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TV BANDWIDTH LIMITATION FOR COMPUTER PAGE DISPLAY

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There have been several attempts to transmit 80 character/line computer data over the CATV system. This high resolution data cannot be resolved on a TV system due to bandwidth limitation of the TV format.

Figure 1 illustrates a typical 5x7 character used in computer displays. Each character requires 6 horizontal character increments (5 increments for the character + 1 space between characters) on a horizontal line. Thus, an 80 character/line display has 480 character increments/line.

The horizontal line period of a U.S. standard commercial TV receiver is 63.5 μsec, 10.5 μsec of which is used for blanking/retrace time.[1] Thus, there is 53 μsec of visible horizontal line. Each character increment is 53 μsec/480 increments or 110.4 nsec. Therefore, in order to resolve the letter H from the letter L as shown in Figure 1, we must be able to resolve the 110 nsec space between the characters.

A black and white (B&W) CRT display of a TV receiver can resolve 10 gray level (3 dB optical steps) starting at black level and up to and including white. The video input voltage to the CRT is adjusted to black level at zero volts input and white (saturated) for maximum input video voltage. When properly set up, the 10 discrete levels can be discerned. Any excessive overdrive of the CRT will result in blooming of the spot and reduce resolution. Also, biasing the CRT to the black level will also reduce resolution since a proper white response on the screen will not register. Bear in mind that the 10 levels are difficult to resolve under high ambient light conditions. High ambient light conditions generally result in the viewer adjusting the contrast (video gain) of the receiver until there are significantly less than the 10 gray levels visible.

Figure 2 illustrates the effect of pulse (video) amplifier rise time on the resolution of characters. Bear in mind that the gray scale per increment shown in the figure is much smaller on a CRT so that small changes will not be evident to a casual observer. If the pulse rise time (t_r) is equal to the character increment/line, as shown in Figure 2A, resolution will be difficult due to the even gradation white-to-black-to-white since there will be little white to contrast with little black. The characters will look like grayish things with little discernible shape. A more practical approach is to make the pulse rise time two-thirds of the character increment/line, as shown in Figure 2B. This will result in definite white and black spaces that could be resolved.

Thus, the video amplifier must have two-thirds of 110 μsec or 73.3 μsec rise time for a step input pulse. Using the relationship of $t_r \times BW = 0.35$ for a pulse amplifier,[2] a video bandwidth of 4.8 MHz is required for an 80 character/line display.

Figure 3 illustrates the bandwidth of a TV receiver IF amplifier. The IF amplifier is the bandwidth limiting section of a TV receiver. The 50% video bandwidth is 3.58 MHz (45.75 MHz - 42.17 MHz). This bandwidth is much less than the 4.8 MHz required for 80 character/line display.

This 3.58 MHz bandwidth is available on color receivers and high quality B&W receivers. Standard practice at the AGS is to use small, inexpensive B&W receivers to view the CATV sytem. These receivers generally have a significantly narrower bandwidth, typically 2.5 to 3 MHz. Thus, the computer display to be sent out on the CATV system <u>should never exceed 40 characters/line</u> if you expect it to be read at the remote locations using a "standard" AGS B&W receiver.

The readability of these computer page displays is greatly affected by "ghosts" due to transmission line reflection caused by improper connection of the receiver (paralleling receivers without using matching networks). The ghosts will result in a letter repeated slightly later in time (either as a positive or negative image).

Whenever computer-generated information is transformed into a TV format, signal problems will arise. The computer industry has no standards governing the type of horizontal synch pulse generated. Modern TV systems are very sensitive to the shape and amplitude of the horizontal synch pulse, as shown in Figure 4. The front and back porch of the synch pulse is used for many purposes in modern video equipment. Video gain is set by measuring the amplitude of the synch pulse referenced to the back porch. Black reference level is fixed to finite value referenced to the back porch. In color receivers, the color burst signal (phase reference for the color) is sent on the back porch. The lack of a proper synch pulse with a front and back porch will result in non-optimum performance of video equipment. Generally, the newer and more complicated video processing and display equipment must detect a front and back porch for proper operation. Unless the computer manufacturer has incorporated a proper TV-compatible synch pulse as part of its "TV Composite Video", less than optimum results will be obtained.

References

1. Basic Television, B. Grob, McGraw-Hill.
2. Electronic and Radio Engineering, F. Terman, McGraw-Hill.

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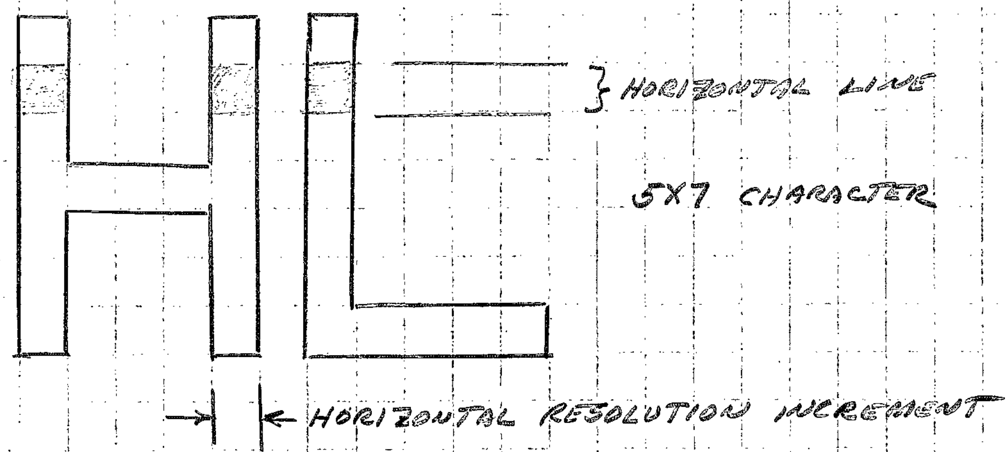
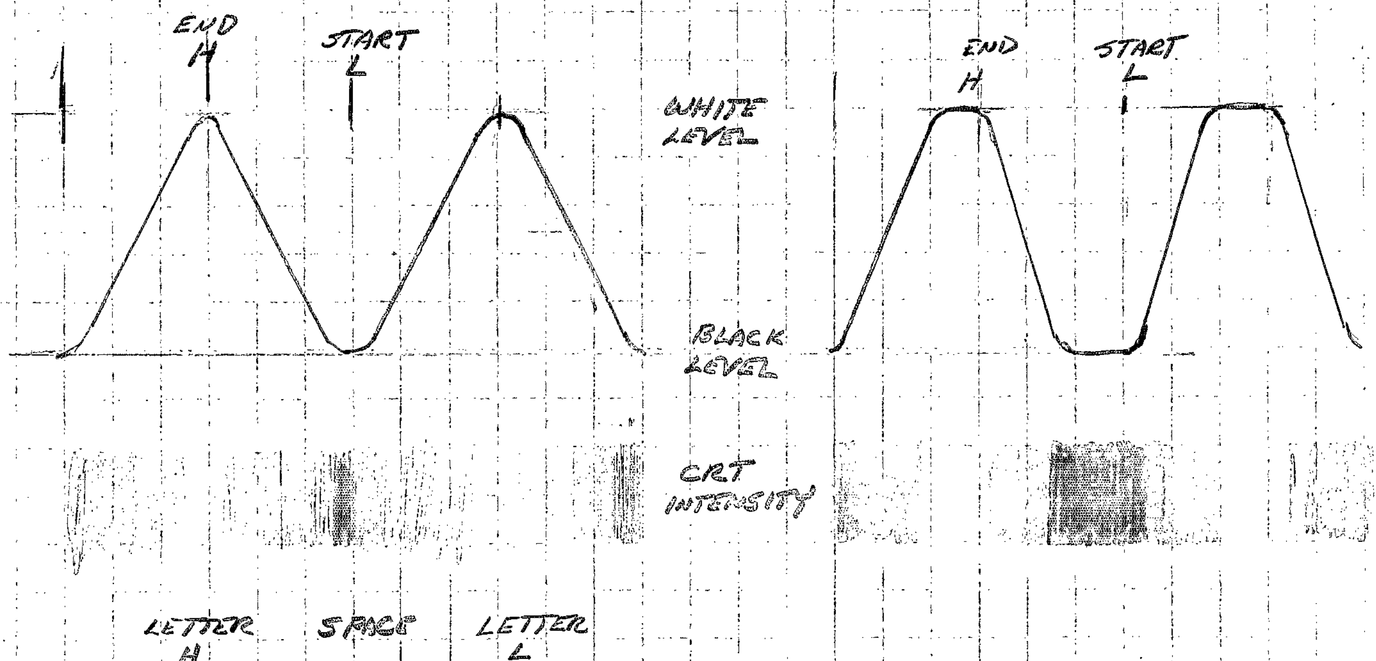


FIGURE 1 CHARACTER FORMAT



A

CRT DISPLAY (GRAY LEVEL) FOR t_R = INCREMENT TIME -- NO CLEAR SEPERATION OF LETTER & SPACE

B

CRT DISPLAY (GRAY LEVEL) FOR $t_R = \frac{2}{3}$ INCREMENT TIME -- DESCERNABLE SEPERATION OF LETTER & SPACE

FIGURE 2
EFFECT OF RISE TIME (t_R) OF AMPLIFIER ON LETTER RESOLUTION

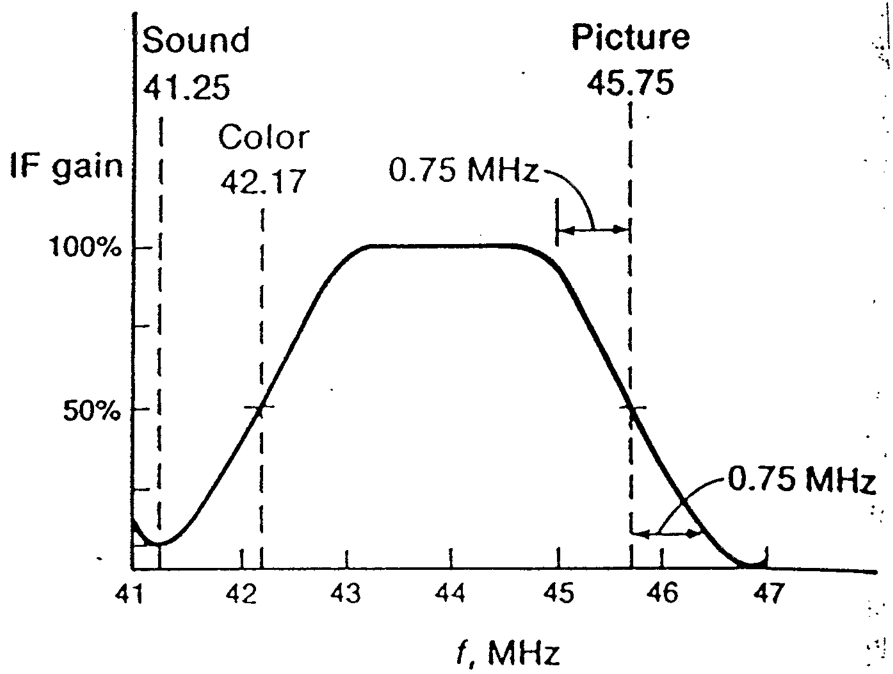
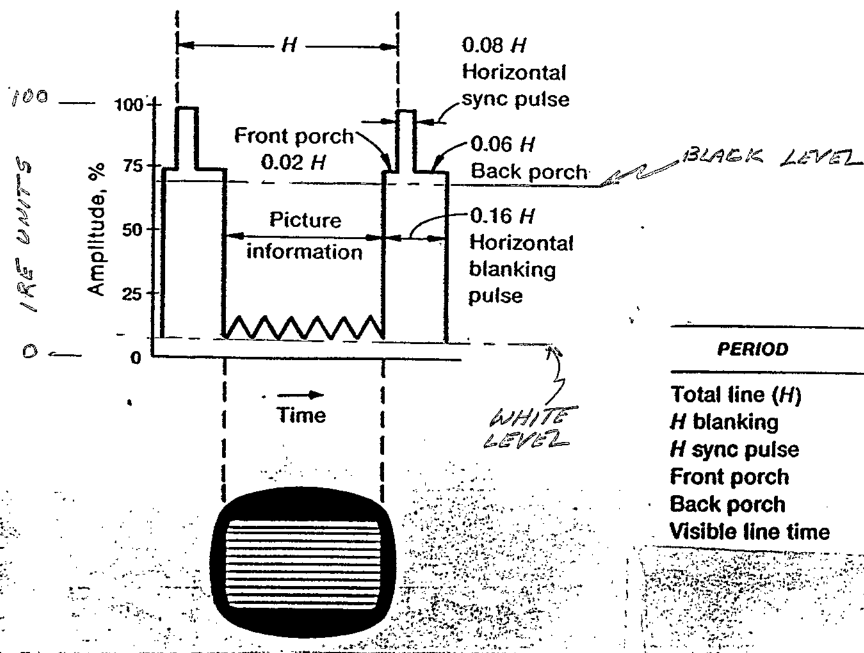


FIGURE 3 IDEAL PICTURE IF RESPONSE CURVE.



PERIOD	*TIME, μs*
Total line (*H*)	63.5
H blanking	9.5–11.5
H sync pulse	4.75 ± 0.5
Front porch	1.27 (minimum)
Back porch	3.81 (minimum)
Visible line time	52–54

FIGURE 4 HORIZONTAL SYNCH & BLANKING PULSE