

Methods of measurement for equipment used in digital microwave radio transmission systems —

Part 2: Measurements on terrestrial radio-relay systems —

Section 2.7 Diversity switching and combining equipment

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Committees responsible for this British Standard

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- British Broadcasting Corporation
- British Radio and Electronic Equipment Manufacturers' Association
- British Telecommunications plc
- Institution of Electrical Engineers
- Radio, Electrical and Television Retailers' Association
- Radiocommunications Agency

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ERA Technology Ltd.

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National foreword

This Section of BS EN 60835 has been prepared by Technical Committee EPL/12 and is the English language version of EN 60835-2-7:1994 *Methods of measurement for equipment used in digital microwave radio transmission systems — Part 2: Measurements on terrestrial radio-relay systems — Section 7: Diversity switching and combining equipment*, published by the European Committee for Electrotechnical Standardization (CENELEC). It is identical with IEC 835-2-7:1994 published by the International Electrotechnical Commission (IEC).

BS EN 60835 is published in three Parts. The other Parts are:

- *Part 1: Measurements common to terrestrial radio-relay systems and satellite earth stations;*
- *Part 3: Measurements on satellite earth stations.*

Some of the many Sections of the three Parts have appeared under the number BS 7573, of the same generic title.

Cross-references

Publication referred to	Corresponding British Standard
	BS EN 60835 <i>Methods of measurement for equipment used in digital microwave radio transmission systems</i>
	Part 1 <i>Measurements common to terrestrial radio-relay systems and satellite earth stations</i>
EN 60835-1-2:1992	Section 1.2:1995 <i>Basic characteristics</i>
EN 60835-1-4:1995	Section 1.4:1995 <i>Transmission performance</i>
EN 60835-2-5:1995	Part 2 <i>Measurements on terrestrial radio-relay systems</i>
	Section 2.5:1995 <i>Digital signal processing sub-system</i>

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, the EN title page, pages 2 to 18, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

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English version

Methods of measurement for equipment used in digital
microwave radio transmission systems
Part 2: Measurements on terrestrial radio-relay systems
Section 7: Diversity switching and combining equipment

(IEC 835-2-7:1994)

Méthodes de mesure applicables au matériel
utilisé pour les systèmes de transmission
numérique en hyperfréquence
Partie 2: Mesures applicables aux faisceaux
hertziens terrestres
Section 7: Equipement de diversité par
commutation et combinaison
(CEI 835-2-7:1994)

Meßverfahren for Geräte in digitalen
Mikrowellen-Funkübertragungs-systemen
Teil 2: Messungen an terrestrischen
Richtfunksystemen
Hauptabschnitt 7: Geräte-einrichtungen für
Schalt- und Kombinationsdiversity
(IEC 835-2-7:1994)

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CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
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Foreword

The text of document 12E(CO)149, as prepared by Subcommittee 12E: Radio-relay and fixed satellite communications systems, of IEC Technical Committee 12: Radiocommunications, was submitted to the IEC-CENELEC parallel vote in April 1993.

The reference document was approved by CENELEC as EN 60835-2-7 on 8 March 1994.

The following dates were fixed:

- latest date of publication of an identical national standard (dop) 1995-07-01
- latest date of withdrawal of conflicting national standards (dow) 1995-07-01

Annexes designated “normative” are part of the body of the standard. In this standard, Annex ZA is normative.

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Introduction

The availability of a radio-relay link for service may be influenced by the reliability of the equipment itself and by propagation conditions. Fading due to multipath propagation arises from interfering paths refracted in a stratified atmosphere. Since all the interfering paths are delayed relative to the direct path, multipath fading results in frequency-dependent amplitude and group-delay variations, in addition to variations in the received signal level (flat fading).

One way to overcome the propagation effects is by transmitting or receiving the signals over two (or more) diversity channels, as described in CCIR Report 376-6 (see clause 5 of this section). Diversity reception is based upon the fact that radio signals arriving at the receiving site by separate paths and/or at different frequencies have partially correlated impairments.

Therefore the effects of flat fading and/or multipath propagation upon the time during which the link is available for service may be decreased by suitably switching or combining the outputs of the diversity receivers.

The following types of diversity systems are in general use:

- frequency and cross-band diversity systems: these diversity arrangements use different frequencies in the same band or different frequency bands;
- space diversity systems: these use a single transmitting antenna and two or more receiving antennas.

1 Scope

This section of IEC 835-2 deals with measurements for diversity equipment used in digital microwave systems. For the purpose of this section, diversity equipment is assumed to consist of the circuits for switching and/or combining the diversity channels, excluding the channel equipment itself, i.e. transmitters, receivers, modulators, demodulators, etc. although these may also be involved in the measurements.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this section of IEC 835-2. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this section of IEC 835-2 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 835-1-2:1992, *Methods of measurement for equipment used in digital microwave radio transmission systems — Part 1: Measurements common to terrestrial radio-relay and satellite earth stations — Section 2: Basic characteristics.*

IEC 835-1-4:1992, *Methods of measurement for equipment used in digital microwave radio transmission systems — Part 1: Measurements common to terrestrial radio-relay and satellite earth stations — Section 4: Transmission performance.*

IEC 835-2-5:1993, *Methods of measurement for equipment used in digital microwave radio transmission systems — Part 2: Measurements on terrestrial radio-relay — Section 5: Digital signal processing subsystem.*

IEC 835-2-8:1993, *Methods of measurement for equipment used in digital microwave radio transmission systems — Part 2: Measurements on terrestrial radio-relay — Section 8: Adaptive equalizer.*

CCITT Recommendation G. 703:1972, *Physicalelectrical characteristics of hierarchical digital interfaces.*

CCITT Recommendation 752:1992, *Diversity techniques for radio-relay systems.*

3 Switching diversity

3.1 General considerations

In all diversity switching sub-systems, equipment alarm signals are fed to a logic circuit which generates a switch-drive signal. Switch-over from one channel to the other may be monitored by an internal test point. In the following, all the test arrangements described will be assumed to include hit-less switching equipment as shown in Figure 1a.

In the case of hit-less base-band switching equipment, a circuit compares the two input signals and aligns one of them with the other.

When making measurements, a high isolation between each of the paths is necessary to avoid degrading the BER, for example not less than 20 dB. In addition the following should be observed:

- all measurements should be made for several specified settings of the equipment controls provided for adjustments of the switch-over conditions;
- step attenuators should not be used in order to avoid momentary interruption of the signal when the attenuation is altered;
- to avoid unnecessary switching in many two-channel switching equipments, the switch retains its last position, even if the original conditions in the failed channel are restored. The measurement methods which follow are also applicable to such “no switch-back” type systems.

3.2 Isolation between the ports of a diversity switch

Diversity switching equipment has two or more input ports and one output port, so it is necessary to measure the isolation between the input port which is not in use and the input port which is in use.

Attenuation measurements should be carried out in accordance with IEC 835-1-2.

3.3 Delay difference between diversity channels

3.3.1 General considerations

For satisfactory diversity operation, a switching circuit which does not cause excessive transmission impairment during switch-overs is required. To achieve this the delay difference between the two bit streams, $\Delta\tau$, needs to be shorter than the pulse duration time T , for example one-third of T , $T/3$.

In high-capacity systems $\Delta\tau$ may become greater than the tolerable delay time difference due to the variation of the propagation delay-time. In such cases automatic delay-time compensation is needed.

The maximum tolerable delay-time difference, $\Delta\tau_{\max}$, at which switch-over is possible without loss of synchronization or bit-slip, has to be greater than the largest expected delay-time difference between diversity channels.

3.3.2 Method of measurement

The arrangements for measuring the limits of the tolerable delay-time difference are shown in Figure 2 and Figure 3. Figure 2 represents a transmit-receive section including an r.f. variable delay. Automatic switch-over is initiated by decreasing the r.f. input level.

Attenuators RF-1 and RF-2 in Figure 2 are first adjusted to obtain nominal receiver input levels. The delay $\Delta\tau$ is adjusted to zero, and the position of the diversity switch, for example channel 1, is noted. Then the r.f. input level in channel 1 is decreased until switch-over to channel 2 occurs at a specified BER. During switch-over neither clock synchronization loss nor bit-slip is allowed.

The same procedure is then repeated for channel 2. The measurement is then repeated by increasing the delay $\Delta\tau$ up to a value $\Delta\tau_{\max}$ when bit-slip or synchronization loss occurs.

The tolerable delay difference can also be measured by the test arrangement shown in Figure 3, which includes a base-band variable delay. This can be checked by noting, for example, the synchronization alarm, as in Figure 5.

In this case, manual switch-over is initiated by an external trigger signal, and the delay is similarly increased, as explained in Figure 2. The base-band switching equipment includes the bit-error detectors in this example.

3.3.3 Presentation of results

The results should be presented as in the following example:

- the delay time $\Delta\tau_{\max}$, at which clock synchronization loss or bit-slip occurs, i.e. $x \mu\text{S}$;
- the number of errors during switch-over, i.e. y .

3.3.4 Details to be specified

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

- a) the tolerable propagation delay difference $\Delta\tau_{\max}$, above which clock synchronization loss occurs;
- b) permitted maximum number of bit-errors during switch-over at nominal input levels and a given propagation delay difference. (This should be zero for “hit-less” switching.)

3.4 Switching due to the BER alarm

3.4.1 General considerations

Bit-stream errors may be detected by bit-error detectors in the demodulators of each receiver or in each channel of the base-band switching equipment.

Fast detection methods, such as the parity check method or pseudo-error detection by measuring the eye-height, are necessary for error-free or “hit-less” diversity switching in fading conditions.

The BER should be measured in accordance with IEC 835-1-4.