# Using the "Creative Sound Blaster X-Fi Surround 5.1 Pro" USB sound interface as baseband sampler for QSD based SDR receivers

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The Creative Sound Blaster X-Fi Surroud 5.1 Pro is a external sound interface for PC with a USB2.0 High speed interface. This card are provided with drivers for WinXP, Vista and Win7.

Easy to install, the bus-powered USB 2.0 Sound Blaster X-Fi Surround 5.1 Pro does not require an extra power adapter. Furthermore, this card (in my case: Model no. SB1095) have a ADC (Cirrus Logic CS5345) and a DAC (Cirrus Logic CS4361) which have a dynamic range of 104 dB and work with a sampling rate up to 96kHz/24bit.
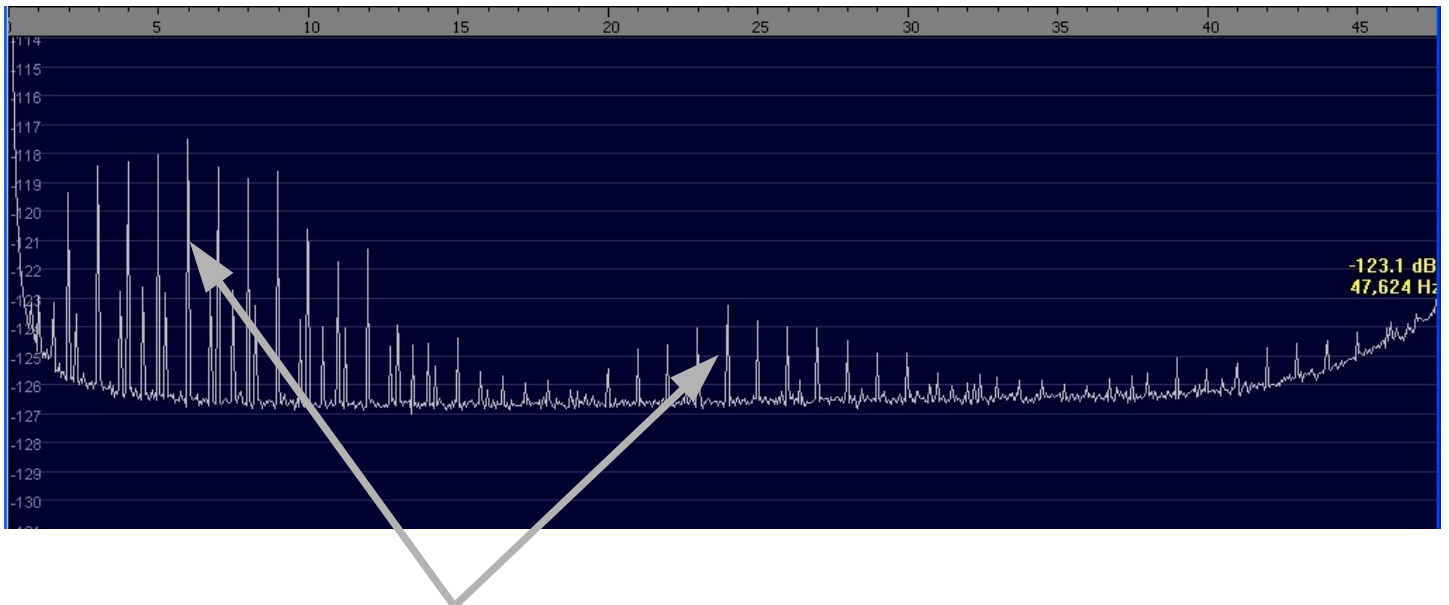(Note: the upper sampling rate limit of the ADC (CS5345) and a DAC (CS4361) are 192kHz)

For a SDR (Software Defined Radio) application, a quality 24 bit soundcard running at 96kHz or more is recommended, but this will not always mean to spending many money....

# *Tests*

The first test after the installation was the noise performance, one of most important feature of a soundcard for SDR applications:

Test conditions:
- All analog inputs are unplugged, line input volume is set to maximum
- PC: HP XW4400 Workstation, WinXP SP3
- Software: HDSDR V2.1, left input mode, RBW=11,7Hz vertical scale: 1dB/div from -131dB to -114dB
- sampling rate 96kHz / 24bit



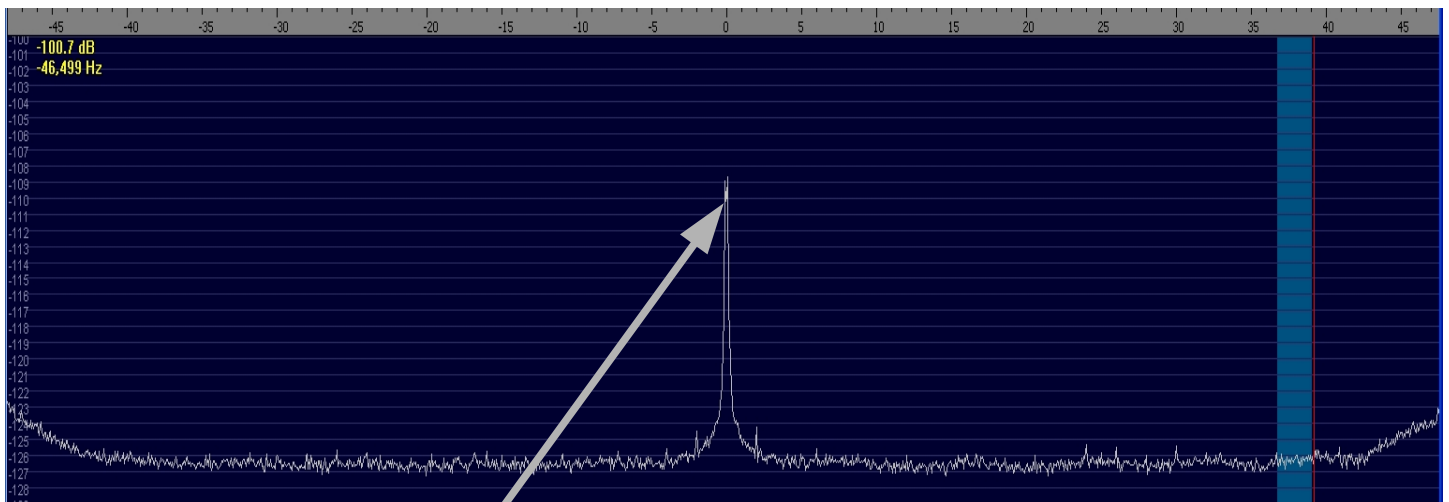Many spures spaced by 1 kHz, maybe from the USB power supply line.
The lowest noise level is about -126,5dB at 20kHz

# *Tests*

The second test was the noise performance at very low frequencies near to 0Hz, another important feature for SDR applications:

Test conditions:
- All analog inputs are unplugged, line input volume is set to maximum
- PC: HP XW4400 Workstation, WinXP SP3
- Software: HDSDR V2.1, I/Q input mode, RBW=11,7Hz vertical scale: 1dB/div from -100dB to -129dB
- sampling rate 96kHz / 24bit



The center peak level around 0 Hz are about -109 dB, maybe due a low filter capacitor for the ADC internal quiescent reference voltage.
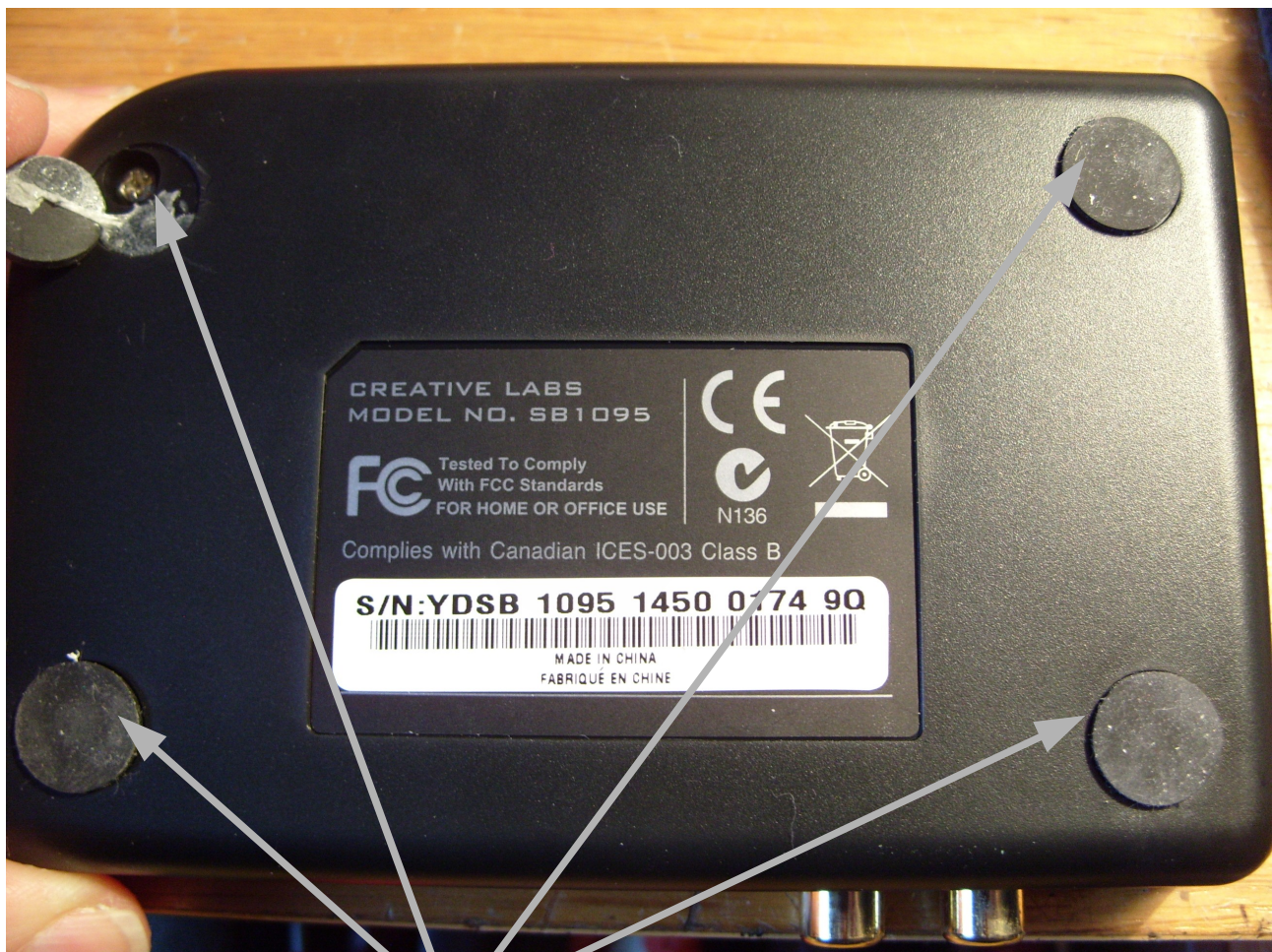
The spures (up to 9 dB above the noise floor) are probably caused by noise on the USB power supply line and can be vary from PC to PC. So i tried to find a solution to reduce these spures.

After some tries, i have found the origin of the spures: The power for the internal analog section (VA) of the ADC. **_High dynamic range ADC's needs a clean, low noise power supply_**.

# Noise&spures level improvement modification
## (and improvement of Power Supply Rejection Ratio)

(Important note: Any disassembly and/or modify of the unit will void the warranty!)
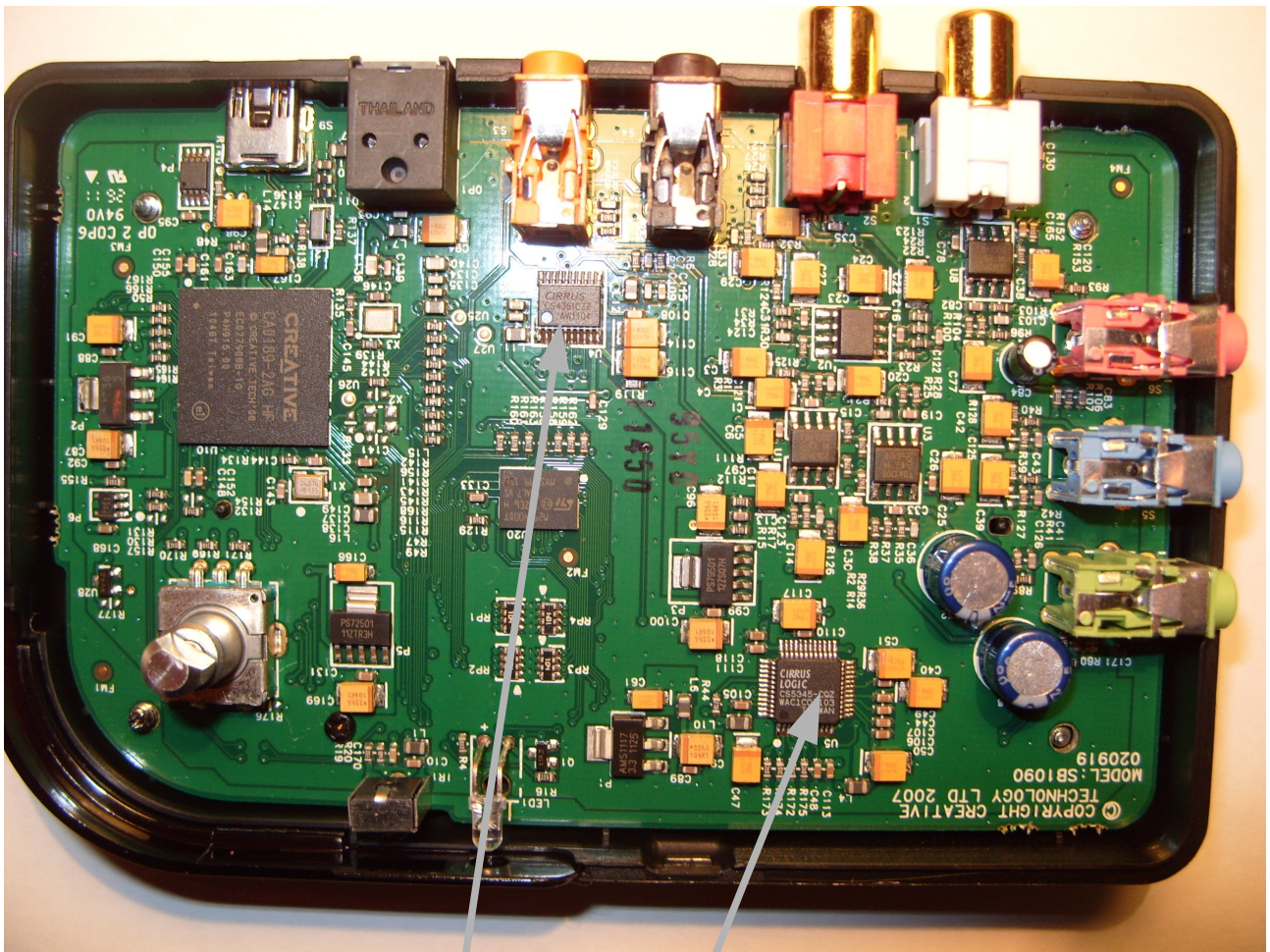
Disassemble the unit:

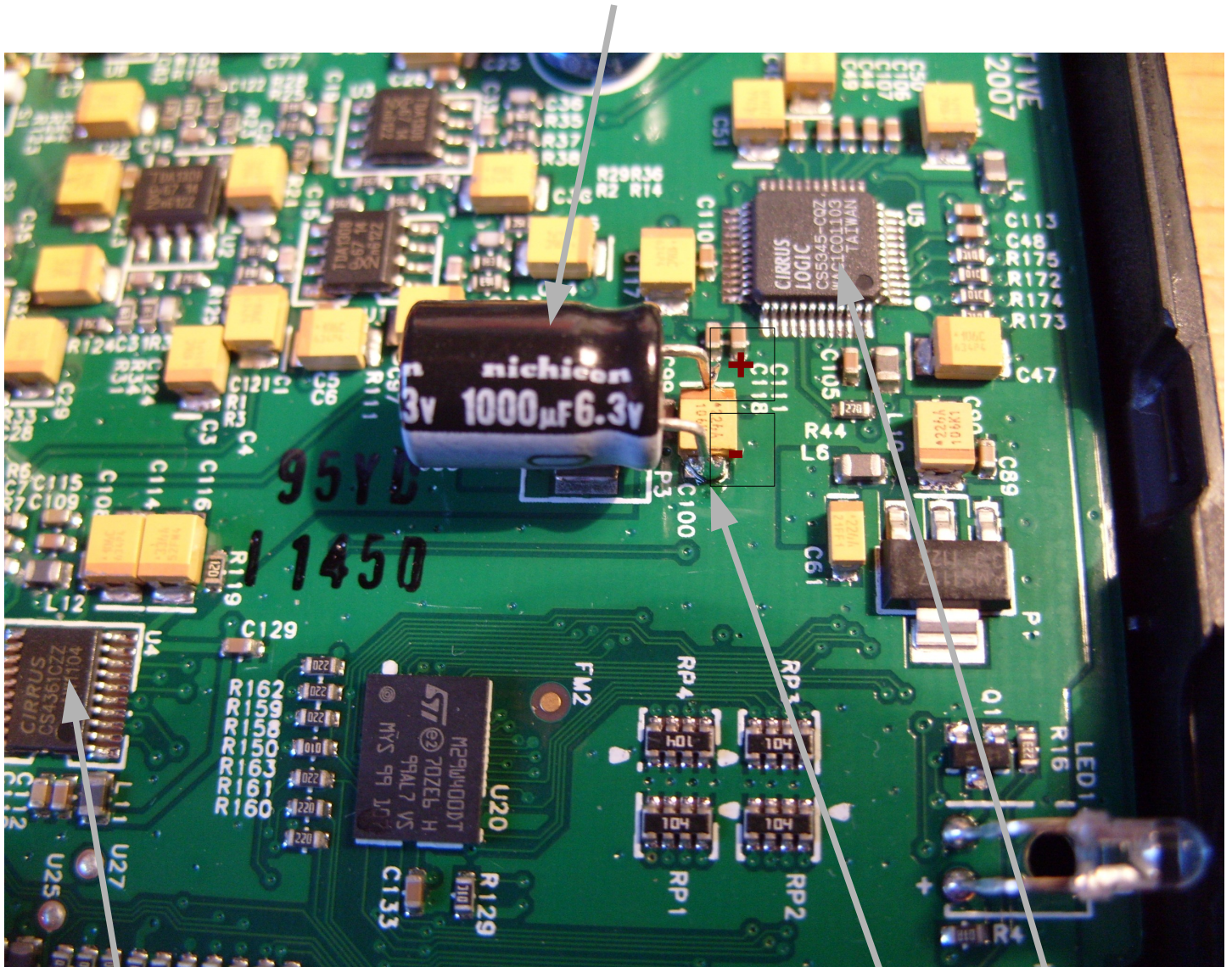1) Remove the pin's to get the 4 screws.

2) Remove carefully the top cover with the knob:



DAC          ADC

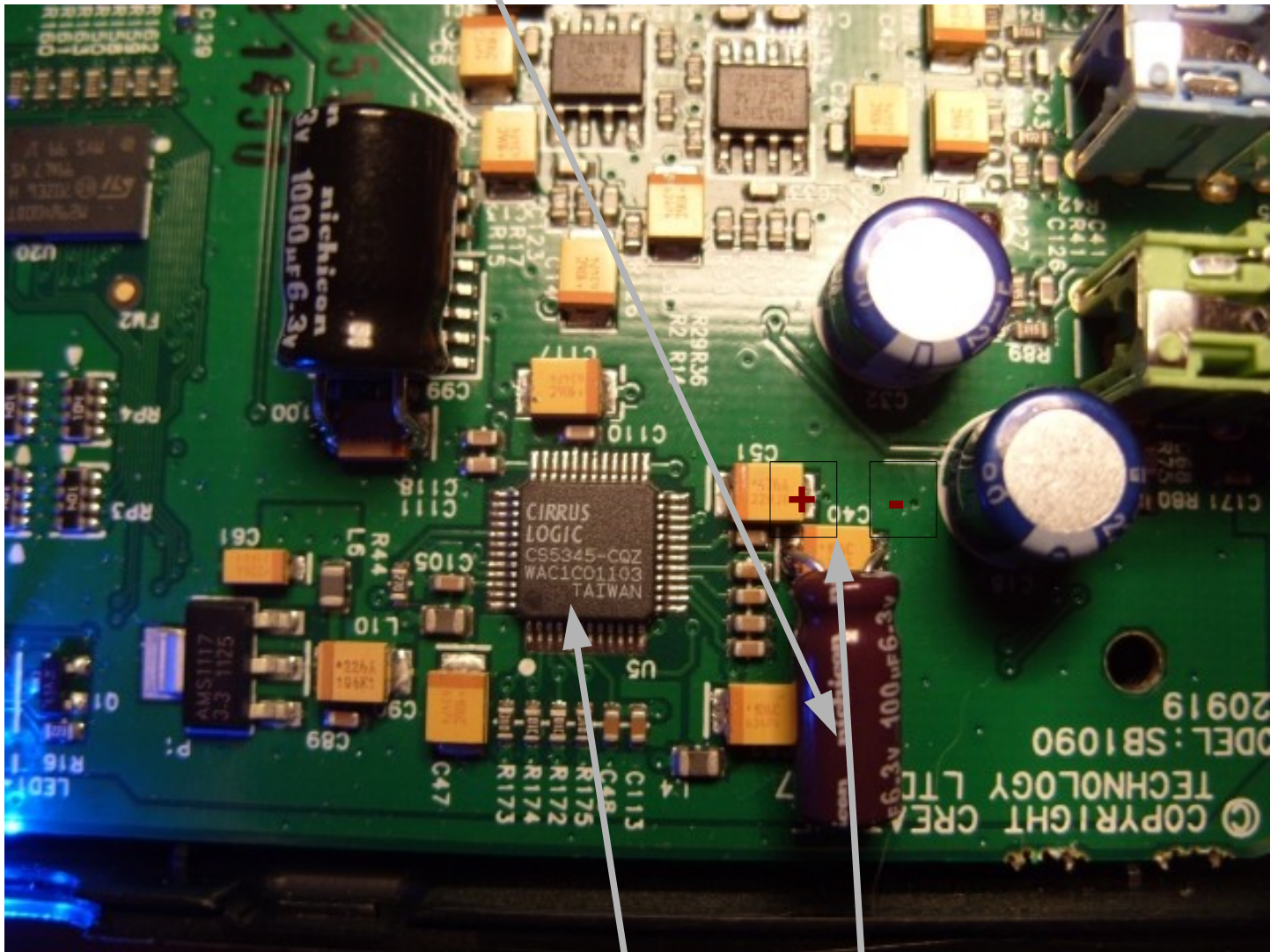3) Add a polarized capacitor (1000 uF/ 6,3V) across C100:



DAC

ADC

C100

Note: Yes, i know that a huge capacitor (1000 uF) cause a high current peak at power on. However, this does not seem to be a problem in this case...;)

4) Add a polarized capacitor (100 uF/ 6,3V) across C40:
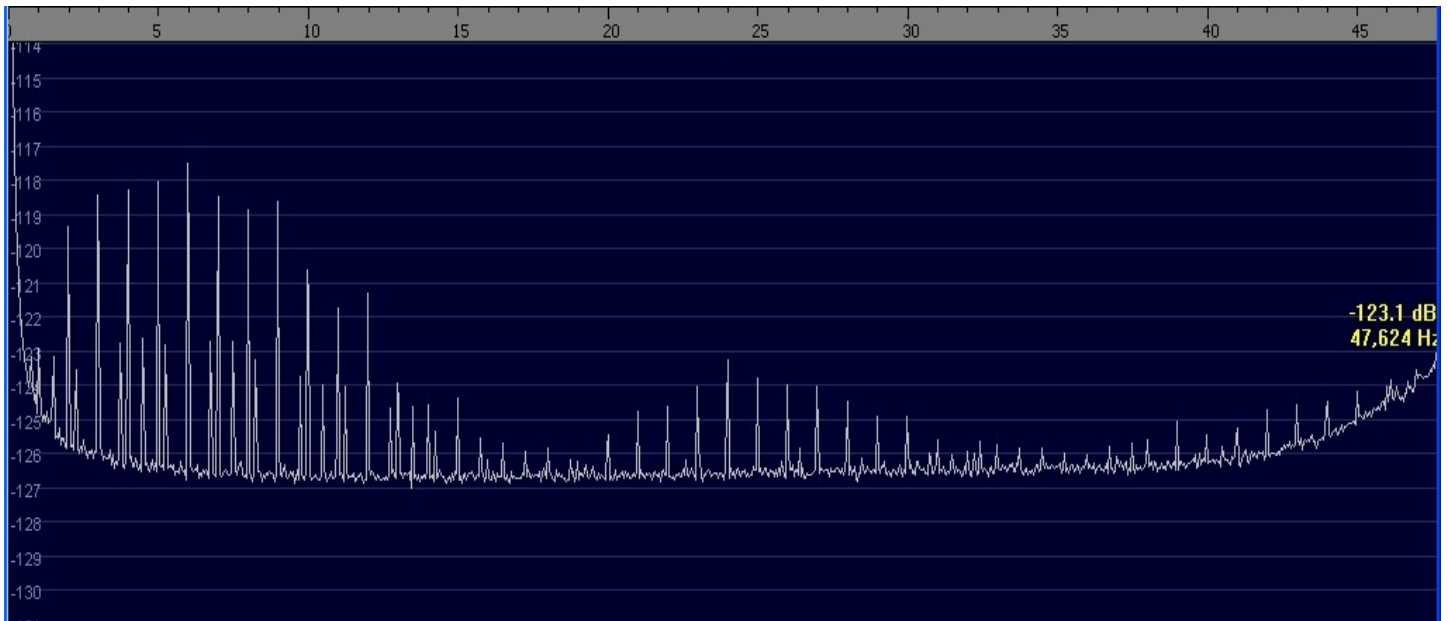


ADC

C40

(9/5/2012) Note: This additional capacitor improve the filtering for the ADC internal quiescent reference voltage, to reduce the noise at very low frequencies.
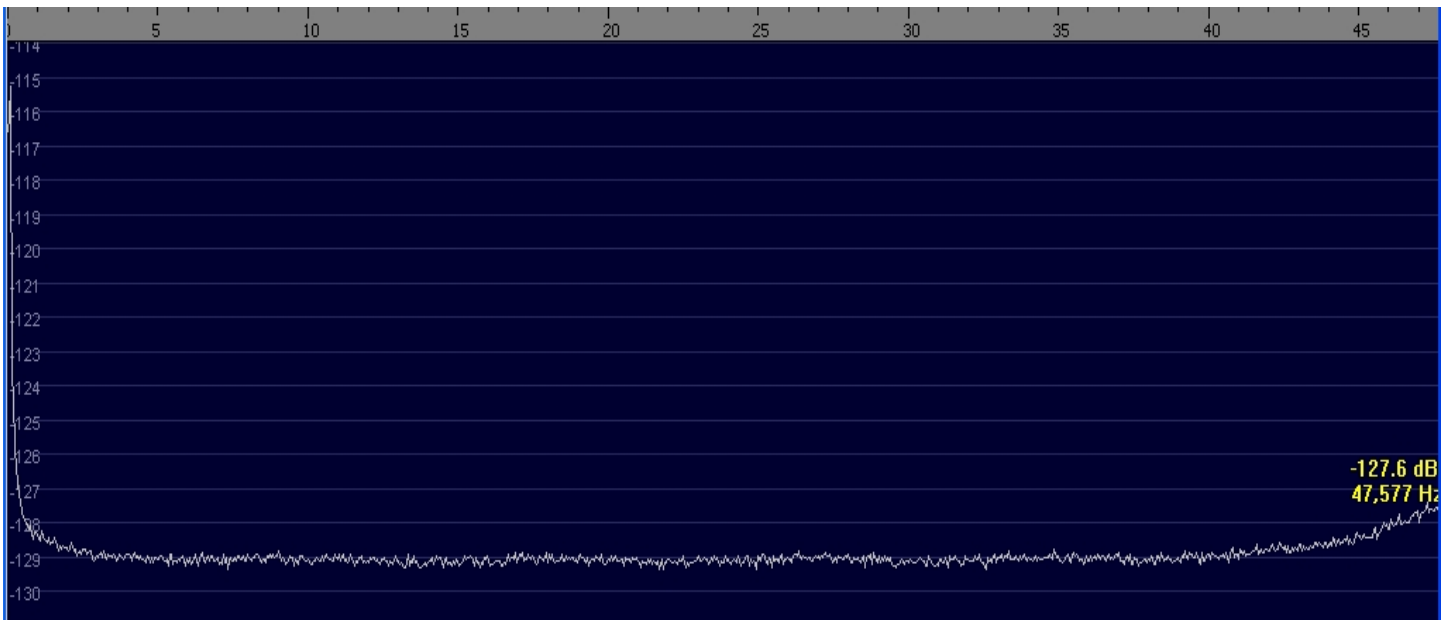
# *Modification results*

The results after the modification are noticeable:
All spures are eliminated and the whole noise level are reduced about by 2,5dB and more (below 2kHz and above 45kHz)!
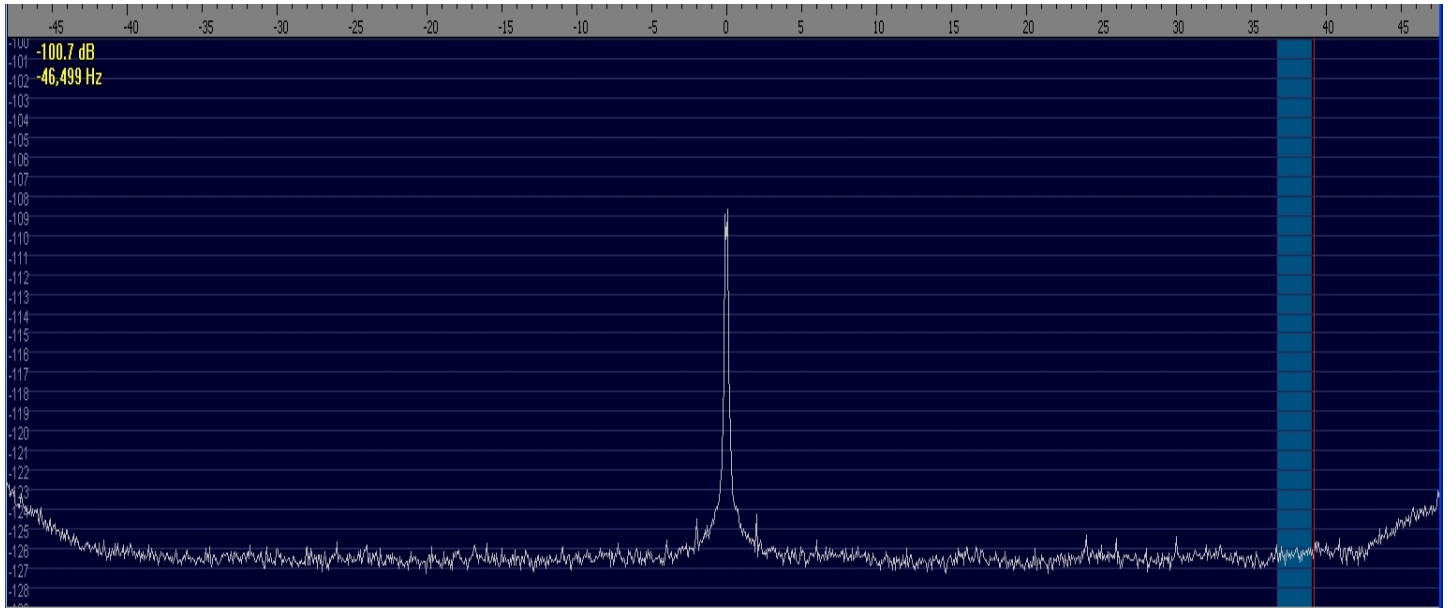
Before modification:



After modification:
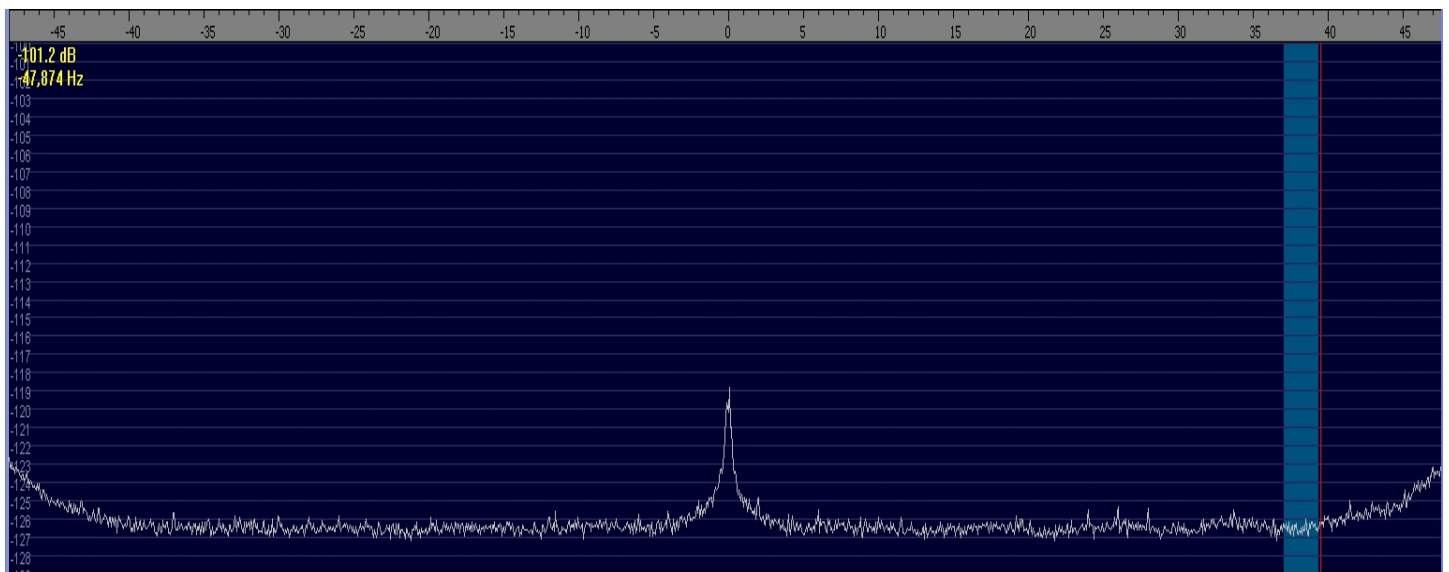
# *Modification results*

Also the result after the modification to increase the filtering for the ADC internal quiescent reference voltage are noticeable:
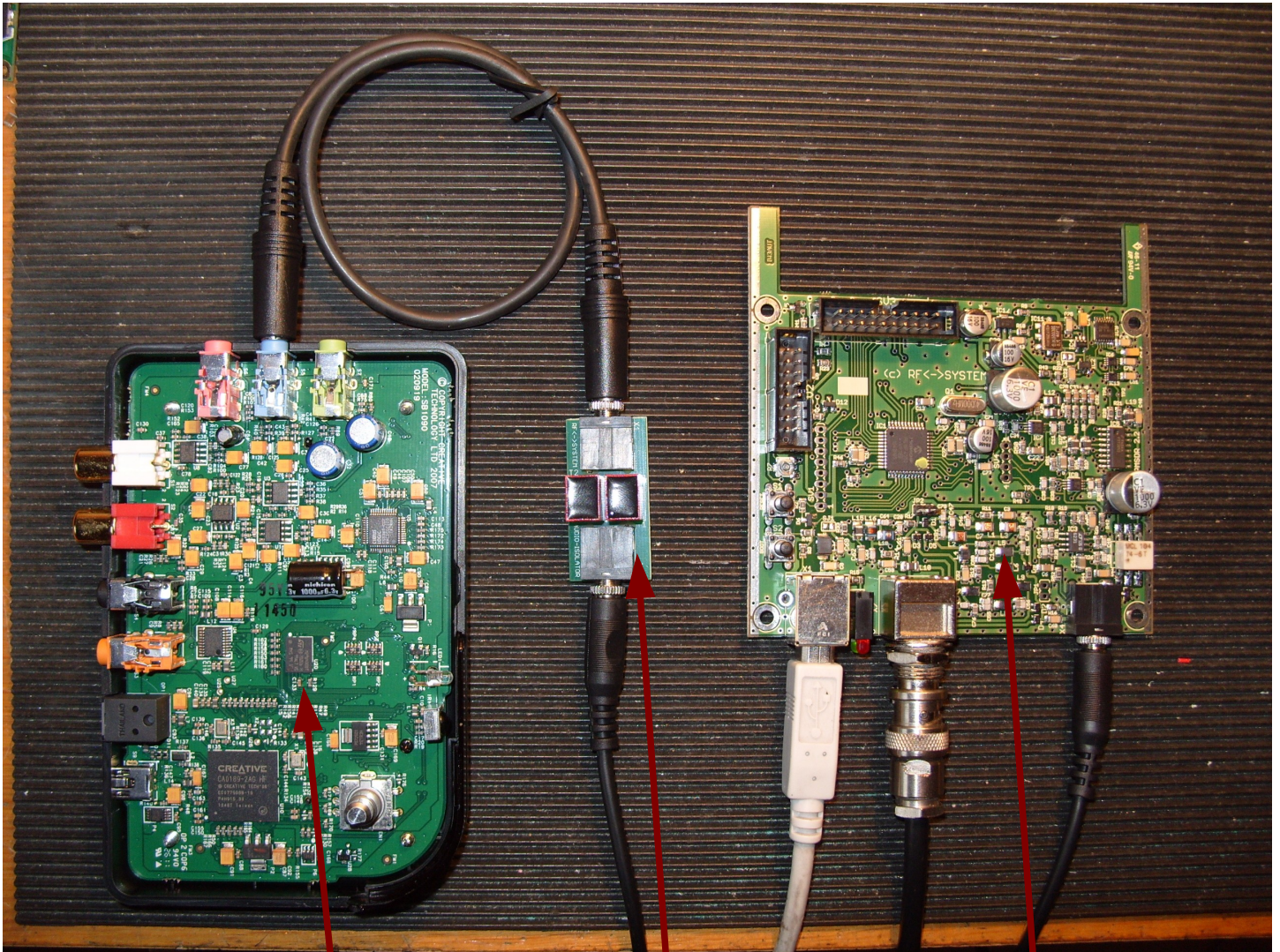The center noise peak was reduced by 10dB!

Before modification:



After modification:

# *Test of a Sound Blaster X-Fi Surround 5.1 Pro on a "PMSDR" SDR-receiver*

Test setup:

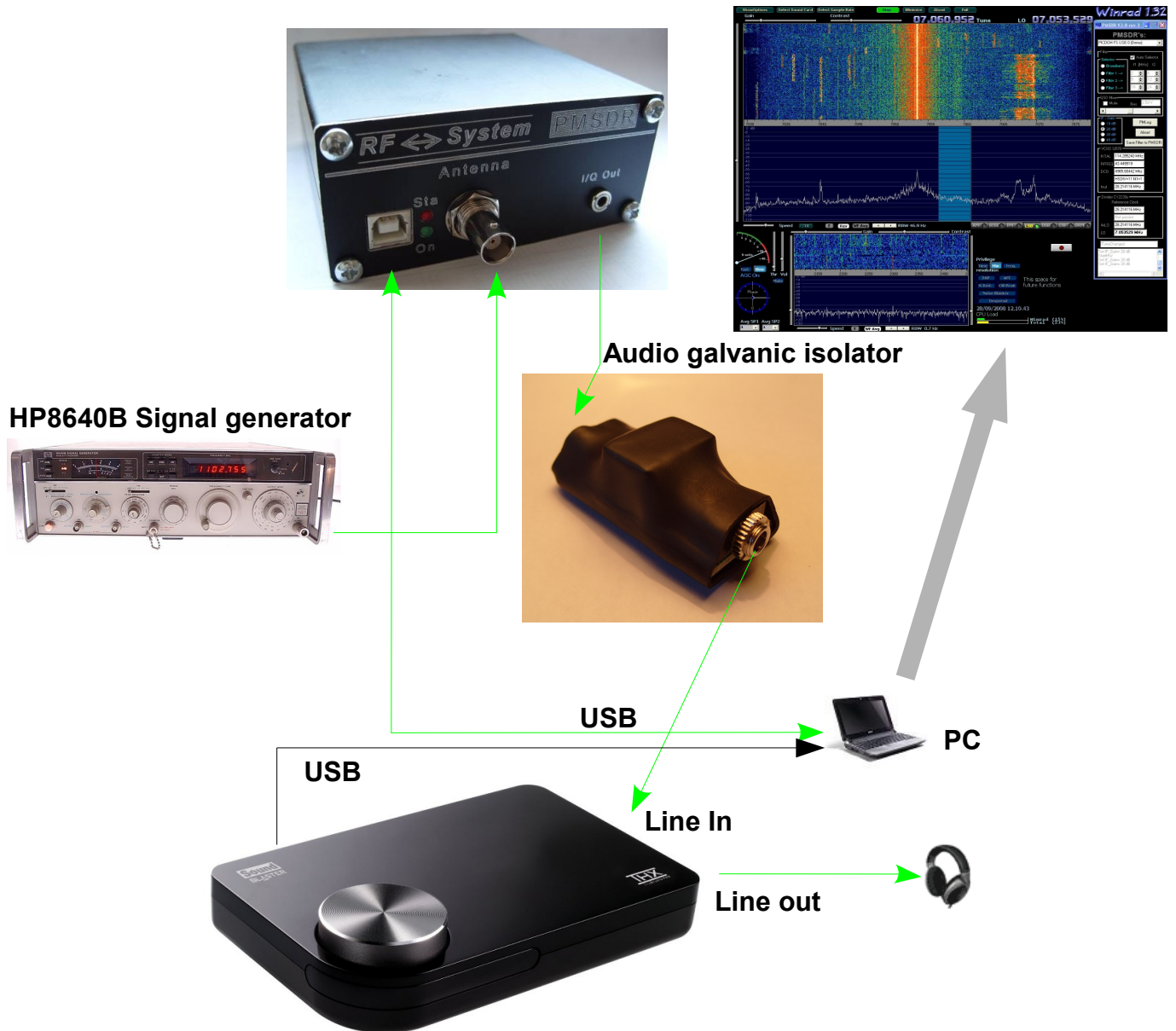

Sound Blaster X-Fi Surround 5.1 Pro

Audio galvanic isolator (RF-SYSTEM)

PMSDR-receiver

To avoid ground loops between sound interface and receiver, i suggest to use a audio galvanic isolator between the sound interface and receiver I/Q-output.

# Test of a Sound Blaster X-Fi Surround 5.1 Pro on a "PMSDR" SDR-receiver

Test setup overview:



**Audio galvanic isolator**

**HP8640B Signal generator**

**USB**

**USB**

**PC**

**Line In**

**Line out**

# *Test results*

Test conditions:
- Input device:Sound Blaster X-Fi Surround 5.1 Pro, Line input volume is set to maximum
- PC: HP XW4400 Workstation, WinXP SP3
- Software: HDSDR V2.1, RBW=11,7Hz sampling rate=96kHz, vertical scale: 5dB/div from -130dB to 0dB

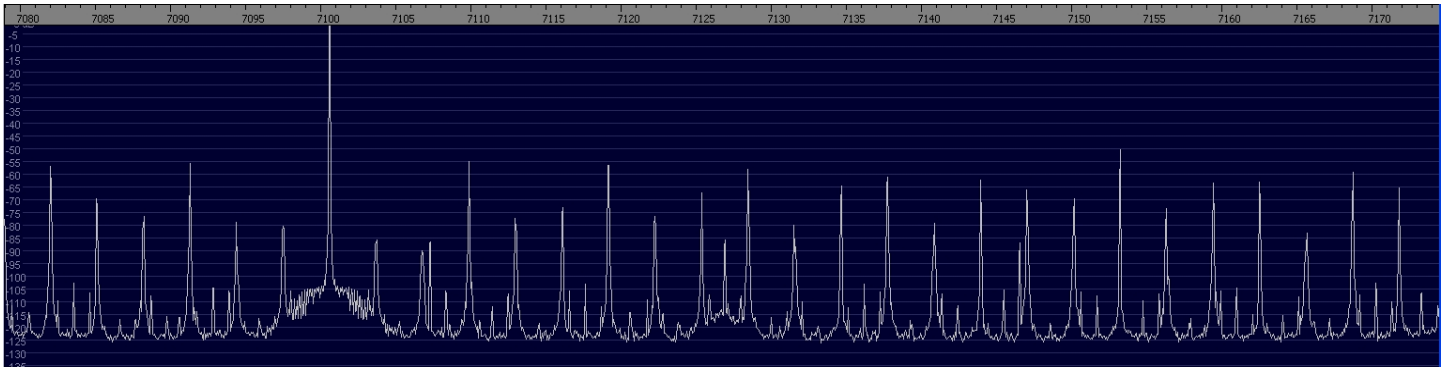**Test 1**: HP8640B Signal generator out: 7100 kHz, level=-130dBm

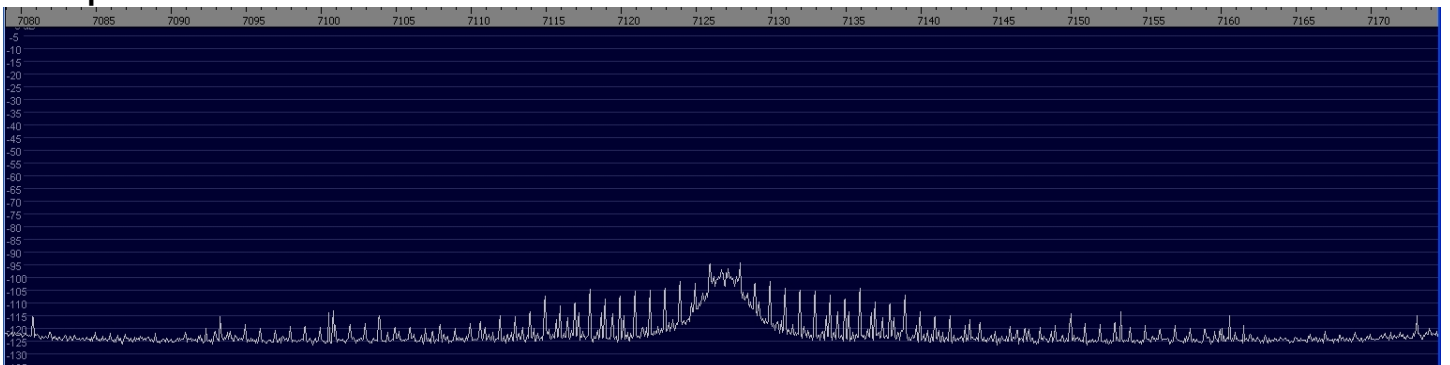**Test 2**: HP8640B Signal generator out: 7100 kHz, level=-17dBm

# *Test results*

**Test 3**: HP8640B Signal generator ou: 7100 kHz, level=-16dBm
The A/D converter input goes to "overloading" or clipping under strong signal conditions: in this case a input level of 1,4Vp. This is the maximum input level if the line input volume is set to maximum:
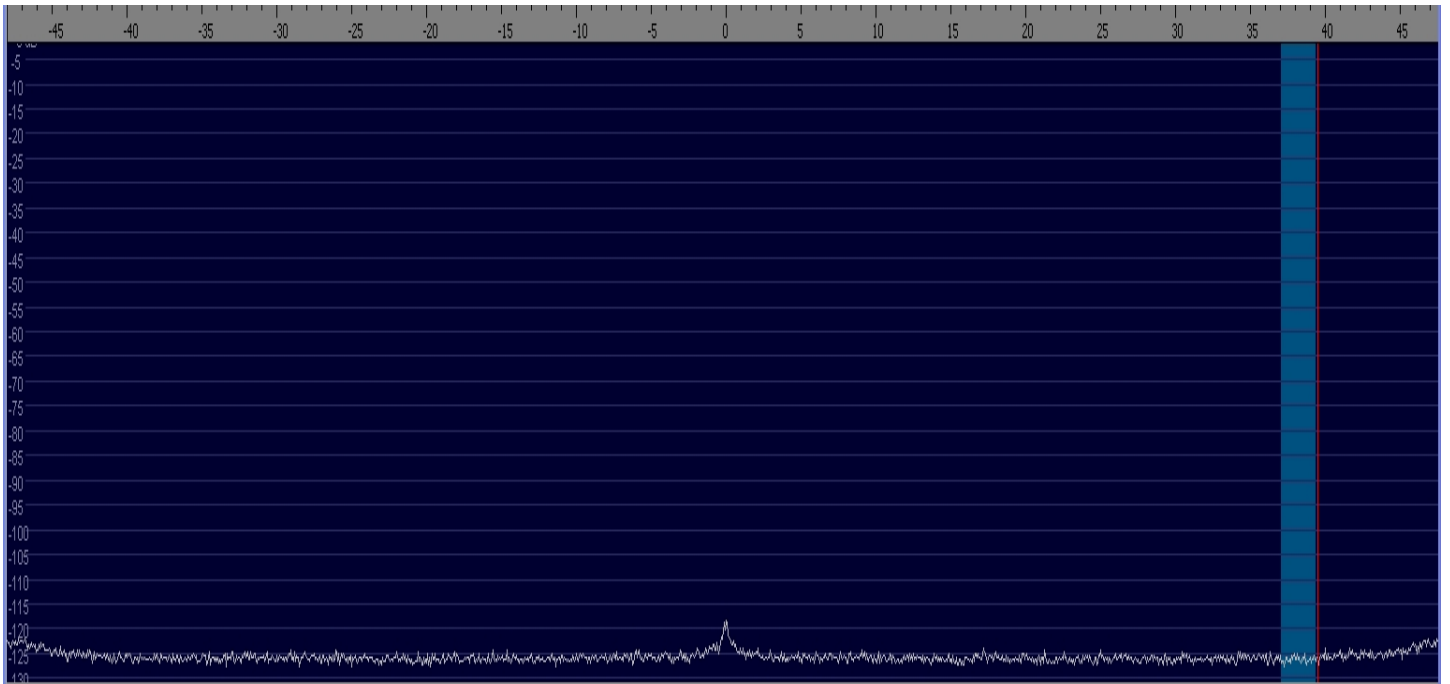


**Test 4**: HP8640B Signal generator out: 7100 kHz, level=-130Bm
This test was made <u>without</u> the Audio galvanic isolator between the PMSDR I/Q-Output and the Sound Blaster X-Fi Surround 5.1 Pro Line-IN. Many spures and noise are present due ground loops:

# *Conclusions*

Full scale noise floor after modification:



The modified Sound Blaster X-Fi Surround 5.1 Pro shows a very clean spectrum. The above described results can slightly vary between boards.

**I reccomend to install and use the audio driver from CREATIVE LABS for MS Windows, which offer a better result and permit also to use the virtual audio device "X-Fi Surr 5.1 Pro What U Hear": This audio device is very useful with digital modes decoding programs (MixW, MTTY, MULTIPSK, Dream) instead of a VAC (Virtual audio cable) to feed the audio output from your soundcard to the input of another software.**

For my opinion, this sound interface have a very good cost to performance ratio, especially for SDR applications. Furthermore it's also suitable to use with netbooks/notebooks and small to put it in their bags.

The already modified and tested Sound Blaster X-Fi Surround 5.1 Pro are available by RF SYSTEM www.rfsystem.it