
**Information technology — MPEG
audio technologies —**

**Part 4:
Dynamic range control**

Technologies de l'information — Technologies audio MPEG —

Partie 4: Contrôle de gamme dynamique

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Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information Technology*, Subcommittee SC 29, *Coding of audio, picture, multimedia, and hypermedia*.

This second edition cancels and replaces the first edition (ISO 23003-4:2015), which has been technically revised. It also incorporates the Amendments ISO 23003-4:2015/Amd.1:2017 and ISO 23003-4:2015/Amd.2:2017. The main changes compared to the previous edition are as follows:

- Amendments to the previous edition that include enhancements, definitions of profiles and levels, reference software, and conformance are integrated.

A list of all parts in the ISO/IEC 23003 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Consumer audio systems and devices are used in a large variety of configurations and acoustical environments. For many of these scenarios, the audio reproduction quality can be improved by appropriate control of content dynamics and loudness.

This document provides a universal dynamic range control tool that supports loudness normalization. The DRC tool offers a bitrate efficient representation of dynamically compressed versions of an audio signal. This is achieved by adding a low-bitrate DRC metadata stream to the audio signal. The DRC tool includes dedicated sections for clipping prevention, ducking, and for generating a fade-in and fade-out to supplement the main dynamic range compression functionality. The DRC effects available at the DRC decoder are generated at the DRC encoder side. At the DRC decoder side, the audio signal may be played back without applying the DRC tool, or an appropriate DRC tool effect is selected and applied based on the given playback scenario.

Loudness normalization is fully integrated with DRC and peak control to avoid clipping. A metadata-controlled equalization tool is provided to compensate for playback scenarios that impact the spectral balance, such as downmix or DRC. Furthermore, the DRC tool supports metadata-based loudness equalization to compensate the effect of playback level changes on the spectral balance.

The International Organization for Standardization (ISO) and International Electrotechnical Commission (IEC) draw attention to the fact that it is claimed that compliance with this document may involve the use of a patent.

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Information technology — MPEG audio technologies —

Part 4: Dynamic range control

1 Scope

This document specifies technology for loudness and dynamic range control. It is applicable to most MPEG audio technologies. It offers flexible solutions to efficiently support the widespread demand for technologies such as loudness normalization and dynamic range compression for various playback scenarios.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 14496-12, *Information technology — Coding of audio-visual objects — Part 12: ISO base media file format*

ISO/IEC 14496-26:2010, *Information technology — Coding of audio-visual objects — Part 26: Audio Conformance*

ISO/IEC 23008-3:2019, *Information technology — High efficiency coding and media delivery in heterogeneous environments — Part 3: 3D audio*

ISO/IEC 23091-3, *Information technology — Coding-independent code points — Part 3: Audio*

3 Terms, definitions and mnemonics

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 14496-12 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

3.1.1

DRC sequence

series of DRC gain values that can be applied to one or more audio channels

3.1.2

DRC set

defined set of DRC sequences that produce a desired effect if applied to the audio signal

3.1.3

album

collection of audio recordings that are mastered in a consistent way

Note 1 to entry: Traditionally, a collection of songs released on a Compact Disk belongs into this category, for example.

3.1.4

conformance test bitstream

bitstream used for testing the conformance of MPEG-D DRC compliant audio decoders

3.1.5

conformance test case

conformance test category and a combination of one or more conformance test conditions for which a conformance test sequence is provided

3.1.6

conformance test condition

condition which applies to properties of a conformance test sequence in order to test a certain functionality of the MPEG-D DRC decoder

3.1.7

conformance test criteria

one or more conformance test tools and corresponding parameters applied to verify the conformance for a certain conformance test sequence

3.1.8

conformance test sequence

set of a conformance test bitstream, a decoder setting, an input audio file and a corresponding reference file

3.1.9

decoder input parameters

input parameters that are supplied to an MPEG-D DRC decoder in addition to a conformance test bitstream, a decoder interface bitstream and an input audio file

3.1.10

decoder setting

combination of a decoder interface bitstream and decoder input parameters that are supplied to an MPEG-D DRC decoder

3.1.11

input DRC set selection parameters

input parameter set for testing of a DRC gain decoder instance

Note 1 to entry: This parameter set is solely used for conformance testing in the context of the DRC gain decoder conformance test category (DrcGainDec).

3.1.12

reference audio file

decoded counterpart of a conformance test bitstream, a decoder setting and an input audio file

3.1.13**reference DRC set selection parameters**

decoded counterpart of a conformance test bitstream and a decoder setting fed to the DRC set selection process

Note 1 to entry: This parameter set is an intermediate result of an MPEG-D DRC compliant decoder implementation solely used for conformance testing in the context of the DRC selection process test category (DrcSelProc).

3.1.14**reference file**

reference audio file or reference DRC set selection parameters

3.2 Mnemonics

bslbf bit string, left bit first, where “left” is the order in which bit strings are written in the ISO/IEC 14496 series

NOTE Bit strings are written as a string of 1s and 0s within single quote marks, for example '1000 0001'. Blanks within a bit string are for ease of reading and have no significance.

byte_align() number of bits to fill for byte alignment at the offset of n bits:
 $\text{byte_align}(n) = 8 \text{ ceil}(n/8) - n$

uimbsf unsigned integer, most significant bit first

vlclbf variable length code, left bit first, where “left” refers to the order in which the variable length codes are written

bit(n) a bit string with n bits in the same format as **bslbf**

unsigned int(n) an unsigned integer with n bits in the same format as **uimbsf**

signed int(n) a signed integer with n bits, most significant bit first

mod modulo operator: $(x \text{ mod } y) = x - y \text{ floor}(x/y)$

sizeof(x) size operator that returns the bit size of a field x

TRUE/FALSE values of Boolean data type, which correspond to numerical 1 and 0, respectively

4 Symbols

a_i filter coefficient

b band index of DRC filter bank (starting at 0)

b_i filter coefficient

$\text{delta}T_{\text{min}}$ smallest permitted DRC gain sample interval in units of the audio sample interval

f_c	cross-over frequency in Hz
$f_{c,norm}$	cross-over frequency expressed as fraction of the audio sample rate
$f_{c,norm,SB}(s)$	cross-over frequency of audio decoder sub-band s expressed as fraction of the audio sample rate
	NOTE The cross-over frequency is the upper band edge frequency of the sub-band.
f_s	audio sample rate in Hz
	NOTE If an audio decoder is present, it is the sample rate of the decoded time-domain audio signal.
M_{DRC}	DRC frame size in units of the audio sample interval $1/f_s$
N_{DRC}	maximum permitted number of DRC samples per DRC frame
	NOTE Identical to the number of intervals with a duration of δT_{min} per DRC frame.
N_{Codec}	codec frame size in units of the audio sample interval $1/f_s$
π	ratio of a circle's circumference to its diameter
s	audio decoder sub-band index (starting at 0)
z	complex variable of the z-transform

ISO/IEC 23003-4:2020

5 Technical overview

The technology described in this document is called the “DRC tool”. It provides efficient control of dynamic range, loudness, and clipping based on metadata generated at the encoder. The decoder can choose to selectively apply the metadata to the audio signal to achieve a desired result. Metadata for dynamic range compression consists of encoded time-varying gain values that can be applied to the audio signal. Hence, the main blocks of the DRC tool include a DRC gain encoder, a DRC gain decoder, a DRC gain modification block, and a DRC gain application block. These blocks are exercised on a frame-by-frame basis during audio processing. In addition to encoded time-varying gain values, the DRC gain decoder can also receive parametric DRC metadata for generation of time-varying gain values at the decoder. Various DRC configurations can be conveyed in a separate bitstream element, such as configurations for a downmix or combined DRCs. The DRC set selection block decides based on the playback scenario and the applicable DRC configurations which DRC gains to apply to the audio signal. Moreover, the DRC tool supports loudness normalization based on loudness metadata.

A typical system for loudness and dynamic range control in the time domain is shown in Figure 1. A more complex system including downmixer and peak limiter is shown in Figure 2. The decoder part of the DRC tool is driven by metadata that efficiently represents the DRC gain samples and parameters for interpolation. The gain samples can be updated as fast as necessary to accurately represent gain changes down to at least 1 ms update intervals. In the following, the decoder part of the DRC tool is referred to as “DRC decoder”, which includes everything except the audio decoder and associated bitstream de-multiplexing.

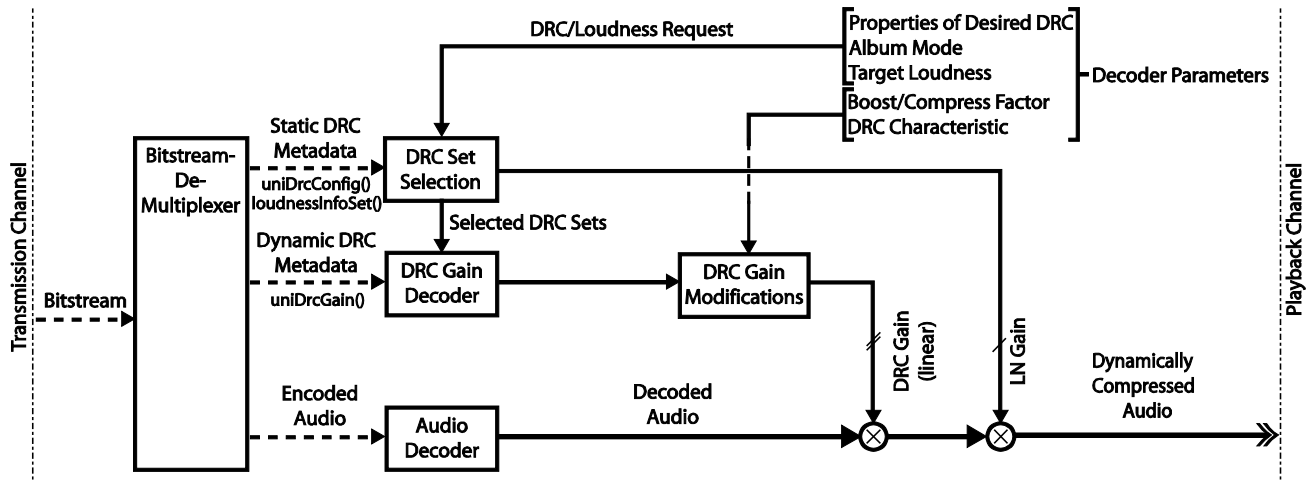


Figure 1 — Block diagram of a typical system with audio decoder and DRC tool modules to achieve loudness normalization (LN) and dynamic range control

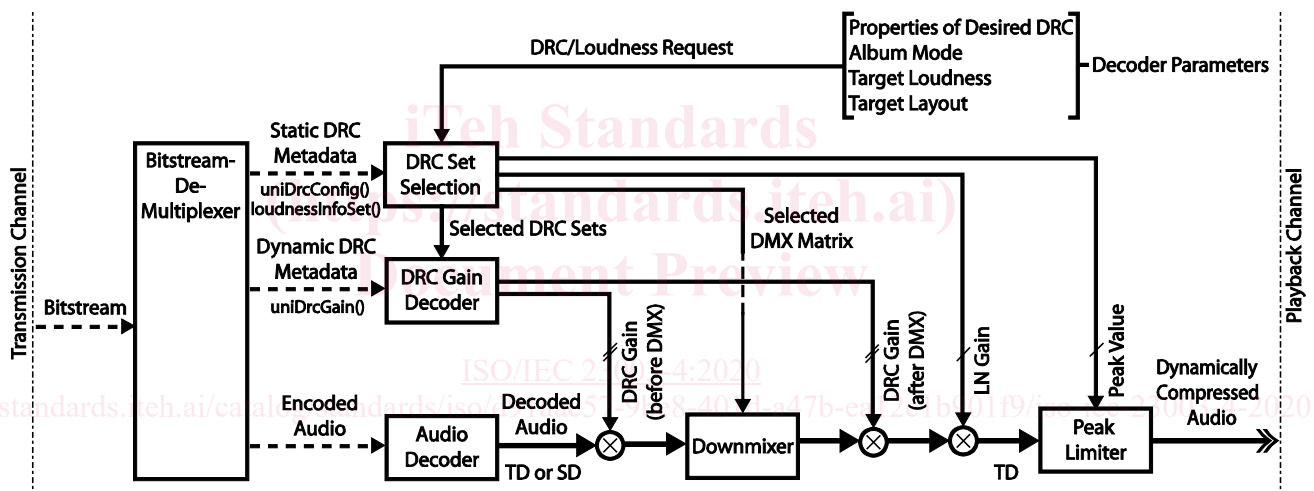


Figure 2 — Block diagram of a more complex system including downmixer and peak limiter (TD = time-domain, SD = subband-domain)

The DRC tool provides support for loudness equalization, sometimes called “loudness compensation”, that can be applied to compensate for the effect of the playback level on the spectral balance. For this purpose, time-varying loudness information can be recovered from DRC gain sequences to dynamically control the compensation module. While the compensation module is out of scope, the interface describes in which frequency ranges the loudness information should be applied.

A flexible tool for generic metadata-controlled equalization is provided. The tool can be used to reach the desired spectral balance of the reproduced audio signal depending on a wide variety of playback scenarios, such as downmix, DRC, or playback room size. It can operate in the sub-band domain of an audio decoder and in the time domain.

The DRC tool is specified in Clause 6. The tool may be subject to profiles and levels that shall be in accordance with Annex I. The bitstream field decoding of the DRC tool shall be in accordance with Annex A. If an interface for external parameter control of the DRC tool is used, it shall conform to Annex B.

6 DRC decoder

6.1 DRC decoder configuration

6.1.1 Overview

The DRC configuration information can be received in-stream using the static payloads `uniDrcConfig()` and `loudnessInfoSet()` described below, or it can be delivered by a higher layer, such as in ISO/IEC 14496-12 (see Table 1). The basic decoding process of the static information is virtually the same. The difference consists mainly in a few syntax changes and reduced field sizes to increase the bit rate efficiency of the in-stream configuration. The syntax of the in-stream static payload is given in 7.3. The associated metadata encoding is given in A.6. The static DRC payload is evaluated once at the beginning of the decoding process and it is monitored subsequently. For static DRC payload changes during playback, see 6.12.

Table 1 — Overview of configuration (setup) and separate metadata track in ISO/IEC 14496-12

	Sample entry code	Setup (in sample entry)	Track reference	Sample format
Audio track	As specified for the audio codec in use (unchanged)	DRCInstructions box using negative values for <i>drcLocation</i>	"adrc" referring to the metadata tracks carrying gain values	As specified for the audio codec in use (unchanged)
Metadata track	"unid"	(none)	(none)	Each sample is a <code>uniDrcGain()</code> payload

The static payload is divided into several logical blocks:

- `channelLayout()`;
- `downmixInstructions()`, `downmixInstructionsV1()`;
- `drcCoefficientsBasic()`, `drcCoefficientsUniDrc()`, `drcCoefficientsUniDrcV1()`;
- `drcInstructionsBasic()`, `drcInstructionUniDrc()`, `drcInstructionUniDrcV1()`;
- `loudnessInfo()`, `loudnessInfoV1()`;
- `drcCoefficientsParametricDrc()`;
- `parametricDrcInstructions()`;
- `loudEqInstructions()`;
- `eqCoefficients()`;
- `eqInstructions()`.

Except for the `channelLayout()`, `drcCoefficientsParametricDrc()`, and `eqCoefficients()`, multiple instances of a logical block can appear. The DRC decoder combines the information of the matching instances of the logical blocks for a given playback scenario. Matching instances are found by matching several identifiers (labels) contained in the blocks.