SMPTE STANDARD

High Dynamic Range Electro-Optical Transfer Function of Mastering Reference Displays

Table of Contents

Page

Foreword ... 3
Intellectual Property ... 3
Introduction ... 3
1 Scope ... 4
2 Conformance Notation ... 4
3 Terms ... 4
3.1 Color Value ... 4
3.2 Digital Code Value ... 4
3.3 Electro-Optical Transfer Function (EOTF) ... 4
3.4 High Dynamic Range ... 5
3.5 Linear Color Value ... 5
3.6 Nonlinear Color Value ... 5
4 Reference EOTF ... 5
4.1 Linearization and Scaling ... 5
4.2 EOTF Linearization Equation ... 5
4.3 EOTF Level Calibration Equation ... 6
4.4 Mastering Reference Viewing Environments ... 6
5 Reference Inverse-EOTF ... 6
5.1 Linearization and Scaling ... 6
5.2 Inverse-EOTF Normalization Equation ... 6
5.3 Inverse-EOTF Nonlinear Encoding Equation ... 7
Annex A Example Digital Representations (Informative) ... 8
A.1 Digital Representations ... 8
A.2 Full Range Code Value Mapping ... 8
A.3 Inverse Full Range Code Value Mapping ... 8
A.4 Reserved Code Values ... 8
A.5 SDI Range Code Value Mapping ... 9
A.6 Inverse SDI Range Code Value Mapping ... 9
A.7 Narrow Range Code Value Mapping ... 10
A.8 Inverse Narrow Range Code Value Mapping ... 10
A.9 Clamping Function for Inverse Code Value Mapping ... 10
A.10 Inverse SDI Range Code Value Mapping with Clamping ... 10
A.11 Inverse Narrow Range Code Value Mapping with Clamping ... 11

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Annex B Example Reference Viewing Environments (Informative) 12
B.1 Consistency with Traditional Program Production Environments 12
B.2 Reference Viewing Environment for HDTV 12
B.3 Reference Viewing Environment for Digital Cinema 12
Annex C Example Inverse-EOTF Use Case (Informative) 13
Annex D Bibliography (Informative) 14

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 its Standards Operations Manual.

SMPTE ST 2084 was prepared by Technology Committee 10E.

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.

This standard defines an electro-optical transfer function (EOTF) with a high luminance range capability of 0 to 10,000 cd/m^2. Because this EOTF is referenced to absolute luminance, the display is assumed to be operating in a specified reference viewing environment, two examples of which are given in Annex B of this document.

The EOTF does not impart a preferred rendering appearance for any particular viewing environment. Image modifications needed for viewer contrast, colorfulness, highlight details, and visible detail in shadows at any particular output level must be chosen as part of the mastering process.

This EOTF is intended to enable the creation of video images with an increased luminance range; not for creation of video images with overall higher luminance levels. For consistency of presentation across devices with different output brightness, average picture levels in content would likely remain similar to current luminance levels; i.e. mid-range scene exposures would produce currently expected luminance levels appropriate to video or cinema. With this EOTF, the upper range of scene exposures would not need to be highly compressed as in traditional video and images with increased realism and sense of presence can be presented.

The reference EOTF is specified by an equation with four independent parameters. With a foundation based on human visual perception, this EOTF creates an efficient mapping from digital code values containing as few as 10 bits to a large, absolute luminance range of 0 to 10,000 cd/m^2. System implementations that utilize this EOTF will be able to represent a luminance level of 10,000 cd/m^2 at their native white point, but can not represent that luminance level at all other chromaticity points. An example of this would be an XYZ system implementation, which could represent 10,000 cd/m^2 at the equal energy white point E, but could only represent about 9187 cd/m^2 at D65.

The reference EOTF and its inverse represent an efficient encoding system for high luminance range data. Though an idealized display device could follow this EOTF exactly, in real world displays the EOTF can be thought of as a nominal target. Actual displays can vary from the absolute curve due to output limitations and effects of non-ideal viewing environments.

1 Scope

This standard specifies an EOTF characterizing high-dynamic-range reference displays used primarily for mastering non-broadcast content. This standard also specifies an Inverse-EOTF derived from the EOTF.

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 Terms

The following terms are described only as used in this context of this document:

3.1
Color Value
A number corresponding to the amount of a specific color component (such as R, G, B, or Y) for an image element.

3.2
Digital Code Value
Digital representation of an image signal value. Usually representative of a nonlinear color value.

3.3
Electro-Optical Transfer Function (EOTF)
Relationship between the nonlinear color values provided to a display device and the linear color values produced by the device.