REAFFIRMED 1999

RP 133-1991
Revision of RP 133-1986

SMPTE RECOMMENDED PRACTICE

Specifications for Medical Diagnostic Imaging Test Pattern for Television Monitors and Hard-Copy Recording Cameras

1 Scope

This practice describes the format, dimensions, and contrast required to make diagnostically significant measurements of the display and camera system resolution for both digital and analog monochrome signal sources. (See note.) The practice provides users of medical diagnostic imaging systems with a comprehensive test pattern for day-to-day operational checks and adjustments of focus, brightness and contrast, resolution response, mid-band streaking, uniformity, and linearity of viewing monitors and hard-copy recordings. This practice is not intended to create a standard for image characteristics such as resolution, geometry and linearity, uniformity, phosphor defects, etc. However, use of the pattern is encouraged as an appropriate tool for evaluating the measurement and specification of such image characteristics.

2 Description

2.1 Pattern

A reproduction of the test pattern is shown in figure 1. Figure 2 is a drawing of the pattern for reference to the following text:

2.2 Background

The background is presented at 50% of maximum white to obtain an approximate average picture level (APL) of 50% (figure 2 [1]).

2.3 Crosshatch pattern

This pattern allows verification of linearity, either by using a straightedge or by overlaying or projecting a perfect reference image (Ball chart) (figure 2 [2]).

2.4 Resolution pattern

Three zones of vertical and horizontal, high-contrast bar patterns are placed in five locations (four corners and the center). The modulation depth of the pattern is 100%. Placement of the patterns facilitates comparison of the resolution in the center and in the corners of the screen (figure 2 [3]). A detailed view of the resolution pattern is shown in figure 3.

2.5 Low-contrast imaging resolution

Three zones of vertical and horizontal, low-contrast, equally-spaced bars are located next to the patterns described in 2.4. The modulation depth of these areas is 1%, 3%, and 5%. This is the most sensitive test for various types of imaging noise (figure 2 [4]).

2.6 Gray step pattern

Blocks of specified signal amplitude, representing 0% to 100% of the input signal in steps of 10%, allow measurements of the response characteristics of the viewing monitors and hard copy (figure 2 [5]).

2.6.1 Small-contrast changes

Small-contrast changes of 5% of the input signal are superimposed on a 0% background, and a 95% value is superimposed on a 100% maximum signal background to allow quick verification that all available gray-scale information can be presented in the image to be displayed (figure 2 [6]).

2.7 White window and black window

During display of these patterns, the display or recording device signal stays relatively long in one state (black or white). These large areas of maximum contrast facilitate detection of mid-band streaking (poor low-frequency response), video amplifier ringing or overshoot, deflection interference, and halo (figure 2 [7] and [8]).

Approved March 1, 1991

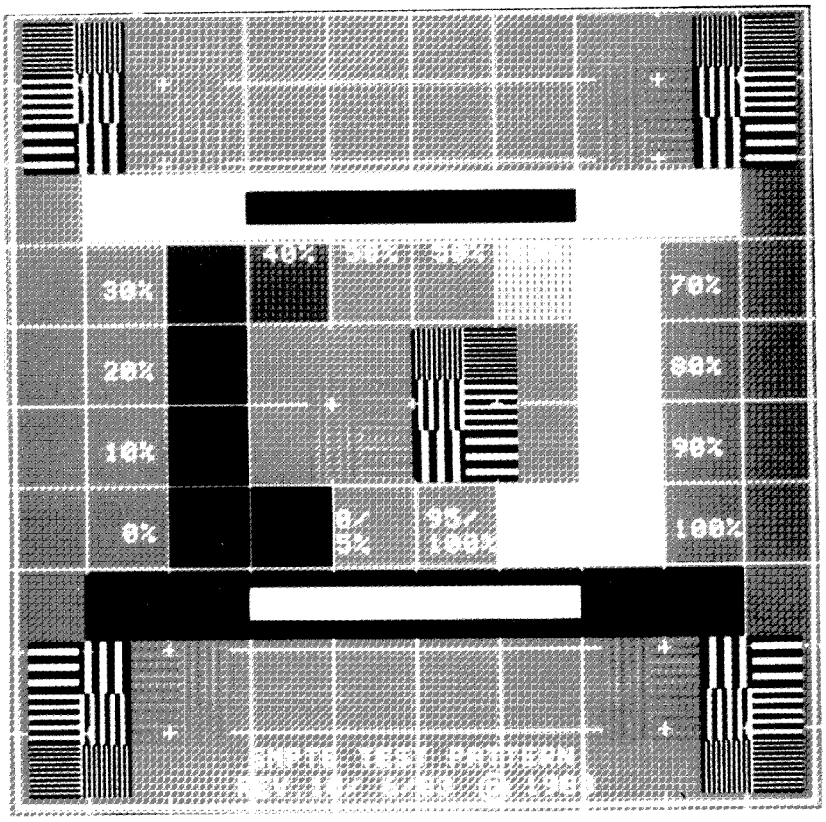

Figure 1 – Video hard-copy camera image of test pattern

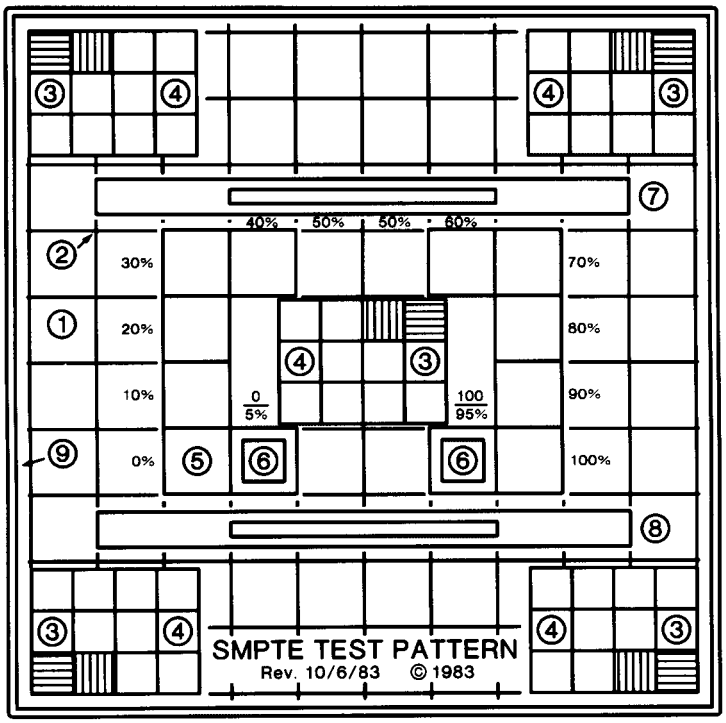

Figure 2 – Schematic drawing of test pattern in a square format

2.8 Picture border

A line is placed around the outside of the pattern that defines the full extent of the pattern (figure 2 [9]).

3 Format

3.1 The test pattern (figure 2) and the following paragraphs shall represent a recommended implementation of the pattern. Specific information for digital implementation is given in table 1.

3.2 The middle gray background is used to isolate the gray-scale and center resolution pattern from interference by adjacent patterns.

3.3 Crosshatch lines in the horizontal direction shall be two raster lines wide, and in the vertical direction, lines shall be of a width equal to two raster lines. The intensity of the line shall be 75% of the maximum signal. The patterns shown consist of square spaces equal to 10% of the raster height. Rectangular aspect ratios and different numbers of scan lines may require fractional spaces (see figure 4). Fractional spaces, if required, should be at the edges of the pattern.

3.4 The high-contrast resolution patterns of lines in the vertical direction are divided into three zones of different spatial frequencies with the highest frequency pattern in the four corners. The center pattern is oriented with its high-contrast, high-resolution pattern in the upper-right corner (see figure 3). Modulation of the high-contrast pattern is 100%.

3.5 It is recommended that the high-contrast middle spatial frequency zone of the horizontal resolution patterns (which are placed in the four corners of the test pattern) should represent the corner resolution specified by the manufacturer for the system being evaluated. The high-contrast middle frequency zone of the resolution pattern (in the center of the test pattern) should represent the central display resolution as specified by the manufacturer of the system being evaluated. The lower frequency pattern in each of these five high-contrast test patterns should be 75% of the resolution specified by the manufacturer for the area in which the resolution pattern is located. The high-contrast highest frequency pattern should be 125% of the resolution specified by the manufacturer for the area in which the pattern is located.

3.5.1 Vertical resolution patterns are limited to three arrangements; one line off and one line on, two lines off and two lines on, and three lines off and three lines on.

3.6 For digital systems, the spatial frequency of the bar patterns is limited to increments of one pixel size. Thus, it is recommended that one pixel on and one pixel off be used for the highest resolution zone and three pixels on and three pixels off be used for the lowest resolution zone.

3.7 Low-contrast patterns repeat the format of the high-contrast patterns except the spatial frequency in all three zones is equal to that of the above middle zone; however, in one zone the modulation is 1% (i.e., white equals 51% and black equals 50%). In the middle zone, the modulation is 3% (51% and 48%), while in the last zone, it is 5% (53% and 48%). The arrangement of patterns is symmetrical, with the lowest-contrast zones closest to the corners.

3.8 A rectangular area 40% of the picture height is used to display at least 10 steps of luminance from white to black. Thus, the resolution performance is evaluated at the proper dynamic range of the image as it is used for operation for both viewing monitor and film hard copy. The individual blocks are intended to be measured with a spot photometer or optical densitometer, and they are concentrated in the middle of the screen to avoid shading caused by off-axis effects in the CRT or optical system.

3.9 Small contrast changes in the blocks next to the white and black ends of the gray scale consist of a 5% maximum signal patch superimposed on 0% (i.e., black) and a 95% maximum signal patch superimposed on 100% (i.e., white) to permit fine tuning of contrast and brightness controls to verify that all shades of gray present in the signal can be perceived in the image. The size of the inset shall be 5% of the picture height.

3.10 The white and black window patterns should have a height equal to 8% of the picture height centered in one square of the crosshatch with the length starting one square away from

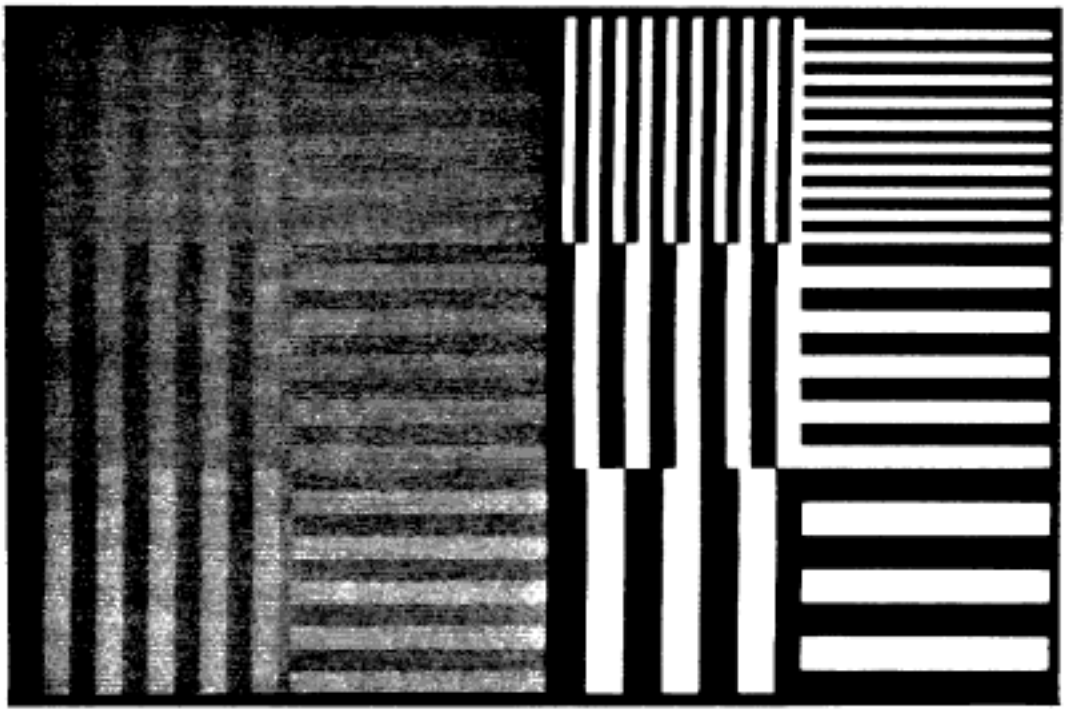

Figure 3 – Detail of digitally-generated resolution pattern portion of test pattern showing high- and low-contrast portions

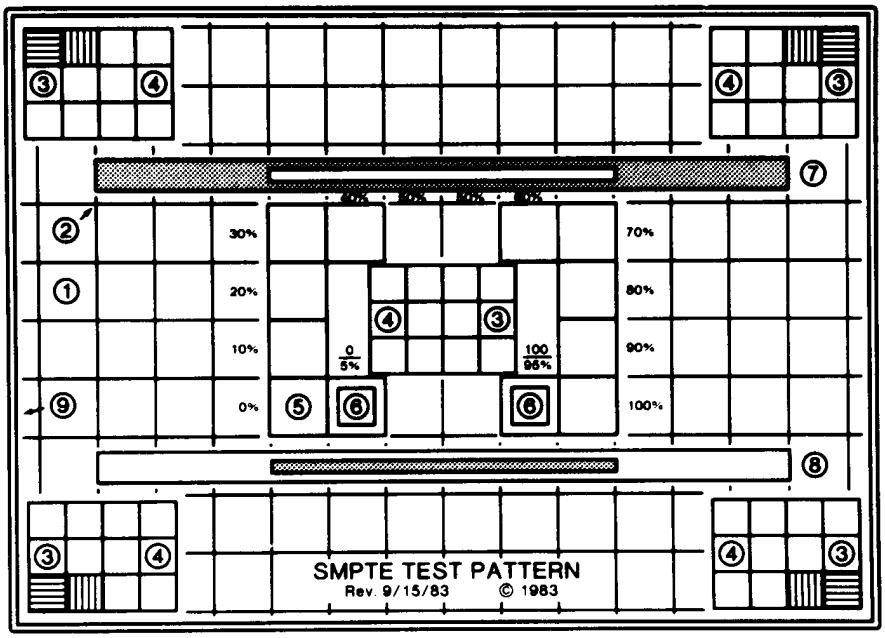

Figure 4 – Schematic drawing of test pattern in rectangular format

Table 1 – Test image pixel sizing for digital imaging systems

				Array size			
		Percent video signal	Percent of picture height	256x 256	320x 320	512x 512	1024x 1024
2.	Crosshatch – vertical spacing	75%	10%	25	32	50	102
	horizontal spacing		10%	25	32	50	102
	line width			2	2	2	2
3.	High-contrast resolution –						
	Each block		6.25%	16	20	32	64
	Low frequency – 3 pixels on, 3 pixels off						
	Mid frequency – 2 pixels on, 2 pixels off						
	High frequency – 1 pixel on, 1 pixel off						
	Contrast all the same – 0-100%						
4.	Low-contrast resolution –						
	Each block		6.25%	16	20	32	64
	Frequency – 2 pixels on, 2 pixels off						
	Contrast – low – 50-51%						
	medium – 48-51%						
	high – 48-53%						
5.	Gray scale pattern		10%	25	32	50	102
6.	Small contrast changes	5% and 95%	5%	12	16	25	51
7. & 8.	White and black window	5% and 95%					
	Surround bar – height		8%	20	26	40	82
	– width		80%	205	256	410	820
	Inset bar – height		4%	20	13	20	41
	– width		40%	102	128	205	410
9.	Border – width	75%	0.5%	2	2	3	5
	– inset		1%	2	3	5	10

NOTE – If other than a square format is used, the four resolution patterns should be placed in the corner of the display.

the left edge and continuing up to the last square on the right.

3.10.1 The inset window shall be 4% of the picture height and 1/2 the length of the background.

3.10.2 In the upper window pattern, the background shall be equal to 95% of the maximum signal, and the window shall be 5% of the maximum signal. In the lower window, the opposite intensities shall be used.

3.11 The border shall be a line inset by 1% of the picture height and shall be 0.5% of the picture height or 2 TV lines or pixels, whichever is larger. The border shall be 75% of the peak white signal.

3.12 All lettering shall be displayed at the 100% signal level. The numbers around the gray-scale are to be kept as small as legibility will allow. It has been found that the percent signs are especially valuable in focusing.

3.13 For systems with video-invert capability, the pattern should invert symmetrically. If the inversion operates about the midpoint of the video signal, the 50% signal background of the pattern should have the same brightness level or film density.

NOTE – The test pattern was initially designed for certification of monochrome systems; however, it can be utilized equally well for color displays and monitors in the RGB or encoded mode of operation.