Keywords: low-cost class D amplifier, digital audio amplifier

APPLICATION NOTE 6643

OPTIMIZE COST, SIZE, AND PERFORMANCE WITH MAX98357 WLP

Abstract: This application note provides recommendations for the inner bump connection of the MAX98357A/B WLP package to minimize PCB fabrication cost and describe the recommended use of the GAIN_SLOT pin.

Although the MAX98357A/MAX98357B are available in two space-saving packages (9-bump WLP (1.44mm x 1.35mm, 0.4mm pitch) and 16-pin TQFN (3mm x 3mm)), choosing which package to use in your end- product depends on your budget and the available space on your PCB. Additionally, as the device package gets smaller, the routing of traces out from the device can become more complex, thereby increasing PCB fabrication cost. This is where the WLP vs. the TQFN is more appealing. The WLP's primary PCB routing concern is the connection of the inner bump (GAIN_SLOT). This application note focuses on the WLP package and some PCB design recommendations that can reduce your overall design-in cost. **Figure 1** shows the WLP pinout.

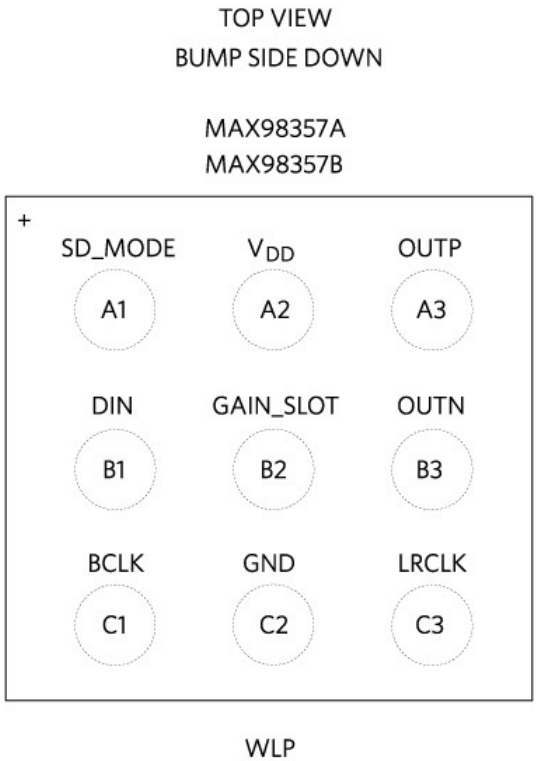

Figure 1. MAX98357A/MAX98357B

Function of GAIN_SLOT Pin

With I^2S input data, the GAIN_SLOT pin is used to set the system gain. With TDM input data, the gain is fixed at 12dB and the GAIN_SLOT pin is used to select which channel of audio to decode.

Table 1. Gain Selection

GAIN_SLOT	I^2S/LJ GAIN (dB)
Connect to GND through 100kΩ ±5% resistor	15
Connect to GND	12
Unconnected	9
Connect to V_{DD}	6
Connect to GND through 100kΩ ±5% resistor	15
Connect to GND	12
Unconnected	9
Connect to V_{DD}	6
Connect to V_{DD} through 100kΩ ±5% resistor	3

Table 2. TDM Mode Channel Selection

SD_MODE	GAIN_SLOT	CHANNEL	BITS
Low	X	Off	N/A
V_{DD}	GND	0	16/32
V_{DD}	V_{DD} with 0Ω	1	16/32
V_{DD}	Float	2	16/32
V_{DD}	V_{DD} with 100Ω	3	16/32
V_{DD}	GND with with 100Ω	4	16/32
V_{DD} through R_{LARGE}	GND	5	16/32
V_{DD} through R_{LARGE}	Float	6	16/32
V_{DD} through R_{LARGE}	V_{DD}	7	16/32

The intended use for GAIN_SLOT is to fix the desired full-scale output (I^2S mode) or channel selection (TDM mode). In any operation case, it is not intended for the GAIN_SLOT pin to be changed while audio is playing as it could result in audible clicks or pops.

It is suggested that volume control be implemented digitally where the audio is generated. Doing so allows a more precise volume control than what is possible by adjusting the GAIN_SLOT pin. The digital implantation also avoids a new route for the GAIN_SLOT pin.

Maxim's patented Dynamic Range Extension (DRE) allows the user to achieve the best dynamic range and noise floor at any gain setting. By using a dynamic range extender, one can avoid use cases where the user would normally reduce the analog gain to maximize dynamic range and noise floor. Full details of DRE and its benefits can be found in the white paper *Designing Better, Simpler Audio Solutions with Dynamic Range Enhancement (DRE)*.

Use Cases Where GAIN_SLOT Does Not Need to Be Routed Out

As shown in **Table 1**, the GAIN_SLOT pin is used to select the gain for I^2S mode. Three of the five gains do not need to be routed out. This is possible because of its placement in relation to V_{DD} and GND. With I^2S data, the pin can be configured for 6dB, 9dB, and 12dB.

Here are sample layouts (**Figure 2a, 2b, 2c**):

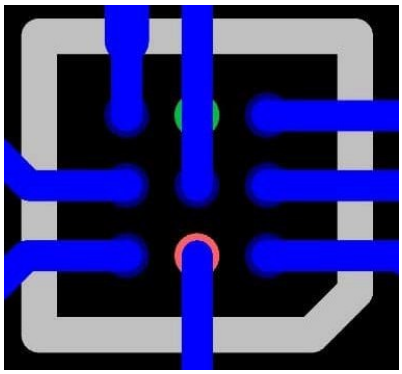

Figure 2a. 6dB (GAIN_SLOT tied to V_{DD}).

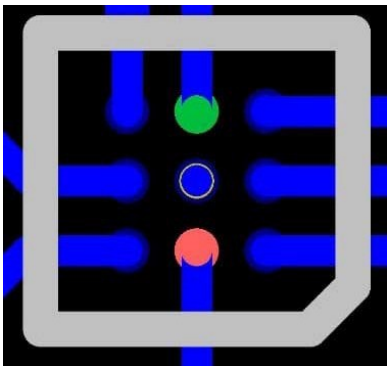

Figure 2a. 6dB (GAIN_SLOT tied to V_{DD}).

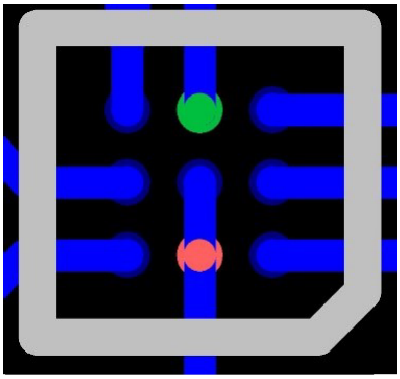

Figure 2c. 12dB (GAIN_SLOT tied to GND).

Similarly, in TDM mode, channels 0, 1, 2, 5, 6, and 7 can be selected without routing out the GAIN_SLOT pin by tying the pin to GND, V_{DD}, or leaving it unconnected. That means six of the eight channels in 8-channel TDM mode do not require routing out GAIN_SLOT.

Use Cases Where GAIN_SLOT Must Be Routed Out

If using I^2S mode with +3dB or +15dB gain, it is required to route the GAIN_SLOT pin so that a 100kΩ resistor can be connected to either V_{DD} or GND. This is also true for using channels 3 or 4 in TDM mode.

Options for Routing GAIN_SLOT Pin

If the use case requires routing out the GAIN_SLOT pin, here are the options:

- Mechanically drilled via: cheaper if PCB volumes are low
- Laser-drilled alternative: cheaper if PCB volumes are high
- Blind and buried vias with dog-boning
- Trace on the top layer: This will be a minimal pitch trace

PCB fabrication technology is constantly evolving, so check with your PCB manufacturer to see what option may work best for your design.

Related Parts		
MAX98357A	PCM Input Class D Audio Power Amplifiers	Free Samples
MAX98357B	PCM Input Class D Audio Power Amplifiers	Free Samples

More Information
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