

In Quest of Absolute Fidelity: The Saga of the Black CD – Finding Black Gold!

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Preface

It's been over two years since I first published the "Black CD Paper", and we have had feedback ranging from "just upgrade to SACD you cheapskate" to "the color of a bit doesn't make a difference you moron" to "Thief! What you are doing is promoting illegal piracy of music".

I am *not* advocating music piracy. What I am doing is trying to make CDs sound better so that you will all rush out and buy more CDs. After all, with 289million CDs shipped in the first half of 2004 against 300,000 SACDs and DVD-A's, the CD format is here to stay. If they sounded better, audiophiles will go out and buy more CDs.

Gratifyingly though, the majority of the feedback came from readers who have had great success and were surprised by how good these black CDs sounded:

"My wife came running in from the kitchen irate because she thought that I spent another \$20,000 upgrading the system. This is truly one of the best value for money tips I've 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!), even when done on a non top of the line black cd on a computer's internal cd-rw drive." T.G.

"This is the single greatest tip in my history of buying and modifying gear." G.A.

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

Over the past two years, hundreds have written back to us to tell us how much better the black CD sounded, and Genesis dealers all over the world regularly use black CDs to demo systems to customers. We now use the Black CD exclusively when doing our two-channel demos at shows. There may be still a few skeptics out there, but we do believe what our ears tell us.

More importantly, there were a number of readers who had great critique, inputs and contributions as they had been doing something like this for sometime. So, this update includes all I've learnt from these, the true digital music-philes who have been experimenting for years.

I also want to thank the real computer experts who think that I am a "complete idiot" because bits are bits. I am always reminded of the quote from F.A. Clark, "We find comfort among those who agree with us - growth among those who don't". From those experts, I have also learnt a great deal, and this paper is all the better for it.

Nevertheless, I have taken out a lot of the conjecture and speculation for why I think that the black CD sounds better. The important part is still here - how to do it - and that's all you really want to know anyway.

Summary of Updates

- Dye formulation and factory important in Black CDs
- Cyanine-based Black CDs sound the best but deteriorate rapidly
- New drive and software - Plextor Premium-U and PlexTools Pro
- Good non-Black CDs found that sound fabulous

1 The Story

Back in mid-2002, when I was contemplating buying the assets of Genesis Technologies, one thing bothered me: I believe passionately that I had to bring something useful to the table. Despite my past experience in business, I wanted to be sure that I could contribute something else to the audio community (besides reviving the Genesis brand).

To find this contribution, I turned to my own frustration as an audiophile (or music-phile!) - I much preferred records to CD's, but yet a lot of material I couldn't find on LP's. CD's were taking over, but I was still dissatisfied with the quality. I wanted CD's that sounded more musical and less harsh. I bought an SACD player (the Sony SCD-1), and lots of SACDs, but the result was still musically unsatisfying.

I guess testimony to the success of the black CD process after 2 years is that my own music-buying habit has changed. I have bought may be 10 LPs

over the past 2 years, and hundreds of CD's - most of which I've backed-up to a Black CD. Besides, most of the new (and old) music is still being released in CD format.

1.1 Relying on Rumours

When I first started looking into this process, I had already heard from audiophiles in Singapore that when they copied a CD, the copy sounded different from the original. How can that be when the copy is digitally identical to the original? To test the theory, I made a backup copy¹ of one of my favorite pieces of music from Jazz in the Pawnshop (JatP).

Then, I listened - yep, it sounded different, but why? I did a bit-by-bit comparison using the computer. Again, identical.

So, I took a different blank CD-R. This time, a gold disc, and copied JatP again. Again, a different sound. Again, identical. How can three seemingly identical copies of a piece of music sound so different?

Well, it did take the whole of my time over the next two months, but by the next time I went to visit Arnie Nudell in June 2002, I had a couple of new CDs to demo to him. He was floored by how good the "Black CD" sounded. I knew then that I was on to something.



Arnie with first Black CD: June 30, 2002

1.2 The Results

Now, with over two years of research, testing over a hundred different types of CD-R media, eleven different CD burners (including DVD burners), and two different software for Digital Audio Extraction, we can now *consistently* make a copied CD sound

¹ I am **against** music piracy, and make back-up copies of only CDs that I own. If you use this process, please respect this. Also, it is tantamount to piracy to make copies of CDs to give away or sell.

spectacularly better than the original. We would like to share this discovery with you.

The CD copy is more *musical*, in particular, the high frequencies ring with trueness that I used to experience only from records and live performances. The air and the image stability are much better, and instruments and vocals sound more dynamic and true-to-life. And most importantly to me, the sense of timing and "foot-tappity-ness"² of live music was there. The music was definitely more involving, and the sense of being transported to the musical event was real.

This made the music on the Black CDs sound much more like a "live" performance than on the original. Our quest for Absolute Fidelity is getting somewhere!

The benefit of this Black CD was evident not only in high-end audiophile systems, but it made the music CD obviously better on *all* playback systems that I tried it out on: in my car, a mini-compo system, a mid-fi system, and even over headphones on a Sony CD Walkman!

However, we have found an increasing number of players having problems with the Black CDs. Many of the older CD players would have problems - but this was not restricted to Black CDs, they were not designed to play CD-Rs. Some of the older Wadia transports seemed not to like the Black CDs (although they had no problems with other CD-Rs) and would skip tracks. Players like the Sony ES9000 would not play them at all due to the built-in copyright protection system. Readers have also written to tell me that many Marantz and Rotel players wouldn't even recognize a black disc.

Nevertheless, we managed to find two non-black CDRs that sound fabulous, and one black Audio CDR that played even on players with built-in copyright protection systems. (More in the Appendix)

2 The Technology

Once I found that there was a difference in sound, I researched some of the technology of the music CD to try to understand why this was happening. What I found out was pretty astounding - to me anyway!

² Some readers have told me that this is called PRaT - Pace, Rhythm and Timing. Well, it makes my foot tap in time to the music!

Firstly, the precision needed to write the data on to the CD is incredible! Space between tracks is $1.6\mu\text{m}$ (one millionth of a meter). That's about one-fiftieth ($1/50$) the width of a strand human hair! The data on these tracks is written as pits and lands, and the pits are $0.8\mu\text{m}$ to $2.8\mu\text{m}$ in length and $0.56\mu\text{m}$ wide.³

The tracks are written in one long spiral and read at constant *linear* velocity (CLV) with your typical CD player. This is in contrast to a record, which is also one long spiral but read at constant *angular* velocity (CAV).

Theoretically, this means that the distortion on the whole CD should be the same, whereas the distortion on an LP increases as the stylus reads towards the inner grooves of a record.

In order to achieve CLV, the angular speed (rpm) of the CD has to be slowed down continuously when data is read from the inside of the disc to the outside in order to maintain constant linear velocity. To do this, all CD transports have a rotational servo to provide the correct disc speed.

However, it is almost impossible to control speed infinitesimally steplessly. Which means that the disc decelerates in tiny steps, so, in reading or writing the data it would go: too slow, a bit too slow, a little bit too slow, just right, a little bit too fast, a bit too fast, too fast, decelerate, too slow, a bit too slow..... This speed difference is theoretically "smoothed" out by the read-ahead buffer and the bitstream regulated by the digital clock on all CD transports. Theoretically.

2.1 Jitter Creation

A CD writer creates discs by a process of transferring audio data to the disc's surface via laser irradiation creating "lands" and "pits" (digital 0's and 1's) on a layer of organic dye. The laser has to turn on and off within the time that it takes the disc to turn $0.8\mu\text{m}$ and still be able to make a "pit" of consistent depth, width and position. Unfortunately, this is also extremely difficult, so these lands and pits end up not being of a uniform length or

³ For those of you interested in more detail, Robert Harley, in *The Complete Guide to High-End Audio*, gives a precise and concise treatise on the technology of digital audio. On the web, <http://www.howstuffworks.com/cd-burner.htm> gives a great description too!

width, and the uneven gaps between them produce a form of distortion known as jitter.

Thus, any vibration or inaccuracy in making the CD could translate to errors in encoding. What is worse is that mass-produced CDs are pressed, not burned - resulting in even more inaccuracy. Typically, the master from which the glass master CD is made is also burned at high speed.⁴

2.2 Timing vs Data

So, why are the copies seemingly identical? Well, firstly, the copies may not be identical; they may just look identical as *data*. The computer does not care *when* the data is read or written, just *what* data is read or written. However, in music, we all know that timing is as important as playing the right note. The right note at the wrong time is the wrong note. (The wrong note at the right time is still the wrong note.)

The CD player/transport/DAC does a lot of buffering and error correction as the music CD technology is inherently error prone (unlike data CD-ROM technology which must be 100% accurate). So, theoretically, the error and timing problems are fixed.

However, high fidelity isn't as simple as a mathematical equation telling us, "You won't hear the difference". There are things that we still have not figured out how to measure. Thus, my simplistic conclusion was that the technology was still imperfect, and that jitter and other errors are created in the process by which CD's are written and read. So, we do have an opportunity to improve on the technology of pressing commercial CDs.

3 The Process

In a nutshell, take the following steps to make the best of CD technology:

⁴ We proved this by making the master CD using the techniques described in this paper for a couple of spectacular sounding releases on Wyse Records.

- Extract a "clean" error-free copy of the music CD to hard-disk without using compression⁵ or error correction,
- use a good quality CD-RW drive, burning at the slowest speed it can⁶,
- burn a copy to a *black*⁷ CDR blank.

The quality of the media makes the most difference. Secondly, comes the CD-RW drive and speed at which you make the copy, and the icing on the cake is to use a "clean" extraction - not just a ripped version of the file.

4 The Details

4.1 The Right Media

Since my initial experiment showed up the difference between a standard silver CD-R, and a gold CD-R, the first place I explored was the media used to make the copy.

Singapore turned out to be a great place to do this experiment. On my first visit to the local IT mall, I ended up with over 30 different types of media. I was surprised at the numerous types available. Different types of gold blanks, the usual silver aluminum ones in different grades, and CD blanks of every shade of every color imaginable - blue, light blue, dark blue, orange, light green, dark green, red, pink, purple, puce, tangerine...



Various blank CD's available

⁵ I had to add this in because one reader ripped to MP3, and then burnt an audio CD with the MP3 files - he reported that it sounded horrible.

⁶ One exception is the Yamaha CRW-F1UX in Audio Master Mode. The best speed using the majority of media is 4X.

⁷ Over the past two years, we've found two non-black CDRs that sounded great.

What I found incredible was that they mostly sounded different. I must have driven my wife mad at that time playing the same piece of music over and over again for almost two months, and insisting that she help me distinguish between the various copies!

What troubled me most at this stage was that while they sounded different, there was no one disc that stood out from the rest. Some were truly awful, a few of them refused to play at all, and others kept skipping on music systems (but played on the computer CD-ROM drive). But a lot of these blanks had some quality that stood out, and were better than the original.⁸

4.2 The Black CD

About a month into the process, a friend of mine - Ben Chia - told me about the black CD's that he and his friends had discovered. Gamers already know this one (I didn't!) - Sony issues all of their Playstation games on Black CDs.

There is lots of conjecture as to why the Black CD sounded better, but that's just lots of speculation. The only thing I care about is that it does sound better. However, over the past two years, I've found over 30 different brands and types of Black CD's.

Most of them were different shades of black. I found that most of them were an extremely deep red that looked black. While they all looked similar, they were made by different factories, and made of different material.



A sampling of different Black CD's

⁸ 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). One reader told me that he thought that the metal azo gave the best sound, but I have not been able to find a black metal azo. It also made sense when some readers suggested that the thickness of the aluminum substrate, and also the thickness of the dye layer had some effect on the sound quality of these discs.

You couldn't even rely on the brand of the media as the same brand could have two different formulations of the organic dye used, and be made at two different factories.

In order to determine what the media actually is, readers have suggested various software that read the ATIP on the CD-R media. Here's an article on what ATIP is:

<http://knowhow.cdfreaks.com/article.php?ID=122>

And here are two software that read the ATIP.

http://w510.tm.odessa.ua/soft/cdr_atip/

.....and

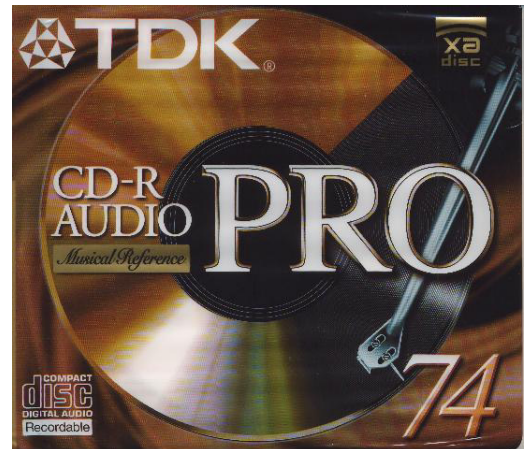
<http://www.gum.de/cdrid/>

For more, see the Appendix on Disc/Dye Types.

4.3 Black Gold!!

Over the course of the past two years, a couple of readers directed me to two different non-Black CDR's that were as good, if not better than the Black CDs. The first is the Mitsui Gold⁹ - made in the Colorado plant of Mitsui. Amazingly, Mitsui makes an identical looking disc in their Japanese plant, and this one sounds nowhere as good as the one made in the USA.

The second non-Black CDR that we found that sounded *better* than the Black CD is the TDK CD-R Audio Pro Musical Reference¹⁰. Unfortunately, this is not only extremely difficult to lay our hands on, but is spectacularly expensive. Hence, I only use it for my most critical recordings.



⁹ Available at http://www.cddimensions.com/cd-r_media/mam-r74gpg-cb.asp

¹⁰ Get it direct from TDK Japan. You have to justify to them why you want to buy it!!!
<http://www.tdk-asia.com/sg/products/audio/cdraudiopro.php>

4.4 Burning Process and Software

The software used for burning and extraction must not compress or process the music in any way. Some are designed for "ripping" CD's and making compressed MP3 files out of them. Most of these sound worse - I have no idea why, even though they say that they store as uncompressed PCM WAV files. I've found that the ones with the least "bells & whistles" sound the best.

4.4.1 Have a constant source

First, make sure that the source you are going to make the copy out of is the best you can get. The best way to do this is to take it off track by track from the CD and put on to the hard disk as different WAV files. Don't take the shortcut of copying the CD using a CD reader and a CD burner.

The most important piece of advice I got from readers is that there are also different audio *extraction* software that take the music off the CD, and they sound different. I had only been using different disk-burning software as I had thought that the extraction process was the same.

By far the best software for music extraction is a freeware called Exact Audio Copy (EAC) - from www.exactaudiocopy.de - that will make many passes to extract the track in the most accurate way, resulting in error-free digital extraction¹¹. Run on its "secure" mode, EAC made the most sonic improvement to the process.

Run on its "paranoid" mode, it sounded even better. However, the horrible noises the CD reader makes while extracting, and the fact that the author of the software recommends *AGAINST* doing it makes me reluctant to recommend doing this - unless you have a spare CD reader drive you don't mind chewing up!

Read the log when EAC finishes. Sometimes, it says that the copy is OK, but you had less than 100% accuracy. In this case, re-extract that track. If you did it using secure mode, try re-extracting using paranoid mode for that one track only. If you extracted using paranoid mode, try the secure mode for

¹¹ Many thanks to Eric Fantone, Warren Parker and Adrian Wang (they were the first three of many) who suggested this.

the second run. You should be able to achieve 100% accuracy or close unless the disk is badly damaged.

If you have one of the top-of-the-line Plextor drives, you can also use DAE on the free included PlexTools professional software. I have had a number of readers telling me that it does a better job than EAC, and in my own initial impressions, I fully agree with that sentiment. It is also faster, and bit-for-bit comparisons show that it does give different results from EAC and a straight rip.

Nevertheless, since I have not had the time to do the full comprehensive blind A-B comparison, I can't make the definitive recommendation here. On scratched discs, sometimes I had to re-extract some tracks with EAC when PlexTools was unable to do it cleanly.

4.4.2 Don't let your computer be interrupted

This is common sense. It's like stopping a band mid-way through a song, and having them restart again!

Windows is a multi-tasking system, so even if you do not realize it, your system is doing a lot of work in the background even while idle. It could be checking email, cleaning up the swap file, doing housekeeping, etc. Hence, disable all other programs on your computer that can interrupt the music recording - virus checkers, internet, networking, system maintenance, etc.

The ideal would be to have a clean computer with just CD writing software, a CD writer and a hard disk installed. You will need a mouse to navigate, but if possible, put that mouse on another port, or use a serial mouse. Since you won't need a speedy computer, any old unit will do! However, the best we've found has been a laptop running on batteries...

I have been told many times by computer experts that this makes no sense. All new CD burners have software to make sure that the buffer is full, buffer under-run protection, etc. But I hear a difference. I was in the computer industry for 22 years before retiring in 1999, and I know that computer programmers cannot think of everything all of the time.

4.4.3 Write Slowly on One Pass

Run the burning operation at the slowest setting that the writer can work at (we can hear the difference when going above 4x. Many burners cannot write at 1x - the slowest being 2x or 4x.¹²

Run the writing process "disc-at-once" so that the laser doesn't switch off and on in between tracks, and need to get "up to speed" again on the next track. This also ensures that the disc in the CD writer spins consistently.

4.5 The Right CD Writer

My first discs were written on a CD writer built into a laptop computer. Later, I tried everything I could get my hands on: a no-brand internal CD writer, units from HP and Teac, an ancient 4x Iomega Predator that was given to me as a present and I had stored away, and a Yamaha that touted "Audio Master Quality" recording features. Lately, I've also acquired a Plextor Premium-U that a UK reader told me was the best sounding, and also

numerous DVD-writers that also write CDs.

An external CD writer definitely works best. A computer is actually a very noisy environment. There are cooling fans for the switching power supply, the CPU, and sometimes for the casing. The hard-disk, CD reader, floppy drives, all contribute vibration.

Just as you won't install your turntable on top of a refrigerator, don't install your music CD writer inside a computer.

Because of the precision needed when writing the CD, any vibration



Iomega Predator
with Isodiscs top and bottom

¹² One reader told me that on the Plextor Premium-U, 16x consistently resulted in lower c1 and c2 errors, and much improved jitter and beta levels. This bears more research as the new dyes do require a shorter strategy burn.

may introduce errors. Treat it like you would treat a piece of hifi equipment. I put the CD writer on four medium Isodiscs¹³ and damp it with another four large Isodiscs on top.

To ensure a stable power supply, I plugged all the computer equipment into a PSAudio Power Plant¹⁴ to ensure that power fluctuations will not affect the writing process. I can't stress how important a proper power supply for the CD burner is. We've tried all sorts of power conditioners, and none of them have worked as well as the Power Plant for the Iomega and Yamaha burners. For the Plextor, I had an "audiophile" power supply built that made the results sound even better than on the Yamaha.

Subjectively, the writer I liked best was the *old* Iomega Predator run at 2x - which was a surprise to me since it was so old.¹⁵ However, the past two years also saw the demise of my Predator. I managed to get a new one, but I only use it very sparingly now, and never for audio extraction! It also does not seem to work as well with the modern high-speed dye formulations.

The other burners that gave me consistently good quality were the Yamaha CRW-F1, and the Plextor Premium-U. Of interest are DVD burners - I acquired the Iomega Super DVD 4x and the TDK 8x DVD burners and the initial tests are very positive - at least on par with the Yamaha.

A new piece of information from some readers is that there is an optimum pairing of CD-burner and media, and that each burner and media pairing has an optimum write speed!

<http://www.cdrinfo.com/Sections/Articles/Specific.asp?ArticleHeadline=Jitter%20Tests&Series=0>

The article also showed how using a different media resulted in different levels of jitter. The surprising conclusion was that using the Yamaha on its Audio Master Mode produced the least jitter at 4x, while using it in normal mode gave the least jitter at 1x! (with Audio Master Mode at 4x producing less jitter than normal mode at 1x).

¹³ Available from Genesis since secondbeat.com went defunct.

¹⁴ More information from www.psaudio.com

¹⁵ A couple of readers suggested that I liked the Predator because it was a top-loading machine with a clamp. I also damped down the clamp and cover with the Isodisc. It was also the only burner that worked better with the Maringo Mat.

It also showed how using a long strategy cyanine or metal azo dye gave reduced jitter as compared to a short strategy dye when burning at 4x on the Yamaha Audio Master Mode. In my tests, I found that with high-speed phthalocyanine media 4x gave the best subjective results, but with the old slow speed cyanine dyes, 1x sounded best.

Plextor has a VariRec mode that also claims to reduce jitter. It allows the user to optimize the laser power to the media used. However, it requires a LOT of experimentation to find the right settings. There are 4 options for phthalocyanine, and it allows varying the laser power from -4 to +4. I'm still working on it!

4.6 Treat/Clean the Blank Media

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 with cleaners like Optrix made a big difference. The other treatment I tried before burning was the Mapleshade Mikro-smooth, but that did not make enough of a difference for me to consistently pick out the treated disc.

One reader reported that the Bendini CD Clarifier made a big difference, and another reader thought that using an industrial strength de-magnetizer before burning made the resulting CD sound better.

5 The Findings

Now, we have three variables - media, burner, software - and theoretically millions of data points. It was initially a two-month rigorous process to work through all that and find the best. Over the past two years, I've also learnt a lot more, and especially with the feedback from helpful readers.

Media:

- Consistently, Black CD-Rs still sounded better than silver/green media. Different brands give subtly different sound. Unfortunately, even different batches of the same brand sounded different. The

later batch of my early favorite - the Platinum - did not sound as good as the first batch. This boiled down to the dye formulation and manufacturer - see the Appendix for more details on discs and dye types.

- Blanks labeled as "Digital Audio" were more expensive because music royalty had been paid for by the manufacturer. However, since some players with copy protection will not play CD-Rs on which the music royalty has not been paid, you're stuck with using one of these. I have only managed to find one digital audio black CDR that sounded good.
- Some brands had a premium silver or gold disc which sounded good with some material, but did not perform consistently well. Nevertheless, the more expensive ones were usually better made, and sounded better than their normal media.
- Many brands of media (including some black ones) did not play at all on some players and transports, and if they did, skipped, even though they read and played well on the computer's CD-reader.
- The best sounding Black CDR I've found is the Melody Black Diamond - it is actually a long-strategy Cyanine type dye manufactured by Gigastorage. It is also available in the "Infinity" brand. Unfortunately, it is not stable and many of the discs I've made over the past 2 years are now unplayable. It rapidly deteriorates as soon as 2 weeks after burning, so I won't recommend this disc other than for very short-term use.
- Melody Black Diamond also makes Black CDRs with long-strategy Phthalocyanine type dye. This one is much more stable, and sounds very close to the Cyanine. It is also made by Gigastorage for Melody. There are two different types available.
- The best easily available Black CD in the US is the Memorex. There are two different ones - the one labeled "ALL USE" is the wrong one. There is also a Maxell branded black CD that many US readers have tried and liked, but I have not been able to find. In Europe, there is also the Parrot brand that I have not been able to test.
- The best sounding CDR we've found is not a Black CD at all, but the TDK Audio Pro Musical Reference. It is TDK's reference media for

studio recording and mastering at \$14 a disc!!!! Made of Cyanine dye, it doesn't last long either (but does last much longer than the Melody).

- The Mitsui Gold blank disc manufactured in the USA at the Mitsui Chemicals Colorado plant is also very good. Subjectively, many readers have told me that the Mitsui sounds better than the Black. I have found that it does sound better on a lot of music - it is just as musical, but brighter than the warmer sounding black CDs. I liken this to a good "solid state sound" while the Black CDs have a more "tube sound".

Software and Process:

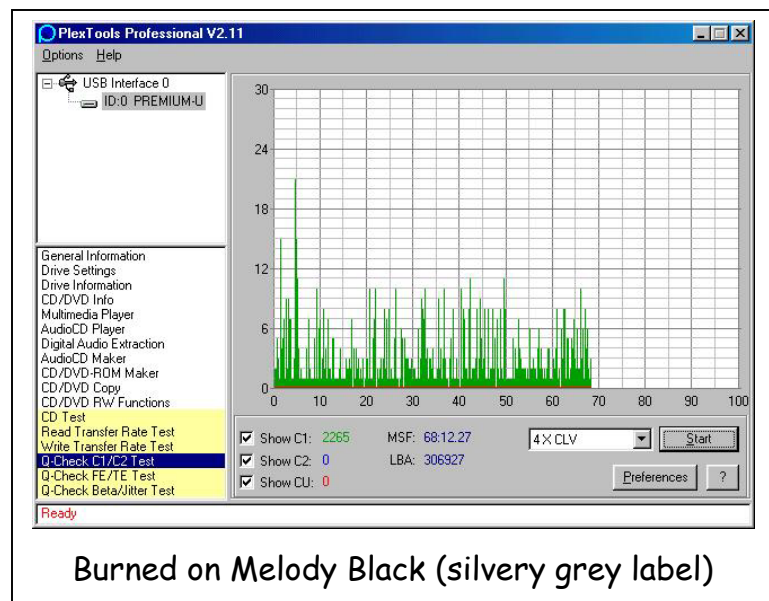
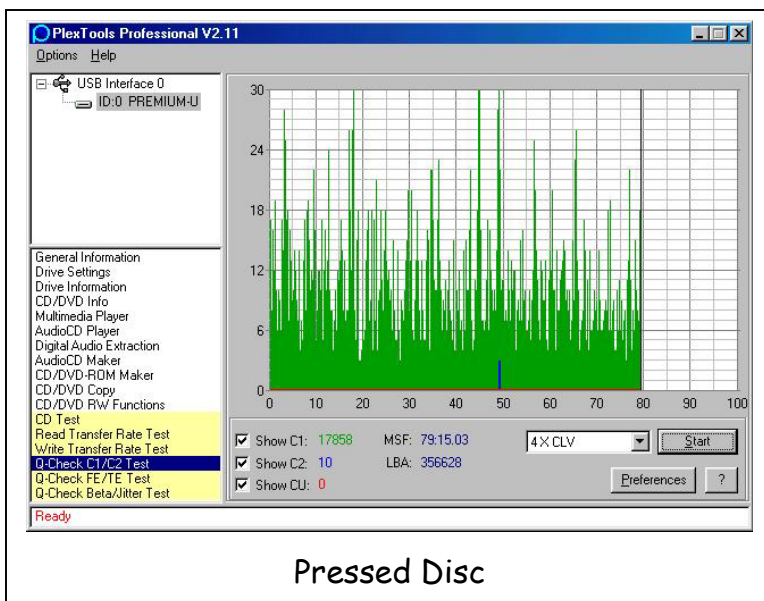
- The best software for music extraction is EAC - Exact Audio Copy on secure or paranoid mode. PlexTools runs a very close second using its "Recover the best bytes" setting, but that only works with the high-end Plextor drives. However, this again depends on the CD-ROM you run EAC on - using EAC and a generic, cheap drive, PlexTools on the Plextor works better.
- The software bundled with the CD burner seemed to work best. Adaptec with the Iomega Predator burning at 2x, Ahead Nero for the Yamaha CRW-F1 on Audio Master Quality recording mode, and PlexTools with the Plextor Premium-U with VariRec. I stopped experimenting with different burning software when it just got too unwieldy with too many different software to try, and not enough difference in the sound¹⁶.
- Run the software at its slowest speed, disc-at-once, taking as a source tracks pre-stored on the hard-disk in WAV format as individual songs. For the short strategy dye types, a minimum speed is 4x, but for the long strategy dye types, it can go as slow as 1x. There have been reports of high-speed media needing to be burned at 16x to keep errors to a minimum but I have not had the chance to do any testing (version 4.0 of the paper?).
- Make sure that the writing process is not interrupted by other software and hardware running on your computer

¹⁶ Although I have been told by some computer experts that the burning software has the job to encode the WAV file into EFM, and thus CAN make a big difference in the sound.

Hardware:

- External CD burners work best: the Iomega Predator (the old 4/4/6 speed top-loading model with the clamp, not the newer 32x drawer model), Yamaha CRW-F1 (USB), and the Plextor Premium-U (USB).
- Support your CD burner as you would a turntable or CD player - it is extremely susceptible to vibration.
- Many readers have asked about using a stand-alone hifi CD recorder - I have not tried these, so I don't know.
- Initial tests with DVD recorders show great promise, but more work is needed.
- Give it excellent power using the PS Audio Power Plant - anything else seems to make the resulting CD lose pace, rhythm and timing. For my Plextor, I had a custom built power supply which made the results much better than with the original switching power supply.
- Use a dedicated recording computer, which is not doing anything else. One reader has suggested that making copies with a laptop computer running on batteries result in better copies. I have found that this is indeed to be true. Computers all use switching power supplies, and this may result in some digital hash that gets into the sound (although the computer geek in me says that cannot make a difference to bits).

It may be a matter of errors (of the C1 correctable variety) although I have been told that it does not matter because of error correction. I tested the



error rate of a brand new CD I bought, and a Black CD I made of the same disc and got the results you see below. The error rate on the Mitsui Gold and the TDK Musical Reference are even lower than on the Black CD!

6 The End of the Beginning

Despite two years of work, all the feedback, and now with so many others working on this process, it is still too preliminary to make a conclusion. There are still a lot of mysteries to be solved, and we don't believe that we have exhaustively explored every angle.

However, it is rewarding work as it opens up a wealth of available music. Even CDs pressed badly from the early 80's sound acceptable (despite the bad A-to-D encoders in use then).

Just as there are so many brands of interconnects, CD transports, DACs, etc., you will have to find the combination of writer, software, and media that works best for you and the music you listen to. There are literally millions of possible combinations - and this should include different playback systems as well. Different combinations of media and burner might also be needed for different types of music as was suggested by one reader. One reader even pointed out that the USB cable used to connect the CD burner to the computer might make a difference - and it did.

Both Arnie and I did all our listening tests in our own systems, and we coincidentally had the same CD transport - the Sony SCD-1. At CES2004, we used the Wadia 27ix and 270, and the discs sounded fabulous there too. I have also been testing Esoteric, Rega, Naim and Wadia players. However, you may find that with a different CD transport, or DAC, you might prefer different writers, software, and media.

Just like some prefer the sound of tubes to transistor, the final decision on media to use may rest on what is available in your market, and your musical preference.

There is one thing, though, that we can confidently conclude - that the music CDs using this process results in a spectacular improvement to the musicality of the CD playback. It is not only with high-end equipment. Readers with very modest entry-level set-ups have written to say that it makes their systems sound very much better than their friend's mega-buck systems.

I've spent many hours going back to CD's that I thought didn't sound good, and with the re-recording, have realized that they were just badly pressed. Now, I have much more music to enjoy!

So, have fun. And please write and let me know how you do if you do try this process and improve on it! gary@genesisloudspeakers.com.

Appendix – Disc/Dye Types

Ever since a number of readers pointed out to me that there are only a handful of manufacturers and dye types in CDR's, I've been looking into that. Just as different vinyl formulations and pressing plants can make records sound different, I thought that the different media made a big difference in the sound of the burnt CDs.

So, armed with NeroCDSpeed and CDR-ATIP, I checked out some of the dye types, and manufacturers of the discs I was using.

The "Rating" column is extremely subjective. How much better is **** than ***? Not a huge amount. Even the ones rated ** would be an improvement on some badly pressed original CDs. For the very well-pressed ones, you need at least *** to get much of an improvement.

Brand	Manufacturer	Dye Type	Rating
e ³ works Music <i>Audio</i> CD (black)	Lead-Data	3: Long Strategy (Cyanine/AZO)	***
Imation Black	CMC Magnetics	6: Short Strategy (Phthalocyanine)	***
Infinity Black 40x	Gigastorage	2: Long Strategy (Cyanine)	*****
Hypermedia 48x	Prodisc	9: Short Strategy (Phthalocyanine)	**
Kodak Gold Ultima	Kodak	5: Short Strategy (Phthalocyanine)	*
Magic Black 24x	CMC Magnetics	6: Short Strategy (Phthalocyanine)	***
Melody Black Diamond 12x (dark grey)	Gigastorage	0: Long Strategy (Cyanine)	****
Melody Black Diamond 40x (dark grey)	Gigastorage	2: Long Strategy (Cyanine)	*****
Melody Black Diamond 40x (lighter grey)	CMC Magnetics	6: Short Strategy (Phthalocyanine)	***
Melody Black Diamond 40x (dark grey, small "melody" word)	Ritek	7: Short Strategy (Phthalocyanine)	**

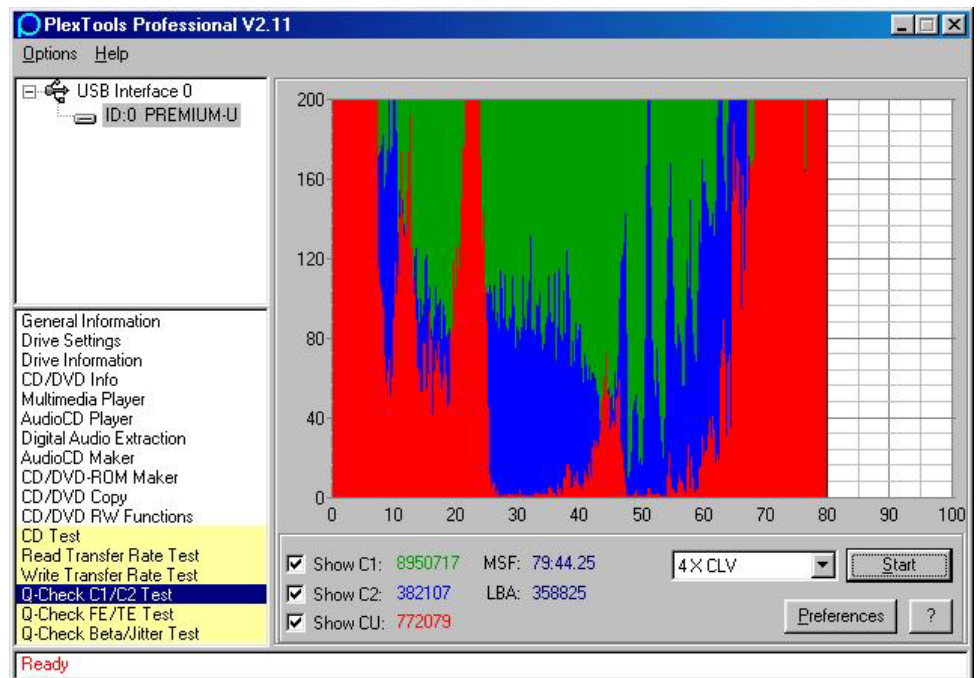
Melody Black Diamond 40x (silvery label)	Gigastorage	5: Short Strategy (Phthalocyanine)	*****
Melody Black Diamond 48x (looks like vinyl)	Plasmon Data Sys	8: Short Strategy (Phthalocyanine)	****
Memorex Black CD-R	Prodisc	9: Short Strategy (Phthalocyanine)	****
Memorex Black CD-R (All Use)	Ritek	7: Short Strategy (Phthalocyanine)	**
Mitsui Gold (blank label made in Japan)	Mitsui	5: Short Strategy (Phthalocyanine)	***
Mitsui Gold (blank label made in Colorado)	Mitsui	8: Short Strategy (Phthalocyanine)	*****
Phono-R Digital <i>Audio</i> (silver/blue)	Mitsubishi	1: Long Strategy (Metal AZO)	*
Spectrum Black 40x	Gigastorage	2: Long Strategy (Cyanine)	***
Platinum Black 12x	CMC Magnetics	6: Short Strategy (Phthalocyanine)	****
Platinum Black 40x	Unknown	0: Long Strategy (Cyanine, AZO)	***
Platinum Premium (silver/green)	CMC Magnetics	6: Short Strategy (Phthalocyanine)	**
Platinum Premium <i>Audio Blue</i>	Multimedia Masters	1: Long Strategy (AZO)	*
Samsung Digital Premium 52x (silver/green)	Prodisc	9: Short Strategy (Phthalocyanine)	**
TDK Audio Pro Musical Reference (silver/green)	TDK	0: Long Strategy (Metal Cyanine)	*****
TDK Audio XA (silver/blue)	Ritek	7: Short Strategy (Phthalocyanine)	**
Verbatim Datalife Plus (silver/blue)	Mitsubishi	1: Long Strategy (AZO)	*

Disc/Dye Type Findings

From the original set of two years ago, the Melody Black Diamond (dark label) and the Infinity Black 40x sounded very, very close, and I was hard pressed to hear the difference. Since they were made by the same factory with the same dye type, I assume that they would be identical except for the branding.

However, the Spectrum Black, even though made by the same manufacturer, and using the same dye, did not sound as good, it had some of the glaring hard treble in the original silver disc.

What distressed me was that most of the original discs I made two years ago that sounded so good then are now totally unreadable. Here's why. It looks like the disc has totally deteriorated. C1 and C2 errors are way beyond what is acceptable, and CU errors - which are uncorrectable - make up a large part of the disc.



Similar copies I made on short strategy phthalocyanine and metal azo dye discs don't display such errors. What I will never find out is what the original error rate was like when I made these discs because I only recently acquired the Plextor, which made it possible for me to do these tests.

The reason the manufacturers of cyanine discs phased them out was that they did not last as long as the new formulations (metal azo and phthalocyanine) but they were supposed to last 4 years - this disc was only a year old, and I had kept it well in a CD folder.

I found that a copy made fresh would start deteriorating over 2 weeks! Hence, the old Melody/Infinity Cyanine dye types are great for only very short-term use.

My favourite discs are still the Melody manufactured by Gigastorage - although it is difficult to determine that they are the right types until you buy a pack, take them home and check them out using Nero CDSpeed or CDR-ATIP.

The latest are the silvery label Melody Black Diamond 40x (back left) and the vinyl-label Melody (back right). I would give the latter another $\frac{1}{2}$ star in its rating. The old Cyanine dye Melody with the dark label and the big "Melody" (front center) is still available, although I would not recommend its use for long term stability issues. Nevertheless, it does sound the best when it's fresh.



The Melody Black Diamond as sold in the US on a couple of websites are a different disc altogether - different manufacturer, dye-type, and look.

The latest find was the TDK Audio Pro Musical Reference and the Mitsui Gold blank label. The last was a rumor that I had heard on the internet, and then with extensive testing from a Genesis dealer - Rob Outlaw in Montana - and my own experiments, we found black gold 😊!!

The Mitsui was a fantastic find - it made the music more lively and vibrant, and instrument separation and soundstage depth and width seemed much better than the Black. On measurements, it had much lower c1 errors than the Black, and displayed lower jitter and beta measurements. It was also of archival quality, which means that the CDs burned are not expected to deteriorate.

In comparison, the black had the warmer sound, and if anything, more inviting and comfortable. However, this could be due to some form of euphonic distortion resulting like with vacuum tube amplifiers.

The TDK Pro Musical Reference is all around the best media I have every found - in all respects. Unfortunately, it is extremely difficult to get hold of, and extremely expensive. It combines the qualities of both the Mitsui Gold and the Melody Black Diamond.

So, in order of my own preference, of the discs that are currently available, I would rate them as:

- 1 TDK CD-R Audio Pro Musical Reference
- 2 Melody Black Diamond (silvery label) and Mitsui Gold (Colorado)
- 3 Melody Black Diamond (vinyl label)

For those readers with a CD player that incorporates copyright protection, the e³works Music CD that I managed to get from OfficeMax in the US was the only black media I have found.

So, the quest continues.....