Finding the exact NTSC Ry and By Channel Gains:

Robert L. Bleidt 12-31-91

SMPTE RP-170 defines these gains as those producing 100 IRE peak signal on the yellow and cyan SMPTE Color Bars. Thus, we start by finding the Y, Ry, and By values of yellow and cyan bars.

$$\mathbf{A} := \begin{pmatrix} 0.587 & .114 & .299 \\ -.587 & .886 & -.299 \\ -.587 & -.114 & .701 \end{pmatrix}$$ These are the basic NTSC equations from RP-170

$$\text{Cyan} := \begin{bmatrix} 0.75\cdot(1 - 0.075) \\ 0.75\cdot(1 - 0.075) \\ 0 \end{bmatrix} \quad \text{Yellow} := \begin{bmatrix} 0.75\cdot(1 - 0.075) \\ 0 \\ 0.75\cdot(1 - 0.075) \end{bmatrix} \begin{matrix} \text{G} \\ \text{B} \\ \text{R} \end{matrix}$$

$$\mathbf{A}\cdot\text{Cyan} = \begin{pmatrix} 0.486 \\ 0.207 \\ -0.486 \end{pmatrix} \qquad \mathbf{A}\cdot\text{Yellow} = \begin{pmatrix} 0.615 \\ -0.615 \\ 0.079 \end{pmatrix}$$

$$\text{CyanComp} := \mathbf{A}\cdot\text{Cyan} \qquad \text{YellowComp} := \mathbf{A}\cdot\text{Yellow}$$

When the Ry and By components are scaled appropriately, the vector magnitude of subcarrier will combine with the Y component to produce a 92.5 IRE signal. Thus, we may set up the following equations for kb and kr, which are the By and Ry channel gains:

$\text{kb} := .1 \quad \text{kr} := .1$ make an initial guess:

Given

Squared Vector Magnitude of Subcarrier = Squared Luminance Residue

$$\left(\text{kb}\cdot\text{CyanComp}_2\right)^2 + \left(\text{kr}\cdot\text{CyanComp}_3\right)^2 = \left(.925 - \text{CyanComp}_1\right)^2$$

$$\left(\text{kb}\cdot\text{YellowComp}_2\right)^2 + \left(\text{kr}\cdot\text{YellowComp}_3\right)^2 = \left(.925 - \text{YellowComp}_1\right)^2$$

$$\text{Find}(\text{kb}, \text{kr}) = \begin{pmatrix} 0.492111041122483 \\ 0.877283219938179 \end{pmatrix}$$ Use mathcad's solver to get solution