PULSE AND BAR MEASUREMENTS

INTRODUCTION

The Composite Pulse and Bar is used to assess the:-
'amplitude versus frequency' response and the
'delay versus frequency' response
of television equipment and systems, within the video pass-band 0 - 5.5 MHz.

Any line of a picture can be analysed into a line frequency (sinusoidal) fundamental component and numerous harmonics, each one having a precise amplitude and phase relationship to the fundamental.

It is these exact amplitude and phase relationships to the fundamental (and each other) that determine how they add together on each part of the active line, to give a voltage which the CRT will turn into a brightness display.

It is fairly obvious that a system giving unequal gain over the pass-band will upset the amplitude relationships; but it is perhaps not so obvious that the equipment or system may have different delay at different frequencies in the pass-band, thus upsetting the phase relationships of the complex input waveform. This can occur even when the amplitude response, shown by a frequency sweep, appears satisfactory.

If either gain or delay change with frequency at the output of a system, relative to its input, the resultant picture will not resemble the original.

The pulse and bar waveform simulates a typical television picture signal. The particular waveform enables measurement to give an indication in three ranges:-

gain and delay	50 Hz to 500 kHz	bar,
gain and delay	100 kHz to 3 MHz	2T pulse,
gain and delay	4.43 MHz ± 1 MHz	Minibar and 10T pulse.

The low frequency (bar) component is the reference for gain measurements, and therefore the high frequency results are expressed as percentages relative to the l.f. response.

EQUIPMENT REQUIRED

Oscilloscope with P & B k-rating graticule.
EQ1/520 oscilloscope equaliser
UN2/503 Colour Calibrator (shared with Non-lin. Meas. bench)
Distort box.

PULSE AND BAR MEASUREMENTS

1. OBJECTIVES

This experiment is intended to be an introduction to the PULSE and BAR waveform.

Measurements are made using a special graticule on an oscilloscope, which must first be calibrated.

The 'clean' Pulse and Bar is then examined, to provide familiarity with the waveform and finally, measurements are made of the amplitude/delay distortion produced by the 'distort box', which simulates a video circuit's response before equalisation.

When on station, information about these measurements can be found in Technical Instruction P2, Sections VTP 1 & 2.

2. OSCILLOSCOPE CALIBRATION

The combination of connecting cable, video termination and oscilloscope Y-amplifier may not have the correct sensitivity at low frequencies (around line frequency) and at colour sub-carrier (4.43 MHz).

Since measurements to 1% are to be made, the oscilloscope and leads must first be calibrated, and an oscilloscope equaliser used to match the hf and lf response of the measuring equipment.

2.1 Luminance (low frequency) Calibration

Connect the Colour Calibrator via the 3dB attenuator to the oscilloscope equaliser mounted directly onto the Y-input, as in figure 1.

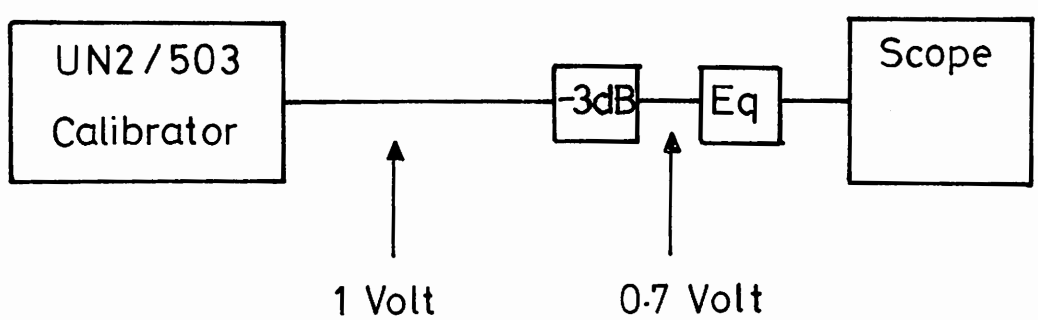


Figure 1: Calibration of the Oscilloscope

The Colour Calibrator contains an accurate 1 volt square-wave source, at 11kHz. Since the oscilloscope graticule has markings corresponding to 'blanking' and 'peak white', (but not syncs), the square-wave (LUM) is connected via a 3dB attenuator which gives 0.7 volt at the termination (inside the equaliser) on the oscilloscope input.

The oscilloscope sensitivity controls should be adjusted for 0.7 volt between the blanking level and peak white marks on the graticule.

2.2 Chrominance/luminance Calibration

The Colour Calibrator should be switched to 'LUM + CHROM', when the output is then a 1 volt sinewave at 4.34 MHz mixed in a 6dB mixing pad with the 1 volt square-wave, figure 2.

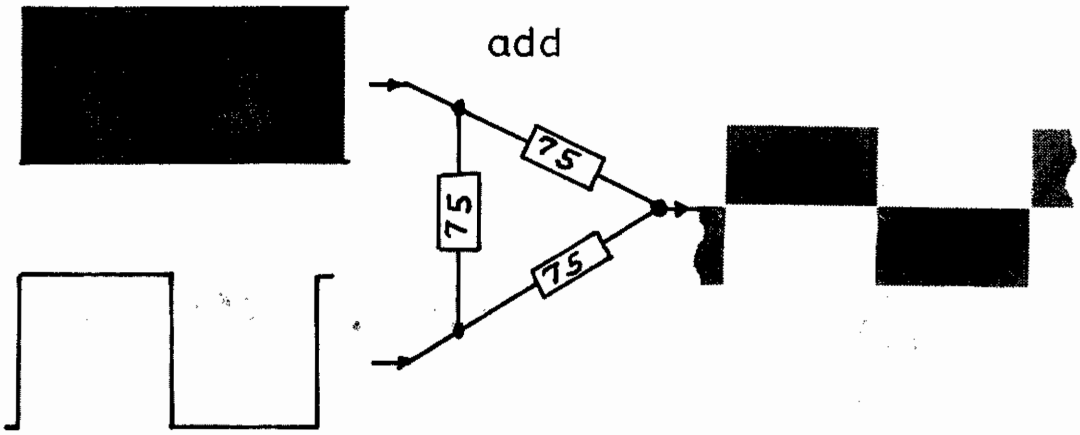


Figure 2: 'LUM and CHROM' output

When the oscilloscope is triggered externally from a source of mixed syncs, the display will be one of those shown in figure 3.

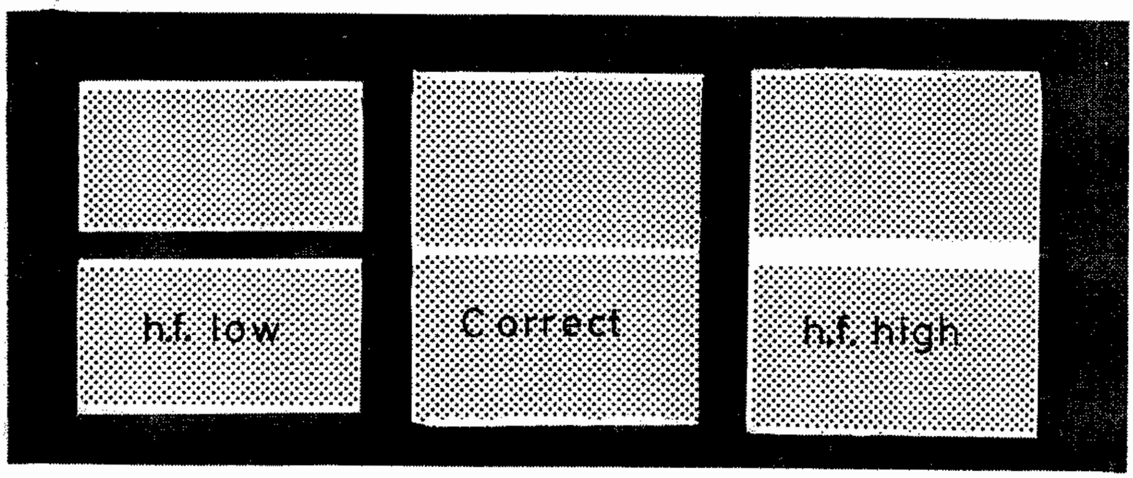


Figure 3: Oscilloscope Equaliser Calibration Waveforms

Adjust the equaliser, using the screw-head preset control, for the correct display.

With the oscilloscope low frequency sensitivity set for 0.7 volt, the amplification of the display at 4.43 MHz is the same as at lf.

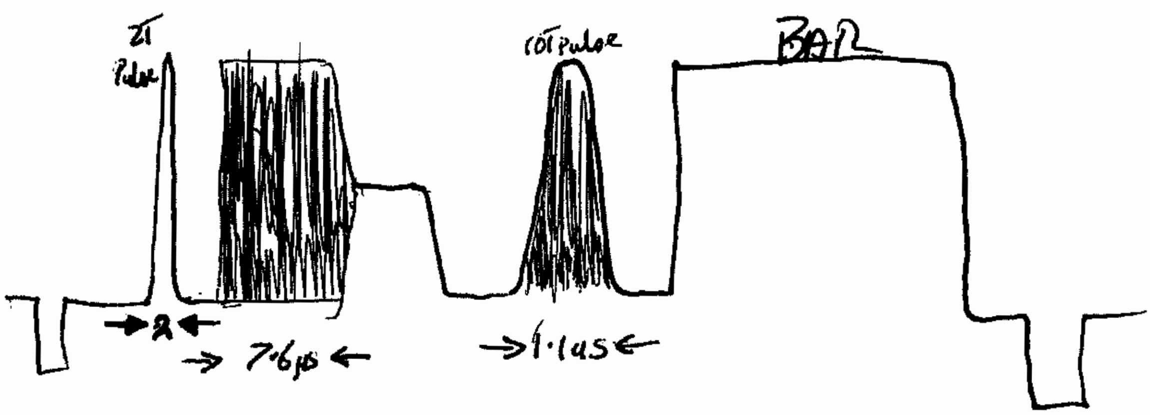
Note that any change in lf sensitivity, eg changing the Y-attenuator, may also affect the relative hf response. (Try it!)

3. PULSE AND BAR WAVEFORM

Disconnect the Calibrator and attenuator, and connect the P & B waveform from the wallbox outlet.

The generator is located in CAR (ask a lecturer to show you) and the cable run from CAR is pre-equalised to give the correct overall response at the wallbox outlet.

Adjust the oscilloscope controls to give a one line display, and sketch the waveform below:-



One line of P & B Waveform

Measure the following timings. (Hint, the oscilloscope writing speed is calibrated in time/cm, and the

8T 6T 4T 2T I 2T 4T 6T 8T 10T 12T

scale marks on the graticule provide a 0 to 10 cm scale).

The measurements should be made at Half Amplitude Duration points on the waveform.

3.1 What is the width of the luminance bar? .25......µs

3.2 What is the width of the luminance pulse? ..2......µs

3.3 What is the width of the chrominance component of the chrominance minibar? ...7.8.... µs

3.4 What is the width of the pedestal on the chrominance minibar? 5.2.......... µs

3.5 What is the width of the chrominance-luminance pulse? 1.1........ µs

Mark the timings and measurement points on the sketch.

4. MEASUREMENTS

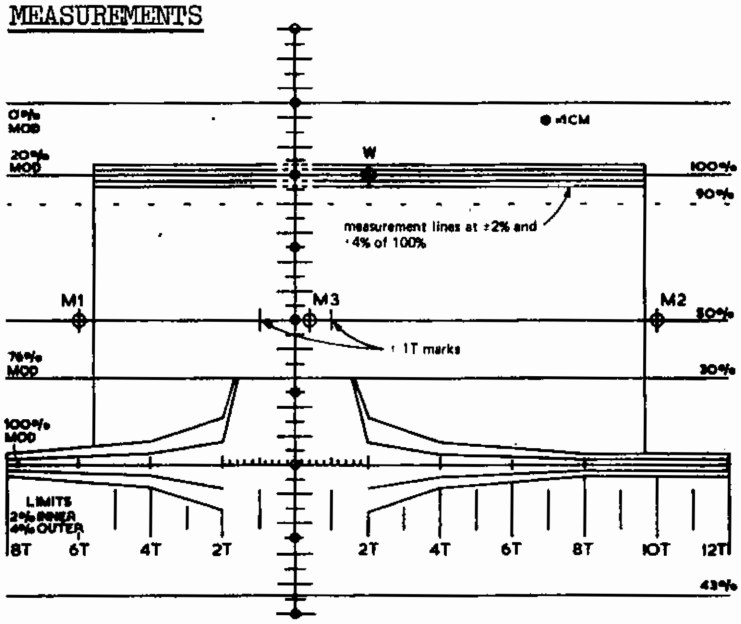


Figure 4: Pulse and Bar Graticule

Connect the 'distort box' as shown in figure 5, and observe the output waveform.

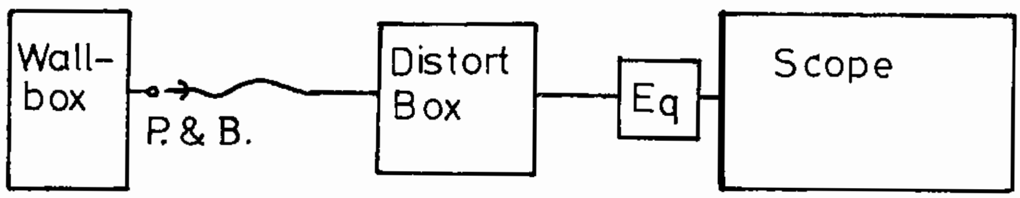


Figure 5: Equipment connected to measure distortions

Carry out the following series of measurements:-

PULSE AND BAR MEASUREMENTS

4.1 Bar Height (Overall Gain)

With a distorted waveform the bar height will vary depending on the exact points between which it is measured. The standard points between which you should make this measurement are:-

White level - at the centre of the white bar (A)
Black level - just before the 10T pulse (B), see figure 6.

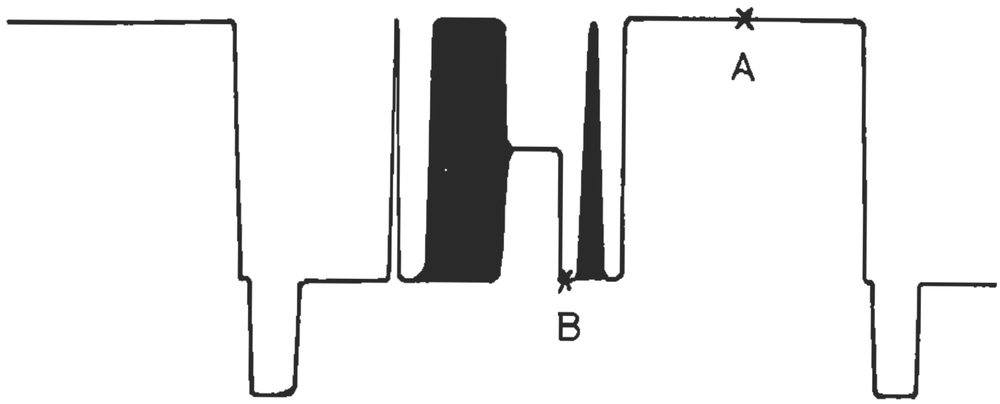


Figure 6: Bar Height Measurement Points

To measure bar height, check that the oscilloscope is calibrated as in sections 2.1 & 2.2.

Return to the P & B waveform, and measure the height A to B on the percentage scale.

Bar height = ...50...%, and in dB, Level = ...dB −6

For most of the other measurements, the results are expressed relative to a bar height of 100%.

Therefore, readjust the scope gain until A is at 100%, when B is at 0%. Check the calibration in section 2.2.

4.2 Slope on bar top (Bar Tilt; or k bar)

This is measured as the percentage sag on the worse half of the bar top. Edge effects are ignored.

Set up the oscilloscope X-deflection so that the leading edge rises through M1 and the trailing edge falls through M2.

2%

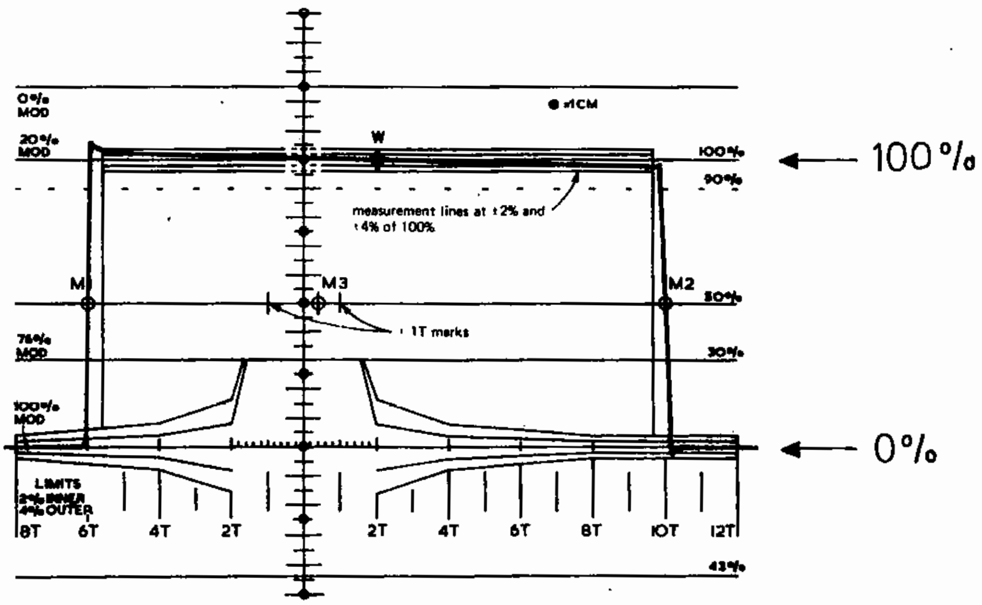


Figure 7: Setting up the oscilloscope display for k bar measurement

Adjust Y-shift until the centre of the bar is on the centre point of the middle line of the k bar limits box when using the older graticule shown in figure 8.

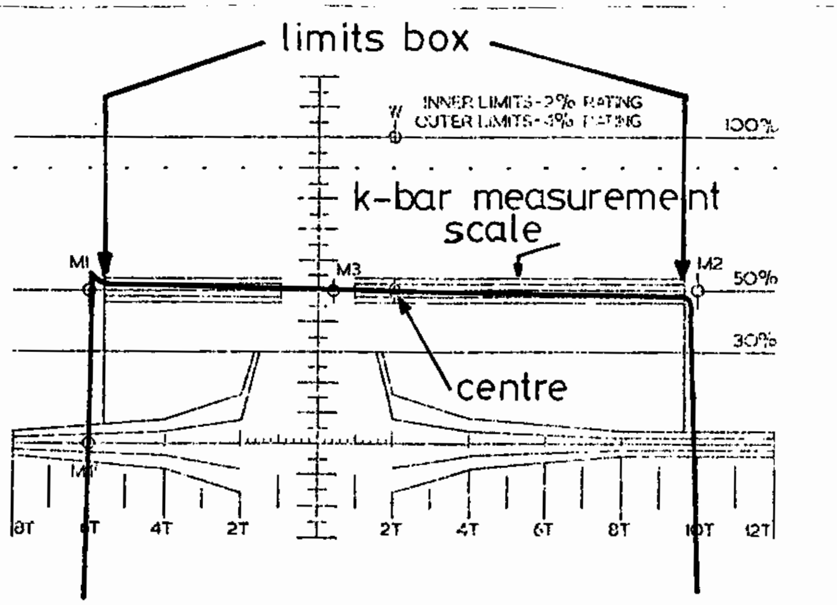


Figure 8: Example of k bar measurement (Old graticule)

The sag on the bar top is measured between the limits shown in figure 8, and, expanded in figure 9. The lines on the scale are at 2% intervals. Round up the measurement to the nearest %.

k bar = ..2.....%.

PULSE AND BAR MEASUREMENTS

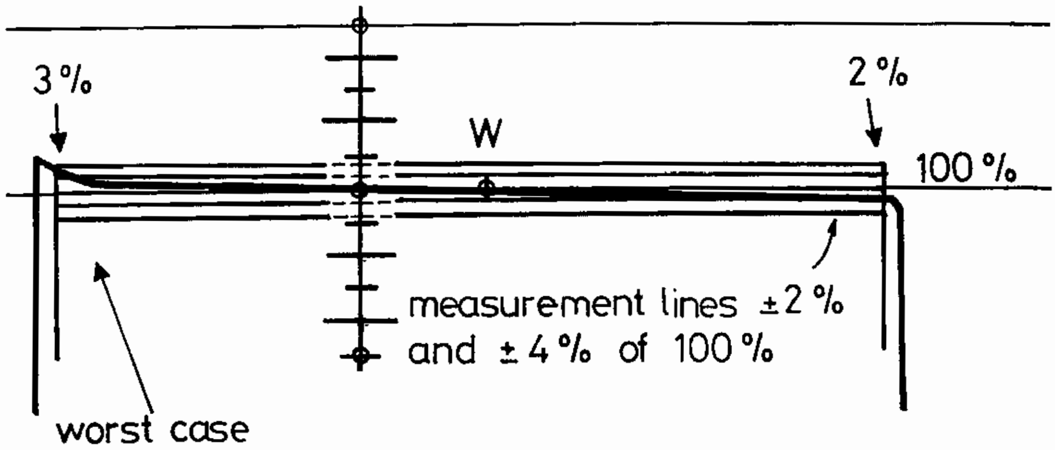


Figure 9: Expanded view of a k bar measurement

4.3 Pulse-to-bar ratio

With the bar height still set to 100%, use the X-shift control to move the 2T lum. pulse next to the percentage scale, figure 10.

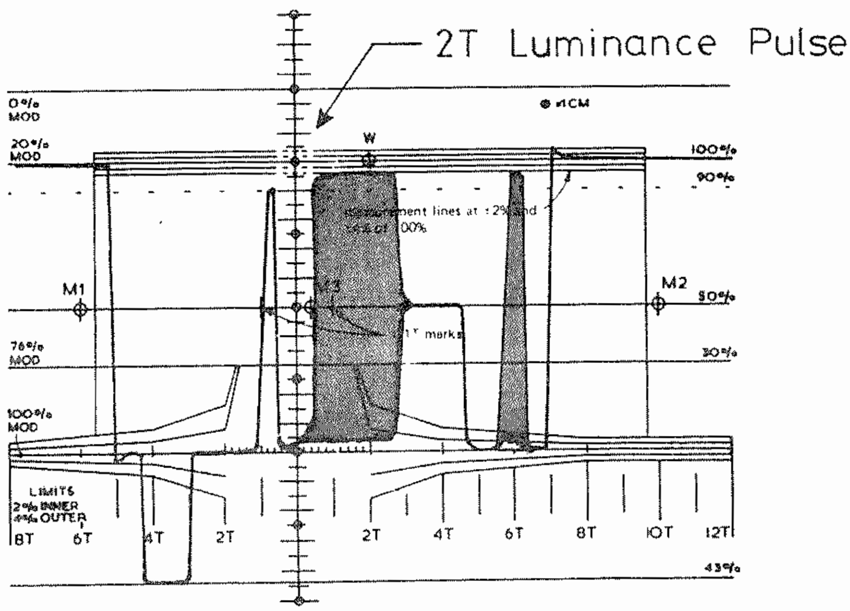


Figure 10: Pulse-to-Bar ratio, measurement example

Pulse- to-bar ratio = .10.6.....%

4.4 K_{2T} Pulse

The pulse shape indicates the degree of delay distortion in the higher luminance frequencies. Adjust Y-shift and -gain, and expand the X- deflection until it fits points A,B,C,D as in figure 11.

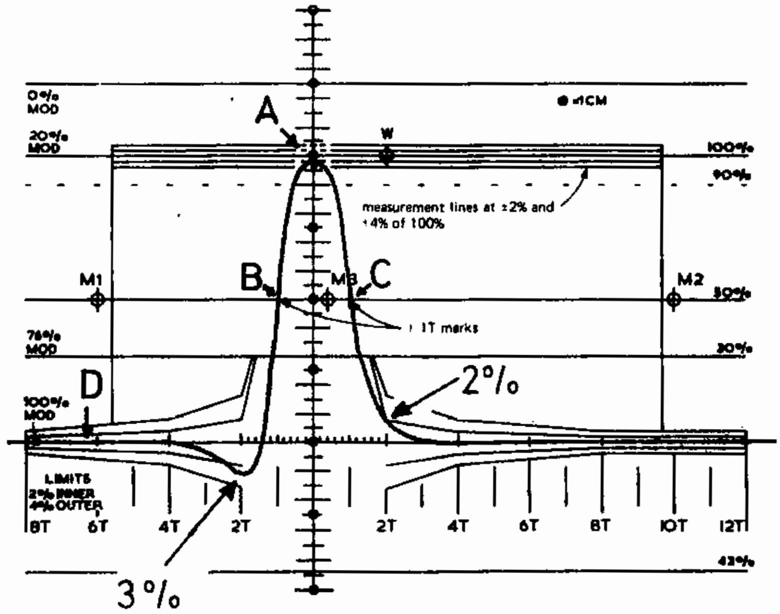
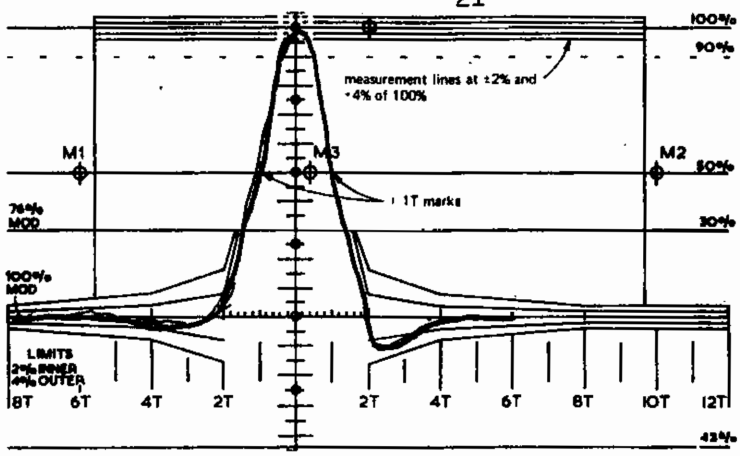


Figure 11: Measurement of K_{2T}

Measure k_{2T}, taking the worst % of pre- and post-shoots, and sketch the pulse shape below. K_{2T} = ..3.......%



Sketch of 2T pulse shape

The previous measurements have all been indications of distortion in the luminance signal. The following are a measure of the relative distortions in the accompanying chrominance signal.

4.5 Chrominance-Luminance Gain Inequality

FIRST reset the luminance bar height to 100% on the graticule.

This measurement is that of relative gain between 1f and 4.43 MHz. The reading is the error between chrominance minibar height and Luminance bar height, expressed as a percentage of the Luminance bar.

With the Luminance bar set to 100%, this can be read directly from the percentage scale, as in figure 12.

PULSE AND BAR MEASUREMENTS

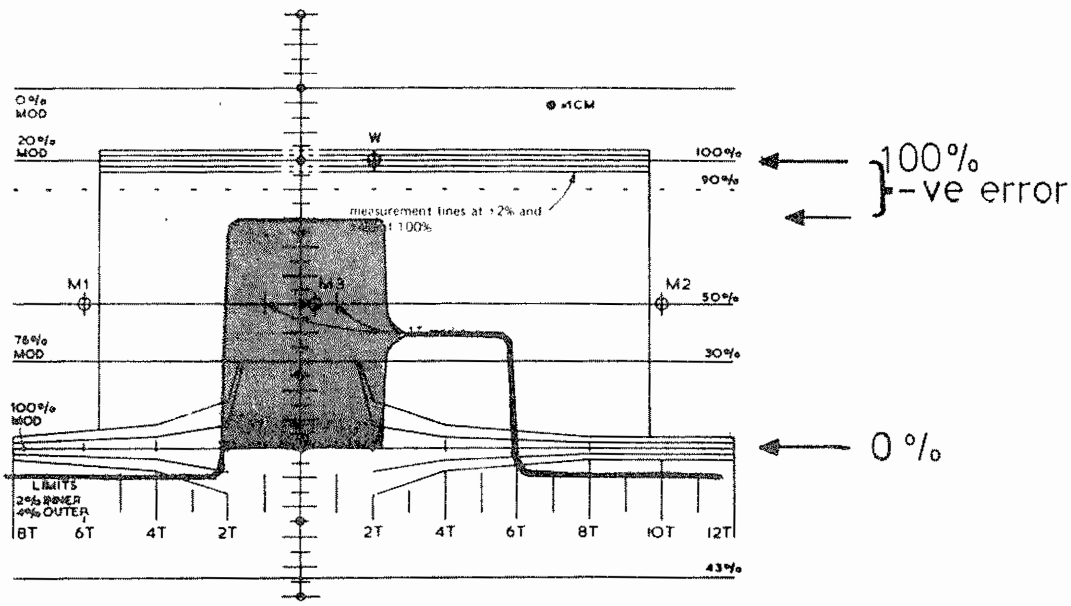


Figure 12: Measurement of c-l gain inequality

Measured Chrominance-Luminance gain inequality = ..9.6.....%

4.6 Chrominance-luminance Delay Inequality

For this measurement the Gain and Delay tester should be connected between the distort box and the oscilloscope. Figure 13.

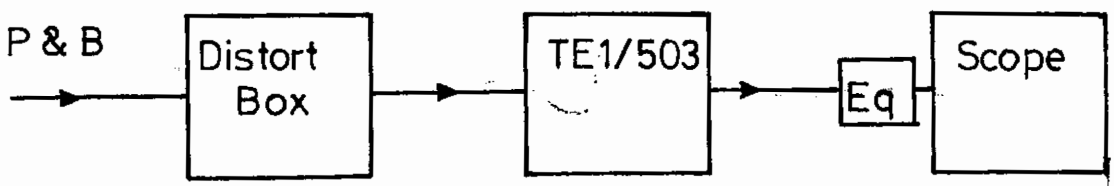


Figure 13: Connection to measure Delay Inequality

Switch the TE1/503 to 'chrominance luminance', then use the gain and delay controls to make the base of the chrominance-luminance pulse as flat and symmetrical as possible. Coarse delay is obtained with the push buttons, and fine delay with a continuously variable control.

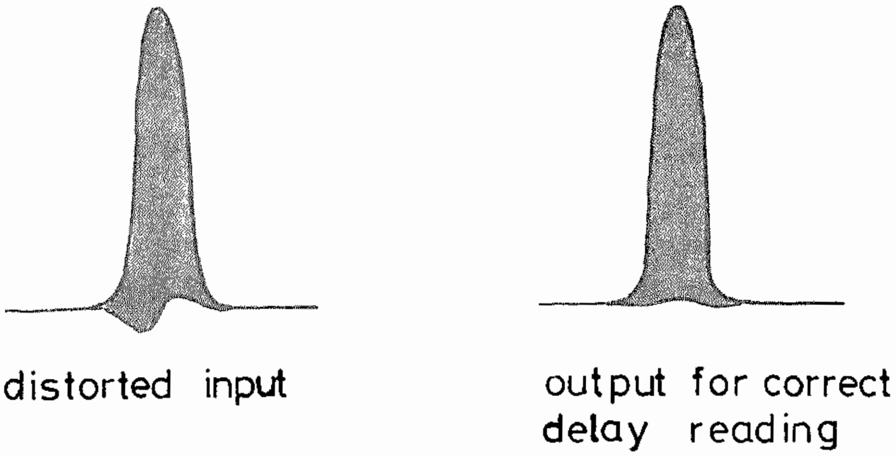


Figure 14: Chrominance-Luminance Pulse Display

The distortion is read off the TE1/503 controls. It is now usually quoted as a +ve or -ve delay (of chrominance relative to luminance). Therefore, 'lead' is a -ve delay, and 'lag' is a +ve delay.

Chrominance-luminance delay inequality = ...20..ns

5. CHROMINANCE TO LUMINANCE INTERMODULATION

(also called chrominance-luminance crosstalk, or subcarrier rectification).

Think of the chrominance and luminance signals as two totally separate channels of information, which are combined just before the signal path and separated out before being used. It is not surprising that for a practical system, there is some interaction. One of the ways this can show up is if the presence of high level signals in the chrominance channel causes a change on the signal in the luminance channel.

This can now be measured on the Chrominance Minibar. By filtering off the 4.43 MHz bar, the luminance pedestal on which is sits can be examined for changes in level due to the presence of the 4.43 MHz subcarrier.

PULSE AND BAR MEASUREMENTS

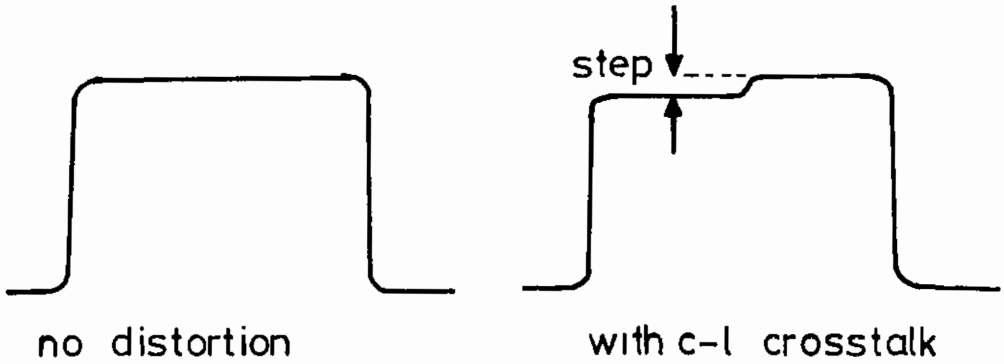


Figure 15: Filtered pedestal of the chrominance minibar

The step seen in figure 15, is to be measured as a percentage of the Luminance bar height, 0.7 volt, NOT the pedestal.

Set the luminance bar height to 100% on the graticule, and use the X-shift to bring the step on the pedestal against the percentage scale.

Measured Chrominance/Luminance crosstalk ....4.....%

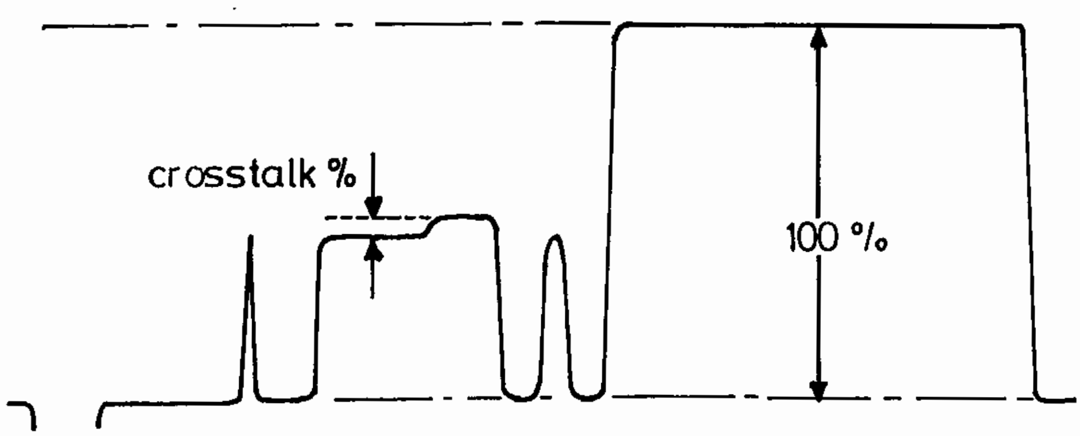


Figure 16: Measurement of Chrominance-Luminance Intermodulation (Crosstalk)

In the example shown, the presence of the subcarrier takes the luminance level negative. This is called -ve crosstalk.
If the first part of the pedestal is taken positive by the presence of CSC, then +ve crosstalk has occurred.

The signs are required on report forms for statistical reasons.

P.J. Harris/VC
9th January 1978