EVM User's Guide: TAS2120EVM

TAS2120 Evaluation Module

Description

The TAS2120EVM has been designed to demonstrate the performance of TAS2120 in a mono configuration. The EVM utilizes the AC-MB to provide a USB to Audio interface to the EVM. Up to four devices can share a common bus through I^2S/TDM and I^2C interfaces. The TAS2120EVM supports a dual-mono configuration combining two TAS2120EVMs or TAS2120EVM and TAS2320EVM.

Get Started

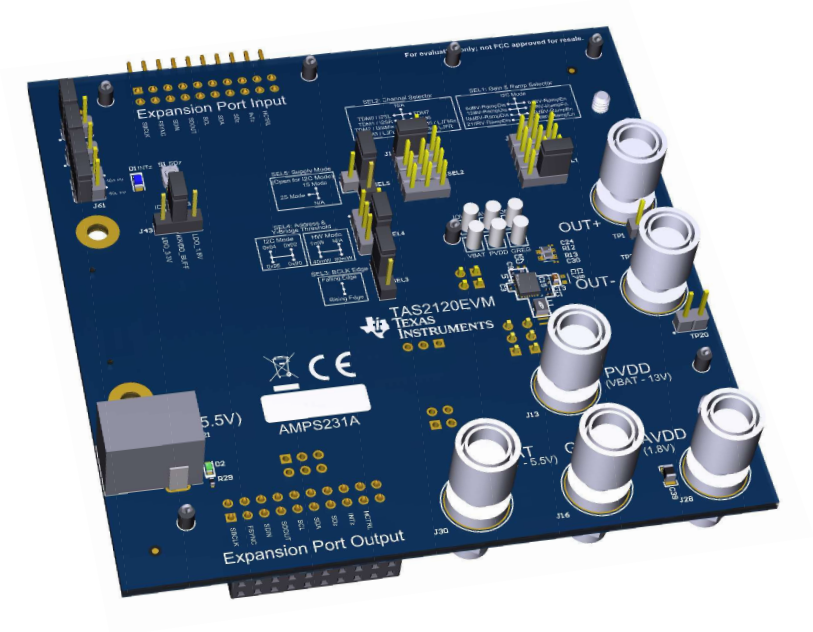
1. Order the TAS2120EVM and request access to download PPC3 from TAS2120 product folder.
2. Read the TAS2120 data sheet.
3. Visit e2e forum for any questions.

Features

- Mono speaker evaluation
- Plug-n-play hardware mode
- Advanced software mode interface using PurePath™ Console 3 Windows® software
- EVM interconnection for stereo testing
- USB input
- External I^2C and I^2S/TDM host controller connection available

Applications

- Mobile phone, tablets and wearables
- Smart speakers with voice assistance
- Bluetooth and wireless speakers



TAS2120 Mono Evaluation Module

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1 Evaluation Module Overview

1.1 Introduction

This user's guide describes the function and use of the TAS2120EVM. This document includes the hardware configuration instructions, a quick-start guide, jumper and connector descriptions, software description, schematics, and printed circuit board (PCB) layout that demonstrate TI's recommended practices for these devices.

This section provides details on what is included inside the evaluation module box, what are TAS2120 capabilities and operation ranges, as well as what is the additional test equipment that can be required for a full audio evaluation.

1.2 Kit Contents

The evaluation kit consists of the following items:

- TAS2120EVM
- AC-MB controller board

A speaker is not included in the kit, however any speaker can be connected to each of the amplifiers outputs using the banana jacks.

Similarly, a power supply is not part of the kit, but the barrel jack connector can be connected to any power supply in a range of 4V to 5.5V.

1.3 Specification

The TAS2120 is a digital input Class-D audio amplifier optimized for delivering best battery life for music playback and voice calls.

The integrated boost operation is flexible so that TAS2120 can be implemented in 1S and 2S battery applications. TAS2120EVM showcases the 1S battery broadly used in mobile and industrial applications. The two EVMs can be interconnected, as shown in Section 3.10.

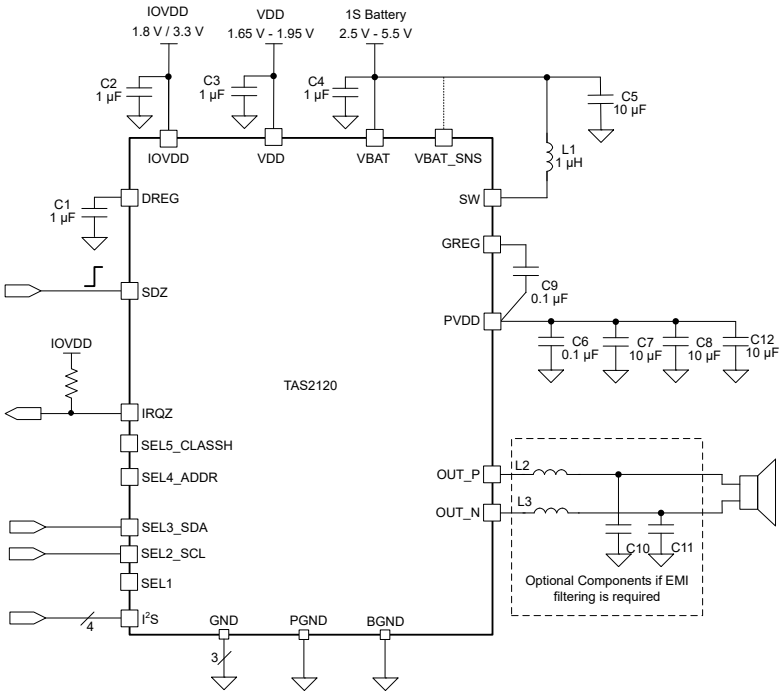

Figure 1-1. Application Diagram for 1S Battery System

For 2S battery applications, the boost inductor can be supplied by a higher supply from 4.7V to 10V. VBAT pin must still be supplied by a voltage from 2.5V to 5.5V.

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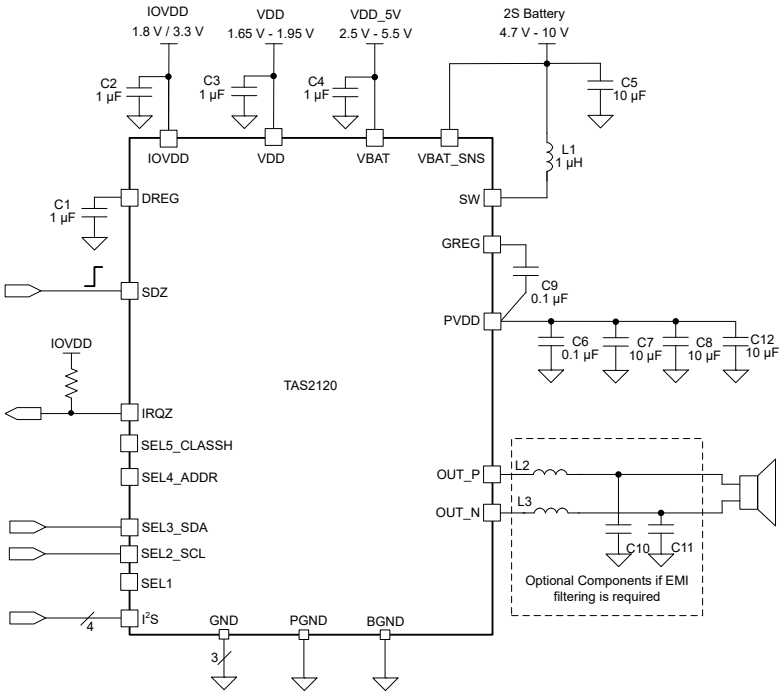

Figure 1-2. Application Diagram for 2S Battery System

In a 3S battery application, the integrated boost can be bypassed, and an external power rail can supply PVDD directly. The boost inductor is not required in this case and SW pins are left open. VBAT pin must still be supplied by a voltage from 2.5V to 5.5V.

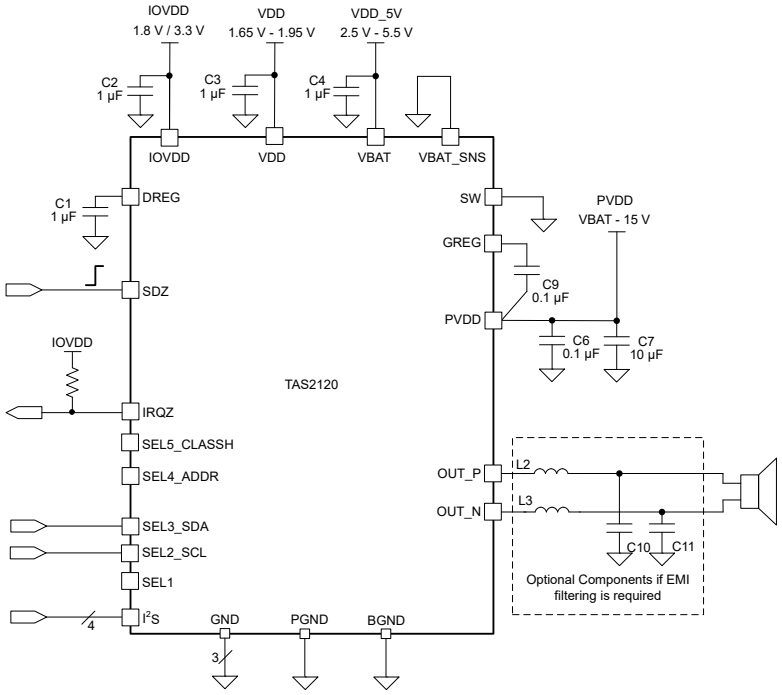

Figure 1-3. Application Diagram for 3S Battery System

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1.4 Device Information

TAS2120 is a mono, digital-input, Class-D audio amplifier optimized for efficiently driving high peak power into small loudspeaker applications. The Class-D amplifier is capable of delivering 6W of max average power into 8Ω load at a battery voltage of 4.2V. Up to four devices can share a common bus via I²S/TDM and I²C interfaces. TAS2120 also supports a simple hardware-controlled mode in which the I²C is disabled and replaced with basic option selection re-purposing some of the digital control pins.

2 Quick Start Guide

2.1 TAS2120EVM Setup for Software Mode

Follow the information presented in this section to properly set the EVM for Software Mode. Place the jumpers as instructed in Table 2-1.

Table 2-1. Software Mode Jumper Settings

Jumper	Setting	Description
SEL1 (J9/J86)	I²C	Short from the middle row to the top pin to select I²C mode.
SEL2 (J10/J87)	Open	This pin is re-purposed as SCL, remove the jumper.
SEL3 (J78)	Open	This pin is re-purposed as SDA, remove the jumper.
SEL4 (J79)	0x90	Select the I²C address option.
SEL5 (J8/J12)	Open	This pin is not used in I²C mode, remove the jumper.

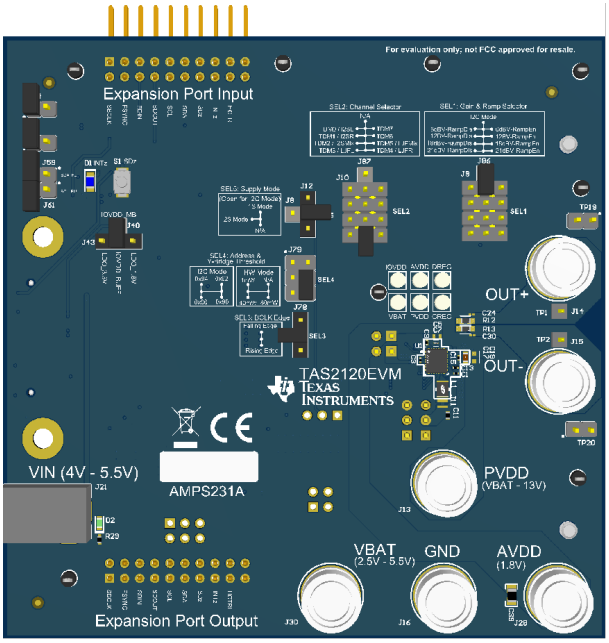

Figure 2-1. Software Mode Jumper Settings

Once all the jumpers on the EVM are properly located, follow the steps below:

- Connect AC-MB to EVM by placing the EVM on top of the edge of the AC-MB.
- Set the IOVDD jumper on AC-MB to either 3.3V or 1.8V.
- Connect USB cable from PC to AC-MB.
- Connect 5V power adapter to barrel jack J21 on TAS2120EVM.

At this moment, the device is powered up and running, ready to play audio. The evaluation kit works as any other sound card, select the EVM as system playback device and use any software like web browser, media player, and so forth.

Users can use PPC3 and connect to the device for specific device settings.

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2.2 TAS2120EVM Setup for Hardware Mode

Follow the information presented in this section to properly set the EVM for Hardware Mode. Place the jumpers as instructed in Table 2-2.

Table 2-2. Hardware Mode Jumper Settings

Jumper	Setting	Description
SEL1 (J9/J86)	21dBV-RampEn	Short from the middle row to a nearby pin to select one of the gain and ramp enable/disable options.
SEL2 (J10/J87)	TDM0 / I2SL	Short from the middle row to a nearby pin to select one of the channel options.
SEL3 (J78)	Falling Edge	Select SBCLK sampling edge.
SEL4 (J79)	80mW	Select the Y-Bridge Threshold option.
SEL5 (J8/J12)	1S Mode	Select 1S power mode. 2S mode requires special power connections.

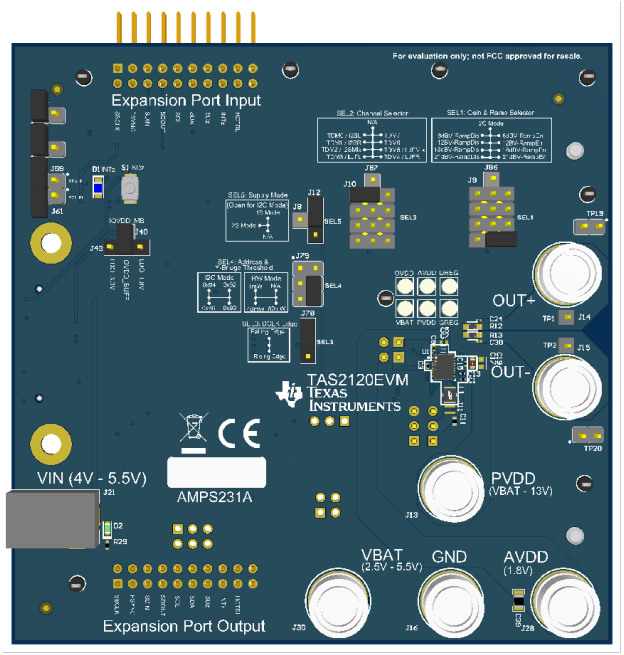

Figure 2-2. Hardware Mode Jumper Settings

Once all the jumpers on the EVM are properly located, follow the steps below:

- Remove jumper from J3 - IOVDD_MB on AC-MB.
- Connect AC-MB to EVM by placing the EVM on top of the edge of the AC-MB.
- Connect 5V power adapter to barrel jack J21 on TAS2120EVM
- Connect USB cable from PC to AC-MB.
- Place back the J3 - IOVDD_MB jumper on AC-MB to either 3.3V or 1.8V.

At this moment, the device is powered up and running, ready to play audio. The evaluation kit works as any other sound card, select the EVM as system playback device and use any software like web browser, media player, and so forth.

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3 Hardware

3.1 AC-MB Settings

3.1.1 Audio Serial Interface Settings

The AC-MB provides the digital audio signals to the evaluation module from the USB, optical connector, stereo jack, and external audio serial interface (ASI) header. A block diagram of the ASI routing on the AC-MB is shown in Figure 3-1.

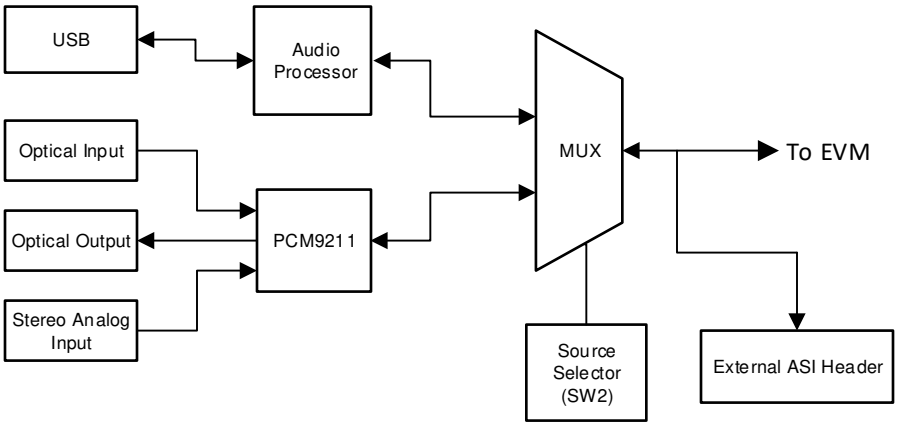

Figure 3-1. AC-MB Audio Serial Interface Routing

Switch SW2 on the AC-MB selects the audio serial bus that interfaces with the TAS2120EVM daughter card. Next to switch SW2, the AC-MB has a quick reference table to identify the audio serial interface source options and switch settings. The AC-MB acts as the controller for the audio serial interface, with three different modes of operation: USB, optical or analog, or external ASI.

3.1.2 USB Audio AC-MB Settings

The serial interface clocks and data are provided from the USB interface. The sampling rate and format are determined by the USB audio class driver on the operating system.

The default settings for the USB audio interface are 32-bit frame size, 48kHz sampling rate, BCLK and FSYNC ratio is 256, and the format is time division multiplexing (TDM).

The AC-MB is detected by the OS as an audio device with the name TI USB Audio UAC2.0. The AC-MB audio setting for the USB mode of operation is shown in Figure 3-2.

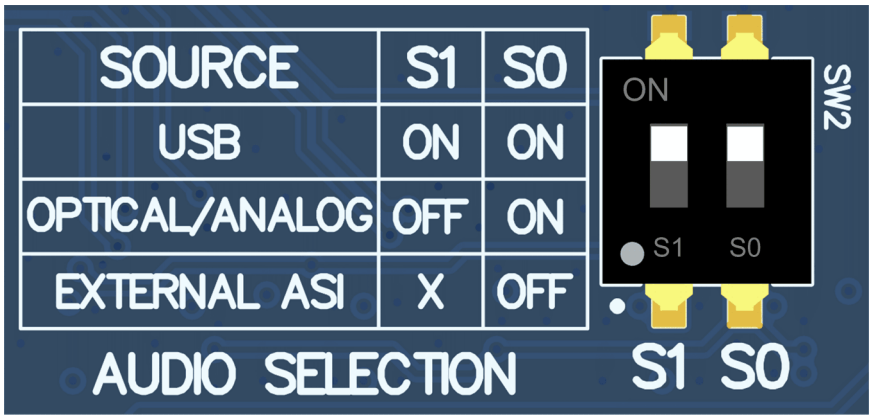

Figure 3-2. AC-MB USB Audio Setting

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3.1.3 External Audio AC-MB Settings

In this mode, the audio serial interface clocks for the evaluation board are provided through connector J7 from an external source. This architecture allows the use of an external system to communicate with the evaluation board, such as a different host processor or test equipment (for instance, Audio Precision PSIA). The clocks generated from the USB interface and PCM9211 are isolated with this setting. The AC-MB audio setting for the external mode of operation is shown in Figure 3-3.

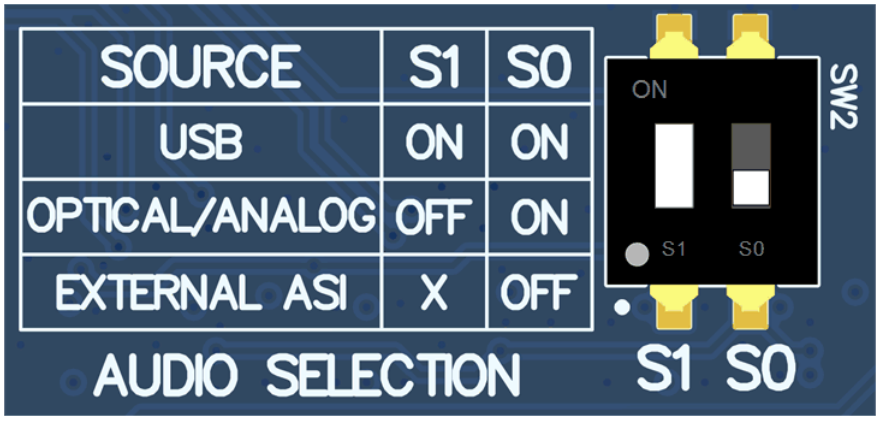

Figure 3-3. AC-MB External Audio Setting

How to connect the external audio interface with the bottom row for the ground and the top row for signals is shown in Figure 3-4.

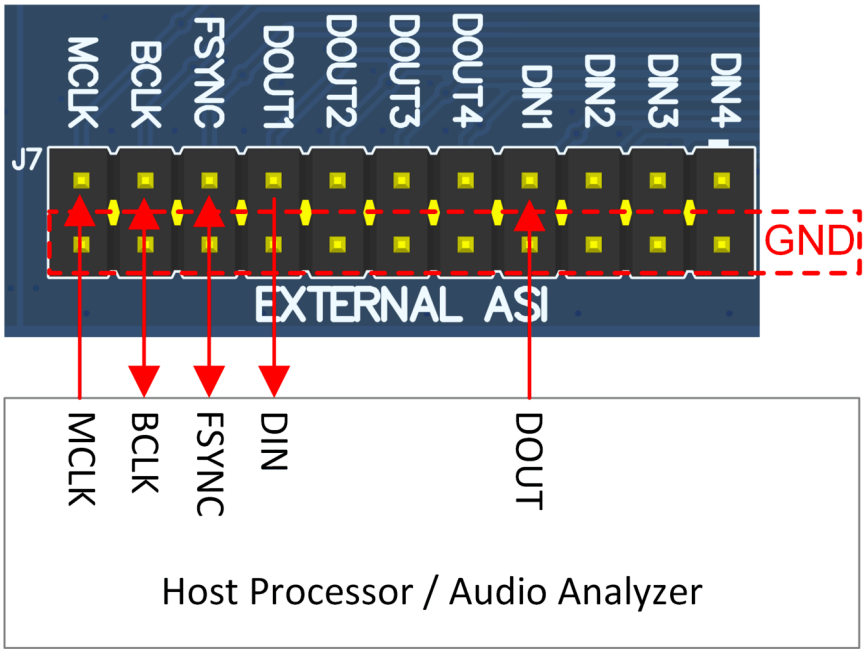

Figure 3-4. AC-MB Connection with External Audio Serial Interface

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3.2 AC-MB Power Supply

The AC-MB motherboard is powered from a single 5V power supply. However, the motherboard has different low-dropout regulators (LDOs) integrated that provide the required power supplies to the different blocks of the board. The block diagram depicting the power structure of the AC-MB is shown in Figure 3-5. The AC-MB can be powered from the host computer by using the USB 5V power supply (VBUS) by shorting header J5, USB POWER. Additionally, the AC-MB can be powered from an external power supply connected to terminal J4, EXTERNAL POWER. Header J5 must be open for external supply operation. The IOVDD voltage for the digital signals that is provided to the evaluation module is generated on the motherboard from the main power supply (USB or external). The voltage levels available are 1.2V, 1.8V and 3.3V, and can be selected via the J3 header IOVDD. Default setting for TAS2120EVM operation is 3.3V; **1.2V operation cannot be used for TAS2120EVM**. When the motherboard is fully powered and the power supplies from the onboard LDOs are correct, the green POWER LED (D3) turns ON. The USB READY LED indicates that a successful USB communication is established between the AC-MB and the host computer.

CAUTION

Please follow the procedure below if using TAS2120EVM in Hardware Mode:

- Remove jumper from J3 - IOVDD_MB on AC-MB
- Connect AC-MB to USB
- Power TAS2120EVM
- Place back jumper J3 - IOVDD_MB on AC-MB to the desired selection (1.8V or 3.3V)

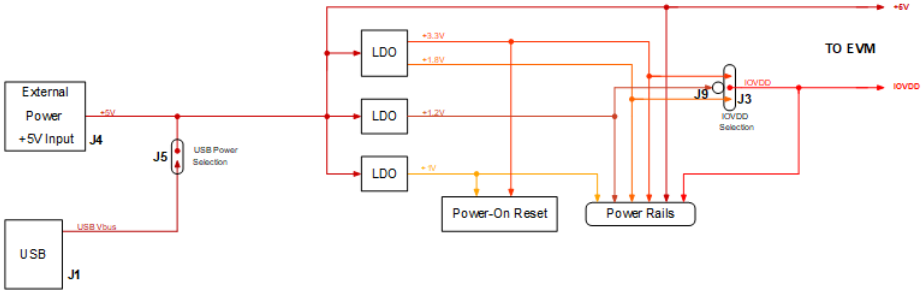

Figure 3-5. Power -Supply Distribution of the AC-MB

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3.3 Default Jumper Setting on TAS2120EVM

TAS2120EVM comes setup for Hardware Mode by default.All the default jumper settings is shown in Figure 3-6.

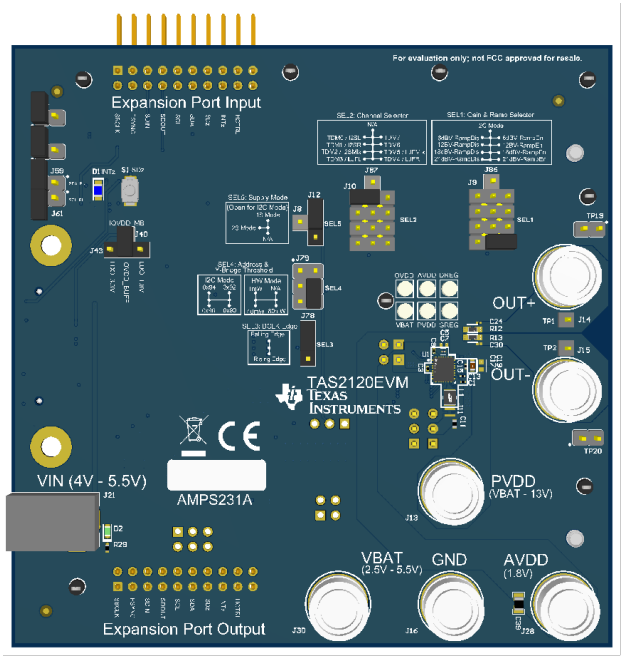

Figure 3-6. Default Jumper Settings for Hardware Mode

The default positions for all the jumpers on TAS2120EVM is shown in Table 3-1.

Table 3-1. Default Jumper Settings

Jumper	Setting	Description
SEL1 (J9/J86)	21dBV-RampEn	Short from the middle row to a nearby pin to select one of the gain and ramp enable or disable options.
SEL2 (J10/J87)	TDM0 / I2SL	Short from the middle row to a nearby pin to select one of the channel options.
SEL3 (J78)	Falling Edge	Select SBCLK sampling edge.
SEL4 (J79)	80mW	Select the Y-Bridge Threshold option.
SEL5 (J8/J12)	1S Mode	Select 1S power mode. 2S mode requires special power connections.
IOVDD_BUFF (J40/J43)	IOVDD_MB	Set IOVDD_BUFF rail to be same as IOVDD_MB.
J54	Open	EEPROM Address.
J53	Short	EEPROM WP.
J59	Open	Additional SDA pull-up.
J61	Open	Additional SCL pull-up.
VBAT (U1) (J5)	VIN (J21)	VBAT pin on TAS2120 powered from J21, refer to Section 3.7.
VBAT_SNS (J4)	GND	VBAT_SNS pin connected to GND.
J3	Short	IOVDD powered from IOVDD_MB when shorted, refer to Section 3.5.
J7	Short	AVDD powered from on-board 1.8V LDO when shorted, refer to Section 3.6.

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3.4 I²C Target Address Selection

TAS2120 supports 4 different I²C selectable addresses. When SEL1 is set to I²C Mode by shorting the middle row to the top pin (J86), the device checks the state of SEL4 to select the device address. Use SEL4 jumper to select the required I2C address.

CAUTION

By default, the amplifier is configured to play the audio slot according to the I²C address, that is, in a TDM system, device with address 0x90 plays slot 0, address 0x92 plays slot 1, and so on.

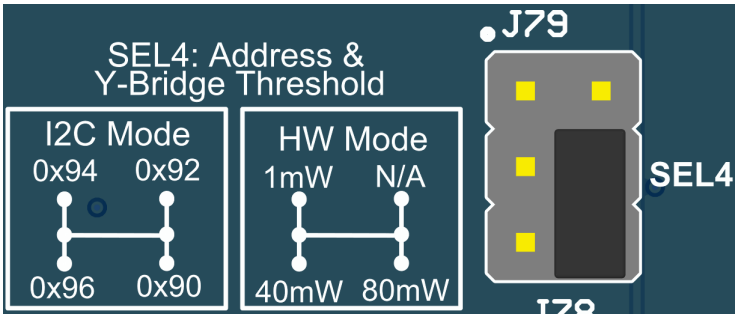

Figure 3-7. J79 Address Selection

3.5 IOVDD Power Supply Options

IOVDD supply to TAS2120 is powered by AC-MB through IOVDD_MB selection. For simplicity, the same IOVDD voltage selected on AC-MB is used for TAS2120.

J3 on the bottom side of the EVM can be used to open this power supply connection for current measurement purposes. If J3 is open, then an external IOVDD must be connected to the IOVDD test point close to TAS2120 - U1.

3.6 AVDD Power Supply Options

AVDD supply to TAS2120 is powered by an on-board 1.8V LDO. This LDO is powered from 5V connected to VBAT barrel jack J21.

J7 on the bottom side of the EVM can be used to open this power supply connection for current measurement purposes. If J7 is open, an external AVDD must be connected to the J28 banana jack.

3.7 VBAT Power Supply Options

VBAT supply to TAS2120 is powered by 5V connected to VBAT barrel jack J21.

J5 on the bottom side of the EVM can be used to select between 2 different sources for VBAT.

- VIN (J21) is selected by default, which is the barrel jack supplied by 5V.
- VBAT (J30) is an alternative banana jack that can be used to supply VBAT to TAS2120; U1 only. Use this for current and efficiency measurements.

CAUTION

5V must be connected to barrel jack J21 even if using J30 for VBAT connection to TAS2120. VIN (J21) is used to power other things in the EVM.

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3.7.1 VBAT 3S EVM Hardware Configuration

This section shows how to set the EVM jumpers to evaluate TAS2120EVM in a 3S battery application for VBAT as depicted in Figure 1-3.

VBAT pin must still be connected to a power supply range from 3V up to 5V. VBAT_SNS cannot be used so VBAT_SNS must be shorted to GND. The internal boost is not used, so the SW pins are left floating and the inductor can be removed from the circuit.

3S battery supply range from VBAT pin level up to 14V is directly connected to PVDD node. The decoupling capacitors and GREG capacitor are still required.

- VBAT pin 5V connection can be powered from VIN (J21) by setting J5 position to 2-3 (default).
- VBAT_SNS pin connection must be left as default with J4 shorted across pins 2-3.
- 3S VBAT supply must be connected to J13.

3.8 IOVDD_BUFF Power Supply Options

IOVDD_BUFF is used to power logic buffers and level translator for miscellaneous devices on the EVM, such as EEPROM for EVM identification as well as SDz and IRQz handling buffers.

IOVDD_BUFF can be supplied by onboard 3.3V or 1.8V LDOs, which are power by 5V from VIN (J21). Use J40 to select the same voltage level as that on J3 from AC-MB.

3.9 Speaker Outputs

OUT+ (J14) and OUT- (J15) are the outputs from the amplifier. Banana cables can be connected directly to these jacks. Alternatively the banana jack can be unscrewed to use bare wires, similar to a screw terminal.

3.10 2-Channel Configuration

Two mono EVMs can be interconnected using J2 and J6 headers, place the EVMs side by side and connect J6 from the first EVM to J2 on the second EVM.

CAUTION

When 2 EVMs are interconnected, both EVMs must be set to the same mode, that is, either both EVMs are in Hardware mode or both EVMs are in Software mode. Mixed configuration is not supported. Use the same jumper settings for both EVMs.

CAUTION

If using Hardware mode for 2-Channel configuration, then R19 located in the center of the bottom side of the PCB must be removed from the EVM to isolate SEL2 for each EVM.

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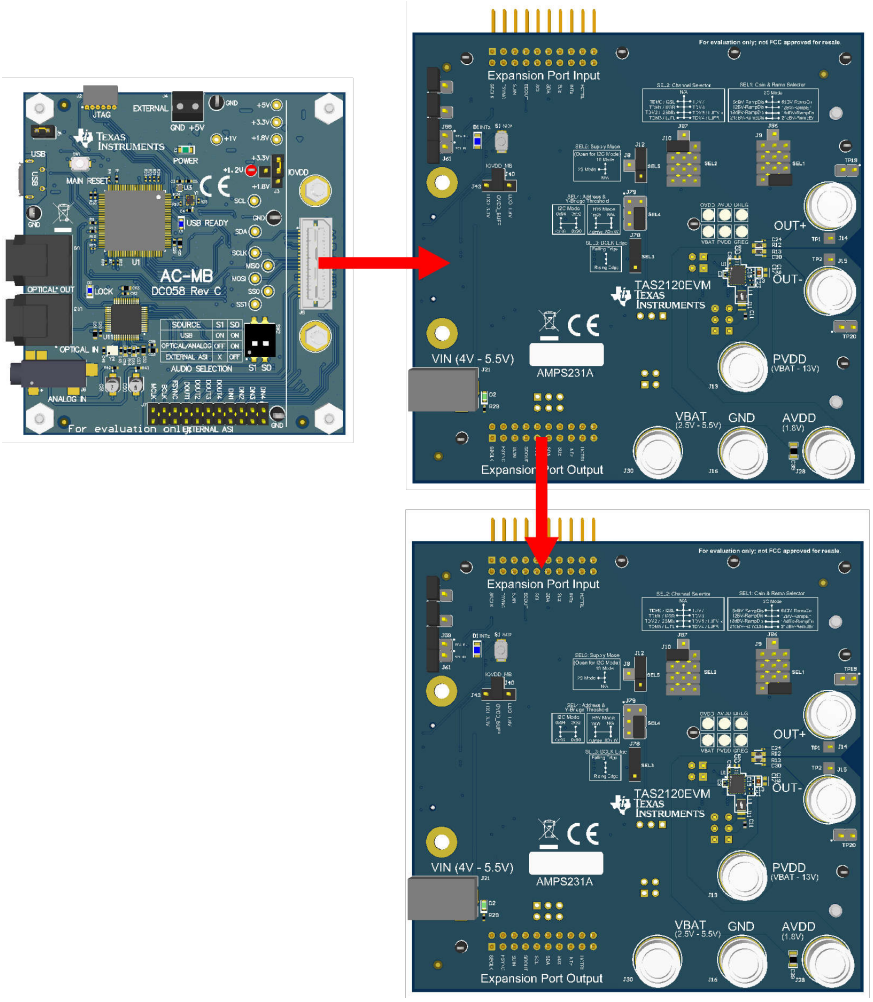

Figure 3-8. 2-Channel EVM Interconnection

3.11 4-Wire Measurement of Load

TAS2120EVM has been designed such that the dummy load or speaker load connected to the device can be measured very accurately directly from the device pin including board parasitic and connector contact resistance using 4-wire method in digital multimeter. Pin header have been provided to be able to connect digital multimeter in 4-wire mode as shown below Figure 3-9.

Connect HI of DMM to pin-1 and HI_SNS of DMM to pin-2 of TP19 test point.

Connect LO of DMM to pin-2 and LO_SNS of DMM to pin-1 of TP20 test point.

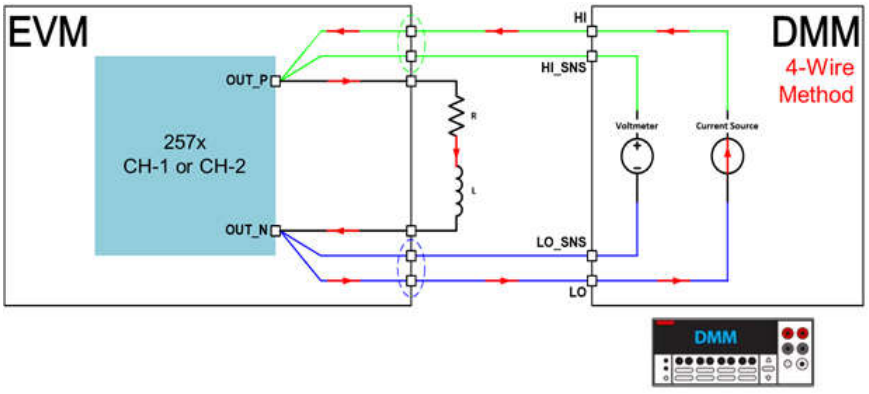

Figure 3-9. Load DC Resistance Measurement in 4-Wire Mode using Digital Multimeter

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4 Hardware Design Files

4.1 Schematics

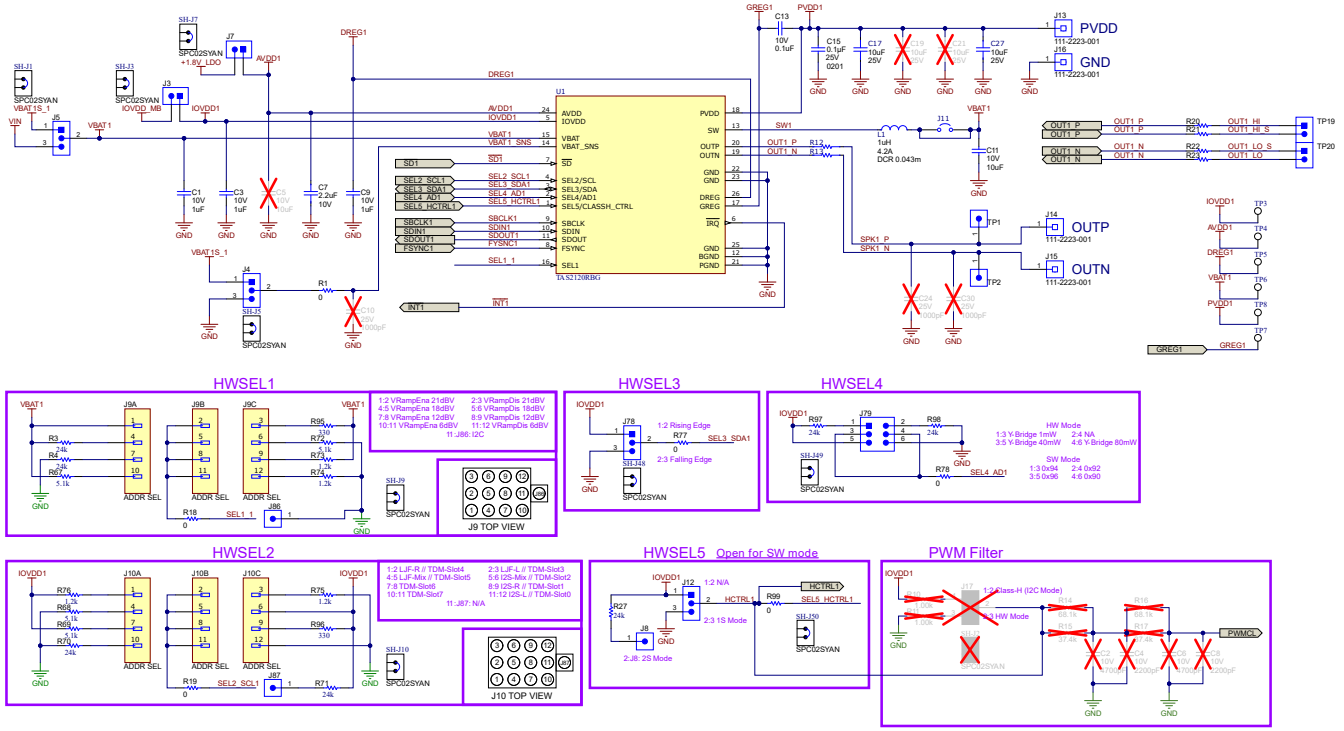

Figure 4-1. TAS2120EVM Schematic (Sheet 1 of 4)

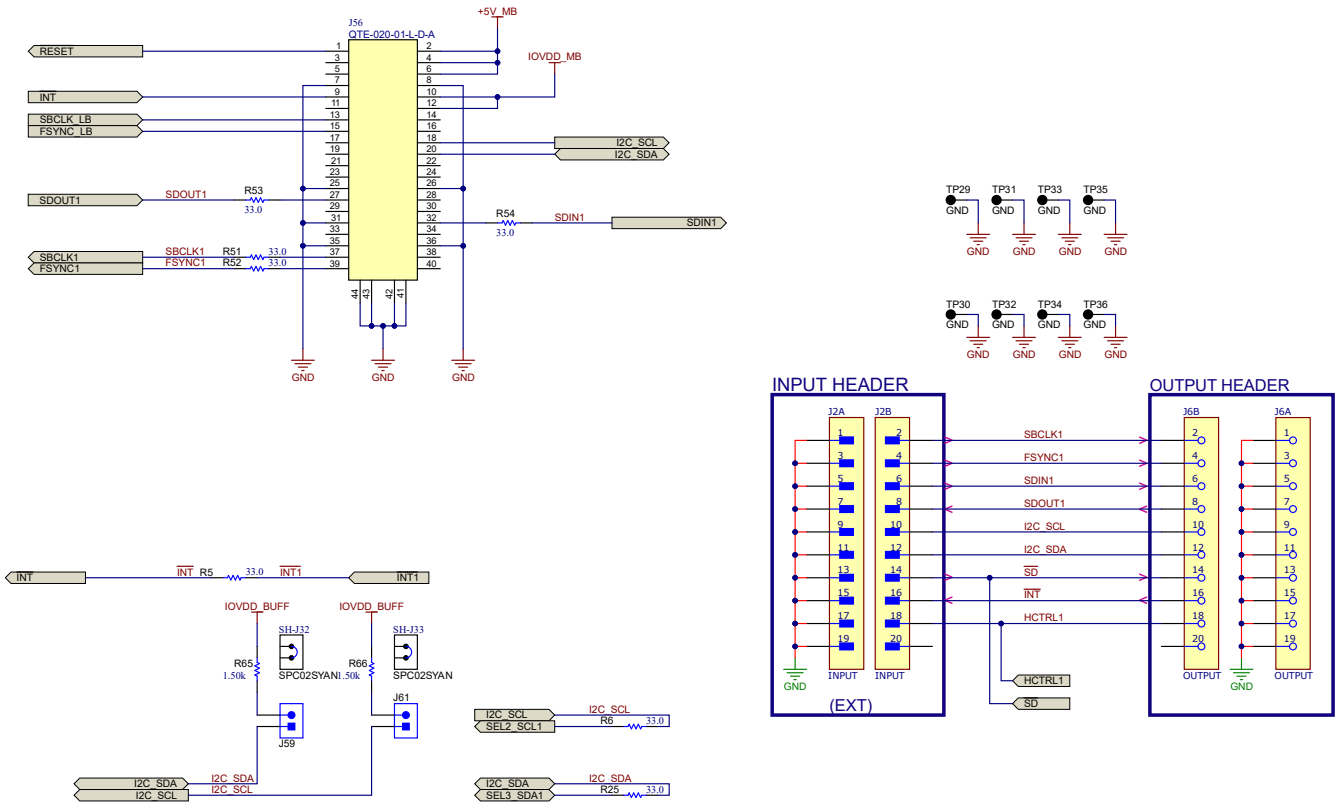

Figure 4-2. TAS2120EVM Schematic (Sheet 2 of 4)

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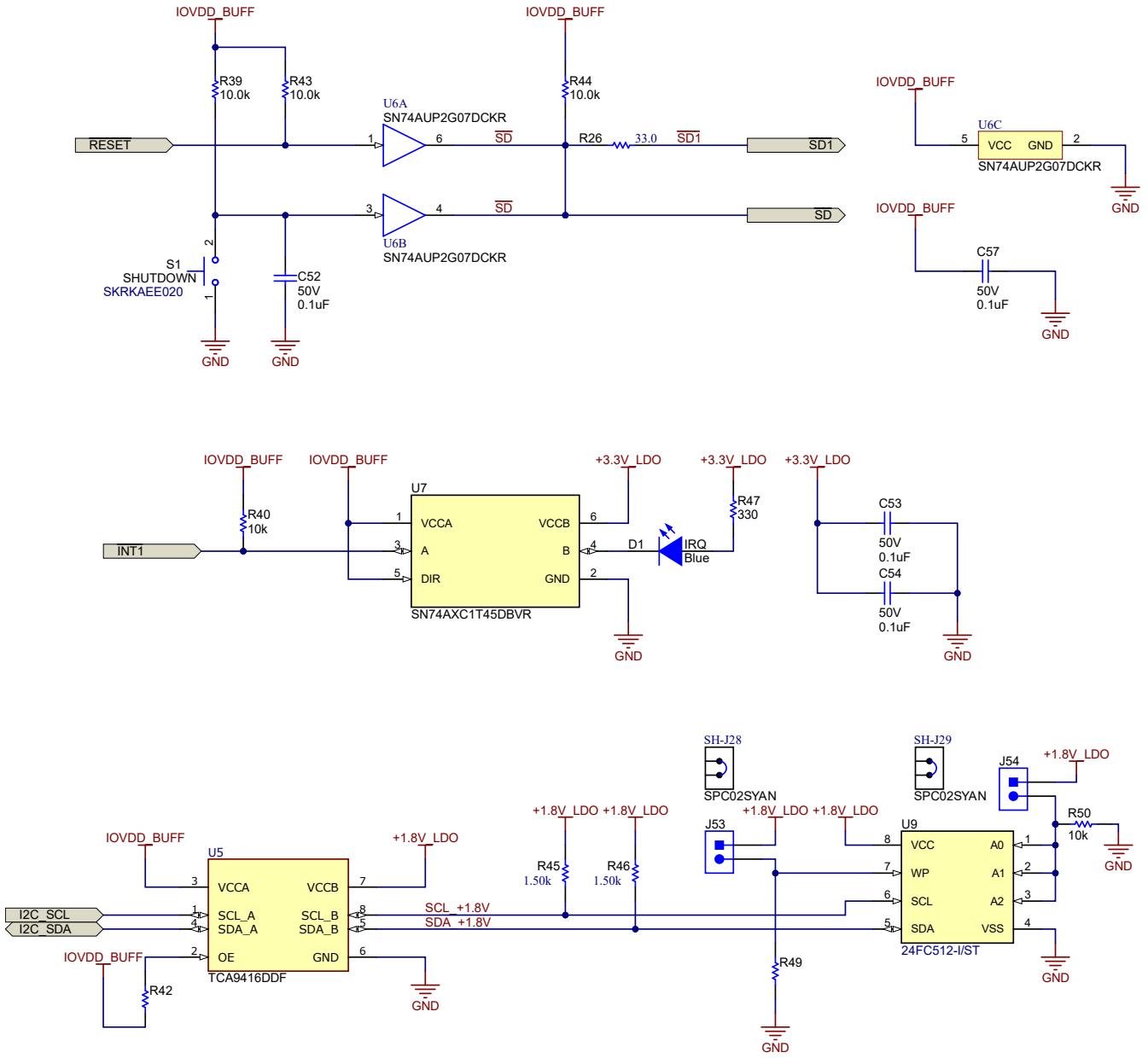

Figure 4-3. TAS2120EVM Schematic (Sheet 3 of 4)

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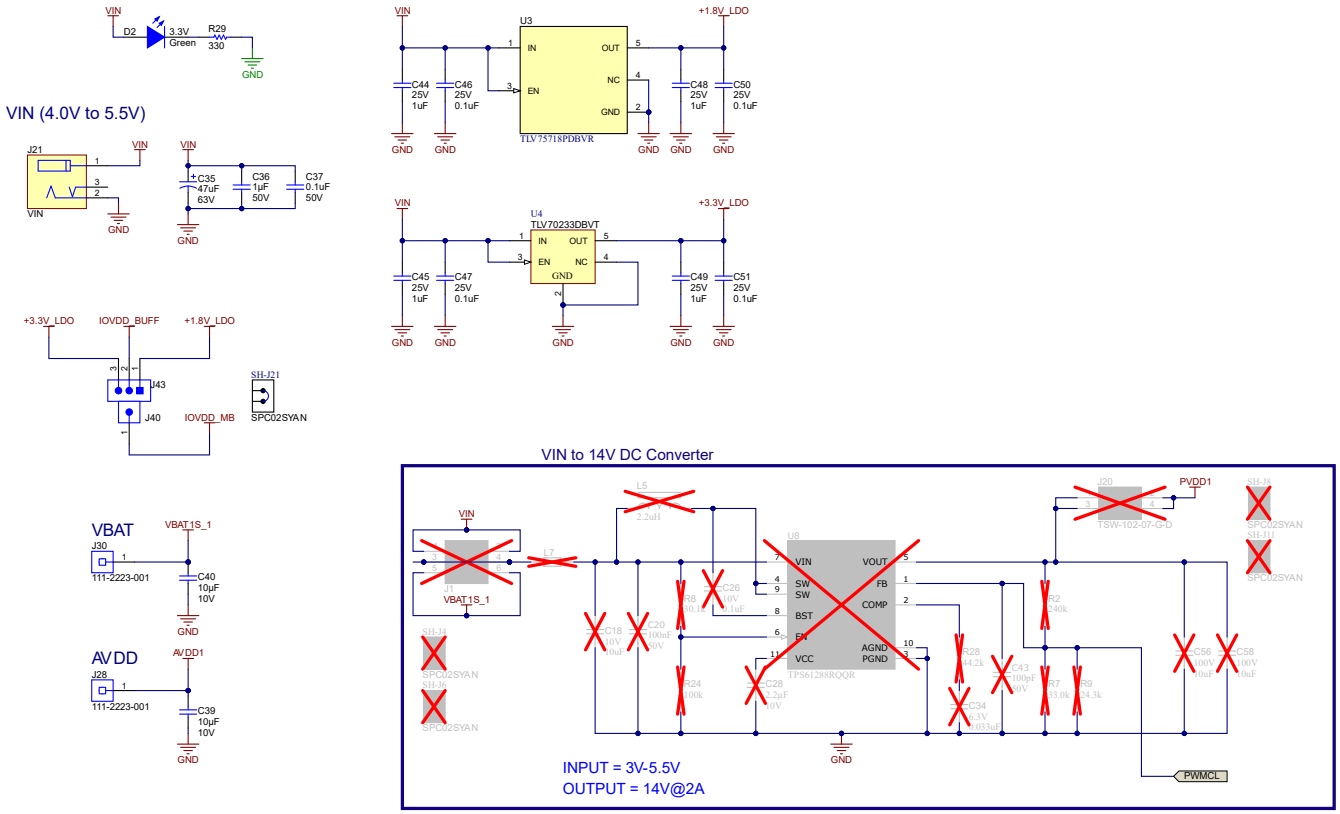

Figure 4-4. TAS2120EVM Schematic (Sheet 4 of 4)

4.2 PCB Layouts

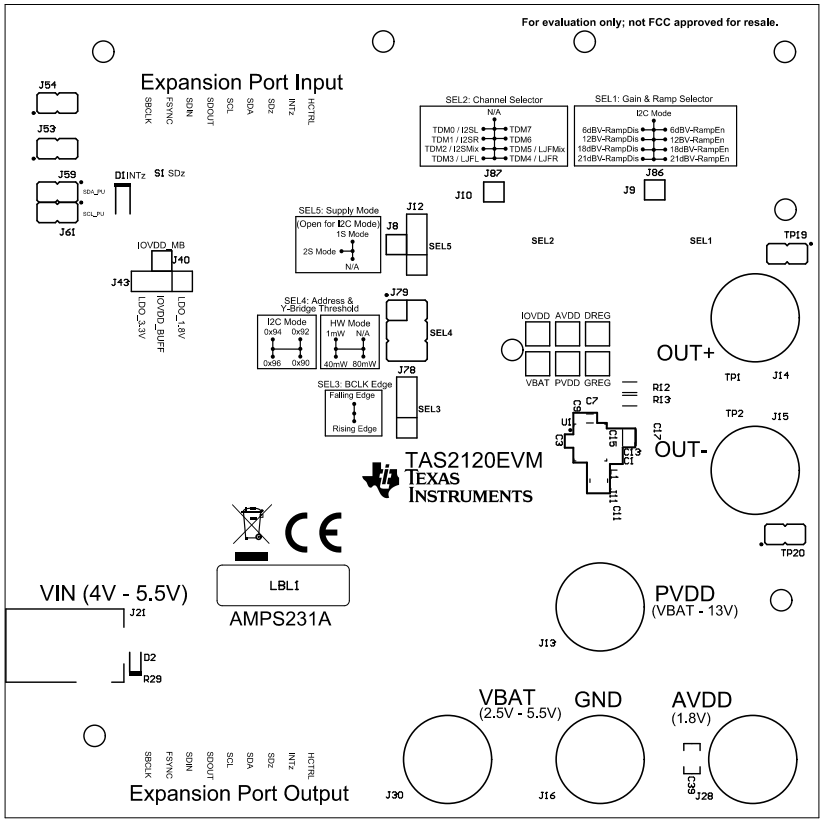

Figure 4-5. TAS2120EVM Top Overlay

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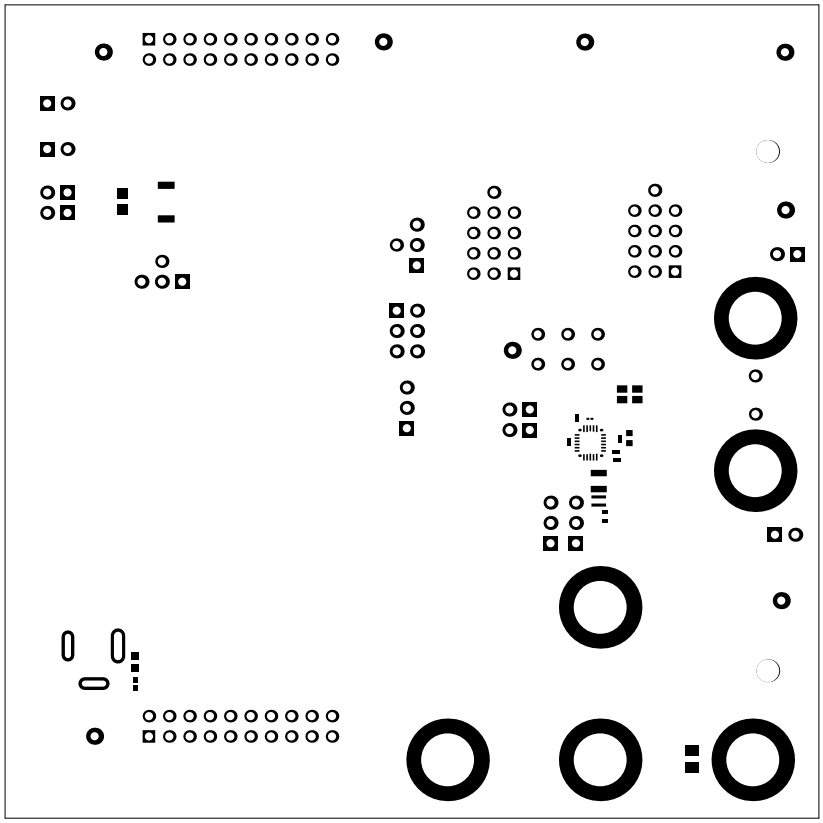

Figure 4-6. TAS2120EVM Top Solder Mask

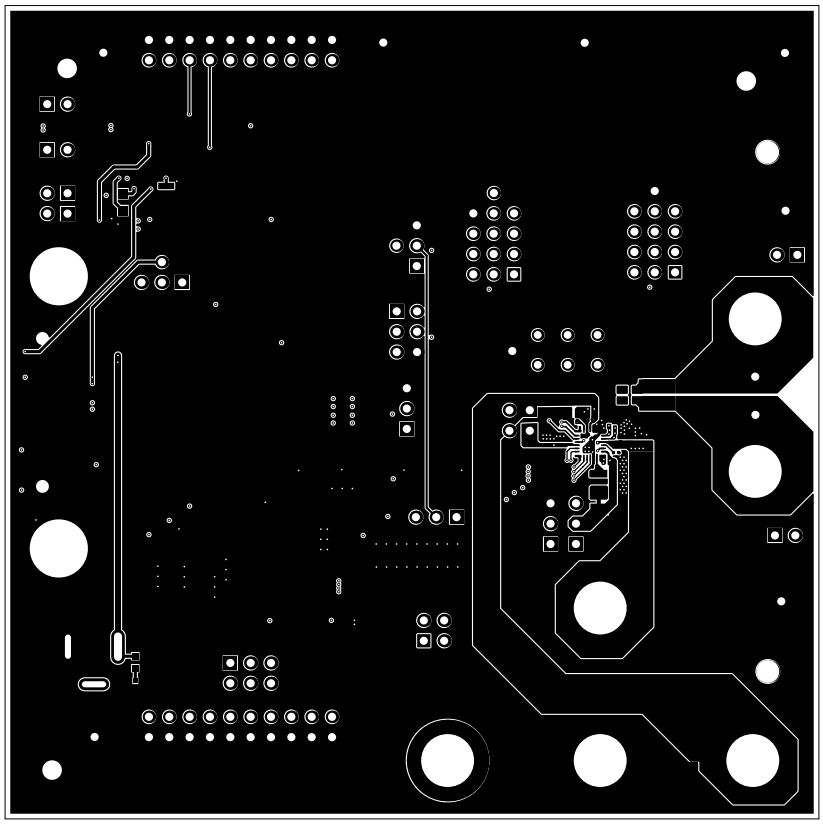

Figure 4-7. TAS2120EVM Top Layer

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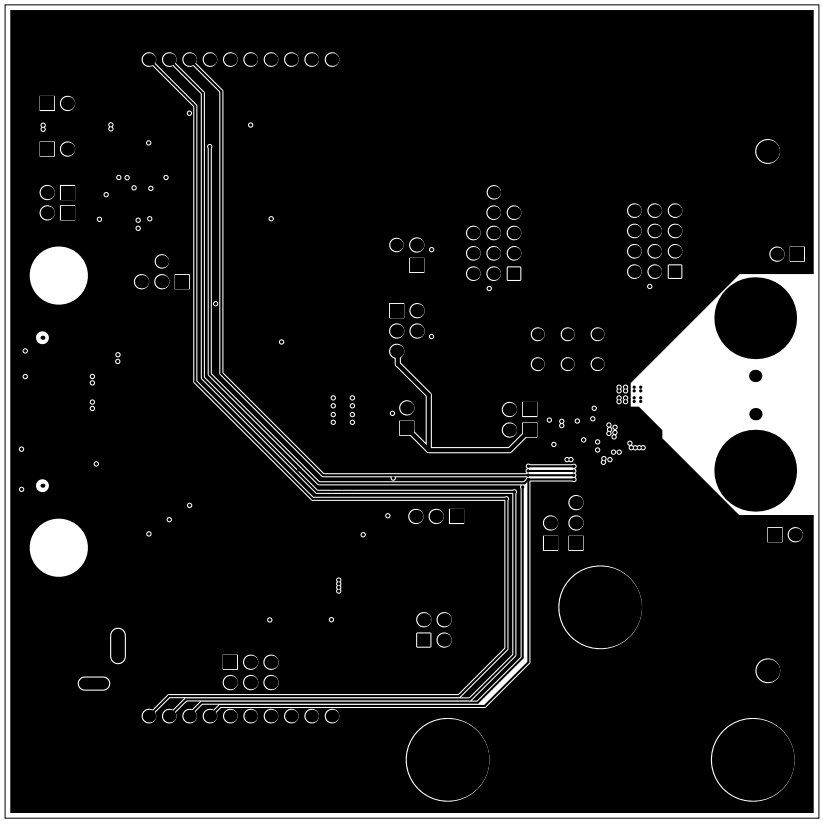

Figure 4-8. TAS2120EVM Layer 2

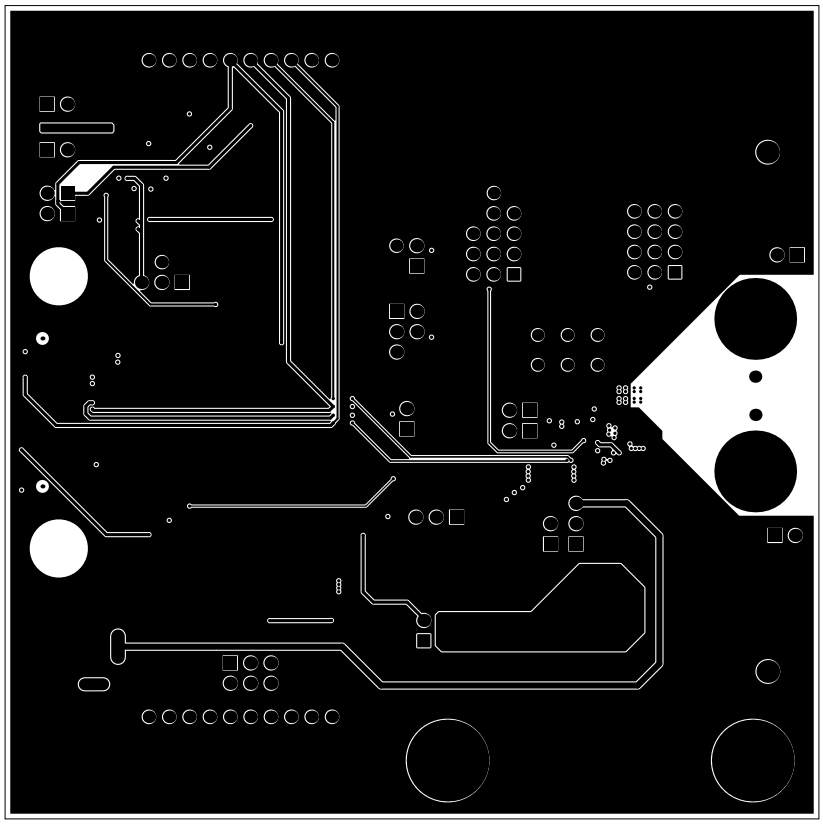

Figure 4-9. TAS2120EVM Layer 3

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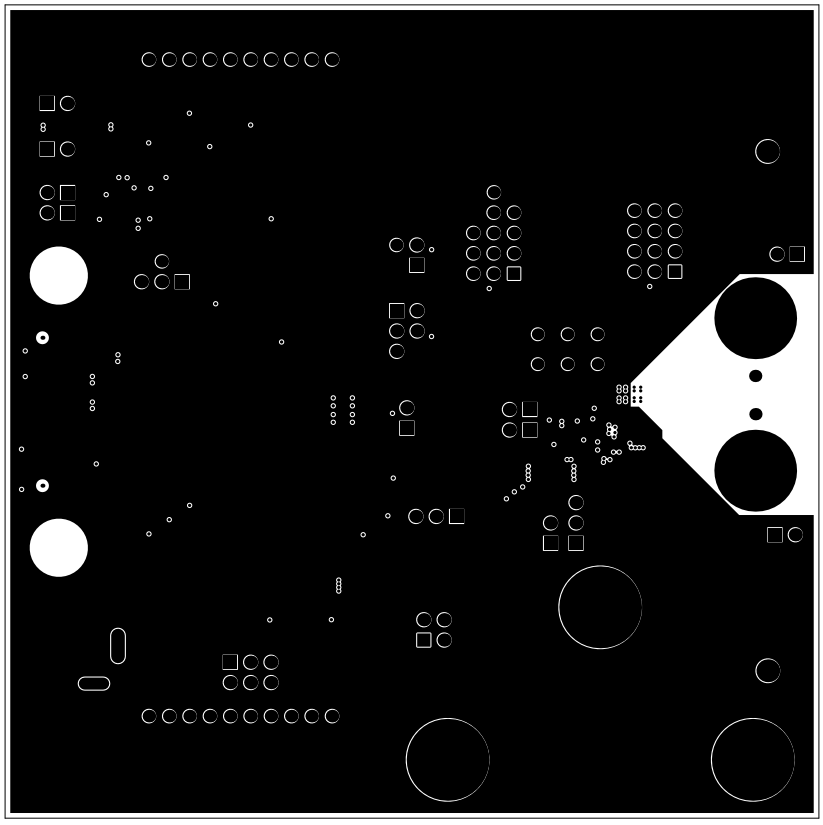

Figure 4-10. TAS2120EVM Layer 4

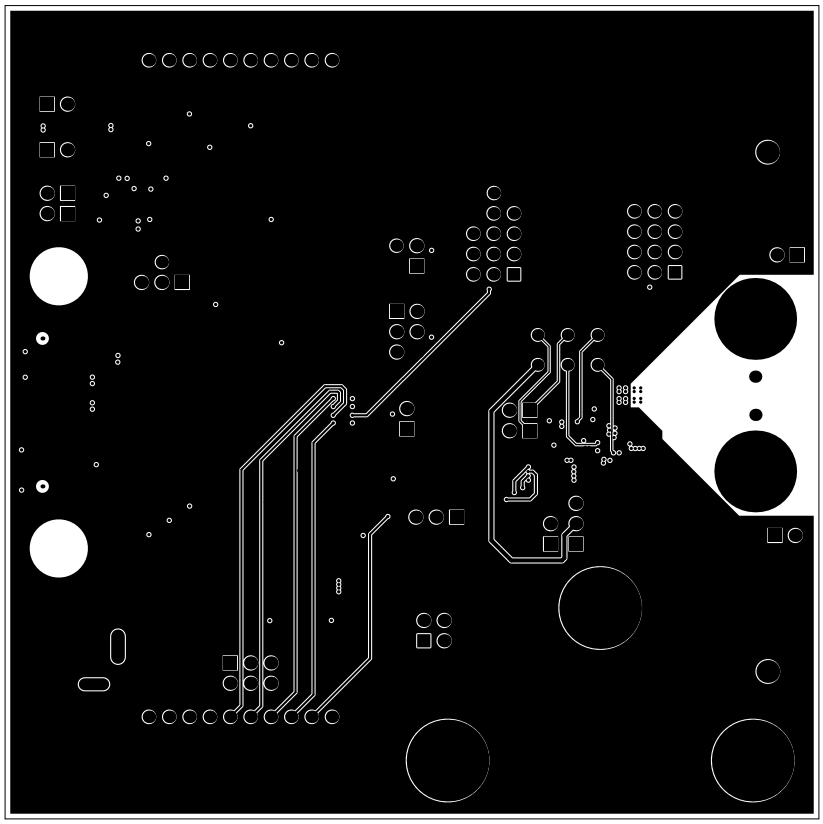

Figure 4-11. TAS2120EVM Layer 5

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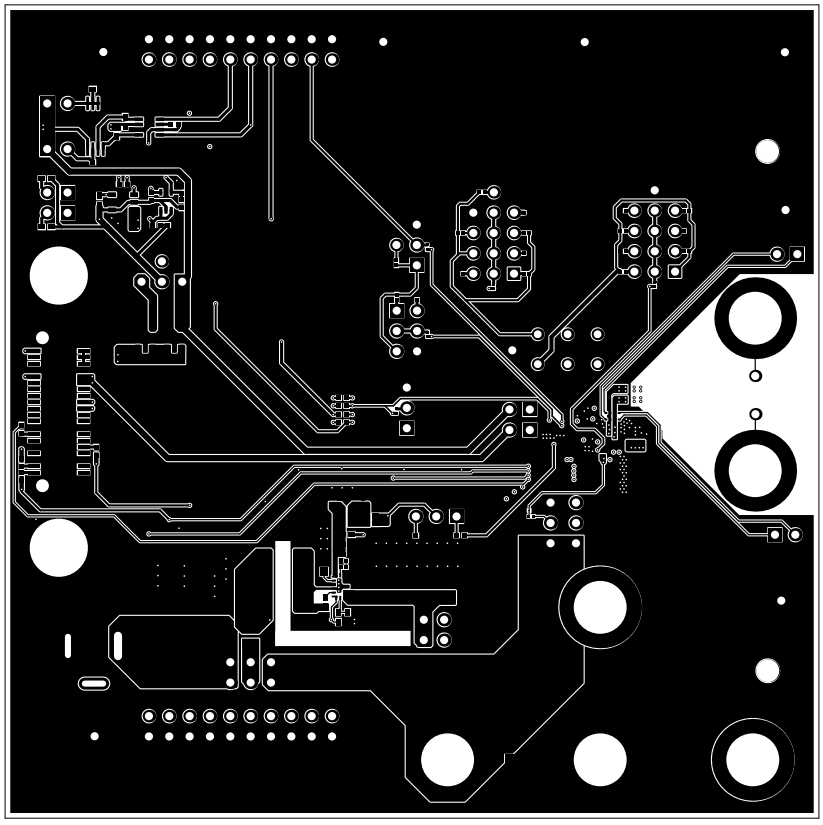

Figure 4-12. TAS2120EVM Bottom Layer

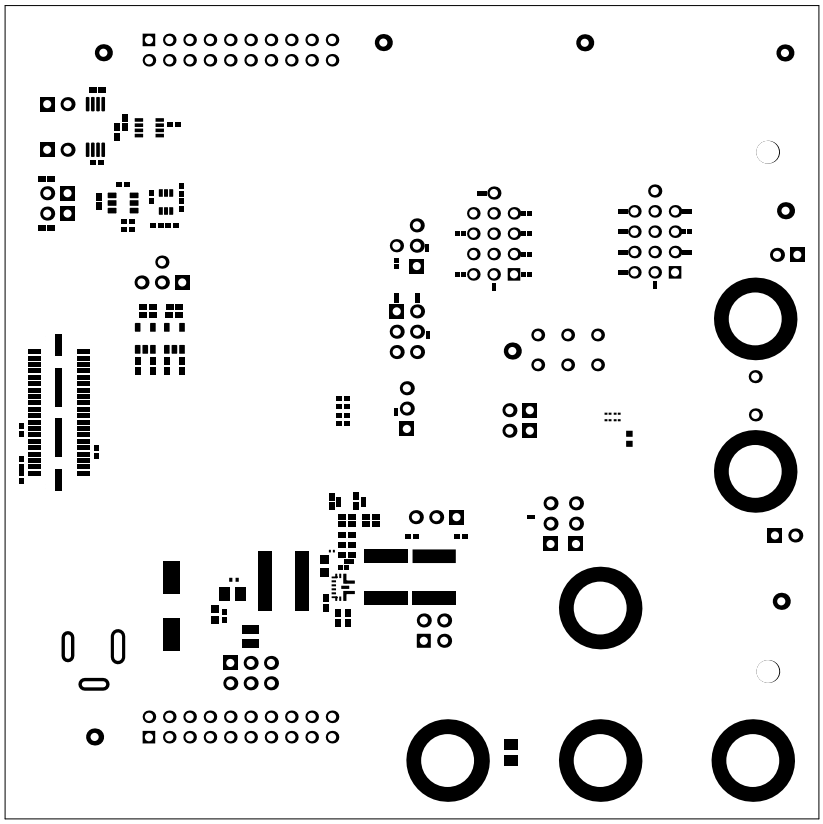

Figure 4-13. TAS2120EVM Bottom Solder Mask

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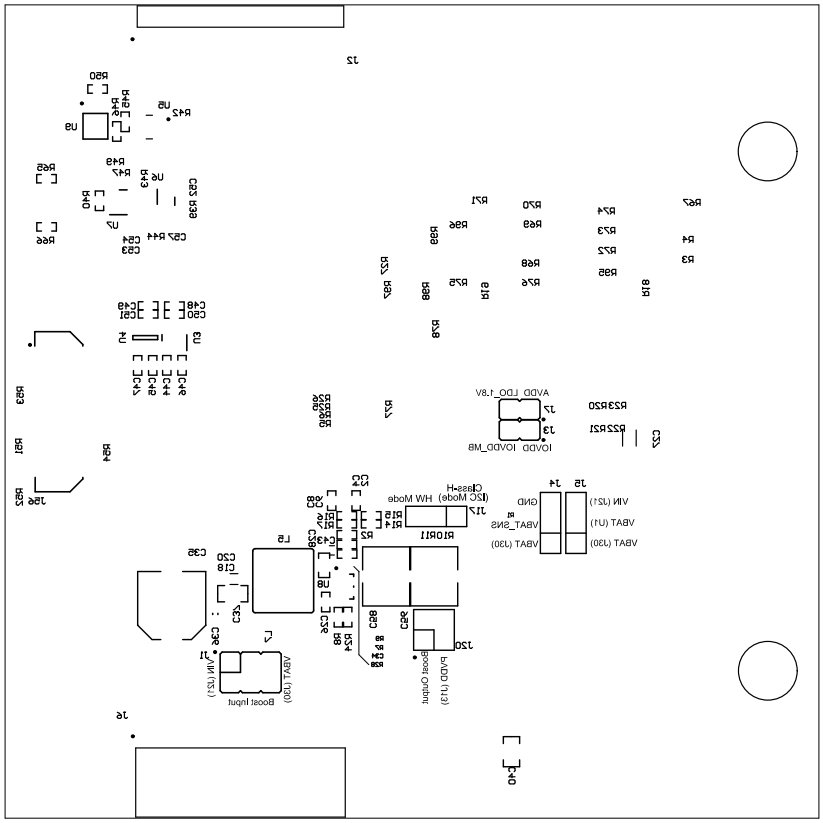

Figure 4-14. TAS2120EVM Bottom Overlay

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4.3 Bill of Materials

The bill of materials for the EVM is listed in Table 4-1.

Table 4-1. Bill of Materials

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer	Alternate Part Number	Alternate Manufacturer
C1, C3, C9	3	1uF	CAP, CERM, 1uF, 10V, +/- 20%, X5R, 0201	0201	CL03A105MP3NSNC	Samsung Electro-Mechanics		
C7	1	2.2µF	Cap Ceramic 2.2uF 10V X5R ±20% Pad SMD 0201 +85°C T/R	0201	CL03A225MP3CRNC	Samsung		
C11	1	10uF	CAP, CERM, 10uF, 10V, +/- 20%, X5R, 0402	0402	CL05A106MP5NUNC	Samsung Electro-Mechanics		
C13	1	0.1uF	CAP, CERM, 0.1uF, 10V, +/- 10%, X5R, 0201	0201	CL03A104KP3NNNC	Samsung Electro-Mechanics		
C15	1	0.1uF	CAP, CERM, 0.1µF, 10V,+/- 10%, X5R, 0201	0201		SAMSUNG ELECTRO-MECHANICS		
C17, C27	2	10µF	Cap Ceramic 10uF 25V X5R ±20% Pad SMD 0603 +85°C T/R	0603	CL10A106MA8NRNC	Samsung		
C35	1	47uF	CAP, AL, 47uF, 63V, +/- 20%, 0.65 ohm, AEC-Q200 Grade 2, SMD	SMT Radial F	EEE-FK1J470P	Panasonic		
C36	1	1uF	CAP, CERM, 1µF, 50V,+/- 20%, X5R, AEC-Q200 Grade 3, 0603	0603	CGA3E3X5R1H105M080AB	TDK		
C37, C52, C53, C54, C57	5	0.1uF	CAP, CERM, 0.1uF, 50V, +/- 10%, X7R, 0402	0402	C1005X7R1H104K050BB	TDK		
C39, C40	2	10uF	CAP, CERM, 10µF, 10V,+/- 10%, X7R, AEC-Q200 Grade 1, 0805	0805	GCJ21BR71A106KE01L	MuRata		
C44, C45, C48, C49	4	1uF	CAP, CERM, 1uF, 25V, +/- 10%, X5R, 0402	0402	C1005X5R1E105K050BC	TDK		
C46, C47, C50, C51	4	0.1uF	CAP, CERM, 0.1uF, 25V, +/- 10%, X5R, 0402	0402	GRM155R61E104KA87D	MuRata		
D1	1	Blue	LED, Blue, SMD	LED_0805	LTST-C170TBKT	Lite-On		
D2	1	Green	LED, Green, SMD	LED_0603	LTST-C191KGKT	Lite-On		
H1, H7	2				HNSS440	B&F Fastener Supply		

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Table 4-1. Bill of Materials (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer	Alternate Part Number	Alternate Manufacturer
H2, H8	2		Standoff; 1/4 Hex Male/female; 4-40 Thread; Stainless Steel; .750LENGTH	HEX_STANDOFF	4538-440-SS	RAF Electronic Hardware		
J2	1			HDR20	TSW-110-08-G-D-RA	Samtec		
J3, J7, J53, J54, J59, J61, TP19, TP20	8		Header, 100mil, 2x1, Gold, TH	Sullins 100mil, 1x2, 230 mil above insulator	PBC02SAAN	Sullins Connector Solutions		
J4, J5, J12, J43, J78	5		Header, 100mil, 3x1, Gold, TH	PBC03SAAN	PBC03SAAN	Sullins Connector Solutions		
J6	1		20 Position Receptacle Connector Through Hole, Right Angle	HDR20	SSQ-110-02-G-D-RA	SAMTEC		
J8, J40, J86, J87	4		Header, 2.54mm, 1x1, Gold, TH	Header, 2.54mm, 1x1, TH	HTSW-101-07-G-S	Samtec		
J9, J10	2			HDR12	TSW-104-07-G-T	Samtec		
J11	1		Jumper-0.015x0.072-0.04p	JUMPER-0.015x0.072-0.04p	Jumper-0.015x0.072-0.04p	Jumper		
J13, J14, J15, J16, J28, J30	6		Binding Post, Nickel, TH	Receptacle, 1x1 Position, Dia 9.8mm, TH	111-2223-001	Cinch Connectivity		
J21	1		Power Jack, mini, 2.5mm OD, R/A, TH	Jack, 14.5x11x9mm	RAPC712X	Switchcraft		
J56	1		Connector, Header, High Speed, 20 pairs, SMT	QTE-020-01-X-D-A	QTE-020-01-L-D-A	Samtec		
J79	1		Header, 100mil, 3x2, Gold, TH	Sullins 100mil, 2x3, 230 mil above insulator	PBC03DAAN	Sullins Connector Solutions		
L1	1	1uH	POWER INDUCTOR 1uH, ±20%, Isat 4.2A, Itemp 4.1A, DCR Max 0.043Ω, 0806	0806	CIGT201610EH1R0MN	Samsung		
LBL1	1		Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	PCB Label 0.650 x 0.200 inch	THT-14-423-10	Brady		
R1, R18, R19, R77, R78, R99	6	0	RES, 0, 5%, 0.05 W, 0201	0201	CRCW02010000Z0ED	Vishay-Dale		

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Table 4-1. Bill of Materials (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer	Alternate Part Number	Alternate Manufacturer
R3, R4, R27, R70, R71, R97, R98	7	24k	RES, 24 k, 5%, 0.05 W, 0201	0201	RC0201JR-0724KL	Yageo America		
R12, R13	2	0	RES 0 OHM JUMPER 1/4W 0603	0603	HCJ0603ZT0R00	Stackpole Electronics		
R20, R21, R22, R23	4		RES SMD 0 OHM JUMPER 1/20W 0201	0201 (0603 Metric)	RC0201JR-070RL	Yageo		
R25, R26, R51, R52, R53, R54	6	33	RES, 33.0, 1%, 0.1 W, 0402	0402	ERJ-2RKF33R0X	Panasonic		
R29, R47	2	330	RES, 330, 1%, 0.1 W, AEC-Q200 Grade 0, 0402	0402	ERJ-2RKF3300X	Panasonic		
R39, R42, R43, R44, R49	5	10.0k	RES, 10.0 k, 1%, 0.063 W, 0402	0402	RC0402FR-0710KL	Yageo America		
R40, R50	2	10k	RES, 10 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0402	0402	ERJ-2GEJ103X	Panasonic		
R45, R46, R65, R66	4	1.50k	RES, 1.50 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	RMCF0402FT1K50	Stackpole Electronics Inc		
R67, R68, R69, R72	4	5.1k	RES, 5.1 k, 5%, 0.05 W, 0201	0201	RC0201JR-075K1L	Yageo America		
R73, R74, R75, R76	4	1.2k	RES, 1.2 k, 5%, 0.05 W, 0201	0201	RC0201JR-071K2L	Yageo America		
R95, R96	2	330	RES, 330, 5%, 0.05 W, 0201	0201	RC0201JR-7D330RL	Yageo America		
S1	1		Switch, SPST-NO, 0.05A, 12 VDC, SMT	3.9x2.9mm	SKRKAEE020	Alps		
SH-J1, SH-J3, SH-J5, SH-J7, SH-J9, SH-J10, SH-J21, SH-J28, SH-J29, SH-J32, SH-J33, SH-J48, SH-J49, SH-J50	14	1x2	Shunt, 100mil, Flash Gold, Black	Closed Top 100mil Shunt	SPC02SYAN	Sullins Connector Solutions		

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Table 4-1. Bill of Materials (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer	Alternate Part Number	Alternate Manufacturer
TP1, TP2	2		Header, 2.54mm, 1x1, Gold, TH	Header, 2.54mm, 1x1, TH	TSW-101-08-G-S	Samtec		
TP3, TP4, TP5, TP6, TP7, TP8	6		Test Point, Miniature, White, TH	Test-Point, Dia 100mil, TH	TP105-01-09	Components Corporation		
TP29, TP30, TP31, TP32, TP33, TP34, TP35, TP36	8		Test Point, Miniature, Black, TH	Black Miniature Test point	5001	Keystone		
U1	1		TAS2120RBG	VQFN-HR26	TAS2120RBG	Texas Instruments		
U3	1		1A low-Iq small-size low-dropout (LDO) regulator, DBV0005A (SOT-23-5)	DBV0005A	TLV75718PDBVR	Texas Instruments	TLV75718PDBVT	Texas Instruments
U4	1		Single Output LDO, 300mA, Fixed 3.3V Output, 2 to 5.5V Input, with Low IQ, 5-pin SOT-23 (DBV), -40 to 125 degC, Green (RoHS & no Sb/Br)	DBV0005A	TLV70233DBVT	Texas Instruments		
U5	1		TCA9416DDF	SOT23-8	TCA9416DDF	Texas Instruments		
U6	1		Low-Power Dual Buffer/Driver With Open-Drain Outputs, DCK0006A (SOT-SC70-6)	DCK0006A	SN74AUP2G07DCKR	Texas Instruments		
U7	1		Single-Bit Dual-Supply Bus Transceiver, DBV0006A (SOT-23-6)	DBV0006A	SN74AXC1T45DBVR	Texas Instruments		Texas Instruments
U9	1		512K I2C Serial EEPROM, TSSOP	TSSOP-8	24FC512-I/ST	Microchip		
C2, C6	0	4700pF	CAP, CERM, 4700pF, 10V, +/- 20%, X5R, 0201	0201	GRM033R61A472MA01D	MuRata		
C4, C8	0	2200pF	CAP, CERM, 2200pF, 10V, +/- 10%, X5R, 0402	0402	GRM155R61A222KA01D	MuRata		
C5	0	10uF	CAP, CERM, 10uF, 10V, +/- 20%, X5R, 0402	0402	CL05A106MP5NUNC	Samsung Electro-Mechanics		
C10, C24, C30	0	1000pF	CAP, CERM, 1000pF, 25V, +/- 10%, X5R, 0201	0201	C0603X5R1E102K030BA	TDK		
C18	0	10uF	CAP, CERM, 10uF, 10V, +/- 10%, X5R, 0805	0805	C0805C106K8PACTU	Kemet		

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Table 4-1. Bill of Materials (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer	Alternate Part Number	Alternate Manufacturer
C19, C21	0	10µF	Cap Ceramic 10uF 25V X5R ±20% Pad SMD 0603 +85°C T/R	0603	CL10A106MA8NRNC	Samsung		
C20	0	100nF	Multi-Layer Ceramic Capacitor 100nF 50V X7R ±10% 0402 Paper T/R	0402	GRT155R71H104KE01D	Murata		
C26	0	0.1uF	CAP, CERM, 0.1uF, 10V, +/- 10%, X7R, 0402	0402	GRM155R71A104KA01D	MuRata		
C28	0	2.2uF	CAP, CERM, 2.2uF, 10V, +/- 10%, X7R, 0603	0603	GRM188R71A225KE15D	MuRata		
C34	0	0.033uF	CAP, CERM, 0.033uF, 6.3V, +/- 10%, X5R, 0201	0201	GRM033R60J333KE01D	MuRata		
C43	0	100pF	Ceramic Capacitor Automotive 100pF ±5% 50V C0G 0201	0201	UMK063CG101JTHF	Taiyo Yuden		
C56, C58	0	10uF	CAP, CERM, 10uF, 100V, +/- 20%, X7S,		C5750X7S2A106M230KB	TDK		
FID1, FID2, FID3	0		Fiducial mark. There is nothing to buy or mount.	N/A	N/A	N/A		
H9, H11	0		8MM RD X 6MM X M3	10x10mm	M3561-SS	RAF Electronic Hardware		
H10, H12	0		Standoff, Male/Male Thread, 5.15mm, M3 x 0.5	Standoff	SO-0515-02-02-01	Samtec		
J1	0		Header, 100mil, 3x2, Gold, TH	Sullins 100mil, 2x3, 230 mil above insulator	PBC03DAAN	Sullins Connector Solutions		
J17	0		Header, 100mil, 3x1, Gold, TH	PBC03SAAN	PBC03SAAN	Sullins Connector Solutions		
J20	0		Header, 100mil, 2x2, Gold, TH	2x2 Header	TSW-102-07-G-D	Samtec		
L5	0	2.2uH	Inductor, Shielded, Composite, 2.2uH, 17.8A, 0.01 ohm, SMD	7.2x7x7.5mm	XAL7070-222MEB	Coilcraft		
L7	0	300 ohm	Ferrite Bead, 300 ohm at 100MHz, 3.1A, 0806	0806	NFZ2MSM301SN10L	MuRata		
R2	0	240k	RES, 240 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW0402240KFKED	Vishay-Dale		

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Table 4-1. Bill of Materials (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer	Alternate Part Number	Alternate Manufacturer
R5, R6	0	33	RES, 33.0, 1%, 0.1 W, 0402	0402	ERJ-2RKF33R0X	Panasonic		
R7	0	33.0k	RES, 33.0 k, 1%, 0.063 W, 0402	0402	RC0402FR-0733KL	Yageo America		
R8	0	30.1k	RES, 30.1 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040230K1FKED	Vishay-Dale		
R9	0	24.3k	RES, 24.3 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040224K3FKED	Vishay-Dale		
R10, R11	0	1.00k	RES, 1.00 k, 1%, 0.1 W, 0402	0402	ERJ-2RKF1001X	Panasonic		
R14, R16	0	68.1k	RES, 68.1 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040268K1FKED	Vishay-Dale		
R15, R17	0	37.4k	RES, 37.4 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040237K4FKED	Vishay-Dale		
R24	0	100k	RES, 100 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW0402100KFKED	Vishay-Dale		
R28	0	44.2k	RES, 44.2 k, 1%, 0.05 W, 0201	0201	CRCW020144K2FNED	Vishay-Dale		
SH-J2, SH-J4, SH-J6, SH-J8, SH-J11	0	1x2	Shunt, 100mil, Flash Gold, Black	Closed Top 100mil Shunt	SPC02SYAN	Sullins Connector Solutions		
U8	0		Fully Integrated Synchronous Boost Converter	VQFN-HR11	TPS61288RQQR	Texas Instruments		

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5 Additional Information

5.1 Trademarks

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STANDARD TERMS FOR EVALUATION MODULES

1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, and/or documentation which may be provided together or separately (collectively, an “EVM” or “EVMs”) to the User (“User”) in accordance with the terms set forth herein. User's acceptance of the EVM is expressly subject to the following terms.

   1.1 EVMs are intended solely for product or software developers for use in a research and development setting to facilitate feasibility evaluation, experimentation, or scientific analysis of TI semiconductors products. EVMs have no direct function and are not finished products. EVMs shall not be directly or indirectly assembled as a part or subassembly in any finished product. For clarification, any software or software tools provided with the EVM (“Software”) shall not be subject to the terms and conditions set forth herein but rather shall be subject to the applicable terms that accompany such Software

   1.2 EVMs are not intended for consumer or household use. EVMs may not be sold, sublicensed, leased, rented, loaned, assigned, or otherwise distributed for commercial purposes by Users, in whole or in part, or used in any finished product or production system.

2 *Limited Warranty and Related Remedies/Disclaimers*:

   2.1 These terms do not apply to Software. The warranty, if any, for Software is covered in the applicable Software License Agreement.

   2.2 TI warrants that the TI EVM will conform to TI's published specifications for ninety (90) days after the date TI delivers such EVM to User. Notwithstanding the foregoing, TI shall not be liable for a nonconforming EVM if (a) the nonconformity was caused by neglect, misuse or mistreatment by an entity other than TI, including improper installation or testing, or for any EVMs that have been altered or modified in any way by an entity other than TI, (b) the nonconformity resulted from User's design, specifications or instructions for such EVMs or improper system design, or (c) User has not paid on time. Testing and other quality control techniques are used to the extent TI deems necessary. TI does not test all parameters of each EVM. User's claims against TI under this Section 2 are void if User fails to notify TI of any apparent defects in the EVMs within ten (10) business days after delivery, or of any hidden defects with ten (10) business days after the defect has been detected.

   2.3 TI's sole liability shall be at its option to repair or replace EVMs that fail to conform to the warranty set forth above, or credit User's account for such EVM. TI's liability under this warranty shall be limited to EVMs that are returned during the warranty period to the address designated by TI and that are determined by TI not to conform to such warranty. If TI elects to repair or replace such EVM, TI shall have a reasonable time to repair such EVM or provide replacements. Repaired EVMs shall be warranted for the remainder of the original warranty period. Replaced EVMs shall be warranted for a new full ninety (90) day warranty period.

WARNING

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

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

NOTE:

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

3 *Regulatory Notices:*

3.1 *United States*

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

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

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

CAUTION

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

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

FCC Interference Statement for Class A EVM devices

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

FCC Interference Statement for Class B EVM devices

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

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

3.2 *Canada*

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

Concerning EVMs Including Radio Transmitters:

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

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

Concernant les EVMs avec appareils radio:

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

Concerning EVMs Including Detachable Antennas:

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

Concernant les EVMs avec antennes détachables

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

3.3 *Japan*

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

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

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

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

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

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

1. 電波法施行規則第6条第1項第1号に基づく平成18年3月28日総務省告示第173号で定められた電波暗室等の試験設備でご使用いただく。
2. 実験局の免許を取得後ご使用いただく。
3. 技術基準適合証明を取得後ご使用いただく。

なお、本製品は、上記の「ご使用にあたっての注意」を譲渡先、移転先に通知しない限り、譲渡、移転できないものとします。

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

東京都新宿区西新宿 6 丁目 2 4 番 1 号

西新宿三井ビル

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

電力線搬送波通信についての開発キットをお使いになる際の注意事項については、次のところをご覧ください。https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-for-power-line-communication.html

3.4 *European Union*

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

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

4 *EVM Use Restrictions and Warnings:*

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

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

4.3 *Safety-Related Warnings and Restrictions:*

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

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

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

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

6. *Disclaimers:*

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

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

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

8. *Limitations on Damages and Liability:*

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

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

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

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

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