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Errata to the first printing, *A Technical Introduction to Digital Video*

This note contains errata to the first printing of the book *A Technical Introduction to Digital Video*, by Charles Poynton (New York: Wiley, 1996). I encourage you to make these corrections in your copy of the book. Several replacement figures are provided here.

This note contains errata for the first second, third, and fourth printings. To determine which printing of the book you have, turn to the copyright page of the front matter, page iv, and examine the bottom line: The rightmost digit of that line indicates which printing you have. If you have the first printing, obtain the *Errata* for that printing. If you have the second printing, although the necessary information is provided here, you will find it easier to correct from the *Errata* for that printing.

I revise this note as I discover errors, and I tag each entry with the date it was posted. I suggest that you annotate the back of the title page of your book with the revision date that you find at the bottom of this page. Then when you check future revisions of this document, you can determine if additional corrections need to be made.

In the entries below, I acknowledge individuals who have contributed corrections. All of the errors dated 1996-06-05 were identified by David J. Carlstrom; those dated 1996-12-30 by Chris Pirazzi of SGI. I am very grateful to them. Other entries without attribution are mine.

In the entries below, I acknowledge individuals who have contributed corrections. All of the errors dated 1996-06-05 were identified by Chris Pirazzi of SGI. I am very grateful to him. Other entries without attribution are mine.

Preface

1996-03-21: Page xxix of the front matter. The correct title of the third book mentioned in the marginal note is *Envisioning Information*.

Chapter 1, Basic principles

1996-06-01: Page 11. In Figure 1.7, *Interlaced scanning*, at the bottom of the page, several numbers need to be incremented by one. Change *261* to *262, 262* to *263, 263* to *264,* and *264* to *265*. A replacement figure is provided on page 9 of this document.

1997-09-07: Page 14. In Figure 1.8, *Vertical sync waveform of 525/59.94*, the 0_V notation should lie under the fourth tick from the left, not the seventh. A replacement figure and caption can be found on page 9 of this document.

1999-06-30: Page 19. In Figure 1.11, *Frequency response*, bandwidth should refer to the frequency where amplitude has fallen to 0.707. A replacement figure and caption can be found on page 9 of this document.

1999-06-30: Page 20. In the penultimate line of the first paragraph, replace *half* with *0.707.*

1997-09-04: Page 25. To clarify that MPEG-2 chroma subsampling is different from the subsampling used in JPEG, H.261, and MPEG-1, I refined Figure 1.14 and its caption. A replacement figure and caption can be found on page 10 of this document.

1997-09-04: Page 26. To clarify JPEG, MPEG-1, and MPEG-2 subsampling, replace the 4:2:0 paragraph in the middle of page 26 with this:

4:2:0

JPEG, H.261, MPEG-1, and MPEG-2 usually use 4:2:0 sampling. C_B and C_R are each subsampled by a factor of 2 both horizontally and vertically; C_B and C_R are sited vertically halfway between scan lines. Horizontal subsampling is inconsistent. In MPEG-2, C_B and C_R are cosited horizontally. In JPEG, H.261, and MPEG-1, C_B and C_R are not cosited horizontally; instead, they are sited halfway between alternate luma samples.

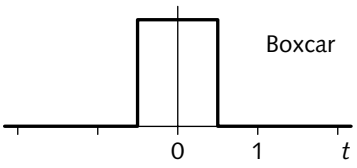
1996-06-05: Page 29. In the penultimate line of the fifth paragraph, $^7/_8$ of the way down the page, replace *synctip* by *blanking*.

Chapter 2, Raster images in computing

1996-12-09: Page 37. In the third paragraph under *Truecolor*, exchange the italicized word *truecolor* in the third line with the italicized words *direct color* in the last line.

Chapter 3, Filtering and sampling

1998-04-28: Page 44. In the first line of the lead paragraph under *Sampling theorem,* insert the word *be* between *to* and *digitized.*



1998-05-30: Page 52. In Figure 3.7 *Fourier transform pairs*, the two boxcar functions are improperly scaled: The function should have a value of unity across the range ±0.5 (not ±1).

1999-06-30: Page 57. In the penultimate line of the first paragraph in the section *Lowpass filter,* replace *half* with *0.707.* In the last line of the page, replace f_P by f_C.

1999-06-30: Page 58. In Figure 3.12, *Lowpass filter characterization*, bandwidth should refer to the frequency where amplitude has fallen to 0.707. A replacement figure and caption can be found on page 10 of this document.

1996-03-21: Page 59, Figure 3.13, *Rec. 601 filter templates*. The *y*-axis is labeled incorrectly. In two places, change *Insertion Loss* to *Insertion Gain*. At the top, the ticks –0.050 and –0.010 need to have their minus signs changed to plus signs; the ticks 10, 20, ..., 60 in the stopband need to be prepended by minus signs.

1996-03-21: Page 61, Figure 3.15, *Half-band filter*. The *y*-axis is labeled incorrectly. In two places, change *Insertion Loss* to *Insertion Gain*. At the top, the tick –0.050 needs to have its minus sign changed to a plus sign. The ticks 10, 20, ..., 80 in the stopband need to be prepended by minus signs.

Chapter 4, Image digitization and reconstruction

1996-03-21: Page 72, Figure 4.10. In the center of the figure, the parenthesized phrase should read *fraction <u>of</u> picture height*.

1996-03-21: Page 73, in the second paragraph, third line, add an "s" to pluralize the first word of the line: *samples*.

1996-03-21: Page 73, Figure 4.11. The figure should be titled *Spatial frequency spectrum of NTSC*. You may also wish to correct that entry in the *List of figures*, on page xx [sic] of the front matter.

1996-03-21: Page 73, 74, and 75, Figures 4.11, 4.12, and 4.13. The horizontal axis in each of these three figures should be labelled *C/PW*.

Chapter 5, Luminance and lightness

1999-12-28: On page 82, replace the first paragraph with:

> *Intensity* measures the flow of power in a particular, specified direction – that is, power per unit solid angle. *Radiance* is intensity per unit area. It is measured with an instrument called a *radiometer*, and is what I call a *linear-light* measure, expressed in units such as watts per steradian per square meter ($W \cdot sr^{-1} \cdot m^{-2}$).

Also on page 82, in the *Luminance* section, second paragraph, second line, replace *radiant power* by *radiance*.

1996-06-05: Page 82. In the *Luminance* section, second paragraph, sixth line, replace *CIIE* by *CIE*.

Chapter 6, Gamma

1999-12-28: On page 91, add this margin note:

> In physics, *intensity* is defined as radiant power per unit solid angle; it has units of watts per steradian ($W \cdot sr^{-1}$). Grayscale image data is normally based upon *relative luminance*, which is intensity per unit area, weighted by the spectral sensitivity of human vision, and normalized to a reference white. This chapter concerns the nonlinear mapping of relative luminance. In this chapter, I use the term *intensity* to emphasize the linear-light nature of the associated quantity. In the following chapter, I will detail luminance.

1996-03-21: On page 94, in the fourth line up from the bottom of the page, replace *above* by *below*.

1997-12-29: At the top of page 102, on the *y*-axis (*Video signal*) of Figure 6.6, replace *0.099* by *0.081*. Thanks to Michael Laird of Avid.

Chapter 7, Color science for video

1999-10-07: On page 119, in the second line of the first paragraph, replace per *unit area* by *in a particular direction*. Replace the last two words of the paragraph, *square meter,* by *steradian*. In the second paragraph, replace the word *power* by *intensity (per unit area)*.

1997-07-01: On page 130, in the third line up from the bottom of the page, replace *or* by *of*.

1998-12-22: On page 135, the chromaticity diagram of Figure 7.12, all of the features associated with blue primary should be positioned about 1 cm lower than shown. A replacement figure is provided on page 13.

Chapter 8, Luma and color differences

1996-06-05: Page 156, Fig. 8.1, *RGB and Y, B–Y, R–Y cubes*. In the bottom sketch of the pair, the (*Y*=0) and (*Y*=1) tags are reversed: The tag beside *Wt* at the top of the cube should be labelled (*Y*=1); the one at the bottom labelled *Bk* should be tagged (*Y*=0).

1996-05-07: Page 157, in the third paragraph, second line, replace *brightness luminance* with *luminance comprises*.

1996-04-28: Page 159, Figure 8.2, *B′–Y′*, *R′–Y′ Orthographic views*. The end of the caption paragraph has a truncated page reference: append *page 173*.

1997-11-19: Page 165. The offset terms of Equation 8.2 need to be corrected by changing *0.0228* to *0.1115,* in three places. Thanks to Jan van Rooy of Philips, Breda. The correct equations are these:

Eq 8.2

$$R'_{240} = 1.1115\,R^{0.45} - 0.1115$$
$$G'_{240} = 1.1115\,G^{0.45} - 0.1115$$
$$B'_{240} = 1.1115\,B^{0.45} - 0.1115$$

1999-12-28: Page 166. Equation 8.5 was correct when printed, but ITU-R subsequently changed the Rec. 709 luma coefficients in the fourth decimal place. The correct coefficients are now these:

Eq 8.5

$$Y'_{709} = 0.2126\,R' + 0.7152\,G' + 0.0722\,B'$$

Chapter 9, Component video color coding

1996-05-02: Page 174. On the fifth line of the section C_BC_R *Components*, change *two's complement* to *offset binary*.

1996-04-28: Page 175, Figure 9.3, C_BC_R *Components*. The extreme value of C_B on the horizontal axis is erroneously indicated as *224*: change this to *240*. Similarly, change *224* on the vertical axis to *240.* In Equation 9.5, in the numerators of the scale factor fractions for C_B and C_R, change *0.5* to *1* in two places. Thanks to Rob Engle of Hewlett-Packard, and to Bill Herz of S3, for reporting these problems.

1998-04-28: Page 177. In the final line of the page, change the phrase *9-bit multipliers are required* to *multipliers having more than 8 bits are required*. Thanks to Chris Parazzi.

1997-11-14: Page 178. In the second paragraph of the section *Kodak PhotoYCC*, at the end of the fifth line, change *189* to *182*. In Eq. 9.12, change the subscript *189* to *182*.

1996-03-21: Page 183, Figure 9.6 *IQ Components* has its color hexagon rotated 33 degrees counterclockwise, instead of clockwise. A replacement figure is provided on page 11 of this document.

Chapter 10, Composite NTSC and PAL

1996-06-27: Page 186. In the paragraph *Subcarrier regeneration*, in the fourth line, replace *cos* by *sin*.

1996-06-27: Page 187. In the second paragraph, under *Quadrature modulation*, in the third line of the second paragraph, exchange *cos* and *sin*. Change Equation 10.1 so as to appear:

Eq 10.1

$$C = U \sin \omega t + V \cos \omega t \qquad \omega = 2\pi f_{SC}$$

1996-06-27: Page 188, 189. Figures 10.3 and 10.4 contain wiring errors. Replacements are provided at the end of this note.

1996-06-05: Page 194. In the fourth line under the topic *PAL-M, PAL-N*, replace the second instance of *M/PAL (PAL-M, PAL-525)* by *N/PAL (PAL-N, PAL-3.58)*.

Chapter 11, Field, frame, line, and sample rates

1996-06-08: Page 200. In the third paragraph, second line, replace *60* by *30*. In the last line of that paragraph, replace *5×5×5×5* by 5^6. In the fifth line of the next topic *Sound subcarrier*, replace *monochrome 525/59.94* by *monochrome 525/60*.

1996-08-02: Page 205. In the last paragraph on the page, at the start of the fourth line from the bottom, insert *is* between *This* and *a hundred*. Thanks to Brian Murray.

Chapter 13, 525/59.94 Component video

1997-11-13: Page 216. In the second paragraph under *Component digital 4:2:2 interface*, in the third line, change *732* to *736*. In Figure 13.2 on the facing page, change two occurrences of *732* to *736*.

1996-12-30: Page 218. In the *y*-axis legend of Figure 13.3, replace 54 $^4/_7$ by 53 $^4/_7$, and replace -286 $^5/_7$ by -285 $^5/_7$.

Chapter 14, 525/59.94 NTSC composite video

1996-06-27: Page 223, *Color difference filtering*. Delete the second bulleted item. In Equations 14.1 and 14.2, exchange *cos* and *sin*, and add $\omega = 2\pi f_{SC}$:

Eq 14.1

$$C = U \sin \omega t + V \cos \omega t \qquad \omega = 2\pi f_{SC}$$

Eq 14.2

$$C = Q \sin(\omega t + 33°) + I \cos(\omega t + 33°) \qquad \omega = 2\pi f_{SC}$$

1996-12-30: Page 227. In the *y*-axis legend of Figure 14.4, replace 54 $^4/_7$ by 53 $^4/_7$, and replace -286 $^5/_7$ by -285 $^5/_7$.

Chapter 15, 625/50 scanning and sync

1997-11-13: Page 230, Table 15.1, *625/50 Line assignment*. A marginal note is missing from the table:

> The vertical center of the picture is located midway between lines 479 and 167.

The terms *odd* and *even* are ambiguous when referring to fields in 625/50 scanning. To avoid confusion, I recommend that you use the terms *first* and *second* instead. In the heading row, replace *Even* with *Second* and *Odd* with *First*. In the shaded area at the bottom right of the table, delete two instances of *Even* and two instances of *Odd*. On the facing page, delete *even* and *odd* from bullet items 1, 5, 6, and 10.

Chapter 16, 625/50 Component video

1997-11-13: Page 238. In the second paragraph under *Component digital 4:2:2 interface*, in the second line, change *736* to *732*. In Figure 16.1 on the facing page, change two occurrences of *736* to *732*.

Chapter 17, 625/50 PAL composite video

1996-06-27: Page 242. The three paragraphs under the heading *Burst* should be replaced; in addition, two marginal notes should be added. Page 14 of this *Errata* provides a complete replacement page.

1996-06-27: Page 243, under *Color difference filtering*, delete the second item in the bulleted list. In Equation 17.1, exchange *cos* and *sin*.

1997-10-15: Page 244. At the end of the penultimate paragraph, delete the phrase *with 7.5-percent setup*. Thanks to Vince Capizzo.

Chapter 18, Electrical and mechanical interfaces

1997-11-13: Page 248. At the end of the last paragraph on the page, change *instead of TRS* to *in addition to TRS*.

Chapter 19, Broadcast standards

1996-03-21: Page 251, Table 19.1, *Summary of broadcast standards*. In the entry for M/NTSC, subcarrier frequency should be *3.579545454+*. Thanks to Marty Kirkland of KUHT.

Chapter 20, Test signals

1998-10-16: Page 257, Figure 20.1, *Colorbars*. Replace two instances of *WHITE* by *100% WHITE.* In the narrow horizontal band between vertical coordinates 0.67 and 0.75, in the third column (underneath CYAN), change *BLUE* to *MAGENTA*. In the fifth column (underneath MAGENTA), change *BLUE* to *CYAN*. In the seventh column (underneath BLUE), change *BLUE* to *75% WHITE*. A replacement figure is provided.

1996-04-28: Page 263, Figure 20.10, *Modulated 12.5T pulse waveform*. At the bottom of the figure, change *3.579454* to *3.579545*.

Chapter 21, Timecode

1996-03-21: Page 267. In the second to last paragraph, delete the last line and its parentheses, and replace it with *using three-pin XLR connectors*. Thanks to the sharp-eyed Larry Martin.

1997-07-11: Page 267. In line 2 of the last paragraph, replace *1.2 Kb/s* with *2.4 kb/s*. Thanks to Ian Holland.

Glossary

1996-04-28: Page 277. In the top two lines of the page, in the final part of the glossary entry for C_B, C_R, replace *use* by *apply*, and insert in front of the colon at the end of the second line *to B′–Y′ and R′–Y′.* In the equations immediately below, change both equal signs to colons, and in the numerators of each of the two fractions, change *0.5* to *1:*

> In systems such as 525/59.94 and 625/50 using Rec. 601 luma, it is standard to apply these scale factors to $B'–Y'$ and $R'–Y'$:
>
> $$C_B: \quad 112 \cdot \frac{1}{0.886}; \qquad C_R: \quad 112 \cdot \frac{1}{0.701}$$

1997-07-01: Page 293. Near the top of the page, in the last line of item 3 of *Resolution, limiting,* change *two cycles in a TV line* to *two TV lines in a cycle.* Thanks to David Farrant.

1998-12-30: Page 295. In the entry for S-video, in the third line, change *two only* to *exactly 2*.

Replacement figures and pages

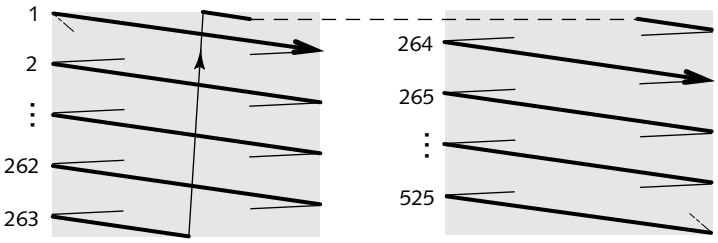


Figure 1.7 **Interlaced scanning** forms a complete picture – the *frame* – from two *fields*, each comprising half the scanning lines. The second field is delayed half the frame time from the first.

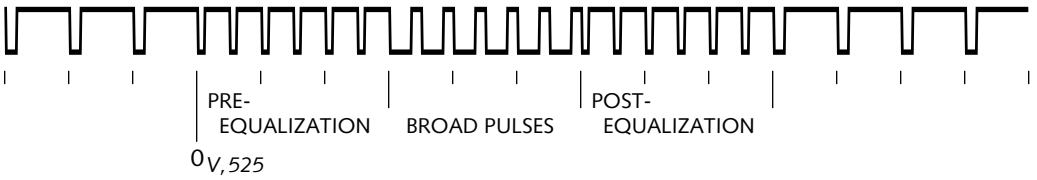
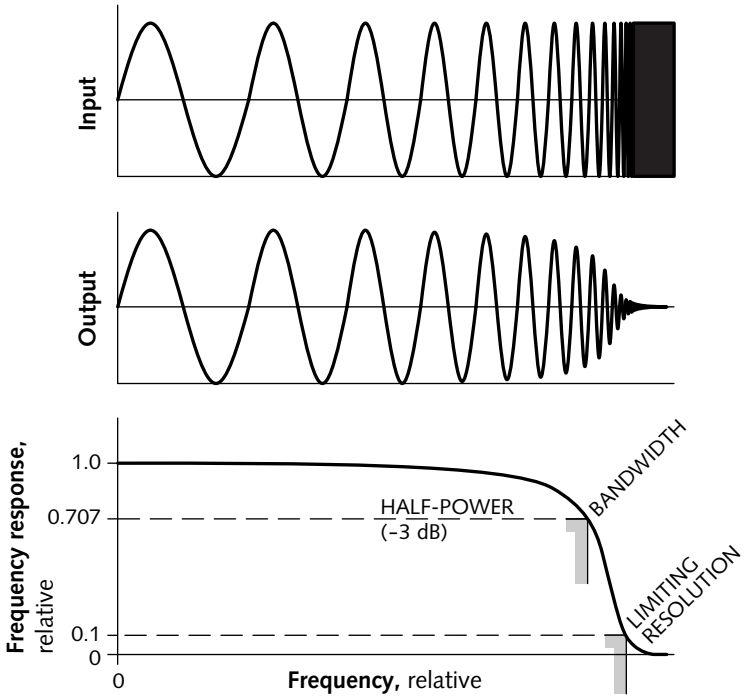


Figure 1.8 **Vertical sync waveform of 525/59.94.**

Figure 1.11 **Frequency response** of any electronic or optical system falls as frequency increases. Bandwidth is measured at the half-power point (–3 dB), where response has fallen to 0.707. Television displays are often specified at *limiting resolution*, where response has fallen to 0.1.



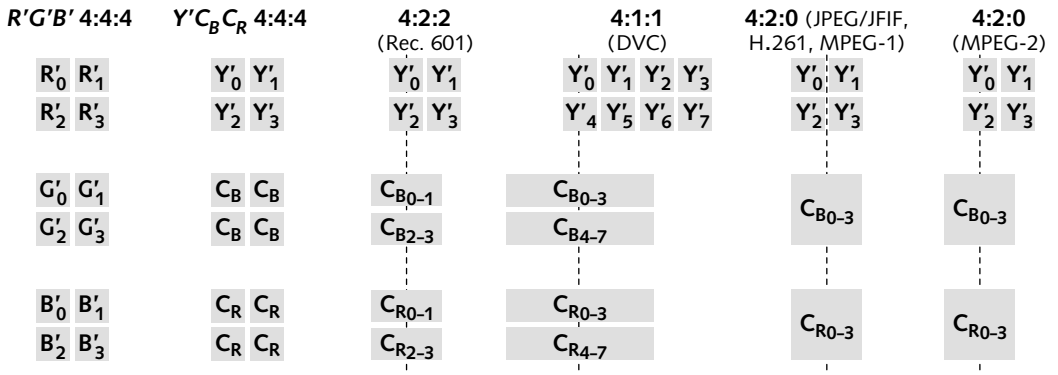


Figure 1.14 **Chroma subsampling.** A 2×2 array of *R′G′B′* pixels can be transformed to a luma component *Y′* and two color difference components C_B and C_R; color detail can then be reduced by subsampling, provided that full luma detail is maintained. The wide aspect of the C_B and C_R samples indicates their spatial extent. The horizontal offset of C_B and C_R is due to cositing. (JPEG, H.261, and MPEG-1 do not use cositing; instead, their C_B and C_R samples are taken halfway between luma samples.)

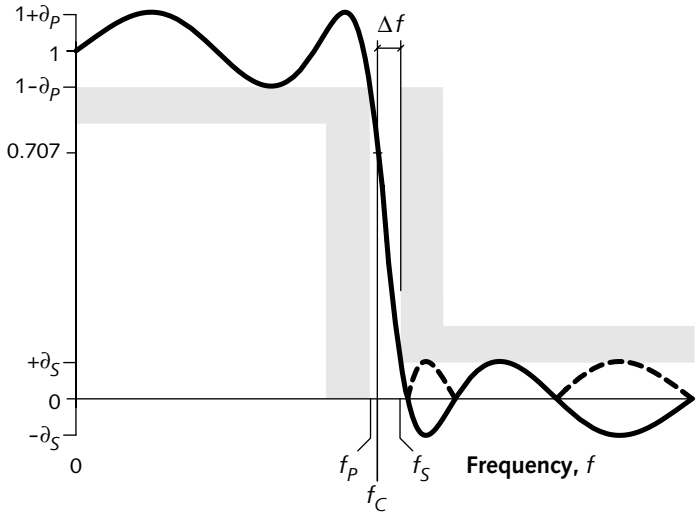


Figure 3.12 **Lowpass filter characterization.** A lowpass filter for use in video sampling or reconstruction has a cutoff frequency f_C, where the attenuation is 0.707. In the *passband*, response is unity within ∂_P, usually 1 percent or so. In the *stopband*, response is zero within ∂_S, usually 1 percent or so. The *transition band* lies between the cutoff frequency and the edge of the stopband. The solid line shows that at certain frequencies, the filter causes phase inversion. Filter response is usually plotted as magnitude; phase inversion in the stopband is reflected as the absolute values shown in dashed lines.

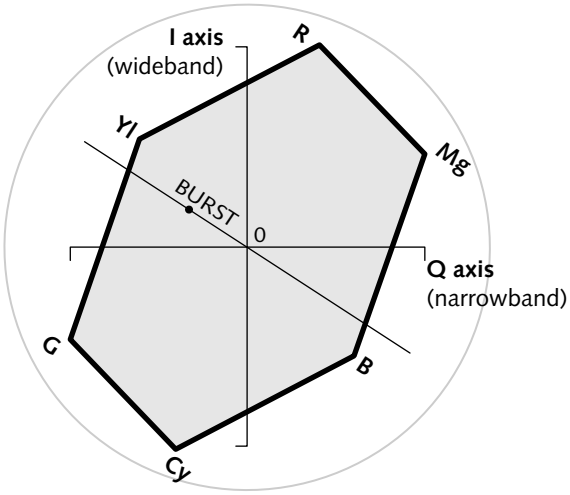


Figure 9.6 **IQ Components.**

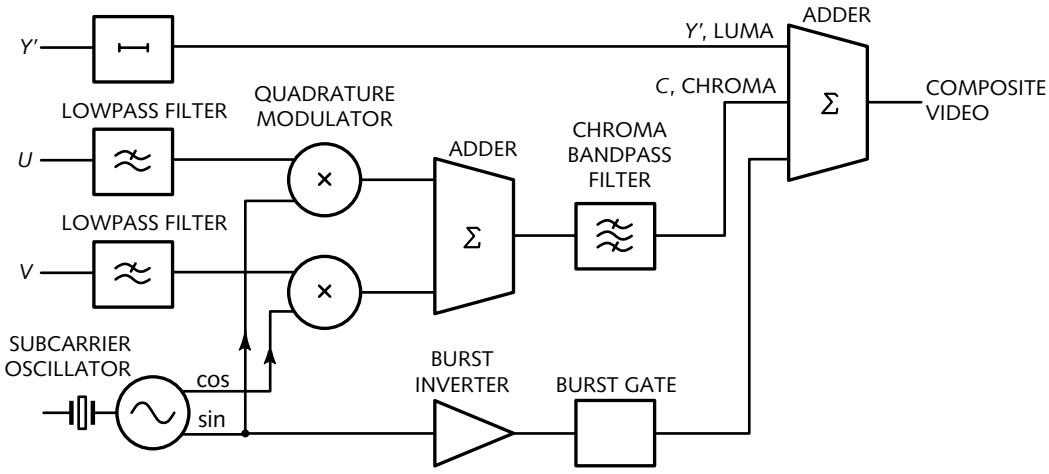


Figure 10.3 **NTSC encoder block diagram.**

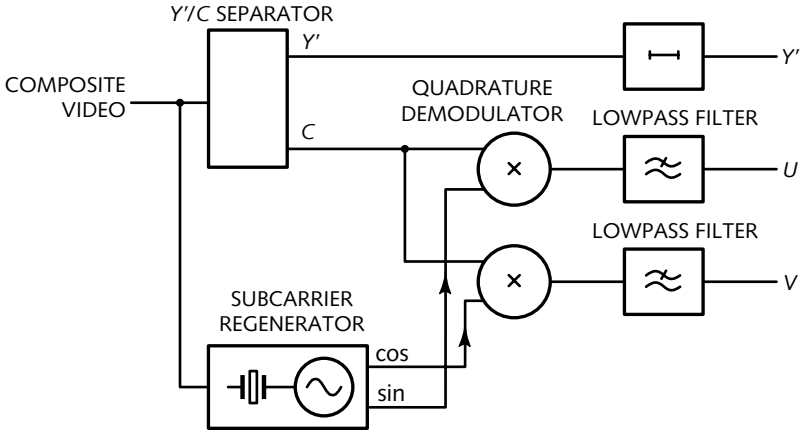
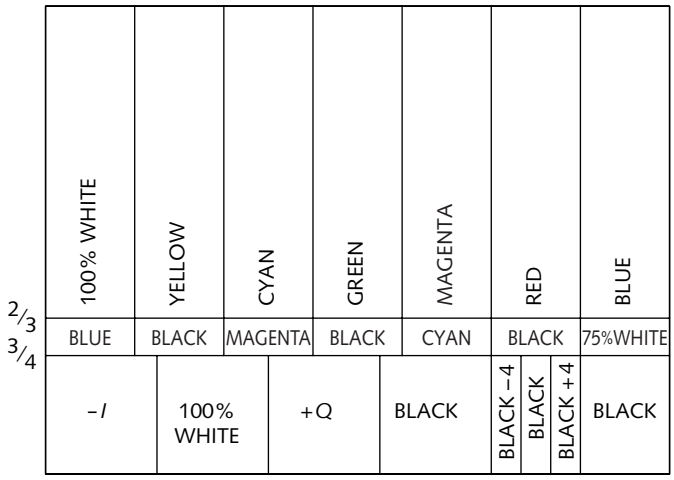


Figure 10.4 **NTSC decoder block diagram.**

Figure 20.1 **Colorbars.**



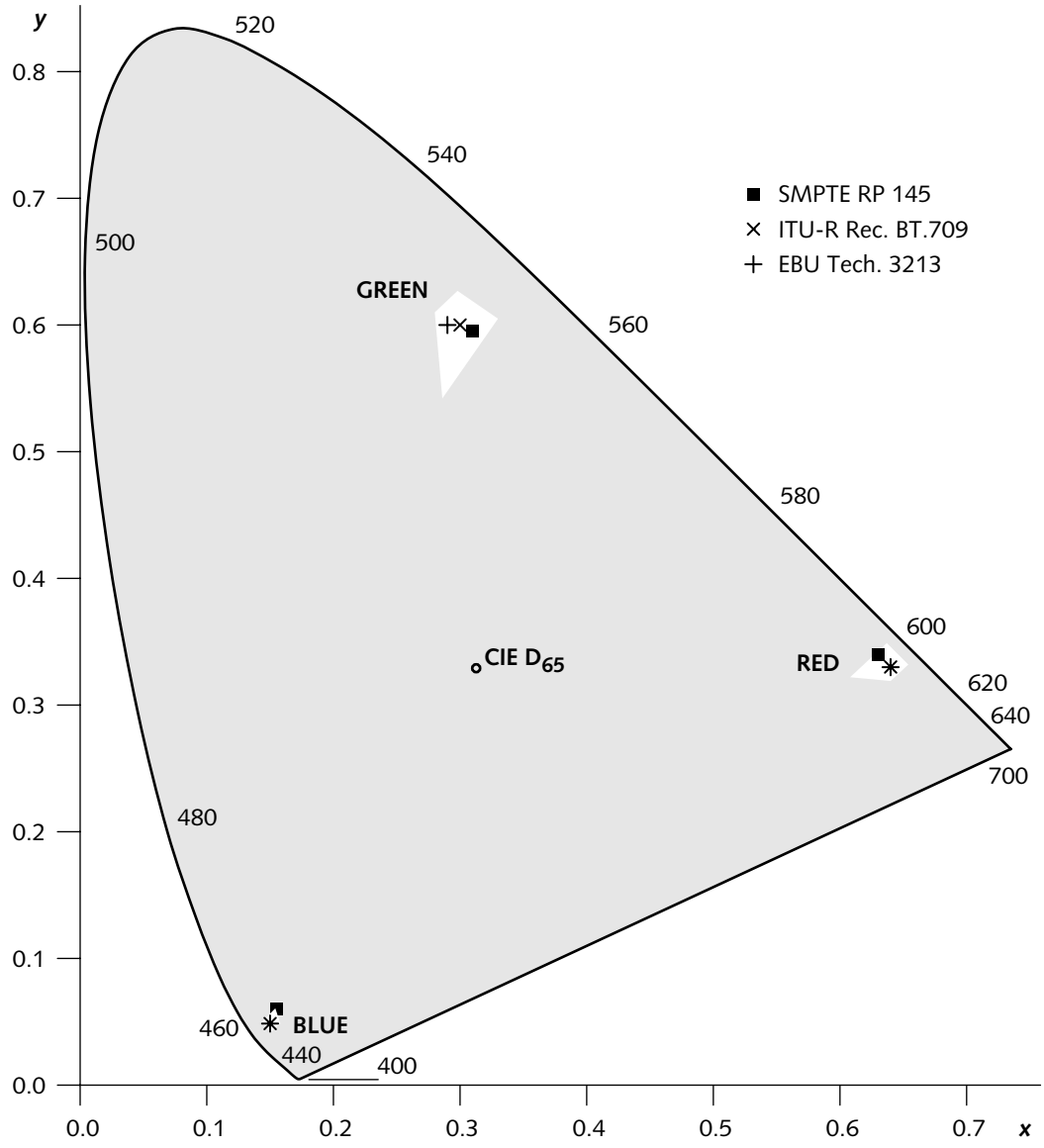


Figure 7.12 **RGB primaries of video standards** are plotted on the CIE (*x*, *y*) chromaticity diagram. The colors that can be represented in positive *RGB* values lie within the triangle formed by the primaries. The Rec. 709 standard specifies no tolerance. SMPTE tolerances are specified as ±0.005 in *x* and *y*. EBU tolerances are shown as white quadrilaterals; they are specified in *u′*, *v′* coordinates related to the color discrimination of vision. The EBU tolerance boundaries are not parallel to the (*x*, *y*) axes.

Burst

Burst – or *colorburst* – is formed by multiplying a phase-shifted version of subcarrier by a *burst gate* that has a duration of 10 ± 1 cycles of subcarrier, and is asserted to unity, 5.6 ± 0.1 µs after 0_H on every line that commences with a normal sync pulse (except lines 6, 310, 320, and 622, which are subject to *meander*, to be described in a moment). Burst gate has raised-cosine transitions whose 50 percent points are coincident with the time intervals specified above, and whose risetimes are 300^{+200}_{-100} ns.

PAL +135° burst lies on the *U* – *V* axis; –135° burst lies on the *U* + *V* axis. The choice of addition or subtraction depends on the polarity of the *V*-switch.

In NTSC, burst is based on the inverted *sin* subcarrier. PAL uses what is known as *swinging* burst: On one line, burst is advanced 135° from the *sin* subcarrier; on the next line, it is delayed 135° from the *sin* subcarrier. PAL burst is located at +135° and –135° (+225°) on a vectorscope display, compared to 180° for NTSC. The subcarrier regenerator of a typical PAL decoder does not process swinging burst explicitly, but relies on the loop filter to average the swinging burst to 180° phase.

A PAL decoder should recover *V*-switch polarity through burst averaging, not by detecting burst meander.

PAL systems have a burst-blanking *meander* scheme (also known as *Bruch blanking* or *Bruch burst*): Burst is suppressed from the first and last full lines of a field if it would take –135° phase. Burst is always suppressed from line 623. The suppression of burst ensures that the closest burst immediately preceding and following the vertical interval has +135° phase.

Color difference components, U, V

Color differences for PAL are computed by scaling *B′*–*Y′* and *R′*–*Y′* components to form *U* and *V* components, as described on page 180. The scaling limits the maximum value of the composite signal, to be defined in *Composite PAL encoding*, on page 244, to the range $-1/3$ to $+4/3$. The scale factors cause 100 percent colorbars to have an excursion from $-33\frac{1}{3}$ percent to $+133\frac{1}{3}$ percent of the picture excursion.The VHF/UHF PAL transmitter places no limit on composite picture excursion in this range (unlike NTSC, where the transmitter imposes a limit of 120 IRE).