AN2514
Application note

TS4997 2x1W stereo fully differential audio power amplifier with 3D effect enhancement- Evaluation board user guidelines

Introduction

This application note concerns the evaluation board DEMO TS4997, designed to evaluate the TS4997 stereo differential audio amplifier with 3D effect enhancement.

In this document, you will find:

- a brief description of the TS4997 differential stereo audio amplifier,
- a description of evaluation board and all of its components,
- the layout of the evaluation board.

About the TS4997

The TS4997 is designed for top-class stereo audio applications. Thanks to its compact and power-dissipation efficient QFN16 package with exposed pad, it suits a variety of applications. With a BTL configuration, this audio power amplifier is capable of delivering 1W per channel of continuous RMS output power into an 8Ω load @ 5V. 3D effects enhancement is programmed through a two digital input pin interface that allows more flexibility on each output audio sound channel.

Each output channel (left and right), also has its own external controlled standby mode pin to reduce the supply current to less than 10nA per channel. The device also features an internal thermal shutdown protection. The gain of each channel can be configured by external gain setting resistors.

Key features of the TS4997 include:

- Operating range from V_{CC}= 2.7V to 5.5V
- 1W output power per channel @ V_{CC}=5V, THD+N=1%, R_L=8Ω
- Ultra low standby consumption: 10nA typ.
- 80dB PSRR @ 217Hz with grounded inputs
- High SNR: 106dB(A) typ.
- Fast startup time: 45ms typ.
- Pop&click-free circuit
- Dedicated standby pin per channel
- Lead-free QFN16 4x4mm package

Figure 1 on page 2 shows a typical application for the TS4997 amplifier. For complete information about the TS4997, refer to the datasheet.

1 Description of the evaluation board

You can evaluate the amplifier in a typical application configuration. Using the board, you can:

- put each channel of the amplifier in standby/operating mode,
- set the level of 3D effect.

Figure 1. Typical application of the TS4997 audio amplifier with gain of +6dB set by input resistors

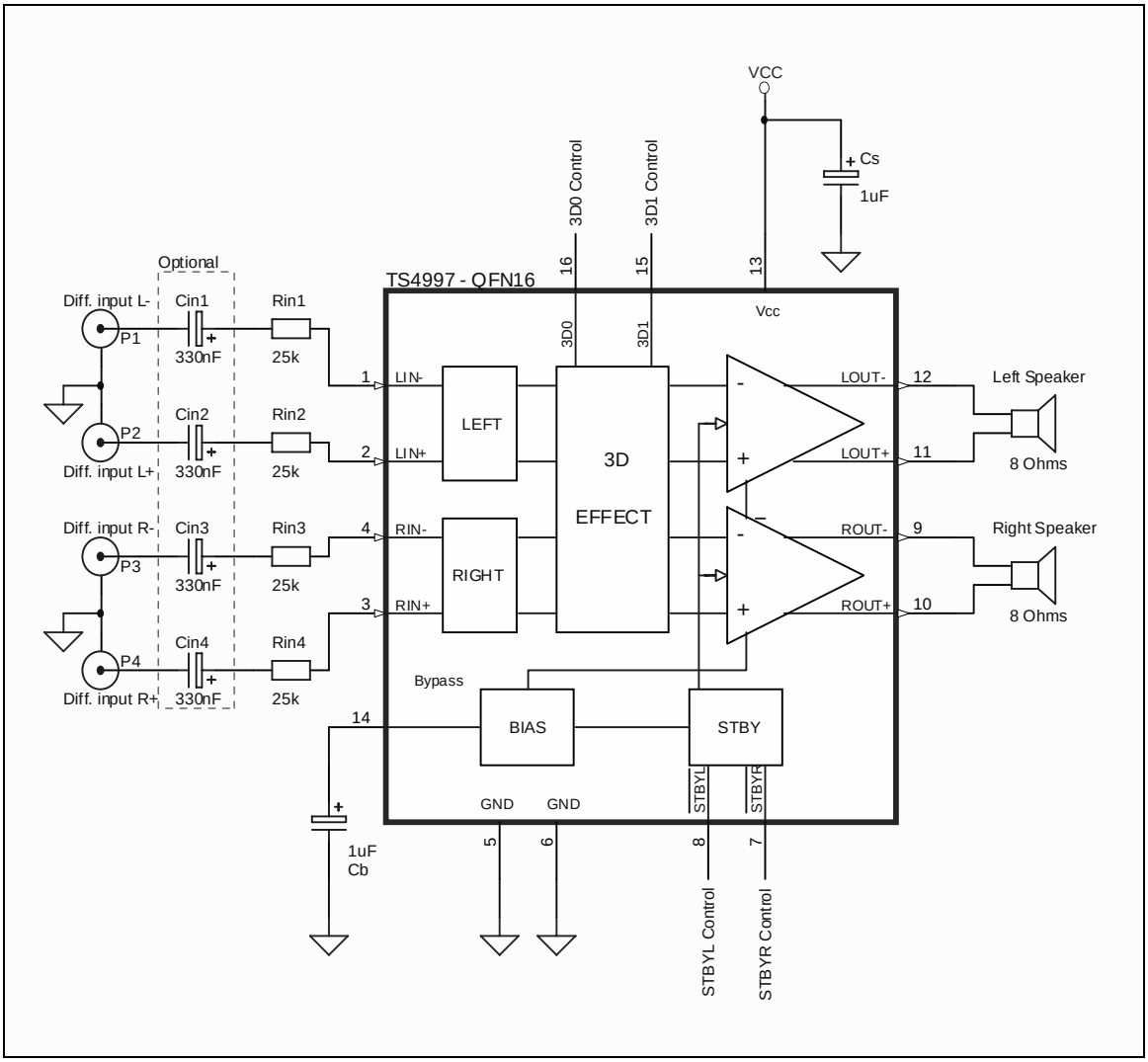


Table 1. External component descriptions

Components	Functional description
R_{IN}	Input resistors that set the closed loop gain in conjunction with a fixed internal feedback resistor (Gain = R_{feed}/R_{IN}, where R_{feed} = 50kΩ).
C_{IN}	Input coupling capacitors that block the DC voltage at the amplifier input terminal. Thanks to common mode feedback, these input capacitors are optional. However, if they are added, they form with R_{IN} a 1st order high pass filter with -3dB cut-off frequency ($f_{cut-off}$ = 1 / (2 x π x R_{IN} x C_{IN})).
C_S	Supply bypass capacitors that provide power supply filtering.
C_B	Bypass pin capacitor that provides half supply filtering.

3D effect enhancement

The TS4997 features 3D audio effects that can be programmed at three discrete levels (LOW, MEDIUM, HIGH) through input pins 3D1 and 3D0 which provide a digital interface. The correspondence between the logic levels of this interface and 3D effect levels are shown in *Table 2.*

The 3D audio effect applied to stereo audio signals evokes perception of spatial hearing and improves this effect in cases where the stereo speakers are too close to each other, such as in small handheld devices, or mobile equipment.

The perceived amount of 3D effect is also dependent on many factors such as speaker position, distance between speakers and listener, frequency spectrum of audio signal, or difference of signal between left and right channel. In some cases, the volume can increase when switching on the 3D effect. This factor is dependent on the composition of the stereo audio signal and its frequency spectrum.

Table 2. 3D effect settings

3D effect level	3D0	3D1
OFF	0	0
LOW	0	1
MEDIUM	1	0
HIGH	1	1

Figure 2. Evaluation board schematic diagram and components

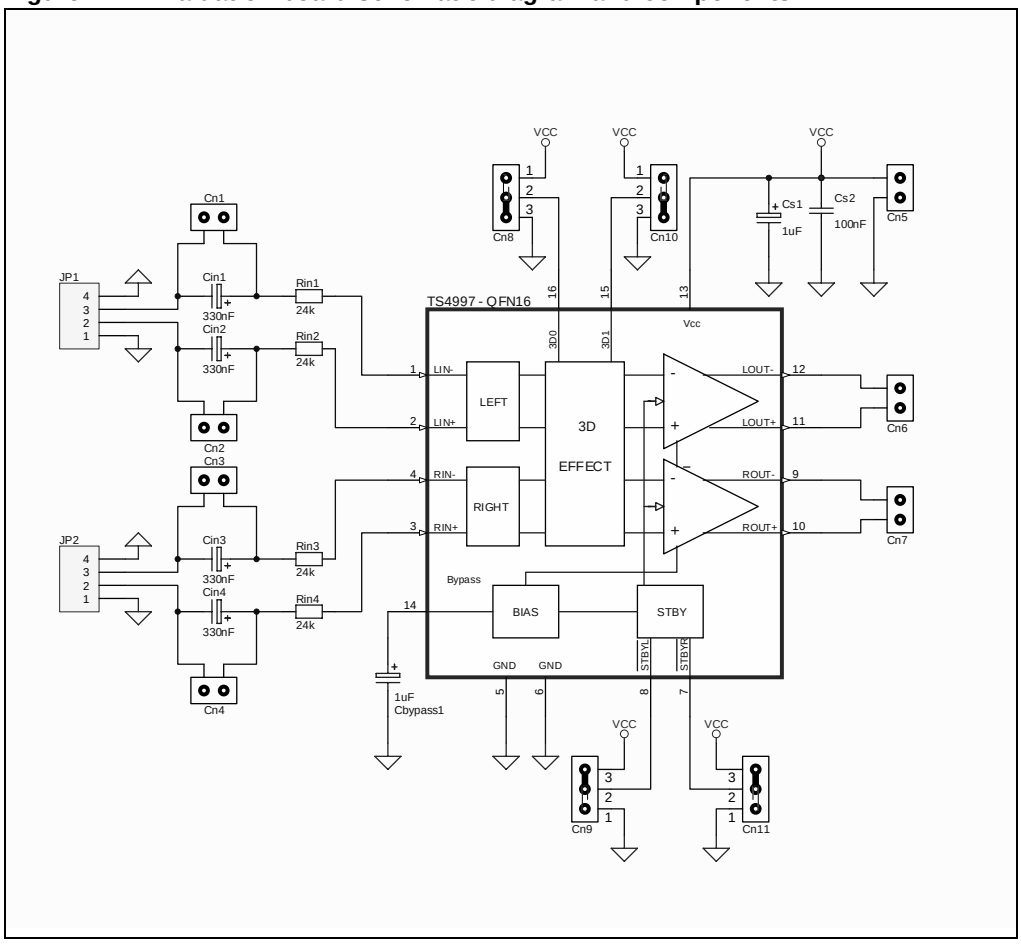


Table 3. Evaluation board bill of materials

Designation	Quantity	Description
U1	1	TS4997 differential stereo audio amplifier (QFN16 package)
C_{in1} to C_{in4}	4	R330nF/10V, ceramic capacitor 0603
C_b, C_{s1}	2	1µF/50V, electrolytic capacitor
C_{s2}	1	100nF/10V, ceramic capacitor
---	4	Jumper, 2.54mm pitch (placed on Cn8, Cn9, Cn10 and Cn11 connectors)
R1 to R4	4	Resistor 24k, 1/4W, 1%, 0603
Cn1 to Cn7	7	2 pins header, 2.54mm pitch
Cn8 to Cn11	4	3 pins header, 2.54mm pitch
JP1, JP2	2	3 pins header, 2.54mm pitch

2 Evaluation board connectors

Table 4. Evaluation board connectors

Connectors	Description
Cn1	Connector used to short-circuit input capacitor C_{in1} by placing a jumper on it when the amplifier is used with common mode feedback input.
Cn2	Connector used to short-circuit input capacitor C_{in2} by placing a jumper on it when the amplifier is used with common mode feedback input.
Cn3	Connector used to short-circuit input capacitor C_{in3} by placing a jumper on it when the amplifier is used with common mode feedback input.
Cn4	Connector used to short-circuit input capacitor C_{in4} by placing a jumper on it when the amplifier is used with common mode feedback input.
Cn5	Power connector (V_{CC}, GND). Power supply voltage from 2.7V to 5.5V.
Cn6	Left channel output signal connector (L_{out}^{+}, L_{out}^{-}).
Cn7	Right channel output signal connector (R_{out}^{+}, R_{out}^{-}).
Cn8	3D0 pin control connector (V_{CC}, 3D0, GND). Together with connector Cn10, allows you to select the level of 3D effect.
Cn9	Left channel standby control connector (V_{CC}, STBYL, GND).
Cn10	3D1 pin control connector (V_{CC}, 3D1, GND). Together with connector Cn8, allows you to select the level of 3D effect.
Cn11	Right channel standby control connector (V_{CC}, STBYR, GND).
JP1	Left channel input signal connector (GND, L_{in}^{-}, L_{in}^{+}, GND).
JP2	Right channel input signal connector (GND, R_{in}^{-}, R_{in}^{+}, GND).

Caution: When you apply the power supply through Cn5, **do not** invert the polarity because it would destroy the amplifier at U1.

3 Configuring the evaluation board characteristics

Differential gain

The value of the differential gain of each amplifier is dependent on the values of external input resistors R_{IN1} to R_{IN4} and of integrated feedback resistors with fixed value.

$$A_{V_{diff}} = \frac{R_{feed}}{R_{IN}} = \frac{50k\Omega}{R_{IN}}$$

where $R_{IN} = R_{IN1} = R_{IN2} = R_{IN3} = R_{IN4}$ expressed in kΩ and R_{feed} = 50kΩ (value of internal feedback resistors).

Because the input resistors values on the evaluation board are $R_{IN1}=R_{IN}=R_{IN3}=R_{IN4}$=24kΩ, the differential gain is set to ~6dB. If necessary, the differential gain can be adapted by modifying the values of resistors R_{IN1} to R_{IN4}.

Input configuration

On the demo board, by placing or removing jumpers on connectors Cn1, Cn2, Cn3 and Cn4 you can elasily change the input configuration.

You can select either **capacitor-coupled** or **common-mode feedback**.

In the **capacitor-coupled** configuration, the -3dB cut-off frequency in Hz is:

$$F_{CL} = \frac{1}{2 \times \pi \times R_{IN} \times C_{IN}} (Hz)$$

with $R_{IN} = R_{IN1} = R_{IN2} = R_{IN3} = R_{IN4}$ expressed in Ω and $C_{IN} = C_{IN1} = C_{IN2} = C_{IN3} = C_{IN4}$ expressed in F.

More information about component calculations is available in the TS4997 datasheet.

4 Evaluation board layout

The following schematics show the layers and the top view of the evaluation board.

Figure 3. PCB top layer

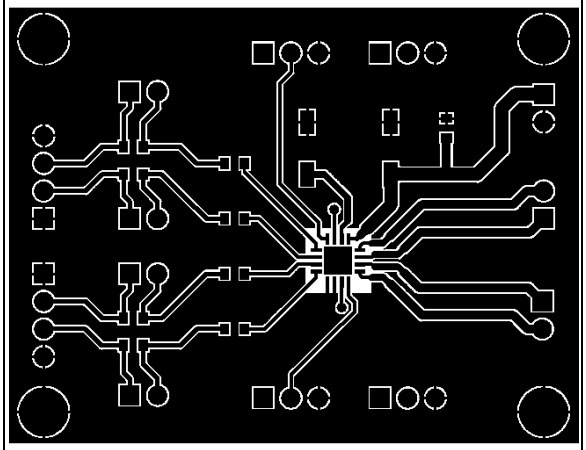


Figure 4. PCB bottom layer

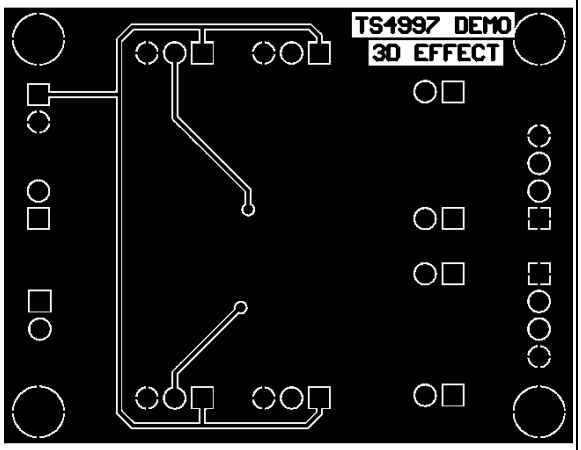
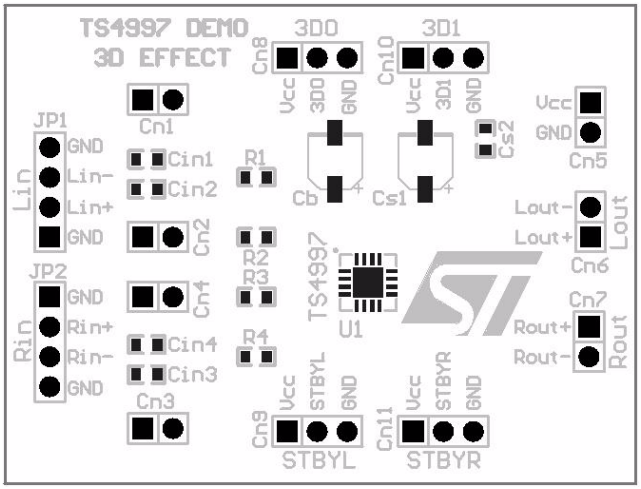


Figure 5. Top view of evaluation board



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