

# Audio Restoration Project – Repair Philips Magnavox Marantz CD650 CDB650 CD Player Modification

This applies to all similar type models using the Philips CDM-2 and CDM-4 transport, commonly combined with the TDA1541 / TDA1541A DAC. These are found in B&O's BeoGram CDX2 , CD3300 , CD3500 , CD4500 , CD5500 , CD6500 , CD7000 , BeoCenter 8000 , 8500 , 9000 , 9300 , and 9500 , and selected models from Acoustic Research , Arcam , Cambridge Audio , Grundig , McIntosh , Mission , Naim , Rotel , SAE , Sherwood , Tandberg , and Tesla.

Time has proven that this combination of Philips DAC and Transport is probably the most long-lasting and mechanically robust ever made, and combined with its superb audio fidelity, it naturally lends itself to modification, in order to extract every last nuance of exceptional sound reproduction.

Correctly restored and modified, the sound quality is superb, and it puts many other CD players, irrespective of their age, to shame.



This unit came onto my lab-bench after showing symptoms of random blackouts on the front-panel, skipping tracks, and difficulty in extending the CD-tray. Track-skipping is indicative of a failing laser – simple enough, but the cause of the random blackouts proved tough to nail down.

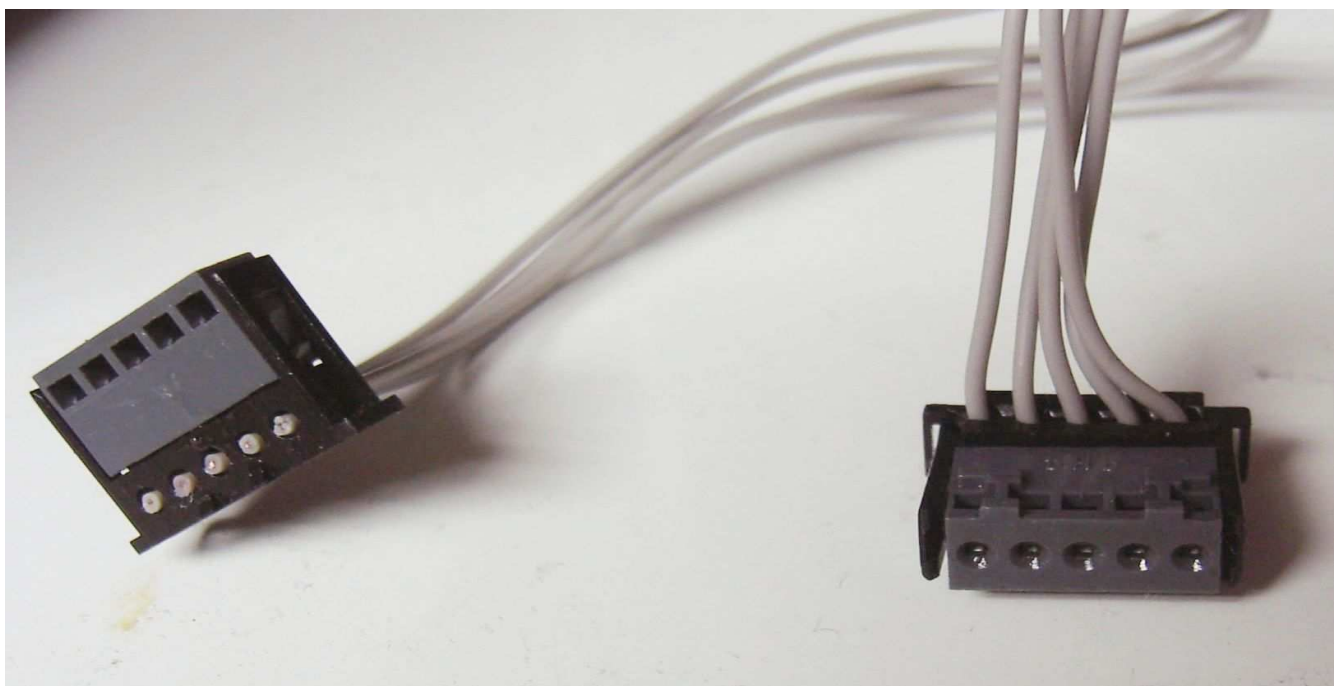
## 1. Clean and reassemble the CD-tray mechanism

On the CD-tray, I have had similar problems many times before, and it is simply a matter of completely disassembling all the plastic toothed gears from the CD-tray, cleaning off the hardened grease, spraying with Silicone spray (I do not use grease on plastic parts) , and reassembling. The Service Manual is very clear about the assembly sequence.

Thereafter, I cleaned the V-ridge on the plastic wheel with alcohol, and replaced the rubber belt – I like to use a thicker (1,8mm) belt than the original 1.2mm square profile.

## 2. Replace the Wiring Harnesses with Litz wire

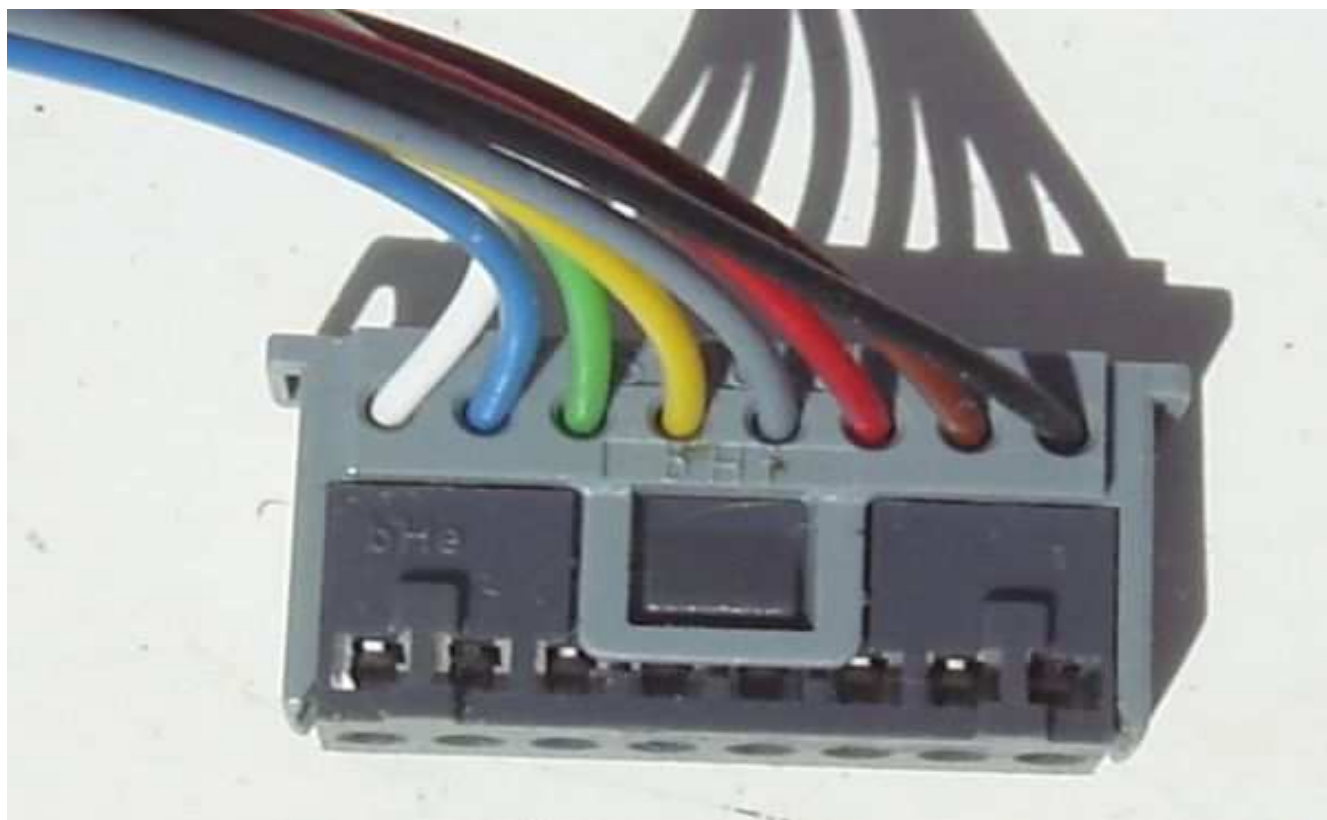
The cause of the random blackouts was traced to the Stocko OEM connectors, whose pincers grip the single-strand copper wire in a knife-cutting action, and over time, the wire simply disconnected from the pincer, destroying the connection.



**These are the original grey single-strand wires, in the Stocko connectors**

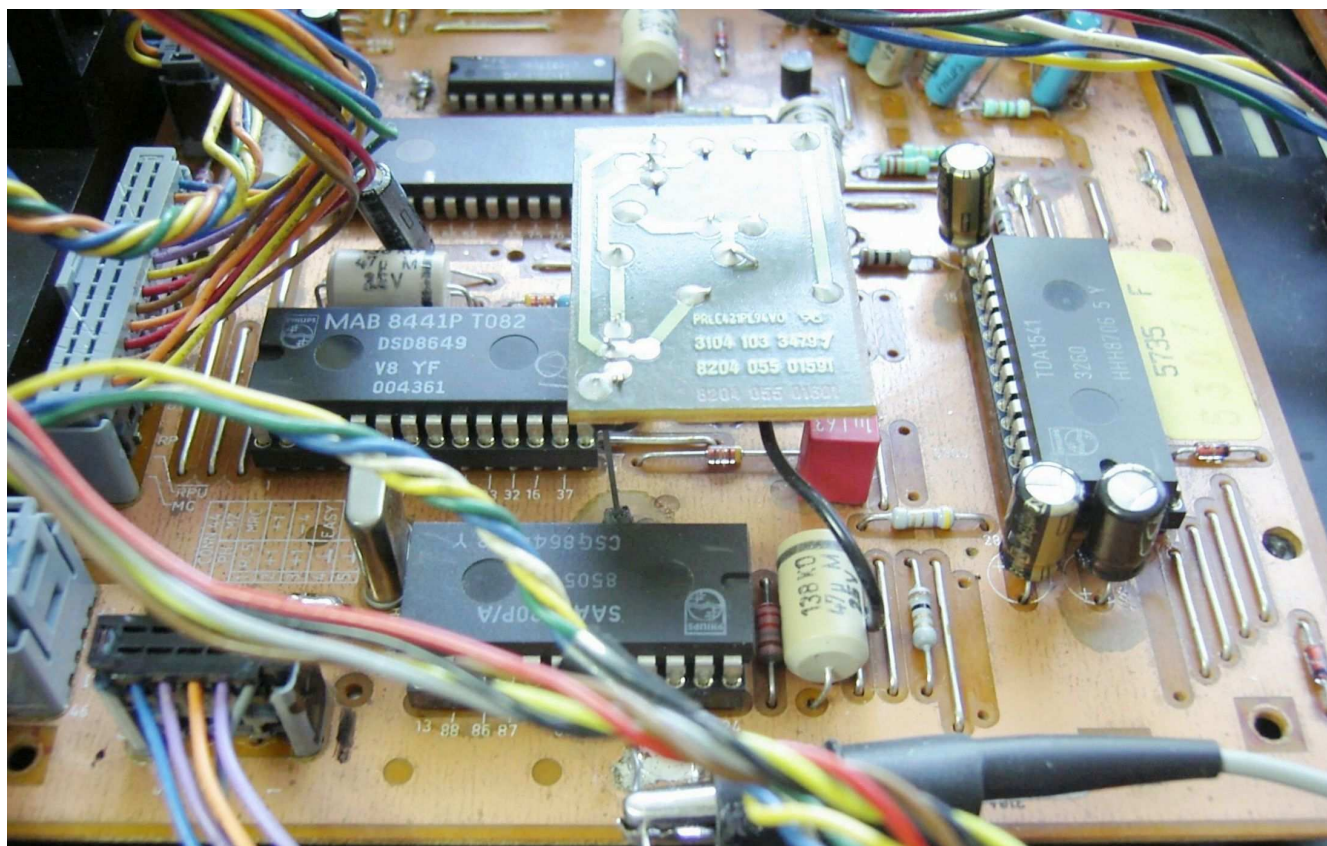
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Once I discovered this, I simply rewired the entire machine, using Litz multi-strand wiring, which is gripped harmlessly by the pincers. A pity that the Philips designers didn't think about this before production.



**These are the new coloured Litz multi-strand wire in the Stocko connector**

I would imagine that this problem is going to show up on all the Philips-sourced CD650 decks at some-time.



**These are the all the new coloured wiring harnesses, with Litz wire**

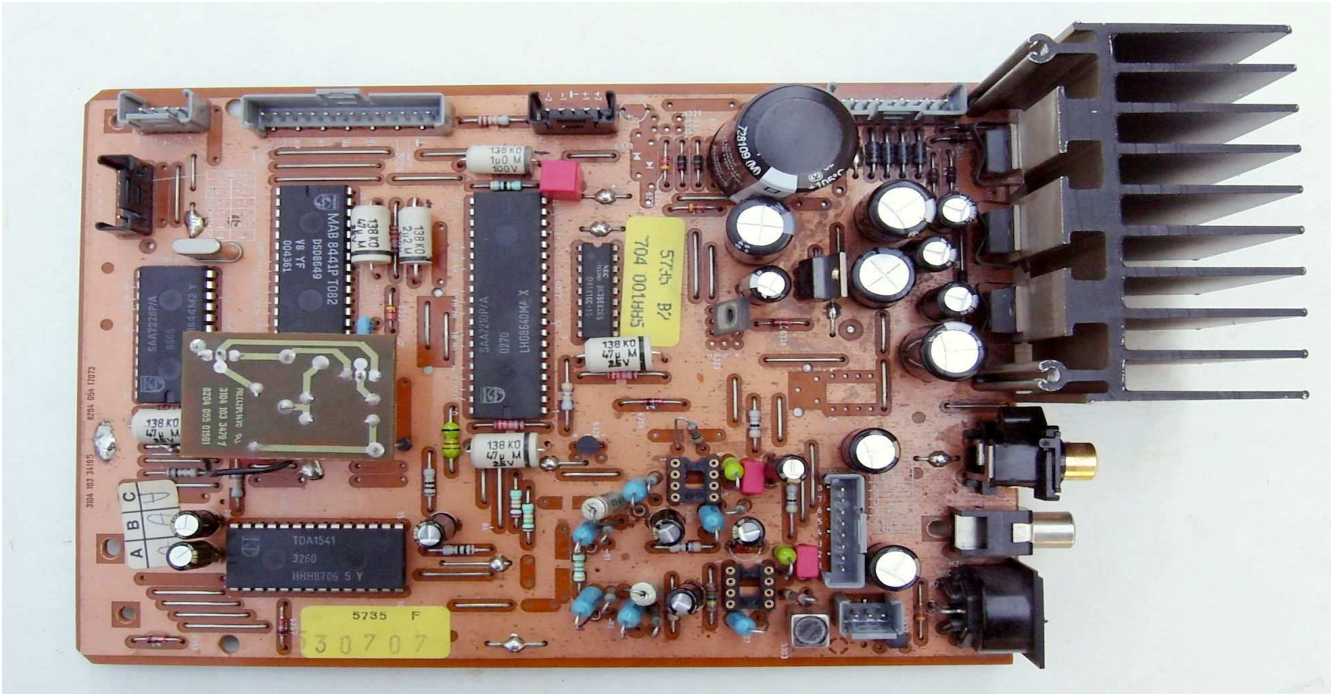
Unfortunately, the consequential damage from the electrical cutouts was not limited to the symptom of blackouts on the front-panel.

1. The SAA7210 IC was not performing correctly, traced with my Tek 2465B scope, and that was replaced from a donor PCB.
2. Also, two 1/2 bridge 1N4148 diodes 6333 and 6334 had failed, and were easily replaced.
3. Not surprisingly, 6325 BC858 PNP , and 6324 and 6326 BC848 NPN had also failed. Not having these in stock, I substituted BC546 NPN and BC556 PNP appropriately soldered onto the SMD pads.
4. On the front-panel display PCB, 6060 15V Zener had failed – it was replaced.
5. The TI TMS3763CNL Display Driver IC was faulty, so I replaced that also.



Now that I had repaired all the electrical damage, I started on the modifications. There are 4 chassis-mounted horizontal PCB's in the CD650 series – the main PSU/DAC PCB with a small daughterboard, the Filter/Display PSU PCB, and the CDM2 PCB. There are also 3 vertically-mounted PCB's behind the front-panel display. All are easily accessible for service.

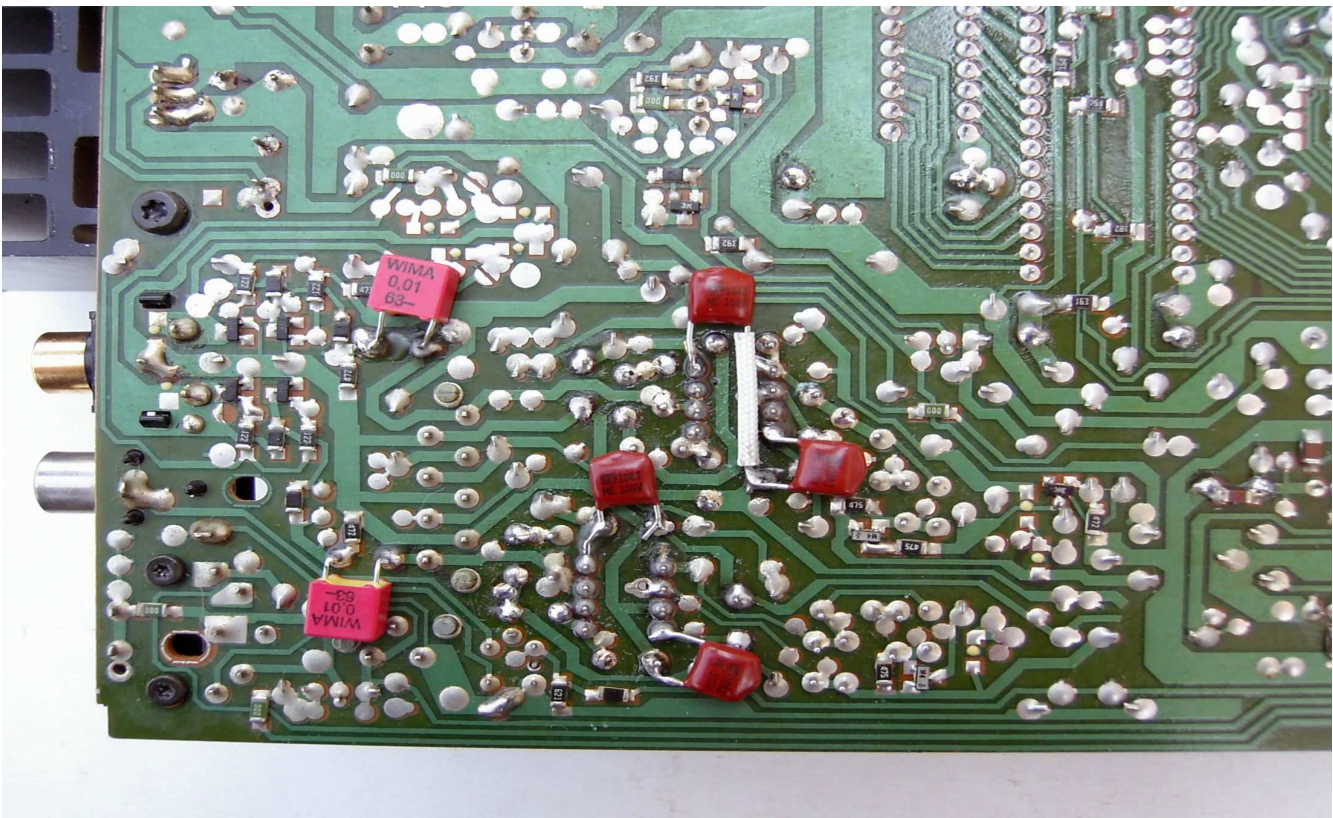
### 3. Main PCB modifications



**This is the Main PCB, showing all the new capacitors, and IC sockets**

For working on the main PCB, I planned the work in 5 stages:

1. Replace the 8 bridge-rectifier diodes 6340 – 6347 1N4002 with Vishay 11DQ10 Schottky units.
2. Replace all the PSU electrolytics with high-quality Nichicon HE capacitors of equal capacitance, except for the main 6800uF PSU decoupling cap 2396, which I replaced with a 10,000uF Panasonic TSHA unit. I am not a fan of willy-nilly increasing capacitance values in a circuit, unless there is a very good reason to do so. Transformer overload and damage can very likely occur. I much prefer using very-high-quality capacitors instead, which certainly justify themselves by a much more stable current flow.



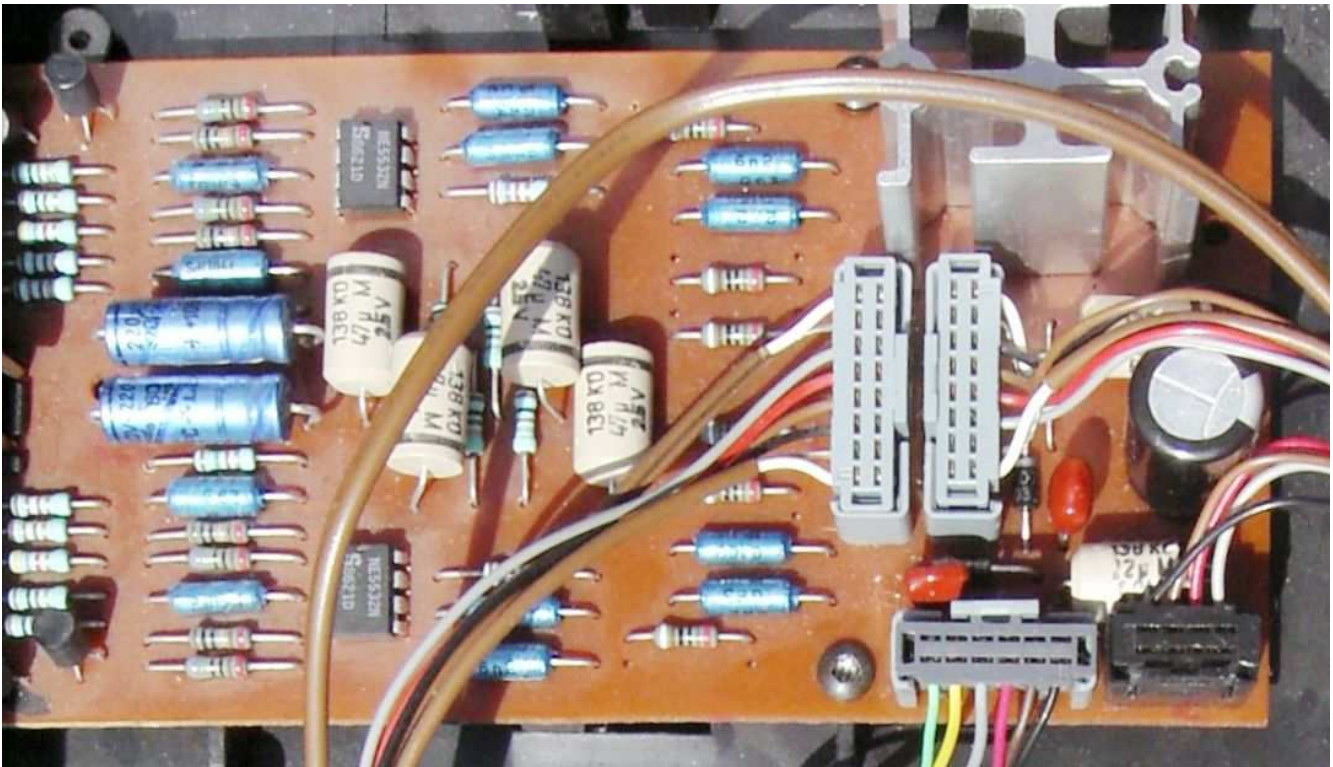
**This is the Main PCB underside, showing the bypass capacitors on the signal coupling capacitors, and on the OpAmp Power Supply circuits**

3. Replace the signal path area capacitors with Panasonic FM and grey Vishay 138 axial electrolytics of equal value. Replace 4 small value electrolytics with red Wima MKS2 film units. Do not touch the original polystyrene axial capacitors, visible around the OpAmp IC sockets.
4. Install sockets for all the IC's – more fun later.



5. On the underside of the PCB, bypass the NE5532 OpAmp's with Panasonic 0.1uF film caps as follows: Power Supply + (Pin 8) to Ground, Power Supply - (Pin 4) to Ground. Bypass the 220uF signal coupling caps 2366 and 2367 with 10nF film caps.

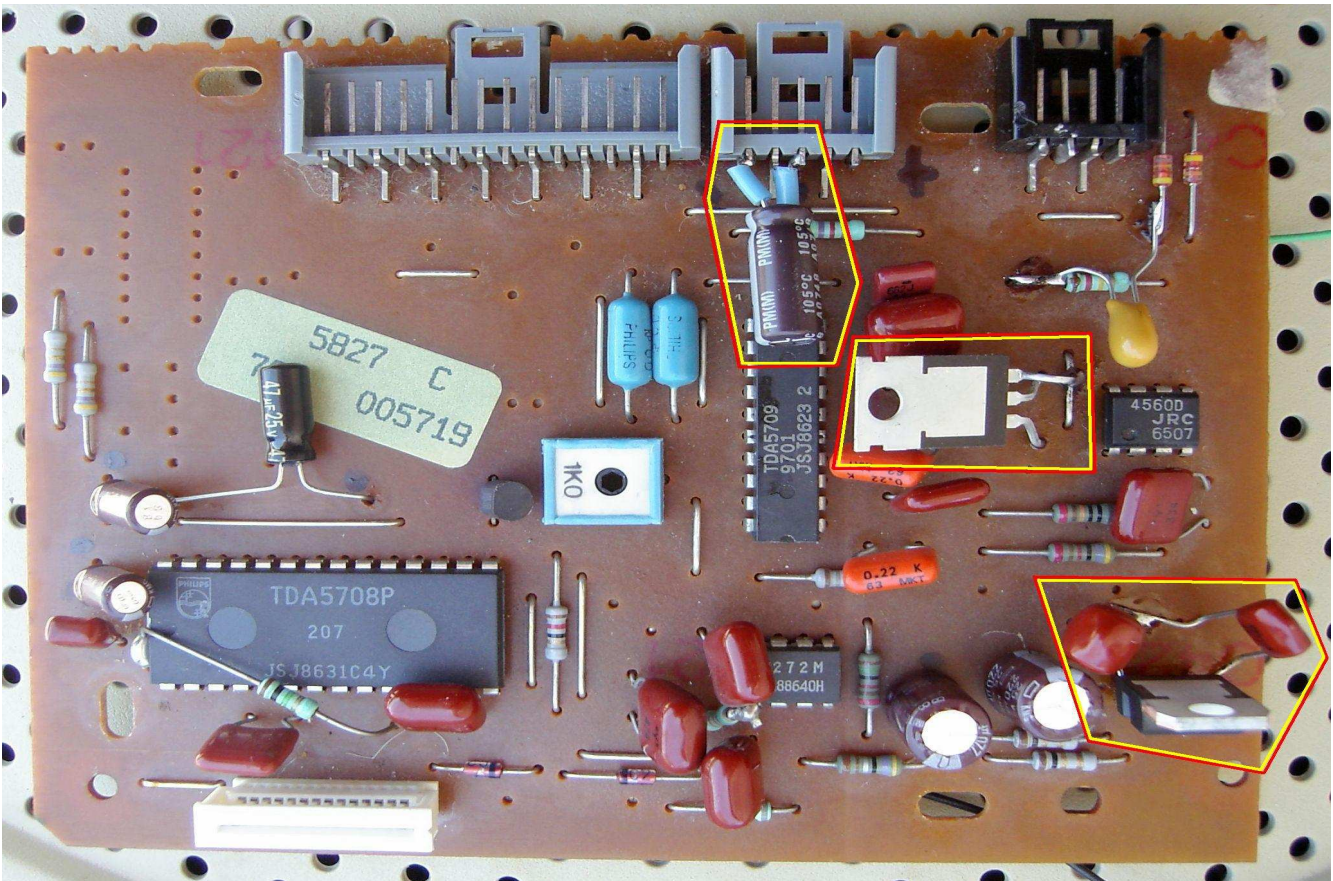
**4. Analogue Filter / Display PSU PCB modifications**



This is the Filter PCB, at the left is the Analogue Filter circuit, and completely separate at the right, is the Power Supply circuit which supplies 32VDC to the Display Panel

On the filter PCB, all electrolytics were changed to grey and blue Vishay 138 axial units. Not really intending to use this analogue output, I left the NE5532 opamps alone.  
In the Display PSU, I changed the main decoupling cap 2922 to a Panasonic EB 470uF unit, and replaced the 1/2 bridge diode bypass ceramic caps 2920 and 2921 with 22nF Panasonic film caps. This PSU circuit uses a 78M24CT regulator, which is bumped up by an 8V Zener diode, to attain the desired 32VDC. So to prevent regulator failure (a common occurrence), the current flow should be very stable, and that requires using high-quality capacitors.

**5. CDM-2 Laser transport PCB Capacitor Replacements**



This is the CDM-2 Laser PCB upper-side, showing all the new capacitors, and the Voltage Regulators to stabilize the input voltage

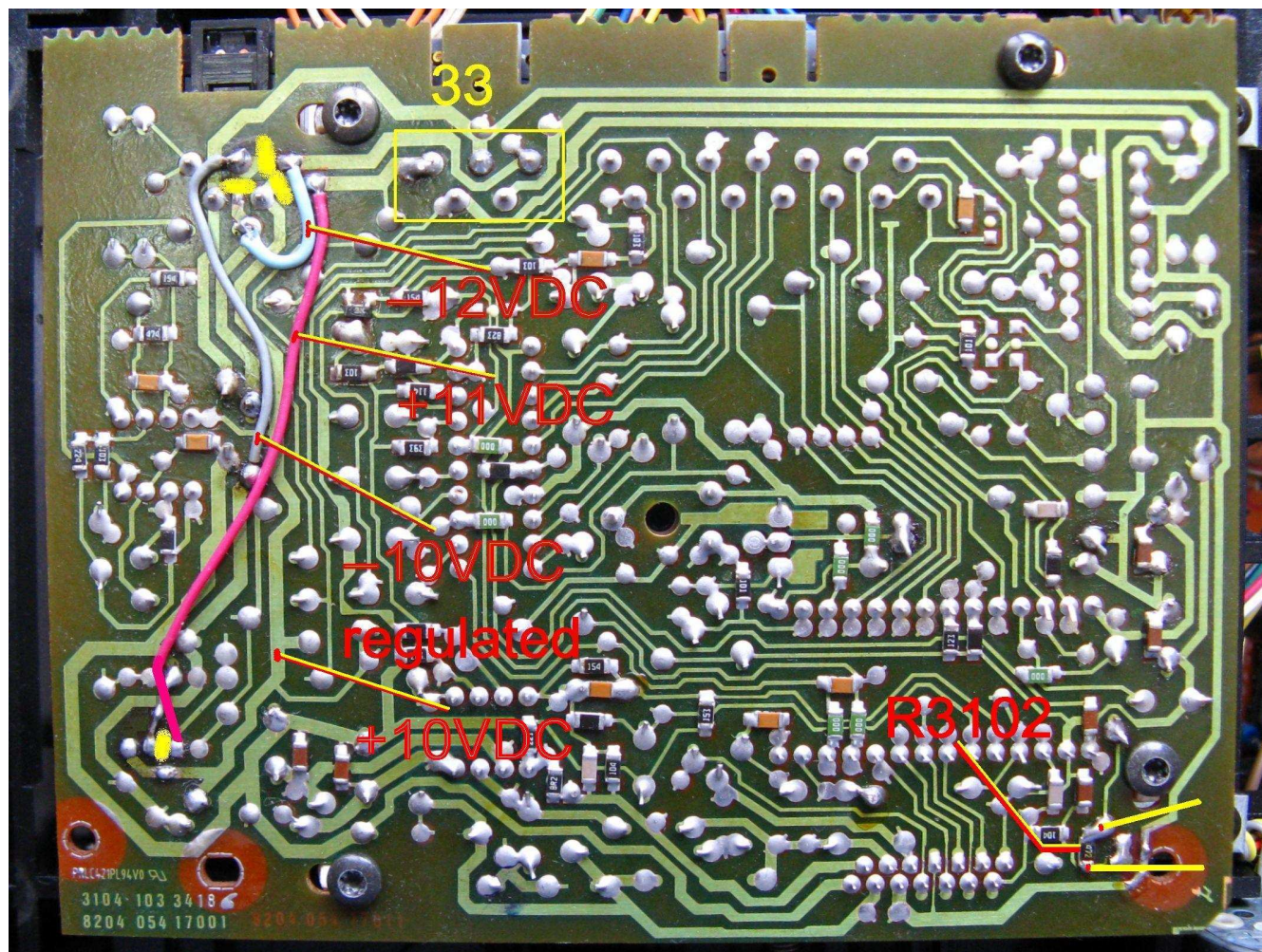


Capacitor C2103 33uF is a known troublemaker, and replacing this with a 47uF 25V unit usually cures all non-laser related ills in this area. For many years in the B&O technical community, we found that unless it was replaced by a Vishay Philips 138 axial capacitor, the circuit would remain dead, but I am now pleased to report that also a Panasonic FM radial capacitor is electrically quite suitable.

All the electrolytic capacitors (except for 2103) are Nichicon PM, but PW or HE are also quite suitable here.

## 6. CDM-2 PCB Focus Drive and Turntable Motor Voltage Regulation

This modification regulates the unstable input voltage to the Turntable Motor Control circuit and the Focus Drive OpAmp L272M. The entire circuit runs much more stably, which is immediately evident, as the track information is displayed within a second after inserting a CD. This is a very worthwhile mod.



This is the CDM-2 Laser PCB underside, showing the wiring changes necessary to accommodate the new regulators. The 4 Orange marks show where circuit traces have been cut. Do not attempt this mod, unless you fully understand the circuit requirements – you may damage the circuit beyond repair.

The power entry point is at Block 33; Pin 1 is +11VDC and Pin 5 is -12VDC. The objective is to regulate these 2 unregulated voltages at + and – 10VDC respectively. I used an L78S10C, and a LM7910C.

I located these 2 IC's on empty areas of the PCB, which already had solder points for the necessary circuits, without needing to do too much surgery. The L78S10C (with its two film capacitors) is at the bottom corner, and the LM7910C is in the middle of the PCB.

At Block 33 Pin 1 (-12VDC), I added a Nichicon PM 100uF 25V capacitor, with the –ve lead polarity on Pin 1.

The Light-blue wire is -12VDC unregulated; the Purple wire is +11VDC unregulated; the Grey wire is -10VDC regulated, and the remaining trace is +10VDC regulated.

The output of these two Regulator IC's is routed on this PCB to the Focus Drive OpAmp, and also goes to Block 36 – the Turntable Motor Control circuit.



## 7. CDM-2 Laser replacement and Laser current adjustment

Replacing the Laser is a 2-step process – firstly installing the new laser assembly, and then adjusting the laser current.

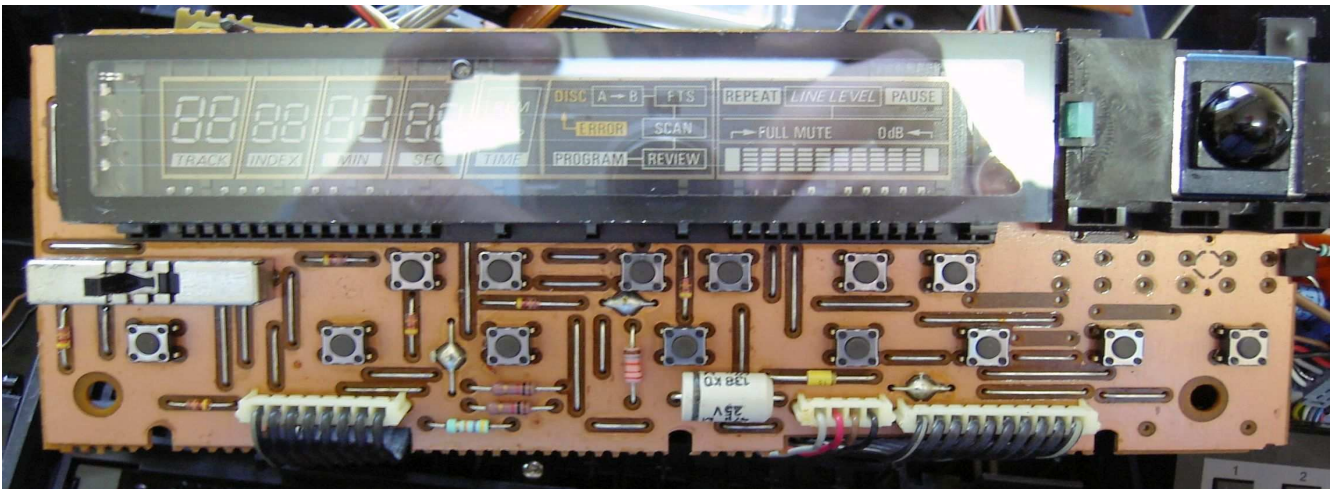
Replacing the actual laser is very straightforward, with no complications.

Insert a CD and select PLAY. The 1Kohm potentiometer R3106 at the center of the PCB, is adjusted through the bottom hole in the PCB, to provide a reading of 50mV, which is measured across R3102. I soldered two wires (marked yellow in the above picture) to R3102, and routed them out of the CD player to my Multimeter. The adjustment is very sensitive, and I was quite happy with 50.7mV.



Here you can see the reading of 50.7mV on the Fluke Multimeter

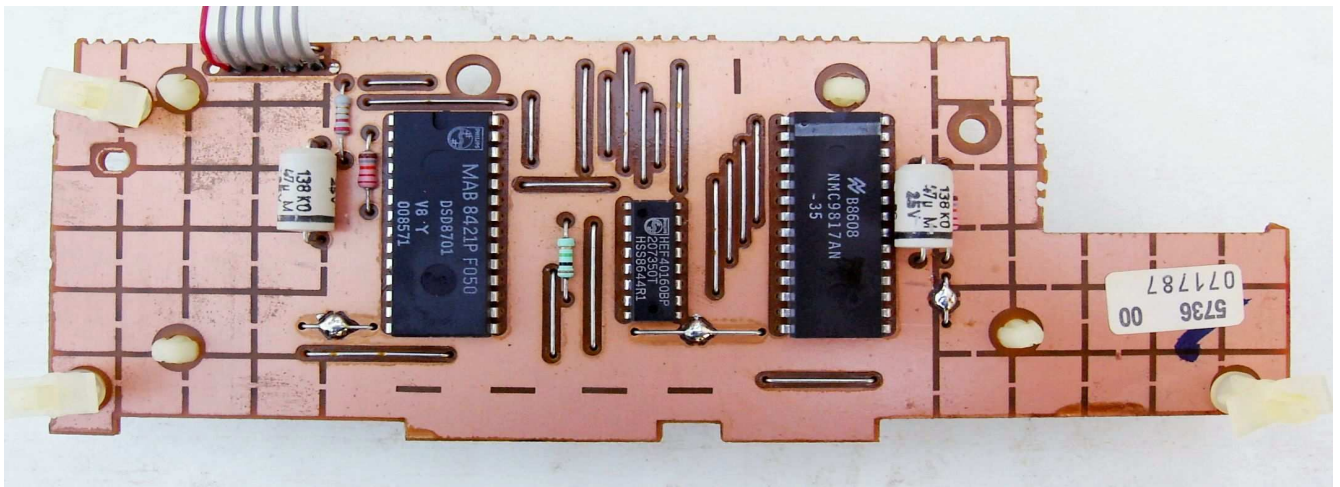
## 8. Front Panel Display PCB's – Capacitor replacement



Above is the front-most PCB, with the new Vishay 138 axial capacitor, and immediately next to it, is the new 15V Zener diode, which was mentioned in Part 2 above.

To replace the TMS3763CNL Display Driver IC, I had to desolder the LCD display completely, in order to gain access to the IC underneath it.



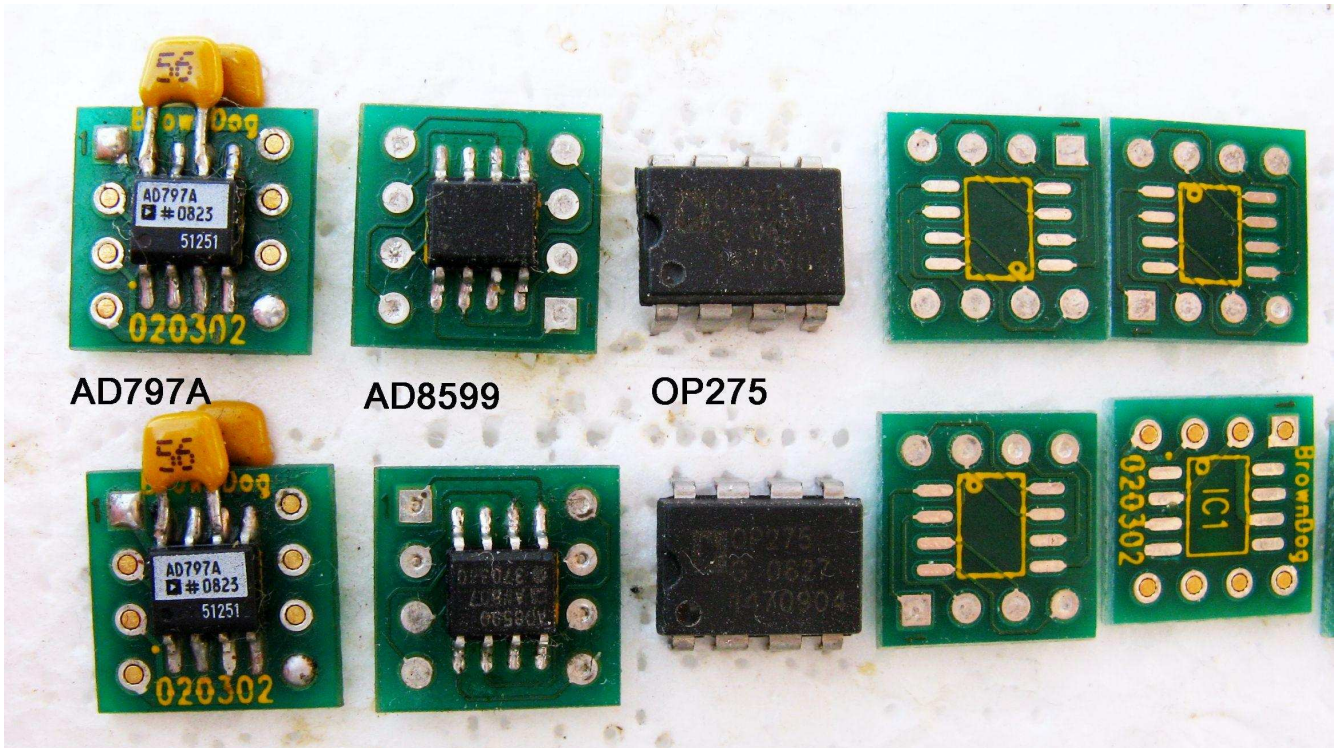


Above is the Display panel's middle PCB, showing the replaced Vishay 138 axial capacitors.

This completed the repairs and modifications, and at this point, I reassembled the CD-player, but left the top cover off, in order to provide access to the IC sockets.

### 9. Selecting Replacement OpAmps

As mentioned in Part 3 above, I installed sockets for the OpAmps. The amplifier stage has 2 NE5532N Dual OpAmps, in the Dip-8 format. In its day, the NE5532 was a top-quality BiPolar OpAmp. Today, there are better choices. The power rails to the OpAmps are +14.6VDC and -14.6VDC. This allows us a wide choice of possible OpAmps. Most of the newer OpAmps are no longer available in Dip-8 format, so I used Brown Dog Adapters to mount the SMD chips. I tried many OpAmps, and the finalists were the AD797A, AD8599, OP275, and OP2134. For pure musical enjoyment and soundstage, my ears preferred the OP2134, and that's what's mounted in there permanently!



Above are some of the OpAmps I tried, and you can see the 56pF compensating capacitors (Output to GND) on the AD797A. Unused Brown Dog adapters are on the right.



## 10. TDA1541 SCK and SAA7220 XSYS Low-Jitter clock modification

The System Clock is a Crystal Oscillator driving the SAA7220 filter, whose output on Pin9 XSYS also controls the SAA7210 Decoder at its Pin19 XIN.

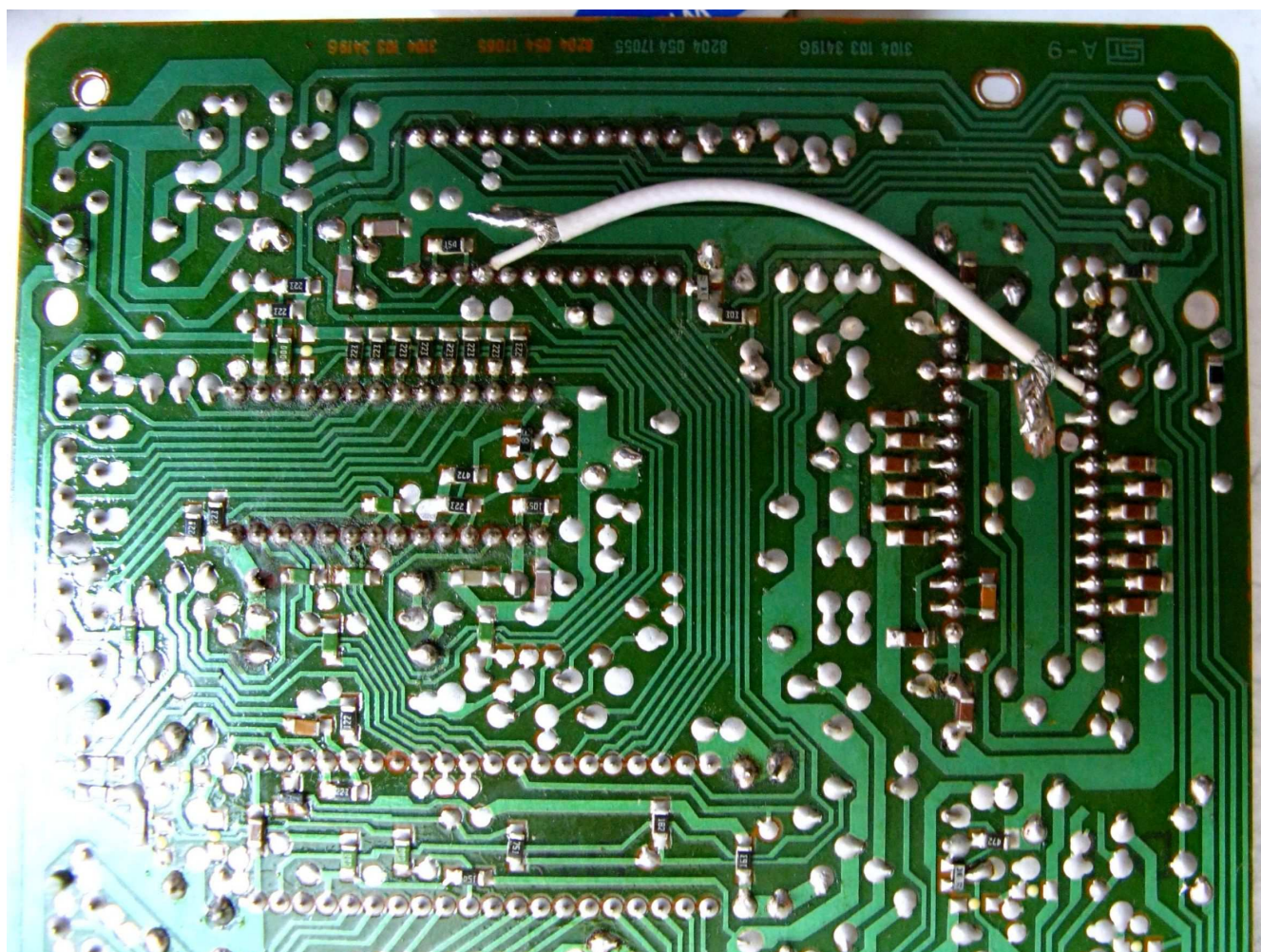
The TDA1541 has 2 clock inputs - the Bit Clock BCK on Pin2 and the System Clock SCK on Pin4. On the standard Philips PCB's, the SAA7220 Pin16 Bit Clock CLBD drives the TDA1541 Pin2 and Pin4 clock inputs, which are linked together.

The TDA1541 datasheet states "A separate system clock input (SCK Pin4) is provided for accurate jitter-free timing of the analogue outputs".

I have separated TDA1541 Pin2 from Pin4, and connected TDA1541 Pin4 SCK directly to SAA7220 Pin9 XSYS via a high-quality Teflon coax cable.

This produced what John Allgaier in Stereophile Magazine 1990 described as "an undeniable cohesion of the sound, a lifting of the veils".

It is not clear whether this jitter-free mod is also applicable to the 1541A, as the 1541A datasheet states that Pin4 should be common-grounded to Pin5 to minimize internal cross-talk. In any case, I cannot comment on the 1541A, as I have not tried it.



## 11. Selecting a Low-Jitter Clock (LJC)

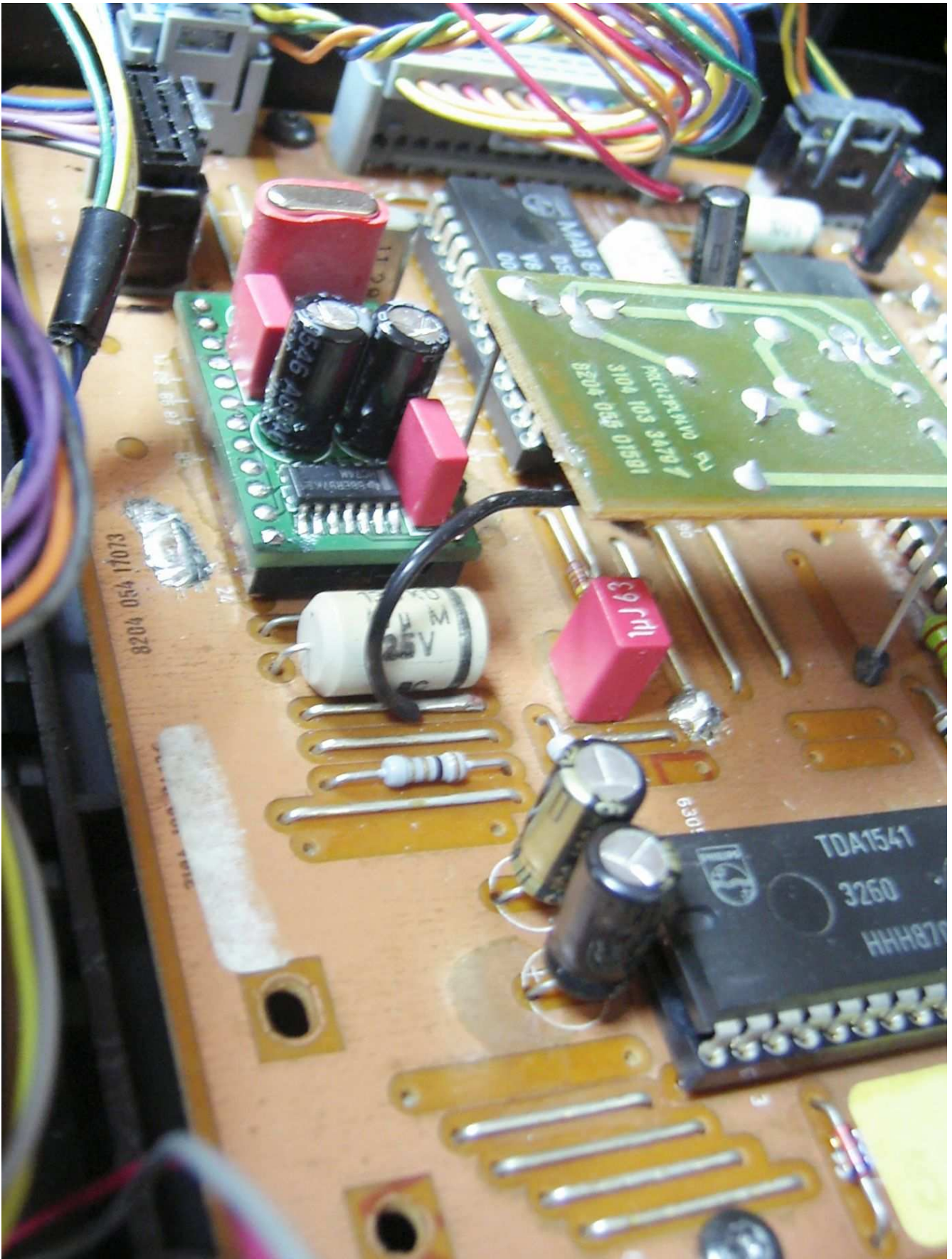
On any CD-player, adding a Low-Jitter clock is an excellent idea to improve the sound characteristics. However, for most of us, budget is a consideration. So, after surveying the market, I selected the NetAudio NOS (Non-OverSampling) mod – cost about \$60.

This is a very easy mod to do, as it requires only the removal of the SAA7220 chip, and the insertion of the NOS mini-PCB, a pin-for-pin replacement.

This mod bypasses the filtering and oversampling circuitry controlled by the SAA7220, and has a good-quality low-jitter clock. A higher-quality crystal can be supplied at slightly higher cost. I chose the most basic model, to see of what improvement it is capable.



I was very impressed with the dramatic improvement. Some techs frown on disabling the SAA7220's filtering capabilities, but it could well be that any possible noise falls outside the frequency range of normal human hearing, so I could not discern any audible noise.



This is a close-up of the NetAudio NOS mod, installed in the SAA7220's socket

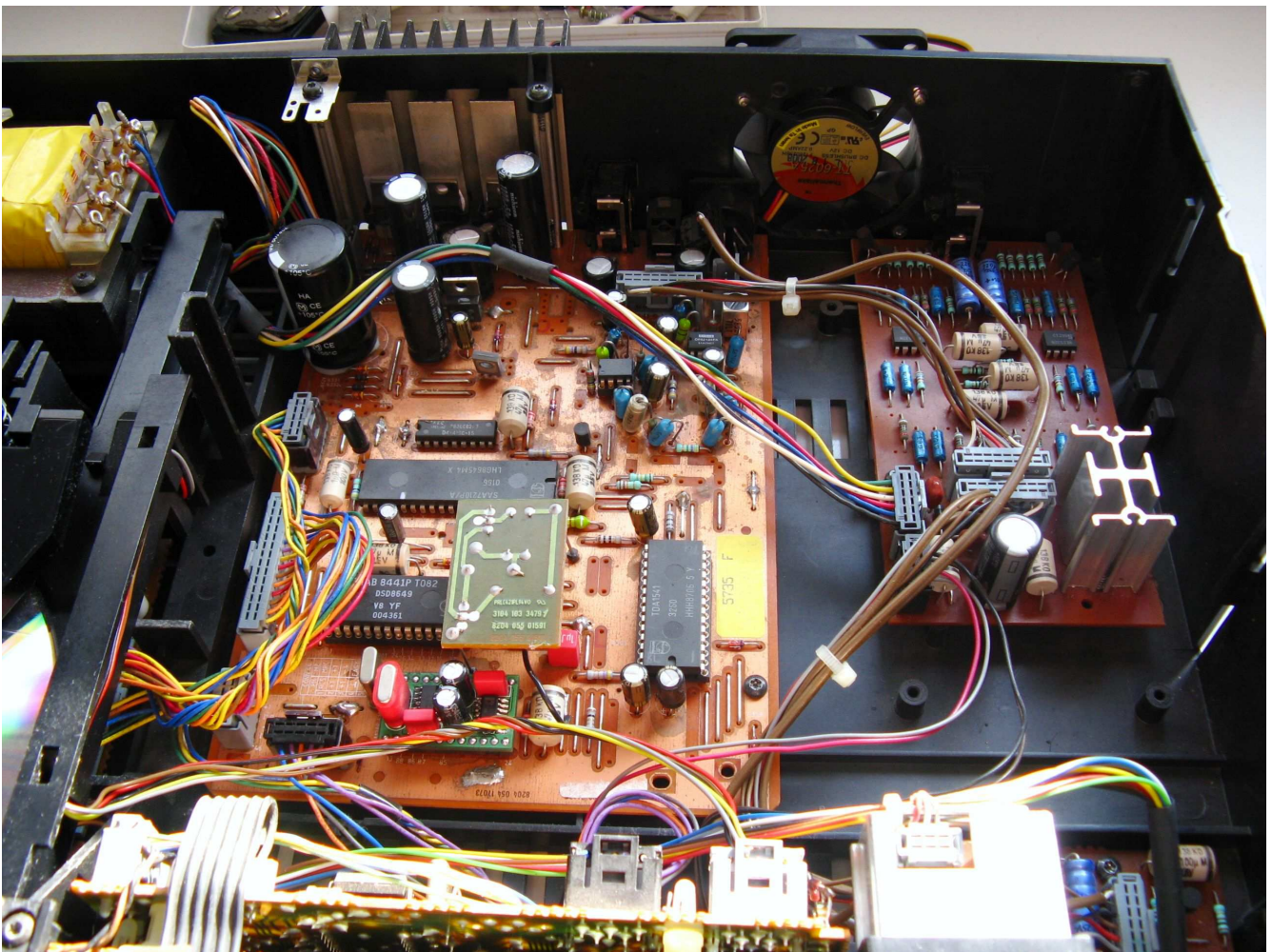
## 12. Installation of a Cooling Fan

This CD650 is well-known for running hot! I installed a 12V Thermaltake 60mm square fan at the rear, between the Main and Filter PCB's.

This is a very quiet fan, and cannot be heard when music is playing, even very softly.

The airflow is directed from the outside to the inside, to provide direct cooling onto some of the hottest components, namely the heat-sink on the Filter PCB's 24V Regulator.





**Completed Interior** – Here you can see the NOS mod, the socketed OpAmps, and all the colourful new wiring harnesses. At the rear, is the new 60mm square fan, for added cooling.

### **Parts for this restoration**

Parts and advice are available for owners who wish to tackle this project by themselves.

<http://www.condoraudio.com>

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