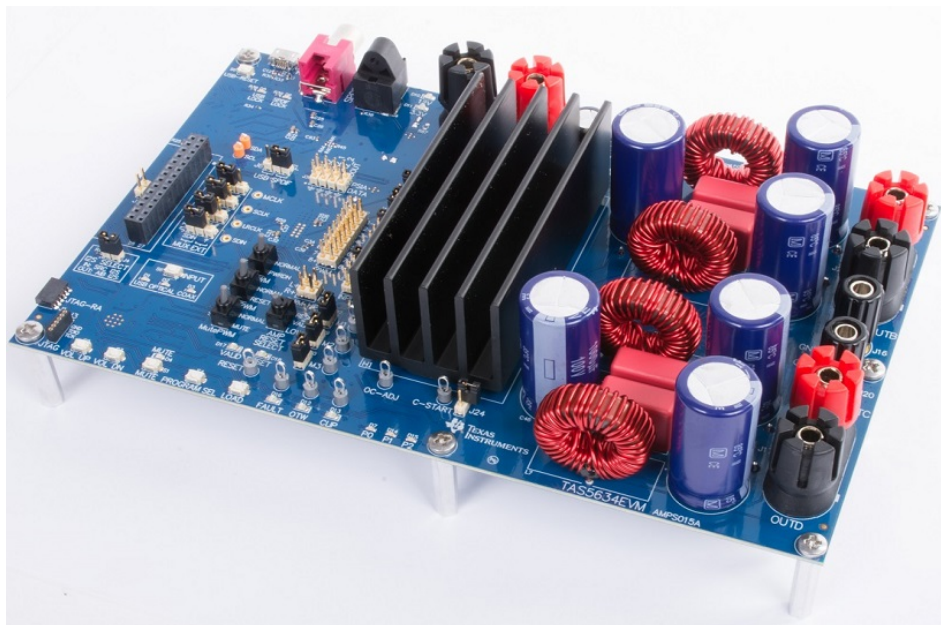


TAS5634 Evaluation Module

This user's guide describes the characteristics, operation, and use of the TAS5634 evaluation module. A complete printed-circuit board (PCB) description, schematic diagram, and bill of materials are also included.

For questions and support go to the E2E forums (e2e.ti.com).



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1 TAS5634EVM Hardware Overview and Features

1.1 Hardware Overview

The TAS5634EVM evaluation module demonstrates the TAS5634DDV integrated circuit from Texas Instruments. The TAS5634DDV is a high-power class-D with high-efficiency class-D technology. This EVM supports two BTL (stereo 2.0) output channels, one PBTL (mono 0.1) output channel, one BTL plus two SE (2.1) output channels, or four SE (4.0) output channels configurations. The EVM contains a TAS5558 modulator which converts I2S audio input to the PWM signal which the TAS5634 uses as input. A built-in MSP430 microcontroller and DIX4192 audio transceiver handles translation from USB-Audio or either of the SPDIF inputs and allows the TAS5558 modulator to accept input from various digital sources. The *Analog Plug-in Board* connector also allows digital audio plug-in boards to be used with the TAS5634EVM. The TAS5634EVM is a complete digital input solution with an output power of up to 2×300-W stereo, or 1×600-W mono.

1.2 TAS5634EVM Features

The TAS5634EVM has the following features:

- High-power audio evaluation module
- Self-contained protection system (short circuit, clip, and thermal)
- SPDIF (Optical or COAX), USB-audio, or analog plug-in board I2S digital input
- BTL, PBTL, and SE output configuration support
- Single-supply voltage range 15–58 V
- Double-sided, plated-through, 2-oz. Cu, 4-layer PCB layout

2 Quick Start (BTL MODE)

The following section describes the necessary hardware, connections, configuration, and steps to quick start the EVM into BTL mode with stereo audio playing out of two speakers.

2.1 Required Hardware and Software

The following hardware is required for this EVM:

- TAS5634EVM (AMPS015)
- Power supply 10–15 A, 12–58 VDC
- Two 6–8 Ω (approximately 200–300 W) speaker or resistor loads
- Four speaker, banana cables
- One Optical or COAX cable (for non-USB audio)
- USB Micro-B cable
- Texas Instruments PurePath™ Console (PPC) 1.16 GUI with TAS5548 support: (<http://www.ti.com/tool/purepathconsole>)

2.2 Connections and Board Configuration (BTL MODE)

Figure 1 and Figure 2 show the top and bottom side of the EVM board, respectively.

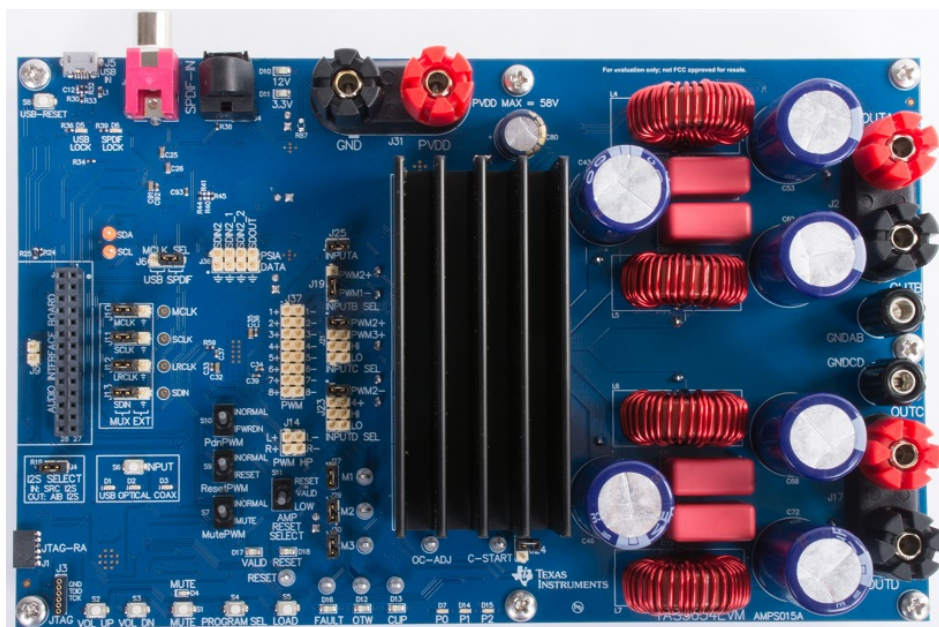


Figure 1. EVM Board (Top Side)

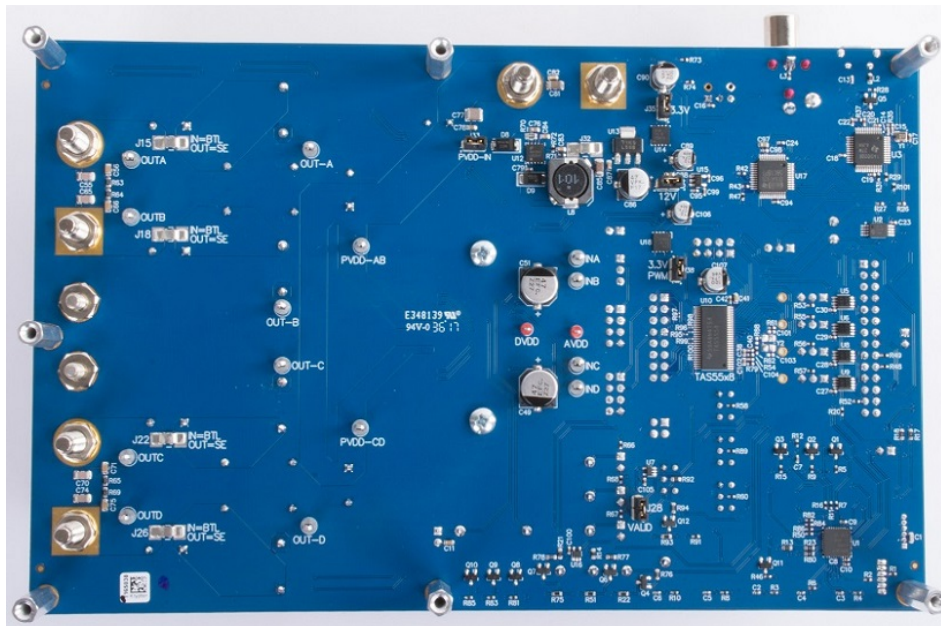


Figure 2. EVM Board (Bottom Side)

Use the following steps when connecting and configuring the board (BTL MODE):

1. Ensure the power supply is OFF. Connect the power supply positive terminal to J31 PVDD (red) and negative terminal to J31 GND (black).
2. Connect the left channel speaker, power resistor load (6–8 Ω) to the TAS5634EVM positive output terminal (J2 OUTA (red)) and other side of the speaker, power resistor to the TAS5634EVM negative output terminal (J2 OUTB (black)).
3. Connect the right channel speaker, power resistor load (6–8 Ω) to the TAS5634EVM positive output terminal (J17 OUTC (red)) and other side of the speaker, power resistor to the TAS5634EVM negative output terminal (J17 OUTD (black)).
4. Check to make sure that the power supply is connected to J31 only and speakers are connected to J2 or J17 only, as their colors are the same.
5. Input Configuration:
 - A. OPTICAL Input: Connect an optical cable between J7 and the optical audio source.
 - B. COAX Input: Connect an optical cable between connector U4 and the COAX audio source.
 - C. USB-Audio Input: Change J6 to USB.
 - D. *Audio Interface Board (AIB)* input: When using the AIB input, remove jumper J4.
6. Ensure that switches S7, S9, and S10 are in the NORMAL position, AMP RESET S11 is in the LOW position.
7. Connect the USB Micro cable between the PC and J5.
8. Check [Table 1](#) for all jumper and switch configurations

Table 1. Jumper and Switch Configurations (BTL Mode)

Component	Component Description	Configuration for BTL
J6	MCLK SEL	USB for USB-Audio, SPDIF for COAX or OPTICAL
J10, J11, J12, J13	PSIA CLK SEL	MUX (position 1-2)
J4	I2S SEL	IN
S7	MutePWM	NORMAL
S9	ResetPWM	NORMAL

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

Component	Component Description	Configuration for BTL
S10	PdnPWM	NORMAL
S11	AMP RESET SELECT	LOW
J25	INPUTA	IN
J19	INPUTB SEL	PWM1-
J21	INPUTC SEL	PWM2+
J23	INPUTD SEL	PWM2-
M1	MODE M1 SELECT	IN
M2	MODE M2 SELECT	IN
M3	MODE M3 SELECT	IN
J37	PWM	OUT
J14	PWM HP	OUT
J24	C-START	OUT
J33	PVDD-IN	IN
J35	3.3 V	IN
J34	12 V	IN
J38	3.3-V PWM	IN
J28	VALID	IN
J15, J18, J22, J26	SE CAP Bypass	IN

2.3 Power Up

Ensure that required connections and configurations have been checked. Also ensure that the PPC 1.16 GUI is installed. Power on the TAS5634EVM board.

1. Enable the power supply at 12 V to 58 V and ensure that LEDs D10 and D11 illuminate. LEDs D12, D13, and D16 should **not** illuminate.
2. Wait for LEDs D1, D2, and D3 to light solid blue, this takes about 5 seconds.
3. Click the LOAD (S5) button on the EVM.
4. OPTICAL (D2) and COAX (D3) should turn off, VALID (D17) should light green, MUTE (D4) light red, and P0 (D7) light blue.
5. Press the MUTE (S1) button once so the MUTE LED turns off.
6. Press the INPUT (S6) button until the selected source (USB, OPTICAL, or COAX) LED starts blinking and then press LOAD (S5). The selected source blue LED remains lit. If using the COAX or OPTICAL input, once the source is on and valid the SPDIF LOCK LED (D6) will light blue.
7. Launch the PPC 1.16 GUI using the TAS5548 icon located at start menu location: "Texas Instruments Inc\PurePath Console 1.16\TAS5548".
8. The GUI will connect to the EVM provided the power is correct and the USB cable is connected. If the connection fails, please check that the drivers are installed.
9. VALID LED D17 should now be on.
10. Bring the EVM out of RESET state by switching AMP RESET SELECT (S11) to RESET = VALID (the upper position). This enables the TAS5634 by connecting the TAS5558 VALID signal to the TAS5634. RESET LED D18 should turn off.
11. Note that the EVM does not have volume control, configure your input for a reasonable audio level before beginning audio playback.
12. Enable audio input playback and the EVM should begin driving audio out of the left and right speakers. If resistor loads are used for testing instead of speakers, they will now be energized.

3 Setup By Mode

The following sections describe the setup and configuration for each output mode. The TAS5634DDV EVM allows for several output modes.

3.1 BTL MODE (Stereo - 2 Speaker Outputs)

This mode is the same as described in [Quick Start \(BTL MODE\)](#).

3.2 PBTL MODE (Mono – 1 Speaker Output)

This mode provides one speaker output that is more powerful than each BTL output and is useful when mono audio is to be played or when more power is needed.

3.2.1 Connections and Board Configuration

Use the following steps when connecting and configuring the board (PBTL):

1. Ensure the power supply is OFF. Connect the power supply positive terminal to J31 PVDD (red) and negative terminal to J31 GND (black).
2. Connect the speaker, power resistor load (3-4 Ω) to the TAS5634EVM positive output terminal (J2 OUTA (red)) and other side of the speaker, power resistor to the TAS5634EVM negative output terminal (J2 OUTB (black)). Use a short banana cable to connect J2 OUTA to J17 OUTC and a second banana short banana cable to connect J2 OUTB to J17 OUTD. This forms the parallel connection of both OUTA and OUTC to the one side of the speaker and parallel connection of both OUTB and OUTD to the other side of the speaker.
3. Check to make sure that the power supply is connected to J31 only and speaker is connected to J2 and J17 only, as their colors are the same.
4. Input Configuration:
 - A. OPTICAL Input: Connect an optical cable between J7 and the optical audio source.
 - B. COAX Input: Connect an optical cable between connector U4 and the COAX audio source.
 - C. USB-Audio Input: Change J6 to USB.
 - D. *Audio Interface Board* input: When using the AIB input, remove jumper J4.
5. Ensure that switches S7, S9, and S10 are in the NORMAL position, AMP RESET S11 is in the LOW position.
6. Connect the USB Micro cable between the PC and J5.
7. Check [Table 2](#) for all jumper and switch configurations necessary.

Table 2. Jumper and Switch Configurations (PBTL Mode)

Component	Component Description	Configuration for BTL
J6	MCLK SEL	USB for USB-Audio, SPDIF for COAX or OPTICAL
J10, J11, J12, J13	PSIA CLK SEL	MUX (position 1-2)
J4	I2S SEL	IN
S7	MutePWM	NORMAL
S9	ResetPWM	NORMAL
S10	PdnPWM	NORMAL
S11	AMP RESET SELECT	LOW
J25	INPUTA	IN
J19	INPUTB SEL	PWM1-
J21	INPUTC SEL	LO
J23	INPUTD SEL	LO
M1	MODE M1 SELECT	IN
M2	MODE M2 SELECT	IN

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

Component	Component Description	Configuration for BTL
M3	MODE M3 SELECT	OUT
J37	PWM	OUT
J14	PWM HP	OUT
J24	C-START	OUT
J33	PVDD-IN	IN
J35	3.3 V	IN
J34	12 V	IN
J38	3.3-V PWM	IN
J28	VALID	IN
J15, J18, J22, J26	SE CAP Bypass	IN

3.2.2 Power Up

Ensure that required connections and configurations have been checked. Also ensure that the PPC 1.16 GUI is installed. Power on the TAS5634EVM board.

1. Enable the power supply at 12 V to 58 V and ensure that LEDs D10 and D11 illuminate. LEDs D12, D13, and D16 should **not** illuminate.
2. Wait for LEDs D1, D2, and D3 to light solid blue, this takes about 5 seconds.
3. Click the LOAD (S5) button on the EVM.
4. OPTICAL (D2) and COAX (D3) should turn off, VALID (D17) should light green, MUTE (D4) light red, and P0 (D7) light blue.
5. Press the MUTE (S1) button once so the MUTE LED turns off.
6. Press the INPUT (S6) button until the selected source (USB, OPTICAL, or COAX) LED starts blinking and then press LOAD (S5). The selected source blue LED remains lit. If using the COAX or OPTICAL input, once the source is on and valid the SPDIF LOCK LED (D6) will light blue.
7. Launch the PPC 1.16 GUI using the TAS5548 icon located at start menu location: "Texas Instruments Inc\PurePath Console 1.16\TAS5548".
8. The GUI will connect to the EVM provided the power is correct and the USB cable is connected. If the connection fails, please check that the drivers are installed.
9. VALID LED D17 should now be on.
10. Bring the EVM out of RESET state by switching AMP RESET SELECT (S11) to RESET = VALID (the upper position). This enables the TAS5634 by connecting the TAS5558 VALID signal to the TAS5634. RESET LED D18 should turn off.
11. Note that the EVM does not have volume control, configure your input for a reasonable audio level before beginning audio playback.
12. Enable audio input playback and the EVM should begin driving audio out of the speaker. If resistor load is used for testing instead of a speaker, it will now be energized.

3.3 SE MODE (4 Speaker Outputs)

This mode provides four speaker outputs and is useful when four channel support is needed.

3.3.1 Connections and Board Configuration

Use the following steps when connecting and configuring the board (SE):

1. Ensure the power supply is OFF. Connect the power supply positive terminal to J31 PVDD (red) and negative terminal to J31 GND (black).
2. Remove jumpers J15, J18, J22, and J26.
3. Connect each of the four speakers, power resistor loads (3-4 Ω) to the TAS5634EVM output channels OUTA, OUTB, OUTC, and OUTD, connect the opposing side of each speaker to the EVM GND posts J16 or J20. All four speakers are driven by one output channel, the other side of each speaker connects to GND.
4. Check to make sure that the power supply is connected to J31 only and speaker is connected to J2 and J17 only, as their colors are the same.
5. Input Configuration:
 - A. OPTICAL Input: Connect an optical cable between J7 and the optical audio source.
 - B. COAX Input: Connect an optical cable between connector U4 and the COAX audio source.
 - C. USB-Audio Input: Change J6 to USB.
 - D. *Audio Interface Board* Input: When using the AIB input, remove jumper J4.
6. Ensure that switches S7, S9, and S10 are in the NORMAL position, AMP RESET S11 is in the LOW position.
7. Connect the USB Micro cable between the PC and J5.
8. Check [Table 3](#) for all jumper and switch configurations necessary.

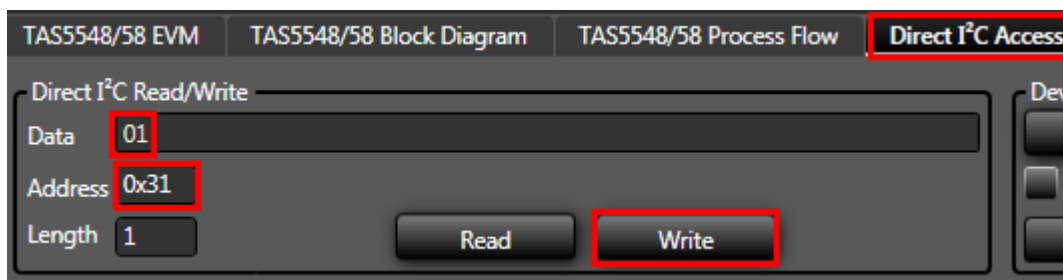
Table 3. Jumper and Switch Configurations (SE Mode)

Component	Component Description	Configuration for BTL
J6	MCLK SEL	USB for USB-Audio, SPDIF for COAX or OPTICAL
J10, J11, J12, J13	PSIA CLK SEL	MUX (position 1-2)
J4	I2S SEL	IN
S7	MutePWM	NORMAL
S9	ResetPWM	NORMAL
S10	PdnPWM	NORMAL
S11	AMP RESET SELECT	LOW
J25	INPUTA	IN
J19	INPUTB SEL	PWM2+
J21	INPUTC SEL	PWM3+
J23	INPUTD SEL	PWM4+
M1	MODE M1 SELECT	OUT
M2	MODE M2 SELECT	IN
M3	MODE M3 SELECT	OUT
J37	PWM	OUT
J14	PWM HP	OUT
J24	C-START	IN
J33	PVDD-IN	IN
J35	3.3 V	IN
J34	12 V	IN
J38	3.3-V PWM	IN
J28	VALID	IN
J15, J18, J22, J26	SE CAP Bypass	OUT

3.3.2 Power Up

Ensure that required connections and configurations have been checked. Also ensure that the PPC 1.16 GUI is installed. Power on the TAS5634EVM board.

1. Enable the power supply at 12 V to 58 V and ensure that LEDs D10 and D11 illuminate. LEDs D12, D13, and D16 should **not** illuminate.
2. Wait for LEDs D1, D2, and D3 to light solid blue, this takes about 5 seconds.
3. Click the LOAD (S5) button on the EVM.
4. OPTICAL (D2) and COAX (D3) should turn off, VALID (D17) should light green, MUTE (D4) light red, P0 (D7) light blue.
5. Press the MUTE (S1) button once so the MUTE LED turns off.
6. Press the INPUT (S6) button until the selected source (USB, OPTICAL, or COAX) LED starts blinking and then press LOAD (S5). The selected source blue LED remains lit. If using the COAX or OPTICAL input, once the source is on and valid the SPDIF LOCK LED (D6) will light blue.
7. Launch the PPC 1.16 GUI using the TAS5548 icon located at start menu location: "Texas Instruments Inc\PurePath Console 1.16\TAS5548".
8. The GUI will connect to the EVM provided the power is correct and the USB cable is connected. If the connection fails, please check that the drivers are installed.
9. Navigate to the *Direct I2C Access* tab and use the following control to write data 01 to address 0x31.



10. VALID LED D17 should now be on.
11. Bring the EVM out of RESET state by switching AMP RESET SELECT (S11) to RESET = VALID (the upper position). This enables the TAS5634 by connecting the TAS5558 VALID signal to the TAS5634. RESET LED D18 should turn off.
12. Note that the EVM does not have volume control, configure your input for a reasonable audio level before beginning audio playback.
13. Enable audio input playback and the EVM should begin driving audio out of the speakers. If resistor loads are used for testing instead of speakers, they will now be energized.

4 Hardware Configuration

4.1 OTW and FAULT Indicators

The TAS5634EVM is equipped with LED indicators that illuminate when the FAULT, or OTW, or CLIP pin goes low. See [Table 4](#) and [TAS5634 300-W Stereo / 600-W Mono HD Digital Input, 58V Class-D Amplifier Power Stage](#) for more details.

Table 4. Fault and Overtemperature Status

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

4.2 CLIP Status

The CLIP LED indicates that the output is approaching clipping (when output PWM starts skipping pulses due to loop filter saturation).

4.3 Output Mode Selection

The TAS5634 uses discrete mode pins and therefore relies on the states of the M1, M2, and M3 pins to set the device mode. The jumpers J27, J29, and J30 are used to control the mode pins on the EVM, leaving the jumper in pulls the pin LOW, removing the jumper lets the pull-up hold it HIGH. The three main modes used in this guide are summarized in [Table 5](#):

Table 5. Output Mode and Modulation Mode Selection

Mode Jumpers			Input Mode	Output Configuration	Modulation Mode
M3 (J30)	M2 (J29)	M1 (J27)			
IN	IN	IN	2N	2 × BTL	AD
OUT	IN	IN	2N	1 × PBTL	AD
OUT	IN	OUT	1N1	4 × SE	AD

All configurations in [Table 5](#) support AD modulation and DC Speaker Protection. The TAS5634 also supports BD mode and the ability to turn off DC Speaker Protection. These additional modes as well as some mixed speaker modes are described in detail in [TAS5634 300-W Stereo / 600-W Mono HD Digital Input, 58V Class-D Amplifier Power Stage](#).

4.4 Overcurrent and Short-Circuit Protection

The TAS5634EVM includes the option to adjust the TAS5634 OC threshold and behavior, CBC3, and Latching. During CBC3, the device will count the number of cycles that an OC event lasts and shut down if this counter times out. In Latching behavior, the device does not count and simply shuts down the affected channel when an OC event occurs. The EVM is configured with 30 kΩ by default which sets the OC behavior to CBC3 and 13-A OC threshold. The complete list of OC_ADJ resistor options is listed in [TAS5634 300-W Stereo / 600-W Mono HD Digital Input, 58V Class-D Amplifier Power Stage](#).

4.5 Audio Front End

The TAS5634EVM includes a TAS5558 modulator and DIX4192 audio transceiver. This allows the EVM to accept USB audio, COAX, or OPTICAL inputs via the DIX4192 which are converted to PWM outputs by the TAS5558 modulator and fed into the TAS5634. The DIX4192 is configured for each input using the onboard MSP430 over I2C and the S6 INPUT selection button.

As the TAS5634 is configurable in many output modes, the J25, J19, J21, and J23 jumpers allow the PWM outputs of the TAS5558 to be routed such that the amp receives the signals in the right phase and orientation. In general, during BTL and PBTL, INPUT_A and INPUT_B are of the same PWM signal but opposite sign, the same applies to INPUT_C and INPUT_D. During SE mode, four positive PWM signals should be used. An example is shown in [Table 6](#):

Table 6. PWM Example Configuration

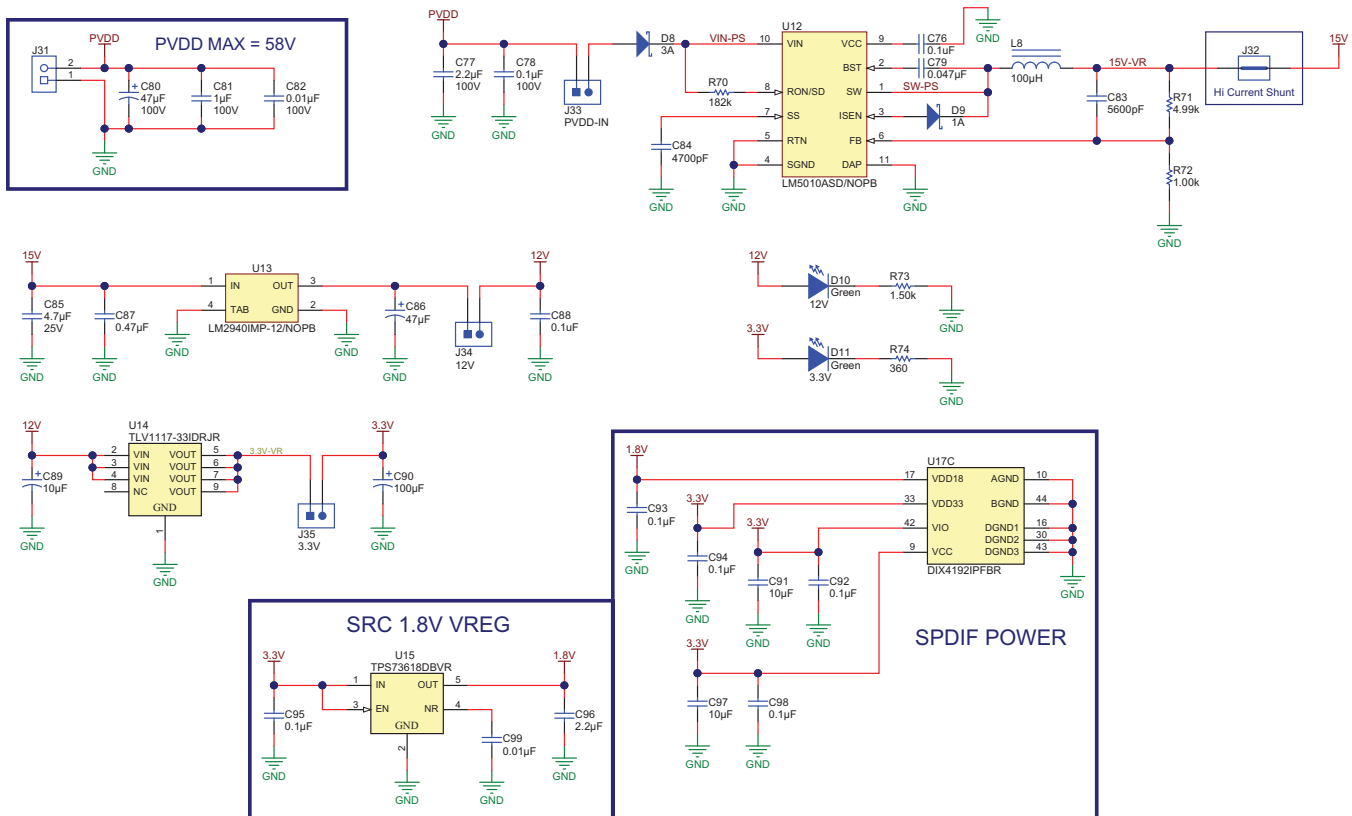
TAS5634 INPUT_x	TAS5558 PWM Signal BTL, PBTL Mode	TAS5558 PWM Signal SE Mode
INPUT_A	PWM1+	PWM1+
INPUT_B	PWM1-	PWM2+
INPUT_C	PWM2+	PWM3+
INPUT_D	PWM2-	PWM4+

Input can also be provided through an audio plug-in board on J9. For this input type, remove jumper J4.

See [TAS5634 EVM Schematics](#) , for complete details.

4.6 EVM Power Tree

The EVM power section is self-contained with all necessary onboard voltages generated from the main PVDD (J31) power input. PVDD is reduced to 15 V and then used to generate the remaining required board voltages of 12 V, and 3.3 V. LDOs are used to generate supplies going to the TAS5634 device itself in order to reduce the chance of extra added noise. LEDs are provided on the 12-V and 3.3-V supplies so that the user can verify that the EVM is powered, see [Figure 3](#).



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Figure 3. Power Tree Schematic

4.7 LC Response and Overview

Included near the output of the TAS5634 device are four output LC filters. These output filters filter the PWM output leaving only the audio content at high power which is fed to the speakers. The board uses a Toroid 15-μH inductor and 0.68-μF film capacitor to form this LC filter. Using the equations listed in [LC Filter Design](#), the filter low pass cut-off is as follows:

$$F_{\text{Cut-off}} = \frac{1}{2\pi\sqrt{L \times C}} = \frac{1}{2\pi\sqrt{15\mu\text{H} \times 0.68\mu\text{F}}} = 49.8 \text{ kHz} \tag{1}$$

The frequency response of the filter per output load is illustrated in [Figure 4](#).

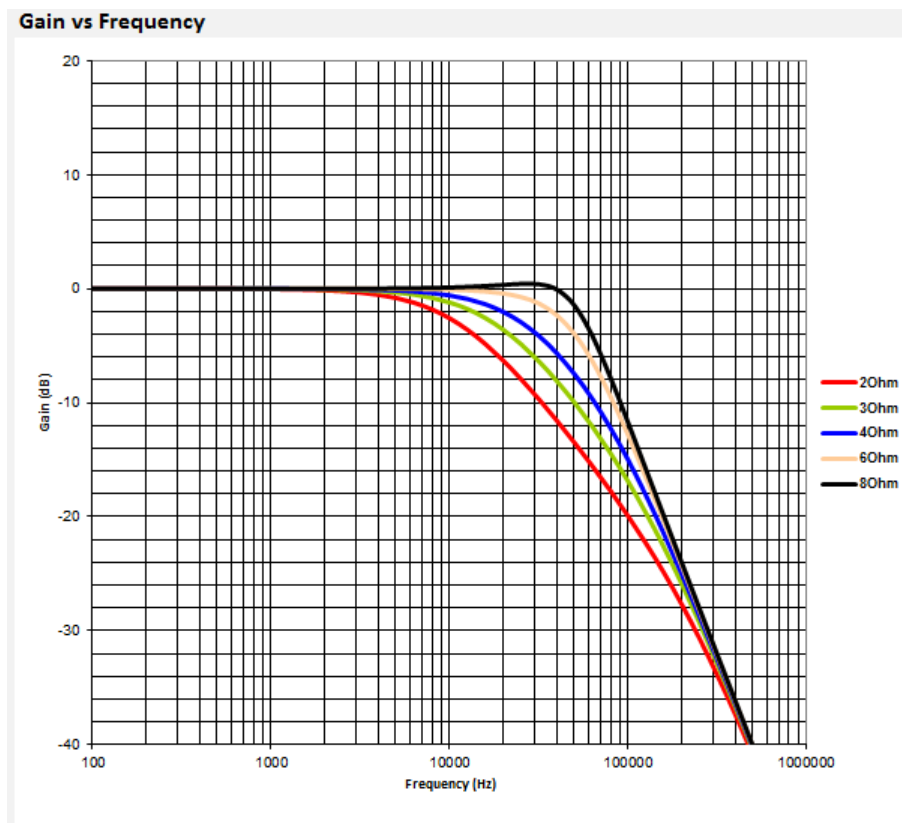


Figure 4. Filter Frequency Response

[Figure 4](#) is taken directly from the *LC Filter Calculator* tool available on [TI.com \(SLAC729\)](#). The tool is configured for BTL common mode with values of 15 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.

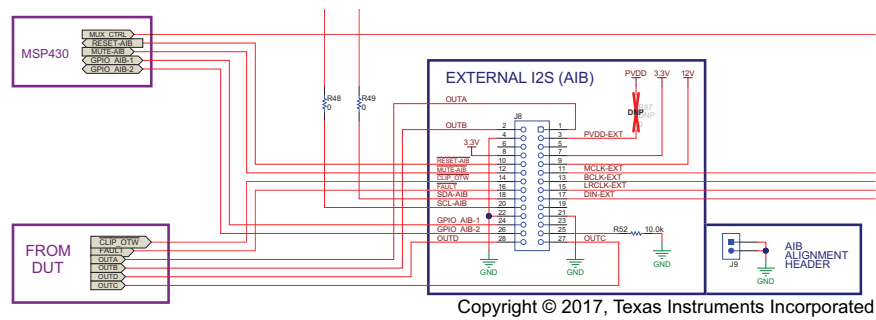
The Coilcraft toroid inductor used (PA6331-AE) has a saturation current of 20 A. This was selected for the EVM since the TAS5634 supports a maximum short-circuit output current of 13 A. The inductance versus current curve for a selected inductor is very important. It is essential for the inductor to maintain at least 5 μH of inductance at the maximum short-circuit current of the power amplifier. The inductance versus current curve is available in the PA6331-AE data sheet on the Coilcraft web site.

4.8 Reset Circuit and POR

The TAS5634EVM includes RESET supervision so that the TAS5634 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 (S11) help ensure that the TAS5634 can be placed in reset easily, as needed, or automatically if there is a power supply issue. The VALID signal of the TAS5558 is also used as the input signal for the TAS5634 RESET since a PWM issue will cause the TAS5558 to pull VALID LOW and therefore shut down the TAS5634 in case of any issue.

4.9 Analog-Input-Board Connector (J28)

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 analog input, analog output, Fault and overtemperature warning (OTW) error reporting, common board voltages (12 V, 3.3 V, and so forth), and EVM reset. These plug-in modules allow for an application-specific front end to be plugged into the TAS5634EVM with ease. Examples of plug-in modules include front ends for guitar amplifier, karaoke, wireless sub-woofer, and front-end audio crossover.


Figure 5. AIB EVM Connector

As [Figure 5](#) shows, the AIB connector includes the pins described in [Table 7](#), associated specifications are listed in [Table 8](#).

Table 7. AIB Connector (J28) Pinout

Pin Number	Function	Description	Audio EVM Input/Output
1	Amp Out A	Speaker-level output from audio Class-D EVM (SE or one side of BTL)	O
2	Amp Out B	Speaker-level output from audio Class-D EVM (SE or one side of BTL)	O
3	PVDD	PVDD voltage supply from audio Class-D EVM (variable voltage depending on Class-D EVM use)	O
4	GND	Ground reference between audio plug-in module and audio class-D EVM	-
5	NC	-	-
6	NC	-	-
7	3.3 V	3.3-V supply from EVM; used for powering Audio Plug-in Module	O
8	3.3 V	3.3-V supply from EVM; used for powering Audio Plug-in Module	O
9	12 V	12-V supply from EVM; used for powering Audio Plug-in Module	O
10	EN and RESET	Assert enable and reset control for audio class-D EVM (active low)	I
11	Analog IN_A	Analog audio input A (analog in EVM) , Master I2S Bus (digital in EVM)	I
12	MUTE	Assert MUTE control for audio class-D EVM (active low)	I
13	Analog IN_B	Analog audio input B (analog in EVM) , Bit Clock I2S Bus (digital in EVM)	I
14	CLIP_OTW	Clipping detection, overtemperature warning, or both from audio class-D EVM (active low)	O
15	Analog IN_C	Analog audio input C (analog in EVM) , Frame Clock I2S Bus (digital in EVM)	I
16	FAULT	Fault detection from audio Class-D EVM (Active Low)	O
17	Analog IN_D	Analog audio Input D (analog in EVM) , Data In I2S Bus (digital in EVM)	I
18	SDA	I2C SDA	I/O
19	NC	-	-
20	SCL	I2C SCL	I/O
21	GND	Ground reference between audio plug-in module and audio class-D EVM	-
22	GND	Ground reference between audio plug-in module and audio class-D EVM	-
23	NC	-	-
24	GPIO1	-	I/O
25	GPIO2	-	I/O
26	NC	-	-
27	Amp Out C	Speaker-level output from audio class-D EVM (SE or one side of BTL)	O
28	Amp Out D	Speaker-level output from audio class-D EVM (SE or one side of BTL)	O

Table 8. AIB Power Rail Specifications

EVM Power Rails	Always Available	Voltage Range	Max Current	Source
PVDD	Yes	15 – 80 V	500 mA	External Source
12 V	Yes	12 V	500 mA	LDO
3.3 V	Yes	3.3 V	100 mA	LDO

5 EVM Design Documents

This section contains the EVM board layouts, schematics, and bill of materials (BOM).

5.1 TAS5634 Board Layouts

Figure 6 and Figure 7 illustrate the EVM board layouts. Note that this is a 4-layer board. The middle two layers are used for front end power and grounding as well as additional output traces from the LC filter to OUT connectors for current handling.

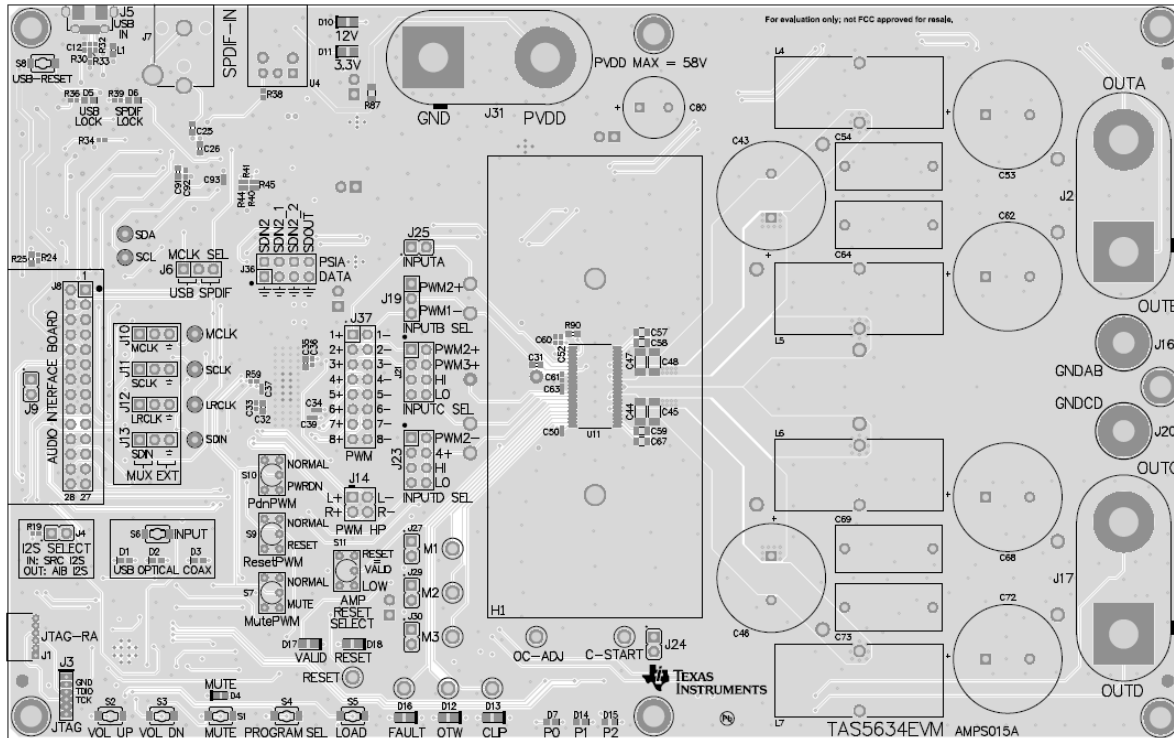


Figure 6. TAS5634 EVM Top Composite Assembly

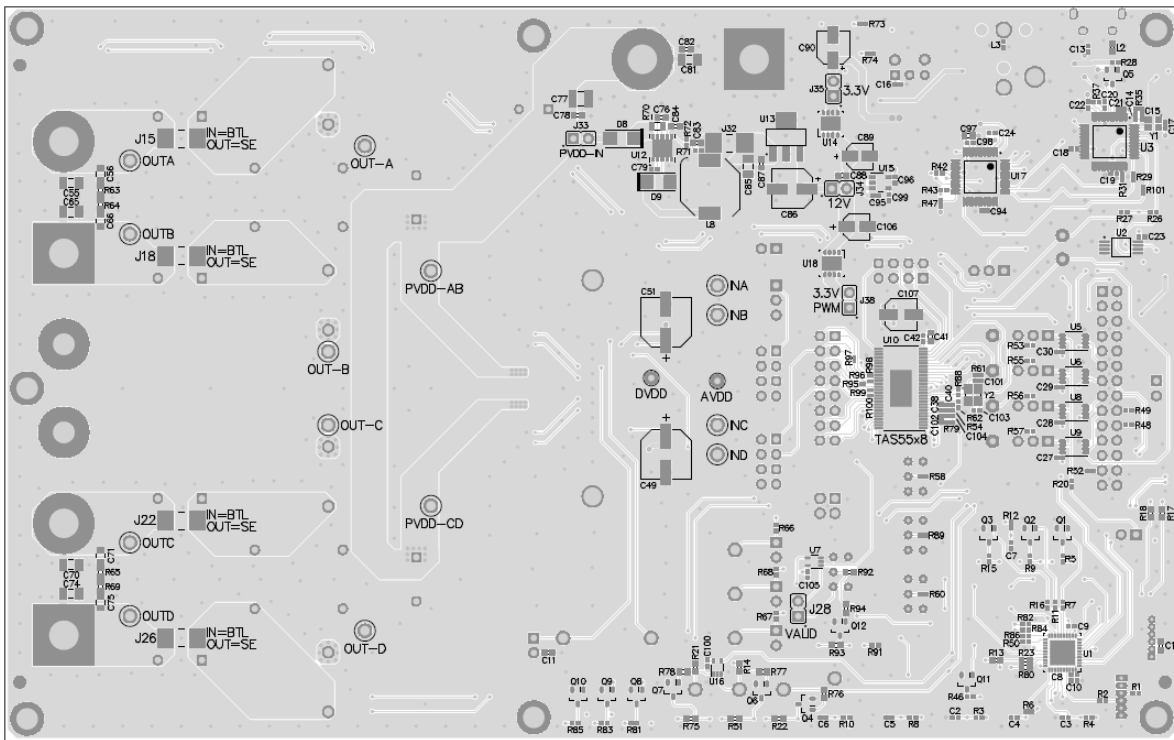


Figure 7. TAS5634 EVM Bottom Composite Assembly

5.2 TAS5634 Board Dimensions

Figure 8 shows the EVM board dimensions.

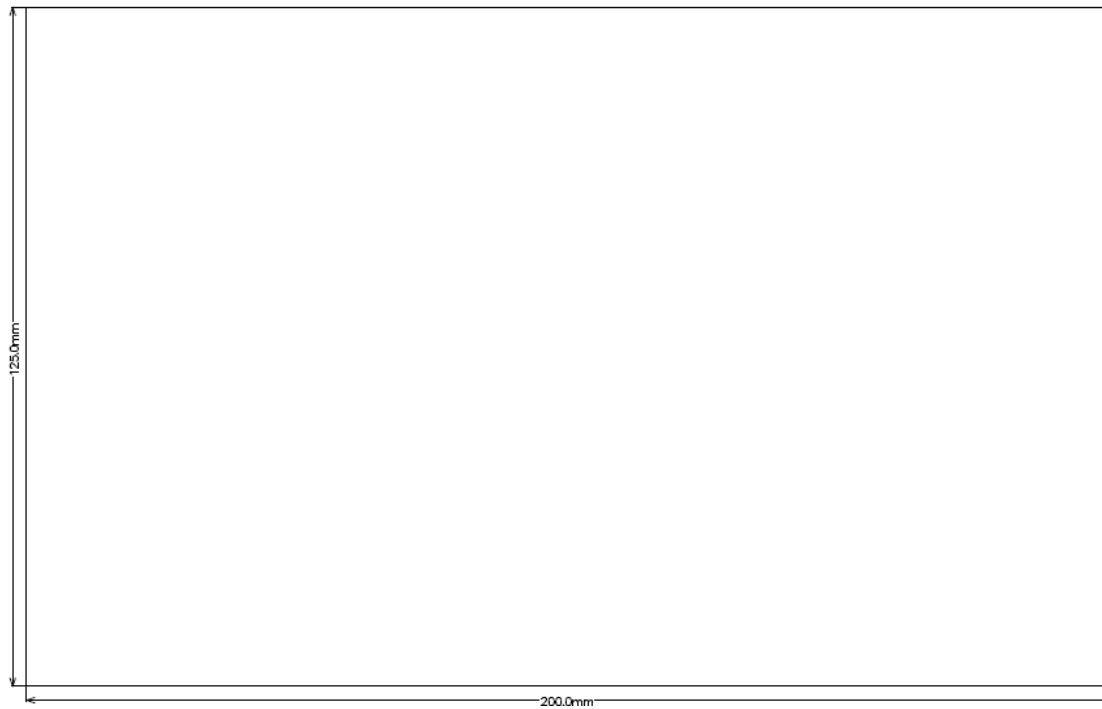
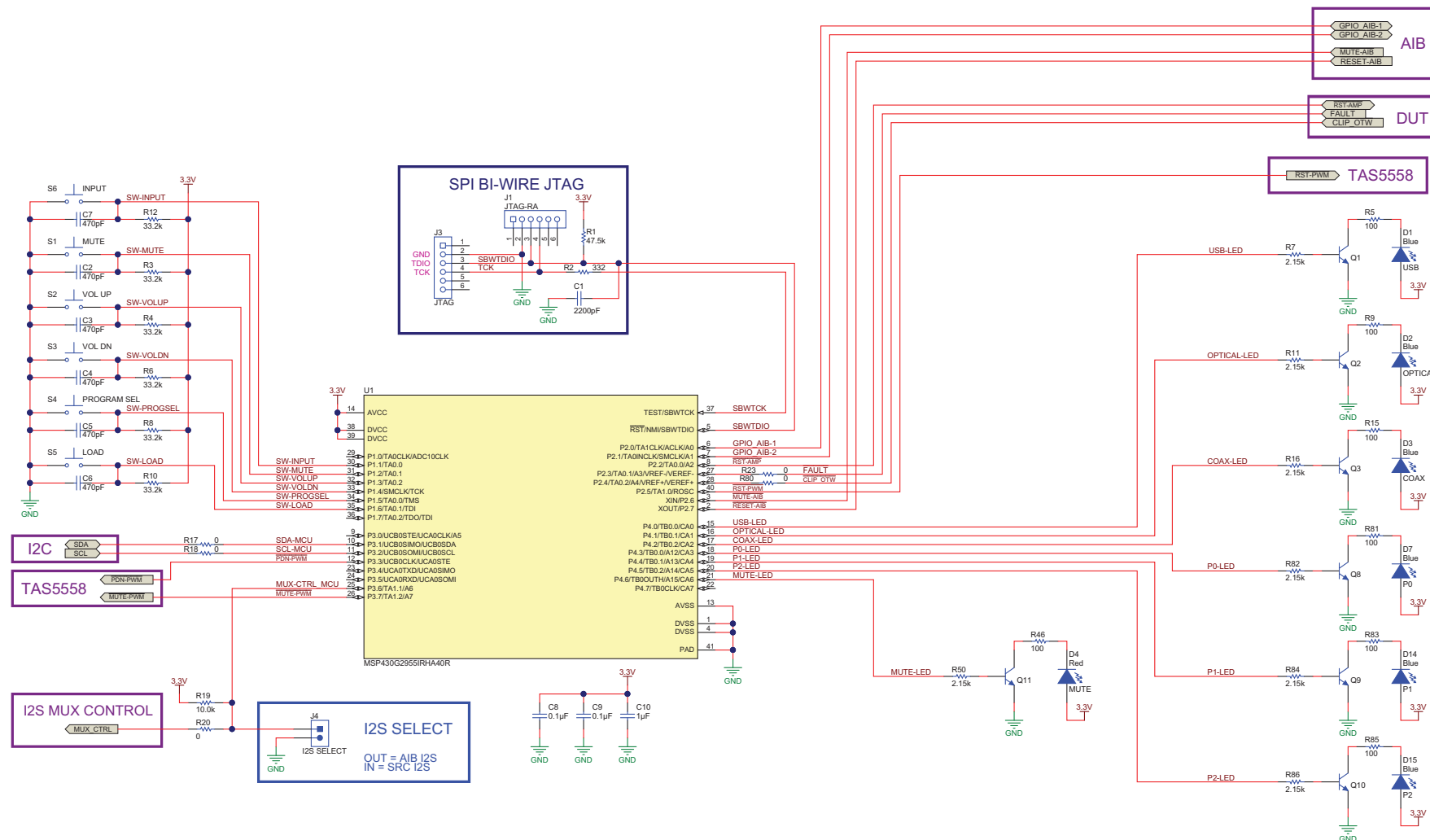


Image shown is not actual size.

Figure 8. TAS5634 EVM Board Dimensions

5.3 TAS5634 EVM Schematics

Figure 9 through Figure 14 illustrate the TAS5634 EVM schematics.



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Figure 9. TAS5634 EVM Schematic 1

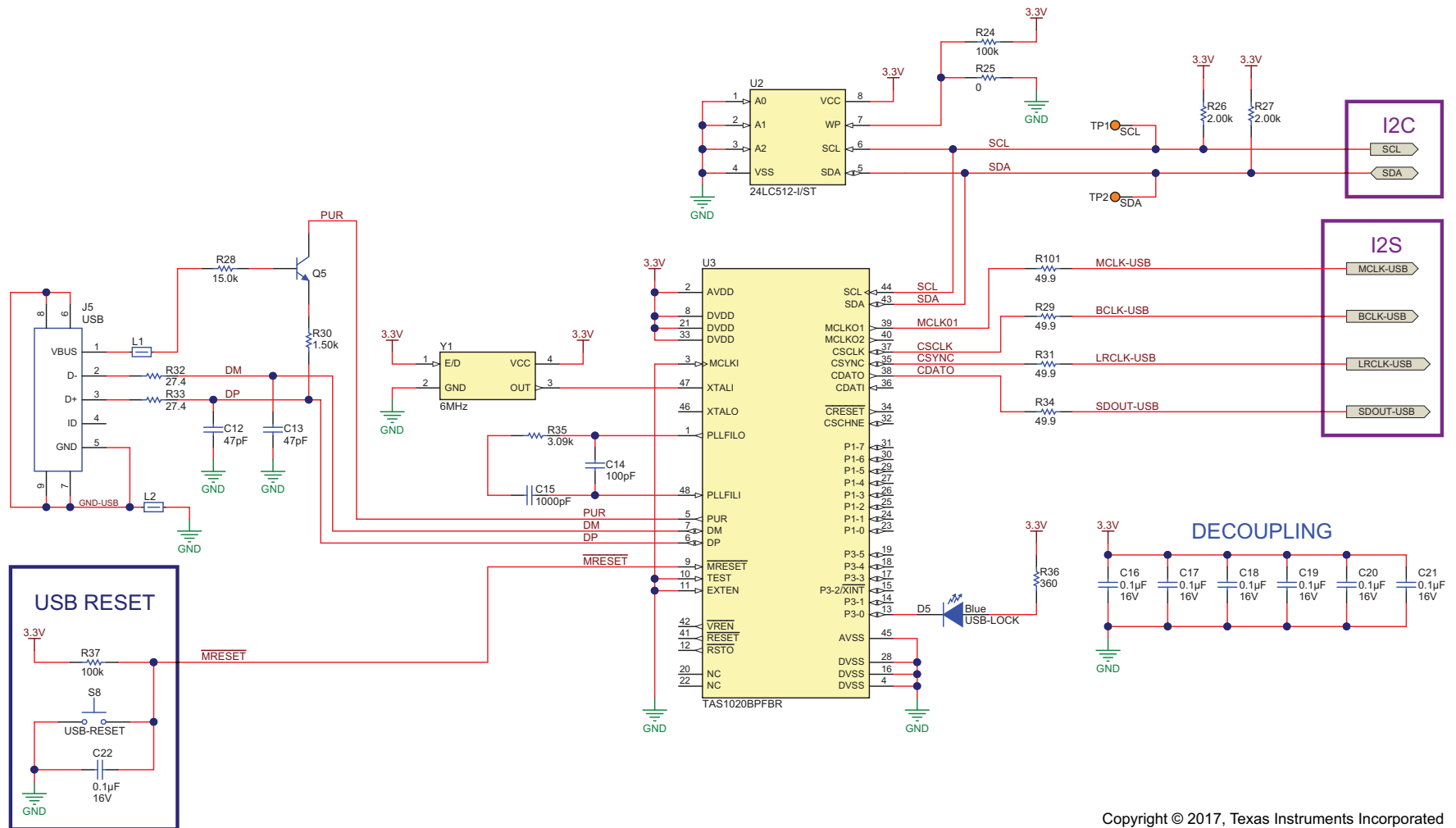
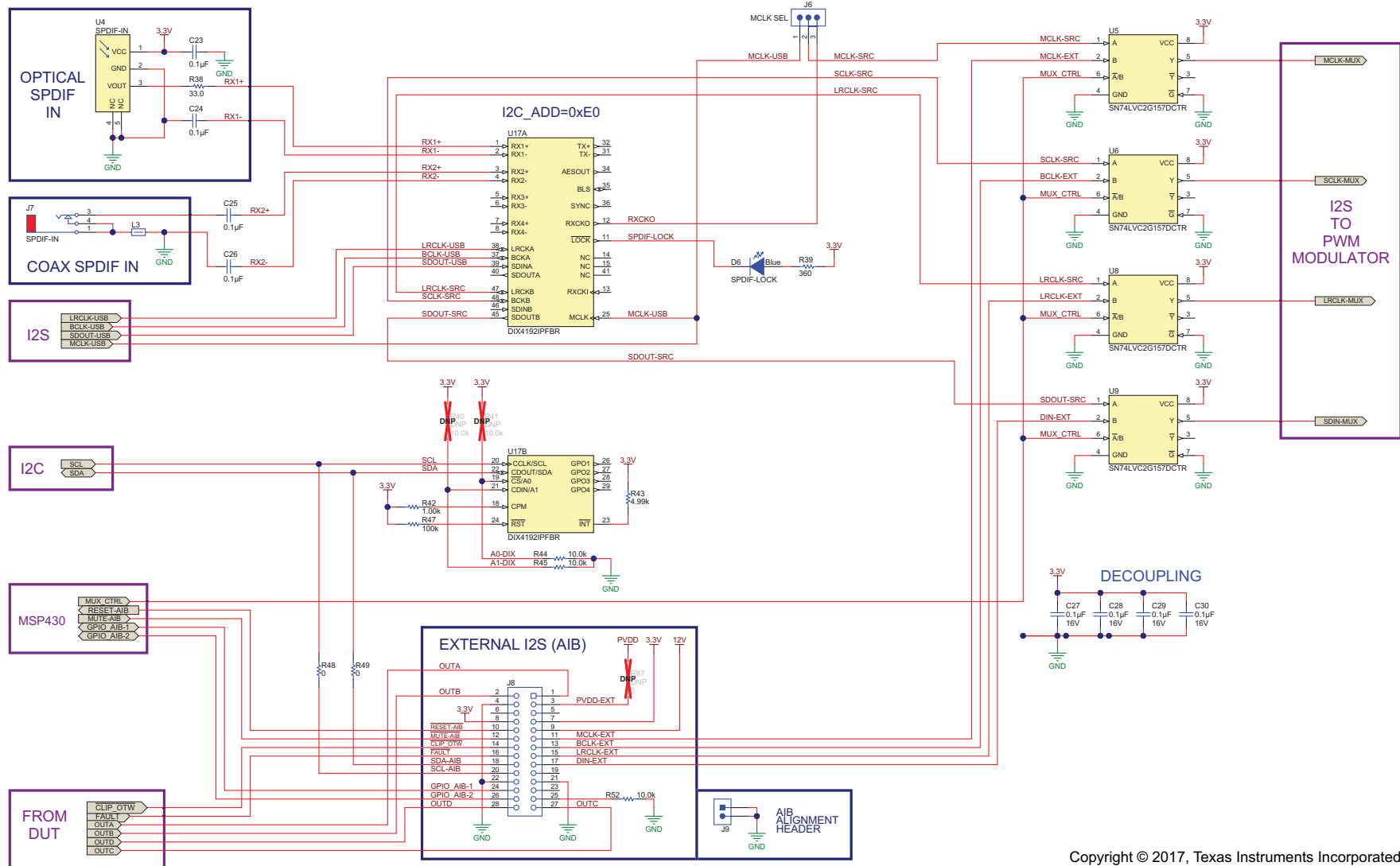


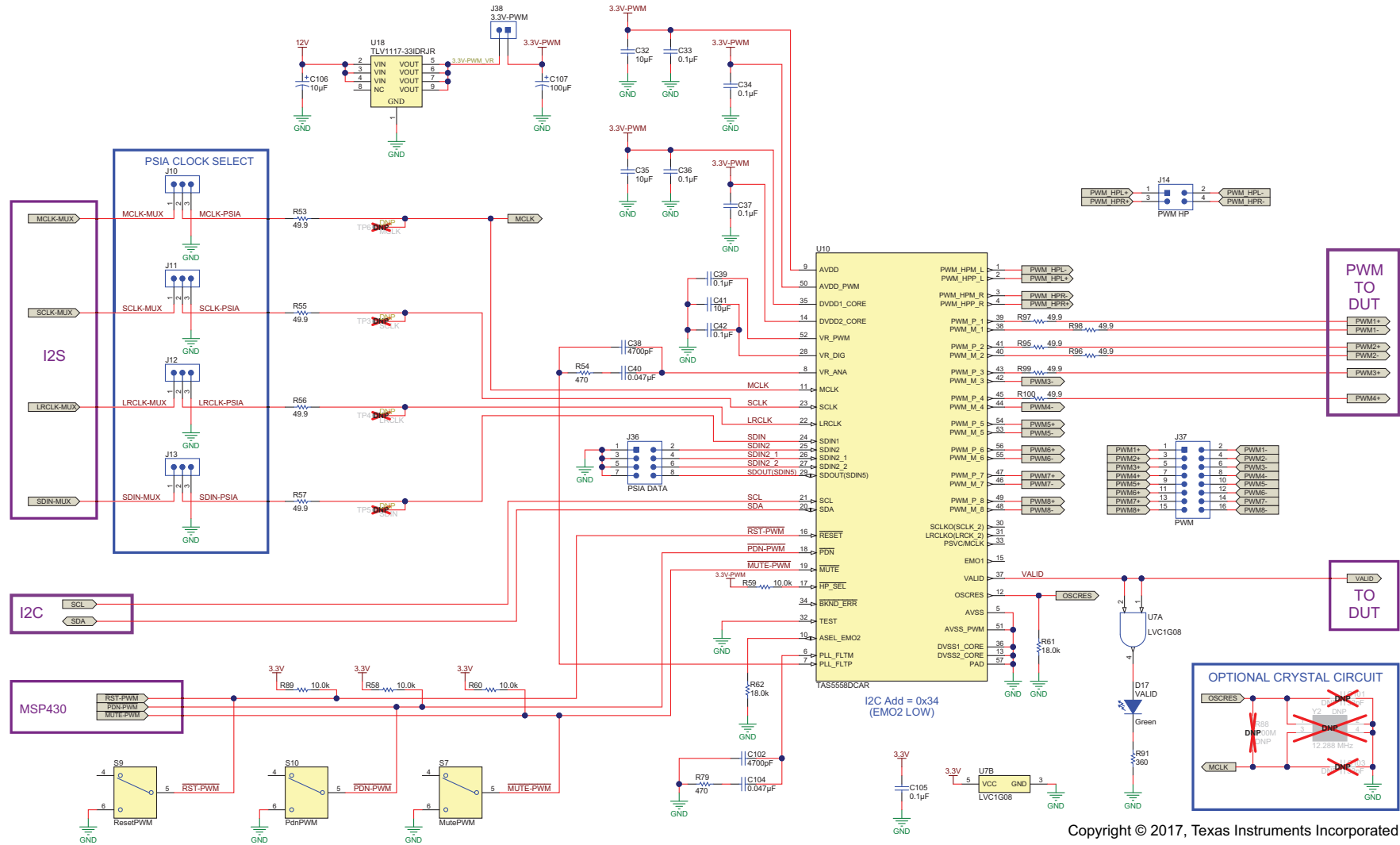
Figure 10. TAS5634 EVM Schematic 2

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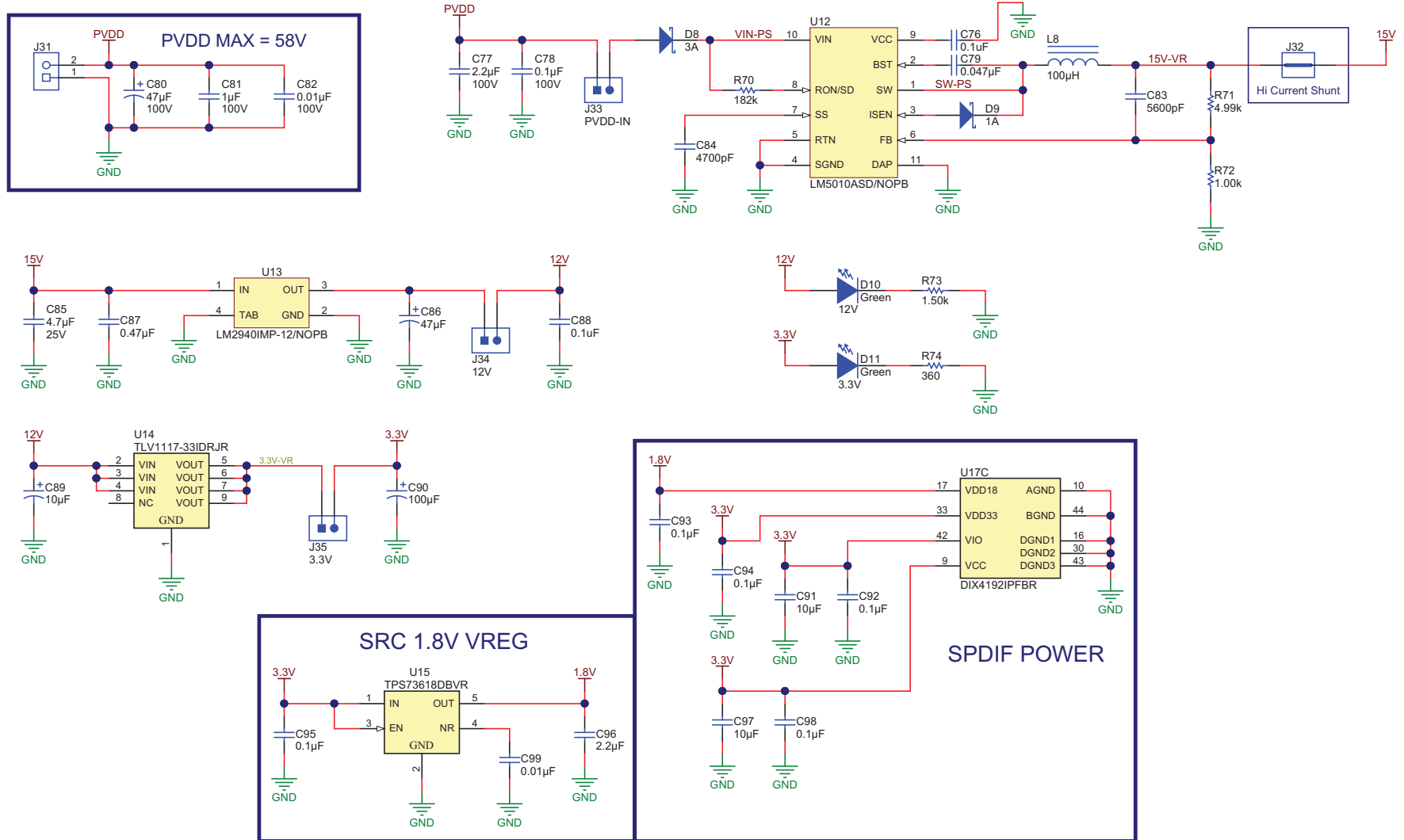
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Figure 11. TAS5634 EVM Schematic 3



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Figure 12. TAS5634 EVM Schematic 4



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Figure 14. TAS5634 EVM Schematic 6

5.4 TAS5634EVM Bill of Materials

Table 9 lists the TAS5634 EVM BOM.

Table 9. TAS5634EVM Bill of Materials⁽¹⁾

Designator	QTY	Value	Description	Package Reference	Part Number	Manufacturer	Alternate Part Number	Alternate Manufacturer
!PCB1	1		Printed Circuit Board		AMPS015	Any	-	-
C1	1	2200pF	CAP, CERM, 2200 pF, 16 V, ±10%, X7R, 0603	0603	885012206036	Wurth Elektronik		
C2, C3, C4, C5, C6, C7	6	470pF	CAP, CERM, 470 pF, 25 V, ±5%, C0G/NP0, 0402	0402	GRM1555C1E471JA01D	Murata		
C8, C9, C23, C24, C33, C34, C36, C37, C39, C42, C92, C93, C94, C95, C98, C100, C105	17	0.1uF	CAP, CERM, 0.1 µF, 10 V, ±10%, X7R, 0402	0402	GRM155R71A104KA01D	Murata		
C10	1	1uF	CAP, CERM, 1 µF, 6.3 V, ±20%, X5R, 0402	0402	C1005X5R0J105M050BB	TDK		
C11	1	1uF	CAP, CERM, 1 µF, 16 V, ±10%, X7R, 0603	0603	GRM188R71C105KE15D	Murata		
C12, C13	2	47pF	CAP, CERM, 47 pF, 25 V, ±5%, C0G/NP0, 0402	0402	GRM1555C1E470JA01D	Murata		
C14	1	100pF	CAP, CERM, 100 pF, 50 V, ±5%, C0G/NP0, 0402	0402	GRM1555C1H101JA01D	Murata		
C15	1	1000pF	CAP, CERM, 1000 pF, 50 V, ±5%, C0G/NP0, 0402	0402	GRM1555C1H102JA01D	Murata		
C16, C17, C18, C19, C20, C21, C22, C27, C28, C29, C30	11	0.1uF	CAP, CERM, 0.1 µF, 16 V, ±10%, X7R, 0402	0402	GRM155R71C104KA88D	Murata		
C25, C26	2	0.1uF	CAP, CERM, 0.1 µF, 16 V, ±10%, X7R, 0603	0603	GRM188R71C104KA01D	Murata		
C31	1	0.33uF	CAP, CERM, 0.33 µF, 16 V, ±10%, X7R, 0603	0603	GRM188R71C334KA01D	Murata		
C32, C35, C41, C91, C97	5	10uF	CAP, CERM, 10 µF, 10 V, ±20%, X5R, 0603	0603	GRM188R61A106ME69D	Murata		
C38, C102	2	4700pF	CAP, CERM, 4700 pF, 16 V, ±10%, X7R, 0402	0402	GRM155R71C472KA01D	Murata		
C40, C104	2	0.047uF	CAP, CERM, 0.047 µF, 16 V, ±10%, X7R, 0402	0402	GRM155R71C473KA01D	Murata		
C43, C46, C53, C62, C68, C72	6	1000uF	CAP, AL, 1000 µF, 100 V, ±20%, TH	D18xL35.5mm	ECA-2AM102	Panasonic		
C44, C45, C47, C48	4	1uF	CAP, CERM, 1 µF, 100 V, ±10%, X7R, 1206	1206	GRM31CR72A105KA01L	Murata		
C49, C51	2	47uF	CAP, AL, 47 µF, 25 V, ±20%, 0.4 ohm, SMD	SMT Radial E	EEE-FC1E470P	Panasonic		
C50, C52, C60, C61, C63	5	0.1uF	CAP, CERM, 0.1 µF, 25 V, ±10%, X7R, 0402	0402	GRM155R71E104KE14D	Murata		
C54, C64, C69, C73	4	0.68uF	CAP, Film, 0.68 µF, 250 V, ±10%, TH	18x8x15mm	MKP4F036804F00KSSD	WIMA		
C55, C65, C70, C74	4	1000pF	CAP, CERM, 1000 pF, 100 V, ±5%, C0G/NP0, 1206	1206	GRM3195C2A102JA01D	Murata		
C56, C66, C71, C75	4	0.01uF	CAP, CERM, 0.01 µF, 100 V, ±10%, X7R, 0805	0805	GRM21BR72A103KA01L	Murata		
C57, C58, C59, C67	4	0.033uF	CAP, CERM, 0.033 µF, 100 V, ±10%, X7R, 0805	0805	GRM21BR72A333KA01L	Murata		
C76, C88	2	0.1uF	CAP, CERM, 0.1 µF, 50 V, ±10%, X7R, 0603	0603	C0603C104K5RACTU	Kemet		
C77	1	2.2uF	CAP, CERM, 2.2 µF, 100 V, ±10%, X7R, 1210	1210	C1210C225K1RACTU	Kemet		
C78	1	0.1uF	CAP, CERM, 0.1 µF, 100 V, ±10%, X7R, 0603	0603	GRM188R72A104KA35J	Murata		
C79	1	0.047uF	CAP, CERM, 0.047 µF, 25 V, ±10%, X7R, 0402	0402	GRM155R71E473KA88D	Murata		

⁽¹⁾ Unless otherwise noted in the alternate part number or alternate manufacturer columns, all parts may be substituted with equivalents.

Table 9. TAS5634EVM Bill of Materials⁽¹⁾ (continued)

Designator	QTY	Value	Description	Package Reference	Part Number	Manufacturer	Alternate Part Number	Alternate Manufacturer
C80	1	47uF	CAP, AL, 47 µF, 100 V, ±20%, 0.24 ohm, AEC-Q200 Grade 2, TH	D10xL20mm	EEU-FC2A470	Panasonic		
C81	1	1uF	CAP, CERM, 1 µF, 100 V, ±10%, X7R, 1206	1206	GRM31CR72A105KA01L	Murata		
C82	1	0.01uF	CAP, CERM, 0.01 µF, 100 V, ±10%, X7R, 0603	0603	06031C103KAT2A	AVX		
C83	1	5600pF	CAP, CERM, 5600 pF, 50 V, ±10%, X7R, 0603	0603	GRM188R71H562KA01D	Murata		
C84	1	4700pF	CAP, CERM, 4700 pF, 50 V, ±10%, X7R, 0603	0603	C0603X472K5RACTU	Kemet		
C85	1	4.7uF	CAP, CERM, 4.7 µF, 25 V, ±10%, X7R, 1206	1206	GRM31CR71E475KA88L	Murata		
C86	1	47uF	CAP, AL, 47 µF, 16 V, ±20%, 0.36 ohm, SMD	SMT Radial D	EEE-FK1C470P	Panasonic		
C87	1	0.47uF	CAP, CERM, 0.47 µF, 25 V, ±10%, X7R, 0603	0603	GRM188R71E474KA12D	Murata		
C89, C106	2	10uF	CAP, AL, 10 µF, 16 V, ±20%, 1.35 ohm, SMD	SMT Radial B	EEE-FK1C100R	Panasonic		
C90, C107	2	100uF	CAP, AL, 100 µF, 6.3 V, ±20%, 0.7 ohm, SMD	SMT Radial C	EEE-FK0J101UR	Panasonic		
C96	1	2.2uF	CAP, CERM, 2.2 µF, 10 V, ±10%, X5R, 0402	0402	C1005X5R1A225K050BC	TDK		
C99	1	0.01uF	CAP, CERM, 0.01 µF, 16 V, ±10%, X7R, 0402	0402	GRM155R71C103KA01D	Murata		
D1, D2, D3, D5, D6, D7, D14, D15	8	Blue	LED, Blue, SMD	BLUE 0603 LED	LB Q39G-L2N2-35-1	OSRAM		
D4	1	Red	LED, Red, SMD	Red LED, 1.6x0.8x0.8mm	LTST-C190CKT	Lite-On		
D8	1	100V	Diode, Schottky, 100 V, 3 A, SMA	SMA	SK310A-TP	Micro Commercial Components		
D9	1	100V	Diode, Schottky, 100 V, 1 A, SMA	SMA	B1100-13-F	Diodes Inc.		
D10, D11, D17	3	Green	LED, Green, SMD	LED_0805	LTST-C171GKT	Lite-On		
D12	1	Orange	LED, Orange, SMD	LED_0805	LTST-C170KFKT	Lite-On		
D13	1	Yellow	LED, Yellow, SMD	0805 LED	LTST-C170KSKT	Lite-On		
D16, D18	2	Red	LED, Red, SMD	Red 0805 LED	LTST-C170KRKT	Lite-On		
H1	1		Heatsink, Vertical	Heatsink	ATS-T11OP-519-C1-R3	Advanced Thermal Solutions		
H2, H3, H4, H5, H6, H7, H8, H16, H17	9		MACHINE SCREW PAN PHILLIPS M3	M3 Screw	RM3X8MM 2701	APM HEXSEAL		
H9, H10, H11, H12, H13, H14, H15	7		Standoff, Hex,25mm Length, M3, Aluminum	Standoff M3	24438	Keystone		
J1	1		Receptacle, 50mil, 6x1, Gold, R/A, TH	6x1 Receptacle	LPPB061NGCN-RC	Sullins Connector Solutions		
J2, J17, J31	3		Dual Binding Posts with Base, 2x1, TH	Dual Binding Posts with Base, 2x1, TH	6883	Pomona Electronics		
J3	1		Receptacle, 50mil, 6x1, Gold, TH	Receptacle, 6x1, 50mil, TH	851-43-006-10-001000	Mill-Max		
J4, J9, J24, J25, J27, J28, J29, J30, J33, J34, J35, J38	12		Header, 100mil, 2x1, Gold, TH	Sullins 100mil, 1x2, 230 mil above insulator	PBC02SAAN	Sullins Connector Solutions		
J5	1		Connector, Receptacle, Micro-USB Type AB, R/A, Bottom Mount SMT	Connector, USB Micro AB	DX4R205JJAR1800	JAE Electronics		
J6, J10, J11, J12, J13, J19	6		Header, 100mil, 3x1, Gold, TH	PBC03SAAN	PBC03SAAN	Sullins Connector Solutions		
J7	1		RCA Jack, Red, R/A, TH	PC Mount Phono Jack-Red, TH	971	Keystone		
J8	1		Receptacle, 100mil, 14x2, Gold, TH	14x2 Receptacle	SSW-114-01-G-D	Samtec		

Table 9. TAS5634EVM Bill of Materials⁽¹⁾ (continued)

Designator	QTY	Value	Description	Package Reference	Part Number	Manufacturer	Alternate Part Number	Alternate Manufacturer
J14	1		Header, 2.54mm, 2x2, Gold, TH	Header, 2.54mm, 2x2, TH	PBC02DAAN	Sullins Connector Solutions		
J15, J18, J22, J26, J32	5		JUMPER TIN SMD	6.85x0.97x2.51 mm	S1911-46R	Harwin		
J16, J20	2		Binding Post, BLACK, TH	11.4x27.2mm	7007	Keystone		
J21, J23, J36	3		Header, 100mil, 4x2, Tin, TH	Header, 4x2, 100mil, Tin	PEC04DAAN	Sullins Connector Solutions		
J37	1		Header, 100mil, 8x2, Gold, TH	PBC08DAAN	PBC08DAAN	Sullins Connector Solutions		
L1, L2	2	220 ohm	Ferrite Bead, 220 ohm @ 100 MHz, 2.2 A, 0603	0603	MPZ1608S221A	TDK		
L3	1	120 ohm	Ferrite Bead, 120 ohm @ 100 MHz, 0.4 A, 0402	0402	MMZ1005Y121C	TDK		
L4, L5, L6, L7	4	15uH	Inductor, Toroid, Powdered Iron, 15 µH, 9.8 A, 0.031 ohm, TH	28.6x12.3mm	PA6331-AE	Coilcraft		
L8	1	100uH	Inductor, Shielded Drum Core, Ferrite, 100 µH, 1.5 A, 0.165 ohm, SMD	SMD	7447714101	Würth Elektronik		
Q1, Q2, Q3, Q5, Q8, Q9, Q10, Q11	8	40 V	Transistor, NPN, 40 V, 0.15 A, SOT-23	SOT-23	MMBT2222A	Fairchild Semiconductor		
Q4, Q6, Q7, Q12	4	60V	MOSFET, N-CH, 60 V, 0.17 A, SOT-23	SOT-23	2N7002-7-F	Diodes Inc.		
R1	1	47.5k	RES, 47.5 k, 1%, 0.063 W, 0402	0402	CRCW040247K5FKED	Vishay-Dale		
R2	1	332	RES, 332, 1%, 0.063 W, 0402	0402	CRCW0402332RFKED	Vishay-Dale		
R3, R4, R6, R8, R10, R12	6	33.2k	RES, 33.2 k, 1%, 0.063 W, 0402	0402	CRCW040233K2FKED	Vishay-Dale		
R5, R9, R15, R46, R81, R83, R85	7	100	RES, 100, 1%, 0.1 W, 0402	0402	ERJ-2RKF1000X	Panasonic		
R7, R11, R16, R50, R82, R84, R86	7	2.15k	RES, 2.15 k, 1%, 0.063 W, 0402	0402	CRCW04022K15FKED	Vishay-Dale		
R13, R14, R21, R92	4	47k	RES, 47 k, 5%, 0.1 W, 0603	0603	RC0603JR-0747KL	Yageo America		
R17, R18, R23, R25, R80	5	0	RES, 0, 5%, 0.1 W, 0603	0603	CRCW06030000Z0EA	Vishay-Dale		
R19, R44, R45, R52, R58, R59, R60, R66, R67, R68, R89	11	10.0k	RES, 10.0k ohm, 1%, 0.063W, 0402	0402	CRCW040210K0FKED	Vishay-Dale		
R20, R48, R49	3	0	RES, 0, 5%, 0.063 W, 0402	0402	ERJ-2GE0R00X	Panasonic		
R22, R51, R75, R93	4	432	RES, 432, 0.1%, 0.1 W, 0603	0603	RT0603BRD07432RL	Yageo America		
R24, R37, R47	3	100k	RES, 100 k, 1%, 0.063 W, 0402	0402	CRCW0402100KFKED	Vishay-Dale		
R26, R27	2	2.00k	RES, 2.00 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0402	0402	ERJ-2RKF2001X	Panasonic		
R28	1	15.0k	RES, 15.0 k, 1%, 0.063 W, 0402	0402	CRCW040215K0FKED	Vishay-Dale		
R29, R31, R34, R53, R55, R56, R57, R101	8	49.9	RES, 49.9, 1%, 0.063 W, 0402	0402	CRCW040249R9FKED	Vishay-Dale		
R30, R73	2	1.50k	RES, 1.50 k, 1%, 0.063 W, 0402	0402	CRCW04021K50FKED	Vishay-Dale		
R32, R33	2	27.4	RES, 27.4, 1%, 0.063 W, 0402	0402	CRCW040227R4FKED	Vishay-Dale		
R35	1	3.09k	RES, 3.09 k, 1%, 0.063 W, 0402	0402	CRCW04023K09FKED	Vishay-Dale		
R36, R39, R74, R91	4	360	RES, 360, 5%, 0.063 W, 0402	0402	CRCW0402360RJNED	Vishay-Dale		
R38	1	33.0	RES, 33.0, 1%, 0.1 W, 0402	0402	ERJ-2RKF33R0X	Panasonic		

Table 9. TAS5634EVM Bill of Materials⁽¹⁾ (continued)

Designator	QTY	Value	Description	Package Reference	Part Number	Manufacturer	Alternate Part Number	Alternate Manufacturer
R42, R72	2	1.00k	RES, 1.00 k, 1%, 0.063 W, 0402	0402	CRCW04021K00FKED	Vishay-Dale		
R43, R71	2	4.99k	RES, 4.99 k, 1%, 0.063 W, 0402	0402	CRCW04024K99FKED	Vishay-Dale		
R54, R79	2	470	RES, 470, 1%, 0.063 W, 0402	0402	RC0402FR-07470RL	Yageo America		
R61, R62	2	18.0k	RES, 18.0 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040218K0FKED	Vishay-Dale		
R63, R64, R65, R69	4	3.3	RES, 3.3, 5%, 0.1 W, 0603	0603	CRCW06033R30JNEA	Vishay-Dale		
R70	1	182k	RES, 182 k, 1%, 0.125 W, 0805	0805	ERJ-6ENF1823V	Panasonic		
R76, R77, R78, R94	4	100	RES, 100, 1%, 0.1 W, 0603	0603	CRCW0603100RFKEA	Vishay-Dale		
R90	1	30.0k	RES, 30.0 k, 1%, 0.1 W, 0603	0603	RC0603FR-0730KRL	Yageo America		
R95, R96, R97, R98, R99, R100	6	49.9	RES, 49.9, 1%, 0.05 W, 0201	0201	CRCW020149R9FKED	Vishay-Dale		
S1, S2, S3, S4, S5, S6, S8	7		Switch, Tactile, SPST-NO, 0.05A, 12V, SMT	Switch, 4.4x2x2.9 mm	TL1015AF160QG	E-Switch		
S7, S9, S10, S11	4		Switch, Toggle, SPDT 1Pos, TH	7 X 11 X4.5 mm	G12AP	NKK Switches		
SH1, SH2, SH3, SH4, SH5, SH6, SH7, SH8, SH9, SH10, SH11, SH12, SH13, SH14, SH15, SH16, SH17, SH18, SH19	19	1x2	Shunt, 100mil, Gold plated, Black	Shunt	SNT-100-BK-G	Samtec	969102-0000-DA	3M
TP1, TP2	2		Test Point, Miniature, Orange, TH	Orange Miniature Testpoint	5003	Keystone		
TP7, TP8, TP9, TP10, TP11, TP12, TP13, TP14, TP16, TP18, TP19, TP20, TP21, TP22, TP23, TP24, TP25, TP26, TP27, TP28, TP29, TP30, TP31	23	Grey	Test Point, Multipurpose, Grey, TH	Grey Multipurpose Testpoint	5128	Keystone		
TP15, TP17	2		Test Point, Miniature, Red, TH	Red Miniature Testpoint	5000	Keystone		
U1	1		MIXED SIGNAL MICROCONTROLLER, RHA0040B (VQFN-40)	RHA0040B	MSP430G2955IRHA40R	Texas Instruments	MSP430G2955IRHA40T	Texas Instruments
U2	1		EEPROM, 512KBIT, 400KHZ, 8TSSOP	TSSOP-8	24LC512-I/ST	Microchip		
U3	1		USB Streaming Controller, PFB0048A, NRND	PFB0048A	TAS1020BPFBR	Texas Instruments	TAS1020BPFB	Texas Instruments
U4	1		Photolink- Fiber Optic Receiver, TH	13.5x10x9.7mm	PLR135/T10	Everlight		
U5, U6, U8, U9	4		Single 2-Line to 1-Line Data Selector Multiplexer, DCT0008A (SSOP-8)	DCT0008A	SN74LVC2G157DCTR	Texas Instruments		Texas Instruments
U7, U16	2		Automotive Catalog Single 2-Input Positive-AND Gate, DCK0005A, LARGE T&R	DCK0005A	SN74LVC1G08QDCKRQ1	Texas Instruments	Equivalent	Texas Instruments
U10	1		192kHz PWM Modulator with integrated ASRC and Audio Processor, DCA0056K (TSSOP-56)	DCA0056K	TAS5558DCAR	Texas Instruments	TAS5558DCA	Texas Instruments
U11	1		300-W Stereo and 600-W Mono HD Digital Input High Efficiency Class-D Power Stage, DDV0044D (TSSOP-44)	DDV0044D	TAS5634DDVR	Texas Instruments	TAS5634DDV	Texas Instruments
U12	1		High Voltage 1A Step Down Switching Regulator, 10-pin LLP, Pb-Free	SDC10A	LM5010ASD/NOPB	Texas Instruments		
U13	1		1A Low Dropout Regulator, 4-pin SOT-223, Pb-Free	MP04A	LM2940IMP-12/NOPB	Texas Instruments		

Table 9. TAS5634EVM Bill of Materials⁽¹⁾ (continued)

Designator	QTY	Value	Description	Package Reference	Part Number	Manufacturer	Alternate Part Number	Alternate Manufacturer
U14, U18	2		LDO with 4.7 to 15 V Input and 3.3 V Output, -40 to 125 degC, 8-Pin SON (DRJ), Green (RoHS & no Sb/Br)	DRJ0008A	TLV1117-33IDRJR	Texas Instruments	Equivalent	Texas Instruments
U15	1		Single Output Low Noise LDO, 400 mA, Fixed 1.8 V Output, 1.7 to 5.5 V Input, with Reverse Current Protection, 5-pin SOT-23 (DBV), -40 to 85 degC, Green (RoHS & no Sb/Br)	DBV0005A	TPS73618DBVR	Texas Instruments	Equivalent	Texas Instruments
U17	1		192 kHz Digital Audio Interface Transceiver, PCM, S/PDIF, 1.8 - 3.3V, -40 to 85 degC, 48-Pin TQFP (PFB), Green (RoHS & no Sb/Br)	PFB0048A	DIX4192IPFBR	Texas Instruments	Equivalent	Texas Instruments
Y1	1		Oscillator, 6MHz, 3.3V, SMD	2.5x1x2.5mm	625L3I006M00000	CTS Electrocomponents		
C101, C103	0	33pF	CAP, CERM, 33 pF, 50 V, ±5%, C0G/NP0, 0402	0402	GRM1555C1H330JA01D	Murata		
FID1, FID2, FID3, FID4, FID5, FID6	0		Fiducial mark. There is nothing to buy or mount.	Fiducial	N/A	N/A		
R40, R41	0	10.0k	RES, 10.0k ohm, 1%, 0.063W, 0402	0402	CRCW040210K0FKED	Vishay-Dale		
R87	0	0	RES, 0, 5%, 0.125 W, 0805	0805	ERJ-6GEY0R00V	Panasonic		
R88	0	1.00Meg	RES, 1.00 M, 1%, 0.063 W, 0402	0402	CRCW04021M00FKED	Vishay-Dale		
TP3, TP4, TP5, TP6	0		Test Point, Miniature, Orange, TH	Orange Miniature Testpoint	5003	Keystone		
Y2	0		Crystal, 12.288 MHz, 18pF, SMD	Crystal, 2.5x1x3.2mm	ABM8G-12.288MHZ-18-D2Y-T	Abracon Corporation		

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 semiconductor 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/lstds/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/lstds/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.

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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。

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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.

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.

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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, INDEMNITY 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.

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