Embedding Metadata in Digital Audio Files
Guideline for Federal Agency Use of Broadcast WAVE Files

By the Federal Agencies Audio-Visual Working Group
http://www.digitizationguidelines.gov/audio-visual/

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What is this document?

This is a revision of the Federal Agencies Audio-Visual Working Group Broadcast WAVE file metadata recommendation published in September 2009. It is one of four documents pertaining to the embedding of metadata in digital audio files. The companion documents are:

- *Introductory Discussion for the Proposed Federal Agencies Guideline(updated April 2012).* http://www.digitizationguidelines.gov/audio-visual/documents/Embed_Intro_20120423.pdf
- *Consultant's report on embedding options in digital audio files (June 2009).* http://www.digitizationguidelines.gov/audio-visual/documents/AVPS_Audio_Metadata_Overview_090612.pdf
- *Discussion paper: Identifiers: Types and Characteristics (November 2011).* http://www.digitizationguidelines.gov/audio-visual/documents/IdentifiersTypesCharacteristics_20111121.pdf

The first part of this document recommends actions pertaining to data elements in the BEXT chunk established as part of the Broadcast WAVE (BWF) file specification by the European Broadcast Union, and references are made to this specification's three versions:

- BWF Version 0. The specification of the Broadcast Wave Format for PCM audio data (now referred to as Version 0) was published in 1997 as EBU Tech 3285.
- BWF Version 1. Version 1 differs from Version 0 only in that 64 of the 254 reserved bytes in Version 0 are used to contain a SMPTE UMID. Published July 2001.
- BWF Version 2. Version 2 is a substantial revision of Version 1 which incorporates loudness metadata (in accordance with EBU R 128) and which takes account of the publication of Supplements 1 – 6 and other relevant documentation. Published May 2011.

PART I. THE BEXT CHUNK

I.A. Strongly recommended elements for bext chunk. *If the Working Group had the authority to do so, these would be "required."*

Originator	
BWF Spec	ASCII string (maximum 32 characters) containing the name of the originator/producer of the audio file. If the length of the string is less than 32 characters, the field is ended by a null character. (Established in version 0 of the BWF specification.)
Fed Agencies Application	This element contains the entity responsible for the creation, maintenance, preservation of this digital item. Entity designations should be as specific as possible including a two-character county code to avoid the potential for conflict in the responsible organization's name. If space permits within the 32 character limit, the archival entity should be identified at the most specific level within the institution. Use a standard abbreviation of entity names such as those found in the Guide to Government Acronyms & Abbreviations. If an entity is not on this list, use a familiar abbreviation. Use the standard two-character ISO 3166 alpha 2 country code list.
Char limit	32
Mandatory/optional	Strongly recommended (if the Working Group had authority: "required")
Values	[Country code]comma space[Entity name]
Example LC	US, LOC/RSS [RSS = Recorded Sound Section]
Example NARA	US, NARA
Example EPA	US, EPA

OriginatorReference	
BWF Spec	ASCII string (maximum 32 characters) containing a non ambiguous reference allocated by the originating organization. If the length of the string is less than 32 characters, the field is ended by a null character. (Established in version 0.)
Fed Agencies Application	This element contains the principal identifier or the "best" identifier which uniquely differentiates one object from another, preferably at the file level. If the principal identifier string is less than 32 characters, enter the entire identifier string. If the principal identifier string is longer than 32 characters, enter this text: "See Description for identifiers."

	Do not embed identifiers that could pose a possible security risk, e.g., by exposing exact pathnames. NOTE: The Working Group perceived value in the practice of repeating the principal identifier as the first identifier in the BEXT Description element (which has 256 available characters) but did not make this detail a strong recommendation. Comments from readers are welcome.
Char limit	32
Mandatory/optional	Strongly recommended (if the Working Group had authority: "required")
Values	Under 32 characters: Identifier string Over 32 characters: See Description
Example NARA	See Description for identifiers [Explanation: actual identifiers extend more than 32 characters.]
Example LC	1201566-2-1 [Explanation: unique number generated by the MAVIS collections management database. Preferred identifier for the LC Recorded Sound Section. Generally for local use.]

Description	
BWF Spec	ASCII string (maximum 256 characters) containing a free description of the sequence. To help applications which only display a short description, it is recommended that a résumé of the description is contained in the first 64 characters, and the last 192 characters are use for details. If the length of the string is less than 256 characters, the last one is followed by a null character (00). (Established in version 0.)
Fed Agencies Application	COMMENT: This element is recommended as a container for identifiers for the work at hand and/or as pointers to additional, non-embedded (externally maintained) metadata. Members of the Working Group have repeatedly encountered the need to provide multiple identifiers for a given item. The resulting extent of data cannot be accommodated in the OriginatorReference element. For these reasons, the Working Group's recommendations for the Description element deviate from the EBU specification. In some cases, the 256-character limit will prevent an agency from listing all of its identifiers; the most important or helpful should be provided. Do not embed identifiers that could pose a possible security risk, e.g., by exposing exact pathnames. NOTE: The Working Group perceived value in two practices but wished to leave these as optional. The first is the tagging of identifiers (see examples, typically URLs) to permit them to be properly understood. The second is the repetition of the principal identifier (as provided without tagging) in OriginatorReference as the first identifier in Description, where labeling as to its origin or purpose can be provided. Comments from

	readers are welcome.
Char limit	256
Mandatory/optional	Strongly recommended (if the Working Group had authority: "required")
Values	If labeled: Identifier [comma space] type [comma space] comment [semicolon-space if more than one identifier] If no labeling: Identifier
Example NARA	[Two labeled identifiers] 58979818, local, principal ID original filename; 306-MUSA-9658B, local, RG-Series-Item Number
Example LC	[One labeled identifier] http://hdl.loc.gov/loc.mbrsmi/westhpp.2033, URL, principal ID handle
Example LC	[One unlabeled identifier] http://hdl.loc.gov/loc.mbrsmi/westhpp.2033
Example LC	[One unlabeled identifier] 1201566-2-1 [Explanation: unique number generated by the MAVIS collections management database. Generally for local use.]
Example LC	[One unlabeled identifier] RYI_6039 [Explanation: Recorded Sound Section shelf number for the original physical item that has been digitally reformatted. For local use.]
Example LC	[One unlabeled identifier] Harmonia Mundi France HM 957 [Explanation: Label information for a phonodisc in the Recorded Sound Section collection]
Example California Digital Library	[One labeled identifier] ark.cdlib.org.org/ark:/13030/tf5p30086k, URL, ARK
Example LC	[One labeled identifier] http://lccn.loc.gov/mp76000002, URL, Permalink

OriginationDate	
BWF Spec	Ten ASCII characters containing the date of creation of the audio sequence. (Established in version 0.)
Fed Agencies Application	This element contains the file creation date. This is understood to mean the local date in the timezone for the archival entity; the structure of the bext chunk does not permit ISO 8601 datetime indication, which unambiguously indicates date and time in terms of UTC (Coordinated Universal Time or Temps Universel Coordonné).
Char limit	10
Mandatory/optional	Strongly recommended (if the Working Group had authority: "required")
Values	ISO 8601 YYYY-MM-DD. Year is defined from 0000 to 9999; Month is defined from 01 to 12 (use leading zeroes if less than 10); Day is defined from 01 to 28, 29, 30 or 31 (use leading zeroes if less than 10). The separator between the items is a hyphen [-] with no spaces. Note: the Working Group adheres to the ISO 8601

	truncation convention: the year should always be given but, if unknown, values for month and day are omitted. Thus the string length may be four, seven, or ten. If the string entered is less than ten characters, end it with a null character.
Example	2005-11-09

Version	
BWF Spec	An unsigned binary number giving the version of the BWF. The number is particularly relevant for the carriage of the UMID and loudness information. This element contains the BWF version. For Version 1 it shall be set to 0001h and for Version 2 it shall be set to 0002h. Version 2 is backwards compatible with Versions 1 and 0. This means that software designed to read Version 1 and Version 0 files will interpret the files correctly except that Version 0 software will ignore the UMID and loudness information which may be present and Version 1 software will ignore the loudness information. Therefore, users of such devices will lose metadata unless special precautions are taken. In addition, early BWF-aware devices will be unable to cope with the larger RF64 and MBWF files and may not recognise any of the chunks which have been defined since 2001. The change is also forwards compatible. This means that Version 2 software will be able to read Version 0 and Version 1 files correctly. Software needs to read the <Version> field to determine if a UMID and loudness metadata are present. (Established in version 0, extended in later versions.)
Fed Agencies Application	Follow the guidance provided by the succession of EBU specifications as outlined on page 2. The ideal version indications would be as follows: • If neither a UMID nor loudness metadata is provided, then mark the file as version 0, using the value 0000h. • If a UMID is provided but not loudness metadata, then mark the file as version 1, using the value 0001h. • If both a UMID and loudness metadata are provided, then mark the file as version 2, using the value 0002h. Note that the EBU specification provides the flexibility to legally designate files as being in a higher version even if no values are provided for a UMID or loudness metadata. For example, a file may be marked as version 2 even if there is neither loudness information nor a UMID, or only one or the other. On the other hand, it is illegal to designate files as "lower version" when they do include an element value specified only for a higher version, e.g., it is wrong to mark a file as version 0 if it does have UMID or loudness information.

Char limit	
Mandatory/optional	Required by EBU specification
Values	
Example	0002h

UMID	
BWF Spec	UMID 64 bytes containing a UMID (Unique Material Identifier) to the SPMTE 330M standard. If only a 32 byte basic UMID is used, the last 32 bytes should be set to zero. (The length of the UMID is given internally.) Note: The EBU intends to publish guidance on the use of the UMID in audio files. (Established in version 1.)
Fed Agencies Application	Follow EBU specification. NOTE regarding the UMID identifier. The Working Group's understanding is that when file-reading software recognizes an instance of BWF version 1, it will look in the Version field to see if there is a UMID and report it. Readers that recognize an instance of version 0 will not look for a UMID. Meanwhile, no federal agencies are using UMID for audio files at this time and the Working Group has no particular recommendation regarding this identifier. NARA reports that their digitization systems produce version 1 files with the "slot" for the UMID left blank.
Char limit	64 bytes reserved for UMID
Mandatory/optional	Required by EBU specification
Values	
Example	

Reserved	
BWF Spec	180 bytes reserved for extensions. If the Version field is set to 0001h, these 180 bytes must be set to a NULL (zero) value. (Version 0 established a 254-byte reservation; 64 bytes were removed in version 1 for the UMID; an additional 10 bytes were removed in version 2 for the five 2-byte loudness elements.)
Fed Agencies Application	Follow EBU specification.
Char limit	190 bytes
Mandatory/optional	Required by EBU specification
Values	
Example	NULL

I.B. Recommended element for bext chunk

TimeReference	
BWF Spec	This field contains the timecode of the sequence. It is a 64-bit value which contains the first sample count since midnight. The number of samples per second depends on the sample frequency which is defined in the field <nSamplesPerSec> from the <format chunk>. (Established in version 0.)

Fed Agencies Application	The Working Group believes that TimeReference can be used in a manner that supports the management and synchronization of files that are parts of multitrack or multisegment works and plans to provide recommendations in the future.
Char limit	64-bit value
Mandatory/optional	Optional but recommended for complex recordings
Values	
Example	2374

I.C. Optional elements for bext chunk

OriginationTime	
BWF Spec	Eight ASCII characters containing the time of creation of the audio sequence. (Established in version 0.)
Fed Agencies Application	This element contains the file creation time. This is understood to mean the local time in the timezone for the archival entity; the structure of the bext chunk does not permit ISO 8601 datetime indication, which unambiguously indicates date and time in terms of UTC (Coordinated Universal Time or Temps Universel Coordonné).
Char limit	8
Mandatory/optional	Optional
Values	ISO 8601 HH:MM:SS. Hour is defined from 00 to 23 (use leading zeroes if less than 10). Minute and second are defined from 00 to 59 (use leading zeroes if less than 10). The separator between the items is a colon [:] with no spaces. Note: the Working Group adheres to the ISO 8601 truncation convention: the hour should always be given but, if unknown, values for minutes and second are omitted. Thus the string length may be two, five, or eight. If the string entered is less than eight characters, end the data with a null character.
Example	01:45:25

CodingHistory	
BWF Spec	Non-restricted ASCII characters, containing a collection of strings terminated by CR/LF. Each string contains a description of a coding process applied to the audio data. Each new coding application is required to add a new string with the appropriate information. This information must contain the type of sound (PCM or MPEG) with its specific parameters: PCM : mode (mono, stereo), size of the sample (8, 16 bits) and sample frequency: MPEG : sample frequency, bit-rate, layer (I or II) and the mode (mono, stereo, joint stereo or dual channel). It is recommended that the manufacturers of the coders provide an ASCII string for use in the coding history. (Established in version 0.)
Fed Agencies Application	This element is designed to hold data on the digitizing process including signal chain specifics, sample rate and bit depth, and other elements. It is defined as a collection of strings, each presented on a separate line,

	containing a history of the coding processes applied to the file. The first line documents the analog source recording, the second line contains data on the capture process, the third line of data records information on the storage of the file. A new line is added when the coding history related to the file is changed.
Char limit	Non-restricted
Mandatory/optional	Optional
Values	Each variable within a string is separated by a comma-space and each line should end with a carriage return and line feed. Summary of subelements: A=coding algorithm F=sampling frequency B=bit rate (only for MPEG) W=word length M=mode T=free ASCII text string; contains no commas but semicolons may be used Detail on subelement syntax: A = Coding Algorithm <ANALOG, PCM, MPEG1L1, MPEG1L2, MPEG1L3, MPEG2L1, MPEG2L2, MPEG2L3> F=Sampling frequency <11000, 22050, 24000, 32000, 44100, 48000> Implied unit of measure [Hz] B (ONLY FOR MPEG ENCODING) = Bit-rate <any bit-rate allowed in MPEG 2 (ISO/IEC13818-3)>, Implied unit of measure [kbit/s per channel] W= Word Length <8, 12, 14, 16, 18, 20, 22, 24> Implied unit of measure [bits] M=Mode <mono, stereo, dual-mono, joint-stereo> T=Text, free string <a free ASCII-text string for in house use. This string should contain no commas (ASCII 2Chex). Examples of the contents: ID-No; codec type; A/D type>
Example	[Each line is another “chapter” in one history:] A=ANALOG,M=stereo,T=Otari MX5050; SN3690; 15 ips; open reel tape A=PCM,F=48000,W=18,M=stereo,T=NVision; NV1000; A/D
Example	A=PCM,F=48000,W=16,M=stereo,T=PCX9; DIO
Example SoundDirections	A=ANALOG,M=mono,T=Studer816; SN1007; 15 ips; open reel tape, A=PCM,F=96000,W=24,M=mono,T=Pyramix1; SN16986, A=PCM,F=96000,W=24,M=mono,T=Lynx; AES16; DIO, [Explanation: Line 1 reads: an analog, mono, open-reel tape played back on a Studer 816 tape machine with serial number 1007 at tape speed 15 ips. Line 2 reads: tape was digitized to PCM coding in mono mode at 96 kHz sampling frequency and 24 bits per sample on a Pyramix 1 DAW with serial number 16986. Line 3 reads: the audio was stored as a BWF file with PCM coding

	in mono mode at 96 kHz sampling frequency and 24 bits per sample using a Lynx AES16 digital input/output interface]

LoudnessValue	
BWF Spec	A 16-bit signed integer, equal to *round* (100x the Inegrated Loudness Value of the file in LUFS). (Established in version 2.)
Fed Agencies Application	None developed at this time.
Char limit	
Mandatory/optional	Optional
Values	*See table in the Appendix for treatment of Loudness parameters* For LoudnessValue, MaxTruePeakLevel, MaxMomentaryLoudness and MaxShortTermLoudness, the range of valid values is D8F1h to FFFFh (corresponding to the floating-point equivalent values of -99.99 to -0.01) and 0000h to 270Fh (0.00 to 99.99). The most significant bit of the 16-bit hexadecimal number is the sign bit; hence, values between 8000h and FFFFh represent negative numbers.
Example	

LoudnessRange	
BWF Spec	A 16-bit signed integer, equal to *round* (100x the Integrated Loudness Range of the file in LU). (Established in version 2.)
Fed Agencies Application	None developed at this time.
Char limit	
Mandatory/optional	Optional
Values	*See table in the Appendix for treatment of Loudness parameters* The range of valid values is 0000h to 270Fh (0.00 to 99.99). The most significant bit of the 16-bit hexadecimal number is the sign bit; hence, values between 8000h and FFFFh represent negative numbers. Therefore, if 7FFFh occurs, it is known that that particular parameter must be ignored. If any parameters are found to have values outside their valid ranges (not just 7FFFh) when reading the chunk then they shall be ignored too.
Example	

MaxTruePeakLevel	
BWF Spec	A 16-bit signed integer, equal to *round* (100x the Maximum True Peak Value of the file in dBTP). (Established in version 2.)
Fed Agencies Application	None developed at this time.
Char limit	
Mandatory/optional	Optional

Values	*See table in the Appendix for values* For LoudnessValue, MaxTruePeakLevel, MaxMomentaryLoudness and MaxShortTermLoudness, the range of valid values is D8F1h to FFFFh (corresponding to the floating-point equivalent values of -99.99 to -0.01) and 0000h to 270Fh (0.00 to 99.99). The most significant bit of the 16-bit hexadecimal number is the sign bit; hence, values between 8000h and FFFFh represent negative numbers.
Example	

MaxMomentaryLoudness	
BWF Spec	A 16-bit signed integer, equal to *round* (100x the highest value of the Momentary Loudness Level of the file in LUFS). (Established in version 2.)
Fed Agencies Application	None developed at this time.
Char limit	
Mandatory/optional	Optional
Values	*See table in the Appendix for treatment of Loudness parameters* For LoudnessValue, MaxTruePeakLevel, MaxMomentaryLoudness and MaxShortTermLoudness, the range of valid values is D8F1h to FFFFh (corresponding to the floating-point equivalent values of -99.99 to -0.01) and 0000h to 270Fh (0.00 to 99.99). The most significant bit of the 16-bit hexadecimal number is the sign bit; hence, values between 8000h and FFFFh represent negative numbers.
Example	

MaxShortTermLoudness	
BWF Spec	A 16-bit signed integer, equal to *round* (100x the highest value of the Short-term Loudness Level of the file in LUFS). (Established in version 2.)
Fed Agencies Application	None developed at this time.
Char limit	
Mandatory/optional	Optional
Values	*See table in the Appendix for treatment of Loudness parameters* For LoudnessValue, MaxTruePeakLevel, MaxMomentaryLoudness and MaxShortTermLoudness, the range of valid values is D8F1h to FFFFh (corresponding to the floating-point equivalent values of -99.99 to -0.01) and 0000h to 270Fh (0.00 to 99.99). The most significant bit of the 16-bit hexadecimal number is the sign bit; hence, values between 8000h and FFFFh represent negative numbers.
Example	

PART II. THE INFO CHUNK ("LIST info chunk")

II.A. Recommended element for info chunk

IARL	
RIFF Spec	Archival Location: Indicates where the subject of the file is archived.
Fed Agencies Application	This element is an approximate equivalent to the Originator element in the bext chunk which records the entity responsible for the creation, maintenance, preservation of this digital item. If used, this element could repeat the data from the Originator element in the same structured format. In some applications, it is automatically carried over to the MP3 ID3 element "ArchivalLocation." Of all the info list chunk elements, this is the most important for Federal Agencies because it is vital to document the archival responsibility for a content item. Entity designations should be as specific as possible including a two-character county code to avoid the potential for conflict in the archiving entity's name. The archival entity should be identified at the most specific level within the institution. Use a standard abbreviation of entity names such as those found in the Guide to Government Acronyms & Abbreviations. If an entity is not on this list, use a familiar abbreviation. Use the standard two-character ISO 3166 alpha 2 country code list.
Mandatory/optional	Strongly recommended ("required") if using info list chunk
Values	[Country code]comma space[Entity name]
Example LC	US, LOC/RSS [RSS = Recorded Sound Section]
Example NARA	US, NARA

II.B. Optional elements for info chunk

INAM	
RIFF Spec	Name: Stores the title of the subject of the file, such as, Seattle from Above.
Fed Agencies Application	If used, this element should contain a *working title*. This phrase is intended to convey the Working Group's understanding that metadata may be updated over time. Users who refer to elements like titles in an embedded block of metadata should understand that this may not represent the latest and best information, and they should be counseled to follow one of the identifiers in order to obtain later and/or better data.
Mandatory/optional	Optional
Values	Free text
Example LC	Symphony no. 3 in A minor, op. 56

Example LC	Interview with Bo Dollis at WWOZ, New Orleans, 1999-03-24 [title assigned by cataloger]
Example LC	Adventures in research. No. 587, Sawing off Manhattan Island [episode in a radio series]

ICMT	
RIFF Spec	Comment: Provides general comments about the file or the subject of the file. If the comment is several sentences long, end each sentence with a period. Do not include newline characters (such as CR/LF/EOL).
Fed Agencies Application	If used, this element should repeat the principal and other identifiers from the OriginatorReference and/or Description element in the bext chunk. Each identifier will be labeled as to its origin or purpose using the “type” and “comment” qualifiers. Using the tag “local” in the "type" qualifier implies the entity identified in the bext Originator element. In some applications, this info list element may carry forward automatically to the MP3 ID3 tagged element "Comment." NOTE: The Working Group perceived value in the practices of labeling identifiers (see examples) but wished to leave this as an optional practice.
Mandatory/optional	Optional
Values	If labeled: Identifier [comma space] type [comma space] comment [semicolon-space if more than one identifier] If no labeling: Identifier
Example NARA	[Tagged identifier] 58979818, local, principal ID original filename
Example NARA	[Tagged identifier] 306-MUSA-9658B, local, RG-Series-Item Number
Example LC	[Two tagged identifiers, from LC, RSS] 1201566-2-1, local, system-generated number; RYI 6039, local, source location number
Example LC	[Tagged identifier] http://hdl.loc.gov/loc.mbrsmi/westhpp.2033, URL, principal ID Handle
Example California Digital Library	[Tagged identifier] ark.cdlib.org.org/ark:/13030/tf5p30086k, URL, ARK
Example LC	[Unlabeled identifier] http://lccn.loc.gov/mp76000002

ICRD	
RIFF Spec	Creation date: Specifies the date the subject of the file was created. List dates in year-month-day format, padding one-digit months and days with a zero on the left. For example, 1999-05-03 for May 3, 1999.
Fed Agencies Application	This element is an equivalent to the OriginationDate in the bext chunk. If used, this element could repeat the information from the OriginationDate element in the bext chunk using the same structured format. In some applications, this info list element may carry forward automatically to MP3 ID3 tagged element "CreationDate."

Mandatory/optional	Optional
Values	ISO 8601 YYYY-MM-DD. Year is defined from 0000 to 9999; Month is defined from 1 to 12; Day is defined from 1 to 28, 29, 30 or 31. The separator between the items is a hyphen [-] with no spaces.
Example	2005-11-30

ICOP	
RIFF Spec	Copyright: Records the copyright information for the file. For example, Copyright Encyclopedia International 1991. If there are multiple copyrights, separate them by a semicolon followed by a space.
Fed Agencies Application	Information about copyright and other restrictions (donor, privacy, etc.). Usage by federal agencies will often refer to the documentation of restrictions provided by other, non-embedded metadata. This element has no equivalent in the bext chunk. In some applications, this info list element may carry forward automatically to MP3 ID3 tagged element "Copyright." If used, this element may contain the information as known at the time of embedding. The Working Group understands that metadata may be updated over time. Users who refer to an embedded block of metadata should understand that this may not represent the latest and best information, and they should be counseled to follow one of the identifiers in order to obtain later and/or better data.
Mandatory/optional	Optional
Values	Free text. If there are multiple copyrights or other restriction statements, separate them by a semicolon followed by a space.
Example LC	Publication and other forms of distribution may be restricted. For details, contact the Recorded Sound Section of the Library of Congress. [Preferred wording from LC, RSS]
Example LC	(p) Rhino Records 2002.
Example LC	See Copyright Restriction Statement. [Used by LC, American Folklife Center]

Part III. APPENDIX A

The following text is from section 2.4 in the version 2 of the Broadcast Wave specification (EBU Tech 3285 v2, May 2011; http://tech.ebu.ch/docs/tech/tech3285.pdf) . Additional general information is offered in the related EBU document Loudness normalisation and permitted maximum level of audio signals (*EBU R 128, http://tech.ebu.ch/docs/r/r128.pdf, August 2011; http://tech.ebu.ch/docs/r/r128.pdf; both URLs accessed April 17, 2012). A key work on loudness metrics has been published by the International Telecommunications Union- Radiocomunication Sector (ITU-R):* Algorithms to measure audio programme loudness and true-peak audio level *(ITU-R BS.1770-2, March 2011; http://www.itu.int/dms_pubrec/itu-r/rec/bs/R-REC-BS.1770-2-201103-I!!PDF-E.pdf).*

Treatment of Loudness Parameters

The loudness parameters are represented by integers, but they preserve a precision of two decimal places by being multiplied by 100 before being rounded. The rounding function which shall be used is defined as follows:

$$\text{integer representation} = \text{integer part of } (x + \text{sgn}(x) \cdot 0.5)$$

where x is the value to be represented, multiplied by 100

and where sgn() is the signum operator. sgn(x) = -1 if x < 0, 0 if x = 0, 1 if x > 0.

This rounding method is commonly referred to as "round to nearest, ties away from zero" because where the fractional part of the number is 5 (midway between integers), the rounding is up for positive numbers and down for negative numbers.

Examples

Negative numbers: Float value	**Calculation**	**Value carried in BWF (decimal/ hexadecimal)**
-22.644	integer[(-22.644 x 100) + sgn(-22.644 x 100) · 0.5]	-2264/ F728h
-22.645	integer[(-22.645 x 100) + sgn(-22.645 x 100) · 0.5]	-2265/ F727h
-22.646	integer[(-22.646 x 100) + sgn(-22.646 x 100) · 0.5]	-2265/ F727h
Positive numbers: Float value	**Calculation**	**Value carried in BWF (decimal/ hexadecimal)**
12.764	integer[(12.764 x 100) + sgn(12.764 x 100) · 0.5]	1276/ 04FCh
12.765	integer[(12.765 x 100) + sgn(12.765 x 100) · 0.5]	1277/ 04FDh
12.766	integer[(12.766 x 100) + sgn(12.766 x 100) · 0.5]	1277/ 04FDh

Part IV. SPECIFICATIONS AND REFERENCES

IV.A. Specifications relevant to the preceding recommendations.

European Broadcast Union. *Audio loudness normalization and permitted maximum level of audio signals.* Online: http://tech.ebu.ch/docs/r/r128.pdf, accessed: April 16, 2012.

European Broadcast Union. *Technical Recommendation R98-1999. Format for the <CodingHistory> field in Broadcast Wave Format files, BWF.* Online: http://tech.ebu.ch/docs/r/r098.pdf, accessed: April 17, 2012.

European Broadcast Union. *Broadcast Wave Format (BWF) user guide.* Online: http://www.ebu.ch/fr/technical/publications/userguides/bwf_user_guide.php, accessed: April 17, 2012.

European Broadcast Union. *BWF: a format for audio data files in broadcasting. Version 1. July 2001.* Online: http://www.jfranze.com/assets/Broadcast_Wave_Specs.pdf, accessed: April 17, 2012.

European Broadcast Union. Specification for the Broadcast Wave Format (BWF): A format for audio data files in broadcasting. Version 2. May 2011. http://tech.ebu.ch/docs/tech/tech3285.pdf, accessed: April 16, 2012.

IBM Corporation and Microsoft Corporation. *Multimedia Programming Interface and Data Specifications 1.0.* Online: http://www.kk.iij4u.or.jp/~kondo/wave/mpidata.txt, accessed: April 16, 2012.

International Organization for Standardization. *ISO 3166 Country Codes.* Online: http://www.iso.org/iso/country_codes/iso_3166_code_lists.htm, accessed: April 16, 2012.

IV.B. Other References

Advanced Television Systems Committee. *ATSC Recommended Practice: Techniques for Establishing and Maintaining Audio Loudness for Digital Television*, Document A/85:2011, 25 July 2011. Online: http://www.atsc.org/cms/standards/a_85-2011a.pdf, accessed April 12, 2012.

Casey, M. and B. Gordon. 2007. *Sound Directions: Best Practices For Audio Preservation.* Trustees of Indiana University and President and Fellows of Harvard University. Online: http://www.dlib.indiana.edu/projects/sounddirections/bestpractices2007/, accessed: April 16, 2012.

Camerer, Florian. "Overview of the EBU Loudness Recommendation R 128." *SMPTE Motion Imaging Journal.* July/August 2011.

Harvard University Library. *Administrative Metadata for Digital Audio Files.* Online: http://hul.harvard.edu/ois/systems/drs/audiometadata.pdf, accessed: April 16, 2012.

Indiana University Archives of Traditional Music. *An Introduction to Technical and Structural Metadata Elements in ATMC.* Online: http://www.dlib.indiana.edu/projects/sounddirections/papersPresent/sd_app1_v1.pdf, accessed: April 16, 2012.

Smith, Kelly L. *GovSpeak: A Guide to Government Acronyms & Abbreviations.* Online: http://libguides.ucsd.edu/govspeak, accessed: April 16, 2012.