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Methods of measurement of equipment used in terrestrial radio-relay systems - Part 2: Measurements for sub-systems - Section 2: Stand-by channel switching equipment

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METHODS OF MEASUREMENT FOR EQUIPMENT USED IN TERRESTRIAL RADIO-RELAY SYSTEMS
PART 2: MEASUREMENTS FOR SUB-SYSTEMS
SECTION TWO - STAND-BY CHANNEL SWITCHING EQUIPMENT

Méthodes de mesure applicables au matériel utilisé dans les faisceaux hertziens terrestres
Deuxième partie: Mesures sur les sous-ensembles
Section deux - Matériel de commutation sur canal de secours

Meßverfahren für Geräte in terrestrischen Richtfunksystemen
Teil 2: Messungen an Untersystemen
Hauptabschnitt zwei - Geräte zum Umschalten auf einen Ersatzkanal

BODY OF THE HD

The Harmonization Document consists of:

- IEC 487-2-2 (1981) ed 1; IEC/SC 12E, not appended

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The English and French versions of this Harmonization Document are provided by the text of the IEC publication and the German version is the official translation of the IEC text. The German translation is available.

According to the CENELEC Internal Regulations the CENELEC member National Committees are bound:

to announce the existence of this Harmonization Document at national level by or before 1987-03-15

to publish their new harmonized national standard by or before 1987-09-15

to withdraw all conflicting national standards by or before 1987-09-15.

Harmonized national standards are listed on the HD information sheet, which is available from the CENELEC National Committees or from the CENELEC Central Secretariat.

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

METHODS OF MEASUREMENT FOR EQUIPMENT USED IN TERRESTRIAL RADIO-RELAY SYSTEMS

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FOREWORD

1) The formal decisions or agreements of the IEC on technical matters, prepared by Technical Committees on which all the National Committees having a special interest therein are represented, express, as nearly as possible, an international consensus of opinion on the subjects dealt with.
2) They have the form of recommendations for international use and they are accepted by the National Committees in that sense.
3) In order to promote international unification, the IEC expresses the wish that all National Committees should adopt the text of the IEC recommendation for their national rules in so far as national conditions will permit. Any divergence between the IEC recommendation and the corresponding national rules should, as far as possible, be clearly indicated in the latter.

PREFACE

This standard has been prepared by Sub-Committee 12E: Microwave Systems, of IEC Technical Committee No. 12: Radiocommunications.

A draft of Section Two was discussed at the meeting held in The Hague in 1977. As a result of this meeting, a draft, Document 12E(Central Office)67, was submitted to the National Committees for approval under the Six Months' Rule in November 1978.

The National Committees of the following countries voted explicitly in favour of publication:

Australia	Netherlands
Belgium	South Africa (Republic of)
Canada	Sweden
Egypt	Turkey
France	United Kingdom
Germany	United States of America

METHODS OF MEASUREMENT FOR EQUIPMENT USED IN TERRESTRIAL RADIO-RELAY SYSTEMS

Part 2: Measurements for sub-systems

SECTION TWO – STAND-BY CHANNEL SWITCHING EQUIPMENT

1. Scope

This section deals with measurements for sub-systems used for stand-by channel switching. Methods of measurement are given for the transmission characteristics of switching sub-systems inserted in the transmission chain at baseband and at intermediate frequency, for the pilot and the noise-detector sub-systems, and for the operate and transfer times of the switches.

2. Introduction

The number of protected working channels and the number of stand-by channels are denoted by $(m + n)$, where:

m is the number of working channels, usually one or more

n is the number of stand-by channels, usually one or two.

In the case where m and n are each equal to one, two modes of operation are possible.

In the first mode, the traffic may be applied to both channels simultaneously so that no switching is necessary at the transmit end (viz. twin-path working).

In the second mode, the traffic is applied to one channel and the second channel is used as a stand-by for the first, but may also be used for other purposes, e.g. for television, provided that the first channel is operating satisfactorily. Switches at each end of the system are necessary for this case and it is accepted that the service on the working channel has priority over the service on the stand-by channel.

Note. — In other cases where the same radio frequencies are used for working and stand-by purposes, switching of each transmitter and receiver will be necessary.

In all cases except that to which the preceding note applies, all the $(m + n)$ channels operate on different radio frequencies and stand-by switching necessarily takes place at baseband or at intermediate frequency.

In the case where $m > 1$, various systems of priority for the use of stand-by channels may be adopted. These systems will not be considered here.

In general, means of communication in both directions between the ends of the switched section are necessary to ensure the correct sequence of the switching operation (Reference 1).

However, in the case of a twin-path switching system, in which the stand-by channel is not used for another service, a return control channel is not required.

Note. — For twin-channel and hot stand-by systems, additional measurements need to be carried out in accordance with Part 2, Section Z of this publication: Diversity, Twin-path and Hot Stand-by Equipment (in preparation).

A multi-line switching system comprises:

- a sensing and logic sub-system to determine if switching is necessary;
- a two-way communication system between the ends of the switched section;
- switches and associated equipment.

Studies of the characteristics of multi-line switching arrangements have not yet reached a point where the interconnection of differing switching systems can occur on a fully standardized basis (see Reference 3). Stand-by switching systems are very diverse, to the extent that it is not possible to give a complete list of measurements for every configuration. In this section, a selection of suitable methods for typical equipment is given.

The tests to be made should be agreed upon by the purchaser and the manufacturer.

Some of the measurements to be described require the use of all or part of the equipment used for one hop of a simulated radio-relay system in order to test the stand-by switching equipment. In such cases, the simulated radio-relay system should be carefully adjusted to ensure that its performance complies with the requirements of the detailed equipment specification.

3. Transmission characteristics

Since the switches are connected in tandem with the sub-systems which form the radio-relay system, it is necessary to measure the transmission characteristics of the switches themselves. Suitable methods of measurement of transmission performance are given in Parts 1 and 3 of this publication.

Switches may be tested separately as intermediate frequency to intermediate frequency or as baseband to baseband sub-systems. Measurements should be made on a simulated system both with and without the switches in circuit so that the effect of the switches can be determined. Each path should be measured separately.

Note. — The loss or gain of each switch needs to be taken into account.

4. Isolation between the ports of a switch

4.1 *Definition and general considerations*

The isolation between any two ports of a switch, only one of which is in the signal path, is the ratio, expressed in decibels, between the levels at the two ports when all ports are terminated with their nominal impedances.

The measurement should be made between each intended output port and all other output ports in turn.

4.2 *Method of measurement*

Isolation is measured using the sweep-frequency method by applying a sweep-frequency signal to one port at intermediate frequency or at baseband frequency as appropriate, and then connecting a suitable receiver successively to the two ports between which the isolation is to be measured, and noting the minimum difference in level. The receiver should correctly terminate the port to which it is connected, and all other ports should also be correctly terminated. Care should be taken to ensure that the output of the generator does not overload the switch.

Alternatively, the point-by-point method may be used.

Note. — The accuracy required for this test is not high, e.g. ±2 dB.

4.3 *Presentation of results*

The results should be given as in the following example:

"The minimum isolation between all ports was *X* dB, occurring between ports *Y* and *Z* at frequency *f* kHz (or MHz)."

Curves of the isolation/frequency characteristic or photographs of corresponding oscilloscope displays may also be included if required.

4.4 *Details to be specified*

The following items should be included, as required, in the detailed equipment specification:

a) points between which measurements are to be made;
b) input level to be used;
c) frequency range over which measurements are to be made;
d) required isolation (e.g. 80 dB).

5. **Switching criteria**

5.1 *General considerations*

Two switching criteria are in general use, namely a specified change in continuity-pilot level (Reference 4) and/or a specified change in noise level in a noise measuring slot (see Sub-clause 5.3.2).

It is necessary to test the pilot and noise detectors to verify that they both operate and recover at the specified levels of pilot and noise signals under the following conditions:

- in the absence of baseband signals;
- in the presence of baseband signals at normal levels;
- in the presence of baseband signals at moderate overload levels.

It is also necessary to verify that the noise detector does not operate erratically when the noise is at or near the operate or recovery level. The effect of the pilot level on the noise-detector operation and of the noise power on the pilot-detector operation should be checked.

Notes 1. — In most cases, pilot detectors operate at a level which is lower than the nominal pilot level. However, in some instances, pilot-detector operation takes place at both lower than nominal and higher than nominal levels.

2. — Step attenuators for changing the pilot or noise levels should *not* be used because the momentary interruptions due to switching may cause false detector operations.

3. — Because of the fluctuating nature of the noise, all measurements involving noise sources should be repeated several times to determine the average level of detector operation.

5.2 *Pilot-detector operate and recovery levels*

5.2.1 *Definitions*

The operate level of a pilot detector is that level of pilot input signal at which the detector operates and indicates a change of condition from "normal" to "abnormal".

The recovery level is that level at which the pilot-detector indicates a change of condition from "abnormal" to "normal".

Notes 1. — The operate level is normally adjustable over a specified range.

2. — The recovery level is specified as being *X* dB above or below the operate level as appropriate. In some cases, *X* is adjustable.

5.2.2 *Method of measurement*

There are two test arrangements for measuring pilot-detector operate and recovery levels. If the detector samples the normal baseband output, it may be tested entirely at baseband as shown in Figure 1*a*, page 32. If the detector monitors the pilot at i.f. by means of a demodulator, the method shown in Figure 1*b*, page 33, is appropriate.

In each case, the pilot is generated by an external generator whose output level, starting from nominal value, is continuously changed, first in one direction until the detector operates, then in the other direction until the detector recovers. If the pilot detector operates at levels both above and below nominal, the operate and recovery levels should be measured for both cases. For i.f. switching (see Figure 1*b*) the frequency deviation owing to the external pilot should be adjusted to the nominal value before starting the measurement.

5.2.3 *Presentation of results*

The operate and recovery levels should be tabulated.

5.2.4 *Details to be specified*

The following items should be included as required in the detailed equipment specification:

a) the required range of operate levels (e.g. −8 to −4 dB relative to nominal pilot level);

b) the required range of recovery levels (e.g. 1 to 3 dB above operate level);

c) pilot-signal frequency.

5.3 *Noise-detector operate and recovery levels*

5.3.1 *Definitions and general considerations*

The operate level of a noise detector is the noise level in a specified part of the baseband required to cause the detector to indicate a change in condition from "normal" to "abnormal".

The recovery level is the level of noise in the same specified band, at which the detector indicates a change of condition from "abnormal" to "normal".

Notes 1. — The operate level is normally adjustable over a specified range.

2. — The recovery level is specified as being *X* dB below the operate level. In some cases, *X* is adjustable.

The band-pass filter for the noise detector is usually integral with the detector and, therefore, a test point following the filter is not usually available. The operate level is expressed by the equivalent noise power measured in a specified part of the baseband. The noise power in this specified band directly indicates the performance quality of the system when a switching action takes place, because there is normally an unambiguous relationship between this noise power and the noise power appearing at the noise-detector input.

The specified band is usually the top measuring channel in the case of telephony (see Reference 5) or the whole video band in the case of television (see Reference 6). The telephony measurement can be used for television systems, however, because of the fixed relationship between the loss-dependent thermal noise in both cases of transmission when switching takes place.

5.3.2 *Method of measurement*

The operate and recovery levels of a noise detector are preferably measured using the "noisy receiver" method, in which the noise source is a normal system receiver to which a variable, low-level input signal is applied in order to vary the noise output. The equipment arrangements are shown in Figures 2*a* and 2*b*, pages 34 and 35, in which the intermediate or radio-frequency attenuation, whichever is more convenient, is increased continuously until the noise detector operates, then decreased until it recovers.

However, if a number of items of the same equipment type are to be measured, it may be more convenient to use the method shown in Figure 3*a* or 3*b*, pages 36 and 37, as appropriate, for subsequent measurements, in which the noise is supplied by a white-noise generator. The output level of the white-noise generator is increased continuously until the noise detector operates, then decreased until it recovers. The noise bandwidth should include the pilot detector and noise-detector frequencies but should be limited—e.g. a 2 700-channel low-pass filter may be used for testing a 1 800-channel system. Using either method, the noise levels causing a change of state of the detector as measured on the white-noise receiver are noted.

The operate and recovery levels measured using the method of Figure 2*a* or 2*b* may differ by several decibels compared with the levels measured by the method of Figure 3*a* or Figure 3*b*. This is due to the fact that the noise power in the detector pass-band and the noise power in the measuring slot are different for the two methods. Once the difference is determined for the particular type of equipment under test, the levels may be measured using the arrangement of Figure 3*a* or Figure 3*b*, then corrected to that which they would have been if the measuring arrangement of Figure 2*a* or 2*b* had been used.

Note. — Some systems use a noise slot centred on the pilot frequency and detect the noise sidebands around the pilot. For such systems, it may be necessary to verify that the pilot is present at normal level whenever any measurements are made on the noise detector.