
Appendix A

The NTSC signal specifications

A.1 General specification

Channel width	6 MHz
Picture signal carrier frequency	1.25 MHz above the lower boundary of the channel
Polarization	horizontal
Vestigial sideband modulation	to be in accordance with Figure 14.2
Aspect ratio	4 (horizontal) to 3 (vertical)
Sound signal carrier frequency	4.5 MHz \pm 1,000 Hz above the picture signal carrier
Sound signal characteristics	frequency modulation, with maximum deviation of \pm 25 kHz, and with pre-emphasis in accordance with a 75 μ s time constant
Sound transmitter output (e.r.p.)	between 50% and 70% of the peak power of the vision transmitter
Out-of-channel radiation	at least 60 db below the peak picture level at any frequency outside the limits of the assigned channel
Scanning and synchronization	
1. Direction of scanning	from left to right and from top to bottom (uniformly) with 525 lines per frame interlaced 2:1
2. Horizontal scanning frequency	2/455 times the color sub-carrier frequency, i.e. 15,734.264 \pm 0.047 Hz
3. Vertical scanning frequency	2/525 times the horizontal scanning frequency, i.e. 59.94 Hz

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| 4. Color television signal | consists 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 |
| 5. Synchronizing signals | as specified in Figure 9.1 as modified by vestigial side-band transmission specified in Figure 9.1 and by the delay characteristic specified in III.B |

A.2 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 as a simultaneous pair of chrominance (coloring) components transmitted as the amplitude modulation sidebands of a pair of suppressed sub-carriers in quadrature having the common frequency relative to the picture carrier of +3.579545 [MHz] \pm 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 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 [MHz], of zero μ secs up to a frequency of 3.0 [MHz]; and then linearly decreasing to 4.18 [MHz] so as to be equal to $-0.17[\mu\text{s}]$ at 3.58 [MHz]. The tolerance on the envelope delay shall be $\pm 0.05[\mu\text{s}]$ at 3.58 [MHz]. The tolerance shall increase linearly to $\pm 0.1[\mu\text{s}]$, down to 2.1 [MHz], and remain at $\pm 0.1[\mu\text{s}]$ down to 0.2 [MHz]. The tolerance shall also increase linearly to $\pm 0.1[\mu\text{s}]$ at 4.18 [MHz].

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 \pm 2.5) per cent of the peak amplitude of the carrier envelope. The reference white (luminance) level shall be (12.5 \pm 2.5) per cent of the peak carrier amplitude. The reference black level shall be separated from the blanking level by the set-up interval, which shall be (7.5 \pm 2.5) per cent of the video range from the blanking level to the reference white level.
3. The overall attenuation versus frequency of the luminance signal shall not exceed the value specified by the FCC for black-and-white transmission.

D. Equation of complete color signal

The color picture signal has the following composition:

$$E_M = E'_Y + \{E'_Q \sin(\omega t + 33^\circ) + E'_I \cos(\omega t + 33^\circ)\} \text{ where}$$

$$E'_Q = 0.41(E'_B - E'_Y) + 0.48(E'_R - E'_Y)$$

$$E'_I = -0.27(E'_B - E'_Y) + 0.74(E'_B - E'_Y)$$

$$E'_Y = 0.30(E'_R + 0.59E'_G) + 0.11E'_B$$

The phase reference in the above equation is the phase of the color burst $+180^\circ$. 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.
- 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

and having a transfer gradient (gamma exponent) of 2.2 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 wideband axes, as specified (above).

The angular frequency ω is 2π times the frequency of the chrominance sub-carrier.

The portion of each expression between brackets represents the chrominance sub-carrier 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 , E'_I and the components of these signals shall match each other in time to $0.05 \mu\text{s}$.
3. A sine wave of 3.58 [MHz] 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 \pm 2) db with respect to a radiated signal produced by a sine wave of 200 [kHz]. In addition, the amplitude of the radiated signal shall not vary by more than \pm 2db between the modulating frequencies of 2.1 and 4.18 [MHz].

4. The equivalent bandwidths assigned prior to modulation to the color-difference signals E'_Q and E'_I are given below:

Q - channel bandwidth

at 400 [kHz] less than 2db down

at 500 [kHz] less than 6db down

at 600 [kHz] less than 6db down

I - channel bandwidth

at 1.3 [MHz] less than 2db down

at 3.6 [MHz] at least 20db down

5. The angles of the sub-carrier measured with respect to the burst phase, when reproducing saturated primaries and their complements at 75 per cent of full amplitude, shall be within \pm 10° and their amplitudes shall be within \pm 20 per cent of the values specified above. The ratios of the measured amplitudes of the sub-carrier 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 advances in the art.