AN3145
Application note

STEVAL-CCA025V1 demonstration board user guidelines for the TS4621 high-performance stereo headphone amplifier

Introduction

This application note describes the STEVAL-CCA025V1 demonstration board, designed to evaluate STMicroelectronics' TS4621, a high-performance class G stereo headphone driver with capacitorless outputs and I^{2}C interface.

The document provides:

- a brief description of the TS4621 device and its key features.
- a description of the demonstration board and all of its components.
- a description of the TS4621 control software provided.
- schematics and layout of the demonstration board.

Figure 1.   TS4621 demonstration board
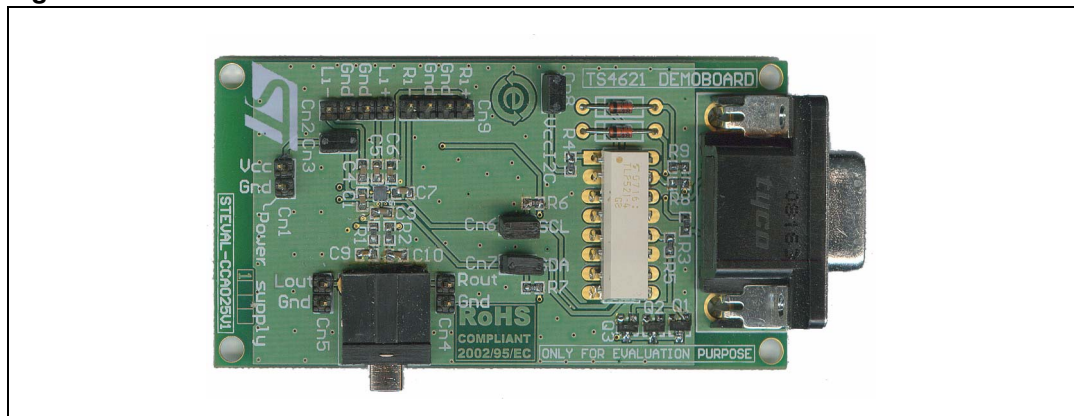
Description

The TS4621 is a class G stereo headphone driver dedicated to high audio performance and space-constrained applications.

It is based on a low-power dissipation amplifier core technology combined with a high-efficiency buck converter to supply this amplifier.

When powered by a battery, the buck converter generates the appropriate voltage to the amplifier according to the amplitude of the audio signal to supply to the headsets.

An I²C interface offers volume control in 32 steps from -60 dB to +4 dB. A dedicated common-mode sense pin is used to remove parasitic noise from the jack.

The device is packaged in a tiny 16-bump, flip-chip package with a pitch of 400 µm.

1 Key features of the TS4621

- Power supply range: 2.3 V to 4.8 V.
- 0.6 mA/channel quiescent current
- 2.1 mA current consumption with 100 µW/channel (10 dB crest factor)
- 0.006% typical THD+N at 1 kHz
- 100 dB typical PSRR at 217 Hz
- Zero pop and click
- I²C interface for volume control.
- Digital volume control range from -60 dB to +4 dB.
- 100 dB of SNR A-weighted at G = 0 dB.
- Independent right and left channel enable control.
- Integrated high-efficiency buck converter.
- Low standby current: 5 µA max.
- No output coupling capacitors (thanks to the internal negative supply).
- Thermal shutdown and short-circuit protection.
- Flip-chip package: 1.65 mm x 1.65 mm, 400 µm pitch, 16 bumps.

Refer to the TS4621 datasheet for complete information.

2 Description of the demonstration board

The STEVAL-CCA025V1 demonstration board is designed to help you evaluate the TS4621 audio differential input stereo headphone amplifier. The TS4621 device is soldered on a four-layer PCB. An on-board RS-232 to I^2C interface makes this board easy to control from a personal computer through its serial port.

The software provided controls all of the TS4621's features (gain, mode, mute, standby and register status). You can also use the connectors on the demonstration board to directly control the features through another I^2C interface.

● By removing the jumpers on Cn6 and Cn7, you can disconnect the on-board I^2C interface to control the TS4621 through an external I^2C bus interface.

● The -3 dB cut-off input high-pass filter is set at about 6 Hz (C4 to C7) at G = 4 dB and with Cin = 2.2 μF. If you want to change this frequency, you have to replace C4 to C7 at the same time. More information on these component calculations is available in the TS4621 datasheet.

● The actual current consumption of the TS4621 can be measured directly by removing the jumper on Cn3 and inserting a DC amperemeter in series. The overall current consumption of the demonstration board is higher than the consumption of the TS4621 because the Cn1 power supply connector supplies the RS-232 to I^2C adapter in addition to the TS4621. The I^2C can be supplied by a second power supply through Cn8, in which case the I^2C voltage (VI^2C) must be 2.3 V< VI^2C < Vcc.

Table 1. Demonstration board connectors

Connector	Description
Cn1	Power connector (V_{CC} and GND). Power supply voltage from 2.3 V to 4.8 V.
Cn2, Cn9	Fully differential positive and negative input signal connectors (active input signal and GND). By shorting one active input to GND, you can use the demonstration board in single-ended input mode (refer to the TS4621 datasheet for more information).
Cn3	Connector that allows direct measurement of the TS4621's current consumption. Remove the jumper and insert a DC amperemeter.
Cn4	Left output connector (GND and active signal).
Cn5	Right output connector (GND and active signal).
Cn6, Cn7	SCL and SDA connectors: – pins shorted, the TS4621 is controlled by the on-board RS 232 to I^2C interface. – pins unshorted, the TS4621 can be controlled by an external I^2C bus.
Cn8	Use this connector as an optional power connector ($V_{CC}I^2C$) thanks to a second power supply.
J1	3.5 mm stereo headphone plug.
J2	DB9 female connector enabling connection of the demonstration board to the RS-232 serial port.

Note: *When you apply the power supply through Cn1, **do not** invert the polarity as this will damage the demonstration board.*

Figure 2.   Schematic diagram
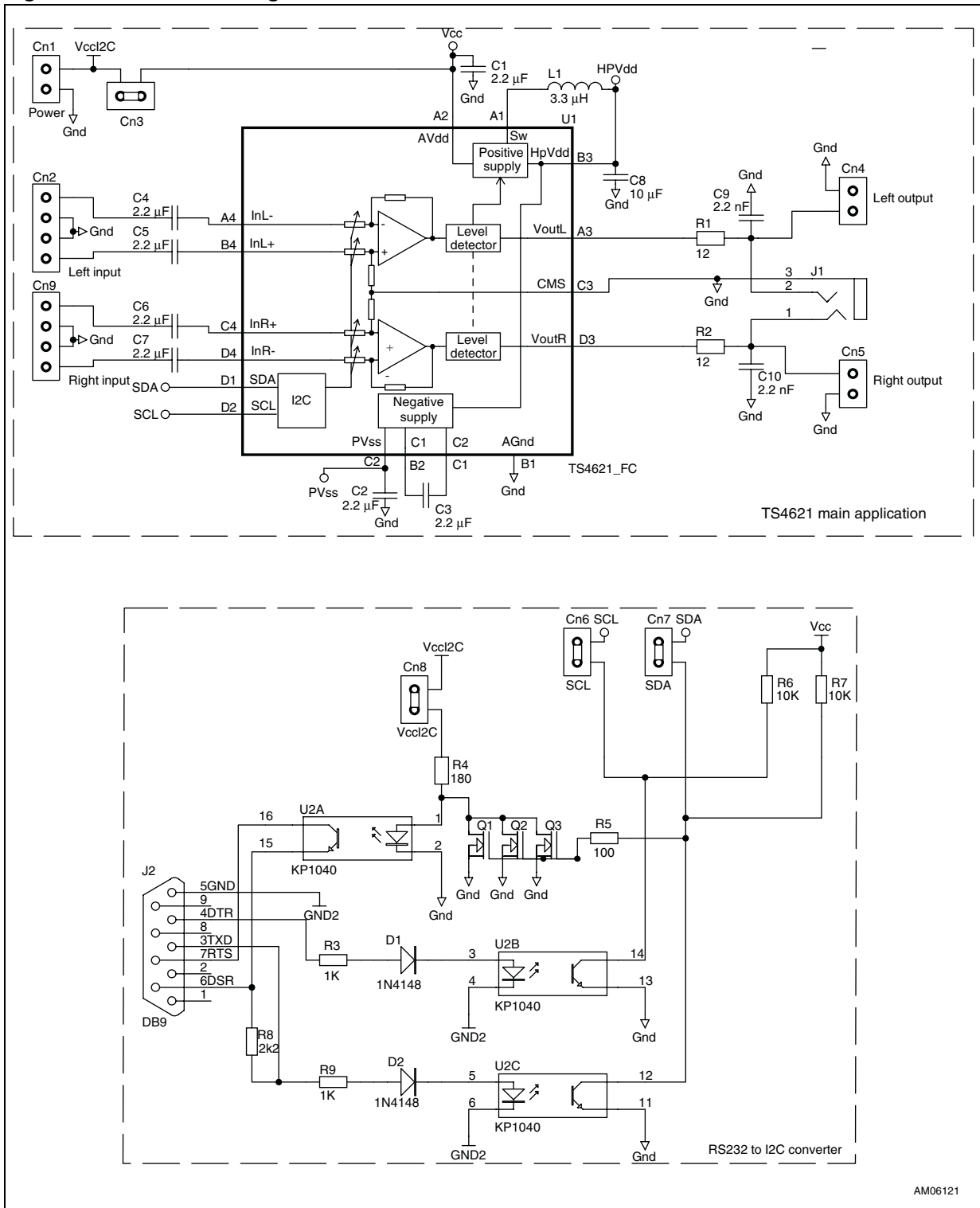
Table 2. **Component list for the demonstration board**

Name	Quantity	Description
L1	1	3.3 μH LQM2MPN3R3 Murata
C2, C3	2	2.2 μF/6.3V X5R, SMD ceramic capacitors 0603
C1, C4, C5,C6, C7	5	2.2 μF/10V X5R, SMD ceramic capacitors 0603
C9, C10	2	2.2 nF/50V X7R, SMD ceramic capacitors, 0603
C8,	1	10 μF/6.3V X5R, SMD ceramic capacitors, 0603
Cn1, Cn3, Cn4, Cn5, Cn6, Cn7,Cn8	7	2-pin header 2.54 mm pitch
Cn2, Cn9	2	4-pin header 2.54 mm pitch
D1, D2	2	1N4148,
J1	1	3.5 mm stereo PCB headphone jack connector
J2	1	PCB 90° female DB9 connector
R1, R2	2	12 Ω/1% SMD resistor, 0603
R3, R9	2	1 kΩ/1% SMD resistor, 0603
R4	1	180 Ω/1% SMD resistor, 0603
R5	1	100 Ω/1% SMD resistor, 0603
R6, R7	2	10 kΩ/1% SMD resistor, 0603
R8	1	2.2 kΩ/1% SMD resistor, 0603
Q1,Q2,Q3	3	2N7002 SOT23 MOSN
U1	1	TS4621EIJT
U2	1	KP1040, TLP521-4(GB)

3 Demonstration board layout

The following figures show the layers and top and bottom views of the demonstration board.

Figure 3.   PCB top layer
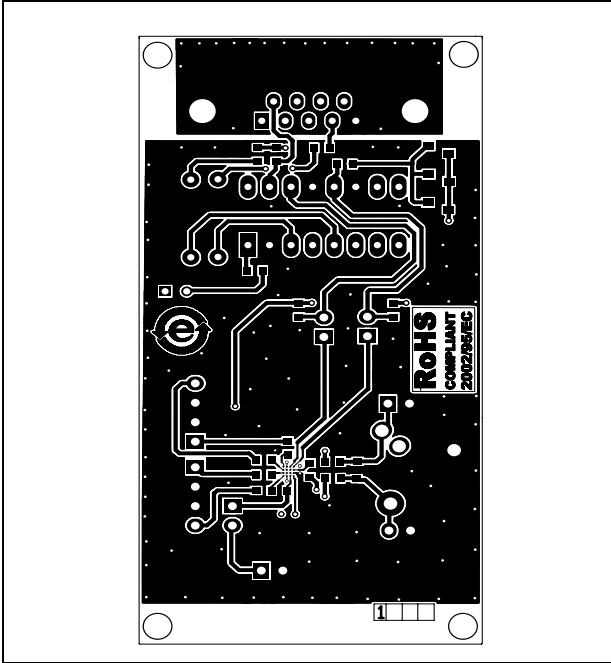
Figure 4.   PCB mid layer 1
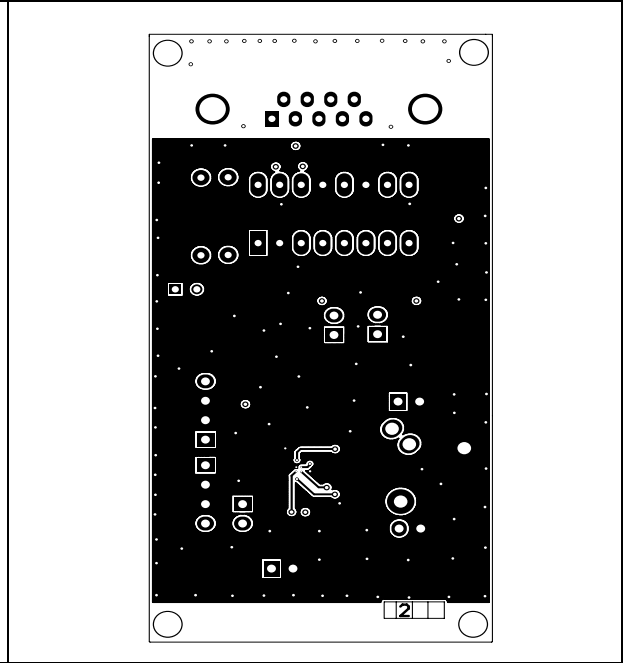
Figure 5.   PCB mid layer 2
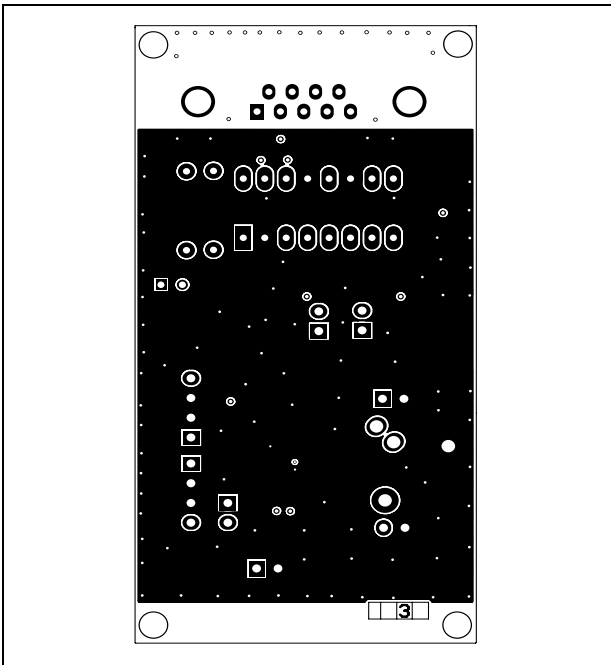
Figure 6.   PCB bottom layer
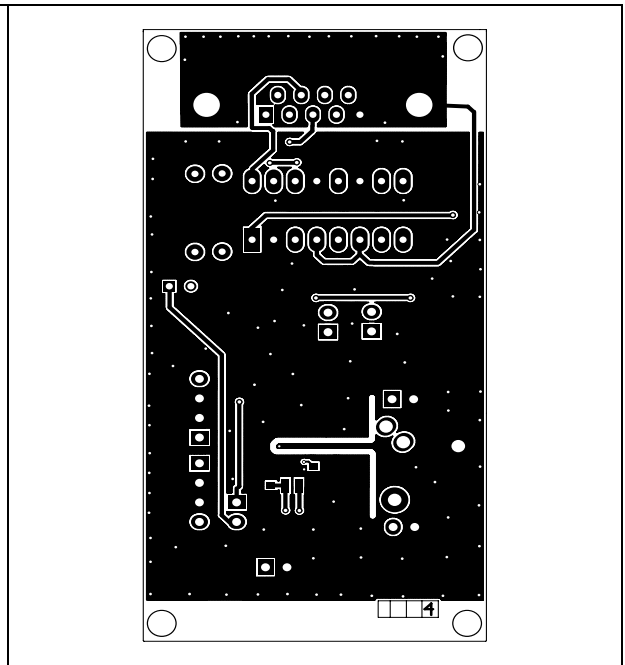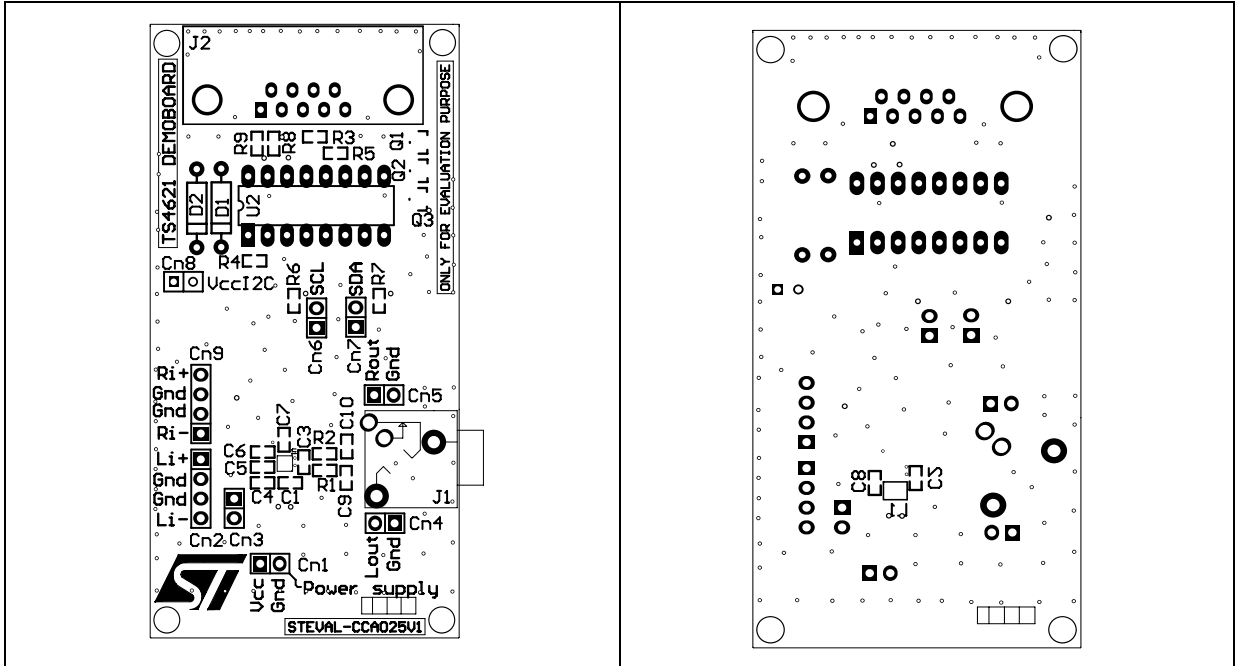
**Figure 7.   Top view of the demonstration
                board**

**Figure 8.   Bottom view of the demonstration
                board**

4 TS4621 demonstration software

The TS4621 demonstration software provides a quick and easy way of driving the TS4621 audio system from a PC, and in particular, of configuring the output mode and the volume.

The software is located on the CDROM provided with the demonstration board. The latest revision of this software is available on STmicroelectronics' web site at *www.st.com*. It runs under Microsoft® Windows XP.

The PC must have a free serial port. If not, a USB-to-serial adapter can be used but note that compatibility with all adapters available on the market has not been tested.

4.1 Connecting the demonstration board and starting the software

Follow these steps to drive the TS4621 from a PC.

1. Use a DB9 female to DB9 male RS-232 cable to connect the PC to the TS4621 demonstration board on J2.
2. Connect the power supply V_{CC} to Cn1 and place the jumper on Cn8.
3. Verify that Cn3, Cn6 and Cn7 are shorted.
4. Connect the modulation source to Cn2 and Cn9 and plug a headphone into J1.
5. Copy the TS4621 demonstration board program *board.exe* provided on the CDROM to the hard drive of your PC and launch it by double-clicking on it (no installation required, copying the program is sufficient).

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

Figure 9.   **TS4621 demonstration software main window**
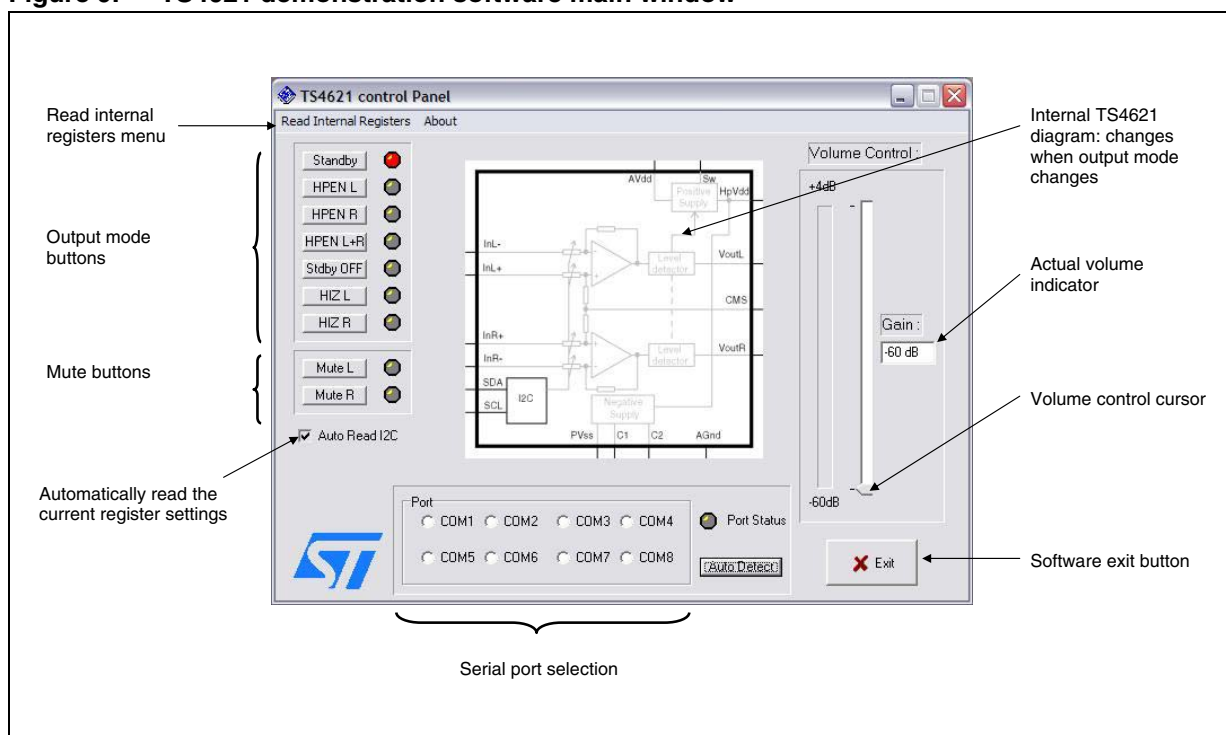
6. Choose the appropriate COM port from the **Port** frame or click **Auto Detect** for the program to select the COM port automatically.

   When the **Port Status** indicator turns to green, the program is ready to send commands to the TS4621.

   In some rare cases, when auto detect is used, a COM port may be selected (**Port Status** is green) which is not the correct one. If this happens, manually force the proper COM port by clicking directly in the **Port** box.

Note: *The COM port to which the device is connected must be in the range of COM1 to COM8. If this is not the case, change the COM port number in Windows by selecting **Start>Control Panel>System>Hardware>Device Manager.***

4.2   Using the TS4621 software

The following features are available in the main window of the TS4621 demonstration software shown in *Figure 9*.

● **Mode select buttons**

Allow you to select the TS4621 output mode. The diagram located in the middle of the window summarizes the mode currently selected and shows which inputs and outputs are active. The indicator located to the right of each output mode lights up when the mode is active. *Figure 10* shows an example of this window when the software is in operation.

Figure 10. TS4621 main window in operating mode
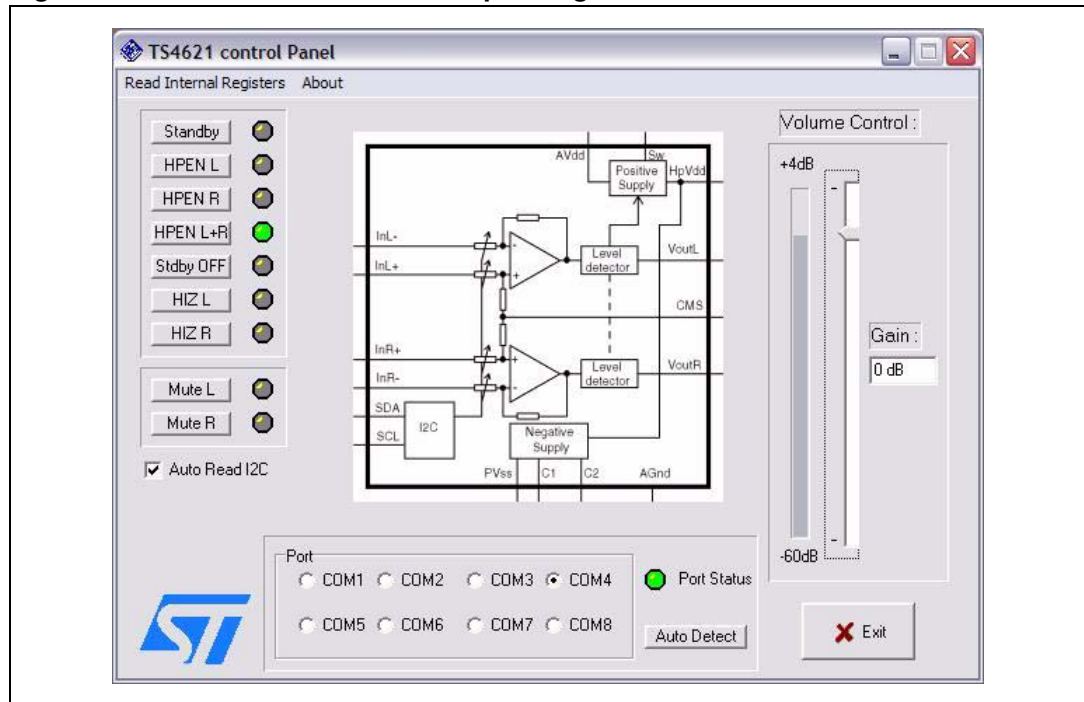
● **Mute buttons**

Allow you to set the TS4621 output to mute or operating mode. When the indicator located to the right lights up in green, the channel mute is active.

● **Auto Read I²C**

Allow you to update the graphical user interface according to the register value automatically (after pressing a button).

● **Read internal register menu**

When you click on this menu, the **TS4621 Internal Registers** pop-up window is displayed (see *Figure 11*). By clicking on the *Read Internal Registers* button, you can display the actual state of the TS4621. The hexadecimal values of the CR1 to CR4 registers are also displayed. By pressing the *Clear Results* button, all results disappear and you need to press the *Read Internal Registers* button again for a new display.

Note that this window remains open until you close it by clicking on the cross in the upper right corner.

Note also that this window is not automatically refreshed. If you change the output mode or something else in the main window, you have to press the *Read Internal Registers* button again to display the new TS4621 settings.

Figure 11.   TS4621 main window + register status window
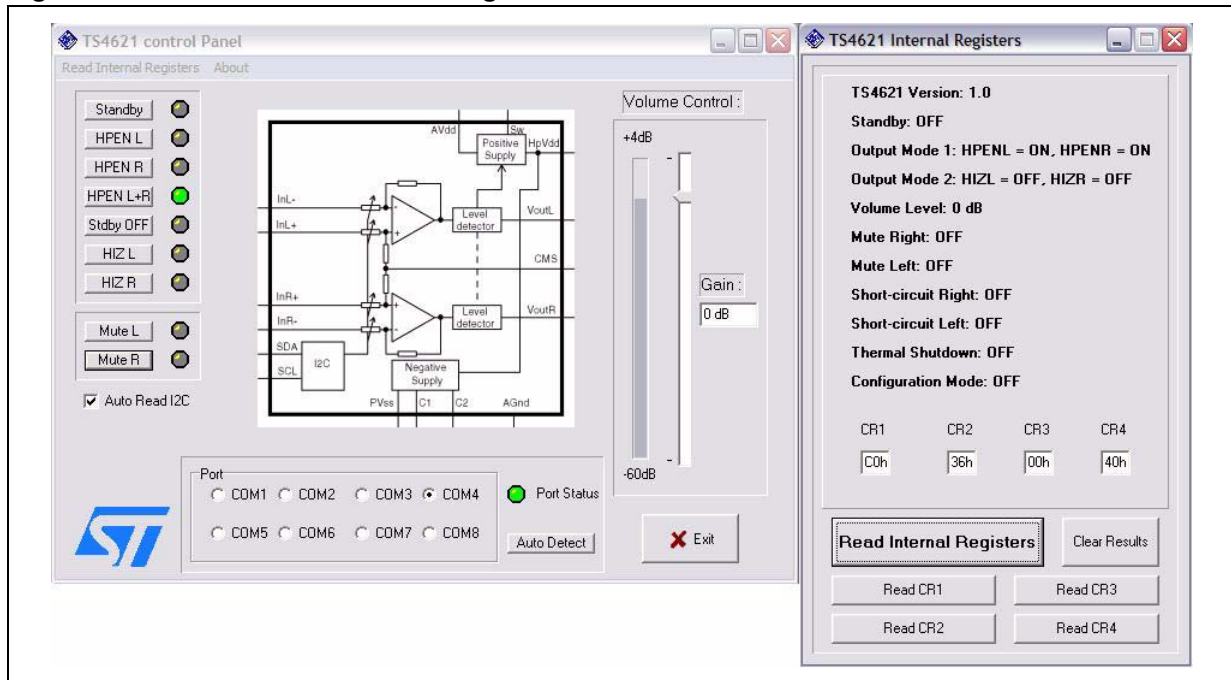
The following feature is available in the main window of the TS4621 demonstration software shown in *Figure 9*.

● **Volume control cursor**

By dragging this cursor up and down, you can control the TS4621's output volume. The actual gain set is displayed in the **Gain** box.

To exit the program, just click the **Exit** button on the bottom right or click the cross in the upper right corner of the window.

Note: *Occasional problems may arise when trying to drive the demonstration board using certain notebook or laptop PCs and the RS-232 output.*

4.3 Common error messages

No acknowledge for address

You pressed an output mode button and the software displays an information pop-up window that indicates "Error: No acknowledge for address!" (see example in *Figure 12*).

This error message can have several causes.

● The power supply is down or disconnected from Cn1.

● One or several jumpers are missing on Cn6 or Cn7 or Cn8.

● The serial cable is disconnected from J2.

● The jumper on Cn3 is missing and there is no amperemeter in series.

● The power supply for the I²C is down or disconnected from Cn8 if a second power supply is optionally used for the I²C.

Figure 12. TS4621 acknowledge pop-up message
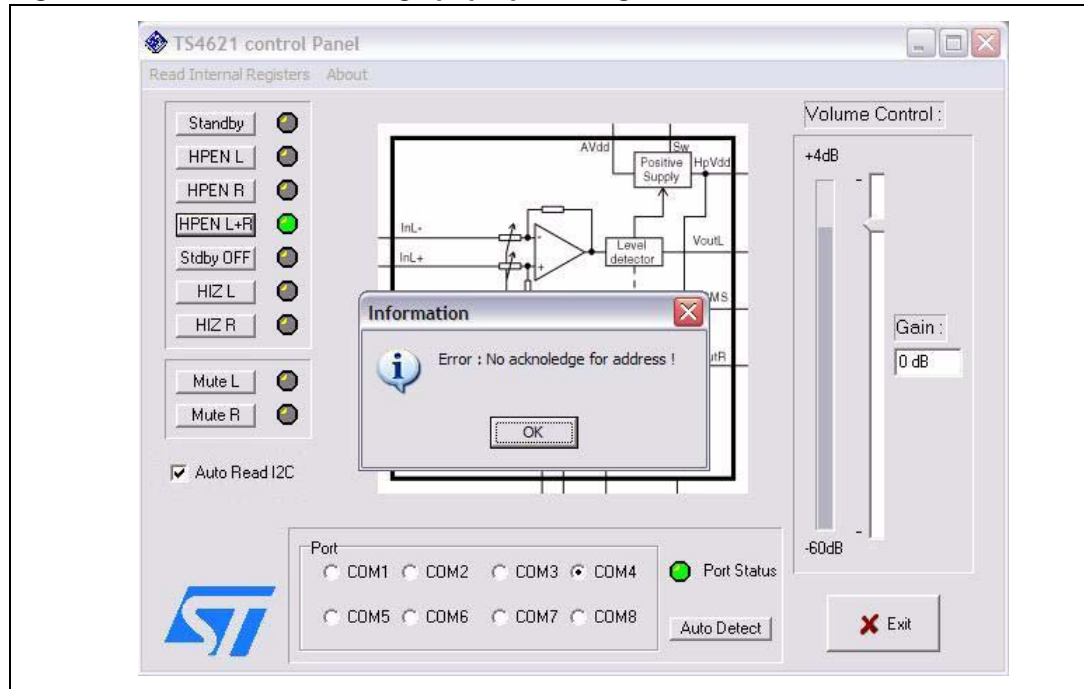
Results displayed in the *Internal Registers* window are different from main window

The **Auto Read I²C** checkbox allows you to update the graphical user interface according to the register value automatically (after pressing a button).

If the **Auto Read I²C** box is unchecked, the main window is not automatically refreshed and if you press the read internal registers button in the TS4621 internal registers window, the results displayed might be different from what the main window indicates (see *Figure 13*).

This can happen if, while the software is running, you switch the TS4621 power supply OFF and ON. When you do this, the TS4621 is reset and all internal registers are set to their initial value. This is why, when you press the **Read Internal Registers** button, the result displayed is quite different from the display in the main window.

To avoid this issue, check the **Auto Read I²C** box.

Figure 13.   Uncorrelated windows in TS4621 demonstration software
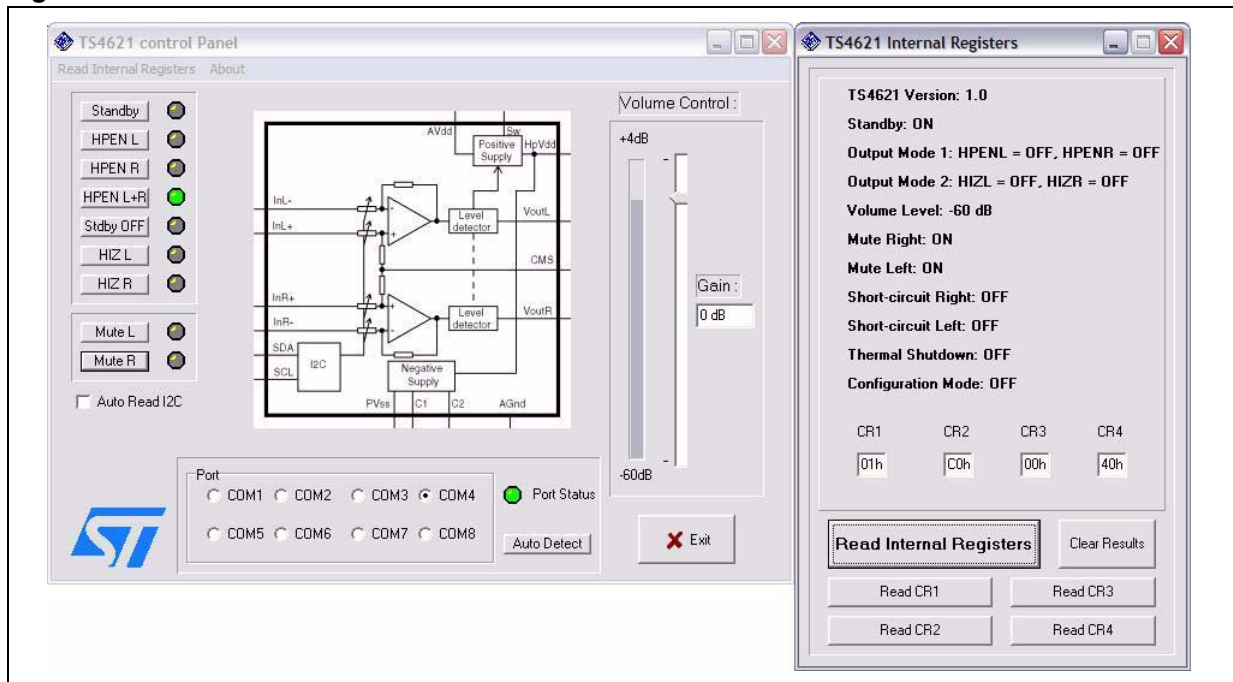
5 Conclusion

To order the board online, go to *http://www.st.com/stonline/domains/buy/buy_dev.htm* and use the order code STEVAL-CCA025V1.

6 Revision history

Table 3. Document revision history

Date	Revision	Changes
09-Apr-2010	1	Initial release.

Please Read Carefully: