
SMPTE STABLE DOCUMENT



The attached SMPTE Engineering Document has been declared “Stable” by the controlling Technology Committee.

The SMPTE Operations Manual for Standards states:

A document should be stabilized if it is believed to be substantially correct, does not contain harmful or misleading recommendations, may still be relevant to equipment or practices in use, is stable, but does not represent current technology, and need not be subject to future reviews.

A Stable document shall still be made available and offered for sale by the Society, but it shall be prefaced by a cover page explaining its current status.

At any time, a Technology Committee may revise, amend, or otherwise initiate a new Project on a Stable document.

A Stable document is “In Force”, and not deprecated or withdrawn.

*** * * * ***

Note:

SMPTE “Stable” documents were previously described as “Archived” and the attached document may be marked as “Archived”. The status of a SMPTE document described as “Archived” is exactly as described above for a “Stable” document.

Stable documents may not adhere to the latest style and format of SMPTE documents, or to current usage of normative language. Suitable care should be taken in interpretation.

SMPTE ENGINEERING GUIDELINE

EG 27-2004
Revision of EG 27-1994

Supplemental Information for SMPTE 170M and Background on the Development of NTSC Color Standards



Page 1 of 14 pages

1 Scope

This guideline is intended to provide supplemental and background information for SMPTE 170M .

The guideline also provides information on the development of the National Television System Committee 1953 Recommendations for Transmission Standards for Color Television.

Use of this guideline will aid in the understanding and implementation of modern NTSC television signals, equipment, and practices.

2 NTSC chroma levels

2.1 Saturated colors

The video from a live camera viewing a saturated color scene can have an upper chroma excursion of 131 IRE units. Full-level color bars are representative of such a saturated color scene. When full-amplitude G, B, and R video signals in the form of a full-field color bar signal are present at the NTSC encoder input, the encoder composite video (N), with the two color components (I and Q or B-Y and R-Y), will be a 100% level, 7.5% setup color bar signal (see figure 1). Full-level color bars, with setup, have the video and chroma levels listed in table 1.

Each individual value in table 1 is rounded to 0.1 IRE. Note that following rounding, chroma maximum minus chroma minimum does not necessarily exactly equal the rounded value for the chroma level. The largest discrepancy is 0.1 IRE. For more precise values, see annex A of SMPTE 170M.

NOTE – Although burst is the phase reference in the NTSC signal, the subcarrier phase reference used in the encoded signal formulas and in table 1 is the phase of the color burst +180°.

2.2 Clipping

In video equipment where the luminance and chrominance signals are separated for processing, white and black level clipping on the luminance (Y) portion of the signal may be employed. Other equipment may clip the composite signal. Note that any such clipping can result in a change in chrominance saturation.

3 Color bar signals

3.1 Color bar signal amplitudes

As noted in 2.1, video from a live camera viewing a saturated color scene can have an upper chroma excursion of 131 IRE units, as represented by full-level color bars.

Properly adjusted television transmitters do not pass chroma information with an amplitude greater than 120 IRE units. Therefore, reduced amplitude color bar signals are used for transmitter testing.

NOTE – The NTSC 1953 standard assumed the use of 75% color bar signals for transmitter testing (see NTSC 1953, appendix A, clause III.D.6, reproduced in annex B of this document).

Many present-day encoders and test generators implement the SMPTE color bar test signal (SMPTE EG 1), which is a reduced amplitude (75%) signal (see table 2). Some equipment also implements full-amplitude color bars (see tables 3 and 4).

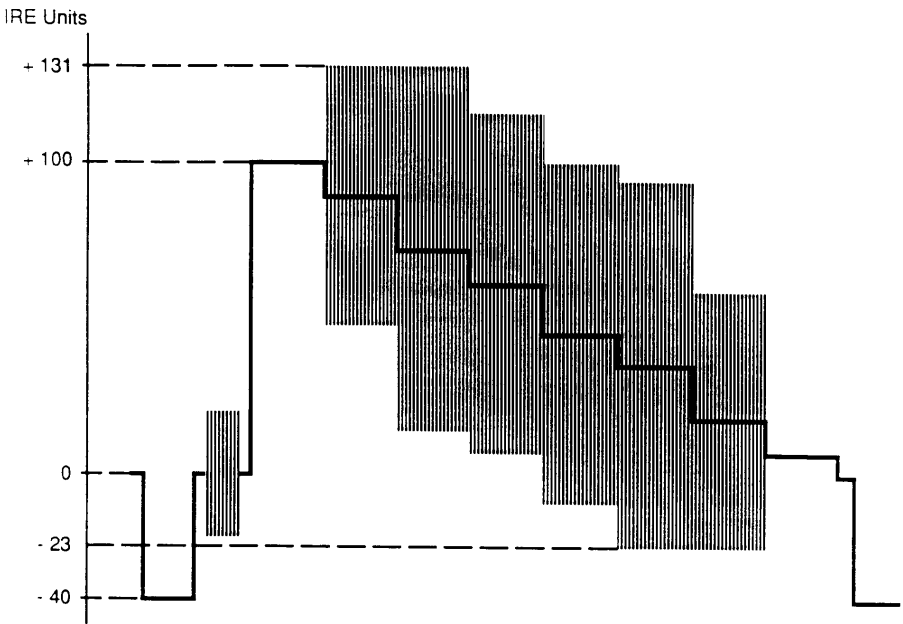


Figure 1 – Composite video signal amplitudes with two color components (full field, full amplitude color bar signal input)

Table 1 – Video and chroma levels

Bar	Luminance (IRE)	Chroma level (IRE)	Minimum chroma excursion (IRE)	Maximum chroma excursion (IRE)	Phase (degrees)
White	100.0	0.0	—	—	—
Yellow	89.5	82.8	48.1	130.8	167.1
Cyan	72.3	117.0	13.9	130.8	283.5
Green	61.8	109.2	7.2	116.4	240.7
Magenta	45.7	109.2	– 8.9	100.3	60.7
Red	35.2	117.0	–23.3	93.6	103.5
Blue	18.0	82.8	–23.3	59.4	347.1
Black	7.5	0.0	—	—	—
Burst	0.0	40.0	–20.0	20.0	180.0

Table 2 – SMPTE color bar test signal with setup (100/7.5/75/7.5)

Bar	Video level nominal (IRE)	Chroma level nominal (IRE)	Chroma excursions (IRE)	
			Lower nominal	Upper nominal
White flag	100.0	0.0	—	—
Gray	76.9	0.0	—	—
Yellow	69.0	62.1	37.9	100.0
Cyan	56.1	87.7	12.3	100.0
Green	48.2	81.9	7.3	89.2
Magenta	36.2	81.9	– 4.8	77.1
Red	28.2	87.7	–15.6	72.1
Blue	15.4	62.1	–15.6	46.4
Black	7.5	0.0	—	—
NOTE – When using the SMPTE color bar test signal, the upper excursion of the yellow and cyan bar chroma signals is exactly 100 IRE units.				

Table 3 – Full-amplitude color bars without setup (100/0/100/0)

Bar	Video level nominal (IRE)	Chroma level nominal (IRE)	Chroma excursions (IRE)	
			Lower nominal	Upper nominal
White	100.0	0.0	—	—
Yellow	88.6	89.5	43.9	133.3
Cyan	70.1	126.5	6.9	133.3
Green	58.7	118.1	– 0.3	117.7
Magenta	41.3	118.1	–17.7	100.3
Red	29.9	126.5	–33.3	93.2
Blue	11.4	89.5	–33.3	56.1
Black	0.0	0.0	—	—
NOTE – When using a full amplitude color bar signal (with or without setup), the upper excursion of the magenta bar chroma is approximately 100 IRE units.				

Table 4 – Full-amplitude color bars with setup (100/7.5/100/7.5)

Bar	Video level nominal (IRE)	Chroma level nominal (IRE)	Chroma excursions (IRE)	
			Lower nominal	Upper nominal
White	100.0	0.0	—	—
Yellow	89.5	82.8	48.1	130.8
Cyan	72.3	117.0	13.9	130.8
Green	61.8	109.2	7.2	116.4
Magenta	45.7	109.2	– 8.9	100.3
Red	35.2	117.0	–23.3	93.6
Blue	18.0	82.8	–23.3	59.4
Black	7.5	0.0	—	—
NOTE – When using a full amplitude color bar signal (with or without setup), the upper excursion of the magenta bar chroma is approximately 100 IRE units.				

3.2 Different color bar signals

Although the NTSC 1953 recommendation clearly called for the use of setup on all signals (see NTSC 1953, appendix A, clause III.C.2, reproduced in annex B of this document), some equipment manufacturers implement full-amplitude color bars with setup and others without setup (see tables 3 and 4).

Some manufacturers implement full-amplitude color bar signals as full-field signals, while others use split fields with both the color bars and the reference white bar (sometimes called white flag) at full amplitude. As a result, there are different color bar signals that have been in common use over the years.

NOTE – The different color bar signals are described by four amplitudes separated by slashes. The amplitudes are all expressed in percent. The first number is the reference white bar amplitude. The second number is the reference black bar amplitude. The third number is the white amplitude from which the color bars are derived. The fourth number is the black amplitude from which the color bars are derived. For example, 100/0/75/7.5 bars would be 75% bars with 7.5% setup in which the white bar has been set to 100% and the black bar is set to 0%.

4 Comparison of NTSC (1953) and equal-bandwidth NTSC encoders

4.1 NTSC (1953) encoder

The 1953 National Television System Committee (NTSC) specifications called for the use of two matrices (see figure 2). The first matrix encoded the gamma-corrected green (G), blue (B), and red (R) video signals into Y, R-Y, and B-Y. The second matrix encoded R-Y and B-Y into I and Q.

The NTSC 1953 standard also called for the I and Q signals to be bandwidth limited as follows:

- | | |
|----------|---|
| I signal | less than 2 dB down at 1.3 MHz
at least 20 dB down at 3.6 MHz |
| Q signal | at 0.4 MHz less than 2 dB down
at 0.5 MHz less than 6 dB down
at 0.6 MHz at least 6 dB down |

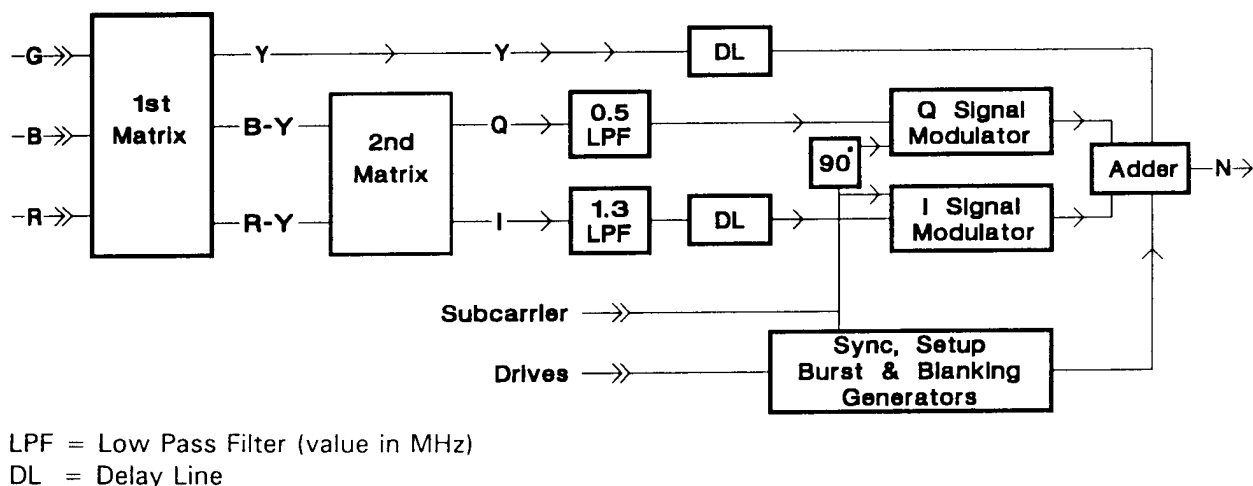


Figure 2 – Original NTSC two-matrix encoder