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Music encoding guide

By now, most of us have a sizeable collection of MP3s cluttering our hard drives. You can claw back some disk space by shrinking file sizes but, as Will Head explains, there's an art to compressing tracks so they sound as good as the original

By now, you can hardly fail to have noticed that the computer industry is keen to have us believe the PC is the most exciting thing to enter the living room since the gramophone. We're as cynical as you about a PC being anywhere near as desirable as a suitably expensive set of stereo components, but we do like the idea of being able to call up any track we fancy from our music collection at will.

There's plenty to be said for having your entire music collection stored in one place. There's no need to hunt down that elusive disc, you can change albums while lounging on the sofa or change to random play and rediscover forgotten gems.

Copying tracks to your PC is easy, but however capacious your system, how can you be sure they're all going to fit? And if you do squeeze them all on, will you be able to multitask or will the PC be so clogged up with data it almost collapses?

Compression is the answer. It's what makes audio files small enough to share and, when copying from CD to your PC, is what the software does to the original track. Often, your PC or the recording and playback software you use automatically selects the compression format used, so you may not be aware of the process.

But if you want to transfer a lifetime's collection of listening pleasure to your PC so you've got a digital jukebox of musical memories, it's as well to know something about the competing compression formats and their respective merits. MP3 is one of many compression formats that takes an audio file, samples it and bundles it back into a much smaller file so it takes up far less disk space. It's ideal for listening to tracks on the move too, since you get up to 10 times more compressed tunes on a CD. A recordable disc costs just a few pence, but can store several hours of music which you can then play back in a digital audio player.

Oo, ah, just a little bit

You won't be surprised to learn all compressed audio is not created equal. While a range of possible methods can be employed for compressing and encoding tracks, it's also down to the individual to select the level of quality. This is dictated by the bit rate – how much information makes up the compressed track.

There's obviously some trade-off between file size and getting a faithful reproduction of the original track. This will be dictated by the amount of hard disk space you have in which to store the music collection if copying to PC or, alternatively, the capacity of your portable digital audio player.

You'll also need to consider a few other factors when archiving your own music collection on a PC. CD ripping tools such as Microsoft's Windows Media Encoder can be downloaded for free, while a number of dedicated MP3-making packages can be bought off the shelf. Even a relatively small collection of 100 CDs or so is still going to take a fair amount of time to encode, regardless of the format you decide to convert them to.

There are many music compression schemes available, all with different quality levels so making the right decision isn't easy. And if you pick the wrong one at the outset, it's going to mean ripping all those CDs again.

With this in mind, we decided to put various codecs (encoder/decoders) to the test. The amount of compression and compatibility with the various software and hardware players available are fairly easy to ascertain for each format, but quality isn't so easy to access.

For this, we enlisted the help of our readers who took part in a blind listening test. If you've got a lot of CDs to compress but don't know which format to use or are interested in how the competing codecs fair, read on.

It ain't what you do, it's the way that you do it

In the digital world there are two ways to compress things: lossless and lossy. As their names imply, lossless compression doesn't lose any of the original data whereas lossy compression discards unnecessary data that, once removed, can't ever be recovered. Lossless compression provides a faithful replica of the original data while lossy is a close approximation.

To explain how the different approaches work, consider the following phrase: *'PC Advisor* is a great magazine and has a vast number of interesting reviews and explains computer technology in plain, understandable English'. A lossless approach to compressing that phrase would be to replace the word 'and' with '&': '*PC Advisor* is a great magazine & has a vast number of interesting reviews & explains computer technology in plain, understandable English'.

This reduces the phrase from 141 characters (including spaces) to 137 – admittedly not the most efficient compression method, but if you replace further sets of repeating characters with symbols you could compress it further. Taking the compressed phrase and converting the '&' characters back to 'and' gives you back the original phrase without loss of data.

The lossy approach would give something similar to the following: *'PC Advisor* is a good magazine with lots of good reviews and no jargon'. As you can see, the overall result is a close approximation of the original but only requires 69 characters. However, in this case there's no way to recover the original phrase from the compressed one.

With lossless compression you retain the original data at the expense of file size while lossy discards redundant data to increase compression.

Creating our samples

To encode the MP3, WMA, Ogg and SHN samples we used the following programs: Lame encoder, Microsoft Windows Media Encoder, Ogg Drop and mkwACT.

You can find details of the various settings used under *How the codecs compared* and for links to the various programs see *Programs used* on page 101.

Once the file was encoded we then converted it back to a WAV file using dBpowerAMP Music Converter. The files were made available for download and were also included on *PC Advisor's* June 03 cover CD. The survey, which was online, was completed by 186 people.

For a summary of which files were used for which questions and the amount of compression see *File summary* on page 101.

When it comes to compressing music, the various codecs work in the same way.

Lossless codecs replace patterns of data with shorter symbols while lossy codecs discard unnecessary or redundant information such as frequencies inaudible to the human ear. Lossy codecs also have a quality setting that allows you to control how much data is removed.

How the codecs compared

The survey was broken down into two sections. The first compared a compressed file against the original and the second compared three files compressed to the same amount against each other. For the first section we used the following codecs: MP3, WMA and Ogg Vorbis which are all lossy codecs and WMA Lossless and SHN (Shorten) which are both lossless. For the lossy codecs we used two settings – one at a high quality and another at a lower quality.

The quality of a lossy codec is dictated by the bit rate, which specifies how much information is used per second of audio and is measured in kilobits per second.

You can choose between a CBR (constant bit rate) for the whole file or a VBR (variable bit rate), which uses less compression for more complicated parts and more compression on simpler parts. With VBR you specify a quality setting for the file.

MP3 VBR is defined on a scale of zero to nine with zero being the best. WMA uses a percentage – 100 percent being the best – while Ogg Vorbis uses a scale of -1 to 10 with 10 being the best. For section of the survey we used MP3, WMA and Ogg Vorbis at high quality and low quality. A full breakdown of the various codecs and quality levels is as follows:

Section one

- MP3 CBR 128Kbps (low quality)
- MP3 VBR Quality setting 1 (high quality)
- WMA 64Kbps (low quality)
- WMA VBR 75 percent (high quality)
- Ogg Quality setting 0 (low quality)
- Ogg Quality setting 5 (high quality)
- WMA Lossless
- SHN Lossless

Section two

- MP3, WMA, Ogg CBR 64Kbps
- MP3, WMA, Ogg CBR 256Kbps

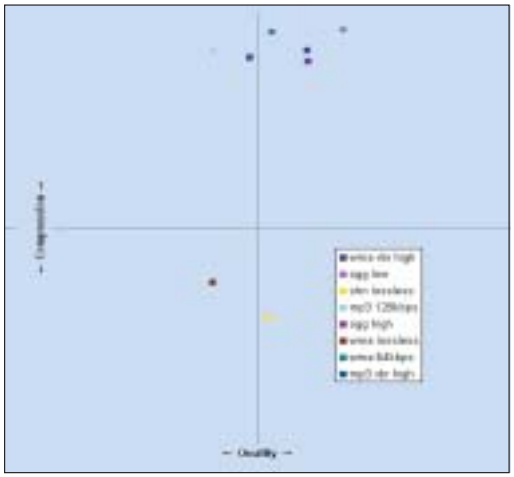
Reading the results

The survey was split into two categories: the first eight sets of samples compare a compressed file with the original, while the final two compare three different compression schemes at two different compression levels.

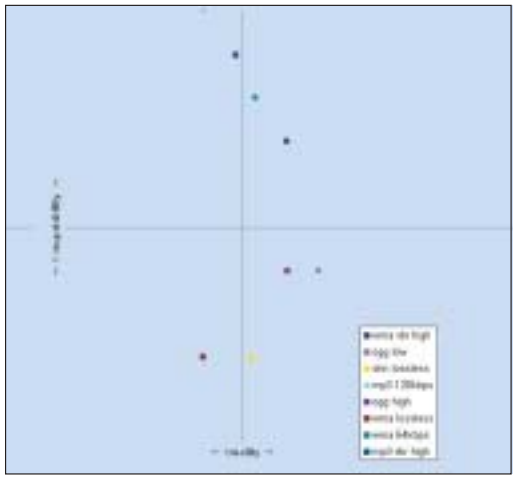
Questions one to eight

The codec gives a brief description of the compression scheme and quality setting used for each file. The Setting shows how we compressed the file for each example. The File refers to which file (a or b) was the compressed one used in the survey.

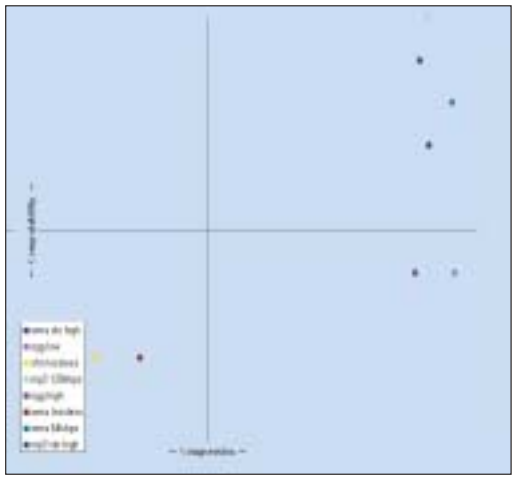
- Frequency The chart (see page 100) shows the frequency analysis of the file in question – basically a breakdown of the various frequencies that make up the resulting file. The original file is plotted in red with the compressed file plotted in yellow. Any variation of the yellow line from the red shows where data has been lost. In the case of the lossless formats, the yellow line follows the red exactly and no red is visible.
- Quality We've assigned a quality score to each sample based on the percentage of respondents who said the compressed file sounded better. For example, if 75 percent of respondents thought the compressed file sounded the best we've given it a score of 7.5.
- Compression The compression score is calculated based on the size of the compressed file compared to the original. If the original file was 5MB and the compressed file was 1MB, the reduction in file size is 80 percent (the original file size minus the compressed file size as a percentage of the original), which gives it a compression score of eight.
- Compatibility Finally we have assigned a score to compatibility. This is a purely subjective figure which has been based on the available hardware and software support on the market for the various file formats. We have assigned the scores as follows:



↑ Comparison: quality vs compression

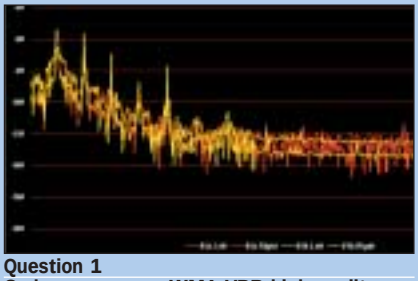


↑ Comparison: quality vs compatibility



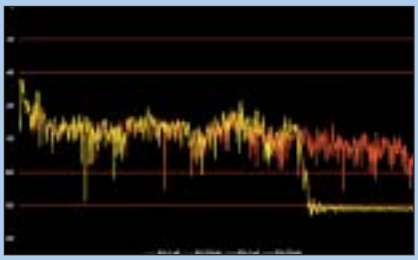
↑ Comparison: compression vs compatibility

Results for all questions



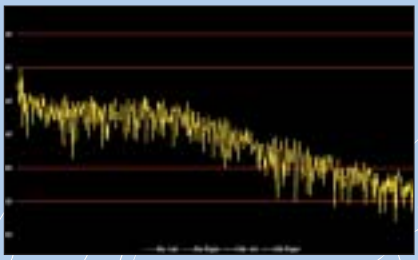
Question 1

Codec:	WMA VBR high quality
Setting:	variable bit rate, 75 percent quality
Compressed file:	1b
Quality:	5.69
Compression:	9.11
Compatibility:	7.00
Total:	7.27



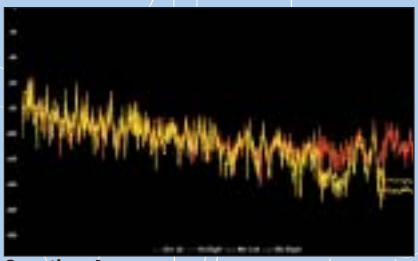
Question 2

Codec:	Ogg low quality
Setting:	quality setting 0
Compressed file:	2b
Quality:	6.19
Compression:	9.58
Compatibility:	4.00
Total:	6.59



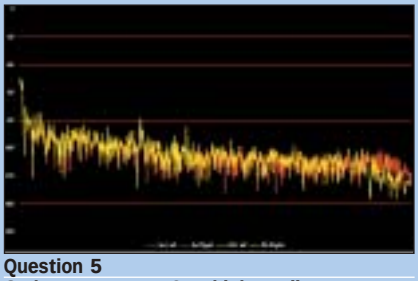
Question 3

Codec:	Shn Lossless
Setting:	n/a
Compressed file:	3b
Quality:	5.15
Compression:	2.91
Compatibility:	2.00
Total:	3.35



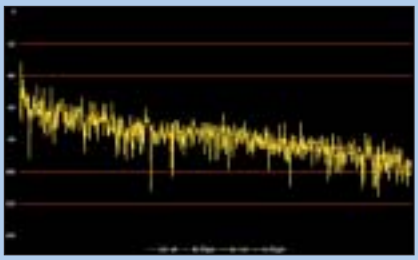
Question 4

Codec:	MP3 128Kbps
Setting:	-b 128 -m s --lowpass 19.5 -q 0
Compressed file:	4a
Quality:	4.40
Compression:	9.09
Compatibility:	10.00
Total:	7.83



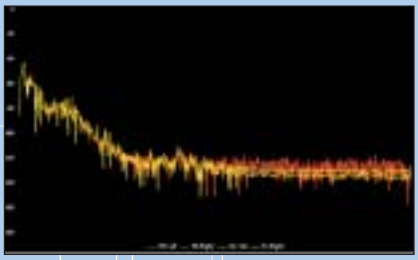
Question 5

Codec:	Ogg high quality
Setting:	quality setting 5
Compressed file:	5b
Quality:	5.70
Compression:	8.85
Compatibility:	4.00
Total:	6.18



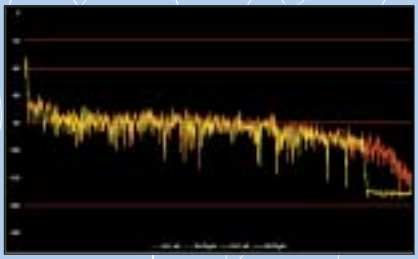
Question 6

Codec:	WMA Lossless
Setting:	Variable bit rate, 100 percent quality
Compressed file:	6a
Quality:	4.39
Compression:	3.74
Compatibility:	2.00
Total:	3.38



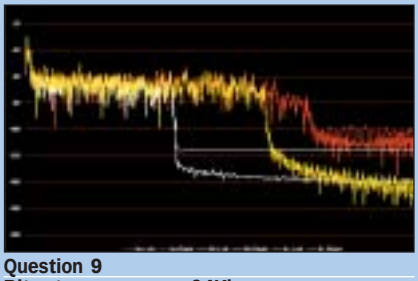
Question 7

Codec:	WMA 64Kbps
Setting:	constant bit rate, CD quality
Compressed file:	7a
Quality:	5.20
Compression:	9.53
Compatibility:	8.00
Total:	7.58



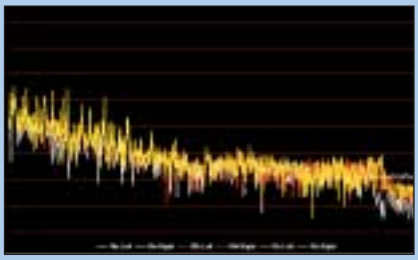
Question 8

Codec:	MP3 VBR high quality
Setting:	--r3mix
Compressed file:	8b
Quality:	4.90
Compression:	8.94
Compatibility:	9.00
Total:	7.61



Question 9

Bit rate:	64Kbps
MP3	
File:	9b
Percentage Best:	19.39
Percentage Worst:	53.06
Quality:	1.63
Compression:	9.55
Compatibility:	10.00
Total:	7.06
WMA	
File:	9c
Percentage Best:	51.02
Percentage Worst:	20.41
Quality:	8.06
Compression:	9.52
Compatibility:	8.00
Total:	8.53
Ogg	
File:	9a
Percentage Best:	29.59
Percentage Worst:	26.53
Quality:	5.31
Compression:	9.55
Compatibility:	4.00
Total:	6.29



Question 10

Bit rate:	256Kbps
MP3	
File:	10a
Percentage Best:	28.57
Percentage Worst:	39.18
Quality:	3.94
Compression:	8.18
Compatibility:	10.00
Total:	7.37
WMA	
File:	10c
Percentage Best:	35.71
Percentage Worst:	25.77
Quality:	5.99
Compression:	8.16
Compatibility:	8.00
Total:	7.38
Ogg	
File:	10b
Percentage Best:	35.71
Percentage Worst:	35.05
Quality:	5.07
Compression:	8.23
Compatibility:	4.00
Total:	5.76

Programs used

- dBpowerAMP Music Converter **www.dbpoweramp.com/dmc.htm**
- Lame Encoder **www.dors.de/razorlame**
- mkwACT **www.etree.org/mkw.html**
- Ogg Drop **www.vorbis.com/download_win.psp**
- Windows Media Encoder **www.microsoft.com/windows/windowsmedia/9series/encoder**

Constant bit rate MP3: 10
Variable bit rate MP3: 9
Constant bit rate WMA: 8
Variable bit rate WMA: 7
Ogg: 4
Lossless WMA: 2
SHN: 2

Fixed-rate codecs get a slightly higher score than variable-rate ones which don't tend to be supported on older devices. MP3 does better than WMA as more players support it. Ogg gets just four as we've yet to see any hardware players that read it. The lossless codecs also score poorly as they are designed as archive formats rather than for playback.

Questions nine and 10

Results for questions nine and 10 (shown on page 100) are laid out similarly to those for one to eight, with a few exceptions.

- Frequency The chart shows the frequency analysis as for questions one to eight, except in this case the Ogg file is plotted in red, the WMA in yellow and the MP3 in white.
- Quality The quality score for questions nine and 10 is made up from the percentage of people that thought it sounded best minus the percentage of people that thought it sounded worst. We then add five to the score to avoid negative values. For example, if 50 percent thought it sounded best and 20 percent thought it sounded worst, this would give a score of three then add on five to give a final score of eight. As the difference between best and worse scores was less for higher bit rates, the quality scores between questions nine and 10 aren't directly comparable.
- Percentage The Percentage Best and Percentage Worst scores show how many respondents chose the respective file as being the best or worst sounding.

The compression, compatibility and total scores are calculated in exactly the same way as questions one to eight.

And the winner is…

Which codec is the best depends on which is more important – quality, compression or compatibility. To make it easier to find the most suitable codec for you, we've made three graphs that compare quality against compression, quality against compatibility and compression against compatibility. The graphs (shown on page 99) use the quality, compression and compatibility scores for questions one to eight. For each graph, the value nearest the top righthand side gives the best trade-off between the two factors. So if quality and compression are the most important factors to you then Ogg at a low-quality setting is the most suitable.

> There's no perfect trade-off between quality and compatibility, with four possible formats and no discernible winner

If, on the other hand, you're more concerned with compression and compatibility, then 128Kbps MP3 easily works out as the favourite option. Interestingly, though, there's no perfect trade-off between quality and compatibility, with four possible formats and no discernible winner.

Taking all factors into account – that is, quality, compression and compatibility – MP3 at 128Kbps comes out as the winner. However, this is mainly due to its high compatibility – you'd be hard pushed to find a player that doesn't support it.

The Ogg Vorbis codec showed promising results for both quality and compression, but unless you're prepared to use only a PC for playback then it's not the best codec to choose. Hopefully hardware support will improve this but at the moment it's a PC-only option.

If you're a quality freak then the lossless codecs are the way to go since all data is preserved. WMA showed a slight advantage over SHN for compression, but there wasn't much in it. If you've decided to opt for a constant bit rate then WMA comes out as the winner both at low-quality 64Kbps and high-quality 256Kbps. ■

PC Advisor would like to thank Creative, Digital Vision and also all the readers who took the time to fill out the survey.

File summary

Question	Codec	Compressed file	Original size (KB)	Compressed size (KB)
1	WMA VBR 75 percent	b	5,631	502
2	Ogg quality 0	b	5,751	239
3	SHN	b	5,230	3,706
4	MP3 CBR 128Kbps	a	5,398	490
5	Ogg quality 5	b	5,283	609
6	WMA lossless	a	6,551	4,100
7	WMA CBR 64Kbps	a	5,600	263
8	MP3 VBR quality 1	b	5,391	572
9a	Ogg CBR 64Kbps	a	5,157	232
9b	MP3 CBR 64Kbps	b	5,157	234
9c	WMA CBR 64Kbps	c	5,157	248
10a	MP3 CBR 256Kbps	a	5,765	1,048
10b	Ogg CBR 256Kbps	b	5,765	1,022
10c	WMA CBR 256Kbps	c	5,765	1,062