

Dual-BTL class-D audio amplifier demonstration board based on the TDA7498E

Introduction

The purpose of this application note is to describe:

- how to connect the TDA7498 demonstration board
- how to evaluate the performance of the demonstration board using the electrical curves
- how to avoid critical issues in the PCB schematic and layout of the TDA7498E

The TDA7498E represents a new generation of analog input class-D devices from STMicroelectronics and is housed in a PSSO36 package. It is able to deliver 160 W +160 W in stereo configuration with $V_{CC} = 36$ V and a 4 Ω load^(a).

Figure 1. TDA7498E demonstration board



a. All of the results and graphs included in this document are measured using Audio Precision equipment.

Contents

- 1 Overview 4**
- 2 Test conditions and connections of the demonstration board 5**
 - 2.1 Power supply and interface connection 5
 - 2.2 Output configuration 5
 - 2.3 Connections 5
- 3 Schematic diagram and PCB layout 6**
- 4 Electrical characteristics 9**
- 5 Test curves 10**
- 6 Design guidelines for PCB schematic and layout 14**
 - 6.1 Schematic 14
 - 6.1.1 Main driver for the selection of components 14
 - 6.1.2 Decoupling capacitors 14
 - 6.1.3 Output filter 14
 - 6.2 Layout 17
- 7 Revision history 21**

List of figures

Figure 1.	TDA7498E demonstration board	1
Figure 2.	TDA7498E demonstration board connections	5
Figure 3.	TDA7498E schematic	6
Figure 4.	PCB layout - top side	7
Figure 5.	PCB layout - bottom side	7
Figure 6.	PCB layout - top and bottom sides plus components	8
Figure 7.	THD+N vs. power	10
Figure 8.	THD+N vs. frequency (ref = 1 W at 1 kHz)	10
Figure 9.	DNR	11
Figure 10.	FFT (0 dB _r at 1 W)	11
Figure 11.	Crosstalk	12
Figure 12.	Linearity	12
Figure 13.	Bandwidth	13
Figure 14.	P _{out} vs. V _{CC} and THD level	13
Figure 15.	Snubber filter - solution 1	15
Figure 16.	Snubber filter - solution 2	15
Figure 17.	Dumping network	16
Figure 18.	Frequency shift	16
Figure 19.	Decoupling capacitors	17
Figure 20.	Snubber network	17
Figure 21.	V _{CC} decoupling electrolytic capacitors	18
Figure 22.	ROSC - component placement	18
Figure 23.	Filter capacitors for SVR, VREF, SVCC, VSS and VDDPW	19
Figure 24.	Input signal routing	19
Figure 25.	Signal ground and power ground routing	20

1 Overview

The following terms used in this application note are defined as follows:

- THD+N vs. Pout: Total Harmonic Distortion (THD) plus noise versus output power
- THD+N vs. Freq: Total Harmonic Distortion plus noise versus frequency curve
- S/N Ratio: Signal-to-noise ratio
- DNR: Dynamic range
- FFT: Fast Fourier Transform Algorithm (method)
- XTalk: Channel separation L to R, or R to L channel crosstalk

The equipment used includes the following:

- Audio Precision 2722A + AES-17 filter + DCX+ AUX-0025 filter
- DC power supply
- Digital oscilloscope (Tektronix TDS5054B)
- Differential voltage probe (LeCroy AP031)
- Current probe (Tektronix TCP300)

Reference documents include:

- TDA7498E datasheet
- Schematic diagram
- PCB layout
- Test curves

2 Test conditions and connections of the demonstration board

2.1 Power supply and interface connection

1. Connect PSU to the V_{CC} terminal block
2. Connect the analog input cable to the RCA connectors on the demonstration board, the other side must be connected to a signal source such as the Audio Precision analog outputs or a DVD player

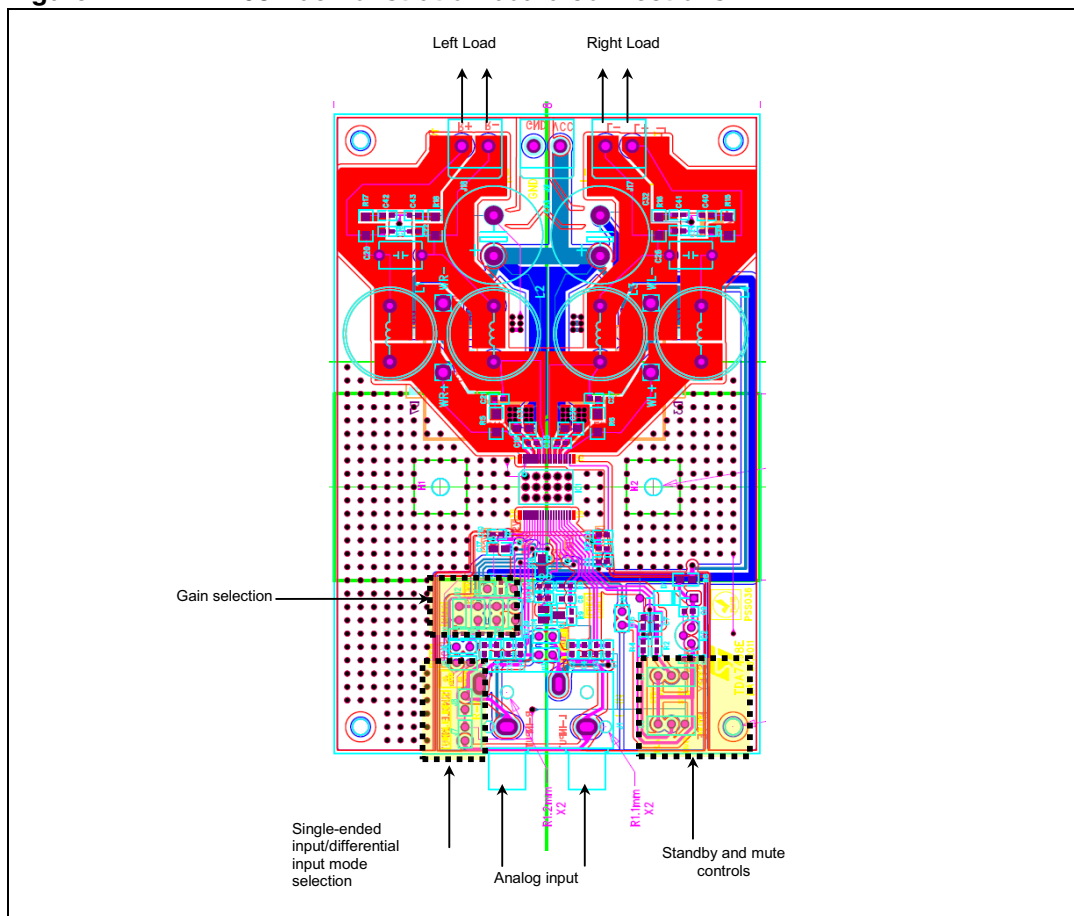
2.2 Output configuration

The TDA7498E demonstration board has been configured in 2-channel BTL output.

2.3 Connections

The board terminals (top view of demonstration board) are visible in [Figure 2](#).

Figure 2. TDA7498E demonstration board connections



3 Schematic diagram and PCB layout

Figure 3. TDA7498E schematic

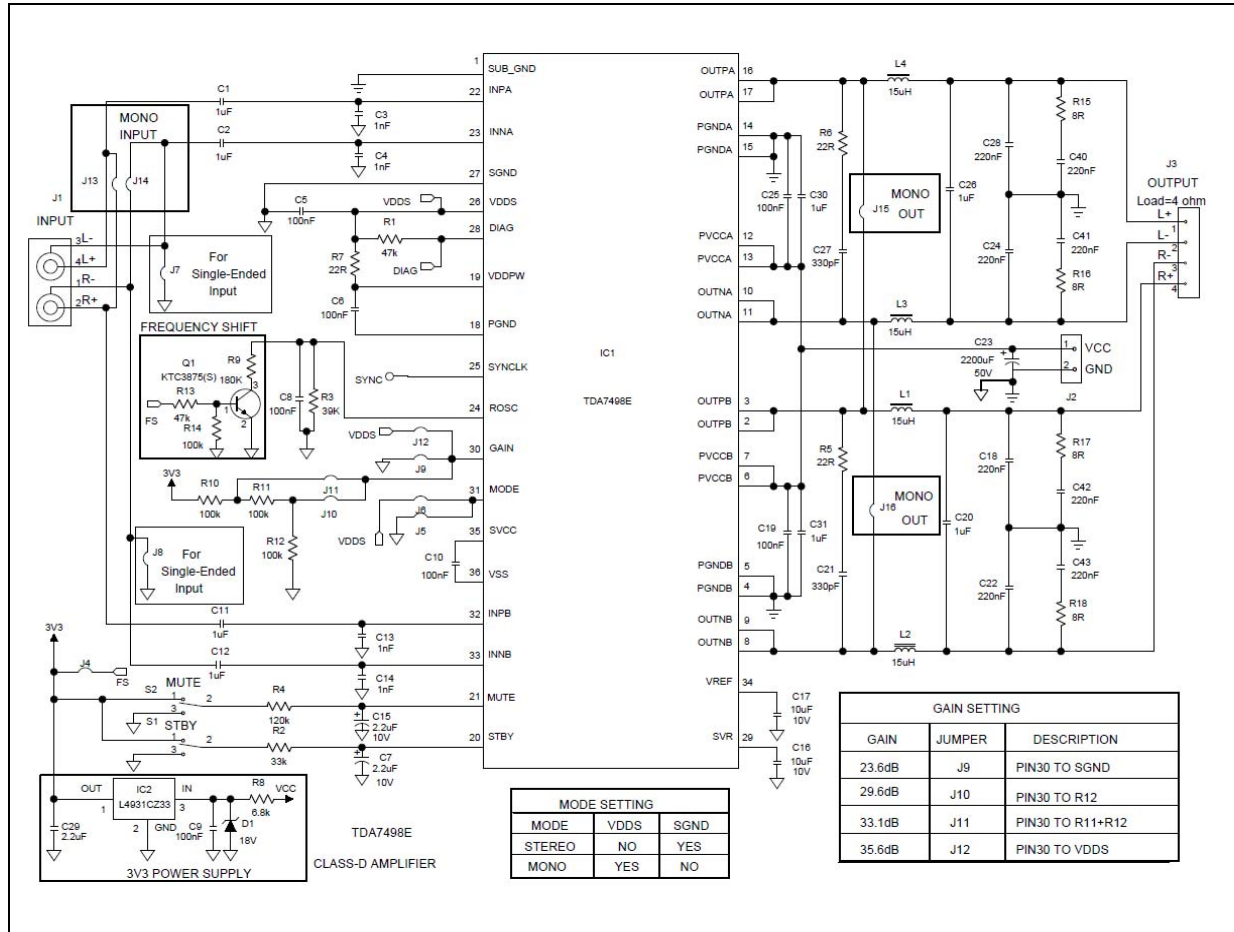


Figure 4. PCB layout - top side

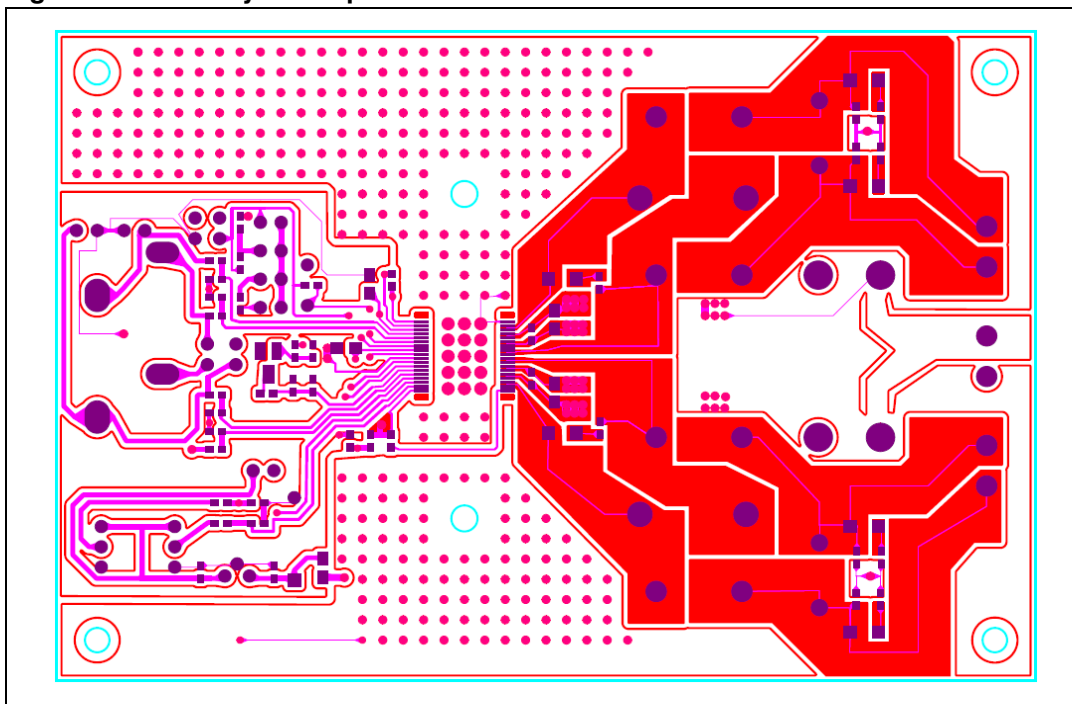


Figure 5. PCB layout - bottom side

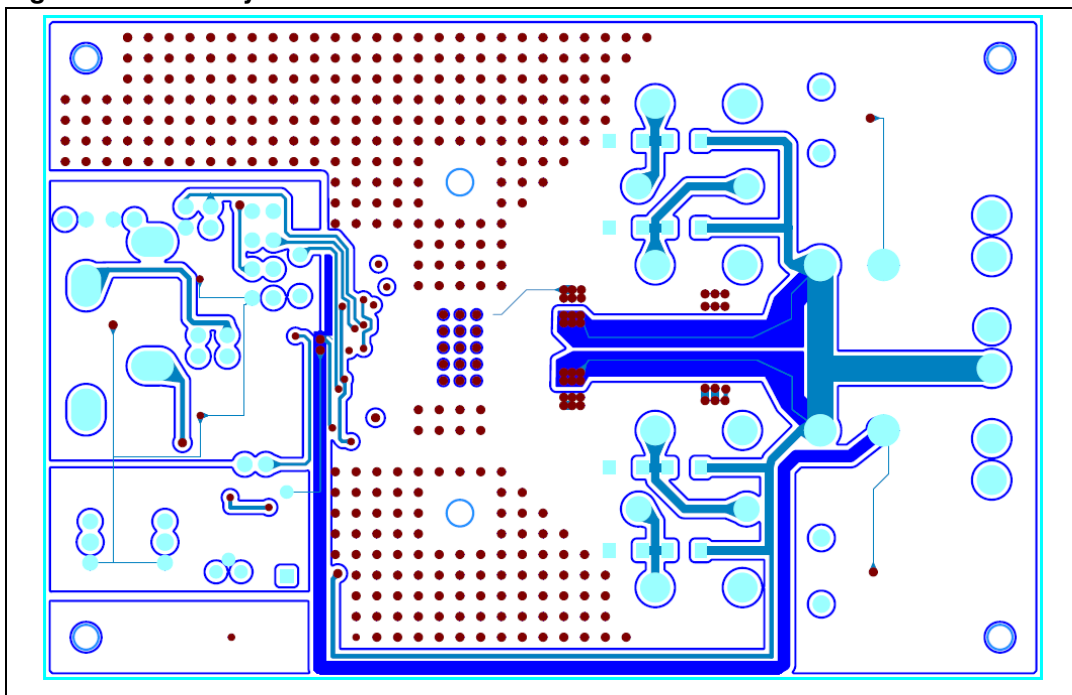
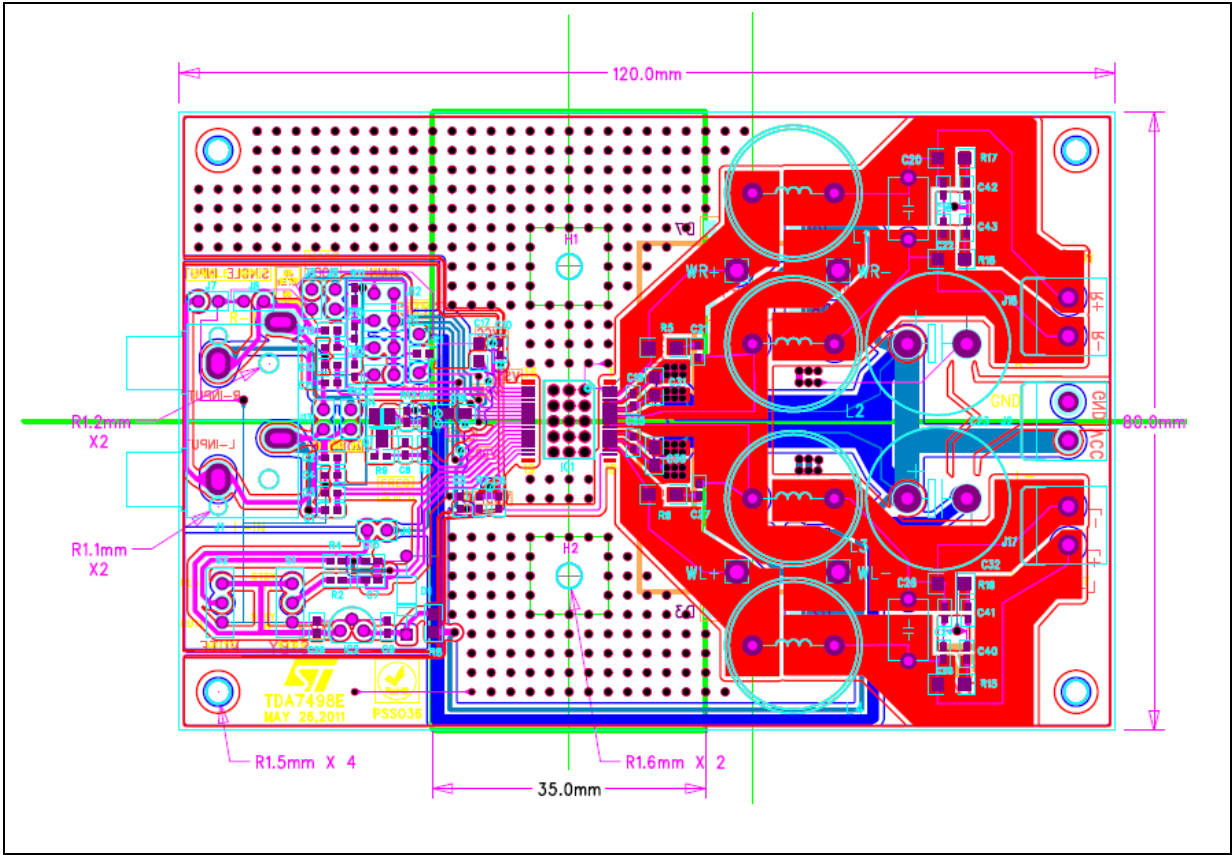


Figure 6. PCB layout - top and bottom sides plus components



4 Electrical characteristics

Referring to [Figure 3: TDA7498E schematic](#), the Left (L) and Right (R) channels are the output for a stereo configuration. $V_{CC} = +36$ V, Gain 23.6 dB; $T_{amb} = 25.5$ °C; InputFreq = 1 kHz; RefLevel = 1 W (0 dBr), Load = 4 Ω (resistive dummy load).

Table 1. Electrical characteristics

THD+N vs. power	Pout = 1 W	0.0555%
I_{OCP}		12 A
SNR	No filter	-74.3 dB
	AW - filter	-77.5 dB
DNR	No filter	-94 dB
	AW - filter	-98 dB
Xtalk	1 kHz	-85.9 dB

5 Test curves

Figure 7. THD+N vs. power

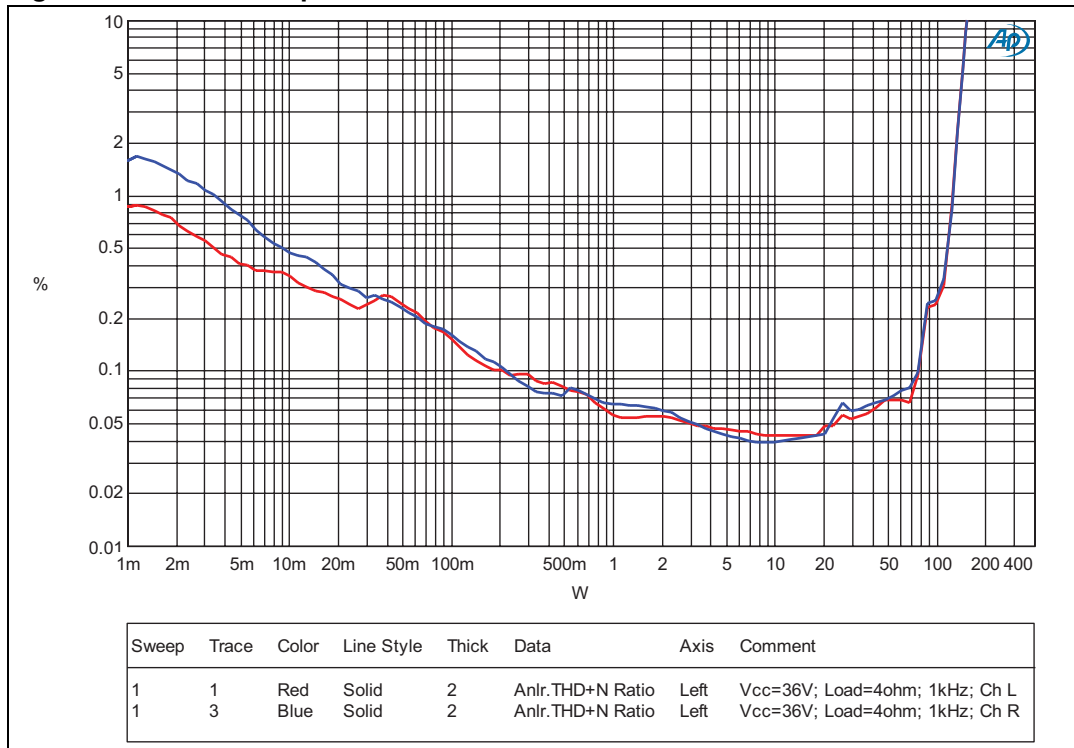


Figure 8. THD+N vs. frequency (ref = 1 W at 1 kHz)

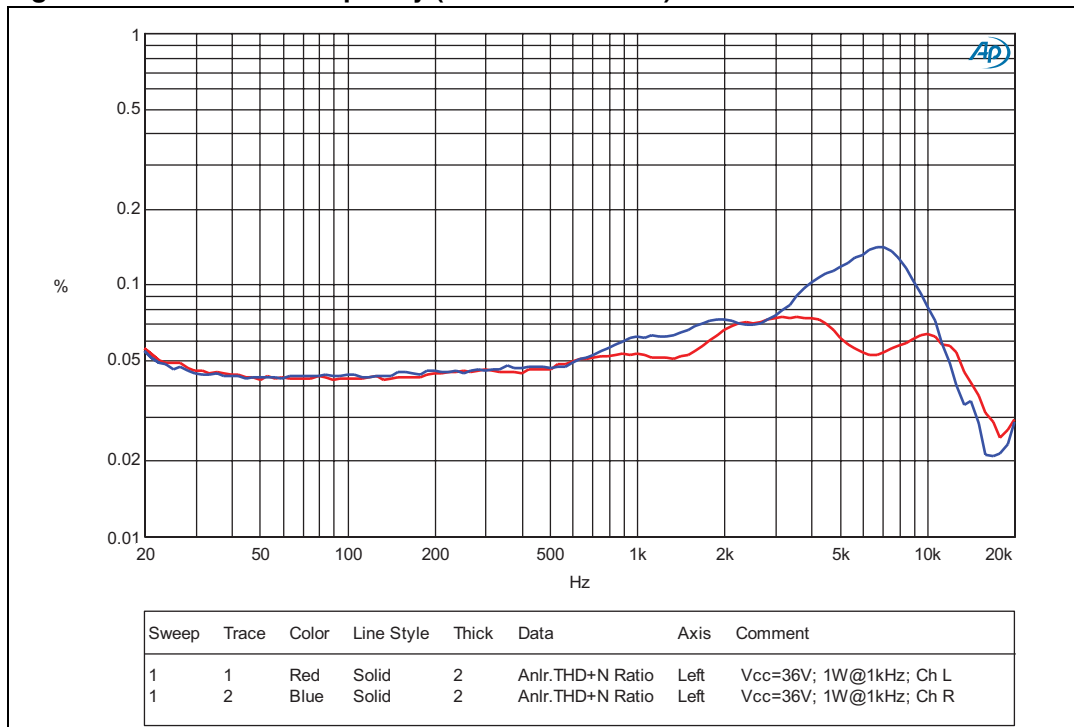


Figure 9. DNR

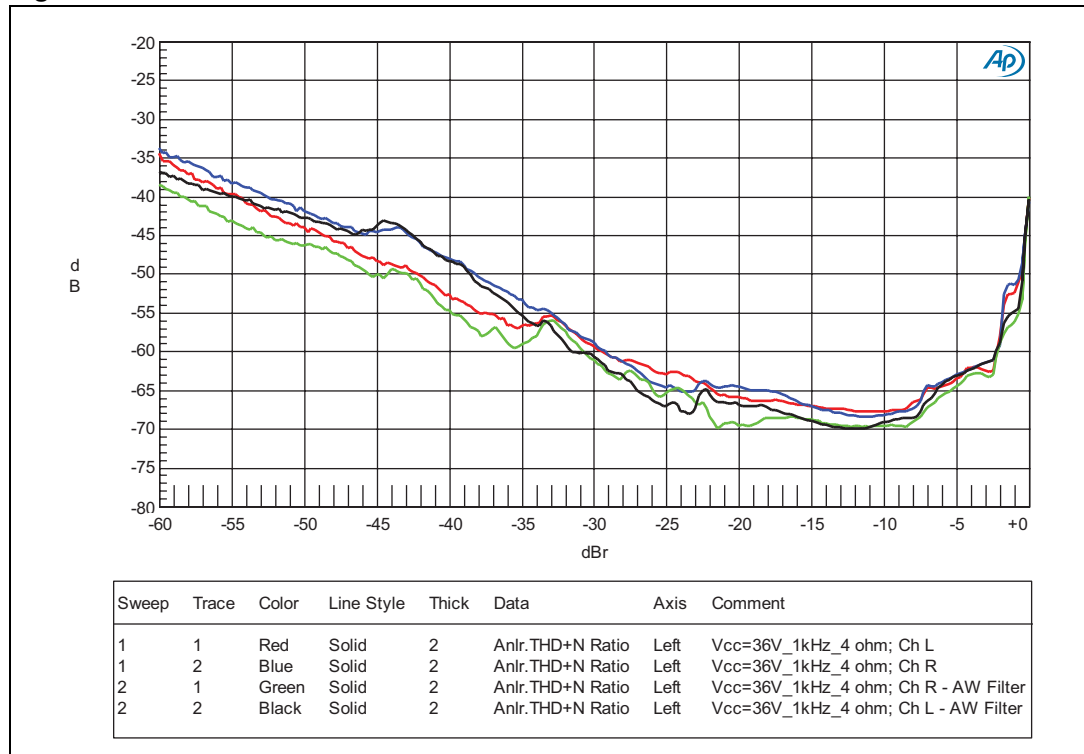


Figure 10. FFT (0 dBr at 1 W)

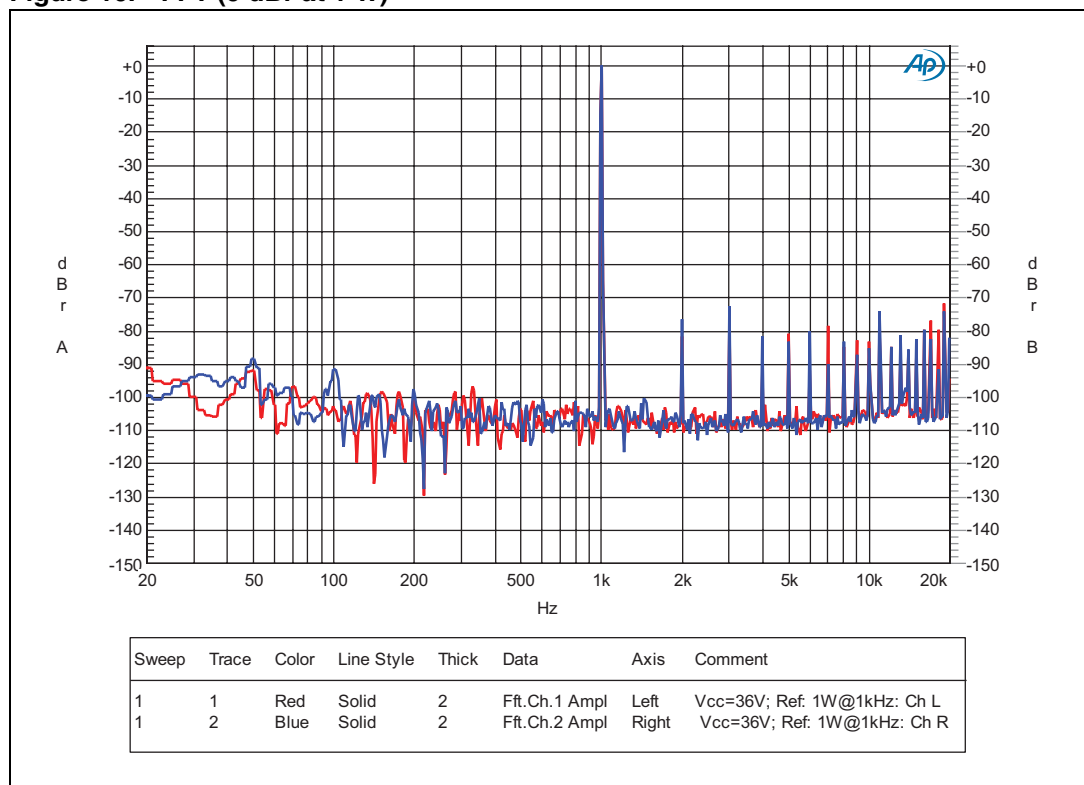


Figure 11. Crosstalk

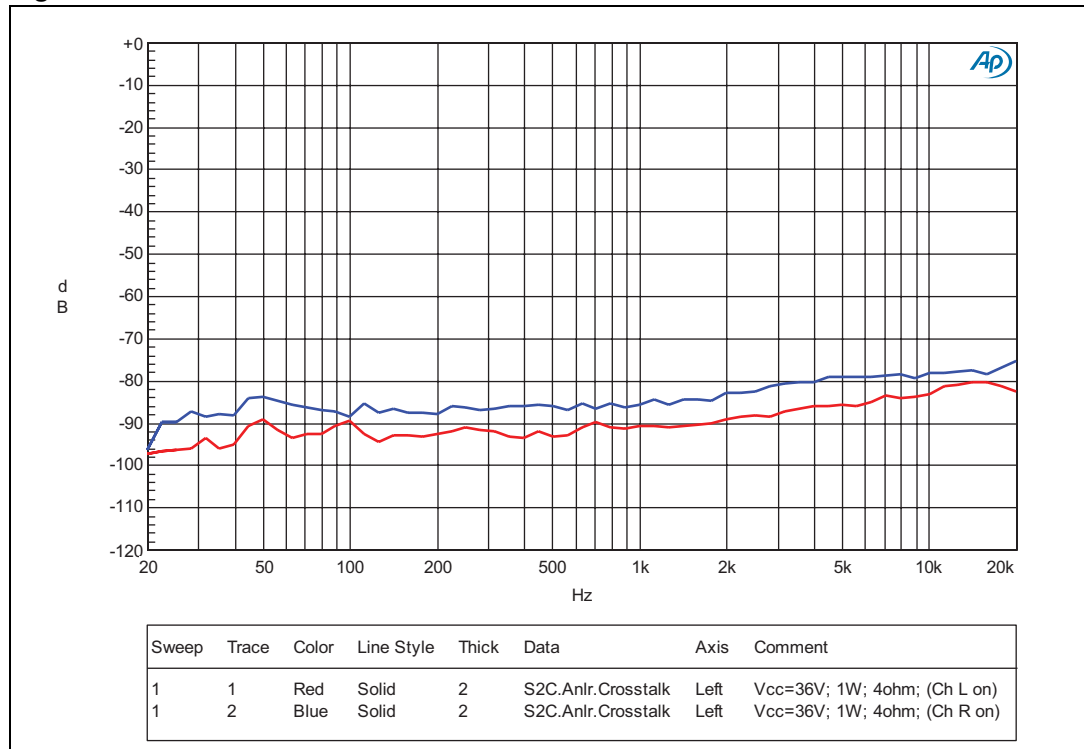


Figure 12. Linearity

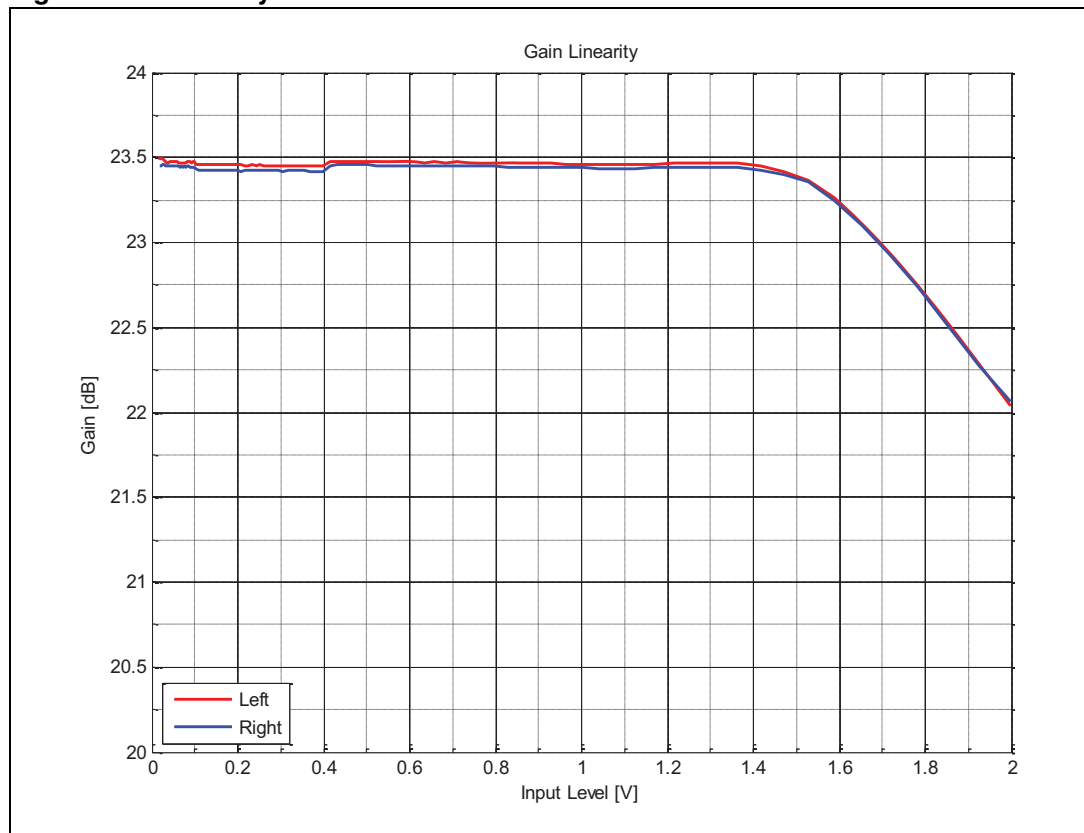


Figure 13. Bandwidth

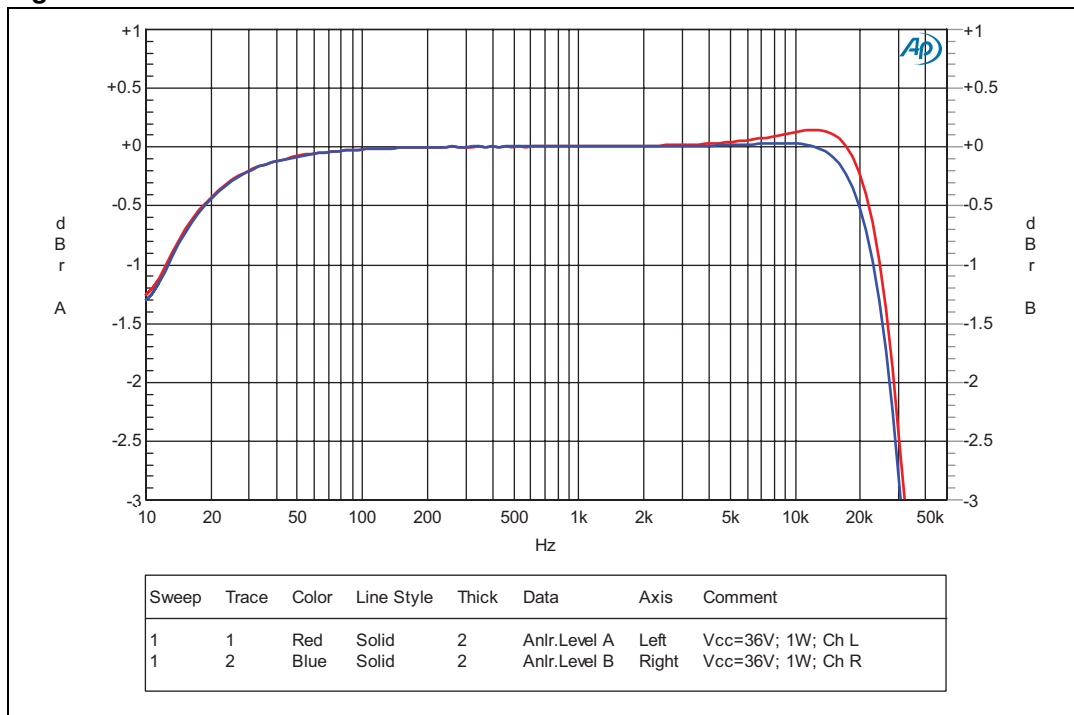
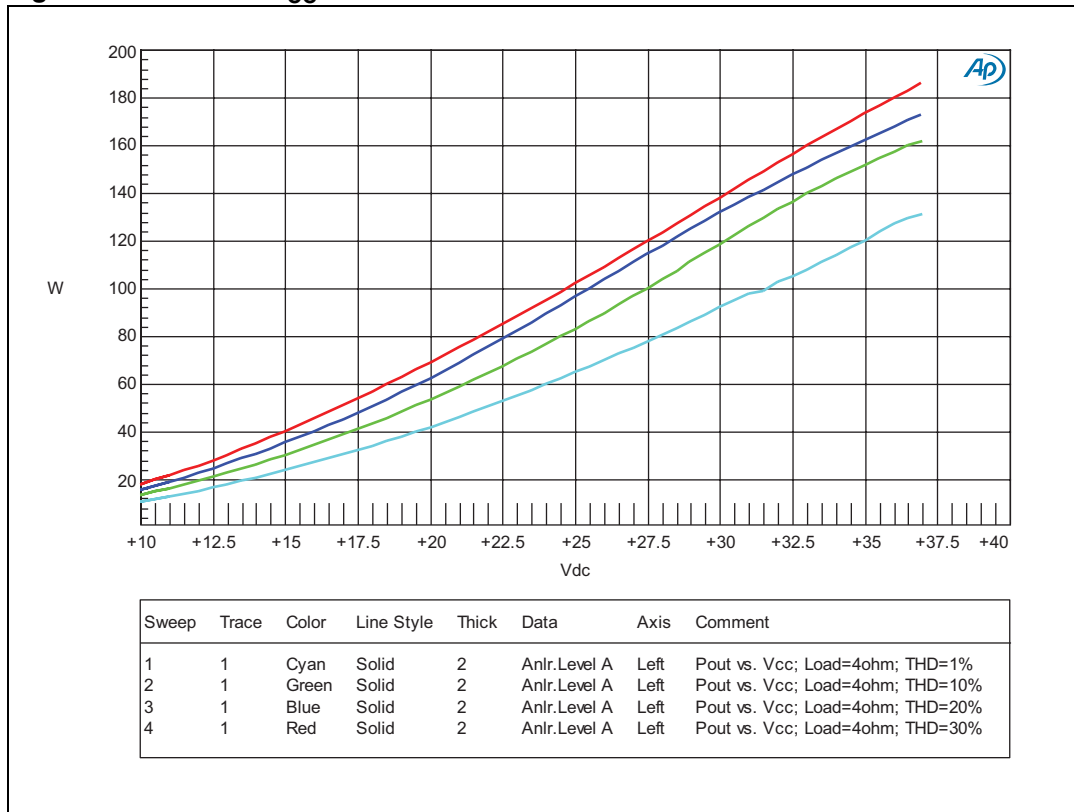


Figure 14. Pout vs. V_{CC} and THD level



6 Design guidelines for PCB schematic and layout

6.1 Schematic

6.1.1 Main driver for the selection of components

- Absolute maximum rate (input V_{CC} supply): 40 V
- Bypass capacitor 100 nF in parallel to 1 μ F for each power V_{CC} branch. Dielectric X7R is suggested.
- Coil saturation current must be compatible with the peak current of application

6.1.2 Decoupling capacitors

There are two different ways to use the decoupling capacitors:

- The decoupling capacitor(s) can be shared among channels; the layout must be designed to implement a "star route" for the V_{CC} paths.
- One decoupling capacitor can be used for each channel. It is mandatory that each decoupling capacitor be placed as close as possible to the IC pins. This solution is implemented on the TDA7498E demonstration board.

6.1.3 Output filter

- Snubber network: the key function of a snubber network is to absorb energy from the inductive component in the power circuit (the output coils and the speaker). The purpose of the snubber RC network is to dissipate the unnecessary high pulse energy, such as a high voltage spike, in the power circuit which is dangerous to the system.
- Main filter (low-pass filter): The purpose of the main filter is to remove the carrier frequency (≈ 310 kHz) and to cut off the frequency higher than the audible range of 20 kHz. The LPF filter is implemented by a passive Butterworth topology. In order to have a clean and flat frequency response, it is mandatory to design the filter to fix the cutoff frequency a little bit above 20 kHz.
- Damping network: The purpose of the damping network is to avoid the high-frequency oscillation issue on the output circuit. When the load is disconnected from the amplifier, the frequency response of the main filter is not flat and there is the possibility of adding gain in a frequency band. The damping network also improves the THD performance. The damping network can also avoid the inductive effect of the PCB tracks when the system is working at high frequency with PWM.

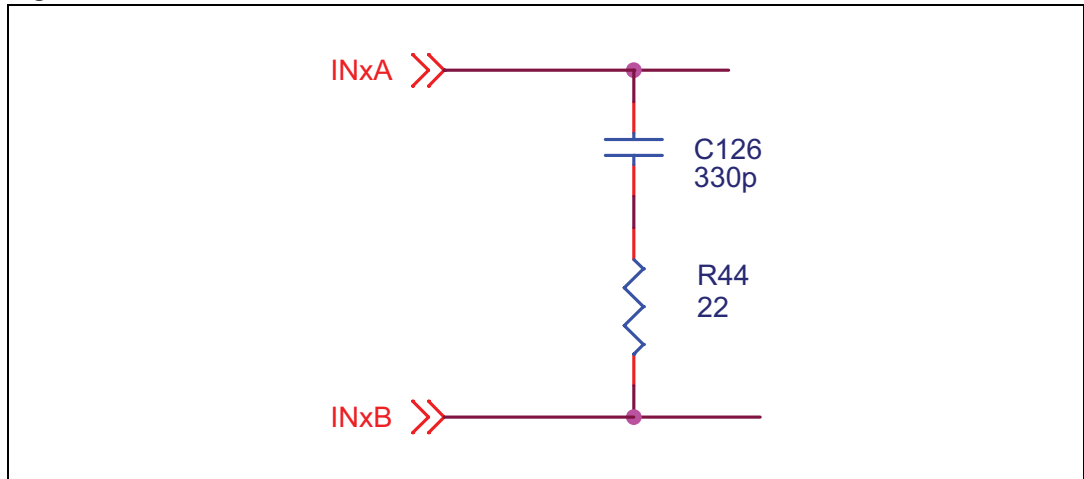
Snubber filter

The snubber circuit must be optimized for the specific application. Starting values are 330 pF in series to 22 ohm. The power dissipation of this network (resistor) depends on the power supply, frequency and capacitor values using following formula:

$$P = C \cdot f \cdot (2 \cdot V)^2$$

This power is dissipated on the series resistance.

Figure 15. Snubber filter - solution 1

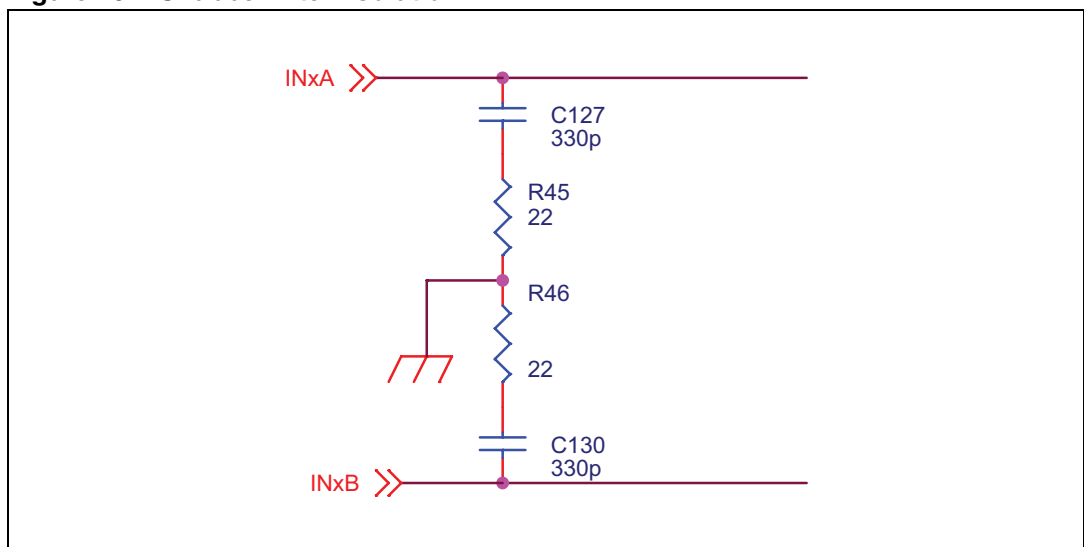


To increase the efficiency, it is possible to use two equal snubber networks toward GND. In this case, the formula to evaluate power is:

$$P = C \cdot f \cdot 2 \cdot V^2$$

This power is dissipated on the resistance.

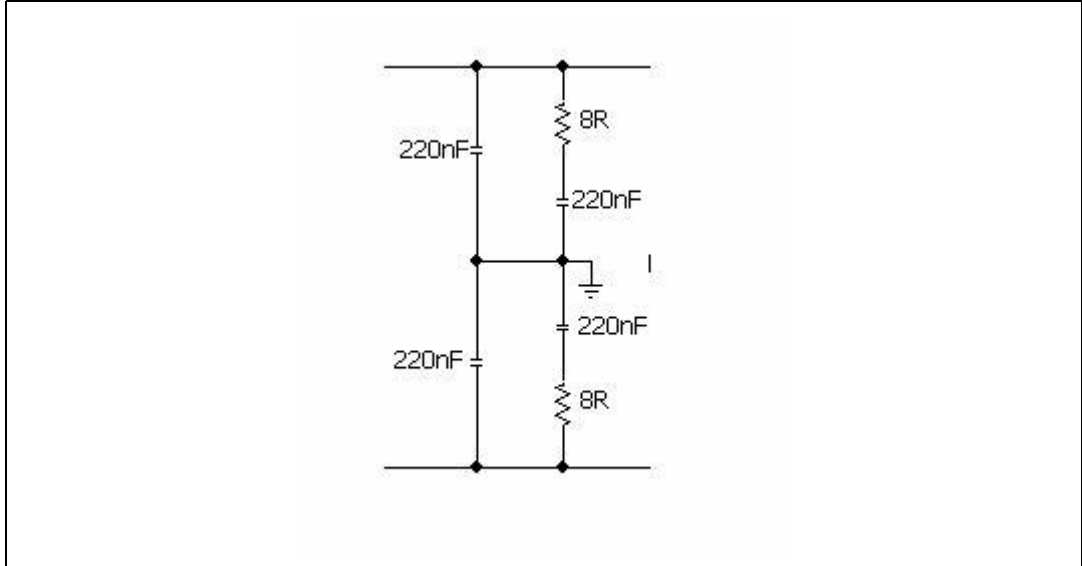
Figure 16. Snubber filter - solution 2



Dumping network

The C-R-C is a dumping network. It is mainly intended for high inductive loads and for common-mode noise attenuation.

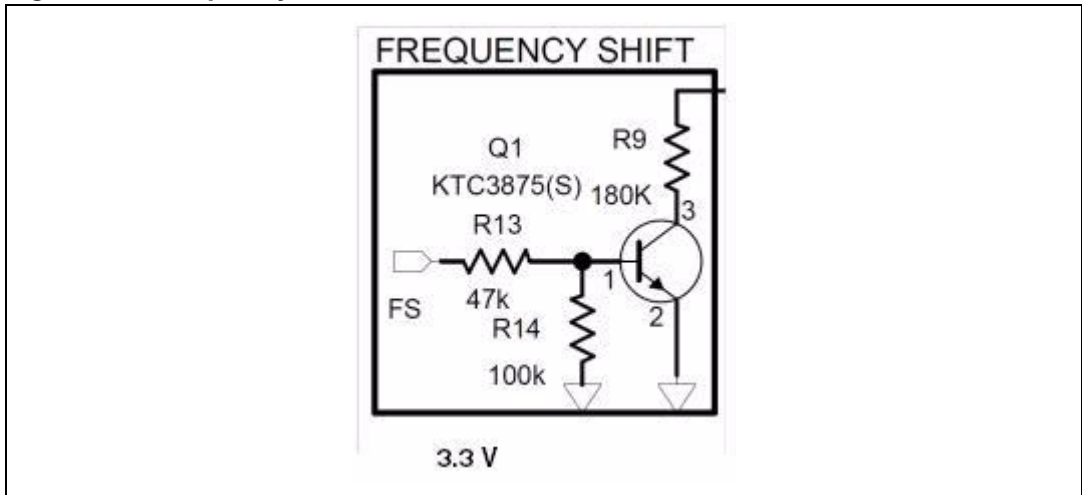
Figure 17. Dumping network



PWM output frequency shifting for AM band radio sensitivity improvement

Using a logic control signal (FS) from MCU or from a DSP (3.3 V) it is possible to modify the PWM output frequency.^(b)

Figure 18. Frequency shift

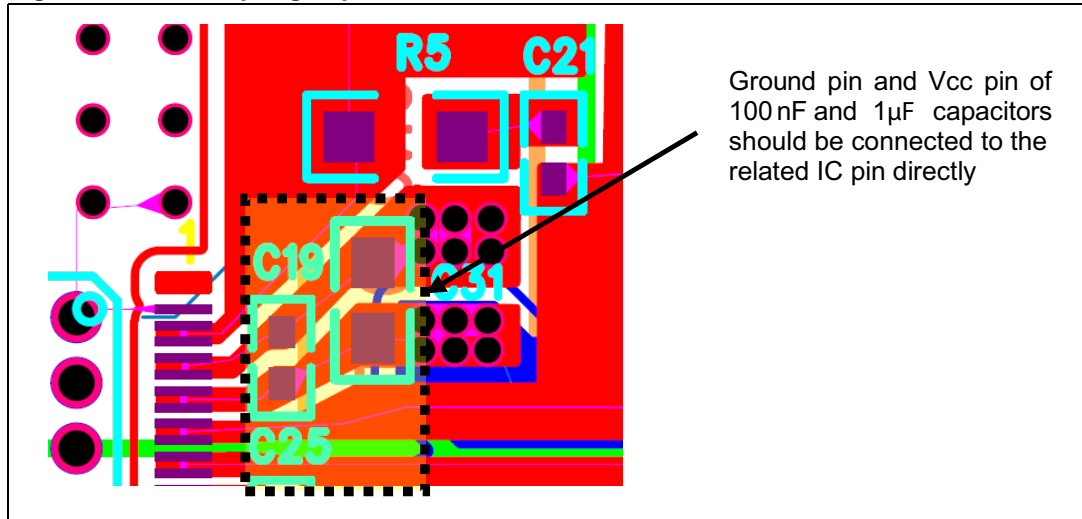


b. For the PWM frequency calculation formula please refer to the datasheet.

6.2 Layout

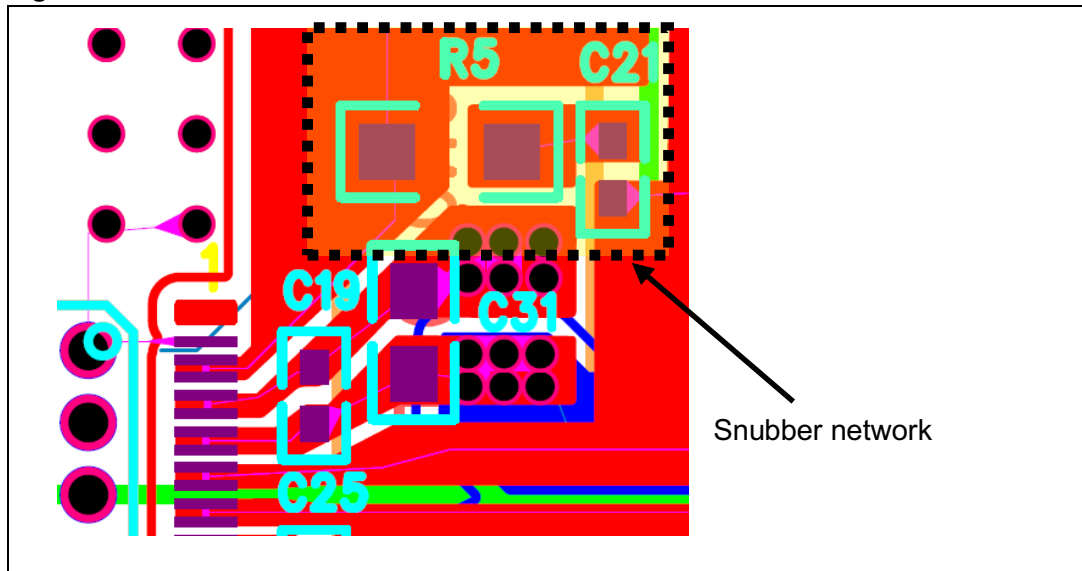
- Solder 100 nF and 1 μ F bypass ceramic capacitors as close as possible to the related IC pin
- To avoid the effect due to the parasitic inductive coil generated by the copper wires, it is suggested to use the ceramic capacitor to balance the reactance. It's mandatory to place the ceramic capacitor as close as possible to the related pins. The distance between the capacitor to the related pins is recommended to be within 5 mm.

Figure 19. Decoupling capacitors



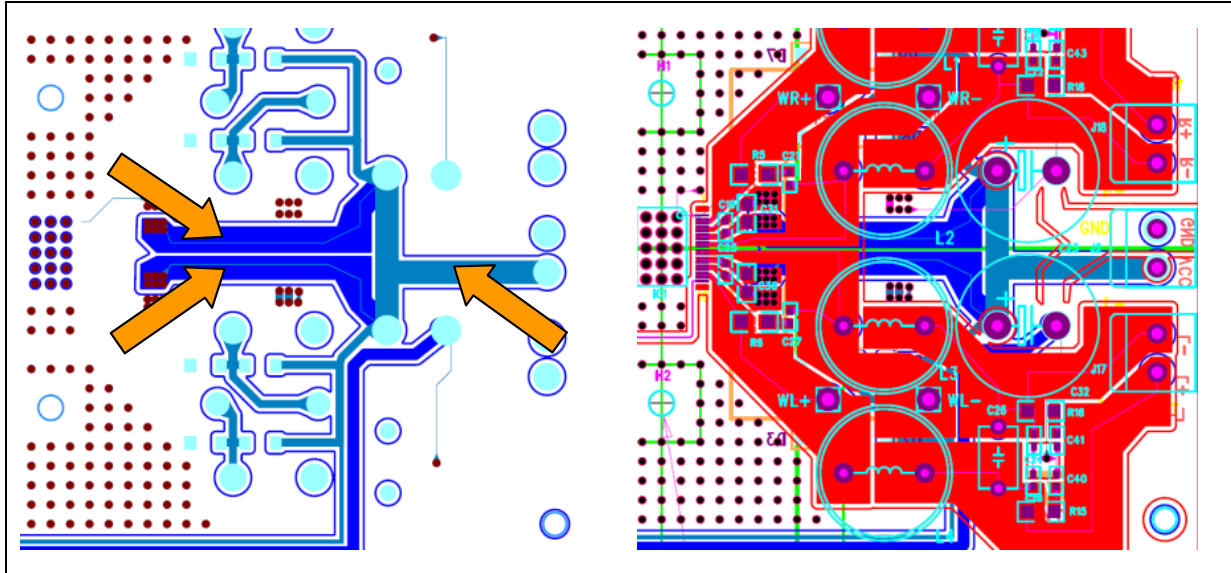
- Solder the snubber networks as close as possible to the related IC pin. A high level spike may occur if the snubber network is placed too far from the pins. It's recommended that the distance from the snubber network be within 3 mm which takes into consideration the width of the copper wire.

Figure 20. Snubber network



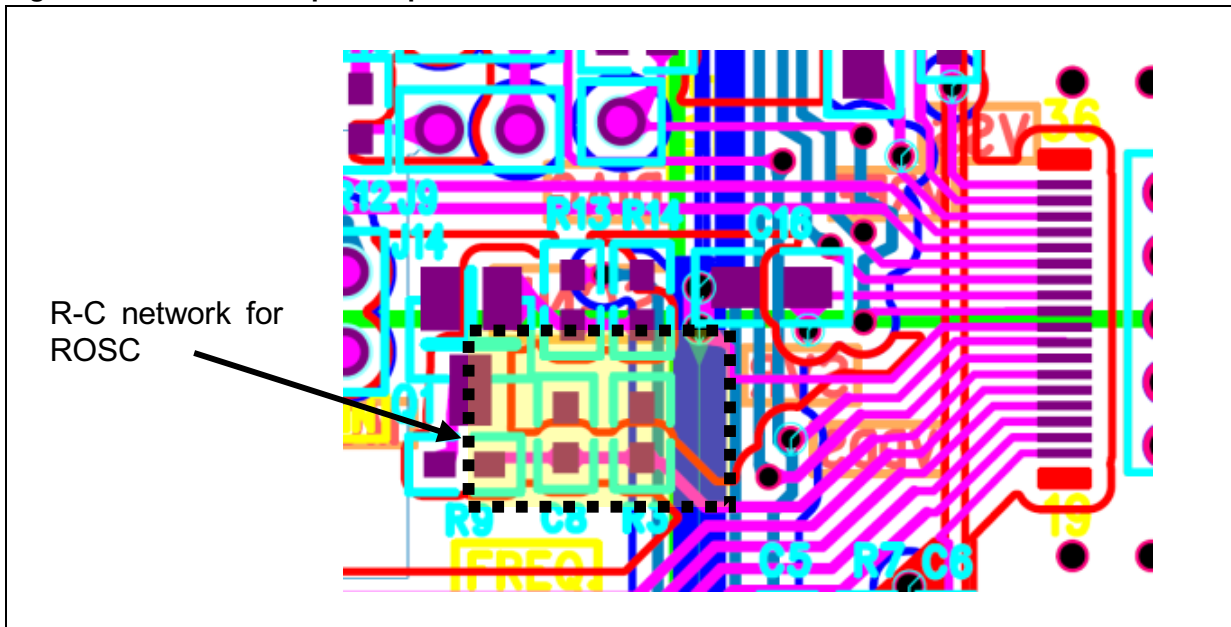
- Use electrolytic capacitors first to separate the V_{CC} branches. A "star route" for the V_{CC} supply is suggested to avoid interference between the channels such as when one channel is idle while the other channel is working with a full load. In applications with high output power, another approach is to filter the two channels separately. This solution is implemented in this demonstration board.

Figure 21. V_{CC} decoupling electrolytic capacitors



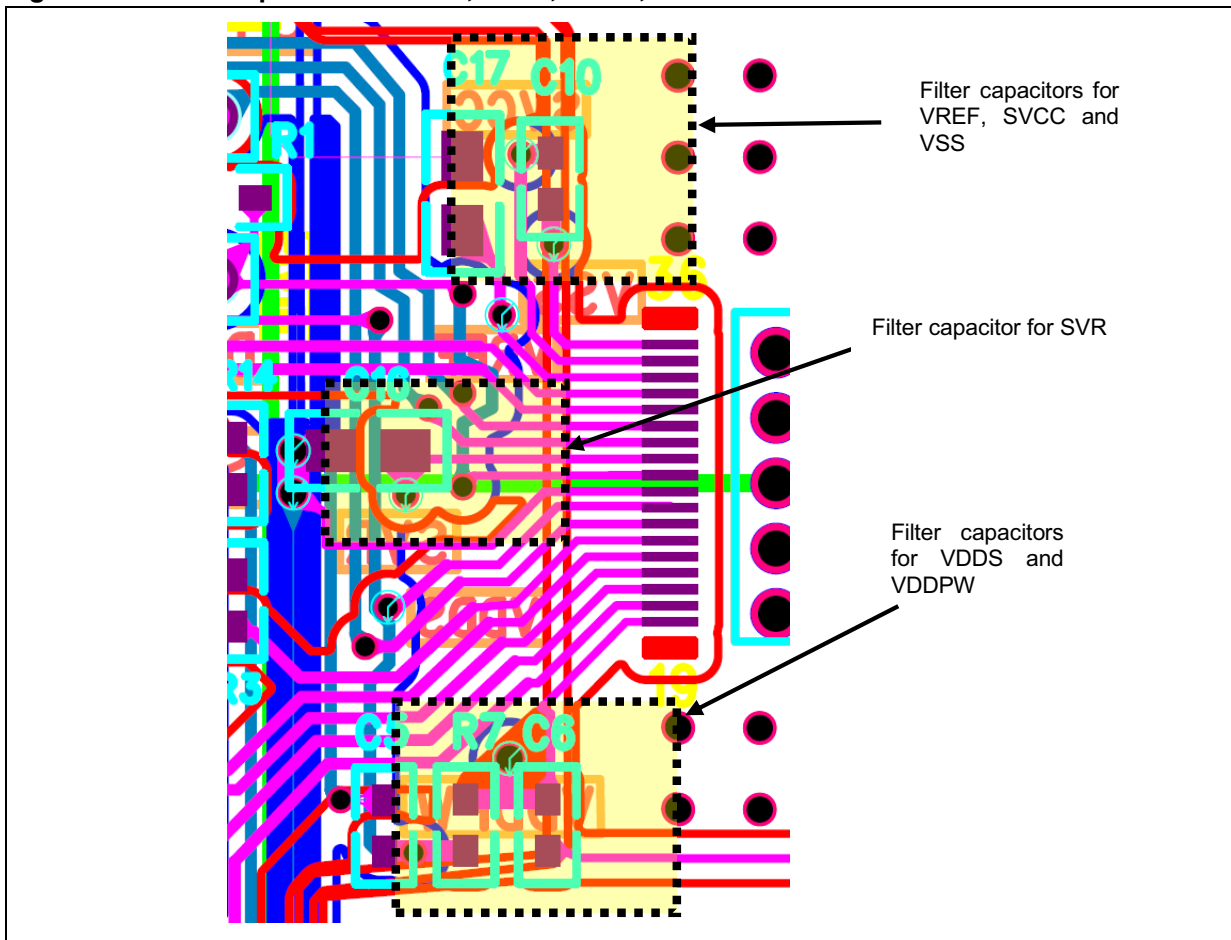
- ROSC network: Place the RC filter for the ROSC pin close to the IC

Figure 22. ROSC - component placement



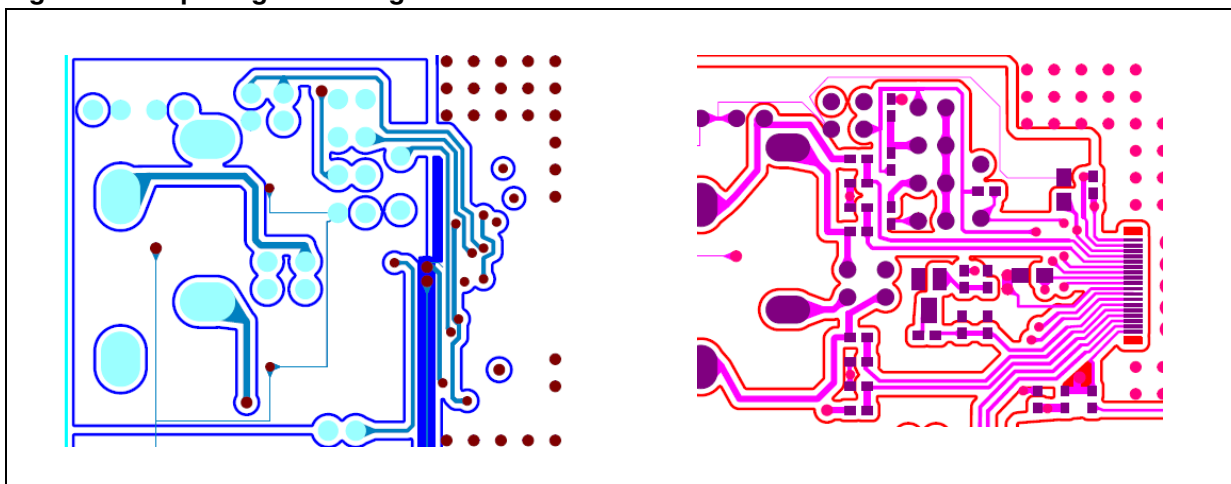
- Place the filter capacitors for SVR, VREF, SVCC, VSS and VDDPW close to the IC.

Figure 23. Filter capacitors for SVR, VREF, SVCC, VSS and VDDPW



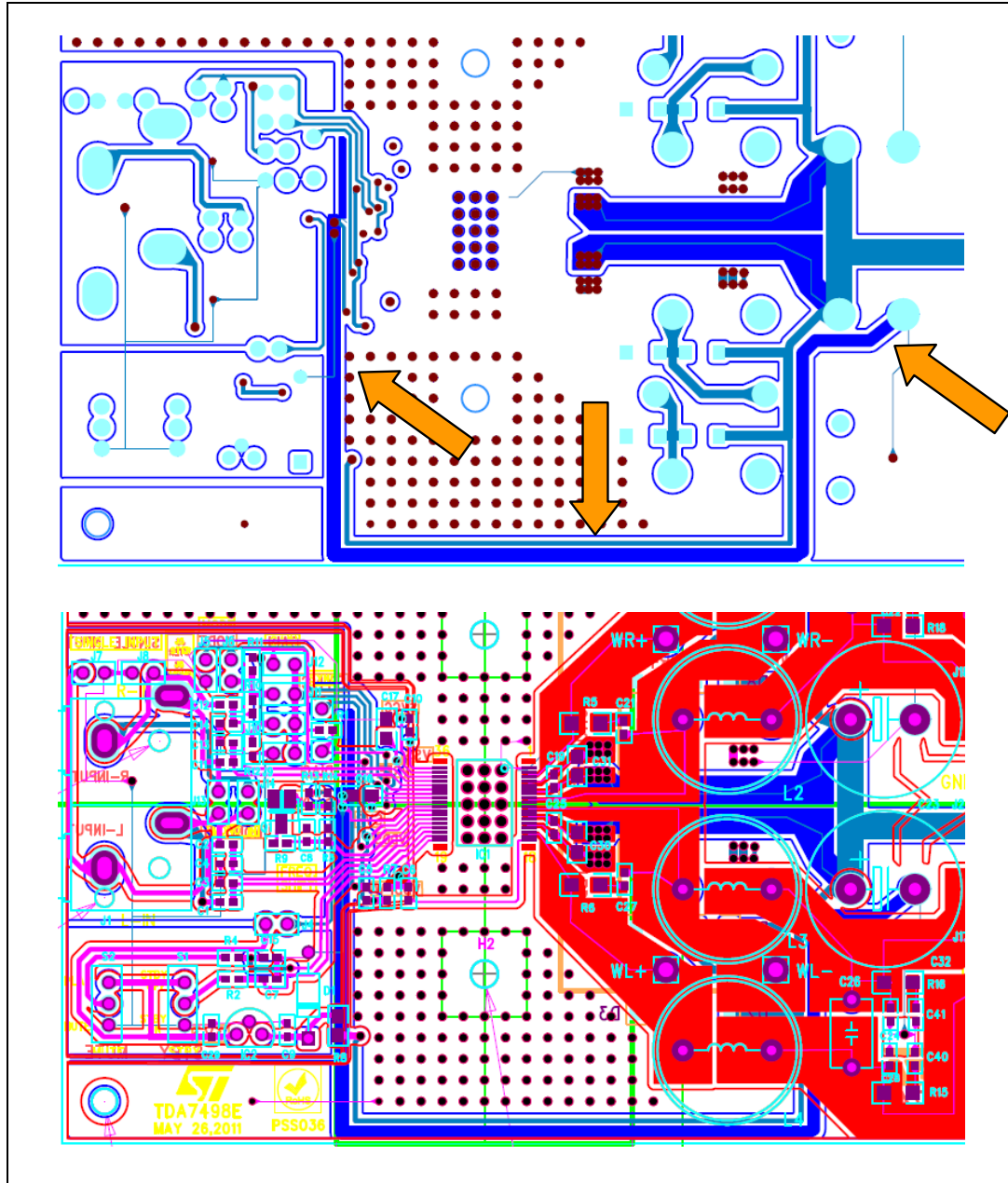
- Input signal routing

Figure 24. Input signal routing



- Signal ground and power ground routing: the signal ground should be connected to the bulk capacitor negative terminal via a dedicated copper track; no vias must be present in the connection path.

Figure 25. Signal ground and power ground routing



7 Revision history

Table 2. Document revision history

Date	Revision	Changes
09-Jan-2012	1	Initial release.

Please Read Carefully:

Information in this document is provided solely in connection with ST products. STMicroelectronics NV and its subsidiaries ("ST") reserve the right to make changes, corrections, modifications or improvements, to this document, and the products and services described herein at any time, without notice.

All ST products are sold pursuant to ST's terms and conditions of sale.

Purchasers are solely responsible for the choice, selection and use of the ST products and services described herein, and ST assumes no liability whatsoever relating to the choice, selection or use of the ST products and services described herein.

No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted under this document. If any part of this document refers to any third party products or services it shall not be deemed a license grant by ST for the use of such third party products or services, or any intellectual property contained therein or considered as a warranty covering the use in any manner whatsoever of such third party products or services or any intellectual property contained therein.

UNLESS OTHERWISE SET FORTH IN ST'S TERMS AND CONDITIONS OF SALE ST DISCLAIMS ANY EXPRESS OR IMPLIED WARRANTY WITH RESPECT TO THE USE AND/OR SALE OF ST PRODUCTS INCLUDING WITHOUT LIMITATION IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE (AND THEIR EQUIVALENTS UNDER THE LAWS OF ANY JURISDICTION), OR INFRINGEMENT OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT.

UNLESS EXPRESSLY APPROVED IN WRITING BY TWO AUTHORIZED ST REPRESENTATIVES, ST PRODUCTS ARE NOT RECOMMENDED, AUTHORIZED OR WARRANTED FOR USE IN MILITARY, AIR CRAFT, SPACE, LIFE SAVING, OR LIFE SUSTAINING APPLICATIONS, NOR IN PRODUCTS OR SYSTEMS WHERE FAILURE OR MALFUNCTION MAY RESULT IN PERSONAL INJURY, DEATH, OR SEVERE PROPERTY OR ENVIRONMENTAL DAMAGE. ST PRODUCTS WHICH ARE NOT SPECIFIED AS "AUTOMOTIVE GRADE" MAY ONLY BE USED IN AUTOMOTIVE APPLICATIONS AT USER'S OWN RISK.

Resale of ST products with provisions different from the statements and/or technical features set forth in this document shall immediately void any warranty granted by ST for the ST product or service described herein and shall not create or extend in any manner whatsoever, any liability of ST.

ST and the ST logo are trademarks or registered trademarks of ST in various countries.

Information in this document supersedes and replaces all information previously supplied.

The ST logo is a registered trademark of STMicroelectronics. All other names are the property of their respective owners.

© 2012 STMicroelectronics - All rights reserved

STMicroelectronics group of companies

Australia - Belgium - Brazil - Canada - China - Czech Republic - Finland - France - Germany - Hong Kong - India - Israel - Italy - Japan - Malaysia - Malta - Morocco - Philippines - Singapore - Spain - Sweden - Switzerland - United Kingdom - United States of America

www.st.com