



# Preservation Handbook

## Digital Audio

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## Definition

Sound in its original state is a series of air vibrations (compressions and rarefactions), which are captured by our ears and then converted to electronic impulses for interpretation. To measure sound waves we use frequency and amplitude. Frequency is a measurement, in Hertz (Hz), of the number of vibrations that occur per second. Optimally, people can hear from 20Hz to 20000Hz (20kHz) although this decreases with age. Amplitude is a measure of how many air molecules are affected by the vibration of a sound.

Digital audio may be constructed within an audio manipulation package (born digital) or sampled from an analogue source and stored as a binary file. Audio quality is influenced by three factors:

- 1) The sampling frequency
- 2) The number of bits used (bit-rate)
- 3) The compression format/codec.

Tens of thousands of samples are taken each second and each sample represents the intensity of the sound pressure wave at that point in time. To replay the digital information in its original form, the audio hardware must convert the binary data into an analogue signal and play it through speakers.

## Digital Audio Files

Digital audio may be stored as a continuous waveform (wave, MP3), instructions that indicate how music should be reproduced (Midi) or a series of short segments that are processed in a non-sequential manner (modules) or music notation (Cmusic). Continuous waveforms are the most suitable method for preservation as a result of the widespread availability of playback software, accuracy of the audio recording and simplicity of the file format. The suitability of these formats varies in accordance with the compression method used, the availability of structural documentation, and specific patent or proprietary restrictions imposed by the formats creator.

### *Uncompressed Audio Formats*

Uncompressed 'lossless' audio formats provide an accurate representation of the analogue recording, at the expense of file size. Popular variants include the Microsoft WAVE PCM encoding (.wav), the default sound format on the MS Windows platform, and Audio Interchange File Format (.aiff), the default format for the Apple MacOS. Due to the lossless nature of their recording (i.e. no information is removed when the data is saved), these two are the formats most suitable for preservation. However, accuracy of recording is at a cost – file sizes are often large, with each minute of audio footage taking an average 10MB of space. Therefore, there is a possibility that depositors will choose a compressed format.

### *Compressed Audio Formats*

Compressed 'lossy' audio formats use specialist codecs (specialised transformations) to compress audio data. Popular variants include MPEG Layer 3 (MP3), Ogg and Real Audio. These sacrifice exact audio duplication for smaller file size, by removing information that is less significant to the human ear (i.e. background and inaudible noise above 20000Hz). For the purpose of depositing audio, MP3 is the most common compressed format. A sample rate of 44.1kHz and bit-rate of 192kbps or higher is advised to preserve quality. However, as mentioned above, uncompressed audio is preferred.



## Additional Information

- Amplitude  
< <http://en.wikipedia.org/wiki/Amplitude> >
- Codecs  
< <http://en.wikipedia.org/wiki/Codec> >
- Introduction to sound and digital sound  
< [http://www.execulink.com/~robin1/da\\_intro.html](http://www.execulink.com/~robin1/da_intro.html) > last checked 05/03/2004
- Introduction to digital preservation of audio  
< <http://www.clir.org/pubs/reports/pub106/sound.html> > last checked 05/03/2004
- Introduction to Audio formats  
< <http://www.teamcombooks.com/mp3handbook/12.htm> > last checked 05/03/2004
- Pulse Code Modulation  
< [http://en.wikipedia.org/wiki/Pulse-code\\_modulation](http://en.wikipedia.org/wiki/Pulse-code_modulation) > last checked 19/07/2005



## Technical Environment

All major operating systems are bundled with preinstalled audio playback software for the common formats and most machines come with some form of audio output as standard. Third party formats, such as Ogg vorbis, Real Audio and Advanced Audio Coding, require third party software, which can sometimes be downloaded for free from the Internet. Analogue audio can be captured and stored as digital data using specific audio recording software, appropriate cables to connect the analogue device to the computer's digitisation hardware. External digitisation hardware (for example a USB audio breakout box) is preferable to internal hardware (such as soundcards) as the latter can pick up a lot of electromagnetic audio interference from other hardware within the computer like cooling fans. Audio extraction from a CD or DAT is relatively simple and can be performed using free software. Utilities such as DAT2WAV and CDDA32 operate by extracting audio encoded on the disc and storing them as digital files.

### Common Formats

Format	File Extension	Notes
Advanced Audio Coding (AAC MPEG-4 Audio)	.aac	Playback is not supported by all audio players. There is a slight loss in sound quality if it is not sampled at a high enough bit rate. Not suitable for preservation at the moment.
Audio Interchange File Format, (AIFF)	.aif, .aiff	Uncompressed audio suitable as a preservation format. However these files are large in size and are not seen as a standard.
Broadcast Wave Format (BWF)	.bwf .wav	Uncompressed audio that supplements the basic RIFF WAVE structure with a "broadcast extension chunk" for metadata. Migration from WAVE to BWF may be problematic. Only linear PCM and MPEG code files are supported in the 2002 specs. Suitable for preservation, particularly in the PCM variant.
CD audio (CDDA)	.cda	A PCM (Pulse Code Modulation) encoded to CD media. Suitable for preservation, however the lack of compression restricts the amount of data that may fit on a disc.
MIDI	.mid .midi	Small audio files that contain instructions on recreating




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		musical compositions. Variations in audio playback on different hardware make it unsuitable for preservation.
Ogg vorbis	.ogg	A non-proprietary open audio format that is constantly being revised. May rival MP3 in popularity at some stage.
MP3 (MPEG-1 Audio Layer -III)	.mp3	A widely accepted format that can be played on most platforms. Several patents cover the format, although a free licence is granted to non-profit organizations. Suitable for distribution, but ill equipped for preservation.
Quicktime	.qt .mov	Apple proprietary streaming Codec. Not suitable for preservation
Real Audio	.ra .ram	Real Networks proprietary streaming Codec. Not suitable for preservation.
Sun AU	.au	Large, high quality files but not widely supported outside the UNIX community, so not suitable for preservation.
WAVEform	.wav	Uncompressed audio suitable as a preservation format. However these files are large in size and not accepted as a standard in some industries.
Windows Media Audio	.wma	Microsoft proprietary streaming Codec. Not suitable for preservation.

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## Additional Information

- Digital Audio Formats  
< <http://www.teamcombooks.com/mp3handbook/12.htm> > last checked 05/03/2004
- DAT2WAV  
< <http://www.ncf.carleton.ca/~aa571/dat2wav.htm> > last checked 11/10/2004
- Mime Types  
< <http://www.freedesktop.org/~gstreamer/data/doc/gstreamer/devel/pwg/html/section-types-definitions.html> > last checked 05/03/2004
- Broadcast Wave specification  
< <http://www.digitalpreservation.gov/formats/fdd/fdd000003.shtml> >



## Ingest Checklist

### Level 1 (Essential)

- File Format
- File Size
- Compression type, if applicable.
- Compression codec (if any)
- Documentation (descriptive Metadata)

### Level 2 (Preferred)

- File format/codecs suitable for preservation.
- Bit-rate (kbps) and sampling frequency range (KHz), if applicable
- Length of recording (in minutes and seconds)
- Requirement information (what software is required for playback?)
- Information on the purpose/use of the sound recording

### Level 3 (Best Practice)

- Adherence to open standards in file creation to make its dissemination and playback as smooth as possible
- Any copyright problems/issues have been addressed.
- Detailed information on the files bit rate (192 kbps or above) to ensure its quality.

### Inform Depositor

- That we cannot guarantee the preservation of audio files that are in proprietary or little-used software e.g. streaming audio formats.



# Preservation

## Significant Characteristics

The most significant characteristics of digital audio files are the length, bit-rate (stored as kbps), frequency (kHz), number of channels (mono, stereo, or higher) and any associated metadata (e.g. ID3 tags).

## Technique

The moment of creation is the most important stage of digital audio preservation. The analogue sound has to be captured correctly and at a sample rate, which will not lead to a deterioration of the original sound. To ensure the audio file is deposited in a format suitable for preservation, it is important that the AHDS provide advice to potential depositors on correct procedures at the project outset.

To successfully preserve audio data, the deposited audio should be migrated into a format suitable for preservation. This may be achieved by performing the following:

- Use a software tool to ensure the file format, length, bit-rate and sample rate equal those provided in the documentation.
- Locate suitable audio conversion software that can handle the source format and is capable of outputting the data as Microsoft Wave. There are a great many free software packages that can perform this task, such as dbPowerAmp .
- Configure the software to output at the same or higher quality bit-rate (kbps) and sample frequency (kHz) data. Some audio codecs offer higher quality than other codecs at similar bit-rates (e.g. the Windows Media Audio format at 128kbps is equivalent to 160kbps for mp3).
- Choose a suitable audio format. Microsoft Waveform (.wav) or the Audio Interchange File Format (.aiff) are recommended as uncompressed, lossless formats suitable for preservation (until a suitable open format becomes common at a later date).
- Ensure that associated metadata integrated into the file itself can be extracted in the software tool and stored in the preservation format. If not, the information should be manually output to an ASCII text file.

Unusual audio formats (e.g. modules) that store audio in a non-sequential manner should be exported or resampled (by connecting the audio-in to the audio-out) and saved as 192kbps, 44.1kHz in the Microsoft Wave format.

## Validation of Data

- Perform a checksum of the file.
- Compare the data rate with the documentation provided.
- Listen to audio file to ensure the quality has not been significantly reduced. This is particularly important if the audio is converted at a similar bit-rate and sample frequency.
- If audio has been recorded in stereo (2 audio outputs) or higher, ensure the audio channels have not been merged or switched to the opposite channel.
- Check the length of the audio track to ensure the audio length has not decreased (i.e. a couple of seconds have been lost).
- Ensure that embedded metadata (e.g. ID3 tags) that identify the author, title, or other information have not been lost on conversion and they are stored in a correct manner.



## Specific Problems

Obscure or obsolete proprietary software compression formats may prove problematic; specialised audio conversion software may be required to convert the file into one of the preservation formats. Audio files that store associated metadata also cause problems if the software tool does not recognise the extension or extract it correctly. If conversion tools cannot be located, advice should be sought from the Executive and other service providers. If appropriate conversion tools cannot be located and/or the deposited audio file is of poor quality, a decision should be made on whether or not it is suitable for the repository.

Conversion to one of the preservation formats should always be the preferred option. This also applies to low quality files. To ensure the longevity of the data, it is important it is converted to the Wav or AIFF format, even if the sound quality of the output is reduced slightly in conversion. A copy of the original data should also be stored in the repository in such cases.

## Additional Information

Global Music Resource: Audio Format Basics

< <http://www.globalmusicresource.com/basics/basics2.html> >

QA Focus. Recording Digital Audio

< <http://www.ukoln.ac.uk/qa-focus/documents/briefings/briefing-23/html/> >

dbPowerAmp

< <http://www.dbpoweramp.com/dmc.htm> >

MP3 Converter

< <http://www.mp3-converter.com/> >