TAS3251 Evaluation Module

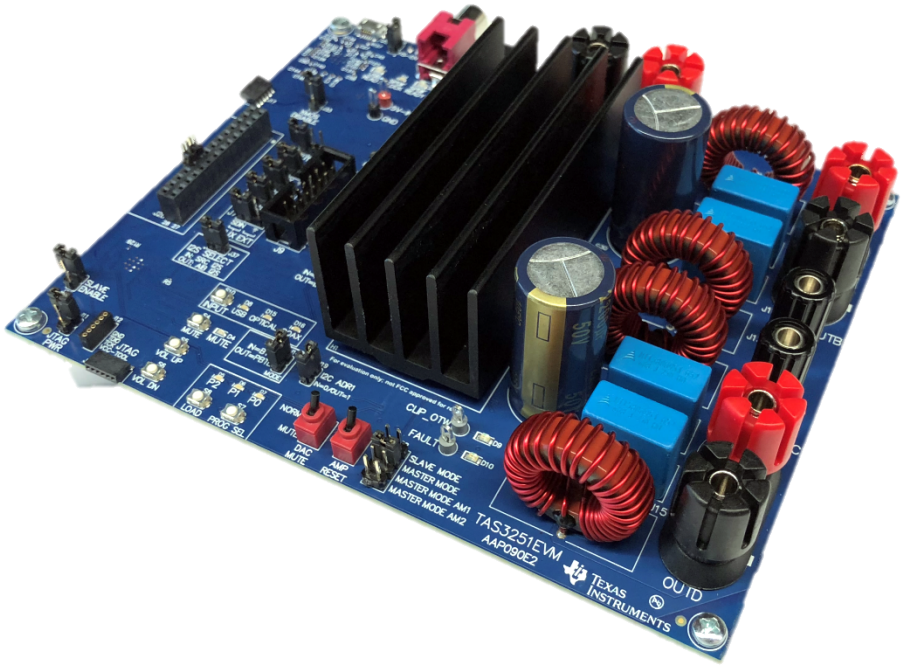
This user's guide describes the characteristics, operation, and use of the TAS3251 evaluation module. A complete printed-circuit board (PCB) description, schematic diagram, and bill of materials (BOM) are also included. For questions and support go to the E2E forums (e2e.ti.com).

The main contents of this document are:

- Hardware descriptions and implementation
- Design information

Related documents:

- TAS3251 175-W Stereo, 350-W Mono Ultra-HD Digital-Input Class-D Amplifier with Advanced DSP Processing data sheet



Contents

List of Figures

List of Tables

Trademarks

PurePath is a trademark of Texas Instruments.
PurePath, are trademarks of ~ Texas Instruments.
All other trademarks are the property of their respective owners.

1 Quick Start (BTL Mode)

Figure 1 shows the output configuration BTL.

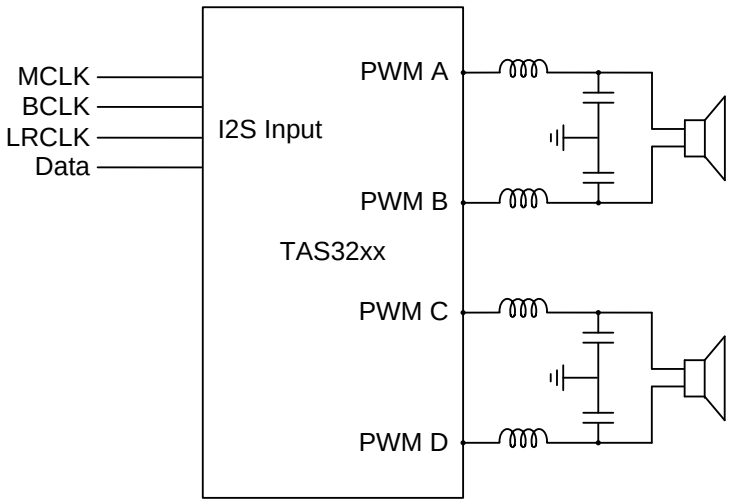


Figure 1. Output Configuration BTL

1.1 Required Hardware

The following is required for this EVM configuration:

- TAS3251EVM
- Power supply 5–17 A, 15–36 V
- Two cables for power supply connection
- Two 3–8 Ω speakers or resistor loads (ensure speaker or load is appropriately sized for required wattage output)
- Four cables for banana or terminal to speaker or load connection
- USB micro cable
- PC with PurePath™ Console 3 (PPC3) and audio track

1.2 Connections and Board Configuration (USB BTL Mode)

Figure 2 and Figure 3 illustrate the top and bottom EVM boards.

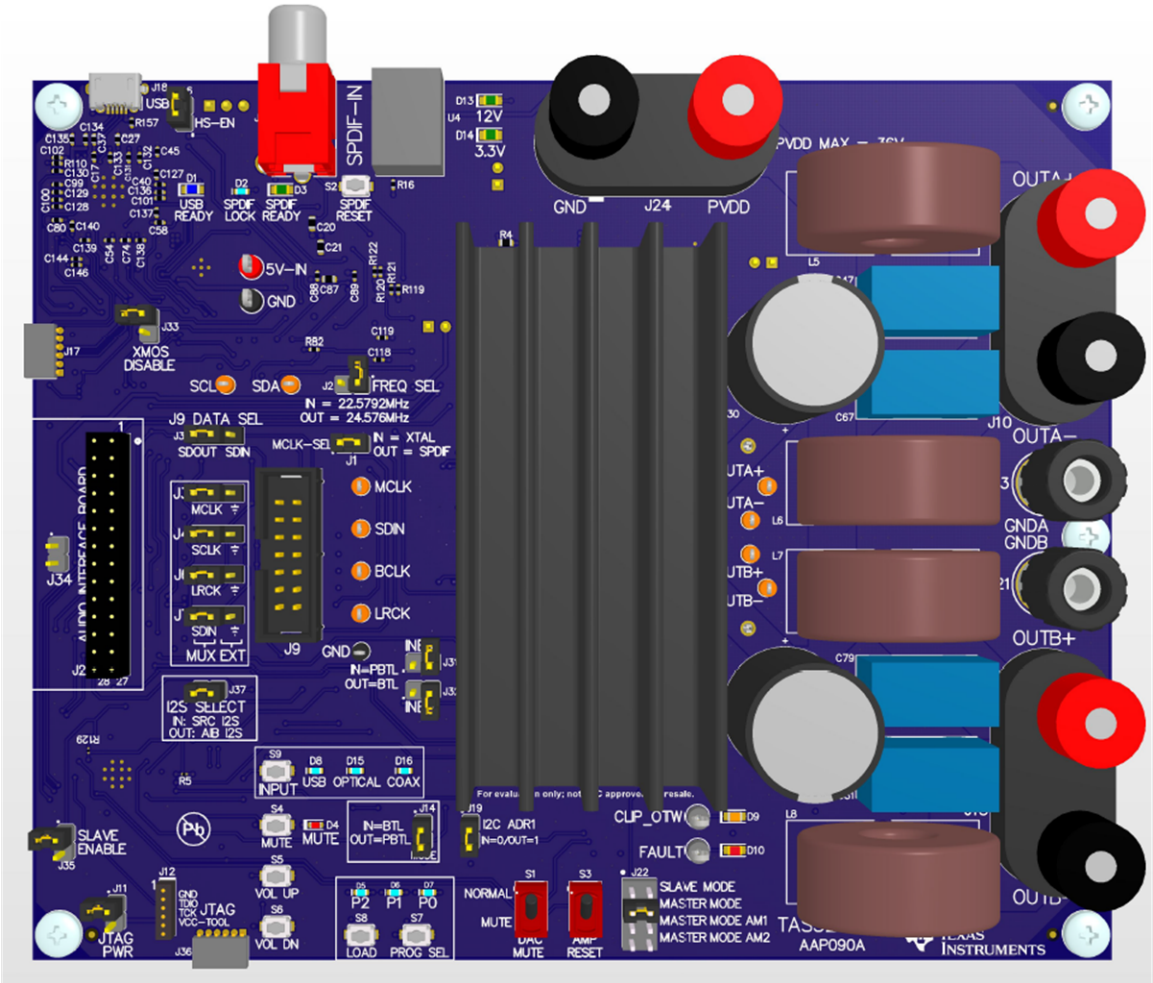


Figure 2. EVM Board (Top Side)

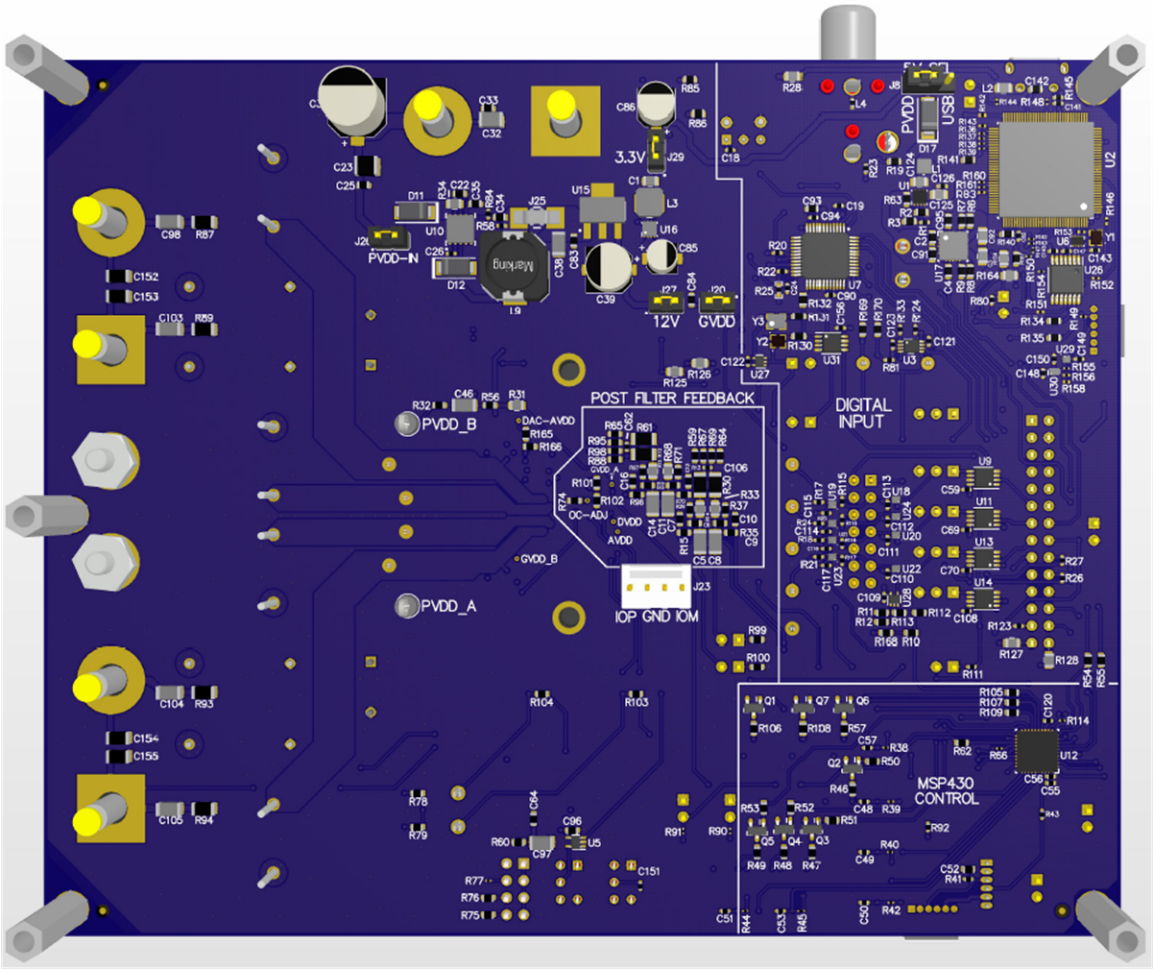


Figure 3. EVM Board (Bottom Side)

Use the following when connecting and configuring the board for 48-kHz USB BTL mode:

1. Ensure the power supply is OFF. Connect the power supply positive terminal to J24 PVDD (red) and negative to J1 GND (black).
2. Connect the left channel speaker or power resistor load (3–8 Ω) to the TAS3251EVM J10 OUTA+ terminal (red) and the other side of the speaker or resistor load to the TPA3251EVM J10 OUTA- terminal (black).
3. Connect the right channel speaker or power resistor load (3–8 Ω) to the TAS3251EVM J15 OUTB+ terminal (red) and the other side of the speaker or resistor load to the TPA3251EVM J15 OUTB- terminal (black).
4. Check to make sure that the power supply is connected to J24 only, and the speakers or resistor loads are connected to J10 or J15 only, as their colors are the same.
5. Connect USB cable from the PC to the TAS3251EVM.
6. Ensure that DAC MUTE S1 and AMP RESET S3 are in the lower positions of MUTE and RESET.
7. Check Table 1 for all jumper and switch configurations.

Table 1. Jumper and Switch Configurations (USB BTL Mode)

Jumper	Description	Configuration for BTL
J16	HS-EN USB high-speed enable	Do not care
J33	XMOS DISABLE	Remove
J2	Frequency select	Remove
J30	Data select for J9	Do not care
J1	MCLK-SEL	Install
J3	MCLK	1-2
J4	SCLK	1-2
J5	LRCLK	1-2
J7	SDIN	1-2
J37	I2S source select	Install
J31	PBTL INC	Remove
J32	PBTL IND	Remove
J14	MODE	Install
J19	ADR	Install
J22	PWM switching frequency	3-4
J35	SLAVE ENABLE	Remove
J11	JTAG power	Do not care
J26	PVDD	Install
J29	3.3V	Install
J27	12V	Install
J20	GVDD	Install
J8	5-V select	1-2
S1	DAC MUTE	MUTE
S3	AMP RESET	RESET

1.3 Power Up

Ensure that the required connections and configurations have been checked. The TAS3251EVM board can now be powered on.

1. Enable the power supply at 15 V to 36 V and ensure that D13 and D14 illuminates. LEDs D9 and D10 should not be illuminated.
2. Bring the *DAC* out of MUTE by switching DAC MUTE (S1) to NORMAL.
3. Bring the *Power Stage* out of RESET by switching AMP RESET (S3) to the high position. You should see the FAULT LED (D10) blink once quickly, then remain unilluminated.

1.4 MSP430 Configuration

The MSP430 can be enabled to program the TAS3251 with default coefficients, or custom coefficients if the MSP430 is flashed with new configurations.

1. To enable the MSP430, hit “PROG SEL” twice. This will trigger the MSP430 to enable the TAS3251 DSP into a default stereo process flow, and put the DSP into a mute state.
2. Press ”INPUT” to cycle through the different digital audio inputs shown by the USB, Optical, and Coax LEDs to the right of the input button. Select the appropriate input for the audio source.
3. Hit the “MUTE” button to unmute the TAS3251. The default volume will be 0 dB through the DAC and DSP.

1.5 Windows USB Audio

When the J15 jumper HS-Enable is installed the TAS3251EVM will identify itself as TI USB Audio UAC2.0 and a USB Audio class 2 device. If the jumper is removed before power up, the TAS3251EVM will enumerate as a USB Audio 1 device.

2 Setup By Mode

The following sections describe the setup and configuration for each output mode. The TAS3251EVM allows for two output modes: Stereo BTL and Mono PBTL.

2.1 BTL Mode

This mode is the same as described in Quick Start (BTL MODE).

2.1.1 Performance Data (BTL Mode)

All measurements are taken at an audio frequency = 1 kHz, PVDD_X = 36 V, R_L = 4 Ω, f_S = 600 kHz, R_{OC} = 22 kΩ, Output filter: L = 7 µH, C = 0.68 µF, with AES17 + AUX-0025 measurement filters.

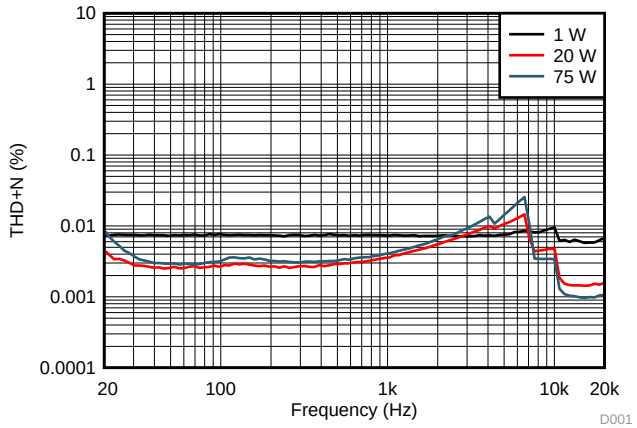


Figure 4. PSIA Input: THD+N vs Frequency

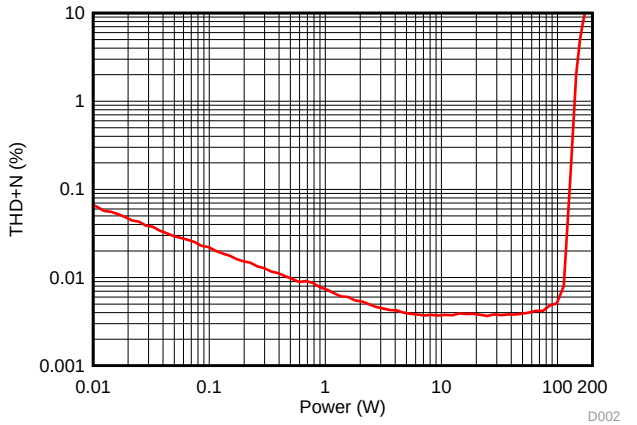


Figure 5. PSIA Input: THD+N vs Power

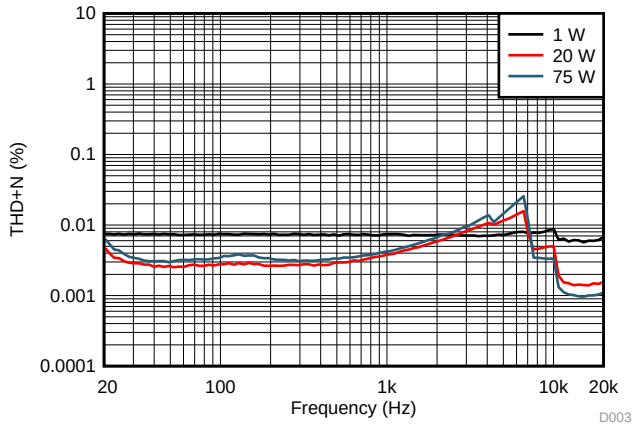


Figure 6. SPDIF Input: THD+N vs Frequency

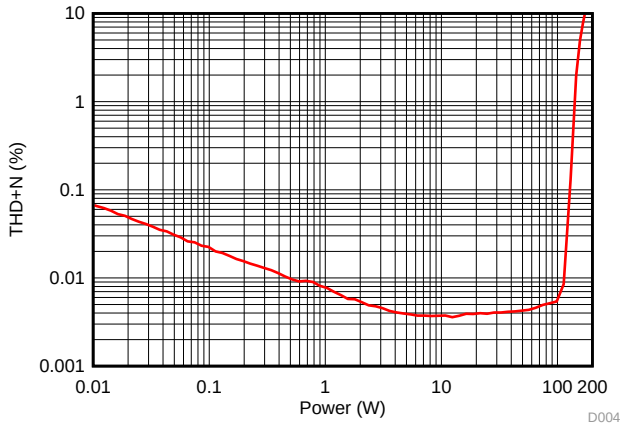


Figure 7. SPDIF Input: THD+N vs Power

2.2 PBTL Mode

This mode provides a mono speaker output for the maximum output power.

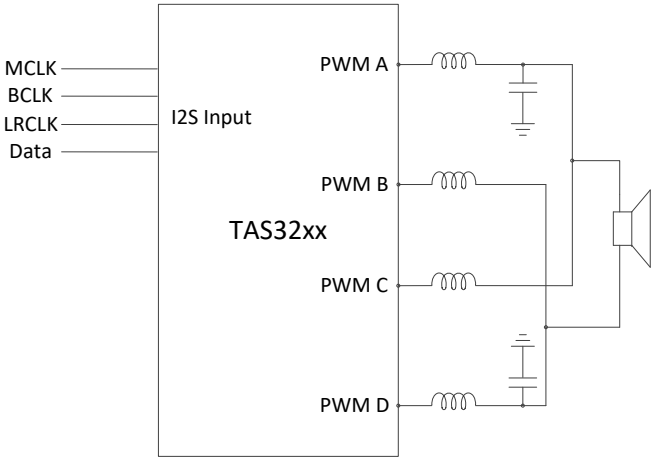


Figure 8. PBTL Output Configuration

Use the following when connection and configuring the board for 48 kHz USB PBTL MODE:

1. Ensure the power supply is OFF. Connect the power supply positive terminal to J24 PVDD (red) and negative to J1 GND (black).
2. Connect the J10 OUTA+ (red) to J15 OUTB+ (red) and J10 OUTA- (black) to J15 OUTB- (black) with banana cables or speaker wire.
3. Connect the speaker or power resistor load (2-8Ω) to the TAS3251EVM OUTA+ J10 terminal (red) and the other side of the speaker or resistor load to the TPA3251EVM J10 OUTA- terminal (black).
4. Check to make sure that the power supply is connected to J24 only, and the speakers or resistor loads are connected to J10 or J15 only, as their colors are the same.
5. Connect USB cable from the PC to TAS3251EVM.
6. Ensure that DAC MUTE S1 and AMP RESET S3 are in the lower positions of MUTE and RESET.
7. Check Table 2 for all jumper and switch configurations.

Table 2. Jumper and Switch Configurations (USB PBTL Mode)

Jumper	Description	Configuration for PBTL
J16	High-Speed USB enable for XMOS	Install
J33	XMOS disable	Remove
J2	Audio master clock frequency select	X
J30	Interboard connector data source	X
J1	MCLK source select	Install
J3	I2S MCLK external input	1-2
J4	I2S SCLK External input	1-2
J6	I2S LRCLK External input	1-2
J7	I2S SDIN External input	1-2
J31	INC short to GND	Install
J32	IND short to GND	Install
J37	I2S source select	Install
J35	Slave board enable	Remove
J14	Mode select	Remove
J19	I2C address select	Remove
J22	Class-D Switching Frequency select	3-4

2.2.1 Performance Data (PBTL Mode)

All measurements are taken at an audio frequency = 1 kHz, PVDD_X = 36 V, R_L = 4 Ω, f_S = 600 kHz, R_{OC} = 22 kΩ, Output filter: L = 7 µH, C = 0.68 µF, with AES17 + AUX-0025 measurement filters.

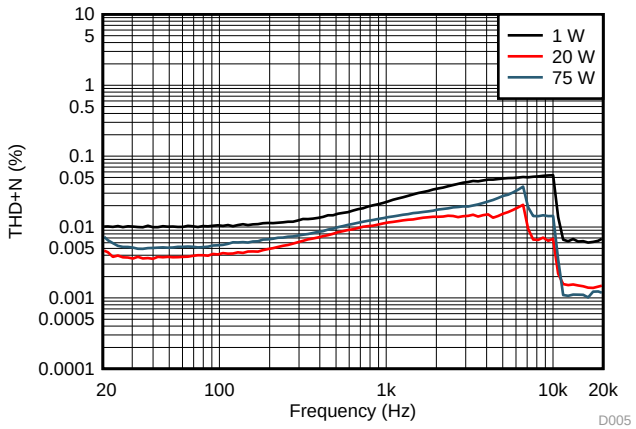


Figure 9. PSIA Input: THD+N vs Frequency

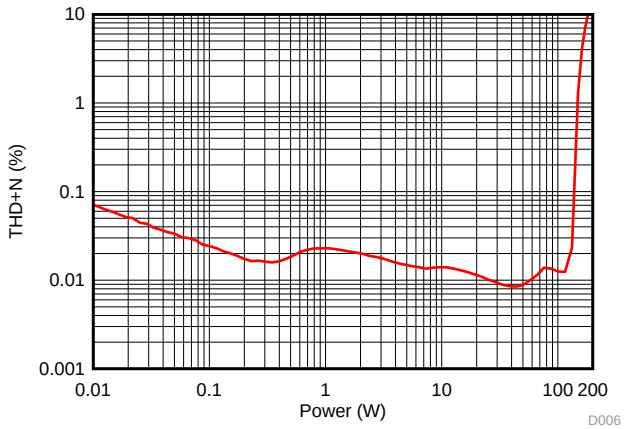


Figure 10. PSIA Input: THD+N vs Power

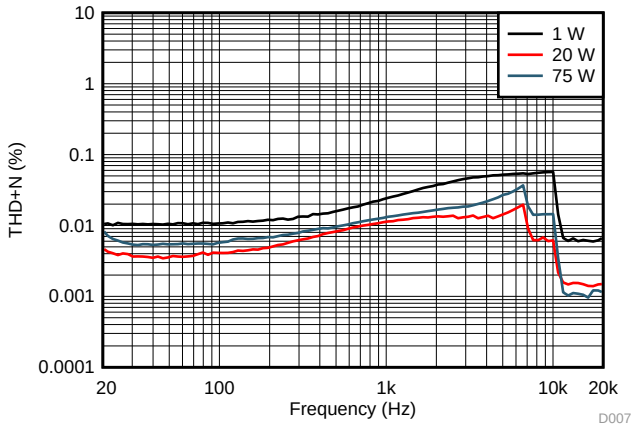


Figure 11. SPDIF Input: THD+N vs Frequency

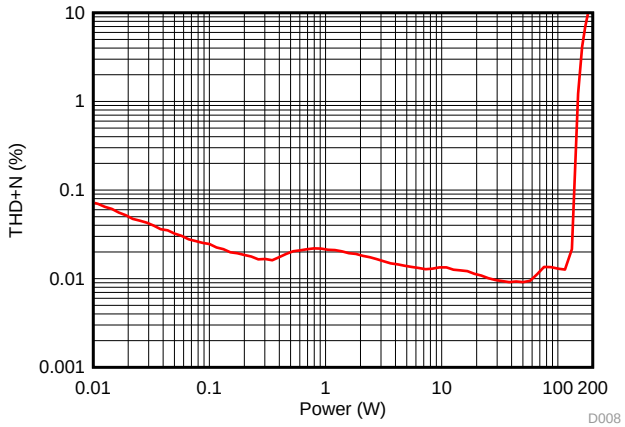


Figure 12. SPDIF Input: THD+N vs Power

3 Hardware Configuration

3.1 Indicators

This section will describe the LED indicators on the TAS3251EVM.

3.1.1 CLIP_OTW and FAULT

The TAS3251EVM is equipped with LED indicators that illuminate when the FAULT or CLIP_OTW pins go low. See Table 3 and the TAS3251 datasheet for more details.

Table 3. Fault and Clip Overteperature Status

FAULT LED Status	CLIP_OTW LED Status	Description
ON	ON	Overtemperature (OTE) or overload (OLP) or undervoltage (UVP) Junction temperature higher than 125°C (overtemperature warning)
ON	ON	Overload (OLP) or undervoltage (UVP). Junction temperature higher than 125°C (over temperature warning)
ON	OFF	Overload (OLP) or undervoltage (UVP). Junction temperature lower than 125°C
OFF	ON	Junction temperature higher than 125°C (overtemperature warning)
OFF	OFF	Junction temperature lower than 125°C and no OLP or UVP faults (normal operation)

In addition to the states above, while the amplifier is operating, the CLIP_OTW pin can indicate clipping or pre-clipping. To discern the difference between an OTW indication from a clip or pre-clip indication, look at the signal with an oscilloscope. If the signal is toggling during operation, this is clipping or pre-clipping. If the signal is a constant low then this will be overtemperature warning.

3.1.2 USB and SPDIF

Table 4. USB and SPDIF Indicators

Indicator	Description
USB Ready (D1)	Status of the USB IC connection to the PC and functioning correctly
SPDIF LOCK (D2)	When SPDIF or COAX input is used, this LED indicated if the SRC4392 is able to lock onto the signal

3.1.3 Power

Table 5. Power Indicators

Indicator	Description
12V (D13)	Status of the 12V power supply output
3.3V (D14)	Status of the 3.3V power supply output

3.2 Digital Audio Front End

3.2.1 Audio Source

The TAS3251EVM is able to receive four different digital inputs of audio. This includes USB audio, optical SPDIF, coax SPIF, or direct PCM data over I2S. The different audio inputs are configured with a combination of jumper settings and register configurations.

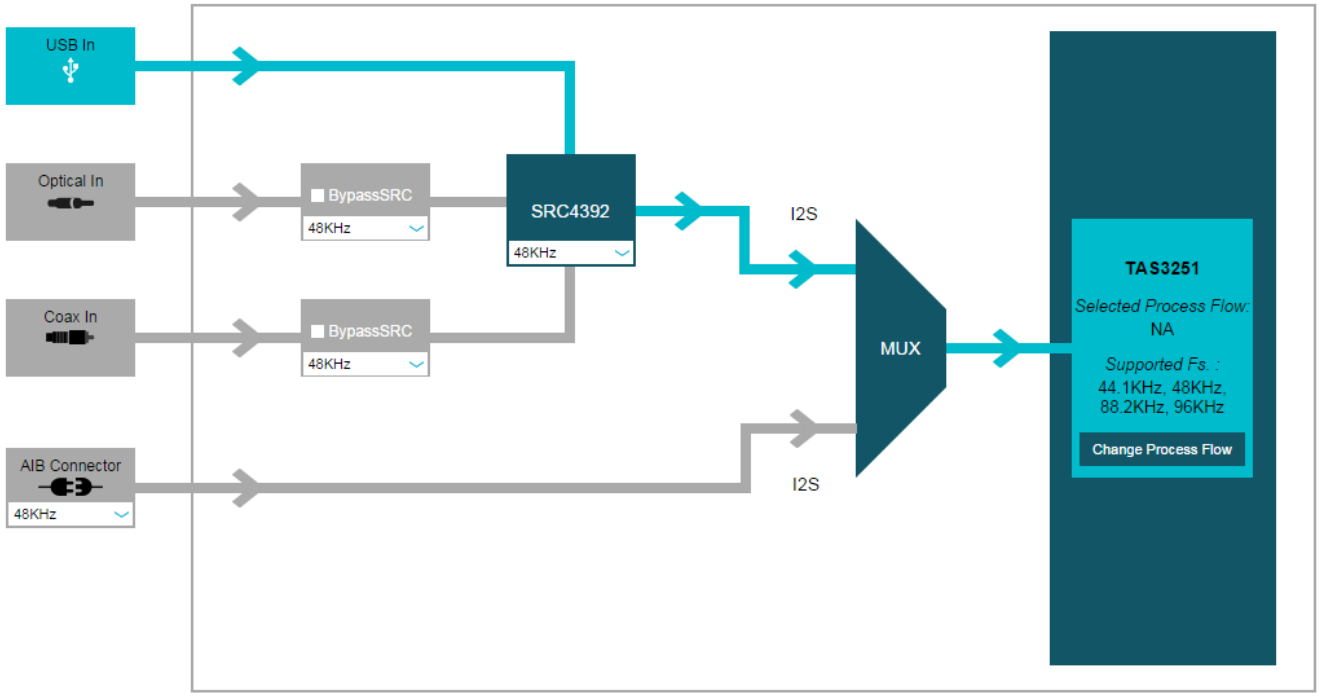


Figure 13. PPC3 Audio I/O Configuration for TAS3251EVM

3.2.1.1 SRC Input

The SRC4392 manages the USB, Optical, and COAX inputs, as well as providing the capability of sample rate conversion. The SRC output in normal operation will be divided down from the frequency provided to the SRC. The TAS3251EVM provides both 22.5792 MHz and 24.576 MHz from oscillators, and is selectable with J2 described in Table 6.

Table 6. FREQ SEL (J2) - Audio MCLK Frequency Select

Setting	Function
Installed	22.5792 MHz
Removed	24.576 MHz

If a direct audio input is desired without sample rate conversion, the sample rate conversion block of the SRC4392 can be bypassed with the optical or coax inputs. Select BypassSRC in the PPC3 I/O page, and set MCLK-SEL (J1) to the correct setting.

3.2.1.2 AIB Input

The Audio Input Board (AIB) input allows various audio plugin modules to be used with the TAS3251. The standard for this connector can be found in Table 7. When using the AIB as the audio source you must adjust the I2S SELECT jumper J37 accordingly.

Table 7. I2S SELECT J37- I2S Select

Setting	Function
Installed	Using the SRC4392 output as I2S source
Removed	Using the AIB J28 input as I2S source

3.2.1.3 PSIA Input

The set of four 3-pin headers J3, J4, J6, and J7 allow for a direct input of I2S signals to the TAS3251. This is described in Table 8

Table 8. J3- MCLK, J4- BCLK, J6- LRCLK, J7- SDIN

Setting	Function
1-2	EVM source for I2S
2-3	Direct input from external I2S source

3.2.2 USB Control

The USB interface is an XMOS device that handles I2S audio and I2C control from the PC with the use of PurePath Console 3. The XMOS device can operate in USB Audio 2.0 mode or USB Audio 1.0 mode. This allows up to 192 kHz audio with 8 channels in and 8 channels out. In order to operate in the USB Audio 2.0 mode, the TI USB audio 2.0 driver must be installed and J16 of the EVM must be set correctly according to Table 9.

Table 9. HS-EN (J16) – High Speed Enable

Setting	Function
Installed	High Speed USB
Removed	Full Speed USB

The XMOS device can be shut down or reset by the use of the XMOS Disable (J33) jumper shown in Table 10.

Table 10. XMOS DISABLE (J33) - XMOS Disable

Setting	Function
Installed	XMOS shutdown
Removed	XMOS Enabled

3.2.3 EVM Slave Operation

The TAS3251EVM in combination with the PPC3 software has the ability to operate and configure 2 EVM's at once providing a stereo 1.1 active crossover setup. This will require that one board be the master, and the sole USB connection to the PC running PPC3. A connector cable must be connected between the master and slave board to J9 that will allow the master board to transfer I2S and I2C data to the slave board. Any audio input source can be used in this mode.

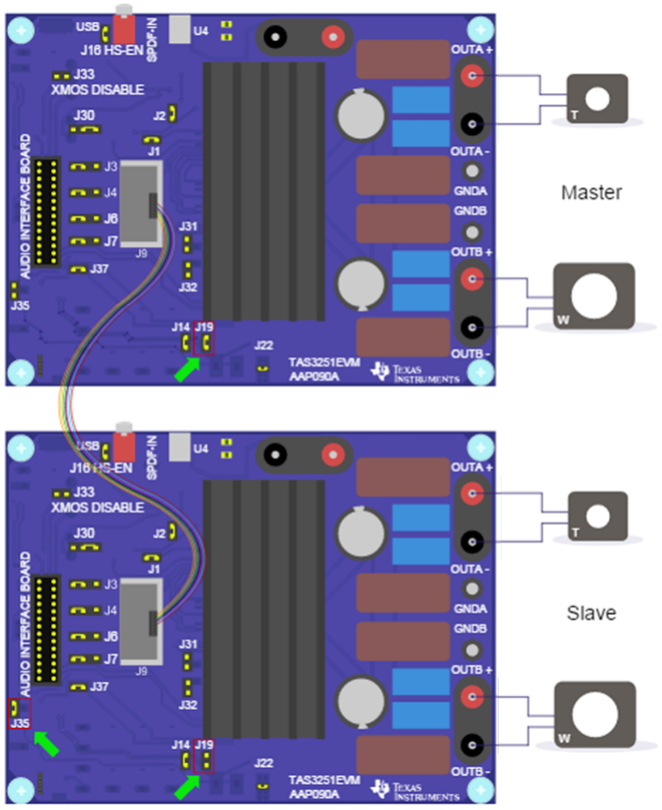


Figure 14. TAS3251EVM 2.2 Configuration

In order for the slave board to function correctly, jumpers must also be correctly configured on both the master and the slave. This would include setting the Slave Enable jumper (J35) and the I2C address jumper (J19) correctly. The Master device should be set to the I2C 0x94 address, with SLAVE ENABLE J14 removed, the slave device should have I2C address 0x96 with SLAVE ENABLE J14 installed.

Table 11. SLAVE ENABLE (J14) - Slave Enable

Setting	Function
Installed	Slave mode
Removed	Master mode

3.3 PWM Frequency

The TAS3251EVM allows for three oscillator frequency options by external configuration of the FREQ_ADJ pin. The frequency adjust can be used to reduce interference problems while using a radio receiver tuned within the AM band. These values should be chosen such that the nominal and the lower value switching frequencies together results in the fewest cases of interference throughout the AM band. The oscillator frequency can be selected by the value of the FREQ_ADJ resistor connected to GND in master mode according to Table 12.

Table 12. PWM Frequency Adjust Values

FREQ_ADJ (J16) Mode	Resistor Selected to GND or Pullup	PWM Frequency
Slave Mode	Pullup to DVDD (3.3V)	N/A
Master Mode	10 kΩ	600 kHz
Master Mode AM1	20 kΩ	500 kHz

Table 12. PWM Frequency Adjust Values (continued)

FREQ_ADJ (J16) Mode	Resistor Selected to GND or Pullup	PWM Frequency
Master Mode AM2	30 kΩ	450 kHz

Selecting Slave Mode configures the OSC_I/O pins as inputs to be slaved from an external differential clock. In a master or slave system, inter-channel delay is automatically set up between the switching phases of the audio channels, which can be illustrated by no idle channels switching at the same time. This will not influence the audio output, but only the switch timing to minimize noise coupling between audio channels through the power supply. This will optimize audio performance and result in better operating conditions for the power supply. The inter-channel delay will be set up for a slave device depending on the polarity of the OSC_I/O connection such that slave mode 1 is selected by connecting the OSC_I/O of the master device with the OSC_I/O of the slave device with the same polarity (+ to + and – to –), while slave mode 2 is selected by connecting the OSC_I/Os with the inverse polarity (+ to – and – to +).

3.4 Output Mode

The TAS3251 MODE pin controls if the TAS3251 is operating in Bridge Tied Load (BTL), or Parallel Bridge Tied Load (PBTL).

Table 13. MODE (J19) – Mode Select

Setting	Function
Installed	BTL Operation
Removed	PBTL Operation

When in PBTL mode, the B channel input pins must be pulled to ground. This is done with J31 and J32.

Table 14. Channel B Settings

Setting	Function
Installed	Short to ground for PBTL mode
Removed	Not shorted to GND for BTL mode

3.5 I2C Address

Two I2C addresses are available for the TAS3251, 0x94 and 0x96. The I2C address selection is determined by the state of the J19 jumper I2C ADR.

Table 15. I2C Addresses

ADR Pin		Hex	Binary
0	7-bit Address	0x4A	1001 010
	7-bit Address + Write Bit	0x94	1001 0100
	7-bit Address + Read Bit	0x95	1001 0101
1	7-bit Address	0x4B	1001 011
	7-bit Address + Write Bit	0x96	1001 0110
	7-bit Address + Read Bit	0x97	1001 0111

3.6 EVM Power Tree

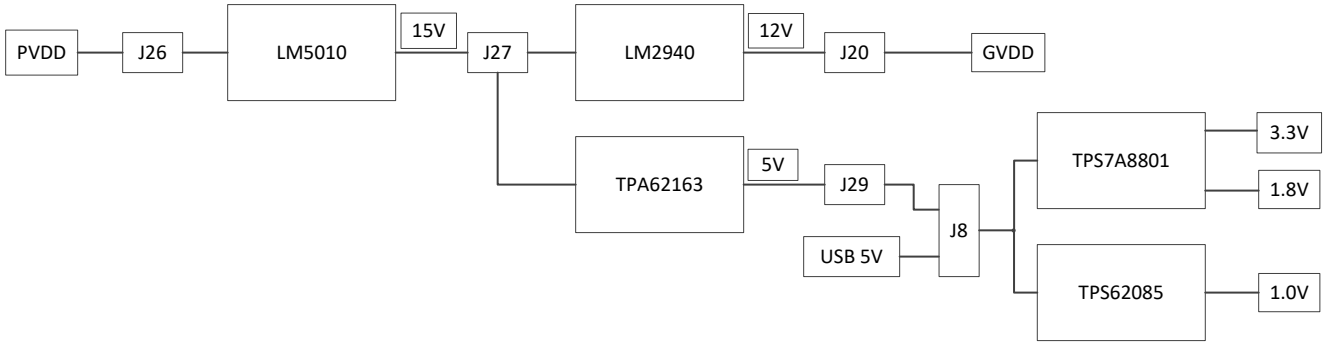


Figure 15. TAS3251EVM Power Tree

The TAS3251EVM power tree consists of 5 power ICs and series of jumpers allowing the user to provide their own supply or for current measurement. The 5V supply can be sourced from the USB 5V or from PVDD.

3.7 LC Response and Overview

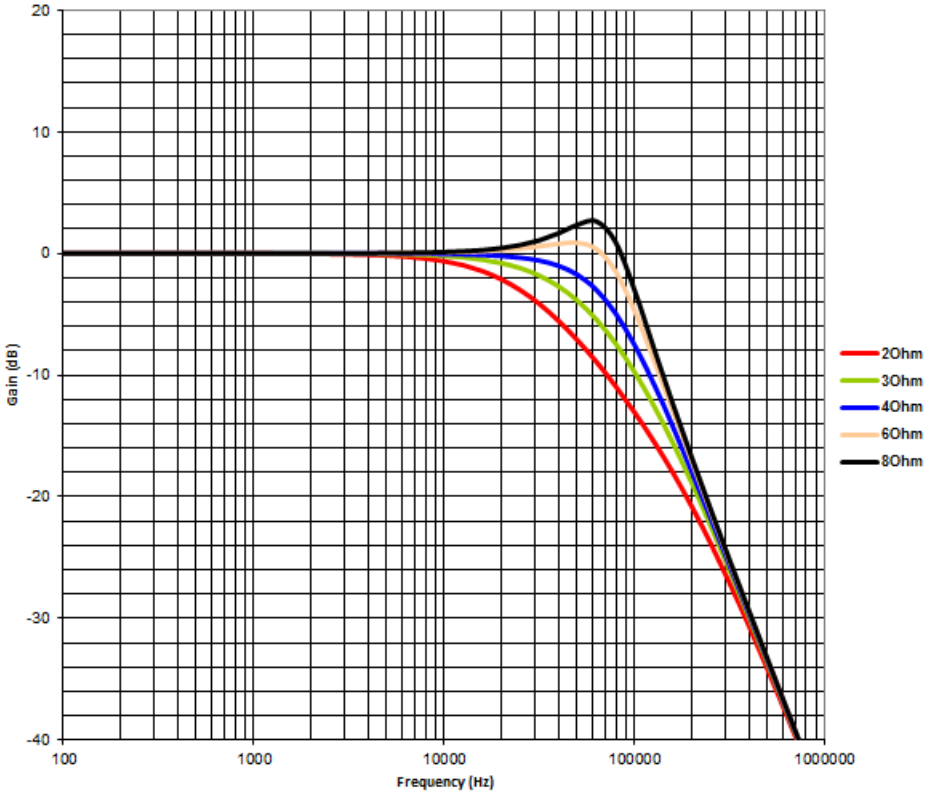


Figure 16. LC Output filter response

Figure 16 is taken directly from the LC Filter Calculator tool available on TI.com. The tool is configured for BTL common mode with values of 7 µH and 0.68 µF for the filter. This tool is also helpful when designing a different board featuring one of TI's class-D amplifiers.
The Coilcraft inductor used (MA5173) has a saturation current of 54 A (10%). The saturation current of the MA5173 is well above the requirements of the TAS3251 which has an OC limit of 14A. The inductance

versus current curve for a selected inductor is very important. It is essential for the inductor to maintain at least 5 µH of inductance at the maximum short-circuit current of the power amplifier. This was selected for the EVM since the saturation current met the requirements of the OC limit of the TAS3251 but also provides great performance in THD vs Power and THD vs Frequency.
To find more information on a variety of inductors see the LC Filter Design application note.

3.8 Reset Circuit and POR

The TAS3251EVM includes RESET supervision so that the TAS3251 device will remain in reset until all power rails are up and stable. The RESET supervisor also ensures that the device will be put into reset if one of the power rails experiences a brown out. This circuit combined with the RESET switch (S3) help ensure that the TAS3251 can be placed in reset easily, as needed, or automatically if there is a power supply issue. Figure 17 illustrates the circuit.

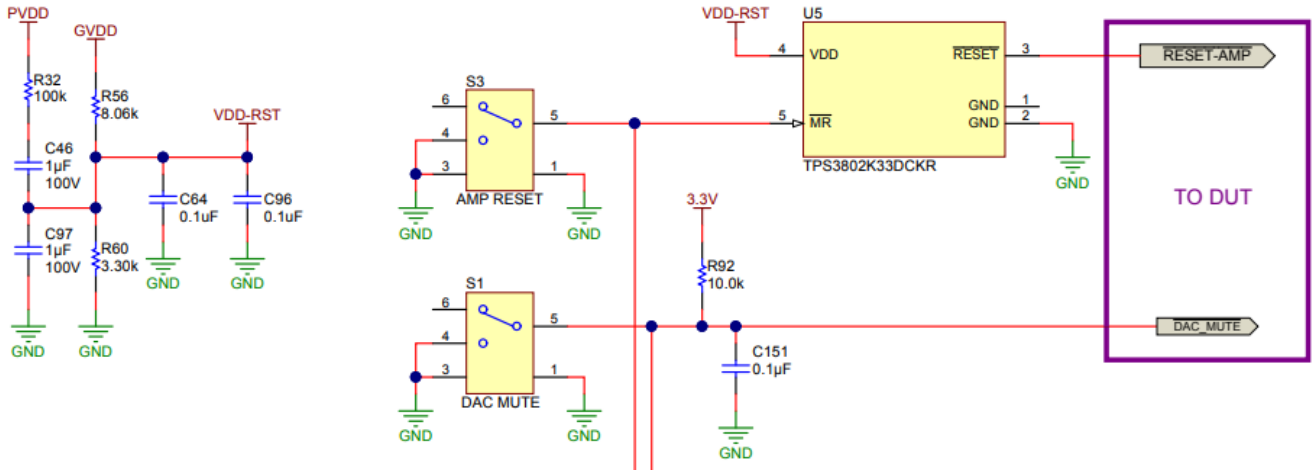


Figure 17. TAS3251EVM Reset Circuit

3.9 Analog Input Board Connector

The Analog-Input-Board (AIB) connector allows for cross compatibility with several Analog Plug-in Modules (APMs) offered by TI. This generic connector provides access to common board connections such as digital input, analog output, I2C, Fault and overtemperature warning (OTW) error reporting, common board voltages (PVDD, 12 V, 3.3 V), and EVM reset. These plug-in modules allow for an application specific front end to be plugged into the TAS3251EVM with ease. The TAS3251 implementation of the AIB connector is shown in Figure 18 and the full pin description is detailed in Table 16

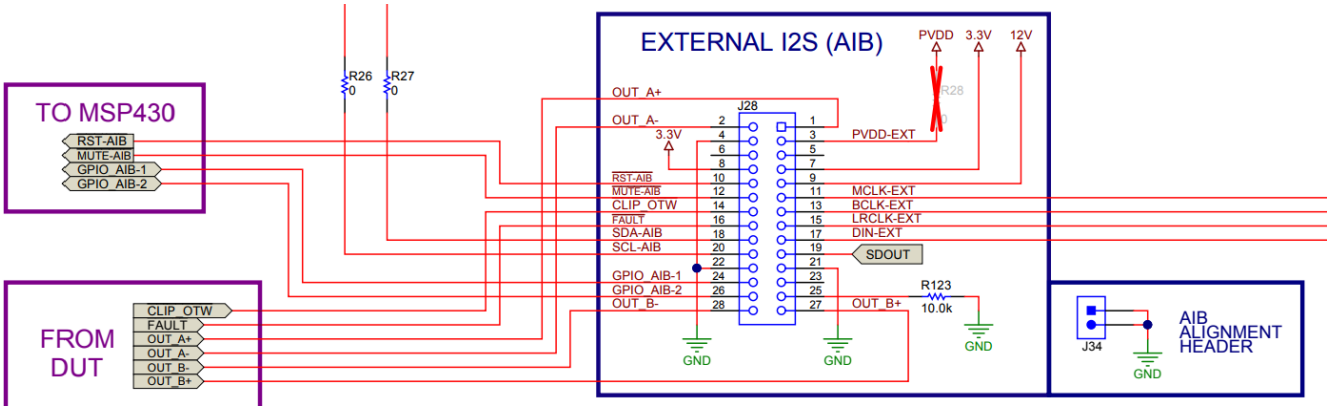


Figure 18. TAS3251EVM AIB Connector

Table 16. AIB Connector Pin Description

Pin Number	Function	Description	Audio EVM Input/Output	SideGig Input/Output
1	Amp Out A	Speaker Level output from audio Class-D EVM (SE or one side of BTL)	O	I
2	Amp Out B	Speaker Level output from audio Class-D EVM (SE or one side of BTL)	O	I
3	PVDD	PVDD voltage supply from audio Class-D EVM (variable voltage depending on Class-D EVM use)	O	I
4	GND	Ground Reference between SideGig and audio Class-D EVM	-	-
5	GPIO / CHIP_SEL	GPIO or Chip Select; used for advanced function	I/O	I/O
6	GPIO / MISO	GPIO for advanced function / MISO for SPI control	I/O	I/O
7	3.3V	3.3V Source from EVM; used for powering SideGig	O	I
8	3.3V	3.3V Source from EVM; used for powering SideGig	O	I
9	12V	12V Source from EVM; used for powering SideGig	O	I
10	EN / RESET	Assert Enable / Reset control for audio Class-D EVM (Active Low)	I	O
11	Analog IN_A / MCLK	Analog audio Input A (analog in EVM) / Master I2S Bus (Digital in EVM)	I	O
12	MUTE	Assert Mute of audio Class-D EVM (Active Low)	I	O
13	Analog IN_B / BCLK	Analog audio Input B (analog in EVM) / Bit Clock I2S Bus (Digital in EVM)	I	O
14	/CLIP_OTW	Clipping detection and/or Over Temperature Warning from audio Class-D EVM (Active Low)	O	I
15	Analog IN_C / LRCLK	Analog audio Input C (analog in EVM) / Frame Clock I2S Bus (Digital in EVM)	I	O
16	/FAULT	Fault detection from audio Class-D EVM (Active Low)	O	I
17	Analog IN_D / DIN	Analog audio Input D (analog in EVM) / Data In I2S Bus (Digital in EVM)	I	O
18	SDA / MOSI	SDA for I2C control / MOSI for SPI control	I/O	I/O
19	GPIO / DOUT	3.3V Source from EVM; used for powering SideGig	I/O	I/O
20	SCL / SCLK / MC	SCL for I2C control / SCLK for SPI control	I/O	I/O
21	GND	Ground Reference between SideGig and audio Class-D EVM	-	-
22	GND	Ground Reference between SideGig and audio Class-D EVM	-	-
23	5V	5V Source from EVM; Not available on all audio Class-D EVMs	O	I
24	GPIO	GPIO used for advanced function	I/O	I/O
25	EVM Input Sense	SideGig sensing for audio Class-D EVM input type. (10K pull-up for analog input; 10K pull-down to 3.3V for digital input)	O	I
26	GPIO	GPIO used for advanced function	I/O	I/O
27	Amp Out C	Speaker Level output from audio Class-D EVM (SE or one side of BTL)	O	I
28	Amp Out D	Speaker Level output from audio Class-D EVM (SE or one side of BTL)	O	I

4 Software Overview

4.1 PurePath™ Console 3 (PPC3)

The TAS3251 is designed to be configured and tuned with the use of the PurePath Console 3 (PPC3) GUI running the TAS3251 PPC3 App. Access to PPC3 can be requested at http://www.ti.com/tool/PUREPATHCONSOLE, please specify TAS3251 as the device to be used. After approval, go to www.ti.com/mysecuresoftware to download PPC3. Figure 19 shows the initial PPC3 interface before signing in with your TI account.

Figure 19. PPC3 App page

4.2 XMOS USB Audio 2.0 Driver

When installing the latest PPC3 version, a Windows driver for the TAS3251EVM USB IC will also be installed. This allows EVM's like the TAS351 that can use the USB Audio Class 2 to operate correctly.

4.3 TAS3251 Home Page

When the TAS3251EVM App is launched, the TAS3251 Home Page is shown, see Figure 20. It displays features that are available for that EVM. When a feature is selected, then the respective page is loaded. If the TAS3251EVM is powered on and the USB is connected to the PC, the Home Page will display “Connected” in the bottom left corner. If the USB is not connected, only “TAS3251 – offline” is shown. There are six pages available in the TAS3251 EVM App: System Checks, Direct I2C, Audio I/O, Register Map, End System Integration and Tuning and Audio Processing.

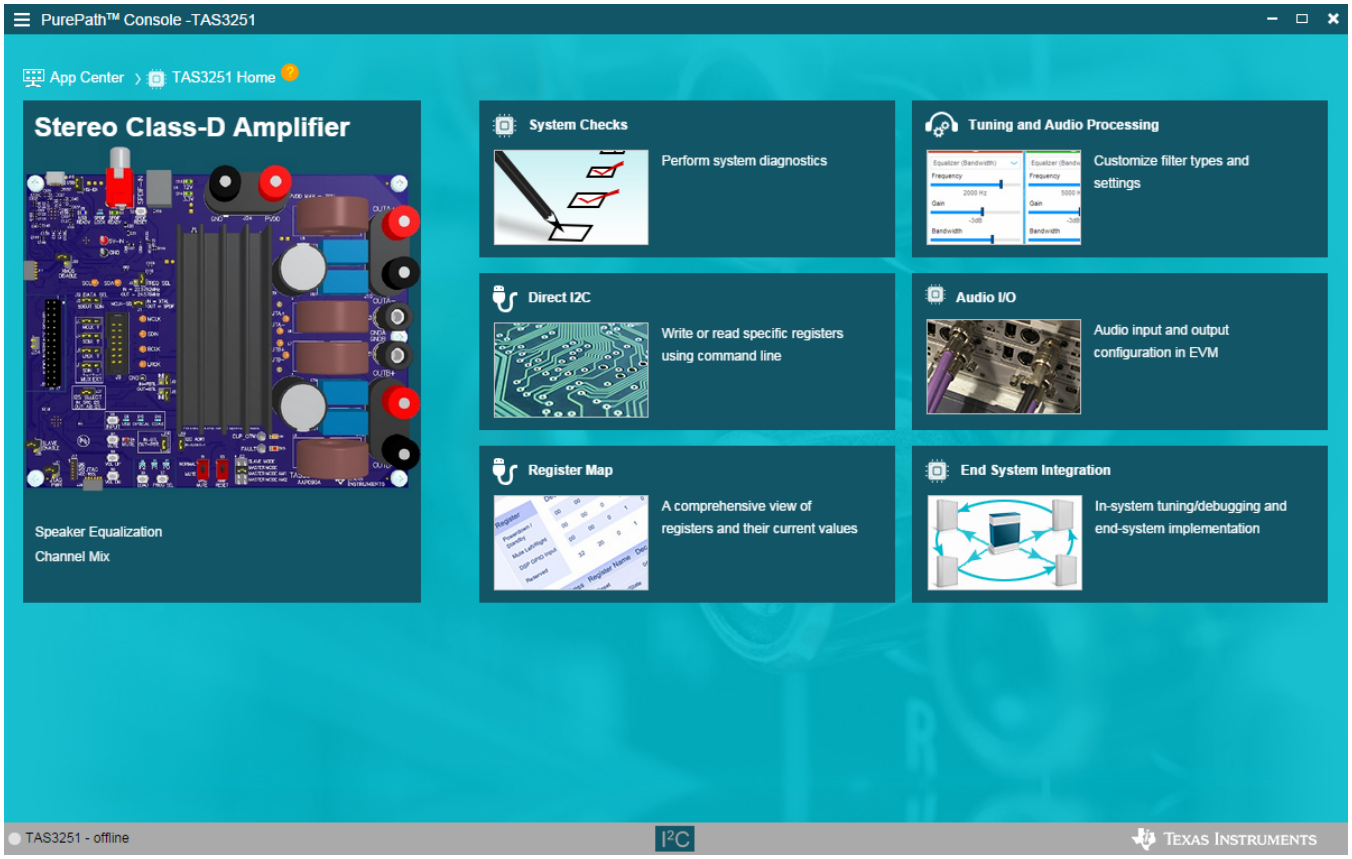


Figure 20. TAS3251 Home page

4.4 System Checks

The System Checks Page shown in Figure 21 is used to determine whether the EVM can be configured correctly and receive audio stream from PC via USB. These checks will complete in a few minutes if no problem is detected. It is recommended to run the system diagnostics before proceeding to the Tuning and Audio Processing Page.

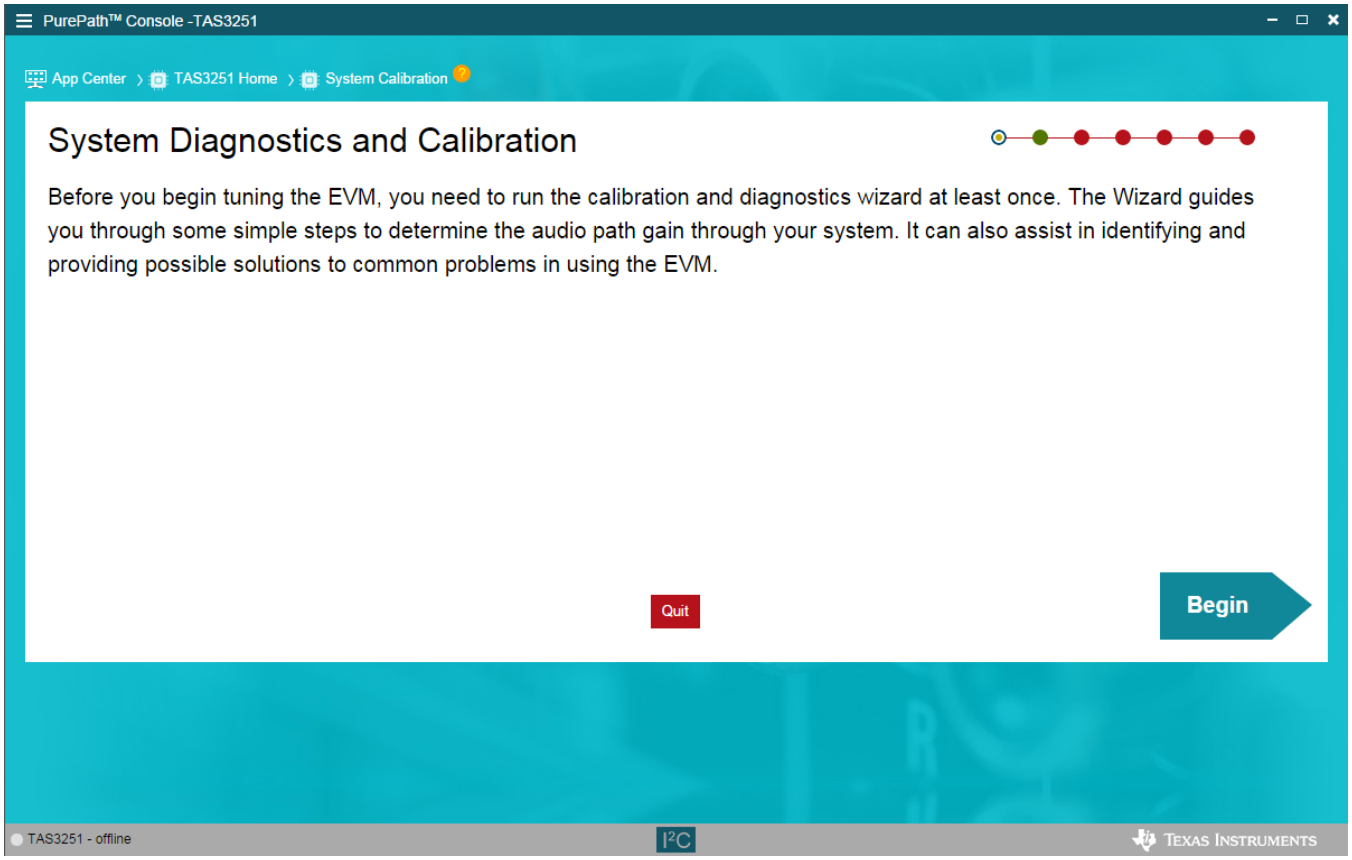


Figure 21. TAS3251EVM System Checks

4.5 Direct I2C

The I/O tab in the Direct I2C has two sub sections. The Input section has the provision to enter the read or write commands scripts. Clicking the Execute button will execute the commands written in the Input section. The status of the execution is displayed in the Output section as shown in Figure 22.
The Checksum button on the right is used to compute the checksum value of a cfg file. Load a cfg file by clicking the Checksum button and then the computed XOR and CRC checksum will show on the Output section.

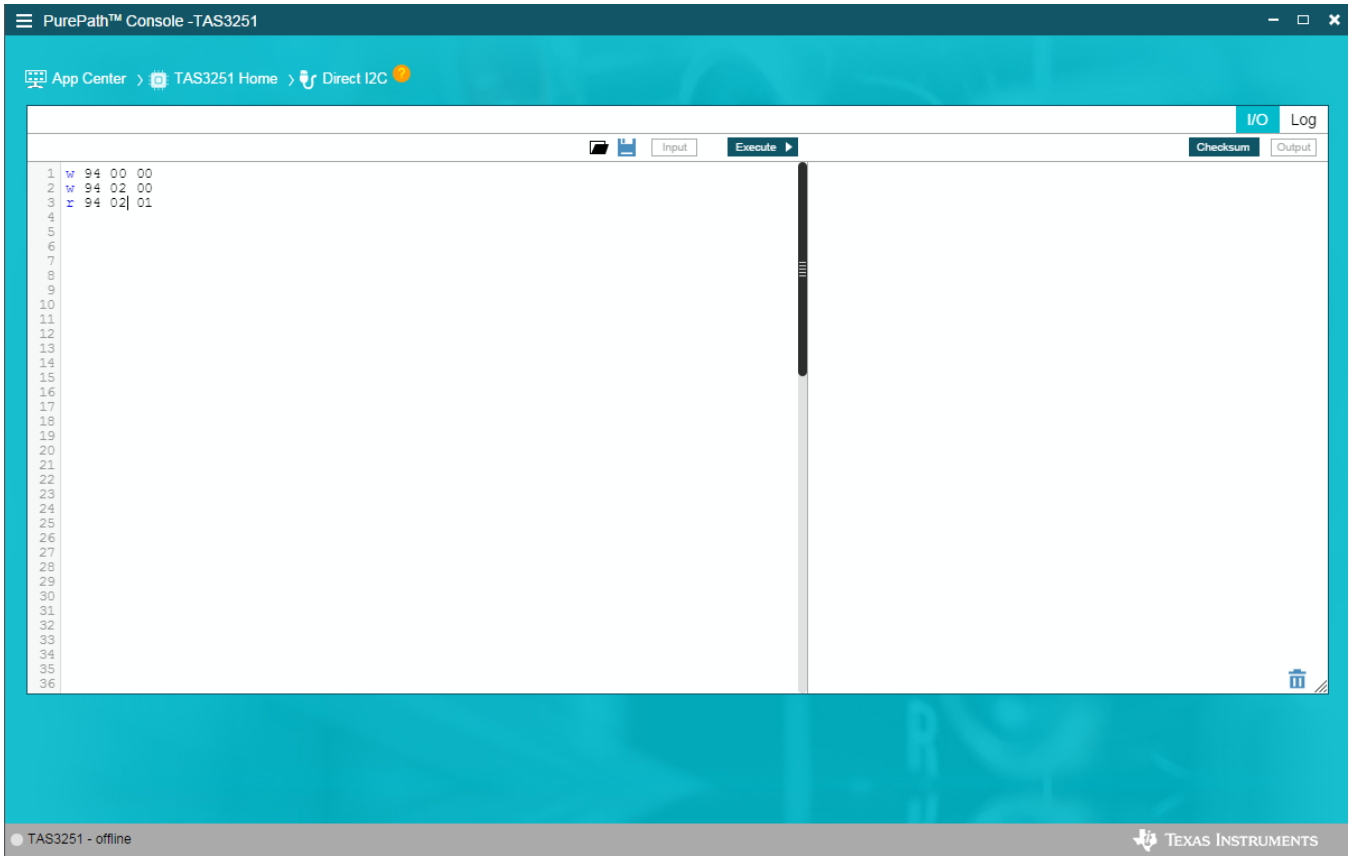


Figure 22. Direct I2C Interface

The Log tab in the Direct I 2C displays the I 2C command history, if the record option is enabled. The log tab has a search option to search for a particular command. The search key is found at the top left of the window with the search icon. ‘Save to a file’ is used to save the log as a .cfg file. ‘Delete Output’ clears the log history. ‘Copy to a Clipboard’ copies the log text to the clipboard. Clicking the ‘Start Recording’ button starts recording the I 2C transactions and displays them in the log window. ‘Stop Recording’ stops recording I 2C transactions.

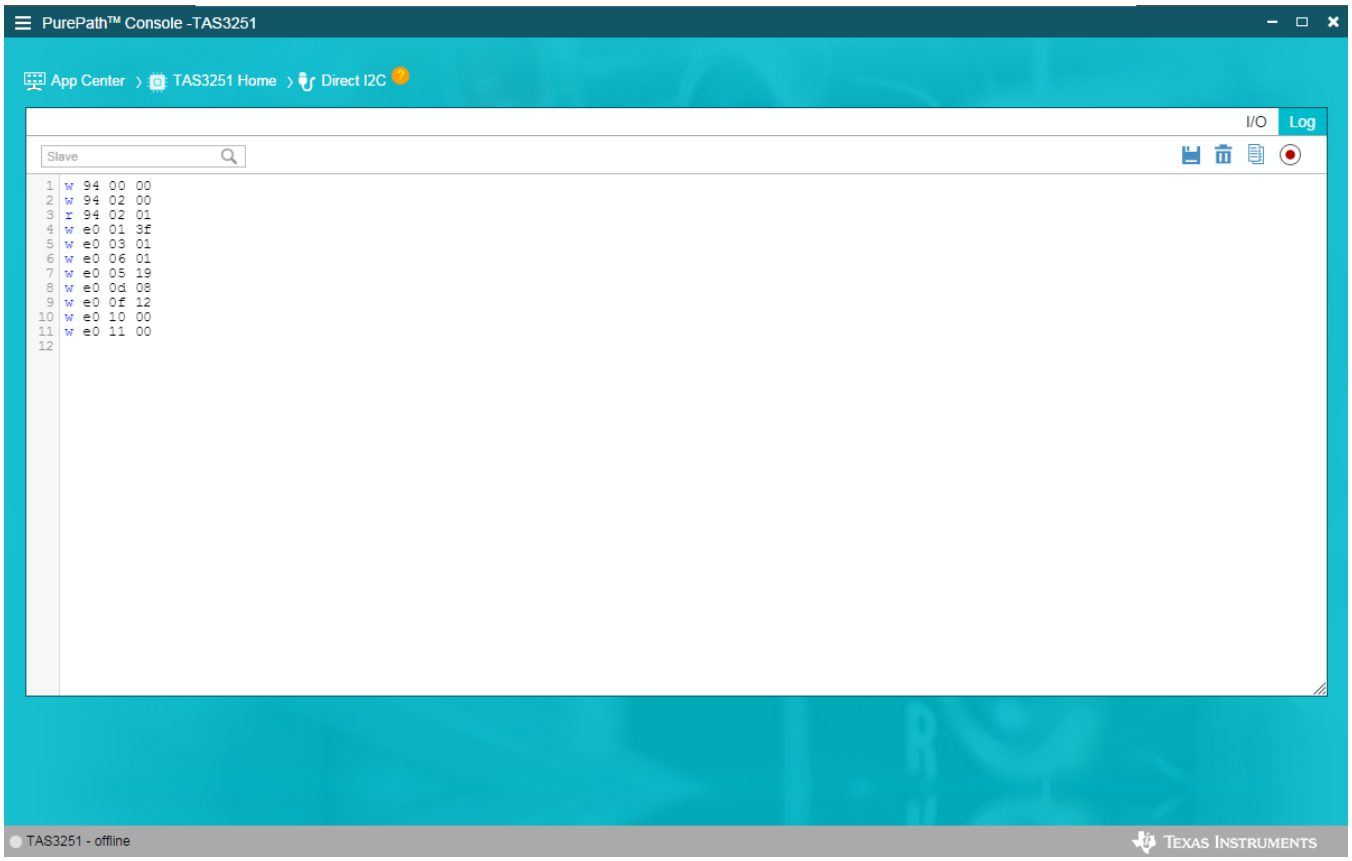


Figure 23. Direct I2C Example Script

4.6 Audio I/0

This page shown in Figure 24 allows the configuration of the digital front end for the audio input. Audio can be input over USB, Coax, Optical, or I2S through the AIB connector or I2S jumpers. BypassSRC allows the use of the Coax or Optical clock to be the master clock for the system, otherwise standalone oscillators on the EVM will provide the master clock.

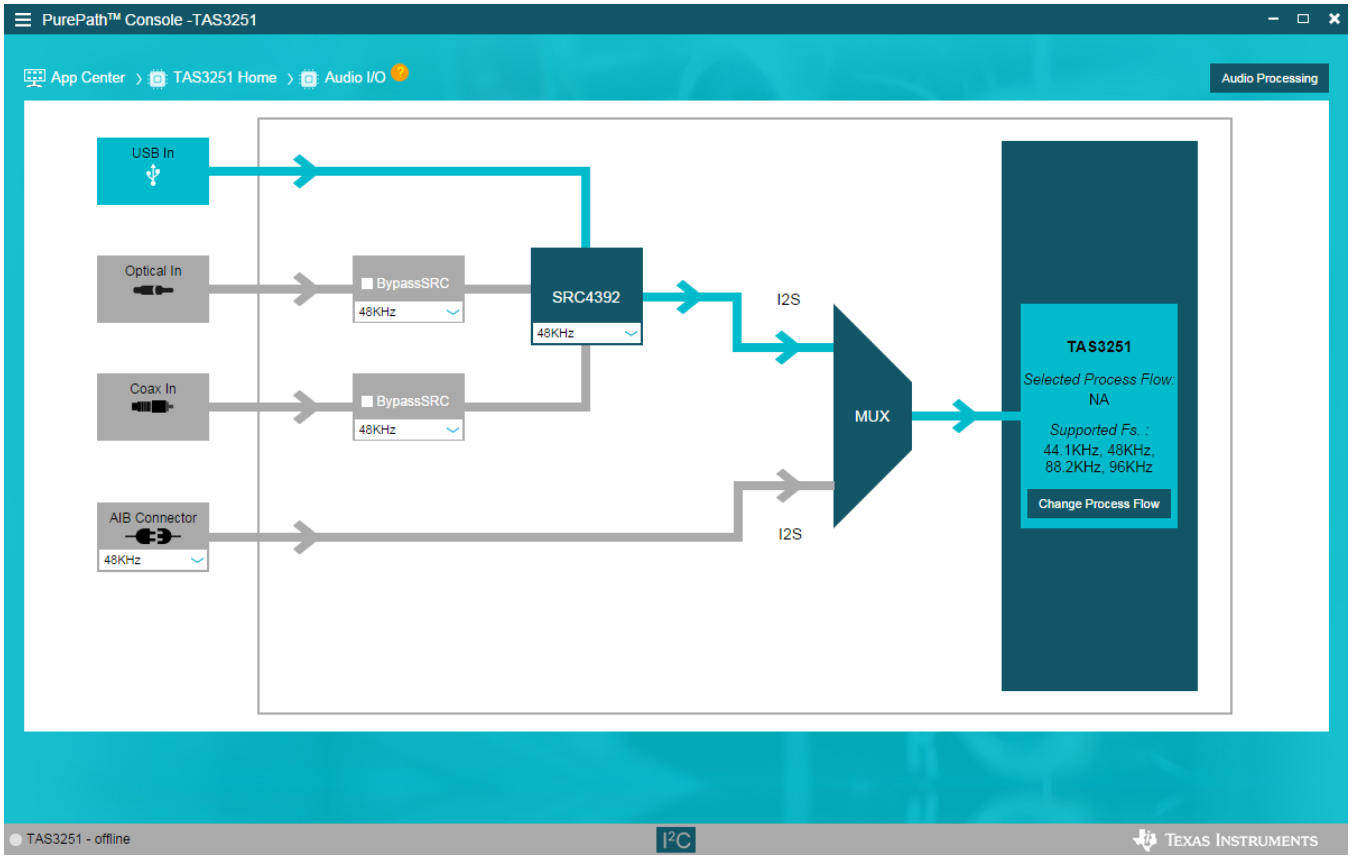


Figure 24. Audio I/O Page

4.7 Register Map

The Register Map Page seen in Figure 25 shows the current I 2C register values (hexadecimal) in the TAS3251 and it can also be used to change the register values. Manually changing register values is accomplished by double clicking in the desired bit to change. Clicking on Read All Registers allows monitoring of the register status of the amplifier. The Fields section shows the register name and a brief description of each bit that affects the selected register.

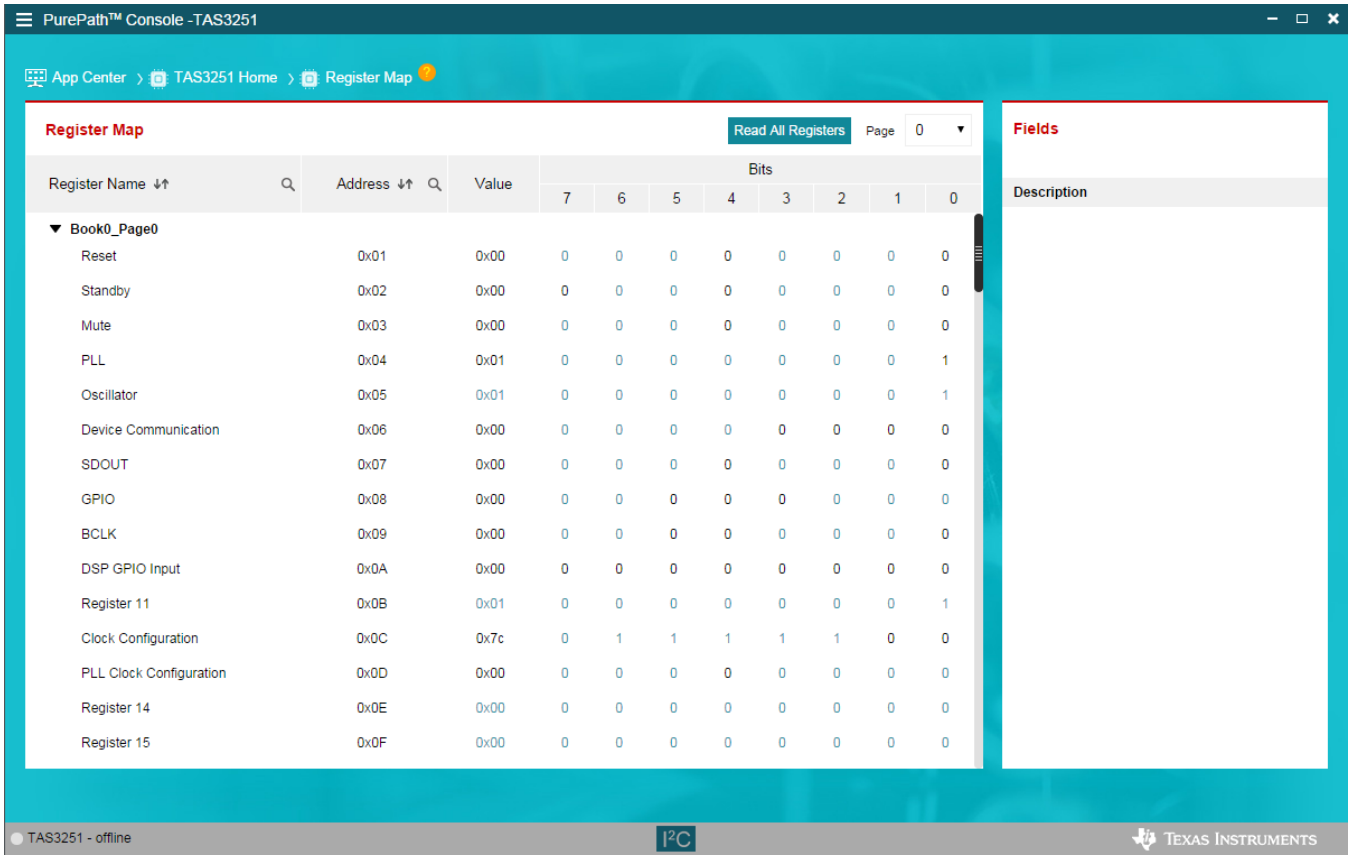


Figure 25. TAS3251 PPC3 Register Map Interface

4.8 End System Integration

The End System Integration Page shown in Figure 26 offers a powerful tool to generate a configuration file to use with processors and a method to debug the device in the end system. Three options are available:

1. Dump Current State into a Header file
2. In-System Debugging
3. In-System Tuning

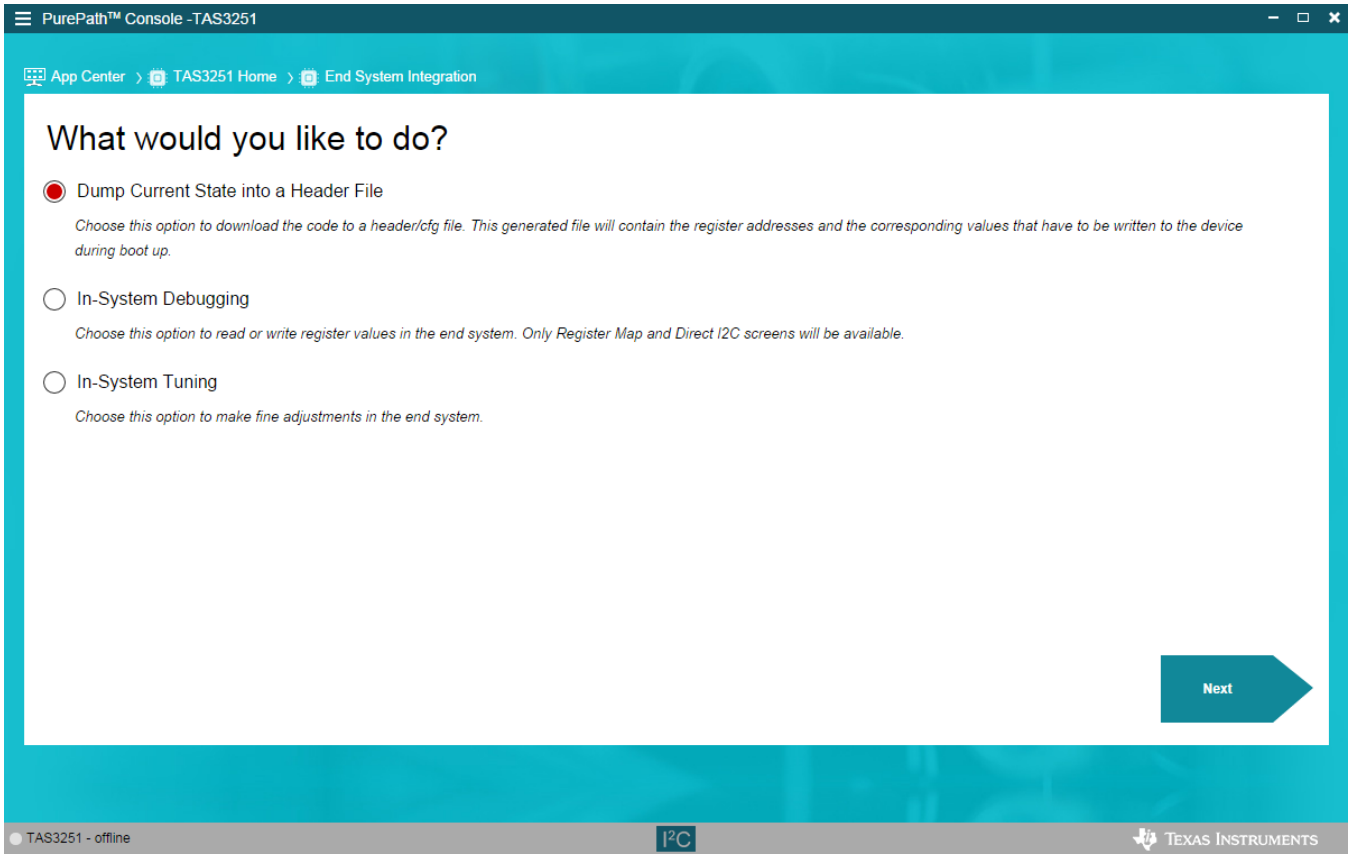


Figure 26. PPC3 End System Integration

4.8.1 Dump Current State into a Header File

Figure 27 shows the Register Dump tool that is used to generate a header or configuration file for the evaluated device according to the features evaluated and configured with PPC3. A few settings are available for file generation, including the format, end system I 2C address, burst length and so forth. The generated file can be saved in the PC or shown in the output window on the right.

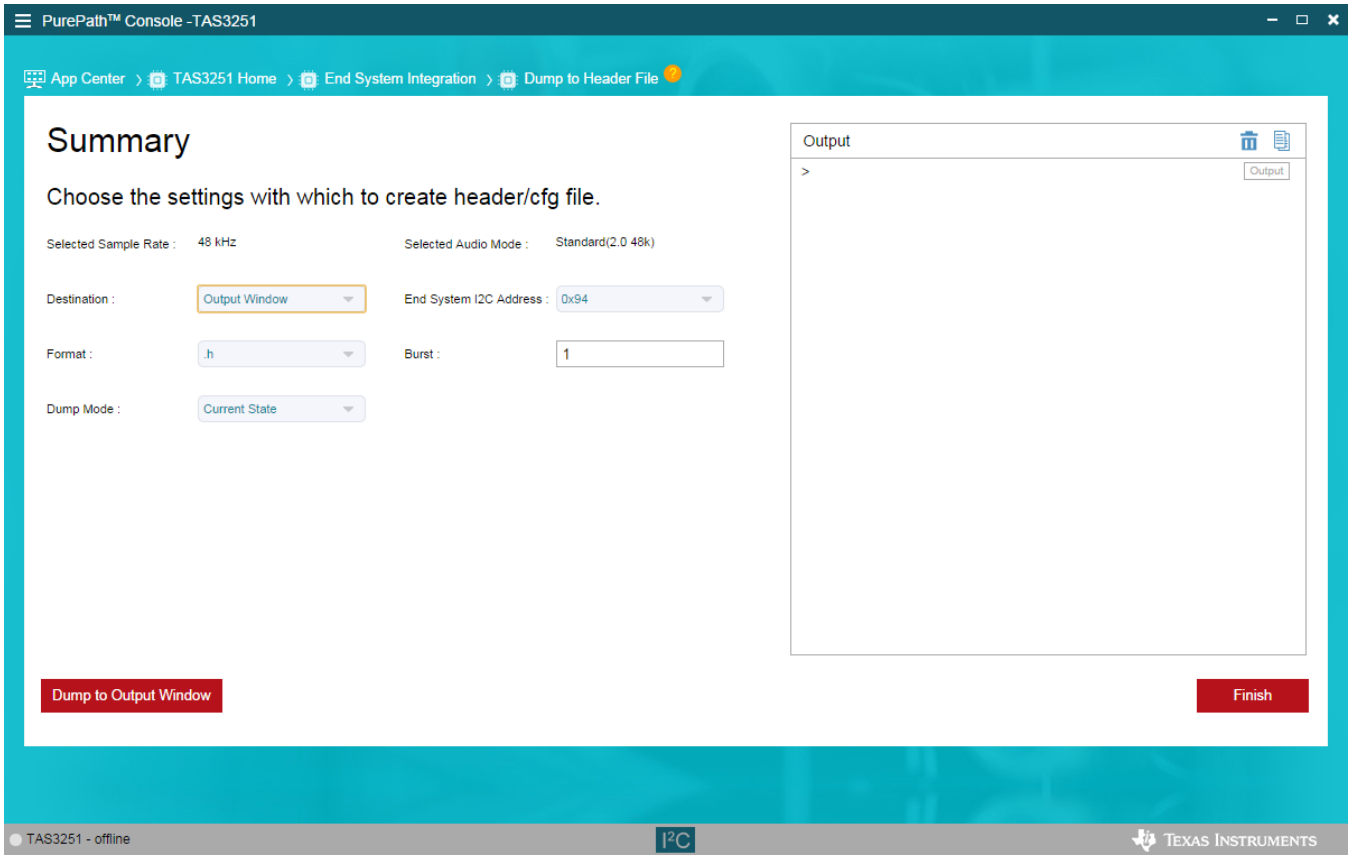


Figure 27. PPC3 Register Dump

4.8.2 In-System Debugging

This tool helps debug the device which is already integrated in the end-system. This is possible by connecting the I2C signals of the end-system device to the SCL, SDA, and GND test points of the TAS3251EVM. Only Register Map and Direct I 2C will be available in this mode. Leave the In-System Debugging Mode by clicking on the Disconnect button on the bottom left corner of the window.

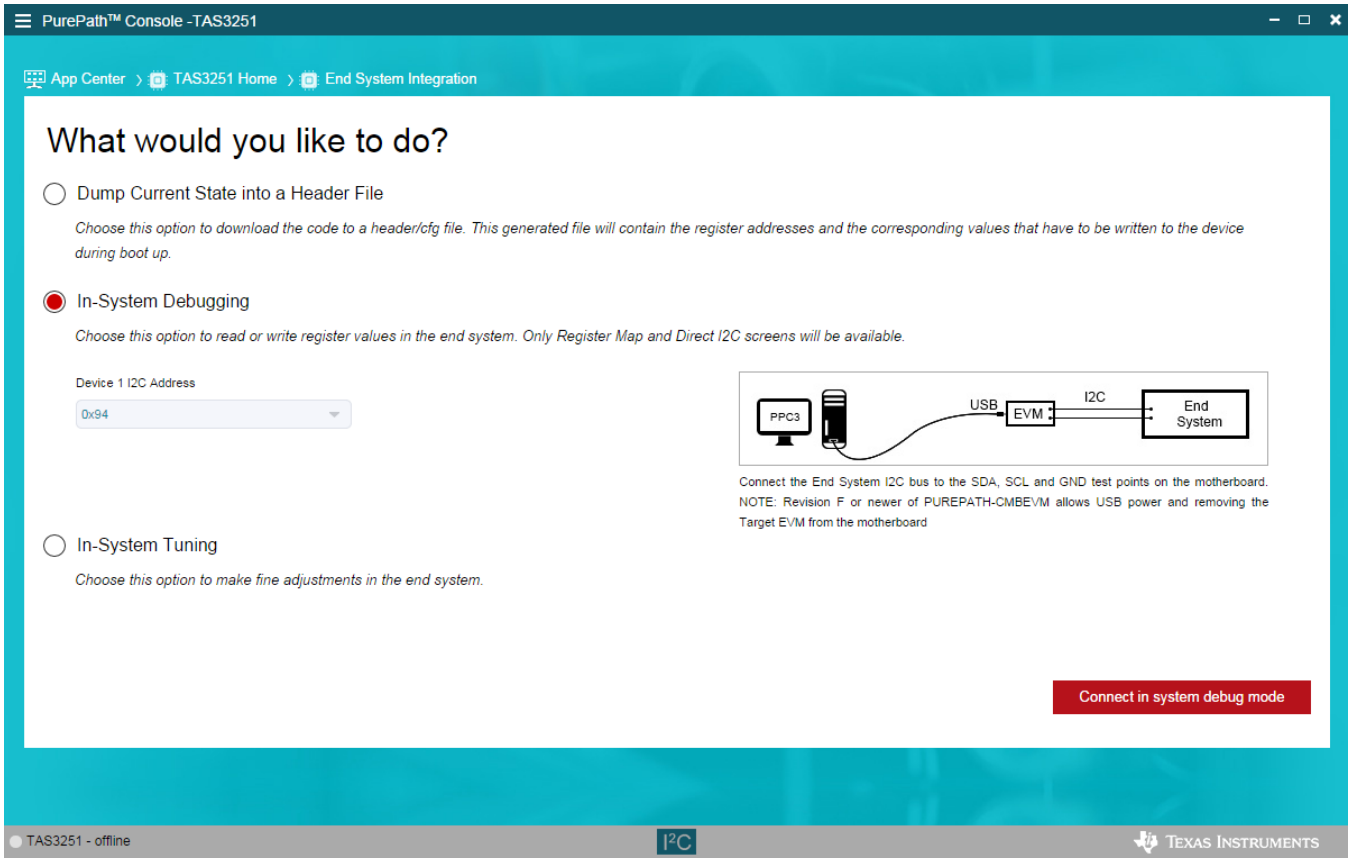


Figure 28. PPC3 In-System Debugging

4.8.3 In-System Tuning

Even if the device is integrated in the end application, it is still possible to make fine adjustments with the help of In-System Tuning. Like the In-System Debugging above, this is done by connecting I2C signals from TAS3251EVM to the TAS3251 device in the end-system.

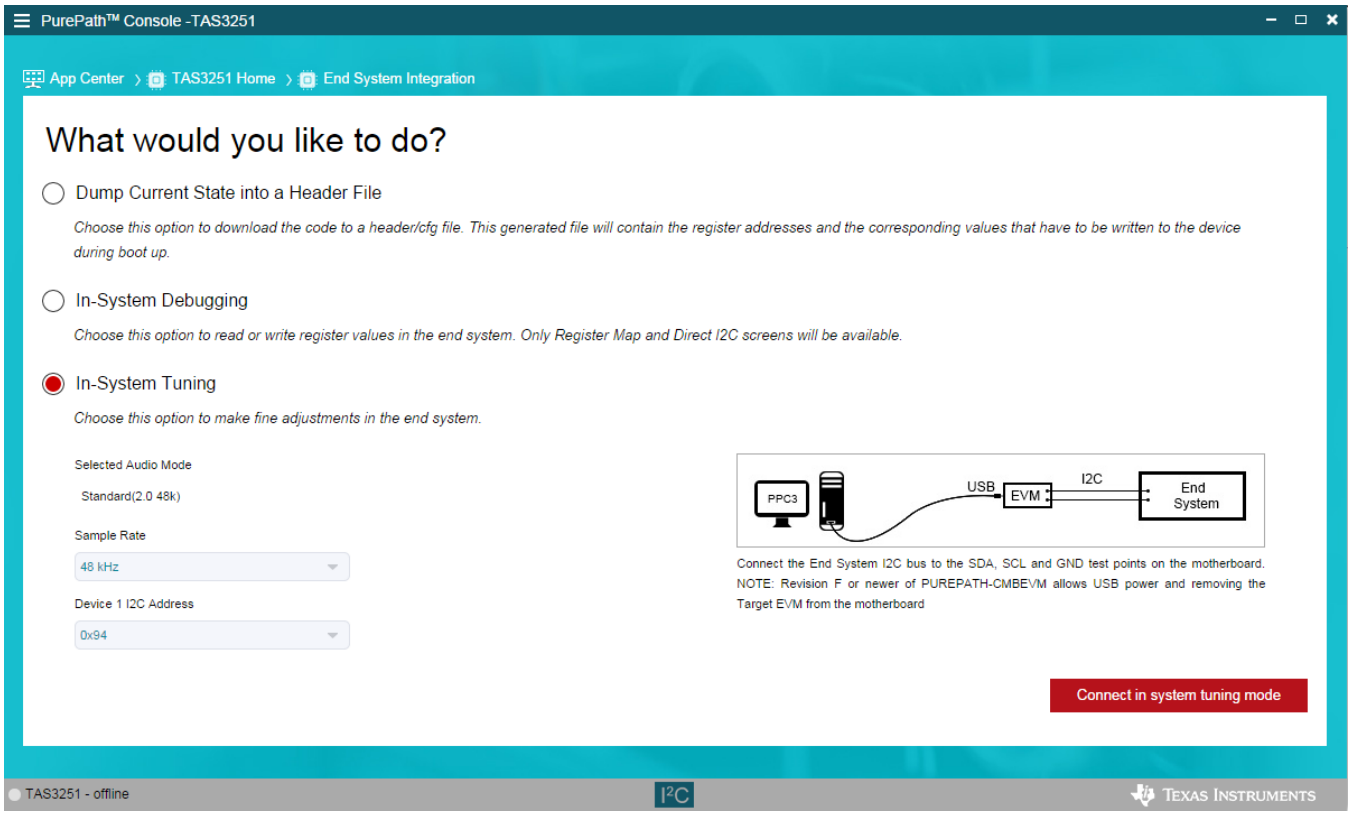


Figure 29. PPC3 In-System Tuning

5 MSP430

This section describes the use of the MSP430 on the TAS3251EVM.

5.1 Startup

The MSP430 comes preprogramed and will stay in a low power state until it is woken with input. To bring the MSP430 out of the low power state press “PROG_SEL” twice. This will trigger the MSP430 to run Program 0 which will bring the DSP out of standby and Mute the DAC. The Audio Input can then be selected

5.2 Programs

The MSP430G2955 has 56 kB of internal flash allowing multiple process flows and sets of coefficients to be stored in memory. These programs can be cycled through by using the “PROG_SEL” button, once on the desired program, pressing load will mute the TAS3251 and load the program. Programs can be loaded by flashing the MSP430 code with the use of a JTAG debugger and the output from PPC3.

Table 17. MSP430 Pre-loaded TAS3251 Flows

Program	Speaker Output	EQ	Process Flow
0	Stereo	Default Flat	48kHz Standard Processing
1	N/A	N/A	N/A
2	N/A	N/A	N/A

5.3 Inputs

The “INPUT” button will cycle through the three digital audio inputs: USB, OPTICAL, and COAX. When the INPUT button is pressed the SRC4392 will be configured by the MSP430 for that input.

5.4 Mute and Volume

The MUTE button will set the DAC output channels to mute in Register 0x03. The VOL UP and VOL DWN buttons will trigger the MSP430 to change the volume in the DSP of the TAS3251. This is done by first reading the current volume level, then adjusting the volume of both channel A and B to next defined volume step shown in the code below.

```
static const unsigned long tas3251_volume_small[] = {

    0x07ECA9CD,    //24dB --
    0x064B6CAE,    //22dB --
    0x05000000,    //20dB --
    0x03F8BD7A,    //18dB --
    0x0327A01A,    //16dB --
    0x02818508,    //14dB --
    0x01FD93C2,    //12dB --
    0x0194C584,    //10dB --
    0x0141857F,    //8dB --
    0x00FF64C1,    //6dB --
    0x00CADDC8,    //4dB --
    0x00A12478,    //2dB --
    0x00800000,    //0dB -- default volume
    0x0065AC8C,    //-2dB --
    0x0050C336,    //-4dB --
    0x004026E7,    //-6dB --
    0x0032F52D,    //-8dB --
    0x00241347,    //-11dB --
    0x00198A13,    //-14dB --
    0x0012149A,    //-17dB --
    0x000CCCCD,    //-20dB --
    0x00081385,    //-24dB --
    0x00051884,    //-28dB --
    0x00033718,    //-32dB --
    0x00019C86,    //-38dB --
    0x0000CEC1,    //-44dB --
    0x00004161,    //-54dB --
    0x000014AD,    //-64dB --
    0x00000347,    //-80dB --
    0x000000A7,    //-94dB --
    0x0000001B,    //-110dB --
};
```

6 Schematic and Bill of Materials

This section includes the TAS3251EVM schematics and the TAS3251EVM BOM.

6.1 Schematic

Figure 30 to Figure 34 display the EVM schematics.

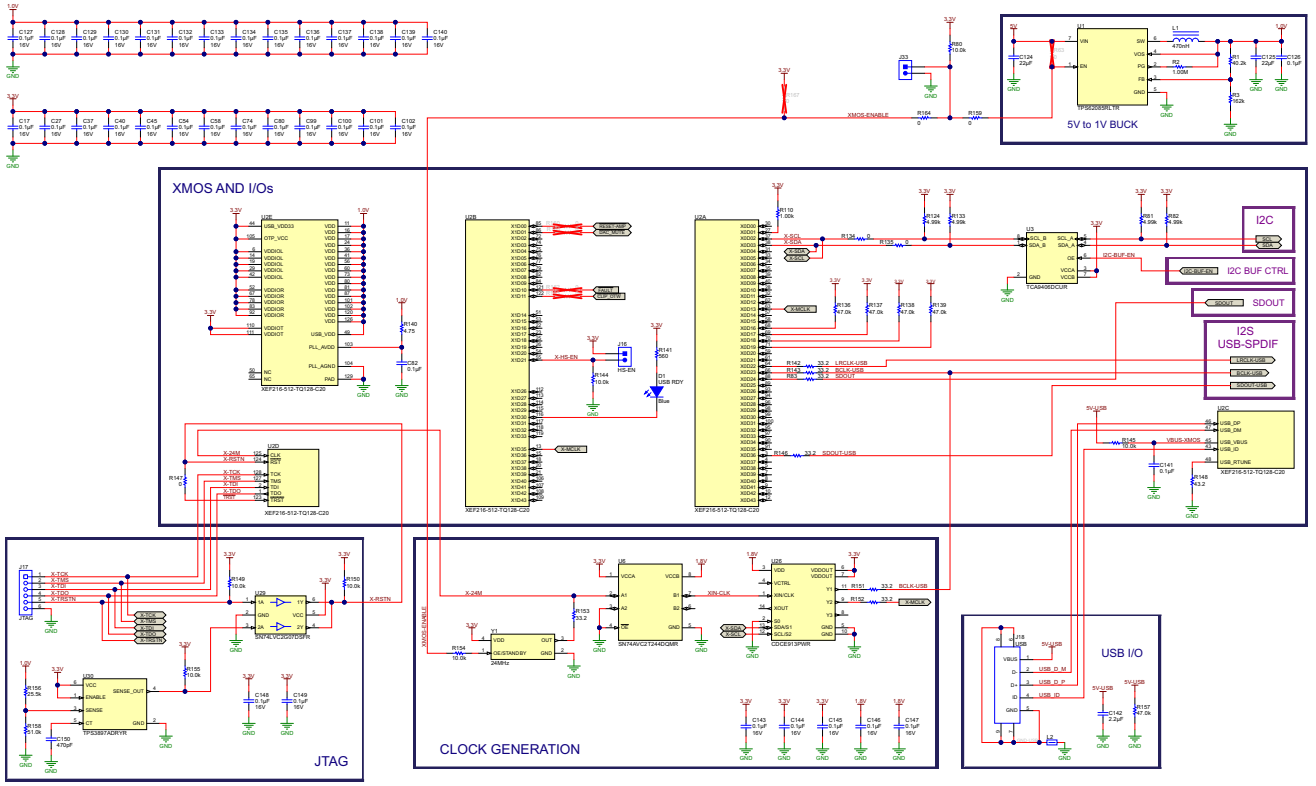


Figure 30. TAS3251EVM Schematics (1 of 5)

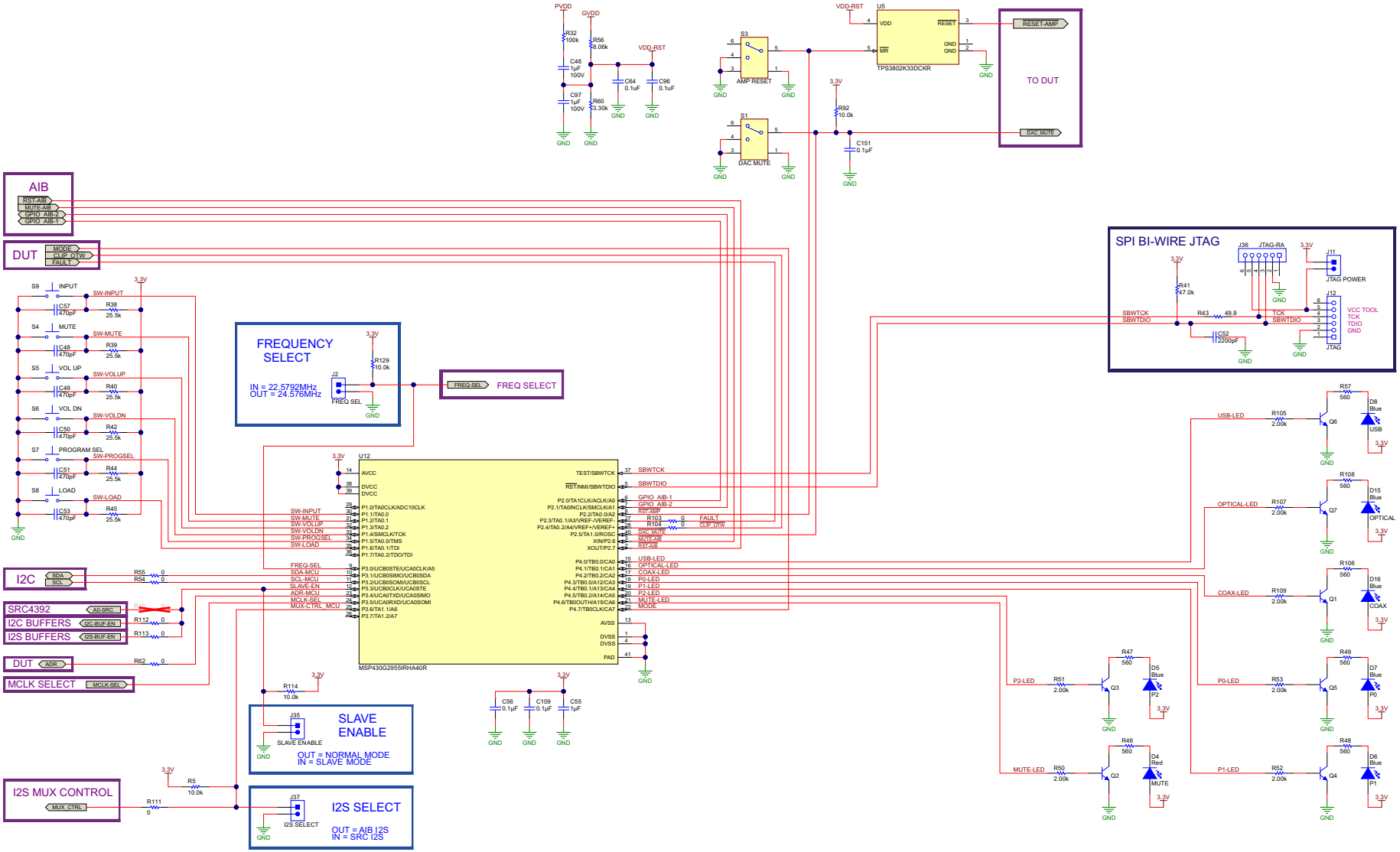


Figure 31. TAS3251EVM Schematics (2 of 5)

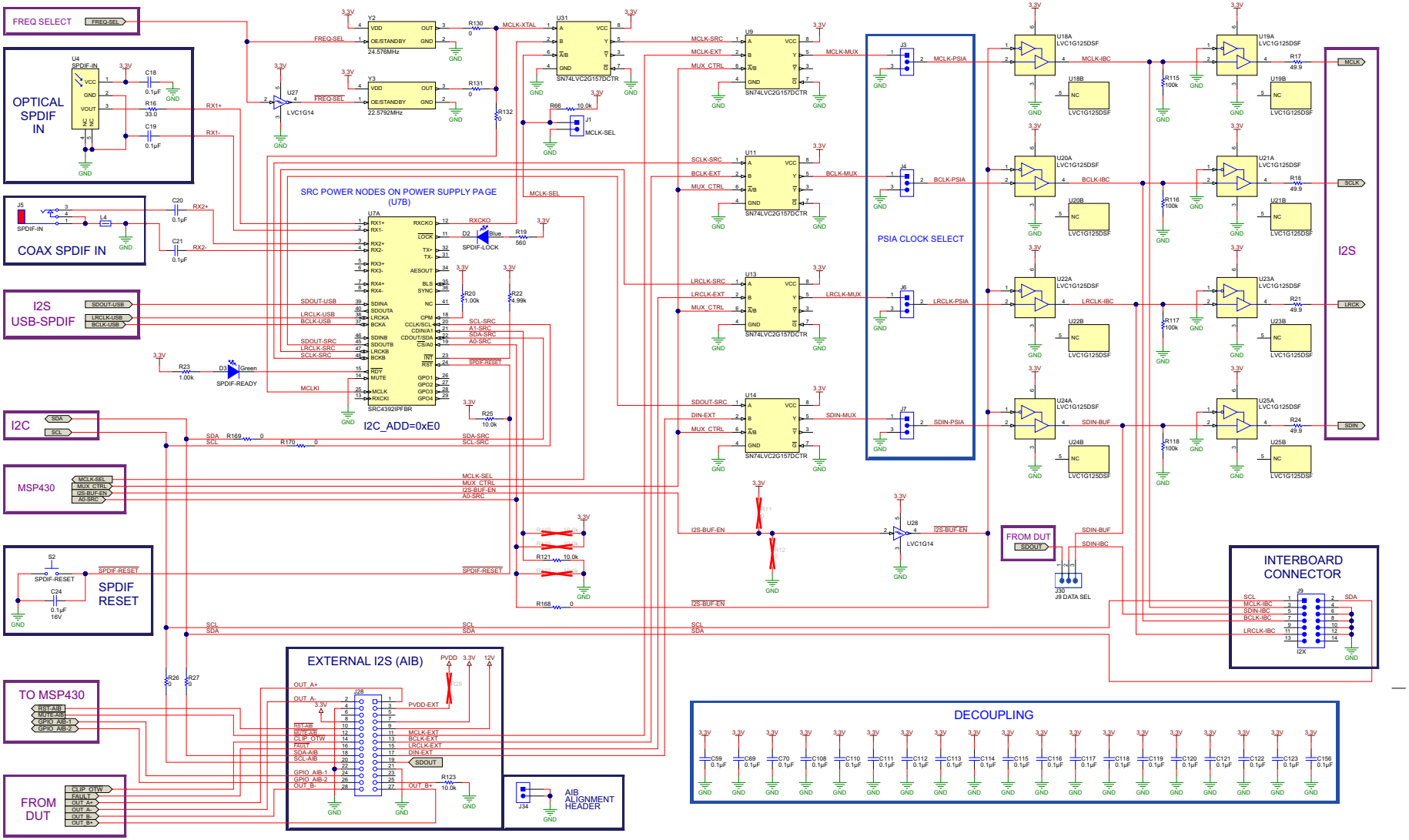


Figure 32. TAS3251EVM Schematics (3 of 5)

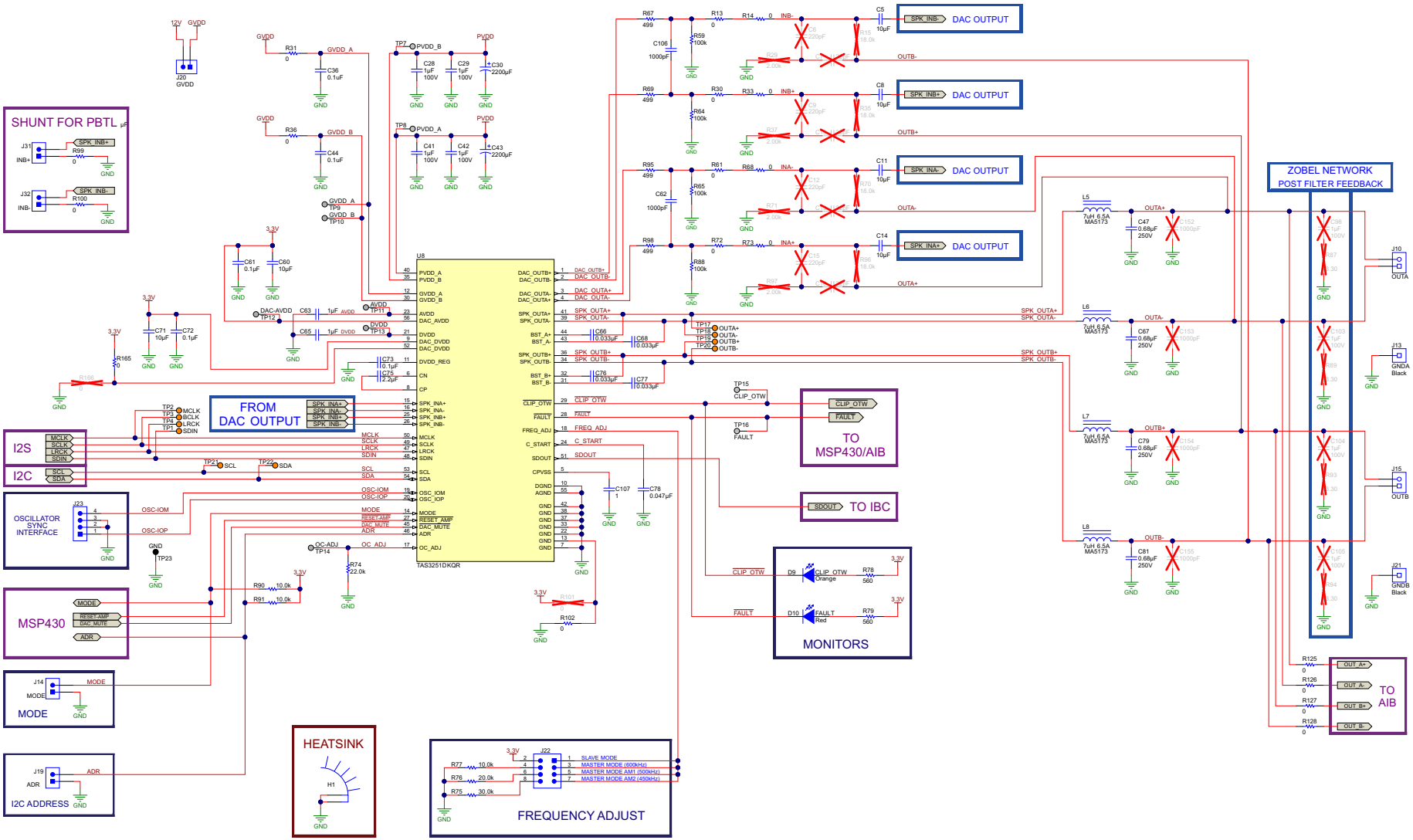


Figure 33. TAS3251EVM Schematics (4 of 5)

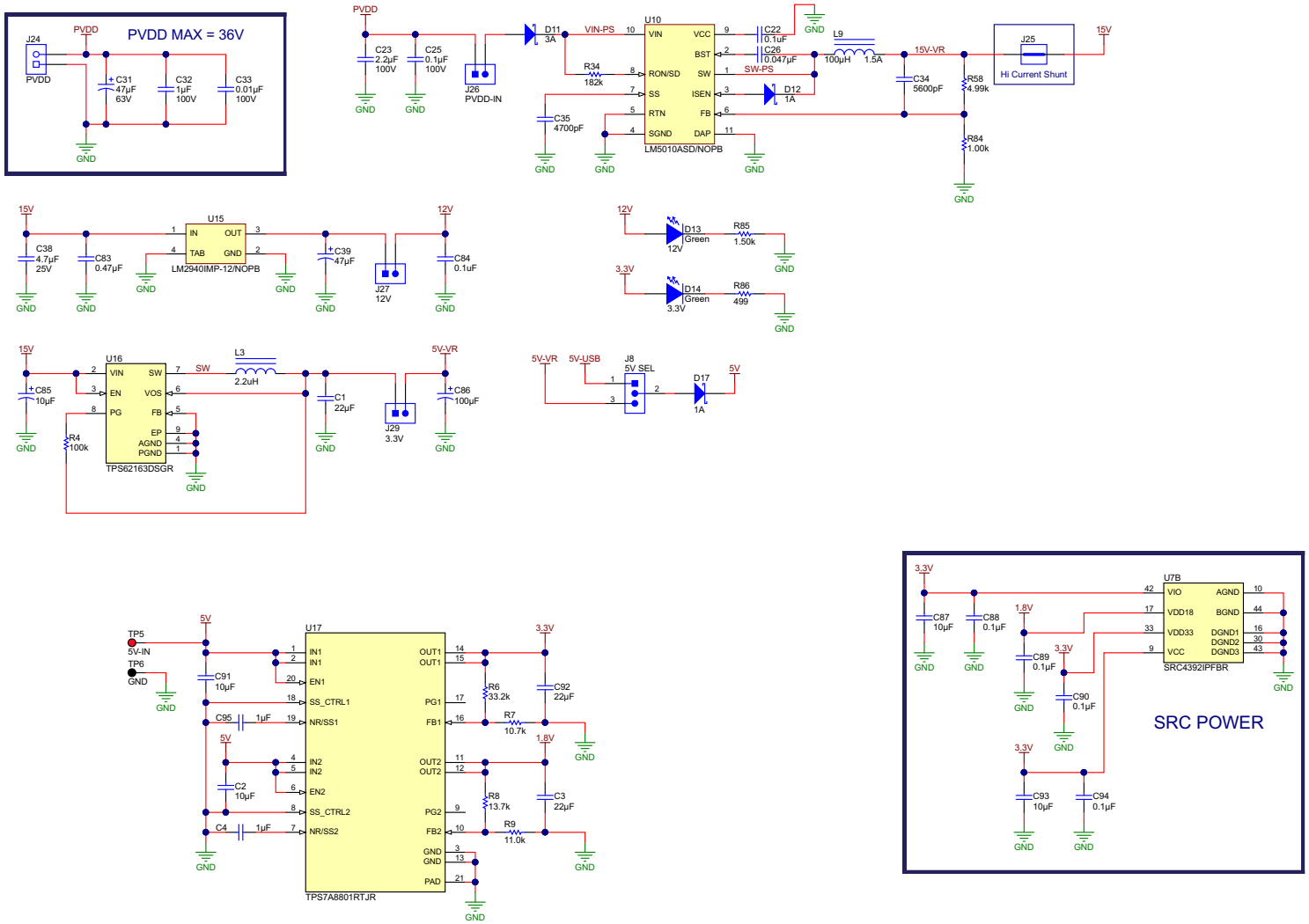


Figure 34. TAS3251EVM Schematics (5 of 5)

6.2 Bill of Materials

Table 18 lists the EVM BOM.

Table 18. TAS3251EVM Bill of Materials

Designator	QTY	Value	Description	Package Reference	Part Number	Manufacturer
!PCB	1		Printed Circuit Board		AAP090	Any
C1, C3, C92, C124, C125	5	22uF	CAP, CERM, 22 µF, 10 V, ±20%, X7R, 0805	0805	GRM21BZ71A226ME15L	Murata
C2, C60, C71, C87, C91, C93	6	10uF	CAP, CERM, 10 µF, 10 V, ±20%, X5R, 0603	0603	GRM188R61A106ME69D	Murata
C4, C63, C65, C95, C107	5	1uF	CAP, CERM, 1 µF, 16 V, ±10%, X7R, 0603	0603	GRM188R71C105KA12D	Murata
C5, C8, C11, C14	4	10uF	CAP, CERM, 10 µF, 16 V, ±10%, X7R, 1206	1206	GRM31CR71C106KAC7L	Murata
C17, C27, C37, C40, C45, C54, C58, C74, C80, C99, C100, C101, C102, C127, C128, C129, C130, C131, C132, C133, C134, C135, C136, C137, C138, C139, C140, C143, C144, C145, C146, C147, C148, C149	34	0.1uF	CAP, CERM, 0.1uF, 16V, ±10%, X7R, 0402	0402	GRM155R71C104KA88D	MuRata
C18, C19, C56, C59, C61, C69, C70, C72, C73, C88, C89, C90, C94, C108, C109, C110, C111, C112, C113, C114, C115, C116, C117, C118, C119, C120, C121, C122, C123, C151, C156	31	0.1uF	CAP, CERM, 0.1 µF, 10 V, ±10%, X7R, 0402	0402	GRM155R71A104KA01D	Murata
C20, C21	2	0.1uF	CAP, CERM, 0.1 µF, 16 V, ±10%, X7R, 0603	0603	GRM188R71C104KA01D	Murata
C22, C36, C44, C64, C84, C96	6	0.1uF	CAP, CERM, 0.1 µF, 50 V, ±10%, X7R, 0603	0603	C0603C104K5RACTU	Kemet
C23	1	2.2uF	CAP, CERM, 2.2 µF, 100 V, ±10%, X7R, 1210	1210	C1210C225K1RACTU	Kemet
C24, C82, C126, C141	4	0.1uF	CAP, CERM, 0.1 µF, 16 V, ±10%, X7R, 0402	0402	GRM155R71C104KA88D	Murata
C25	1	0.1uF	CAP, CERM, 0.1 µF, 100 V, ±10%, X7R, 0603	0603	GRM188R72A104KA35J	Murata
C26	1	0.047uF	CAP, CERM, 0.047 µF, 25 V, ±10%, X7R, 0402	0402	GRM155R71E473KA88D	Murata
C28, C29, C32, C41, C42, C46, C97	7	1uF	CAP, CERM, 1 µF, 100 V, ±10%, X7R, 1206	1206	GRM31CR72A105KA01L	Murata
C30, C43	2	2200uF	CAP, AL, 2200 µF, 50 V, ±20%, 0.023 ohm, TH	Dia 18mm	EEU-FC1H222	Panasonic
C31	1	47uF	CAP, AL, 47 µF, 63 V, ±20%, 0.65 ohm, SMD	SMT Radial F	EEE-FK1J470P	Panasonic
C33	1	0.01uF	CAP, CERM, 0.01 µF, 100 V, ±10%, X7R, 0603	0603	06031C103KAT2A	AVX
C34	1	5600pF	CAP, CERM, 5600 pF, 50 V, ±10%, X7R, 0603	0603	GRM188R71H562KA01D	Murata
C35	1	4700pF	CAP, CERM, 4700 pF, 50 V, ±10%, X7R, 0603	0603	C0603X472K5RACTU	Kemet
C38	1	4.7uF	CAP, CERM, 4.7 µF, 25 V, ±10%, X7R, 1206	1206	GRM31CR71E475KA88L	Murata
C39	1	47uF	CAP, AL, 47 µF, 16 V, ±20%, 0.36 ohm, SMD	SMT Radial D	EEE-FK1C470P	Panasonic
C47, C67, C79, C81	4	0.68uF	CAP, Film, 0.68 µF, 250 V, ±5%, TH	18x9x17.5mm	B32652A3684J	EPCOS Inc
C48, C49, C50, C51, C53, C57, C150	7	470pF	CAP, CERM, 470 pF, 25 V, ±5%, C0G/NP0, 0402	0402	GRM1555C1E471JA01D	Murata
C52	1	2200pF	CAP, CERM, 2200 pF, 16 V, ±10%, X7R, 0603	0603	885012206036	Wurth Elektronik
C55	1	1uF	CAP, CERM, 1 µF, 6.3 V, ±20%, X5R, 0402	0402	C1005X5R0J105M050BB	TDK
C62, C106	2	1000pF	CAP, CERM, 1000 pF, 50 V, ±5%, C0G/NP0, 0402	0402	GRM1555C1H102JA01D	Murata
C66, C68, C76, C77	4	0.033uF	CAP, CERM, 0.033 µF, 25 V, ±10%, X7R, 0603	0603	GRM188R71E333KA01D	Murata
C75	1	2.2uF	CAP, CERM, 2.2 µF, 10 V, ±10%, X5R, 0402	0402	C1005X5R1A225K050BC	TDK
C78	1	0.047uF	CAP, CERM, 0.047 µF, 50 V, ±10%, X7R, 0603	0603	GRM188R71H473KA61D	Murata

Table 18. TAS3251EVM Bill of Materials (continued)

Designator	QTY	Value	Description	Package Reference	Part Number	Manufacturer
C83	1	0.47uF	CAP, CERM, 0.47 µF, 25 V, ±10%, X7R, 0603	0603	GRM188R71E474KA12D	Murata
C85	1	10uF	CAP, AL, 10 µF, 16 V, ±20%, 1.35 ohm, SMD	SMT Radial B	EEE-FK1C100R	Panasonic
C86	1	100uF	CAP, AL, 100 µF, 6.3 V, ±20%, 0.7 ohm, SMD	SMT Radial C	EEE-FK0J101UR	Panasonic
C142	1	2.2uF	CAP, CERM, 2.2 µF, 10 V, ±10%, X7R, 0603	0603	GRM188R71A225KE15D	Murata
D1	1	Blue	LED, Blue, SMD	LED_0805	LTST-C170TBKT	Lite-On
D2, D5, D6, D7, D8, D15, D16	7	Blue	LED, Blue, SMD	BLUE 0603 LED	LB Q39G-L2N2-35-1	OSRAM
D3, D13, D14	3	Green	LED, Green, SMD	LED_0805	LTST-C171GKT	Lite-On
D4	1	Red	LED, Red, SMD	Red LED, 1.6x0.8x0.8mm	LTST-C190CKT	Lite-On
D9	1	Orange	LED, Orange, SMD	LED_0805	LTST-C170KFKT	Lite-On
D10	1	Red	LED, Red, SMD	Red 0805 LED	LTST-C170KRKT	Lite-On
D11	1	100V	Diode, Schottky, 100 V, 3 A, SMA	SMA	SK310A-TP	Micro Commercial Components
D12, D17	2	100V	Diode, Schottky, 100 V, 1 A, SMA	SMA	B1100-13-F	Diodes Inc.
H2, H3, H4, H5	4		MACHINE SCREW PAN PHILLIPS M3	M3 Screw	RM3X8MM 2701	APM HEXSEAL
H6, H7, H8, H9	4		Standoff, Hex, 25mm, M3, Aluminum	Aluminum M3 25mm Hex Standoff	24438	Keystone
H10, H11, H12, H13, H14, H15	6		WASHER FLAT #6 STAINLESS STEEL		FWSS 006	B&F Fastener Supply
J1, J2, J11, J14, J16, J19, J20, J26, J27, J29, J31, J32, J33, J34, J35, J37	16		Header, 100mil, 2x1, Gold, TH	Sullins 100mil, 1x2, 230 mil above insulator	PBC02SAAN	Sullins Connector Solutions
J3, J4, J6, J7, J8, J30	6		Header, 100mil, 3x1, Gold, TH	PBC03SAAN	PBC03SAAN	Sullins Connector Solutions
J5	1		RCA Jack, Red, R/A, TH	PC Mount Phono Jack-Red, TH	971	Keystone
J9	1		Header (shrouded), 100 mil, 7x2, Gold, TH	7x2 Shrouded Header	SBH11-PBPC-D07-ST-BK	Sullins Connector Solutions
J10, J15, J24	3		Dual Binding Posts with Base, 2x1, TH	Dual Binding Posts with Base, 2x1, TH	6883	Pomona Electronics
J12	1		Receptacle, 50mil, 6x1, Gold, TH	Receptacle, 6x1, 50mil, TH	851-43-006-10-001000	Mill-Max
J13, J21	2		Binding Post, BLACK, TH	11.4x27.2mm	7007	Keystone
J17, J36	2		Receptacle, 50mil, 6x1, Gold, R/A, TH	6x1 Receptacle	LPPB061NGCN-RC	Sullins Connector Solutions
J18	1		Connector, Receptacle, Micro-USB Type AB, R/A, Bottom Mount SMT	Connector, USB Micro AB	DX4R205JJAR1800	JAE Electronics
J22	1		Header, 100mil, 4x2, Tin, TH	Header, 4x2, 100mil, Tin	PEC04DAAN	Sullins Connector Solutions
J23	1		Header (friction lock), 100mil, 4x1, Gold, TH	Header 4x1 keyed	0022112042	Molex
J25	1		JUMPER TIN SMD	6.85x0.97x2.51 mm	S1911-46R	Harwin
J28	1		Receptacle, 100mil, 14x2, Gold, TH	14x2 Receptacle	SSW-114-01-G-D	Samtec
L1	1	470nH	Inductor, Shielded Drum Core, Ferrite, 470 nH, 2 A, 0.059 ohm, SMD	Inductor, 2x1.2x2mm	VLS2012ET-R47N	TDK
L2	1	600 ohm	Ferrite Bead, 600 ohm @ 100MHz, 2A, 0805	0805	MPZ2012S601A	TDK
L3	1	2.2uH	Inductor, Shielded, Ferrite, 2.2 uH, 1.72 A, 0.059 ohm, SMD	4.0x2.0x4.0mm	VLCF4020T-2R2N1R7	TDK
L4	1	120 ohm	Ferrite Bead, 120 ohm @ 100 MHz, 0.4 A, 0402	0402	MMZ1005Y121C	TDK
L5, L6, L7, L8	4	7uH	Inductor, Toroid, Powdered Iron, 7 µH, 6.5 A, 0.0215 ohm, TH	28.6x12.3mm	MA5173-AE	Coilcraft
L9	1	100uH	Inductor, Shielded Drum Core, Ferrite, 100 µH, 1.5 A, 0.165 ohm, SMD	SMD	7447714101	Wurth Elektronik
Q2, Q3, Q4, Q5, Q8, Q9, Q10	7	40 V	Transistor, NPN, 40 V, 0.15 A, SOT-23	SOT-23	MMBT2222A	Fairchild Semiconductor
R1	1	40.2k	RES, 40.2 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0402	0402	ERJ-2RKF4022X	Panasonic
R2	1	1.00Meg	RES, 1.00 M, 1%, 0.1 W, 0603	0603	RC0603FR-071ML	Yageo America
R3	1	162k	RES, 162 k, 1%, 0.1 W, 0603	0603	RC0603FR-07162KL	Yageo America
R4, R32, R59, R64, R65, R88	6	100k	RES, 100 k, 1%, 0.1 W, 0603	0603	RC0603FR-07100KL	Yageo America

Table 18. TAS3251EVM Bill of Materials (continued)

Designator	QTY	Value	Description	Package Reference	Part Number	Manufacturer
R5, R66, R77, R90, R91, R114, R129, R144, R149, R150, R154, R155	12	10.0k	RES, 10.0 k, 1%, 0.05 W, 0201	0201	RC0201FR-0710KL	Yageo America
R6	1	33.2k	RES, 33.2 k, 1%, 0.1 W, 0603	0603	RC0603FR-0733K2L	Yageo America
R7	1	10.7k	RES, 10.7 k, 1%, 0.1 W, 0603	0603	RC0603FR-0710K7L	Yageo America
R8	1	13.7k	RES, 13.7 k, 1%, 0.1 W, 0603	0603	RC0603FR-0713K7L	Yageo America
R9	1	11.0k	RES, 11.0 k, 1%, 0.1 W, 0603	0603	RC0603FR-0711KL	Yageo America
R54, R55, R62, R99, R100, R102, R103, R104, R112, R113, R130, R131, R132, R134, R135, R165, R168, R169, R170	19	0	RES, 0, 5%, 0.1 W, 0603	0603	ERJ-3GEY0R00V	Panasonic
R13, R30, R61, R72	4	0	RES, 0, 5%, 0.25 W, 1206	1206	RC1206JR-070RL	Yageo America
R14, R33, R68, R73	4	0	RES, 0, 5%, 0.125 W, 0805	0805	ERJ-6GEY0R00V	Panasonic
R16	1	33.0	RES, 33.0, 1%, 0.1 W, 0402	0402	ERJ-2RKF33R0X	Panasonic
R17, R18, R21, R24, R43	5	49.9	RES, 49.9, 1%, 0.063 W, 0402	0402	RC0402FR-0749R9L	Yageo America
R19, R46, R47, R48, R49, R57, R78, R79, R106, R108, R141	11	560	RES, 560, 5%, 0.1 W, 0603	0603	RC0603JR-07560RL	Yageo America
R20, R23, R84, R110	4	1.00k	RES, 1.00 k, 1%, 0.0625 W, 0402	0402	RC0402FR-071KL	Yageo America
R22, R58, R124, R133	4	4.99k	RES, 4.99 k, 1%, 0.063 W, 0402	0402	RC0402FR-074K99L	Yageo America
R25, R123	2	10.0k	RES, 10.0 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	RMCF0402FT10K0	Stackpole Electronics Inc
R26, R27, R111	3	0	RES, 0, 5%, 0.063 W, 0402	0402	ERJ-2GE0R00X	Panasonic
R31, R36, R125, R126, R127, R128, R159, R164	8	0	RES, 0, 5%, 0.125 W, 0805	0805	RC0805JR-070RL	Yageo America
R34	1	182k	RES, 182 k, 1%, 0.125 W, 0805	0805	ERJ-6ENF1823V	Panasonic
R38, R39, R40, R42, R44, R45, R156	7	25.5k	RES, 25.5 k, 1%, 0.05 W, 0201	0201	RC0201FR-0725K5L	Yageo America
R41, R157	2	47.0k	RES, 47.0 k, 1%, 0.0625 W, 0402	0402	RC0402FR-0747KL	Yageo America
R50, R51, R52, R53, R105, R107, R109	7	2.00k	RES, 2.00 k, 1%, 0.1 W, 0603	0603	RC0603FR-072KL	Yageo America
R56	1	8.06k	RES, 8.06 k, 1%, 0.1 W, 0603	0603	RC0603FR-078K06L	Yageo America
R60	1	3.30k	RES, 3.30 k, 1%, 0.1 W, 0603	0603	RC0603FR-073K3L	Yageo America
R67, R69, R86, R95, R98	5	499	RES, 499, 1%, 0.1 W, 0603	0603	RC0603FR-07499RL	Yageo America
R74	1	22.0k	RES, 22.0 k, 1%, 0.1 W, 0603	0603	RC0603FR-0722KL	Yageo America
R75	1	30.0k	RES, 30.0 k, 1%, 0.1 W, 0603	0603	RC0603FR-0730KL	Yageo America
R76	1	20.0k	RES, 20.0 k, 1%, 0.1 W, 0603	0603	RC0603FR-0720KL	Yageo America
R80, R92, R121, R145	4	10.0k	RES, 10.0 k, 1%, 0.1 W, 0402	0402	ERJ-2RKF1002X	Panasonic
R85	1	1.50k	RES, 1.50 k, 1%, 0.1 W, 0603	0603	RC0603FR-071K5L	Yageo America
R115, R116, R117, R118	4	100k	RES, 100 k, 1%, 0.0625 W, 0402	0402	RC0402FR-07100KL	Yageo America
R136, R137, R138, R139	4	47.0k	RES, 47.0 k, 1%, 0.05 W, 0201	0201	RC0201FR-0747KL	Yageo America
R140	1	4.75	RES, 4.75, 1%, 0.1 W, 0603	0603	RC0603FR-074R75L	Yageo America
R142, R143, R146, R151, R152, R153	6	33.2	RES, 33.2, 1%, 0.05 W, 0201	0201	RC0201FR-0733R2L	Yageo America
R147	1	0	RES, 0, 5%, 0.05 W, 0201	0201	ERJ-1GE0R00C	Panasonic
R148	1	43.2	RES, 43.2, 1%, 0.05 W, 0201	0201	RC0201FR-0743R2L	Yageo America
R158	1	51.0k	RES, 51.0 k, 1%, 0.05 W, 0201	0201	RC0201FR-0751KL	Yageo America
S1, S3	2		Switch, SPDT, On-On, 2 Pos, TH	Switch, 7x4.5mm	200USP1T1A1M2RE	E-Switch

Table 18. TAS3251EVM Bill of Materials (continued)

Designator	QTY	Value	Description	Package Reference	Part Number	Manufacturer
S2, S4, S5, S6, S7, S8, S10	7		Switch, Tactile, SPST-NO, 0.05A, 12V, SMT	Switch, 4.4x2x2.9 mm	TL1015AF160QG	E-Switch
SH1, SH2, SH3, SH4, SH5, SH6, SH7, SH8, SH9, SH10, SH11, SH12, SH13, SH14, SH15, SH16, SH17, SH18, SH19, SH20, SH21, SH22	22	1x2	Shunt, 100mil, Gold plated, Black	Shunt	969102-0000-DA	3M
TP1, TP2, TP3, TP4, TP17, TP18, TP19, TP20	8		Test Point, Miniature, Orange, TH	Orange Miniature Testpoint	5003	Keystone
TP5	1		Test Point, Multipurpose, Red, TH	Red Multipurpose Testpoint	5010	Keystone
TP6	1		Test Point, Multipurpose, Black, TH	Black Multipurpose Testpoint	5011	Keystone
TP7, TP8, TP15, TP16	4		Test Point, Multipurpose, Grey, TH	Grey Multipurpose Testpoint	5128	Keystone
U1	1		3-A Step-Down Converter with Hiccup Short Circuit Protection in 2x2 QFN Package, RLT0007A	RLT0007A	TPS62085RLTR	Texas Instruments
U2	1		IC MCU 32BIT, TQFP-128	TQFP-128	XEF216-512-TQ128-C20	XMOS semiconductor
U3	1		TCA9406 Dual Bidirectional 1-MHz I2C-BUS and SMBus Voltage Level-Translator, 1.65 to 3.6 V, -40 to 85 degC, 8-pin US8 (DCU), Green (RoHS & no Sb/Br)	DCU0008A	TCA9406DCUR	Texas Instruments
U4	1		Photolink- Fiber Optic Receiver, TH	13.5x10x9.7mm	PLR135/T10	Everlight
U5	1		ULTRA-SMALL SUPPLY VOLTAGE SUPERVISORS, DCK0005A	DCK0005A	TPS3802K33DCKR	Texas Instruments
U6	1		2-BIT UNDIRECTIONAL VOLTAGE-LEVEL TRANSLATOR, DQM0008A (X2SON-8)	DQM0008A	SN74AVC2T244DQMR	Texas Instruments
U7	1		216 SPS High-end Combo Sample Rate Converter, 144dB, 1.8 / 3.3V, -40 to 85 degC, 48-Pin TQFP (PFB), Green (RoHS & no Sb/Br)	PFB0048A	SRC4392IPFBR	Texas Instruments
U8	1		175-W Stereo, 350-W Mono PurePath Ultra-HD Digital-Input Class-D Amplifier with DSP Processing, DKQ0056A (SSOP-56)	DKQ56	TAS3251DKQR	Texas Instruments
U9, U11, U13, U14, U31	5		Single 2-Line to 1-Line Data Selector Multiplexer, DCT0008A (SSOP-8)	DCT0008A	SN74LVC2G157DCTR	Texas Instruments
U10	1		High Voltage 1A Step Down Switching Regulator, 10-pin LLP, Pb-Free	SDC10A	LM5010ASD/NOPB	Texas Instruments
U12	1		MIXED SIGNAL MICROCONTROLLER, RHA0040B (VQFN-40)	RHA0040B	MSP430G2955IRHA40R	Texas Instruments
U15	1		1A Low Dropout Regulator, 4-pin SOT-223, Pb-Free	MP04A	LM2940IMP-12/NOPB	Texas Instruments
U16	1		Buck Step Down Regulator with 3 to 17 V Input and 5 V Output, -40 to 85 degC, 8-Pin WSON (DSG), Green (RoHS & no Sb/Br)	DSG0008A	TPS62163DSGR	Texas Instruments
U17	1		Dual, 1-A, Low Noise (3.8-uVRMS), LDO Voltage Regulator, RTJ0020D (WQFN-20)	RTJ0020D	TPS7A8801RTJR	Texas Instruments
U18, U19, U20, U21, U22, U23, U24, U25	8		Single Bus Buffer Gate With 3-State Output, DSF0006A (X2SON-6)	DSF0006A	SN74LVC1G125DSFR	Texas Instruments
U26	1		Programmable 1-PLL VCXO Clock Synthesizer With 1.8-V, 2.5-V, and 3.3-V Outputs, PW0014A (TSSOP-14)	PW0014A	CDCE913PWR	Texas Instruments
U27, U28	2		SINGLE SCHMITT-TRIGGER INVERTER, DRL0005A (SOT-5)	DRL0005A	SN74LVC1G14DRLR	Texas Instruments
U29	1		DUAL BUFFER/DRIVER WITH OPEN DRAIN OUTPUTS, DSF0006A	DSF0006A	SN74LVC2G07DSFR	Texas Instruments
U30	1		Single-Channel, Adjustable Supervisory Circuit in Ultra-Small Package, DRY0006A (USON-6)	DRY0006A	TPS3897ADRYR	Texas Instruments
Y1	1		OSC, 24 MHz, 2.25 - 3.63 V, SMD	2x1.6mm	ASTMLPA-24.000MHZ-EJ-E-T	Abracon Corporation
Y2	1		OSC, 24.576 MHz, 2.25 - 3.63 V, SMD	2x1.6mm	ASTMHTA-24.576MHZ-AJ-E	Abracon Corporation
Y3	1		Oscillators, 22.5792MHz, CMOS, 3.3V, SMD	2x2.5mm	TD-22.5792MBD-T	TXC Corporation
C6, C9, C12, C15	0	220pF	CAP, CERM, 220 pF, 50 V,±5%, C0G/NP0, 0603	0603	GRM1885C1H221JA01D	Murata
C7, C10, C13, C16	0	22pF	CAP, CERM, 22 pF, 50 V, ±5%, C0G/NP0, 0603	0603	GRM1885C1H220JA01D	Murata

Table 18. TAS3251EVM Bill of Materials (continued)

Designator	QTY	Value	Description	Package Reference	Part Number	Manufacturer
C98, C103, C104, C105	0	1uF	CAP, CERM, 1 µF, 100 V, ±10%, X7R, 1206	1206	GRM31CR72A105KA01L	Murata
C152, C153, C154, C155	0	1000pF	CAP, CERM, 1000 pF, 50 V, ±5%, C0G/NP0, 1206	1206	GRM3195C1H102JA01D	Murata
FID1, FID2, FID3, FID4, FID5, FID6	0		Fiducial mark. There is nothing to buy or mount.	Fiducial	N/A	N/A
H1	0		Heat Sink, Vertical	Heatsink	ATS-TI1OP-1099-C1-R1	Advanced Thermal Solutions
R10	1	0	RES, 0, 5%, 0.1 W, 0603	0603	ERJ-3GEY0R00V	Panasonic
R11, R12, R63, R101, R166, R167	0	0	RES, 0, 5%, 0.1 W, 0603	0603	ERJ-3GEY0R00V	Panasonic
R15, R35, R70, R96	0	18.0k	RES, 18.0 k, 1%, 0.1 W, 0603	0603	RC0603FR-0718KL	Yageo America
R28	0	0	RES, 0, 5%, 0.125 W, 0805	0805	ERJ-6GEY0R00V	Panasonic
R29, R37, R71, R97	0	2.00k	RES, 2.00 k, 1%, 0.1 W, 0603	0603	RC0603FR-072KL	Yageo America
R87, R89, R93, R94	0	3.30	RES, 3.30, 1%, 0.25 W, 1206	1206	ERJ-8RQF3R3V	Panasonic
R119, R120, R122	0	10.0k	RES, 10.0 k, 1%, 0.1 W, 0402	0402	ERJ-2RKF1002X	Panasonic
R160, R161, R162, R163	0	0	RES, 0, 5%, 0.05 W, 0201	0201	ERJ-1GE0R00C	Panasonic

Revision History

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

Changes from A Revision (November 2018) to B Revision	Page
• Changed column 3 title From: Configuration for BTL To: Configuration for PBTL in Table 2	9
• Changed J19 Configuration From: Install To: Remove in Table 2	9

Revision History

Changes from Original (January 2018) to A Revision	Page
• Changed the document From: Advanced Information To: Production Release	1

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.

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/lsds/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。
http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page

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。
3. 技術基準適合証明を取得後ご使用いただく。

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。

上記を遵守頂けない場合は、電波法の罰則が適用される可能性があることをご留意ください。 日本テキサス・インスツルメンツ株式会社

東京都新宿区西新宿６丁目２４番１号

西新宿三井ビル

3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_02.page

電力線搬送波通信についての開発キットをお使いになる際の注意事項については、次のところをご覧ください。http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_02.page

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.

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.

6. *Disclaimers:*

   6.1 EXCEPT AS SET FORTH ABOVE, EVMS AND ANY MATERIALS PROVIDED WITH THE EVM (INCLUDING, BUT NOT LIMITED TO, REFERENCE DESIGNS AND THE DESIGN OF THE EVM ITSELF) ARE PROVIDED "AS IS" AND "WITH ALL FAULTS." TI DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, REGARDING SUCH ITEMS, INCLUDING BUT NOT LIMITED TO ANY EPIDEMIC FAILURE WARRANTY OR IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF ANY THIRD PARTY PATENTS, COPYRIGHTS, TRADE SECRETS OR OTHER INTELLECTUAL PROPERTY RIGHTS.

   6.2 EXCEPT FOR THE LIMITED RIGHT TO USE THE EVM SET FORTH HEREIN, NOTHING IN THESE TERMS SHALL BE CONSTRUED AS GRANTING OR CONFERRING ANY RIGHTS BY LICENSE, PATENT, OR ANY OTHER INDUSTRIAL OR INTELLECTUAL PROPERTY RIGHT OF TI, ITS SUPPLIERS/LICENSORS OR ANY OTHER THIRD PARTY, TO USE THE EVM IN ANY FINISHED END-USER OR READY-TO-USE FINAL PRODUCT, OR FOR ANY INVENTION, DISCOVERY OR IMPROVEMENT, REGARDLESS OF WHEN MADE, CONCEIVED OR ACQUIRED.

7. *USER'S INDEMNITY OBLIGATIONS AND REPRESENTATIONS.* USER WILL DEFEND, INDEMNIFY AND HOLD TI, ITS LICENSORS AND THEIR REPRESENTATIVES HARMLESS FROM AND AGAINST ANY AND ALL CLAIMS, DAMAGES, LOSSES, EXPENSES, COSTS AND LIABILITIES (COLLECTIVELY, "CLAIMS") ARISING OUT OF OR IN CONNECTION WITH ANY HANDLING OR USE OF THE EVM THAT IS NOT IN ACCORDANCE WITH THESE TERMS. THIS OBLIGATION SHALL APPLY WHETHER CLAIMS ARISE UNDER STATUTE, REGULATION, OR THE LAW OF TORT, CONTRACT OR ANY OTHER LEGAL THEORY, AND EVEN IF THE EVM FAILS TO PERFORM AS DESCRIBED OR EXPECTED.

8. *Limitations on Damages and Liability:*

   8.1 *General Limitations*. IN NO EVENT SHALL TI BE LIABLE FOR ANY SPECIAL, COLLATERAL, INDIRECT, PUNITIVE, INCIDENTAL, CONSEQUENTIAL, OR EXEMPLARY DAMAGES IN CONNECTION WITH OR ARISING OUT OF THESE TERMS OR THE USE OF THE EVMS , REGARDLESS OF WHETHER TI HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. EXCLUDED DAMAGES INCLUDE, BUT ARE NOT LIMITED TO, COST OF REMOVAL OR REINSTALLATION, ANCILLARY COSTS TO THE PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES, RETESTING, OUTSIDE COMPUTER TIME, LABOR COSTS, LOSS OF GOODWILL, LOSS OF PROFITS, LOSS OF SAVINGS, LOSS OF USE, LOSS OF DATA, OR BUSINESS INTERRUPTION. NO CLAIM, SUIT OR ACTION SHALL BE BROUGHT AGAINST TI MORE THAN TWELVE (12) MONTHS AFTER THE EVENT THAT GAVE RISE TO THE CAUSE OF ACTION HAS OCCURRED.

   8.2 *Specific Limitations.* IN NO EVENT SHALL TI'S AGGREGATE LIABILITY FROM ANY USE OF AN EVM PROVIDED HEREUNDER, INCLUDING FROM ANY WARRANTY, INDEMITY OR OTHER OBLIGATION ARISING OUT OF OR IN CONNECTION WITH THESE TERMS, , EXCEED THE TOTAL AMOUNT PAID TO TI BY USER FOR THE PARTICULAR EVM(S) AT ISSUE DURING THE PRIOR TWELVE (12) MONTHS WITH RESPECT TO WHICH LOSSES OR DAMAGES ARE CLAIMED. THE EXISTENCE OF MORE THAN ONE CLAIM SHALL NOT ENLARGE OR EXTEND THIS LIMIT.

9. *Return Policy.* Except as otherwise provided, TI does not offer any refunds, returns, or exchanges. Furthermore, no return of EVM(s) will be accepted if the package has been opened and no return of the EVM(s) will be accepted if they are damaged or otherwise not in a resalable condition. If User feels it has been incorrectly charged for the EVM(s) it ordered or that delivery violates the applicable order, User should contact TI. All refunds will be made in full within thirty (30) working days from the return of the components(s), excluding any postage or packaging costs.

10. *Governing Law:* These terms and conditions shall be governed by and interpreted in accordance with the laws of the State of Texas, without reference to conflict-of-laws principles. User agrees that non-exclusive jurisdiction for any dispute arising out of or relating to these terms and conditions lies within courts located in the State of Texas and consents to venue in Dallas County, Texas. Notwithstanding the foregoing, any judgment may be enforced in any United States or foreign court, and TI may seek injunctive relief in any United States or foreign court.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265

IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATASHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES “AS IS” AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, or other requirements. These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI’s products are provided subject to TI’s Terms of Sale (www.ti.com/legal/termsofsale.html) or other applicable terms available either on ti.com or provided in conjunction with such TI products. TI’s provision of these resources does not expand or otherwise alter TI’s applicable warranties or warranty disclaimers for TI products.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265