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There are mainly three standards in use across the world . They are

1. National television systems committee standards (NTSC)
2. Phase altered line (PAL)
3. Sequential with memory(SECAM)

Television signals in U.S.A are broadcast using the NTSC-M standards. According to NTSC-M standards used in U.S.A
Number of horizontal scans per frame = 525
number of frames per second = 59.94(~ 60).

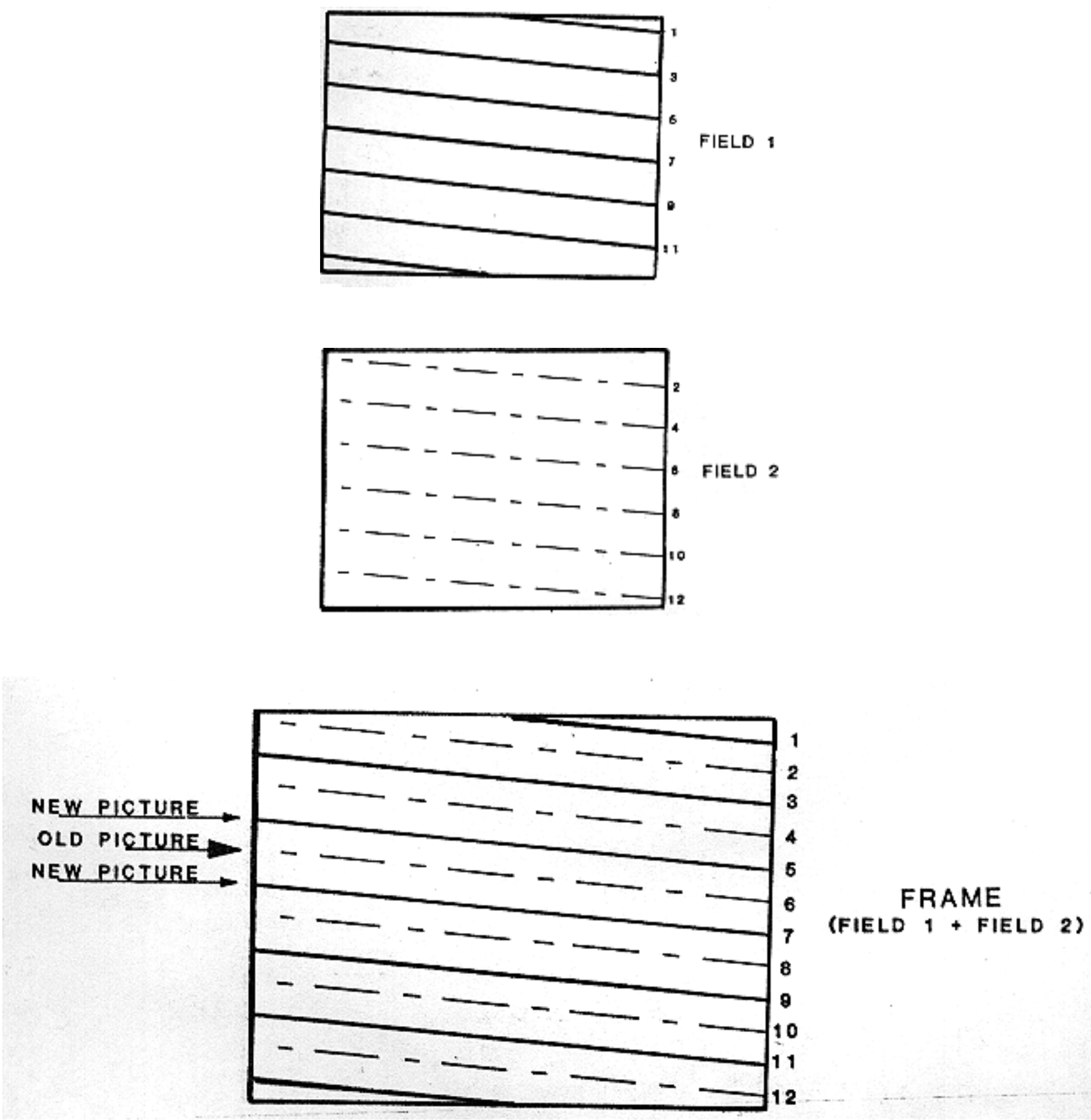


FIGURE 1. TWO FIELDS INTERLACE TO FORM ONE FRAME

Usually the image is scanned along the lines shown above until it completes scanning the image. This type of scanning is called **progressive scanning**. But to reduce the effect of flickering the frame shown above is divided into two fields and each field is used to show consecutive images . The odd fields represent the first image and even fields represent the image that follows. This type of scanning is called **interlaced scanning**. This type of scanning reduces the effect of flicker to a considerable extent.

So there are ,
525 Horizontal scan paths per frame.
262.5 Horizontal scan paths per field.
30 frames (complete pictures per second).
60 fields (half pictures) per second.

So the horizontal scan frequency = 525 x 30
= 15,750 .

Therefore Time for each scan = 63.5×10^{-6}

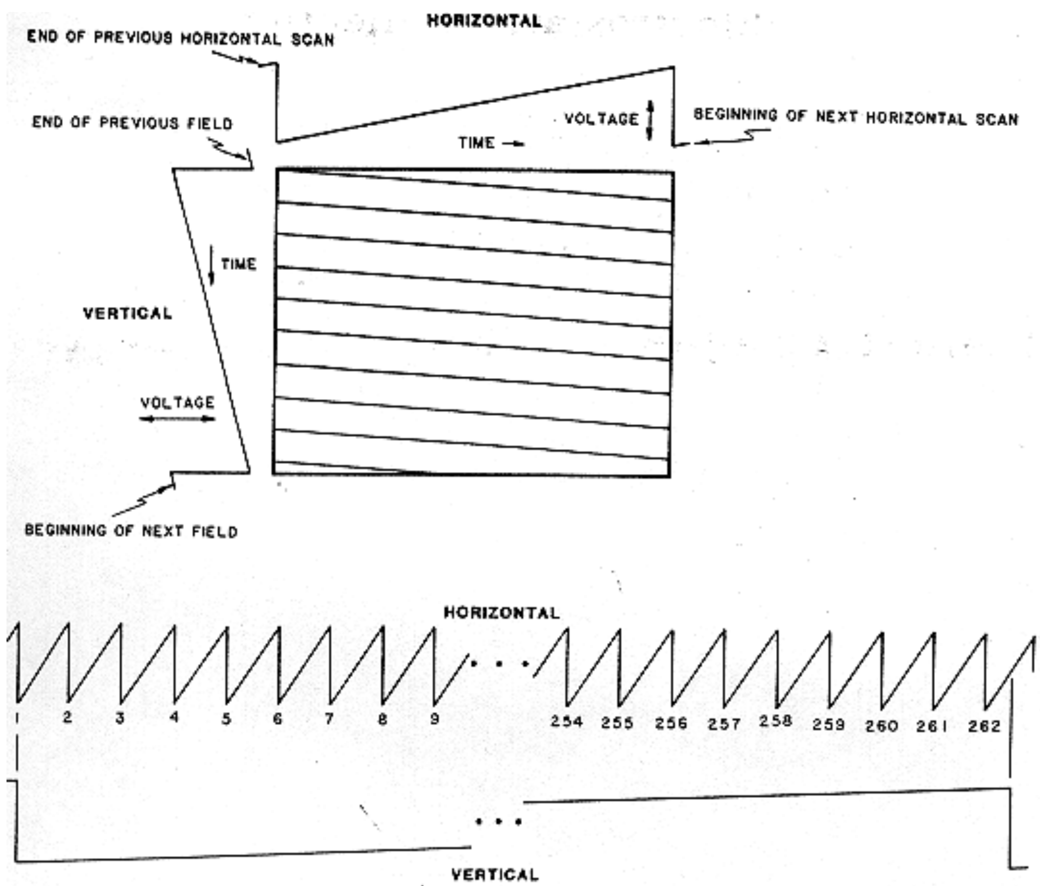


FIGURE 2. SCANNING PATTERN FOR A FIELD

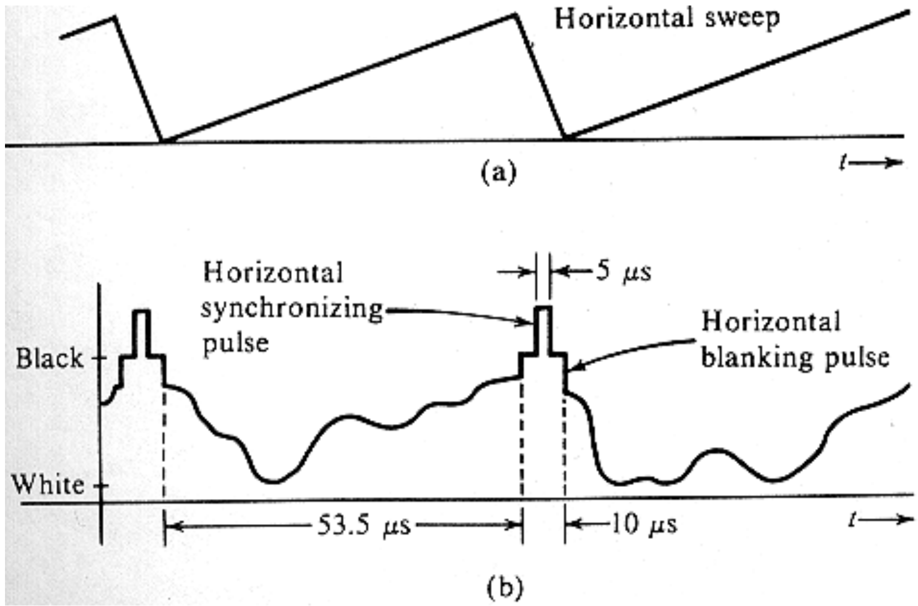
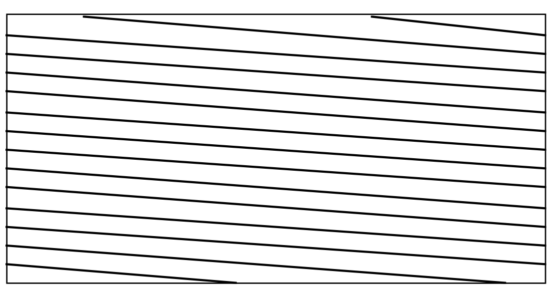


FIGURE 3. TV VIDEO SIGNAL.

PROBLEM :

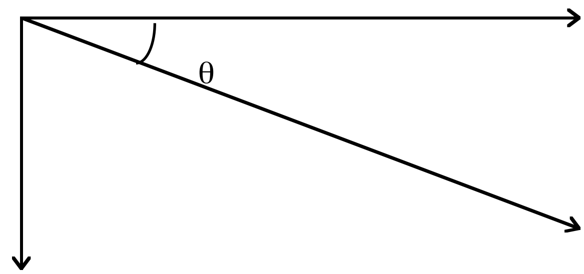


A 40 cm x 30 cm television is scanned on 525 scan lines , each of which contains 650 samples. We wish to consider one frame of the video as a two - dimensional signal,(i.e., ignore the time variable and assume that there is no interlacing).

Determine the sampling matrix, V , that defines this sampling lattice .

SOLUTION :

To determine V , We need two sampling vectors that define the lattice. This choice is not unique, But one convenient choice is to let V_1 point down the scan line and let V_2 point to the first point on the next scan line.



$$V_1 = \begin{bmatrix} 40/650 \text{ cm} \\ 30/525\text{x}525 \text{ cm} \end{bmatrix} \qquad V_2 = \begin{bmatrix} 0 \\ 30/525 \text{ cm} \end{bmatrix}$$

$$V = \begin{bmatrix} .0615 \text{ cm} & 0 \text{ cm} \\ .000088 \text{ cm} & .0571 \text{ cm} \end{bmatrix}$$

$$U = \begin{bmatrix} 2\pi \text{ x } 650/40 & -2\pi /40 \\ 0 & 2\pi \end{bmatrix} \text{ rad/cm}$$

MODULATION : In TV Transmission the use of FM is made for Audio transmission and AM for Video transmission.

Vestigial Sideband modulation (VSB) is used for the following reasons :

1. Video signal exhibits a large bandwidth and significant low-frequency content which suggests the use of VSB

2. The circuitry for demodulation in the receiver should be simple and therefore cheap. VSB demodulation uses a simple envelope detection.

But the practical TV signals are not exactly VSB modulated due to the following reasons :

I) The power at the transmitter is very high and it would be expensive to rigidly control the filtering of sidebands. Instead, a VSB filter is inserted in the receiver where the powers are low.

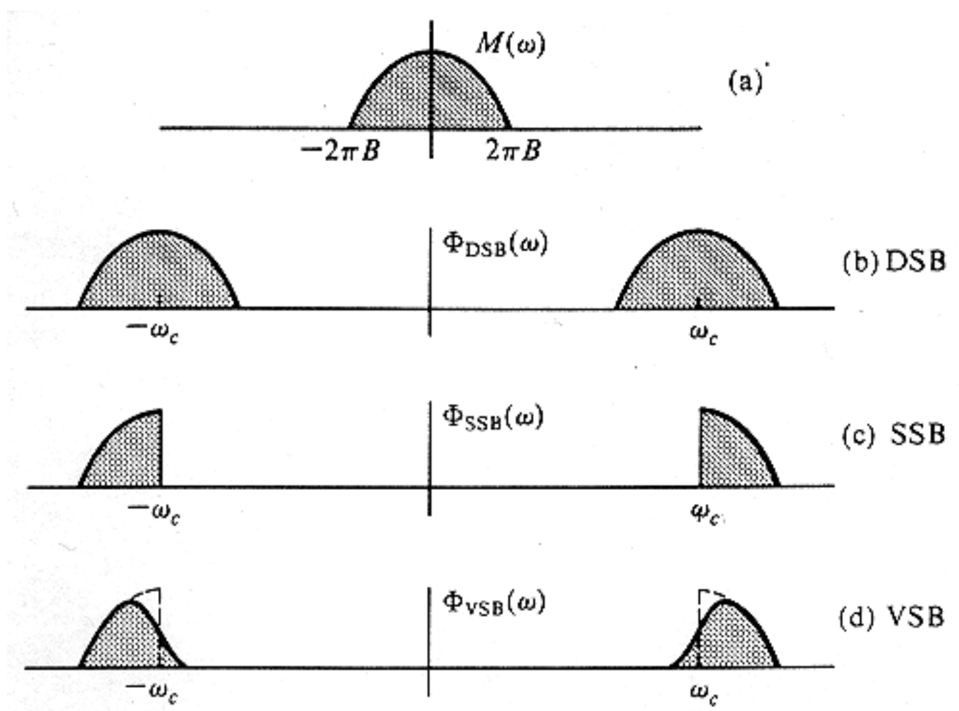


FIGURE 4. SPECTRA OF MODULATING SIGNAL AND CORRESPONDING DSB , SSB, VSB SIGNALS .

For SSB signals the output is given by

$$\phi_{ssb}(w) = m(t) \cos w_c t + m_n(t) \sin w_c t$$

$$\phi_{vsb}(w) = [\, M(w + w_c) + M(w-w_c)]H(w) \qquad \text{------} \quad (1)$$

H(w) is the Vestigial Shaping filter

We require that m(t) is recoverable from $\phi_{vsb}(t)$

So, $e_d(t) = 2*\phi_{vsb}(t) \cos w_c t$ <---> $[\phi_{vsb}(w+w_c) + \phi_{vsb}(w-w_c)]$ -------- (2)

For distortionless reception we have

$e_o(t)$ <---> C *M(w) where C is a constant.

Choosing C = 1 we have

$H(w + w_c) + H(w - w_c) = 1 \quad |w| <= 2*\pi*B$

For any real filter H(-w) = H*(w)

So $H(w_c+w) + H^*(w_c-w) = 1 \quad |w| <= 2*\pi*B$

or $H(w_c+x) + H^*(w_c+x) = 1 \quad |x| <=2*\pi*B$

If we construct a filter of the form $H(w)\, e^{-jwt_d}$ the term e^{-jwt_d} represents a pure delay.

Hence only H(w) need satisfy the above equation as |H(w)| is real

So $|H(wc+x)| + |H(wc-x) = 1 \quad |x| <= 2*\pi*B$

Since $\phi vsb(w)$ is a band pass Spectrum we can express,

$\phi_{vsb}(t) = m_c(t) \cos w_c(t) + m_s(t) \sin w_c t$ -------- (1)

If $\phi_{vsb}(t)$ is multiplied by $2*\cos w_c t$, we get

$$2*\phi_{vsb}(t)*\mathrm{Cos} w_c t = m_c(t) + \underbrace{m_c(t)\ \cos 2w_c t + m_s(t)\ \sin 2w_c t}_{\text{eliminated by lpf}}$$

So, $m_c(t) = m(t)$

To determine ms(t), (1) is multiplied by $2\mathrm{Sin} w_c t$ & LPF, the output is $m_s(t)$.

Thus VSB suppresses the transmitted Sideband and compensates it with the gradual roll off filter. Thus it has both the cost and increased bandwidth advantage over DSB and SSB.

The above reasons justify the use of VSB for TV broadcasting.

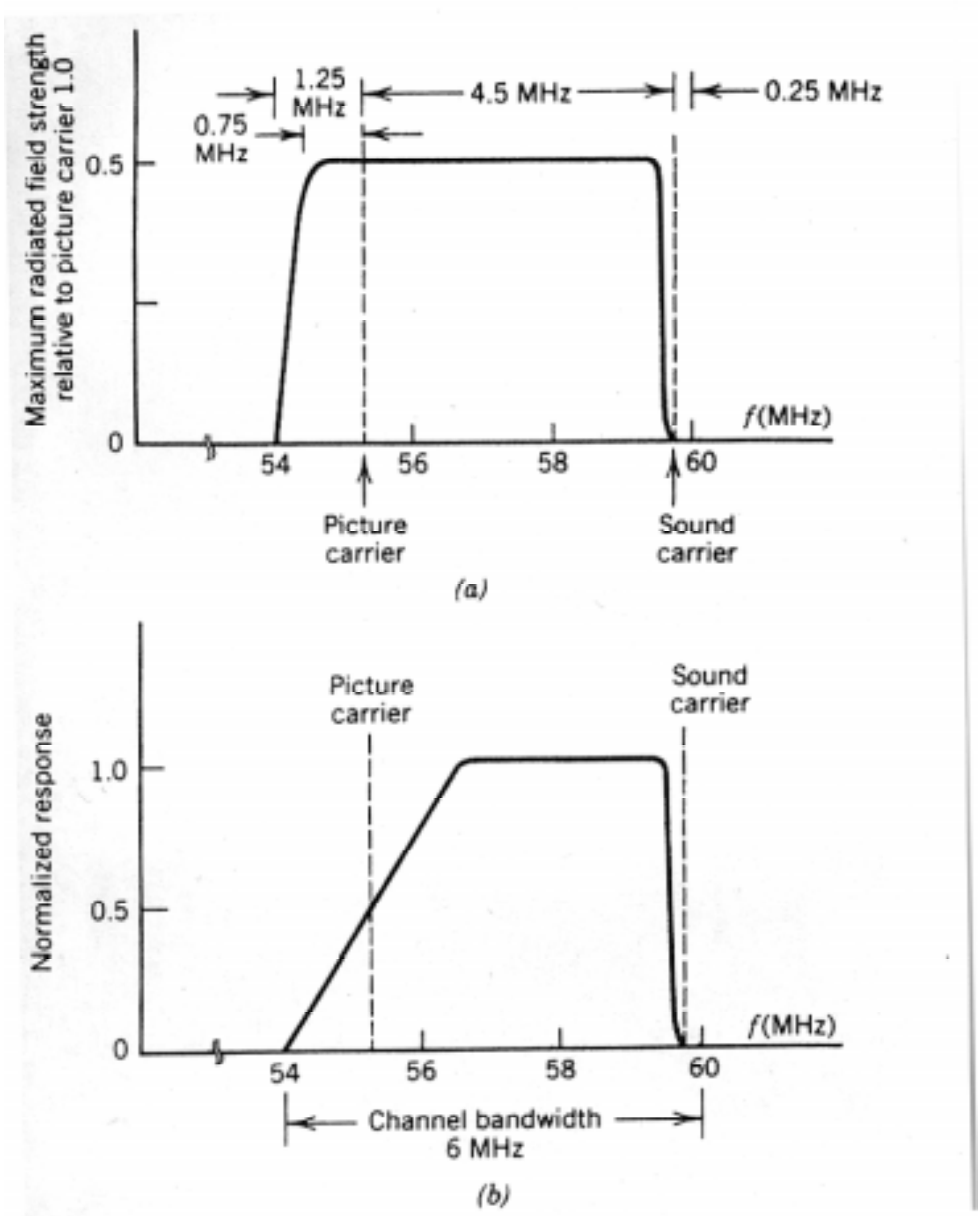
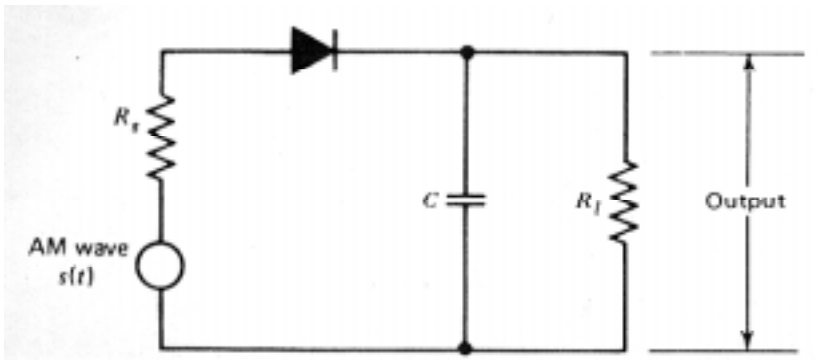


FIGURE 5.

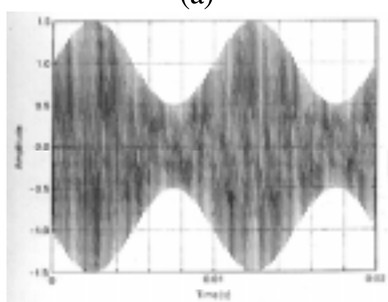
(a) IDEALIZED AMPLITUDE RESPONSE SPECTRUM OF A TRANSMITTED TV SIGNAL.

(b) AMPLITUDE RESPONSE OF VSB SHAPING FILTER IN THE RECEIVER.

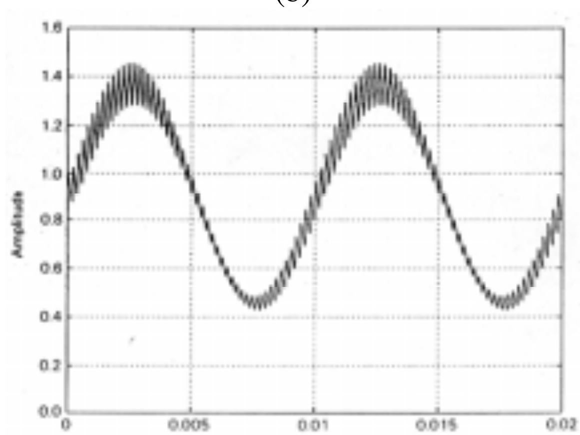
The demodulation of VSB transmitted waves can be done with the use of a simple **envelope detector** at the receiver



(a)



(b)



(c)

FIGURE 6.
(a) AMPLITUDE DEMODULATOR (ENVELOPE DETECTOR).
(b) AMPLITUDE MODULATED WAVE .
(c) OUTPUT OF THE ENVELOPE DETECTOR .

RBG - Y-U-V (intensity - luminance - chrominance)
or Y-I-R (luminance, chrominance(hue, saturation))

All colors are synthesized by mixing the 3 primary colors-Red , Blue and Yellow

In TV, Red, Blue and Green (blue + yellow) are used instead, due to the reason that Phosphors that glow with these colors are available when excited by an electron beam.

In TV cameras the optical system resolves the image into 3 primary colors. A set of camera tubes can be used to produce these 3 primary color images. But there are some difficulties at the reception end. It requires 3 times as much bandwidth as monochrome TV and secondly it is not compatible with the existing system because monochrome TV receives only one color.

This problem is solved by signal matrixing. The information about $m_r(t)$, $m_g(t)$ and $m_b(t)$ can be transmitted by 3 signals, each of which is a linear combination of the above and provided they are independent of each other.

$m_y(t) = 0.3m_r(t) + 0.59m_g(t) + 0.11m_b(t)$
$m_i(t) = 0.60m_r(t) - 0.28m_g(t) - 0.32m_b(t)$
$m_q(t) = 0.21m_r(t) - 0.52m_g(t) + 0.31m_b(t)$

Signals $m_r(t)$, $m_g(t)$ and $m_b(t)$ are normalized to a maximum value of 1 so that each amplitude range lies between 0 to 1

$m_y(t)$ is always > 0
$m_i(t)$ and $m_q(t)$ are bipolar.

$m_i(t)$ is also known as luminance because this particular combination of RBG matches the luminance of monochrome signals

The signals $m_i(t)$ and $m_q(t)$ are known as chrominance signals

Also **Hue = a tan $[(m_q(t)/m_i(t)]$**
Saturation = $\sqrt{[m_i^2(t) + m_q^2(t)]}$

MULTIPLEXING OF LUMINANCE & CHROMINANCE SIGNALS

Both luminance signal (Y) and Chrominance (I & Q) signals have the same BW of 4.2 MHz. But the eye doesn't perceive the changes in chrominance over smaller areas. Thus the BW's of I & Q signals are limited to 1.6 and 0.6 MHz respectively.

The Q signal and the 0 to 0.6 MHz portion of I are sent by QAM whereas mih(t) and 0.6 to 1.6 MHz portion of I signal is sent is LSB.