



Recommendation ITU-R S.1521-1
(01/2010)

**Allowable error performance for
a hypothetical reference digital
path based on synchronous
digital hierarchy**

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Note: This ITU-R Recommendation was approved in English under the procedure detailed in Resolution ITU-R 1.

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RECOMMENDATION ITU-R S.1521-1

Allowable error performance for a hypothetical reference digital path based on synchronous digital hierarchy

(2001-2010)

Scope

The fixed-satellite service (FSS) plays an important role in providing reliable international digital communications. Because of the integration with the terrestrial facilities, a satellite link should be designed to fulfil requirements that are compatible with terrestrial systems. ITU-T Recommendation G.828 specifies performance parameters and objectives for international synchronous digital paths which are intended to carry synchronous digital hierarchy (SDH) and asynchronous transfer mode (ATM) traffic. In response to those objectives, this Recommendation gives guidance on bit-error probability (BEP) or bit-error rate (BER) design masks which can fully comply with the requirements of ITU-T Recommendation G.828.

The ITU Radiocommunication Assembly,

considering

- a) that satellites operating in the fixed-satellite service play an important role in providing reliable international digital communications;
- b) that satellite link performance must be sufficient to allow compliance with overall end-to-end performance objectives and in turn end-user quality objectives;
- c) that satellite link performance is generally distance independent;
- d) that Recommendation ITU-R S.1062 specifies satellite link performance objectives which comply with the objectives specified in ITU-T Recommendation G.826;
- e) that the error performance for international constant bit-rate synchronous digital paths which are intended to carry ATM traffic as defined in ITU-T Recommendation I.356 has been specified in ITU-T Recommendation G.828;
- f) that Recommendation ITU-R S.1429 specifies the error performance allowance due to interference between different satellite systems;
- g) that Recommendation ITU-R S.1323 specifies how to calculate the operating margins to allow for both fading and time-varying interference;
- h) that in defining error performance criteria, it is necessary to take into account all error-inducing mechanisms, especially time-varying propagation conditions and interference;
- j) that satellite systems can be designed to meet a wide range of performance requirements,

recommends

- 1** that satellite links within the public network and intended to carry SDH and ATM traffic should be designed to at least meet the specifications set forth in this Recommendation which is based upon ITU-T Recommendation G.828 (see Annex 1);

2 that the methodology explained in Annex 2 should be used to generate the necessary BEP design masks, see also Note 2. To fully comply with ITU-T Recommendation G.828, the BEP divided by the average number of errors per burst (BEP/α , see § 3 of Annex 2) at the output of either end of a two-way hypothetical reference digital path (HRDP) should not exceed, during the total time including the worst month, the design masks defined in Table 1 and also in the BEP masks given in Fig. 2 in Annex 2;

TABLE 1

Bit rate (kbit/s)	Percentage of total time (worst month)	BEP/ α
1 664	0.2	1×10^{-9}
	2.0	1×10^{-9}
	10.0	1×10^{-9}
2 240	0.2	1×10^{-9}
	2.0	1×10^{-9}
	10.0	1×10^{-9}
6 848	0.2	1×10^{-9}
	2.0	7×10^{-10}
	10.0	6×10^{-10}
48 960	0.2	1×10^{-9}
	2.0	2×10^{-10}
	10.0	1×10^{-10}
150 336	0.2	1×10^{-9}
	2.0	2×10^{-10}
	10.0	9×10^{-11}
601 334	0.2	To be determined
	2.0	To be determined
	10.0	To be determined

3 that the following Notes are a part of this Recommendation:

NOTE 1 – The HRDP referred to is specified in Recommendation ITU-R S.521.

NOTE 2 – The BEP ratios given in Table 1 could be estimated by a BER measurement taken over a sufficiently long period of time. A method for measuring BERs as a function of a shorter percentage of time is given in Annex 1 of Recommendation ITU-R S.1062.

NOTE 3 – For ease of application, the values given in Table 1 are in terms of total time and represent the limits of a BEP performance model utilizing the method outlined in Annex 2. In arriving at the figures in Table 1 the errors occurring during the unavailable time have been excluded. The BEPs in Table 1 are not the only ones that meet the requirements of ITU-T Recommendation G.828. Other BEP masks may be used where appropriate to satisfy ITU-T Recommendation G.828.

NOTE 4 – This Recommendation applies to satellite systems operating below 15 GHz. The extension to systems operating at higher frequencies is the subject of further study.

NOTE 5 – A BEP value of 1×10^{-8} has been used as the unavailability threshold.

NOTE 6 – The objectives given in Table 1 are given in terms of percentage of the worst month. These monthly percentages correspond to the following yearly percentages:

- 10% of a month = 4.0% of year;
- 2% of a month = 0.6% of year;
- 0.2% of a month = 0.04% of year.

NOTE 7 – In order to comply with Table 1 at frequencies greater than 10 GHz (see also Note 4), it may be advantageous to make use of fade countermeasures including adaptive forward error correction (FEC) coding, power control or site diversity. Information on site diversity operation is given in Annex 1, Recommendation ITU-R S.1061.

NOTE 8 – The preferred method of verifying digital satellite link performance is on the basis of in-service measurements. These measurements would utilize the block error detection schemes, which are related to the inherent SDH block size and structure of the transmission system. FEC, scrambling and differential encoding have an impact on interpretation of the measurements (see Annex 2, § 3).

NOTE 9 – The error performance described in Table 1 was developed based on the use of an HRDP in the international portion of the link (e.g. switched international gateway-to-switched international gateway). Other applications of the HRDP within the connection are possible (e.g. end office-to-end office) and the error performance objectives can be adjusted accordingly.

NOTE 10 – The methods described in this Recommendation may be applied to the design of satellite links in private networks.

NOTE 11 – The performance objectives shall be met for the required transmission rate not for any higher rate created to support multiplexing or error correction. For instance, if the transmission rate over a satellite link is 6 Mbit/s and the required transmission rate between the end points is 2 Mbit/s, then the performance objectives for 2 Mbit/s transmission apply.

Annex 1

1 General

ITU-T Recommendation G.828 defines error performance parameters and objectives for international synchronous digital paths which are intended to carry SDH and ATM traffic. This Recommendation adopts all the definitions parameters and objectives defined therein. The objectives given in ITU-T Recommendation G.828 are defined as being independent of the physical network supporting the path.

In-service measurement of error rates at the SDH layer is supported by bit interleaved parity (BIP) codes carried in the SDH container headers.

1.1 Definitions

For convenience, the definitions in ITU-T Recommendation G.828 are repeated here.

Error performance measurements are based upon blocks whose size is consistent with the SDH frame structure and varies according to the bit rate, see Table 2.

1.1.1 A block

A block is a set of consecutive bits associated with the path; each bit belongs to one and only one block. Consecutive bits may not be contiguous in time.

1.1.2 Error events

- *Errored block (EB)*: A block in which one or more bits are in error.
- *Errored second (ES)*: A 1 s period with one or more EBs or at least one defect. Defects and related performance criteria are listed in Annex B of ITU-T Recommendation G.828.
- *Severely errored second (SES)*: A 1 s period which contains $\geq 30\%$ EBs or at least one defect. SES is a subset of ES. To simplify measurements, the defect is used in the definition of SES instead of defining SES directly in terms of severe bit errors. However, it should be appreciated that there may exist error patterns that would not trigger a defect. Field experience will establish if this is a major problem in measuring errors.
- *Background block error (BBE)*: An EB not occurring as part of an SES.
- *Severely errored period (SEP)*: A sequence of between 3 and 9 consecutive SESs. The period is terminated by a second that is not a SES. Thus the SEP event is the same as the consecutive SES (CSES) event, as defined in ITU-T Recommendation G.784, with the lower threshold set to 3 s.

Table 2 gives the relationships between block sizes, bit rates, error detection code (EDC) and path types.

TABLE 2
Block sizes versus bit rates

Bit rate (kbit/s)	Path type	SDH block size used in ITU-T Recommendation G.828 (bits)	EDC
1 664	VC-11, TC-11	832	BIP-2
2 240	VC-12, TC-12	1 120	BIP-2
6 848	VC-2, TC-2	3 424	BIP-2
48 960	VC-3, TC-3	6 120	BIP-8
150 336	VC-4, TC-4	18 792	BIP-8
601 344	VC-4-4c, TC-4-4c	75 168	BIP-8
2 405 376	VC-4-16c, TC-4-16c	300 672	BIP-8
9 621 504	VC-4-64c, TC-4-64c	1 202 688	BIP-8

1.1.3 Error performance parameters

Error performance should only be evaluated whilst the path is in the available state. For a definition of the entry/exit criteria for the unavailable state, see ITU-T Recommendation G.828, Annex A.

- *Errored second ratio (ESR)*: The ratio of ES to total seconds in available time during a fixed measurement interval.
- *Severely errored second ratio (SESR)*: The ratio of SES to total seconds in available time during a fixed measurement interval.