SMPTE ST 428-11:2013
Revision of
SMPTE 428-11-2009

SMPTE STANDARD

Additional Frame Rates for D-Cinema

Table of Contents

Approved
August 27, 2013

Foreword

SMPTE (the Society of Motion Picture and Television Engineers) is an internationally-recognized standards developing organization. Headquartered and incorporated in the United States of America, SMPTE has members in over 80 countries on six continents. SMPTE's Engineering Documents, including Standards, Recommended Practices and Engineering Guidelines, are prepared by SMPTE's Technology Committees. Participation in these Committees is open to all with a bona fide interest in their work. SMPTE cooperates closely with other standards-developing organizations, including ISO, IEC and ITU.

SMPTE Engineering Documents are drafted in accordance with the rules given in Part XIII of its Operations Manual.

SMPTE ST 428-11 was prepared by Technology Committee 21DC.

Intellectual Property

At the time of publication no notice had been received by SMPTE claiming patent rights essential to the implementation of this Engineering Document. However, attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. SMPTE shall not be held responsible for identifying any or all such patent rights.

Introduction

This section is entirely informative and does not form an integral part of this Engineering Document.

The frame rates initially standardized by the D-Cinema Technology Committee are 24 and 48 frames per second (fps).

The history of film making is littered with other frame rates ranging from less than 16 fps to 60 fps and beyond and there is considerable support for the making of films using readily available equipment made specifically for the film production market.

This standard defines how implementations that conform to the D-Cinema specifications can be extended to support the additional frame rates of 25 fps, 30 fps, 50 fps, 60 fps, 96 fps, 100 fps and 120 fps.

1 Scope

This standard defines additional frame rates for D-Cinema that are in addition to the primary frame rates of 24 and 48 frames per second. These additional frame rates are defined to ensure that the artistic intent of the content producer can be maintained at the point of delivery. All other parameters defined by SMPTE ST 428-1 remain as specified.

This document is part 11 of a suite of SMPTE engineering documents. This first part defines the additional frame rates individually at 25, 30, 50, 60, 96, 100 and 120 frames per second and defines the resulting audio samples per edit unit.

Other parts will define further provisions to support the additional frame rates defined by this standard.

2 Conformance Notation

Normative text is text that describes elements of the design that are indispensable or contains the conformance language keywords: "shall", "should", or "may". Informative text is text that is potentially helpful to the user, but not indispensable, and can be removed, changed, or added editorially without affecting interoperability. Informative text does not contain any conformance keywords.

All text in this document is, by default, normative, except: the Introduction, any section explicitly labeled as "Informative", or individual paragraphs that start with "Note:".

The keywords "shall" and "shall not" indicate requirements strictly to be followed in order to conform to the document and from which no deviation is permitted.

The keywords, "should" and "should not" indicate that, among several possibilities, one is recommended as particularly suitable, without mentioning or excluding others; or that a certain course of action is preferred but not necessarily required; or that (in the negative form) a certain possibility or course of action is deprecated but not prohibited.

The keywords "may" and "need not" indicate courses of action permissible within the limits of the document.

The keyword “reserved” indicates a provision that is not defined at this time, shall not be used, and may be defined in the future. The keyword “forbidden” indicates “reserved” and in addition indicates that the provision will never be defined in the future.

A conformant implementation according to this document is one that includes all mandatory provisions ("shall") and, if implemented, all recommended provisions ("should") as described. A conformant implementation need not implement optional provisions ("may") and need not implement them as described.

Unless otherwise specified the order of precedence of the types of normative information in this document shall be as follows. Normative prose shall be the authoritative definition. Tables shall be next, followed by formal languages, then figures, and then any other language forms.

3 Normative References

Note: All references in this document to other SMPTE documents use the current numbering style (e.g. SMPTE ST 428-1:2006) although, during a transitional phase, the document as published (printed or

PDF) may bear an older designation (such as SMPTE 428-1-2006). Documents with the same root number (e.g. 428-1) and publication year (e.g. 2006) are functionally identical.

The following standards contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent edition of the standards indicated below.

SMPTE ST 428-1:2006, D-Cinema Distribution Master — Image Characteristics

SMPTE ST 428-2:2006, D-Cinema Distribution Master — Audio Characteristics

4 Glossary of Acronyms and Terms

The following acronyms are used in this document:

- AFR – Additional Frame Rate.
- DCDM – Digital Cinema Distribution Master.
- FPS (fps) – Frames Per Second

The following terms are used in this document:

- Edit Unit – the smallest unit of D-Cinema content that can be successfully edited while maintaining the integrity of the content. The edit unit value must be an integer multiple of the duration of a single D-Cinema frame. In most cases, the edit unit value is the same as frame duration, but in certain applications, the value can be >1 (for example, stereoscopic D-Cinema requires an edit unit value twice that of the frame duration).
- Edit Rate – the rate of edit units per second.
- Primary - for the purposes of this document, primary frame rates are those frame rates defined in SMPTE ST 428.1.

5 Additional Frame Rate Values

The primary D-Cinema frame rates and levels shall be as defined by SMPTE ST 428-1.

The additional frame rate values for D-Cinema use shall be 25, 30, 50, 60, 96, 100 and 120 frames per second. All additional frame rates shall be integer values.

5.1. Definition of AFR levels

The additional frame rates shall be defined in association with the picture size to form AFR levels as shown in Table 1.

Table 1 – AFR Level Definitions

AFR Level	Maximum Horizontal Pixels	Maximum Vertical Pixels	Frames per Second
AFR Level 1	4096	2160	25
AFR Level 2	2048	1080	25
AFR Level 3	4096	2160	30
AFR Level 4	2048	1080	30
AFR Level 5	2048	1080	50
AFR Level 6	2048	1080	60
AFR Level 7	2048	1080	96
AFR Level 8	2048	1080	100
AFR Level 9	2048	1080	120

These AFR levels are in addition to the primary DCDM levels that are defined in SMPTE ST 428-1.

Implementations may support any one or more of the AFR levels defined in table 1. Implementations using this standard shall identify the values of AFR level that are supported.

Note: The AFR level names use the prefix “AFR” to avoid confusion with the level values defined in SMPTE ST 428-1.

5.2. D-Cinema Sound Sample Rates

The audio sampling parameters shall be as defined in SMPTE ST 428-2.

The additional frame rates result in values for the number of audio samples per edit unit as defined in Table 2.

Table 2 – Audio Samples per Edit Unit for the Additional Frame Rate

Audio Sample Rate → ↓ Edit Rate	*48 kHz*	*96 kHz*
25	1920	3840
30	1600	3200
50	960	1920
60	800	1600
96	500	1000
100	480	960
120	400	800

Annex A **Bibliography** (Informative)

Note: All references in this document to other SMPTE documents use the current numbering style (e.g. SMPTE ST 428-9:2008) although, during a transitional phase, the document as published (printed or PDF) may bear an older designation (such as SMPTE 428-9-2008). Documents with the same root number (e.g. 428-9) and publication year (e.g. 2008) are functionally identical.

SMPTE ST 428-9:2008, D-Cinema Distribution Master — Image Pixel Structure Level 3 — Serial Digital Interface Signal Formatting

SMPTE ST 428-10:2008, D-Cinema Distribution Master — Closed Caption and Closed Subtitle

SMPTE ST 428-19:2010, D-Cinema Distribution Master — Additional Frame Rates Level AFR2 and Level AFR4 – Serial Digital Interface Signal Formatting

SMPTE ST 429-2:2011, D-Cinema Packaging — DCP Operational Constraints

Amendment 1:2013 to SMPTE ST 429-2:2011

SMPTE ST 429-4:2006, D-Cinema Packaging — MXF JPEG 2000 Application

SMPTE ST 429-10:2008, D-Cinema Packaging — Stereoscopic Picture Track File

SMPTE ST 429-13:2009, D-Cinema Packaging — DCP Operational Constraints for Additional Frame Rates

SMPTE DC28.0 Stereoscopic D-Cinema Study Group Report, 2005

SMPTE DC28 Study Group Report on Additional Frame Rates, July 2007

SMPTE 21DC Second Interim Study Group Report on High Frame Rates, November 2011