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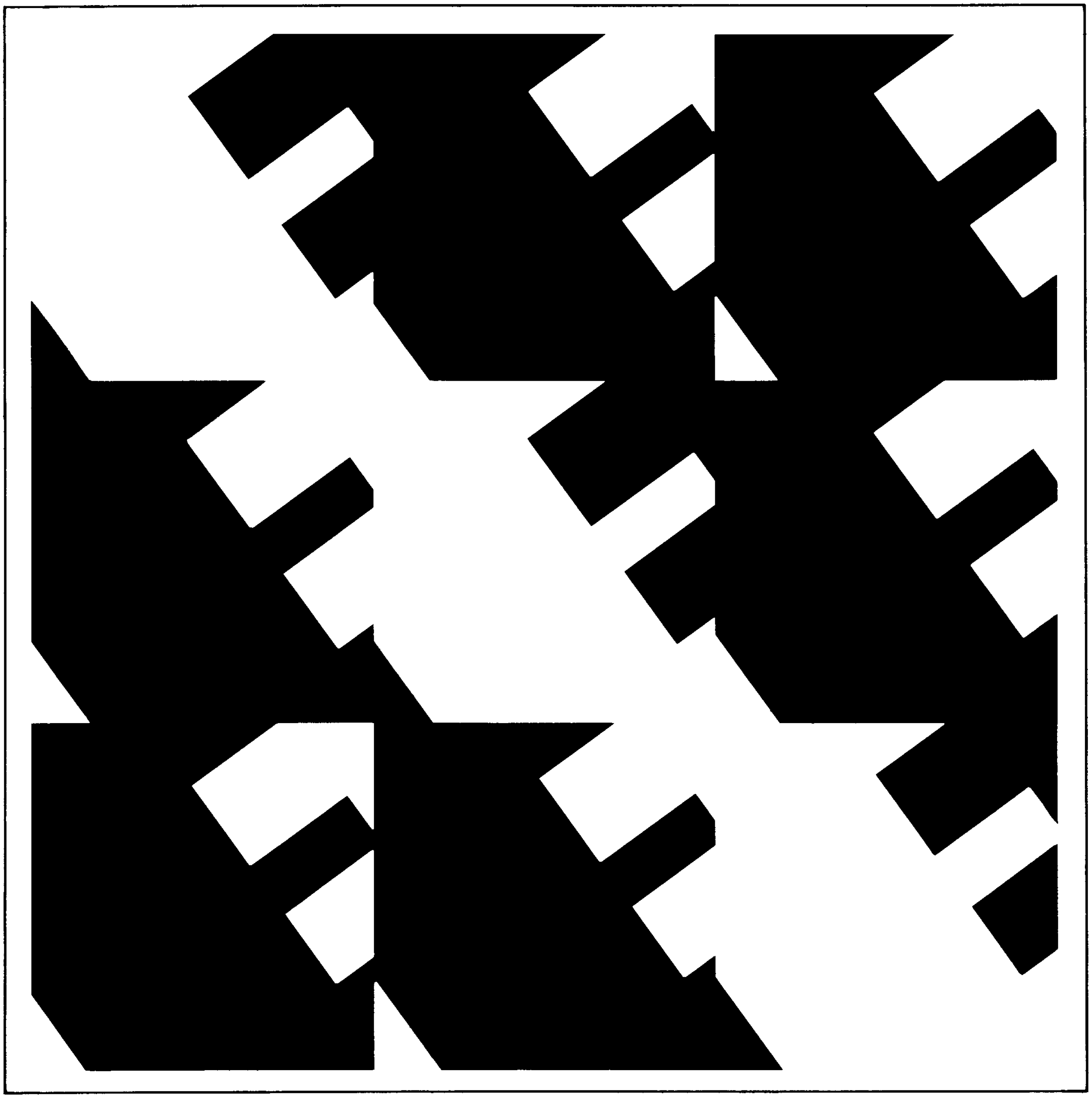
IEEE Standards on Television: Measurement of Luminance Signal Levels



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IEEE Standards on Television: Measurement of Luminance Signal Levels

The Institute of Electrical and Electronics Engineers, Inc
345 East 47th Street, New York, NY 10017, USA

IEEE Standards on Television: Measurement of Luminance Signal Levels

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1.0 Introduction

This Standard is a revision of Part 1 of Standard 50 IRE 23. S1 and replaces in all respects this previously issued part of the Standard. The need for the revision stems from the standardization of color television signals in the USA, and the inadequacy of the earlier Standard in providing methods of measuring the luminance component of the color signal. The revision consists primarily of a change in the response characteristics of the oscilloscopes to insure adequate suppression of the color subcarrier. Other minor changes in wording and in the associated figures have been made to bring the standard into accord with present terminology and practice.

1.1 Description

This Standard describes methods of measuring the significant amplitude levels of a monochrome or color television signal, either composite or noncomposite. It is concerned with measurements at points in transmission systems where the signals are at video frequency. The methods described in this Standard are limited to those involving the use of oscilloscopes, and are primarily directed to specifying means of measuring television signal levels for operating purposes.

For the purposes of this Standard, the levels which are significant are the levels of monochrome signals or the levels of the luminance portion of color signals. The peak amplitude excursion of a color signal may exceed, by substantial amounts, the peak amplitude excursions of the luminance portion of the signal, but since subjective brightness is more nearly proportional to the luminance signal than to any other quantity, it is most desirable from the operating standpoint to control and adjust levels using the luminance signal as a gauge. When this is done, monochrome and color signals, interspersed in a given program sequence, will produce approximately the same brightness and contrast when viewed on color or monochrome monitors without supplementary adjustments.

In the succeeding paragraphs of this Standard, the words "luminance signal" will refer to either a monochrome signal or to the luminance portion of a color signal.

Six significant amplitude levels of a composite luminance signal have been defined as follows.[1] These are shown in the right-hand portion of Fig. 1.

Reference White Level. The picture signal level corresponding to a specified maximum limit for *White Peaks.*

White Peak. A peak excursion of the picture signal in the white direction.

Black Peak. A peak excursion of the picture signal in the black direction.

[1] Cf. "IRE standards on television: Definitions of television signal measurement terms, 1955 (55 IRE 23. S1)," Proc. IRE, vol. 43, pp. 619–622; May, 1955.

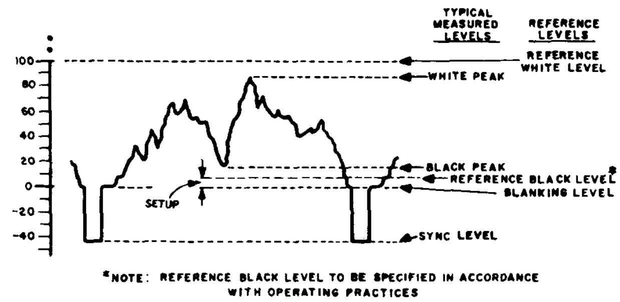


Fig. 1—Significant levels and details of IRE standard scale.

Reference Black Level. The picture signal level corresponding to a specified maximum limit for *Black Peaks.*

Blanking Level. That level of a composite picture signal which separates the range containing picture information from the range containing synchronizing information.

Note: The setup region is regarded as picture information.

Sync Level. The level of the peaks of the sync signal.

This Standard specifies a method of measuring the differences between these levels in a manner permitting ready correlation between the measurements at different parts of a system, regardless of the nominal voltages at the points of measurement.

1.2 Theory of Measurements

1.2.1 General: The method of level measurement prescribed in this Standard is based on the provision of oscilloscopes of standardized characteristics, with a linear scale for indicating the various levels. The scale is the same on all oscilloscopes, but each oscilloscope is calibrated with a voltage related to the nominal signal level at the point where the measurements are to be made. If the gains or losses between two measuring points on a system are normal, therefore, similar scale readings should be obtained for all the significant levels on oscilloscopes at both points regardless of differences in the voltages at the two points.

1.2.2 Scale: The standard scale is shown in the left-hand portion of Fig. 1, together with an illustrative luminance signal to show the relation between the scale and the oscilloscope presentation. It will be observed that the zero or reference point of the scale is placed at the blanking level. The upper part of this scale is marked from 0 to 100 with 100 corresponding to the reference white level. The scale is linear and two additional points (at 110 and 120) are provided to permit reading abnormally high *White Peaks.* The various levels of the picture signal are read on this scale above zero. The lower part of the scale is marked in linear steps from 0 to -50 and on it are read the levels of the sync signal.

Where other scales are used for specific purposes, such as modulation monitoring at broadcast transmitters, the standard scale should be added to any existing scales to permit correlation with measurements at other points in the system. The standard level scale should be placed with the 0 and 100 markings corresponding to the normal *Blanking* and *Reference White Levels*, respectively, of the other scale.

2.0 Apparatus Required

2.1 List of Equipment

A suitable oscilloscope is required for these measurements. Its specifications are given below and form a part of this Standard.

2.2 Specifications of Standard Oscilloscope for Level Measurements

2.2.1 Measurement Accuracy: An oscilloscope which is suitable for this application should be capable of television level measurements with errors not exceeding 2.5 units on the scale. Factors which contribute to error include:

Spot size and brightness,
Deflection amplitude,
Amplifier linearity,
Readability of scales or markers, including a reasonable allowance for parallax,
Calibration accuracy, and stability of calibration.

2.2.2 Bandwidth: The oscilloscope response characteristic should be such as to introduce negligible measurement errors due to low-frequency distortion or overshoot. The response characteristics should be standardized so that uniform measurements are obtained with different oscilloscopes. The bandwidth should be great enough to yield satisfactory luminance signal level readings and narrow enough that the readings are negligibly affected by the subcarrier portion of a color signal. To meet these requirements, this Standard prescribes that the response shall be monotonic and within the limits indicated in Fig. 2. This provides 20-db attenuation (−3 db or +5 db) at 3.58 mc with respect to the low frequencies and a rise time on the order of 0.3 μsec.

The specified characteristic may be obtained by adding a suitable network to an oscilloscope of wider bandwidth. For example, Fig. 3 shows a one-stage four-terminal network that may be used for this purpose with an oscilloscope having a bandwidth much wider than the specified characteristic. By arranging to remove the network, the oscilloscope can be made available for other uses where its full bandwidth is needed, such as 1) to measure color burst amplitude in terms of IRE scale units or 2) to check the amplitude of chrominance signal peaks on a color test signal. Fig. 3 also shows the circuit constants of an idealized three-stage amplifier having the specified nominal characteristics. For oscilloscopes having intermediate bandwidth, the prescribed responses may be attained with a smaller number of interstage networks or with different constants in the three networks.

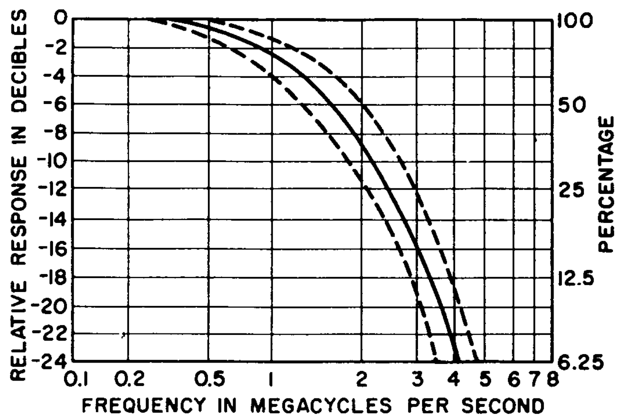
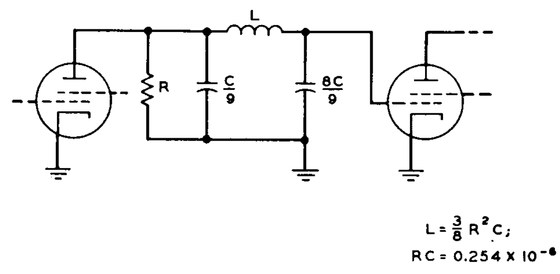
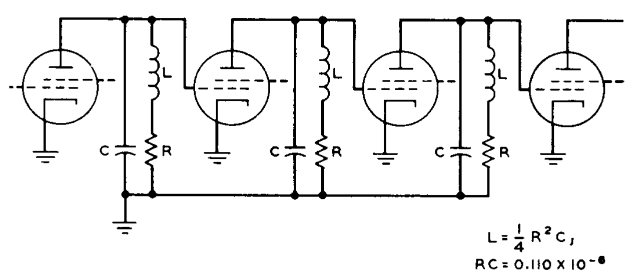


Fig. 2—Frequency response for standard oscilloscope (IRE roll-off).



(a)



(b)

Fig. 3—Idealized networks for standard oscilloscope, R in ohms, L in henrys, and C in farads. (a) One-stage four-terminal network and (b) three-stage RCL network.

There should be no sudden break in the response curve above 3.58 mc and the maximum response above 5 mc should be at least 20 db down with respect to that of 100 kc. The oscilloscope should indicate less than 2 per cent tilt in a 60-cps symmetrical square wave.

2.2.3 Scale: The oscilloscope shall be provided with the standard scale shown in Fig. 1 and described in 1.2. of this Standard.

2.2.4 Calibration: A suitable voltage calibration means shall be provided.

2.2.5 DC Restoration: It is highly desirable that restoration at the deflection plates of the oscilloscope be employed for operational measurements on signals having changing picture content in order to prevent shifts of the trace with variations in average value of the signal. It is desirable that the time constants of such dc restoration circuits be shorter than the equivalent time constants of the ac portions of the oscilloscope amplifier to avoid shift and bounce of the base line with picture changes. At the same time, it is desirable that the time constants of the restoration circuits be as long as the above limitation allows, in order that the true low-frequency content of the signal may be exhibited.

2.2.6 Vertical and Horizontal Centering: Means shall be provided for adjusting the relative position of the scale and the oscilloscope image. This may consist either of electrical centering controls on the oscilloscope or of a movable scale.

3.0 Method of Measurement

3.1 Application

Whether the oscilloscope is permanently connected to the circuit to be measured, as is the case in many operational systems, or is connected only periodically, care must be taken that the oscilloscope input circuit and the manner of connection have no adverse effect upon the signal circuit. It is essential that the circuit being measured operate with its normal source and the load impedances during the measurements.

In a transmission system the terminations may often be complex impedances, which cause the waveform to appear severely distorted when observed on an oscilloscope bridged across such a circuit. In measuring signal levels at such points, care must be exercised to properly interpret the indications. For example, where a constant-current source is used to drive a transmission system through a coupling transformer, the waveform measured directly across the transformer terminals may be so distorted as to be unusable for level measurements. It is usually preferable to connect the oscilloscope across a constant resistance point in the circuit, to which transmission from the signal origin is constant with frequency.

Low-frequency interference or distortion may seriously impair the accuracy of observation unless effective clamping means are employed. It is therefore recommended that such devices be employed wherever possible.

3.2 Adjustment

In using the oscilloscope the usual precautions must be taken to insure adequate brightness, sharp nonastigmatic beam focus, and gain-control settings which allow the necessary deflection without amplifier overload.

The oscilloscope time base should normally be synchronized at either the line rate or at one half of the line rate when making level measurements, providing a convenient display of the longer duration *Blanking* and *Sync Levels* which occur during the vertical blanking interval. The oscilloscope brightness and focus should be adjusted to make these portions of the signal wave form visible and well defined.

3.3 Calibration

Since, in general, the measurements will be made on a video bus or line in which the signal is to be maintained at a predetermined voltage chosen for that point in the system, it shall be standard practice to maintain an oscilloscope deflection within the appropriate calibrated boundaries of the standard scale.

In using the oscilloscope method of level measurement, accurate calibration of the oscilloscope amplifier gain is a very important aspect of the technique. Calibration is concerned with adjustment of the oscilloscope amplifier gain so that a normal signal will produce a standard oscilloscope deflection. This may conveniently be done by introducing a known calibrating voltage to the input of the oscilloscope in place of the normal input signal. The calibrating signal should be one whose principal frequency components lie within the band of uniform response of the oscilloscope. If such a calibrating signal has a peak-to-peak deflection equivalent to, for example, the *Blanking*-to-*Reference-White Level* of the standard signal, the oscilloscope gain would be adjusted so its calibrating voltage produces a deflection from 0 to 100 on the standard scale. Experience will indicate how often calibration checks should be made to maintain the desired accuracy of level measurement.

3.4 Interpretation

Standardizing the response characteristic of the oscilloscope serves to minimize possible differences in interpretation of signal levels. To further insure uniformity in interpreting the oscilloscope indication, the measurement of *Sync* and *Blanking Levels* should be observed at a point in the waveform where the voltages representing these levels are substantially at their steady-state value. The longer duration signals of both *Sync* and *Blanking Levels* which occur during the vertical sync interval are suitable. A representation of the appearance of these portions is shown in Fig. 4, the measurements being made as indicated to minimize errors due to transmission distortion. For noncomposite picture signals, *Blanking Level* may be observed similarly during the vertical blanking interval. In setting picture signal levels, important information-bearing signal peaks will be normally held within the 0 to 100 scale range. Certain highlight signals may occasionally exceed this range. Where comparison measurements are being made at different points in a transmission system, it is important to insure that identical peaks are being considered.

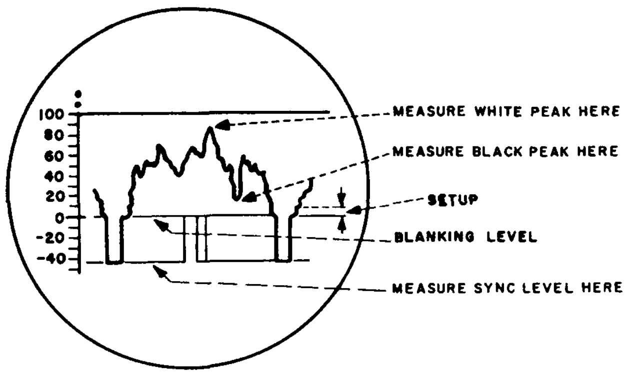


Fig. 4—Use and interpretation of IRE standard scale.

Measurements made with the IRE standard scale may be expressed as follows:

White Peak. 86 (meaning 86 IRE scale units or 86 per cent of the range between *Blanking* and *Reference-White Levels*).

Black Peak. 13 (meaning 13 IRE scale units or 13 per cent of the range between *Blanking* and *Reference-White Levels*).

Sync Level. −43 (meaning 43 IRE scale units or 43 per cent of the range between *Blanking* and *Reference-White Levels* but negative with respect to *Blanking Level*).

CORRECTION

The horizontal scale in Fig. 2 was not drawn correctly below 1 megacycle per second. Going back to the primary data from which the design objective was plotted and comparing this data with that read from Fig. 2, the following results were obtained:

Frequency in megacycles per second	Correct Data in Decibels	Fig. 2 Data in Decibels
0.2	0.1	0 (marked division)
0.3	0.3	0.1 (estimated)
0.4	0.45	0.4 (estimated)
0.5	0.75	0.7 (marked division)
0.6	1.0	1.1 (estimated)
0.8	1.6	1.8 (estimated)
1.0	2.5	2.5 (marked division)

This comparison shows that errors of the order of 0.2 dB can be made if the scale below 1 megacycle per second is used as a purely arbitrary scale. If the curve is read only at the marked divisions along the horizontal scale, the error is of the order of 0.1 dB (or less).

July 1958