

Dateiformate für audiovisuelle Inhalte

Reto Kromer • AV Preservation by reto.ch

Memoriav-Workshop
Digitale Archivierung im Wandel
Kinemathek Lichtspiel in Bern
4. November 2021

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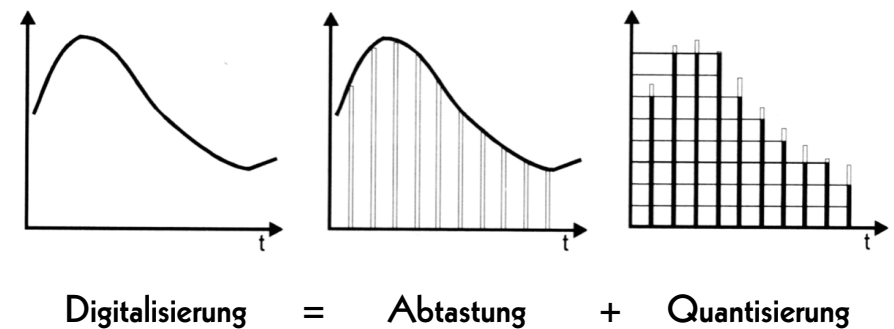
Inhalte

- Digitaler Ton und digitales Bild
- Dateiaufbau
- Dateiformate
- Vor- und Nachteile

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Digitaler Ton und digitales Bild

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Digitaler Ton

- Abtastung
- Quantisierung

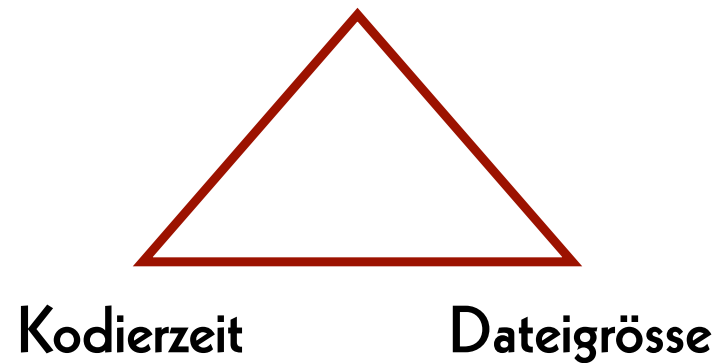
5

Digitales Bild

- Auflösung
- Quantisierungsauflösung
- linear, Potenzfunktion, logarithmisch
- Farbraum
- Farbunterabtastung und Kompression
- Normlicht

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Bildqualität



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Kompression

- nicht komprimiert
- verlustfrei komprimiert
- verlustbehaftet komprimiert
- Farbunterabtastung
- komprimiert generiert

8

Nicht komprimiert

- + Daten sind leichter zu bearbeiten
- + Software läuft schneller
- grössere Dateien
- langsames Schreiben, Übermitteln und Lesen der Dateien

Beispiele: TIFF, DPX, DNG, OpenEXR

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Verlustfrei komprimiert

- + kleinere Dateien
- + schnelleres Schreiben, Übermitteln und Lesen der Dateien
- Daten sind komplexer zu bearbeiten
- Software läuft langsamer

Beispiele: JPEG 2000, FFV1

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Verlustbehaftet komprimiert

- optimiert für Aufnahme und/oder Postproduktion
- optimiert für Zugang und Distribution

Beispiele (Mezzanine): ProRes 422, ProRes 4444; DNxHD, DNxHR

Beispiele (Zugang): H.264 (AVC), H.265 (HEVC), H.266 (VVC); AV1

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Farbunterabtastung

- 4:4:4
- 4:2:2
- 4:2:0 / 4:1:1

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Komprimiert generiert

- sowohl für Aufnahme als auch für Postproduktion optimiert

Beispiele: CineForm RAW, ProRes RAW, Blackmagic RAW

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Unbequeme Wahrheiten

- Sensoren sind farbenblind
- Bayer-Sensoren erzeugen kein vollständiges RGB-Bild

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United States Patent [19] [111] **3,971,065**
Bayer [45] **July 20, 1976**

[54] **COLOR IMAGING ARRAY** [57] **ABSTRACT**
[75] Inventor: Bryce E. Bayer, Rochester, N.Y. A sensing array for color imaging includes individual luminance- and chrominance-sensitive elements that are so intermixed that each type of element (i.e., according to sensitivity characteristics) occurs in a repeated pattern with luminance elements dominating the array. Preferably, luminance elements occur at every other element position to provide a relatively high frequency sampling pattern which is uniform in two perpendicular directions (e.g., horizontal and vertical). The chrominance patterns are interlaid therewith and fill the remaining element positions to provide relatively lower frequencies of sampling.

[73] Assignee: Eastman Kodak Company, Rochester, N.Y.

[22] Filed: Mar. 5, 1975

[21] Appl. No.: 558,477

[52] U.S. CL. 358/41; 350/162 SP; 350/317; 358/44

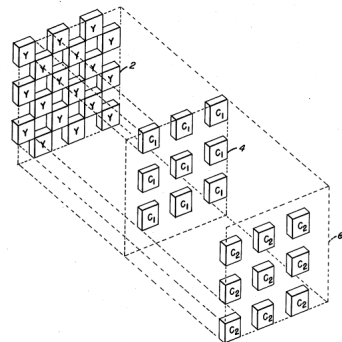
[51] Int. Cl. H04N 9/24

[58] Field of Search 358/44, 45, 46, 47, 358/48; 350/17, 162 SP, 315/169 TV

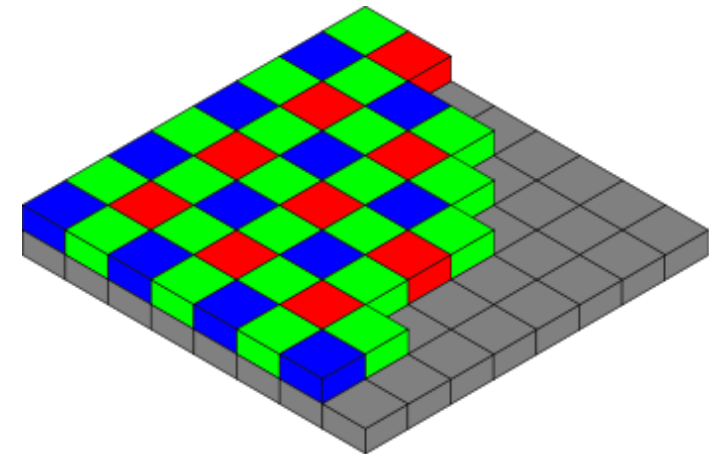
[56] **References Cited**
UNITED STATES PATENTS
2,446,791 8/1948 Schroeder 358/44
2,508,267 5/1950 Kasperowicz 358/44
2,884,483 4/1959 Ehrenhaft et al. 358/44
3,725,372 4/1973 Kurokawa et al. 358/46

Primary Examiner—George H. Libman
Attorney, Agent, or Firm—George E. Grosser

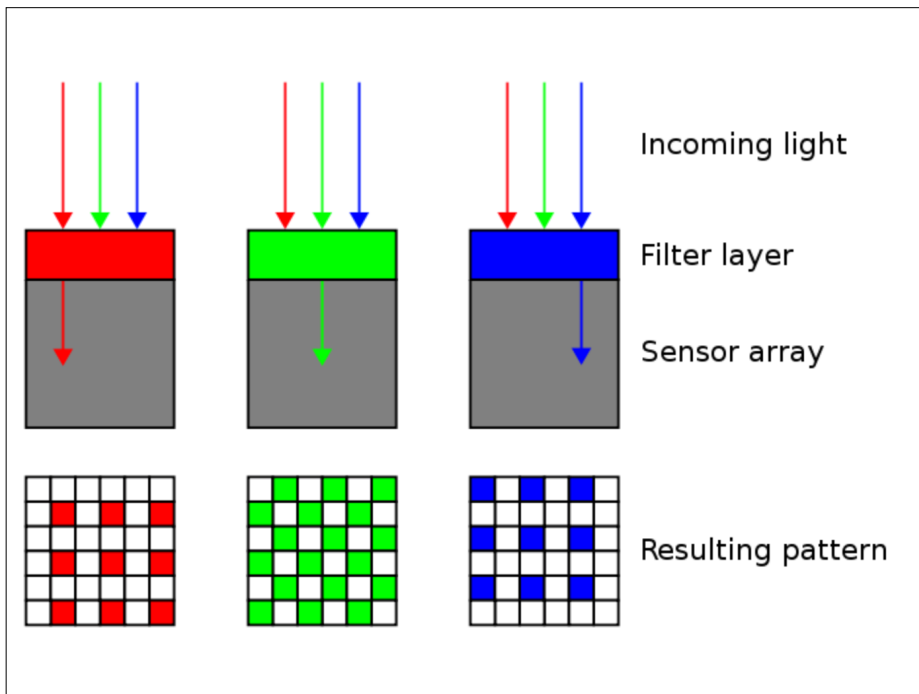
11 Claims, 10 Drawing Figures



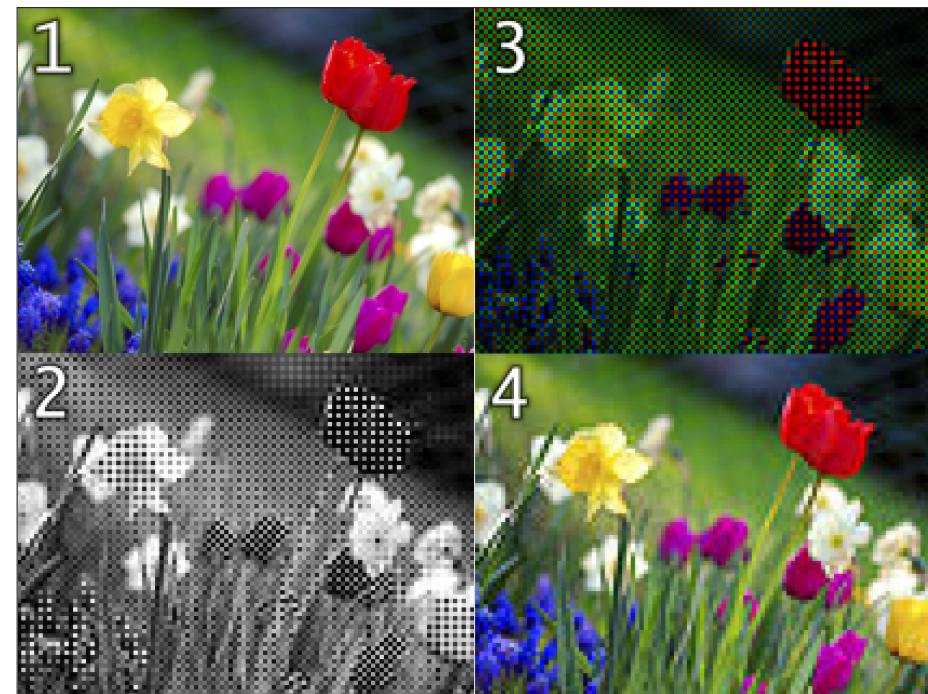
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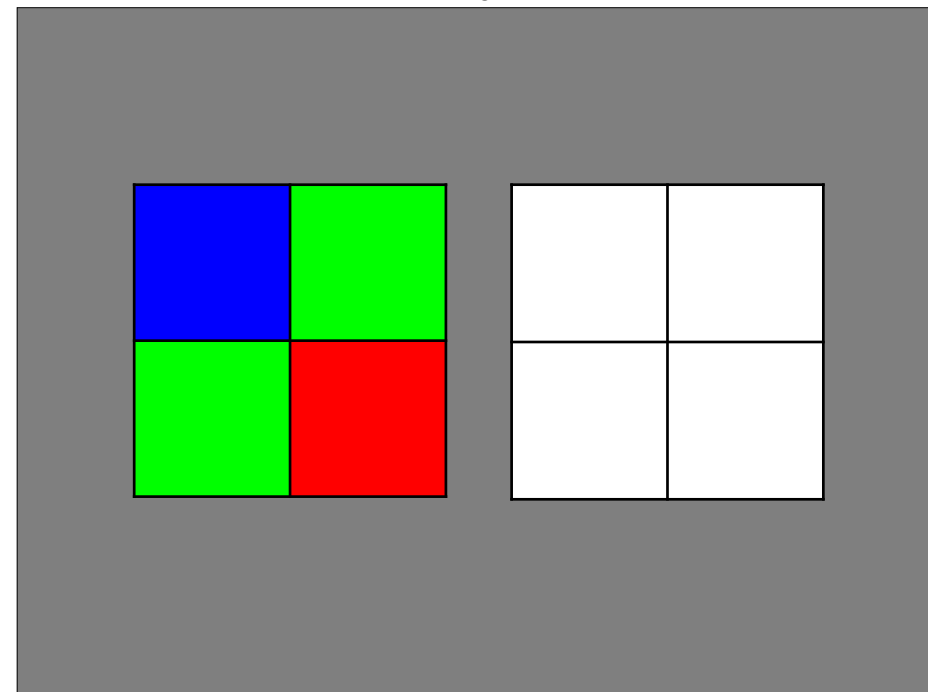
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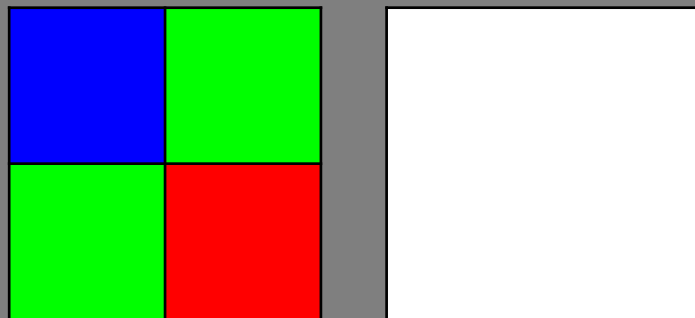
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21

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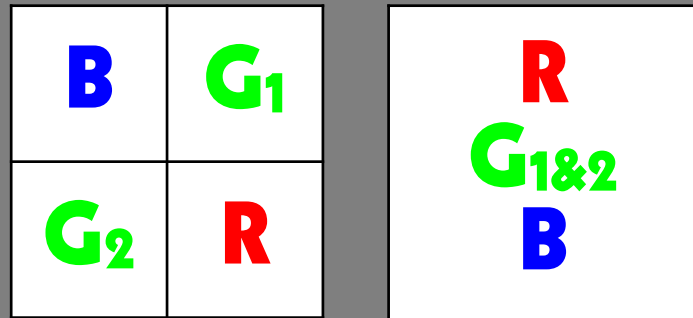
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101010 011010	101001 010101	

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Zwei Möglichkeiten, Bayer-Daten zu verwenden

digitales Aufblasen auf RGB

- die generierten Daten werden verdreifacht
- die Datei hat die volle Sensorauflösung
- nur die Hälfte der Daten ist real

digitale Reduktion auf RGB

- drei Viertel der generierten Daten sind gespeichert
- die Datei hat die halbe Sensorauflösung
- die gesamten Daten sind real

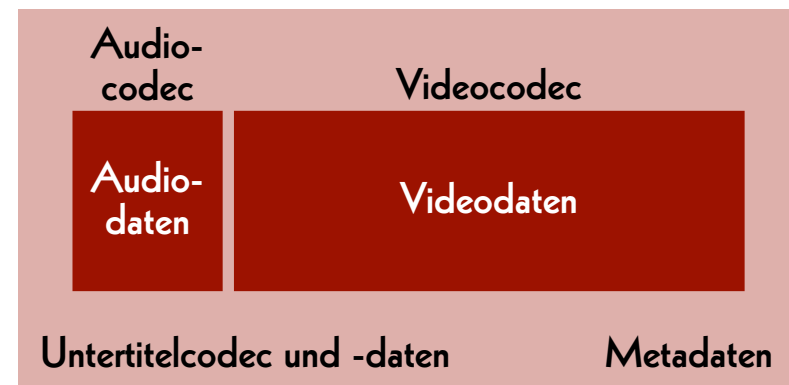
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Dateiaufbau

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Dateiaufbau

Container (Wrapper)



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Container für Datenfluss

- MP4
- QuickTime (.mov)
- AVI
- Flash
- MXF
- Matroska (.mkv)

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Container für Einzelbilder

- Ordner
- TAR
- ZIP
- MXF
- Matroska (.mkv)
- CinemaDNG
- Motion JPEG

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Audiocodec

- WAVE
- BWF
- AAC
- MP3
- FLAC

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Videocodec (Master)

Einzelbilder

- TIFF
- DPX
- JPEG 2000
- OpenEXR
- DNG

Datenfluss

- 8 bit raw
- 10 bit raw
- HuffYUV
- FFV1

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Videocodec (Mezzanine)

- ProRes 422, ProRes 4444, ProRes RAW
- DNxHD, DNxHR
- CineForm RAW
- Blackmagic RAW

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Videocodec (Zugang)

- H.264 (AVC)
- H.265 (HEVC)
- H.266 (VVC)

- AV1

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Audiodaten

- pcm_s16le
- pcm_s24le
- pcm_s32le

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Videodaten

- rgb48le
- rgb24
- rgb72le
- bayer_bggr16le
- bayer_bggr24le
- yuv444p16le
- yuv422p10le
- uyvy422
- yuv420p
- yuv444p24le

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Dateiformate

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Formate für verschiedene Anwendungszwecke

Archivmasterformat

→ zur Erhaltung und Archivierung

Mezzanine-Format

→ zur Bearbeitung und Postproduktion

Distributionsformat

→ zur Verbreitung und Zugänglichmachung

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Grundsätze

- **Ein Archiv muss seine Dateien pflegen und handhaben können.**
- Open Source
- einfache Bedienung und ausführliche Dokumentation
- weite Verbreitung

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Archivmaster (heute)

«Film» (Einzelbilder)

- Ordner, TIFF, 2K oder 4K, RGB, 16 bit
- MXF, DPX, 2K oder 4K, R'G'B', 10 bit

«Video» (Datenfluss)

- AVI, «raw», HD, Y'CbCr 4:2:2, 10 bit
- Matroska, FFV1, HD, Y'CbCr 4:2:2, 10 bit

Ton

- BWF, 96 kHz, 24 bit
- FLAC, 96 kHz, 24 bit

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Mezzanine (heute)

Bild

- ProRes 4444, 2K
- DNxHR, 2K
- ProRes 422 HQ, HD
- DNxHD 175x, HD

Ton

- BWF, 48 kHz, 24 bit
- WAVE, 48 kHz, 24 bit

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Zugang (heute)

MP4

Bild

- H.264, SD, Y'CbCr 4:2:0, 8 bit, lossy
- H.264, «HD», Y'CbCr 4:2:0, 8 bit, lossy

Ton

- AAC, 44.1 kHz, 16 bit
- AAC, 48 kHz, 16 bit

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Archivmaster und Mezzanine

«Film» (Einzelbilder)

- Matroska, FFV1, 4K oder 2K, RGB, 16 bit

«Video» (Datenfluss)

- Matroska, FFV1, «HD», Y'CbCr 4:2:2, 10 bit

Ton

- Matroska, FLAC, 192 kHz, 24 bit

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Zugang

MP4

Bild

- H.265, «HD», Y'CbCr 4:2:0, 8 bit, lossy
- H.266, «HD», Y'CbCr 4:2:0, 8 bit, lossy
- AV1, «HD», Y'CbCr 4:2:0, 8 bit, lossy

Ton

- AAC, 96 kHz, 16 bit

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Vor- und Nachteile

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Container:

- Ordner
- TAR
- ZIP
- MXF
- Matroska
- AXF

Videocodec:

- TIFF
- DPX
- JPEG 2000
- FFV1
- OpenEXR
- CineForm RAW
- ProRes RAW
- Blackmagic RAW

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	Vorteile	Nachteile
TIFF DPX OpenEXR	Daten leichter zu bearbeiten	grössere Dateien
JPEG 2000 FFV1	kleinere Dateien	Daten komplexer zu bearbeiten

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MXF-Container (.mxf)

Videocodec

- DPX
- JPEG 2000
- DNxHD, DNxHR
- ProRes 422, ProRes 4444

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**SMPTE REGISTERED
DISCLOSURE DOCUMENT**



**MXF Archive and Preservation
Format Registered Disclosure
Document**

Page 1 of 113

The attached document is a Registered Disclosure Document prepared by the sponsor identified below. It has been examined by the appropriate SMPTE Technology Committee and is believed to contain adequate information to satisfy the objectives defined in the Scope, and to be technically consistent.

This document is NOT a Standard, Recommended Practice or Engineering Guideline, and does NOT imply a finding or representation of the Society.

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All other inquiries in respect of this document, including inquiries as to intellectual property requirements that may be attached to use of the disclosed technology, should be addressed to the proponent identified below.

Proponent Contact Information:

Kate Murray
Library of Congress
101 Independence Ave, S.E.
Washington, DC 20540-1300

Email: kmur@loc.gov

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MXF / DPX

MXF

→ SMPTE RDD 48:2018

DPX

→ SMPTE ST 268M:2015

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MXF / JPEG 2000

MXF

→ SMPTE RDD 48:2018

JPEG 2000

→ ISO/IEC 15444-1:2019

→ usw.

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MXF / DN_x

MXF

→ SMPTE RDD 48:2018

DN_xHD, DN_xHR

→ nicht veröffentlicht

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MXF / ProRes

MXF

→ SMPTE RDD 48:2018

ProRes 422, ProRes 4444

→ SMPTE RDD 36:2015

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Matroska-Container (.mkv)

Videocodec

- FFV1
- ProRes 422, ProRes 4444

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SMPTE RDD 36:2015

SMPTE REGISTERED DISCLOSURE DOCUMENT

Apple ProRes Bitstream Syntax and Decoding Process



Page 1 of 39 pages

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Proponent contact information:

ProRes Program Office
Apple Inc.
1 Infinite Loop, MS: 77-2YAK
Cupertino, CA 95014
USA

Email: ProRes@apple.com

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Matroska / FFV1

Matroska (.mkv)

→ IETF Internet Draft

FFV1

→ IETF RFC 9043

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Stream: Internet Engineering Task Force (IETF)
RFC: 9043
Category: Informational
Published: August 2021
ISSN: 2070-1721
Authors: M. Nieder Mayer D. Rice J. Martinez

RFC 9043 FFV1 Video Coding Format Versions 0, 1, and 3

Abstract

This document defines FFV1, a lossless, intra-frame video encoding format. FFV1 is designed to efficiently compress video data in a variety of pixel formats. Compared to uncompressed video, FFV1 offers storage compression, frame fixity, and self-description, which makes FFV1 useful as a preservation or intermediate video format.

Status of This Memo

This document is not an Internet Standards Track specification; it is published for informational purposes.

This document is a product of the Internet Engineering Task Force (IETF). It represents the consensus of the IETF community. It has received public review and has been approved for publication by the Internet Engineering Steering Group (IESG). Not all documents approved by the IESG are candidates for any level of Internet Standard; see Section 2 of RFC 7841.

Information about the current status of this document, any errata, and how to provide feedback on it may be obtained at <https://www.rfc-editor.org/info/rfc9043>.

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Matroska / ProRes

Matroska (.mkv)

→ IETF Internet Draft

ProRes 422, ProRes 4444

→ SMPTE RDD 36:2015

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OpenEXR-Dateiformat (.exr)

OpenEXR

→ 3-Klausel-BSD-Lizenz

→ nicht normiert

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AV Preservation by reto.ch

zone industrielle Le Trési 3
1028 Préverenges
Switzerland

Web: reto.ch
Twitter: @retoch
Email: info@reto.ch



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