NTSC SIGNAL SPECIFICATIONS

These technical signal specifications were formulated by the National Television System Committee and approved by the Federal Communications Commission on December 17, 1953 as the technical transmission standards for commercial color broadcasting in the United States.

I. GENERAL SPECIFICATIONS

A. Channel

The color television signal and its accompanying sound signal shall be transmitted within a 6 mc channel.

B. Picture Signal Frequency

The picture signal carrier, nominally 1.25 mc above the lower boundary of the channel, shall conform to the frequency assigned by the FCC for the particular station.

C. Polarization

The radiated signals shall be horizontally polarized.

D. Vestigial Sideband Transmission

Vestigial sideband transmission in accordance with Fig. 2 shall be employed.

E. Aspect Ratio

The aspect ratio of the scanned image shall be four units horizontally to three units vertically.

F. Scanning and Synchronization

1. The color picture signal shall correspond to the scanning of the image at uniform velocities from left to right and from top to bottom with 525 lines per frame interlaced 2:1.

2. The horizontal scanning frequency shall be 2/455 times the color subcarrier frequency; this corresponds nominally to 15,750 cycles per second (with an actual value of 15,734.264+-0.047 cycles per second). The vertical scanning frequency is 2/525 times the horizontal scanning frequency: this corresponds nominally to 60 cycles per second (the actual value is 59.94 cycles per second).

3. The color television signal shall consist of color picture signals and synchronizing signals, transmitted successively and in different amplitude ranges except where the chrominance penetrates the synchronizing region, and the burst penetrates the picture region.

4. The horizontal, vertical, and color synchronizing signals shall be those specified in Fig. 1, as modified by vestigial sideband transmission specified in Fig. 2 and by the delay characteristic specified in III.B.

G. Out-of-Channel Radiation

The field strength measured at any frequency beyond the limits of the assigned channel shall be at least 60 db below the peak picture level.

II. SOUND

A. Sound Signal Frequency

The frequency of the unmodulated sound carrier shall be 4.5 mc ± 1,000 cycles above the frequency actually in use for the picture carrier.

B. Sound Signal Characteristics

The sound transmission shall be by frequency modulation, with maximum deviation of ± 25 kc, and with pre-emphasis in accordance with a 75 μsec time constant.

C. Power Ratio

The effective radiated power of the aural-signal transmitter shall be not less than 50 per cent nor more than 70 per cent of the peak power of the visual signal transmitter.

III. THE COMPLETE COLOR PICTURE SIGNAL

A. General Specifications

The color picture signal shall correspond to a luminance (brightness) component transmitted as amplitude modulation of the picture carrier and a simultaneous pair of chrominance (coloring) components transmitted as the amplitude modulation sidebands of a pair of suppressed subcarriers in quadrature having the common frequency relative to the picture carrier of +3.579545 mc ± 0.0003 per cent with a maximum rate of change not to exceed 1/10 cycle per sec per sec.

B. Delay Specification

A sine wave introduced at those terminals of the transmitter which are normally fed the color picture signal, shall produce a radiated signal having an envelope delay, relative to the average envelope delay between 0.05 and 0.20 mc, of zero μsecs up to a frequency of 3.0 mc; and then linearly decreasing to 4.18 mc so as to be equal to -0.17 μsecs at 3.58 mc. The tolerance on the envelope delay shall be ± 0.05 μsecs at 3.58 mc. The tolerance shall increase linearly to ± 0.1 μsec, down to 2.1 mc, and remain at ± 0.1 μsec down to 0.2 mc.[1] The tolerance shall also increase linearly to ± 0.1 μsec at 4.18 mc.

[1] Tolerances for the interval of 0.0 to 0.2 mc should not be specified in the present state of the art.

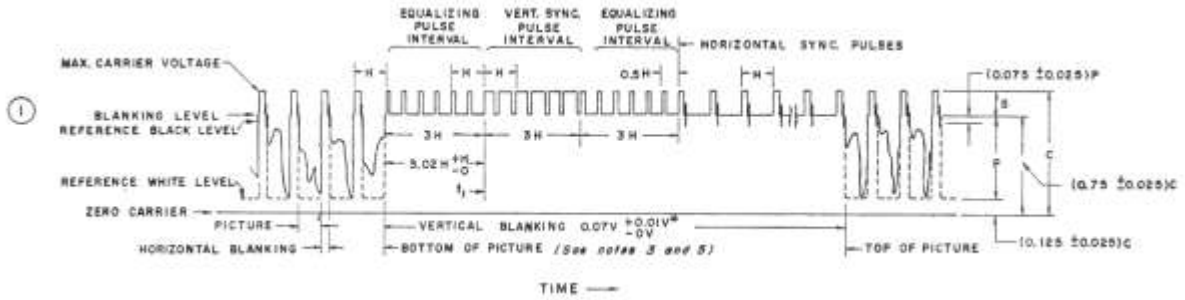
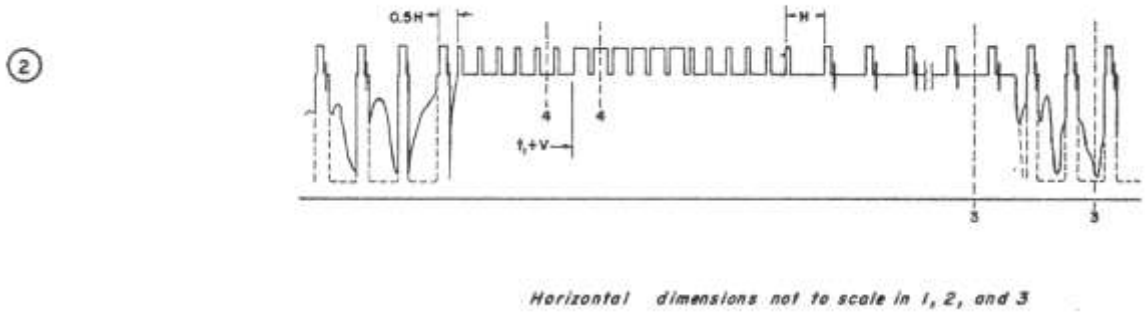


Fig. 1-1



Horizontal dimensions not to scale in 1, 2, and 3

Fig. 1-2

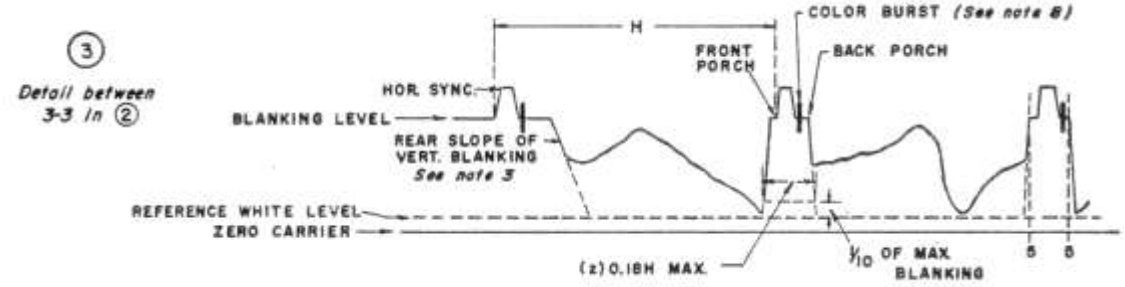


Fig. 1-3

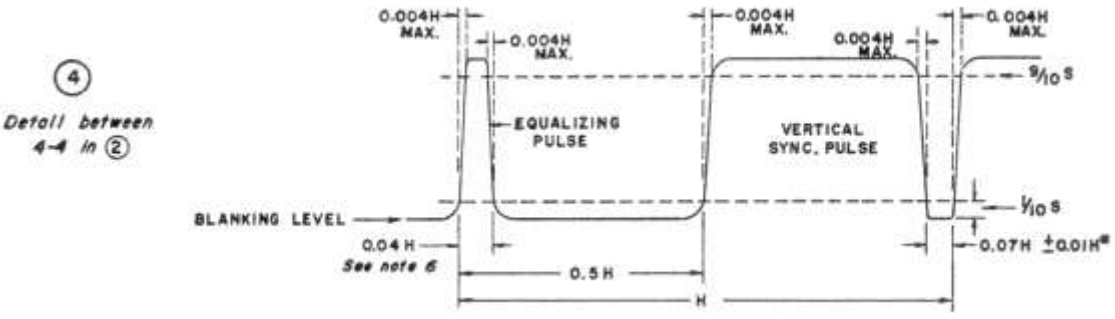


Fig. 1-4

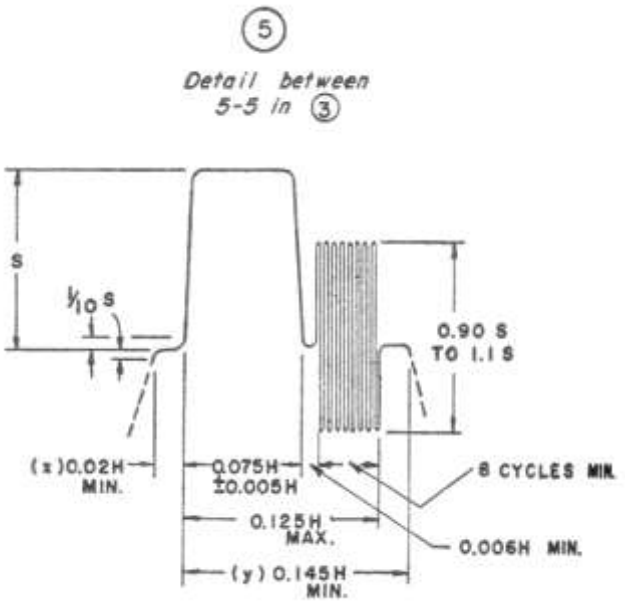


Fig. 1-5

NOTES

1. H = Time from start of one line to start of next line.
2. V = Time from start of one field to start of next field.
3. Leading and trailing edges of vertical blanking should be complete in less than 0.1 H.
4. Leading and trailing slopes of horizontal blanking must be steep enough to preserve minimum and maximum values of (x + y) and (z) under all conditions of picture content.
5. Dimensions marked with asterisk indicate that tolerances given are permitted only for long time variations and not for successive cycles.
6. Equalizing pulse area shall be between 0.45 and 0.5 of area of a horizontal sync pulse.
7. Color burst follows each horizontal pulse, but is omitted following the equalizing pulses and during the broad vertical pulses.
8. Color bursts to be omitted during monochrome transmissions.
9. The burst frequency shall be 3.579545 mc. The tolerance on the frequency shall be ±0.0003% with a maximum rate of change of frequency not to exceed 1/10 cycle per second per second.
10. The horizontal scanning frequency shall be 2/455 times the burst frequency.
11. The dimensions specified for the burst determine the times of starting and stopping the burst, but not its phase. The color burst consists of amplitude modulation of a continuous sine wave.
12. Dimension "P" represents the peak excursion of the luminance signal from blanking level, but does not include the chrominance signal. Dimension "S" is the sync. amplitude above blanking level. Dimension "C" is the peak carrier amplitude.
13. Refer to text for further explanations and tolerances.

C. The Luminance Component

1. An increase in initial light intensity shall correspond to a decrease in the amplitude of the carrier envelope (negative modulation).

2. The blanking level shall be at (75 ± 2.5) per cent of the peak amplitude of the carrier envelope. The reference white (luminance) level shall be (12.5 ± 2.5) per cent of the peak carrier amplitude. The reference black level shall be separated from the

blanking level by the setup interval, which shall be (7.5 ± 2.5) per cent of the video range from the blanking level to the reference white level.

3. The over-all attenuation versus frequency of the luminance signal shall not exceed the value specified by the FCC for black-and-white transmission.

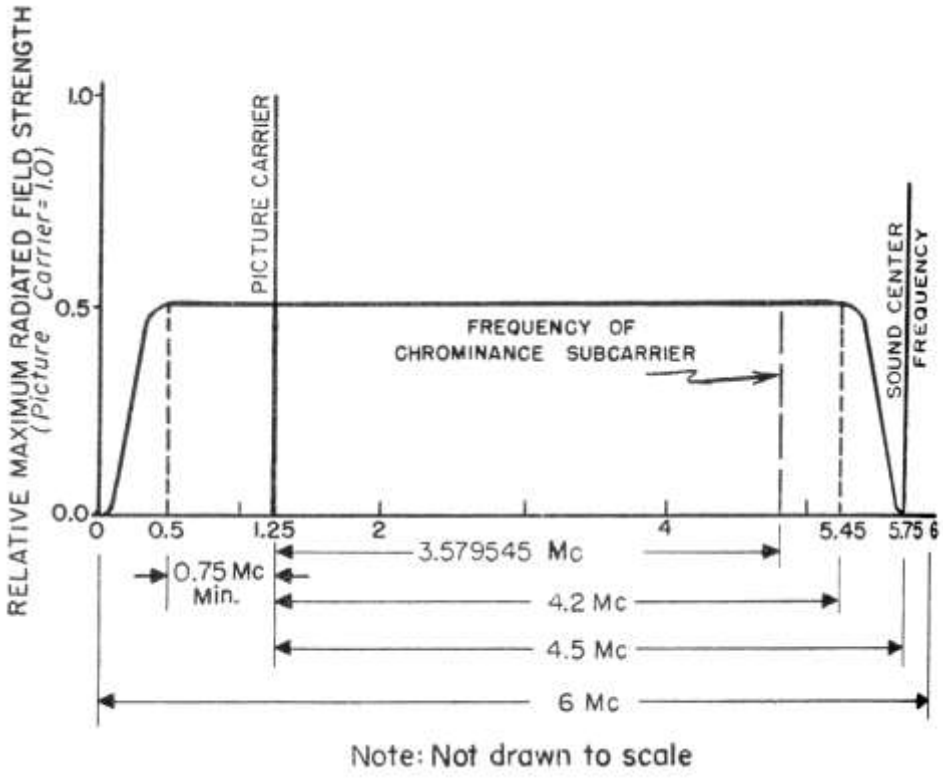


Fig. 2

D. Equation of Complete Color Signal

The color picture signal has the following composition:

$$E_M = E_{Y'} + \{E_{Q'} \sin + (\omega t + 33°) + E_{I'} \cos (\omega t + 33°)\}$$

where

$$E_{Q'} = 0.41 (E_{B'} - E_{Y'}) + 0.48 (E_{R'} - E_{Y'})$$
$$E_{I'} = -0.27 (E_{B'} - E_{Y'}) + 0.74 (E_{R'} - E_{Y'})$$
$$E_{Y'} = 0.30E_{R'} + 0.59E_{G'} + 0.11E_{B'}$$

The phase reference in the above equation is the phase of the (color burst +180°), as shown in Fig. 3. The burst corresponds to amplitude modulation of a continuous sine wave.

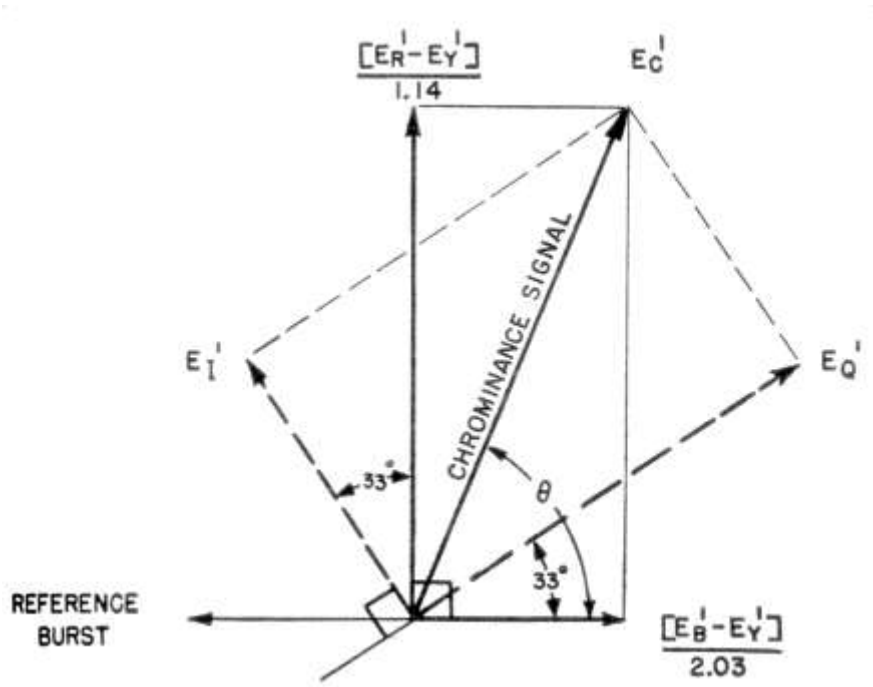


Fig. 3

Notes: For color-difference frequencies below 500 kc, the signal can be represented by

$$\mathrm{E_M} = E_{Y'} + \left\{ \frac{1}{1.14} \left[\frac{1}{1.78} \left(\mathrm{E_{B'}} - \mathrm{E_{Y'}}\right) \sin \omega t + \left(E_{R'} - E_{Y'}\right) \cos \omega t \right] \right\}$$

In these expressions the symbols have the following significance:

E_M is the total video voltage, corresponding to the scanning of a particular picture element, applied to the modulator of the picture transmitter.

E_Y' is the gamma-corrected voltage of the monochrome (black-and-white) portion of the color picture signal, corresponding to the given picture element. [2]

E_R', E_G', and E_B' are the gamma-corrected voltages corresponding to red, green, and blue signals during the scanning of the given picture element.

The gamma corrected voltages E_R', E_G', and E_B' are suitable for a color picture tube having primary colors with the following chromaticities in the CIE system of specification:

	x	*y*
Red (*R*)	0.67	0.33
Green (*G*)	0.21	0.71
Blue (*B*)	0.14	0.08

[2] Forming of the high frequency portion of the monochrome signal in a different manner is permissible and may in fact be desirable in order to improve the sharpness of saturated colors.

and having a transfer gradient (gamma exponent) of 2.2[3] associated with each primary color. The voltages E_R', E_G', and E_B' may be respectively of the form $E_R^{1/\gamma}$, $E_G^{1/\gamma}$, and $E_B^{1/\gamma}$, although other forms may be used with advances in the state of the art.

E_Q' and E_I' are the amplitudes of two orthogonal components of the chrominance signal corresponding respectively to narrow-band and wide-band axes, as specified in paragraph D.

The angular frequency ω is 2 π times the frequency of the chrominance subcarrier.

The portion of each expression between brackets represents the chrominance subcarrier signal which carries the chrominance information.

1. The chrominance signal is so proportioned that it vanishes for the chromaticity of CIE illuminant *C* (x - 0.310, y = 0.316).

2. E_Y', E_Q', and E_I' and the components of these signals shall match each other in time to 0.05 μsecs.

3. A sine wave of 3.58 mc introduced at those terminals of the transmitter which are normally fed the color picture signal shall produce a radiated signal having an amplitude (as measured with a diode on the RF transmission line supplying power to the antenna) which is down (6 ± 2) db with respect to a radiated signal produced by a sine wave of 200 kc. In addition the amplitude of the radiated signal shall not vary by more than ± 2 db between the modulating frequencies of 2.1 and 4.18 mc.

4. The equivalent bandwidths assigned prior to modulation of the color-difference signals E_Q', and $E_I'$are given by Table I.

TABLE I

Q-channel bandwidth
at 400 kc less than 2 db down
at 500 kc less than 6 db down
at 600 kc at least 6 db down
I-channel bandwidth
at 1.3 mc less than 2 db down
at 3.6 mc at least 20 db down

The angles of the subcarrier measured with respect to the burst phase, when reproducing saturated primaries and their complements at 75 per cent of full amplitude, shall be within ± 10° and their amplitudes shall be within ± 20 per cent of the values specified above. The ratios of the measured amplitudes of the subcarrier to the luminance signal for the same saturated primaries and their complements shall fall between the limits of 0.8 and 1.2 of the values specified for their ratios. Closer tolerances may prove to be practicable and desirable with advance in the art.

[3] At the present state of the art it is considered inadvisable to set a tolerance on the value of gamma and correspondingly this portion of the specification shall not be enforced.