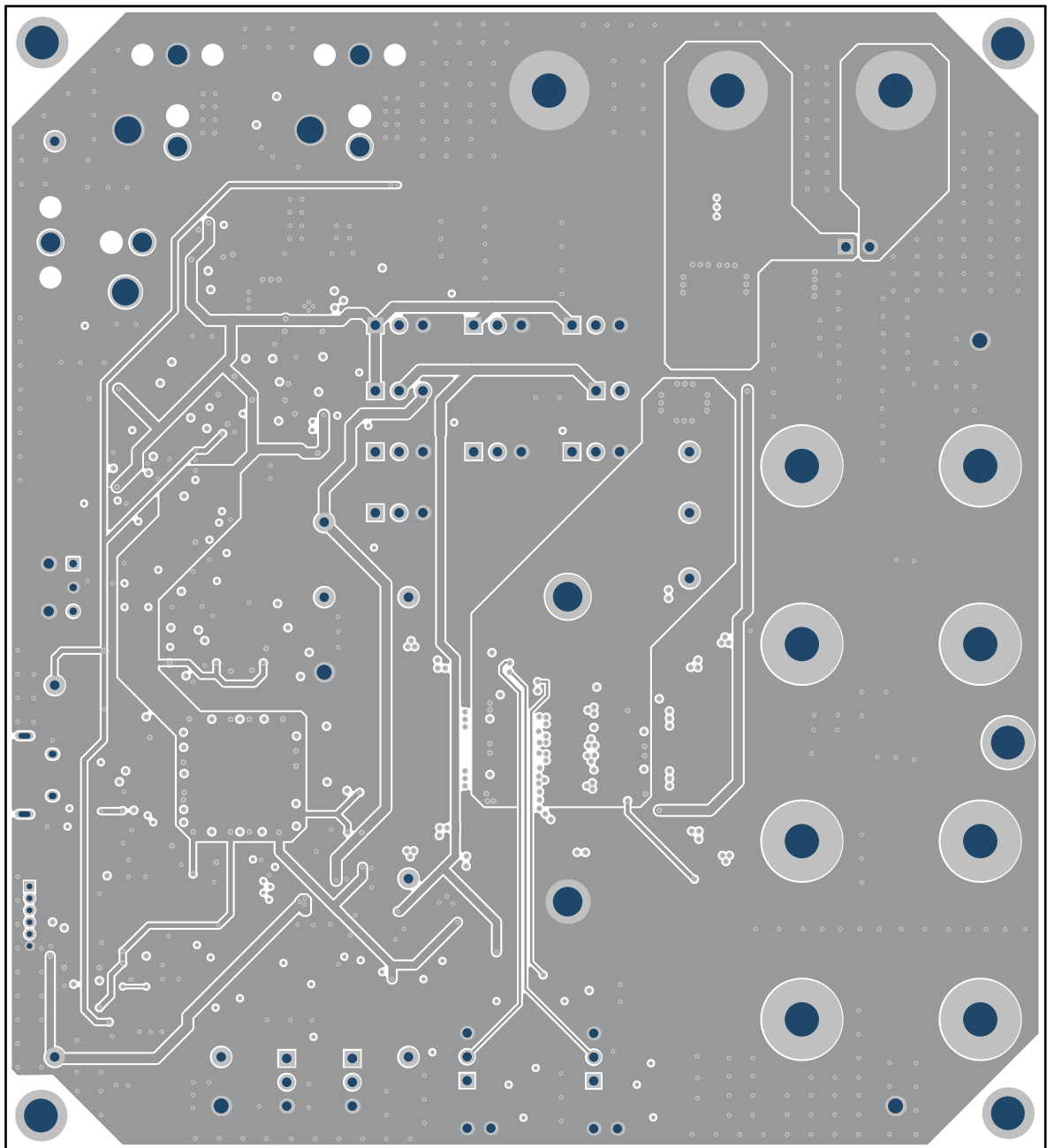
**Figure 4-2. Bottom Composite**



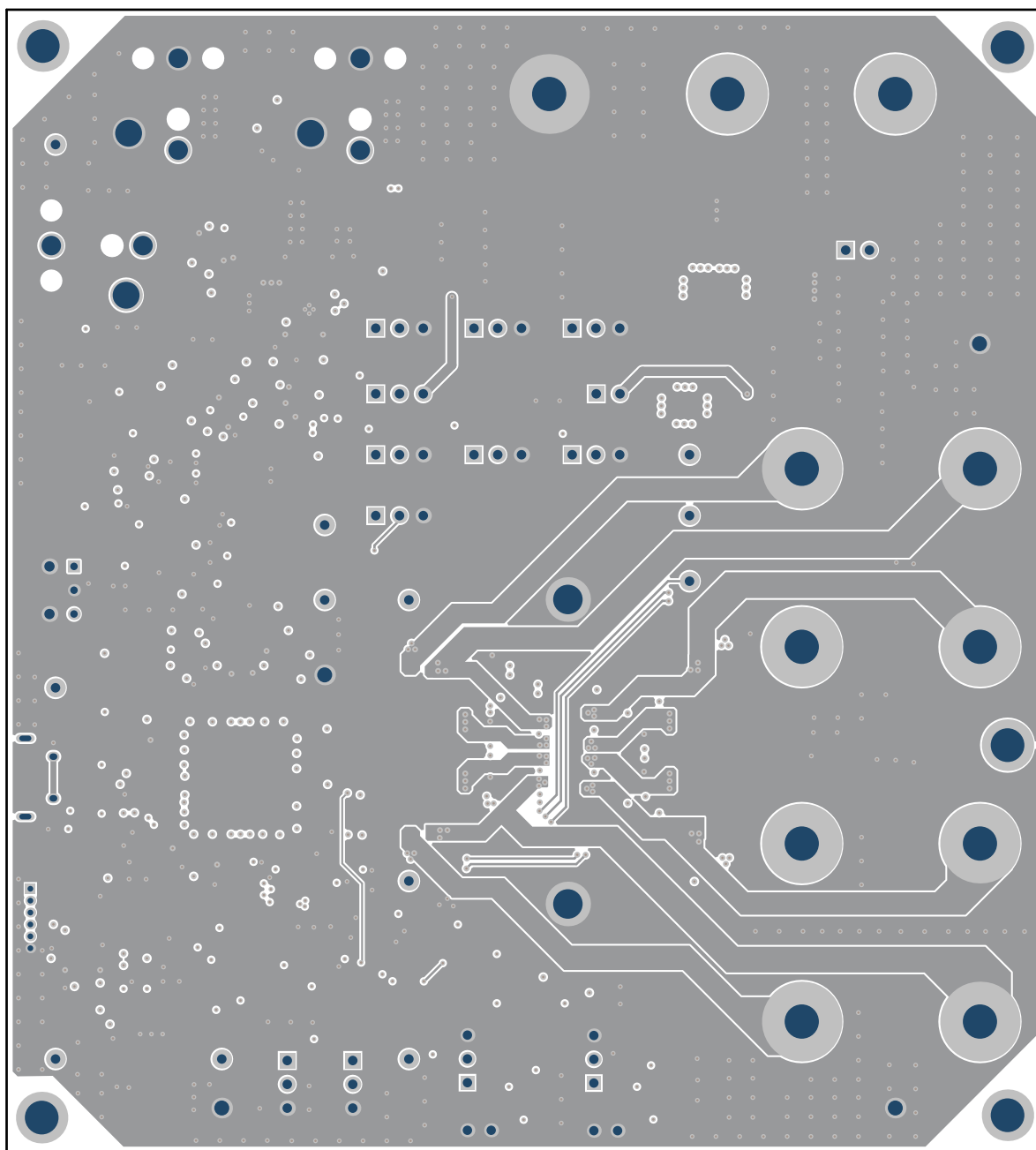
**Figure 4-3. Top Layer**



**Figure 4-4. Signal Layer 1**

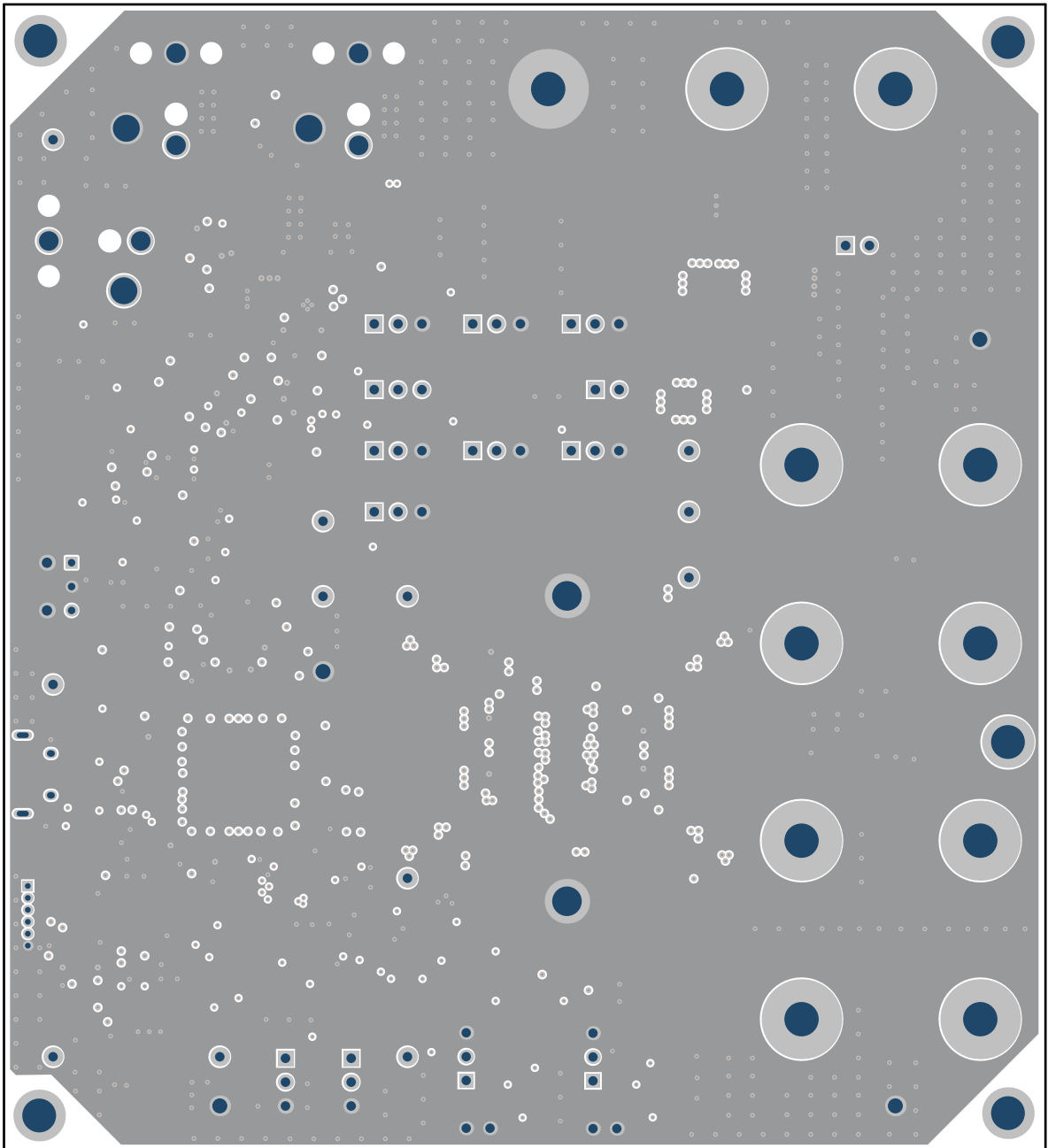


**Figure 4-5. Signal Layer 2**

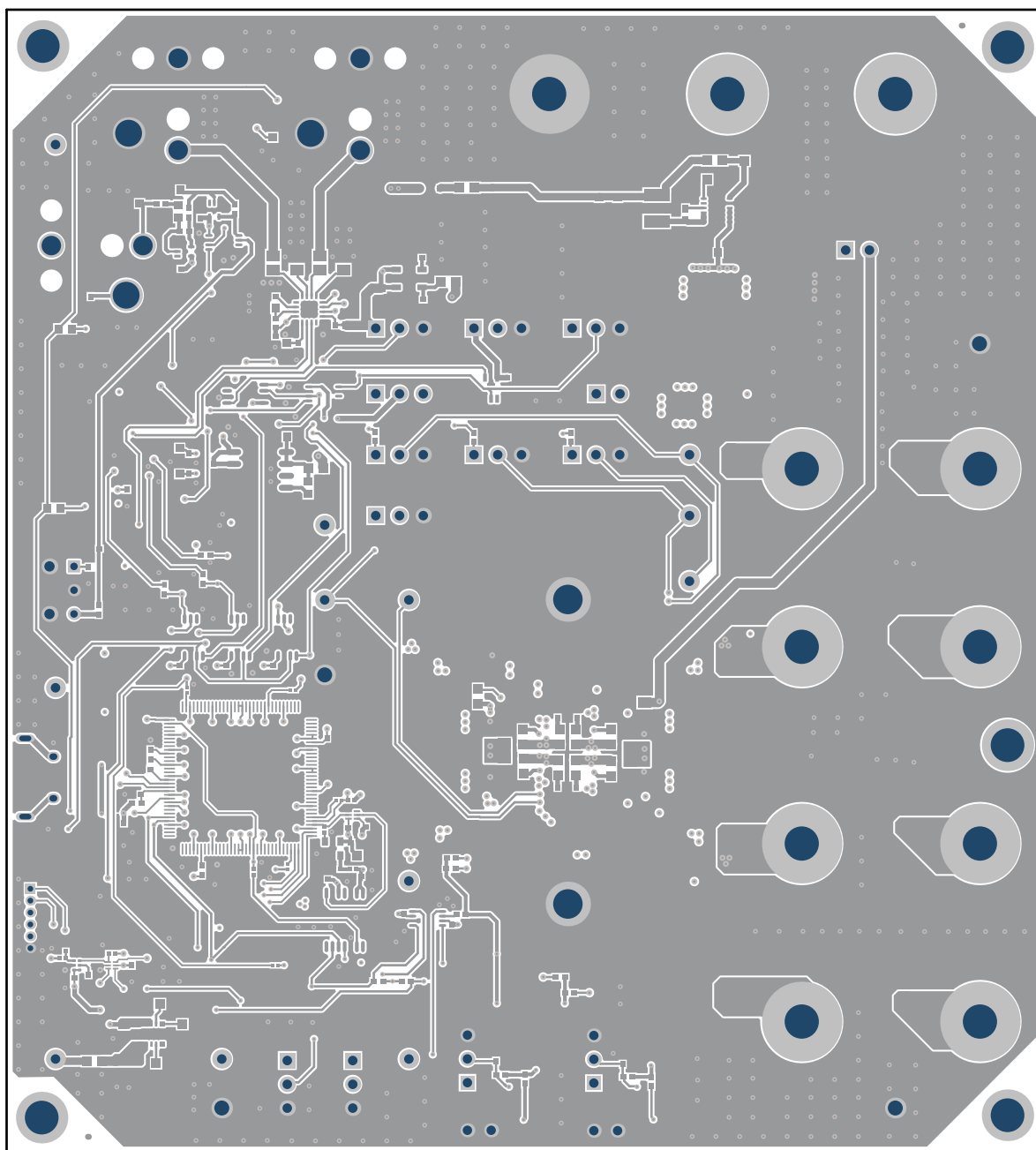


**Figure 4-6. Signal Layer 3**





**Figure 4-7. Signal Layer 4**



**Figure 4-8. Bottom Layer**

## 4.3 Bill of Materials (BOM)

**Table 4-1. Bill of Materials**

Designator	Quantity	Value	Description	Package	PartNumber	Manufacturer
C1, C4, C6, C8, C27	5	1uF	CAP, CERM, 1μF, 50V, +/- 20%, X7R, AEC-Q200 Grade 1, 0805	0805	GCJ21BR71H105MA01L	MuRata
C2, C5, C7, C9, C12, C14, C16, C41, C42	9	0.1uF	CAP, CERM, 0.1μF, 100V, +/- 10%, X8L, 0603	0603	GCJ188L8EL104KA07D	MuRata
C3, C21	2	0.047uF	CAP, CERM, 0.047uF, 16V, +/- 10%, X7R, 0402	0402	GRM155R71C473KA01D	MuRata
C11, C29, C34, C39	4	150nF	Automotive 150nF ±10% 50VDC X7R 0603 Paper T/R	0603	GCM188R71H154KA64D	MuRata
C15	1	390uF	CAP, AL, 390uF, 35V, +/- 20%, 0.08ohm, SMD	10x10	UCL1V391MNL1GS	Nichicon
C17	1	2.2uF	CAP, CERM, 2.2uF, 16V, +/- 10%, X7R, 0603	0603	EMK107BB7225KA-T	Taiyo Yuden
C18, C28, C32, C38	4	1uF	CAP, CERM, 1μF, 50V, +/- 10%, X7R, AEC-Q200 Grade 1	0805	GCM21BR71H105KA03K	MuRata
C19, C20, C105, C154	4	1uF	CAP, CERM, 1uF, 16V, +/- 20%, X7R, AEC-Q200 Grade 1	0603	GCM188R71C105MA64D	MuRata
C22	1	0.1uF	CAP, CERM, 0.1uF, 6.3V, +/- 10%, X7R, 0402	0402	GRM155R70J104KA01D	MuRata
C23, C25, C26, C44, C45, C46, C47, C48, C49, C50, C51, C52, C53, C54, C55, C56, C57, C61, C65, C66, C67, C68, C69, C70, C71, C72, C73, C74, C75, C76, C77, C78, C79, C81, C82, C83, C86, C88, C89, C90, C91, C92, C93, C94, C95, C99, C100, C104, C111, C114, C115, C116, C117, C120, C145, C148, C150, C152	58	0.1uF	CAP, CERM, 0.1uF, 16V, +/- 10%, X7R, 0402	0402	8.85012E+11	Wurth Elektronik
C24, C62, C125, C156, C167	5	10uF	CAP, CERM, 10uF, 10V, +/- 20%, X5R, 0603	0603	C1608X5R1A106M080AC	TDK
C30, C166	2	0.1uF	CAP, CERM, 0.1uF, 16V, +/- 10%, X7R, 0402	0402	GCM155R71C104KA55D	MuRata
C31	1	10pF	CAP, CERM, 10 pF, 50V, +/- 5%, C0G/ NP0, 0402	0402	GRM1555C1H100JA01D	MuRata
C33	1	0.33 uF	CAP, CERM, 0.33uF, 16V, +/- 10%, X7R, 0603	0603	GRM188R71C334KA01D	MuRata
C35, C36, C123	3	1uF	CAP, CERM, 1uF, 6.3V, +/- 10%, X7R, 0402	0402	GRM155R70J105KA12D	MuRata
C37, C43, C157, C159, C160, C162, C163, C165	8	0.01 uF	CAP, CERM, 0.01uF, 50V, +/- 5%, C0G/ NP0, 0603	0603	GRM1885C1H103JA01D	MuRata

**Table 4-1. Bill of Materials (continued)**

Designator	Quantity	Value	Description	Package	PartNumber	Manufacturer
C40, C124, C130, C138	4	1uF	CAP, CERM, 1uF, 16V, +/- 10%, X7R, AEC-Q200 Grade 1	0603	GCM188R71C105KA64D	MuRata
C58, C59, C60	3	22uF	CAP, CERM, 22uF, 10V, +/- 20%, X5R, 0603	0603	C1608X5R1A226M080AC	TDK
C63, C144, C146	3	1uF	CAP, CERM, 1uF, 6.3V, +/- 20%, X5R, 0402	0402	GRM152R60J105ME15D	MuRata
C64, C85, C106	3	0.01 uF	CAP, CERM, 0.01uF, 16V, +/- 10%, X7R, 0402	0402	8.85012E+11	Wurth Elektronik
C80, C97, C118, C119	4	330pF	CAP, CERM, 330pF, 50V, +/- 10%, X7R, 0402	0402	GRM155R71H331KA01D	MuRata
C84	1	470pF	CAP, CERM, 470pF, 50V, +/- 5%, C0G/ NP0, 0402	0402	GRM1555C1H471JA01D	MuRata
C87	1	2.2uF	CAP, CERM, 2.2uF, 10V, +/- 10%, X7R, 0603	0603	GRM188R71A225KE15D	MuRata
C96, C98, C101, C110, C147, C149, C151	7	10uF	CAP, CERM, 10uF, 16V, +/- 20%, X5R, 0603	0603	EMK107BBJ106MA-T	Taiyo Yuden
C102, C103, C107	3	10pF	CAP, CERM, 10pF, 50V, +/- 5%, C0G/ NP0, 0402	0402	8.85012E+11	Wurth Elektronik
C112	1	4700pF	CAP, CERM, 4700pF, 25V, +/- 10%, X7R, 0402	0402	CC0402KRX7R8BB472	Yageo
C113	1	0.068uF	CAP, CERM, 0.068uF, 50V, +/- 10%, X7R, AEC-Q200 Grade 1, 0402	0402	CGA2B3X7R1H683K050BB	TDK
C134, C135	2	0.1uF	CAP, CERM, 0.1uF, 16V, +/- 10%, X7R, AEC-Q200 Grade 1	0402	C0402C104K4RACAUTO	Kemet
C153, C155	2	1uF	CAP, CERM, 1uF, 50V, +/- 10%, X7R, 0805	0805	8.85012E+11	Wurth Elektronik
C168, C169	2	10uF	CAP, CERM, 10uF, 25V, +/- 20%, X6S, 0805	0805	GRM21BC81E106ME51L	MuRata
C170	1	3300pF	CAP, CERM, 3300pF, 50V, +/- 5%, C0G/ NP0, 0603	0603	GRM1885C1H332JA01D	MuRata
D1, D5, D10	3	Red	LED, Red, SMD	Red 0805 LED	LTST-C170KRKT	Lite-On
D2, D3	2	Blue	LED, Blue, SMD	LED_0805	LTST-C170TBKT	Lite-On
D4, D6, D7, D8	4	Green	LED, Green, SMD	0805 LED	LTST-C171GKT	Lite-On
D19, D20	2	10V	Diode, Schottky, 10V, 2A, SOD-323F	SOD-323F	PMEG1020EJ,115	Nexperia
H1, H2, H3, H4, H5	5		MACHINE SCREW PAN PHILLIPS M3	M3 Screw	RM3X8MM 2701	APM HEXSEAL
H6, H7, H8, H9, H10	5		Standoff, Hex, 12mm, M3, Aluminum	Aluminum M3 12mm Hex Standoff	24434	Keystone
H11	1		20.0 x 41.4 x 32.8mm BGA Heat Sink - High Performance Device Specific - TI	HTSNK_41MM4_20 MM0	ATS-TI10P-1918-C1-R0	Advanced Thermal Solutions

**Table 4-1. Bill of Materials (continued)**

Designator	Quantity	Value	Description	Package	PartNumber	Manufacturer
J1, J7, J12, J17, J18, J28	6		Binding Post, RED, TH	11.4x27.2mm	7006	Keystone
J2	1		JUMPER TIN SMD	6.85x0.97x2.51 mm	S1911-46R	Harwin
J3, J30	2		Header, 100mil, 2x1, Gold, TH	Sullins 100mil, 1x2, 230 mil above insulator	PBC02SAAN	Sullins Connector Solutions
J4, J6, J10, J11, J13, J14, J15, J19, J21, J22, J23	11		Header, 100mil, 3x1, Gold, TH	PBC03SAAN	PBC03SAAN	Sullins Connector Solutions
J5, J8, J20, J27, J29	5		Binding Post, BLACK, TH	11.4x27.2mm	7007	Keystone
J9, J16, J26	3		RCA Jack, White, R/A, TH	Phono Jack-White	970	Keystone
J24	1		Receptacle, 50mil, 6x1, Gold, R/A, TH	6x1 Receptacle	LPPB061NGCN-RC	Sullins Connector Solutions
J25	1		Connector, Receptacle, Micro-USB Type AB, R/A, Bottom Mount SMT	5.6x2.5x8.2mm	475890001	Molex
L1, L2, L3, L4	4	3.3uH	Inductor, 3.3uH, 4.5A, 0.038ohm, AEC-Q200 Grade 0, SMD	5.45x5.25x3.0mm	VCMV053T-3R3MN22M	Cyntec
L5	1	120 ohm	Ferrite Bead, 120 ohm at 100MHz, 0.4A, 0402	0402	MMZ1005Y121CT000	TDK
L6	1	10uH	Inductor, Wirewound, 10uH, 0.9A, 0.1729ohm, SMD	3.2x2.5x2.5mm	CBC3225T100MR	Taiyo Yuden
L7, L8	2	600 ohm	Ferrite Bead, 600 ohm at 100MHz, 2A, 0805	0805	MPZ2012S601AT000	TDK
R1, R2, R37, R38	4	2.2k	RES, 2.2k, 5%, 0.063W, AEC-Q200 Grade 0, 0402	0402	CRCW04022K20JNED	Vishay-Dale
R3	1	1.00Meg	RES, 1.00M, 1%, 0.1W, 0402	0402	ERJ-2RKF1004X	Panasonic
R4	1	7.50k	RES, 7.50 k, 1%, 0.063W, AEC-Q200 Grade 0, 0402	0402	CRCW04027K50FKED	Vishay-Dale
R5, R9, R31	3	4.99k	RES, 4.99 k, 1%, 0.063W, AEC-Q200 Grade 0, 0402	0402	CRCW04024K99FKED	Vishay-Dale
R6, R61, R74, R75, R76	9	0	RES, 0, 1%, 0.1W, AEC-Q200 Grade 0, 0603	0603	RMCF0603ZT0R00	Stackpole Electronics Inc
R7, R8, R22	3	10.0k	RES, 10.0k, 1%, 0.063W, AEC-Q200 Grade 0, 0402	0402	RMCF0402FT10K0	Stackpole Electronics Inc
R10	1	100	RES, 100, 1%, 0.1W, AEC-Q200 Grade 0, 0603	0603	CRCW0603100RFKEA	Vishay-Dale
R11	1	2.00k	RES, 2.00 k, 1%, 0.1W, AEC-Q200 Grade 0, 0603	0603	CRCW06032K00FKEA	Vishay-Dale
R12	1	75	RES, 75.0, 1%, 0.1W, AEC-Q200 Grade 0, 0603	0603	CRCW060375R0FKEA	Vishay-Dale

**Table 4-1. Bill of Materials (continued)**

Designator	Quantity	Value	Description	Package	PartNumber	Manufacturer
R13, R60, R65, R67	4	49.9	RES, 49.9, 1%, 0.063W, AEC-Q200 Grade 0, 0402	0402	CRCW040249R9FKED	Vishay-Dale
R14, R20, R28, R29, R45, R68	6	1.5k	RES, 1.5k, 5%, 0.1W, AEC-Q200 Grade 0, 0603	0603	CRCW06031K50JNEA	Vishay-Dale
R15, R16, R17, R62	4	33	RES, 33.0, 1%, 0.1W, 0402	0402	ERJ-2RKF33R0X	Panasonic
R25	1	249k	RES, 249k, 1%, 0.1W, 0603	0603	RC0603FR-07249KL	Yageo
R32, R42, R43, R44, R47, R52, R53, R56	8	33.2	RES, 33.2, 1%, 0.05W, 0201	0201	RC0201FR-0733R2L	Yageo America
R34	1	26.1k	RES, 26.1k, 0.1%, 0.1W, 0603	0603	RT0603BRD0726K1L	Yageo America
R35	1	8.87k	RES, 8.87 k, 1%, 0.1W, 0603	0603	CRCW06038K87FKEA	Vishay-Dale
R36	1	1.0k	RES, 1.0 k, 5%, 0.063W, AEC-Q200 Grade 0, 0402	0402	CRCW04021K00JNED	Vishay-Dale
R39, R46	2	10.0k	RES, 10.0 k, 1%, 0.1W, 0402	0402	ERJ-2RKF1002X	Panasonic
R40	1	4.7	RES, 4.7, 5%, 0.1W, AEC-Q200 Grade 0, 0603	0603	CRCW06034R70JNEA	Vishay-Dale
R41	1	10k	RES, 10 k, 5%, 0.063W, AEC-Q200 Grade 0, 0402	0402	CRCW040210K0JNED	Vishay-Dale
R48	1	0	RES, 0, 5%, .05W, AEC-Q200 Grade 0, 0201	0201	ERJ-1GN0R00C	Panasonic
R49	1	43.2	RES, 43.2, 1%, 0.1W, AEC-Q200 Grade 0, 0402	0402	ERJ-2RKF43R2X	Panasonic
R50, R51, R55, R57	4	10.0k	RES, 10.0 k, 1%, 0.05W, 0201	0201	CRCW020110K0FKED	Vishay-Dale
R54	1	25.5k	RES, 25.5 k, 1%, 0.05W, 0201	0201	RC0201FR-0725K5L	Yageo America
R58	1	51.0k	RES, 51.0 k, 1%, 0.05W, 0201	0201	RC0201FR-0751KL	Yageo America
R59	1	47.0k	RES, 47.0 k, 1%, 0.0625W, 0402	0402	RC0402FR-0747KL	Yageo America
R66	1	10.0k	RES, 10.0 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040210K0FKED	Vishay-Dale
R69, R70, R72, R73	4	3.3	RES, 3.3, 5%, 0.1W, AEC-Q200 Grade 0, 0603	0603	CRCW06033R30JNEA	Vishay-Dale
R71	1	680	RES, 680, 5%, 0.063W, AEC-Q200 Grade 0, 0402	0402	CRCW0402680RJNED	Vishay-Dale
R77	1	27.0k	RES, 27.0 k, 1%, 0.1W, 0603	0603	RC0603FR-0727KL	Yageo
R78	1	4.70k	RES, 4.70 k, 1%, 0.1W, 0603	0603	RC0603FR-074K7L	Yageo
S1, S2	2		Switch, SPDT, On-On, 1 Pos, 0.4A, 28 VDC, TH	5.6x5.4mm	FT1D-4M-Z	Copal Electronics
SH-J1, SH-J2, SH-J3, SH-J4, SH-J5, SH-J6, SH-J7, SH-J8, SH-J9, SH-J10, SH-J11, SH-J12, SH-J13	13	1x2	Shunt, 100mil, Gold plated, Black	Shunt	SNT-100-BK-G	Samtec

**Table 4-1. Bill of Materials (continued)**

Designator	Quantity	Value	Description	Package	PartNumber	Manufacturer
TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP8, TP13, TP14, TP16, TP22	12		Test Point, Miniature, Orange, TH	Orange Miniature Testpoint	5003	Keystone
TP9, TP10, TP11, TP12	4		Test Point, Compact, Black, TH	Black Compact Testpoint	5006	Keystone
U1, U2	2		Single Inverter Gate, DRL0005A, LARGE T&R	DRL0005A	SN74LVC1GU04DRLR	Texas Instruments
U3	1		3V to 17V, High Efficiency and Low IQ Buck Converter	uSiL11	TPSM82903SISR	Texas Instruments
U4	1		Fast Transient Response LDO, 1A, Fixed 3.3V Output,	D0008A	TPS76833QDR	Texas Instruments
U5	1		Single Output LDO, 400mA, Adj.(1.2 to 5.5V), Cap free	DBV0005A	TPS73618DBVR	Texas Instruments
U6	1		XCore XEF Microcontroller IC 32-Bit 16-Core 2000MIPs	TQFP128	XEF216-512-TQ128-C20A	XMOS
U7	1		1MHz I2C Bus and SMBus Voltage-Level Shifter	DCU0008A	TCA9406DCUR	Texas Instruments
U8	1		1-PLL VCXO Clock Synthesizer	PW0014A	CDCE913PWR	Texas Instruments
U9	1		Dual-Bit Dual-Supply Bus Transceiver, DQM0008A	DQM0008A	SN74AVC2T244DQMR	Texas Instruments
U10	1		Dual Buffer/Driver with Open-Drain Output, DCK0006A	DSF0006A	SN74LVC2G07DSFR	Texas Instruments
U11	1		Adjustable Supervisory Circuit With Active-High Open-Drain	DRY0006A	TPS3897ADRYR	Texas Instruments
U12, U24, U27	3		Single 2-Line to 1-Line Data Selector/Multiplexer	DCU0008A	SN74LVC2G157DCUR	Texas Instruments
U13	1		4V to 36V, 5A Synchronous Step-Down DC/DC Converter	WS0N12	LMR51450SDRRR	Texas Instruments
U14	1		Optical Receiver 25Mbps Single 650nm	PTH_9MM70_13M M50	PLR237/T10BK	Everlight Electronics
U15	1		216kHz Digital Audio Interface Transceiver (DIX)	PT0048A	PCM9211PT	Texas Instruments
U16, U17, U19, U29	4		Single 2-Line to 1-Line Data Selector/Multiplexer	DCT0008A	SN74LVC2G157DCTR	Texas Instruments
U18, U28	2		Single Schmitt-Trigger Inverter, DCK0005A	DCK0005A	SN74LVC1G14DCKR	Texas Instruments
U20	1		26.4V, 7.5A, 4-Channel Class-D Audio Amplifier	HSSOP56	TAS67524QDKQRQ1	Texas Instruments
U21	1		4-Bit Dual-Supply Bus Transceiver	RSV0016A	SN74AVC4T774RSVR	Texas Instruments
U23	1		2-Channel, 768-kHz, Burr-Brown Audio ADC	WQFN20	PCM6120QRTERQ1	Texas Instruments

**Table 4-1. Bill of Materials (continued)**

Designator	Quantity	Value	Description	Package	PartNumber	Manufacturer
Y1	1		High-Performance BAW Oscillator, LVCMOS	VSON4	LMK6CE02400CDLF	Texas Instruments
Y2	1		24.576 MHz XO (Standard) CMOS Oscillator 1.6V ~ 3.6V	SMT_OSC_2MM5_2MM0	SG-210STF 24.5760ML0	Epson



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## STANDARD TERMS FOR EVALUATION MODULES

1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, and/or documentation which may be provided together or separately (collectively, an "EVM" or "EVMs") to the User ("User") in accordance with the terms set forth herein. User's acceptance of the EVM is expressly subject to the following terms.
  - 1.1 EVMs are intended solely for product or software developers for use in a research and development setting to facilitate feasibility evaluation, experimentation, or scientific analysis of TI semiconductors products. EVMs have no direct function and are not finished products. EVMs shall not be directly or indirectly assembled as a part or subassembly in any finished product. For clarification, any software or software tools provided with the EVM ("Software") shall not be subject to the terms and conditions set forth herein but rather shall be subject to the applicable terms that accompany such Software
  - 1.2 EVMs are not intended for consumer or household use. EVMs may not be sold, sublicensed, leased, rented, loaned, assigned, or otherwise distributed for commercial purposes by Users, in whole or in part, or used in any finished product or production system.
2. *Limited Warranty and Related Remedies/Disclaimers:*
  - 2.1 These terms do not apply to Software. The warranty, if any, for Software is covered in the applicable Software License Agreement.
  - 2.2 TI warrants that the TI EVM will conform to TI's published specifications for ninety (90) days after the date TI delivers such EVM to User. Notwithstanding the foregoing, TI shall not be liable for a nonconforming EVM if (a) the nonconformity was caused by neglect, misuse or mistreatment by an entity other than TI, including improper installation or testing, or for any EVMs that have been altered or modified in any way by an entity other than TI, (b) the nonconformity resulted from User's design, specifications or instructions for such EVMs or improper system design, or (c) User has not paid on time. Testing and other quality control techniques are used to the extent TI deems necessary. TI does not test all parameters of each EVM. User's claims against TI under this Section 2 are void if User fails to notify TI of any apparent defects in the EVMs within ten (10) business days after delivery, or of any hidden defects with ten (10) business days after the defect has been detected.
  - 2.3 TI's sole liability shall be at its option to repair or replace EVMs that fail to conform to the warranty set forth above, or credit User's account for such EVM. TI's liability under this warranty shall be limited to EVMs that are returned during the warranty period to the address designated by TI and that are determined by TI not to conform to such warranty. If TI elects to repair or replace such EVM, TI shall have a reasonable time to repair such EVM or provide replacements. Repaired EVMs shall be warranted for the remainder of the original warranty period. Replaced EVMs shall be warranted for a new full ninety (90) day warranty period.

### **WARNING**

**Evaluation Kits are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems.**

**User shall operate the Evaluation Kit within TI's recommended guidelines and any applicable legal or environmental requirements as well as reasonable and customary safeguards. Failure to set up and/or operate the Evaluation Kit within TI's recommended guidelines may result in personal injury or death or property damage. Proper set up entails following TI's instructions for electrical ratings of interface circuits such as input, output and electrical loads.**

**NOTE:**

EXPOSURE TO ELECTROSTATIC DISCHARGE (ESD) MAY CAUSE DEGRADATION OR FAILURE OF THE EVALUATION KIT; TI RECOMMENDS STORAGE OF THE EVALUATION KIT IN A PROTECTIVE ESD BAG.

### 3 Regulatory Notices:

#### 3.1 United States

##### 3.1.1 Notice applicable to EVMs not FCC-Approved:

**FCC NOTICE:** This kit is designed to allow product developers to evaluate electronic components, circuitry, or software associated with the kit to determine whether to incorporate such items in a finished product and software developers to write software applications for use with the end product. This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter.

##### 3.1.2 For EVMs annotated as FCC – FEDERAL COMMUNICATIONS COMMISSION Part 15 Compliant:

#### **CAUTION**

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

#### **FCC Interference Statement for Class A EVM devices**

*NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.*

#### **FCC Interference Statement for Class B EVM devices**

*NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:*

- *Reorient or relocate the receiving antenna.*
- *Increase the separation between the equipment and receiver.*
- *Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.*
- *Consult the dealer or an experienced radio/TV technician for help.*

#### 3.2 Canada

##### 3.2.1 For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210 or RSS-247

#### **Concerning EVMs Including Radio Transmitters:**

This device complies with Industry Canada license-exempt RSSs. Operation is subject to the following two conditions:

(1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

#### **Concernant les EVMs avec appareils radio:**

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

#### **Concerning EVMs Including Detachable Antennas:**

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication. This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

### Concernant les EVMs avec antennes détachables

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante. Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur.

#### 3.3 Japan

3.3.1 *Notice for EVMs delivered in Japan:* Please see [http://www.tij.co.jp/sds/ti\\_ja/general/eStore/notice\\_01.page](http://www.tij.co.jp/sds/ti_ja/general/eStore/notice_01.page) 日本国内に輸入される評価用キット、ボードについては、次のところをご覧ください。

<https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-delivered-in-japan.html>

3.3.2 *Notice for Users of EVMs Considered "Radio Frequency Products" in Japan:* EVMs entering Japan may not be certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of Japan, User is required to follow the instructions set forth by Radio Law of Japan, which includes, but is not limited to, the instructions below with respect to EVMs (which for the avoidance of doubt are stated strictly for convenience and should be verified by User):

1. Use EVMs in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan,
2. Use EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
3. Use of EVMs only after User obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless User gives the same notice above to the transferee. Please note that if User does not follow the instructions above, User will be subject to penalties of Radio Law of Japan.

【無線電波を送信する製品の開発キットをお使いになる際の注意事項】 開発キットの中には技術基準適合証明を受けていないものがあります。技術適合証明を受けていないもののご使用に際しては、電波法遵守のため、以下のいずれかの措置を取っていただく必要がありますのでご注意ください。

1. 電波法施行規則第6条第1項第1号に基づく平成18年3月28日総務省告示第173号で定められた電波暗室等の試験設備でご使用いただく。
2. 実験局の免許を取得後ご使用いただく。
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なお、本製品は、上記の「ご使用にあたっての注意」を譲渡先、移転先に通知しない限り、譲渡、移転できないものとします。

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3.3.3 *Notice for EVMs for Power Line Communication:* Please see [http://www.tij.co.jp/sds/ti\\_ja/general/eStore/notice\\_02.page](http://www.tij.co.jp/sds/ti_ja/general/eStore/notice_02.page)

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#### 3.4 European Union

3.4.1 *For EVMs subject to EU Directive 2014/30/EU (Electromagnetic Compatibility Directive):*

This is a class A product intended for use in environments other than domestic environments that are connected to a low-voltage power-supply network that supplies buildings used for domestic purposes. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

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4 *EVM Use Restrictions and Warnings:*

4.1 EVMS ARE NOT FOR USE IN FUNCTIONAL SAFETY AND/OR SAFETY CRITICAL EVALUATIONS, INCLUDING BUT NOT LIMITED TO EVALUATIONS OF LIFE SUPPORT APPLICATIONS.

4.2 User must read and apply the user guide and other available documentation provided by TI regarding the EVM prior to handling or using the EVM, including without limitation any warning or restriction notices. The notices contain important safety information related to, for example, temperatures and voltages.

4.3 *Safety-Related Warnings and Restrictions:*

4.3.1 User shall operate the EVM within TI's recommended specifications and environmental considerations stated in the user guide, other available documentation provided by TI, and any other applicable requirements and employ reasonable and customary safeguards. Exceeding the specified performance ratings and specifications (including but not limited to input and output voltage, current, power, and environmental ranges) for the EVM may cause personal injury or death, or property damage. If there are questions concerning performance ratings and specifications, User should contact a TI field representative prior to connecting interface electronics including input power and intended loads. Any loads applied outside of the specified output range may also result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM user 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, even with the inputs and outputs kept within the specified allowable ranges, some circuit components may have elevated case temperatures. These components include but are not limited to linear regulators, switching transistors, pass transistors, current sense resistors, and heat sinks, which can be identified using the information in the associated documentation. When working with the EVM, please be aware that the EVM may become very warm.

4.3.2 EVMs are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems. User assumes all responsibility and liability for proper and safe handling and use of the EVM by User or its employees, affiliates, contractors or designees. User assumes all responsibility and liability to ensure that any interfaces (electronic and/or mechanical) between the EVM and any human body are designed with suitable isolation and means to safely limit accessible leakage currents to minimize the risk of electrical shock hazard. User assumes all responsibility and liability for any improper or unsafe handling or use of the EVM by User or its employees, affiliates, contractors or designees.

4.4 User assumes all responsibility and liability to determine whether the EVM is subject to any applicable international, federal, state, or local laws and regulations related to User's handling and use of the EVM and, if applicable, User assumes all responsibility and liability for compliance in all respects with such laws and regulations. User assumes all responsibility and liability for proper disposal and recycling of the EVM consistent with all applicable international, federal, state, and local requirements.

5. *Accuracy of Information:* To the extent TI provides information on the availability and function of EVMs, TI attempts to be as accurate as possible. However, TI does not warrant the accuracy of EVM descriptions, EVM availability or other information on its websites as accurate, complete, reliable, current, or error-free.

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