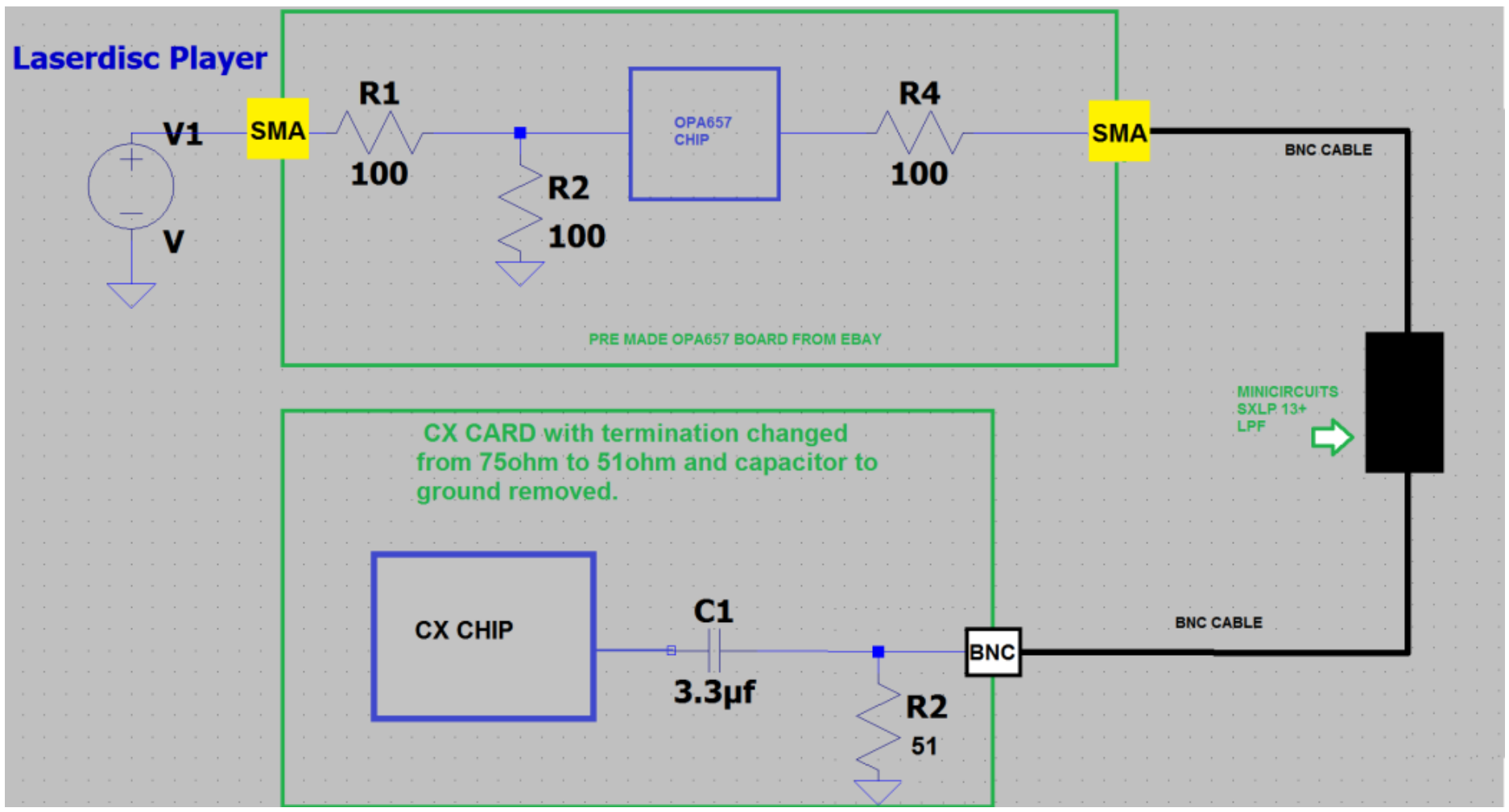
This information is deprecated, and provided for historical reference only.

Current Setup as of 4/2022:

Opa657 board $15
https://www.aliexpress.com/item/1005003423802332.html
White PCI cx card
$25 https://www.aliexpress.com/item/1005003461248897.html
Mini-Circuits sxlp 13+ $12
https://www.minicircuits.com/WebStore/dashboard.html?model=SXLP-13%2B
ABRACON ABLS2-40.000MHZ-D4YF-T 40mhz crystal replacement $2
https://www.mouser.com/ProductDetail/ABRACON/ABLS2-40.000MHZ-D4YF-T?qs=LoTOQoUkC8SsxxUxj0Db0w%3D%3D

Modifications:
Opa657: 100ohm smd placed at positions labeled C3, R4, C4 (while labeled C3 and C4 indicating a slot for a capacitor, they come with a zero ohm resistor in this spot).
Cx card: remove cap to ground and 75ohm terminator to ground. Sever trace back from vmux 2 input. Mount BNC jack and attach BNC wire to vmux2 DC blocking cap. Add 50ohm termination. (see picture in chapter 2)

NOTE: No output cap needed on opa657 because there is DC blocking cap on CX card.
Crude layout of my circuit:



CX card notes. This is not a “how to” document, but just a rather disorganized collection of information and possibly the route to how it was found. This is based 100% of of LD and signal generation RF, i have no VHS setup currently.

Chapter 1: PCI beginnings

1. How to mod a CX card involves a lot of “if → then” type logic.
    - **If** only capturing VHS, depending on VCR (high RF output) **then** you may not need to mod at all.
    - **If** you are not using an amp, **then** removing onboard termination and not adding any gives best SNR
    - **If** you are using an external amp (ebay opa657, some kind of vga amp) **then** adding 50ohm termination gives best SNR
2. For reasons i can’t recall, i ended up on the page for the original CX card modification, where i read:

Once you have chosen the input, all the components (capacitors to ground, series inductor) along that input will need to be removed. The only component left is the DC blocking capacitor which is connected to the VMUX pin. The other end of the DC blocking capacitor will be your ADC input for SDR. Note there is no anti-aliasing filter here. The other way is that you find the DC blocking capacitor, desolder it, solder it back tilted so that it is connected to the VMUX pin only. The other end of the capacitor is not connected to anything and will be your ADC input. https://www.geocities.ws/how_chee/cx23881fc6.htm

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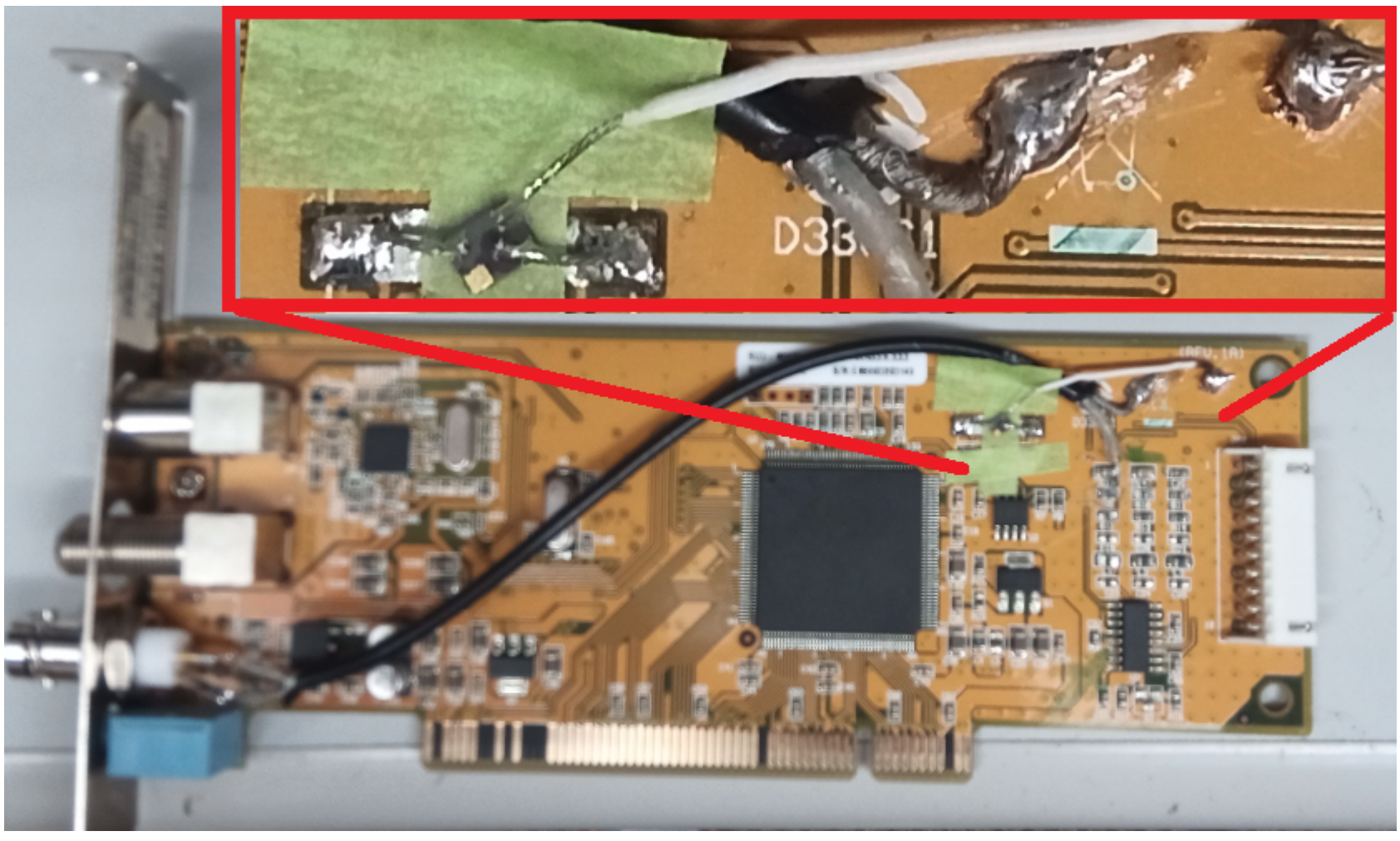
3. This led to the thought: if we need to remove these components for SDR, then we would probably need to remove them for LD RF capture too.
4. My first attempt at modification was the second method listed in the paragraph above, the PCI card was “busy” so i worked backwards from the chip, isolated the DC blocking cap (scratched out traces on the “away from the chip side”, and soldered a coax cable directly to it, grounding the coax shield nearby
5. As stated by How Chee, there is no anti aliasing filter. I had some already (probably 10mhz crystek iirc) from SDR experiments so used that. (at this time, i was working with PAL discs, which have a lower RF spectrum than NTSC, and the crystek 10mhz LPF performed moderately well, it would prove too low for NTSC though):

NOTE: a 75ohm external terminator was used because that is all i had at the time. 50ohm terminators and additional low pass filters were ordered and on the way.

6. This is still using a PCI card. SNR increased considerably now.
7. Things get a little foggy and circular, with a number of false positives and false negatives.
    - It “appears” that software methods in cx driver for changing sample rate, don’t actually change the HW sample rate, however, this was unknown at the time. The result is somewhere in the middle though… e.g., using the mini-ciruits 13+ LPF (which doesn’t actually hit -3 db until 15.2mhz, above nyquist for 28.8msps) did improve SNR for NTSC discs above the crystek 10mhz. In retrospect, this is probably because the aliasing caused less degradation than the premature attenuation. For some time, i played around trying to get 40msps software speed from cx card driver, and eventually succeeded. However, only cx23881 cards seem to be able to capture a usable signal at this configuration (realistically, the ADC was still at 28.8msps, that is my belief)
    - However, another unknown quantity at the time: a fairly large variation in cx chip SNR, probably led to a false positive that the 40msps was resulting in a “better” SNR (e.g., it wasn’t the softrware 40msps that made SNR better, it was that since the software 40msps didn’t work on the main card i was using, i tried it on a second card, cx23881, and it did work, but that card may have just had inherently better SNR) In addition to this, the ability to use ld-decode at the “native rate” of 40msps was a huge motivation, because the machine i was using at the time, showed significantly faster decodes when it didn’t have to resample the input RF flie (ld/vhs decode run internally at 40msps, any other sample rate is resampled transparently to the user by ffmpeg on the front end of ld/vhs decode).
    - There is some kind of discrepancy i have observed, that when doing shorter captures, i get better SNR. When testing different configurations, i would mainly just capture chapter 33 on ggv 1069. At one point, i was getting average white SNR of around 44db. However, when doing a full disc capture, the same section of the disc is at best, averaging 42db (more often 41db). Possibly the cx chip gets slightly less SNR after being actively capturing? This happens with or without heatsink. So something else is causing it.
8. Since i couldn’t get software 40msps to work on all cards, i decided to do “crystal swap”. I matched up crystal specs in the datasheet as best i could, and found some 40mhz fundamental crystals: https://www.mouser.com/datasheet/2/115/FL400WFQA1-1129572.pdf (see further down this document for alternate crystals with the same form factor)
9. I had various LPFs arrive, from a crystek 15mhz, mini circuits 10.7+ and 13+. I made the mini circuits LPFs into components that were easily interchangeable:

10. At this point, i had a PCI cx card, fully bypassed all onboard components with a coax cable tapped directly onto the isolated “away” side of the CX chip.



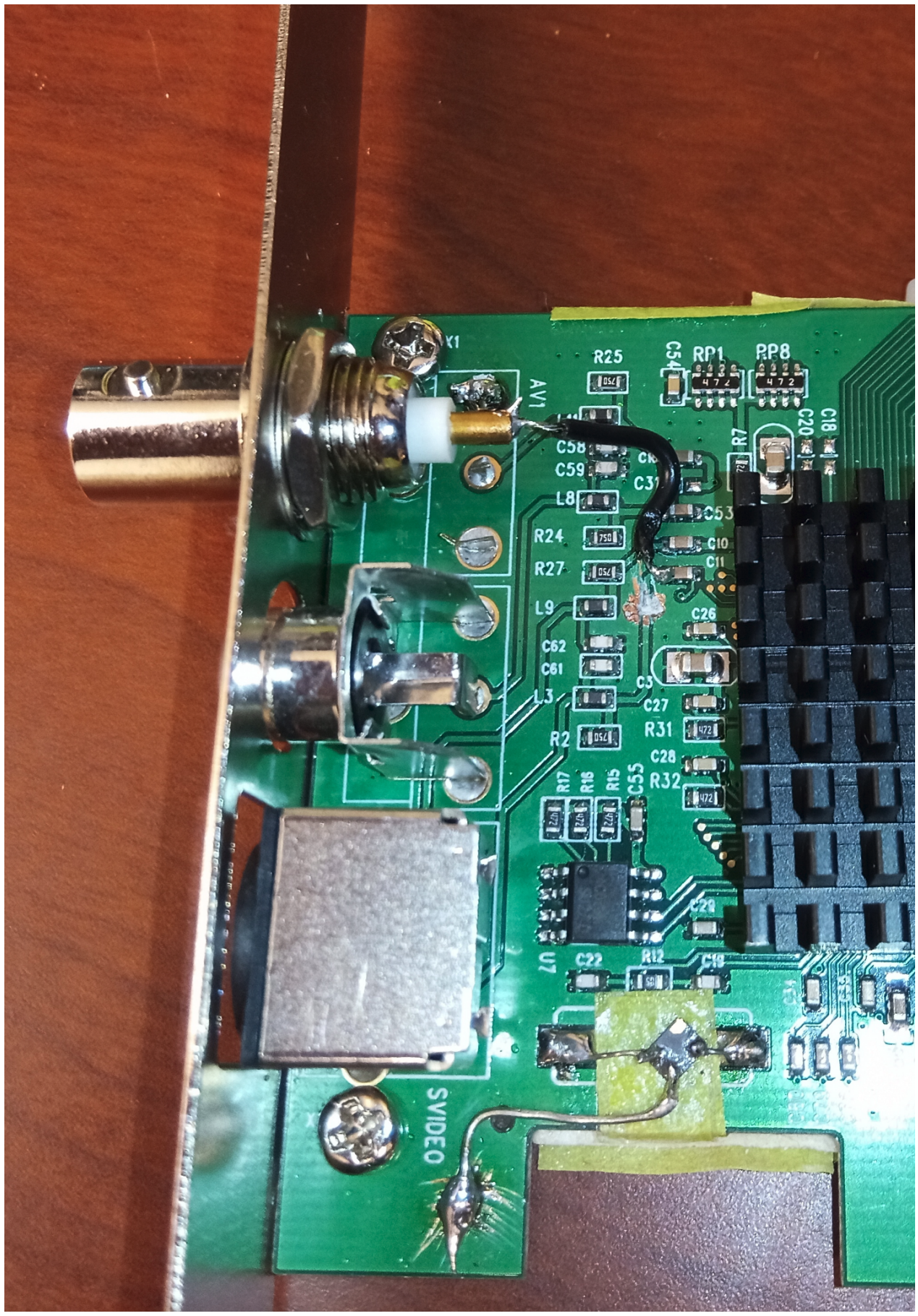
11. An attempt was made to try and help other users on forum.lddb.com modify their cards, with poor results. A decent understanding of electronics, electronic components, and circuit tracing is needed to identify the components to remove, or to find a DC blocking cap tap point. Around this time, the discovery of the PCIe CX card was made, and i decided to focus on this model, because it is still consistently available for purchase. Helping “the average Joe” track down and mod any one of 1000s of different card models was just a “fool’s errand”. Something “standardized” had to be found...

NOTE: some users have had a bad “input” on a cx card. Probably a good idea to test them all first before modding.

CHAPTER 2: PCIe

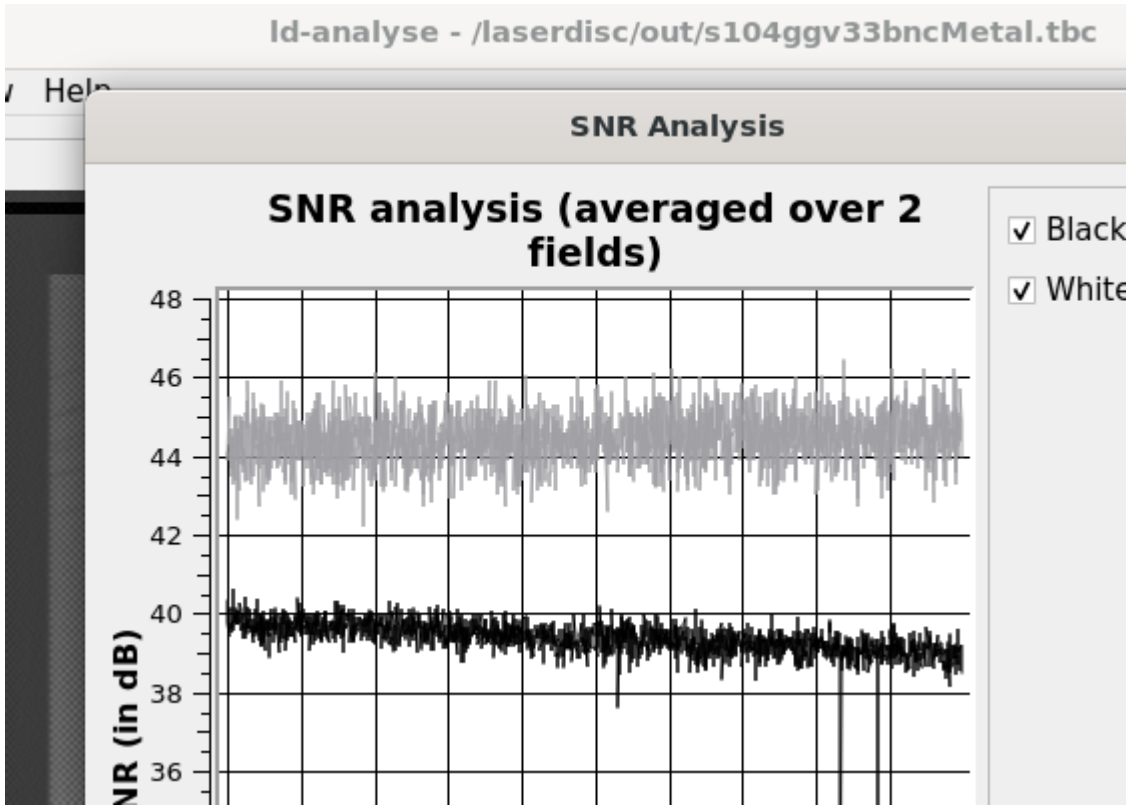
At some point, someone brought to my attention the PCIe CX card. I ordered 2. The initial ones were green PCB, with RCA jacks, and sold as Vt600ex on aliexpress for $52. As luck would have it, both of these first 2 cards were of exceptional quality. I achieved SNR values on GGV1069 that were quite high. As unluck would have it, one got ruined in testing (my fault), and one got lost by USPS.

1. It seems highly likely that the cx chips (or at least some of them) on the PCIe cards are not “new” or “new old stock” but rather, harvested from older cards. Some that i and others have received, the writing is partially worn, or there are nicks/chips/scratches. This could be a factor in the SNR variation. If the chip came of a card installed in a CCTV system that was on 24/7 for 20 years, it could be degraded.
2. There are some less than ideal design aspects, as the signal goes from the front, to the back, then back to the front (under CX chip), so traverses a longer path than what is ideal. It is mentioned in the datasheet to pay attention to the routing of the input traces to limit noise, but it seems no HW designers paid it a mind.
3. With the RCA PCIe card, the first thing to do was remove an RCA jack and install a BNC connector. In this mod, i simply broke the trace leading back from the DC blocking cap and soldered a lead to the DC blocking cap. This is closer to the method i used on the PCI card. The crystal mod and bnc mod for the RCA card looked like this:

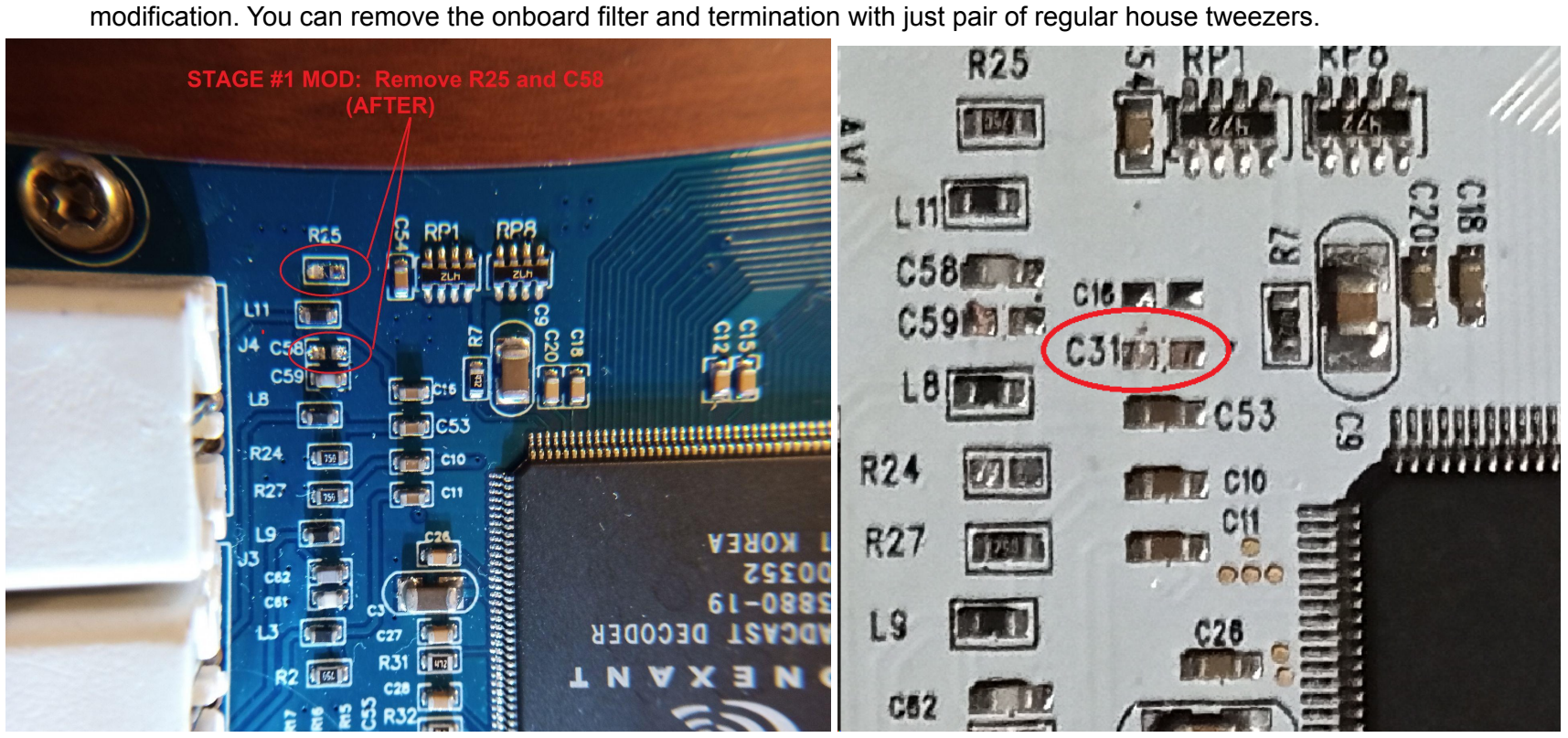


   a. As i write this, I wonder if this may actually be a better way to go? although slightly more difficult, it does provide for possibly a better BNC connector, and if you are doing an onboard LPF, more room.
   b. For early modifications, i had a preference for VMUX2 (the SVIDEO in). I no longer have all my original test captures, because i lost a large RAID0 of spinning disks with all that on it, but iirc it may have had better SNR. **FURTHER TESTING OF THIS IS NEEDED**

4. Some of my earlier SNR graphs showed extremely good partial captures of ggv1069 chapter 33. Here is an average of 45db white SNR for that chapter, with a green RCA card modified as depicted above.



   a. For some reason, partial captures (e.g. , just capturing chapter 33 of ggv 1069) seem to have a higher SNR than when capturing the full disc with the same setup, and then comparing to that section. This isn't "hard fact" but seems to be the case. It could be due to other variables though, of what i am not sure??? Using my gain changing script, the gain should be approximately the same.
   b. At some point, i suffered a regression, and SNR slipped. It could be because i lost my "good" cards.
5. Then the PCIe BNC card were found. This was attractive to users who wanted the least amount of modification, or a "no solder" modification. You can remove the onboard filter and termination with just pair of regular house tweezers.



   a. The above picture shows the components to remove for VMUX0 input circled: R25 & C58, L11 must be removed and jumpered, either with solder or 0 ohm resistror
   b. VMUX1 input components are: C59 & R24 , (and C31 on white cards) L8 must be removed and jumpered, either with solder or 0 ohm resistor
   c. VMUX2 input components are: C61 & R2 (not R27 & C62, that is the svideo C input), L3 must be removed and jumpered, either with solder or 0 ohm resistor
   d. The DC blocking caps are: VMUX0=C16, VMUX1=C53, VMUX2=C11 you could break the traces to the left of those, and solder lead to the left side of the cap, as i did on the green card
   e. https://www.youtube.com/watch?v=RIOXlb6VUbU video example of how to remove SMD components with just tweezers. This should only be tried for components that aren't needed. If you damage the pads, it doesn't matter.

CHAPTER 3: Amping it up

For best results, an amp is needed.

To be added later, but see appendix 3

Future Plans:

1. In the cx card datasheet, it says:

ADC Interface (23 Pins)					
[145:142]	VMUX[1:4]	I	A	Video Mux {1:4}	Analog composite video inputs to the on-chip 4:1 analog multiplexer. Unused inputs should be tied to AGA1.

So wonder if you dedicate yourself to use “”one” vmux input, maybe one of the middle 2, if you could improve SNR? The signal is visible on other vmux inputs, just at a lower level. This may actually be some kind of “bleeding”?

Appendix 1: Card purchase links

NOTE: in all my experience with CX cards, both PCI and PCIe, the cx23880 chip seems to provide lower SNR when compared to the cx23881 and cx23883. I have never come across a cx23882 in the wild.

https://www.aliexpress.com/i/4000386216474.html $52 green RCA card
https://www.aliexpress.com/item/4001286595482.html $25 blue BNC card
https://www.aliexpress.com/item/1005002068971441.html $23 green RCA card
https://www.aliexpress.com/item/1005003461248897.html $24 white RCA card ***
https://www.ebay.com/itm/165266174639 yellow card no one bought yet, $55.

***As of now (2022 JAN 07), 4 of 4 white PCIe cards all came with cx23883 chip and the ITE bridge chip. My blue and green cards have come with an assortment of cx23880/cx23881/cx23883 and an assortment of bridge chips, including the asmedia bridge chip which has issues.

Appendix 2: Crystals i’ve tried with **PCIe CX** card

NOTE: Most CX cards need “Fundamental” crystals. Some cards i have, have circuits and pathways for 3rd overtone setup, but none actually ever used. All cards i have had, used fundamental.

1. `CRYSTAL 40.000MHz 7pF 10ppm PART: FL400WFQA1` ***DID WORK***

2. **40MHz - ABRACON ABLS2-40.000MHZ-D4YF-T 18pF 30ppm HC-49/US *DID WORK* *SAME FORM FACTOR / PACKAGE TYPE***
3. CRYSTAL 48.0000MHZ 18PF SMD 0.53000 3.18 PART: XC2669CT-ND ***DID WORK***
4. CRYSTAL 50.0000MHZ 18PF SMD 0.53000 3.18 PART: XC2672CT-ND ***DID WORK***
5. CRYSTAL 54.0000MHZ 8PF SMD 0.56000 3.36 PART: XC2555CT-ND ***DID WORK***
6.
7. CRYSTAL 57.1425MHZ SMD PART: 150-VXM7-1363-57M1425000CT-ND ***DID NOT WORK***
8. CRYSTAL 60.0000MHZ 8PF SMD PART: FW6000006QDICT-ND ***DID NOT WORK***
9. CRYSTAL 80.0000MHZ 8PF SMD PART: XC1567CT-ND ***DID NOT WORK***
10.
11. CRYSTAL 40.0000MHZ PART: 449-LFXTAL028207BULK ***DID NOT WORK* (3rd overtone, not Fundamental)**
12. CRYSTAL 64.0000MHz 20pF 3rd OT PART: ATS640A-E ***DID NOT WORK* (3rd overtone, not Fundamental)**

Appendix 3: Amplification

So far, i've had the best results with opa657 board, purchased some from aliexpress and some from ebay, but the AD8367 seems susfficient too and utilizes single power supply:.

1. https://www.aliexpress.com/item/1005002970528228.html (opa657)
2. https://www.ebay.com/itm/265072074692 (AD8367)