INTERNATIONAL TELECOMMUNICATION UNION

ITU-T G.151

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

TRANSMISSION SYSTEMS AND MEDIA

GENERAL CHARACTERISTICS OF INTERNATIONAL TELEPHONE CIRCUITS AND NATIONAL EXTENSION CIRCUITS

GENERAL PERFORMANCE OBJECTIVES APPLICABLE TO ALL MODERN INTERNATIONAL CIRCUITS AND NATIONAL EXTENSION CIRCUITS

ITU-T Recommendation G.151

(Extract from the *Blue Book*)

NOTES

1 ITU-T Recommendation G.151 was published in Fascicle III.1 of the *Blue Book*. This file is an extract from the *Blue Book.* While the presentation and layout of the text might be slightly different from the *Blue Book* version, the contents of the file are identical to the *Blue Book* version and copyright conditions remain unchanged (see below).

2 In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

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Recommendation G.151

GENERAL PERFORMANCE OBJECTIVES APPLICABLE TO ALL MODERN INTERNATIONAL CIRCUITS AND NATIONAL EXTENSION CIRCUITS

(Geneva, 1964; amended at Mar del Plata, 1968 and Geneva, 1972 and 1980)

1 Attenuation distortion

The circuit performance objectives for attenuation distortion of international circuits and national extension circuits should individually be such that the network performance objectives of Recommendation G.132 are complied with. Recommendation G.232 [1] gives equipment design objectives.

It follows from the Recommendations mentioned above that, as a rule, the frequency band effectively transmitted by a telephone circuit, according to the definition adopted by the CCITT (i.e. the band in which the attenuation distortion does not exceed 9 dB compared with the value for 800 Hz), will be a little wider than the 300-3400 Hz band, and for a single pair of channel terminal equipments of this type, the attenuation distortion at 300 Hz and 3400 Hz should never exceed 3 dB and in a large number of equipments should not average more than 1.7 dB (see Graphs A and B in Figure 1/G.232 [2]). Even more complex circuits, and circuits using terminal equipments with 3-kHz-channel spacing in accordance with Recommendation G.235 [3], should satisfy the limits in Figure I/G.151; to ensure that these limits are respected, equalizers are inserted, if necessary, when the circuits are set up (Recommendation M.580 [4]).

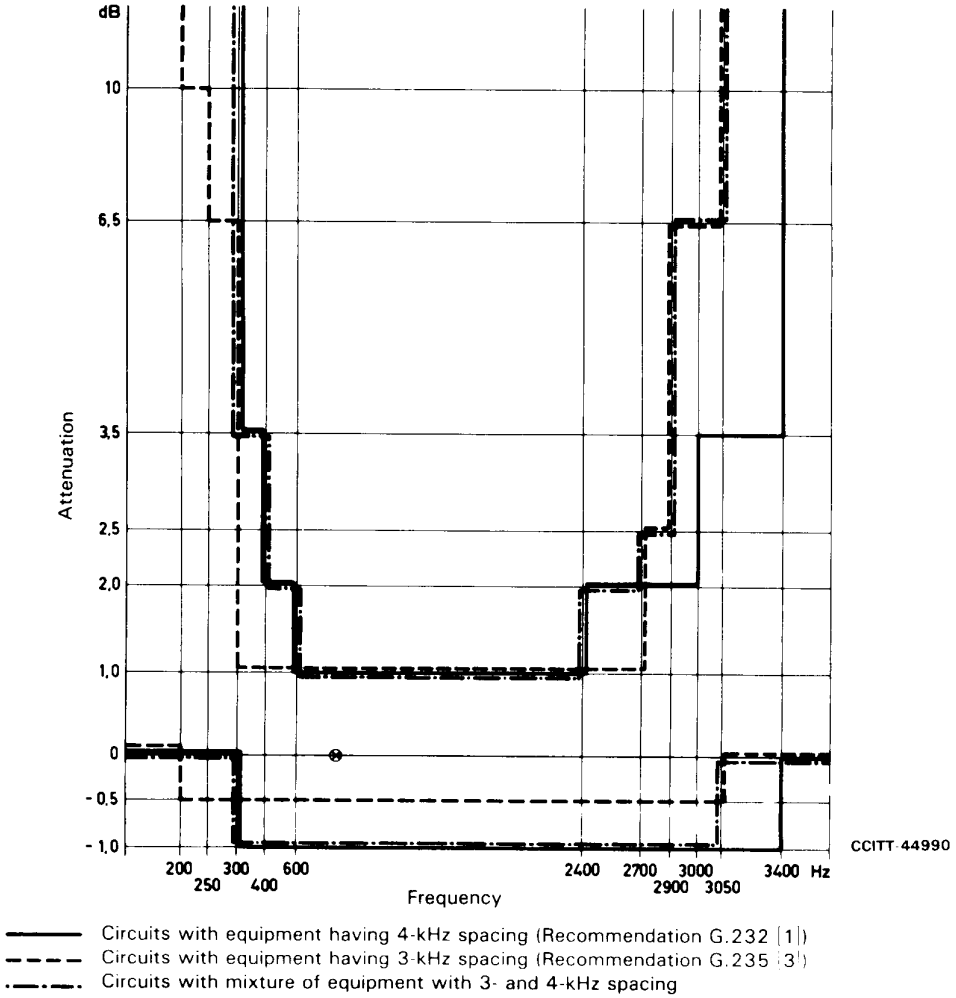

FIGURE 1/G.151

Line-up limits of circuits with 3-kHz and 4-kHz channel equipment

Note 1 - The CCITT examined the possibility of recommending a specific frequency below 300 Hz as the lower limit of the frequency band effectively transmitted, taking the following considerations into account:

1) The results of subjective tests carried out by certain Administrations show that it is possible to improve transmission quality if the lower limit of the transmitted frequency band is reduced from 300 Hz to 200 Hz. These tests show a definite increase in the loudness of the received speech, and also in the quality of the transmission as judged by opinion tests; the improvement in articulation is, on the other hand, very slight.

2) However, such an extension would probably have the following disadvantages:

   a) it would slightly increase the cost of equipment;

   b) it would introduce some difficulties in balancing the terminating sets at the ends of the 4-wire chain, if it were desired to use 4-wire circuits without exceeding the values of nominal transmission loss recommended in the new transmission plan;

   c) it would increase the possible susceptibility to interference, whether as subjective noise or as disturbances interfering with carrier equipment (see the Recommendation cited in [5]) or affecting compandor gain;

   d) the additional energy transmitted in consequence of extending the band could increase the loading of carrier systems;

   e) the out-of-band signalling systems recognized by the CCITT could not be used.

In view of the above, the CCITT has issued the aforementioned Recommendations concerning signals transmitted at frequencies between 300 and 3400 Hz.

Note 2 - In applying the Recommendations, Administrations may mutually agree to transmit signals at frequencies below 300 Hz over international circuits. Every Administration may, of course, decide to transmit signals at frequencies below 300 Hz over its national extension circuits, provided it is still able to apply the CCITT transmission plan to international communications.

2 Group delay

The group-delay performance objectives of international circuits and national extension circuits should be such that the network performance objectives of Recommendations G.114 and G.133 are met.

3 Variations of transmission loss with time

The CCITT recommends the following circuit performance objectives [objective a) has been used to assess the stability of international connections - see Recommendation G.131, § 1]:

a) The standard deviation of the variation in transmission loss of a circuit should not exceed 1 dB. This objective can be obtained already for circuits on a single group link equipped with automatic regulation and should be obtained for each national circuit, whether regulated or not. The standard deviation should not exceed 1.5 dB for other international circuits.
b) The difference between the mean value and the nominal value of the transmission loss for each circuit should not exceed 0.5 dB.

4 Linear crosstalk[1)]

4.1 *Between circuits*

The circuit performance objective for the near-end or far-end crosstalk ratio (intelligible crosstalk only) measured at audio-frequency at trunk exchanges between two complete circuits in terminal service position should not be less than 65 dB.

Note 1 - When a minimum noise level of at least 4000 pW0p is always present in a system (e.g. this may be the case in satellite systems, for example) a reduced crosstalk ratio of 58 dB between circuits is acceptable.

Note 2 - Coaxial pair cables complying with Recommendations G.622 [6] and G.623 [7] already allow this condition to be fulfilled if it is assumed that the frequency bands for which crosstalk is caused by the cable and those for which crosstalk is due to the equipments are not the same. On the other hand FDM systems on symmetric pair cables do not always allow a limit more stringent than 58 dB to be met.

Note 3 - In cases where the length of a homogeneous section of a real transmission system substantially exceeds the length of a homogeneous section of the HRC, the 65 dB limit may not be met in all cases for all the channels in the system.

4.2 *Between the go and return channels of a 4-wire circuit*

4.2.1 *Ordinary telephone circuit (see Note 1 below)*

Since all ordinary telephone circuits may also be used as VF telegraph bearers, the circuit performance objective for the near-end crosstalk ratio between the two directions of transmission should be at least 43 dB.

4.2.2 *Circuits used with a speech concentrator*

For circuits and circuit sections used to interconnect terminal speech concentrator equipments, near-end crosstalk between any two channels will appear in the form of crosstalk between circuits and hence the circuit performance objective for the total near-end crosstalk ratio introduced between speech concentrators should not be less than 58 dB. (See Notes 2 and 4 below.)

4.2.3 *Circuits used with modern echo suppressors, for example high-altitude satellite circuits*

The circuit performance objective for the near-end crosstalk ratio of any circuit equipped with terminal far-end operated, half-echo suppressors of modern design should not be less than 55 dB. This is to avoid nullifying the effect of the suppression loss introduced by modern echo suppressors. (See Notes 2, 3 and 4 below.)

Note 1 - Telephone circuits which are not equipped with (or used in conjunction with) modern echo suppressors designed for long propagation times are referred to in § 4.2.1 above. Circuits which can form part of switched connections with a long propagation time and which then lie between terminal half-echo suppressors of modern design should, wherever possible, conform to the higher standards given in this § 4.2.3.

Note 2 - The channel-translating equipment provides the principal go-to-return crosstalk path on circuits or circuit-sections routed on carrier systems with modern translating and line transmission equipment (but see Note 4 below). It should be noted that crosstalk paths between the high-frequency input and the high-frequency output and also between the voice-frequency input and the voice-frequency output on channel-translating equipments contribute to the go-to-return crosstalk ratios of circuits and circuit sections. Both these paths must be taken into account when considering circuits or circuit sections used between terminal speech concentrator equipments or modern echo suppressors. The following cases arise:

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1) The methods recommended for measuring crosstalk are described in Annex A to Recommendation G.134.

Speech concentrators

Both the high-frequency path and the voice-frequency path contribute to the crosstalk ratio.

Echo suppressors

1) A circuit comprising one circuit section between far-end operated, half-echo suppressors: the high-frequency path is dominant.

2) A circuit comprising more than one circuit section between the suppressors: at points where channel-translating equipments are connected together at voice-frequency. The voice frequency crosstalk path of one equipment is effectively in parallel with the high-frequency crosstalk path of the other, so that both must be taken into account.

3) More than one circuit between the suppressors: this occurs when intermediate adjacent half-echo suppressors are switched out (or disabled) and the go-to-return crosstalk arises in a fashion analogous to that described in 2) above, circuits replacing circuit sections.

Note 3 - If channel equipments just conforming to the Recommendation cited in [8] are used on a circuit comprising three circuit sections, then assuming r.m.s. addition of crosstalk paths the crosstalk ratio would be approximately 60 dB.

Note 4 - If channel equipments used on a circuit comprising three circuit sections just comply with the Recommendation cited in [9], then the least go-to-return crosstalk ratio, assuming r.m.s. addition of the various paths, would be approximately 56 dB which is 2 dB less than is required for speech concentrators in § 4.2.2 above. However, the assumptions are most pessimistic and there is not likely to be any difficulty in practice. The limit for echo suppressor in § 4.2.3 above is complied with.

Note 5 - Some types of symmetrical-pair line transmission systems introduce significantly low go-to-return crosstalk ratios on the derived circuits and wherever possible such systems should not be used to provide, circuits or circuit sections for use with speech concentrators or modern echo suppressors.

Note 6 - Some attention must be given to the unbalance of the audio parts of FDM channel equipments if the crosstalk of 65 dB is not to be diminished by crosstalk in station cabling due to unbalanced cable terminating equipment.

5 Nonlinear distortion

Experience has shown that telephone. circuits set up on systems for which the CCITT has issued recommendations (the elements of which systems, taken separately, meet the relevant nonlinearity requirements) are equally suitable, as far as nonlinearity is concerned, for telephone and voice-frequency telegraph transmission.

Note - In carrier telephone circuits, the nonlinear distortion produced by the line amplifiers and by modulation stages other than the channel-translating equipment can be ignored. Hence the above remarks are applicable to circuits of any length.

6 Error on the reconstituted frequency

See Recommendation G.135.

7 Interference at harmonies from the mains and other low frequencies

Signals carried by transmission systems are sometimes modulated by interfering signals from mains frequency power supplies, induced voltages caused by railway traction currents and from other sources. This unwanted modulation can take the form of amplitude or phase modulation or a combination of both. This interference may be characterized by the level of the strongest unwanted side component when a sine wave signal is applied with a power of 1 mW at the point of zero relative level (0 dBm0) on a telephone circuit. The circuit performance objective for the maximum admissible level of the unwanted side components on a complete telephone circuit should then not exceed -45 dBm0 (i.e. the minimum side component attenuation should be 45 dB). This circuit performance objective should apply to all low frequency interfering signals up to about 400 Hz.

Note 1 - This level was found to be acceptable for circuits for FM and AM VF-telegraphy, facsimile transmission, speech, telephone signalling and data transmission.

Note 2 - For limits applicable to sound-programme circuits, see the Recommendation cited in [10].

Note 3 - The main causes of interference due to power sources are:

a) residual ripples at the terminals of d.c. supply which are directly transmitted to equipments through the power-fed circuits;

b) the a.c. to the dependent power-fed stations in some systems, which interferes through the power-separating filter or through the iron tapes of coaxial pairs;

c) the induction voltages in the d.c. supply line to power-fed dependent stations in some systems;

d) the amplitude and phase unwanted modulations of the various carriers due to cause a) which are increased in the frequency-multiplying equipments.

Note 4 - The effect of the modulation process is that an input signal of frequency f Hz will produce, for example, corresponding output signals at frequencies *f , f* ± *50, f* ± *100, f* ± 150 Hz, etc.

8 Single tone interference in telephone circuits

The single tone interference level in a telephone circuit should not be higher than -73 dBm0p (provisional value, pending the conclusion of studies by Study Group XII). Psophometric weighting should only be accounted for when the frequency of the interference is well defined.

References

[1] CCITT Recommendation *12-channel terminal equipments*, Vol. III, Rec. G.232.

[2] *Ibid.,* Figure 1/G.232, Graphs A and B.

[3] CCITT Recommendation *16-channel terminal equipments,* Vol. III, Rec. G.235.

[4] CCITT Recommendation *Setting-up and lining-up an international circuit for public telephony*, Vol. IV, Rec. M.580.

[5] CCITT Recommendation *12-channel terminal equipments,* Vol. III, Rec. G.232, § 6.

[6] CCITT Recommendation *Characteristics of 1.214.4-mm coaxial cable pairs,* Vol. III, Rec. G.622.

[7] CCITT Recommendation *Characteristics of 2.619.5-mm coaxial cable pairs,* Vol. III, Rec. G.623.

[8] CCITT Recommendation *12-channel terminal equipments,* Vol. III, Rec. G.232, § 9.1.

[9] *Ibid., §* 9.3.

[10] CCITT Recommendation *Performance characteristics of 15-kHz type sound-programme circuits*, Vol. III, Rec. J.21, § 3.1.7.