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**SMPTE STANDARD****SMPTE 240M-1999**Revision of  
ANSI/SMPTE 240M-1995

# for Television — 1125-Line High-Definition Production Systems — Signal Parameters



Page 1 of 7 pages

**1 Scope**

This standard defines the basic characteristics of the analog video signals associated with origination equipment operating in 1125-line high-definition television production systems. This standard defines systems operating at 60.00 Hz and 59.94 Hz field rates.

The digital representation of the signals described in this standard may be found in SMPTE 260M. These two documents define between them both digital and analog implementations of 1125-line HDTV production systems.

**2 Normative reference**

The following standard contains provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the edition indicated was 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 standard indicated below.

SMPTE 260M-1999, Television — 1125/60 High-Definition Production System — Digital Representation and Bit-Parallel Interface

**3 Scanning parameters**

The video signals represent a scanned raster with the characteristics shown in table 1.

**4 System colorimetry and transfer function**

The system is intended to create a metameric reproduction (visual color match) of the original scene as if lit by CIE illuminant D<sub>65</sub>. To this end, the combination of a camera's optical spectral analysis and linear signal matrixing shall match the CIE color-matching functions (1931) of the reference primaries. Further, the combination of a reproducer's linear matrixing and reproducing primaries shall be equivalent to the reference primaries (see annex A.1).

**Table 1 – Scanned raster characteristics**

|                                                                                                                                     | 1125/60 system    | 1125/59.94 system                 |
|-------------------------------------------------------------------------------------------------------------------------------------|-------------------|-----------------------------------|
| Total scan lines per frame                                                                                                          | 1125              |                                   |
| Active lines per frame                                                                                                              | 1035              |                                   |
| Scanning format                                                                                                                     | Interlaced 2:1    |                                   |
| Aspect ratio                                                                                                                        | 16:9              |                                   |
| Field repetition rate                                                                                                               | 60.00 Hz ± 10 ppm | 59.94... Hz <sup>1</sup> ± 10 ppm |
| Line repetition rate (derived)                                                                                                      | 33750.00 Hz       | 33716.28... Hz <sup>2</sup>       |
| <sup>1</sup> The 59.94... Hz notation denotes an approximate value. The exact value is $\frac{60}{1.001}$ .                         |                   |                                   |
| <sup>2</sup> The 33716.28... Hz notation denotes an approximate value. The exact value is $\frac{60 \times 1125}{2 \times 1.001}$ . |                   |                                   |

#### 4.1 Chromaticity of reference primaries

The reference red, green, and blue primaries shall have CIE 1931 (x,y) chromaticities as follows:

|       | CIE x | CIE y |
|-------|-------|-------|
| red   | 0.630 | 0.340 |
| green | 0.310 | 0.595 |
| blue  | 0.155 | 0.070 |

#### 4.2 Reference white

The system reference white is an illuminant which causes equal primary signals to be produced by the reference camera, and which is produced by the reference reproducer when driven by equal primary signals. For this system, the reference white is specified in terms of its 1931 CIE chromaticity coordinates, which have been chosen to match those of CIE illuminant D<sub>65</sub>:

|       | CIE x  | CIE y  |
|-------|--------|--------|
| white | 0.3127 | 0.3290 |

#### 4.3 Opto-electronic transfer characteristic of reference camera

The opto-electronic transfer function of the reference camera is defined to be:

$$V_c = \begin{cases} 4L_c & 0 \leq L_c < 0.0228 \\ 1.1115L_c^{0.45} - 0.1115, & 0.0228 \leq L_c \leq 1 \end{cases}$$

where  $V_c$  is the video signal output of the reference camera normalized to the system reference white, and  $L_c$  is the light input to the reference camera normalized to the system reference white.

#### 4.4 Electro-optical transfer characteristic of reference reproducer

The electro-optical transfer function of the reference reproducer is defined to be:

$$L_r = \begin{cases} \frac{V_r}{4}, & 0 \leq V_r < 0.0913 \\ \left( \frac{V_r + 0.1115}{1.1115} \right)^{\left( \frac{1}{0.45} \right)}, & 0.0913 \leq V_r \leq 1 \end{cases}$$

where  $V_r$  is the video signal level driving the reference reproducer normalized to the system reference white,

and  $L_r$  is the light output from the reference reproducer normalized to the system reference white.

### 5 Video signal definitions

The image is represented by three parallel, time-coincident video signals. Each incorporates a synchronizing waveform. The signals shall be either of the following sets:

| Color primary set | Color difference set              |
|-------------------|-----------------------------------|
| $E_G'$ – green    | $E_Y'$ – luma                     |
| $E_B'$ – blue     | $E_{PB}'$ – blue color difference |
| $E_R'$ – red      | $E_{PR}'$ – red color difference  |

where  $[E_G' E_B' E_R']$  are the signals appropriate to directly drive the primaries of the reference reproducer (being nonlinearly related to light levels as specified in 4.3 and 4.4) and  $[E_Y' E_{PB}' E_{PR}']$  can be derived from  $[E_G' E_B' E_R']$  as follows:

The luma function is specified to be:

$$E_Y' = (0.701 \times E_G') + (0.087 \times E_B') + (0.212 \times E_R') \quad [\text{base equation}]$$

$E_{PB}'$  is amplitude-scaled ( $E_B' - E_Y'$ ), according to:

$$E_{PB}' = \frac{(E_B' - E_Y')}{1.826} \quad [\text{derived equation}]$$

and  $E_{PR}'$  is amplitude-scaled ( $E_R' - E_Y'$ ), according to:

$$E_{PR}' = \frac{(E_R' - E_Y')}{1.576} \quad [\text{derived equation}]$$

where the scaling factors are derived from the signal levels given in 7.3.

(See annex A.3 for the derivation of the coefficients in the luma equation, and annex A.4 for a summary of the formulas for converting between the two sets).

### 6 Reference clock

Signal durations and timings in this standard are specified both in reference clock periods and in microseconds. The reference clock as defined in the following table is the fundamental timing reference in the system.