Table 6—Comparison of Burning Software [a]

BURNING SOFTWARE	BURN SPEED	SOUND SCORE	$C1_{AVG/S}$; $C1_{MAX/S}$; $C2_{AVG/S}$; $C2_{MAX/S}$; $C1_{TOTAL}$; $C2_{TOTAL}$ [b]
JRMC	4x	130	3.8; 33; 0.1; 101; 5443; 170
Easy CD-DA	16x	120	3.5; 23; 0; 8; 5026; 9
Foobar 2000	16x	110	8.9; 37; 0; 0; 12910; 0
EAC	16x	105	2; 19; 0; 0; 1438; 0
CD on PS Audio PWT-PWD	NA	100	NA
Audition	16x	90	4.1; 24; 0; 0; 3000; 0
dBPA	16x	85	2.6; 23; 0; 0; 3854; 0
iTunes	NA	85	2.5; 23; 0; 0; 1841; 0
Media Monkey	24x	75	2.2; 31; 0; 0; 3202; 0
Nero (ripping speed not specified)	"minimum"	70	3.6; 32; 0.2; 99; 2647; 125

[a] All tracks ripped to the HD as WAV files with Easy CD-DA.
[b] C1 and C2 refer to common errors found on CD's and refer to Block Error Rates and Frame Errors, respectively.

Table 7—Influence of CDR Quality [a]

CDR DESCRIPTION	MANUFACTURER	BURN SPEED	SOUND SCORE	$C1_{AVG/S}$; $C1_{MAX/S}$; $C2_{AVG/S}$; $C2_{MAX/S}$; $C1_{TOTAL}$; $C2_{TOTAL}$
MAM-A Gold	Mitsui	8x	130	7.2; 31; 0; 0; 10535; 0
Taiyo Yuden Green	Taiyo Yuden	16x	120	2; 36; 0.9; 82; 2926; 1319
Memorex Black/Gold	CMC Magnetics	16x	115	3.5; 23; 0; 8; 5026; 9
PNY Black Diamond	PNY Technologies	8x	110	4.9; 35; 0; 3; 7056; 3
Original CD on PS Audio PWT-PWD	Sony	NA	100	NA
AudioXSell Black	Plasmon	16x	100	68.1; 137; 0; 4; 99068; 4
HP Silver	CMC Magnetics	16x	95	8.4; 30; 0; 0; 12170; 0
TDK Silver	CMC Magnetics	16x	85	4.2; 37; 6; 6045; 6
Media Monkey	24x	24x	75	2.2; 31; 0; 0; 3202; 0
Nero (ripping speed not specified)	"minimum"	"minimum"	70	3.6; 32; 0.2; 99; 2647; 125

[a] There have been several reports that the sound of standard CDs can be improved by ripping and burning to specific CDRs. Although our investigation was not exhaustive in scope, we tested this claim with a variety of discs we had at our disposal. In general we can confirm the results obtained by other audiophiles (see Table 7) and can provide a rank order of merit for burned CDs as compared to the sound of the original CD. As others have found, the Mitsui MAM-A Gold disc produced a very useful improvement in sound quality that bested all the other discs tested. It is important to note, however, that not all CDRs produced a sonic benefit and some actually degraded the sound compared to the original CD. Here too, our hopes were dashed of finding some objective measurement that correlated with our subjective rankings or, for that matter, effective burning speed. Sigh!

iZotope was found to produce the best-sounding results for downconversion as well. In fact, this program was uniquely capable of creating a 44/16 WAV file that actually exceeded the sound of our ripped CD standard, much to our pleasant surprise. r8brain Pro also did a creditable job in this task but the other programs fared much more poorly. As we think about this result, perhaps we shouldn't be so surprised that we could create a higher quality Red Book standard CD master file, given the magnitude of losses that probably occur when converting a high-resolution mastertape to the CD production master and the CD stamping process itself.

The Best Way to Copy CDs and Rip Music to Your Computer

Evaluation of Ripping Software

The process of ripping a CD, that is, transferring CDA files from the CD to WAV files (or other formats) for archival storage on an HD, actually involves three distinct steps. The first is to read the CD, then convert the file to the desired format, and finally write the file to the HD. In Table 4, we rank the sonic quality of ten programs for the complete ripping process using the slowest speed options permitted by each program. Initially, JRMC was found to give the best results. Later in the testing we added Foobar 2000 and dBPA, which were found to provide just detectably better quality.

Table 8-Influence of Burning Speed on Sound Quality

SOFTWARE	BURN SPEED	SOUND SCORE
Original CD on PS Audio PWT-PWD	NA	100
JRMC	1x	105
JRMC	2x	110
JRMC	4x	120
JRMC	6x	95
JRMC	8x	85
JRMC	16x	75

[a] Using one of the poorer performing discs in Table 7, we examined the influence of burning speed on the sound of the final CDR. The results of this experiment are presented in Table 8. Using JRMC, we found a biphasic curve for optimal burning speed, which peaked at 4x. Such inflexion points may be quite common among burners from different manufacturers. If one wishes to optimize this parameter, it will likely have to be determined experimentally on each specific brand of drive.

What is clear from these results is that the programs themselves were more important in controlling sound quality than was the actual ripping speed.

Late in this study, we found that one of the programs, JRMC, provided the option of varying the reading speed phase of the ripping process. This variable was examined (see Table 5) and we found a biphasic pattern peaking at the 2X setting, rather than the 4X setting (used elsewhere in this study), giving a 10 point sonic benefit and equaling the best performer (dBPA) in Table 4, above.

Regardless of the read speed, JRMC, dBPA and several other programs use an "accurate rip" verification process to ascertain that the ripped file sizes conform to an on-line database of file sizes for individual tracks on an album. Although JRMC reported an accurate rip for all reading speeds, and are bit-for-bit identical at all reading speeds, we are still able to detect sonic differences in the resulting files. We know these results drive engineers crazy. We would love it if someone could come up with a definitive explanation that could provide input to software developers.

Evaluation of Burning Software

One of the major questions we posed at the beginning of these studies was whether it really is possible to make copies of CDs that sound better than the originals. Given the differences we found between different ripping programs, we tested whether there are real software differences in the burning process. We found that such differences do exist and our results are summarized in Table 6. Compared against our references, we are now in a position to state that copies ripped from the original CD can be better or worse than the original. We can also conclude with some confidence that what we judge to be better sound is qualitatively more like our authentic high-resolution standards.

We sought to determine whether these differences could be explained by variations in C1/C2 errors.[5] After our subjective rankings were determined, the various discs were measured by an independent party using Plextools software supplied with a PX-716UF Plextor drive. These results are listed in Table 6. It can be seen that there is not the slightest relationship between our subjective sonic rankings and these error rates. There also seems to be no relationship between burning speed and C1 and C2 errors. These results are disappointing since we were hoping that our subjective evaluation procedures might correlate with variances in some objective measurement. Clearly, it is not this particular measurement. *C'est la vie!* tas

[5] C1 and C2 errors are defined as read errors on a CD which occur over single or over many interleaved frames, respectively. They are reported in Table 5 and 6 as: C1/C2 average errors per second; C1/C2 maximum errors per second; and, C1/C2 total errors.