

TAS2564 Schematic and Layout Guidelines

Luis Fernando Rodriguez S.

ABSTRACT

In audio applications, it is always important to minimize the noise effects that may be induced by external conditions or even by the same components of the PCB. All the audio amplifiers require a clean and stable power supply to get the best performance. Any noise issue at the power supplies may be the cause of a high THD+N, SNR, and PSRR levels. In addition, the analog inputs and outputs require good noise immunity against the digital activity from nearby devices.

This document describes an optimized layout for the TAS2564 device in mono and stereo configuration. The goal of utilizing these layout guidelines is to minimize the noise issues and ensure the best device performance. The TAS2564EVM was taken as reference for the suggested guidelines.

Contents

1	Mono Version.....	3
2	Stereo Version	20
3	Bill of Materials (BOM).....	33
4	Decoupling Capacitors.....	34
5	PVDD Capacitor selection.	34
6	SW Inductor Selection	35
7	Layout Guidelines Summary.....	36

List of Figures

1	TAS2564 Schematic.....	3
2	Components Location	4
3	Components Location (3-D View)	4
4	Layout Line Color Codes in This Document	4
5	GREG Pin Connection	5
6	SW Pin	6
7	Ground Plane With Keepout Region	6
8	VBAT Pin Connection	7
9	DREG Pin Connection	8
10	PVDD and VBST Pins Connection.....	10
11	VDD Pin Connection.....	11
12	OUT_N and OUT_P Pin Connections	12
13	VSNS_N and VSNS_P Pin Connections.....	13
14	TAS2564 Analog and Digital Portions	14
15	Digital Pins Connections	15
16	Top Layer	16
17	Copper Layer 2 (GND Exclusive Layer).....	16
18	Copper Layer 3	16
19	Copper Layer 4	16
20	Copper Layer 5	17
21	Bottom Layer.....	17

22	TAS2564YFP Stereo Schematic	20
23	Components Location (Stereo)	21
24	Components Location (3-D View, Stereo)	21
25	GREG Pin Connection (Stereo)	22
26	SW Pin Connection (Stereo).....	22
27	Ground Plane With Keepout Region (Stereo)	22
28	VBAT Pin Connection (Stereo)	23
29	DREG Pin Connection (Stereo)	24
30	VBST and PVDD Pins Connection (Stereo)	25
31	VDD Pin Connection (Stereo)	26
32	OUT_N and OUT_P Pins Connection (Stereo)	27
33	VSNS_N and VSNS_P Pins Connection (Stereo)	28
34	Digital Pins Connections	29
35	Top Layer (Stereo)	30
36	Copper Layer 2 (GND Exclusive Layer).....	30
37	Copper Layer 3	30
38	Copper Layer 4	30
39	Copper Layer 5	30
40	Bottom Layer.....	30
41	VIAS Placement	34
42	Capacitor vs DC Voltage Response	35
43	Inductance vs Current Response	35

List of Tables

1	Recommended External Components.....	19
2	Recommended External Components.....	32
3	Bill of Materials	33
4	Layout Guidelines Summary.....	36

Trademarks

All trademarks are the property of their respective owners.

1 Mono Version

1.1 Typical Application Circuit

Figure 1 shows the typical application circuit for the TAS2564 device with the component names used in this document.

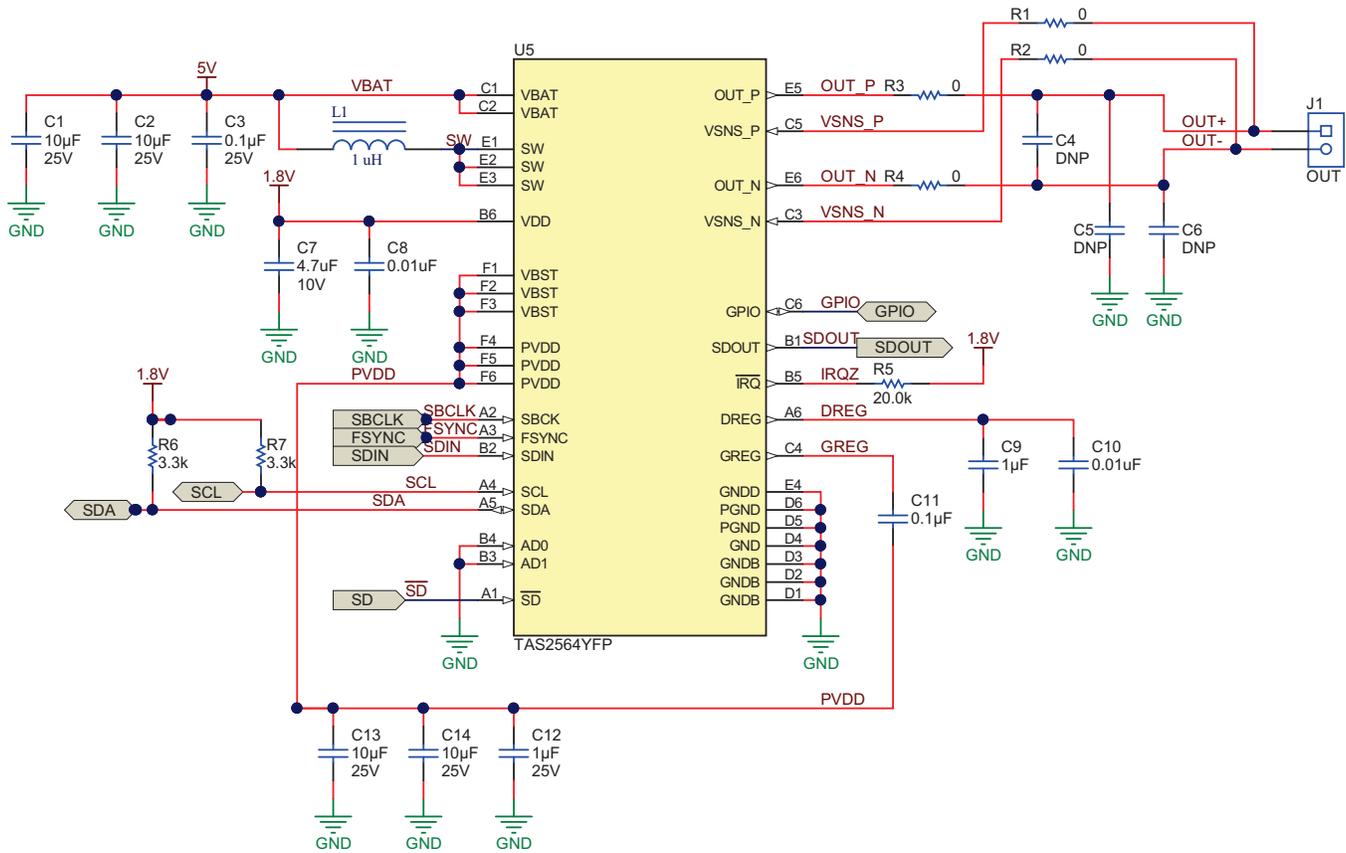


Figure 1. TAS2564 Schematic

Figure 2 and Figure 3 show the components location of the PCBA reference layout.

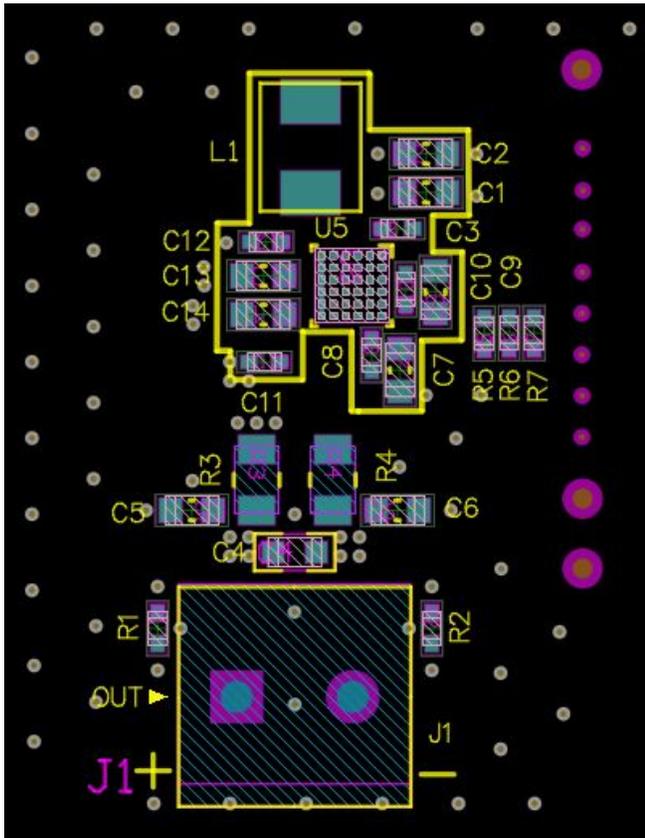


Figure 2. Components Location

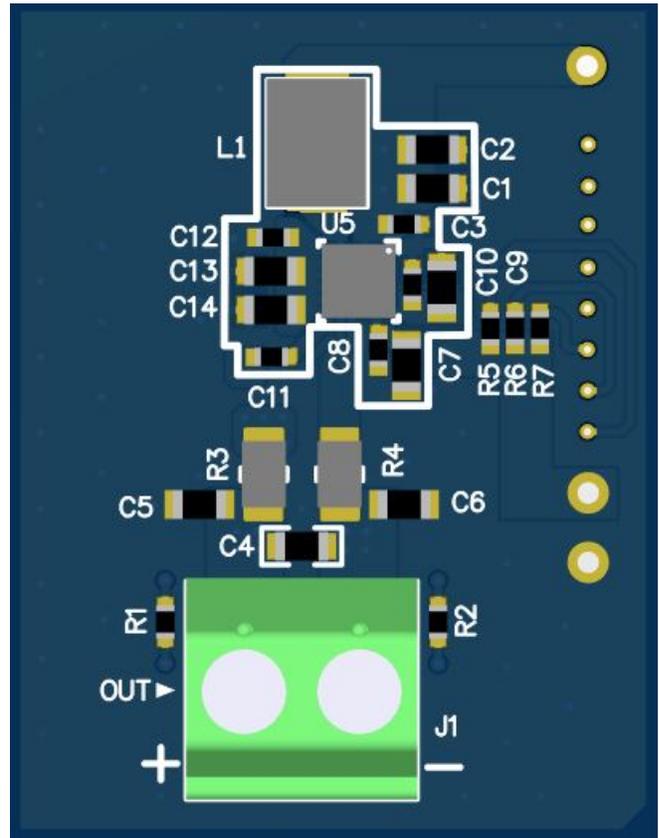


Figure 3. Components Location (3-D View)

Figure 4 illustrates the colors used for all the layout lines in this document.

<ul style="list-style-type: none"> Top Layer Copper Layer 2 Copper Layer 3 	<ul style="list-style-type: none"> Copper Layer 4 Copper Layer 5 Bottom Copper
--	--

Figure 4. Layout Line Color Codes in This Document

For detailed information about the recommended external components, see [Table 1](#).

1.3 SW Pin

The boost inductor is selected to carry a high amount of current. Its saturation current should be higher than the limit current to deliver Class-D peak power. The PCB traces must be wide enough to handle this overcurrent limit.

The inductance derate characteristic must be considered when choosing the inductor. It is important to verify that the inductance does not derate more than 20% at the current limit value. In addition, the AC resistance must be low at the switching frequency (4 MHz).

The immediate layer below the top layer must be dedicated as a ground plane. A keepout region should be placed below the SW pin trace for noise reduction.

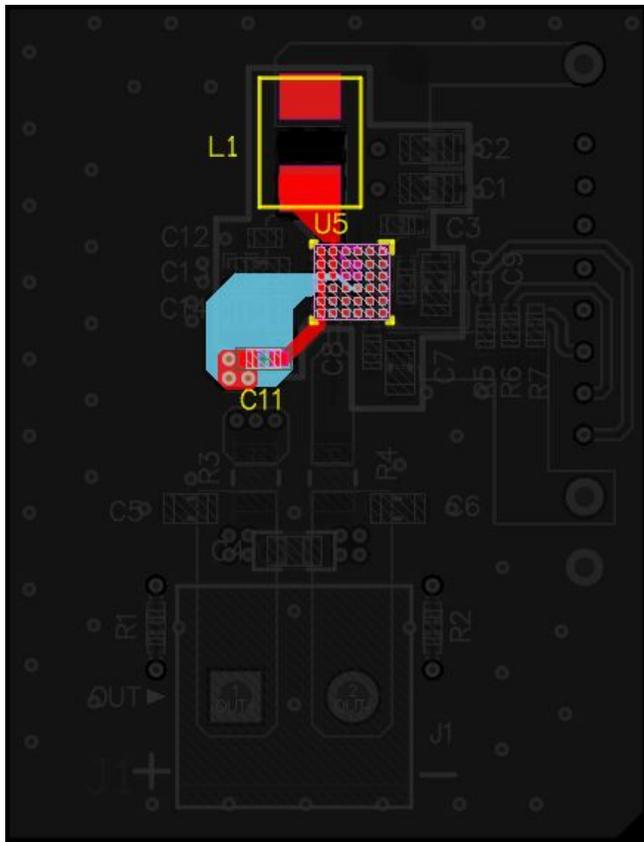


Figure 6. SW Pin

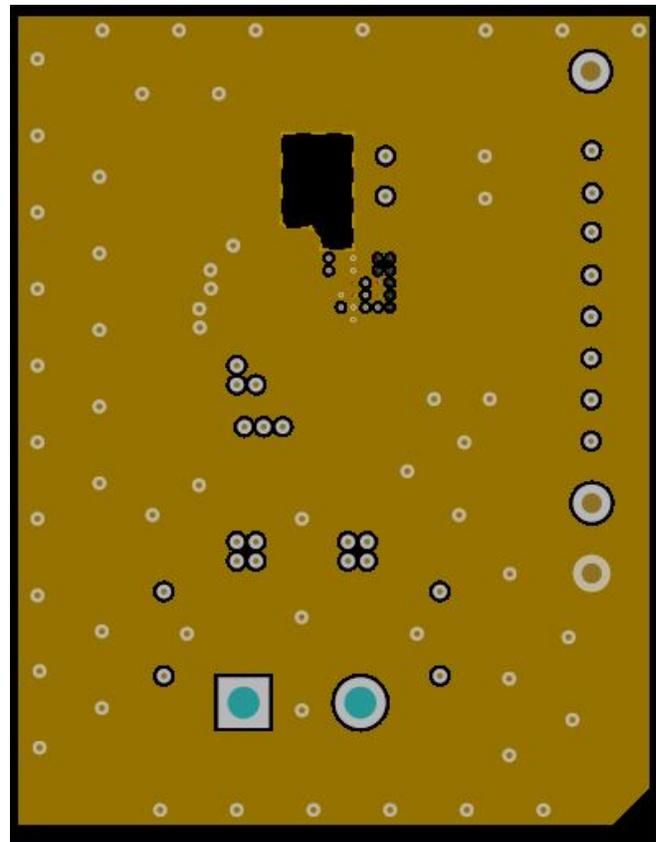


Figure 7. Ground Plane With Keepout Region

1.4 VBAT Pin

VBAT is the battery power supply input. This power pin supplies the internal boost. Since it carries a considerable amount of current, a decoupling capacitor is required. At least a 10- μ F decoupling capacitor must be used to bypass VBAT to GND. See the [Decoupling Capacitors](#) section for details.

It is important to consider the following recommendations for VBAT:

1. Ensure that the parasitic inductance from the device pin to decoupling is below 500 pH.
2. Add an extra bulk decoupling capacitor to reduce overall THD+N at high power.
3. Have the VBAT traces wide enough to handle total output power.
4. Connect VBAT to and SW inductor through the thick plane.
5. Do not use vias between device pins and related capacitors and inductor.

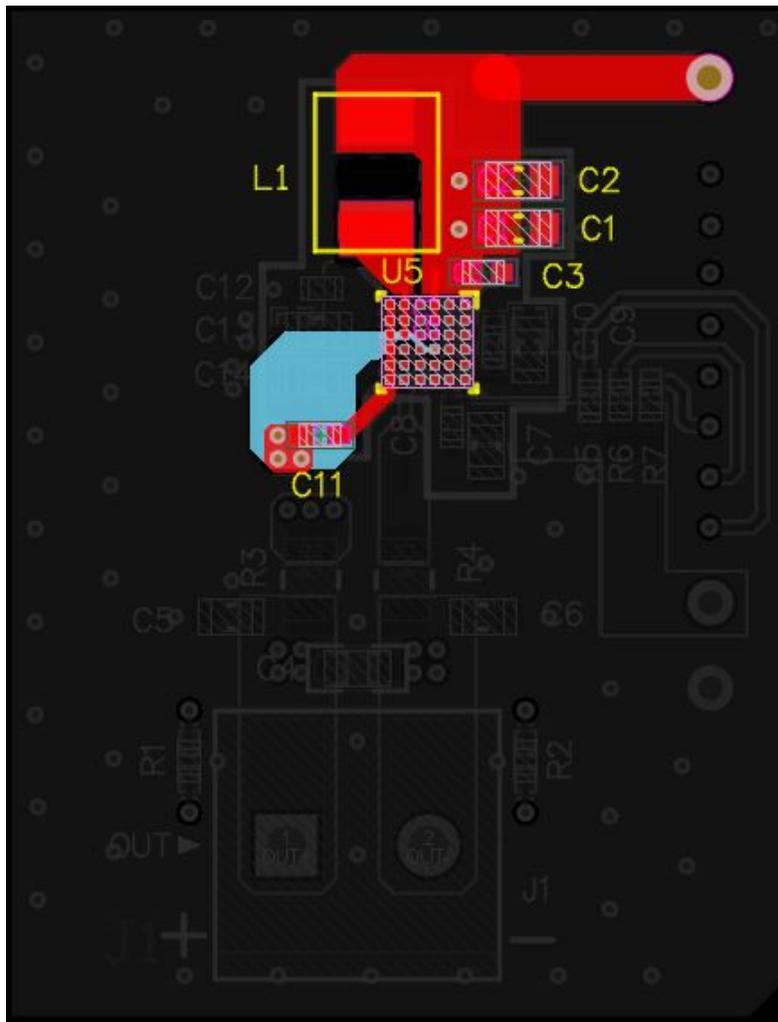


Figure 8. VBAT Pin Connection

1.6 VBST and PVDD Pins

VBST is the internal boost converter output. This is the pin that will supply the power stage supply pin (PVDD). PVDD must be shorted to the VBST pin using a strong connection.

There are a few considerations that must be taken into account for the PVDD to VBST connection:

- VBST must not be connected to an external load. This pin should be bypassed to GND with a decoupling capacitor. The decoupling capacitor ends should see as low an inductance as possible between the VBST pin and the BGND pin. See the [Decoupling Capacitors](#) section for details.
- There should be a maximum parasitic inductance of 100 pH from the device pin to decoupling.
- VBST should be connected to PVDD through the tick plane (use multiple vias to reduce parasitic inductance).
- PVDD should be connected with a star connection to the GREG capacitor.
- VBST and PVDD traces carry a high amount of current. The traces should support currents up to the device overcurrent limit.
- Boost capacitor derating should satisfy the ratio with boost inductor: $L/C < 1/3$
- Ceramic capacitors derate with the applied DC voltage. Often, a 10- μ F capacitor loses 80% of the nominal value at the 10-V to 12-V range (for example, a 10- μ F capacitance value would result in 2 μ F). Typically, it is recommended to use a 20- μ F capacitor (or a pair of two 10- μ F capacitors) as decoupling capacitor, which results in 4- μ F capacitance after the derate.

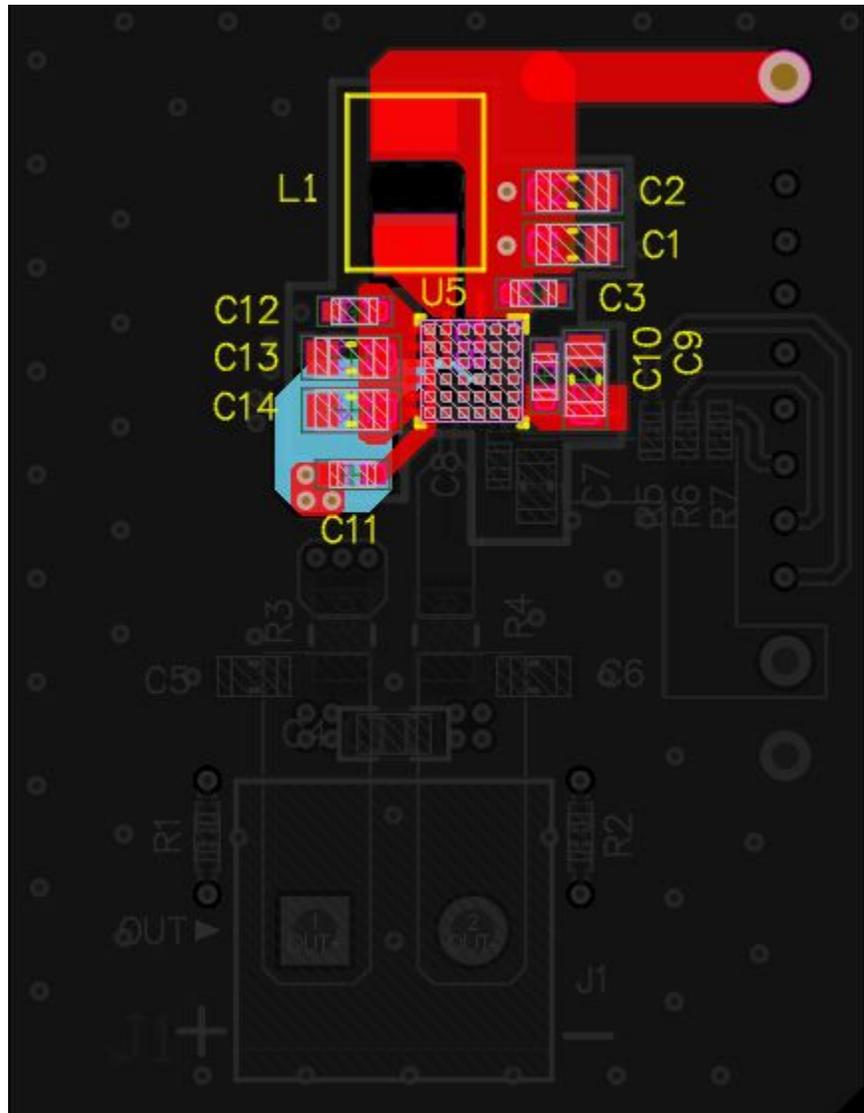


Figure 10. PVDD and VBST Pins Connection

1.7 VDD Pin

VDD is the analog, digital, and I/O power supply input. Similar to the VBAT pin, this power pin requires a decoupling capacitor. A minimum of 4.7- μ F capacitor is suggested to bypass VDD to GND. See the [Decoupling Capacitors](#) section for details.

This pin requires having a maximum parasitic inductance of 200 pH.

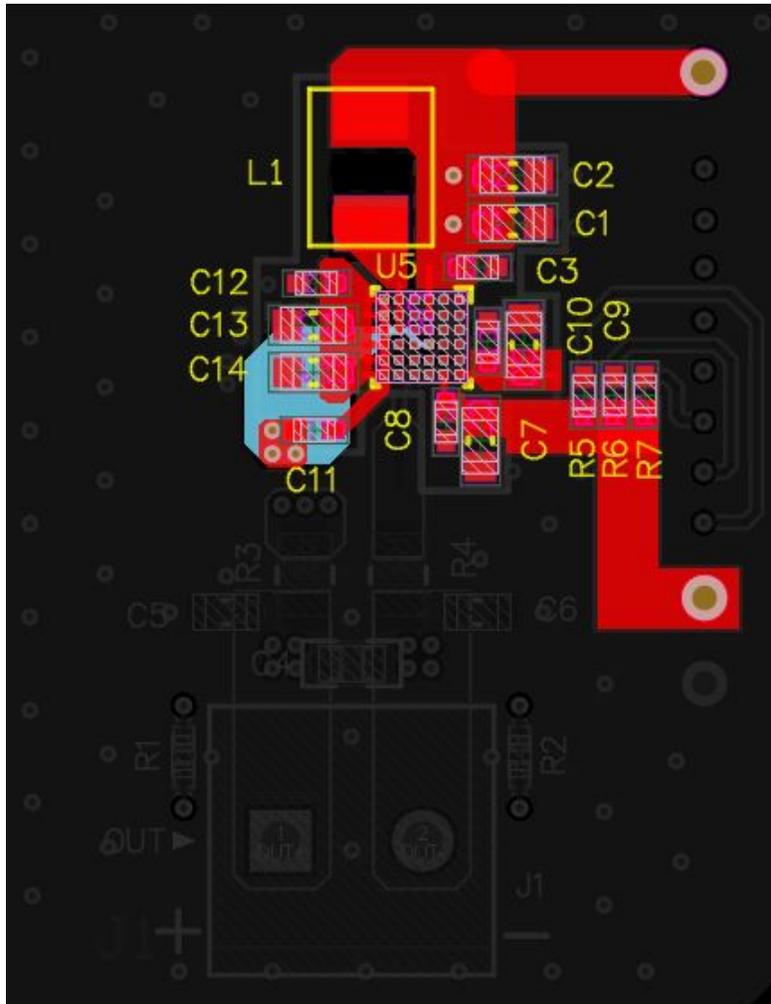


Figure 11. VDD Pin Connection

1.8 Output Pins (*OUT_N* and *OUT_P*)

OUT_N and *OUT_P* are the Class-D receiver channel negative and positive output, respectively. Due to its switching nature, TI recommends keeping the routing short to limit the emissions.

For optimal current flow, the PCB traces must be widened closely to the output pins. In addition, the outputs need to be routed on two layers using several vias to minimize parasitic impedance.

It is important to consider a few things when using an EMI filter (LC array):

- Inductance should be the first element in the filter.
- Capacitance to GND or other output will pull high-current spikes capable of triggering overcurrent protection.
- TI recommends fixing 1.5 MHz as the lower limit of the corner frequency to simplify the filter debug and noise issues.

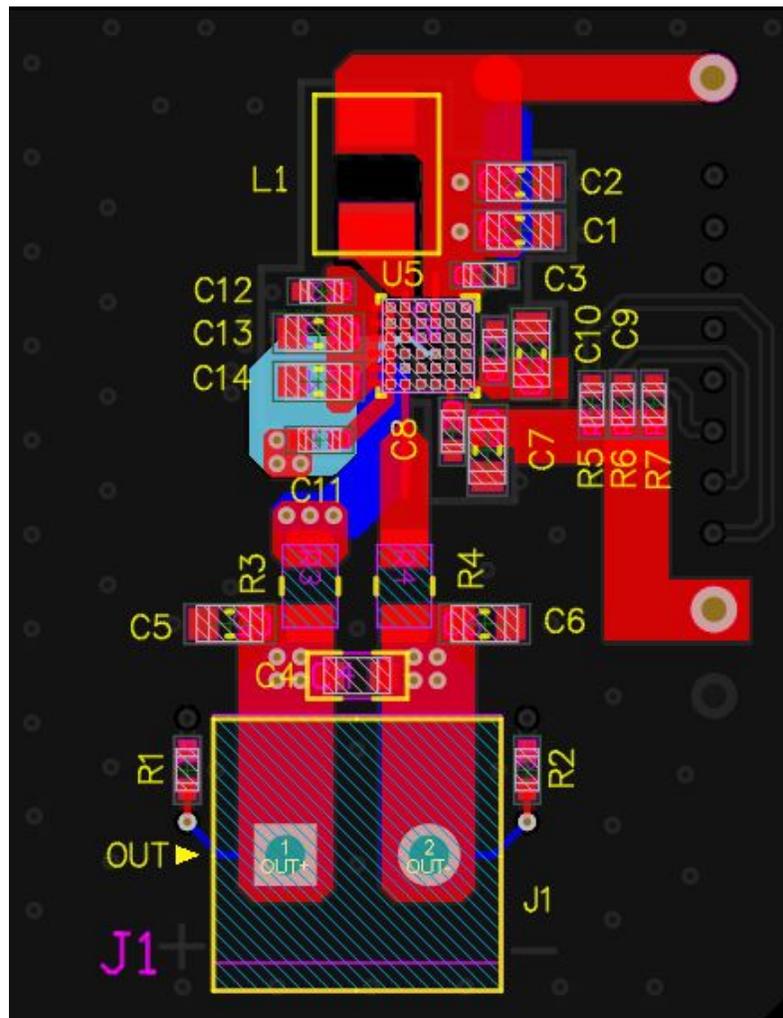


Figure 12. *OUT_N* and *OUT_P* Pin Connections

1.9 VSNS_N and VSNS_P Pins

VSNS_N and VSNS_P are the voltage sense negative and positive inputs, respectively. These inputs are connected to the Class-D outputs (VSNS_N to OUT_N and VSNS_P to OUT_P) after the ferrite bead filter.

When routing these pins to the ferrite bead filter, it is necessary to make the connection to its respective output at the speaker terminal, not to a pin or trace. In addition, it is recommended to add a 1-k Ω resistor for each voltage sense path. This practice helps to reduce emissions and reduce ICN increments that result from the EMI filter.

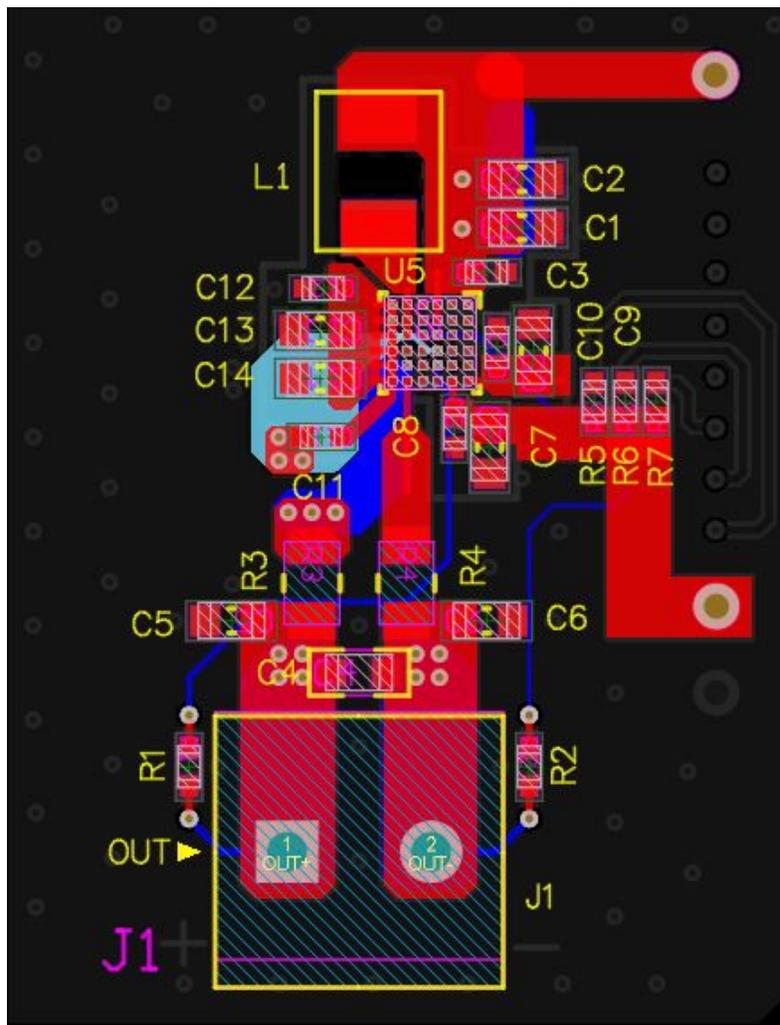


Figure 13. VSNS_N and VSNS_P Pin Connections

1.10 Digital Portion Connections

The TAS2564 device involves digital and analog activity. Care must be taken when routing the different signals since it may result in noise issues, especially from the digital lines to the analog portion.

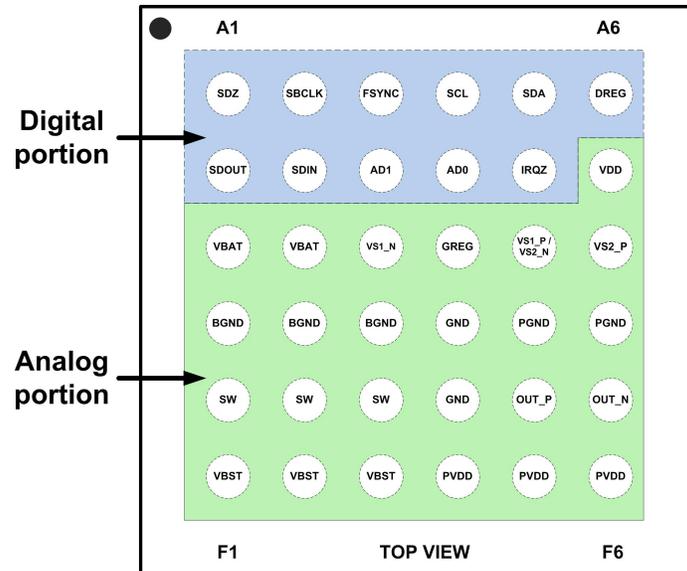


Figure 14. TAS2564 Analog and Digital Portions

The digital lines can reach frequencies up to 1 MHz for the I2C lines in *Fast-Mode Plus* and up to 50 MHz for the I2S lines. This high-frequency content can affect the performance of the analog signals. For measurement purposes, the digital noise level may affect the scope captures or a THD+N measurement.

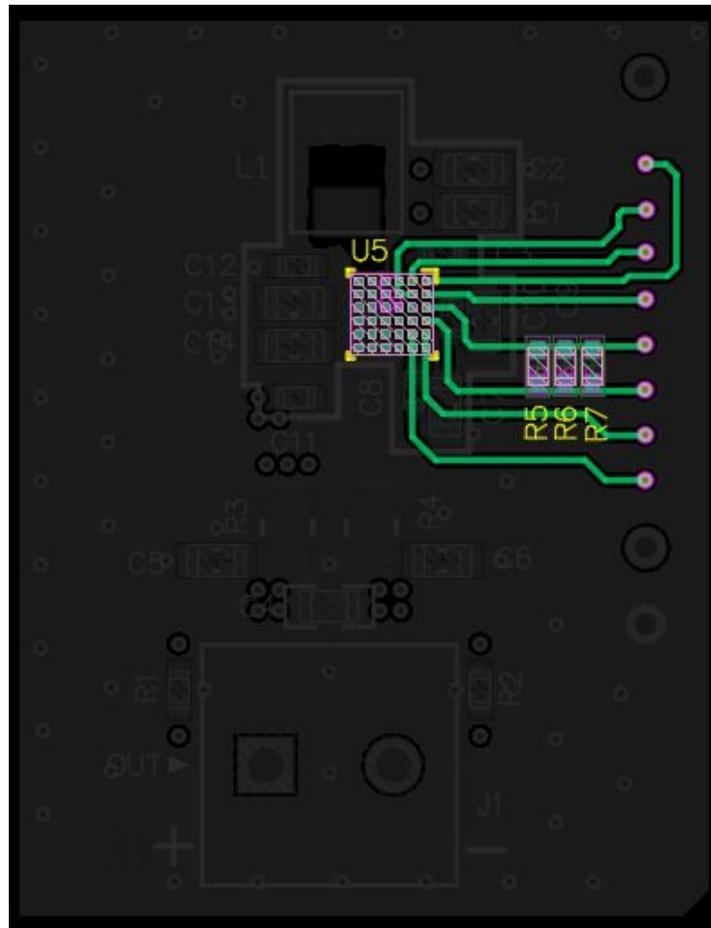


Figure 15. Digital Pins Connections

The TAS2564 device is already designed to separate the digital and analog traces. In [Figure 16](#), the analog portion involves almost all the four pins lines C to F, while the digital portion is located in lines A and B. This structure allows routing the digital and analog planes separately.

1.11 Ground Pins (BGND, GND, and PGND)

The ground plane routing is important when designing the PCB layout. These planes must be designed to have a proper thermal dissipation and minimize the parasitic impedance as much as possible. Design tips for the different ground pins are listed here:

- All the ground pins must be shorted below the package and connected to the PCB ground plane through multiple vias.
- The vias are the best way to carry heat from the different sections in the board. Since the GND plane will need to quickly dissipate all the elevated temperatures, it is necessary to add multiple vias close to the ground pins.
- A maximum 150 pH of parasitic inductance is recommended. Having many vias reduces the additional impedance and provides good conduction in both electrical and thermal perspective.
- An entire layer immediately below the top layer must be dedicated to GND, as best practice.

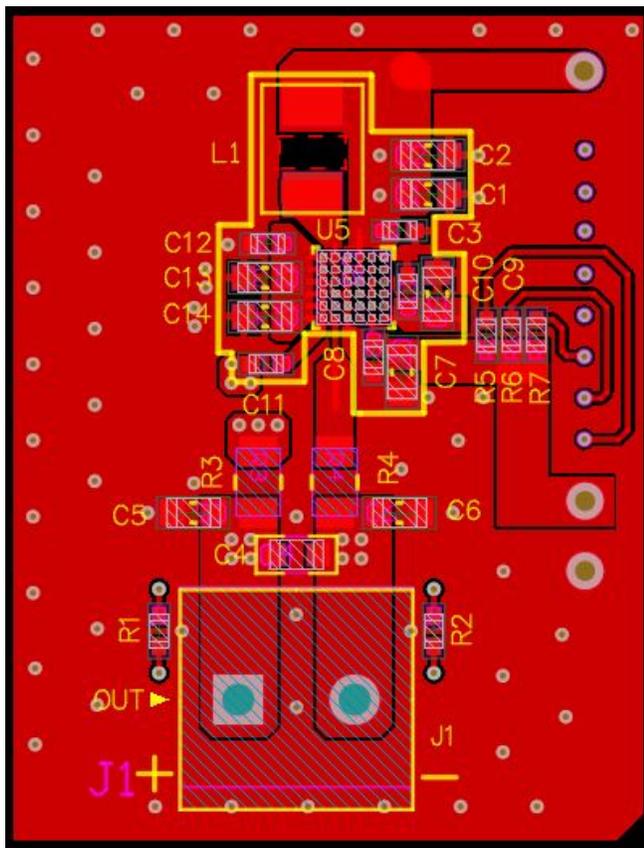


Figure 16. Top Layer

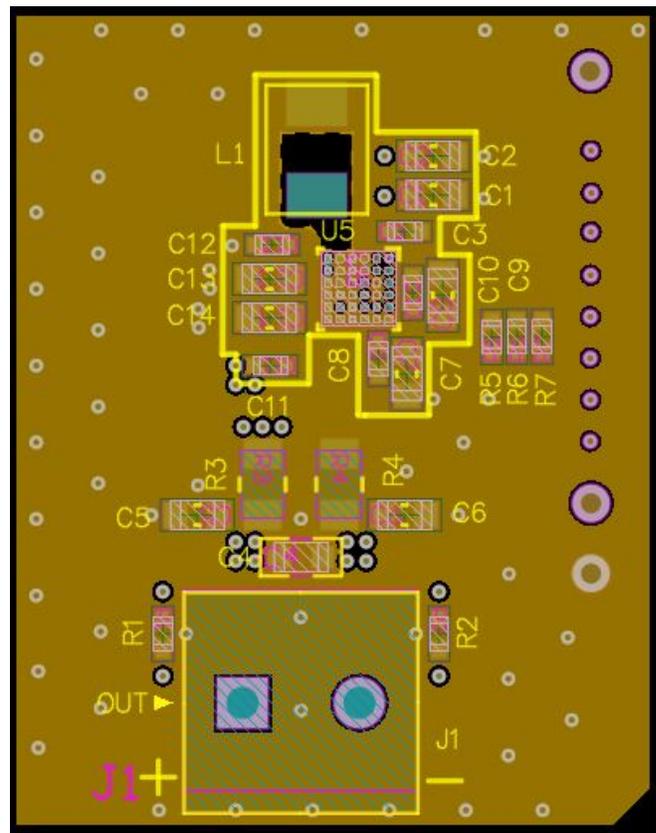


Figure 17. Copper Layer 2 (GND Exclusive Layer)

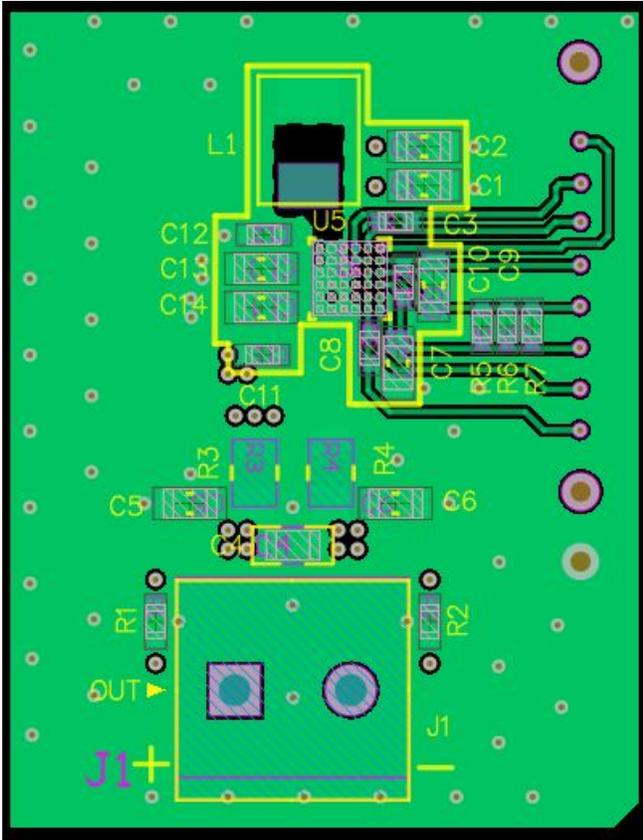


Figure 18. Copper Layer 3

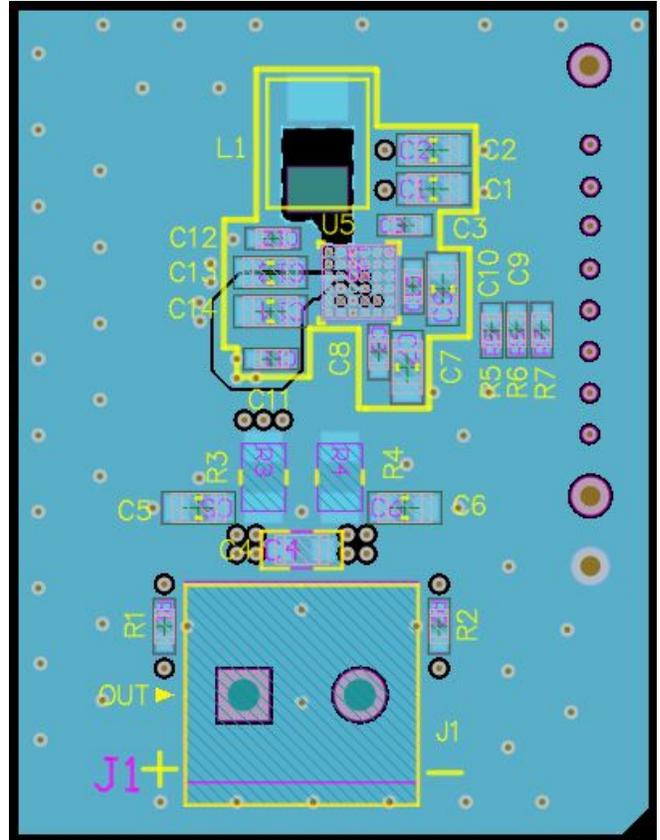


Figure 19. Copper Layer 4

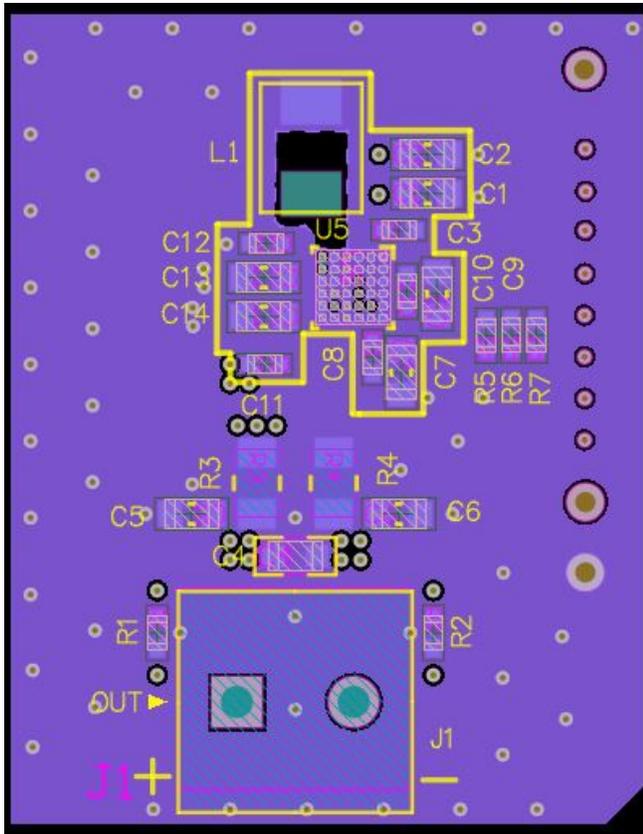


Figure 20. Copper Layer 5

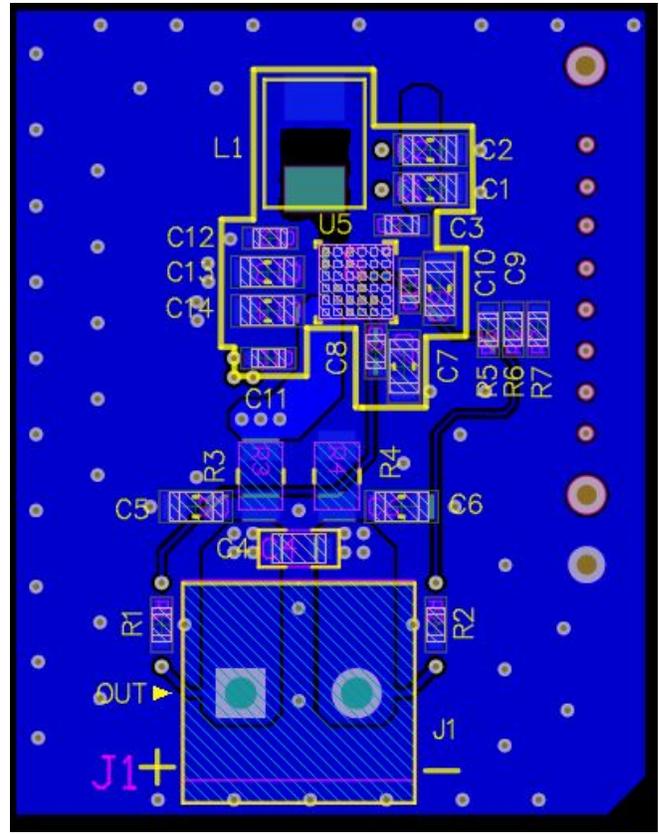


Figure 21. Bottom Layer

Table 1. Recommended External Components

Component	Description	Specification	MIN	TYP	MAX	Unit
L1, L2, L3	Boost converter inductor	Inductance, 20% tolerance	0.47	1		μH
		Saturation current		5.5		A
		Inductance derate at saturation current			20	%
N/A	EMI filter inductors (optional). These are not recommended because it degrades THD+N performance. The TAS2564 device is a filter-less class-D and does not require these bead inductors.	Impedance at 100 MHz		120		Ω
		DC resistance			0.095	Ω
		DC current			2	A
		Size		0402		EIA
C1, C2, C15, C16	Boost converter input capacitor	Capacitance, 20% tolerance	10			μF
C13, C14, C27, C28	Boost converter output capacitor	Capacitance, 20% tolerance	10		47	μF
		Rated voltage	25			V
		Capacitance at 13 V after derating	4			μF
N/A	EMI filter capacitors (optional, must use L2, L3 if C3, C4 used)	Capacitance		1		nF
C7, C21	VDD decoupling capacitor	Capacitance	4.7			μF
C9, C23	DREG decoupling capacitor	Capacitance	1			μF
C11, C25	GREG Fly capacitor	Capacitance	100			nF
C12, C29, C26, C30	PVDD decoupling capacitor	Capacitance	10		47	μF
		Rated Voltage	25			V
		Capacitance at 13 V after derating	4			μF

2 Stereo Version

2.1 Typical Application Circuit

Figure 22 shows the TAS2564 in stereo configuration.

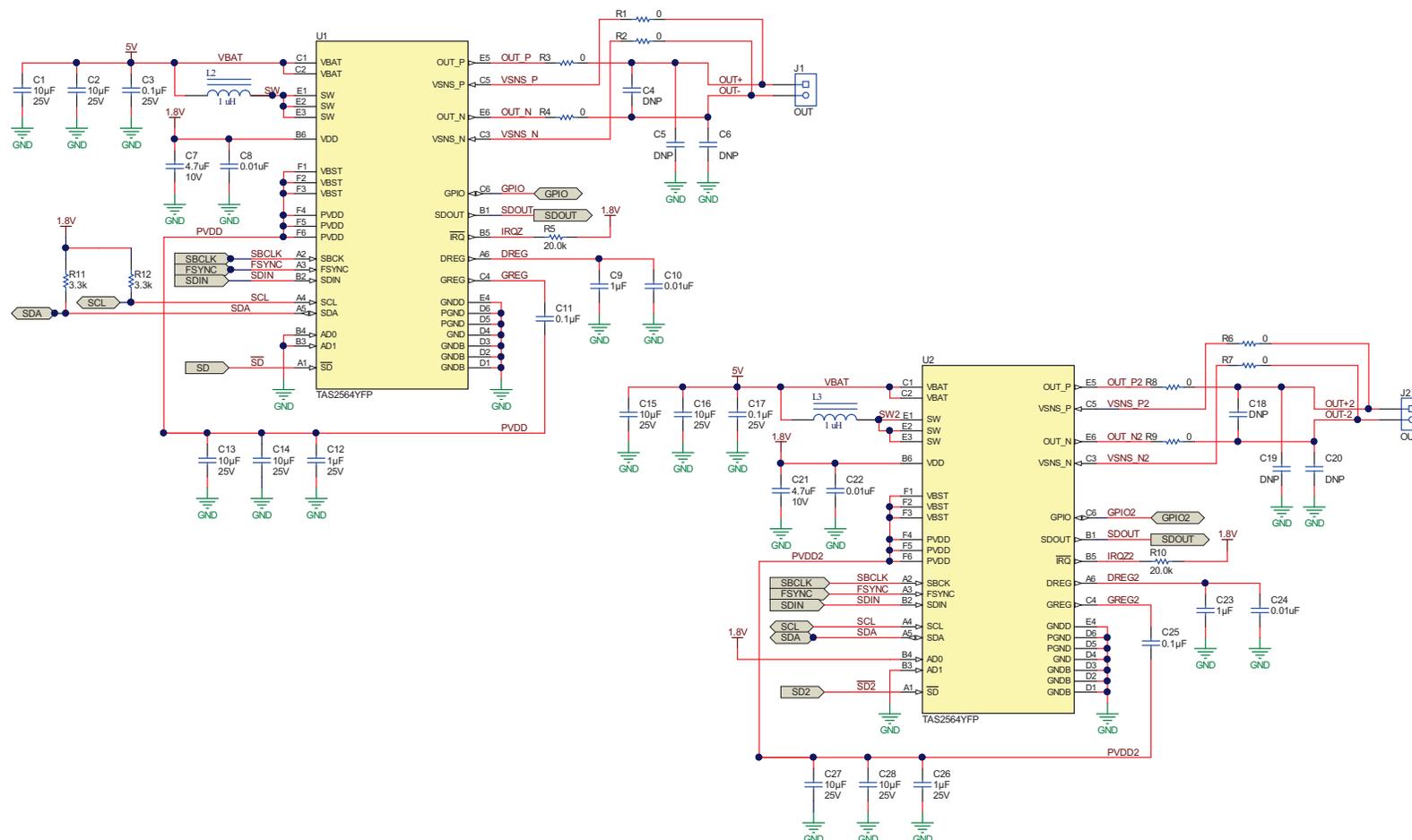


Figure 22. TAS2564YFP Stereo Schematic

Figure 23 and Figure 24 show the component locations of the PCBA reference layout.

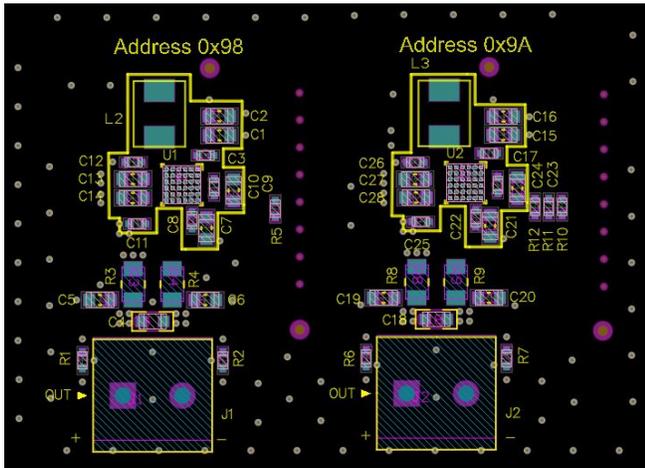


Figure 23. Components Location (Stereo)

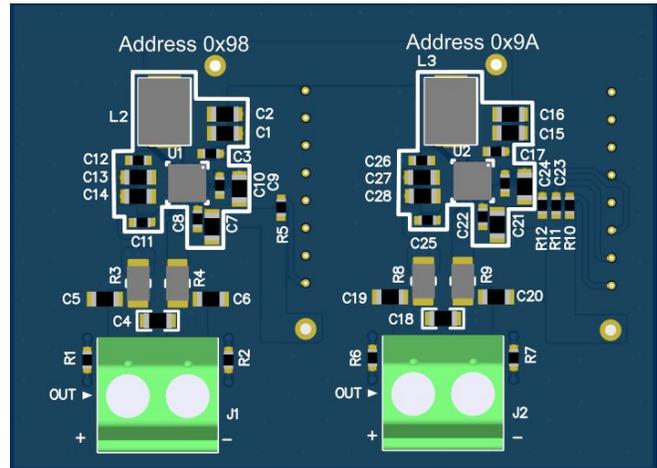


Figure 24. Components Location (3-D View, Stereo)

For more information, see the [TAS2564 6.1-W Boosted Class-D Audio Amplifier with IV Sense](#) data sheet.

2.2 GREG Pin (Stereo)

The GREG pins for the stereo version have the same recommendations as stated in [Section 1.2](#).



Figure 25. GREG Pin Connection (Stereo)

2.3 SW Pin (Stereo)

The GREG pins for the stereo version have the same considerations as stated in [Section 1.3](#).

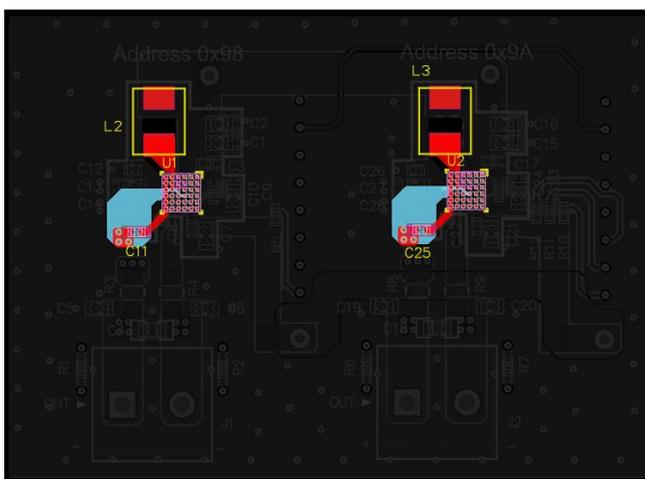


Figure 26. SW Pin Connection (Stereo)

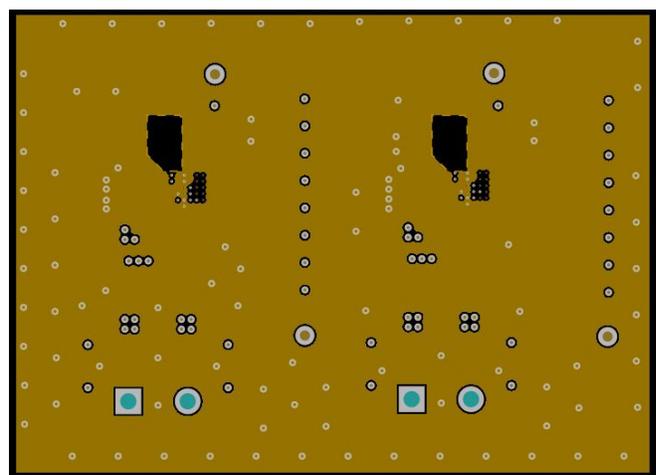


Figure 27. Ground Plane With Keepout Region (Stereo)

2.4 VBAT Pin (Stereo)

The VBAT pins for the stereo version have the same considerations as stated in [Section 1.4](#).

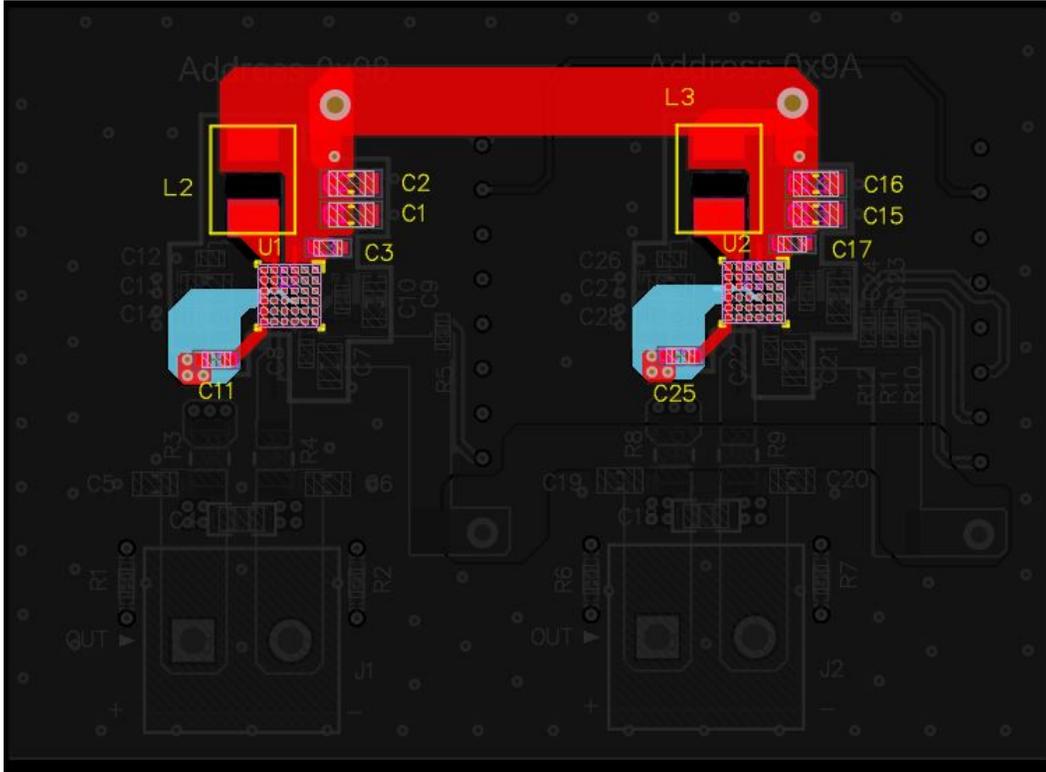


Figure 28. VBAT Pin Connection (Stereo)

2.5 DREG Pin (Stereo)

The DREG pins for the stereo version have the same considerations as stated in [Section 1.5](#).

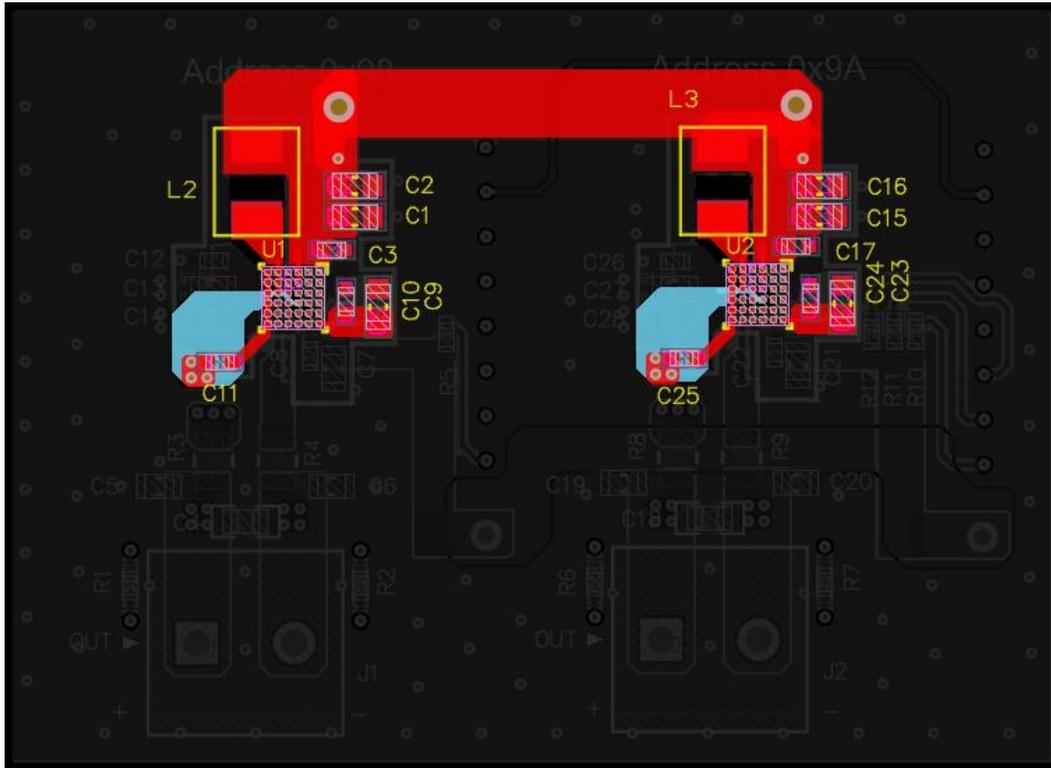


Figure 29. DREG Pin Connection (Stereo)

2.6 VBST and PVDD Pins (Stereo)

The VBST and PVDD pins for the stereo version have the same considerations as stated in [BVST and PVDD Pins](#).

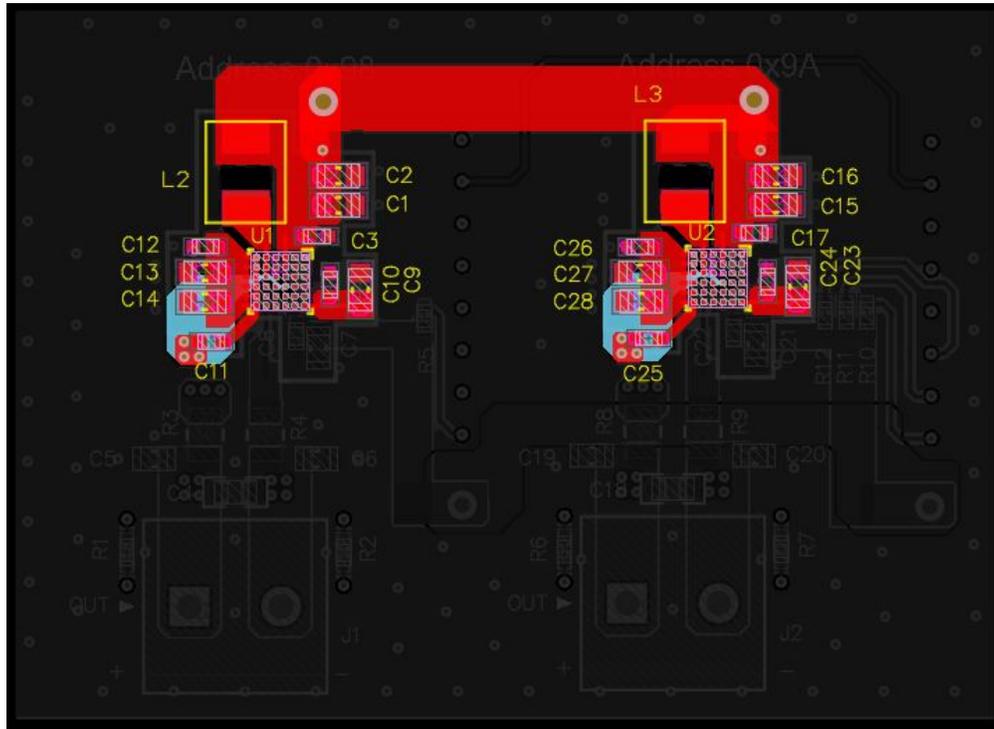


Figure 30. VBST and PVDD Pins Connection (Stereo)

2.7 VDD Pin (Stereo)

The VDD pin for the stereo version has the same considerations as stated in [Section 1.7](#).

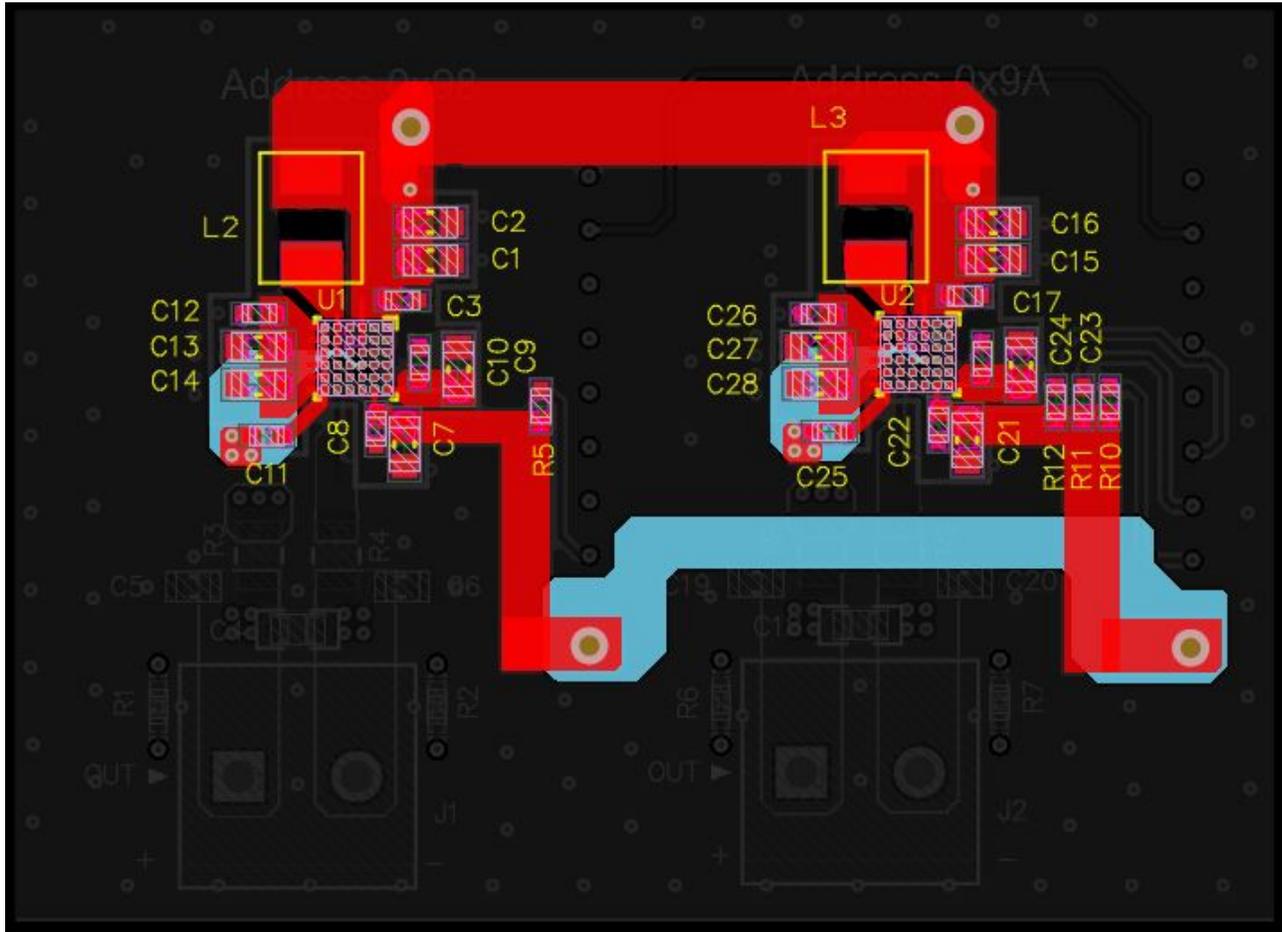


Figure 31. VDD Pin Connection (Stereo)

2.8 Output Pins (OUT_N and OUT_P, Stereo)

The output pins (OUT_N and OUT_P) for the stereo version have the same considerations as stated in Section 1.8.

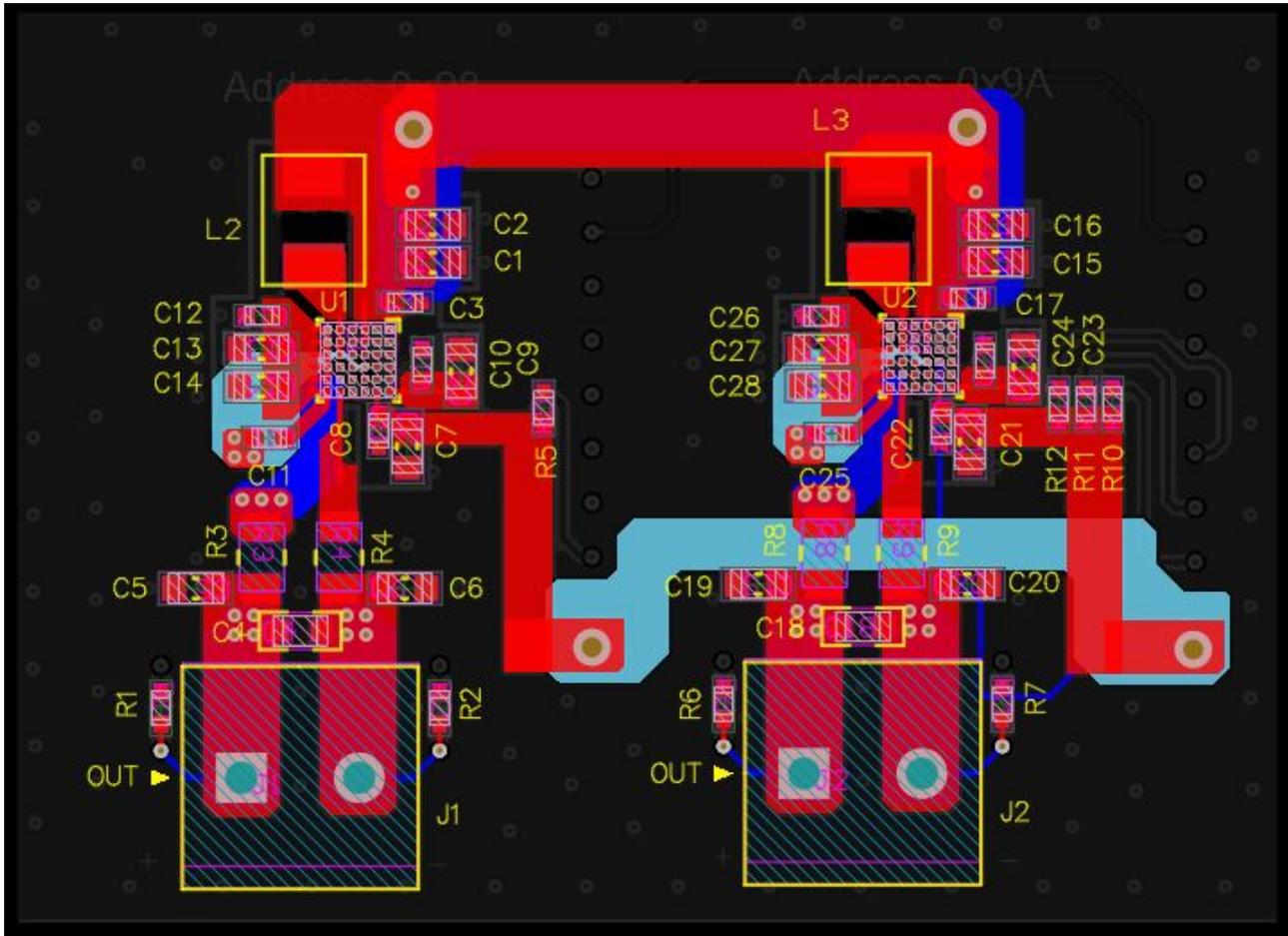


Figure 32. OUT_N and OUT_P Pins Connection (Stereo)

2.9 VSNS_N and VSNS_P Pins (Stereo)

The VSNS_N and VSNS_P pins for the stereo version have the same considerations as stated in Section 1.9.

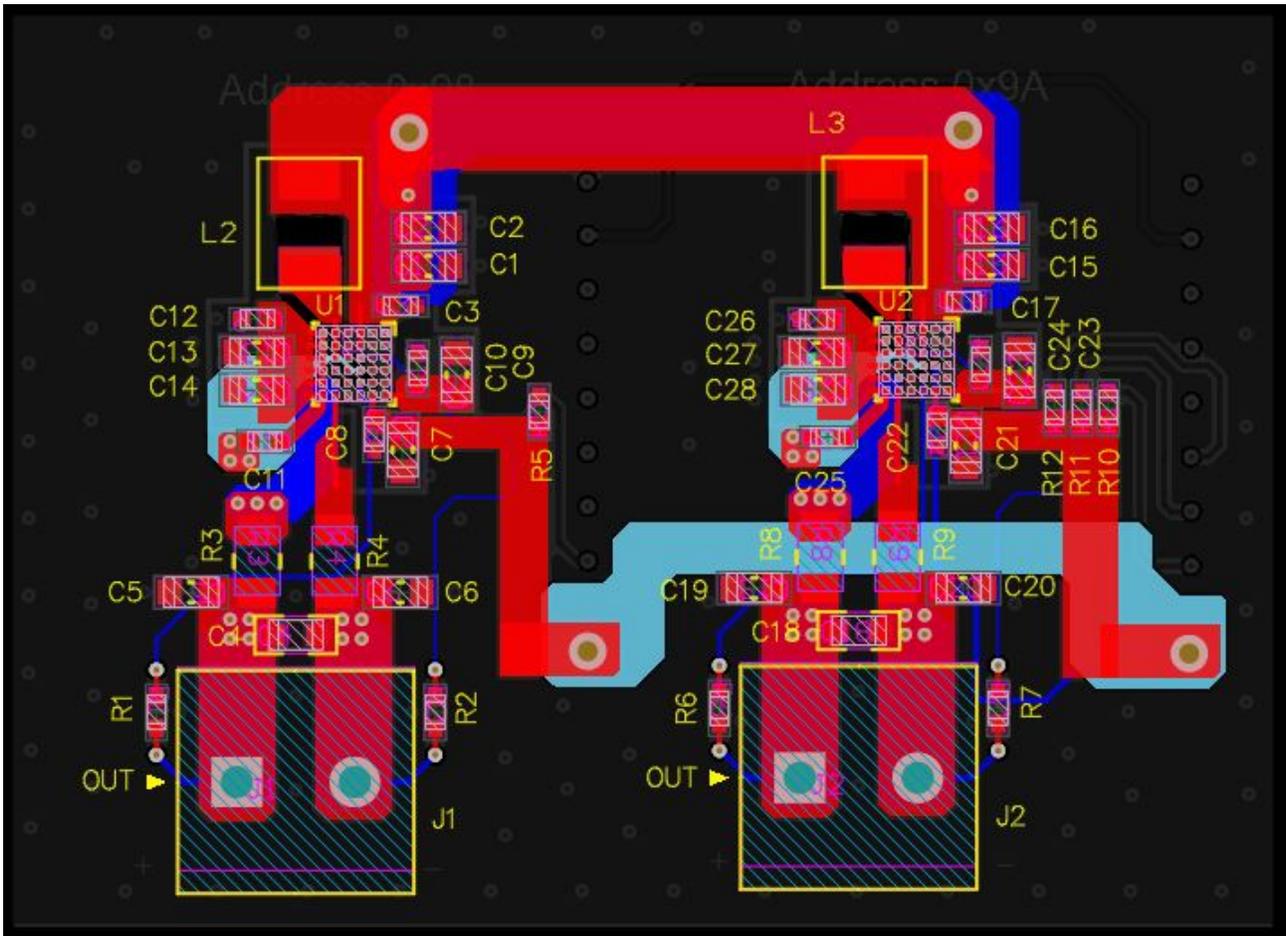


Figure 33. VSNS_N and VSNS_P Pins Connection (Stereo)

2.10 Digital Portion Connections (Stereo)

The digital portion connections for the stereo version have the same considerations as stated in [Section 1.10](#).

In addition, care must be taken when routing the digital pins between both TAS2564 channels. Avoid routing the digital traces below the traces with switching activity such as the SW pin. Otherwise, there could be noise on the digital portion and may cause a wrong activity.

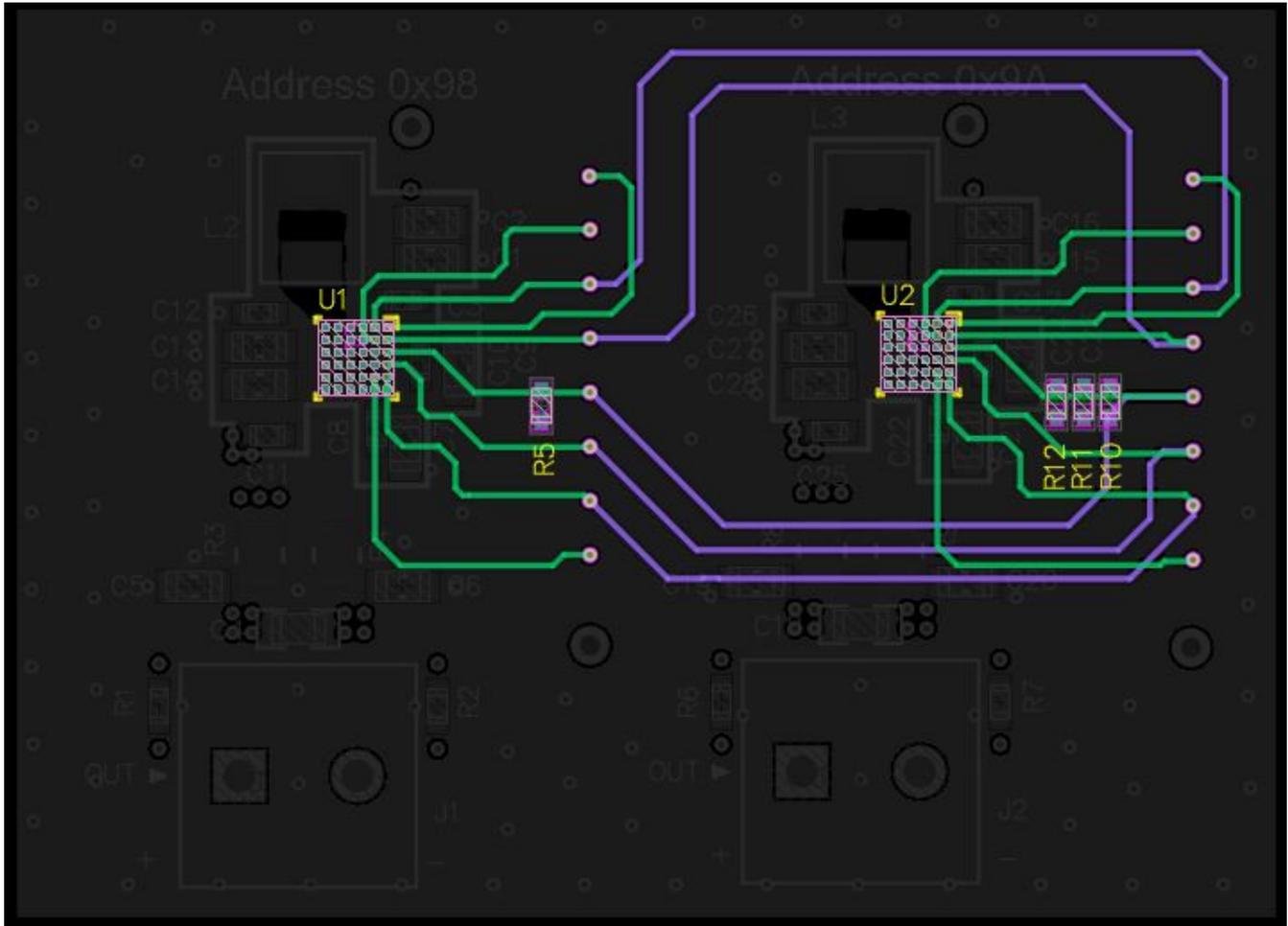


Figure 34. Digital Pins Connections

2.11 Ground Pins (BGND, GND, and PGND)

The ground pins (BGND, GND, and PGND) for the stereo version have the same considerations as stated in [Section 1.11](#).

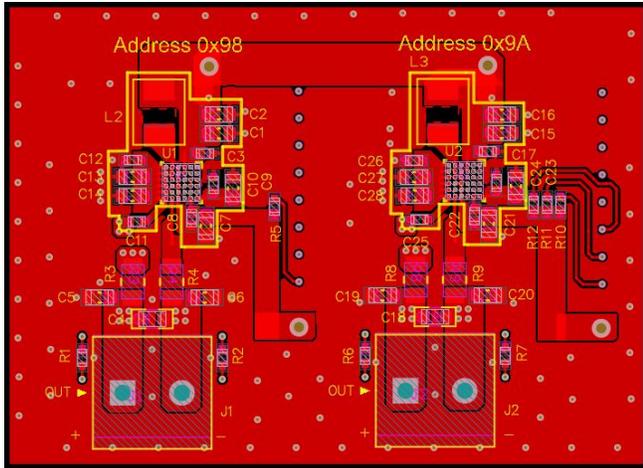


Figure 35. Top Layer (Stereo)

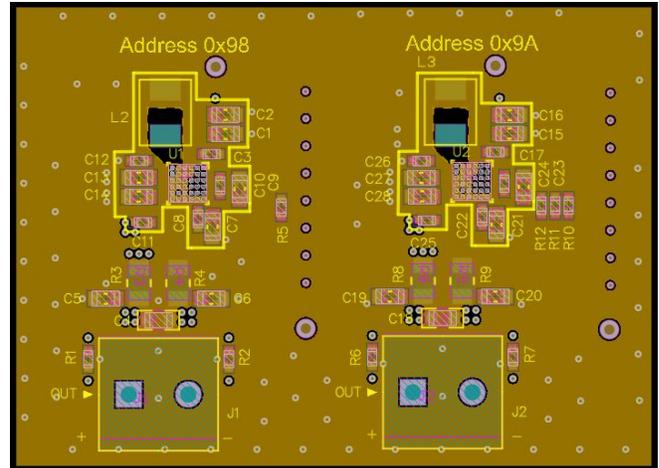


Figure 36. Copper Layer 2 (GND Exclusive Layer)

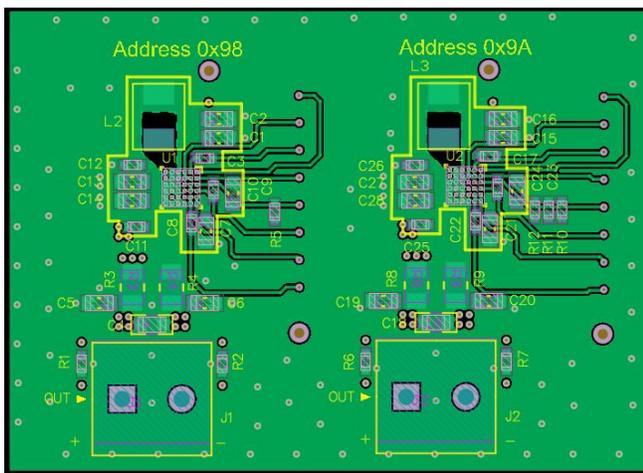


Figure 37. Copper Layer 3

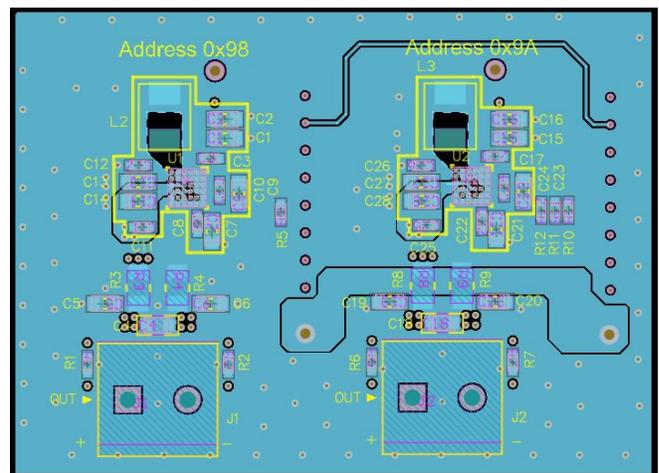


Figure 38. Copper Layer 4

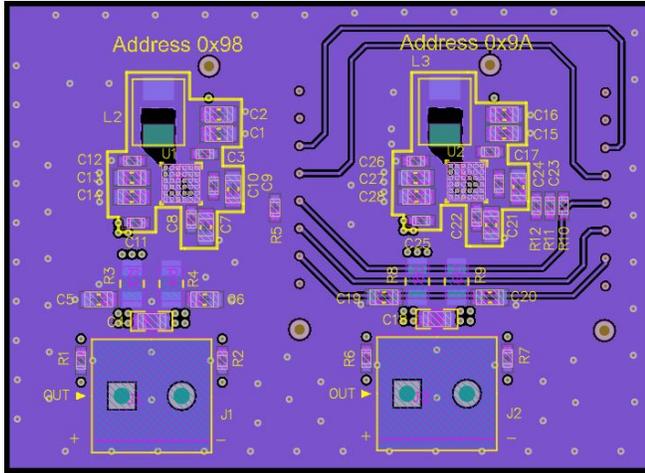


Figure 39. Copper Layer 5

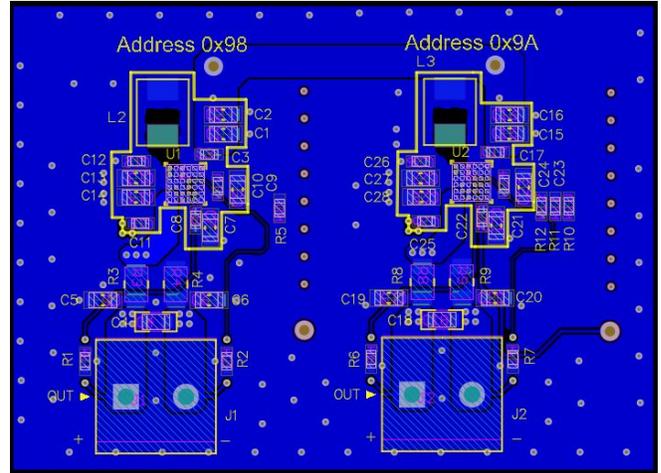


Figure 40. Bottom Layer

Table 2. Recommended External Components

Component	Description	Specification	MIN	TYP	MAX	Unit
L1, L2, L3	Boost converter inductor	Inductance, 20% tolerance	0.47	1		μH
		Saturation current		5.5		A
		Inductance derate at saturation current			20	%
N/A	EMI filter inductors (optional). These are not recommended because it degrades THD+N performance. The TAS2564 is a filter-less Class-D and does not require these inductors	Impedance at 100 MHz		120		Ω
		DC resistance			0.095	Ω
		DC current			2	A
		Size		0402		EIA
C1, C2, C15, C16	Boost converter input capacitor	Capacitance, 20% tolerance	10			μF
C13, C14, C27, C28	Boost converter output capacitor	Capacitance, 20% tolerance	10		47	μF
		Rated voltage	25			V
		Capacitance at 13 V after derating	4			μF
N/A	EMI filter capacitors (optional, must use L2, L3 if C3, C4 used)	Capacitance		1		nF
C7, C21	VDD decoupling capacitor	Capacitance	4.7			μF
C9, C23	DREG decoupling capacitor	Capacitance	1			μF
C11, C25	GREG Fly capacitor	Capacitance	10		47	μF
C12, C29, C26, C30	PVDD decoupling capacitor	Capacitance	10		47	μF
		Rated Voltage	25			V
		Capacitance at 13 V after derating	4			μF

3 Bill of Materials (BOM)

Table 3 details the bill of materials.

Table 3. Bill of Materials

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer	Alternate Part Number	Alternate Manufacturer
C1, C2, C13, C14, C15, C16, C27, C28	8	10 μ F	CAP, CERM, 10 μ F, 25 V, 10%, 0603, SMD	3.2 mm x 1.7 mm	GRM188R61E106KA73D	Murata Electronics		
C7, C21	2	4.7 μ F	CAP, CERM, 4.7 μ F, 10 V, \pm 10%, X5R, 0603	0603	CGB3B1X5R1A475K055AC	TDK		
C4, C5, C6, C9, C12, C18, C19, C20, C23, C26	10	1 μ F	CAP, CERM, 1 μ F, 16 V, \pm 20%, X7R, 0603	0603	CL10B105M08NNWC	Samsung		
C3, C11, C17, C25	4	0.1 μ F	CAP, CERM, 0.1 μ F, 25 V, \pm 10%, X7R, AEC-Q200 Grade 1, 0402	0402	CGA2B3X7R1E104K050BB	TDK		
C8, C10, C22, C24	4	0.01 μ F	CAP, CERM, 0.01 μ F, 25 V, \pm 10%, X7R, 0402	0402	GCM155R71E103KA37D	MuRata		
J1, J2	2		Conn Term Block, 2POS, 3.81 mm, TH	2POS Terminal Block	1727010	Phoenix Contact		
L1, L2, L3	3	1 μ H	Inductor, Shielded, Metal Composite, 1 μ H, 5.5 A, SMD	3.3 mm x 1.5 mm x 1.2 mm	IHLP1212ABEV1R0M01	Vishay / Dale		
R3, R4, R8, R9	4	0 Ω	RES, 0, 5%, 0.125 W, 0805	0805	RC0805JR-070RL	Yageo America		
R5, R10	2	20.0 k Ω	RES, 20.0 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	RMCF0402FT3K3	Stackpole Electronics Inc		
R11, R12	2	3.3 k Ω	RES, 3.3 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	RMCF0402FT3K3	Stackpole Electronics Inc		
R1, R2, R6, R7	4	0 Ω	RES, 0, 5%, 0.1 W, AEC-Q200 Grade 0, 0402	0402	ERJ-2GE0R00X	Panasonic		
U1, U2, U5	3		6W Boosted Class-D Audio Amplifier with IV-sense, YFP0036-C02 (DSBGA-36)	YFP0036-C02	TAS2564YFPR	Texas Instruments	TAS2564YFPT	Texas Instruments

4 Decoupling Capacitors

All the PCB routes have defined impedance that must be considered during all design stages. These signal paths will act as additional components in the board. In addition, the PCB lines have a parasitic inductance and capacitance that result in a different power distribution.

To reduce the negative effects of all these parasitic impedances, we recommend that the VBAT and VDD decoupling capacitor connections respect the following rules:

- Place the decoupling capacitor close to the device pin in the same layer.** The decoupling capacitor stores local charge and supplies the large transient currents when it is required. The TAS2564 device has many switching activity and voltage fluctuations that demand large current transients in a short period of time. In addition, the parasitic effects caused by the vias, traces, and pads generate a voltage drop in the power supply. The proximity of the decoupling capacitors to the power pins compensates these effects and supplies the large transient currents when it is required. On a multi-layer board, the capacitors must be placed in the same layer where the TAS2564 device is located. Otherwise, the decoupling capacitor value may be reduced by the additional capacitance due to the vias connections.
- Place the VDD and GND vias as close as possible to the decoupling capacitors.** If possible, place the via directly or the closest as possible to the capacitor mounting pads. The vias have defined impedance determined by its length and diameter. This impedance may cause a voltage drop (in high-frequency applications the signal integrity is greatly influenced) and a current flow that must be reduced or avoided. For that reason, it is recommended to add many vias around the mounting pads. This practice reduces the parasitic impedance.

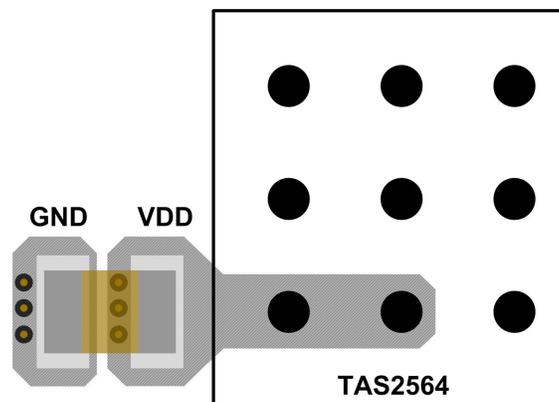


Figure 41. VIAS Placement

Refer all the pins that require a decoupling capacitor to this section for detailed information.

5 PVDD Capacitor selection.

To maximize the device performance, it is important to ensure that the selected capacitors and inductors for this design are capable to achieve the voltage and current ratings respectively.

The TAS2564 requires at least 4- μ F capacitor connected to PVDD. However, we recommend to verify the capacitance degradation of the selected capacitor to ensure that its value will not be less than 4 μ F at 13-V voltage.

As [Figure 42](#) shows, the capacitors have a particular *Capacitance vs DC voltage response* that degrades the capacitor value if the voltage increases.

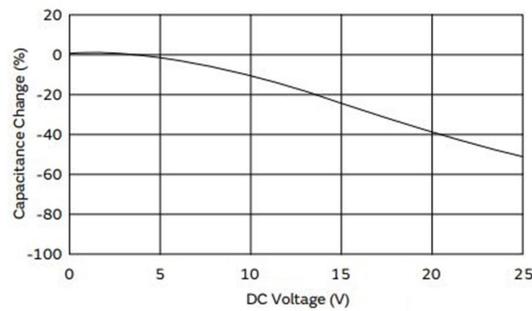


Figure 42. Capacitor vs DC Voltage Response

A 10- μF capacitor with this degradation curve would be reduced to 80% of its nominal value at 13 V. Since the typical VBST level is 13 V, a 10- μF capacitor would lose a 20% of its nominal value. This would result in a 8- μF capacitor. A capacitor with this response would be a good choice as PVDD capacitor. In cases where the capacitance is derated more than 80%, more capacitors in parallel are required to reach the minimum value since the capacitance degradation response affects significantly the nominal value.

6 SW Inductor Selection

Regarding the inductor selection, it is important to ensure that its inductance vs current response does not affect the inductor value in high percentage rates. The recommended inductor must be near of 1 μH even if the current increases.

Figure 43 shows an example of an inductance vs current response.

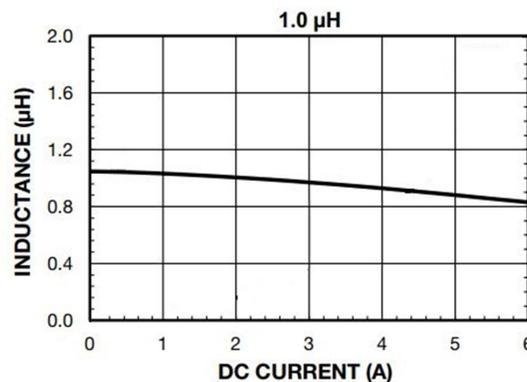


Figure 43. Inductance vs Current Response

In this case, the current increment reduces the inductance value. Having a significant loss of inductance must be considered to configure the boost inductor range of the device. A 1- μH inductor with a loss of no more of 20% is a good choice.

In addition, the inductor ACR and Q factor must be taken into account when the inductor is chosen. Preferably, Q factor at 4-MHz frequency (the switching frequency) must be below 1. In case of the ACR value, it is recommended to select an inductor with no more of 100 m Ω at 4 MHz. Otherwise, VBAT voltage would see a considerable voltage drop.

The boost inductor and decoupling capacitor ranges are specified using BST_IR and BST_LR registers.

7 Layout Guidelines Summary

Table 4 summarizes the layout guidelines.

Table 4. Layout Guidelines Summary

Name	Pin	Description	Typical Component Value	Component Instructions	Maximum Parasitic Inductance	Layout Instructions	Priority
BGND	D1, D2, D3	Boost ground. Connect to PCB GND plane.			150 pH	Short BGND, GND, GNDD, PGDN below the package and connect them to PCB ground plane strongly through multiple vias. Minimize inductance as much as possible	Critical
GND	D4, E4	Digital ground. Connect to PCB GND plane.			150 pH	Short BGND, GND, GNDD, PGDN below the package and connect them to PCB ground plane strongly through multiple vias. Minimize inductance as much as possible	Critical
GREG	C4	High-side gate CP regulator output. Do not connect to external load	100 nF	Connect between GREG and PVDD. Connection to PVDD should be a star connection instead of connecting to decoupling route. Layer changes should use multiple vias to minimize parasitic inductance	200 pH	Connect it to PVDD with a star connection and not to boost plane. Do not connect to external load.	Critical
PGND	D5, D6	Power stage ground. Connect to PCB GND plane			150 pH	Maximum 150-pH parasitic inductance. Short BGND, GND, GNDD, PGDN below the package and connect them to PCB ground plane strongly through multiple vias. Minimize inductance as much as possible	Critical
SW	E1, E2, E3	Boost converter switch input	1 μ H	Inductor connects between SW and VBAT.		Connect to VBAT with boost inductor. Reduce parasitic capacitor and resistance for efficiency. Boost inductor should be as close as possible to the SW pin. Inductor should be connected to SW through thick plane. Traces should support currents up to device over-current limit. Ground bounce can be reduced by placing a keep out \odot this trace and preventing any signal from routing beneath. Do not route digital under this net.	Critical
VBAT	C1, C2	Battery power supply input. Connect to 2.7 V to 5.5-V supply and decouple with a capacitor	10 μ F	Extra bulk decoupling may help reduce overall THD+N at high power by preventing supply droop	500 pH	Bypass to GND with capacitor. Should be connected to inductor through thick plane. Both ends of decoupling capacitor should see as low inductance as possible between VBAT pin and PGND pin. Routing from VBAT should be wide enough to handle total output power.	Critical

Table 4. Layout Guidelines Summary (continued)

Name	Pin	Description	Typical Component Value	Component Instructions	Maximum Parasitic Inductance	Layout Instructions	Priority
DREG	A6	Digital core voltage regulator output. Bypass to GND with a cap. Do not connect to external load.	1 μ F		500 pH	Bypass to GND with capacitor. Do not connect to external load. Both ends of decoupling cap should see as low inductance as possible between this pin and GND pins.	High
PVDD	F4, F5, F6	Power stage supply.	20 μ F	Capacitor derating should satisfy ratio of $L/C < 1/3$ with respect to Boost inductor. Considering component tolerances, should target no less than 3.3 μ F at a typical 11.5 V Boost when using a 1- μ H inductor. This requirement requires checking the DC bias derating of the capacitor. 16 V capacitors typically are derated by around 80% at the boost voltage.	100 pH	Short it to VBST(boost) plane through strong connection. Connect it to GREG with a star connection and not to boost plane.	High
VBST	F1, F2, F3	Boost converter output. Do not connect to external load.	20 μ F	Capacitor derating should satisfy ratio of $L/C < 1/3$ with respect to Boost inductor. Considering component tolerances, should target no less than 3.3 μ F at a typical 11.5 V Boost when using a 1- μ H inductor. This requirement requires checking the DC bias derating of the capacitor. 16 V capacitors typically are derated by around 80% at the boost voltage.	100 pH	Do not connect to external load. Bypass to GND with capacitor. Connect to PVDD through thick plane. Both ends of decoupling capacitor should see as low inductance as possible between VBST pin and BGND pin. Traces should support currents up to device over-current limit.	High
VDD	B6	Analog, digital, and I/O power supply. Connect to 1.8-V supply and decouple to GND with a capacitor.	4.7 μ F		200 pH	Bypass to GND with capacitor. Both the end of decoupling cap should see as low inductance as possible between this pin and GND pin	High
OUT_N	E6	Class-D negative output for receiver channel.		If using an EMI filter, inductance should be the first element in the filter. Capacitance to GND or other output will pull high current spikes capable of triggering over current protection. It is recommended to set the filter corner frequency no lower than 1.5 MHz.		Route with wide traces to speaker connection. Make Vsense connections as close to speaker as possible. Keep route short to limit emissions.	Medium
OUT_P	E5	Class-D positive output for receiver channel		If using an EMI filter, inductance should be the first element in the filter. Capacitance to GND or other output will pull high current spikes capable of triggering over current protection. It is recommended to set the filter corner frequency no lower than 1.5 MHz.		Route with wide traces to speaker connection. Make Vsense connections as close to speaker as possible. Keep route short to limit emissions.	Medium
VSNS_N	C3	Voltage sense negative input. Connect to Class-D out_N output after ferrite bead filter	1 k Ω	Additional place holder for series resistance may be beneficial with limiting emissions		Make connection to OUTN at speaker terminal	Medium
VSNS_P	C5	Voltage sense positive input. Connect to Class-D Out_P output after ferrite bead filer.	1 k Ω	Additional place holder for series resistance may be beneficial with limiting emissions		Make connection to OUTN at speaker terminal	Medium

Table 4. Layout Guidelines Summary (continued)

Name	Pin	Description	Typical Component Value	Component Instructions	Maximum Parasitic Inductance	Layout Instructions	Priority
FSYNC	A3	I2S word clock or TDM frame sync for ASI1 and ASI2 channels					Low
SBCLK	A2	ASI1 channel I2S/TDM serial bit clock.					Low
SCL	A4	I2C Mode: I2C clock pin. Pull up to VDD with a resistor. SPI Mode: active low chip select.					Low
SDA	A5	I2C Mode: I2C Data Pin. Pull up to VDD with a resistor. SPI Mode: Serial data input pin					Low
SDIN	B2	ASI1 channel I2S/TDM serial data input					Low
SDOUT	B1	ASI1 channel I2S/TDM serial data output					Low
AD0	B4	I2C Mode - Address selection pin See General I2C operation. SPI Mode - SPI clock					Not critical
AD1	B3	I2C Mode - Address selection pin See General I2C operation. SPI Mode - SPI clock					Not critical
IRQZ	B5	Open drain, active low interrupt pin. Pull up to VDDD with resistor if optional internal pull up is not used.	10 k Ω				Not critical
SDZ	A1	Active low hardware shutdown.					Not critical
GPIO	C6	General purpose I/O, no connect if not used		Additional place holder for series resistance may be beneficial with limiting emissions		Make connection to OUTP at the speaker terminal	Not critical

IMPORTANT NOTICE AND DISCLAIMER

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

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

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

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2020, Texas Instruments Incorporated