

Modding the Music Hall CD25.2 CD Player

If you're looking for a project with endless possibilities and a big payoff in sound, modifying the Music Hall CD25.2 CD Player may be just the ticket.



PHOTO 1: Exterior view of CD25.2

Why people buy things has so much to do with personal taste that it's hard to justify a particular purchase on purely logical or technical grounds. Suffice it to say that I needed to replace my aging Rotel 855 player (which had been heavily modified already) with a more reliable one (the CD drawer wouldn't open automatically anymore). I considered spending thousands for a high-end player (if I had the money) or buying a less expensive player and trying to make it high end—thus the Music Hall CD25.2 (Photo 1).

It didn't hurt that I had once met Roy Hall and knew his taste for “musical” audio equipment. At \$600 the player came with good credentials^{1,2}, but certainly not the ratings of expensive solid-state players, nor the tube circuitry in vogue with audiophiles. For additional reviews of its features and opinions, you can search the web. Buying it was as much a search for a project as it was a search for nirvana in the audio realm.

WHY THIS CD PLAYER?

Right out of the box, it blew away the Rotel, even with my improvements (all-new analog section). It presented a solid, dynamic sound but with a forward tilt and limited dimensionality. Still, it was a major step up. However, the sound

quality of some more expensive players I had also just auditioned was ringing in my ears, so I opened up the case and looked inside to see what could be done.

Two notes first:

1. Making the following modifications could void your warranty.
2. The ideas here could very well be applicable to other CD players because the analog architectures after the D/A converter may be similar. Also, be extremely careful with live voltages with the cover off—you could receive a nasty shock or you could accidentally damage the circuitry.

UNDER THE COVERS

All CD25.2 audio components are mounted on a very nicely laid out board (Photo 2). Only two surface-mount devices are

used for the transport control and D/A converter. Every IC has nearby decoupling electrolytics, each of which is also bypassed with a 0.1μF Mylar film capacitor.

The bottom side of what looks to be a four-layer board is almost a solid ground plane, well divided into sections that all terminate in a central ground point. The grounding is further enhanced with about a 3mm wide ground trace heaped with solder along its entire length, forming a semi-circular mound of solder (Photo 3). Even though solder is only about 10% as conductive as copper, the net result is a decrease in ground resistance by a factor of about 35 over the copper trace, according to my calculations!

There are no fewer than seven regulated power supplies onboard, fed by a 50VA toroidal transformer. Even the bridge rectifier diodes are bypassed with the same Mylar caps as on the analog ±15V supplies. The audio outputs include a back-to-back pair of large electrolytics bypassed with a “For Audio” 1μF capacitor (never heard of the brand, but it's a big polypropylene cap). All-in-all, well done for this price range!

MODS-R-US

The CD25.2 seems to have been “designed to be modified.” All components except two ICs are through-hole devices, all wiring to the motherboard is via removable connectors (making them easy to remove for soldering), all six op amps (two of which are duals) come already socketed for easy removal, and the motherboard is well marked with component IDs and values. If you Google modifications to this player, you will get several hits from highly capable companies who offer



PHOTO 2: Inside the CD25.2 with modified board.

many upgrades^{3,4}. One nice feature of these offers is that the original manufacturer's warranty is still honored. But I looked at those possibilities and said to myself, "Great, but what fun is that?" So here we are with a whole lot of possibilities to explore.

I needed to pare down the list of potential mods to something manageable. My criterion was primarily that I had to be able to "undo" and "redo" the mod quickly so that I could listen to the effects while my auditory memory was still relatively fresh. This necessitated putting sockets on many capacitors as well as on the digital voltage regulator.

An interesting sidelight to modifications is the answer to the question, "If these changes are so good, why didn't the manufacturer do them at the factory?" It turns out that the answer is simple economics. The typical markup from factory to buyer is about four times on parts and labor. This covers factory and distributor or retailer overheads, sales expenses, and

so on. This means adding \$25 in parts increases the list price by about \$100. Whoa!

Say you replace eight op amps that cost \$2 each with OPA627Bs which cost \$20 each in quantity. $\$20 \times 8 \times 4 = \640 , bringing the price of the CD25.2 from \$600 to \$1240. Well, you may say, it now sounds like a \$1200 player. Maybe so, but that's not the price point Music Hall was aiming for. By comparison, a modification house will charge only about two times on the parts and labor cost—perhaps \$300. Of course, doing it yourself can be even less, so stay tuned!

MEASUREMENTS (OR NOT)

One objective of this project was to try to relate sound improvements to improvements in known audio measures, such as frequency response and distortion. Alas, to my great disappointment, this was not to be because, with rare exceptions, the normal measurements were virtually unchanged throughout the modification

process. Even using an Audio Precision One system, the differences between the stock CD player and the fully modified one are minuscule, as seen in the following series of figures for frequency response (Fig. 1—dark blue is stock), total harmonic distortion (THD) (Fig. 2—dark blue is stock), intermodulation distortion (Fig. 3—dark blue is stock), using the *HiFi News* test CD⁵.

These results were both a great disappointment and a puzzlement, because I thought the audible differences were great. Perhaps the issue was that the technical performance of the CD player was already very near the 16-bit threshold limits to begin with, rendering measurement beyond my instrumentation's capacity. However, I believe there must be some measurements that will show the effects but clearly not the traditional ones. Figuring this out sounds like a future project.

For listening evaluation I originally chose at least a half dozen different types

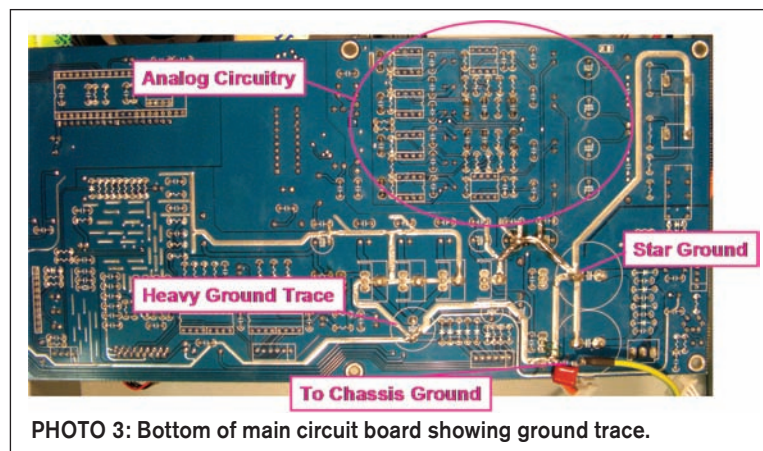


PHOTO 3: Bottom of main circuit board showing ground trace.

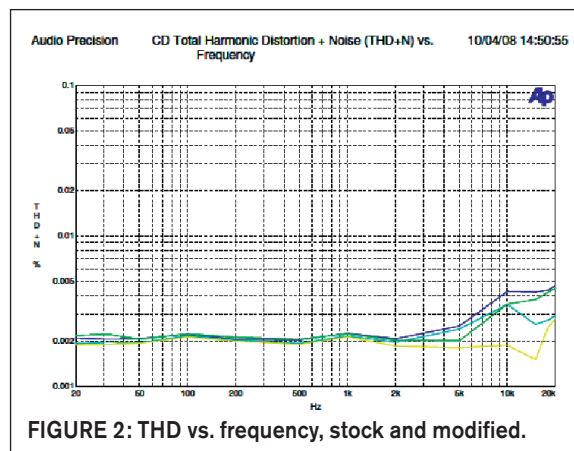


FIGURE 2: THD vs. frequency, stock and modified.

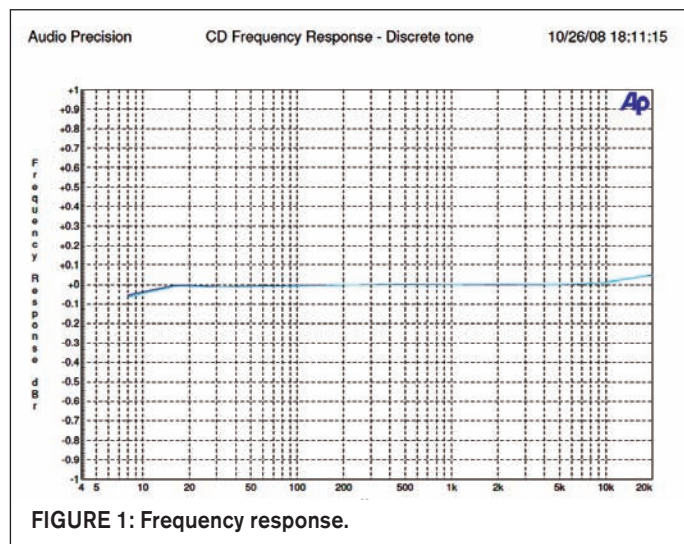


FIGURE 1: Frequency response.

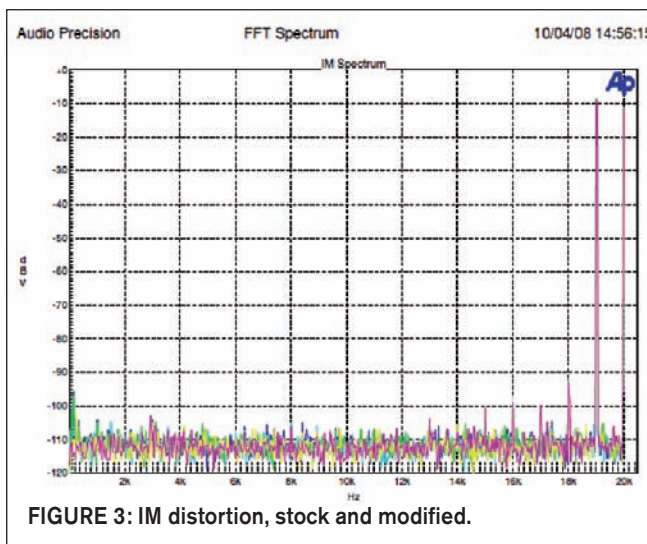


FIGURE 3: IM distortion, stock and modified.

of music, from folk to jazz to rock to classical, with and without voice. As I became more familiar with each piece and the effects of each mod, it was possible to detect the differences with just one or two CDs because the effect was similar on all the music. In fact, after a while I could hear the “before and after difference” in less than 10 seconds with a given track. That doesn’t mean it is easy to describe. There is no way I can fill up five pages describing the nuances of each change as might be done in the audiophile magazines. I have tried to use the words “air,” “soundstage,” and so on as best as I can here, but you’ll need to decide for yourself what you like.

Just so you know, my personal leaning is toward what’s often called “musicality”—does it have good rhythm? Clean, clear, solid bass? Dynamics? My whole system has been solid-state for 20 years. That said, I have been on a quest to improve the air and soundstage depth of my system without sacrificing musicality, and I was reasonably successful with this project, so don’t give up hope, tube fans!

THE MUSIC

I used two cuts for air and transient response:

1. Joni Mitchell’s *Urge for Going*, which seems to be available only on her Hits album, Reprise #9-46326-2. The two guitars which start the piece show off plucking of strings, soundstage separation, and airiness very well. Of course, so does her voice. It’s hard to believe this was made from a 40-year old analog recording.
2. The beginning of Handel’s Harp concerto Opus 4 No 6 with Marisa Robles at the Harp, London 452585-2. Both the strings in the orchestra and the solo harp use plucked notes, making it easy to tell whether a mod has added clarity or mud to the mix. It’s a delightful piece.

For socko (deep bass and kick drum togetherness)—Gorillaz’ *Windmill* cut on their Demon Days album will almost shake out your fillings, but reveals much about how the bass is affected.

THE MODS

The sequence of making changes and testing was a quandary. The best approach seemed to be to work from the

output in—that is, make changes from the “end” of the component chain inward, thereby unblocking any upstream improvements that would otherwise be constricted.

To make the changes easy, I first installed a number of sockets for the components that would be changed often. This required disconnecting the board and turning it over, using solder wick on the desired components, removing them, and reinstalling pin sockets. The board is ROHS compliant and the solder is much more difficult to remove than the traditional lead-based type. I used silver-bearing lead solder to install the pin sockets without difficulty. **Photos 4 and 5** show the board with stock components and with the pin sockets installed. Remember that the board comes with the six 8-pin DIP sockets for op amps installed.

OUTPUT CAPS

The schematic for the entire left channel of the analog section is shown in **Fig. 4**. By the way, all schematics here were done by reverse-engineering the circuit board and may not be absolutely accurate. Also, the component numbers do not necessarily correspond to those on the circuit board. Working from the outputs of the CD player inward, the first thing you find is a sizable output capacitor arrangement.

The outputs are normally shorted to ground by the relay until a CD track is actually playing. The 4.7Ω resistor allows for the output op amps to have some offset without excessive output current when shorted. I measured 3.5mV and 4.5mV offset on the left and right channels, respectively. You can only measure this by playing a completely silent CD track so the relays will open but no audio signal will disturb the meter readings.

I must admit that I kind of cheated on this mod. Instead of trying a whole bunch of different capacitors, I followed the dictum that “the best capacitor is no capacitor.” **Figure 5** shows where they were bypassed with a silver wire. (Note that if you wire the output of the op amps directly to the output RCA jacks, the 4.7Ω resistor is also bypassed and the op amps are shorted directly to ground by the relays.)

Bypassing the output caps causes a very (very) slight “click” every time you



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start playing a new CD, because the input to your preamp goes from ground to a few millivolts DC offset. With the op amp substitutions noted later in this article, it is possible to install an offset adjusting potentiometer and bring the DC offset down to zero, but I didn't find this necessary.

Eliminating the output capacitors was a clear improvement overall. It was as though a veil had been lifted from all the music. For the first time I noticed that the violas in the orchestra behind the harpist on the Handel piece were actually plucking their strings instead of bowing them. A little air was added to all instruments, too. It's not a huge difference, but definitely worth doing.

OP AMPS

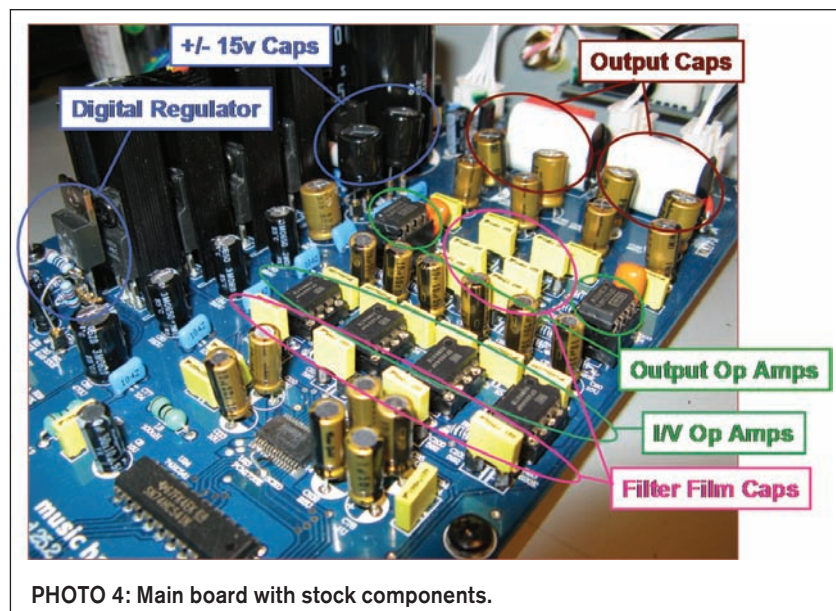
Each channel of the analog section of the CD25.2 consists of two individual current to voltage (I/V) converter OPA604s op amps followed by a dual OPA2134 output op amp. The schematic is almost an exact copy of that recommended in the Burr-Brown datasheet for the PCM1738 D/A converter, with the exception that an extra output op amp has been added at the end as shown in **Fig. 4**.

Why a dual op amp was chosen for the critical output section is a mystery. The companies that do mods generally replace this with two single OPA627B op amps using an adapter, so I started looking for the parts but immediately

encountered bad news.

No one had any stock on the 8-pin plastic DIP op amps, which is the only way Texas Instruments (who now owns Burr-Brown) makes the coveted "B" model, and wouldn't have any for at least six months. Mouser's site said they would get 85 in December. Just 85?!? Aren't op amps supposed to be sold in lots of 1,000? Maybe the \$27 price tag suppresses sales.

Judging from the web forums, this is a chronic problem. What to do? Well, eBay to the rescue—sort of. I ordered two batches of OPA627Bs from Hong Kong. As it turns out, I think both sets are counterfeit. They were too cheap, and one set had terrible characteristics



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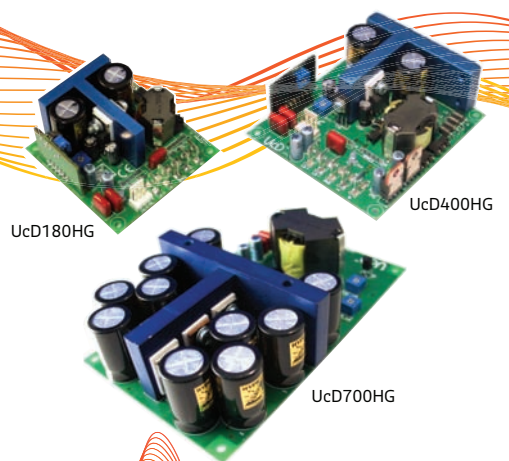
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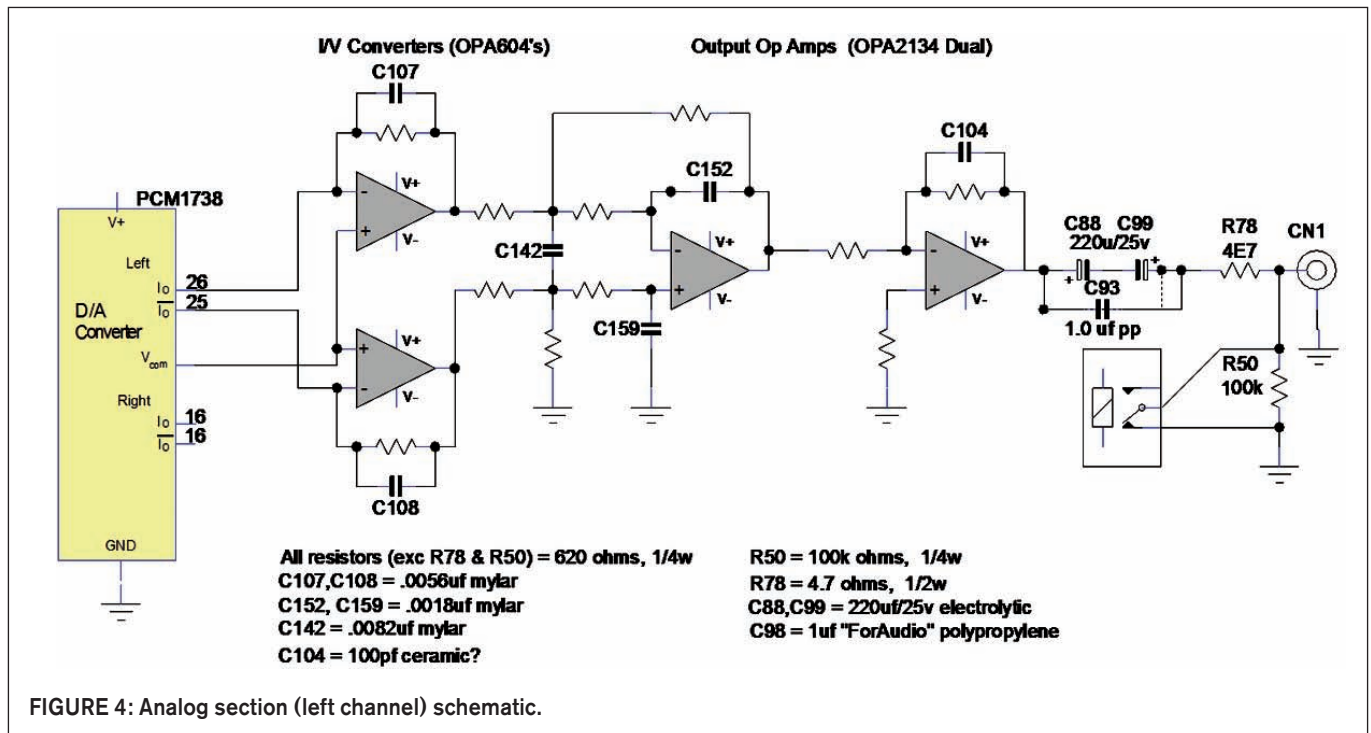
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for distortion and noise. However, the other set did measure well and sounded great, so I used those but that was only enough for the four output op amps. The markings on the "B" type in Photo

6 may help you to get at least something decent in the near term. I also purchased the 2-to-1 adapters on eBay, which were fine.

An alternative approach was required

for trying OPA627s at the I/V position. I used genuine "A" variety op amps, available from Digi-Key and others, which can be had for around \$18. Unfortunately, these models are only made



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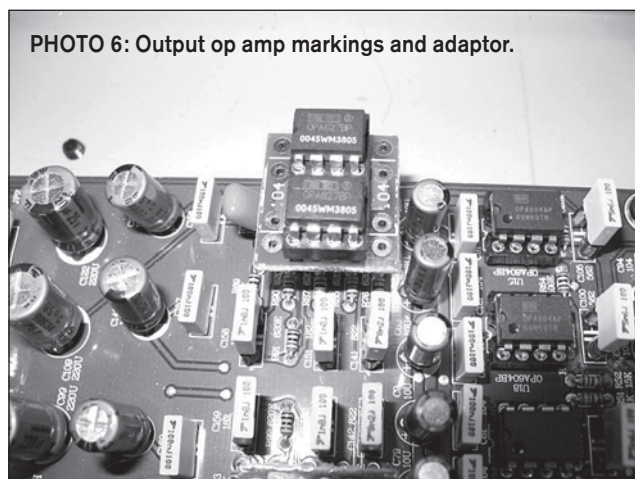
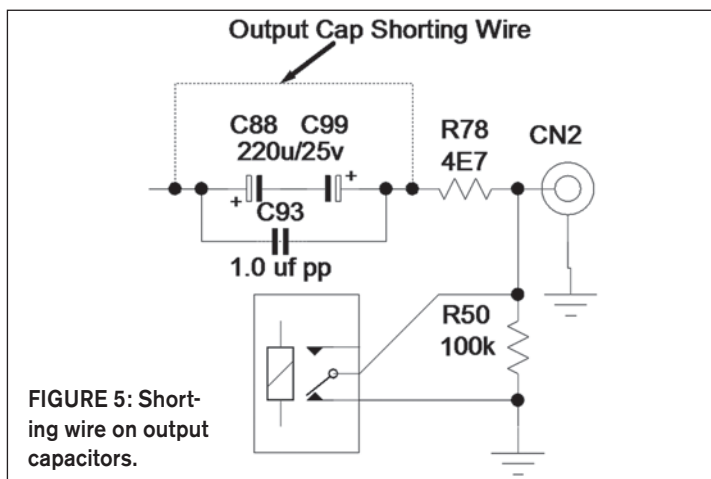
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in SOIC surface-mount packages! Go figure. I found some very nice SOIC-to-DIP adapters with the right kind of pins on them to fit into the PC board's sockets and soldered away. **Photo 7** shows the various op amp configurations with the dual OPA627B adaptor on the left and two OPA627As soldered to the SOIC-to-DIP adaptors on the right.

There are so many "audio grade" op amps now being touted that I got a couple of others for comparison with the Burr-Brown 627s, including Linear Technologies LT1115 and National Semi's LME 49710. Thankfully, these are readily available in 8-pin DIP packages.

You can make a career out of listening to op amps, but in this case the choices quickly became clear. In going from the stock dual op amp to the pair of OPA627Bs on the outputs, my socks were blown off while listening to the Gorillaz Demon Days cuts. This was big time better. Bass notes especially were much cleaner and sounded an octave lower, too. You felt kick drums in the chest. The soundstage was nice and wide but only somewhat deeper than before. A slight mellowing of Joni Mitchell's voice and the overall sound was welcomed,

too. Definitely much more "musical" if not super airy. At least half the battle was won.

During these "op amp wars," the "B"s handily beat the competition in the output position. While all the single op amps were better than the stock dual, the "A"s came in a noticeable second with a slightly more analytical sound and less air.

The LT1115s came in a clear third with even less air, narrowed soundstage, and a more "forward" sound overall. Good dynamics, though, with as solid a bass as the OPA627Bs. National Semi's LME49710s were fourth with a harsher sound. For comparison, the stock dual op amps have a very two-dimensional soundstage and forward sound that was further behind these in my ranking. When I put the OPA627Bs back in again after listening to the others, it was no contest. You could tell the harpist on the Handel concerto was really excited about playing!

With that settled, the I/V op amps were next. To make a long story short, the stock OPA604s had a little more air than the OPA627As I tried (I didn't have any more "B" models available to try). Not much difference really, so I left

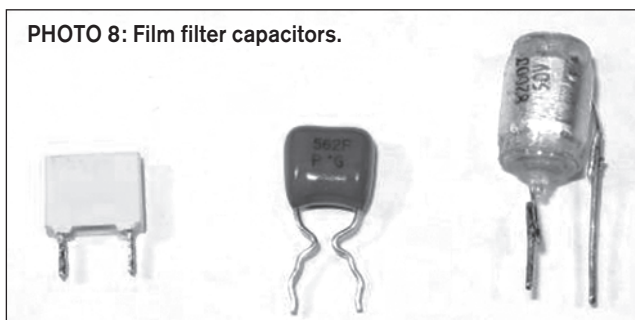
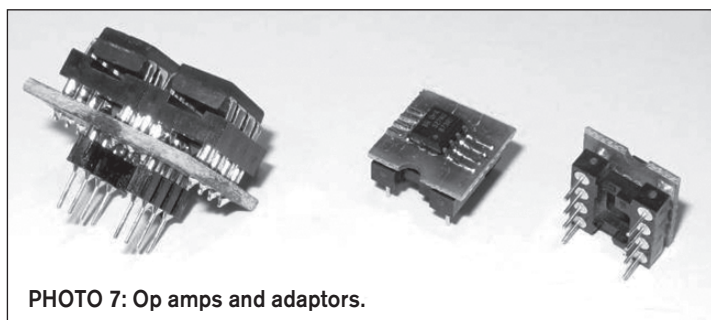
it stock. Apparently the output op amps make a much bigger difference to the sound.

FILM FILTER CAPS

From **Fig. 4** you can see that five small capacitors are part of the high-frequency filters that help roll off the output above 20kHz (C5-C9, ignoring C4, which is just for stability of the op amp and doesn't affect the audio range). The stock CD player uses Thompson Mylar (polyester) caps in these positions. These seemed ripe for replacement with the often exalted polypropylene and polystyrene caps.

Digi-Key had Panasonic polypropylene caps and Mouser had suitable polystyrene caps (one value had to be made up by paralleling two separate capacitors). In removing the stock capacitors, I was careful to safeguard their short leads for reuse in the pin sockets.

While the polypropylene caps could just have their leads cut to fit and work well in the sockets, the small space available on the board meant squeezing the physically larger polystyrene caps in vertically. These caps also come with incredibly thin leads, so I soldered on thicker pieces of leads cut from spare



¼W resistors to get them to fit snugly into the sockets. **Photo 8** shows these different cap types (from left to right: stock Mylar, polypropylene, and polystyrene).

I spent much more time changing these capacitors than with any other mod. The effect on the sound was enormous and confusing at the same time. Both polypropylene and polystyrene added large amounts of soundstage depth and air to every piece of music. This also has a sweetening effect. Some of my notes say “lush,” “smooth,” “mellow,” “sheen,” and so on. That’s the good news.

I’m afraid there’s bad news, too. They both diminished the dynamics of virtually everything. Joni Mitchell sounded as though she was all of a sudden playing a nylon string guitar; Gorillaz’ kick drum had a “hangover” on each beat, plus the treble was dulled; the orchestra on Handel’s concerto was waaaaay back there (the big soundstage), and the harp sounded as though it had the sustain pedal stuck in the “on” position. Oh boy, not an easy choice.

For those of you who like the warm tube sound, it’s a no brainer. Definitely go with the polystyrenes—they’re noticeably more musical than the polypropylenes. Personally I wish I could easily install a switch depending on the type of music. But for now, the stock Mylar caps are staying in my unit. It’s just too big a penalty in transient response for me. You must come to your own conclusions—I’m exhausted with this one.

ANALOG REGULATOR CAPS

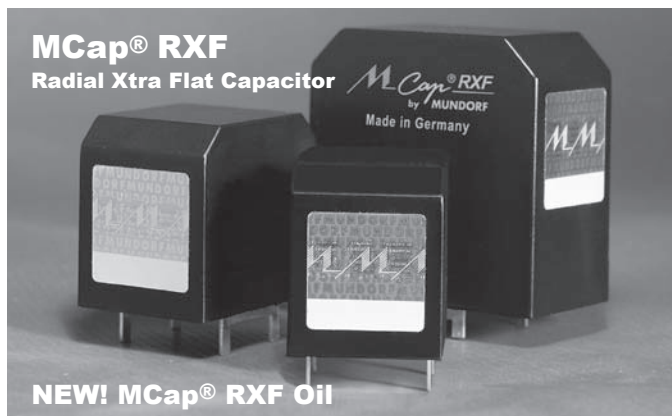
The whole analog section of the player is powered by two standard three-terminal voltage regulators at $\pm 15V$. Music Hall did a nice job of bypassing the output capacitors on these regulators with 100nF Mylars and, in addition, put more electrolytics and bypass Mylar caps at the power pins of each op amp. A serious attempt at power-supply quality. The analog regulator and distribution circuitry is shown in **Fig. 6**.

The main output electrolytics at the regulators are 220µF/25V Nichicons—Gold with black stripe. I found sources for the much regarded Nichicon Muse and Elna Silmic (silk impregnated) capacitors but only at 50V ratings. Panasonic EEU audio capacitors from Digi-Key were also included with a 35V rating.

All the new caps are physically larger with thicker leads than the stock types. For use in the sockets, the leads had to have thinner lead pieces soldered onto them to allow for swapping, the exact reverse problem of the polystyrene filter caps. The capacitors are compared in **Photo 9** from left to right: stock, Panasonic EEU, Nichicon Muse, and Elna Silmic.

The Panasonics were eliminated right away—my notes just say “bad!” That’s two strikes against Panasonic. Not sure whether they’re really interested in audio.

There must be something about the silk in the Elnas because they definitely made the sound smoother but at a noticeable loss in dynamics. On the other hand, the Muse caps made everything clearer and more musical. More bass socko, more ringing on the guitars while preserving most of the air that had been added by the op amp switch. Despite



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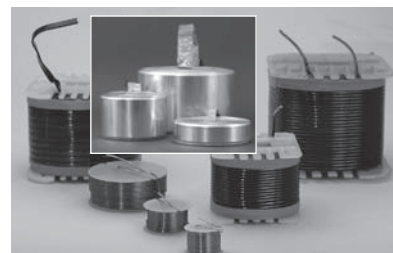
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the added punch, there was no additional harshness. The overall effect was modest but there. The Muse caps were a keeper.

DIGITAL SUPPLY REGULATOR

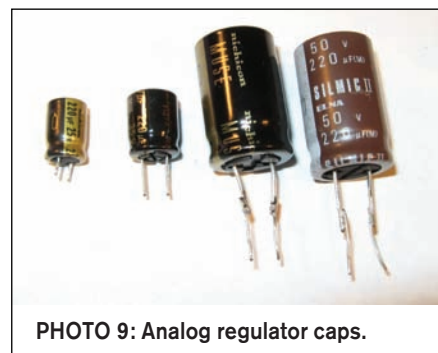
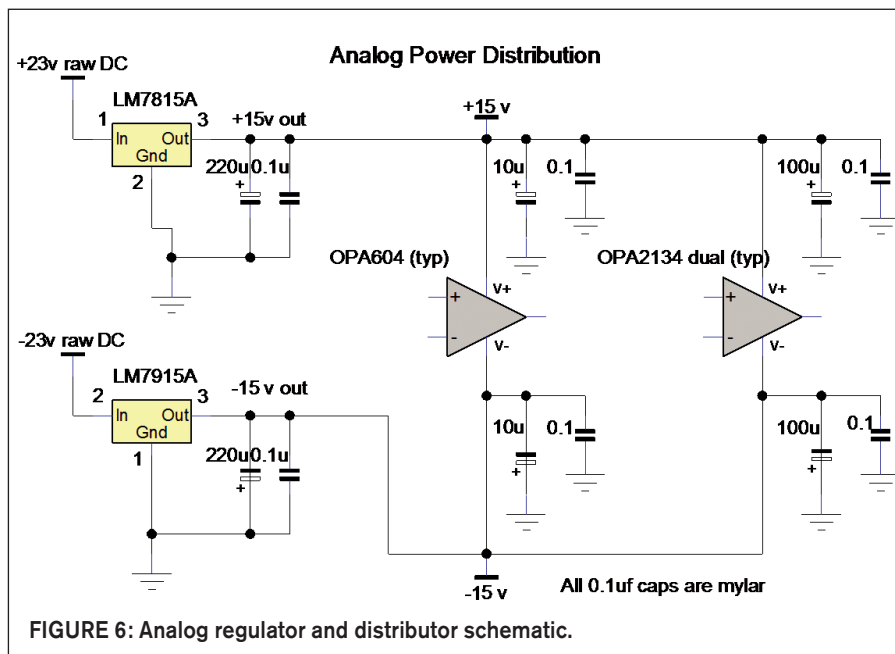
The three major digital ICs are fed 3.3V from a single LM317 regulator. Each IC

is well isolated and filtered as you can see in **Fig. 7**. One of the mod companies makes a big deal out of changing this regulator, so I thought it worth a look.

The stock circuit consists of a garden-variety LM317 regulator followed by some very thoughtful filtering. Perhaps noise on this regulator could affect the

D/A conversion process and may be audible in the way of jitter on the main 16.394MHz oscillator. Digging into IC regulators netted a crop of lower noise types such as the LT3080 that could be adapted for a swap. Because they are not pin-for-pin replacements for the stock units, I had to remove two resistors and a diode from the PC board and solder two of them onto the stock regulator pins.

Using two pin sockets for the voltage setting resistor, it is then possible to use the LM317 with its 330Ω resistor, then pull them both out and substitute the LT3080 with its 330k resistor. **Photo 10** shows how the two regulators were



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configured for rapid change-out with the stock unit on the right. **Photo 11** shows how the board was modified with the removed components and added pin sockets. The setting resistor goes between the two pin sockets where R25 used to be.

I made a surrogate measurement on jitter, namely phase noise on the master

clock as it is seen by the D/A converter. It has a clock output pin that will drive the 50Ω input to my spectrum analyzer, and I tested it with the two different regulators (**Fig. 8**). The A trace is the Tektronix 495P residual phase noise, B is with the stock regulator, while the C is with the low-noise LT3080 regulator. It looks as though there's about a 2dB

reduction in phase noise for most of the audio region with the LT3080.

A couple of back and forths on these parts and the verdict was obvious—the difference was audible and the lower noise regulator was better, although this had nothing to do with audible “noise” (e.g., hiss). Bass notes seemed even lower now, while the dynamics were maintained and the soundstage was widened and deepened somewhat. Overall, it brought good benefits with no penalties. I don't know whether a hand-made, discrete component regulator would do even more, but this was sure a good \$4

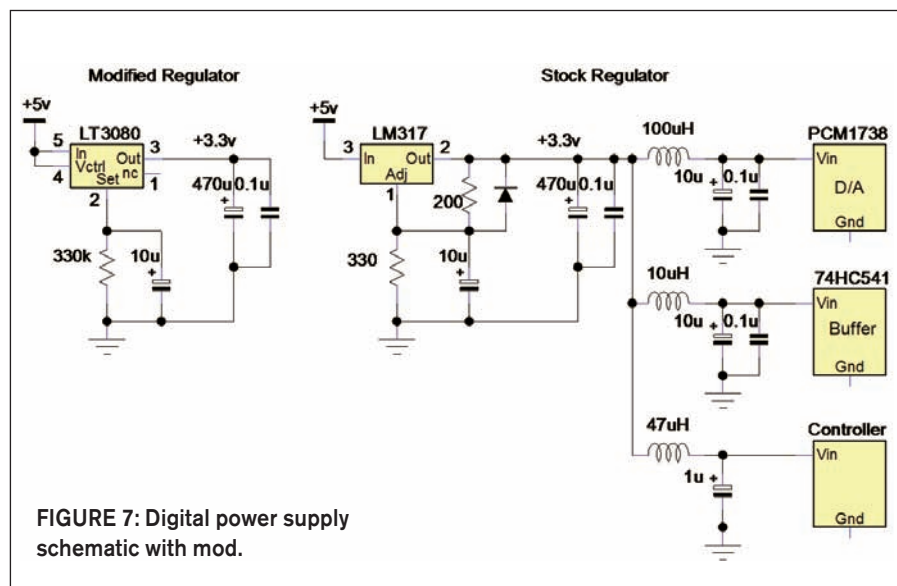


FIGURE 7: Digital power supply schematic with mod.

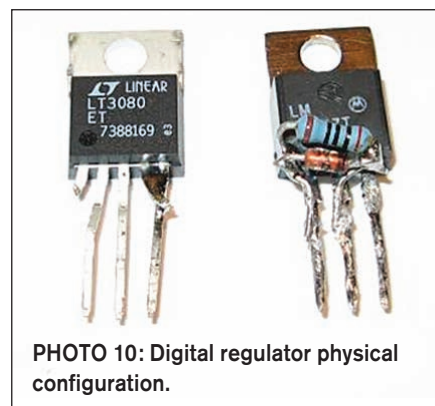


PHOTO 10: Digital regulator physical configuration.

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- REAR [2] @ 200WATTS MAGNETIC/VIDEO SHIELDED
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- EASY SET UP AND SMART OPERATION
- HDTV COMPATIBLE
- 3.5MM DIRECT INPUT FOR MP3, MP4 PLAYERS
- COMPATIBLE WITH BLUE STREAM TECHNOLOGY

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SYSTEM GENERAL FEATURES

- FREQUENCY RANGE 250Hz-20KHz
- SENSITIVITY 92 dB @ 1w / 1m / SYSTEM
- NOMINAL IMPEDANCE 4 Ω - 16 Ω
- DIMENSIONS 10" x 4" x 5" (SATELLITE)
- 8" x 20" x 14.5" (SUBWOOFER)
- POWER SUPPLY AC 110 Volts / 60Hz
- WEIGHT 50 LBS

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- FULL FUNCTION SLIM-LINE IMAGE® REMOTE CONTROL
- IA 4 SERIES 24 CARAT GOLD PLATED AUDIO / VIDEO INTERCONNECT CABLE
- IA 5.1-SC HYBRID CABLES
- TV / TABLE MOUNT STAND FOR CENTER CHANNEL
- WALL / CEILING MOUNT SWIVEL BRACKETS FOR SATELLITES
- UNIVERSAL TUNER LINK ANTENNA

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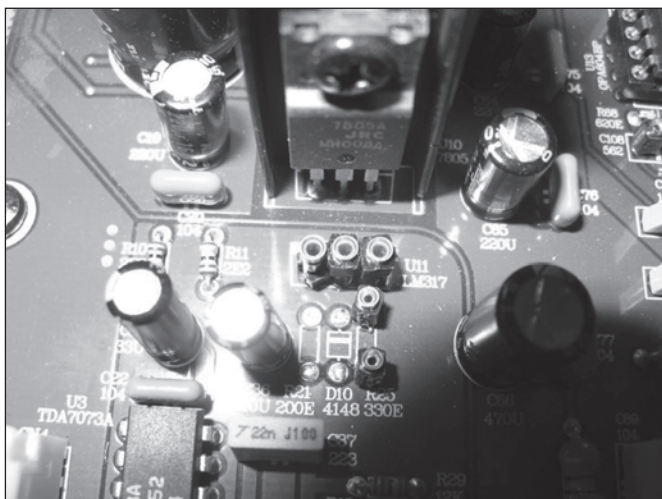


PHOTO 11: Digital regulator modifications.



PHOTO 12: Power cords—14 gauge vs. 18 gauge stock.

investment.

POWER CORD

I don't know why I even thought of changing the power cord. Every engineer knows that it can't have any effect on the sound after power goes through a transformer, rectifier, filter caps, regulated power supply, more filter caps, and then to an op amp that has 100dB of PSRR (power supply rejection ratio). Let's get real here.

However, I ran across some cords on eBay for just \$10 each and tried one out. These were 14g and much thicker than

stock. They came with clamp-on RF filters which are easily removed (which I did just to be sure they weren't interfering with the sound). The impedance at 120Hz measured 0.081Ω for an 8' length compared with 0.196Ω for the 6' stock unit. Based on that ratio, the stock cord was probably 18 gauge. See the size difference in **Photo 12**.

All I can say is that when I changed power cords, I was shocked (no pun intended). Everything was better—air, soundstage, dynamics, and so on. Typical CD harshness was reduced, too. Musicality was unaffected. Is this really

possible? Must be.

But the story was more complex than that, actually, because at first I compared the stock cord plugged into the power strip I have used for years (computer type with surge protection) with the new cord plugged directly into the wall socket. The wall socket in my system has a dedicated 20A circuit breaker with 12 gauge wire running straight to the hi-fi system. When I plugged the stock cord directly into the wall, it was better, too, but not nearly like the heavy gauge cord.

Two lessons to take away from this: first, if you have a cheesy power strip like I did, remove it from your system immediately. Everything will sound better. Second, buy a heavy power cord because it makes a difference no matter what the experts and instruments may say. For \$10 how can you miss?

As an aside, this change was so dramatic to me that I've begun rewiring all my components with heavy cords and a direct connection to a heavy-duty, non-protected power strip. It seems that every one of these changes brings an improvement to the overall system.

CASE DAMPING

To be efficient and not have long-time lags between listening sessions for these mods, I removed the top of the player case throughout these changes. I put two layers of damping material available from Parts Express on the inside of the top, which clearly deadened the case ringing, but I really didn't notice any difference in the sound with the case on

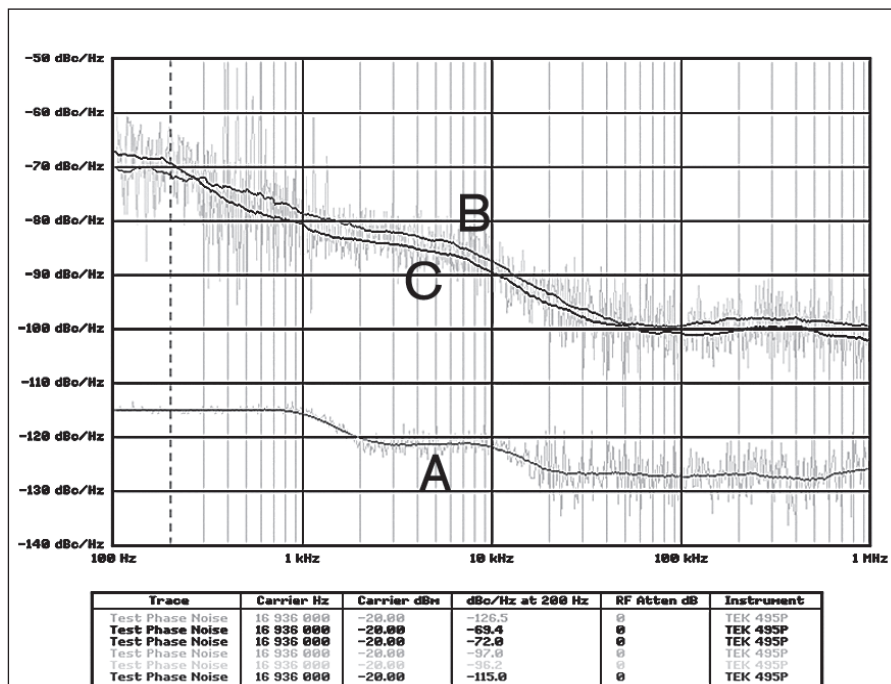


FIGURE 8: Digital phase noise on master clock.

or off, damped or not. Still, it's cheap insurance and gives the unit a more solid, expensive feel. By the way, it was difficult to fit two layers of the material in because there's not much clearance between the metal top and the mechanical workings of the CD tray. You may just want to do one layer.

SUMMARY

All the results of my experimentation are charted in **Table 1**, which indicates the direction and extent to which a change was considered to affect the sound. A big asterisk and footnote goes to the op amp filter capacitor option because this is such a big trade between soundstage and dynamics. The chart also indicates the cost of each option. Amazing improvements can be made for just a few dollars, the exception being the real OPA627Bs if you can find them.

There are literally thousands of combinations of these mods plus many others that could be tried. For example, I did not replace the power supply diodes with soft recovery types, put special feet on the case, try super-duper resistors, or try different bypass caps on each op amp. When I heard an improvement with a change I left it in and went on, but you can experiment with other mixes to your heart's content. I am quite happy with the sound now but am still looking for more depth to the soundstage without compromising the musicality. Happy modding!

aX

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2. Elusive Disc review online: www.elusivedisc.com/prodinfo.asp?number=MHCD252.
3. Reference Audio Mods at www.referenceaudiomods.com
4. Underwood HiFi at www.underwoodhifi.com
5. *HiFi News & Record Review* Test Disc II, HFN 015, 1989.

PARTS SOURCES

Digi-Key

OPA627A op amp (SMT package only)
LT1115 op amp
LME49710 op amp
Panasonic polypropylene and electrolytic caps
LT3080 adjustable low noise regulator

Handmade Electronics,

(www.hndme.com) (handmade@hndme.com)
Elna Silmic electrolytics
Nichicon Muse electrolytics
Silver wire (20g)

Mouser

polystyrene caps

Speakersformusic, (eBay vendor)

(speakersformusic@windstream.net)
14g power cords

Logical Systems (www.logicalsyst.com)

(shopadmin@logicalsyst.com)
SOIC to DIP adapter, 8-pin (#PA-SOD3SM18-08)

Tube_buyer (eBay vendor) (raychow830@yahoo.com.hk)

Dual to mono DIP adapter with OPA627B op amps (these were the good-sounding ones)

Parts Express

Damping material (#268-015)

Component / Effect	Output Op Amps	I/V Op Amps	Output Cap	Band pass caps	15v Supply caps	*3.3V Digital Regulator	Power Cord
Better ↑	OPA627B						
	OPA627A						14 gauge
	LT1115		bypass		Muse	LT3080	
	LME49710						
Stock ↓	OPA2134	OPA604	ForAudio	Mylar*	Nichicon	LM317	18 gauge
				Polystyrene			
		OPA627A			Silmic		
				Polypropylene			
Worse							
Cost for best upgrade	\$110	\$0	\$1	\$0	\$2	\$4	\$10

* Capacitor effect is huge and a trade-off between soundstage and musicality

Table 1

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