Audio Restoration Project – Repair Upgrade Arcam AVR350 Audio Video Receiver

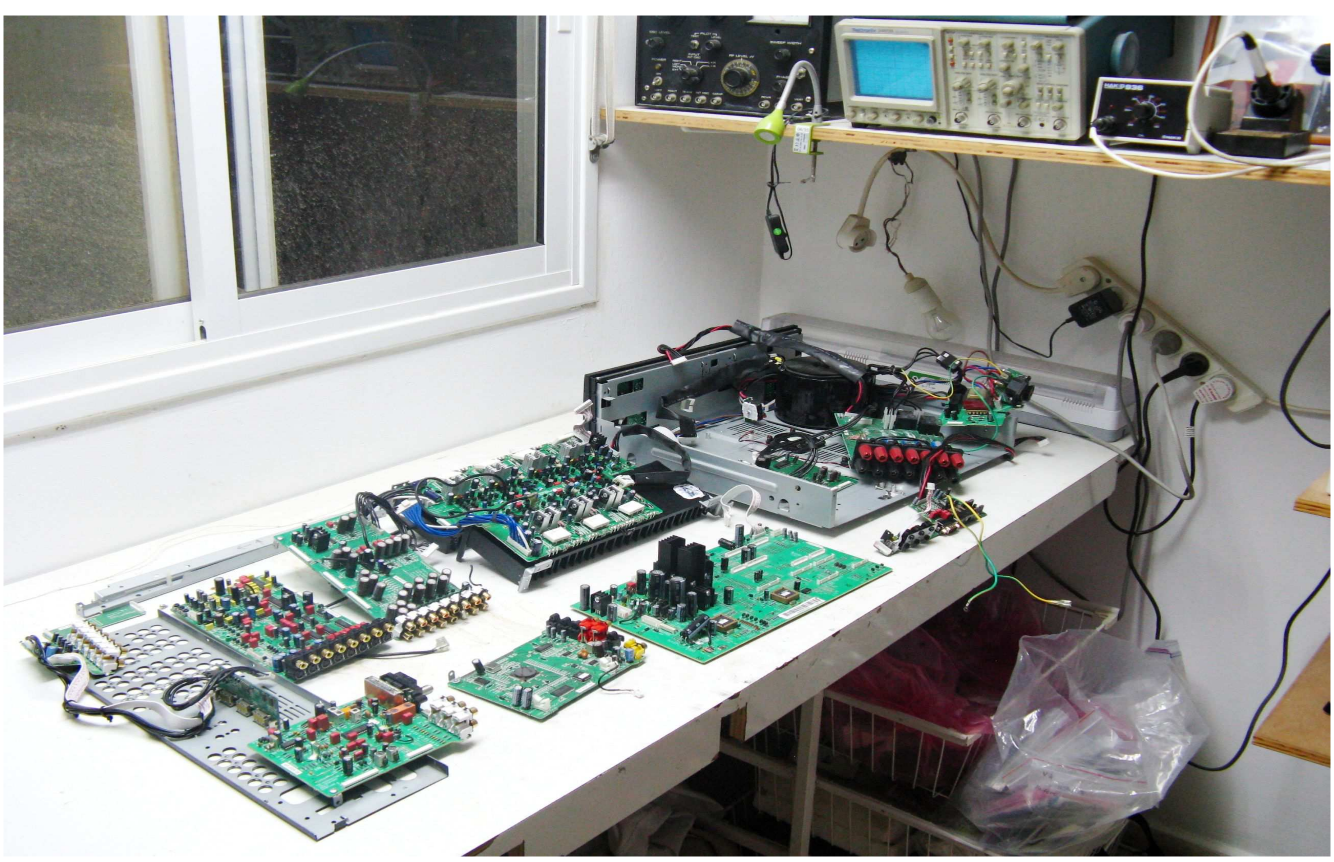
This applies to all similar type models **AVR100, AVR200, AVR250, AVR280 and AVR300** which share common circuit boards.

Although I have had much experience (and much pleasure) restoring the super-heavy classics of the 1970's and 1980's (no need to elaborate here), I have been hankering for some time now to get my hands onto one of the heavyweight classics of today. There is no shortage of contenders whose manufacturers claim in bawdy hype that their offerings are the last word in audio quality, and so I never pay any attention to them anyway. I do however respect Arcam (even though some of their offerings are disappointing, in the form which they come off the production line), and so I was intrigued when a client asked me to do something for his Arcam AVR350 (which has received rave reviews), disappointed because he did not feel that he was hearing the sound he thought he'd paid for.

The first thing I did was connect it to my reference speakers – restored 1977-vintage Bang and Olufsen Beovox S45's. I was very disappointed also, as I am well aware of the full, detailed sound that they are capable of delivering, when powered by a capable amplifier. They are powered daily by my restored 1976 B&O BeoMaster 3400, and this system's sound will stand up to anything with which anyone may care to challenge it !

Even on the AVR350's "Direct" sound, which defeats all the DSP circuitry, the music played through my restored Arcam CD92 sounded muted, as if were we separated from the source by a heavy curtain (and that's being nice).

This unit was manufactured in 2006, which does not speak well for the demonstrably too-short lifetime of the poor-quality components installed at the factory. Again IMO, Arcam has not shown evidence of good judgment, by selecting such poor-quality capacitors as original equipment, and then charging a premium price for this product.



This was the start of my most ambitious restoration project ever, which during the course of 6 full work-weeks, consumed over 400 capacitors, diodes and resistors, in a complete rebuild of the system.

After completely dismantling the unit, I always start by drawing a component map of each circuit board – that was a full week (14 circuit boards). Thereafter, another full week: reviewing the Circuit Diagrams, in order to differentiate between the power circuits, the processing circuits, and the signal paths, in order to decide what I wanted to do with each circuit.

Caps	Dim	TOTAL	1 Key	2 Audio Ou	3 Audio Ii	4 OSD	5	6 SH(	7 RS232	8 DSP	9 Main	10 AC PSL	11 Tune	12 HDMI	13 Amp1	14 Amp2	CD92PSU	CD92DAC	CD72DAC
1.5nF	WIMA	2											2						
0.22		2				1							1						
0.47		5				3							2						
1 50		12				5			4				3						
2.2 50		41				38							3						
3.3 50		1									1								
4.7 50	WIMA	1											1						
4.7 50	A	14													8	6			
10 16	SMD	5												5					
10 16	FC EB PW	34	1		2	4			14	4	6		3						
10 16	KT	10				9				1									Silmic 2
10 25	Silmic	2													Silmic 4	Silmic 3			
10 35	KT Silmic	7																	3
10 50	FC EB	10			5						2						1	5	
10 50	HE Fc	6													12	9			
10 50	KT	25			4													5	1
10 63	BP ES	6																	
22 16	KT	5				1 KT							33KZ 4						
22 16	HE	4		3									1				1	1	1
22 20	Oscon	4		1														1 Silmic	
22 25	Silmic	1															1		
22 50	HE	1																	
47 16	HE	29	3	5		14			3		3		1						
47 16	KT	2				1				1							1		
47 50	HE	3	1								1								
47 63	FC HE KT	14													47/63 PW 8	PW 6			
100 16	HE	17		2		3					3		4		5		5	6	2
100 25	HE	15										2					1	3	2
100 25	FM	6																3 KZ	
100 25	Silmic KZ	3																	
100 50	HE	2								1	1						2		
100 100	HE	2													2 20/35				
220 10	HE	1									1				HE PW 4x Silmic 5	PW 3		1	
220 16	HE	RFS 9																	
220 16	KT	26		RFS 24	RFS 2 KZ														

Then, I returned to the component maps, to mark at each component what will be the selected replacement part, then compiling a BoM, and then sourcing the selected parts from my distributors. Signal path components are coloured, to emphasize special attention.

Beyond the long research period mentioned above, this was a very time-consuming project in its execution. The circuit-boards are double-layer, and all the circuit board through-holes are plated, and soldered with lead-free solder. The components' legs are bent 90-degrees flush.
So any technicians reading this, can well understand the logistics involved in removing each of the more than 400 components, without damaging the circuit board.

Removing each component was a 5-step operation, as opposed to a 2-step operation on older units with non-plated single-layer PCB's. And I had to work quickly, to avoid PCB-damage because of the higher soldering temperatures required working with lead-free solder. Needless to say, all my soldering is done with fully-leaded solder, and I will not be convinced to change over.

Firstly, I had to heat each component leg, and bend it vertical with a miniature stainless-steel blade. Then heat it again to remove the component. Then heat the hole while poking a stainless-steel pin through the hole to eject the solder, ready for inserting the new component. Then finally inserting, and soldering the new component. Very time-consuming and labor-intensive.

On the Main PSU PCB, I resoldered every joint with fully-leaded solder. On this PCB especially, random problems have been reported due to the unleaded solder originally used, which breaks down with the continual expansion and contraction during the normal heating/cooling cycles of operation.

Output Power Amplifier Circuit Boards

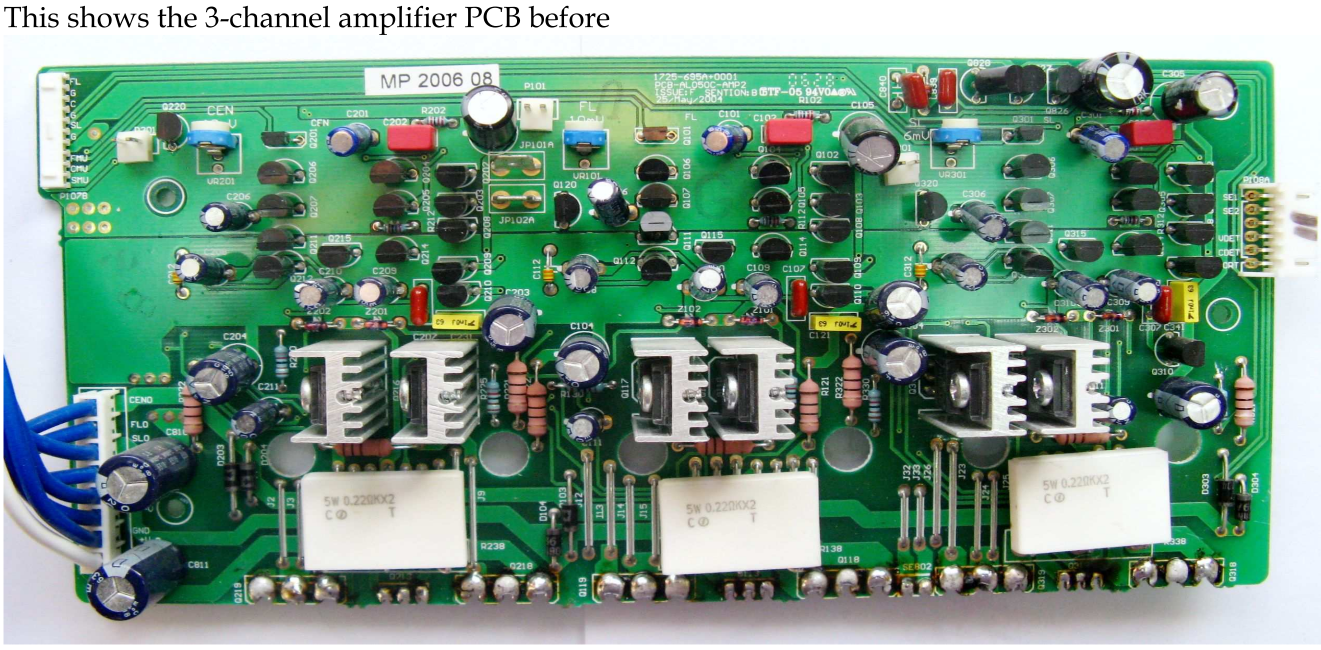
I started on the 2 output amplifier PCB's. Arcam gets a plus for using discrete amplifier stages (instead of STK IC's) here! The 7 channels are split up into 2 PCB's – 3 channels on one, and 4 on the other. The output transistors are 2SA1987 (PNP) and 2SC5359 (NPN) and the drivers are 2SC3421 (NPN).

After desoldering them from the PCB's, I tested for Hfe on each transistor, to see if Arcam had done a correct job during assembly of matching the pairs within 10%. I was disappointed. They appeared to have been placed randomly, with no consideration given to matching them.

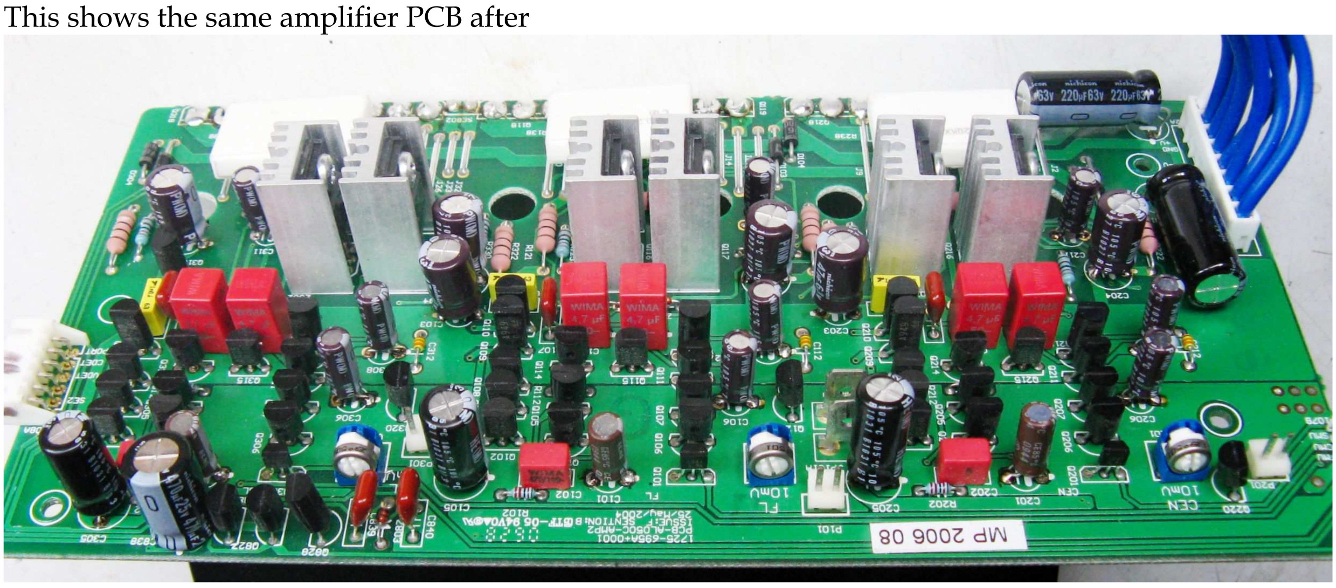
By moving them around, I managed to match 5 of the 7 transistor pairs within 10% (FL, FR, CEN, SL, SR), and the 2 less-well matched pairs I put on the BSL and BSR channels (which are the least used - if at all, in a 5.1 system).

Practically, it means that those 2 channels will have bias-current fluctuations during operation and will run slightly hotter, even after adjusting the bias-current, in this case to 6mV or 10mV, depending on the channel.

This shows the 3-channel amplifier PCB before

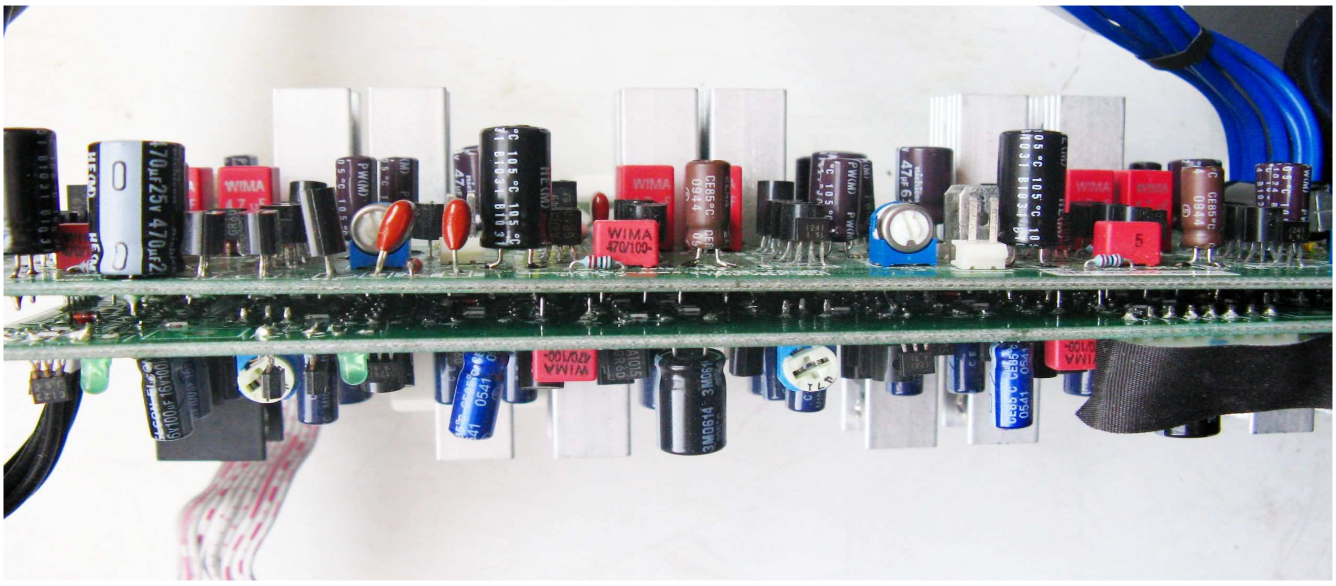


This shows the same amplifier PCB after



Here I used Elna Silmic II and Wima MKS2 in the signal path, and Nichicon HE and PW for power decoupling. On these 2 PCB's, I replaced 74 capacitors and 7 potentiometers. Notice the dual 0.22ohm ceramic bias resistors.

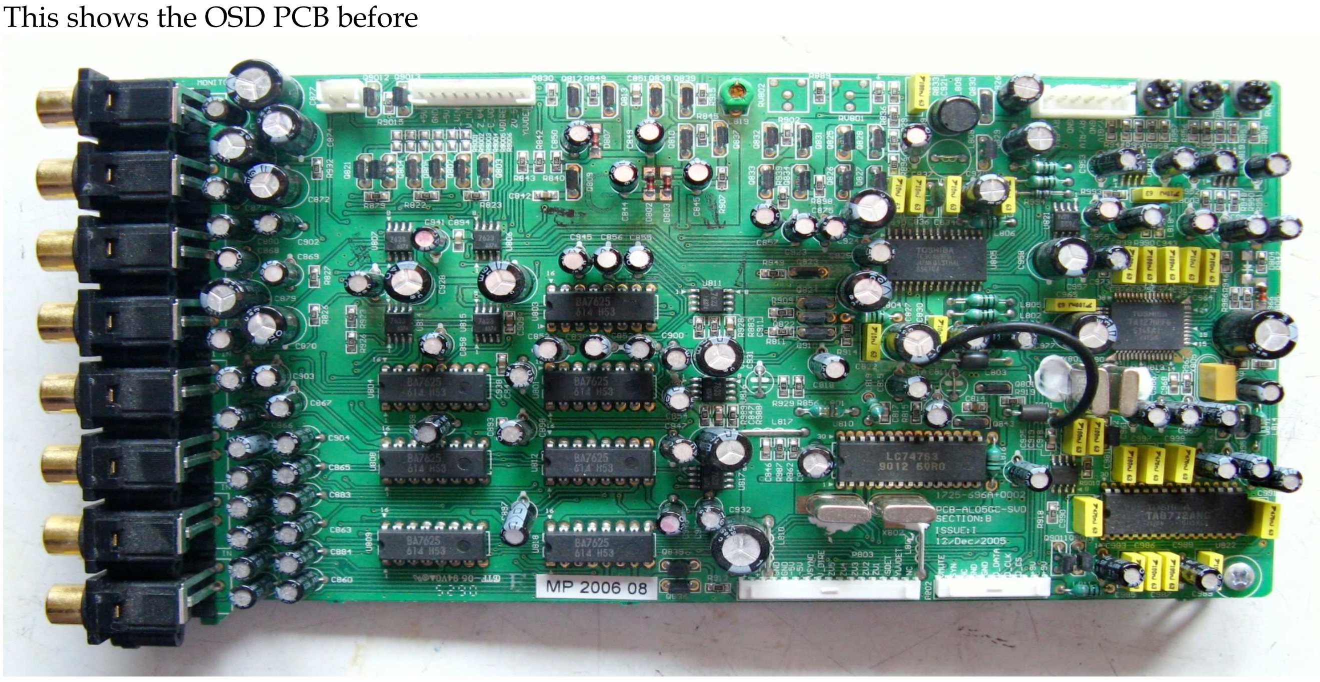
Here is a profile view showing clearly the Before (bottom) and After (top) views. Notice the new Bourns 3329 Cermet potentiometers (top) vs the standard unreliable Carbon units (bottom).



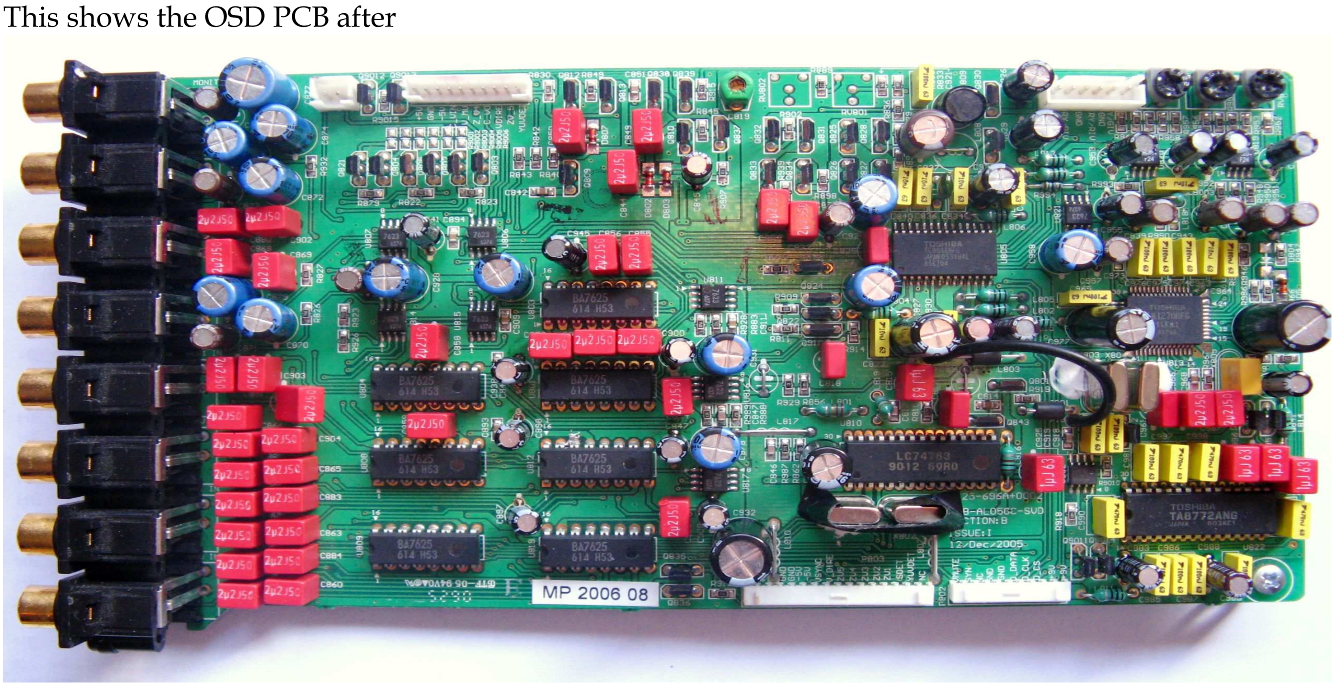
OSD / SHQ Video Processing Circuit Board

This was the PCB with the most replacements of all – exactly 97 capacitors replaced. Although I would have liked to have used Nichicon KZ and Elna Silmic in the signal path, I settled for the smaller Nichicon KT units (blue), because of the limited space available.

This shows the OSD PCB before



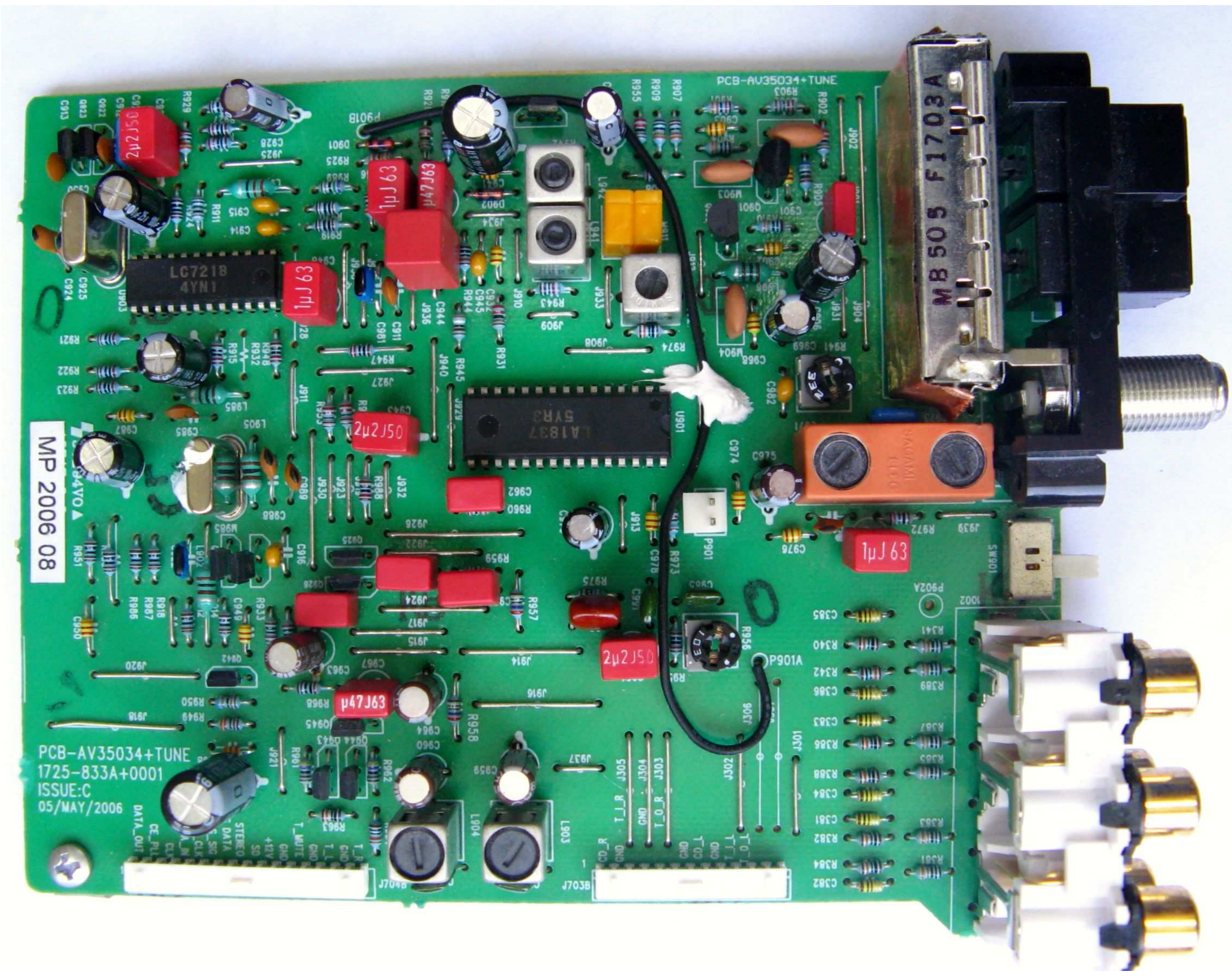
This shows the OSD PCB after



FM / AM Tuner Circuit Board

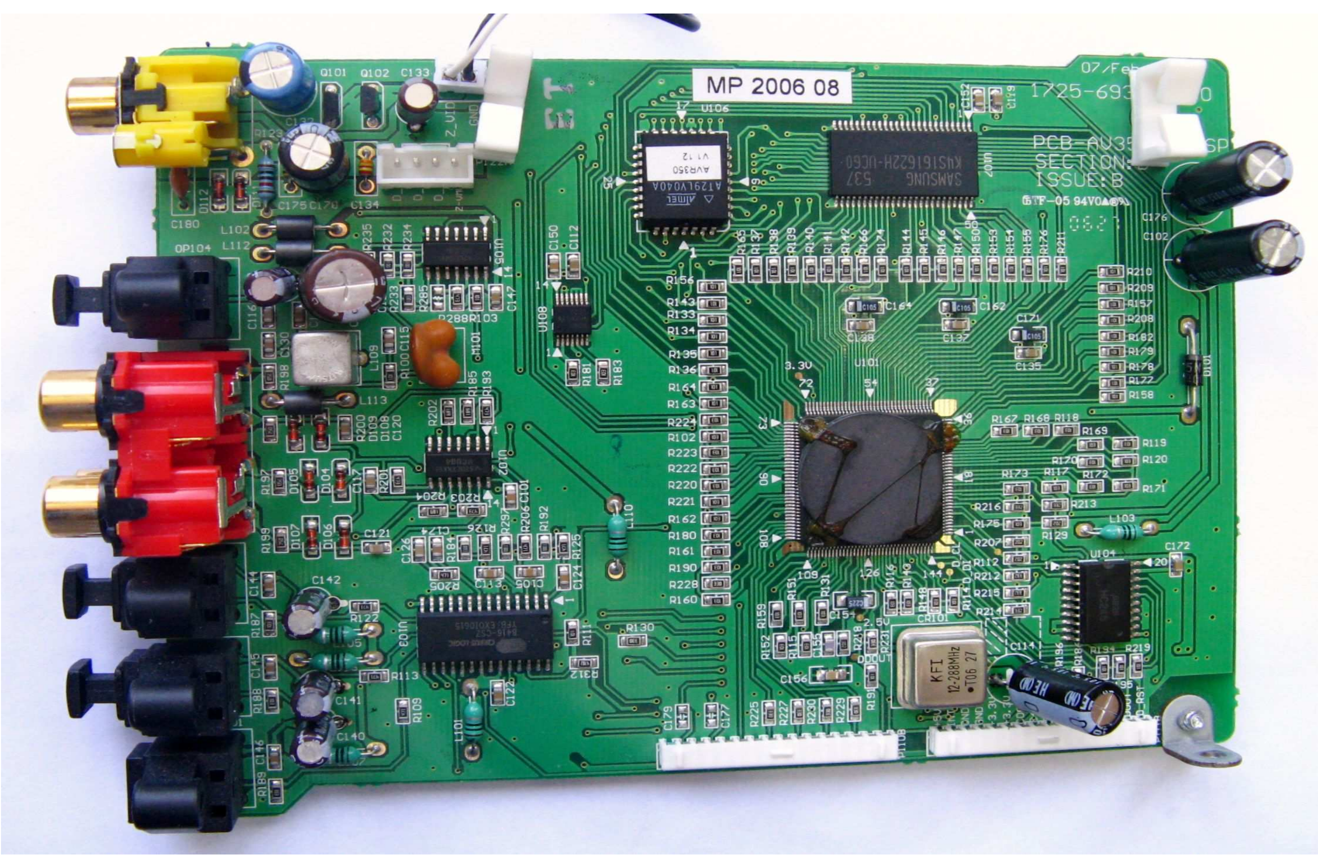
This is a classic example of drastically improving the enjoyment level of the customer on a daily basis. By simply using much better components, a more stable reception apparatus is achievable.

Here I used Wima MKS2 film capacitors extensively, and Elna Silmic II in the audio path.



DSP Circuit Board

This PCB has the fewest number of discrete components, and it's the place where the blackest of blacks and quietest of quiet images are achievable, so I'm surprised that Arcam didn't make a little extra effort to beat me to this?

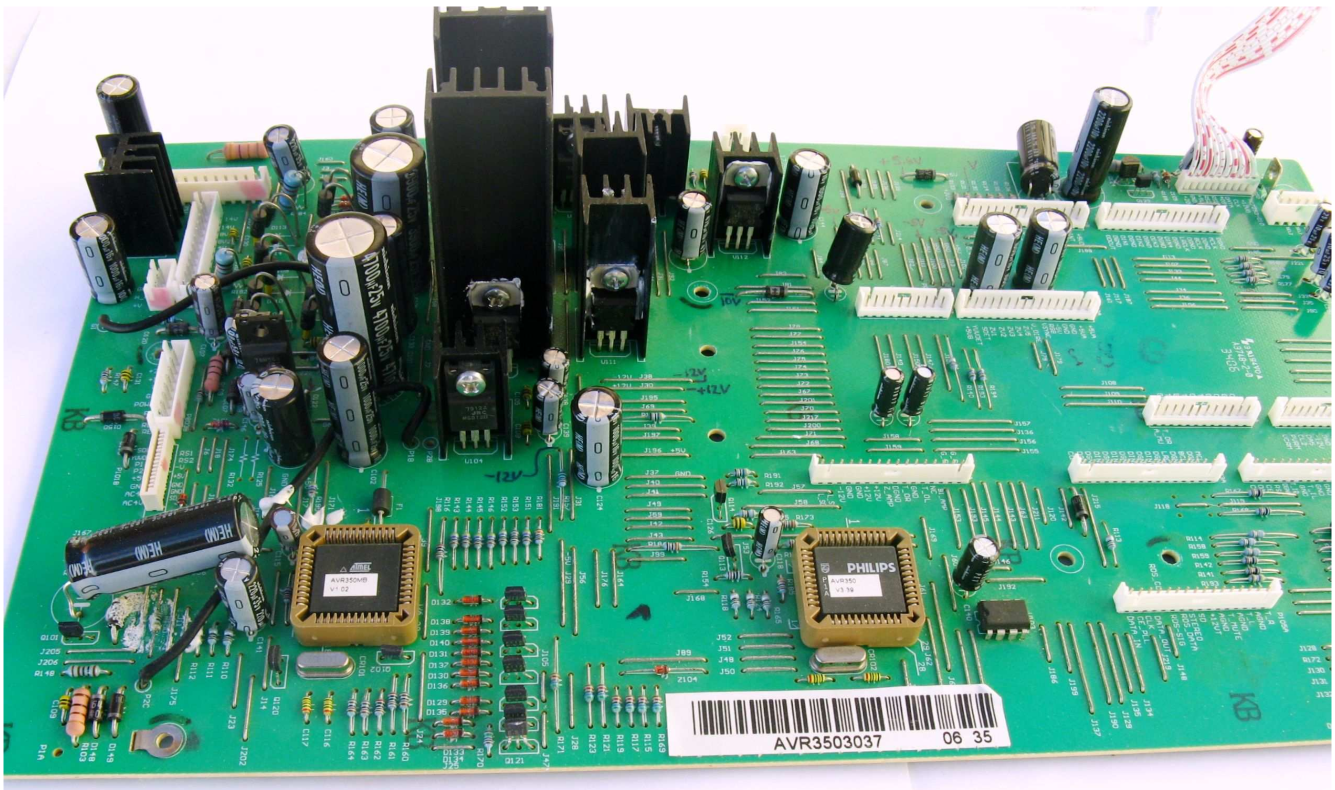


Main PSU Motherboard PCB

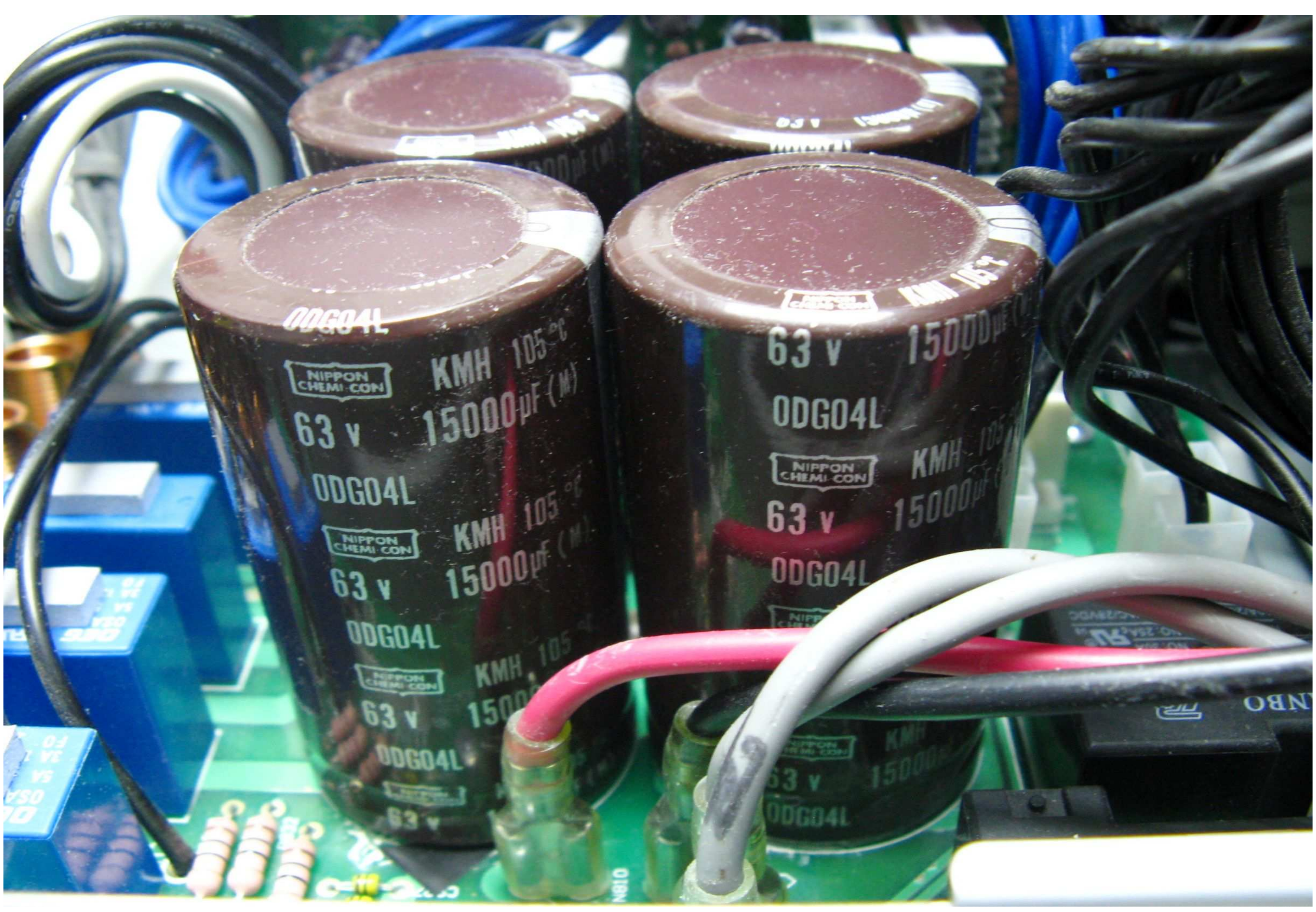
Physically, the AVR series is organised internally into a main horizontally-mounted motherboard (like a desktop computer), on which all the ancillary PCB's mount vertically.

At the left, are the sockets for cables from the enormous toroid transformer, which supplies AC power. This is then rectified by the banks of diodes into DC power, and then regulated by the 78xx and 79xx regulators with the big heat sinks. That is evidence of a lot of heat being dissipated.. To cool things down, I substituted the original JRC L78xx 1 amp regulators with the new range of ST–Micro (Siemens-Thomson) L78Sxx regulators capable of 2 amps per circuit.

Here, I used all Nichicon HE capacitors to replace the original Elcon units. The HE are my favorites for power decoupling. The 2 Firmware chips are also clearly visible. There is a 3rd firmware chip on the Keyboard PCB.



I also replaced the 4 original unknown "Nover" 12,000uF Power capacitors, with tried-and-true Nippon Chemicon KMH 15,000uF units. Over the years, I have had very good experience with using the KMH series as power caps, and I was not disappointed here! They are much higher than the originals, but there is plenty of vertical space available.



Correction of defective power supply over-voltage, which results in failure of the DSP Circuit Board

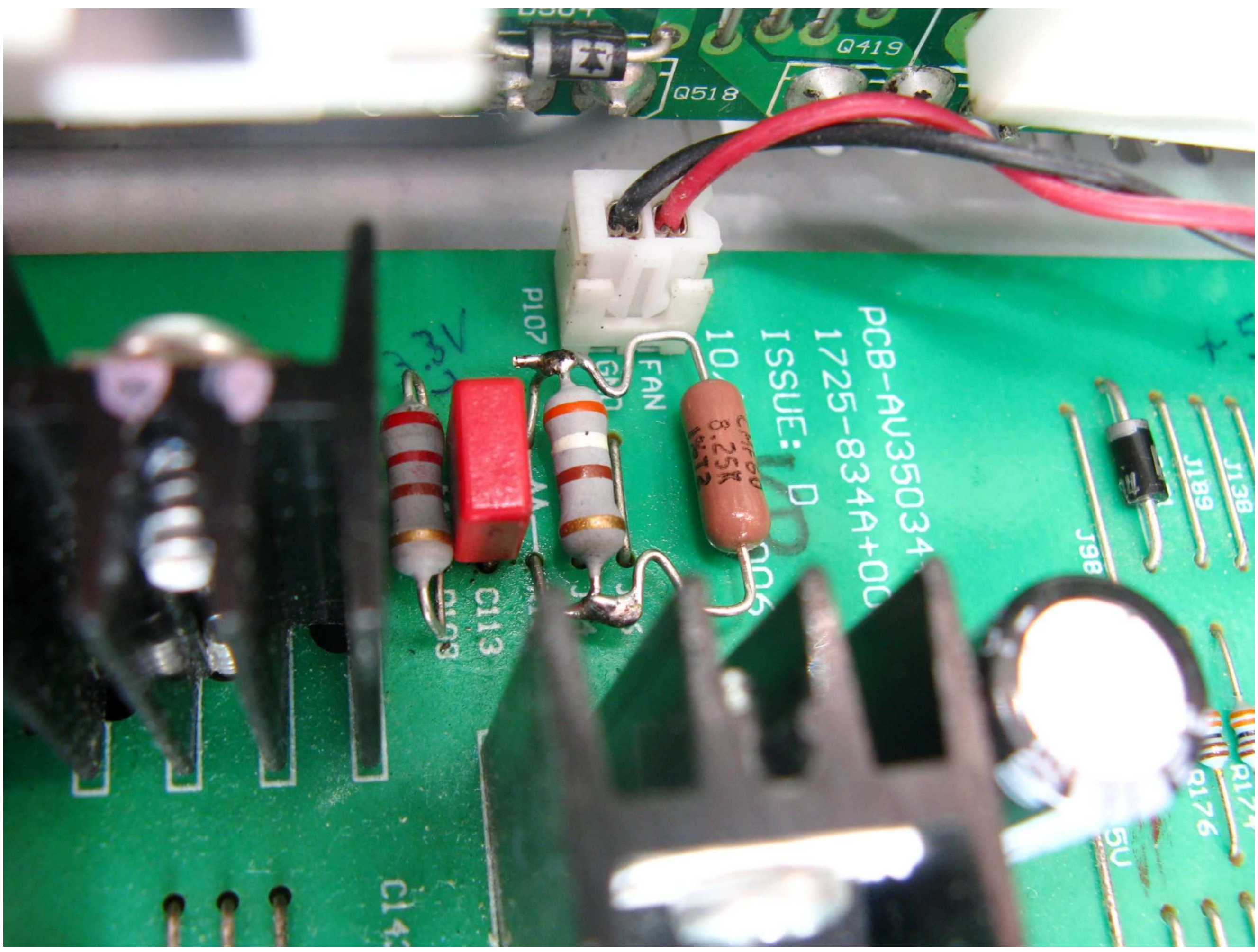
All models of this series, including the AVR250, AVR280, AVR300, and AVR350 suffer from an inordinately high failure rate of the DSP circuit board.

The DSP PCB requires 3.30VDC, which is supposed to be supplied by the main motherboard, via U108 – an LM317 positive regulator. The LM317 is a superbly reliable IC, and will do exactly what it's commanded to do, as long as the circuit designer installs the appropriate values of the control resistors R107 and R108.

I did the math here, and there is no way that the LM317 would ever deliver 3.30V with the original installed control resistors. So there was an inherent design fault here.

To correct the problem, I replaced the original R107 with a 1/2W 390 ohm precision metal-oxide resistor, paralleled with a 1/2W 8.25 Kohm precision metal-film resistor. This provides exactly 3.30VDC, under load.

I also replaced the original R108 with a 1/2W 220 ohm precision metal-oxide resistor, and C113 with a precision Wima 100nF polypropylene capacitor. These are the original values, but better quality.



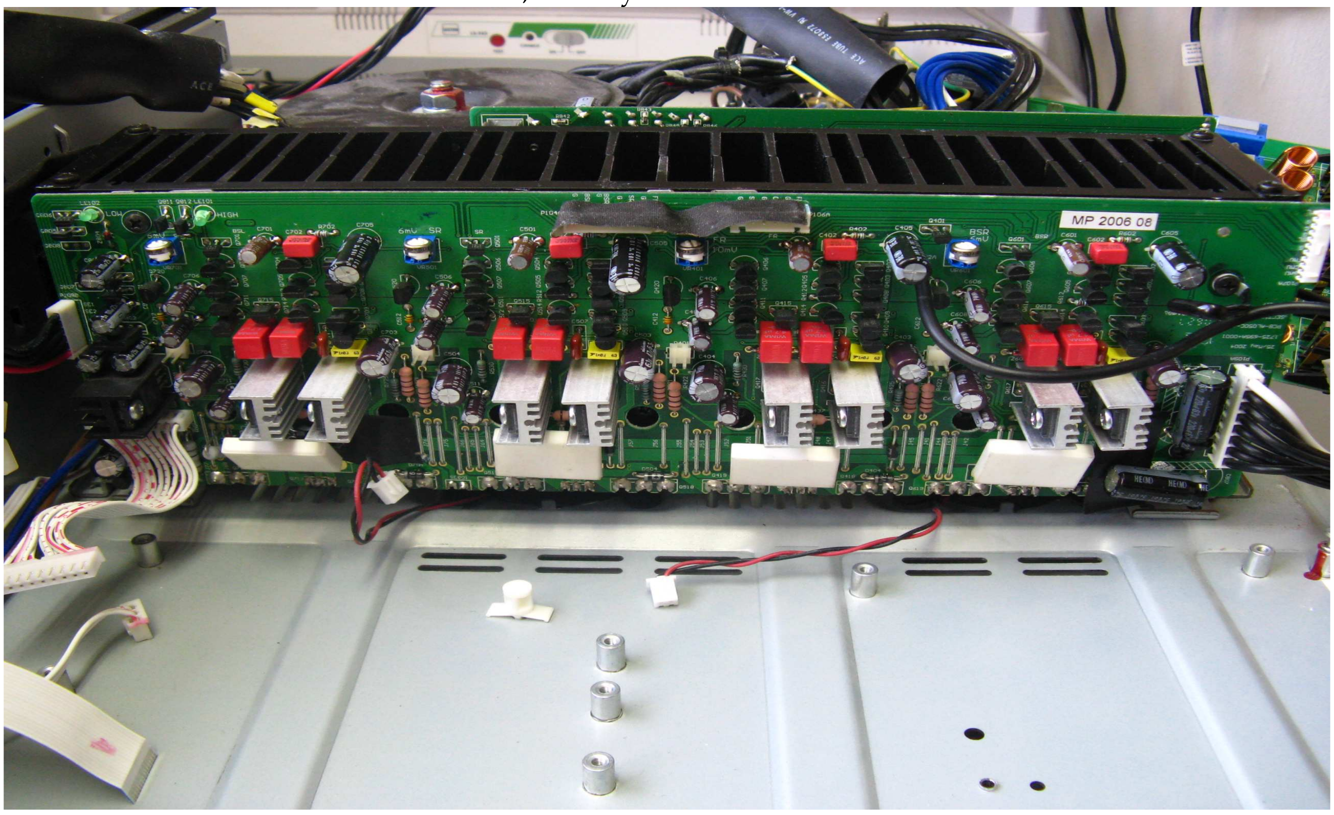
To their credit, Arcam's Service Department was quite grateful that I shared this solution with them.

I asked them to ship me only the defective IC on the DSP PCB (which I intended to replace on the existing PCB), but they informed me that they do not warehouse individual board-level components, and so they shipped me a complete replacement DSP PCB by return post.

Without correcting the power supply circuit to the proper voltage, a frustrated owner would replace the DSP PCB time and again, without ever solving the problem; the DSP PCB is not the problem at all – it's just overheating because of excessive supply voltage!

Reassembly

Here is the 4-channel amplifier PCB, remounted on its enormous heat sink, in the center of the receiver. The 2 red/black wires at the bottom are for the 2 sensor-driven cooling fans. The power transistors are mounted behind the PCB, directly onto the black heat-sinks.

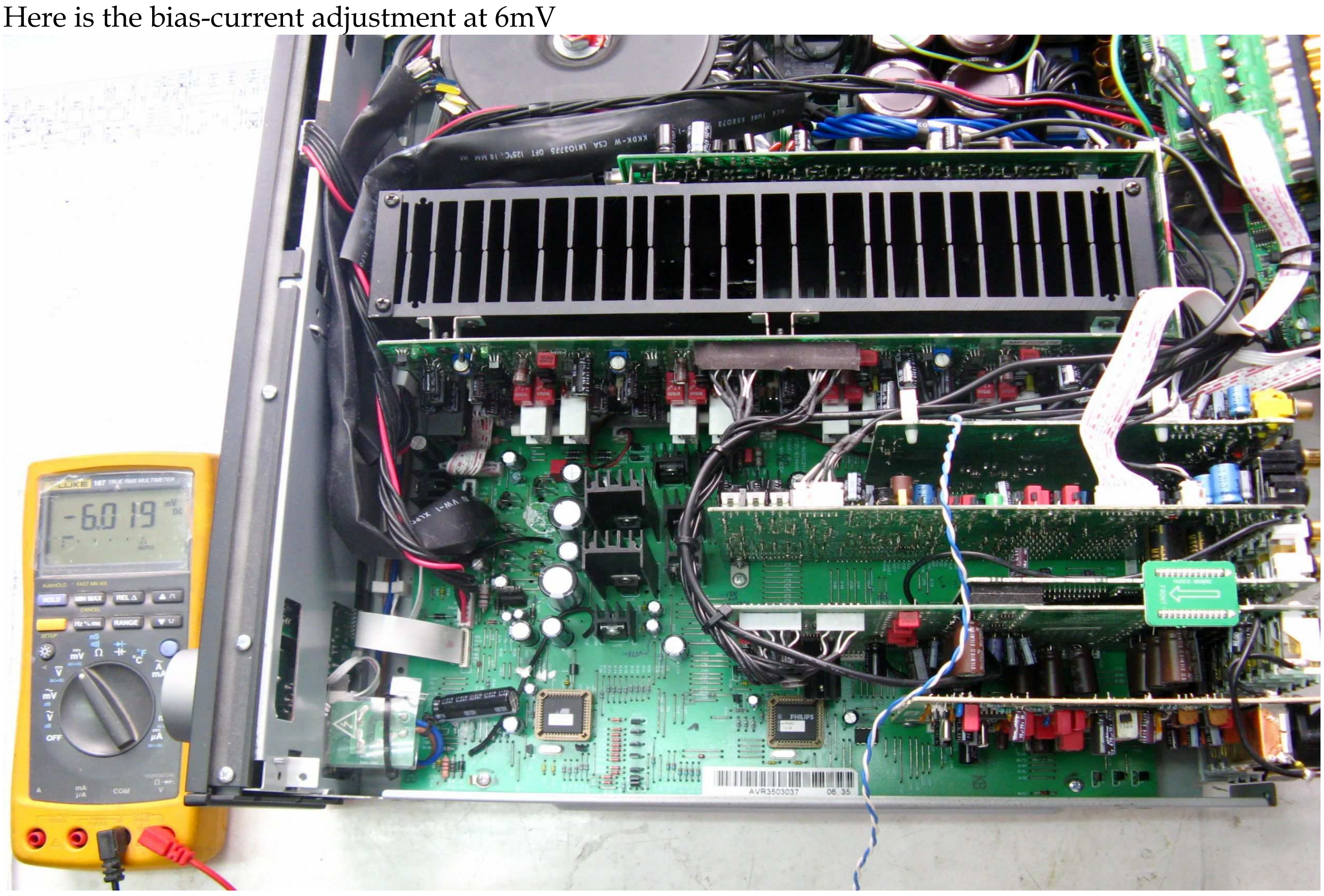


Calibration and Alignment

Upon request for the Service Manual, Arcam sent me the Circuit Diagrams of the AVR350. When I requested that section of the Service Manual containing the calibration adjustments, I was informed that this was not available. I then searched on the web for Service Manuals for the rest of the Arcam AVR range, knowing that all these units share common circuit boards, and perhaps I might be able to use another unit's Manual for this AVR350. I did in fact find a complete Service Manual for the AVR200, which as I expected, had thorough calibration instructions, common to this AVR350 as well.

I set the bias current for 6mV and 10mV on the 7 amplifiers respectively. The power amplifier heat sinks are just barely warm now, versus prior to this overhaul they were hot to the touch. I then aligned the FM and AM sections. There is one small difference in the AM Oscillator alignment procedure – voltage must be read from J902 on the AVR350, instead of that mentioned in the AVR200 manual.

Here is the bias-current adjustment at 6mV



Final Impressions

Before even judging the improvement in sound quality, it's good to know that the machine will have many years of trouble-free life ahead of it. Quality components (especially that the customer cannot see them, and even if he could, he would be hard-pressed to understand them) are vital for long-term peace-of-mind, and THAT is what makes for satisfied repeat customers.

Having said that, I was pleasantly surprised at the more open, full sound now playing through those very same BeoVox S45 speakers. A very noticeable difference was apparent using "Direct" sound – a real pleasure now. Tight, punchy bass, sibilant treble, open midrange, clear vocals, well, I could go on. Suffice to say that this massive effort was well worth it.

Summary

For 95% of the capacitors, Arcam chose to use standard units manufactured by Elcon – IMO a 3rd-rate manufacturer, as evidenced by the short lifetime of their products; there were also a few "Licon" caps, and exactly 8 Elna caps, but nothing special, just the standard 85℃ blue series. At the end of the day, my selection of (mostly 105°C) Nichicon (KT KZ Muse) and Elna (Silmic II) audio capacitors, Nippon Chemicon (KMH), Nichicon (HE PW) and Panasonic (FM FC) power capacitors, Wima (MKS2) film capacitors, and Vishay (PRO2) metal-film resistors and (11DQ10) diodes and Bourns (3329) cermet potentiometers came to just over $280. Let's translate that to about only $60/receiver-unit, when bought in +1000's quantity.

IMO, Arcam short-changed the customer, by selecting substandard capacitors and other components, instead of those produced by well-known reliable trustworthy component manufacturers, as I mentioned above.

That's very unfortunate, because Arcam's reputation was founded on high-quality – it's sad to see them also venturing out on that tempting decline, chasing Greed before Quality, on which so many other previously respected manufacturers have found their demise.

Parts for this restoration

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

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