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Methods of measurement for equipment used in terrestrial radio-relay systems - Part 2: Measurements for sub-systems - Section 6: Diversity, twin-path and hot stand-by equipment

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METHODS OF MEASUREMENT FOR EQUIPMENT USED IN TERRESTRIAL RADIO-RELAY SYSTEMS
PART 2: MEASUREMENTS FOR SUB-SYSTEMS
SECTION SIX - DIVERSITY, TWIN-PATH AND HOT STAND-BY EQUIPMENT

Méthodes de mesure applicables au matériel utilisé dans les faisceaux hertziens terrestres
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Hauptabschnitt sechs - Geräte für Diversity, Zweikanal- und Heußersatzbetrieb

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CENELEC

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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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.

The text of this standard is based upon the following documents:

Six Months' Rule	Report on Voting
12E(CO)82	12E(CO)102

Further information can be found in the Report on Voting indicated in the table above.

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

Part 2: Measurements for sub-systems

SECTION SIX — DIVERSITY, TWIN-PATH AND HOT STAND-BY EQUIPMENT

1. Scope

This section deals primarily with measurements on diversity equipment used for making two or more receivers at a radio-relay station suitable for diversity reception. For the purpose of this section, diversity equipment is assumed to comprise the circuit for switching and/or combining the diversity channels, excluding the diversity channel equipment itself i.e. transmitters, receivers, modulators, demodulators, etc., although these may also be involved in the measurements.

In addition to measurements on diversity equipment, measurements on twin-path and hot stand-by equipment which are not treated in Part 2, Section Two of this publication: Stand-by Channel Switching Equipment, will also be considered in this section. However, measurements related to the properties of the switch and of the switching process, which are applicable equally to stand-by channel switching equipment and to diversity, twin-path and hot stand-by equipment, will be covered by reference to Part 2, Section Two.

2. Introduction

The availability of a radio-relay link may be influenced, among other factors, by the propagation conditions and the reliability of the equipment itself. The first aspect is dealt with in Sub-clause 2.1 and the second in Sub-clause 2.2.

2.1 *Diversity systems*

Diversity reception is based upon the fact that radio signals arriving at the reception site over separate paths and/or frequencies may have partially uncorrelated levels and phases; therefore, the effects of fading may be decreased by suitable switching or combining methods.

In many applications in line-of-sight systems, two paths and/or frequencies are used. Diversity channels are fed simultaneously by the same baseband signal, selection being accomplished at the end of the diversity section. Two signals with different signal-to-noise (S/N) ratios are thus available at the receiving end, and either an automatic switch is used to select the output signal having a better S/N ratio, or a combiner is employed to combine the two output signals in order to achieve an improvement in the S/N ratio.

The following types of diversity systems are in general use:

Frequency diversity systems: this diversity arrangement uses different r.f. channels and common aerials which are used for both transmission and reception. A frequency difference as low as 1% or 2% yields substantially uncorrelated fading characteristics for channels in the microwave range. Frequency diversity is used primarily to diminish the effect of fading caused by multipath propagation.

Space diversity and angle diversity systems: a single transmitting aerial and two or more receiving aerials are used. Space diversity is primarily applied if reflection makes the field-strength height dependent, therefore the receiving aerials are placed one above the other. Angle diversity may be applied in tropospheric scatter reception, with the receiving aerials pointed in slightly different directions, but is not considered here.

Route diversity systems: the diversity paths follow different geographical routes, each involving two or more radio hops. Such systems are intended primarily for the frequency ranges above 10 GHz in order to reduce the effect of heavy rainfall upon the S/N ratio.

2.2 *Twin-path and hot stand-by systems*

In contrast with diversity systems, twin-path and hot stand-by systems are intended for reducing the effect of equipment failure, rather than the effect of fading, by switching over to a spare equipment and are similar to the frequency diversity system in as much as separate transmitting and receiving equipment are used. However, in twin-path systems, the frequency difference may be lower than 1% and in hot stand-by systems the same frequency is used for the two channels. In the latter system, switching is carried out not only at the receiving end but also at each transmitter and receiver of the radio-relay link.

3. Switching diversity, twin-path and hot stand-by equipment

3.1 *General considerations*

Figure 1*a*, page 29, shows a simplified block diagram of a baseband switching equipment which may be applied in diversity systems, twin-path systems and in the receiving part of hot stand-by systems. Switching is actuated by pilot-detector and noise-detector or a.g.c. voltages.

Figure 2*a*, page 30, shows a simplified block diagram of an i.f. switching equipment which may be applied to diversity systems, twin-path systems and in the receiver part of hot stand-by systems. In addition to the pilot and noise detectors, an i.f. detector with a fast response time may also be used in the i.f. switching equipment. The branches shown by broken lines are optional; the noise detector may be replaced by the a.g.c. detector of the r.f. receiver. For an a.g.c.-operated switch, the i.f. switching equipment should always be treated in conjunction with the r.f. receiver.

Figure 3*a*, page 31, shows a simplified block diagram of an r.f. switching equipment which may be applied to the transmit part of hot stand-by systems. Switching is actuated by r.f. detector voltages.

In all switching equipment, detector voltages are fed to a logic circuit which generates a switch-drive signal from the incoming voltages. All detectors are normally equipped with alarm lamps which indicate a change of condition from "normal" to "abnormal". The two-position switches are normally equipped with lamps indicating the switch position.

Note. — In most two-channel switching equipment, in order to avoid unnecessary switching, the switch retains its last position even if the original conditions in the failed channel are restored. The measurement methods which follow are applicable to such "no switchback" type systems.

Switch-over from one channel to another is initiated by a change of pilot level, noise level, i.f. level, r.f. level or a.g.c. level. These levels are measured by using the arrangements shown in Figures 1*b*, 2*b* and 3*b*, pages 29, 30, and 31, involving the switching equipment under test and additional pilot-level, i.f. and r.f. attenuators for simulating propagation conditions or equipment failure. The required pilot i.f. or r.f. levels are obtained by setting these attenuators, and noise levels are measured by a white-noise receiver connected to the output of the switching equipment (directly if it is baseband equipment, or via an i.f. measurement demodulator if it is i.f. equipment). The operational pilot generators, if present, are disabled, pilot band-stop filters, if used, are by-passed, and an external pilot generator is used to provide a pilot signal of nominal level for both channels.

Notes 1. — All measurements should be made for several specified settings of the equipment controls provided for switch-over level adjustment.

2. — Step attenuators should not be used in order to avoid momentary interruption of the signal

3.2. *Switching due to pilot level changes*

Pilot level changes are sensed by the pilot detectors in the baseband and i.f. switching equipment shown in Figures 1*a* and 2*a*, pages 29 and 30. Two specific levels which may initiate switching—the operate and recovery levels—need to be measured. For the definition and method of measurement of these levels, see Part 2, Section Two of this publication. The measurements described should be carried out separately for the pilot detectors in each channel. Whilst carrying out these measurements, the correct switch-over operation when reaching the operate and recovery level should be verified.

3.3 *Switching due to i.f. or r.f. level changes*

3.3.1 *Definition and general considerations*

I.F./R.F. level changes are sensed by the i.f./r.f. detectors used in the i.f./r.f. switching equipment shown in Figures 2*a* and 3*a*. Two specific levels which may initiate switching—the operate and recovery levels—need to be measured. The operate level of an i.f. or r.f. detector is that level of i.f./r.f. input signal at which the detector operates and indicates a change of condition from "normal" to "abnormal". This level is normally adjustable over a specified range. The recovery level is that level at which the i.f./r.f. detector indicates a change of condition from "abnormal" to "normal".

This level is specified as being X dB above the operate level and, in some cases, X is adjustable.

3.3.2 *Method of measurement*

The arrangements for measuring the i.f./r.f. detector levels in i.f./r.f. switching equipment are shown in Figures 2*b* and 3*b*, pages 30 and 31. In the case of i.f. level measurements (Figure 2*b*) and r.f. level measurements (Figure 3*b*), the attenuators R.F. 1 and R.F. 2 are adjusted to obtain the nominal r.f. levels, either at the receiver inputs (see Figure 2*b*) or at the switching device input (see Figure 3*b*). In the case of switching by varying the i.f. level (Figure 2*b*), the attenuators I.F. 1 and I.F. 2 are first adjusted to give zero attenuation, corresponding to the nominal i.f. levels in both input channels to the switching device. These i.f. levels are measured by the methods described in Part 1, Section Three of this publication. In the case of switching by variation of the r.f. levels, the levels are measured at the switching device input by the methods described in Part 1, Section Two of this publication.

The Channel 1 detector levels are then measured by increasing the attenuation of I.F. 1 (for switching by variation of i.f. level (Figure 2*b*)), or the attenuation of R.F. 1 (for switching by variation of r.f. level (Figure 3*b*)) until the detector triggers, and then reducing the attenuation until the detector indicates a normal situation again. The measurements are obtained starting from the initial measurement mentioned above by calibrating the attenuator concerned. The same procedure is then repeated for the Channel 2 detector.

Whilst carrying out these measurements, the correct switch-over operation when reaching the operate and recovery level is verified.

Note. — In many cases, the couplers and detectors shown as parts of the r.f. switching equipment in Figure 3*a*, page 31, are included in the transmitters. In such cases, it is necessary that the transmitters form part of the test arrangement.

3.3.3 *Presentation of results*

The operate and recovery levels should be tabulated and it should be confirmed that correct switch-over operation occurred.

3.3.4 *Details to be specified*

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

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

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

3.4 *Switching due to noise level changes*

3.4.1 *General considerations*

Noise level changes are sensed by the noise detectors in the baseband/i.f. switching equipments shown in Figure 1*a* and 2*a*, pages 29 and 30.

The operate and recovery levels of the noise detectors in Channels 1 and 2 and the noise level difference between the two channels may be used as switching criteria. For definition and method of measurement of the operate and recovery levels, see Part 2, Section Two of this publication.