Evaluating the SSM6515 Ultra Low Power, Class-D Audio Amplifier

EVALUATION KIT CONTENTS

- EVAL-SSM6515Z evaluation board
- EVAL-ADUSB2EBZ (USBi) communications adapter
- USB cable with mini USB plug

DOCUMENTS NEEDED

- SSM6515 data sheet

GENERAL DESCRIPTION

This user guide explains the design and setup of the EVAL-SSM6515Z evaluation board.

The EVAL-SSM6515Z provides access to all analog and digital inputs/outputs on the SSM6515.

The SSM6515 amplifier is controlled by Analog Devices, Inc., SigmaStudio® software, which interfaces to the EVAL-SSM6515Z via a USB connection. The EVAL-SSM6515Z can be powered by the USB bus or by a single 3.8 V to 5 V supply. These supplies are regulated to the voltages required on the EVAL-SSM6515Z. The printed circuit board (PCB) is a 4-layer design, with a ground plane and a power plane on the inner layers. The EVAL-SSM6515Z contains 0.1 in. pitch male headers for connecting to external speakers. The minimum speaker load must be 8 Ω. The EVAL-SSM6515Z consists of two SSM6515s for evaluating the stereo headphone output.

For full details on the SSM6515, see the SSM6515 data sheet, which must be consulted in conjunction with this user guide when using the EVAL-SSM6515Z.

EVALUATION BOARD PHOTOGRAPH

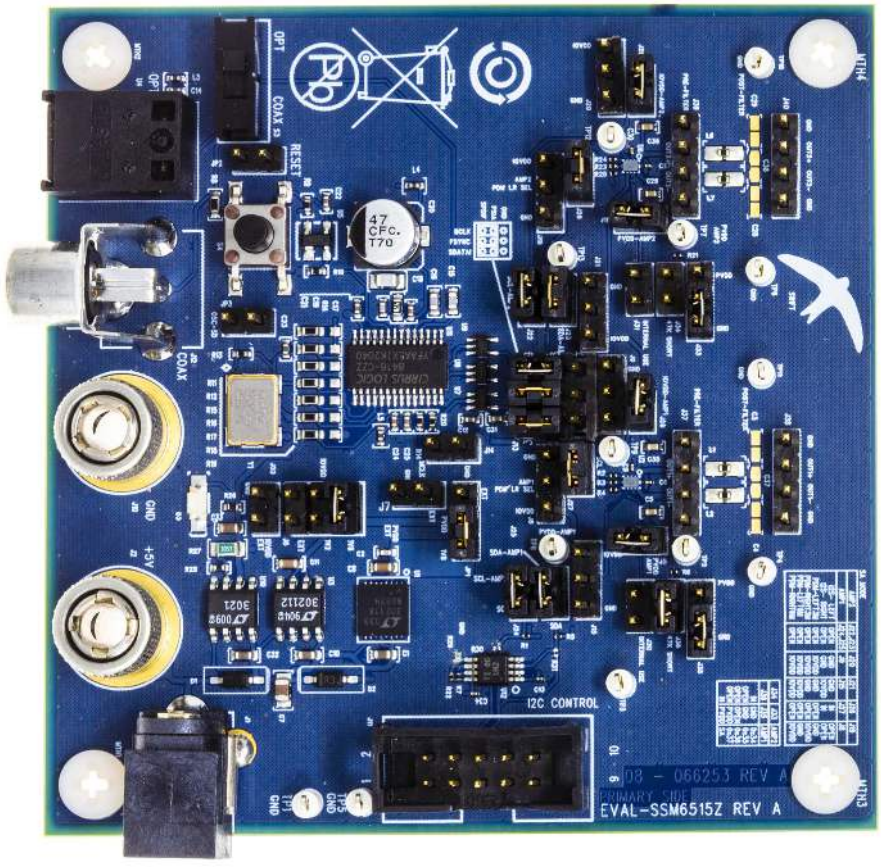

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Figure 1.

Analog Devices is in the process of updating documentation to provide terminology and language that is culturally appropriate. This is a process with a wide scope and will be phased in as quickly as possible. Thank you for your patience.

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REVISION HISTORY

4/2022—Revision 0: Initial Version

EVALUATION BOARD BLOCK DIAGRAM

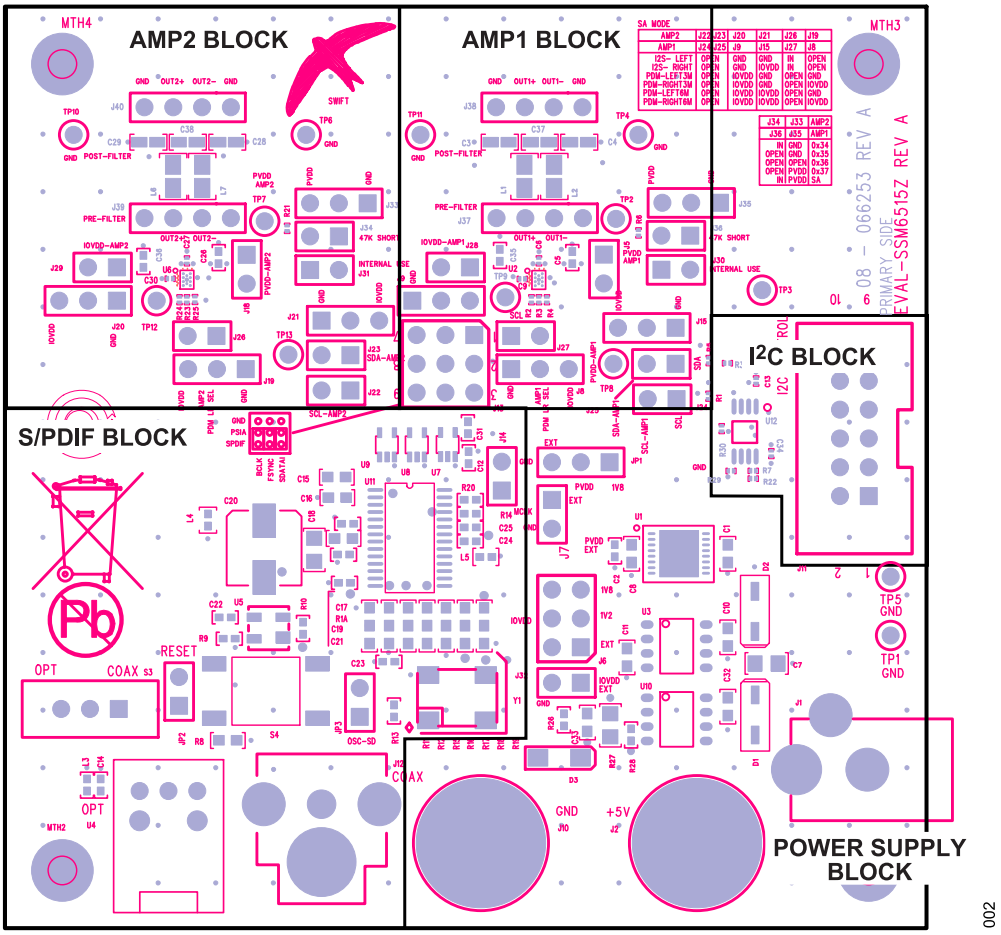

Figure 2. EVAL-SSM6515Z Block Diagram

HARDWARE DESCRIPTION

JUMPERS AND CONNECTORS

Table 1. Connector and Jack Descriptions

Reference Designator	Type	Functional Name	Description
J1	DC jack	5 V dc input	Barrel jack that provides external power to the EVAL-SSM6515. J1 accepts a 3.8 V dc to 5 V dc input.
J2	Binding post	5 V	Binding post used to connect the external 5 V supply to the EVAL-SSM6515.
J5	2-pin header, 0.1 in. pitch	PVDD (AMP1)	Jumper connects PVDD to the SSM6515 (AMP1).
J6	6-pin header, 0.1 in. pitch	IOVDD select	Used to select the IOVDD source: 1.2 V regulator, 1.8 V regulator, or external 1.8 V IOVDD source.
J7	2-pin header, 0.1 in. pitch	External PVDD	Used to connect the external 1.8 V PVDD supply.
J8	3-pin header, 0.1 in pitch	Pulse density modulation (PDM) LR_SEL (AMP1)	Used to select the PDM left and right channels for AMP1 in standalone mode.
J9	3-pin header, 0.1 in. pitch	Mode select (AMP1)	Used to select the I^2S or PDM mode for AMP1 in standalone mode.
J10	Binding post	GND	Connect to GND or 0 V of the power supply.
J11	10-pin header, 0.1 in. pitch	USB interface (USBi) header	10-pin header used to connect the USBi.
J12	RCA cinch jack	Coaxial S/PDIF input	Used to connect the coaxial S/PDIF input.
J13	9-pin header, 0.1 in. pitch	S/PDIF, external I^2S, PDM Input	9-pin header for selecting the internal input source (S/PDIF) or connecting the external I^2S/PDM input source for the amplifiers.
J14	2-pin header, 0.1 in. pitch	S/PDIF master clock (MCLK) out	Used to access the recovered master clock from the S/PDIF receiver.
J15	3-pin header, 0.1 in. pitch	I^2S/PDM select (AMP1)	Used to select the left and right channel in I^2S standalone mode or the PDM_FS of 3 MHz or 6 MHz for AMP1 in PDM standalone mode.
J18	2-pin header, 0.1 in. pitch	PVDD (AMP2)	Jumper connects PVDD to the SSM6515 (AMP2).
J19	3-pin header, 0.1 in. pitch	PDM LR_SEL (AMP2)	Used to select the PDM left and right channels for AMP2 in standalone mode.
J20	3-pin header, 0.1 in. pitch	I^2S/PDM select (AMP2)	Used to select the I^2S or PDM input for AMP2 in standalone mode.
J21	3-pin header, 0.1 in. pitch	I^2S/PDM select (AMP2)	Used to select the left and right channels in I^2S standalone mode or the PDM_FS of 3 MHz or 6 MHz for AMP2 in PDM standalone mode.
J22	2-pin header, 0.1 in. pitch	I^2C SCL (AMP2)	Jumper connects the USBi SCL to AMP2. Leave open in standalone mode.
J23	2-pin header, 0.1 in. pitch	I^2C SDA (AMP2)	Jumper connects the USBi SDA to AMP2. Leave open in standalone mode.
J24	2-pin header, 0.1 in. pitch	I^2C SCL (AMP1)	Jumper connects the USBi SCL to AMP1. Leave open in standalone mode.
J25	2-pin header, 0.1 in. pitch	I^2C SDA (AMP1)	Jumper connects the USBi SDA to AMP1. Leave open in standalone mode.
J26	2-pin header, 0.1 in. pitch	FSYNC	Jumper connects FSYNC to AMP2. Leave open for PDM in standalone mode.
J27	2-pin header, 0.1 in. pitch	FSYNC	Jumper connects FSYNC to AMP1. Leave open for PDM in standalone mode.
J28	2-pin header, 0.1 in. pitch	IOVDD (AMP1)	Jumper connects IOVDD to the SSM6515 (AMP1).
J29	2-pin header, 0.1 in. pitch	IOVDD (AMP2)	Jumper connects IOVDD to the SSM6515 (AMP2).
J30	2-pin header, 0.1 in. pitch	Do not use	Leave this jumper open (Reserved for internal use).
J31	2-pin header, 0.1 in. pitch	Do not use	Leave this jumper open (Reserved for internal use).
J32	2-pin header, 0.1 in. pitch	External IOVDD	Used to connect the external 1.2 V to 1.8 V IOVDD supply.
J33	3-pin header, 0.1 in. pitch	I^2C address select (AMP2)	J33 and J34 are used to select the I^2C address for AMP2. Connect J33 to PVDD in standalone mode.
J34	2-pin header, 0.1 in. pitch	I^2C address select (AMP2)	J33 and J34 are used to select the I^2C address for AMP2. Shunt J34 in standalone mode.
J35	3-pin header, 0.1 in. pitch	I^2C address select (AMP1)	J35 and J36 are used to select the I^2C address for AMP1. Connect J35 to PVDD in standalone mode.
J36	2-pin header, 0.1 in. pitch	I^2C address select (AMP1)	J35 and J36 are used to select the I^2C address for AMP1. Shunt J36 in standalone mode.
J37	4-pin header, 0.1 in. pitch	AMP1 output	AMP1 pre-filter output.
J38	4-pin header, 0.1 in. pitch	AMP1 output	AMP1 pre-filter output.
J39	4-pin header, 0.1 in. pitch	AMP2 output	AMP2 post-filter output.
J40	4-pin header, 0.1 in. pitch	AMP2 output	AMP2 post-filter output.
JP1	3-pin header, 0.1 in. pitch	PVDD select	Used to select the 1.8 V regulator or external 1.8 V PVDD source.
JP2	2-pin header, 0.1 in. pitch	S/PDIF reset jumper	Shunt JP2 to keep the S/PDIF receiver in reset.
JP3	2-pin header, 0.1 in. pitch	SD_OSC (active low)	Shunt JP3 to disable the 12.288 MHz oscillator input to the S/PDIF receiver.

HARDWARE DESCRIPTION

Table 1. Connector and Jack Descriptions

Reference Designator	Type	Functional Name	Description
S3	Single pole double throw (SPDT) slide switch	S/PDIF source select	Select the optical S/PDIF input or coaxial S/PDIF input.
S4	Momentary switch	S/PDIF reset button	Push S4 to reset the S/PDIF receiver.
U4	Optical fiber connector	S/PDIF optical input	S/PDIF optical input.

J13 (I^2S Input Selection Header)

The J13 is a 9-pin header. Pin 1, Pin 4, and Pin 7 of J13 are GND, whereas Pin 2, Pin 5, and Pin 8 are used as signal inputs. The outermost pins, Pin 3, Pin 6, and Pin 9, are connected to the S/PDIF receiver I^2S outputs. See Table 2 for the pin connections.

The I^2S signals must be 1.8 V p-p.

Table 2. J13 9-Pin (3×3) Header Connections

Pin	Signal	Test Conditions/Comments
1, 4, 7	GND	GND
2	SDATA	SSM6515 serial data input
5	FSYNC	SSM6515 frame sync input
8	BCLK	SSM6515 bit clock input
3	SDATA S/PDIF	S/PDIF serial data output
6	FSYNC S/PDIF	S/PDIF frame sync output
9	BCLK S/PDIF	S/PDIF bit clock output

INSTALLING THE SIGMASTUDIO SOFTWARE

Download and install the latest version of SigmaStudio by completing the following steps:

1. Install the latest version of the Microsoft® .NET framework if it is not already installed on the PC. The latest version of the .NET framework can be downloaded from the Microsoft website.
2. Go to www.analog.com/SigmaStudio and download the latest version of SigmaStudio from the **Downloads And Related Software** section.
3. Download the installer and run the executable file. Follow the prompts, including accepting the license agreement, to install the software.

INSTALLING THE USBI (EVAL-ADUSB2EBZ) DRIVERS

SigmaStudio must be installed to use the USBi. When the SigmaStudio installation completes, perform the following steps:

1. Connect the USBi to an available USB 2.0 port using the USB cable included in the evaluation board kit (the USBi does not function properly with a USB 3.0 port).
2. Install the driver software (see the Using Windows XP section or the Using Windows 7 or Windows Vista section for more information).

Using Windows XP

After connecting the USBi to the USB 2.0 port, Windows® XP recognizes the device (see Figure 3) and prompts the user to install the drivers.

Figure 3. Found New Hardware Notification

Use the **Found New Hardware Wizard** to complete the installation of the drivers. The installation of the drivers is shown in the following steps:

1. From the **Found New Hardware Wizard** window, select the **Install from a list or specific location (Advanced)** option and click **Next >** (see Figure 4).

Figure 4. Found New Hardware Wizard: Installation

2. Select **Search for the best driver in these locations**, select **Include this location in the search:**, and click **Browse** to find the USB drivers subdirectory within the SigmaStudio directory (see Figure 5). Then, click **Next >**.

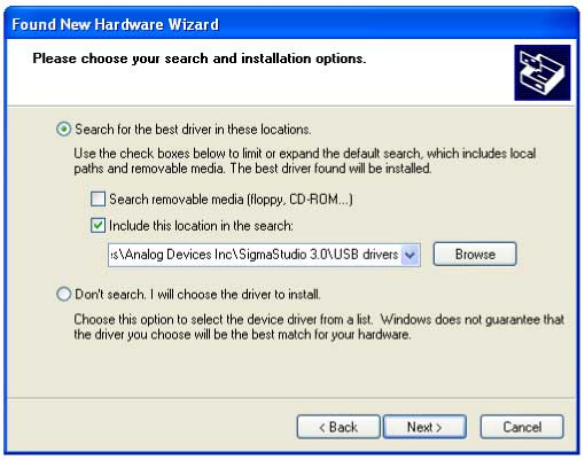

Figure 5. Found New Hardware Wizard: Search and Installation Options

3. When the **Hardware Installation** warning appears, click **Continue Anyway** (see Figure 6).

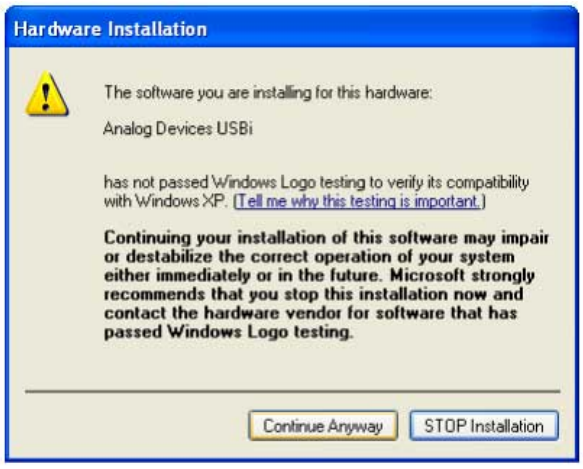

Figure 6. Hardware Installation Warning

INSTALLING THE SIGMASTUDIO SOFTWARE

The USBi drivers are now installed. Leave the USBi connected to the PC.

Using Windows 7 or Windows Vista

After connecting the USBi to the USB 2.0 port, Windows 7 or Windows Vista recognizes the device and installs the drivers automatically (see Figure 7). When the installation completes, leave the USBi connected to the PC.

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Figure 7. USBi Drivers Installed Properly

Confirming Proper Installation of the USBi Drivers

To confirm that the USBi drivers are installed properly, complete the following steps:

1. With the USBi still connected to the USB 2.0 port of the PC, check that both the yellow I^2C LED and the red power indicator LED are illuminated (see Figure 8).

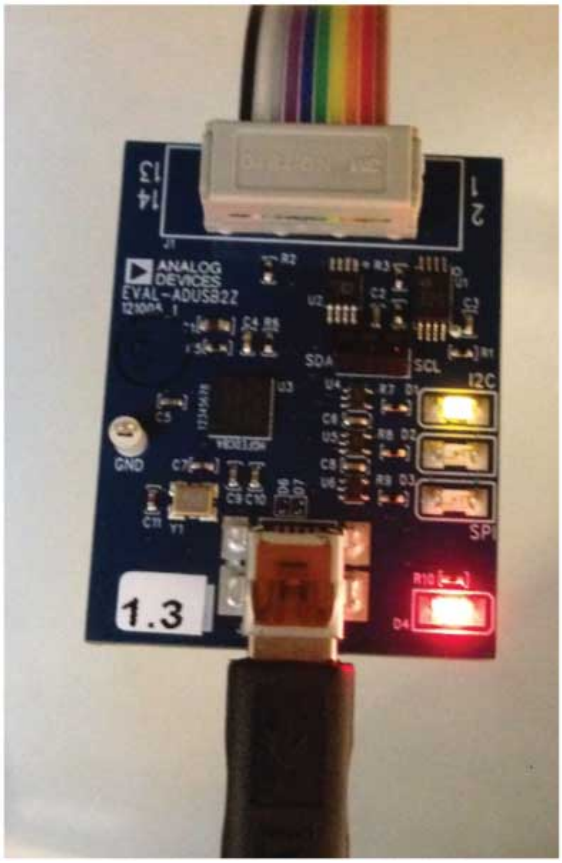

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Figure 8. State of USBi Status LEDs After Driver Installation

2. In the Windows **Device Manager**, under the **Universal Serial Bus controllers** section, check that **Analog Devices USBi (programmed)** appears as shown in Figure 9.

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Figure 9. Confirming Driver Installation Using the Device Manager

ADDING THE DLL FILE

Add the provided **SSM6515.dll** file manually by copying the **SSM6515.dll** file to the **C:\ProgramFiles\AnalogDevices\SigmaStudio** folder in the PC. To add the SSM6515 to the **Tree ToolBox**, click **Tools** and then click **Add-Ins Browser...** (as shown in Figure 10). The **AddIns** popup window opens (see Figure 11).

In the list of devices displayed in the **AddIns** popup window, ensure the **SSM6515** checkbox is selected, as shown in Figure 11. Click **File** and then click **Save** before exiting the window.

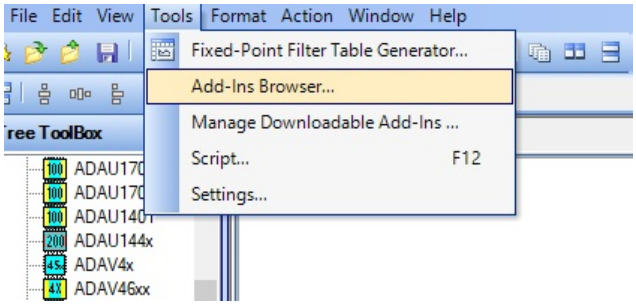

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Figure 10. Adding an SSM6515

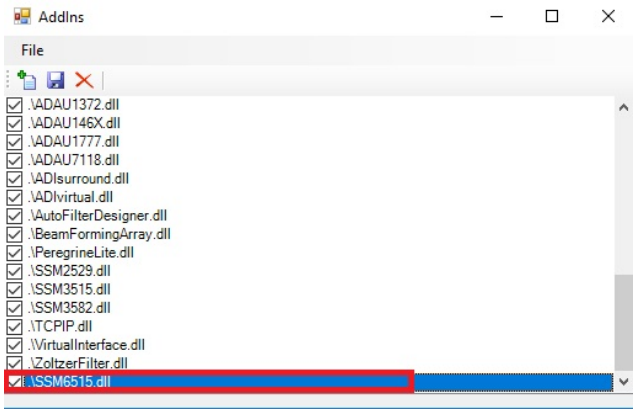

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Figure 11. Saving the SSM6515.dll File in the AddIns Popup Window

INSTALLING THE SIGMASTUDIO SOFTWARE

SETTING UP SIGMASTUDIO

Start SigmaStudio by double clicking the shortcut on the desktop.

Click **File** and then click **New Project**, or press Ctrl + N to create a new project, as shown in Figure 12. The default view of the new project is the **Hardware Configuration** tab. Figure 13 shows a new SigmaStudio project.

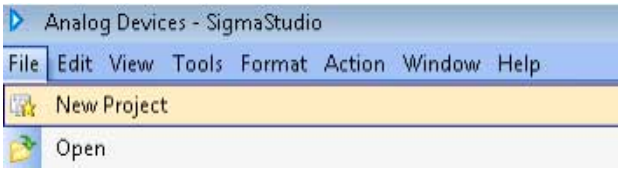

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Figure 12. New Project

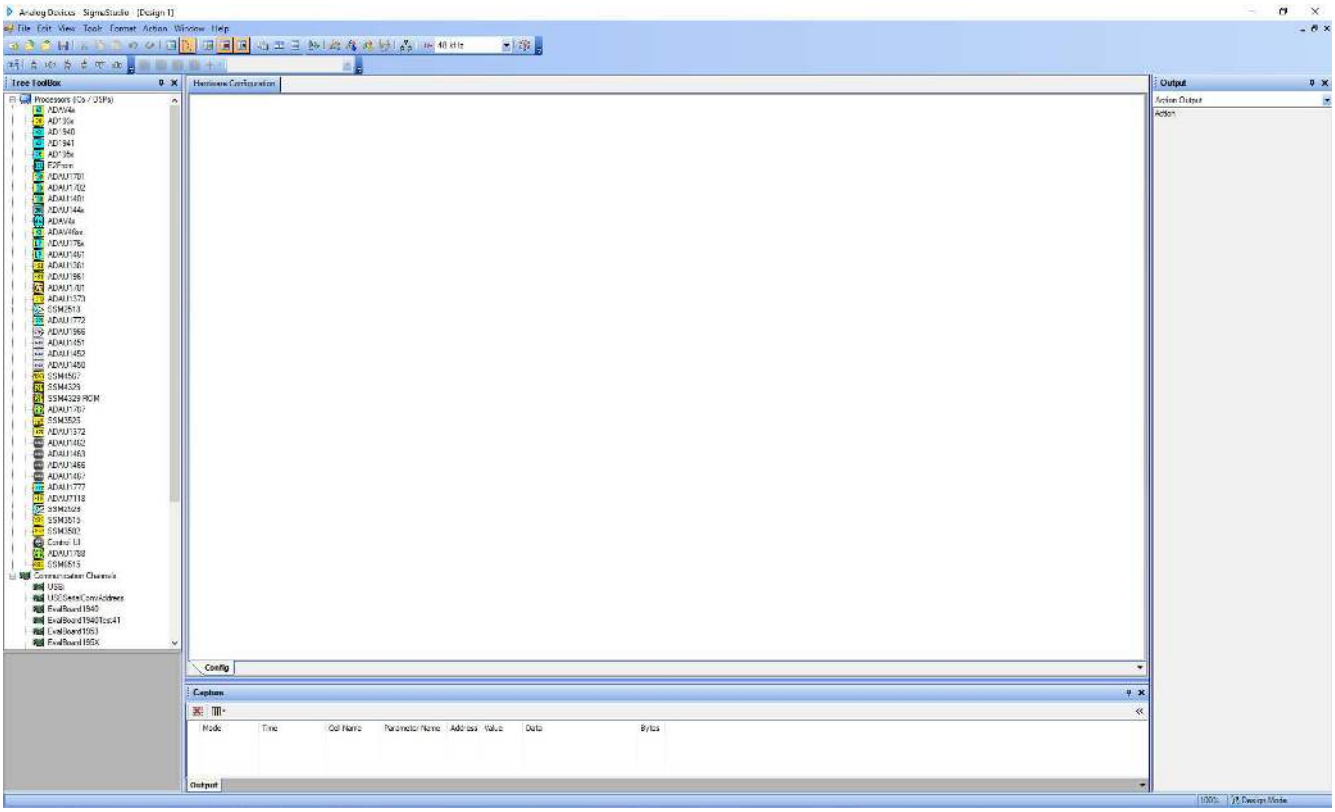

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Figure 13. New SigmaStudio Project

INSTALLING THE SIGMASTUDIO SOFTWARE

To use the USBi with SigmaStudio, select **USBi** from the **Communication Channels** list of the **Tree Toolbox** (see Figure 14), and drag it to the right to add it to the project space.

Figure 14. Adding the USBi Communication Channel

If SigmaStudio cannot detect the USBi board on the USB port of the PC, the background of the **USB** label is red (see Figure 15). The label turns red when the USBi is not connected or when the drivers are installed incorrectly.

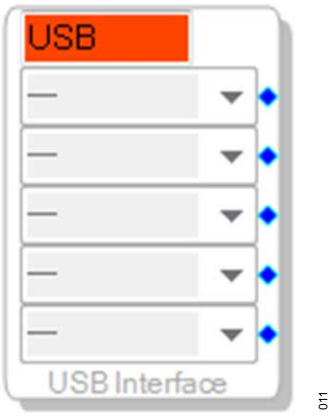

Figure 15. USBi Not Detected by SigmaStudio

If SigmaStudio detects the USBi board on the USB port of the PC, the background of the **USB** label is green (see Figure 16).

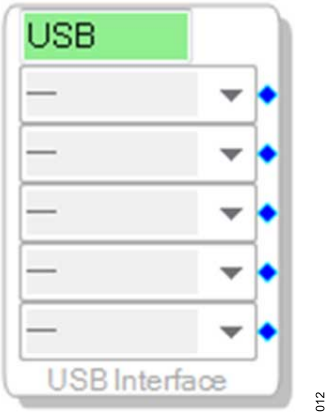

Figure 16. USBi Detected by SigmaStudio

Add two SSM6515s from the **Tree ToolBox** to the **Hardware Configuration** tab by selecting **SSM6515** from the **Processors (ICs / DSPs)** list and dragging it to the project space (see Figure 10).

To use the USBi board to communicate with the target IC, connect the IC by clicking and dragging a wire between the blue pin of the USBi and the green pin of the IC (see Figure 17). The corresponding dropdown box of the USBi automatically fills with the default mode and channel for that IC.

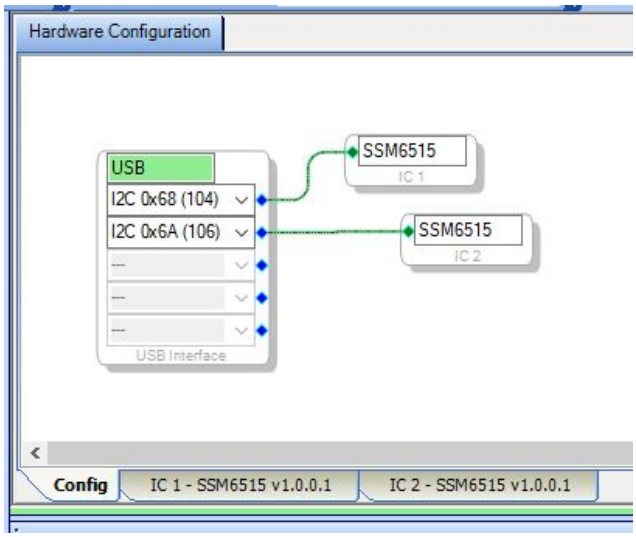

Figure 17. Connecting the USBi to an SSM6515 IC

SETTING UP THE EVALUATION BOARD

DEFAULT SWITCH AND JUMPER SETTINGS (S/PDIF INPUT, I²C MODE)

The EVAL-SSM6515Z consists of two SSM6515s for stereo headphone output. Refer to Figure 19 for the switch and jumper settings. These settings set the EVAL-SSM6515Z for external I²S input with I²C control using the USBi.

The EVAL-SSM6515Z provides multiple options for configuring the SSM6515. See Table 3 for the I²C mode and device address settings. By default, the EVAL-SSM6515Z is configured for Address 0x34 (AMP1) and Address 0x35 (AMP2). If other addresses are required, refer to Table 3.

To use the on-board S/PDIF receiver I²S input, insert jumpers for J13 as shown in Figure 18.

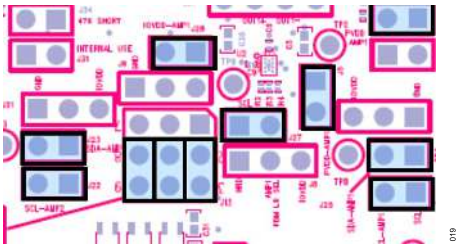

Figure 18. S/PDIF as I²S Source

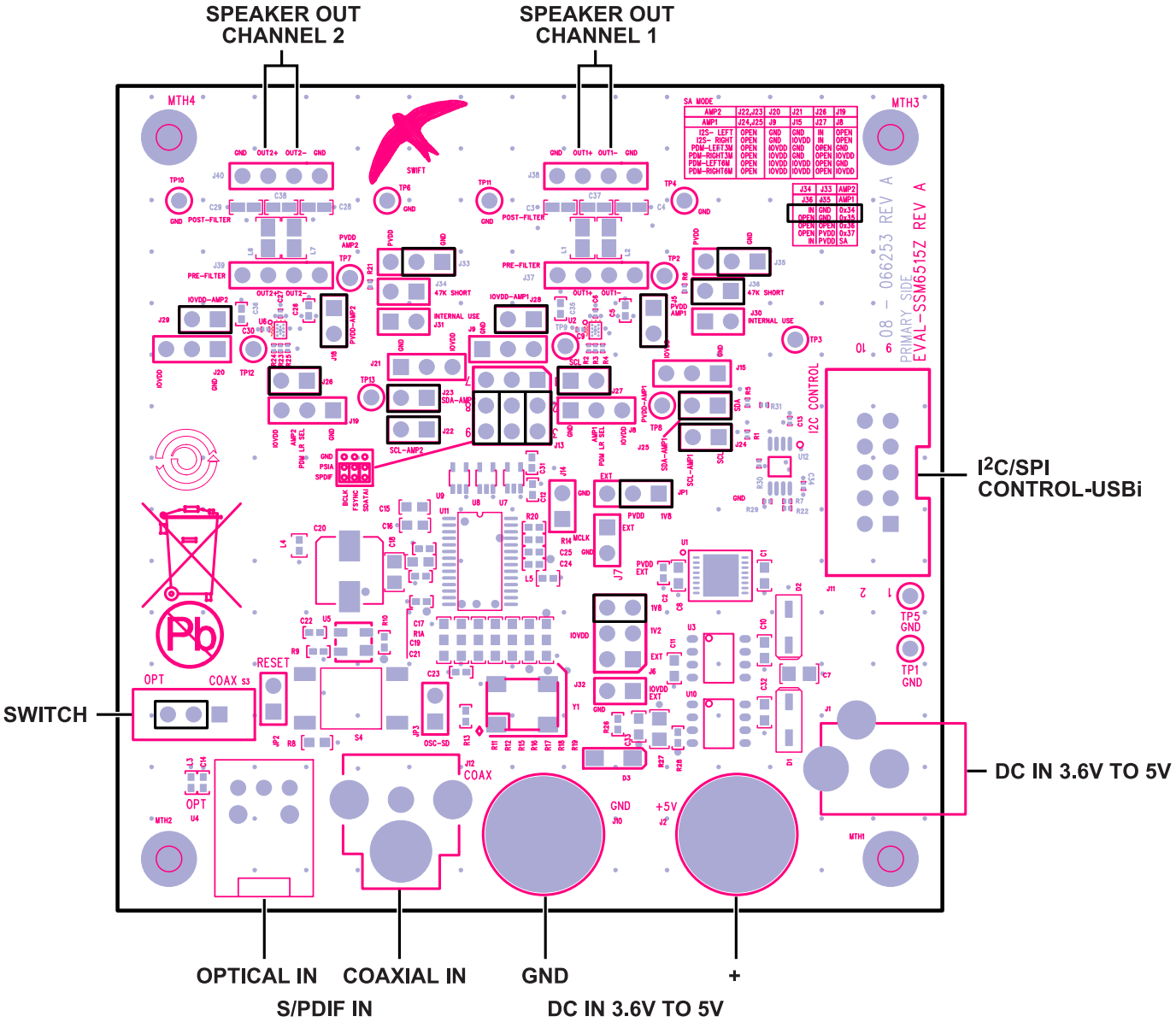

Figure 19. S/PDIF Input, I²C Mode

SETTING UP THE EVALUATION BOARD

Table 3. I²C or Standalone Mode Selection, AMP1[1]

Parameter	I²C Device Address	J24, J25	J35	J36
I²C Mode	0x34	Installed	GND	Installed
I²C Mode	0x35	Installed	GND	Open
I²C Mode	0x36	Installed	Open	Open
I²C Mode	0x37	Installed	PVDD	Open
Standalone Mode	N/A	Open	PVDD	Installed

[1] N/A means not applicable.

Table 4. I²C or Standalone Mode Selection, AMP2[1]

Parameter	I²C Device Address	J22, J23	J33	J34
I²C Mode	0x34	Installed	GND	Installed
I²C Mode	0x35	Installed	GND	Open
I²C Mode	0x36	Installed	Open	Open
I²C Mode	0x37	Installed	PVDD	Open
Standalone Mode	N/A	Open	PVDD	Installed

[1] N/A means not applicable.

Table 5. I²S or PDM Input Selection in Standalone Mode

	AMP2	J22, J23	J20	J21	J26	J19
Mode	AMP1	J24, J25	J9	J15	J27	J8
I²S	Left channel	Open	GND	GND	Installed	Open
	Right channel	Open	GND	IOVDD	Installed	Open
PDM	Left channel, 3 MHz	Open	IOVDD	GND	Open	GND
	Right channel, 3 MHz	Open	IOVDD	GND	Open	IOVDD
	Left channel, 6 MHz	Open	IOVDD	IOVDD	Open	GND
	Right channel, 6 MHz	Open	IOVDD	IOVDD	Open	IOVDD

POWERING UP THE EVAL-SSM6515Z

To power up the EVAL-SSM6515Z, connect the ribbon cable of the USBi board to J1 (control port) of the EVAL-SSM6515Z.

POWER

Power can be supplied to the EVAL-SSM6515Z in one of three ways: connecting the EVAL-ADUSB2EBZ (USBi) board to J11 (see Figure 20), connecting a 3.8 V dc to 5 V dc power supply to J1 (tip positive), or using the binding posts, J2 (5 V) and J10 (GND). If no external supply is used, the EVAL-SSM6515Z draws power from the USBi board.

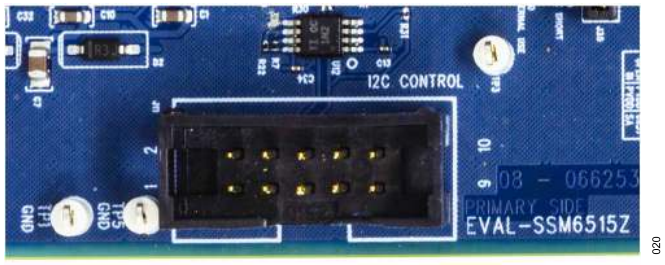

Figure 20. Header J11, Control Port

The on-board regulators generate the 1.8 V, 1.2 V, and 3.3 V dc supplies. The JP1 and J6 jumpers are used to set the PVDD and IOVDD supplies to the SSM6515. By default, the 1.8 V supply is used for PVDD and IOVDD. The J5 and J18 jumpers provide the PVDD supply to individual SSM6515 amplifiers, and the J28 and J29 jumpers provide the IOVDD supply. By removing these jumpers, the currents to the individual SSM6515s can be measured.

USING I²C CONTROL MODE

Connecting the USBi to J11 provides I²C control for the SSM6515. See Figure 20.

USING SIGMASTUDIO WITH USBI FOR I²C CONTROL

Take the following steps to use SigmaStudio with the USBi for I²C control and to configure the registers for I²S operation:

1. In the **Hardware Configuration** tab, click the **IC 1 - SSM6515 v1.0.0.1** tab, then click the **ChipID** tab (see Figure 21). Click **Get ID** to read the device ID and revision.
2. Click the **Datapath** tab. Click **Mute Control** to select **DAC Unmuted** to unmute the DAC, as shown in Figure 22.

SETTING UP THE EVALUATION BOARD

3. Click the **Control/Status** tab. Click **Software Master Power-down** to select **Normal** to turn on the amplifier if the I²S clocks are provided. The amplifier outputs the audio at J38 (AMP1) and J40 (AMP2).

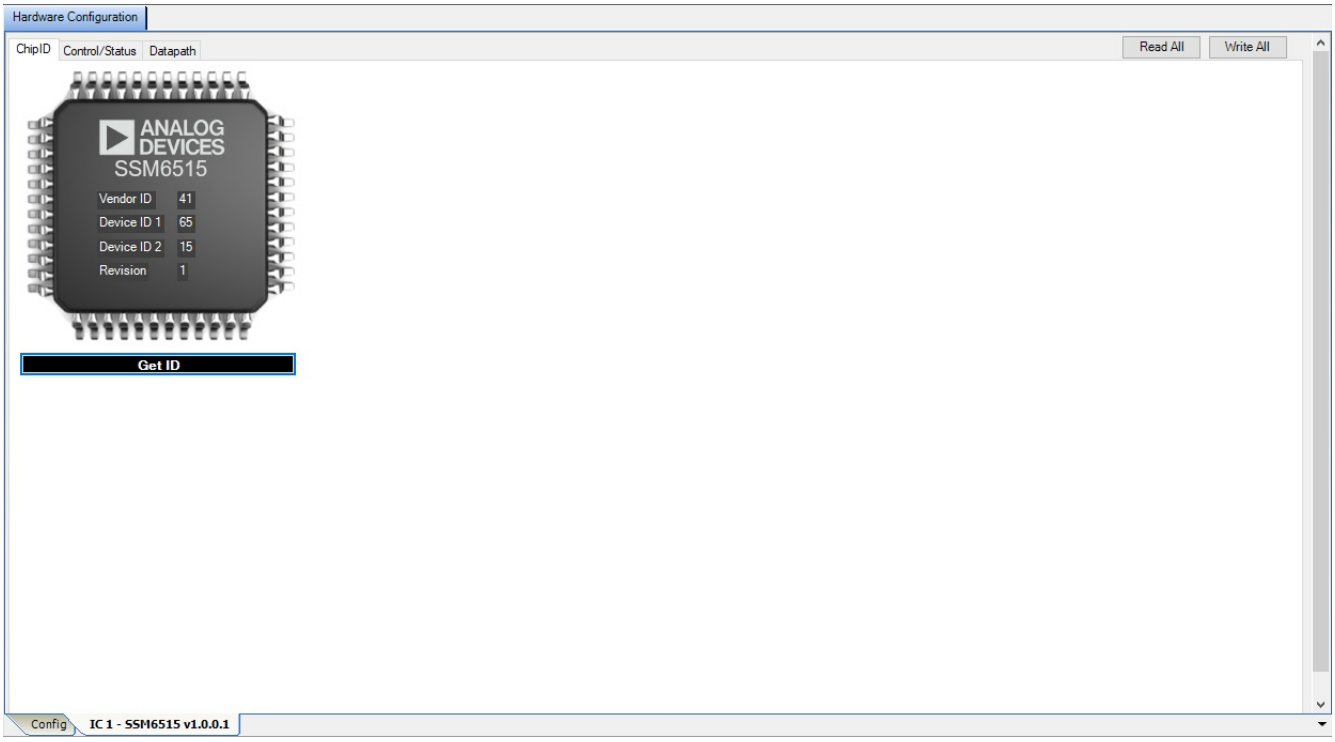

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Figure 21. ChipID Tab

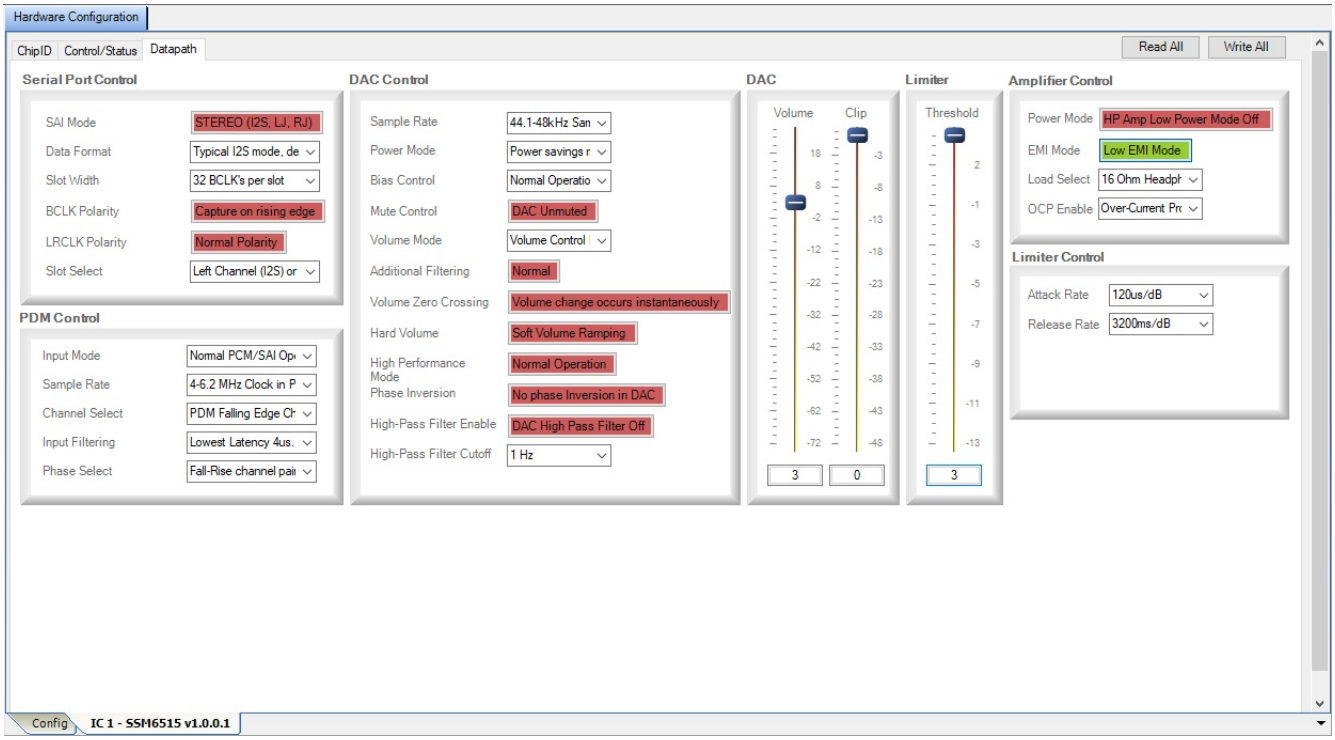

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Figure 22. Datapath Tab

SETTING UP THE EVALUATION BOARD

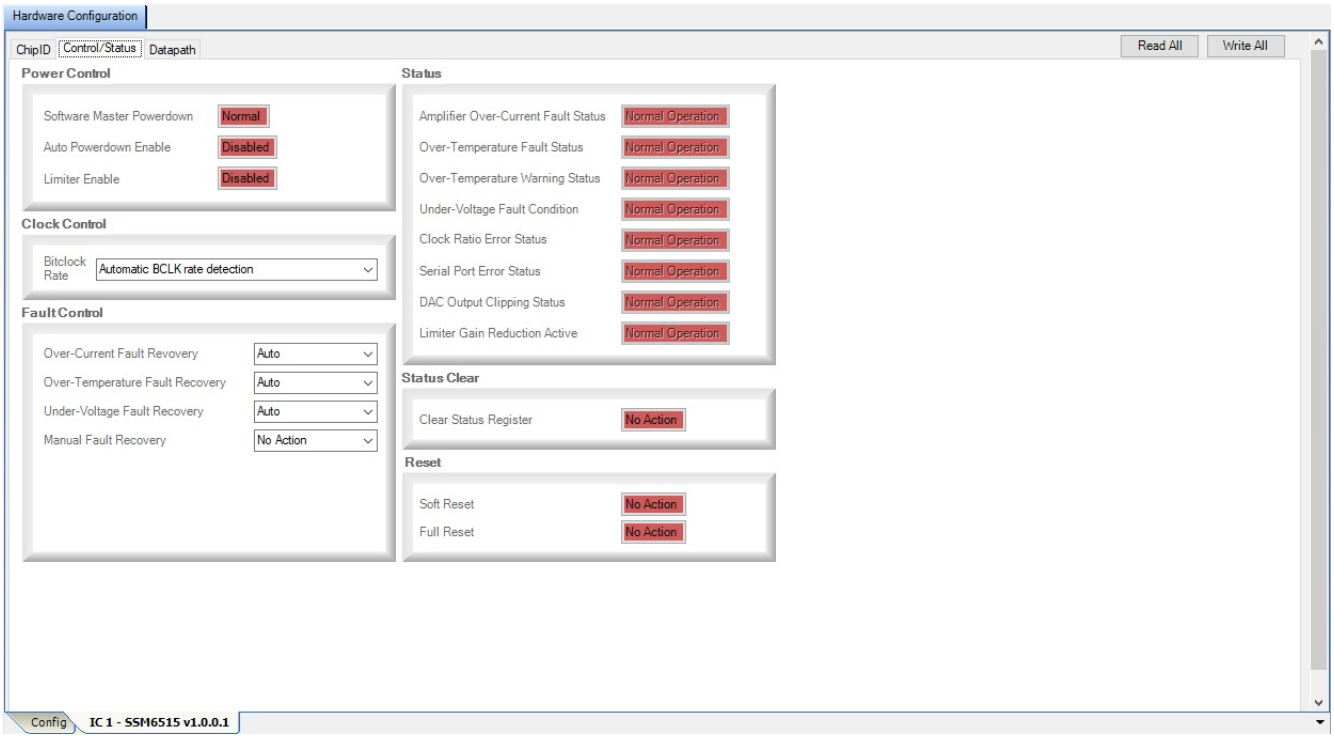

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Figure 23. Control/Status Tab

EXTERNAL I²S INPUT, I²C MODE

If using the external I²S input, the only change needed is for J13. Connect a digital I²S audio source to J13. The external I²S signals must be 1.8 V p-p. Refer to Table 2 for the J13 header connections.

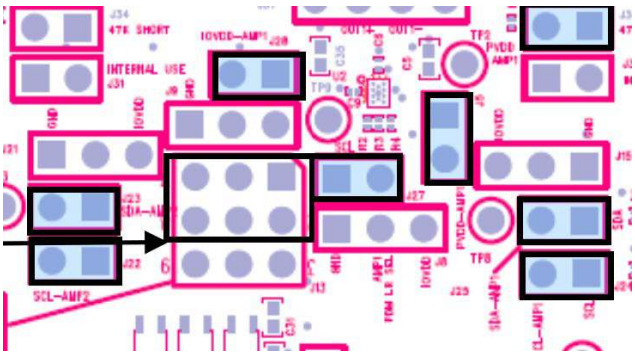

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Figure 24. External I²S Selection

DEFAULT SWITCH AND JUMPER SETTINGS (PDM INPUT, I²C MODE)

If using the PDM source as an input, use the same settings as shown in Figure 19, but connect only the PDM data and clock at Pin 2 and Pin 8 of J13. Leave Pin 5 (center) unconnected. Follow Table 5 for the desired PDM mode. Then, use SigmaStudio to configure the PDM mode for the SSM6515, as shown in Figure 22.

Turn on the PDM signals to the EVAL-SSM6515Z. The audio output is available at J38 (AMP1) and J40 (AMP2).

SETTING UP THE EVALUATION BOARD

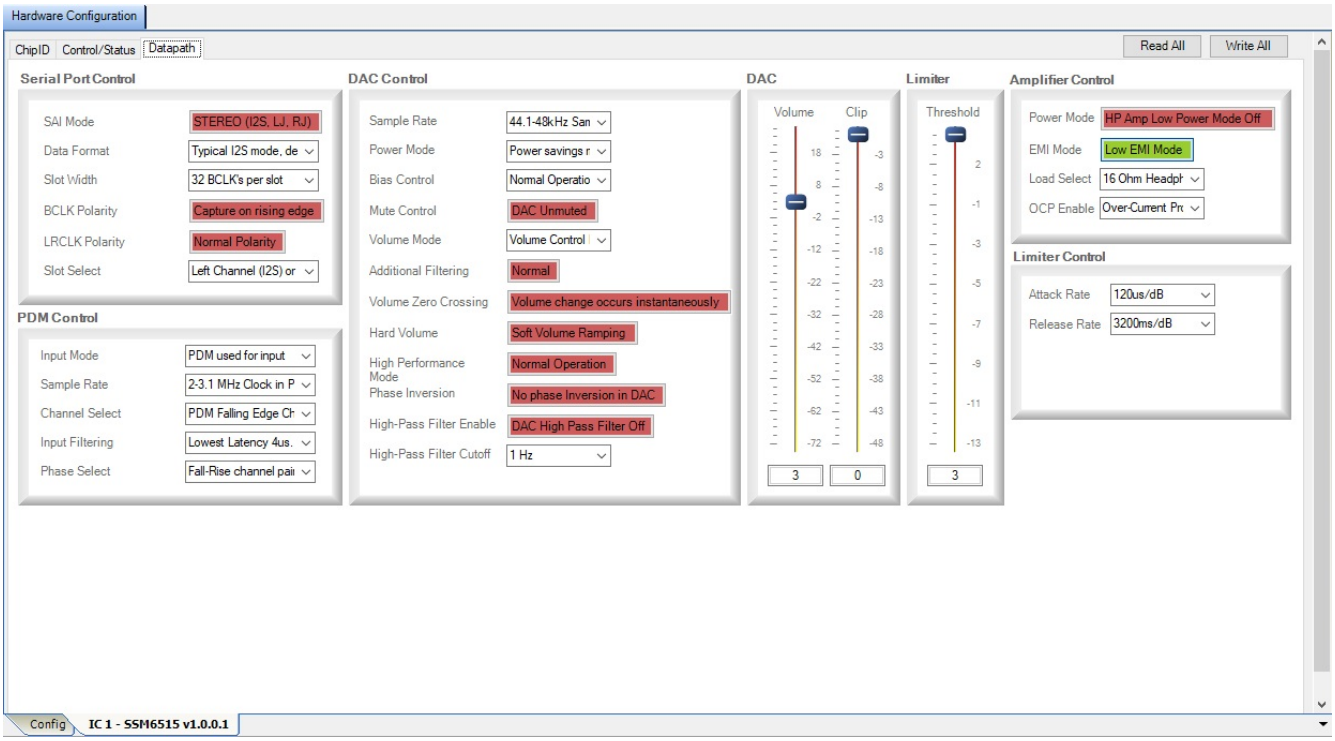

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Figure 25. PDM Configuration

DEFAULT SWITCH AND JUMPER SETTINGS (S/PDIF INPUT, STANDALONE MODE)

To configure the EVAL-SSM6515Z for standalone mode, refer to Table 3 and set the desired input I²S or PDM mode using Table 5.

Configure J13 accordingly. If using the on board S/PDIF receiver I²S input, insert the jumpers as shown in Figure 18. If using the external I²S input, refer to Figure 24 for J13. If using the PDM source, connect only the PDM data and PDM clock at Pin 2 and Pin 8 of J13, respectively. Leave Pin 5 (center) unconnected.

EVALUATION BOARD SCHEMATICS AND ARTWORK

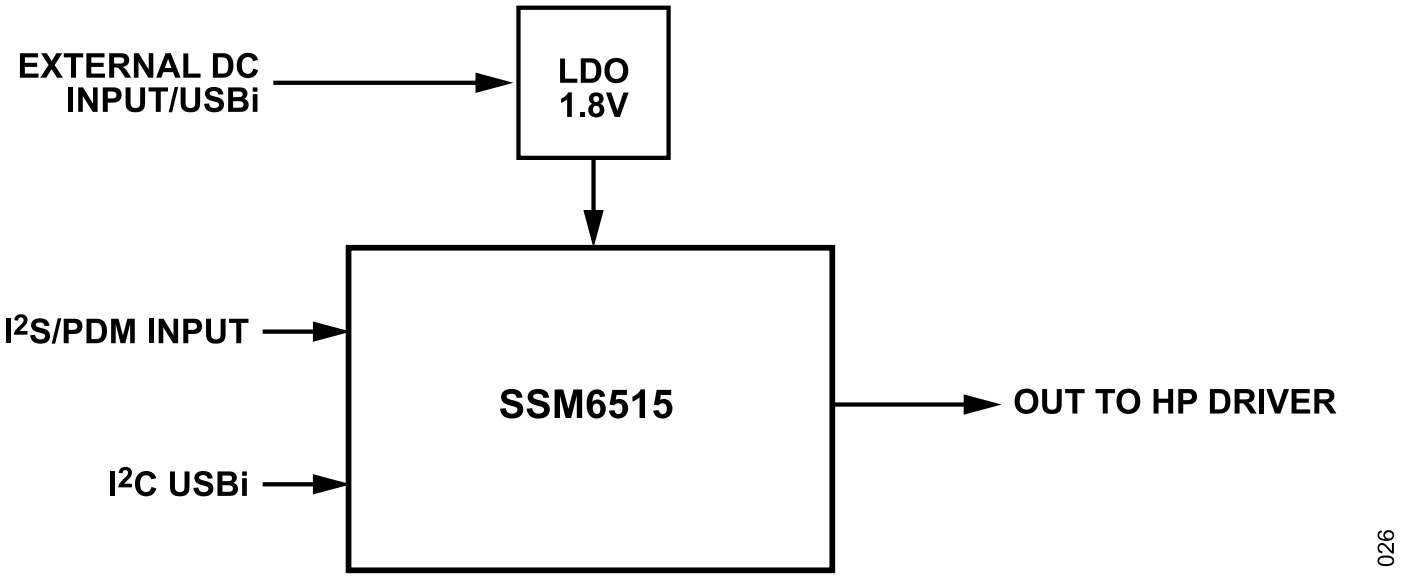

Figure 26. EVAL-SSM6515Z Schematic: Block Diagram (HP Is Headphone)

EVALUATION BOARD SCHEMATICS AND ARTWORK

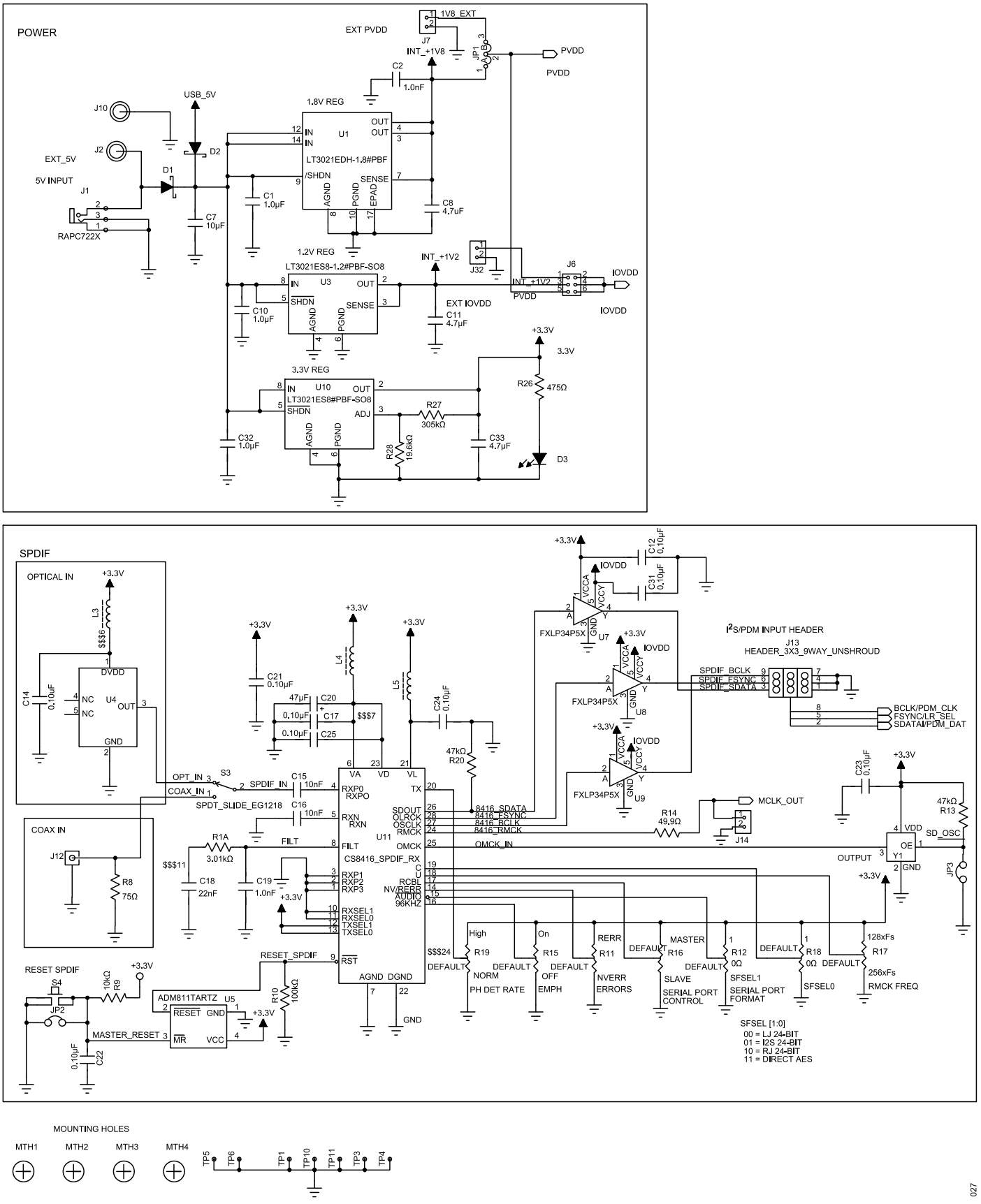

Figure 27. EVAL-SSM6515Z Schematic Page 1

EVALUATION BOARD SCHEMATICS AND ARTWORK

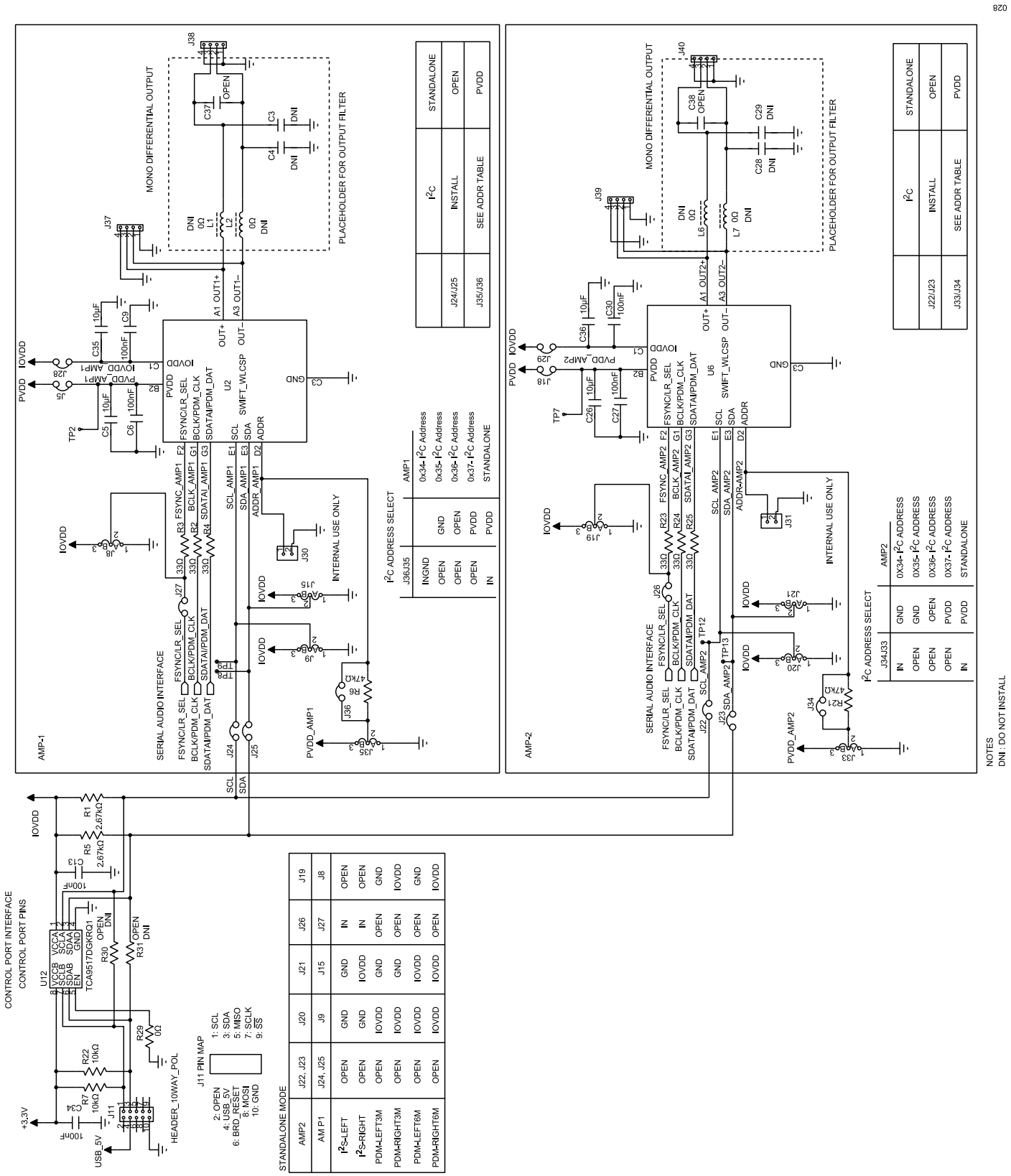

Figure 28. EVAL-SSM6515Z Schematic Page 2

EVALUATION BOARD SCHEMATICS AND ARTWORK

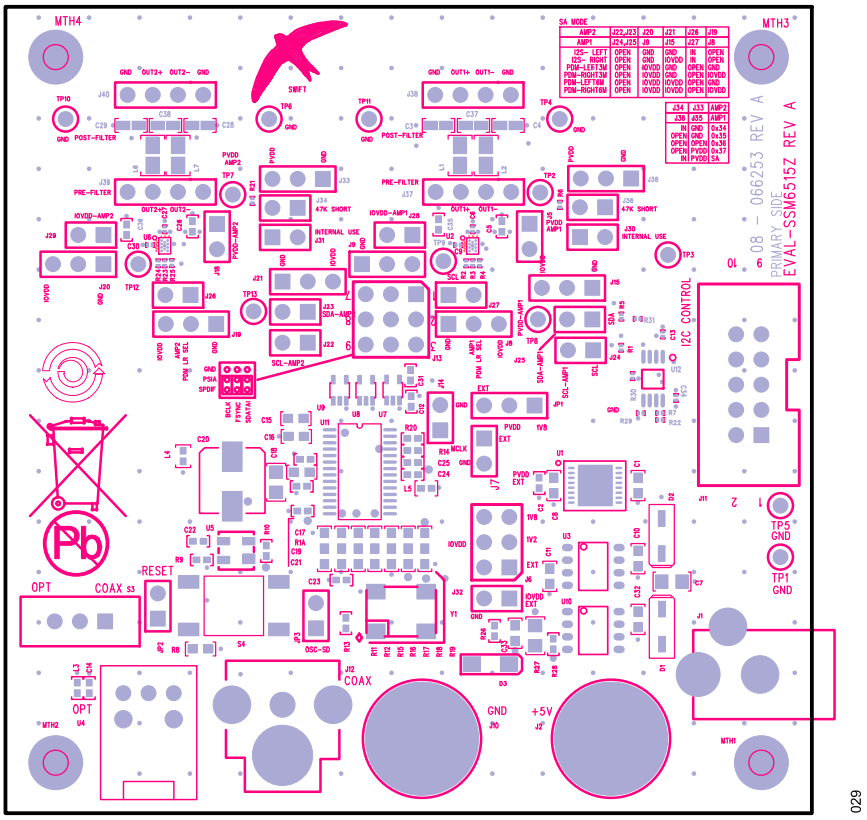

Figure 29. EVAL-SSM6515Z Layout: Top Assembly

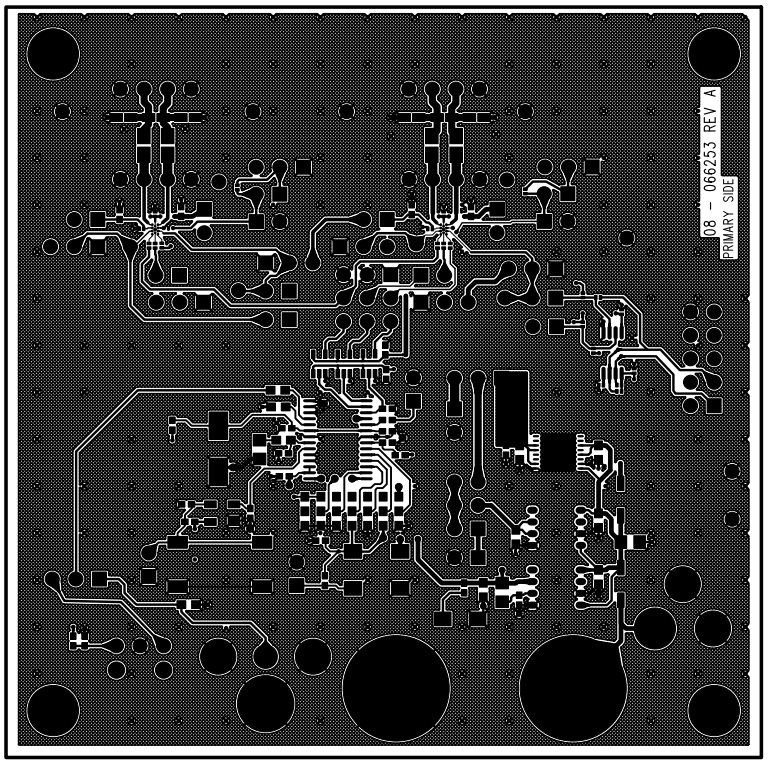

Figure 30. EVAL-SSM6515Z Layout: Top Copper

EVALUATION BOARD SCHEMATICS AND ARTWORK

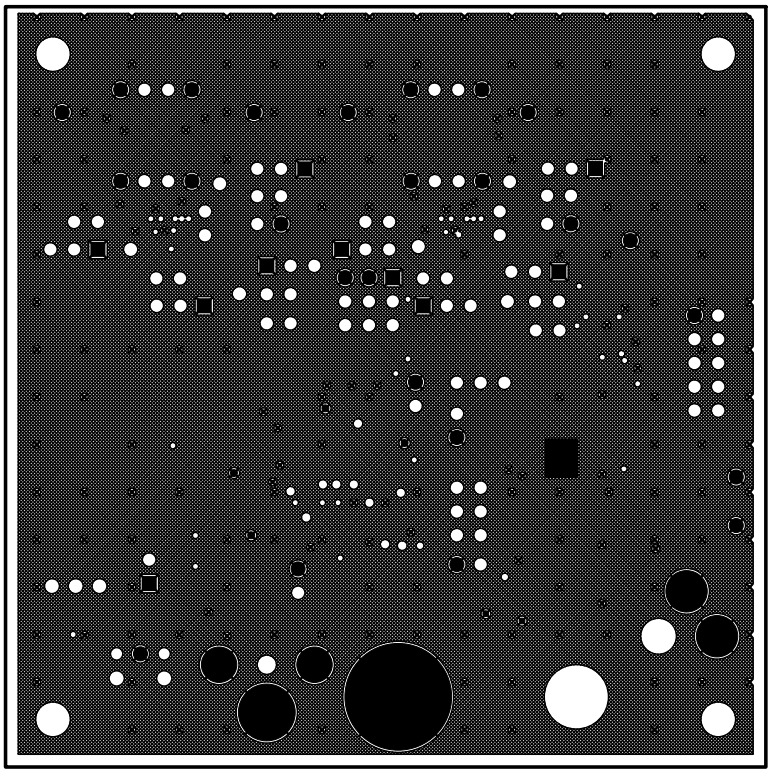

Figure 31. EVAL-SSM6515Z Layout: Ground Plane

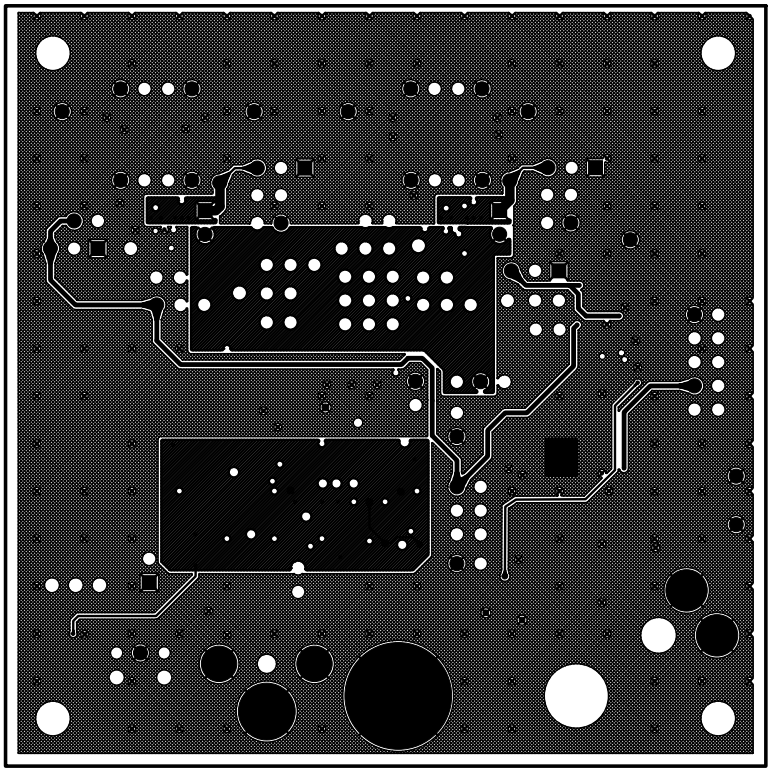

Figure 32. EVAL-SSM6515Z Layout: Power Plane

EVALUATION BOARD SCHEMATICS AND ARTWORK

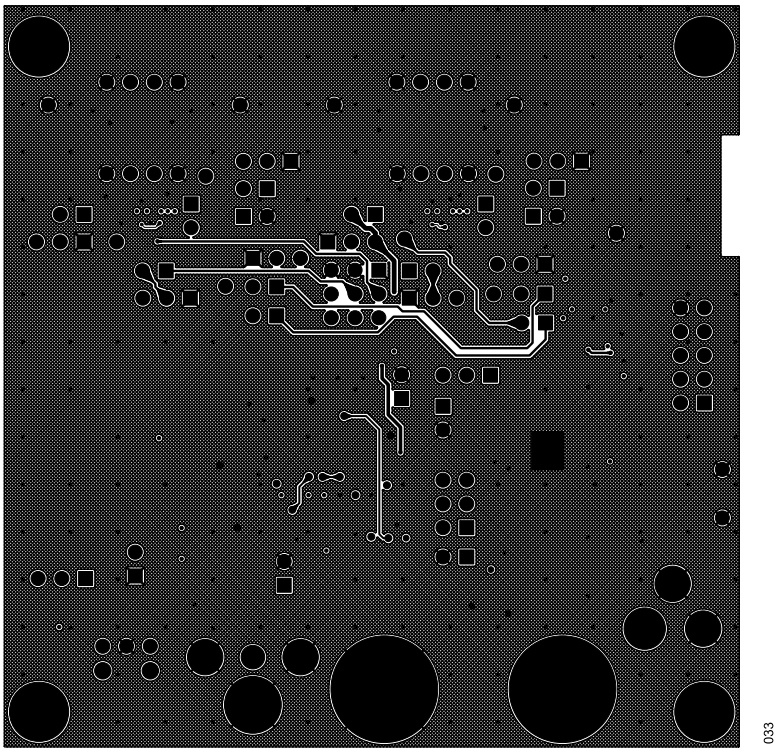

Figure 33. EVAL-SSM6515Z Layout: Bottom Copper

EVALUATION BOARD SCHEMATICS AND ARTWORK

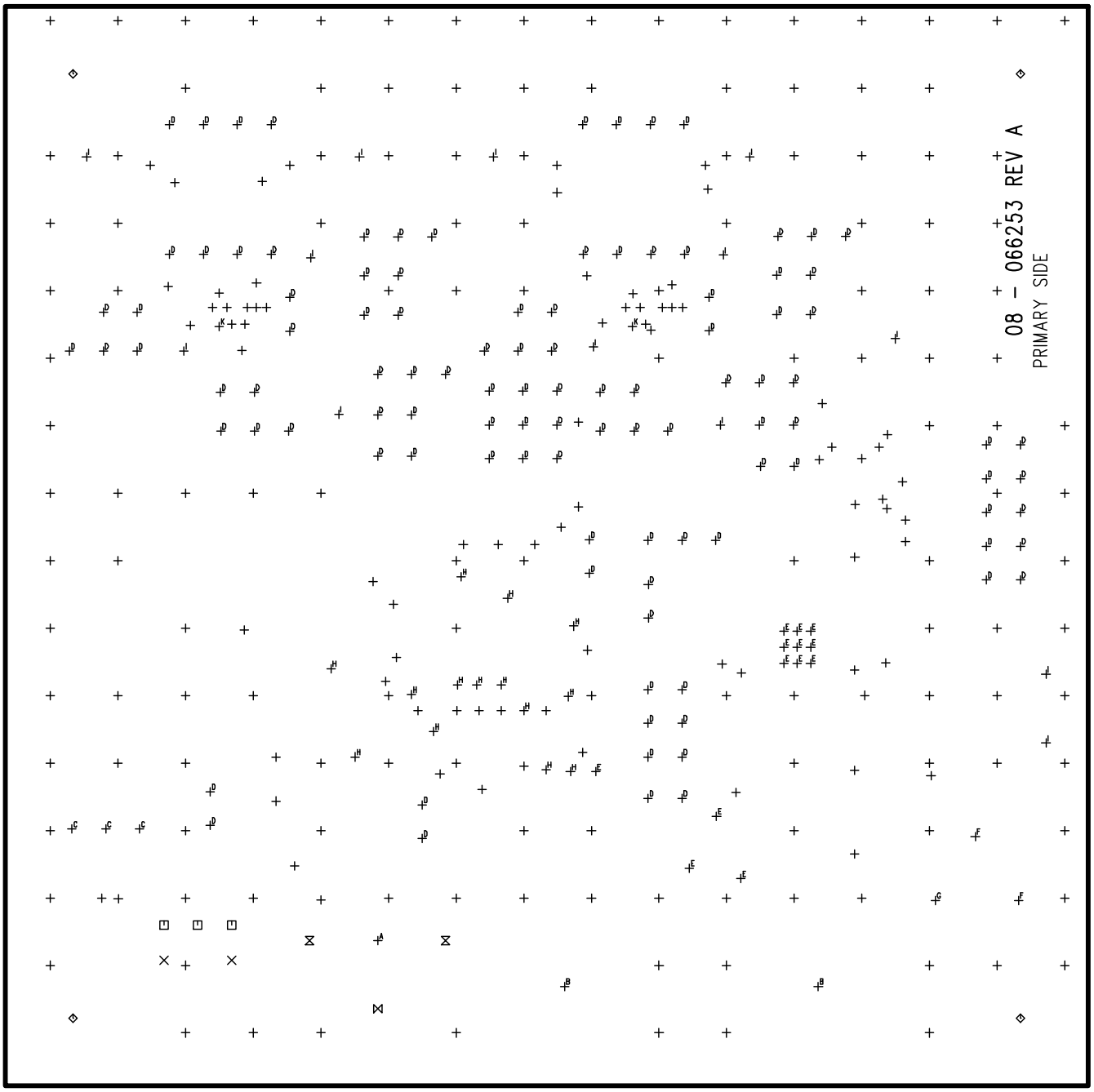

Figure 34. EVAL-SSM6515Z Layout: Fab Drawing

ORDERING INFORMATION

BILL OF MATERIALS

Table 6.

Qty	Reference	Description	Vendor	Vendor Order Number
3	C1, C10, C32	Multilayer ceramic capacitors, 1 µF, 16 V, X7R, 0603	Digi-Key	490-3900-1-ND/445-1604-2-ND
2	C2, C19	Multilayer ceramic capacitors, 1 nF, 50 V, NP0, 0402	Digi-Key	490-3244-1-ND
6	C3, C4, C28, C29, C37, C38	Multilayer ceramic capacitors, 25 V, NP0, 0201, do not install (DNI)	Digi-Key	311-1611-1-ND
4	C5, C26, C35, C36	Multilayer ceramic capacitors, 10 µF, 6.3 V, X5R, 0402	Digi-Key	490-13211-1-ND
6	C6, C9, C13, C27, C30, C34	Multilayer ceramic capacitors, 100 nF, 6.3 V, X5R, 0201	Digi-Key	490-3167-1-ND
1	C7	Multilayer ceramic capacitors, 10 µF, 10 V, X7R, 0805	Digi-Key	490-3905-1-ND/445-6857-2-ND
3	C8, C11, C33	Ceramic capacitors, 4.7 µF, 6.3 V, 10% X5R, 0603	Digi-Key	490-3297-1-ND/490-7205-2-ND
9	C12, C14, C17, C21 to C25, C31	Multilayer ceramic capacitors, 0.10 µF, 16 V, X7R, 0402	Digi-Key	490-3261-1-ND/445-4952-1-ND
2	C15, C16	Multilayer ceramic capacitors, 10 nF, 25 V, NP0, 0603	Digi-Key	445-2664-1-ND/399-5779-1-ND
1	C18	Multilayer ceramic capacitors, 22 nF, 25 V, NP0, 0805	Digi-Key	490-1644-1-ND
1	C20	Aluminum electrolytic capacitor, 47 µF, 105°, surface-mount device (SMD)	Digi-Key	PCE4000CT-ND
2	D1, D2	Schottky, 30 V, 0.5 A, SOD123 diodes	Digi-Key	MBR0530T1GOSCT-ND
1	D3	Red diffused, 6.0 millicandela, 635 nm, 1206	Digi-Key	67-1003-1-ND
1	J1	Mini power jack, 0.08 in., through hole, right angle	Digi-Key	SC1313-ND
2	J2, J10	Nickel binding post mini uninsulated base through hole	Digi-Key	J587-ND
19	J5, J7, J14, J18, J22 to J32, J34, J36, JP2, JP3	2-pin (1×2) unshrounded headers, 0.10 in., use Shunt Tyco 881545-2	Digi-Key	S1011E-02-ND
1	J6	6-pin (2×3) unshrouded header	Digi-Key	S2011E-03-ND
9	J8, J9, J15, J19 to J21, J33, J35, JP1	3-pin (1×3) single inline position (SIP) headers	Digi-Key	S1011E-03-ND
1	J11	10-pin (2×5) shroud polarized header	Digi-Key	MHC10K-ND
1	J12	RCA jack, printed circuit board (PCB), through hole, right angle, yellow	Connect Tech Products	CTP-021A-S-YEL/CP-1403-ND
1	J13	9-pin (3×3) unshrouded header	Digi-Key	A108960-ND
4	J37 to J40	4-pin (1×4) unshrouded headers, single row	Digi-Key	S1011E-04-ND/S1011E-36-ND
4	L1, L2, L6, L7	Chip ferrite beads, low total harmonic distortion (THD), MAF1005GAD352AT000, 270 mA, 0402, 500 Ω at 100 MHz	Digi-Key	445-174614-1-ND
3	L5, L3, L4	Chip ferrite beads, 600 Ω at 100 MHz	Digi-Key	445-2162-1-ND/490-7806-2-ND
4	MTH1 to MTH4	Nylon screw pans Phillips 4-40	Digi-Key	H542-ND
4	MTH1 to MTH4	Nylon hexagonal standoff 4-40, ½ in.	Digi-Key	1902CK-ND
2	R1, R5	Chip resistors, 2.67 kΩ, 1%, 1/20 W, thick film, 0201	Digi-Key	541-CRCW02012K67FNEDCT-ND
1	R1A	Chip resistor, 3.01 kΩ, 1% ,100 mW thick film, 0603	Digi-Key	RHM3.01KHCT-ND/311-3.01KHRCT-ND
6	R2 to R4, R23 to R25	Resistors, 33 Ω, 1/20 W, 5%, 0201, SMD	Digi-Key	311-33NCT-ND
2	R6, R21	Chip resistors, 47 kΩ, 1%, 50 mW thick film, 0201	Digi-Key	311-47KMCT-ND
2	R7, R22	Chip resistors, 10 kΩ, 1%, 50 mW, thick film, 0201	Digi-Key	311-10KNCT-ND
1	R8	Chip resistors, 75 Ω, 1%, 100 mW, thick film, 0603	Digi-Key	P75.0HCT-ND
1	R9	Chip resistors, 10 kΩ, 1%, 63 mW, thick film, 0402	Digi-Key	RHM10.0KLCT-ND/541-10.0KLTR-ND
1	R10	Chip resistors, 100 kΩ, 1%, 100 mW, thick film, 0402	Digi-Key	P100KLCT-ND
7	R11, R12, R15 to R19	Chip resistors, 47.5 kΩ, 1%, 100 mW, thick film, 0603	Digi-Key	P47.5KHCT-ND
2	R13, R20	Chip resistors, 47 kΩ, 1%, 63 mW, thick film, 0402	Digi-Key	311-47.0KLRCT-ND
1	R14	Chip resistors, 49.9 Ω, 1%, 63 mW, thick film, 0402	Digi-Key	311-49.9LRCT-ND
1	R26	Chip resistors, 475 Ω, 1%, 63 mW, thick film, 0402	Digi-Key	541-475LCT-ND
1	R27	Chip resistors, 305 kΩ, 1%, 125 mW, thick film, 0805	Digi-Key	541-1892-1-ND
1	R28	Chip resistors, 19.6 kΩ, 1%, 63 mW, thick film, 0402	Digi-Key	P19.6KLCT-ND

ORDERING INFORMATION

Table 6.

Qty	Reference	Description	Vendor	Vendor Order Number
1	R29	Chip resistors, 5%, 50 mW, thick film, 0201, DNI	Digi-Key	P0.0JCT-ND
2	R30, R31	Chip resistors, 5%, 50 mW, thick film, 0201	Digi-Key	P0.0JCT-ND
1	S3	SPDT slide switch, PC mount	Digi-Key	EG1903-ND
1	S4	Single pole single throw normally open circuit (SPST-NO) tactile switch, 6 mm, gull wing	Digi-Key	450-1133-ND
13	TP1 to TP3, TP6 to TP13	Mini test points, white, .1 in. diameter	Digi-Key	5002K-ND
1	U1	High accuracy, ultralow quiescent current (IQ), 1.8 V, 500 mA, low dropout regulator	Digi-Key	LT3021EDH-1.8#PBF-ND
2	U2, U6	Mono Class-D headphone amplifier	Analog Devices	SSM6515BCBZRL
1	U3	High accuracy, ultralow IQ, 1.2 V, 500 mA, low dropout regulator	Digi-Key	LT3021ES8-1.2#PBF-ND/ LT3021ES8-1.2#TRPBFCT-ND
1	U4	16 Mbps optical receiver	Digi-Key	1080-1433-ND
1	U5	Voltage supervisor logic low reset output	Analog Devices	ADM811TARTZ-REEL7
3	U7 to U9	Translators, 1-bit, unidirectional, SC70-5	Digi-Key	FXLP34P5XCT-ND
1	U10	High accuracy, ultralow IQ, adjustable, 500 mA, low dropout regulator	Digi-Key	LT3021ES8#PBF-ND/ LT3021ES8#TRPBFCT-ND
1	U11	192 kHz, digital receiver, 28-lead thin shrink small outline package (TSSOP)	Digi-Key	598-1124-5-ND
1	U12	IC, I^{2}C bus repeater, 8-lead TSSOP	Digi-Key	296-TCA9517DGKRQ1CT-ND
1	Y1	12.288 MHz, fixed SMD oscillator, 3.3 V dc to 5 V dc	Cardinal Components/Digi-Key	CPPFXC7LT-A7BR - 12.288TS/110-CB3LV-3I-12M288000CT-ND/887-1359-1-ND

I^{2}C refers to a communications protocol originally developed by Philips Semiconductors (now NXP Semiconductors).

ESD Caution
ESD (electrostatic discharge) sensitive device. Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.