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METHODS OF TEST FOR TELEVISION RECEIVERS

SRI LANKA STANDARDS INSTITUTION

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SRI LANKA STANDARD

METHODS OF TEST FOR TELEVISION RECEIVERS

FOREWORD

This Sri Lanka Standard was authorised for adoption and publication by the Council of the Sri Lanka Standards Institution on 1985-06-26, after the draft finalised by the Drafting Committee on Methods of Test for Television Receivers.

All values in this standard have been given in SI units.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value observed or calculated expressing the result of a test or observation shall be rounded off in accordance with CS 102. The number of figures to be retained in the rounded off values shall be the same as that of the specified value in this standard.

The object of this standard is to standardize the conditions and methods for the measurements to be used for the study of a receiver for television broadcasting so as to make possible the comparison of the results of measurements. Specifying limiting values of the various quantities for acceptable performance in not an object of this standard.

The standard constitutes a catalogue of selected measurements recommended for assessing the essential properties of receivers of a given type. It is neither mandatory nor limiting; a choice of measurements can be made in each particular case and, if necessary additional measurements may be carried out.

The recommended methods are designed to make possible the assessment of the performance of the complete receiver, without going into more than a minimum of detail and without giving its components separate consideration.

It should be realized that the measurements proposed are subject to future improvements as methods are refined and with the development of receiver techniques.

The assistance derived from the Publication of the International Electrotechnical Commission in the preparation of this standard is gratefully acknowledged.

1 SCOPE

The methods of measuring the electrical, acoustic and optical properties described in this standard apply more particularly to broadcast television receivers designed for monochrome and colour vision reception with accompanying sound of the system of the CCIR* recommendations and reports, due regard being given to national transmission standards.

2 REFERENCES

Recommendations and Reports of the CCIR, 1982 Volume XI-Part 1.

IEC 68-2	Basic environmental testing procedures
IEC 86	Primary cells and batteries
IEC 107-2	Electrical and acoustic measurements of audio frequencies
IEC 107-3	Colorimetric and photometric measurements
IEC 284	Rules and behavious with respect to possible hazards when dealing with electronic equipment and equipment employing similar techniques
SLS 580:Part 1	Basic environmental testing procedures-General and guidance

3 DEFINITIONS

For the purpose of this standard the following general definitions shall apply;

3.1 artificial aerial : A network which replaces the receiving aerial and its associated transmission line when taking measurements.

3.2 battery operation : Operation on accumulator **and/or** dry batteries irrespective of the application of d.c. voltage - transforming device.

3.3 bel : The fundamental division of a logarithmic scale used to express the ratio of two specified or implied amounts of power, the number of bels denoting such a ratio being the logarithm to the base 10 of this ratio.

NOTE - With P_1 and P_2 designating two amounts of power and N the number of bels denoting their ratio.

$$N = \log_{10} \frac{P_1}{P_2} \quad \text{bels}$$

3.4 brightness : The subjective impression of the luminance.

3.5 chromaticity : Colour quality of a colour stimulus definable by its chromaticity co-ordinates or by its dominant (or complementary) wavelength and its purity taken together. Chromaticity co-ordinates can be x and y of the CIE*(1931) standard colorimetric system or u and v of the CIE (1960) uniform chromaticity system.

**CIE : International Commission on Illumination.*

3.6 colour bar signals : Electrotechnically generated patterns and usually consist of vertical bands of colours in order of descending luminance, left to right. Colour bar signals referred to in this publication, unless otherwise stated, are those of the examples in Recommendation 471 of the CCIR XVth Plenary Assembly, Geneva, 1982.

3.7 composite video signal : A signal consisting of picture information, luminance and, where appropriate, chrominance (produced for instance by a camera or a pattern generator) and the complete synchronizing information. The signal should comply with the CCIR system B for which the receiver is designed.

3.8 decibel : One tenth of a bel, the number of decibels denoting the ratio of two specified or implied amounts of power being 10 times the logarithm to the base 10 of this ratio. The symbol db is commonly used for the term decibel. It is also used to express voltage and current ratios, the relations being:

$$\text{number of decibels} = 20 \log_{10} \frac{U_1}{U_2} \text{ or } 20 \log_{10} \frac{I_1}{I_2}$$

By definition, these formulae are applicable when the impedances at the reference points, at which the voltages and currents occur, are identical. However, it has long become customary to use the decibel notation in an extended sense, to express numerical ratios in general on a logarithmic basis. In such cases, it is recommended that a note be made of the special use of the decibel notation and if possible information added about the impedances to which the ratio values refer

3.9 decibel suffixes : A decibel ratio related to a specified quantity will define the level of a new quantity. The reference quantities used in expressing the levels of power, voltage, current or field strength may be indicated by means of a suffix associated with db.

Commonly used references and their suffixes are :

Quantity	**Reference**	**Abbreviation**
Power	1 milliwatt	db (mW)
Voltage	1 volt	db (V)
Current	1 ampere	db (A)
Field strength	1 volt per metre	db (V/m)

3.10 envelope level : This is expressed on a linear scale to indicate the level of the vision radio frequency signal at any given instant.

100 per cent envelope level corresponds to highest level for a monochrome signal, and 0 per cent envelope level corresponds to the zero carrier level. 100 per cent envelope level corresponds to the radio-frequency signal level at the top of the synchronizing pulses (See Fig. 1). This value can be exceeded for colour signals.

The relative radio-frequency signal levels of the picture and associated sound are these defined for the CCIR system B.

3.11 field : The part of the picture which is scanned in the interval between two successive vertical synchronizing impulses.

3.12 hanover blind effect : Spurious variation in luminance level, hue or saturation in the reproduced picture signal, line by line due to effects associated with the chrominance signal.

3.13 luminance : Luminous intensity per unit of projected area of any surface as viewed from a given direction.

The luminance value is expressed in candela per square metre (1 cd/m^2).

3.14 picture : Consist of two consecutive fields (see **3.11**).

3.15 picture modulation percentage : This is expressed on a linear scale to indicate the picture signal level at any given instant.

0 per cent picture modulation corresponds to the black level, and 100 per cent picture modulation corresponds to the white level.

Values below 0 per cent and above 100 per cent can occur with colour signals.

Intermediate values correspond to intermediate levels of the picture signal (see Fig. 1).

3.16 representative number of channels : An example of a representative number of channels where measurements are not carried out on all channels in which a receiver is designed to operate is :

2 channels in band 1 - the lowest and the highest;

2 channels in band 3 - the lowest and the highest;

3 channels each in bands 4 and 5 - one near each end of the band and one in the middle.

3.17 supply mains : Any power source with an operating voltage of more than 24 V that is not used solely to supply television receivers.

3.18 television signal : A radio-frequency signal containing both vision and sound information in accordance with the CCIR system B.

3.19 **terminal device** : Any device for connecting external conductors or apparatus.

3.20 test patterns : A test pattern is used for checking the complete television system. It comprises a combination of monochrome or monochrome and colour signal components that offer as much information as possible on the performance of the system. Such a pattern should include at least the following items:

a) Vertical and horizontal definition wedges in the centre and in the four corners of the picture area, calibrated in *number of lines*. The wedges should enable definition to be checked up to the theoretical maximum of the system. The definition is always referred to the corresponding number of horizontal scanning lines, the same figure indicating the same definition, both vertically and horizontally. The video frequency corresponding to each *number of lines* may be calculated for the television system under consideration.

b) Patterns for linearity and colour registration or convergence checks, consisting of a pattern of equidistant horizontal and vertical lines and/or dots. Circles may be included to facilitate adjustment of picture size and geometry.

c) A marking to check the aspect ratio.

d) Marks to facilitate centring of the picture even when the mask partly cuts the corners.

e) A known brightness scale of from 5 to 10 brightness steps for gradation checks.

f) Alternate black and white blocks at the vertical edges of the picture to check synchronizing quality. These may be combined with the linearity patterns and the aspect ratio marking.

g) Special patterns, such as single vertical bars of different widths and suitable horizontal blocks giving black-white and white-black transitions, for checking overshoot, reflections (ghosts) and low-frequency response.

h) Coloured areas to check decoding operation, colour transitions and luminance/chrominance time equalization.

j) Areas at white level and black level to check drive levels, beam current limiting and intercarrier sound.

Some of the features may be provided by the inclusion of an area of colour bar signal (see CCIR Recommendation 471, XVth Plenary Assembly, Geneva 1982).

The mean brightness of the patterns should correspond to a mean picture modulation percentage of approximately 50 per cent.

3.21 unacceptable performance : Performance may be considered unacceptable when one or more of the following phenomena occur:

a) loss of synchronization;
b) cross-modulation of sound and picture;
c) loss of resolution;
d) distortion of grey scale;
e) noise effects in picture or sound;
f) errors of colour reproduction;
g) spurious colour effects;
h) spurious interlined differences;
j) spurious colour killing; and
k) sound distortion.

3.22 voltage and current values : In television technique mostly imply *peak - to - peak* values. This is indicated by P-P. Without such indication, voltage and current imply r.m.s. values unless otherwise specified. A fully modulated radio-frequency signal is a radio-frequency signal modulated to white level in accordance with the standards of the CCIR system B. By convention, the signal strength is considered to be equal to the r.m.s. value of an unmodulated radio-frequency signal having the same peak amplitude as the modulated signal has at the peak of modulation. This corresponds to synchronizing level for negative modulation (system adopted in Sri Lanka) as shown in Fig. 1.

NOTES

1 Greater modulation depths can occured with colour signals see **3.15** *and* **3.10**.

2 The true r.m.s. value of a modulated signal will be different from this value, the magnitude of the difference depending on the depth of modulation and its waveform. In the tests in which a sine-wave modulated carrier can be used, the factor for conversion to peak values is given in the appropriate figures.

SECTION ONE - NOTES ON MEASUREMENTS

4 GENERAL CONDITIONS

4.1 Introduction

All measurements shall, unless specified otherwise, be carried out under the conditions specified in the relevant clauses, whilst the following points shall also be taken into consideration.

In all measurements on a television receiver, it is assumed that both the sound and the picture sections are operating, so that any influence one section may have on the other will be present during the measurements, except where otherwise stated. For instance, an AFC circuit operated by the vision signal may influence the sound channel circuits and the reverse may be the case. One of the signals may be omitted from the composite television input signal only when it has been ascertained that this does not affect the results of the measurement in question.

For most measurements, it is important that the scanning circuits be properly synchronized.

4.2 Measuring conditions

A description of the condition under which the measurement has been made should be added to the results, including the set-up of the measuring equipment, external circuit elements, the applied signal levels and the applicable environmental conditions.

4.3 Accuracy of measuring instruments

The accuracy of the measuring instruments used, if known, shall either be stated as a percentage or in decibels as appropriate. Alternatively, the accuracy class may be quoted.

4.4 Presentation of results

If the results of measurements are presented graphically, the points which have been obtained experimentally shall always be indicated on the graph, together with other specifically required data of the measurements. If a continuous record has been made, this shall be stated.

4.5 Deviations

If deviations from the recommended methods are adopted, they shall be explicitly stated with the results.

5 ENVIRONMENTAL CONDITIONS

5.1 Introduction

Unless otherwise specified, the following standard atmospheric conditions apply for the purposes mentioned in 5.2 and 5.4 (in accordance with **SLS** 580:Part 1).

Other environmental conditions are referred to in 5.5.

5.2 Standard reference conditions

If the quantities to be measured depend on temperature **and/or** air pressure and the law of dependence is known, the values are measured under the conditions given in 5.4 and, if necessary, corrected by calculation to the following reference values:

a) temperature : + 20 °C; and

b) air pressure : 101.300 kPa.

NOTE - No requirements for relative humidity are given here, because a correction by calculation is generally not possible.

5.3 Standard referee conditions

If the quantities to be measured depend on temperature, humidity and air pressure and the law of dependence is unknown, the measurements may be made, by mutual agreement, under one of the following conditions.

TABLE 1 - Temperature humidity and air pressure conditions under which measurements to be carried out

Temperature °C	Relative humidity %	Air pressure kPa
+20±1	63 - 67	86.0 - 106.0
+23±1	48 - 52	86.0 - 106.0
+25±1	48 - 52	86.0 - 106.0
+27±1	63 - 67	86.0 - 106.0
		(1 Pa = 10^{-5} bar)

When the temperature of measurement differs from 20 °C or such other temperature as may be prescribed in the relevant specification, suitable limits for the characteristic values shall be agreed between user and manufacturer.

The test report shall give the actual values of temperature, relative humidity and air pressure during the measurements.

For large equipment or test rooms, where temperature, relative humidity and air pressure limits as indicated above are difficult to maintain, wider tolerances are allowed, subject to mutual agreement. The actual values shall be given in the test report.

5.4 Standard testing conditions

Measurements and mechanical tests are normally carried out at any existing combination of temperature, humidity and air pressure within the following limits:

a) temperature : +15;

b) relative humidity : 45; and

c) air pressure : 86.0 to 106.0 kPa.

In addition, for receivers intended for operation over a wider temperature range such as portable and motor vehicle receivers, the temperature range may be extended further, covering one of the ranges specified in SLS 580:Part 1.

The temperature and relative humidity shall be substantially constant during a series of measurements carried out as a part of one test on one equipment.

Where it is impracticable to carry out measurements under these standard atmospheric conditions for testing, a note to this effect, stating the actual conditions, shall be added to the test report.

5.5 Other environmental conditions

When, by mutual agreement, the essential properties of receivers have to be assessed in environmental conditions other than those laid down in 5.3 and 5.4, the measurements shall be made during or after subjection of equipment to such conditions as laid down in IEC Publication 68-2, Tests, and as required according to the relevant specification sheets.

6 PRECAUTIONS DURING MEASUREMENTS

6.1 Damage to equipment

When carrying out measurements on a receiver, all test conditions or operations which may lead to damage to the receiver and/or its tubes, valves or semiconductor devices, shall be avoided. This applies particularly to sensitive solid state devices such as integrated circuits and similar constructions.

6.2 Safety arrangements

If a protecting cover is removed and parts which are directly connected to the mains (for example the chassis) become accessible, it is recommended, for the safety of personnel performing measurements that equipment be connected to the a.c. mains via a safety transformer, the secondary winding of which is insulated in accordance with the principle of double insulation.

It shall be ascertained that the use of a safety transformer does not influence the receiver properties to be measured. In particular, the internal impedance of the safety transformer, shall be sufficiently low, for the behaviour of the receiver to be the same as when connected directly to the mains supply. If a safety transformer is not used, the safety aspect shall be taken care, (see also IEC Publication 284).

7 POWER SUPPLY

7.1 Types of power supply and relevant measuring conditions

The following ways of operation with regard to power supply are defined:

7.1.1 *Mains*

Operation from any centralized a.c. or d.c. power source with a nominal operating voltage of more than 24 V.

7.1.2 *Batteries*

Operation on accumulators, primary batteries or any similar energy source, for example solar batteries, thermo-electric cells, etc.

Accumulators, primary batteries, and/or other similar energy source of the type, voltage and internal resistance, as specified for use with the receiver, shall be employed; other sources, which sensibly simulate the characteristics of those specified, may also be used and the substitute arrangements stated with the results.

Receivers intended for use on more than one type of power supply shall be measured by connecting the receiver to each type of power supply in turn.

NOTE - In this respect, a.c. mains and d.c. mains are considered different types of power supply.

The normal measuring conditions, as laid down in **7.2**, **7.3** *or* **7.6**, *whichever are applicable, shall apply for all measurements.*

Receivers designed to operate over a wide range of voltages without adjustment are testing under the conditions laid down in **7.9** *and* **7.10**.

To determine the influence of variations in the supply voltages on various characteristics of a receiver, supplementary measurements shall, unless otherwise specified, be carried out. Where a rated voltage but no tolerance is given or where a rated voltage with a tolerance is given, supplementary measurements shall be carried out at overvoltages and undervoltages, whichever are applicable, deviating from the chosen rated values, and as laid down in **7.3**, **7.5**, **7.7** *and and* **7.8**.

The conditions chosen shall be stated. See also Table 2.

7.2 Mains-operated receivers, normal conditions

The rated voltage at the rated frequency shall be applied to the mains terminal device.

For receivers with more than one rated operating voltage or frequency, a specified rated voltage, at a rated frequency, shall be applied to the mains terminal device.

If the receiver has to operate on a mains supply with a rated frequency differing considerably from the field frequency of the television system, (for example 50 Hz), all measurements should be made under these conditions, special attention being paid to measurements where the difference of frequency may give rise to spurious effects.

7.3 Mains-operated receivers, overvoltages and undervoltages

An overvoltage of +10 per cent or the given tolerance and an undervoltage of -10 per cent or the given tolerance at a rated frequency shall be applied to the mains terminal device.

For receivers with more than one rated operating voltage or frequency, the highest overvoltage at the lowest rated frequency and the lowest undervoltage at the highest rated frequency, shall be applied to the mains terminal device; where tappings for the range of voltages are provided, the appropriate range shall be selected for the measurements.

7.4 Accumulator-operated receivers, normal conditions

The normal operating voltage for accumulator batteries is fixed at 2.0 V per cell for lead batteries not under charge, 2.2 V per cell for lead batteries under charge and 2.4 V per cell for car batteries, measured at the terminals of the battery. If accumulators other than lead accumulators are used, these voltages per cell shall be chosen accordingly and stated with the results (see also Table 2).

7.5 Accumulator-operated receivers, overvoltages and undervoltages

The under voltage for lead accumulators is fixed at 1.8 V per cell. The overvoltages for lead accumulators of motor-cars is fixed at 2.6 V per cell. If accumulators other than lead accumulators are used, the undervoltage and overvoltage per cell shall be chosen accordingly and stated with the results (see also Table 2).

NOTE - For batteries in vehicles, switching peaks of very short duration and nearly double the normal operating voltage may occur, whilst at low operating temperatures higher battery voltages may be encountered.

7.6 Primary battery-operated receivers, normal conditions

The normal operating voltages for primary batteries are generally to be found in the relevant IEC Publication 86. The normal operating voltage for primary batteries of the Leclanche type is fixed at 1.5 V per cell, if other voltages apply, these shall be stated with the results.

7.7 Primary battery-operated receivers, overvoltages and undervoltages

The test overvoltage corresponding to that possible occurring with new Leclanche cells shall be 1.65 V per cell, obtained from a voltage source of negligible internal resistance. The tests at this overvoltage shall be of sufficient duration to check that operation in normal and without instability, but shall be kept short, in order to avoid possible excessive power dissipation.

TABLE 2 - Survey of voltages for various types of power supply

Type of power supply for television receivers	Rated voltage (V)	Operating voltage (V)		
		Normal	Maximum	Minimum
(1)	(2)	(3)	(4)	(5)
Mains	U	U	U+10% or U+X†	U-10% or U-Y†
Primary battery*	1.5	1.5	1.65	1.10
Accumulator*				
Lead accumulators	2.0	2.0	-	1.8**
- under charge	-	2.2	-	-
- for car receivers	-	2.4	2.6	-
Nickle-cadmium accumulators with incorporated gasvent	1.2	1.2	-	1.1
- under charge	-	1.4	-	-
- for car receivers	-	-	1.6	-
Nickle-cadmium accumulators of the sealed type	1.2	1.2	-	1.1
- under charge	-	1.35	-	-
- for car receivers	-	-	1.4	-

* *Voltage per cell*

** *Where manufacturers define a higher minimum voltage than 1.8* V, *this higher voltage should be considered to be the minimum value.*

† *X and Y correspond to the given tolerance (if other than 10%) see* **7.3**.

The test undervoltage on load for primary batteries of the Leclanche type shall be of 1.10 V per cell.

Normally, undervoltages, shall be obtained by using adjustable resistors in series with fresh batteries or any other sources of the rated voltages having negligible internal resistance. Under the conditions of the particular test in progress, the series resistor shall be adjusted once and for all, to obtain the specified undervoltages on full load of the receiver. It is to be noted that the addition of a series resistance to a source of negligible internal impedance does not simulate a partially discharged battery perfectly, the impedance of which may be non-linear.

Alternatively, under special circumstances, the undervoltage may be obtained in a similar way using an initial voltage source of a specified percentage, for example 20 per cent below the rated voltage value, with an appropriately smaller value for the series resistance; this deviation from the normal procedure shall be explicitly stated with the results.

7.8 Additional information

Table 2 gives a survey of the different overvoltages and undervoltages for various types of operation.

If the undervoltage is to be obtained by an adjustable resistor in series with an adjustable constant voltage source, as prescribed in 7.7, it is convenient to apply first the relevant undervoltage directly, with the adjustable series resistor set at zero resistance, and to adjust the various parameters of the receiver as required. Then, without changing these parameters, the normal operating voltage is applied the adjustable resistor being set at maximum resistance, after which the resistance shall be gradually decreased until the same chosen undervoltage is reached. The series resistance shall be kept constant during further tests with the same equipment.

If, during operation at the extreme voltages specified in this section, the receiver ceases to give useful operation, measurements shall be made at less extrume voltages. A clear statement of these conditions shall be added to the results.

7.9 Receivers designed to operate over a moderate range of voltages without adjustment

The voltage range of operation is defined as follows:

$$U_1 < U_2 < 1.5\ U_1$$

where U_1 is the lower voltage limit of the range of operation and U_2 is the higher voltage limit of the range of operation.

An example of such a range is 190 V to 260 V

Normal conditions are defined as $\frac{U_1 + U_2}{2}$

The overvoltage is U_2

The undervoltage is U_1

See also Notes 1 and 2 of 7.10.

7.10 Receivers designed to operate over a wide range of voltages without adjustment

The voltage range of operation is defined as follows:

$$U_2 \geq 1.5\ U_1$$

where U_1 is the lower voltage limit of the range of operation and U_2 is the higher voltage limit of the range of operation.

An example of such a range is 95 V to 255 V.

Normal conditions are defined as U_2 - 20%.

The overvoltage is U_2.

The undervoltage is U_1.

NOTES

1 Where a wide range of operation is obtained by an automatic switching arrangements, the receivers shall be tested over the narrow range of voltages within which the switch operates. This is to ensure that no instability over this range occurs.

2 The values of U_1 and U_2 are the absolute values outside which operation should not be attempted in any circumstances.

7.11 Power and current consumption of receivers

The power and/or current consumption of receivers shall be measured under normal measuring conditions (see 7.2, 7.4 and/or 7.6), for each of the following conditions:

a) without a radio-frequency input signal;

b) with a radio-frequency input signal using a suitable test pattern and sound modulated 30 per cent at the standard reference frequency, the receiver delivering the reference audio output power* (see Section Four, IEC Publication 107, Part 2);

c) as b) but delivering 40 per cent of the reference audio output power;

d) as b) but delivering maximum useful audio output power, obtained, if necessary, by increasing the modulation factor up to 100 per cent; and

e) as b) but in the two extreme conditions of minimum and maximum setting of the brightness control.

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* *The reference output power is defined as a power 10 db below the level of the relevant maximum useful output power.*

7.12 Maximum power and current consumption of receivers

The maximum power **and/or** current consumption of receivers shall be measured under the input signal conditions and setting of user and externally adjustable controls that, while maintaining usable picture and sound give maximum power **and/or** current consumption. When carrying out this measurement, due care should be taken to avoid damage to the receiver under test.

8 RADIO-FREQUENCY INPUT SIGNALS AND INPUT ARRANGEMENTS

8.1 General

To facilitate the comparison of results, the selection of radio-frequency input signals with regard to frequencies and input signal levels used for measurements shall preferably be restricted to a minimum. However, the appropriate measurements shall be made using channels at the extreme ends and distributed within all of the frequency bands for which the receiver is designed. The frequencies used shall conform to the standards of the CCIR system B. Additional measurements shall be made using any channel showing or expected to show anomalous response or receiver behaviour. The video and audio modulating signals are defined in each section describing a particular measurement or groups of related measurements.

8.2 Introduction

Depending on the type of receiver, the radio-frequency signal normally enters the radio-frequency input circuit by an unbalanced or balanced cable with a characteristic impedance equal to the specified source impedance for which the receiver has been designed, or through a (in some cases built-in) magnetic aerial.

The following clauses describe the ways in which measuring signals from a radio-frequency signal generator are applied to receivers of these various types. Great care must be taken in the construction of the matching networks in order that results are reliable at the high frequencies used for television channels.

8.3 Matching networks for providing a specified source impedance for the receiver requiring such impedances

The specified source impedance for which the receiver has been designed (R_r) is not to be confused with the actual input impedance of the receiver, as measurable at the aerial input terminals.

A receiver with a balanced or an unbalanced input circuit for a specified source impedance shall be measured with a signal source having a balanced output e.m.f. or having an unbalanced one, respectively, its internal impedance (R_i) matched to the specified source impedance (R_r).

If the specified source impedance R_r and the internal resistance of the signal source R_i are unequal, a suitable matching network shall be inserted between the signal source and the receiver.

Care shall be taken that connecting cables in the relevant parts of the circuit have characteristic impedances R_r and R_i as appropriate.

If a balanced signal source is not available, a suitable unbalanced-to-balanced transformer (balun) shall be used; its influence on the input signal shall be taken into account in connection with the calculation of the actual value of this level.

Figure 2a to Figure 2e gives examples of matching networks for providing specified source impedances for various cases, including also a balanced-to-unbalanced transformer.

8.4 Combining networks

For the application to two or multi-signal measuring methods, suitable combining networks shall be applied when coupling various signal generators.

Figure 3a and Figure 3b gives the following examples of combining networks for measuring methods using more than one signal generator:

a) unbalanced network for combining two signals; and

b) unbalanced network for combining n signals.

In cases of combination of a symmetrical and an asymmetrical signal generator, a suitable balanced-to-unbalanced transformer (balun) shall be used; its influence on the input signal level, from the relevant signal generator shall be taken into account in calculating the actual value of this level.

A combining network may be followed by a matching network or a transformer, according to the application; its influence on the input signal level shall be taken into account.

Instead of combining several networks, reducing the output resistance of the different generators to that of an equivalent generator and adapting this equivalent generator to the receiver, other networks can be used to adapt the generators to the receivers.

8.5 Balanced radio-frequency input circuit

Some types of receivers are provided with a balanced radio-frequency input circuit, for example to reduce certain types of interference, especially those entering in an asymmetrical mode.

This effect may or may not have been enhanced by applying a form of electrical screening between the actual input coil and the rest of the radio-frequency circuit.

The efficacy of a balanced input circuit is determined by the unbalance ratio, which represents the ability of the circuit to increase the immunity of the receiver to incoming unbalanced signals (asymmetrical mode).

As the unbalance ratio is usually expressed in decibels, it is necessary to specify, apart from the specified source impedance R_r for which the receiver has been designed, the source impedance R_{un} of the unbalanced system to which the receiver input circuit is connected. R_{un} will generally be equal to the characteristic impedance of the unbalanced system, formed by the balanced feeder, as a whole, and earth.

8.6 Method of measurement of the unbalance ratio

The unbalance ratio is determined by measuring the available power (see **10**) of an asymmetrical signal that produces a specified value of output signal and the available power of a normal balanced signal that produces the same value of signal output, the ratio between the two values of available power being expressed in decibels.

Care shall be taken that the measurement is not influenced by the effects of an AFC system or a limiting device. For other special cases, see the relevant part covering the radio-frequency properties of the receiver under test.

The asymmetrical signal shall be applied through a resistive network to the radio-frequency input terminal device of the receiver, as shown in Figure 4.

The configuration of this network is based on the assumption that the input impedance for the asymmetric mode is very high compared with the value of R_{un} and is not necessarily applicable if this condition is not met.

The value of R_{un} in practice depends upon the installation, but a value of 600 Ω is representative of this parameter.

The symmetrical signal shall be applied according to Figure 2a, Figure 2c and Figure 2e.

Both signals shall be applied, and the necessary available power calculated in accordance with the relevant sub clauses of 8. (see **8.3**).

NOTE - The accuracy of the method of measurement is limited, particularly at the higher frequencies used for television and care must be taken in interpreting the results.

8.7 Input arrangements for built-in aerials

If a receiver is provided with built-in aerial or is intended to be connected to an external aerial in the close vicinity of the receiver, the input signal should be provided by means of a radio-frequency field. The various methods of producing such fields which are at present available are not valid for the full range of frequencies for which the need to make measurements exists.

9 RECOMMENDED VALUES FOR RADIO-FREQUENCY INPUT SIGNAL LEVELS

9.1 Introduction

Depending on the type of receiver under consideration and the different input arrangements, various ways of expressing the radio-frequency input level are recommended.

For amplitude-modulated signals (a.m.) and for frequency-modulated signals (f.m.), the electromotive force E' shall be expressed as the r.m.s. value of the unmodulated carrier. For television signals (t.v), the electromotive force E' shall be expressed as the r.m.s. value at the peak amplitude of the unmodulated signal.

For receivers with input circuits for specified source impedances, the input signal level is expressed in decibels (microvolts), in terms of the apparent signal source e.m.f. E'.

To facilitate the direct comparison of receivers for which different source impedances are specified, it is useful to compare the input signal levels in terms of the available power at the output terminals of the relevant network. The available power is the power which would be delivered by the signal generator and its associated network to a matched load.

It is equal to :

$$\frac{E'^2}{4\,R_r}$$

where, measured between the output terminals of the network (see Figure 2a to Figure 2e, Figure 3a and Figure 3b), the apparent signal source e.m.f. E' is equal to the open-circuit voltage caused by the signal generator and R_r is the source impedance of the network, which shall be equal to the specified value (see **8.3**). The available power is preferably expressed in decibels (milliwatts).

Where the input signal level to a receiver is expressed in terms of power, it should be clearly understood that the figure refers to the available power, and if it is expressed in terms of voltage, the source e.m.f. is the value referred to. The actual input power may be less than the figure quoted.

For tests requiring the application of very low input signal levels, care shall be taken that interfering signals entering the receiver, in any spurious way, do not influence the results of the measurements. Relative values for maximum permissible interference signal levels are given in the relevant part covering the radio-frequency properties of the receiver under test.

TABLE 3 - Values of input signal level expressed in terms of available power

Input signal level, expressed in terms of available power			Equivalent source e.m.f. E'	
Recommended values			Approximate values	
Preferred values db(mW)	Intermediate values db(mW)	Equivalent available power $\frac{E'^2}{4R_r}$	For R_r=300 Ω	For R_r=75 Ω
	-120	0.001 pW*	1.1 µV	0.55 µV
-110		0.01 pW*	3.5 µV	1.7 µV
	-100	0.1 pW*	11 µV	5.5 µV
- 90		1 pW*	35 µV	17 µV
	- 80	10 pW	110 µV	55 µV
- 70		100 pW	350 µV	170 µV
	- 60	1 nW	1.1 mV	550 µV
- 50		10 nW	3.5 mV	1.7 mV
	- 40	100 nW	11 mV	5.5 mV
- 30		1 µW	35 mV	17 mV
	- 20	10 µW	110 mV	55 mV
- 10		100 µW	350 mV	170 mV
	0	1 mW	1.1 V	350 mV

* *These values may also be expressed in femtowatts (1 fW = 10^{15}W).*

9.2 Input signal levels, expressed in terms of the available power

If it is deemed desirable to express the values of input signal levels related to the available power, $\frac{E'^2}{4R_r}$ values indicated in Table 3 are recommended, of which those given in the first column are preferred values.

In the last two columns approximate values of source e.m.f. E' for two different values of the specified source impedance R_r are given. Corresponding values may be calculated for other impedance values (see 9.1).

As a first choice, a value of -50 db(mW) is considered to be convenient.

10 TUNING METHODS

10.1 General methods of tuning

Tuning shall be carried out using a signal having a test pattern as vision modulation and a suitable audio-frequency tone, for instance 1 kHz sine-wave tone at 30% modulation depth as sound modulation.

The signal shall be of such a level as to give substantially noise-free reproduction, a convenient initial figure being -50 db(mW).

If the receiver has a calibrated scale or a channel selection switch marked with channel identification, this is first adjusted to correspond to the input signal.

The fine tuning method depends upon both the electrical and mechanical aspects of the design. If the manufacturer's instructions are available, these should be followed.

In the absence of such instructions, the criteria listed below may be used. It is unlikely that all the criteria will be fulfilled for a given tuning condition, so a compromise aimed at optimum performance must usually be adopted.

If an automatic frequency control circuit is included, its effect must be considered when tuning, particularly if it is possible to switch it manually out of operation (see 12.1).

Tuning criteria:

a) tuning indicator;

b) picture sharpness;

c) colour reproduction;

d) rejection of co-channel sound and adjacent channel signals from the picture circuits;

e) satisfactory sound reproduction; and

f) intermediate frequency picture carrier set at the nominal value or the value stated by the manufacturer.

NOTE - For each tuning method the difference from the nominal value or the value stated by the manufacturer of the intermediate frequency picture carrier should be measured and recorded. However, in some receiver designs this may not be possible as the intermediate frequency signal may not be accessible.

Where the tuning control is not calibrated, care must be taken to distinguish between the true or possible spurious responses. The spurious responses will not normally meet the above criteria or will be excessively noisy for reasonable input signal levels.

10.2 Frequency limits of the tuning ranges

Signals shall be applied to the receiver to establish the range of channels in each band to which it is capable of being tuned or to confirm that the extreme channels in the various bands are within its runing ranges.

SECTION TWO - PERFORMANCE CHARACTERISTICS OF TUNING SYSTEMS

11 TUNING SENSITIVITY

11.1 Definition

The tuning sensitivity is the extent by which the receiver tuning may deviate from the correct condition in order to give rise to a just noticeable effect according to the criteria of **10.1**.

11.2 Method of measurement

The receiver is set at a chosen channel near the centre of each band as accurately as possible. A signal generator providing a signal of this same channel with test pattern and sound modulation and (unless otherwise specified due to receiver sensitivity), with a signal level of -50 db (mW) is tuned to the actual operating frequency of the receiver following the procedure specified in **10.1**. The applied method or methods of tuning shall be stated and the actual operating vision carrier frequency determined, for example by means of a digital frequency meter.

The frequency of the signal generator is gradually detuned until a just noticeable mistuning has occurred according to the criteria of **10.1**. The detuning process being carried out for both higher and lower frequencies.

The signal generator is then detuned lower in frequency so that a recognizable signal is not received and the reference frequency gradually approached. The signal generator frequency, at which the criteria of **10.1** are met, is noted and the process repeated approaching the reference frequency from the high-frequency side.

11.3 Presentation of results

The results of the measurements are presented in the form of a table showing the deviations of frequency in a direction away from the reference frequency for which correct operation is maintained and the frequencies at which correct operation is achieved approaching the reference frequency from both directions. The particular criteria of **10.1** that are not complied with when detuning are to be noted.

12 AUTOMATIC FREQUENCY CONTROL PERFORMANCE CHARACTERISTICS

12.1 Introduction

Automatic frequency control (AFC) means a device which automatically tunes a receiver very closely to the frequency of a sufficiently strong signal if the operation frequency (see **13.4**) of the receiver itself, in the absence of any control, would deviate from the frequency of the signal within certain limits. From measurements, the values of frequency errors, pull-in range, hold-in range, etc., can be determined.

The method of measurement described in **12.2** and **12.3** is used where the receiver design is such that an i.f. signal can be conveniently injected. However, in some designs the appropriate terminals are not available, in which case a measurement of tuning sensitivity is carried out as described in **11**.

12.2 Method of measurement

The receiver is set at a chosen channel near the centre of each band, as accurately as practicable.

A signal generator, providing a signal on this same channel, with test pattern and sound modulation and (unless otherwise specified, due to receiver sensitivity) with a signal level of -50 db (mW), is tuned to the actual operating frequency of the receiver, following a procedure specified in **10.1**, the applied method or methods of tuning to be stated and the actual operating vision-carrier frequency being determined for example by means of a digital frequency meter.

A second signal generator, coupled loosely to the receiver, is adjusted to the intermediate frequency until the beat-note observed on the video signal, oscillographically or on the picture display screen, has reached zero. The frequency of the first signal generator (the signal frequency) is then detuned slightly and the change in intermediate frequency is determined by readjusting the second signal generator. This process is repeated, measurements being made for both increasing and decreasing signal frequency, because the ralation between the departure of the latter frequency from the initial operating frequency and the resulting change in the intermediate frequency is, as a rule, irreversible.

Measurements are normally carried out at a frequency near the middle of each of the tuning ranges of the receiver. The measurements may be repeated at other frequencies and input signal levels.

Where a tuning indicator, coupled to the automatic frequency control, is provided, this shall be used to carry out the initial adjustment according to **10.1**.

Where no such tuning indicator is provided, but a switch is incorporated to disconnect the automatic frequency control, the initial adjustment shall be made with the switch in the *off* position.

12.3 Presentation of results

The result of the measurements by the first method are presented graphically by plotting as abscissa the difference between the signal frequency and the reference frequency, plus or minus being indicated, and as ordinate the frequency error, corresponding to the change in i.f. frequency. Both scales shall be linear, and the frequency expressed in megahertz or kilohertz. Arrows point in the direction in which the change in signal frequency takes place.

As a reference, the initial operating frequency shall be chosen.

An example of such a curve, representative for automatic frequency control, is shown in Figure 5.

13 OPERATING FREQUENCY AND ITS STABILITY

13.1 Introduction

The operation frequency is the actual value, at any time, of the frequency at which the receiver operates, according to a specified method of tuning (see 10.1). This frequency may differ from the one to which the receiver was tuned originally.

This deals with measurements of the variation of the operating frequency of a receiver with respect to time, temperature, supply voltage and input signal level. The sign of the variation of operation frequency relative to any reference operating frequency shall be included in the results, since the effect upon the receiver performance may be different.

The operating frequency may be influenced by the operation of an automatic frequency control if present; its performance characteristics are assessed according to 12.

Various measurements can only be adequately performed when the operating frequency of the receiver is reasonably stable, in case of doubt, it is advisable to check the operating frequency stability and to measure the period of initial variation of operating frequency before proceeding to other measurements. See 13.3 and following clauses.

13.2 Method of measurement

The operating frequency is measured by tuning a signal generator, the tuning controls of the receiver remaining in a fixed position, following a procedure specified in 10.1.

The operating frequency is subsequently determined by assessing the frequency of the signal generator with a suitable frequency measuring device.

The chosen method of tuning shall be stated with the results.

13.3 Variation of operating frequency with time

If no other influence is present, the variation of the operating frequency with time is mainly due to the temperature dependence of the component characteristic and the internal heating of the receiver. It is expressed as the frequency difference including its sign, in kilohertz., between the actual operating frequency and an arbitrary reference frequency, as a function of time.

13.4 Method of measurement

The value of the variation of the operating frequency with time shall be derived from a series of measurements of the operating frequency in a specified period, under constant supply voltage, ambient temperature and relative humidity, without touching the tuning controls.

If the receiver is provided with a switchable automatic frequency control device, the measurements should be carried out with it both operative and inoperative.

NOTE - Where the automatic frequency control device is automatically switched off during manual tuning and automatically becomes operative at the end of the tuning procedure, the receiver shall not be considered to be provided with switchable AFC.

If applicable, it is recommended that the measurement be repeated at the lowest and the highest values of the ambient temperature to be encountered in practice. Measurements may also be repeated for a range of ambient temperatures.

13.5 Period of initial variation of operating frequency

The period of initial variation of operating frequency is the time elapsing between initial switching on and the establishment of a condition in which the frequency stays within a specified tolerance. The initial variation of operating frequency has two values, corresponding to the upper and lower limits of the frequency variation with respect to the reference operating frequency.

13.6 Method of measurement

Before the commencement of the measurements, the receiver shall be switched off for a sufficiently long period for all parts of the receiver to attain approximately the test - room temperature.

The duration and the extent of the initial variation of operating frequency shall be derived from the results of a series of measurements of the operating frequency.

Time is measured from the moment of switching on, but the frequency measurements begin as soon as these are performable.

13.7 Presentation of results

The variation in frequency is plotted as a function of time in a curve having, as abscissa, the time in minutes on a logarithmic scale and, as ordinate, the frequency change in kilohertz on a linear scale.

As reference, the operating frequency at 1 min or, where necessary, 5 min after the initial switching on may be chosen.

An example of curves showing the initial variation of operating frequency Δf_i, its duration, t_i, is given in Figure 6.

13.8 Operating frequency as a function of the supply voltage

A variation in the supply voltage may result in a change of the operating frequency of a receiver. The operating frequency is determined according to **13.2** as a function of the supply voltage, the latter being varied within the limits of overvoltages and undervoltages as laid down in **7**.

This measurement shall not be performed during the period of initial variation of operating frequency.

13.9 Presentation of results

Curves representing the operating frequency as a function of the supply voltage are plotted with the frequency variation as ordinate, expressed in kilohertz, on a linear scale, the frequency at nominal supply voltage being chosen as reference point. The supply voltage variation is expressed as a percentage on a linear horizontal scale.

An example of a curve showing the operating frequency as a function of the supply voltage is given in Figure 7.

13.10 Operating frequency as a function of the input signal level

A variation in the input signal level may result in a change of the operating frequency of a receiver. The operating frequency is determined according to **13.3** as a function of the radio-frequency input signal level, the signal applied being varied over the full range of recommended values, in accordance with **9.1** and **9.2**.

The measurement shall not be performed during the period of initial variation of operating frequency.

NOTE - For practical reasons, and if applicable, this measurement may be combined with the AGC measurement in accordance with **41.2**.

13.11 Presentation of results

Curves representing the operating frequency as a function of the input signal level are plotted with the frequency variation, expressed in kilohertz, as ordinate on a linear scale, the recommended reference value depending on the receiver sensitivity being that obtained with an input signal level of -50 db(mW). The input signal is expressed in decibels on a horizontal linear scale.

An example of a curve showing the operating frequency as a function of the input signal level is given in Figure 8.

14 GENERAL MECHANICAL PROPERTIES OF TUNING SYSTEMS

14.1 Introduction

The following general properties determine the quality of the mechanical part of the tuning system.

They apply to manually tuned receivers, to receivers with presettable tuning systems, and to the process of tuning such presettable systems to the required channel.

14.2 Mechanical tuning characteristic

The mechanical tuning characteristic of a receiver is understood to mean the travel, for a certain change in frequency, of a point on the periphery of the part of the tuning control normally handled. It is expressed in millimetres per kilohertz or megahertz depending upon the frequency band and total control range.

This measurement shall preferably be made at the measuring frequencies specified in **8.1**. Care shall be taken that the results of the measurements are not influenced by play in the tuning mechanism (see **14.5**) and that allowance is made for the effect of any automatic frequency control system. If such a system is available and switchable, measurements shall be made for both conditions.

14.3 Tuning dial characteristic

The tuning dial characteristic of a receiver is understood to mean the dial length corresponding to a certain change in frequency. It is expressed in millimetres per kilohertz, megahertz or by channel numbers.

These measurements shall preferably be made at the measuring frequencies specified in **8**.

14.4 Calibration error

The difference between the operating frequency of a receiver and the indication read on its dial is the calibration error of the receiver at that operating frequency. It is expressed in kilohertz or megahertz and its maximum value for each tuning range shall be stated, together with the chosen method of tuning, as described in **10.1**, using a signal of known frequency, its accuracy being stated with the results.

The calibration error shall preferably be determined at the measuring frequencies specified in **8**, and unless otherwise specified at an input signal level of -50 db(mW).

Care shall be taken that the results of the measurement are not influenced by play in the tuning mechanism (See **14.5**).

If necessary, the calibration error shall be determined by tuning the receiver in both directions of the frequency scale.

The receiver shall have reached its steady temperature state before measurements are started.

NOTE - This measurement is significant only if the dial has a graduated and calibrated scale.

14.5 Play in the tuning mechanism

Play in the tuning mechanism is separated into play of the tuning knob and play of the indicator.

Measurement of play shall be, made by tuning the receiver twice to the same frequency, tuning the tuning knob first in one direction and then in the opposite direction. The two adjustments to the same operating frequency shall be ascertained by the criteria of **10.1** or by the method using an auxiliary generator tuned to the intermediate-frequency of the receiver, analogous to that of **12.2**. In case of play, two different positions of the tuning knob and likewise two different positions of pointer will be found.

The play of the tuning knob is defined as the angular difference between the positions of the tuning knob found by tuning in opposite directions to the same frequency. The travel between the two positions of the knob may be translated to kHz at any operating frequency of the receiver and the results compared, with the mechanical tuning characteristic in accordance with **14.2**.

The play of the indicator is defined as the ratio of the difference between the two indicated positions, found by tuning in opposite directions to the total movement of the pointer. Also, in this case, the difference between the two positions may be converted into kHz and the results compared, with the tuning dial characteristic in accordance with **14.3**.

15 PERFORMANCE CHARACTERISTICS OF PRE-SETTABLE TUNING SYSTEMS

15.1 Introduction

Pre-settable tuning systems can be divided into three groups:

a) mechanical systems, in which one of a number of pre-selected frequencies is chosen, either in a purely mechanical way, or by means of a suitable mechanism, such as an electric motor;

b) electrical systems, in which one of a number of pre-selected frequencies is chosen by means of presettable switches, either directly, by actuating a motor-driven switching system, or applying a pre-selected potential to a voltage-dependent reactor; and

c) systems using a combination of both methods.

Any system may or may not be equipped with a correcting system of automatic frequency control, according to **12**.

The tuning errors that may occur and their dependence on various conditions shall be determined.

15.2 Methods of measurement

Receivers with a presettable tuning system which are not provided with automatic frequency control shall initially be tuned according to the manufacturers instructions to one of the recommended frequencies of 8, this being the operating frequency.

Method (A)

During the following frequency measurements, no radio-frequency input signal shall be applied.

The oscillator frequency f_{o0}, corresponding to the operating frequency, shall be measured and used as the reference frequency for this series of measurements.

A starting position, corresponding to a different frequency from that chosen for measurement is selected. That chosen for measurement is now selected and the resulting oscillator frequency measured. This porcedure is repeated until a sufficient number of frequency measurements has been obtained, but at least ten times, resulting in for example ten. possibly different, frequencies f_{o1} to f_{o10}.

The differences between these frequencies are the tuning errors, which shall be presented in the following way:

a) The individual tuning error:

$$\Delta f_i = f_{oi} - f_{o0} \text{(kHz)}$$
$$i = 1,..n$$

b) The mean tuning error for n measurements:

$$\overline{\Delta f_{(n)}} = \frac{1}{n} \sum_{i=1}^{i=n} \Delta f_i \text{(kHz)}$$

c) The standard deviation from the mean tuning error for n measurements:

$$S_{(n)} = \pm \sqrt{\frac{1}{n-1} \sum_{i=1}^{i=n} \{\Delta f_i - \overline{\Delta f_{(n)}}\}^2} \text{(kHz)}$$

If the mean tuning error or the standard deviation depends on the magnitude and sense of the difference between the frequency of the starting position and the chosen operating frequency, the dependence of the values of the mean tuning error and the standard deviation can be determined and given in graphical form.

The measurements shall be repeated with another combination of selections, from which the most unfavourable performance shall be derived and stated with the results.

The measurements shall also be repeated at other frequencies described in **8.1**.

If the accuracy of tuning depends on the force with which a button is pressed or on the voltage applied to the driving mechanism, these values shall be varied between their permissible limits and quoted with the resulting tuning errors at these limits.

Method (B)

In some cases, it may be inconvenient or impossible to measure the oscillator frequency, in which case after tuning the receiver to the selected operating frequency, the radio-frequency input signal shall remain connected.

A starting position, corresponding to a different frequency from that chosen for measurement is selected. That chosen for measurement is now selected and the sound and picture reproduction noted for compliance with the criteria of 10.1. This procedure is repeated until a sufficient number of observations has been made, at least ten, resulting in, for example ten, possibly different, tuning conditions. Measurements shall also be repeated at other frequencies as described in **8**.

If the accuracy of tuning depends on the force with which a button is pressed or the voltage applied to the driving mechanism, these values shall be varied between their permissible limits and quoted with the resulting observations at these limits.

15.3 Presentation of results

Method (A)

In case the mean tuning error or the standard deviation depends on the sense and the frequency spacing between the frequency of the starting position and the chosen operating frequency, these relations shall be presented graphically by plotting, as abscissa, the difference between the frequency of the starting position and the chosen operating frequency, plus or minus being indicated, and, as ordinate, the corresponding mean tuning error $\overline{\Delta f_{(n)}}$ with its sign, and the standard deviation $S_{(n)}$. Both scales shall be linear, frequency being expressed in kilohertz. The operating frequency corresponding to the reference frequency f_{oo} and the number of measurements n shall be given with the results.

Figure 9, shows an example of curves giving the mean tuning error and the standard deviation for a presettable tuning system, as functions of the difference between the frequency of the starting position and the chosen operating frequency.

Method (B)

The number and proportion of the observations in which the criteria 10.1 are met should be tabulated, and the effects recorded for the occasions when the criteria are not met.

SECTION THREE - GEOMETRICAL PROPERTIES OF THE PICTURE

16 PICTURE SIZE

16.1 Definition

The picture size as given by the dimensions of the available picture reproduction area is defined by the following three quantities, maximum picture height in centimetres, maximum picture width in centimetres, and effective picture area in square centimetres. It is assumed that under standard measuring conditions, the visible part of this area is completely filled with the television picture.

16.2 Method of measurement

The maximum picture height and width are determined by means of a sliding gauge, cathetometer or other suitable device. To ascertain the effective picture area, a photograph of the picture reproduction area may be taken from a point situated on the optical axis of this area at a distance of ten times the maximum picture height. From this photograph the effective picture area may be determined.

16.3 Presentation of results

The results shall include a note of which method of measurement has been used. This is because the results obtained by the photographic method are not directly comparable with those obtained by means of a gauge or similar device.

17 CURVATURE OF PICTURE SCREEN

17.1 Definition

The curvature of the picture screen is defined by the ratio between the picture depth and the maximum picture height or maximum picture width, whichever has the greatest curvature, only the selected one being stated with the result. The picture depth is defined as the distance between two geometrical planes, both perpendicular to the optical axis, one going through the point nearest to the observer and the other going through the most distant points of the visible reproduction area.

17.2 Method of measurement

The picture depth may be measured with the aid of a travelling microscope or other suitable means.

18 GEOMETRICAL DISTORTION

18.1 Introduction

Any deviation in the reproduced picture from the transmitted signal relationship between time and the co-ordinates of the picture elements is a geometrical distortion. Geometrical distortions can be divided into three categories; these are described in 18.2, 18.3 and 18.4.

18.2 Influence of mains supply related effects on geometrical distortion

A part of the total geometrical distortion may be caused by effects related to the mains supply. These are most noticeable when the mains supply frequency differs slightly from the field frequency.

18.2.1 *Method of measurement*

The receiver is operated from a mains supply differing by approximately 1 Hz from the field frequency. The excursion of the points in the picture where the greatest vertical or horizontal displacements are observed and the displacements are measured.

18.2.2 *Presentation of results*

The displacements measured are expressed as a percentage of the active horizontal or vertical scan periods as appropriate.

18.3 Non-linearity of scanning

Distinction is made between horizontal and vertical non-linearity.

Horizontal non-linearity is evaluated by means of the relative deviation of the horizontal velocity of the scanning spot projected orthogonally on to the tangential plane through the centre of the picture reproduction area. The relative deviation is the difference between the instantaneous velocity and the mean velocity, expressed as a percentage of the mean velocity of the scanning spot and is given in a graph representing the deviation as a function of time.

Similarly, vertical non-linearity is evaluated by means of the relative deviation of the vertical velocity of the scanning spot.

Both horizontal and vertical non-linearity should be measured in terms of geometrical distortions along a horizontal and a vertical line approximately through the centre of the picture area.

If the relative phase between the mains supply and the received signal vertical scan synchronization significantly influences the non-linearity of scanning, the measurements should be made with the test signal generator not locked to the mains supply frequency but with the difference frequency suitably low.

18.3.1 *Method of measurement*

An electronically generated test pattern may be used consisting of a system of horizontal and vertical lines, both equidistant in time, dividing the picture area into elementary areas of approximately square shape. It is preferable but not essential that these dividing bars themselves be visible but at least the corners of the elementary areas (intersection points of the lines) must be visible. It is desirable to use at least ten dividing bars because the information given by the measurements increases with the number of dividing bars. If desired, the horizontal and vertical lines may be used separately for these measurements. To ascertain the non-linearity, a photograph of the reproduced pattern may be taken under the same conditions as mentioned in **16.2**.

A cathetometer or other suitable means may also be used, as an alternative, but only if the picture is sufficiently stable.

The distance between two adjacent intersection points of the projected pattern is used to determine the instantaneous velocity.

The total distance traversed divided by the number of intervals is used to determine the mean velocity.

18.3.2 Graphic representation

The non-linearity is plotted on a linear time scale as abscissa and a linear-percentage scale as ordinate. The equal time intervals corresponding to the divisions of the picture area by the line pattern are marked on the abscissa.

The difference between the instantaneous velocity and the mean velocity is plotted as a percentage of the mean velocity at the centre of each time interval on the abscissa.

In the graph of Figure 11, short-time non-linearity of scanning, such as results from scan ringing, does not necessarily appear. To measure such deviations, a finer pattern may be necessary, but to reduce measurement errors, measurements may be taken over groups of lines.

18.4 Picture outline distortion

Picture outline distortions are deviations from a true rectangle of the largest completely visible contour of approximately the correct aspect ratio formed by the test pattern.

18.4.1 *Method of measurement*

An electronically generated test pattern as described in **18.3.1** may be used.

If desired, the horizontal and vertical lines may be used separately for these measurements. To ascertain the picture outline distortions, a photograph of the reproduced pattern may be taken under the conditions specified in **16.2**.

The distorted reproduction of the contour of the largest completely visible rectangle formed by the test pattern and having approximately the correct aspect ratio is traced (see Figure 12b) on this photograph, or a similar projection of the reproduced pattern, on a plane perpendicular to the optical axis.

This contour is normall y adequate and should be reproduced with the results. If one form of distortion predominates, it may be measured in accordance with the following methods.

The corner points A, B, C and D are marked and the auxiliary lines AB, BC, CD, DA, KF and HE are then drawn so that AE = EB, BF = FC, CH = HD, DK = KA (see Figure 12b).

The distance between AB and the point of the contour lying farthest away from AB inside the quadrilateral ABCD is called a_1.

The greatest distance between the line AB and that part of the contour between A and B lying outside the quadrilateral ABCD is called a_2.

The distances b_1, b_2, c_1, c_2, d_1 and d_2 are similarly defined.

It possible to specify the following distortion percentages:

horizontal trapezium distortion

$$T_H = \frac{AB - BC}{AD + BC} . 100\%$$

and
vertical trapezium distortion

$$T_v = \frac{AB - DC}{AB + BC} . 100\%$$

If the contours AB and DC lie completely outside the quadrilateral ABCD, only a_2 and b_2 can be measured and the

horizontal barrel distortion

$$B_H = 2 . \frac{a_2 + b_2}{AD + BC} . 100\%$$

If the contours AB and DC lie completely within the quadrilateral ABCD, only a_1 and b_1 can be measured and the

horizontal pincushion distortion

$$C_H = 2 . \frac{a_1 + b_1}{AD + BC} . 100\%$$

similarly if only c_2 and d_2 can be measured the vertical barrel distortion

$$B_v = 2 . \frac{c_2 + d_2}{AB + CD} . 100\%$$

and if only c_1 and d_1 can be measured the vertical pincushion distortion

$$C_v = 2 . \frac{c_1 + d_1}{AB + CD} . 100\%$$

Parallelogram distortion is expressed by the angle α in degrees.

Ripple distortion of the contour is present when the contours AB, CD BC and DA show undulations (see Figure 12b).

If desired, the peak-to-peak value of such undulations or oscillations can be expressed as a percentage of picture height or width (Figures 12c, 12d and 12e) the values being taken from the contour reproduction.

Greater distortions of picture outline may occur nearer the centre of the screen than that defined by the largest completely visible rectangle of the test pattern. In this case, the measurements should be repeated for smaller rectangles and the size of all the rectangles used with the results.

Since the picture outline distortion may also be influenced by beam current, additional measurements may be made by increasing the background level of the pattern. The background level or levels used should be recorded with the results as a percentage of the signal voltage difference between black level and white level.

19 OVERALL GEOMETRICAL DISTORTION ALTERNATIVE METHOD OF MEASUREMENT

19.1 Definition

This measurement procedure provides an overall indication of the scanning non-linearity and picture outline distortion. It may be used to give more rapid results than the separate methods described in **18**.

19.2 Method of measurement

A grill pattern is applied to the receiver having at least 14 horizontal lines and 19 vertical lines.

The vertical lines shall be of approximately sine-squared form with a duration at the half amplitude points of 0.2 µs to 0.3 µs. The amount of signal drive applied to the picture tube must be such that any defocusing that may occur does not affect the accuracy of measurement.

Each horizontal line shall consist of a pair of specially adjacent lines, one in each of the pair of interlaced fields.

The peaks of the horizontal and vertical lines shall be at white level and the background normally at black level. In order to ascertain the effect of beam current, the background should be adjustable in level.

The point of intersection of the horizontal and vertical lines nearest to the geometrical centre of the picture is defined. The mean vertical line spacing is determined by measuring the distance between the second vertical line to the left and the second vertical line to the right of the centre intersection and dividing by 4.

The mean horizontal line spacing is determined in the same way with the second horizontal lines above and below the centre intersection.

Using the mean spacing as a reference, the horizontal displacements of the vertical lines from their theoretically correct positions along all the horizontal lines are measured. The process is then repeated for the vertical scan direction by measuring the vertical displacements of the horizontal lines along all of the vertical lines.

The measurements may be conveniently carried out by photographing the pattern. Where the picture is sufficiently stable, measurements may be carried out using a sliding gauge, cathetometer, or other suitable device.

19.3 Presentation of results

The displacements of the intersections of the pattern are to be expressed as a percentage of the maximum picture width and height respectively (see 16). They are to be tabulated identifying the intersections by assigning a pair of co-ordinates obtained by numbering the lines in the direction of scan, the first representing the vertical scan direction and the second, the horizontal scan direction (see Figure 12f).

20 CONVERGENCE ERRORS

20.1 Definition

Convergence errors are the extent to which all three electron beams of a colour display tube fail to converge upon a common phosphor triad over the entire screen area.

20.2 Method of measurement

A grill pattern is applied to the receiver having at least 14 horizontal lines and 19 vertical lines.

The vertical lines shall be of approximately sine-squared form with a duration at the half amplitude points of 0.2 s to 0.3 s. The amount of signal drive applied to the picture tube must be such that any defocusing that may occur does not affect the accuracy of measurement.

Each horizontal line shall consist of a pair of specially adjacent lines, one in each of the pair of interlaced fields.

The background of the patterns shall be at black level and the peaks of both horizontal and vertical lines shall be at white level.

The vertical and horizontal separation between the red and green components and the vertical and horizontal separation between the blue and green components is measured along the vertical and horizontal lines at their intersections (see Figure 12f).

20.3 Presentation of results

The results are to be tabulated for:

a) red/green horizontal error;

b) red/green vertical error;

c) blue/green horizontal error;

d) blue/green vertical error.

the separations measured being expressed as a percentage of maximum picture width (see **18**) and related to the appropriate intersection. The intersections may be identified by assigning a pair of co-ordinates obtained by numbering the lines in the directions of scan, the first representing the vertical scan direction and the second, the horizontal scan direction (see Figure 12f).

21 OVER-AND UNDER-SCANNING AND CENTRING

21.1 Definition

The displayed picture area may not correspond with the total active picture of the applied signal, some parts being obscured due to over-scanning. Alternatively, the displayed picture may not entirely fill the available screen area due to under-scanning.

21.2 Method of measurement

An electronically generated test pattern may be used consisting of a system of horizontal and vertical lines both equidistant in time dividing the picture into elementary areas of approximately square shape. One vertical and one horizontal line should correspond with the mid-points of the active picture period and means should be included to identify the centre of the picture as represented by the intersection of these two lines. The number of lines included in the pattern depends upon the required accuracy of measurement.

The centre of the screen area is derived from the maximum picture height and width, determined as in **16**. The separation of the mid-point of the pattern from the centre of the screen and the amounts of over-and under-scanning are measured on the horizontal and vertical scanning axes.

21.3 Presentation of results

The over and under scanning, also the displacement of the centre of the picture, are plotted on line diagrams for the horizontal and vertical scanning axes expressed as a percentage of the maximum picture height and width (see Figure 10).

NOTES

1 This measurement may be carried out over a range of power supply voltages as described in **6**.

2 This measurement may be carried out using a range of adjustments of the appropriate user controls.

3 This measurement may be carried out using picture content having low, medium and high average values.

SECTION FOUR - SYNCHRONIZING QUALITY

22 LINE SCAN PHASE ERROR CHARACTERISTIC

22.1 Introduction

The phase error characteristic of a line scan flywheel circuit indicates the extent to which the receiver line scan circuit will follow phase perturbations present on the line synchronizing pulses and thus indicates the disturbance that will occur to vertical picture components in the presence of either random or coherent noise affecting the line synchronizing pulse train and the associated picture signal. Such perturbations may be present in the output signal of some video recording and reproducing equipment.

22.2 Method of measurement

The measurement procedure is shown in Figure 13. The line synchronizing pulse generator is phase modulated by the output of a low-frequency sine-wave oscillator. The phase error is displayed on the oscilloscope, care being taken to ensure that the trigger is taken from the correct point. The level of signal applied to the receiver shall be such that noise and overloading effects are avoided.

Measurements should be carried out for a range of perturbating frequencies extending from below field frequency up to half line scan frequency. A typical characteristic is shown in Figure 14, indicating that below a given frequency, the receiver line scan generator tracks with the perturbating signal while at some high frequency no tracking occurs due to filtering action of the flywheel automatic phase control circuit. The result is plotted with the frequency of perturbation on a logarithmic horizontal scale and the receiver line scan generator tracking error as a percentage on a linear vertical scale.

22.3 Presentation of results

The value of $\frac{|\phi_o - \phi_1|}{|\phi_o|}$ % is plotted as a function of the frequency of perturbation by the low frequency sine-wave oscillator where
ϕ_o = phase deviation of the input synchronizing signal.
ϕ_1 = phase deviation of the line scan oscillator output
(see Figure 14).

23 LINE SCAN PHASE TRANSFER CHARACTERISTIC

23.1 Introduction

The phase characteristic of a line scan flywheel circuit indicates the extent to which the receiver line scan circuit will reject noise present on the synchronizing signals that does not also phase-modulate the associated picture signal. This is the situation when receiving a signal accompanied by background noise.

23.2 Method of measurement

The measurement procedure is as in **22.2** except that the oscilloscope connections are different (see Figure 15), a typical characteristic is shown in Figure 16, indicating that the receiver line scan generator response falls with increasing frequency of perturbation. The result is plotted with frequency on a logarithmic horizontal scale and the receiver line scan generator perturbation as a percentage on a linear vertical scale.

23.3 Presentation of results

The value of $\frac{|\phi_1|}{|\phi_o|}$ % is plotted as a function of the frequency of perturbation by the low frequency sinewave oscillator where
ϕ_o = phase deviation of the input synchronizing signal.
ϕ_1 = phase deviation of the line scan oscillator output
(see Figure 16).

24 METHOD OF MEASUREMENT OF LINE SCAN SYNCHRONIZING RANGE

The hold-in range of line scan generator is measured by setting the receiver for optimum performance using a signal of nominal line scan frequency. The receiver line scan oscillator frequency is then slowly varied in the high-frequency direction until synchronization is lost. The input signal is removed and the free-running frequency of the line scan generator is measured. This procedure is then repeated in the low-frequency direction and the two frequencies noted at which unlocking occurs. Since the line scan generator frequency may be influenced by noise present when the input signal is removed, it is recommended that the picture carrier input is retained and the modulation removed. The carrier level in the absence of modulation must be carefully controlled since overloading may take place when the synchronizing signal is not present.

The pull-in range is measured by adjusting the receiver line scan generator to a free-running frequency in the high-frequency direction outside the range at which locking occurs. The oscillator is then slowly moved towards the nominal frequency and frequency noted at which locking occurs. This procedure is then repeated starting from the low-frequency direction.

It may be more convenient in some cases to carry out these measurements by varying the frequency of the master oscillator in the waveform generator.

Since receivers employing either direct lock rather than a flywheel or dual mode flywheel automatic phase control circuits may be capable of locking over a very wide range of frequencies, care must be taken with these measurements not to introduce so great a frequency error that damage to the scanning circuit might result.

The results may be conveniently expressed by marking the frequencies of interest on a frequency scale.

See note 1 to note 5 in 33.

25 METHOD OF MEASUREMENT OF PULLING ON WHITES

A test pattern, having the appropriate black and white and black and coloured areas of high saturation and luminance (that is yellow) near the edges of the picture, is applied, to the receiver and the horizontal displacement d of those parts of a vertical bar in the picture that are co-linear with the picture content near the edges, this displacement is expressed as a percentage of the picture width.

See Figure 17a and note 1 to note 4 in 33.

26 METHOD OF MEASUREMENT OF PULLING ON VERTICAL SYNCHRONIZING PULSES

Measured as the horizontal displacement d_1 at the top of a vertical bar expressed as a percentage of the picture width w and the extent V of this effect expressed as a percentage of the picture height h. If the displacement exhibits one or more undulations, their positions in the vertical axis and their extent should be noted (see Figure 17b).

27 METHOD OF MEASUREMENT OF RAGGING

Displaying a test pattern signal containing vertical lines, random displacements of groups of scanning lines in the picture should, where possible, be expressed as the average displacement as a percentage of picture width, together with the distribution in the vertical scan direction.

See note 1 to note 5 in 33.

28 METHOD OF MEASUREMENT OF WEAVE AND RIPPLE

Coherent horizontal displacements of a vertical bar should be expressed as a percentage of picture width and the frequency or frequencies estimated.

See note 1 to note 5 in 33.

29 METHOD OF MEASUREMENT OF HORIZONTAL SCAN PHASING

The accuracy of phasing of the scan relative to the line synchronizing pulses is assessed by expressing the portions w_1 of the picture at the left or right-hand edges that are missing or folded as a percentage of the picture width w. The effect of the horizontal frequency or horizontal hold control must be included in the results. If the receiver is fitted with a horizontal phase control, this should be adjusted to the optimum position (see Figure 17c).

See note 1 to note 4 in 33.

30 METHOD OF MEASUREMENT OF QUALITY OF INTERLACE

The distances between a given scanning line of one identical field and the two adjacent lines belonging to the other interlaced field of the pair each expressed as a percentage of the distance between two consecutive lines of a single field, shall be measured at several points on the screen (see Figure 18).

Particular note is to be taken of the effect of the field or vertical hold control and the effect of small variations in the picture height and vertical linearity controls. If the receiver is fitted with an interlace control, this is adjusted for optimum performance. Observations of the line spacing can be made easier by turning down the brightness of the picture tube to a observable amount and by using a magnifying glass.

See note 1 to note 6 in 33.

31 METHOD OF MEASUREMENT OF JUMPING

Vertical movement of the picture is expressed as a percentage of the picture height, note being taken whether the disturbances are random or coherent.

See note 1 to note 6 in 33.

32 SCAN GENERATOR FREQUENCY VARIATION WITH TIME

32.1 Method of measurement

A television signal of convenient level modulated with a test pattern is applied to the receiver input terminals and the receiver adjusted for optimum results. All modulation, inlcuding the synchronizing signals, is removed from the picture carrier which remains applied at a suitable level to suppress background noise effects that might otherwise influence the results.

Line and field scan frequency are set to their nominal value and a series of measurements made at suitable intervals until frequency stability has been achieved, with the receiver operating under conditions of constant supply voltage, ambient temperature and relative humidity. If applicable, the measurements shall be repeated at the lowest and highest values of ambient temperature to be encountered in practice.

NOTE - It may not be possible to carry out this test in some receiver designs since in such cases damage may occur to the scan generators, or misoperation of automatic gain control circuits may occur in the absence of synchronizing signals.

32.2 Presentation of results

The variation in frequency is plotted as a function of time in a curve having as abscissa the time in minutes on a logarithmic scale and as ordinate the frequency change in hertz.

33 METHOD OF MEASUREMENT OF EFFECTS OF SCANNING CIRCUITS UPON COLOUR SIGNAL DECODING

A test pattern signal is applied to the receiver and the hold or scan frequency controls adjusted over the range giving satisfactory scan synchronization. Any effect upon colour decoding is noted.

NOTES

1 This measurement may be carried out over a range of power supply voltages as described in **6**.

2 This measurement should be carried out at an input signal level of - 50 db(mW) and at other levels as appropriate depending upon the behaviour of the receiver.

3 This measurement should be repeated, using a range of adjustments of the user controls.

4 This measurement may be carried out using picture content having low, medium and high average values.

5 This measurement may also be carried out with impulsive interference present on the input signal.

6 This measurement may be carried out for various phase relationships between supply mains wave-form and field synchronizing pulse.

SECTION FIVE - SENSITIVITY

34 GENERAL CONSIDERATIONS

Measurements are carried out unless otherwise stated, using the standard image and the standard video output voltage. Where performance is not measured on all channels in which the receiver is designed to operate, it should be carried out on a representative number of channels (see **3.16**). When an overall figure for the receiver sensitivity is required, it should be that corresponding to the channel having the lowest sensitivity and that channel shall be identified in the results.

35 STANDARD IMAGE AND STANDARD VIDEO OUTPUT VOLTAGE

35.1 Definition

A standard image is defined as a display in which those parts of the picture corresponding to white level have a luminance of 80 cd/m^2, and those parts corresponding to black level have a luminance of 2 cd/m^2 both in the absence of ambient illumination. Other levels of luminance may be used if the receiver has special characteristics or if the manufacturer's information infers that different values from those recommended should be used. In these cases, the levels of luminance used and why they were used shall be stated with the results. The standard image shall take the form of a test pattern in which the mean level of the picture modulation is close to 50% (see **3.20**).

The pattern should include an area at white level sufficiently large for luminance measurements to be carried out conveniently and distinguished through interfering noise. The corresponding voltage excursion between black level and white level at the appropriate electrodes of the picture tube is the standard video output voltage.

35.2 Method of measurement

The standard video output voltage is measured at the appropriate picture tube electrodes by means of an oscilloscope. Where a colour display tube uses different drive levels for the various guns, the greatest of them is considered to be standard video output voltage; the receiver grey scale tracking having been first correctly adjusted to correspond with the white point of the intended television system.

Care must be taken that any beam current limiting device does not influence results when defining the standard video output voltage. Alternatively, where appropriate, that beam current limiting must be so adjusted that it is not operative at the standard video output voltage.

36 GAIN LIMITED SENSITIVITY

36.1 Definition

The gain limited sensitivity of the receiver is the lowest value of the available power from a signal source (see 9.1) required to obtain the standard image (see 35.1) when the gain controls are set for maximum amplification.

36.2 Method of measurement

The input signal shall be a television signal with test pattern picture content consistent with the standard image (see 35.1) and with components giving 100 per cent picture modulation (see 3.15).

The input signal is applied to the input terminals of the receiver as described in 8. The carrier frequency of the signal generator is adjusted to the carrier frequency of the television channel selected. The receiver is tuned in accordance with 11.

The controls of the receiver should be adjusted for maximum sensitivity.

The input signal level is then adjusted until the standard video output voltage is obtained, this level being the input level corresponding to the gain-limited sensitivity of the receiver. Measurements should be carried out using a representative number of channels in each of the bands for which the receiver is designed.

37 NOISE LIMITED SENSITIVITY

37.1 Definition

The p-p signal ratio is the ratio between the peak-to-peak black level to white level r.m.s. noise. Level voltage swing at the appropriate picture tube electrodes corresponding to the standard image (see **35**) and the r.m.s. noise voltage at the same picture tube electrodes which occurs at 50 per cent picture modulation. At the valve of the input signal level that provides the standard video output voltage, this ratio may attain a value which is considered unacceptable. This value is not the same for all receivers. In cases, however, when it is considered practical to define a certain value for this ratio which limits the acceptability of the receiver performance, the available power input for which this value is obtained is called the noise limited sensitivity. This value can be marked on the $\frac{\text{p-p signal}}{\text{r.m.s. noise}}$ ratio curve (see **37.2**).

37.2 Method of measurement

Radio-frequency input signal containing monochrome picture modulation at levels, 0 per cent, 50 per cent and 100 per cent either simultaneously in the pattern (see Figure 19a) or by adjustment of the pattern generator and with a switchable colour synchronizing signal, is applied to the input terminals of the receiver. Two sets of measurements are made, one with the colour synchronizing signal included so that the colour decoding circuits are operative and the other with the colour synchronizing signal removed.

The receiver is always set for standard video output voltage (see **35**). The level of the input signal is varied in steps and at every step, the r.m.s. noise voltage is measured with an oscilloscope. Since the r.m.s. noise voltage cannot be determined exactly by this method, it is recommended that the ratio between the excursions observed on the oscilloscope screen and the r.m.s. noise voltage be established before the measurement is carried out. To do this, a noise signal of known r.m.s. value and having a bandwidth approximately equal to the noise bandwidth of the receiver is applied to the oscilloscope. The bandwidth of the oscilloscope must be greater than the bandwidth of the receiver.

NOTES

1 As an aid to assessing the r.m.s. noise voltage on the oscilloscope screen, the signal from the receiver may be applied to both channels of a dual trace oscilloscope. The traces are then shifted together until the two halos due to the noise just meet. A noise signal may then be applied alone to the two oscilloscope inputs, care being taken that the traces are not shifted, and the noise signal level adjusted again until the two halos just meet. The value of noise signal may be read from the calibrated signal generator output. The $\frac{\text{p-p signal}}{\text{r.m.s. noise}}$ *ratio is obtained as a function of the available power and a curve plotted as shown in Figure 19b.*

The impairment caused by a given r.m.s. noise voltage is influenced by various characteristics of the receiver. This should be kept in mind when comparing different receivers.

2 For monochrome receivers, only the second set of measurements shall be made.

3 This measurement may alternatively be carried out using a suitable video noise measuring instrument.

38 SYNCHRONIZING SENSITIVITY

38.1 Definition

The synchronizing sensitivity is the level of the input signal applied to the receiver for which synchronization is completely or partly lost, causing the picture quality to become unacceptable.

38.2 Method of measurement

The receiver is set up for a standard image with a television signal modulated by a test pattern (see 3.20) applied to the input terminals. Subsequently, the input signal level is reduced in steps completely interrupting the signal on each occasion. The user controls are adjusted for optimum performance at each level. The level at which the picture becomes unacceptable due to loss of synchronization should be noted, this input level being the synchronizing sensitivity. The manner in which the synchronization is lost should also be noted. In some cases, the picture may be unacceptable due to noise or lack of contrast rather than loss of synchronization, in which case the synchronizing sensitivity cannot be defined.

39 COLOUR SENSITIVITY

39.1 Definition

The colour sensitivity is the level of input signal applied to a colour receiver at which the colour decoding circuits cease to operate, causing colour values to become unacceptable or causing the receiver to revert to monochrome operation.

39.2 Method of measurement

The receiver is set up for a standard image with a television signal modulated by a test pattern (see 3.20) applied to the input. Subsequently, the input signal is reduced in steps, and at each input level the receiver controls are set for optimum performance. The level at which the picture colour quality becomes unacceptable or at which the receiver reverts to monochrome operation is noted, this input signal level being the colour sensitivity. The manner in which the picuture colour reproduction becomes unacceptable should be noted.

40 COEFFICIENT OF REFLECTION AT THE RECEIVER INPUT

40.1 Definition

Reflections at the receiver input are caused by a mismatch between the impedance of the specified aerial cable and the receiver input.

If the receiver input impedance is called Z and the characteristic impedance of the cable is R, the coefficient of reflection at the receiver input is:

$$Q = \frac{Z - R}{Z + R}$$

The voltage standing wave ratio is:

$$s = \frac{1 + (Q)}{1 + (Q)}$$

40.2 Method of measurement

A suitable method of measurement is the following:

A long aerial cable of the specified characteristic impedance is connected to the aerial input terminals of the receiver, which is switched on and tuned to the appropriate channel. A signal generator is connected to the other end of the cable. The generator applies an unmodulated radio-frequency signal of constant e.m.f. and variable frequency to this end of the cable. The strength of the signal at this end is measured with a detector. The combination of the signal generator and the detector must terminate the cable accurately with its characteristic impedance (see Figure 20a). The strength of the signal measured by the detector instrument is plotted as a function of the input signal frequency, first with the receiver end of the cable short-circuited and secondly with the receiver end of the cable connected to the aerial input terminals of the receiver. From these two curves (see Figure 20b), the magnitude of the coefficient of reflection (Q) is derived as a function of frequency.

The cable must be long enough for a sufficient number of undulations to be recorded within a frequency range corresponding to the passband of the receiver. The frequency separation between adjacent minima is equal to:

$$\Delta f = \frac{v}{2l}$$

v = velocity of propagation in the cable

l = length of the cable

when the far end of the cable is short-circuited.

The attenuation of the cable must be low enough for the undulations to be of sufficient amplitude when the far end of the cable is short-circuited (see Figure 20b).

The undulations may be displayed when a sweeping signal generator is used and the detected signal is made visible on an oscilloscope. The zero reference line may then be made visible by periodically blanking out the sweep-generator output.

The coefficient of reflection should be measured in each of the channels for which the receiver has been designed.

Alternatively, any equivalent method, expressing the coefficient of reflection in terms of admittance or impedance as a function of frequency, may be used.

NOTE - This measurement may be conveniently carried out by means of a reflectometer or bridge indicating the reflection coefficient directly. A normal television signal may then be used as a signal source in order that the automatic gain control of the receiver operates normally.

41 AUTOMATIC GAIN CONTROL STATIC CHARACTERISTICS

41.1 Definition

Each of the automatic gain control (AGC) characteristics relates the output level of sound or vision channels of a television receiver to the input level of a television signal.

41.2 Method of measurement

A television signal in accordance with the CCIR system B is applied to the input terminals of the receiver through any necessary matching networks (see **8.1** and **8.2**). The relative levels of the vision and the sound carriers are adjusted to the ratio specified by the above standards.

The vision carrier is modulated with a monochrome test pattern video signal having parts corresponding to 100 per cent modulation (see **3.20**). The associated sound carrier is 30 per cent modulated with a suitable audio-frequency tone, for instance 1 kHz (see IEC **107-2**, Clause **9**).

The sensitivity, contrast and volume controls are so adjusted that standard video output voltage (see **35**) is obtained for a vision input signal level of -50 db (mW) and that the sound output power equals one-half of the maximum useful output power (see IEC **107-2**).

The input signal level is then varied (maintaining a constant ratio between the vision and sound input signal levels) and the output voltage excursion between black level and white level, as well as the sound output power are measured as a function of the input signal level. The results are plotted and the input signal levels at which overloading, distortion or cross modulation occurs, should be noted on the graph.

The measurements should be repeated with the receiver adjusted in the same way, for some other recommended values of input signal level (see **9**).

If the receiver has a "local-distant" switch or a sensitivity control, measurements shall be made over a range of settings.

A check may be made to find out to what extent the vision or the sound AGC characteristics change when the sound or the vision radio-frequency signal is switched off or when their relative levels are changed.

41.3 Graphic representation

The results are plotted on graphs showing the relative amplitude of the picture modulation at the picture tube electrodes, or the relative level of the sound output power, respectively, as a function of the input signal level.

For the vision channel, an example of such a graph is shown in Figure **21**.

42 AUTOMATIC GAIN CONTROL DYNAMIC CHARACTERISTICS

42.1 Definition

Each automatic gain control (AGC) dynamic characteristic relates the output level of both sound and vision channels of a television receiver, to the input level of a television signal when the input level is varying cyclically or is subject to a transient change.

42.2 Method of measurement

A television signal in accordance with the CCIR system B is applied to the input terminals of the receiver through an attenuator the attenuation of which is controllable by a low-frequency signal. Any necessary matching networks are included between the signal generator and the controllable attenuator and between the controllable attenuator and the receiver.

The relative levels of the vision and sound carriers are adjusted to the ratio specified by the standards of the CCIR system B. The picture carrier is modulated with a monochrome test pattern video signal having parts corresponding to 100 per cent modulation (see **3.20**). The corresponding sound carrier is 30 per cent modulated with a suitable audio-frequency tone, for instance 1 kHz.

The sensitivity, contrast and volume controls are so adjusted that standard video output voltage (see **35**) is obtained for a vision input level of -50 db (mW) and that the sound output power equals one half of the maximum useful output power (see IEC **107-2**).

A low frequency sinusoidal controlling singal is applied to the terminals of the controllable attenuator such that the signal level applied to the receiver **varies** ± 3 db in power. The frequency of the sinusoid is varied from a very low frequency such that the response time of the automatic gain control circuit does not influence the results, for instance 0.1 Hz, up to a frequency where the gain control circuitry does not influence the variations of video output voltage. The peak-to-peak variations of the video output voltage excursions between black level and white level and the peak-to-peak variations of sound output power, corresponding to the variations of input signal level are measured over the defined range of frequencies. If overloading, distortion or cross-modulation occur at certain frequencies, the effect should be noted in the results and if necessary, the range of variations of input signal level reduced, this level being shown in the results.

The measurements should be repeated with the receiver adjusted in the same way for some other recommended values of the mean input signal level (see 9). If the receiver has a "local-distant" switch or a sensitivity control, measurements shall be made over a range of settings.

The measurements should be repeated with a low-frequency squarewave controlling the attenuator and the video output voltage excursions between black level and white level, as well as the sound power, measured as a function of time following the squarewave transition. The frequency of the squarewave should be sufficiently low for the response time of the AGC circuit to be fully displayed.

42.3 Graphic representation

The results are plotted for sinusoidal variations on graphs showing the relative level of the sound output power as a function of frequency of variation of the input signal level. For the vision channel, an example of such a graph is shown in Figure 22.

Results for squarewave variation of the input signal level are plotted on graphs showing relative amplitude of the picture modulation at the picture tube electrodes or the relative level of the sound output power as a function of time following the squarewave transition. For the vision channel an example of such a graph is shown in Figure 23.

43 CHROMINANCE AUTOMATIC GAIN CONTROL CHARACTERISTIC

43.1 Definition

The chrominance automatic gain control characteristic relates the output level of the chrominance component of the primary colour signals generated by the receiver decoder to the level of the chrominance carrier reference burst at the input to the decoder.

43.2 Method of measurement

A television signal in accordance with the CCIR system B is applied to the receiver through any necessary matching networks (see 8.1 and 8.2). The vision carrier is modulated with one of the recommended colour bar signals (see 3.6) having the chrominance component at 75 per cent of maximum amplitude. The receiver controls are adjusted for normal operation and so that standard video output voltage (see 35) is obtained for an input signal level of -50 db (mW).

Where the receiver uses separate colour difference signal drive to the display tube, the following method is used. An oscilloscope is connected to the electrode of the blue gun to which the colour difference signal is applied. With the receiver adjusted for normal operation and standard input conditions as described above, the level of the colour difference component corresponding to the blue bar is noted as the reference level. The level of the chrominance signal component, including the reference burst, at the coder is then adjusted in steps both above and below the nominal level, the luminance signal component being kept constant. The corresponding levels of the blue bar colour difference component are plotted. An example of such a graph is shown in Figure 24.

Where the receiver uses primary colour signal drive to the picture tube, the following method is used. With the receiver set for normal operation as above, an oscilloscope is connected to the picture tube electrode to which the blue primary colour signal is applied. The chrominance signal component is switched off at the coder and the level of the blue bar luminance component remaining is noted as zero chrominance signal level. The chrominance component is then switched on at the coder and the level of the blue bar noted as the reference level. The level of the chrominance signal including the reference burst, is varied at the coder in steps, the luminance signal remaining constant and the corresponding levels of the blue bar are plotted. An example of such a graph is shown in Figure 24.

The measurements shall be repeated for some other recommended values of input signal level (see 9).

44 COLOUR KILLING

44.1 Definition

The colour killer circuit is defined by the levels of colour synchronizing or reference signal at which the chrominance signal decoding circuits are activated or de-activated.

44.2 Method of measurement

A television signal is applied to the input terminals of the receiver at a vision carrier input signal level of -50 db (mW). The vision carrier is modulated with a test pattern video signal. The receiver is adjusted for normal operation, and the level of the chrominance signal, including the reference burst at the coder, is reduced stepwise, the luminance signal remaining constant. The level of chrominance signal at which the colour killer operates in noted.

Starting from substantially zero chrominance level, the chrominance signal, including the reference burst at the coder, is then increased stepwise, the luminance signal remaining constant, and the level noted at which the chrominance decoding circuits become active. These measurements should be repeated for some other recommended values of input signal level (see **9**).

45 COLOUR KILLER RESPONSE TIME

45.1 Definition

The colour killer response time is the respective time taken for the colour killer to disable and restore operation of the decoding circuits in response to the removal and application of the chrominance signal.

45.2 Method of measurement

A television signal is applied to the input terminals of the receiver at a vision carrier input signal level -50 db (mW). A vision carrier is modulated with a test pattern video signal and the receiver adjusted for normal operation. A double beam long persistence storage type oscilloscope is arranged to display both the video signal applied to the signal generator modulator and one of the primary colour signals or colour difference signals at the terminals of the picture tube.

The chrominance signal, including the reference burst at the colour system coder, is switched off and the time taken for the output from the decoder to decay substantially to zero is noted. This observation may require care since on removal of the chrominance signal, including the reference burst, the output from the decoding section of the receiver may consist of noise and/or spuriously demodulated luminance components and it is the time of effective suppression of these that must be observed.

The chrominance signal, including the reference burst, is now restored on the colour system coder, and the time to achieve substantially normal output from the decoder is measured. The two periods measured are the disabling and enabling response times and are expressed in milliseconds.

46 MAXIMUM USABLE SINGLE INPUT SIGNAL LEVEL

46.1 Definition

The maximum usable single input signal level is the highest level of input signal for which the receiver can give acceptable performance under conditions as specified in **46.2**.

46.2 Method of measurement

A television signal of convenient level with test pattern modulation is applied to the receiver input terminals. The receiver is tuned and adjusted for optimum results. The input signal level is gradually increased and the receiver sensitivity controls and local-distant switch are adjusted to maintain optimum performance. The highest input signal level for which the performance remains acceptable is then noted.

The measurements should be repeated in order to find the maximum input signal level which will not cause the receiver to fail to operate normally when manipulating the channel selector (for example: lock-out by blocking of the AGC).

The maximum input level which will not cause the receiver to fail to operate normally when switched on with this signal impressed should also be ascertained.

The lowest value of maximum usable input signal level is recorded together with the conditions and description of the effect which causes the performance to be unacceptable.

The measurements should be repeated for a representative number of channels in all of the bands for which the receiver is intended.

47 MAXIMUM USABLE MULTIPLE INPUT SIGNAL LEVEL

47.1 Definition

The maximum usable multiple input signal level is the highest level of input signal on a selected channel for which the receiver can give acceptable performance, under conditions as specified in **47.2**, when accompanied by either or both adjacent channel signals at a level 6 db higher than that of the selected signal.

47.2 Method of measurement

A television signal of convenient level with test pattern modulation is applied to the receiver input terminals. The receiver is tuned and adjusted for optimum results. The lower adjacent channel signal is then simultaneously applied at a level 6 db higher than the signal on the selected channel. The level of both signals is gradually increased and the receiver sensitivity controls and local-distant switch are adjusted to maintain optimum performance. The highest input signal level for which the performance remains acceptable is then noted.

The measurements are then repeated first for the upper adjacent channel and then both adjacent channels. The measurements should also be carried out in order to find the maximum input signal level which will not cause the receiver to fail to operate normally when manipulating the channel selector. The maximum input level which will not cause the receiver to fail to operate normally when switched on with the signals impressed should also be ascertained.

The adjacent channel signals are also to be modulated with a test pattern that can be distinguished from the modulation of the signal to which the receiver is tuned.

The lowest value of maximum usable input signal level is recorded together with the conditions and a description of the effect which causes the performance to be unacceptable.

The measurements should be repeated for a representative number of channels in all bands for which the receiver is intended.

NOTE - Filters must be included in the signal generators providing the adjacent channel signals in order that signal modulated components in the selected channel are suppressed by a factor of at least 60 db.

SECTION SIX - SELECTIVITY AND RESPONSE TO UNDESIRED SIGNALS

48 SINGLE SIGNAL SELECTIVITY

48.1 Definition

The single signal selectivity of a television receiver is represented by a characteristic showing either

a) the relationship between the input signal level and the input signal frequency: at constant amplification for constant output at the video detector, or

b) the relationship between output level at the video detector and input frequency for constant input signal level, depending upon the method of measurement. It gives a certain measure of the receiver's ability to reject undesired signals at nearby frequencies.

48.2 Method of measurement

The measurement should be carried out with the receiver tuned to each television channel for which it has been designed or at least to a representative number of channels in each television band for which operation is intended. A television signal (see **3.20**) in the channel to which the receiver is tuned, is applied to the receiver input terminals through a suitable matching network (see **8.1**). The receiver controls are set so that standard output is obtained for both vision (see **35.1**) and sound (see IEC **107-2**) for two different input signal levels. These two input signal levels are the lowest level for which the receiver can give standard video output voltage and the level of -50 db (mW) or the maximum usable input signal level (see **46**), whichever is the higher.

Any AGC circuit is made inoperative and a fixed bias equal to the AGC bias corresponding to the two input levels is determined and applied to the controlled circuits. The measurements below are carried out for each of these two settings of the receiver.

Instead of the television signal, a radio-frequency carrier 30 per cent sinewave amplitude modulated with a suitable audio-frequency tone, for example 1 kHz is now applied to the receiver input terminals through a suitable matching network (see **8.1**). The carrier signal generator is tuned to the vision carrier frequency. The input signal level is adjusted until the audio tone output obtained is 12 db below the standard video output voltage (see **35.1**) as indicated by an oscilloscope connected to the video detector or equivalent circuit point. The input signal frequency is varied over a sufficiently wide range to cover at least the adjacent television channels.

The response is measured at a number of frequency settings of the carrier signal generator including the co-channel sound, co-channel chrominance sub-carrier and the vision, sound and chrominance sub-carrier frequencies of the adjacent channels, plus any other rejection points. At each of these frequencies, the input signal level is adjusted until an output voltage 12 db below the standard video output voltage is obtained. The single signal selectivity is expressed by the ratio of the input signal level at these frequencies to the input signal level at the vision carrier frequency, both giving an output voltage of 12 db below the standard video output voltage. If it is not possible to obtain an output voltage of 12 db below standard output voltage at any frequency within the range under consideration, measurement may be carried out at a different level of output voltage, for example: to avoid overloading. In this case, the output level used for the measurements should be given with the results.

Alternatively, a swept signal generator and logarithmic oscilloscope display may be used as the signal source and indicator. In this case, the input level is adjusted so that the maximum of the response corresponds to the standard video output voltage. Care must be taken to ensure that the response is not distorted by the presence of time constants, d.c. restorers, clamps or similar devices in the associated receiver circuits. The signal generator sweep speed must be sufficiently slow to avoid the response of regions of high selectivity such as traps being distorted.

NOTE - This method of measurement cannot be applied to receivers using multiplicative intermediate frequency demodulation or to receivers in which the AGC circuit cannot be rendered inoperative. Furthermore, the application of c.w. or purely sinewave modulated signals may give rise to anomalous operation in some receivers. In these cases, the methods of measurement described in **49** *should be applied.*

48.3 Presentation of results

The results of the measurements of each of two settings of the receiver (see **48.2**) are represented as a function of frequency by a graph. The frequency is plotted on a linear scale as abscissa and respectively signal input ratio or the response relative to the vision carrier frequency expressed in decibels on a linear scale as ordinate. The O db level corresponds to the frequency of the vision carrier (see Figure 25a).

49 MULTIPLE SIGNAL SELECTIVITY

49.1 Definition

The multiple signal selectivity of a television receiver is represented by a characteristic showing the input signal level of a given frequency required to generate a beat of a given level at the video detector, when accompanying a television signal the picture content of which is at black level or white level. It provides a measure of the receiver's ability to reject signals at nearby frequencies.

49.2 Method of measurement

The measurements should be carried out with the receiver tuned to each television channel for which it has been designed or at least to a representative number of channels in each band for which operation in intended.

A television signal (see **3.8**) in the channel to which the receiver is tuned is applied to the receiver input terminals through a suitable combining network (see **8.4**) and a suitable matching network (see **8.1**).

A c.w. signal generator adjustable in frequency over a range extending to at least the two adjacent channels, is applied to the other input of the combining network. The receiver controls are set so that the standard output is obtained for both vision (see **35**) and sound (see IEC **107-2**) for two different input signal levels. These two input signal levels are the lowest level for which the receiver can give standard video output voltage (That is the gain limited sensitivity) and the level of -50 db (mW) or the maximum usable input signal level (see **46**). The following measurements are carried out for each of these two input levels. In some cases, it may not be possible to carry out a measurement at the input level corresponding to the gain limited sensitivity since noise may mask the signal, in which case the input level corresponding to the noise-limited sensitivity shall be used (see **37**).

The c.w. signal tuned to the frequency of interest is applied to the receiver in addition to the television signal. The resulting beat is observed by an oscilloscope connected to the video detector output or equivalent point. The c.w. signal level is adjusted until a peak-to-peak output voltage of 12 db below the standard video output voltage is obtained. The measurement is carried out with the c.w. signal set to the vision, chrominance and sound carrier frequencies of both adjacent channels and any other rejection points.

The response at the co-channel sound carrier frequency is measured by removing the sound signal from the television signal and tunning the c.w. signal generator to the sound carrier frequency, the beat being measured as above but care must be taken to allow for the effect of any intercarrier sound signal take-off or video intercarrier frequency trap.

These measurements are carried out with the television signal having the picture content corresponding to black level and again corresponding to white level. When carrying out tests with the picture content at white level, care must be taken to avoid spurious effects due to overloading of subsequent video stages or the high tension supply to the picture tube. These effects may be avoided for instance, if there is a subsequent video contrast control available or in the case of the high tension supply, by removing the video drive to the picture tube.

The multiple signal selectivity is expressed by the ratio of the c.w. input signal level at the frequencies of interest to the vision carrier input signal level. If it is not possible to obtain and output voltage of 12 db below the standard video output voltage for the beat at any frequency within the range under consideration, the measurements may be carried out at a different level of output voltage, for example: to avoid overloading of the receiver stages.

49.3 Presentation of results

Four values may be tabulated for each frequency of measurement corresponding to the two input signal levels and the two levels of picture content.

Due allowance must be made in the results for the measurements taking place at beat signal levels 12 db below the standard video output voltage, this adding 12 db to the value of rejection at the various frequencies. Where measurements are carried out at a different beat level as described above, this is the value that should be taken into consideration (see Figure 25b).

50 INTERMEDIATE FREQUENCY INTERFERENCE RATIO

50.1 Definition

The intermediate frequency interference ratio of a television receiver represents the ability of the receiver to reject a signal in the intermediate frequency band.

50.2 Method of measurement

The measurement is carried out by either the single signal selectivity measurement method (see 48) or the multiple signal selectivity method (see 49). The measurement is repeated with the receiver tuned to each television channel for which it has been designed or at least to a representative number of channels in each television band for which operation is intended. For receivers with a balanced antenna input. The measurements are made with balanced and unbalanced input of the interfering signal.

The signal generator frequency is adjusted within the intermediate frequency band until a maximum intermediate frequency response is obtained and also to the vision carrier frequency of the channel to which the receiver is tuned. The ratio between the input signal levels required to give an output voltage 12 db below the standard video output voltage at these two frequencies is the intermediate frequency interference ratio. If it is not possible to obtain an output voltage of 12 db below the standard video output voltage when the intermediate frequency signal is applied, the intermediate frequency interference ratio may be determined at a lower output level. In this case, the output level used for the measurements should be given with the results.

The results are presented in the same manner as those respectively described in **48.3** and **49.3**.

51 IMAGE INTERFERENCE RATIO

51.1 Definition

The image interference ratio of a television receiver represents the ability of the receiver to reject a signal at the image frequency.

51.2 Method of measurement

The method of measurement and the presentation of results are carried out in exactly the same manner as that for the intermediate frequency interference ratio (see **50**) and is repeated with the receiver tuned to each channel for which it has been designed or at least to a representative number of channels in each television band for which operation is intended. In this case, the signal generator frequency is adjusted within the image channel and the adjacent channels of the image until a maximum for two or more significant image responses are obtained.

52 SPURIOUS RESPONSES

52.1 Definition

Spurious responses can be caused if external signals or one of their internally generated harmonics mix with the receiver local oscillator frequency or one of its harmonics or in combination with an internally generated spurious oscillation and thereby produce an interfering signal in the intermediate frequency passband or at the video detector. Such reponses may also be caused by cross-modulation.

52.2 Method of measurement

The procedures to be described should be followed for two conditions corresponding to the lowest and highest signal levels as mentioned in **36**, **37** and **46**. These input signal levels should be given with the results.

In addition to the television signal referred to above, an interfering carrier, sinewave amplitude modulated 30 per cent with a suitable audio-frequency tone, for example: 1 kHz, is applied to the receiver input terminals through a suitable combining network (see **8.4**). The level of the interfering signal is made as high possible, bearing in mind the effects of cross-modulation, its value being stated and its frequency varied over a wide range, which should also be stated. This frequency range may extend upwards from 150 kHz and should include the significant parts of the radio-frequency spectrum, bearing in mind possible local conditions. Special attention should be paid to the LF, MF, HF, VHF, and UHF broadcast bands, also those allocated for mobile, amateur and radio-telephone use. In some cases the SHF bands used for radar and point-to-point communication may be important.

Care must be taken that the television input signal and the interfering carrier are adequately free from harmonics. The picture screen is observed and every time an interference pattern is noticed, the interfering carrier level is reduced until the pattern remains just visible.

This level and the frequency range over which the pattern remains visible, is recorded for every spurious response encountered. The levels of the interfering carrier for which sound interference is just audible, are also recorded.

It is desirable to check the interference observed in each case with an unmodulated interfering carrier.

The measurements should be carried out with the receiver tuned to each channel for which it has been designed or at least to a representative number of channels in each television band for which operation is intended.

52.3 Presentation of results

The results and measurements are represented in a graph with the frequency plotted on a logarithmic scale as abscissae and the ratio between the interfering and desired signals expressed in db on a linear scale as ordinates. The two levels mentioned in **52.2** and the channel to which the receiver is tuned should be indicated. An example is shown in Figure 26.

53 INTERNALLY GENERATED UNDESIRED SIGNALS

53.1 Definition

The following are the commonest sources of internally generated unwanted signals.

a) Harmonics of the vision and sound intermediate frequency signals that fall into the radio-frequency passband to which the receiver is tuned;

b) Harmonics of the desired input signal mixing with harmonics of the local oscillator producing signals that fall within the intermediate frequency passband of the receiver;

c) Harmonics of the carrier chrominance signal that fall within the intermediate frequency passband of the receiver or the radio-frequency passband to which the receiver is tuned;

d) Harmonics of the reference or regenerated chrominance sub-carrier that fall within the intermediate frequency passband of the receiver or the radio-frequency passband to which the receiver is tuned;

e) Video signal components appearing in the audio channel causing interference in the sound output;

f) Sound modulation appearing in the synchronizing circuits causing interference with synchronization;

g) Sound modulation and intercarrier beats appearing in the video amplifier causing interference on the picture screen;

h) Deflection waveforms appearing in the audio amplifier causing interference in the sound output;

j) Deflection waveforms appearing in the video systems causing interference in the picture ; and

k) Spurious self-oscillation having frequency components interfering with the radio-frequency, intermediate frequency, video frequency or audio-frequency signals.

53.2 Method of measurement

A television signal is applied to the receiver input terminals, the picture modulation being a test pattern as described in **3.20** and sound modulation where applicable at 90 per cent.

The performance is investigated with the receiver tuned and a television signal applied for each television channel for which it has been designed or at least to a representative number of channels in each television band for which operation is intended.

The observations are carried out with input signals corresponding to the lowest and the highest levels and a note is made where any interference pattern in the picture or equivalent interference in the sound output is observed. If the receiver is equipped with manual tuning , the tuning adjustment is varied to either side of optimum to determine whether the interference effect critically depends upon the receiver tuning.

54 CROSS - MODULATION

54.1 Definition

Cross-modulation occurs when two or more signals are applied to a television receiver and the modulation of an unwanted signal is transferred to the wanted signal over a range of input signal levels. This form of interference is distinct from those arising due to the receiver selectivity (see **49** to **53**) and intermodulation (see **55**).

54.2 Method of measurement

The measurements should be carried out with the receiver tuned to each channel for which it has been designed or at least to a representative number of channels in each television band for which operation is intended. A television signal (see **3.8**) in the channel to which the receiver is tuned is supplied to the receiver input terminals through a suitable combining network (see **8.4**) and a suitable matching network (see **8**). A signal generator covering the required range of frequencies and 90 per cent sinewave amplitude modulated with a suitable frequency tone, for example 1 kHz, is applied to the other input of the combining network. The receiver controls are set so that the standard output is obtained for both vision (see **35.1**) and sound (see IEC **107-2**) for three different input signal levels.

- The first of these three input signal levels is, as appropriate, the level corresponding to either the gain-limited sensitivity (see **36**) or the noise-limited sensitivity (see **37**).

- Second, a level of -50 db (mW) or the maximum usable input signal level (see **46**).

- Third, the intermediate signal level.

The following measurements are carried out for each of these three input levels. The television signal to which the receiver is tuned has a 50 per cent level grey pedestal as picture modulation. The signal generator is tuned to the frequency of interest (see below) and the level increased until an output voltage of the tone modulation at the picture tube electrodes is obtained that is, unless another value has been specified, 12 db below the standard video output voltage.

If it is not possible to obtain an output voltage 12 db below the standard video output voltage measurements may be carried out at a different level of output voltage that should be given with the results. Frequencies to which the tone modulated signal generator are set may depend upon local conditions but frequencies should be avoided where the measurement process is affected by beats resulting from the receiver selectivity or spurious responses. Measurements should be made with the signal generator set to suitable frequencies in the band to which the receiver is tuned and to frequencies in other bands used for television and VHF sound radio broadcasting and mobile communications transmissions in Sri Lanka.

54.3 Presentation of results

Values for the level of interfering signal applied to the receiver to obtain cross-modulation products having a voltage 12 db below the standard video output voltage are tabulated for all measurement frequencies and television signal input levels. Due allowance must be made in the results when measurements are made at cross-modulation product levels other than 12 db below the standard video output voltage.

55 INTERMODULATION

55.1 Definition

Intermodulation occurs when two unwanted signals are applied to a television receiver together with a wanted signal and modulation products between the two unwanted signals give rise to an interfering signal within the wanted channel. This form of interference is distinct from those arising due to the receiver selectivity (see **49** to **53**) and cross-modulation (see **54**).

55.2 Method of measurement

Measurements should be carried out with the receiver tuned to each channel for which it has been designed or at least to a representative number of channels in each television band for which operation is intended. A television signal (see **3.8**) in the channel to which the receiver is tuned is supplied to the receiver input terminals through a suitable combining network (see **8.4**) and a suitable matching network (see **8.3**). Two c.w. signal generators covering the required range of frequencies are connected to the other two inputs of the combining network.

The receiver controls are set so that the standard output is obtained for both vision (see **35.1**) and sound (see IEC **107-2**) for three different input signal levels.

- The first of these three input signal levels is, as appropriate, the level corresponding to either the gain-limited sensitivity (see **36**) or the noise-limited sensitivity (see **37**).
- Second, a level of -50db(mW) or the maximum usable input signal level (see **46**).
- Third, the intermediate signal level.

The following measurements are carried out for each of these three input levels. The television signal to which the receiver is tuned has a 50 per cent level grey pedestal as picture modulation. The signal generators are tuned to the frequencies of interest (see below) with such a relationship that any signal generated by intermodulation shall be off-set from the vision carrier frequency of the wanted signal by between 1 and 2 MHz in the direction of the sound carrier of the wanted signal. The level of the signal generators is increased until an output voltage of the resulting signal between the modulation product derived from the c.w. signal generators and the vision carrier of the wanted signal is 12 db, unless otherwise specified below the standard video output voltage at the picture tube electrodes. If it is not possible to obtain an output voltage 12 db below the standard video output voltage, measurements may be carried out at a different level of output voltage to be stated with the results. The frequencies to which the c.w. signal generators are set are those that will give rise directly or from their harmonics to an interfering signal in the channel to which the television receiver is tuned. The particular frequencies selected may depend upon local conditions but frequencies should be avoided when the measurement process is affected by other signals. These can result from receiver selectivity, spurious responses or components of the video signal such as harmonics of the horizontal scanning frequency. The frequencies used to generate the interfering signal should be those used for television and VHF sound radio broadcasting and mobile communications transmissions in Sri Lanka.

Where available a spectrum analyzer may be used to simplify the measuring process.

55.3 Presentation of results

Values, for the level of the pair of interfering signals applied to the receiver to obtain intermodulation products having a voltage 12 db below the standard video output voltage are tabulated for all measurement frequencies and television input signal levels. Due allowance must be made in the results when measurements are made of intermodulation product levels other than 12 db below the standard video output voltage.

56 FREQUENCY DOUBLING SPECIAL TEST FOR RECEIVERS USING MULTIPLICATIVE INTERMEDIATE FREQUENCY DEMODULATION

56.1 Definition

Although the generation of even order harmonics of the modulation frequency can occur in most intermediate frequency systems, frequency doubling has a special significance in i.f. sections using multiplicative demodulation. When the carrier channel contains a sideband corresponding to a component of the modulation frequencies that is not eliminated by the filtering or limiting action, multiplication occurs giving rise to a spurious double frequency component in the passband output.

56.2 Method of measurement

Measurement is carried out on a representative range of channels in which the receiver is designed to operate. The receiver must be tuned in accordance with **10** and the method used stated in the results. The radio frequency signal is applied to the input terminals of the receiver through a vestigial side band filter as required by the standards of the CCIR system B and a suitable matching network (see **8.3**). The input signal level is adjusted to be between those levels defined in **37** and **46** and in such a way that noise effects do not influence measurement.

The sound carrier is removed and the radio-frequency carrier is modulated with a video signal having sinewave picture modulation in the range from approximately 100 kHz upwards, adjustable to swing over the following ranges:

a) black level to white level;

b) 25 per cent to 75 per cent picture modulation;

c) 40 per cent to 60 per cent picture modulation (see Figure 27).

A selective voltmeter or spectrum analyzer is connected to a suitable point following the intermediate frequency video detector to observe the demodulated signal. The sinewave modulation is varied in steps from a frequency of approximately 100 kHz to a frequency higher than the difference between the sound and vision carrier frequencies.

At each frequency the ratio of the wanted modulation sinewave signal and any generated second harmonic is measured. Particular care must be taken to carry out measurements in the vicinity of modulation frequencies of half the difference frequency between sound and vision carriers.

56.3 Presentation of results

The results are presented by plotting the difference in level between the modulation frequency and the generated harmonics in decibels as a function of the modulation frequency, indicating specifically the frequency corresponding to half the difference between sound and vision carriers.

SECTION SEVEN - FIDELITY

57 GENERAL

The overall electrical fidelity is the response at the picture tube electrodes to all modulation frequencies from zero up to the limit of the system for which the receiver is intended, the modulated radio-frequency signal being applied to the receiver input terminals through a suitable matching network (see 8).

NOTE - Where electrodes of the picture tube other than those used for measurement are not adequately decoupled, care must be taken in interpreting the results of the measurements.

Three types of measurement are described:

a) the modulation-frequency response from 100 kHz upwards;

b) response to limited spectrum pulse and bar signals; and

c) the low-frequency response.

Influence of vestigial side-band filter.

A vestigial side-band filter need not be used with the radio-frequency signal source if the combined radio-frequency/intermediate frequency circuits of the receiver sufficiently limit the radio-frequency spectrum. When it is desired to know if the spectrum is so limited, the radio-frequency/intermediate frequency response of the receiver must be measured as described in 48.1 and 49.1.

The vestigial side-band filter mentioned in the following clauses must be introduced if the area B of the portion of the radio-frequency/intermediate frequency response curve indicated in Figure 28, greater than 2 per cent of the area A within the passband.

Where a vestigial side-band filter is used, care must be taken that the resultant signal is free from group delay errors, and that pre-correction of the group delay characteristic required by the standards of the CCIR system B is fulfilled.

58 MODULATION-FREQUENCY/RESPONSE CHARACTERISTIC, LUMINANCE CHANNEL

58.1 Definition

The luminance channel modulation-frequency/response characteristic represents the amplitude of the luminance signal picture modulation at the picture tube electrodes as a function of the modulation frequency.

58.2 Method of measurement

The modulation-frequency/response characteristic in the range from approximately 100 kHz upwards is measured on a representative range of channels in which the receiver is designed to operate. The receiver must be tuned in accordance with **10**, and the method used stated in the results.

The radio-frequency carrier is modulated with a video signal having sinewave picture modulation, adjustable to swing over the following ranges (see Figure 27).

a) black level to white level;

b) 25 per cent to 75 per cent picture modulation; and

c) 40 per cent to 60 per cent picture modulation.

The radio-frequency signal is applied to the input terminals of the receiver through a vestigial side-band filter as required by the standards of the CCIR system B (see **57**) and a suitable matching network (see **8**). The input signal level is adjusted to be between those levels defined in **37** and **46** and such that noise effects do not influence measurement.

The receiver is adjusted to provide standard video output voltage (see **35**).

On at least one channel, the measurement should also be carried out with maximum and minimum input signal levels as defined in **37** and **46**.

When a luminance channel response control is provided, measurements shall be carried out in each position where it is switchable and over a range of positions where it is continuously adjustable. When automatic control is provided modifying the response when a colour signal is received, measurements shall be carried with and without the chrominance signal reference burst or chrominance carrier signal included.

When a vision interference limiter control is provided, it should be set to give the least effect on the picture.

An oscilloscope is connected in place of the picture tube in such a manner that the frequency response of the video circuits is unchanged and the electrodes continue to have suitably applied potentials. In a colour receiver each electrode driven by the luminance signal, either directly or as a component of a primary colour signal is to be measured.

The level of the picture modulation is kept constant, the frequency being varied between approximately 100 kHz and the sound/vision carrier-frequency difference. The peak-to-peak amplitude of the picture modulation either side of mid-grey level displayed on the oscilloscope is plotted as a function of the modulation frequency.

The measurements are carried out for the three levels of picture modulation defined above.

Measurement may be carried out by means of a video sweep generator instead of the sine-wave signal generator, the result being displayed on a suitable indicator.

58.3 Graphic representation

The amplitude of the picture modulation of the waveform displayed on the oscilloscope is plotted as a function of the modulation frequency. When a swept signal is used, the result may be recorded.

The frequency scale on the abscissa and the amplitude scale on the ordinate may be either linear or logarithmic (see Figure 29).

59 LINEAR WAVEFORM RESPONSE, LUMINANCE CHANNEL

59.1 Definition

The linear waveform response, luminance, is the waveshape measured at the picture tube electrode or electrodes when applying the stated limited spectrum test signals to the input terminals of the receiver. The results are expressed as a percentage of the difference between black level and maximum white level. A rating factor K may also be used in some cases; this allows for the differing subjective effects of the various distortions.

Alternatively, the results may be presented by photographic records of the various waveforms.

Four types of response measurement are described indicating the frequency and group delay response throughout the video frequency range*.

a) Line rate bar response;

b) Pulse response;

c) Pulse to bar ratio; and

d) Field frequency square wave response.

59.2 Method of measurement

The responses a,b,c, and d to the appropriate signal are measured on a representative range of the channels in which the receiver is designed to operate. The receiver must be tuned in accordance with 10.

**Lewis W.N.: Waveform responses of T.V. links, Proc. IEE Volume 101, Part III, 1954.*

Macdiarmid I.F.: The waveform distortion in Television links, Post Office Electrical Engineers Journal, 1959.

The radio-frequency signal is modulated with a video signal corresponding to a 2 T pulse and bar, a field-rate square wave and a composite 2 T_c pulse and bar.

$T = \frac{1}{2f_c}$ where f_c is the nominal upper video frequency limit of the system.

$T_c = \frac{1}{2f_{cc}}$ where f_{cc} is the difference between f_c or the upper limit of the chrominance signal passband, whichever is the lower value, and the chrominance sub-carrier frequency of the CCIR system PAL B.

Suitable networks for band-limitng the spectrum of pulse and bar signals are shown in Figure 30 page 112.

The waveforms of the test signals are shown in Figure 31.

The radio-frequency signal is applied to the input terminals of the receiver through a vestigial sideband filter as required by the standards of the CCIR system B and a suitable matching network (see **8**). The input signal level is adjusted to be between those levels defined in **36** and **45** and such that noise effects do not influence measurement.

The signal should be pre-corrected for receiver group delay characteristic and this pre-correction must be included in the test signal generator.

The receiver is adjusted to provide standard video output voltage (see **35**).

On at least one channel the measurements shall be carried out with maximum and minimum input signal levels as defined in **37** and **45**.

When a luminance channel response control is provided, measurements shall be carried out in each position where it is switchable and over a range of positions where it is continuously adjustable. When automatic control is provided modifying the response when a colour signal is received, measurements shall be carried with and without the chrominance signal reference burst or chrominance sub-carrier signal included.

When a vision interference limiter control is provided it shall be set to give least effect upon the picture.

An oscilloscope is connected in place of the picture tube in such a manner that the frequency response is unchanged and the electrodes continue to have suitably applied potentials. In a colour receiver, each electrode driven by the luminance signal, either directly or as a component of a primary colour signal, shall be measured.

59.3 2 T bar response

The oscilloscope is adjusted as shown in **32**, so that the half-amplitude points of the bar transitions coincide with points m_1 and m_2. Points A and B respectively at black level and the mid-point of the bar are then set at unit-amplitude. The maximum departure b of the bar from unit-amplitude between points extending to 0.01 H from the half-amplitude points of each transition is measured and expressed as a percentage of the difference between black level and white level. The result may be expressed in terms of the rating factor K using the expression below.

K rating of 2 T bar response expressed as a function of b:

$$K = \left| b - 100 \right|$$

59.4 2 T pulse response

The oscilloscope is adjusted as shown in Figure 33, such that the sweep velocity corresponds with time scale indicated, the black level of the response coincides with the horizontal axis and the peak of the response falls on the unit-amplitude line and the half-amplitude points of the response are symmetrically disposed about the vertical axis.

The amplitude of the signal is measured at the indicated points on the horizontal axis and expressed as percentage b of the peak response. The difference in time a between the half amplitude points of the response is measured and expressed in nanoseconds. These values may be expressed in terms of the rating factor K using the expressions below:

K rating of 2 T pulse half-amplitude duration a in the same unit as T

$$K = \left| \frac{1 - 2T}{10T} \right|$$

TABLE 4 - Expressions to calculate K at points on time axis and unit intervals

Points on time axis and unit intervals	K rating as a function of percentage of peak response b
± 1	$K = \left\| \frac{b}{400} \right\|$
± 2	$K = \left\| \frac{b}{200} \right\|$
± 4	$K = \left\| \frac{b}{100} \right\|$

59.5 2 T pulse/bar rating

The oscilloscope is adjusted as shown in Figure 32, and indicated in **59.3**. The ratio of the amplitude of the 2 T pulse to the amplitude of the 2 T bar response at point B is measured and may be expressed in terms of the rating factor K using the expression below.

K rating of 2 T pulse to bar ratio expressed as a function of b:

$$K = \left| \frac{100 - b}{4b} \right|$$

59.6 Chrominance sub-carrier response of luminance channel

The oscilloscope is adjusted as in **59.3** using the 2 T pulse and bar signal (Figure 31a). The composite chrominance pulse and bar signal (Figure 31c) is then applied and the peak-to-peak excursions of the chrominance sub-carrier in the neighbourhood of point B is measured.

The chrominance sub-carrier response is expressed as the ratio of the peak-to-peak excursions of the chrominance sub-carrier measured as above to the difference between black level and white level.

The measurement should be repeated with the composite chrominance pulse and bar signal picture modulation reduced by 50 per cent and half the difference between black level and white level used in expressing the result.

59.7 Composite chrominance sub-carrier 2 T_c pulse response of luminance channel

The composite chrominance 2 T_c pulse and bar signal is applied as picture modulation. The oscilloscope is adjusted as shown in Figure 34, such that the sweep velocity corresponds to the time scale indicated, the black level of the response coincides with the horizontal axis, the peak of the response corresponds to unit-amplitude and the half-amplitude points are symmetrically disposed about the vertical axis.

The maximum excursions of the envelope are measured at the indicated points on the horizontal axis and expressed as a percentage of the peak response.

59,8 Field frequency square-wave response

The oscilloscope is adjusted as shown in Figure 35, so that the half-amplitude points of the bar transitions coincide with points m_1 and m_2, and so that the mid-points of the positive and negative excursions correspond with points A and B. The display is adjusted so that points A and B correspond to the unit amplitude, the synchronizing pulses being ignored.

The maximum departure b of the bar amplitude above and below the unit-amplitude level B, between points 0.01 V from the half amplitude points of each transition, are measured and expressed as a percentage of unit-amplitude (V is the duration of one vertical field). The results may be expressed in terms of the rating factor K using the expression below:

K rating of field frequency-wave response expressed as a function of b:

$$K = \frac{b - 100}{2}$$

60 Modulation-frequency/response characteristic, chrominance channel

60.1 Definition

The chrominance channel modulation-frequency/response characteristic represents the amplitude of the chrominance signal picture modulation at the picture tube electrodes as a function of the modulation frequency.

60.2 Method of measurement

The chrominance channel modulation-frequency/response characteristic in the range from 100 kHz upwards is measured on a representative channel chosen from those in which the receiver is designed to operate. The receiver must be tuned in accordance with 10.

The receiver is adjusted to provide standard video output voltage (see **35**). A suitable test pattern signal is then applied and the receiver adjusted to provide optimum colour decoding.

The radio-frequency carrier is modulated with the output signal from a PAL colour system coder having inputs for the three primary colours and an independent luminance channel. A 50 per cent constant level grey pedestal is applied to the luminance channel input and sinewave picture modulation swinging over the ranges 25 per cent to 75 per cent and 40 per cent to 60 per cent is applied in turn to the three primary colour inputs of the coder.

The radio-frequency signal is applied to the input terminals of receiver through a vestigial sideband filter as required by the standards of the CCIR system B (see **57**) and a suitable matching network (see **8**). The input level is adjusted to be between those levels defined in **37** and **46** and such that noise effects do not influence measurement.

An oscilloscope is connected in place of the picture tube, to each appropriate primary colour or colour difference output signal in turn, in such a manner that the frequency response of the video circuits is unchanged and the electrodes continue to have suitably applied potentials.

The level of the picture modulation is kept constant, the frequency being varied between approximately 100 kHz at the nominal system upper limit of the chrominance passband. The peak-to-peak amplitude of the picture modulation to either side of the mid-value displayed on the oscilloscope is plotted as a function of the modulation-frequency. Measurements are carried out at the two levels of picture modulation defined above.

Measurement may be carried out by means of a video sweep generator instead of the sinewave signal generator, the result being displayed on a suitable indicator.

60.3 Graphic representation

The amplitude of the sinusoidal component of the picture modulation waveform displayed on the oscilloscope is plotted as a function of the modulation frequency. When a swept signal is used, the result may be recorded photographically. The frequency scale on the abscissa and the amplitude scale on the ordinate may be either linear or logarithmic (see **41**).

61 LINEAR WAVEFORM RESPONSE, CHROMINANCE CHANNEL

61.1 Definition

The linear waveform response, chrominance is the wave shape measured at the appropriate picture tube electrodes when applying the stated limited spectrum test signals to the colour system coder providing the video signal to radio-frequency modulator. The results are expressed as a percentage of the difference between black level and the signal level occurring in the appropriate channel corresponding to unit-amplitude. A rating factor *K* may also be used in some cases; this allows for the differing subjective effects of various distortions.

Alternatively, the results may be presented by photographic records of the various waveforms.

Four types of response measurement are described indicating the frequency and group delay response over the chrominance passband and the chrominance carrier frequency band.

a) line rate bar response;

b) pulse response;

c) pulse to bar ratio; and

d) field frequency squarewave response.

61.2 Method of measurement

The responses a,b,c and d to be appropriate signals are measured on a representative range of the channels in which the receiver is designed to operate. The receiver must be tuned in accordance with **10**. The receiver is adjusted to provide standard video output voltage (see **35**). A test pattern is then applied and the receiver adjusted to provide optimum decoding. The radio-frequency carrier is modulated with the output signal from PAL colour system coder having inputs for the three primary colours and an independent luminance channel. A 50 per cent grey level constant pedestal is applied to the luminance channel input and picture modulation corresponding to a 2 T_c pulse and bar and a field rate squarewave is applied in turn, to the three primary colour inputs of the coder at 50 per cent and 30 per cent of the maximum system level. Suitable networks for band-limiting pulse and bar signals are shown in Figure 30. The waveforms of the test signals are shown in Figure 31 and T_c is as defined in **59.2**. The radio-frequency signal is applied to the input terminals of the receiver through a vestigial side band filter as required by the standards of the CCIR system B and a suitable matching network (see **8**).

Since the system in use requires that the signal be pre-corrected for receiver group delay characteristic this pre-correction must be included in the signal generator.

The input level is adjusted to be between those levels defined in **37** and **46** and such that noise effects do not influence measurement. An oscilloscope is connected in place of the picture tube to each appropriate primary colour or colour difference output signal in turn, in such a manner that the frequency response of the video circuits is unchanged and the electrodes continue to have suitably applied potentials.

61.3 2 T_c bar response

The oscilloscope is adjusted as shown in Figure 32, so that the half-amplitude points of the bar transitions coincide with points m_1 and m_2. Points A at black level or the grey pedestal level and B at the mid-point of the bar, are set at unit-amplitude. The maximum departure of the bar from unit-amplitude between points extending to from the half-amplitude points of each transition is measured and expressed as a percentage b of unit-amplitude. The result may be expressed in terms of the rating factor K using the expression below:

K rating of 2 T_c bar response expressed as a function of b:

$$K = \left| b - 100 \right|$$

61.4 2 T_c pulse response

The oscilloscope is adjusted as shown in Figure 33, such that the sweep velocity corresponds with the time scale indicated, the black level or grey pedestal level of the response coincides with the horizontal axis, the peak of the response corresponds with unit-amplitude and the half-amplitude points of the response are symmetrically disposed about the vertical axis. The amplitude of the signal is measured at the indicated points on the horizontal axis and expressed as a percentage of the peak response. The difference in time between the half-amplitude points of the response is measured and expressed in nanoseconds.

These values may be expressed in terms of the rating factor K using the expressions below:

$$K = \left| \frac{a - 2T_c}{10T_c} \right|$$

(a and T_c are expressed in the same units)

TABLE 5 - Expressions to calculate K at the points on time axis in unit intervals

Points on time axis in unit intervals	K rating as a function of percentage of peak response b
± 1	$K = \left\| \frac{b}{400} \right\|$
± 2	$K = \left\| \frac{b}{200} \right\|$
± 4	$K \left\| \frac{b}{100} \right\|$

61.5 2 T_c pulse/bar rating

The oscilloscope is adjusted as shown in Figure 32, and indicated in **61.3.** The ratio of the amplitude of the 2 T_c pulse to the amplitude to the 2 T_c bar response at point *B* is measured and expressed in terms of the rating factor *K* using the expression below:

K rating of 2 T_c pulse/bar ratio expressed as a function of *b:*

$$K = \left| \frac{100 - b}{4b} \right|$$

61.6 Field frequency squarewave response

The oscilloscope is adjusted as shown in Figure 35, so that the half-amplitude points of the bar transitions correspond with points m_1 and m_2 and so that the mid-points of the positive and negative excursions correspond with points A and B. The display is adjusted so that points A and B correspond to the unit-amplitude, the synchronizing pulses and grey pedestal, if either are present, being ignored. The maximum deviations above and below the unit-amplitude level up to points 0.01 *V* from the half-amplitude point of each transition are measured and expressed as a percentage of unit-amplitude. The result may be expressed in terms of the rating factor *K* using the expression below.

K rating of the field frequency squarewave response expressed as a function of *b:*

$$K = \left| \frac{b - 100}{2} \right|$$

61.7 Presentation of results

Since significant differences in the response of the colour difference channels can give rise to errors in colour transitions, the responses to a given test signal may be superimposed on a single graph with those relating to the various colour difference channels being suitably identified in order to indicate the presence of such differences.

62 BLACK LEVEL AND ITS STABILITY

62.1 Introduction

Black level is the television signal level during the active line period in the absence of picture modulation. It applies to the luminance signal, the individual primary colour signals and the individual colour difference signals. Measurements of the luminance generated by the picture tube when the signal is at black level may be carried out (see IEC 107-3) or of the equivalent signal voltage levels at the picture tube electrodes (see below). This clause deals with measurements of the variation of the voltage corresponding to black level at the picture tube electrodes with respect to time, temperature, supply voltage, input signal level and between monochrome and colour operation. It must be borne in mind when interpreting the following electrical measurements that the picture tube luminance corresponding to black level may be influenced by changes in supply potentials and changes in the voltages or ancillary electrodes of the picture tube.

62.2 Voltage corresponding to black level

The voltage corresponding to black level is the potential on a controlling electrode of the picture tube relative to ground potential or the potential of a supply rail. All guns of a multigun colour picture tube are to be measured individually. Where more than one picture tube electrode is modulated with the same signal or with associated signals, the difference in potential between the two controlling electrodes measured with the signal at black level, is the voltage corresponding to black level.

62.3 Variation of black level with time

If no other influence is present, the variation of the voltage corresponding to black level with time is mainly due to the temperature dependence of the component characteristics and the internal heating of the receiver. It is the change in the voltage corresponding to black level, expressed as a percentage of the difference between black level and white level, as a function of time.

62.4 Method of measurement

Measurement is carried out on a representative channel of those in which the receiver is designed to operate. The receiver must be tuned in accordance with **10** and is adjusted to provide standard video output voltage (see **35**). A test pattern is applied and the receiver adjusted for optimum decoding. The radio-frequency signal is applied to the input terminals of the receiver through a vestigial sideband filter as required by the standards of the CCIR system B (see **55.1**) and a suitable matching network (see **8**). The input signal level is adjusted to be between those levels defined in **37** and **46** and such that noise effects to not influence measurements. The radio-frequency signal is modulated with a selectably monochrome or colour video signal having picture content at black level.

An oscilloscope is connected to the appropriate picture tube electrode or electrodes and the variation of the voltage corresponding to black level measured at specific time intervals under constant supply voltage, ambient temperature and relative humidity without touching the receiver controls. If applicable, it is recommended that the measurements be repeated at the lowest and highest values of ambient temperature to be encountered in practice. Measurements may also be repeated for a range of ambient temperatures. Measurements should be carried out with both monochrome and colour signals and in the case of a colour receiver, for the electrodes or groups of electrodes generating the individual primary colour images. When the picture tube has a number of electrodes influencing the sensitivity of the main control electrodes, variations in the operating potentials of these electrodes should also be measured under the various conditions and any significant changes recorded with the results.

62.5 Period of initial variation of black level

The period of initial variation of black level is the time elapsing between initial switching on and the establishment of a condition in which the voltage corresponding to black level stays within a specified tolerance. The initial variation of black level is the value of the variation of the voltage corresponding to black level and the difference between the highest and lowest voltages corresponding to black level expressed as a percentage of the difference between black level and white level occurrring in this period.

62.6 Method of measurement

Before commencement of the measurements, the receiver should be switched off for a sufficiently long period for all parts of the receiver to attain approximately the test room temperature.

The duration and extent of the initial variation of black level shall be derived from a series of measurements from the moment of switching on, but measurements of the voltage corresponding to black level begin as soon as these are performable.

The signals used for measurement, their application to the receiver and the measurement instrumentation are as in **62.5**. Due to the necessity of commencing measurements at room temperature, arrangements may be made to carry out various measurements simultaneously or to restrict the number of measurements to those considered the most significant.

62.7 Presentation of results

The variation in the voltage corresponding to black level expressed as a percentage of the difference between black level and white level is plotted as a function of time in a curve having as abscissa, time in minutes on a logarithmic scale and as ordinate, the change of voltage. As reference, the voltage corresponding to black level at either 1 minute or 1 hour after initial switching on may be chosen. An example of a curve showing the variation of voltage corresponding to black level as a function of time is shown in Figure 42.

62.8 Black level as a function of supply voltage

A variation in the supply voltage may result in a change of the voltage corresponding to black level. The signals used for measurement and the instrumentation are those of **62.5**. The voltage corresponding to black level is measured as defined in **62.3** as a function of supply voltage, the latter being varied within the appropriate limits as selected from those laid down in **7**. This measurement shall not be performed during the period of initial variation of black level. When the picture tube has a number of electrodes influencing the sensitivity of the main control electrodes, variations in the operating potentials of these electrodes should also be measured and any significant changes recorded with the results.

62.9 Presentation of results

Curves representing the voltage corresponding to black level as a function of the supply voltage are plotted with the voltage variation as ordinate expressed as a percentage of the difference between black level and white level on a linear scale. The supply voltage variation is expressed as a percentage on a linear horizontal scale. An example of a curve showing the variation of the voltage corresponding to black level as a function of supply voltage is shown in Figure 43.

62.10 Black level as a function of input signal level

A variation in the input signal level may result in a change of the voltage corresponding to black level. The signals used for measurement and the instrumentation are those of **62.5**. The voltage corresponding to black level is measured as defined in **62.3** as a function of input signal, the latter being varied within the appropriate limits over the full range of the values in accordance with **9**. This measurement shall not be performed during the period of initial variation of black level. When the picture tube has a number of electrodes influencing the sensitivity of the main control electrodes, variations in the operating potentials of these electrodes should also be measured and any significant changes recorded with the results.

62.11 Presentation of results

Curves representing black level as a function of input signal level are plotted with the variation of the voltage corresponding to black level expressed as a percentage of the difference between black level and white level as ordinate on a linear scale. The recommended reference value depending on the receiver sensitivity being that obtained with an input signal level of -50 db (mW). The input signal is expressed in decibels as the abscissa on a linear scale. An example of a curve showing variation of voltage corresponding to black level as a function of input signal level is shown in Figure 44.

62.12 Change in black level between colour and monochrome operation

Due to the presence of a chrominance synchronizing signal such as a reference carrier burst, differences in black level can occur between monochrome and colour operation. It applies to the luminance black level and to both the individual primary colour signal and the individual colour difference signal black levels.

62.13 Method of measurement

The signals used for measurement and the instrumentation are those of clause **62.5**. The voltage corresponding to black level is measured as defined in **62.3**, first for monochrome operation and then for colour operation. Measurements are carried out at the extreme positions of any colour saturation control as well as at the position giving optimum decoding.

63 D.C. COMPONENT DISTORTION, LUMINANCE CHANNEL

63.1 Definition

The distortion of the d.c. component of the luminance signal is the shift of the voltage corresponding to black level on or between the control electrode or electrodes of the picture tube due to a change in picture luminance signal level.

63.2 Method of measurement

Measurement is carried out on a representative channel of those in which the receiver is designed to operate. The receiver must be tuned in accordance with **10**, and is adjusted to provide standard video output voltage (see **35**). A test pattern is applied and the receiver adjusted for optimum decoding. When a vision signal interference limiter control is provided, it should be set to have least effect upon the picture. The radio-frequency signal is applied to the input terminals of the receiver through a vestigial sideband filter as required by the standards of the CCIR system B (see **57**) and a suitable matching network (see **8**).

The input signal level is adjusted to be between those levels defined in **37** and **46** and such that noise effects do not influence measurement. Measurements are also carried out at high and low signal levels as defined respectively in **46** and **37** (the low signal level being, however, such that measurement accuracy is not impaired by noise). The radio-frequency signal is modulated with a video signal corresponding, successively to black level, 50 per cent of white level and white level. The signals at 50 per cent white level and white level shall include a small area at black level (see Figure 36a).

An oscilloscope is connected to the appropriate picture tube electrode or electrodes and the voltage corresponding to black level is measured at the control electrode or electrodes of the picture tube. The shift in the voltage corresponding to black level for the three picture signal conditions is expressed as a percentage of the difference in potential between black level and white level for standard video output voltage (see 36b).

In a colour receiver, each electrode driven by the luminance signal either directly or as a component of a primary colour signal, is to be measured. Where both grid and cathode of a picture tube electron gun have a luminance signal or luminance signal derived component applied, a differential oscilloscope measurement must be made between the appropriate electrodes. Care should be taken in making measurements to observe whether any distortions to the d.c. component are due to beam current limiting arrangements. Any such effects should be noted in the results. When the picture tube has a number of electrodes influencing the sensitivity of the main control electrodes, variations in the operating potentials of those electrodes should also be measured under the various conditions and any significant changes recorded with the results.

64 D.C. COMPONENT DISTORTION, COLOUR DIFFERENCE SIGNALS

64.1 Definition

The distortion of the d.c. component of the colour difference signals where these are applied to the picture tube electrodes separately from the luminance signal is the shift of the voltage corresponding to colour difference signal black level on the control electrode or electrodes of a given fun of the picture tube due to a change in picture-colour difference signal level.

64.2 Method of measurement

Measurement is carried out on a representative channel of those in which the receiver is designed to operate. The receiver must be tuned in accordance with **10** and is adjusted to provide standard video output voltage (see **35**). A test pattern is applied and the receiver adjusted for optimum decoding.

The radio-frequency signal is applied to the input terminals of the receiver through a vestigial sideband filter as required by the standards of the CCIR system B (see 55.1) and a suitable matching network (see **8**). The input signal level is adjusted to be between those levels defined in **37** and **46** and such that noise effects do not influence measurement.

Measurements are also carried out at low signal levels as defined in **37**, the low signal level being, however, such that measurement accuracy is not impaired by noise. The radio-frequency signal is modulated by the output of a PAL colour system coder. Input signals corresponding, successively to black level, 50 per cent of peak level and peak level, with the latter two including a small area at black level of the primary colour signals, are applied in turn to the red, blue, green, blue and green, red and green and red and blue primary colour inputs of the coder (see Figure 37a).

An oscilloscope is connected to the appropriate picture tube electrodes in turn and in each case the voltage corresponding to the colour difference signal black level is measured for the three signal conditions applied in the six combinations to the coder inputs. The change in the voltage expressed as a percentage of the difference in potential between black level and the level corresponding to the maximum level as measured when the input signal is a full amplitude, full purity colour bar signal with the white bar at white level. That is 100/0/75/0 of CCIR Recommendation 471 of the XV th Plenary Assembly, Geneva, 1982. Care must be taken in making measurements to observe whether any effects are due to beam current limiting arrangements. Any such effects should be noted in the results (see Figure 37b and Figure 37c).

65 D.C. COMPONENT DISTORTION, PRIMARY COLOUR SIGNALS

65.1 Definition

D.C. Component distortion of the primary colour signals is the shift of voltage corresponding to black level on the control electrode of a picture tube to which a primary colour signal is applied, due to a change in primary colour signal level.

65.2 Method of measurement

Measurement is carried out on a representative channel of those in which the receiver is designed to operate. The receiver must be tuned in accordance with **10** and is adjusted to provide standard video output voltage (see **35**). A test pattern is applied and the receiver adjusted for optimum decoding.

The radio-frequency signal is applied to the input terminals of the receiver through a vestigial sideband filter as required by the standards of the CCIR system B (see 55.1) and a suitable matching network (see **8**).

The input signal level is adjusted to be between those levels defined in **37** and **46** and is such that noise effects do not influence measurement. Measurements are also carried out at low signal level as defined in **37**, the low signal level being, however, such that measurement accuracy is not impaired by noise. The radio-frequency signal is modulated by the output of a PAL colour system coder. Input signals corresponding successively to black level, 50 per cent of peak level and peak level, with the latter two including a small area at black level of the primary colour signals, are applied in turn to the red, blue, green, blue and green, red and green and red and blue primary colour inputs of the coder (see Figure 37a).

An oscilloscope is connected to the appropriate picture tube electrodes in turn and in each case the voltage corresponding to the primary colour signal black level is measured for the three signal conditions applied in six combinations to the coder inputs. The change in the voltage corresponding to black level for the various conditions is expressed as a percentage of the standard video output voltage. Care should be taken in making measurements to observe whether any distortions to the d.c. component are due to beam current limiting arrangements. Any such effects should be noted in the results. When the picture tube has a number of electrodes influencing the sensitivity of the main control electrodes, variations in operating potentials of these electrodes should also be measured under the various conditions and any significant changes recorded in the results (see Figure 37d).

66 ERRORS OF CHROMINANCE SIGNAL DEMODULATION ANGLE - PAL SYSTEM

66.1 Definition

Three aspects of the chrominance signal demodulation are measured:

a) the demodulation angles of the carrier chrominance signal:

b) the delayed carrier chrominance signal phase matching, and

c) the amplitude matching of delayed and undelayed carrier chrominance signals.

66.2 Method of measurement

Measurement is carried out on a representative channel of those in which the receiver is designed to operate. The receiver must be tuned in accordance with **10** and is adjusted to provide a standard video output voltage (see **35**). A test pattern is applied and the receiver adjusted for optimum decoding. The radio-frequency signal is applied to the input terminals of the receiver through a vestigial side-band filter, as required by the standards of the CCIR system B (see **55.1**) and suitable matching network (see **8**). The input signal level is adjusted to be between those levels defined in **37** and **46** and such that noise effects do not influence measurement.

Measurements are also carried out at low signal levels as defined in **37**, the low signal level being, however, such that the measurement accuracy is not impaired by noise.

66.3 Errors of chrominance signal demodulation angle

The radio-frequency signal is modulated by the output of a PAL colour system coder, the input signals being colour bars occurring on alternate lines, the intermediate lines being at black level.

An oscilloscope is connected to the appropriate point in the circuit where the *R-Y* signal may be observed. The *R-Y* modulation component is switched off at the coder.

The mean phase of the chrominance carrier reference burst is adjusted to achieve a minimum response averaged over pairs of lines. The value and sign of the necessary shift are recorded as the *R-Y* error. The mean phase of the reference bursts where this has been shifted is now returned to nominal and the oscilloscope connected to a suitable point to observe the *B-Y* signal. The *R-Y* modulation at the coder is now switched on and the *B-Y* modulation switched off. The mean phase of the chrominance carrier reference bursts is adjusted at the coder to give minimum response averaged over pairs of lines. The value and sign of this phase shift is recorded as the *B-Y* error.

66.4 Delayed chrominance carrier signal phase matching

The measurement is as defined in **66.3** when measuring the *R-Y* error. An error in direct and delayed path phase matching will result in a different adjustment at the coder of the chrominance carrier reference burst mean phase to achieve minimum response on each of the adjacent lines in time. This difference in phase shift is measured observing the *R-Y* output. The differences expressed either in degrees of chrominance carrier phase or converted into time in nanoseconds is recorded as the error.

66.5 Amplitude matching of delayed and direct chrominance carrier signal

The test set-up is as defined in **66.3**, the oscilloscope being connected to observe the *R-Y* signal. The *B-Y* modulation of the coder is switched off and the amplitude of the *R-Y* signal measured on adjacent lines in time. The amplitude matching error of delayed and direct signals is the ratio of the smaller to the larger expressed as a percentage.

67 EFFECTS OF PHASE DISTORTION ON INCOMING SIGNAL FOR SMALL PICTURE AREAS - PAL SYSTEM

67.1 Definition

Chrominance signal side-band asymmetry in the receiver will cause the decoder to respond differently to transients as compared with large areas of the picture when there is distortion of the phase relationship between the chrominance carrier reference bursts and the carrier chrominance picture signal as received. Hanover blind effects can arise on transitions and the transient response can be degraded.

67.2 Method of measurement

Measurement is carried out on a representative channel of those in which the receiver is designed to operate. The receiver must be tuned in accordance with **10** and is adjusted to provide a standard video output voltage (see **35**). A test pattern is applied and the receiver is adjusted for optimum decoding. The radio-frequency signal is applied to the input terminals of the receiver through a vestigial sideband filter as required by the standards of the CCIR system B (see **57**) and a suitable matching network (see **8**). The input signal level is adjusted to be between those levels defined in **35** and **46** and such that noise effects do not influence measurement. Measurements are also carried out at low signal level as defined in **37**, the low signal level being, however, such that the measurement accuracy is not impaired by noise.

The radio-frequency signal is modulated by the output of a PAL colour system coder having inputs for the three primary colours and an independent luminance channel. A 50 per cent grey level constant pedestal is applied to the luminance channel and picture modulation corresponding to a 2 T_c pulse and bar is applied to the three primary colour inputs of the coder at 55 per cent and 30 per cent of the maximum system level. Suitable networks for band-limiting pulse and bar signals are shown in Figure 30. The waveforms of the test signals are shown in Figure 31 and T_c is as defined in **59.2**.

An oscilloscope is connected in place of the picture tube to each appropriate primary colour or colour difference output signal in turn, in such a manner that the frequency response of the video circuits is unchanged. The 2 T_c pulse/bar ratio is measured as indicated in **61.5** and the peak-to-peak amplitude of the pulse is measured. The mean phase of the reference chrominance carrier burst at the coder is advanced 30° in phase from the nominal condition. The pulse to bar ratio is again measured as above and the peak-to-peak value of any Hanover blind effect occurring on the peak of the pulse is also measured. These measurements are then repeated with the mean phase of the reference chrominance carrier burst at the coder retarded 30° in phase.

67.3 Presentation of results

Results are tabulated for the three primary colour signals and in each case, for the three conditions of phase and two of amplitude showing the pulse/bar amplitude ratios and the changes in the amount of Hanover blind effects on the pulse, as shown in Figure 38a to Figure 38d.

68 LUMINANCE/CHROMINANCE DELAY INEQUALITY

68.1 Definition

Luminance/chrominance delay inequality is a measure of the error in relative timing of the luminance and chrominance components of the primary colour signals or the equivalent separate luminance and chrominance signals applied to the picture tube.

68.2 Method of measurement

Measurement is carried out on a representative channel of those in which the receiver is designed to operate. The receiver must be tuned in accordance with **10** and is adjusted to provide standard video output voltage (see **35**). A test pattern is applied and the receiver adjusted for optimum decoding. The radio-frequency signal is applied to the input terminals of the receiver through a vestigial sideband filter as required by the standards of the CCIR system B (see **57**) and a suitable matching network (see **8**). The input signal level is adjusted to be between those levels defined in **37** and **46** and such that noise effects do not influence measurement. The radio-frequency signal is modulated by the output of a PAL colour system coder having inputs for the three primary colours and an independent luminance channel. The input signals of the coder sonsist of a 2 T_c pulse and bar signal applied in the proportions indicated in Table 6, according to the primary colour channel being measured.

TABLE 6 - Proportion of the input signal of the coder for primary colour channel being measured

	Coder inputs in % of maximum value			
Channel to be measured	**R**	**G**	**B**	**Y**
R	0	75	75	53
B	75	75	0	67
G	75	0	75	31
R	0	30	30	21
B	30	30	0	27
G	30	0	30	12

The three primary colour channels are measured in turn at the two levels defined in the Table 6 by connection of an oscilloscope in place of the picture tube to the primary colour output in such a manner that the frequency response of the video circuits is unchanged. Where luminance and colour difference components are applied to separate picture tube electrodes, a differential oscilloscope must be used to give an indication of the primary colour signals.

In the case of each primary colour channel, the appropriate input signal to the coder are applied and the receiver chrominance channel gain control adjusted to nullify the bar component of the pulse and bar signal.

Since the system in use requires that the signal be pre-corrected for receiver group delay characteristic, this pre-correction must be included in the signal generator.

Where there is luminance/chrominance timing error, the pulse component will not disappear entirely but will leave a residual sinusoidal disturbance. Where this sinusoidal disturbance commences in the direction of white level, the chrominance channel is delayed relative to luminance and when in the other direction, luminance is delayed relative to chrominance. The chrominance component is switched off and the amplitude of the pulse measured. The chrominance component is then switched on and the peak-to-peak magnitude of the sinusoidal disturbance is measured. These values are used in the formula below to determine the magnitude of the luminance/chrominance timing error. Typical resulting waveforms are shown in Figure 39.

$$\tau = \frac{2T_c A}{\pi B}$$

where:

τ = the magnitude of the delay inequality

T_c = as defined in **59.2**

A = peak-to-peak amplitude of sinusoidal disturbance

B = amplitude of luminance channel pulse alone

68.3 Presentation of results

The results are tabulated for the three primary colour channels at the two stated levels showing the magnitude and sign of the relative timing error between the luminance and chrominance components.

69 G-Y signal matrixing error

69.1 Definition

Where the *G–Y* signal is obtained by matrixing proportions of *R–Y* and *B–Y*, this measurement defines the deviation of these proportions from the nominal value.

69.2 Method of measurement

Measurement is carried out on a representative channel of those in which the receiver is designed to operate. The receiver must be tuned in accordance with **10** and is adjusted to provide standard video output voltage (see **35**). A test pattern is applied and the receiver adjusted for optimum decoding. The radio-frequency signal is applied to the input terminals of the receiver through a vestigial side-band filter as required by the standards of the CCIR system B (see **57**) and a suitable matching network (see **8**). The input signal level is adjusted to be between those levels defined in **35** and **46** and such that noise effects do not influence measurement. The radio-frequency signal is modulated by the output of a PAL colour system coder. The input signals to the coder consist of a constant pedestal signal of 50 per cent maximum amplitude to the blue input and 14 per cent maximum amplitude to the green input with no signal applied to the red channel. An oscilloscope is connected to a suitable point to observe the *G–Y* signal or where this is not available, the green signal. The chrominance signal is switched off at the coder and the signal level on the oscilloscope observed. The chrominance signal is restored and the amplitude of the green input is adjusted for zero *G–Y* output, that is the same level as when the chrominance signal was not present. The level of the green input signal to the coder is measured.

NOTE – Where the G–Y signal is observed, measurement may be facilitated by using a line rate squarewave for the blue and green input signals permitting observation of the amplitudes under both conditions without the need to switch off the chrominance signal at the coder.

69.3 Presentation of results

The result of the measurement is expressed as the percentage error of the *B–Y* signal contribution to the *G–Y* signal calculated as follows:

From the measured value of the green input to the coder and the known blue signal input, the equivalent values of *R–Y* and *B–Y* are calculated using the standard formulation for *Y*, the luminance signal, that is $Y' = 0.30\ R' + 0.59\ G' + 0.11\ B'$. The values are normalized for unit value of *R–Y* by dividing the coefficient of *B–Y* by the coefficient of *R–Y*. The resulting decimal fraction is expressed as a percentage of 0.37, this being the nominal ratio of *B–Y* and *R–Y* contributions to *G–Y*. This percentage represents the measured contribution of *B–Y* to the *G–Y* signal.

70 PRIMARY COLOUR SIGNAL MATRIXING ERROR

70.1 Definition

These measurements define the accuracy with which the blue and green primary colour signals are formed from the luminance and colour difference signal components, with the receiver adjusted to correctly proportion the red colour separation signal.

70.2 Method of measurement

Measurement is carried out on a representative channel of those in which the receiver is designed to operate. The receiver must be tuned in accordance with **10** and is adjusted to provide standard video output voltage (see **35**). A test pattern is applied and the receiver adjusted for optimum decoding. The radio-frequency signal is applied to the input terminals of the receiver through a vestigial sideband filter as required by the standards of the CCIR system B (see **57**) and a suitable matching network (see **8**). The input signal level is adjusted to be between those levels defined in **37** and **46** and such that noise effects do not influence measurement. The radio-frequency signal is modulated by the output of a PAL colour system coder. The signals applied to the coder are constant pedestal signals of 60 per cent maximum amplitude to the red, blue and green inputs. An oscilloscope is connected to observe the red primary colour signal where it is applied to the picture tube. Where luminance and chrominance signals are applied to separate terminals of the picture tube, the primary colour signals may be observed by using an oscilloscope with differential inputs. The level of the signal at the red output is noted and the blue and green inputs to the coder removed. If necessary, the receiver chrominance channel gain control is adjusted to provide the same output level as existed when all three inputs were applied to the coder. The oscilloscope is now transferred to the blue signal output to the picture tube and the signal level noted with the signal applied to all three coder inputs as before.

The red and green inputs to the coder are removed and the level of the signal noted, expressed as a percentage of that when all three inputs were applied to the coder. The oscilloscope is now transferred to the green output to the picture tube and the signal level noted with signals applied to all three coder inputs as before. The red and blue inputs to the coder are removed and the level of the signal noted, expressed as a percentage of that when all three inputs were applied to the coder.

70.3 Presentation of results

The results of the measurements are expressed as the percentage of the $B-Y$ contribution to the blue primary colour signal and the $G-Y$ contribution to the green primary colour signal, 100 per cent being the nominal value, calculated using the following expressions where n is the percentage obtained from the measurements in **70.2**.

Blue primary colour signal *B-Y* contribution as a percentage of nominal

$$= \frac{100\ (n-11)}{89}\ \%$$

Green primary colour signal contribution of *G-Y* as a percentage of nominal

$$= \frac{100\ (n-59)}{41}\ \%$$

71 SPURIOUS LINE SEQUENTIAL EFFECTS

71.1 Definition

Receivers can show differences in signal levels or different levels of spurious signals on lines sequential in time.

71.2 Method of measurement

Measurement is carried out on a representative channel of those in which the receiver is designed to operate. The receiver must be tuned in accordance with **10** and is adjusted to provide standard video output voltage (see **35**). A test pattern is applied and the receiver adjusted for optimum decoding. The radio-frequency signal is applied to the input terminals of the receiver through a vestigial sideband filter as required by the standards of the CCIR system B (see **57**) and a suitable matching network (see **8**). The input signal level is adjusted to be between those levels defined in **37** and **46** and such that noise effects do not influence measurement. The radio-frequency signal is modulated by the output of a PAL colour system coder.

A colour bar signal is applied to the coder that will give rise to chrominance signals having approximately 75 per cent of the maximum value (see **3.6**). An oscilloscope is connected to the tube electrodes in turn, to which the colour difference signals are applied. Where luminance and chrominance signals are applied to separate terminals of the picture tube, the colour difference signals are observed by using an oscilloscope with differential inputs. The oscilloscope is triggered so that lines sequential in time are superimposed. The magnitude of any line sequential level difference or the presence of any line sequential spurious signal is noted, the value being expressed as a percentage of the difference between black level and white level.

71.3 Presentation of results

The magnitudes of the measured effects are tabulated for the colour separation signal outputs, showing the levels in the various colour bars where some are more significant than others.

72 LINE TIME NON-LINEARITY LUMINANCE SIGNAL

72.1 Definition

The non-linearity distortions in the luminance channel are measured with a five riser staircase signal of line time duration extending between black level and white level. Intermediate lines are interposed at black level or white level to cause maximum shift of the mean signal level.

72.2 Method of measurement

Measurement is carried out on a representative channel of those in which the receiver is designed to operate. The receiver must be tuned in accordance with **10** and is adjusted to provide standard video output voltage (see **35**). A test pattern is applied and the receiver adjusted for optimum decoding. The radio-frequency signal is applied to the input terminals of the receiver through a vestigial side band filter as required by the standards of the CCIR system B (see **57**) and a suitable matching network (see **8**). The input signal level is adjusted to be between those levels defined in **37** and **46** and such that noise effects do not influence measurement. The radio-frequency signal is modulated by a video signal consisting of a five riser staircase in every fourth line. The intermediate three lines may be at black level or white level, as desired. An oscilloscope is connected to each electrode of the tube to which a luminance signal is applied. The departure of the amplitude measured at the centre of each step from its nominal amplitude is expressed as a percentage of the difference between black level and white level. Measurements are made with intermediate lines both at black level and white level (see Figure 40).

72.3 Presentation of results

The measured values expressed as a percentage of the difference between black level and white level are tabulated for each electrode measured, each step of the staircase signal and the two levels of the intermediate lines.

73 LINE TIME NON-LINEARITY COLOUR DIFFERENCE SIGNALS

73.1 Definition

Where colour difference signals are applied to picture tube electrodes separately from the luminance signal, measurements are made of the non-linearity distortions for both positive and negative going excursions, using a five riser staircase signal of line time duration. Intermediate lines are interposed at black level and maximum level to cause maximum shift of mean signal level.

73.2 Method of measurement

Measurement is carried out on a representative channel of those in which the receiver is designed to operate. The receiver must be tuned in accordance with **10** and is adjusted to provide standard video output voltage (see **35**). A test pattern is applied and the receiver adjusted for optimum decoding. The radio-frequency signal is applied to the input terminals of the receiver through a vestigial sideband filter as required by the standards of the CCIR system B (see **57**) and a suitable matching network (see **8**). The input signal level is adjusted to be between those levels defined in **37** and **46** and such that noise effects do not influence measurement. The radio-frequency signal is modulated by the output of a PAL colour system coder.

The signals applied to the coder consist of three lines of a five riser staircase covering the range from black level to maximum level followed by nine lines either at black level or maximum level. An oscilloscope is connected to the tube electrode driven by the *R–Y* signal and the staircase signal applied to the red input of the coder.

The departure of each step from its nominal amplitude, measured in the centre of each step, is expressed as a percentage of the difference between black level and maximum level. Measurements are made with the intermediate lines at black level and maximum level. The staircase signal is then applied simultaneously to the blue and green inputs of the coder and the measurements repeated. The oscilloscope is then transferred to the electrode driven by the *G–Y* signal and the measurements above carried out first with the staircase signal applied to the green input of the coder and then simultaneously to the blue and red inputs. The oscilloscope is then connected to the picture tube electrode driven by the *B–Y* signal and the measurements carried out first with the staircase signal applied to the blue input of the coder and then applied simultaneously to the red and green inputs (see Figure 40).

NOTE – In the case of receivers employing a one line delay, four lines of chrominance component will be displayed on the oscilloscope. The second and third of these lines shall be used for measurement and the first and fourth ignored.

73.3 Presentation of results

The results of the measurements are tabulated for each of the colour difference signals and for the two coder input conditions showing the departure of each step of the staircase from its nominal amplitude expressed as a percentage of the difference between black level and maximum level, for both conditions of the intermediate lines.

74 LINE TIME NON-LINEARITY PRIMARY COLOUR SIGNALS

74.1 Definition

Non-linearity distortions of the primary colour signals are measured for both positive and negative going excursions of the associated colour difference signals by using a five riser staircase signal of line time duration. Intermediate lines are interposed at black level and maximum level to cause maximum shift of mean signal level.

74.2 Method of measurement

Measurement is carried out on a representative channel of those in which the receiver is designed to operate. The receiver must be tuned in accordance with **10** and is adjusted to provide standard video output voltage (see **35**). A test pattern is applied and the receiver is adjusted for optimum decoding. The radio frequency signal is applied to the input terminals of the receiver through a vestigial sideband filter as required by the standards of the CCIR system B (see **57**) and a suitable matching network (see **8**). The input signal level is adjusted to be between those levels defined in **37** and **46** and such that noise effects do not influence measurement. The radio-frequency signal is modulated by the output of a PAL colour system coder.

The signals applied to the coder consist of three lines of a five riser staircase covering the range from black level to maximum level followed by nine lines selectably at black level or maximum level. An oscilloscope is connected to the tube electrode driven by the primary red colour signal and the staircase signal applied to the red input of the coder. The departure of each step from its nominal amplitude measured in the centre of each step is expressed as a percentage of the difference between black level and maximum signal level, with the intermediate lines both at black level and maximum level. The measurements are repeated with the staircase signal applied simultaneously to the red and blue inputs to the coder. The oscilloscope is then transferred to the electrode driven by the primary blue colour signal and the measurements above carried out with the staircase signal applied first to the blue input of the coder and then simultaneously to the blue and green inputs. The oscilloscope is then connected to the picture tube electrode driven by the green primary colour signal and measurements carried out with the staircase signal applied to the green input of the coder. The measurements are then repeated with the staircase signal applied to the green and red inputs of the coder (see Figure 40).

74.3 Presentation of results

The results of the measurements are tabulated for each of the primary colour signals showing the departure of each step of the staircase from its nominal amplitude expressed as a percentage of the difference between black level and maximum level for the two coder input conditions and both conditions of the intermediate lines.

SECTION EIGHT - COMPATIBILITY WITH AUDIO VISUAL RECORDING EQUIPMENT

75 FLAGGING

75.1 Definition

Distrubances to the line synchronizing pulse train may occur with certain audio visual recording equipment. For example: due to head switching **and/or** changes in tape tension. These can give rise to a fluctuating horizontal displacement at the top of the picture known as "flagging". The magnitude and extent of the effect for an input signal with a given amount of disturbance depends upon the design of the horizontal scan circuit.

75.2 Method of measurement

Measurement is carried out on a representative channel of those in which the receiver is designed to operate. The receiver must be tuned in accordance with **10** and is adjusted to provide standard video output voltage (see **35**). A test pattern is applied and the receiver adjusted for optimum decoding in the case of a colour receiver. The radio-frequency signal is applied to the input terminals of the receiver through a suitable matching network (see **8**). The input signal level is adjusted to be between those levels defined in Sections **37** and **46** and such that noise effects do not influence measurement. The radio-frequency signal is modulated by a video signal including vertical bars and having the controlling master oscillator capable of frequency modulation. The master oscillator is frequency modulated by a rectangular signal of such mark/space ratio that the first 50 lines of each field are modulated in frequency selectably above or below the nominal value by 50 Hz, the remainder of the field being at nominal line scan frequency. The amount of any horizontal disturbance at the top of the displayed picture for both higher and lower modulation frequencies is measured peak-to-peak and expressed as a percentage of the active line period. The form of the disturbance is recorded with the result, that is: its shape and the extent to which it persists down the field. If the receiver has selectable horizontal control circuit character stics such as time constants, measurements should be made with all available control positions.

Where the receiver has a video frequency input socket, the signal having the master oscillator frequency modulated should be applied thereto, through a suitable matching network is required by the input impedance stated by the manufacturer. The input signal level should be either that given by the manufacturer or where this is not known, at such a level that gives standard video output voltage. The measurement process in other respects is as with the antenna input condition.

76 HORIZONTAL WEAVE

76.1 Definition

Certain audio visual recording equipment can cause field rate cyclic disturbances to the line synchronizing pulse train, for example: lack of ideal centring in video disc players. This can give rise to a displacement of horizontal scanning lines over a region of the display picture. The magnitude and extent of the effect for an input signal with a given amount of disturbance depends upon the design of the horizontal scan circuit.

76.2 Method of measurement

Measurement is carried out on a representative channel of those in which the receiver is designed to operate. The receiver must be tuned in accordance with **10** and is adjusted to provide standard video output voltage (see **35**). A test pattern is applied and the receiver adjusted for optimum decoding in the case of a colour receiver. The radio-frequency signal is applied to the input terminals of the receiver through a suitable matching network (see **8**). The input signal level is adjusted to be between those levels defined in **37** and **46** and such that noise effects do not influence measurement. The radio-frequency signal is modulated by a video signal including vertical bars and having the controlling master oscillator capable of frequency modulation. The master oscillator is frequency modulated by a field frequency sinusoidal signal and adjustable phase relative to the field synchronizing signal, and of such an amplitude that the peak-to-peak frequency deviation is 50 Hz. The phase is adjusted to bring the maximum disturbance of the displayed picture approximately to the centre of the screen. The maximum amount of any horizontal disturbance is measured peak-to-peak and expressed as a percentage of the active line period. The form of the disturbance is also recorded with the results, that is: its shape and its extent down the field.

Where the receiver has a video frequency input socket, the signal having the master oscillator frequency modulated should be applied thereto, through a suitable matching network as required by the input impedance stated by the manufacturer. The input signal level should be either that given by the manufacturer or where this is not known, at such a level that gives standard video output voltage. The measurement process in other respects is as with the antenna input condition.

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