The White Color of Television Receivers

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Abstract

Historically, the color receiver industry required the tube manufacturer to supply them with current ratios suitable for attaining the white color point 9,300K + 27MPCDs then it was shifted to 6550K. Now the current ratios for both 8200K and 9300K + 27MPCD are supplied to the receiver manufacturer. A number of reasons for these changes are reviewed. This paper presents our new data on the pre-set white color of modern color receivers. We re-visit the area of receiver white color temperatures and compare our receiver data measurements with that of Lisk (1970) and Fiat (1969). The data shows that the trend is to move toward a bluer white than the older 6550K white. More importantly, it was found that the pre-set white color for the group of receivers evaluated varied from about 5,700K to 13,700K with an average white color temperature of 8,000K.

Introduction

In this paper we will detail the pre-set white measurements made on a number of color tube manufacturer's receivers (briefly discussed in ref 1). Measurements show a trend away from the 6500K white recommended by Brill & Derefeldt (ref 2) in their recent article on reference white standards.

Historically, the color CRT industry used the 9,300K (CIE 1931 2° standard observer) white color point, in part, because it was near the monochrome 11,000K white that the customer was accustomed to, before the advent of color sets. Brill & Derefeldt also point out that the phosphor efficencies played a role. The high efficiency of the blue phosphor and the inefficiency of the old Sulfide red phosphor as described by Dr. B. E. Bartels, et. al., (ref 3) played a role in the choice of the white point. After the birth of the more efficient yttrium orthovanadate europium activated red and its sister red phosphors Y_20_3:Eu and Y_20_2S:Eu the industry turned to the 6550K white.

The industry now appears to be moving to a white color region near 8200K and thus towards the old 9,300K + 27MCPD. We have measured the factory pre-set white color of eighteen sets from five manufacturers and have observed that a wide range of white pre-set color points exist. We will show that this is similar to the range of white points measured in viewers homes measured by Lisk (ref 5). It is however noteworthy to mention that we measured one set which had a switch marked normal & cool which, switches the white point from 5,700K to 7,100K for viewer preference.

Discussion

Pre-Set White

A large range in pre-set and/or customer adjusted white color has previously been observed by Lisk (who measured 30 home receivers). The adjusted white for TV station monitors was discussed in Fiat's paper (ref 4). These papers show that the receivers or monitors:

1. were set bluer than the 6550K normally thought suit able for best color viewing.
2. had a large range in the white chromaticity.

Receiver Set Up And Background Information

Experimentally, a Philips Color Generator PM5631 was connected to the video input of the receivers under test (see fig 1). The color generator's 100% white (pattern 92) was selected.

Since there are differences in the phosphors used by color tube manufacturers the receiver designer optimizes the demodulation angles in a particular receiver to provide the maximum outputs of the correct color to match the phosphors used in that CRT. Some receivers use integrated circuits to automatically set the CRT white color point based on the ratios of the three cathode currents. There are various names for this feature. AKB (Auto-matic Kine Bias ref 6) is perhaps the most widely used designation.

The AKB circuit (set at the factory) samples the three cathode currents during each vertical retrace interval by means of an injected white bar and automatically changes the drive signal to maintain a constant ratio of CRT currents.

Colorimetry

In our measurements we used a Minota TV-Color Analyzer II model TV2150 colorimeter and a Gamma Scientific spectroradiometer. The Gamma Scientific spectroradiometer consists of a GS-4100 Intelligent Radiometer, NM-3H Monochrometer, 2020-31 Telescope and a D-46 PMT.

Many set manufacturers use low cost colorimeters. The advantage, besides price, is rapid data acquisition. The disadvantage with the low cost colorimeters is that the color filters mated to the three or four photocells "simulate" the tristimulus curves. Small errors in matching the response of the photo-receptors to the color matching functions can give rise to errors in the measured color coordinates.

Table I

Size	Color Coord. x	Color Coord. y	Color Temp (K)*
27	0.313	0.344	6,500
27	0.290	0.305	8,500
27	0.279	0.294	10,000
27	0.268	0.272	13,700
27	0.288	0.303	8,700
27	0.277	0.290	10,500
27	0.290	0.303	8,500
27	0.331	0.302	5,700
20	0.290	0.299	8,600
27	0.312	0.326	6,600
19	0.304	0.348	7,000
32	0.288	0.319	8,400
27	0.330	0.343	5,700**
27	0.304	0.326	7,100**
27	0.309	0.310	6,800
27	0.290	0.309	8,400
31	0.294	0.301	8,200
27	0.311	0.313	6,700
27	0.304	0.315	7,200

* *Note: color temperature given to nearest 100K and no MPCD's are given*

** *Note: Data from same receiver, one at "normal" and the other at "cool"*

However, these colorimeters can be calibrated to a standard illuminant incandescent source and recently to CRTs. We have correlated our colorimeter readings to the Gamma spectroradiometer. The spectroradiometer readings are accurate to +/- 0.002 in "x" and in "y" .

Results

Table 1 shows our measurement results of the factory pre-set white color points. This data shows a wide range of white color temperatures from 5,700K to 13,700K. The average white color is near 8,000K. This average value is not unexpected since the tube manufacturer has been supplied the 8,200K current ratios. What is surprising is the large range.

Comparison With Lisk and Fiat

Lisk in 1970 showed that the white color points of home receivers varied from 9,000K to 15,000K and some data were seen at 30,000K. His data showed that the white color temperature had a range of about 6,000K (excluding the 30,000K data). Fiat's data indicated that the color monitors were not even on the black body line but cyan in color. Our average white color temperature is lower than Lisk's results but the large range of data is still present. In Table II we summarize this data.

Table II

Source	Color Temperature (K)	Comments
Donofrio et al (Philips) 1993	5,900 to 13,700 avg. = 8,000 sigma = 1,847	Sets from mfg or supplier
Lisk (Kodak) 1970	9,000 to 15,000 some data to 30,000	Sets in homes
Fiat (ABC) 1969	off blackbody line avg. x=0.208, y=0.139 - CYAN	Color monitors at TV station

Current Ratio Calculations

The modification of the white color point is driven by both perceptual color considerations and by the quest to attain unity current ratios. If one gun of the CRT is driven more strongly than the others, the spot profile for this color is larger than the other two. This situation can lead to color and resolution problems.

In order to show this effect, an example is given below in which the current ratios are calculated for three different white color points. We consider the case where the color coordinates for each field and luminance (at 500 μA) is seen in Table III.

Table III

Field	x	y	Luminance (ftL)
red	0.620	0.340	8.4
green	0.290	0.610	25.8
blue	0.150	0.070	4.9

Using the methods developed in ref 7, the current ratios are given in Table IV.

Table IV

White	Ir/Ig	Ir/Ib	Ib/Ig
6550 K	1.1	1.7	0.7
8200 K	1.1	1.3	0.9
9300 K	0.8	1.0	0.8

It is clear that if one has a system as described above, the white color temperature higher than 8200K would give near unity current ratios.

Conclusions

Our new data regarding the white color of color CRT receivers show that they are pre-set for about 8,000K, on average. However, the large range of this data is similiar to that measured by Lisk. The reasons for this large range are not known and should be addressed by the receiver manufacturers, specifically their color measurement devices, procedures and white color point goals. We have shown that a number of factors could be responsible for this range of white color points. Factors such as viewer preference for reddish or bluish whites, unity current ratios and actual control procedures are all possible.

References

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