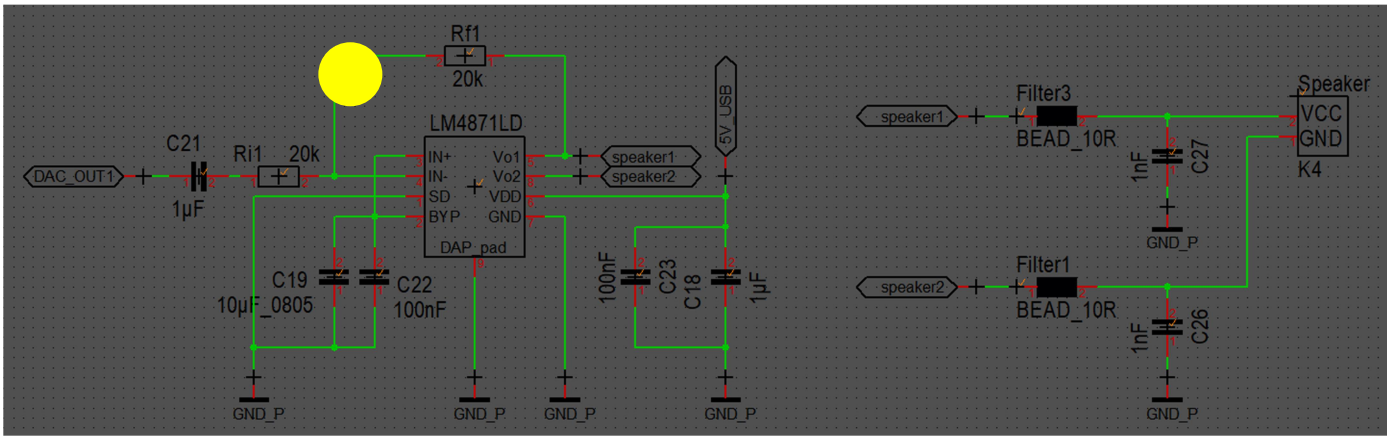
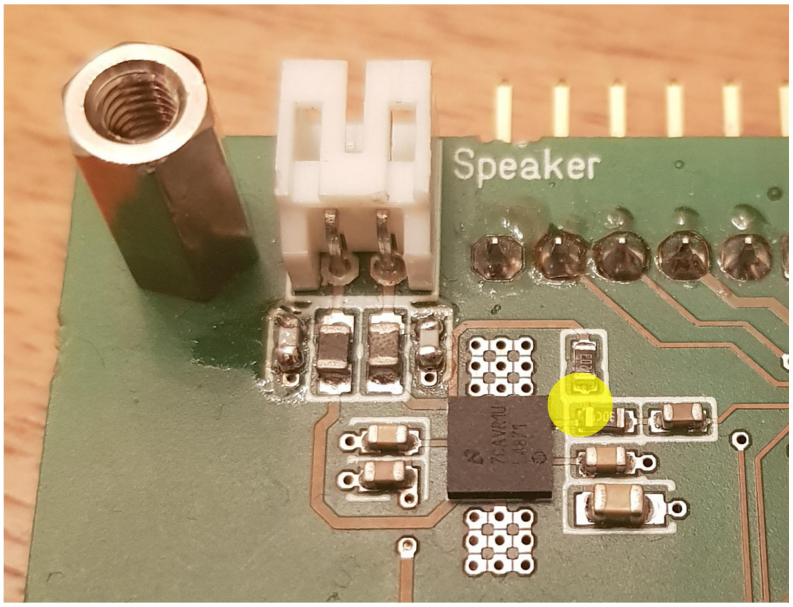
LM4871 noise analyze 2021.04.23

1. Current design analyze regarding noise
2. Further design check regarding remaining noise
3. General Layout improvement

1. Current design analyze regarding noise



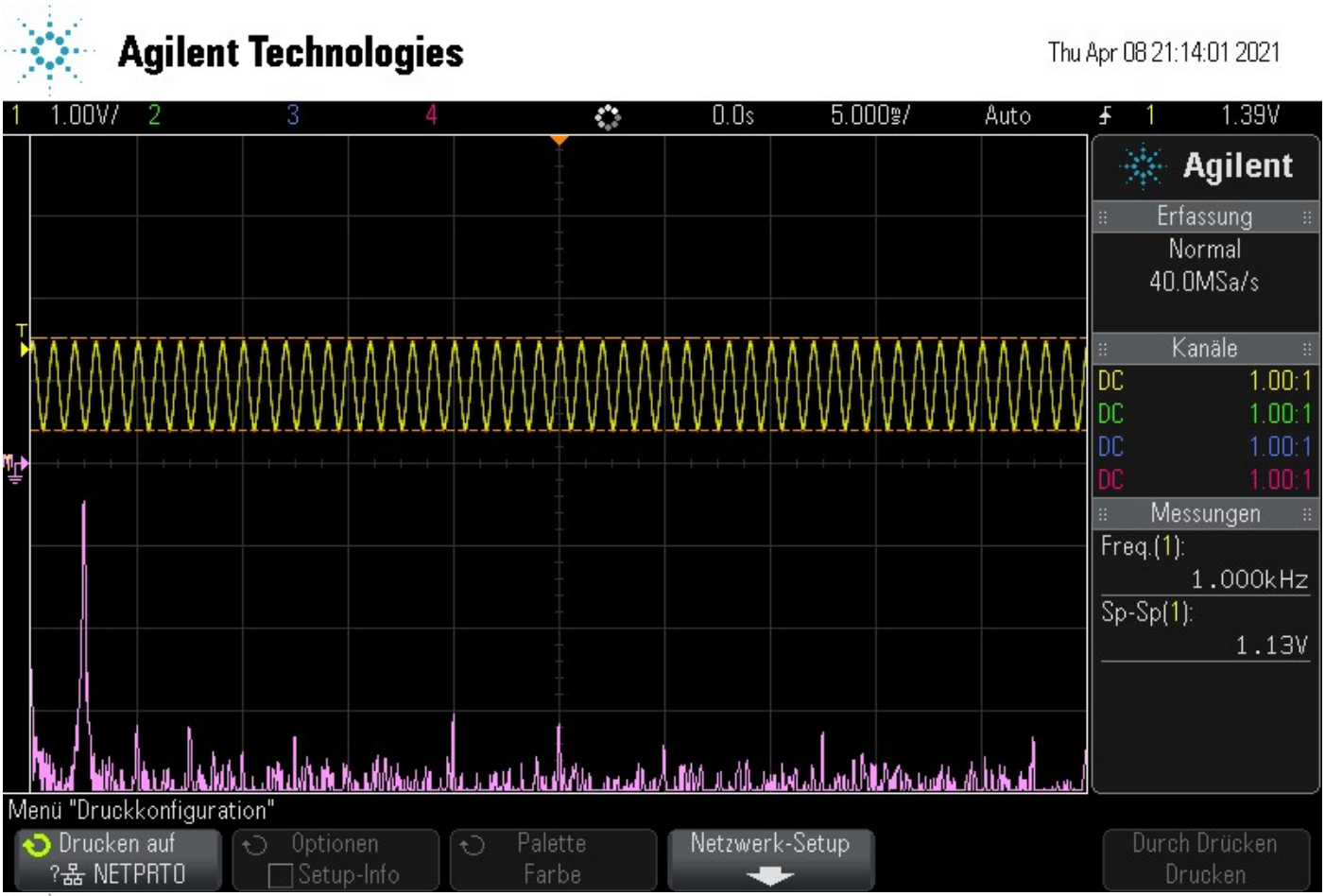
(current design for the LM4871 on all PCBs)

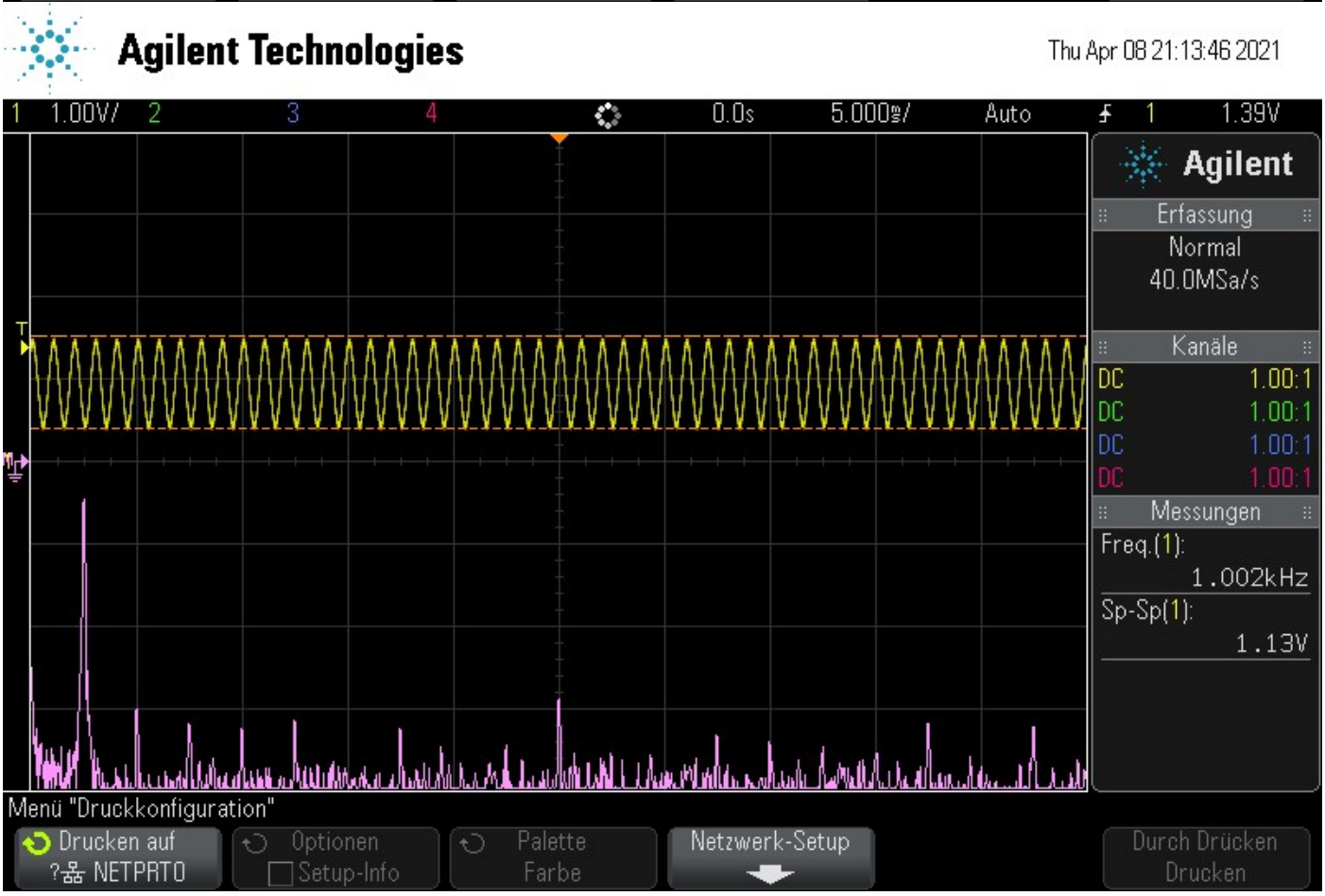


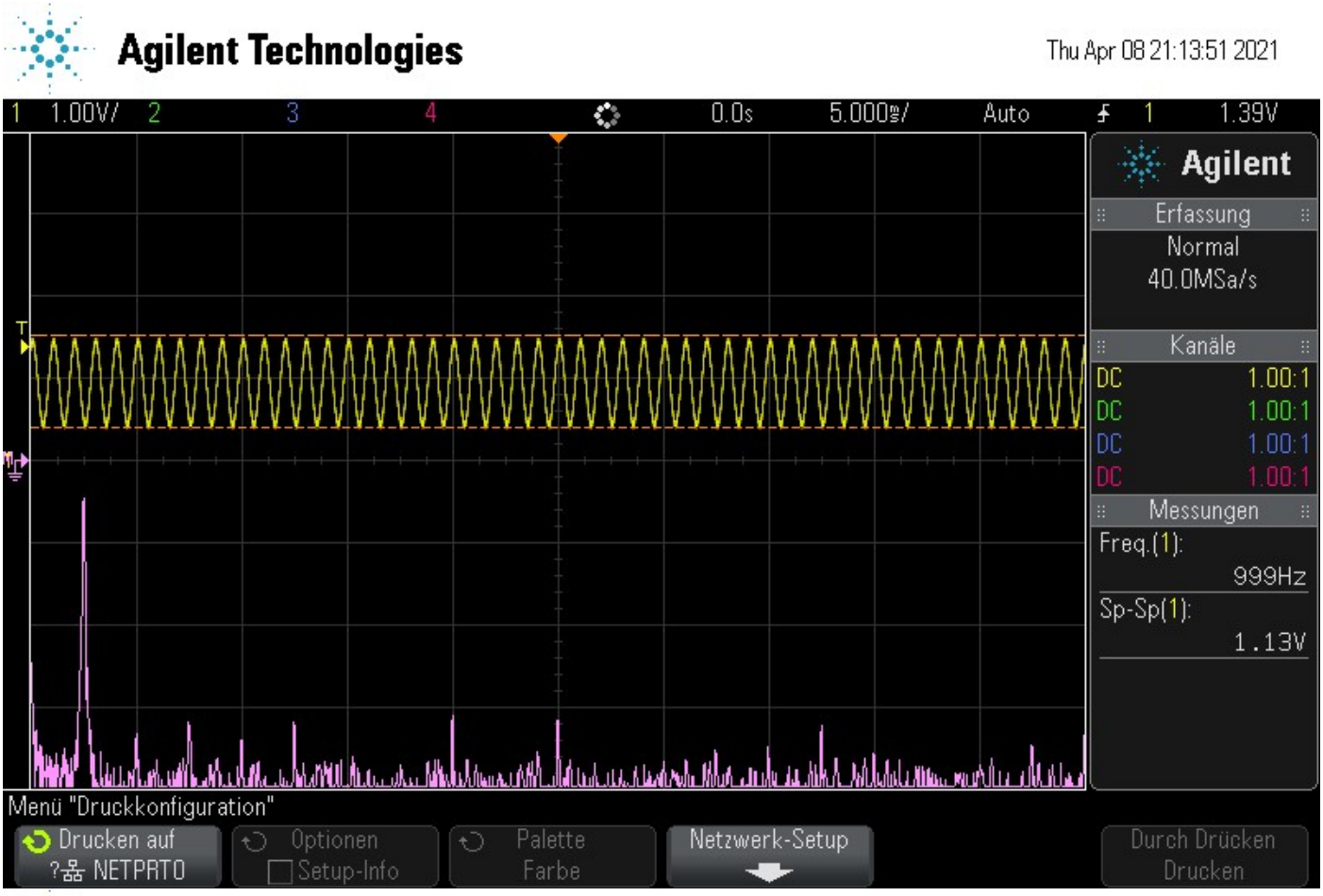
(PCB example)

Starting point:
A STM32F405 reads data from wav-files of a µSDcard and applies the voltage over the internal 12bit DAC to the LM4871. The sound output is overlain by a “scratchy” noise.
The shown schematic is used on different PCBs. Some show that noise and others do not show that noise.
Touching the yellow marked area on the PCB removes the noise almost completely.

Frequency analyze:
The STM32 was off and a 1kHz Signal was attached to the input capacitor C21 of the audio amplifier. Yellow shows the input signal and pink the FFT measured on the speaker pins (y: -20dB/div, x: 2kHz/div).






Agilent Technologies
Thu Apr 08 21:13:51 2021
1 1.00V/ 2 3 4 0.0s 5.000s/ Auto 1 1.39V
Agilent
Erfassung
Normal
40.0MSa/s
Kanäle
DC 1.00:1
DC 1.00:1
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Messungen
Freq.(1):
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Menü "Druckkonfiguration"
Drucken auf NETPRTO
Optionen
Setup-Info
Palette Farbe
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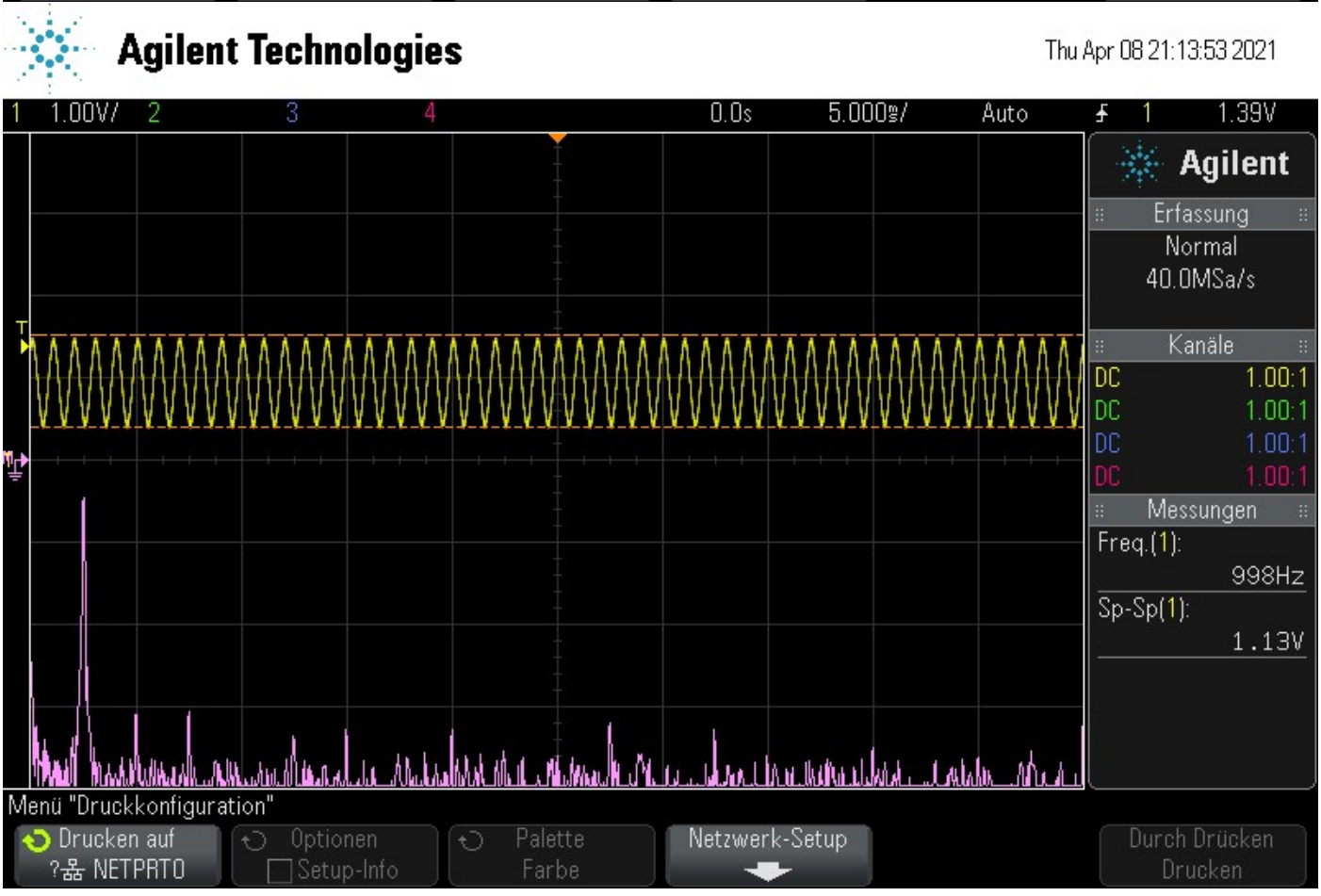
Durch Drücken Drucken


Agilent Technologies
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1 1.00V/ 2 3 4 0.0s 5.000s/ Auto 1 1.39V
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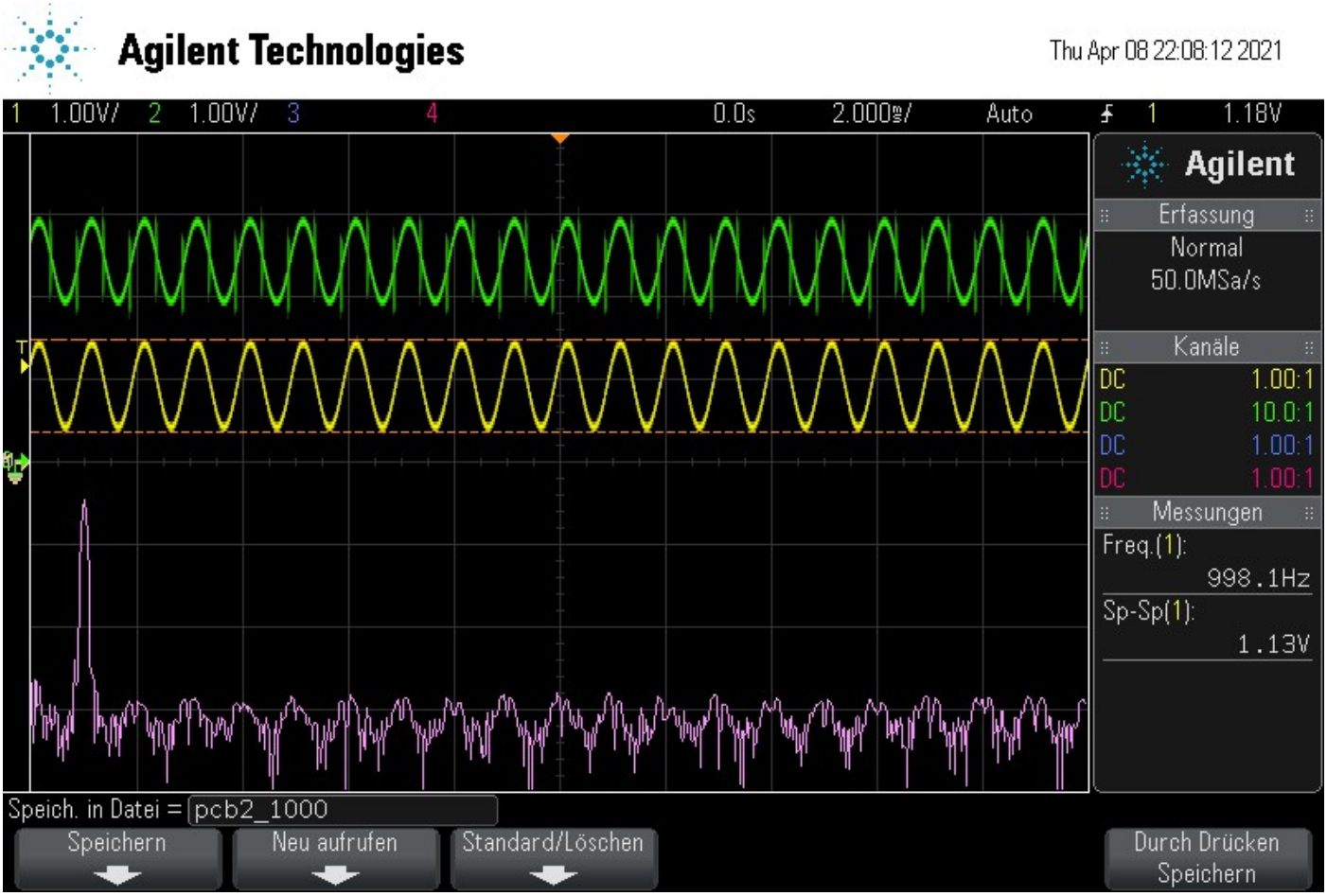
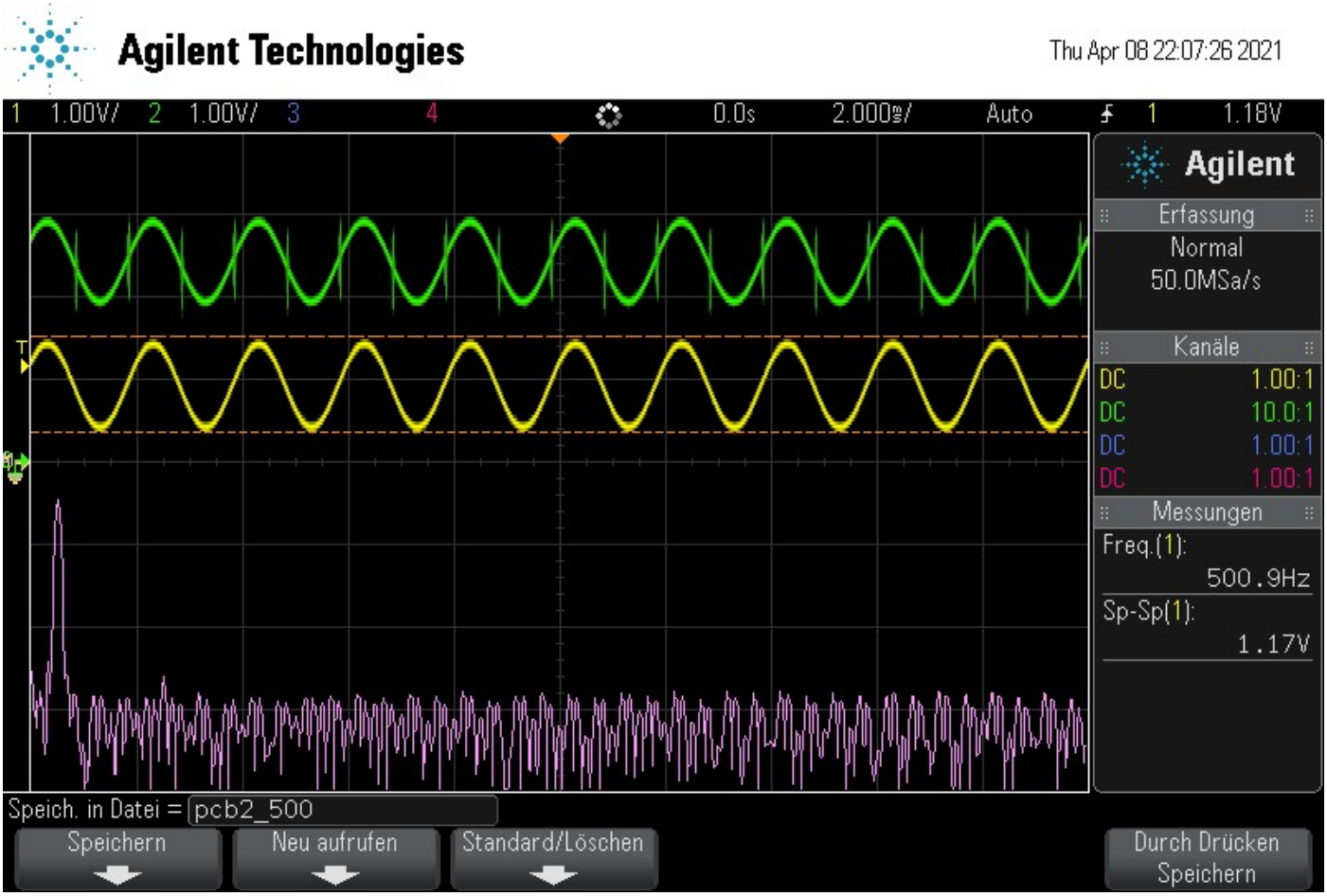
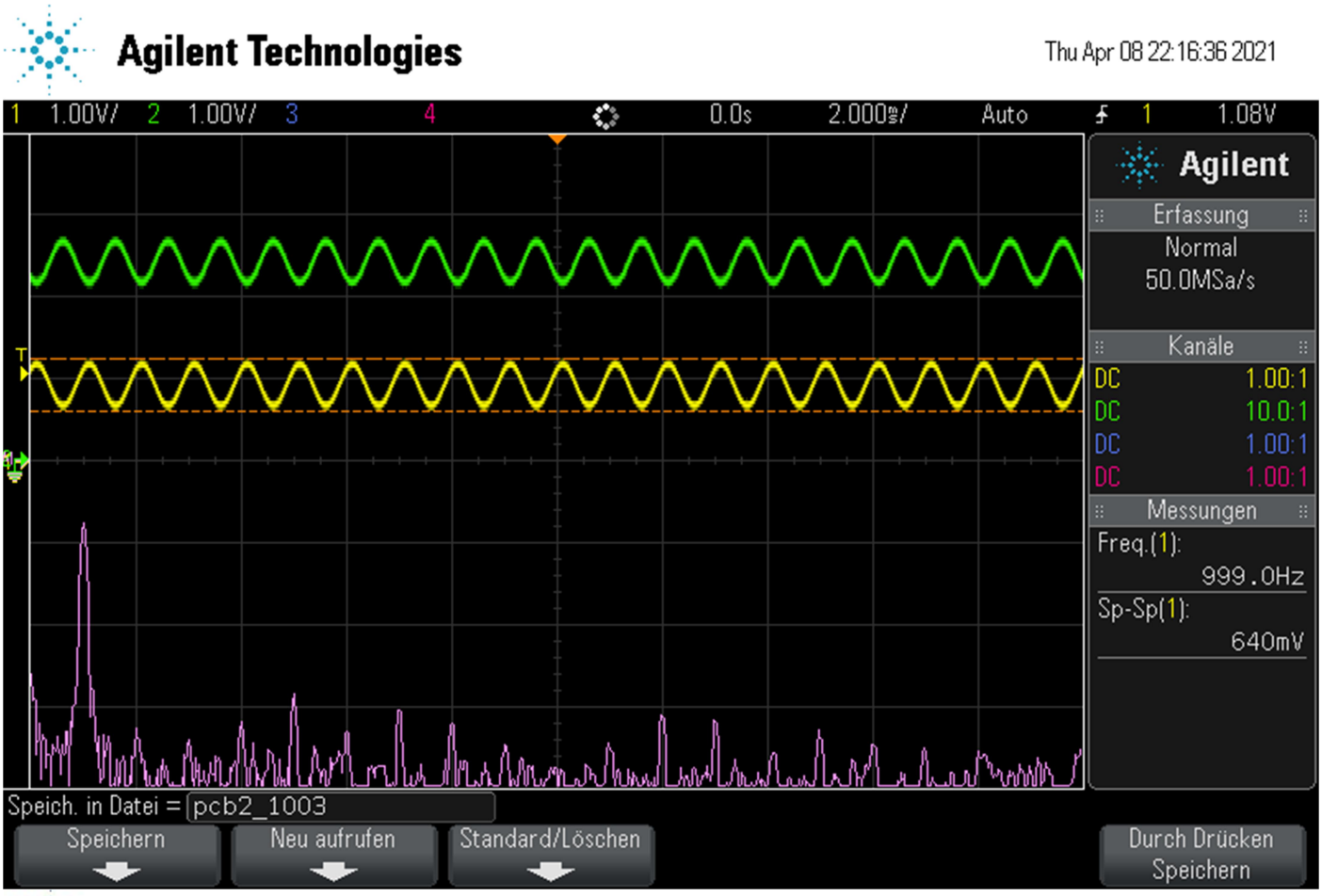
Green shows the output signal on the speaker pins. The noise shows up on every zero-crossing.

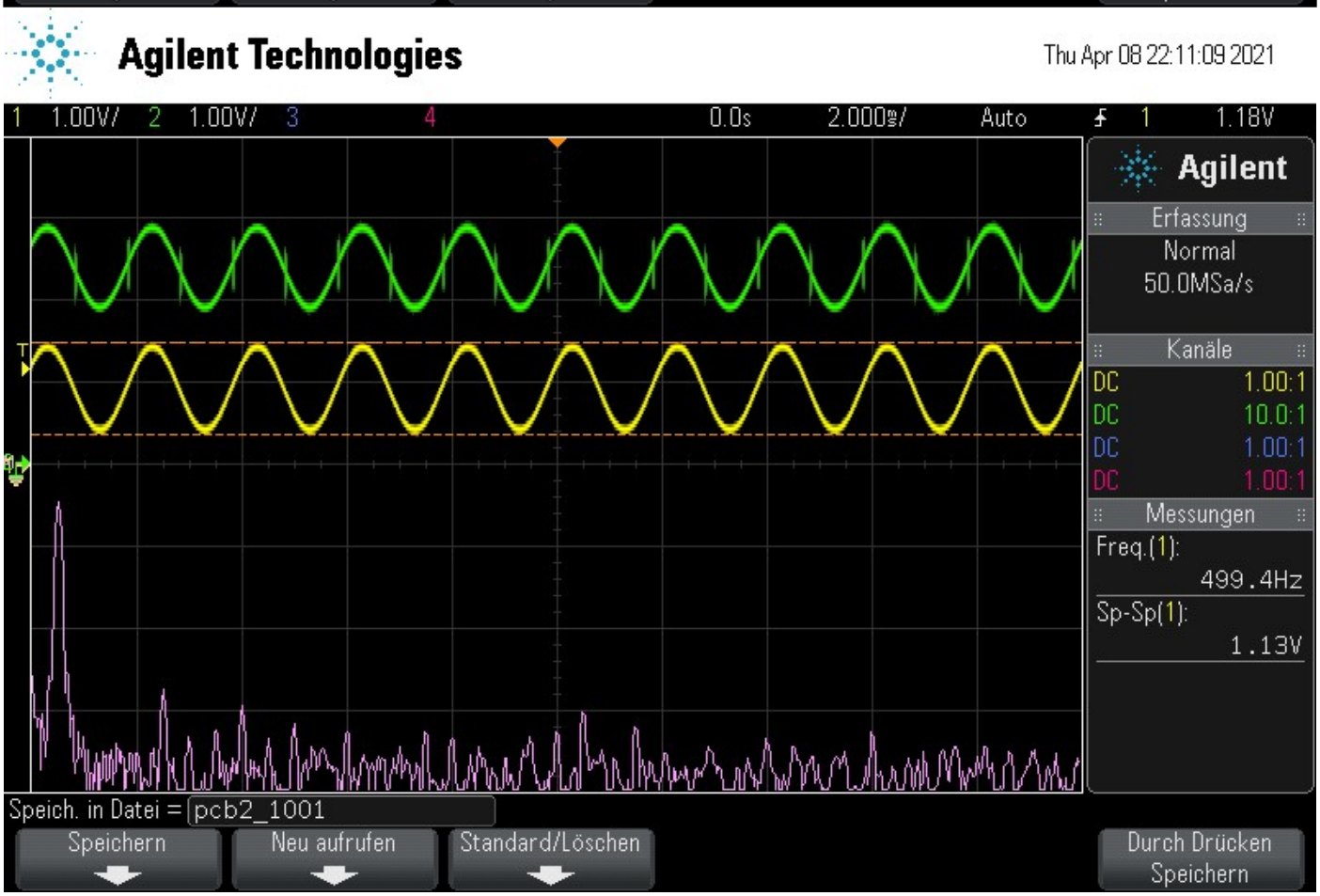


The same behavior with a 500 Hz input signal.

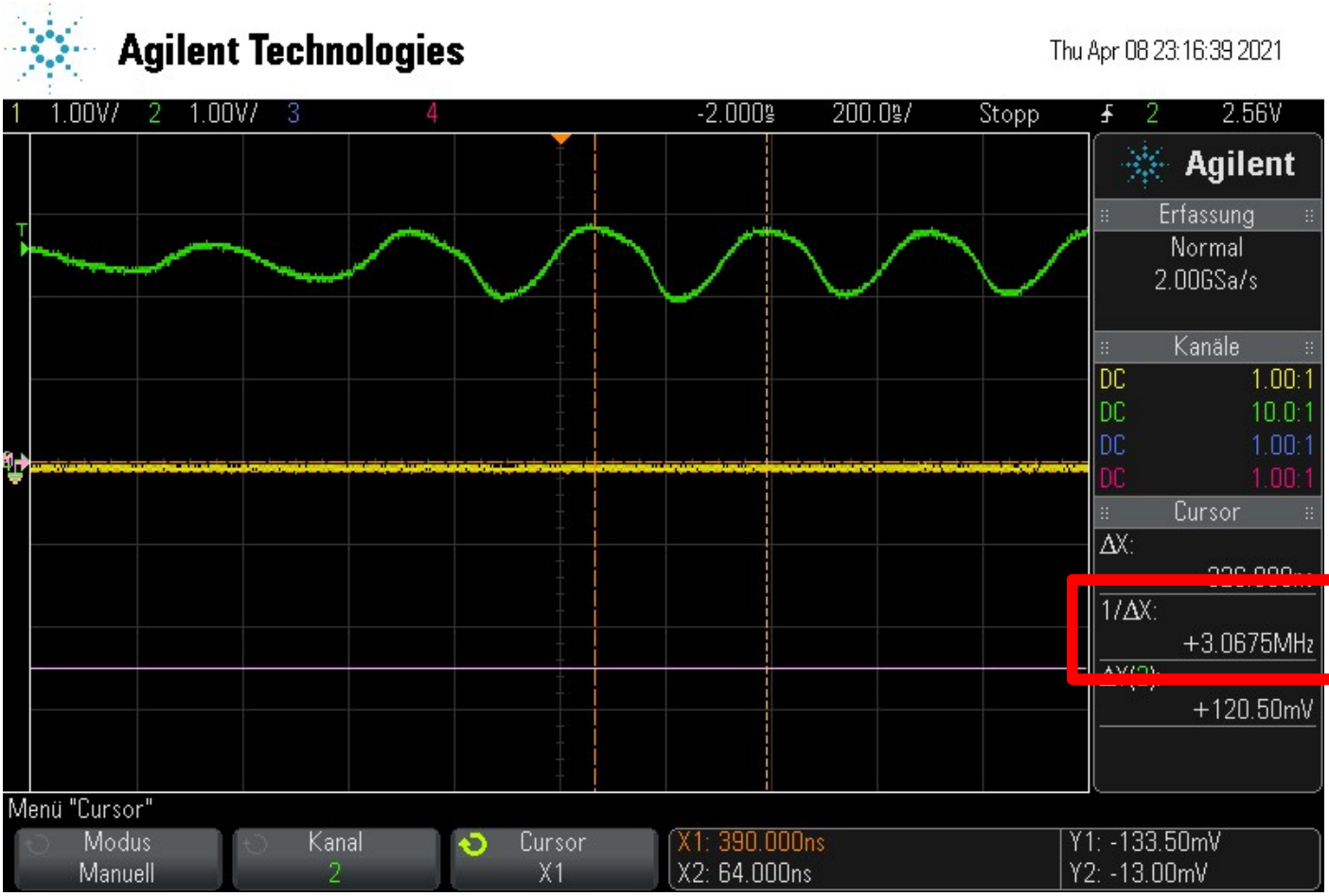


The noise disappears/decreases when the yellow marked area (see schematic and PCB picture) is touched. The noise intensity depends on the finger pressure on the PCB, more pressure results in less noise.

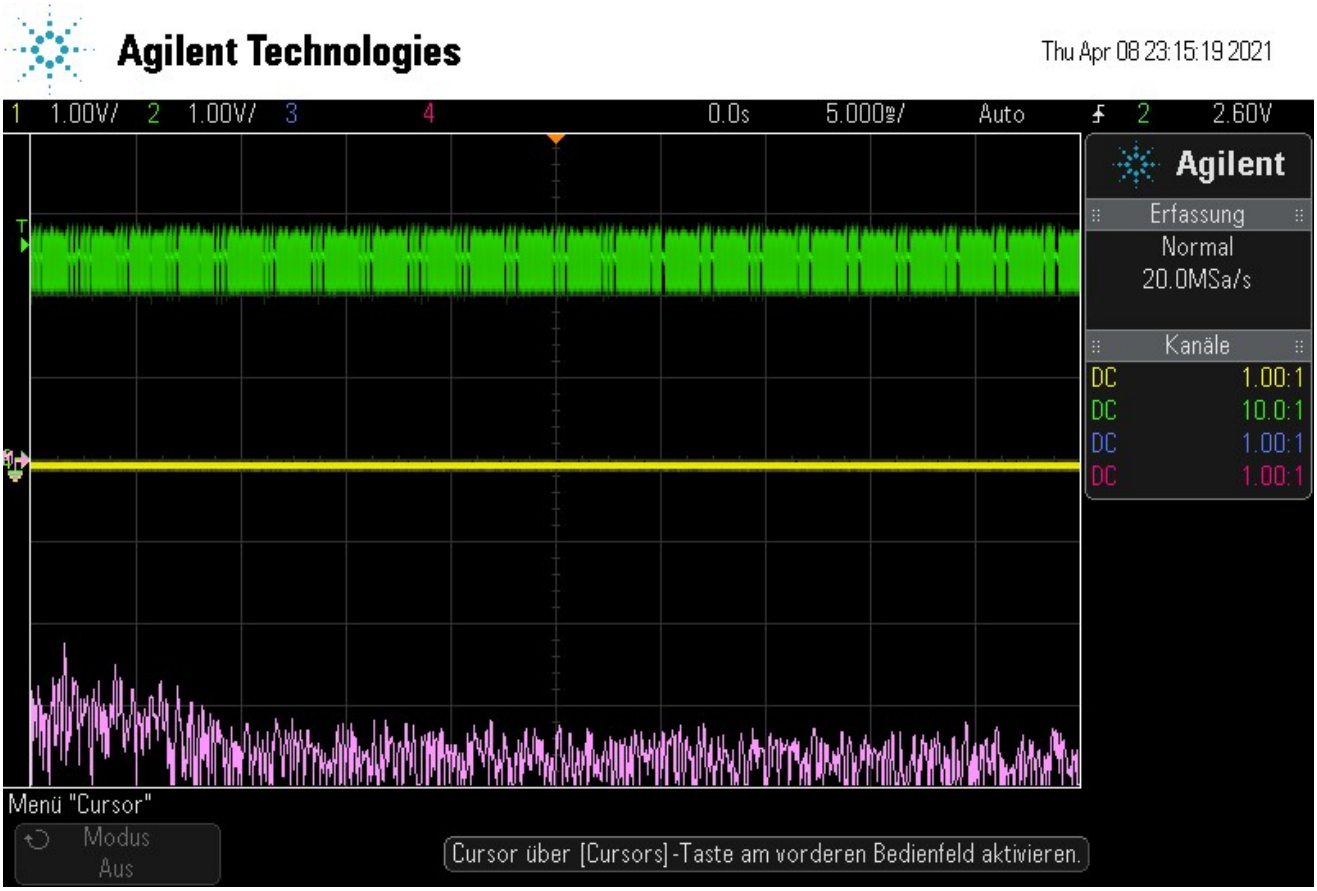




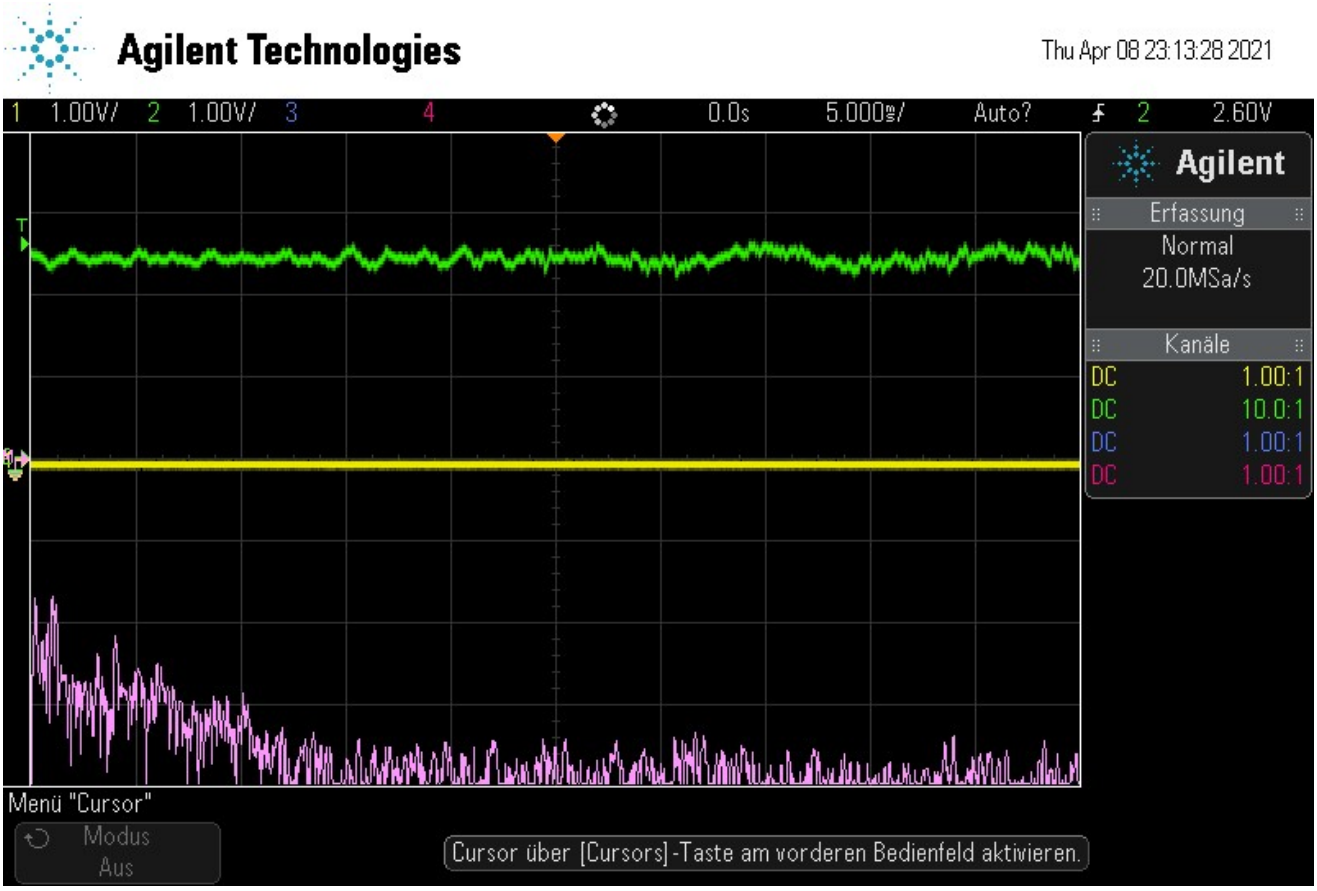
The periodic noise has a frequency of about 3 MHz, when zoomed into the noise peaks.



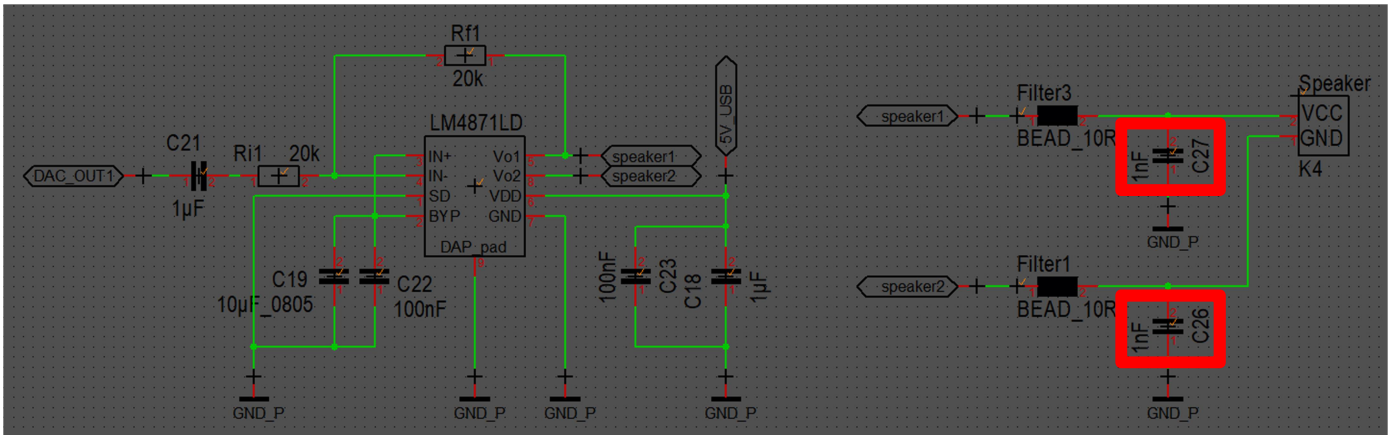
When playing a real sound file (ACDCs *highway to hell*) via the DAC of the STM32 the behavior is the same. Noise overlays the sound output.



It is removed/decreased when touched with the finger:



Further analyze and solution:
The noise disappears completely when the two red marked capacitors are removed. The right part of the schematic (beads and capacitors) was found on some sources on the internet to “improve the audio output”. As mentioned in the LM4871 datasheet an additional improvement is not needed but we thought it would be good. It was not unfortunately…
Can you give some more insight why this behavior may occur?



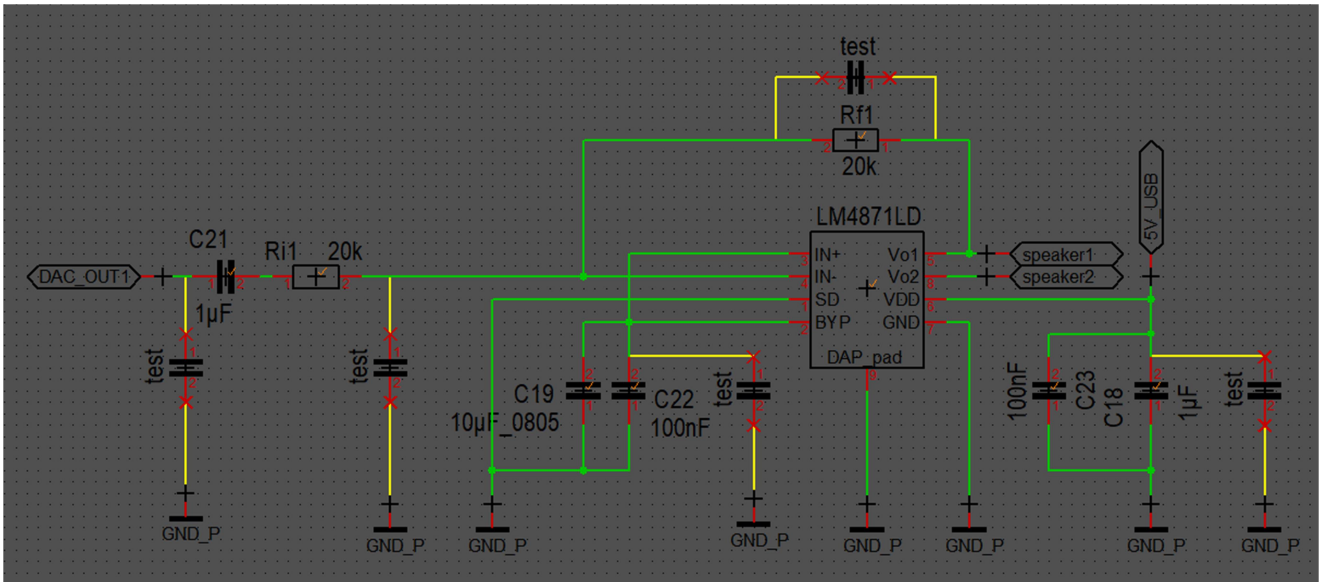
When the two marked capacitors are removed the sound quality improved on all PCBs with the LM4871.

2. Further design check regarding small remaining noise
The main noise problem is solved, but we recognized that there is still some small scratchy sound left when you are close to the speaker with your ear when the audio output signal of the STM32 is forced to constant 1650mV (VCC/2 = mean sinus).

Replacing the remaining beads with 0R resistors has no effect.

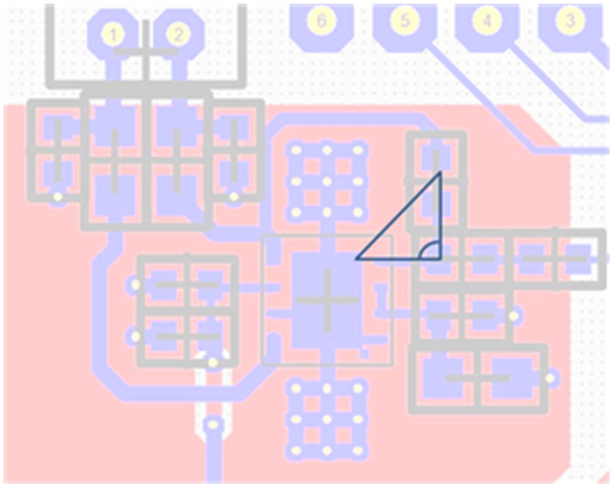
We placed some additional capacitors on various places around the LM4871 as shown in the picture. Only one “test” capacitor was soldered on the PCB at once. We tested 48pF and 680pF. Both values had no effect on the remaining noise. Is it possible that that remaining noise is generated internally by the LM4871?

When the sound volume is increased, the remaining noise remains constant (it is not amplified). When sound is played and the volume is loud enough the remaining noise is inaudible.



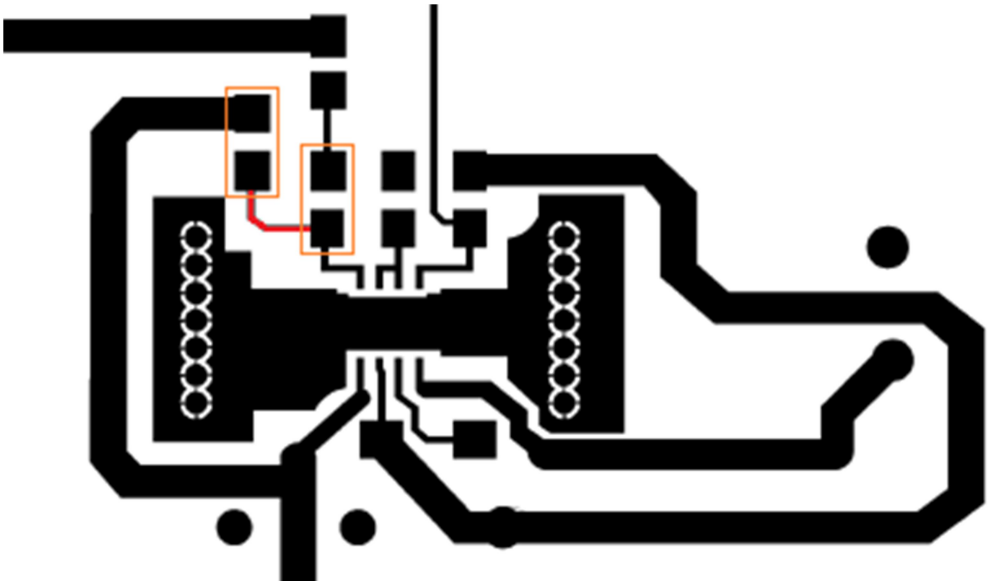
3. General Layout improvement

You mentioned the layout improvement regarding the (to avoid) 90° traces at Ri and Rf.

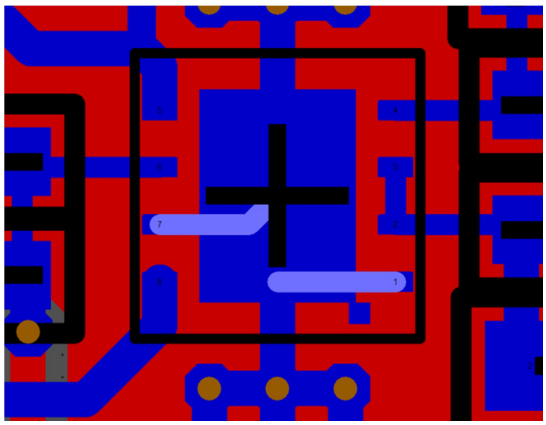


This is the TI layout example from the datasheet (figure 29, page 13). I think you prefer this placement and traces?

Can you give more insight whey to avoid the 90° angle as shown above?



I noticed that there is no GND connection of the pins directly to the exposed pad underneath the chip. As you can see in our schematic we connected PIN 1 and 7 “the short way” directly to the GND exposed pad. Should we avoid that? Maybe you can give some more insight here, too.



Thanks a lot

Alexander