AN2612
Applications note

How to use the BT_HTS_RX_R2 evaluation board

Features

- Support A2DP/AVRCP (sink side) profile.
- Class 2 (max +4 dBm RF power output), BQB qualified module.
- Single 5-V DC power supply.
- 1.5-Vpp line-out (stereo) with full scale input.

Hardware/software version

- Hardware version: R2A.
- Software version: E1.0.3.

Overview

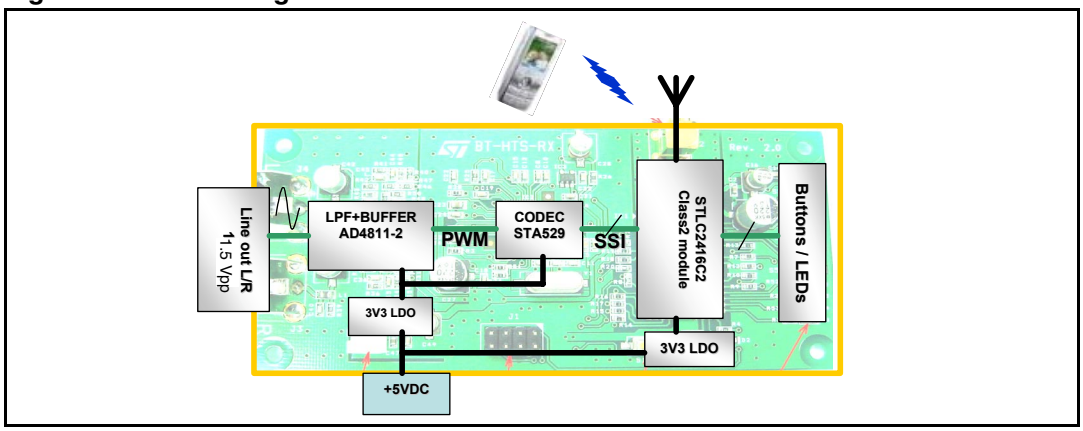
The demo-board BT_HTS_RX_R2 facilitates the evaluation of the BT-STA2416C2 Bluetooth® technology wireless module in an A2DP environment. It is based on the SOUNDabout® and BLUEmagic® software of Open Interface North America, Inc and it guarantees a broad compatibility (*Table 6*) and a full set of certifications (*Table 4*, *Table 5*).

Figure 1. shows a block diagram of the BT_HTS_RX_R2 board. The Bluetooth® technology stream received by the RF antenna is sent to the BT-STA2416C2. This highly-integrated module is able to communicate wirelessly with BTA2DP sources such as cellular phones, BT dongles and notebook PCs.

Audio data is then fed into the STA529. This device provides the codec and a high-efficiency class-D output stage based on FFX™ technology.

The PWM output signal is then reconverted to an analog audio signal by a TS462 (or an ADA4841-2) op-amp configured to filter the PWM and supply a standard 1.5-Vpp line output.

Figure 1. Block diagram



Contents

1 Picture and port description

Figure 2. Ports available on the board

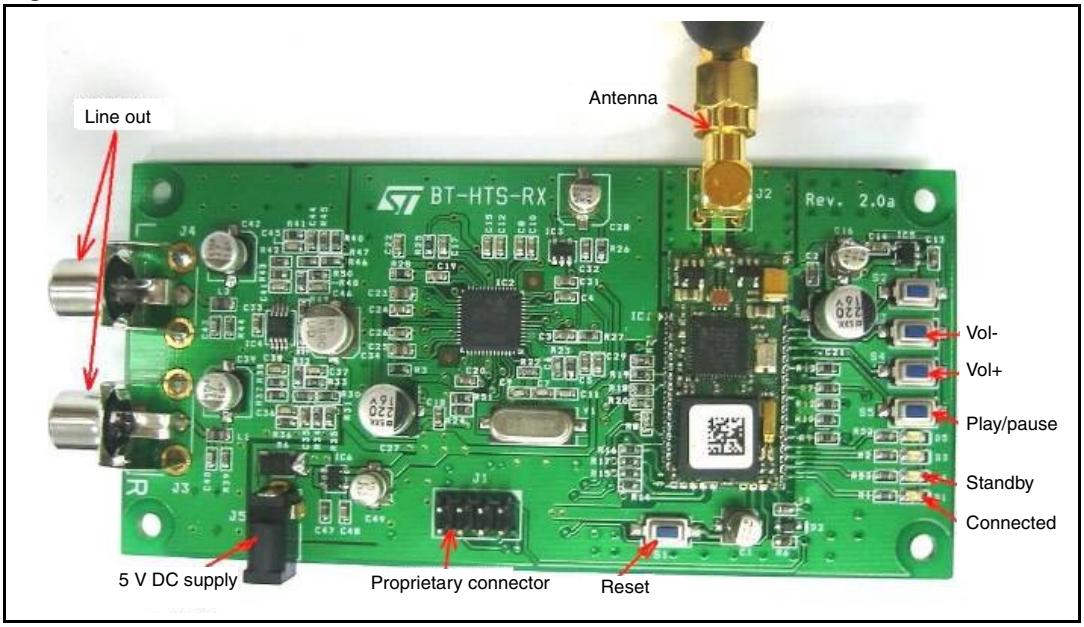


Table 1. Port description

Port name	Description		Port name	Description
J5	5-V DC power supply		S3	Volume -
J1	Proprietary connector		S4	Volume +
J3	Audio line out, right channel		S5	Play / Pause
J4	Audio line out, left channel		D1	BT link indicator
J2	External antenna connector		D3	Reserved
S1	Reset button		D4	Standby
S2	Reserved		D5	Reserved

2 Board configurations

Figure 3. Configuration 1

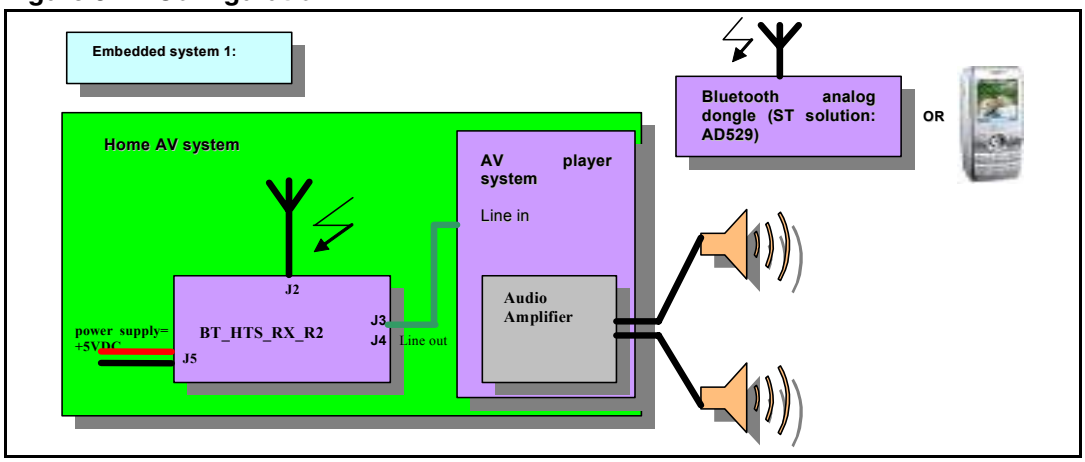
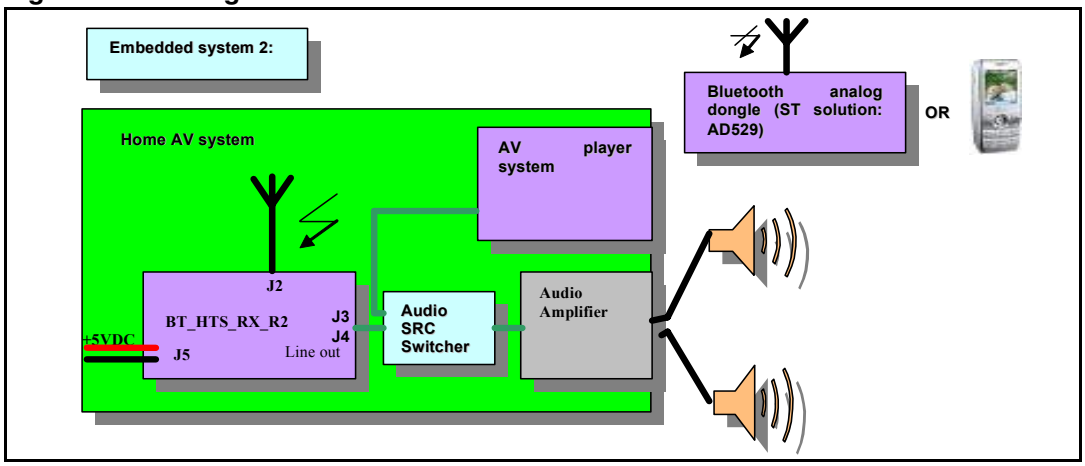


Figure 4. Configuration 2



2.1 Electrical specifications

(VCCin = 5.0 V and ambient temperature = 25° C unless otherwise specified)

Table 2. Electrical characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{CCin}	Board power supply		4.5	5.0	16	V
I_{ddw}	Supply current (working mode)	Bluetooth® technology streaming mode, CODEC in binary mode	-	72	80	mA
I_{ddn}	Supply current (working mode, no streaming)	Bluetooth® technology module connected, no data streaming, CODEC in binary mode	-	57	65	mA
I_{dds}	Supply current (standby mode)	Bluetooth® technology module not connected.	-	44	50	mA
$V_{lineout}$	Signal voltage on line out	Bluetooth® technology streaming mode, IVT BlueSoleil™, full-scale streaming 1-kHz sine wave, CODEC in binary mode	1.4	1.5	1.6	Vpp
R_{out}	Line-out impedance (L, R)	-	1	3.6	10	Ω
P_{RFout}	RF output power	Bluetooth® technology linked	-6	<4	4	dBm
Z_{out}	RF output impedance(J2)	-	-	50	-	Ω
VSWR	Return loss	-	-	-	2.8	dB
THD+N	Total harmonic distortion+noise (L, R)	Test with Bluetooth® technology USB dongle, IVT BlueSoleil™ Version 1.4.8.1, 1-kHz sine wave full scale input, 1-Vpp line out, 20-20 kHz.	-	0.089	0.1	%
SNR	Signal to noise ratio (L, R) (no weighting)	Test with Bluetooth® technology USB dongle, IVT BlueSoleil™ version 1.4.8.1, 1-kHz sine wave full scale input, 1-Vpp line out, 20-20 kHz.	72	-	-	dB

3 Design information

3.1 Schematics

Figure 5. Receiver stage

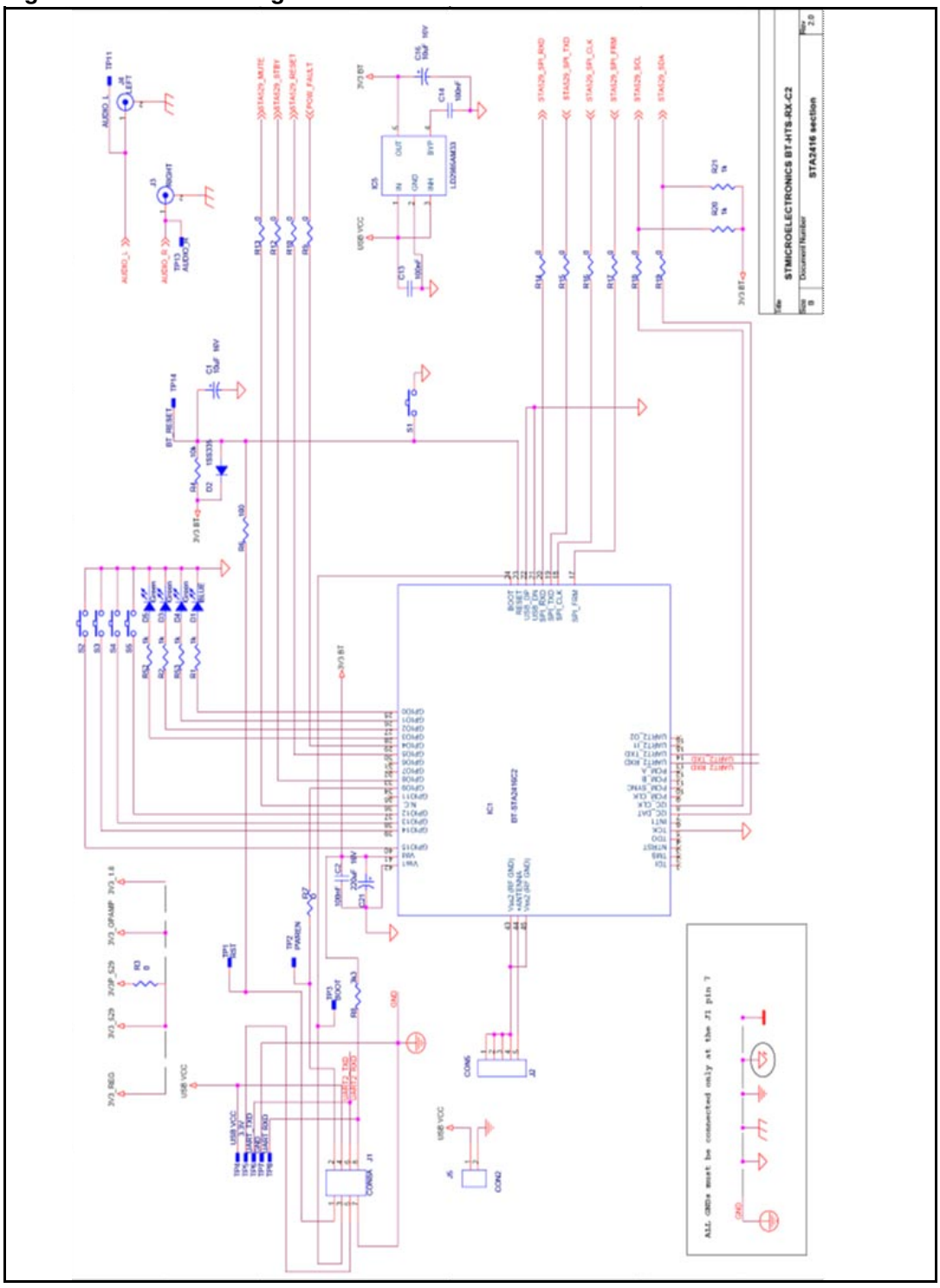


Figure 6. Codec and PWM stage

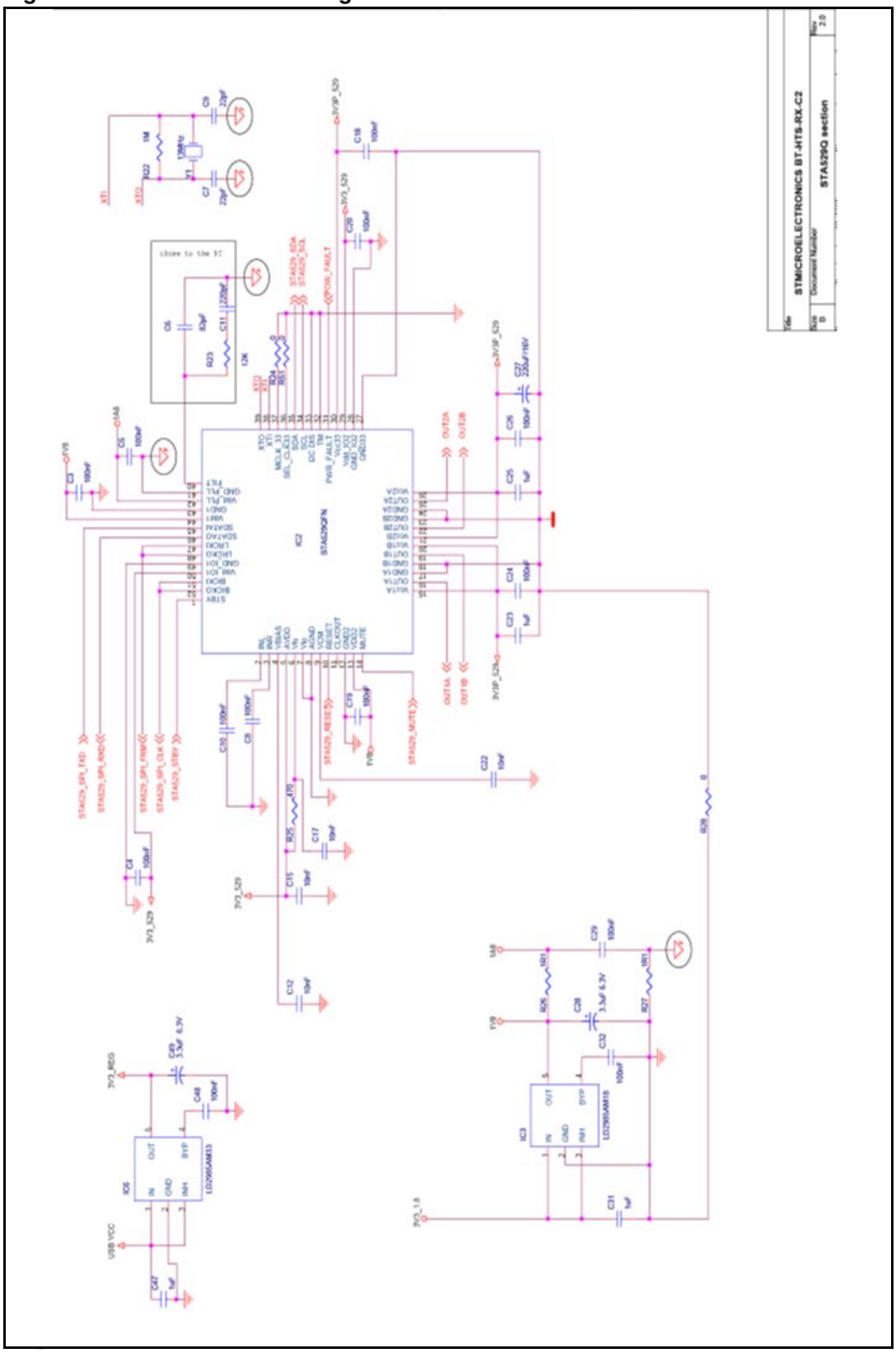
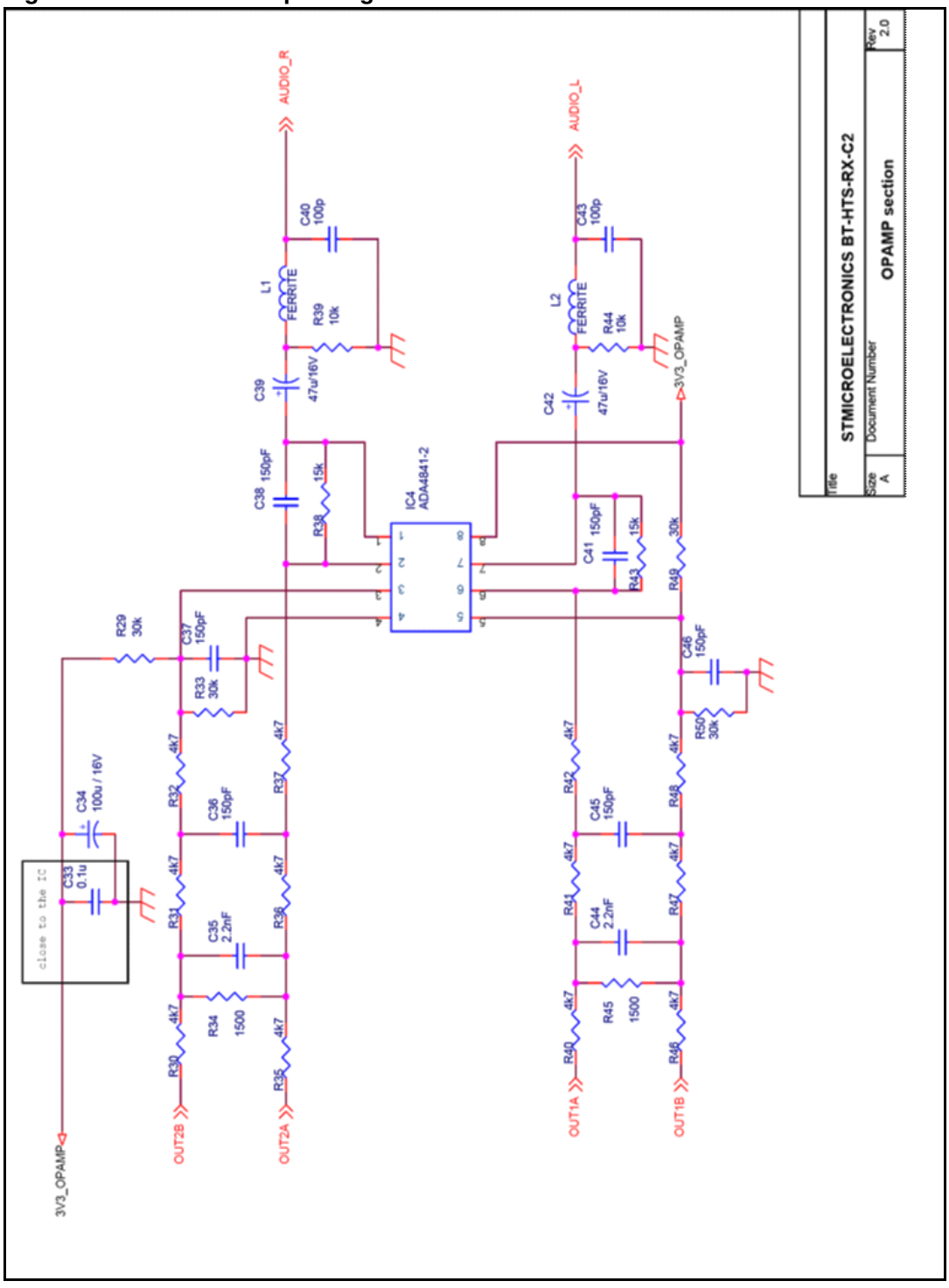


Figure 7. Filter and output stage



3.2 Bill of materials

Table 3. BOM for BT_HTS_RX_R2 (V01)

Item	Ref	Qty	Designator	Part	Footprint	Remarks
1	CAP	2	C1, C16	10 µF, 16 V	CE45	Aluminium capacitor 4.5mm
2	CAP	16	C2, C3, C4, C5, C8, C10, C13, C14, C18, C19, C20, C24, C26, C29, C32, C48	100 nF	0603	
3	CAP	1	C6	82 pF	0603	
4	CAP	2	C7, C9	22 pF	0603	
5	CAP	1	C11	220 pF	0603	
6	CAP	4	C12, C15, C17, C22	10 nF	0603	
7	CAP	1	C21	220 µF 16 V	CE66	Aluminium capacitor 6.6mm
8	CAP	2	C23, C25	1 µF	0805	
9	CAP	2	C31, C47	1 µF	0603	
10	CAP	1	C27	220 µF, 16 V	CE83	Aluminium capacitor 8.3mm
11	CAP	1	C28	3.3 µF, 6.3 V	CE66	Aluminium capacitor 6.6mm
12	CAP	1	C33	0.1 µF	0603	
13	CAP	1	C34	100 µF, 16 V	CE66	Aluminium capacitor 6.6mm
14	CAP	2	C35, C44	2.2 nF	0603	
15	CAP	6	C36, C37, C38, C41, C45, C46	150 pF	0603	
16	CAP	2	C39, C42	47 µF, 16 V	CE66	Aluminium capacitor 6.6mm
17	CAP	2	C40, C43	100 pF	0603	
18	CAP	1	C49	3.3 µF, 6.3 V	CE45	Aluminium capacitor 4.5mm
19	LED	1	D1	Blue, high efficiency	0805	
20	DIODE	1	D2	1SS335	0805	
21	LED	3	D3, D4, D5	Green, high efficiency	0805	

Table 3. BOM for BT_HTS_RX_R2 (V01) (continued)

Item	Ref	Qty	Designator	Part	Footprint	Remarks
22	DIODE	1	TMBYV10-60	Diode		Can take replacement
23	IC	1	IC1	BT-STA2416C2		
24	IC	1	IC2	STA529QFN	QFN52	
25	IC	1	IC3	LD2985AM18	SOT23-5L	
26	IC	1	IC4	TS462	MSOP8	Alternative: ADA4841-2
27	IC	2	IC5, IC6	LD2985AM33	SOT23-5L	
28	CON	1	J1	CON8A	2 x 4-pin step 2.54mm	
29	CON	1	J2	CON5	SMA	
30	CON	1	J3	RIGHT	RCA	
31	CON	1	J4	LEFT	RCA	
32	CON	1	J5	CON2	DC jack	
33	BEAB	2	L1, L2	FERRITE	0805	
34	RES	6	R1, R2, R20, R21, R52, R53	1 kΩ	0603	
35	RES	15	R3, R7, R9, R10, R12, R13, R14, R15, R16, R17, R18, R19, R24, R28, R51	0 Ω	0603	
36	RES	3	R4, R39, R44	10 kΩ	0603	
37	RES	1	R6	100 Ω	0603	
38	RES	1	R8	3.3 kΩ	0603	
39	RES	1	R22	1 MΩ	0603	
40	RES	1	R23	12 kΩ	0603	
41	RES	1	R25	470 Ω	0603	
42	RES	2	R26, R27	1.1 Ω	0603	
43	RES	4	R29, R33, R49, R50	30 kΩ	0603	
44	RES	12	R30, R31, R32, R35, R36, R37, R40, R41, R42, R46, R47, R48	4.7 kΩ	0603	
45	RES	2	R34, R45	1.5 kΩ	0603	
46	RES	2	R38, R43	15 kΩ	0603	
47	SW	5	S1, S2, S3, S4, S5	KSR221J	KSR221J	Can take replacement
48	TP	1	TP1	RST	1 pin not soldered	
49	TP	1	TP2	PWREN	1 pin not soldered	
50	TP	1	TP3	BOOT	1 pin not soldered	

Table 3. BOM for BT_HTS_RX_R2 (V01) (continued)

Item	Ref	Qty	Designator	Part	Footprint	Remarks
51	TP	1	TP4	USB VCC	1 pin not soldered	
52	TP	1	TP5	3.3V	1 pin not soldered	
53	TP	1	TP6	UART_TXD	1 pin not soldered	
54	TP1	1	TP7	GND	1 pin not soldered	
55	TP	1	TP8	UART_RXD	1 pin not soldered	
56	TP	1	TP11	AUDIO_L	1 pin not soldered	
57	TP	1	TP13	AUDIO_R	1 pin not soldered	
58	TP	1	TP14	BT_RESET	1 pin not soldered	
59	Crystal	1	Y1	13 MHz	49SX	

3.3 Gerber

Figure 8. Silkscreen - top

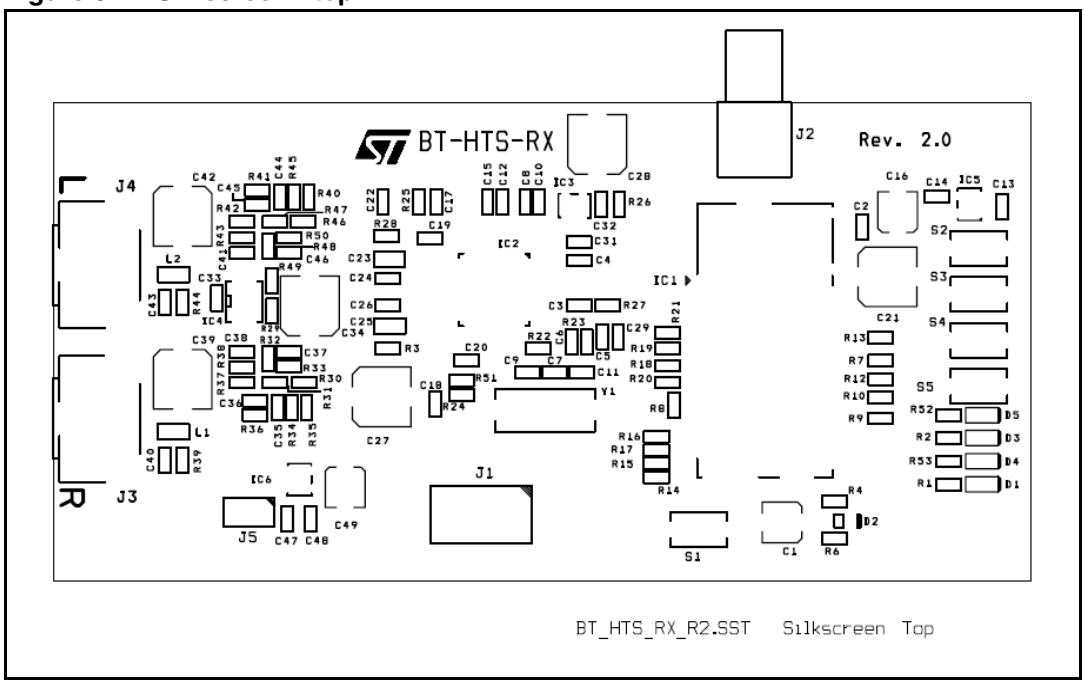


Figure 9. Silkscreen - bottom (viewed from top of board)

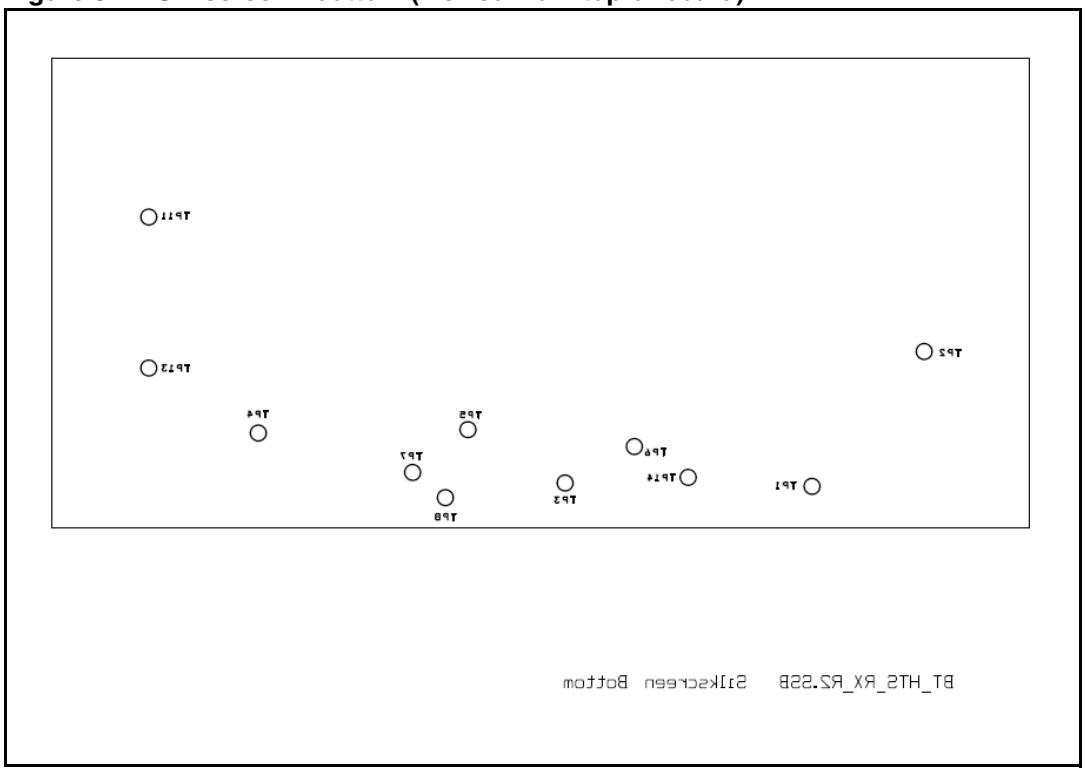


Figure 10. Copper layer - top

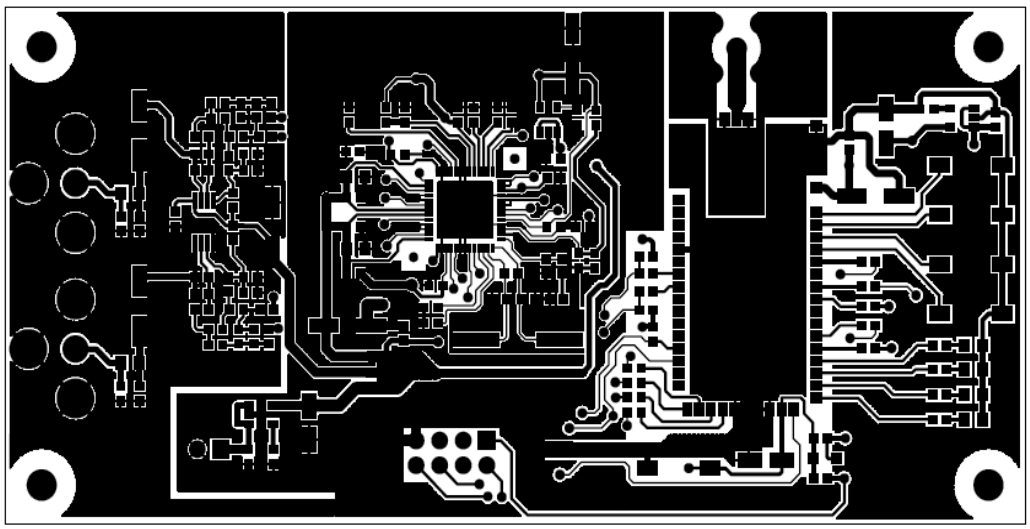
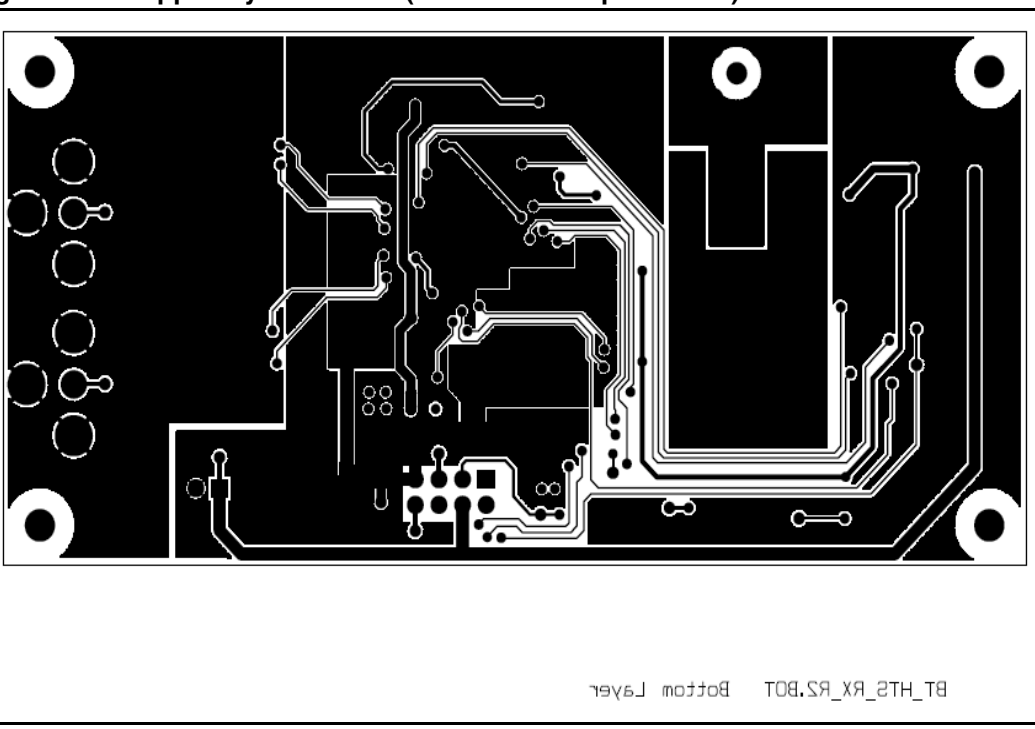


Figure 11. Copper layer - bottom (viewed from top of board)



3.4 Design information for power management

3.4.1 Recommendations for the codec layout

- Use an electrolytic capacitor at each branch of the Vcc power track.
- Place decoupling capacitors as close as possible to the Vcc and ground pins.
- Dissipate the heat with a large ground plane.
- Place the PLL filter components as close as possible to pin FILT.
- For differential applications create symmetrical paths for the output stage.

Please refer to the STA529 datasheet/applications note for details of the above points.

3.4.2 Power supply considerations

The Bluetooth® technology transmitter and receiver are alternately switching on and off and there is a risk that the switching noise will appear on the power supply lines. Furthermore this switching frequency is in the audio band. So, if the supply is shared with the audio stage and insufficient decoupling is employed, it could lead to a noisy audio line output when used in single-ended mode, as shown in *Figure 13*, upper photo. In order to minimize this possibility it was decided to employ separate regulators on the BT_HTS_RX_R2 board for the RF part and for the analog audio part. The lower photo of *Figure 13* shows the resulting line output for single-ended mode.

Figure 12 shows how the power management is implemented on the board. IC5, IC6 are two 3.3 V low dropout (LDO) regulators (ST reference LD2985AM33). 3V3_BT is the supply for Bluetooth® technology module, and 3V3_REG is that for the STA529Q (codec). Other brands of LDO are also usable, but they should have a high PSRR and a good regulation rate. Switching type DC/DC power supplies are also workable for the Bluetooth® module supply.

Figure 12. Power management

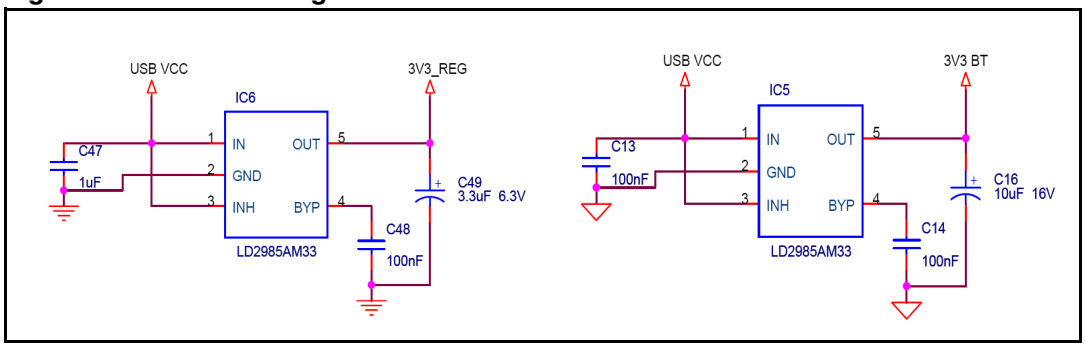
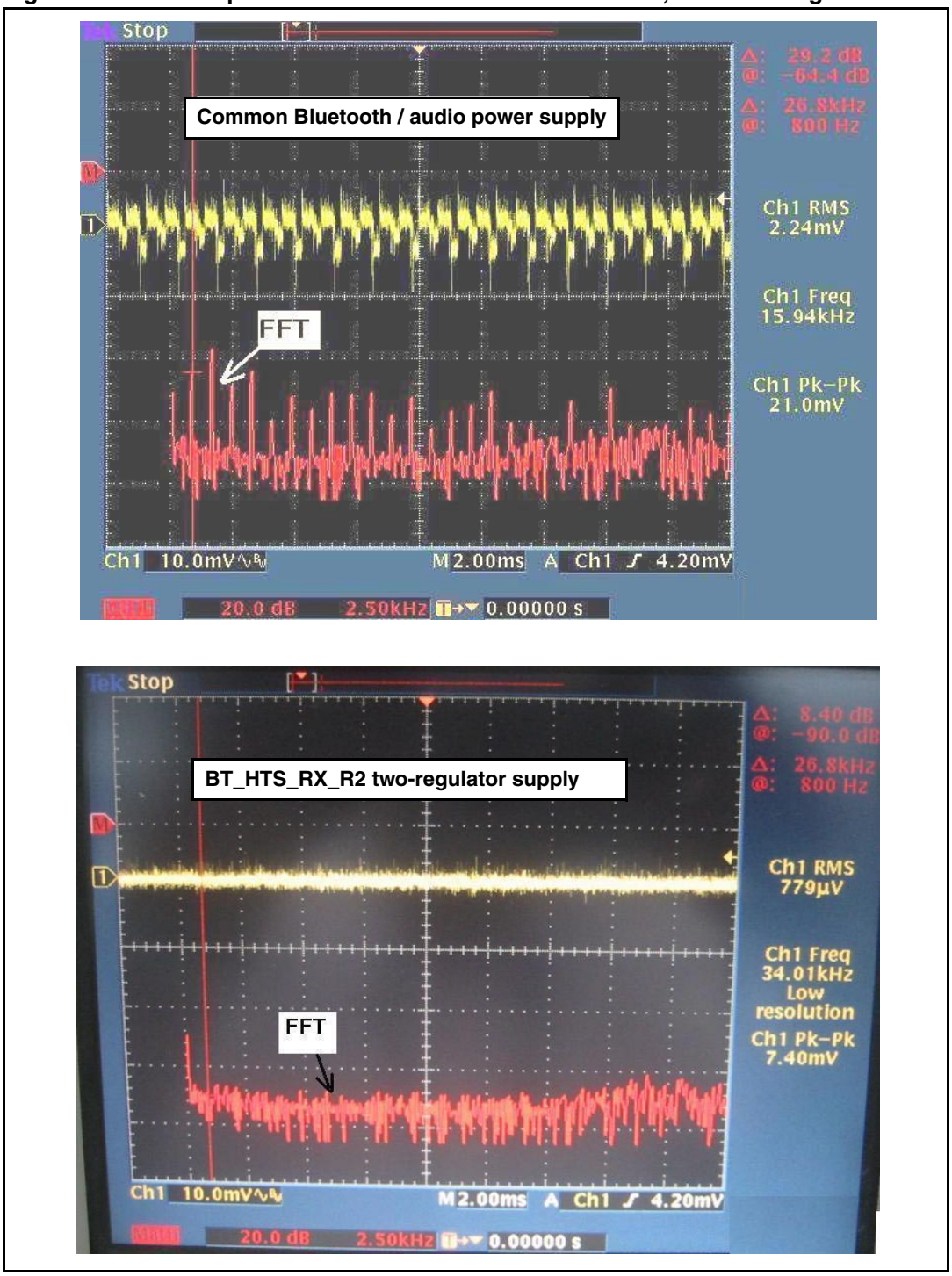


Figure 13. Line output noise with Bluetooth module active, no streaming



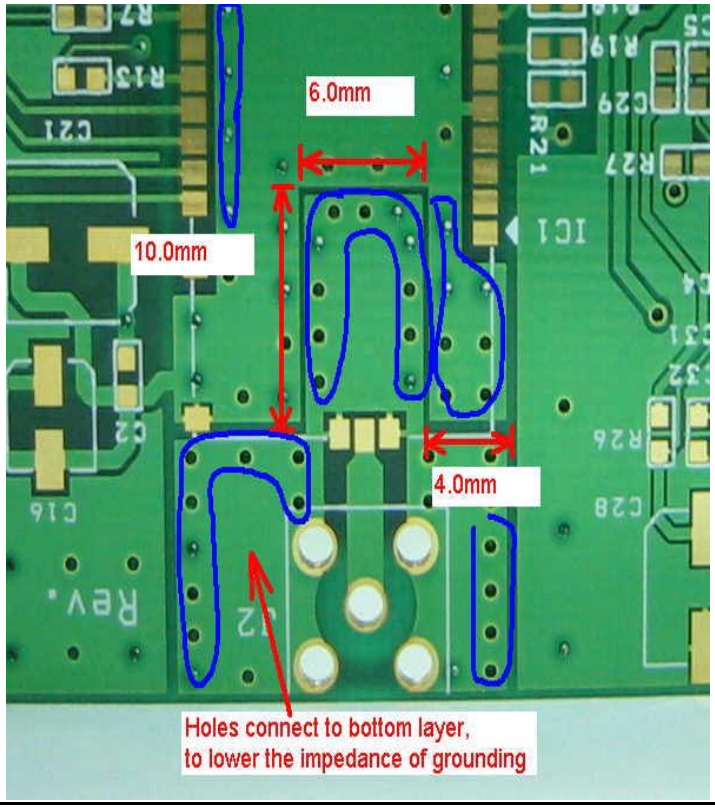
3.5 Ground planes

As usual, good grounding is very important for audio products. Since BT_HTS_RX_R2 is a mixed analog and digital signal board, the ground connections were considered very carefully.

- RF grounding below the BT-STA2416C2 module is separate from the other modules, and is connected to the main ground inside the BT-STA2416C2 module.

  Figure 14 shows the antenna and RF grounding for improved RF reception.

Figure 14. Antenna and RF grounding



- Bluetooth® technology digital ground, codec digital ground, codec analog ground, codec PA ground and op-amp analog ground are all separate, and each of them is connected to one main grounding point as shown below in *Figure 15* and *Figure 16*.

Figure 15. Grounding arrangement on schematics

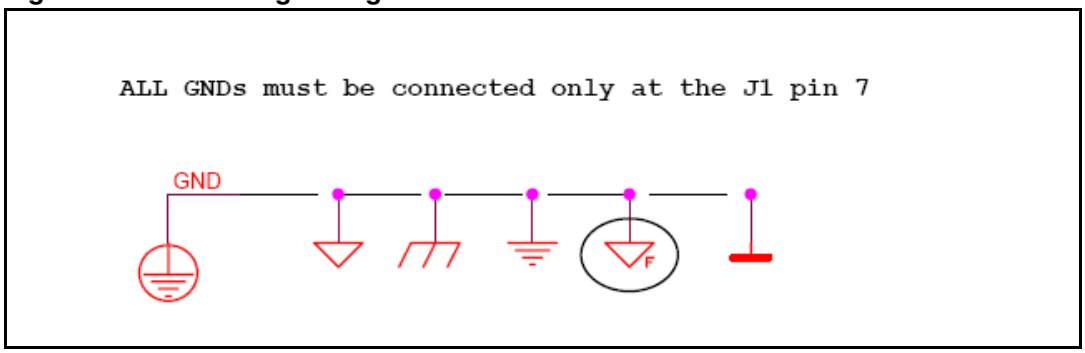


Figure 16. Ground arrangement on layout (bottom view)

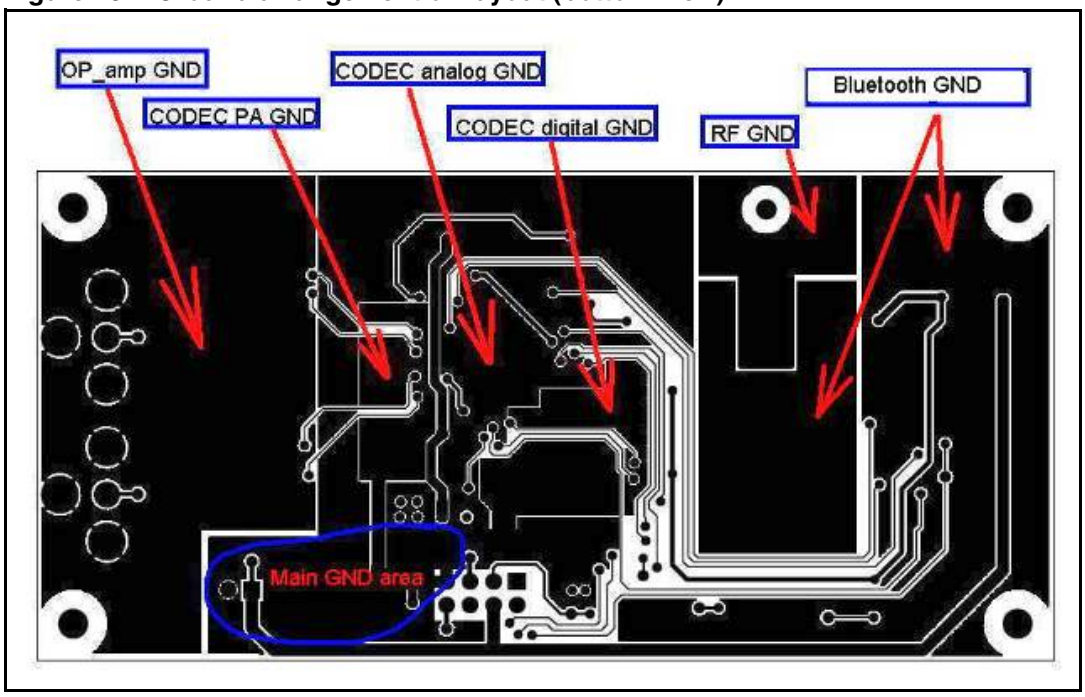
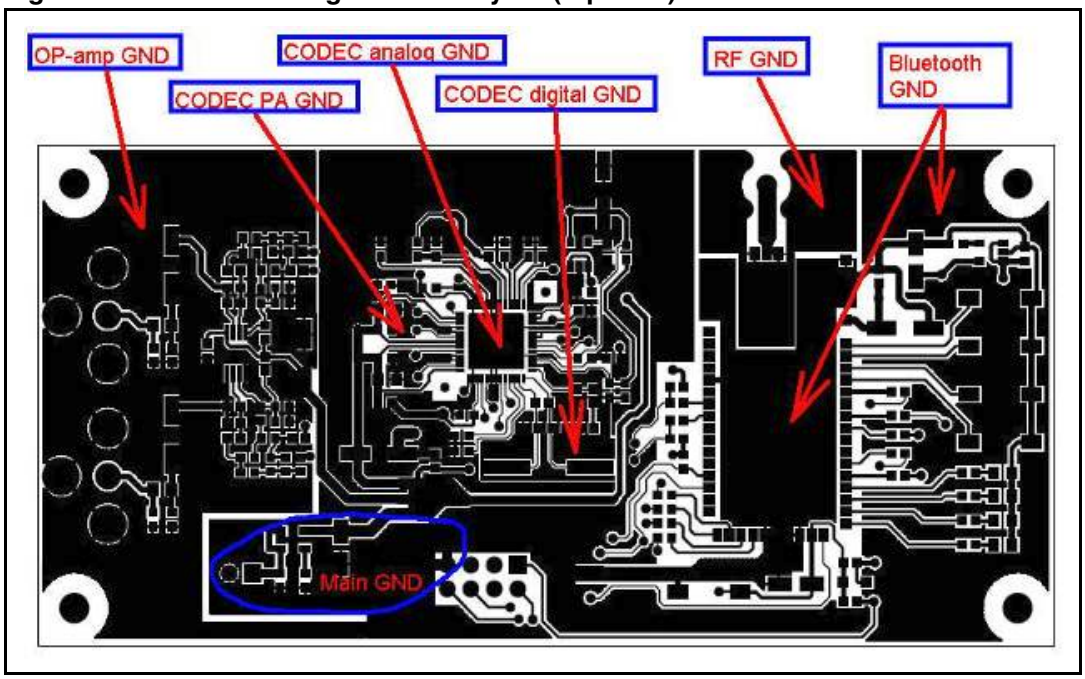


Figure 17. Ground arrangement on layout (top view)



3.6 EMI

The EMI was minimized by:

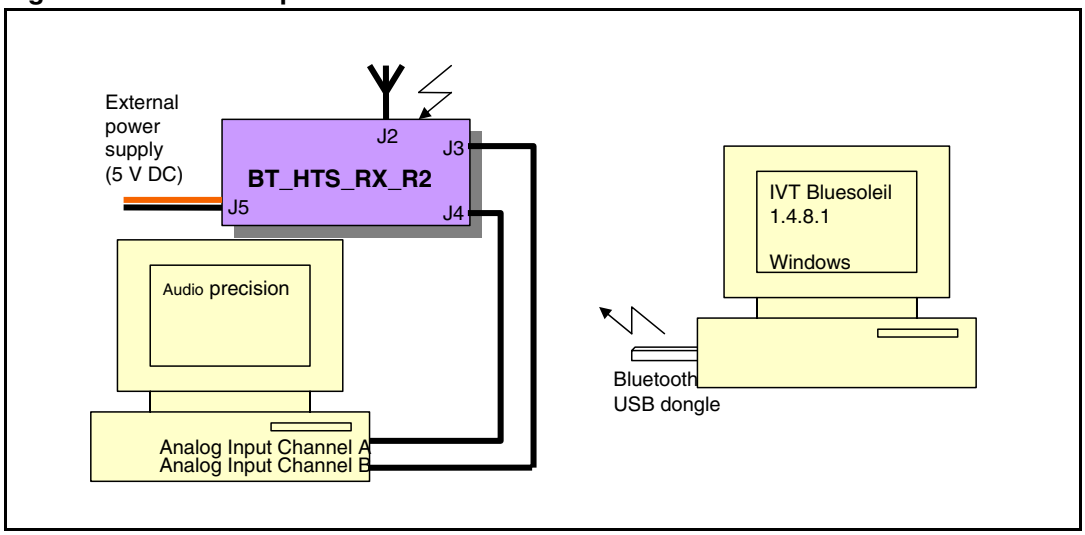
- following the recommendations in *Section 3.5 on page 16* for the ground configuration.
- placing the 13-MHz crystal as close as possible to the codec (STA529). The tracks between the crystal and the STA529 oscillator pins were made as short as possible and the IC was well grounded.
- making the tracks from OUT1A, OUT1B, OUT2A and OUT2B of the STA529 to the op-amp as short as possible. For more details on this point please refer to the datasheet and applications note for the STA529.

4 Audio performance testing of the board

4.1 Test set-up

Testing is done with the Bluetooth® technology V1.2 Class-2 USB dongle, running with IVT BlueSoleil 1.4.8.1 software, streaming 1 kHz sine-wave signal by Windows Media® player 10 on the computer, and measuring with audio precision. The diagram for the set-up is shown below in *Figure 18*.

Figure 18. Test set-up



4.2 FFT results

Figure 19. FFT 0-dBFS input, 3.3 V, 600 Ω

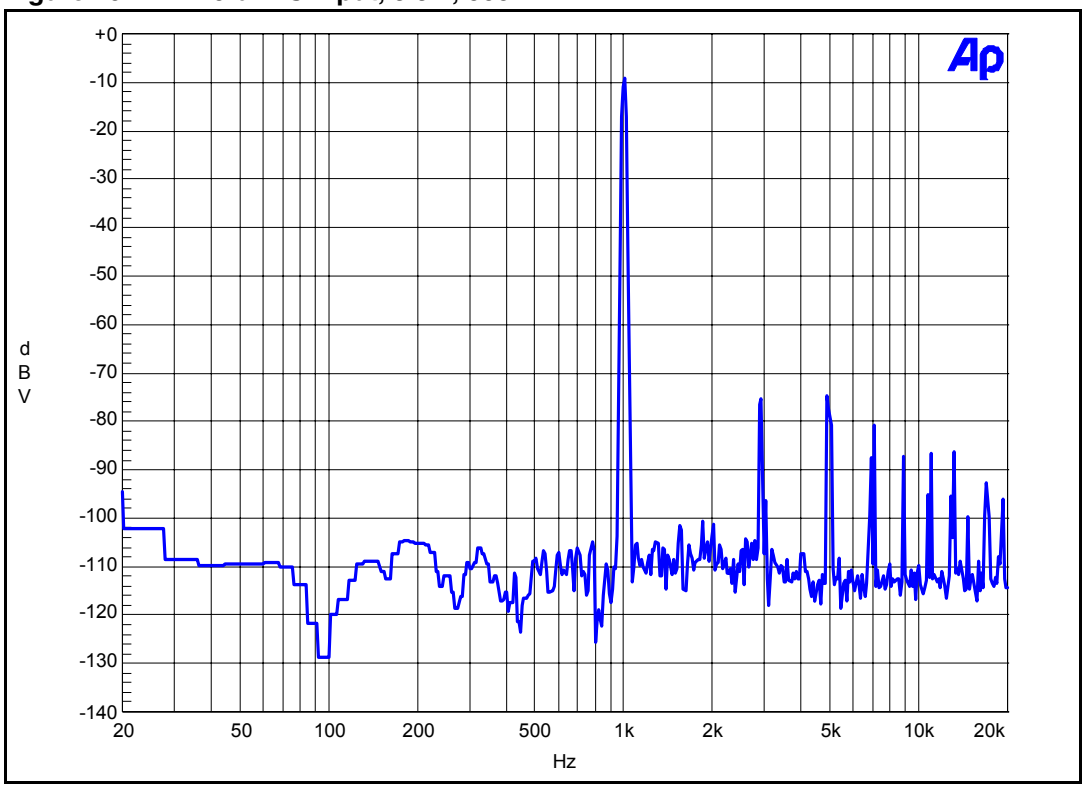
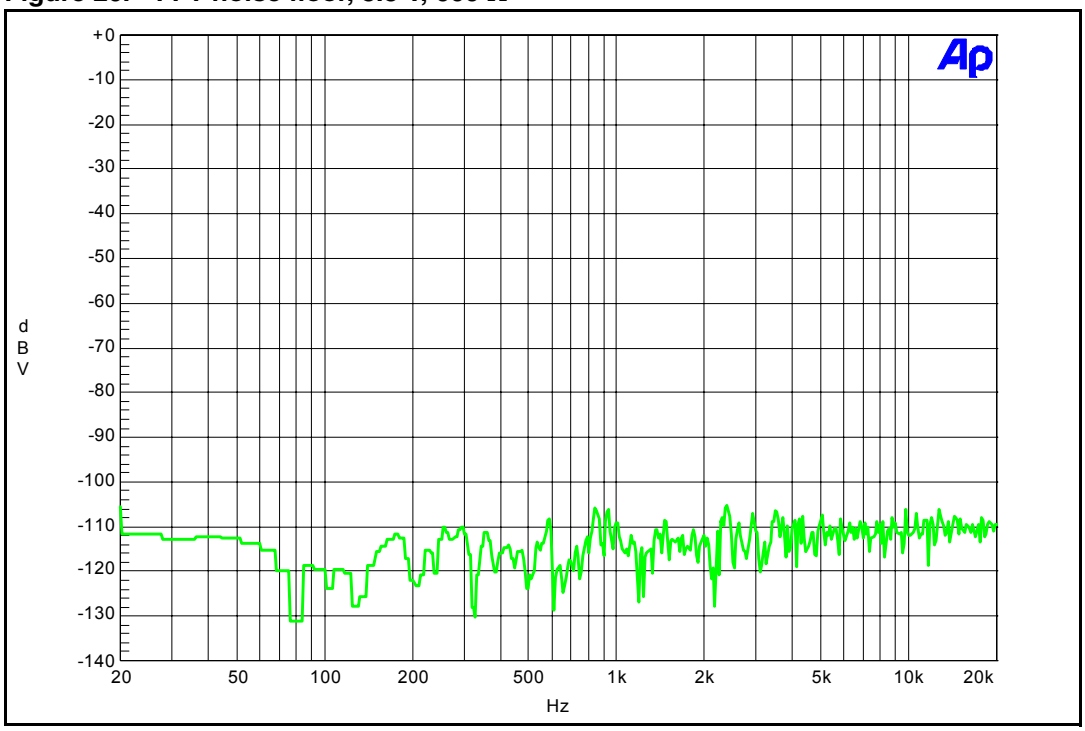
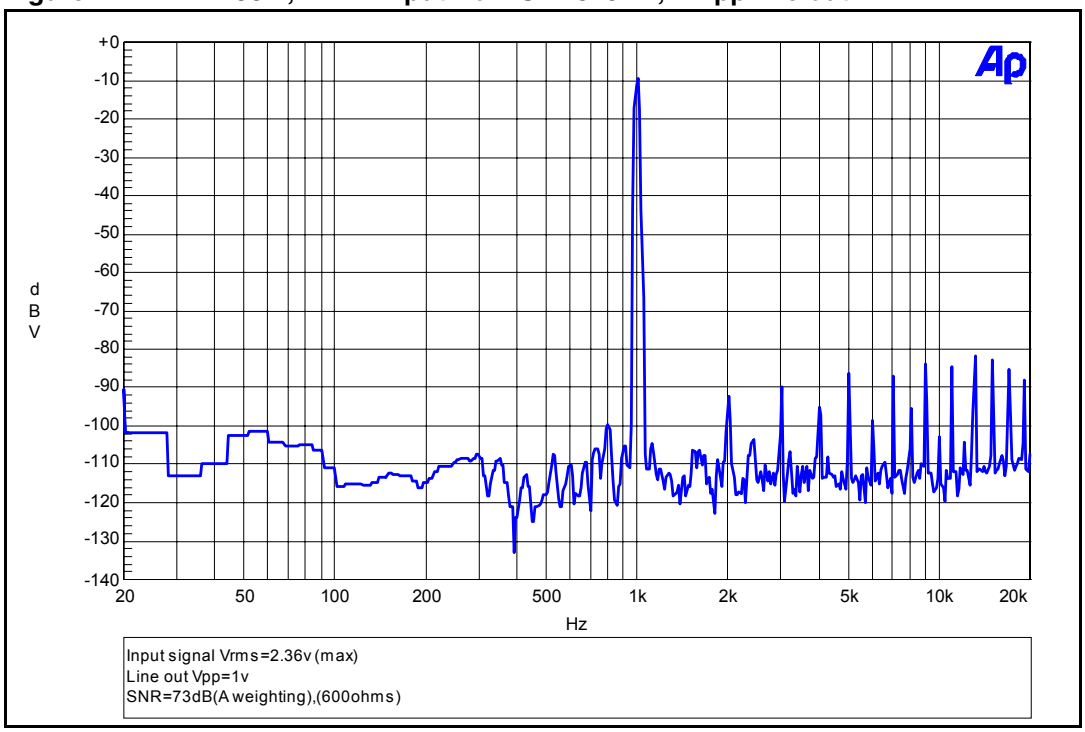


Figure 20. FFT noise floor, 3.3 V, 600 Ω



4.3 Test result with STM529AD (STM analog dongle)

Figure 21. FFT 2.36-V, 1-kHz input from STM529AD, 1-Vpp line out



Minimum SNR = 73 dB (A weighting)

Caution: The maximum input level for STM529AD is 2.36 V RMS.

Figure 22. THD + N vs frequency (2.36-V RMS input, 1-Vpp line out)

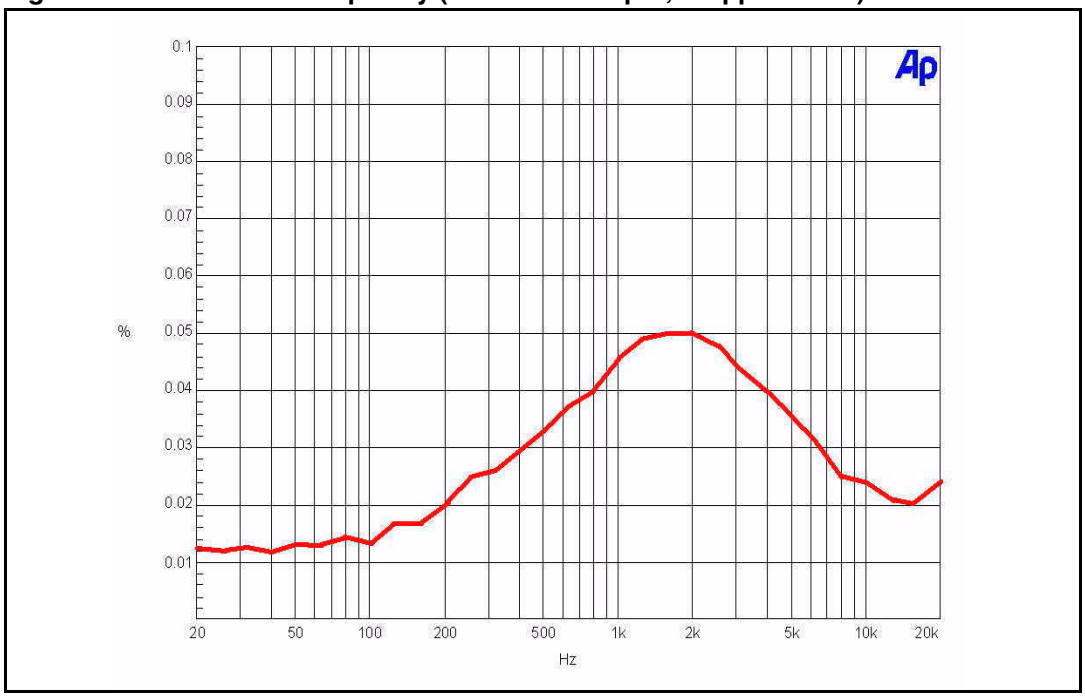
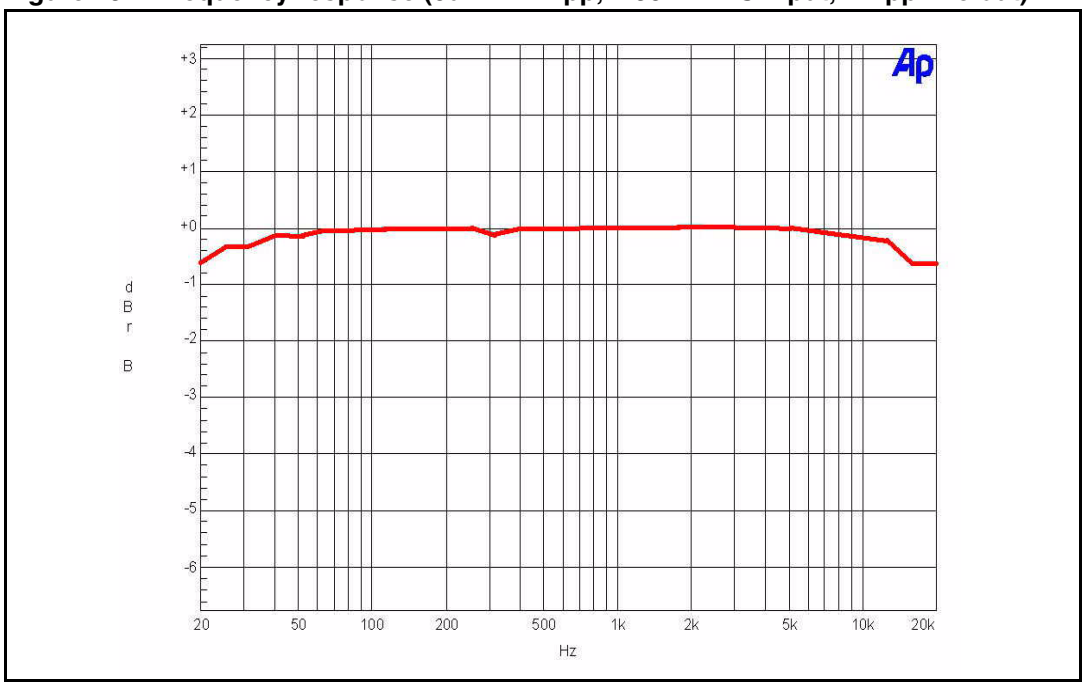


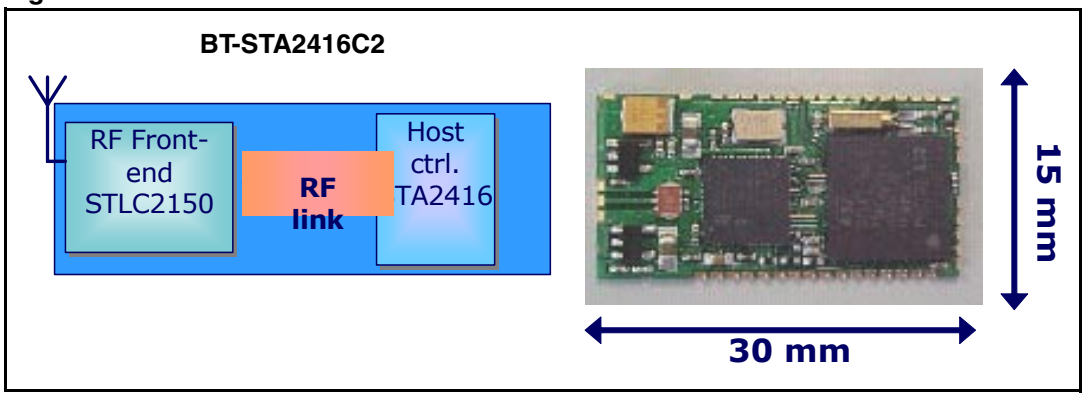
Figure 23. Frequency response (0dBr = 1 Vpp, 2.36-V RMS input, 1-Vpp line out)



5 Appendix

5.1 Overview of BT-STA2416C2 module

Figure 24. BT-STA2426C2 module



The BT-STA2416C2 module is based on two ICs:

- STA2416 host controller
- STLC2150 RF

Information for the STMicroelectronics ICs.

- Supported interfaces:
  - USB (1.1)
  - UART
  - PCM (pulse code modulation)
- Output power level: Class 2 (max +4 dBm)
- Bluetooth® technology protocol layer support up to HCI
- ACL & SCO links
- Transmission rate up to 721 kbit/s
- Optimized link manager and control
- Support WLAN coexistence
- Integrated 4-Mbit flash, 64-Kbyte RAM, 4-Kbyte ROM
- Single 3.3-V power supply
- Low power consumption
- CE compliant
- Safety EN60950-1 (2001)
- EMC EN301 489 17V1.2.1
- Radio ES 300 328 V1.6
- BQB: RF - HCI - LM - BB

5.2 Certification of Bluetooth® module

The STMicroelectronics chipset and modules given in *Table 4* are fully compliant with the following BQB certifications under PRD2.0 standard:

Table 4. BQB qualified designs (chipset and modules)

Qualified designs	Manufacturer	Product ID	Product type	Profiles	QD ID
Bluetooth technology module	ST Microelectronics	BT_STA2416C2	Component	RF, BB, LM, HCI	B012535

The stack supplied by Open Interface North America, Inc. is BQB certified and provides full connectivity for our Bluetooth® technology wireless kit by supporting different profiles.

Table 5. Supported profiles

Qualified designs	Manufacturer	Product ID	Product type	Profiles	QD ID
Bluetooth technology stack	Open Interface North America, Inc.	BLUEmagic® 3.0	Profile sub-system	SDP, GAP, A2DP, AVCTP, AVDTP, AVRCP, BIP, BNEP, BPP, CTP, DUN, FAX, FTP, GAVDP, HCRP, HFP, HID, HP, ICP, OPP, PAN, RFCOMM, SAP, SDAP, SPP, SYNC, L2CAP	B010293

5.3 Interoperability list

The board can sink audio from A2DP compliant audio sources. The table below lists the commercial source products tested as of April 2007. Some source products may require a firmware update in order to operate properly.

Table 6. Interoperability list (April 2007)

Manufacturer	Type	Model
Blackjack	PDA	
HP	PDA	IPAQ
LG	Mobile phone	GSM type
LG	Mobile phone	(EU) U890
LG	Mobile phone	Chocolate VX8500
Motorola	Mobile phone	(USA)krzr k1
Motorola	Mobile phone	V3X
Nokia	Mobile phone	8801
Samsung	Mobile phone	(China) E788
Samsung	Mobile phone	(EU) D820
Samsung	Mobile phone	(Korea) SCH-B380
Samsung	Mobile phone	(Korea)SCH-B5050
Samsung	Mobile phone	(Korea)SCH-B560
Samsung	Mobile phone	(Korea)SCH-B630
Samsung	Mobile phone	(Korea)SCH-V740
Samsung	Mobile phone	(Korea)SGH-D600
Samsung	Mobile phone	(Korea)SPH-V9600
Samsung	Mobile phone	(Korea)SPH-V9850
Samsung	MP3 Player	YP-T9B
Sony Ericsson	Mobile phone	W850i
Sony Ericsson	Mobile phone	(China)P990i
Sony Ericsson	Mobile phone	(EU)W810i
Sony Ericsson	Mobile phone	(USA)K800i
Sony Ericsson	Mobile phone	(USA)W710i
Sony Ericsson	Mobile phone	(USA)W850i

Tests will follow and the firmware of the receiver demo board will be revised, if necessary, in order to suit new commercial products. The present FW release is marked STM849_SINK_V10_E1.0.3, and updates will be available on newer demo boards as soon as they are released.

6 Trademark and other acknowledgements

Bluetooth is a registered trademark of Bluetooth SIG Inc.

SOUNDabout and BLUEmagic are registered trademarks of Open Interface North America, Inc.

FFX is an STMicroelectronics proprietary digital modulation technology.

BlueSoleil is a trademark of IVT Corporation.

Windows Media is a registered trademark of Microsoft Corporation.

7 Revision history

Table 7. Document revision history

Date	Revision	Changes
Sep-2007	1	Initial release.