TS4956 stereo audio amplifier system with I^{2}C bus interface
evaluation board user guidelines

Introduction

This application note describes the DEMO TS4956 evaluation board, designed for evaluation of the TS4956 stereo audio amplifier.

The evaluation board allows the TS4956 amplifier to be driven directly via the I^{2}C bus or by a PC connected to the evaluation board over an RS232 interface.

In this document, you will find:

■ A brief description of the TS4956 stereo audio amplifier system,

■ A description of the evaluation board,

■ A list of the evaluation board components,

■ The layout of the evaluation board,

■ Information on how to configure the evaluation board using the software. You can download the software TS4956.exe from www.st.com/audioamps.

About the TS4956

The TS4956 is a complete audio system device with three dedicated outputs, one stereo headphone, one loudspeaker drive and one mono line for a hands-free set. The stereo headphone is capable of delivering more than 25 mW per channel of continuous average power into 16 Ω single-ended loads with 0.3% THD+N from a 5 V power supply. The device functions are controlled via an I²C bus, which minimizes the number of external components needed. The overall gain and the various output modes of the TS4956 are controlled digitally by the control registers which are programmed via the I²C interface. It also features an internal thermal shutdown.

The TS4956 key features are:

■ Stereo audio amplifier system with I^{2}C bus interface

■ Operating range from V_{CC} = 2.7 V to 5.5 V

■ I^{2}C bus control interface

■ 38 mW output power @ V_{CC} = 3.3 V, THD = 1%, F = 1 kHz, with 16Ω load

■ Ultra-low consumption in standby mode: 0.5 µA

■ 32-step digital volume control ranging from +12 dB to -34.5 dB

■ Stereo loudspeaker option by I²C

■ 8 different output mode selections

■ Pop & click reduction circuitry

■ Lead-free flip-chip package, 18 bumps with 300 µm diameter

■ Output power limitation on headphone for eardrum damage consideration

Contents

1   Typical application schematics

Figure 1 on page 4 and *Figure 2. on page 5* show typical application schematics for the TS4956 amplifier with different configurations and different modes.

The eight possible output modes are defined in *Table 1*.

Table 1.   **Output mode selection: Gain from -34.5 dB to + 12 dB (by steps of 1.5 dB)**

Output mode #	RHP	LHP	Speaker P/N	Mono L/O
0	SD	SD	SD	SD
1	SD	SD	GX (MIP + MIN)	SD
2	SD	SD	GX (RIN + LIN)	SD
3	GX (MIP + MIN)	GX (MIP + MIN)	SD	SD
4	G x RIN	G x LIN	SD	SD
5	SD	SD	SD	GX (MIP + MIN)
6	SD	SD	SD	GX (RIN + LIN)
7	BTL: G x RIN	BTL: G x RIN	G x LIN	SD

Where:

     SD = shutdown mode

     G = audio gain

     MIP = mono input positive

     MIN = mono input negative

     RIN = stereo input right

     LIN = stereo input left

For complete information about the TS4956, refer to the datasheet.

Figure 1. Typical application for the TS4956 (mode 1, 2, 3, 4, 5, 6)

Figure 2.   Typical application for the TS4956 (mode 7)

2 Description of the evaluation board

The evaluation board is divided into two parts. One part includes a typical application for the TS4956 and provides connectors for stereo headphones with a load of 16/32Ω. The other part allows you to evaluate I^{2}C bus control of the TS4956 using a PC. These two parts are opto-separated in order to obtain better suppression of noise caused by the PC power supply.

With this evaluation board you can use the TS4956 amplifier in most typical applications with typical external components. You can also use the on-board I^{2}C circuit or external I^{2}C controller to control the TS4956 amplifier (see *Section 3: Evaluation board connectors on page 9*).

For I^{2}C control, the V_{CC}-I^{2}C voltage needs to be applied to the I^{2}C V_{CC} pin of the TS4956 and to the on-board I^{2}C circuit. There are two ways of supplying this input:

● One solution is to use the V_{CC} voltage of the amplifier by shorting pins 1 and 2 of connector Cn4 using a jumper. Note that in this case the supply current is higher than the TS4956 supply current itself due to additional current flowing through the on-board I^{2}C circuit.

● The second solution is to use an external power supply connected to connector Cn4 to supply the I^{2}C V_{CC} input. In this case, the current that supplies the analog part of the evaluation board is equal to the supply current of the TTS4956 itself. (See *Section 3: Evaluation board connectors on page 9*).
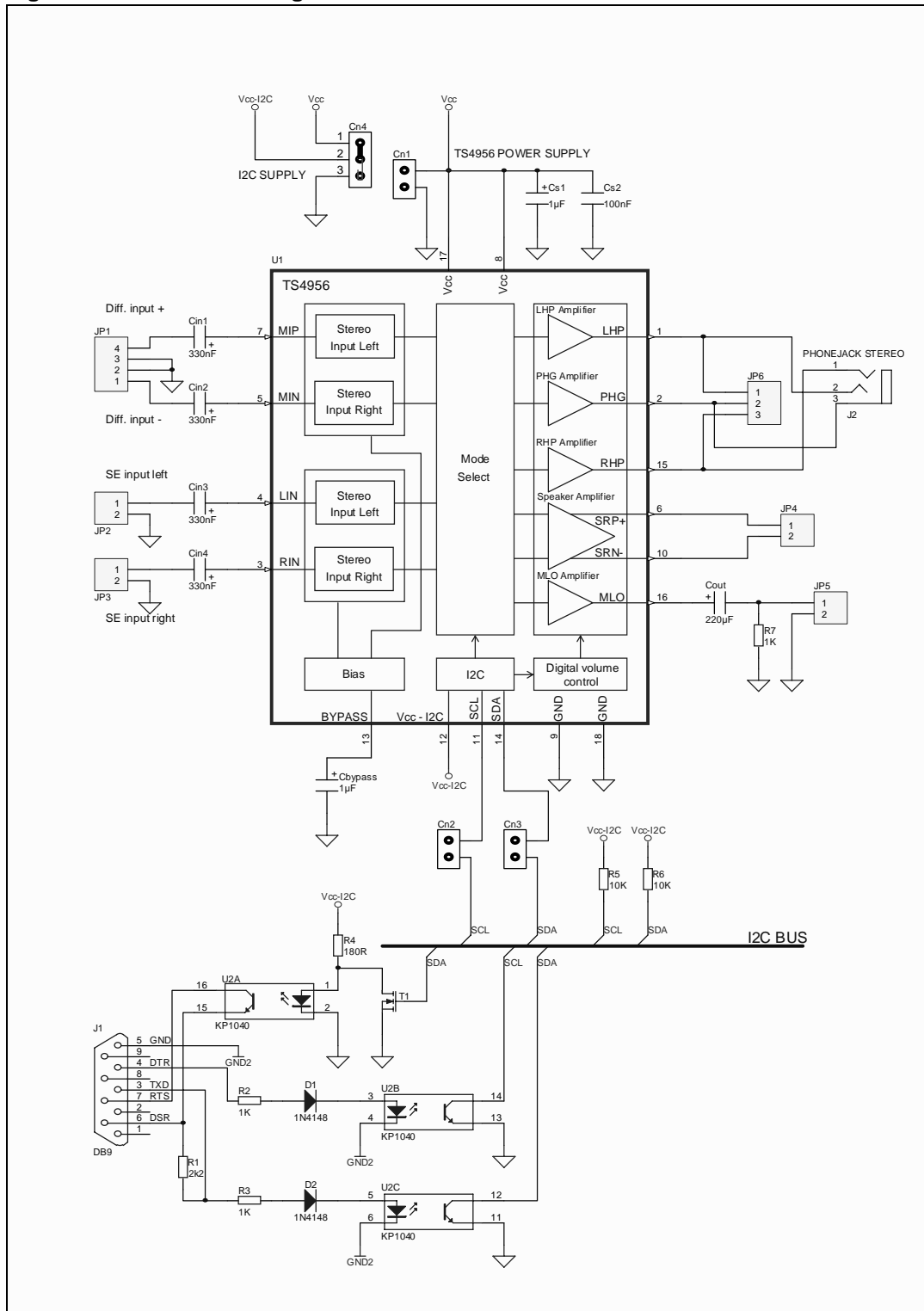
Figure 3.   Schematic diagram of the evaluation board

Table 2. **Evaluation board bill of materials**

Designation	Quantity	Description
U1	1	TS4956 flip-chip to DIP16 adapter
U2	1	KP1040 photo coupler
C_{bypass}, C_{s1}	2	1μF/50V, electrolytic capacitor
C_{s2}	1	100nF/63V, ceramic capacitor
C_{in1}, C_{in2}, C_{in3}, C_{in4}	4	330nF/63V, ceramic capacitors
C_{out}	1	220μF/10V, electrolytic capacitor
R1	1	2k2, 0.6W 1% resistor
R2, R3, R7	3	1k, 0.6W 1% resistor
R4	1	180R, 0.6W 1% resistor
R5, R6	2	10k, 0.6W 1% resistor
J1	1	Dsub 9 pins socket (female)
J2	1	3.5mm stereo headphone jack
---	3	Jumper, 2.54mm pitch
D1, D2	2	Diode 1N4148
T1	1	N-channel MOSFET transistor, BS170
Cn1, Cn2, Cn3	3	2 pins header 2.54mm pitch
Cn4	1	3 pins header 2.54mm pitch
JP1	1	4 pins header 2.54mm pitch
JP2, JP3, JP4, JP5	4	2 pins header 2.54mm pitch
JP6	1	3 pins header 2.54mm pitch

3   Evaluation board connectors

Caution: When you apply the power supply through Cn1 and Cn4, **DO NOT** invert the
polarity because it would destroy the amplifier at U1.

Connectors	Description
Cn1	Power connector for analog part of V_{CC}. Power supply voltage from 2.7 V to 5.5 V.
Cn2, Cn3	When pins of Cn2 and Cn3 are shorted by jumpers, the TS4956 can be driven by on-board I^2C circuits or from a PC. When pins of Cn2 and Cn3 are disconnected, the TS4956 can be driven by an external I^2C interface over Cn2 and Cn3 pins. The Cn4 connector must be supplied by V_{CC}-I^2C voltage in both cases.
Cn4	Connector for V_{CC}-I^2C power supply. Possible configuration settings: – ⬚ pins 2 and 3 are shorted, V_{CC}-I^2C is grounded and the TS4956 is in total shutdown with ultra low current consumption. – ⬚ pins 1 and 2 are shorted, V_{CC}-I^2C is supplied by V_{CC} of the TS4956. After removing a jumper, the V_{CC}-I^2C can be supplied by an external voltage: – Pin 2 of Cn4 is connected to an external V_{CC}-I^2C supply (positive node) – And pin 3 of Cn4 is connected to the ground pin (negative node) of the V_{CC}-I^2C supply. In this case, ensure the condition 2.7 V $\leq V_{CC}$-$I^2C \leq V_{CC}$ is respected for proper operation.
J1	RS232 connector (DSR, TRS, TXD, DTR, GND2).
J2	Stereo jack for connecting stereo headphones 16/32 Ω (LHP, RHP, PHG)
JP1	Input signal connector (MIP, MIN, GND).
JP2	Input signal connector (LIN, GND).
JP3	Input signal connector (RIN, GND).
JP4	Output signal connector (SRP, SRN).
JP5	Output signal connector (MLO, GND).
JP6	Output signal connector (LHP, RHP, PHG).

Figure 4.   TS4956 flip-chip adapter pinout

Figure 5.   TS4956 DEMO BOARD top view

4   Evaluation board layout

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

Figure 6.   PCB top layer   **Figure 7.   PCB bottom layer**
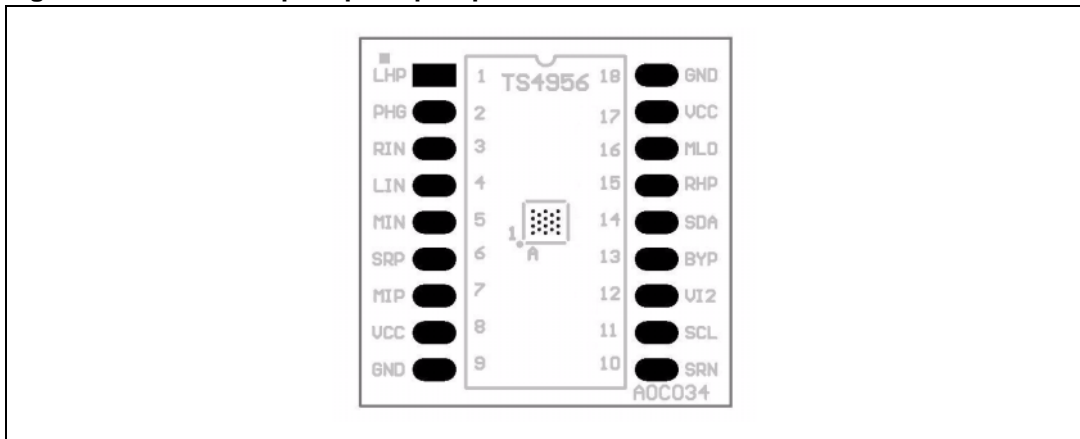

Figure 8.   Top view of evaluation board
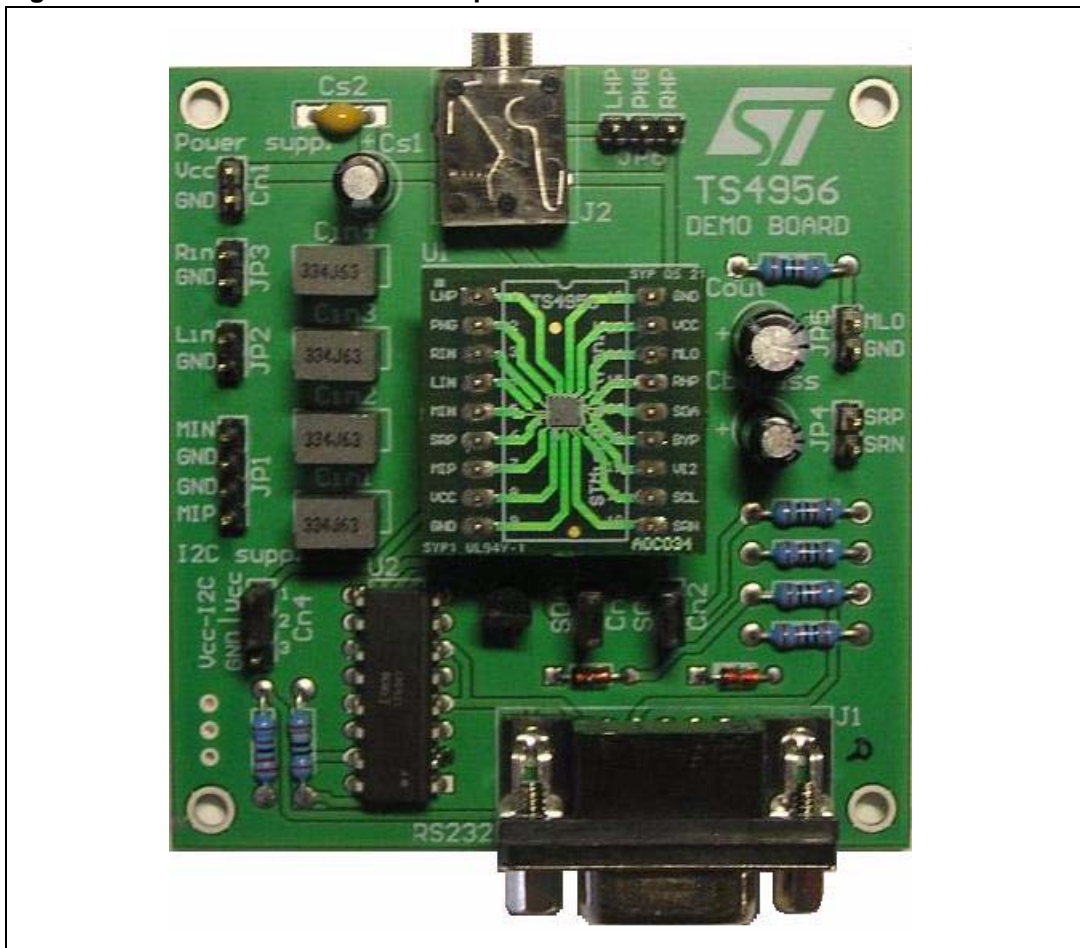
5 TS4956 command software

The TS4956 command software provides a quick and easy way of driving the TS4956 audio system from a PC, and in particular of configuring the output mode and the volume.

The software is available for download from the www.st.com/audioamps web site. It runs under MS Windows 95/98/ME/2000/XP.

Connecting the hardware, and starting the software

To drive the TS4956 from a PC, follow these steps:

1. Connect the PC to the TS4956 evaluation board with the RS232 cord.
2. Connect the power supply V_{CC} to Cn1, set jumper on Cn4 to short pins 1 and 2 or connect the external V_{CC}-I^2C supply to Cn4 to supply the I^2C part externally.
3. Launch the TS4956.exe program downloaded from the *st.com* web site.

   The software dialog box shown in *Figure 9* is displayed.

Figure 9. Command software view
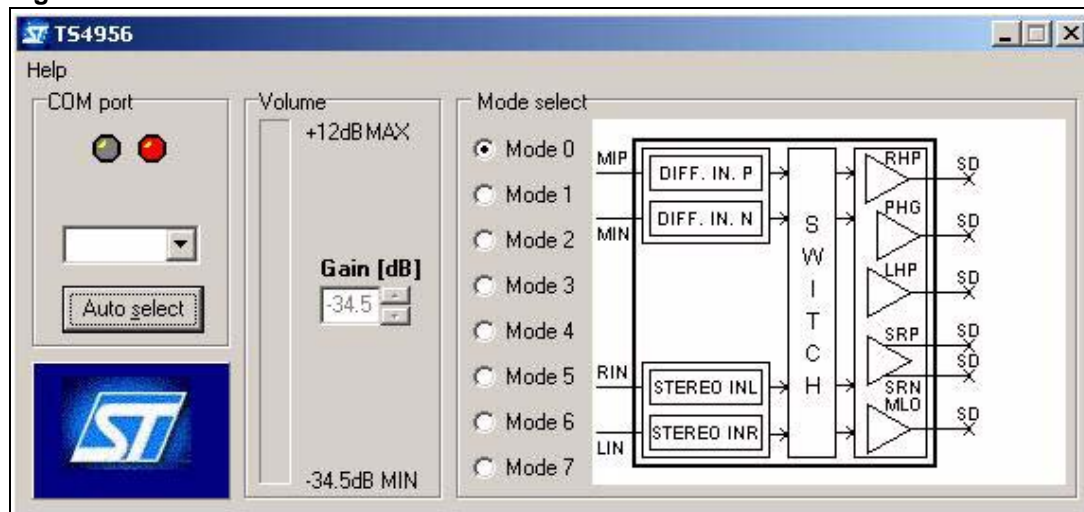
4. Choose the appropriate COM port from the pop-up menu in the COM Port box or click Auto Select for the program to select the COM port automatically.

   When the green LED diode in the *COM Port* box lights up, the program is ready to send commands to the TS4956.

Note: The COM port where the device is connected must be in the range from COM1 to COM4. If this is not the case, change the COM port number in Windows by selecting **Start>Control Panel>System>Hardware>Device Manager.**

Configuring the evaluation board using the software interface

There are two options that can be configured using the software interface:

● **Volume:** Changes the gain in the range from -34.5dB to +12 dB by steps of 1.5dB.
● **Mode select:** Allows you to select the TS4956 output mode. The schema in the Mode Select box summarizes the mode currently selected and shows which inputs and outputs are active.

These options are illustrated in the command software view in *Figure 9*.

Note: *Occasionally, problems may arise when trying to drive the evaluation board using certain notebook or laptop PCs and the RS232 output.*

6 Revision history

Table 3. Document revision history

Date	Revision	Changes
14-Nov-2006	2	First public release.

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