The Black CD White Paper

The Ultimate Edition May 2010

Gary Leonard Koh

Preface

It has been over five years since I wrote the last revision and nearly eight years since the original "Black CD White Paper", and we still deliver over 300 downloads a month. Enthusiasts are still calling and emailing for updates.

So, I thought that it was time to issue the "Final Edition" with all the updates from the past 5 years. We've moved from the original black CDR's to green, gold and silver CDR's. So, this paper is only called the Black CD White Paper for nostalgic reasons. For more details, background and a history of this saga, older versions of this paper are available in the Genesis archives.

Over the last couple of years, the quality of digital music sources took a few leaps forwards: firstly, with the introduction of K2HD by First Impressions Music (24bit 100kHz resolution on redbook CDs), and then with the availability of high-resolution digital files from HDTracks.com (up to 24bit 92kHz) and Reference Recordings (24bit 176.4kHz). Most recently, Cardas started selling high-resolution digital files on a credit-card-sized USB disc. Even Apple Corps released a 24-bit 44.1kHz version of The Beatles on USB.

This increased transparency and resolution of the music source also drove development of the Genesis Reference Amplifier and the Absolute Fidelity Loudspeaker Interface cable. These days, I mostly play digital files using a music server bypassing laser playback off the physical CD.

However, it is still important for many of us to have a physical medium that we can easily carry. We burn CDs to play in our cars, and compilations of our CDs so that we don't have to keep switching CDs when doing demos, or when we just want to have our own " party mix". However, I feel that the days of the CD are numbered – when even my car has a USB plug for digital music (only MP3 though……).

1   Introduction

This paper describes a way to make your music CDs sound better. It is a process whereby you take any music CD you own, and make a physically

better version of it for playback on a CD transport. It does not modify the digital information on the CD and does not mess with the musician's or recording engineer's intent.

There is a lot of conjecture over why the resulting CD sounds better than the original. There are a couple of theories: one is that the jitter on the disc itself is reduced, and the other is that are less C1 and C2 errors.

There are opponents to both theories. The first is that we can hear the difference even when a jitter reducing DAC such as the Benchmark DAC-1 or the Weiss Minerva/DAC2 is used. Secondly, because almost all CD transports have built-in error correction and buffering, the sort of errors being reduced by the process are instantly corrected anyway, so reducing the number of C1 and C2 errors **should** not make a difference to the reproduced sound but it does.

Nevertheless, in every demo we have done, most of the audience have heard a significant difference between the original disc and the new copy. The vast majority of listeners have regarded this difference as a big improvement in musicality and/or sonority.

2 The Process

2.1 Use the Right Media

The first step is to find the right CDR media for burning. This makes one of the biggest differences in the sound.[1]

In the beginning, the "Melody" Black CD sounded the most musical and "analog", but they suffered from a very short shelf life. All of the black CDs started to deteriorate almost as soon as they were burned. When "fresh", they sounded best, but as little as 3 weeks after burning, the quality begins to decline. All the Black CDs I burned are now unreadable and unusable.

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[1] CD-Rs are made of a layer of aluminum coated with an organic dye that changes when "burned" with a laser. In general, there are only 3 types of dyes used in CD-R's cyanine (long strategy), phthalocynine (short strategy), and metal azo (long/short strategy). Different dyes sounded different, and the quality and thickness of the aluminum, gold or silver substrate, and also the thickness of the dye layer had some effect on the sound quality of these discs.
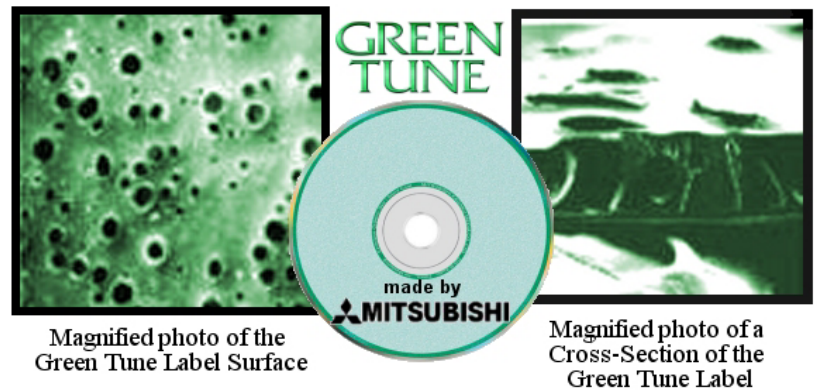
What is worse is that having bought thousands of these Black CDR's, they no longer make good copies even when freshly burned. The dye has deteriorated over the years even though they were carefully stored.

Over the past five years, we found that the MAM-A Gold Audio Master – made by the Mitsui plant in Colorado, USA was the best replacement for the Black CD. These are designed to work at 1x to 12x speed for mastering and also real-time recording of live music. The Gold Audio Master has a full, warm, analog sound and is extremely musical.

MAM-A also makes an excellent pure silver (aluminum) CDR that I feel is even better. I find the silver more accurate, dynamic and transparent. Both are available directly from the factory at http://www.mam-a.com/.

A third option is the Green Tune disc. I find the sound of this CDR somewhere between the MAM-A gold and silver. This is made by Mitsubishi with a special formulation of AZO dye, and is designed for professional use – good, but it's expensive though.

Magnified photo of the Green Tune Label Surface

Magnified photo of a Cross-Section of the Green Tune Label

2.2 Get the Best Source

Make sure that the source file from which you are going to make the new copy out of is the best you can get out of the original music CD[2]. This process is called Digital Audio Extraction or DAE.

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[2] Burning CDs from a high-rez music file is a whole different preposition and will not be addressed in this paper. The sample rate conversion problem is not trivial and needs more research than I have time to do.
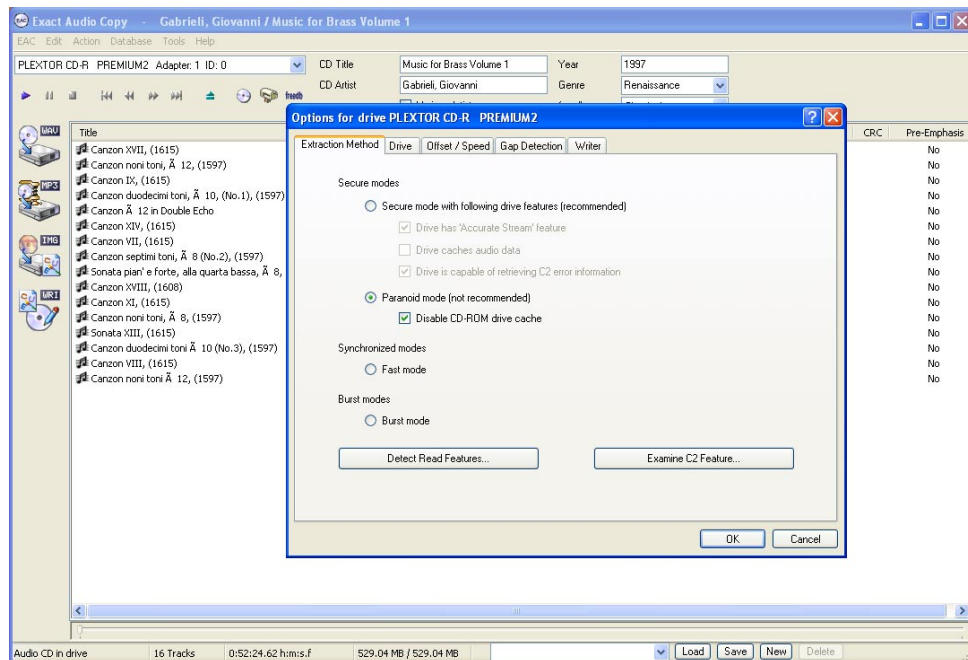
The best software for DAE is a freeware called Exact Audio Copy (EAC) – available for download from www.exactaudiocopy.de - that will make many passes to extract the track in the most accurate way, resulting in an error-free digital copy.

Run EAC in its "paranoid" mode with CD-ROM cache

disabled. The author of EAC does not recommend using this option because it destroys CD-drives, but an external CD-ROM is so cheaply available that you can buy a few to do your extraction. I have not found a difference in sound using different drives, so I just buy the cheapest external CD-reader I can find and destroy them running on paranoid mode.

Read the execution log file when EAC finishes. Sometimes, it says that the copy is OK, but you had less than 100% accuracy on some tracks. In this case, I will re-extract that particular track. If necessary, clean the disc first. You should be able to achieve greater than 98% unless the disk is badly damaged[3].

If you have one of the Plextor drives, you can also use DAE on the free included PlexTools Professional software. The software can be downloaded from www.plextools.com but it only works on Plextor-brand drives. On a Plextor drive, it works faster than EAC in paranoid mode with much the same result. In the Preferences dialog, choose "5. Recover the best bytes (least errors)" and check Allow Speed Down.

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[3] If you have a damaged track that you absolutely must extract perfectly, I recommend Novus acrylic polish. This is a system of 3 liquids that has restored every disc that I have tried it on. The first removes heavy scratches, the second removes the light scratches, and the third polishes the CD.

2.3 Use a Dedicated Computer

I use my dedicated music server for extraction and burning with WinXP, EAC, and Plextools – depending on the drive used. When used for playback, as well as when burning a CD, the computer should be dedicated to one function for the best results. Don't surf the web and write your emails while simultaneously burning a CD.
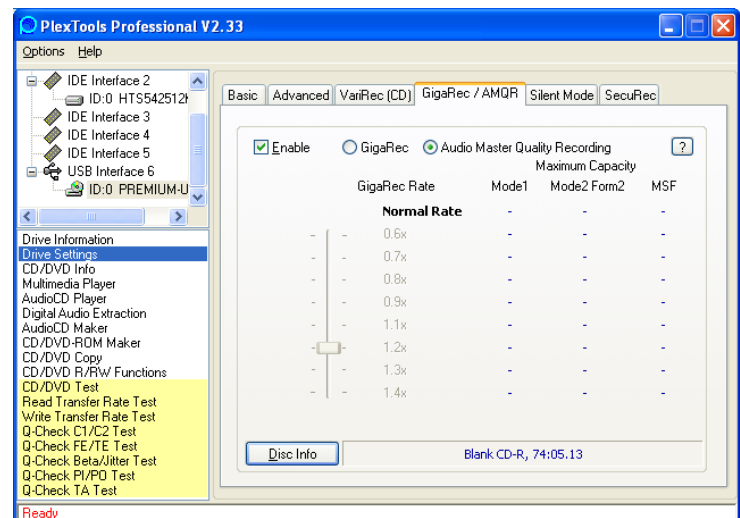
While even the slowest computer should be able to multitask effectively, I find that even turning WiFi on makes the sound deteriorate. Read the White Paper on building a dedicated music server on the Genesis loudspeakers website for more information on how to build one.

We are not sure why this is so, but burning the CD from a source file stored on solid-state media makes it sound substantially better. On my music server, I have a 128Gb SLC Solid-State drive for music storage. Putting the WAV files onto this SSD (make sure the file is not fragmented), and then using this as a source for burning consistently creates better sounding CDs.

So, even if you do not build a dedicated music server, use a notebook computer that has a dedicated Compact Flash, ExpressBus, or SDHC slot, and a solid-state drive in one of those slots (not a USB thumbdrive though). Turn off WiFi and BlueTooth, and disable the anti-virus software during your burn. Given the speed of computers these days, it should not matter, but we can hear the difference when WiFi and/or BlueTooth networks are left on. Better yet, run it on batteries with the screen turned off.

2.4 Use the Best Burner

Any CD-ROM drive can be used for extraction, but the Plextor Premium-2 is by far the best for burning. The original top-loading Iomega Predator burner I recommended in 2003 is no longer available. The Yamaha CRW-F1 UX drive that I recommended in version 3 of the paper 5 years ago is now as rare as hens teeth – and the ones that you can find are already worn out.

The Plextor Premium-2 has the [Audio Master Quality Recording](#) mode licensed from Yamaha and is still rarely available from European eBay sellers, and the Amazon UK website. The Plextor Premium-2 is an internal-only drive, but there are IDE to USB adapters easily available for it.

If you cannot find a Plextor Premium-2, then use a BluRay burner to burn the CDR's. Because of the additional precision needed for burning BluRay discs, I have found that they work extremely well. Less well is a DVD burner.

In order to ensure a stable power supply, I developed my own linear power supply to replace the (usually) switched-mode one supplied with the CD burner. See Appendix 1 for how to build one.

Because of the precision needed when writing the CD, any vibration of the burner may introduce errors.

Hence, treat your burner as you would treat a delicate piece of hifi equipment. I put the CD burner spiked on a butcher's block. Choose one with end-grain construction such as is available from [Ikea](#) or [John Boos](#). I further damp any vibrations in the burner by placing an acrylic disk on the burner, and an old toroidal transformer (about 4lbs) that I longer use. You could probably use a VPI brick or any other audiophile approved damping device.

Do NOT install the burner in a computer. The computer chassis is a horrible place for a burner to be with vibration generated by fans and hard-drives. I've had many readers complain that the process does not work, and makes copies that sound worse than the original. Usually, this is because they make the copy on the burner that is already installed in their computer.

Plextor PlexWriter Premium-II on top of Ikea butcher's block; spikes are screwed into the block and point up to couple

With the Plextor Premium-2, I use the included PlexTools Professional software to burn. This seems to be the only software that allows AMQR mode to be activated. Burn at 4x speed. This seems to sound better than 1x

or 8x – the other two speeds allowed by AMQR (although I have heard from others that 8x or 1x sound better).

It is unfortunate, but burners wear out. With a fresh new Premium-2, I have been able to achieve burns with an average of less than one C1 error per second. The burner deteriorates, and by the time it has done a couple of hundred burns, it will produce discs with some 20-plus C1 errors per second. All is not lost as I then relegate it to DAE duties where it will spend the rest of its useable life.

2.5 Treat/Clean the Blank Media before Burning

This is pretty obvious; the laser can't be expected to burn consistently if there are specks of dust on the blank. Just as dust and dirt will cause pops and crackles on a record, dust, dirt or oily fingerprints on the blank media may cause "bad bits" to be written.

Also, cleaning the blank disc before burning makes a big difference. It removes the de-molding chemicals on brand-new discs, and whatever has been deposited from the atmosphere. The best solution for this is de-ionized water. Brillianize works very well to remove static as well, but I would still wash the CDR in de-ionized water.

Use a soft cloth (not a paper towel or tissues as paper fibers are abrasive) and make sure whatever liquid you use is completely removed before burning.

The MAM-A and the Green Tune media are usually well-balanced. But if you are using any other media, the AudioDesk CD Sound Improver is a lathe that shaves the CD down to balance it and could possibly improve the CDR.

3 In Summary – the Absolute Fidelity® CD process

1)   Extract the music from the original CD using EAC in "Paranoid" mode or PlexTools DAE on "best bytes" mode.

2)   Before you start burning, copy the WAV file to a Solid State Drive – either Compact Flash, ExpressBus, or SDHC, not a USB Flash Drive.

3) Burn the cleaned MAM-A Audio Master Gold, MAM-A 74-minute Silver, or Green Tune CDR with a Plextor Premium-2 using PlexTools on AMQR mode at 4x.

4) Enjoy!

Please write and let me know your results if you do try this process and if you have improved on it. Email: gary@genesisloudspeakers.com.

A Selection of Comments

This is the single greatest tip in my history of buying and modifying gear. (It's the software, stupid.) – G.A.

They have a sound quality that is much more delicate and reminiscent of vinyl. – G.R.

Improvements so great that even Madonna burnt on a Black CD showed profound improvements to sonics and image. – G.F.

Your article has allowed me to listen again to a lot of music that I haven't been able to enjoy on CD. – R.C.

I find myself listening for longer periods of time and being more involved in the music. It's almost as if I'm hearing what the artists originally intended for their listeners to hear. – R.C. again, a month later

What I heard was astounding! There was a lot of information there that I had not heard before!! It was like listening to these discs for the first time!!! – M.G.

You are a fraud. There is no way that two identical discs can sound different just because one is silver and the other black. – N.F.

My wife came running in irate because she thought that I spent another $20,000 upgrading my system. This is truly one of the best value for money tips I have ever had. – M.L.

Amazing how a copy is improved, by using black cd's. I did a blind test with my son. He picked the black as better within 3 seconds! I find the top end opens up and is more detailed, musical with added height to the image. – M.F.

It does make a dramatic improvement of CD sound (takes away much of the stridency but gives more detail, particularly on voices and piano!) – T.G.

After trying Memorex's black CDRs on the (Yamaha) CRW I am seriously jazzed, this is the most significant tweak that I've ever heard. – K.T.

Better, and cheaper than buying a new CD player. – M.P.

Appendix 1: Burner Power Supply

The following information, including circuit diagram and list of components are what I use in the power supply that I built for myself and I am pleased to share it. Genesis Advanced Technologies, Inc. makes no representations or warranties, express or implied, with the information below which is provided "as-is" as a courtesy only.

The best burner is the Plextor Premium-2. This burner was released in Asia and Europe in Apr 2007 and features the Audio Master Quality Recording mode licensed from Yamaha, and also includes Plextor's own Gigarec and Varirec. As far as we know, it was never released in the US or Canada.

Unfortunately, unlike the Yamaha CRW-F1 and the Premium-U, the Premium-2 is an internal-only CD burner. Such a burner typically requires separate 5V and 12V DC. We propose here a linear power supply to optimize burns.

The burner requires two different power supplies – a low current voltage supply for the digital circuits, and a higher current supply for the motor electronics. Both supplies must be regulated.
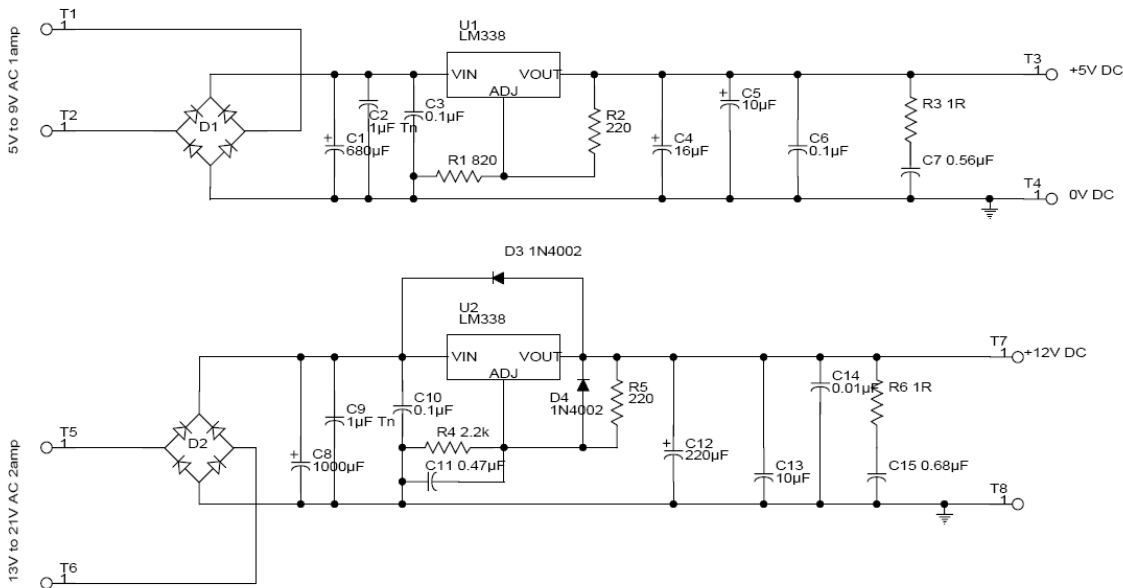
The variable voltage regulator used is the LM338 capable of up to 5Amp continuous and 7A peak. This is a bit of an overkill as only 3A are needed, but the additional headroom seems to make for better burns. For the digital circuits, impedance needs to be optimized for speed and noise managed carefully. Forward noise is not as much of a problem as the noise generated by the digital electronics.

For the motor electronics, careful optimization is done to reduce output impedance to deliver current for the requirements of the motor servo system. As a servo system will make sudden current draws, the power supply must be isolated from the low voltage supply. Hence, two separate transformers, or at least a transformer with two secondary windings is recommended.

The use of fast diodes for rectification is actively discouraged. Speed is not critical, and symmetry of rectification is more important. Hence, a bridge is the best solution. Otherwise, matching diodes is long and difficult. Also, 250V X2 self-healing snubber caps are used across all four poles of the bridge to reduce diode noise and slow down the diodes so that they can most effectively rectify the 60Hz/50Hz that is typical of the mains.

The circuit is simple enough that the components can all be point-to-point direct soldered. A small heatsink is essential for the LM338 regulator even though it is only very lightly stressed.

Besides the schematic below, and suggested components, no other support will be provided for this. Sorry. It takes up far too much time.

A: Digital Voltage Supply
1) C1: Extremely low ESR/ESL cap – Nichicon PM-series – bypassed by C2 – 1uF tantalum cap.
2) C3: C0G or NP0 solid tantalum as close to the regulator as physically possible
3) R1 & R2: metal film – Vishay RN55-series
4) C4: Nichicon "Muse" (1st choice) or "Fine Gold" (2nd choice)
5) C5: Nichicon Muse bipolar
6) C6: polyester film – AVX BQ-series
7) R3: 0.1% high power metal film resistor
8) C7: 0.5% polyester film "Orange drop"
9) Vishay 0.01uF 275V Class X2 self-healing film caps across the 4 poles of the bridge (not shown on the schematic)

B: Motor Servo and Laser Power Supply
1) C8: Nichicon PM-series – 35V; bypassed by C9 tantalum film
2) C10: polyester film AVX BQ-series as close to regulator as possible
3) R4 & R5: metal film – Vishay RN55-series
4) C11: polypropylene film
5) C12: Nichicon "Muse" or "Fine Gold"
6) C13: low ESL electrolytic – Nichicon Muse bipolar
7) C14: WIMA polypropylene film
8) R6: 0.1% high power metal film resistor
9) C15: 0.5% polyester film "Orange drop"
10) Vishay 0.01uF 275V Class X2 self-healing film caps, at least 250V across 4 poles of bridge