COLOUR TELEVISION

ECE 523E – ANTENNA & RADIOWAVE PROPAGATION

Tuesday, 6 October 2026

A GREAT ELECTRICAL ENGINEERING TRIUMP

1. One of the great electrical engineering triumphs was the development of colour television in such a way that it remained compatible with black and white television.

2. A major driving force behind the majority of current colour TV standards was to allow black-and-white TVs to continue to be able to receive a good TV signal after colour service was in place.

BROAD COMPATIBILITY REQUIREMENTS

1. **Colour television signal must produce a normal black and white picture on a monochrome receiver without any modification** of the receiver circuitry.

2. Colour TV receiver must be able to produce a black and white picture from a normal monochrome signal. This is referred to as reverse compatibility.


PANTRONIC III
WHAT IS TELEVISION COMPATIBILITY ?
The ability of monochrome TV receiver to produce a black and white picture from the color television on signal without any modification of of the receiver circuit.

REQUIREMENTS ON THE COLOUR SIGNAL /01

To make the system fully compatible the composite colour signal had to meet the following requirements:

1. Occupy the same bandwidth as the corresponding monochrome signal.
2. Have the same location and spacing of picture and sound carrier frequencies.
3. Have the same luminance (brightness) information as would a monochrome signal transmitting the same scene.

REQUIREMENTS ON THE COLOUR SIGNAL /02

Further, to make the system fully compatible the composite colour signal had to meet the following requirements:

4. Contain colour information together with the ancillary signal needed to allow this to be decoded.
5. Carry colour information in such a way that it does not affect the picture reproduced on the screen of a monochrome receiver.
6. employ the same deflection frequencies and synchronization signals as used for monochrome transmission and reception.

REQUIREMENTS ON THE COLOUR SIGNAL /03

Further, to make the system fully compatible the composite colour signal had to meet the following requirements:

7. Encode the colour information of the scene in such a way that it can be transmitted within the same channel bandwidth of 6 MHz and without disturbing the brightness signal.
8. Similarly at the receiving end a decoder must be used to recover the colour signal back in its original form for feeding it to the tricolour picture tube.

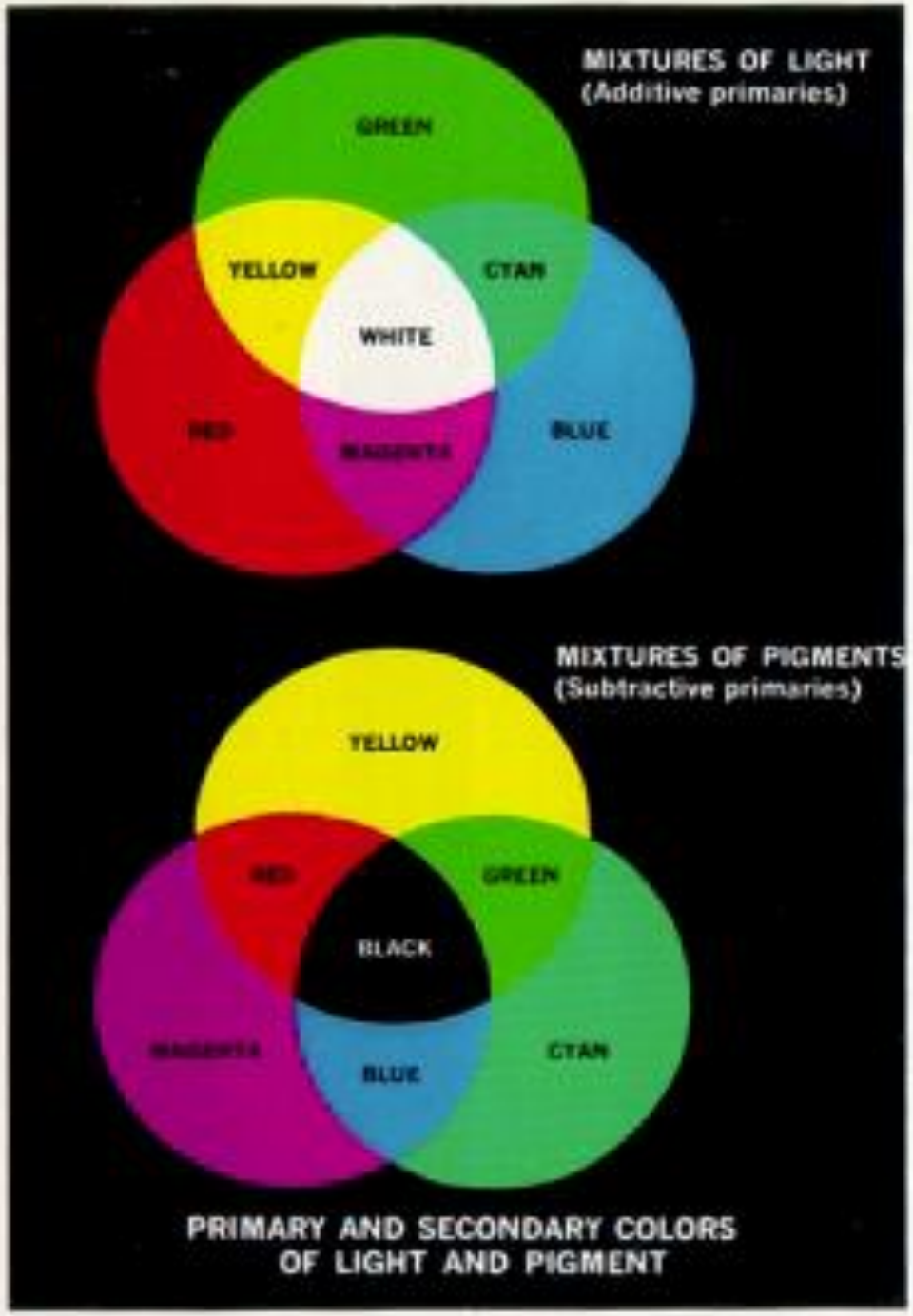
EXAMPLES OF BACKWARD COMPATIBILITY REQUIREMENTS IN COMMUNICATION SYSTEMS

1. The NTSC colour broadcast system was engineered by RCA Corporation to be backward compatible with black-and-white NTSC television sets.
2. Backward compatibility is essential in all mass consumption systems, e.g.
   a) DVB-T MPEG4 television tuners can also decode MPEG2 signal.
   b) Most DVD drives are able to play standard CDs.
   c) 5G mobile telephones are 2G, 3G and 4G compatible

TRIRECEPTOR THEORY OF VISION

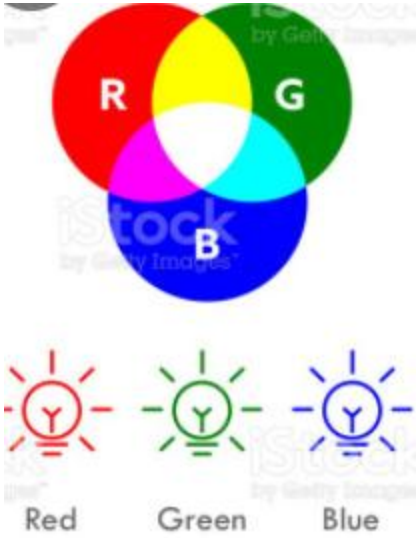
Why we use RGB monitors?

- If you ask someone why **red**, **green** **and** **blue** are used in computer monitors -- the immediate answer is "Because these are the primary colors".
- If you then ask, "But why are these primary colors?" -- the answer you get is that "If you mix light of these colors together you can make any colour".


MIXTURES OF LIGHT
(Additive primaries)
GREEN
YELLOW
CYAN
WHITE
RED
BLUE
MIXTURES OF PIGMENTS
(Subtractive primaries)
YELLOW
RED
GREEN
BLACK
BLUE
CYAN
PRIMARY AND SECONDARY COLORS
OF LIGHT AND PIGMENT

COLOR INFORMATION TRANSMISSION IN TV /01

1. In the most basic form, color television could simply be implemented by having cameras with three filters (red, green and blue) and then transmitting the three colour signals to a receiver with three electron guns and three drive circuits.



2. Unfortunately, this idealized view is **not compatible** with the previously allocated ***6 MHz bandwidth*** and with previously existing **monochrome receivers.**

COLOR INFORMATION TRANSMISSION IN TV /01

3. To preserve monochrome information, one signal, called **luminance (Y)** was chosen to occupy the major portion (0-4 MHz) of the channel.

4. **Luminance (Y)** is monochrome TV signal and contains the brightness information and detail.

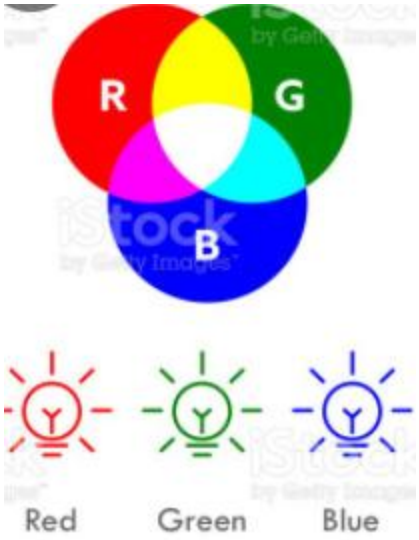
5. Next, we consider the model of a scene being filmed with three cameras. One camera has a red filter, one camera a green filter and one camera a blue filter.

COLOR INFORMATION TRANSMISSION IN TV /02

6. Assume that the cameras all adjusted so that when pointed at "white" they each give equal voltages.
7. To create the Y signal, the red, green and blue inputs to the Y signal must be balanced to compensate for the colour perception misbalance of the eye. The governing equation is:

$$\mathbf{Y = 0.3R + 0.59G + 0.11B}$$

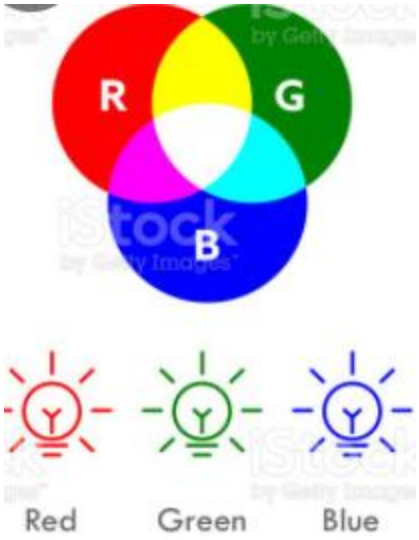
8. This is the "monochrome" part of the TV signal. It takes up the first 4 MHz of the 6 MHz bandwidth of the TV signal.



Additional Reading: What Is Color Balance in Photography and Image Processing? - Color Meanings (color-meanings.com)

COLOR INFORMATION TRANSMISSION IN TV /03

8. Two signals are then created to carry the **chrominance (C)** information.
9. One of these signals is called **"Q"** and the other is called **"I".**
10. They are related to the R, G and B signals by:



$$Q = 0.21R - 0.52G + 0.31B$$

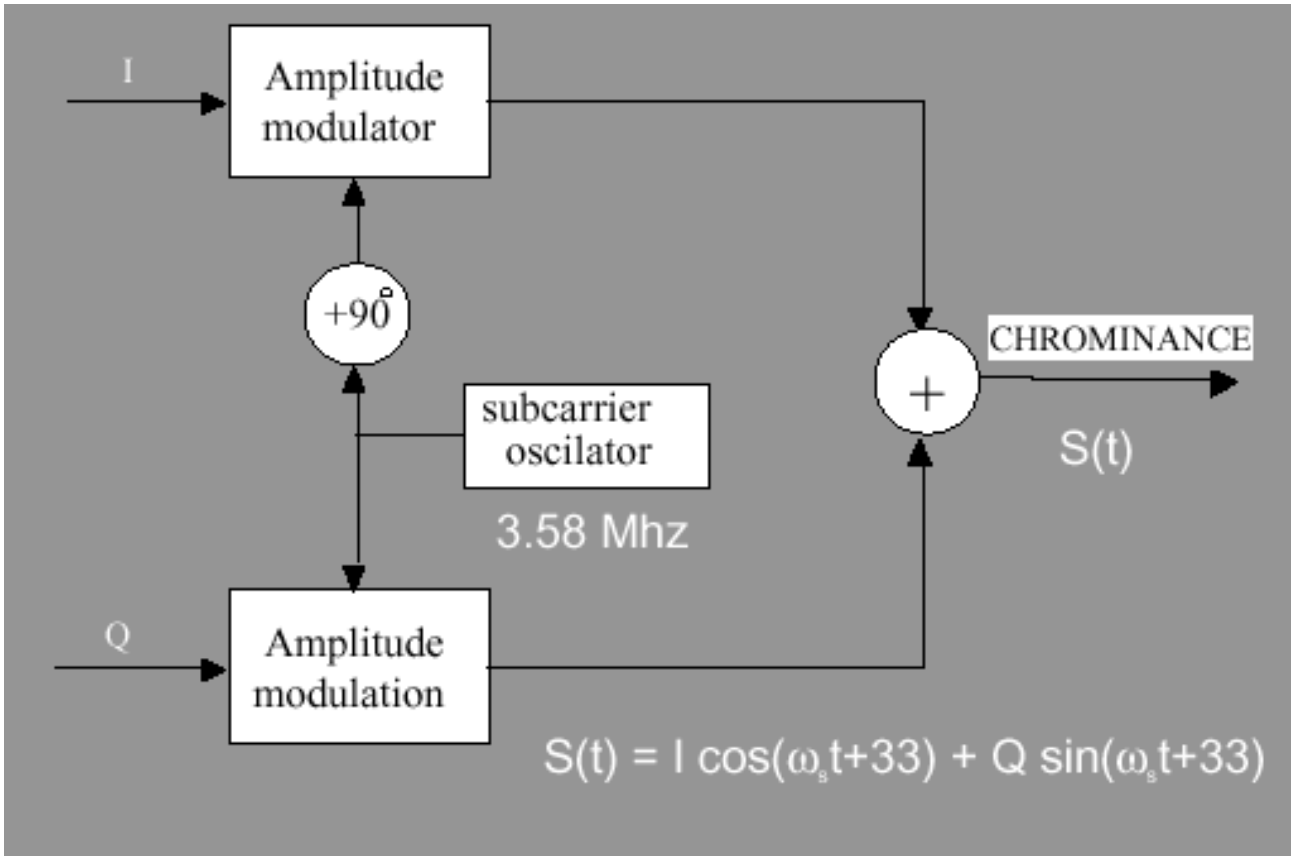
$$\mathrm{I} = 0.6\mathrm{R} - 0.28\mathrm{G} - 0.32\mathrm{B}$$

COLOR INFORMATION TRANSMISSION IN TV /04

11. The positive polarity of Q is purple, the negative is green.
12. The positive polarity of I is orange, the negative is cyan.
13. It turns out that the human eye is more sensitive to spatial variations in the "orange-cyan" than it is for the "green purple". Thus, the "orange-cyan" or I signal is allocated a maximum bandwidth of **1.5 MHz** and the "green purple“ or Q is allocated a maximum bandwidth of **0.5 MHz.**

COLOR INFORMATION TRANSMISSION IN TV /05

15. Now, the Q and I signals are both modulated by a 3.58 MHz carrier wave. However, they are modulated 90 degrees out of phase **(QAM)** These two signals are then summed together to make the C or chrominance signal.



COLOR INFORMATION TRANSMISSION IN TV /06

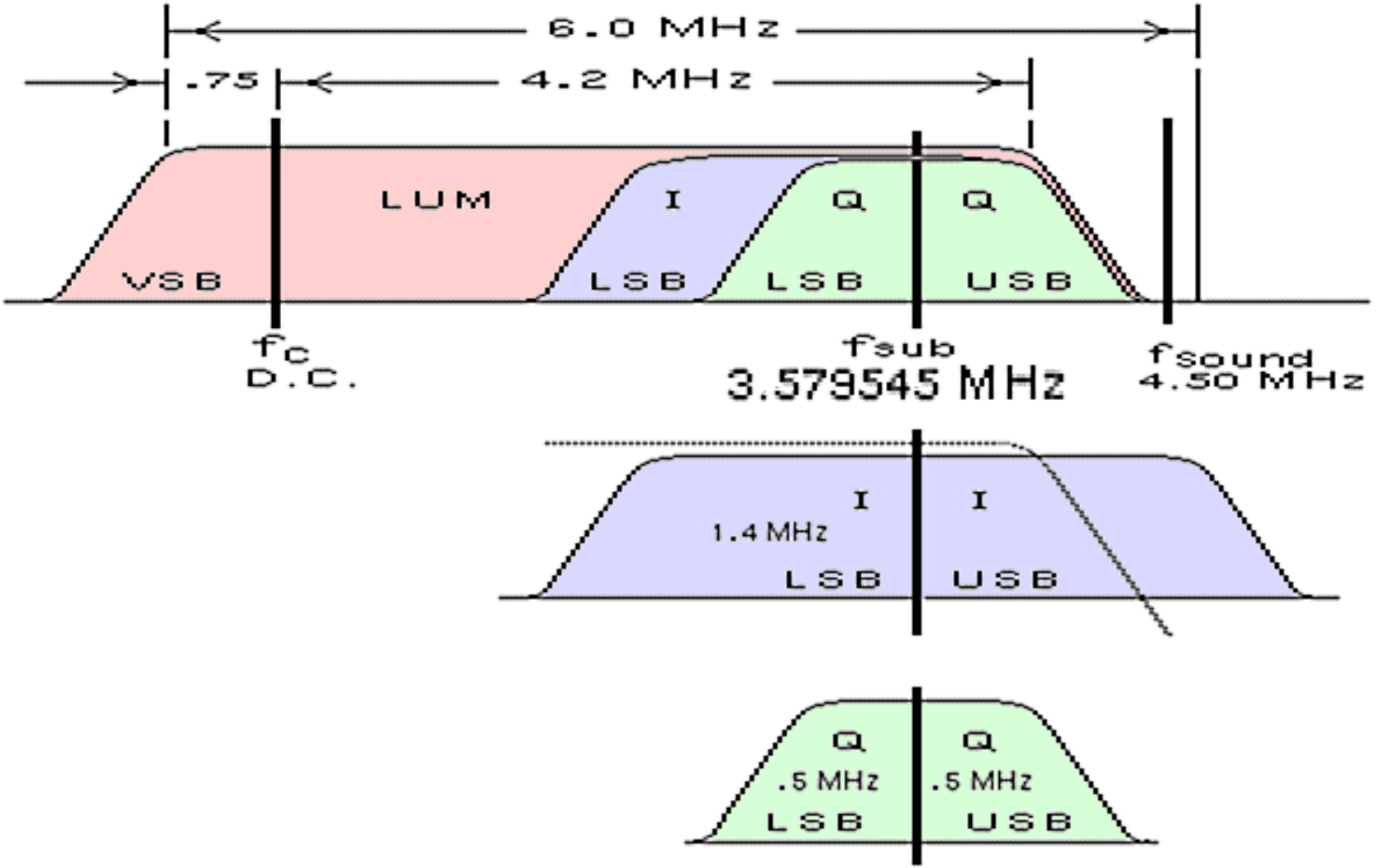
16. With real video signals, the chrominance component typically changes much slower than luminance,
17. The human eye is less sensitive to changes in chrominance than to changes in luminance
18. The eye is more sensitive to the orange-cyan range (I) than to green- purple range (Q)
19. The above factors lead to

    I: bandlimitted to 1.5 MHz

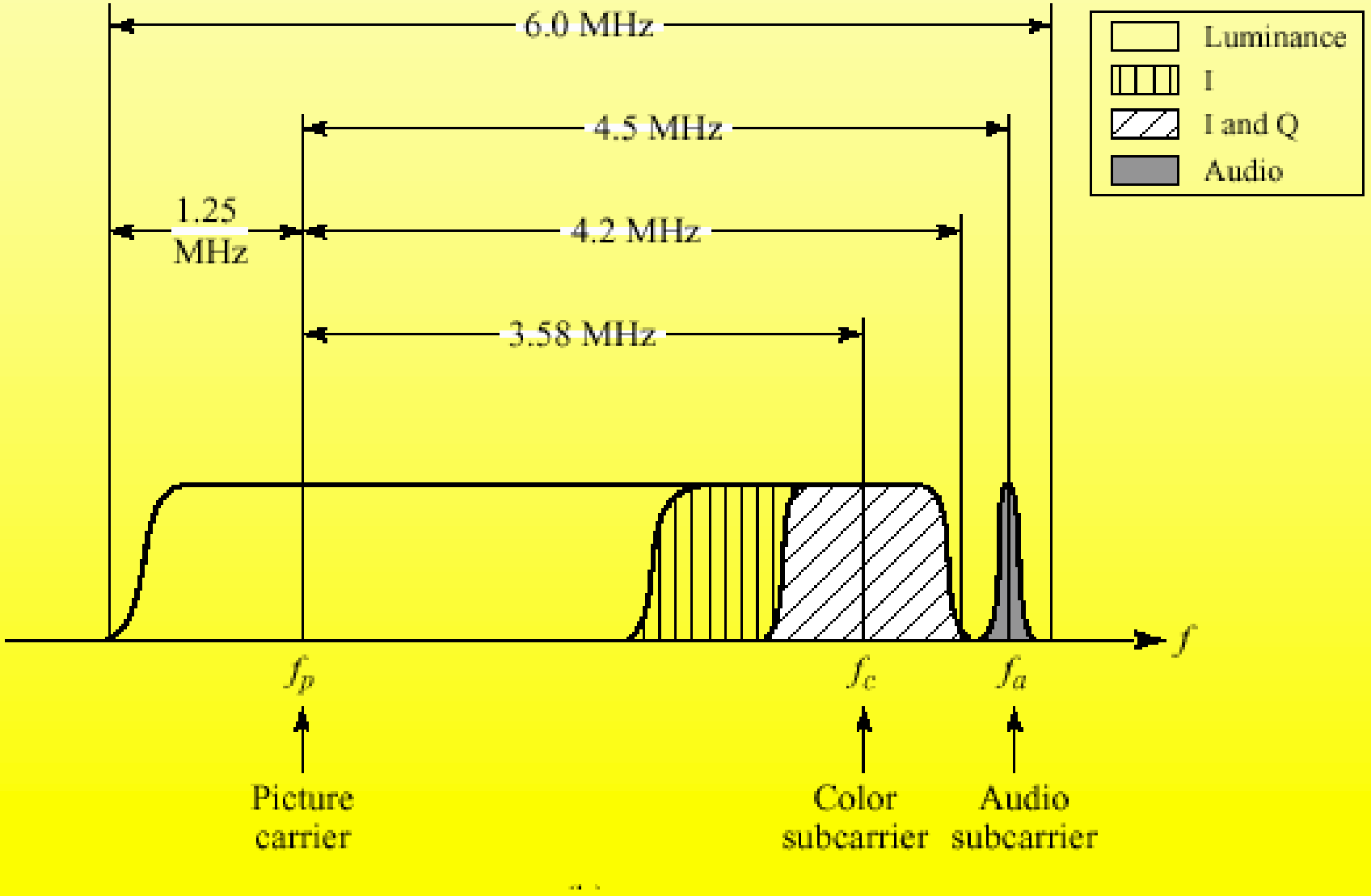
    Q: bandlimitted to 0.5 MHz

COLOR INFORMATION TRANSMISSION IN TV /07

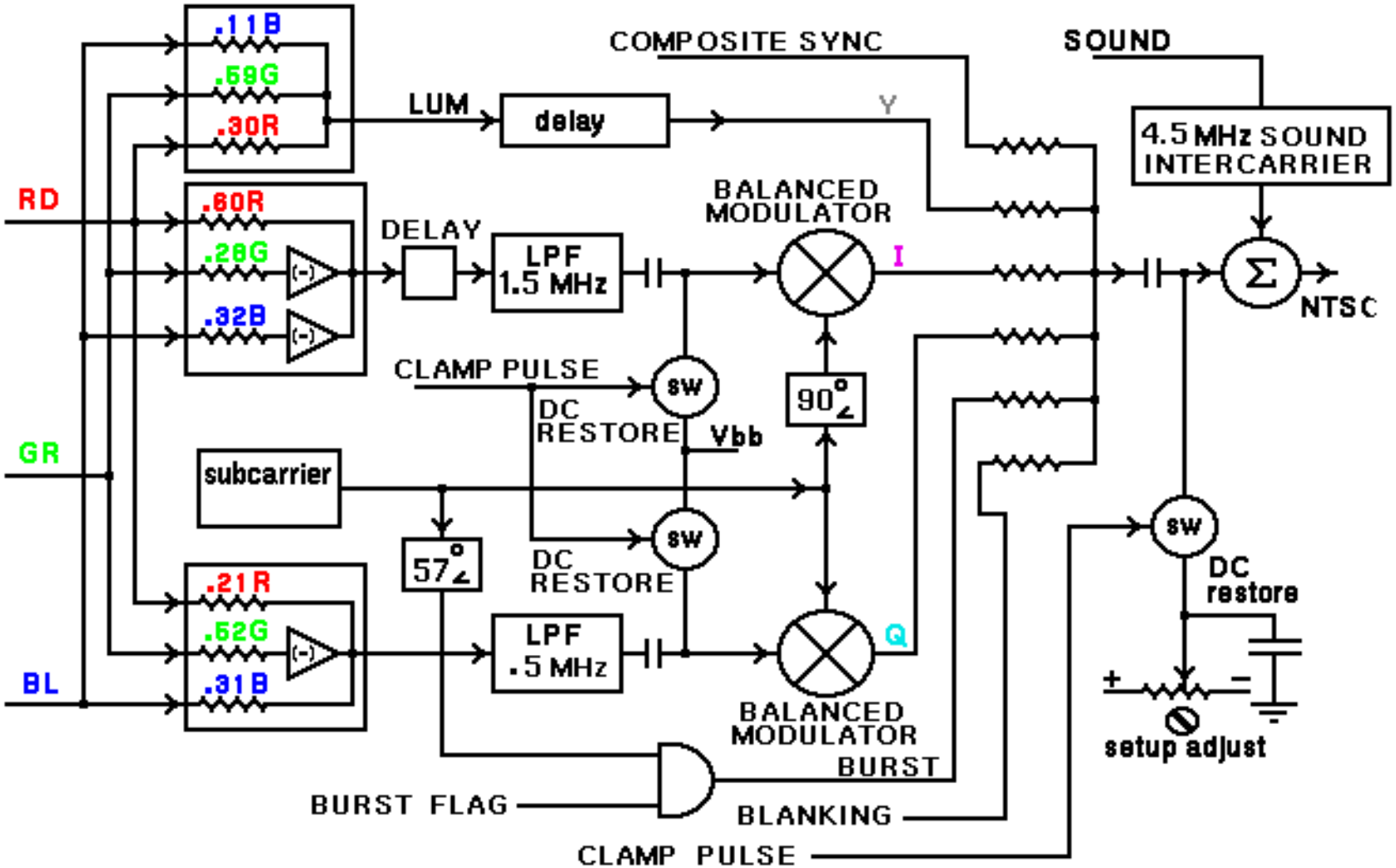
20. In NTSC Luminance is AM VSB, the Chroma is QAM I&Q, and the Aural FM.



COLOR INFORMATION TRANSMISSION IN TV /08



TRANSMITTER BLOCK DIAGRAM



NTSC COLOR TV RECEIVER

