INTERNATIONAL TELECOMMUNICATION UNION

CCITT

THE INTERNATIONAL
TELEGRAPH AND TELEPHONE
CONSULTATIVE COMMITTEE

YELLOW BOOK

VOLUME III – FASCICLE III.4

LINE TRANSMISSION OF NON-TELEPHONE SIGNALS

RECOMMENDATIONS OF THE H SERIES

TRANSMISSION OF SOUND-PROGRAMME AND TELEVISION SIGNALS

RECOMMENDATIONS OF THE J SERIES

VII[TH] PLENARY ASSEMBLY
GENEVA, 10–21 NOVEMBER 1980

Geneva 1981

INTERNATIONAL TELECOMMUNICATION UNION

CCITT

THE INTERNATIONAL
TELEGRAPH AND TELEPHONE
CONSULTATIVE COMMITTEE

YELLOW BOOK

VOLUME III – FASCICLE III.4

LINE TRANSMISSION OF NON-TELEPHONE SIGNALS

RECOMMENDATIONS OF THE H SERIES

TRANSMISSION OF SOUND-PROGRAMME AND TELEVISION SIGNALS

RECOMMENDATIONS OF THE J SERIES

VII[TH] PLENARY ASSEMBLY
GENEVA, 10–21 NOVEMBER 1980

Geneva 1981

ISBN 92-61-00991-3

CONTENTS OF THE CCITT BOOK
APPLICABLE AFTER THE SEVENTH PLENARY ASSEMBLY (1980)

YELLOW BOOK

Volume I	– Minutes and reports of the Plenary Assembly. Opinions and Resolutions. Recommendations on: – the organization and working procedures of the CCITT (Series A); – means of expression (Series B); – general telecommunication statistics (Series C). List of Study Groups and Questions under study.
Volume II	
FASCICLE II.1	– General tariff principles – Charging and accounting in international telecommunications services. Serie D Recommendations (Study Group III).
FASCICLE II.2	– International telephone service – Operation. Recommendation E.100 - E.323 (Study Group II).
FASCICLE II.3	– International telephone service – Network management – Traffic engineering. Recommendations E.401 - E.543 (Study Group II).
FASCICLE II.4	– Telegraph and "telematic services"[1] operations and tariffs. Series F Recommendations (Study Group I).
Volume III	
FASCICLE III.1	– General characteristics of international telephone connections and circuits. Recommendations G.101 - G.171 (Study Group XV, XVI, CMBD).
FASCICLE III.2	– International analogue carrier systems. Transmission media – characteristics. Recommendations G.211 - G.651 (Study Group XV, CMBD).
FASCICLE III.3	– Digital networks – transmission systems and multiplexing equipments. Recommendations G.701 - G.941 (Study Group XVIII).
FASCICLE III.4	– Line transmission of non telephone signals. Transmission of sound programme and television signals. Series H, J Recommendations (Study Group XV).
Volume IV	
FASCICLE IV.1	– Maintenance; general principles, international carrier systems, international telephone circuits. Recommendations M.10 - M.761 (Study Group IV).
FASCICLE IV.2	– Maintenance; international voice frequency telegraphy and facsimile, international leased circuits. Recommendations M.800 - M.1235 (Study Group IV).
FASCICLE IV.3	– Maintenance; international sound programme and television transmission circuits. Series N Recommendations (Study Group IV).
FASCICLE IV.4	– Specifications of measuring equipment. Series O Recommendations (Study Group IV).

[1] "Telematic services" is used provisionally.

Volume V – Telephone transmission quality. Series P Recommendations (Study Group XII).

Volume VI

FASCICLE VI.1 – General Recommendations on telephone switching and signalling. Interface with the maritime service. Recommendations Q.1 - Q.118 *bis* (Study Group XI).

FASCICLE VI.2 – Specifications of signalling systems Nos. 4 and 5. Recommendations Q.120 - Q.180 (Study Group XI).

FASCICLE VI.3 – Specifications of signalling system No. 6. Recommendations Q.251 - Q.300 (Study Group XI).

FASCICLE VI.4 – Specifications of signalling systems R1 and R2. Recommendations Q.310 - Q.490 (Study Group XI).

FASCICLE VI.5 – Digital transit exchanges for national and international applications. Interworking of signalling systems. Recommendations Q.501 - Q.685 (Study Group XI).

FASCICLE VI.6 – Specifications of signalling system No. 7. Recommendations Q.701 - Q.741 (Study Group XI).

FASCICLE VI.7 – Functional Specification and Description Language (SDL). Man-machine language (MML). Recommendations Z.101 - Z.104 and Z.311 - Z.341 (Study Group XI).

FASCICLE VI.8 – CCITT high level language (CHILL). Recommendation Z.200 (Study Group XI).

Volume VII

FASCICLE VII.1 – Telegraph transmission and switching. Series R, U Recommendations (Study Group IX).

FASCICLE VII.2 – Telegraph and "telematic services"[1] terminal equipment. Series S, T Recommendations (Study Group VIII).

Volume VIII

FASCICLE VIII.1 – Data communication over the telephone network. Series V Recommendations (Study Group XVII).

FASCICLE VIII.2 – Data communication networks; services and facilities, terminal equipment and interfaces. Recommendations X.1 - X.29 (Study Group VII).

FASCICLE VIII.3 – Data communication networks; transmission, signalling and switching, network aspects, maintenance, administrative arrangements. Recommendations X.40 - X.180 (Study Group VII).

Volume IX – Protection against interference. Series K Recommendations (Study Group V). Protection of cable sheaths and poles. Series L Recommendations (Study Group VI).

Volume X

FASCICLE X.1 – Terms and definitions.

FASCICLE X.2 – Index of the Yellow Book.

---

[1] "Telematic services" is used provisionally.

CONTENTS OF FASCICLE III.4 OF THE YELLOW BOOK

Part I – Series H Recommendations

Lines used for the transmission of signals other than telephone signals, such as telegraph, facsimile, data, etc., signals

Rec. No. Page

SECTION 6 – *Characteristics of visual telephone systems*

Part II – Series J Recommendations

Sound-programme amd television transmissions

SECTION 1 – *General recommendations concerning sound-programme Transmissions*

SECTION 2 – *Performance characteristics of sound-programme circuits*

SECTION 3 – *Characteristics of equipment and lines used for setting up sound-programme circuits*

SECTION 6 – *Characteristics of circuits for television transmissions*

Part III – Supplements to H and J Series Recommendations

REMARKS

1 The questions entrusted to each Study Group for the Study Period 1981-1984 can be found in Contribution No. 1 to that Study Group.

2 *Units*

The units used in this volume are in conformity with CCITT Recommendations B.3 and B.4 (Volume I).

The following abbreviations are used, particularly in diagrams and tables, and always have the following clearly defined meanings:

dBm the absolute (power) level in decibels;

dBm0 the absolute (power) level in decibels referred to a point of zero relative level;

dBr the relative (power) level in decibels;

dBm0p the absolute psophometric power level in decibels referred to a point of zero relative level.

CCITT NOTE

In this Fascicle, the expression "Administration" is used for shortness to indicate both a telecommunications Administration and a recognized private operating agency.

PART I

Series H Recommendations

LINES USED FOR THE TRANSMISSION
OF SIGNALS OTHER THAN TELEPHONE SIGNALS,
SUCH AS TELEGRAPH, FACSIMILE,
DATA, ETC., SIGNALS

PAGE INTENTIONALLY LEFT BLANK

PAGE LAISSEE EN BLANC INTENTIONNELLEMENT

LINES USED FOR THE TRANSMISSION OF SIGNALS OTHER THAN TELEPHONE SIGNALS, SUCH AS TELEGRAPH, FACSIMILE, DATA, ETC., SIGNALS [1)]

Part I contains two classes of Recommendations: those which define the characteristics of *transmission channels* (telephone-type, group, supergroup, etc., circuits) used only to transmit signals other than telephone signals, and those which define the characteristics of the *signals* used in such transmissions.

In this Part, "wideband" is used to qualify the transmission channels, and "wide-spectrum" the signals transmitted, so as to avoid any confusion between the transmission channels and the signals transmitted with regard to the frequency bands involved in transmission over group links, supergroup links, etc.

As far as possible, one should avoid specifying the characteristics of particular channels or signals in defining a new service and refer only to the characteristics of the channels mentioned in Section 1 of this Recommendation Series.

Section 6 of this Series is reserved for Recommendations concerning the characteristics of visual telephone systems.

Table 1 indicates the correspondence of Series H Recommendations to Recommendations of other Series.

TABLE 1

Series H Recommendation	*Recommendations of other Series*
H.12, § 1	M.1040 (Volume IV)
H.12, § 2	M.1025 (Volume IV)
H.12, § 3	M.1020 (Volume IV)
H.13	See Recommendation O.71 (Volume IV)
H.14, § 2	M.910 (Volume IV)
H.21	See also the Recommendations M.800 (Volume IV) and R.77 (Volume VII)
H.22	See also the Recommendation M.810 (Volume IV)
H.23	Extract of Recommendations R.31 and R.35 (Volume VII)
H.32	R.43 (Volume VII)
H.41	T.11 (Volume VII)
H.42	T.12 (Volume VII)
H.43	T.10 (Volume VII)
H.51	V.2 (Volume VIII)

1) Excluding the transmission of sound-programme and television signals, which is the subject of the Series J Recommendations.

PAGE INTENTIONALLY LEFT BLANK

PAGE LAISSEE EN BLANC INTENTIONNELLEMENT

SECTION 1

CHARACTERISTICS OF TRANSMISSION CHANNELS USED FOR OTHER THAN TELEPHONE PURPOSES

Recommendation H.11

CHARACTERISTICS OF CIRCUITS IN THE SWITCHED TELEPHONE NETWORK

(Mar del Plata, 1968)

The characteristics of these telephone circuits, when of modern type, are in conformity with Recommendations G.151 [1], G.152 [2] and G.153 [3]. Audio-frequency circuits, the characteristics of which are in accordance with Recommendations G.124 [4], G.511 [5] and G.543 [6], may also be found.

Some information on the characteristics of communications established in the switched telephone network is given in [7] and [8].

References

[1] CCITT Recommendation *General performance objectives applicable to all modern international circuits and national extension circuits*, Vol. III, Fascicle III.1, Rec. G.151.

[2] CCITT Recommendation *Characteristics appropriate to long-distance circuits of a length not exceeding 2500 km*, Vol. III, Fascicle III.1, Rec. G.152.

[3] CCITT Recommendation *Characteristics appropriate to international circuits more than 2500 km in length*, Vol. III, Fascicle III.1, Rec. G.153.

[4] CCITT Recommendation *Characteristics of long-distance loaded-cable circuits liable to carry international calls*, Orange Book, Vol. III-1, Rec. G.124, ITU, Geneva, 1977.

[5] CCITT Recommendation *General characteristics of audio-frequency circuits*, Orange Book, Vol. III-1, Rec. G.511, ITU, Geneva, 1977.

[6] CCITT Recommendation *Specification for repeater sections of loaded telecommunication cable*, Orange Book, Vol. III-1, Rec. G.543, ITU, Geneva, 1977.

[7] *Results of measurements and observations on the stability of the overall loss of circuits in the international network*, Green Book, Vol. IV.2, Supplement No. 4.1, ITU, Geneva, 1973.

[8] *Characteristics of leased international telephone-type circuits*, Green Book, Vol. IV.2, Supplement No. 4.3, ITU, Geneva, 1973.

CHARACTERISTICS OF TELEPHONE-TYPE LEASED CIRCUITS

(Mar del Plata, 1968; amended at Geneva, 1972, 1976 and 1980)

1 Ordinary telephone-type circuits [1), 2)] (formerly Part A)

1.1 *Scope of § 1 of the Recommendation and constitution of a leased circuit*

Paragraph 1 of this Recommendation details the characteristics of international leased circuits for telephony and other purposes that do not require the use of special-quality leased circuits conforming to §§ 2 or 3. These circuits are set up as described in Recommendation M.1050 [1].

1.2 *Characteristics*

1.2.1 *Nominal overall loss*

Because of the differing nominal level at renters' premises due to the various national practices, it is not normally possible to predict the nominal overall loss of the circuit at the reference frequency. Only exceptionally can a predetermined specified nominal overall loss at the reference frequency between renters' installations be offered and then only after prior consultation among the Administrations concerned.

Generally, however, for 4-wire circuits, the value of the sending relative level at the renter's premises should provisionally not be higher than +13 dBr and the receiving relative level provisionally not lower than −15 dBr [3)]. It can therefore be assumed that the maximum nominal overall loss will not normally exceed 28 dB, and in the majority of cases a nominal overall loss smaller than this can be expected.

It should be noted that the overall loss in each direction of transmission may not have the same value.

1.2.2 *Loss/frequency distortion*

The provisional limits for the overall loss relative to that at 800 Hz for the circuit between renters' installations are given in Figure 1/H.12.

1.2.3 *Random circuit noise*

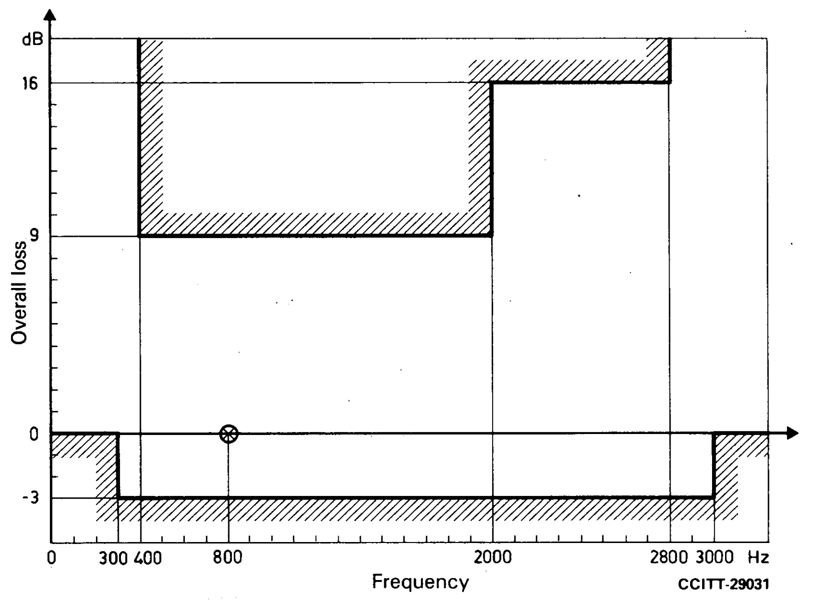
The nominal level of the psophometric noise power at a renter's premises depends upon the actual constitution of the circuit, in partiular upon the length of frequency division multiplex carrier systems in the circuit. The provisional limit for leased circuits of distances greater than 10 000 km is −38 dBm0p. However, circuits of shorter length will have substantially less random noise (see also Annex A).

---

1) The application of § 1 of this Recommendation to multiterminal leased circuits is intended only for radial networks in which these specifications are to be met between a designated central station and each of the outlying stations. It does not apply to multiterminal conference networks between any two stations.

2) The contents of § 1 correspond to part of Recommendation M.1040 [2].

3) The level of −15 dBr and the resulting maximum loss of 28 dB are incompatible with the threshold signal level specified for leased circuit modems. This question requires further study.



Note – At frequencies below 300 Hz and above 3000 Hz the loss shall not be less than 0.0 dB but is otherwise unspecified. These frequencies should be confirmed or amended after further study.

FIGURE 1/H.12

Limits for overall circuit loss relative to that at 800 Hz

2 Special quality leased circuits with basic bandwidth conditioning [4), 5)]

2.1 *Scope of § 2*

Paragraph 2 of this Recommendation deals with leased circuits for uses other than telephony – for example, data transmission.

The characteristics of §§ 2 and 3 are intended to ensure the provision of a circuit which will meet the requirements of digital transmission rates higher than those possible on a normal telephone-type circuit [6)]. § 2 is primarily intended for use with modems that contain equalizers.

2.2 *Characteristics* [7)]

Note – Except for the bandwidth characteristics (loss/frequency and group-delay distortions), the characteristics of § 2 are common to both types of "special quality leased circuits", that is, to §§ 2 and 3 of this Recommendation.

---

4) The application of § 2 of this Recommendation to multiterminal leased circuits is intended only for radial networks in which these specifications are to be met between a designated central station and each of the outlying stations. It does not apply to multiterminal conference networks between any two stations.

5) The contents of § 2 correspond to part of Recommendation M.1025 [3].

6) In order to ensure the proper operation of certain V Series modems operating at data signalling rates greater than 4800 bit/s, it is necessary to specify improved and/or modified values for the following transmission system characteristics: random circuit noise, quantizing noise, harmonic distortion (intermodulation distortion). This subject requires further study.

7) Additionally, the characteristics for short breaks in transmission, phase hits, amplitude hits and low-frequency phase jitter are under study.

2.2.1 *Nominal overall loss*

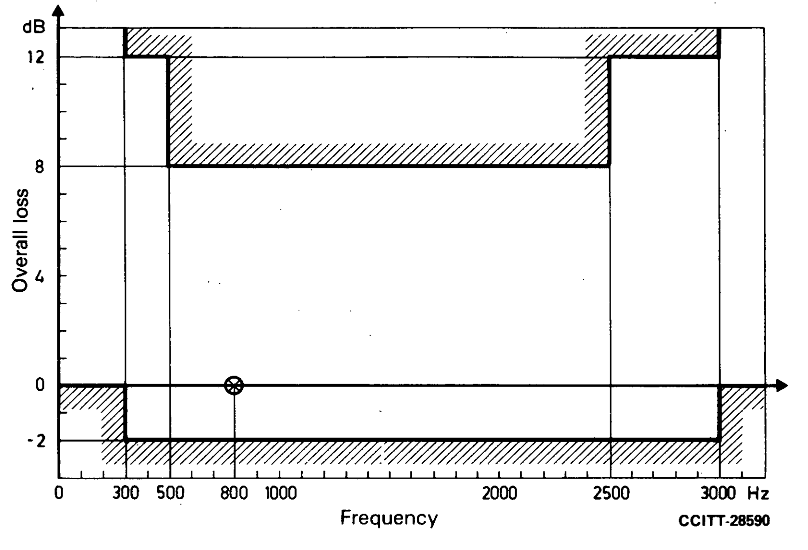
Because of the differing nominal level at renters' premises due to the various national practices, it is not normally possible to predict the nominal overall loss of the circuit at the reference frequency. Only exceptionally can a predetermined specified nominal overall loss at the reference frequency between renters' installations be offered and then only after prior consultation among the Administrations concerned.

Generally, however, for 4-wire circuits, the value of the sending relative level at the renter's premises should provisionally not be higher than +13 dBr and the receiving relative level provisionally not lower than −15 dBr [8]. It can, therefore, be assumed that the maximum nominal overall loss will not normally exceed 28 dB, and in the majority of cases a nominal overall loss smaller than this can be expected.

It should be noted that the overall loss in each direction of transmission may not have the same value.

2.2.2 *Loss/frequency distortion* [9), 10)]

The limits for the overall loss relative to that at 800 Hz for the circuit between renters' installations are given in Figure 2/H.12.



Note — At frequencies below 300 Hz and above 3000 Hz, the loss shall not be less than 0.0 dB but is otherwise unspecified. These frequencies should be confirmed or amended after further study.

FIGURE 2/H.12

Limits for the overall loss of the circuit relative to that at 800 Hz

2.2.3 *Group-delay distortion* [9), 10)]

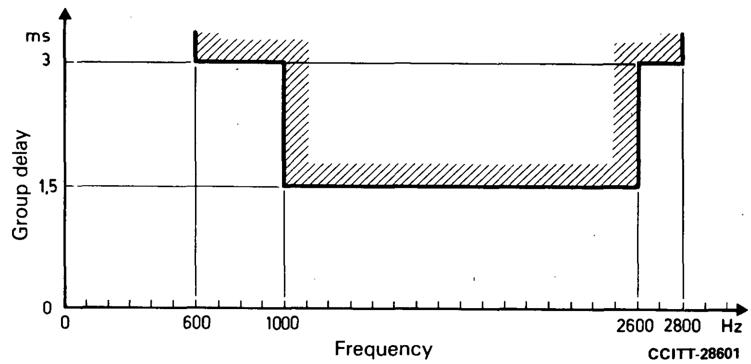
The limits that apply to group-delay distortion are given in Figure 3/H.12 in which the limiting values over the frequency band are expressed as values relative to the minimum measured group delay.

---

8) The level of −15 dBr and the resulting maximum loss of 28 dB are incompatible with the threshold signal level specified for leased circuit modems. This Question requires further study.

9) It is expected that in most cases these "basic bandwidth" characteristics may be available without the addition of loss/frequency and/or group-delay equalization equipment.

10) The values of loss/frequency and group delay distortion are provisional and should be confirmed or amended after further study.



Note — It should be noted that the value of 3 ms between 600 and 1000 Hz should be confirmed or amended after further study, to ensure that equalization would not be necessary in the majority of cases and that proper modem operation would be possible.

FIGURE 3/H.12

Limits for group delay relative to the minimum measured group delay in the 600-2800 Hz band

2.2.4 *Variation with time of the overall loss at 800 Hz*

The variation with time of the overall loss at 800 Hz should be as small as possible and should not exceed the following limits:

– short-term variations
(over a period of a few seconds) . . . . ± 3 dB

– long-term variations
(over long periods including daily and seasonal variations) . . . . ± 4 dB

2.2.5 *Random circuit noise*

The nominal level of the psophometric noise power at the renter's premises depends upon the actual constitution of the circuit, in particular upon the length of frequency division multiplex carrier systems in the circuit. The provisional limit for special quality leased circuits of distances greater than 10 000 km is −38 dBm0p. However, circuits of shorter length will have substantially less random noise (see also Annex A).

Note – In the case of multiterminal circuits, the length to be taken into consideration is the sum of the lengths of the various sections of the link.

2.2.6 *Impulsive noise*

Impulsive noise should be measured with an instrument complying with Recommendation O.71 [4].

As a provisional limit, the number of impulsive noise peaks exceeding −21 dBm0 should not be more than 18 in 15 minutes.

2.2.7 *Phase jitter*

The value of phase jitter measured at a renter's premises depends upon the actual constitution of the circuit (for example, upon the number of modulation equipments involved). It is expected that any measurement of phase jitter using an instrument complying with Recommendation O.91 [5] will not normally exceed 10° peak-to-peak. However, for circuits of necessarily complex constitution and where 10° peak-to-peak cannot be met, a limit of up to 15° peak-to-peak is permitted. These limits are provisional and subject to further study.

2.2.8 *Quantizing noise (quantizing distortion)*

If any circuit section is routed over a PCM system, the signal will be accompanied by quantizing noise. The minimum ratio of signal-to-quantizing noise normally expected is 22 dB.

2.2.9 *Single tone interference*

The level of single tone interference in the band 300-3400 Hz shall not exceed a value which is 3 dB below the circuit noise objective indicated in Figure A-1/H.12. This limit is provisional pending further study.

2.2.10 *Frequency error*

The frequency error introduced by the circuit must not exceed ± 5 Hz. It is to be expected that in practice the error will be within closer limits than these.

2.2.11 *Harmonic distortion*

When a 700-Hz test frequency of −13 dBm0 is injected at the transmit end of a point-to-point circuit, the level of any individual harmonic frequency at the receiving end shall provisionally be at least 25 dB below the received level of the fundamental frequency.

3 Special quality leased circuits with special bandwidth conditioning [11), 12)]

3.1 *Scope of § 3*

Paragraph 3 of this Recommendation deals with leased circuits for uses other than telephony – for example, data transmission.

The characteristics of §§ 2 and 3 of this Recommendation are intended to ensure the provision of a circuit which will meet the requirements of digital transmission rates higher than those possible on a normal telephone-type circuit. § 3 is primarily intended for use with modems that do not contain equalizers.

3.2 *Characteristics*

Note – As discussed in § 2, except for the bandwidth characteristics (loss/frequency and group-delay distortions), the characteristics of § 2 are common to both types of "special quality leased circuits". Thus only the loss/frequency distortion and group-delay distortion will be described in this section.

3.2.1 *Nominal overall loss*

See § 2.2.1.

3.2.2 *Loss/frequency distortion*

The limits for the overall loss relative to that at 800 Hz for the circuit between renters' installations are given in Figure 4/H.12.

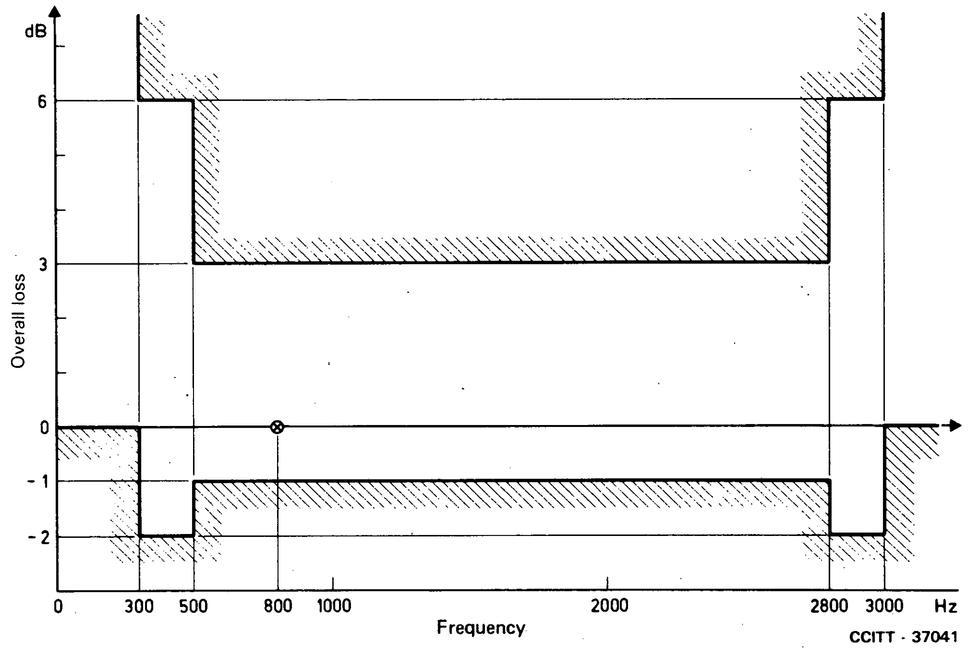
3.2.3 *Group-delay distortion*

The limits that apply to group-delay distortion are given in Figure 5/H.12 in which the limiting values over the frequency band are expressed as values relative to the minimum measured group delay.

The other characteristics correspond to these of §§ 2.2.4 to 2.2.11 of this Recommendation (see the Note to § 2.2).

11) The application of § 3 of this Recommendation to multiterminal leased circuits is intended only for radial networks in which these specifications are to be met between a designated central station and each of the outlying stations. It does not apply to multiterminal conference networks between any two stations.

12) The contents of § 3 correspond to part of Recommendation M.1020 [6].



Note — At frequencies below 300 Hz and above 3000 Hz, the loss shall not be less than 0.0 dB but is otherwise unspecified.

FIGURE 4/H.12

Limits for the overall loss of the circuit relative to that at 800 Hz

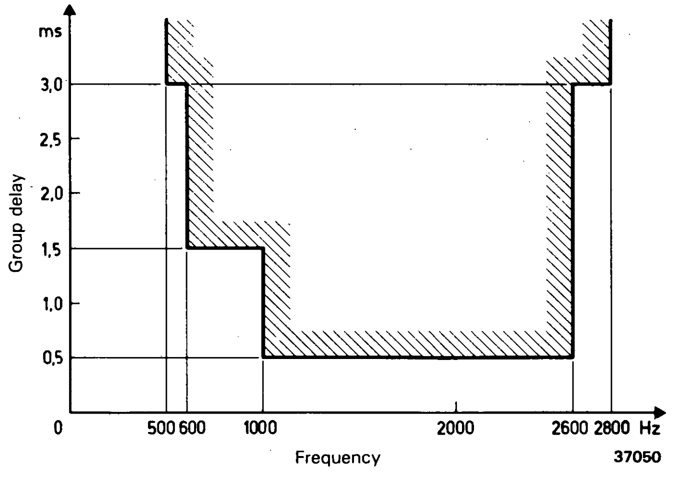


FIGURE 5/H.12

Limits for group delay relative to the minimum measured group delay in the 500-2800 Hz band

ANNEX A

(to Recommendation H.12)

Random circuit noise

Figure A-1/H.12 displays random noise versus length and is presented as a guide to the random noise performance which may be found on an international leased circuit.

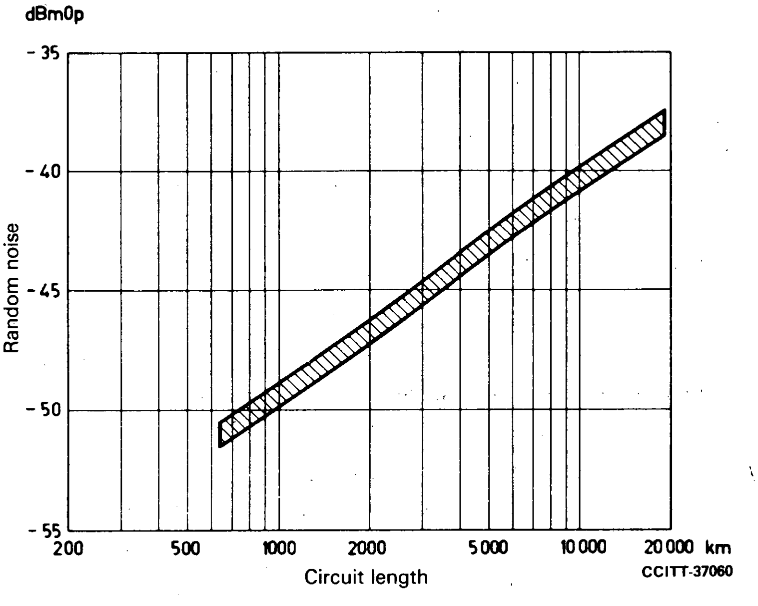


FIGURE A-1/H.12

Random noise circuit performance

Note – At the present time the section of the circuit provided by satellite (between earth stations) contributes approximately 10 000 pW0p (–50 dBm0p) of noise. Therefore, for the purpose of determining maintenance limits for noise measurements on leased circuits, the length of a circuit section routed on a communications satellite may be considered to be equivalent to 1000 km in Figure A-1/H.12.

References

[1] CCITT Recommendation *Lining up an international point-to-point leased circuit*, Vol. IV, Fascicle IV.2, Rec. M.1050.

[2] CCITT Recommendation *Characteristics of ordinary quality international leased circuits*, Vol. IV, Fascicle IV.2, Rec. M.1040.

[3] CCITT Recommendation *Characteristics of special quality international leased circuits with basic bandwidth conditioning*, Vol. IV, Fascicle IV.2, Rec. M.1025.

[4] CCITT Recommendation *Specification for an impulsive noise measuring instrument for telephone-type circuits*, Vol. IV, Fascicle IV.4, Rec. O.71.

[5] CCITT Recommendation *Essential clauses for an instrument to measure phase jitter on telephone circuits*, Vol. IV, Fascicle IV.4, Rec. O.91.

[6] CCITT Recommendation *Characteristics of special quality international leased circuits with special bandwidth conditioning*, Vol. IV, Fascicle IV.2, Rec. M.1020.

Recommendation H.13

CHARACTERISTICS OF AN IMPULSIVE NOISE MEASURING INSTRUMENT FOR TELEPHONE-TYPE CIRCUITS

(The text of this Recommendation can be found in Recommendation O.71 in Fascicle IV.4 of Volume IV.)

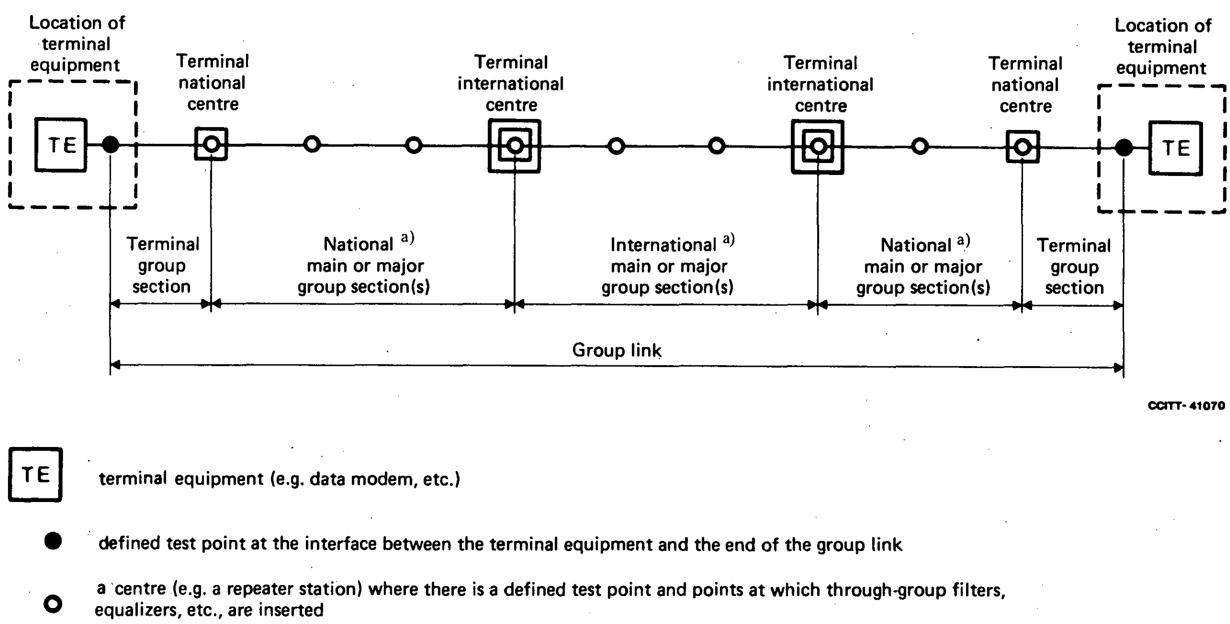
Recommendation H.14

CHARACTERISTICS OF GROUP LINKS FOR THE TRANSMISSION OF WIDE-SPECTRUM SIGNALS

(Mar del Plata, 1968; amended at Geneva, 1972, 1976 and 1980)

1 Constitution of a link, terminology, and scope of the Recommendation (formerly Part A)

A group link is composed of one or more group sections in tandem, generally prolonged at each end by "local lines" (denoted terminal group sections in Figure 1/H.14). These terminal group sections connect the group distribution frames of the terminal national centres with the equipment for sending and receiving wide-spectrum signals (modems, etc.) which may be situated either in the subscriber's premises or in any other place. In the latter case they are normally switched over the local telephone cable network, or sometimes over a special cable line or a radio-relay link. Only local lines carrying the 60-108 kHz wide-spectrum signal are termed "terminal group sections" and are included in the definition of a group link. The other case in which a baseband signal occupying a frequency band other than 60-108 kHz is transmitted over the local lines, the frequency translation to the 60-108 kHz band being made at the terminal national centres, is not dealt with in this Recommendation.



a) These sections are composed of one or more group sections.

FIGURE 1/H.14

Example of the constitution of a group link for wide-spectrum signal transmission

It should be noted that the group link does not comprise any terminal equipment (modems, etc.). Figure 1/H.14 illustrates these considerations.

2 Characteristics of corrected group links (formerly Part B) [1)]

The characteristics mentioned in §§ 2.1 and 2.2 below imply the use of a group pilot at 104.08 kHz. The use of a pilot in the middle of the group band requires different characteristics.

2.1 *Group-delay distortion*

The group-delay distortion over the band 68-100 kHz should not exceed 45 μs with respect to the value of the least group delay within that band. This value can be observed on a tandem connection of three group sections which includes two terminal group sections.

Note 1 – The following assumptions have been made:

1) The group-delay distortion of through-group connection equipment can be corrected so as not to exceed 15 μs over the band 68-100 kHz. It should be noted that through-group connection equipment comprises the group demodulating equipment, the through-group filter and the group modulating equipment (see Recommendation G.242 [2]). The equalization should be made in such a way that at least 6 group-delay maxima are obtained.

2) To respect these limits it may be necessary to avoid groups 1 and 5.

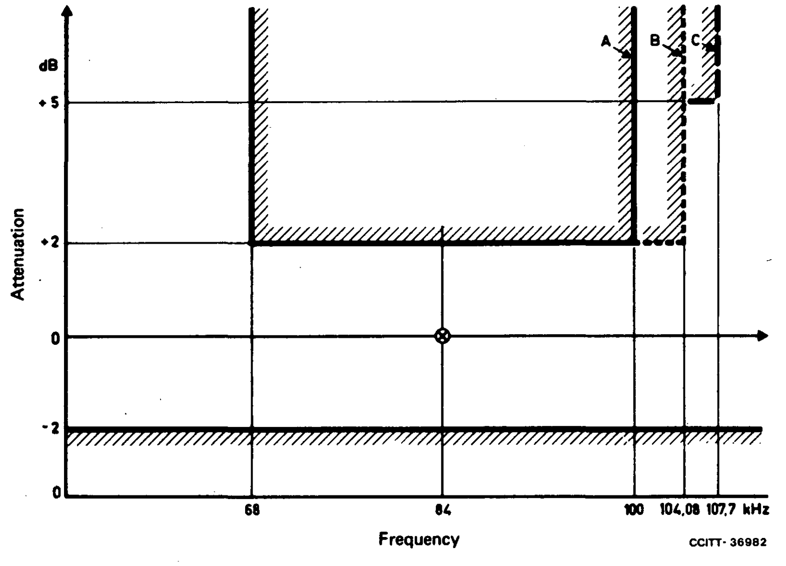
3) The use of a group containing the supergroup pilot should always be avoided.

In particular, group 3 should not be used when the supergroup pilot is at 411.920 or 411.860 kHz.

Note 2 – In certain cases where disturbing signals outside the basic group band have to be expected, additional filtering has to be provided in the local lines.

2.2 *Attenuation/frequency distortion*

The attenuation/frequency distortion of the whole link is given in Figure 2/H.14. It should be measured over the 60-108 kHz frequency range and equalized with a group link equalizer as necessary to meet the limits with respect to loss at 84 kHz.



A = These limits apply if the group reference pilot (104.08 kHz) is injected at an intermediate point on the link (e.g. the terminal national centre)

B = These limits apply if the group reference pilot is transmitted from end to end on the link (e.g. if it is injected by the terminal equipment)

C = These limits apply if the service channel is provided

FIGURE 2/H.14

Limits for attenuation/frequency distortion

1) This § 2 corresponds to Recommendation M.910 [1].

No ripple, should, however, exceed a value of 2 dB peak-to-peak.

Note 1 – The definition of the term "ripple" requires further study.

Note 2 – If the service channel is provided, additional equalization may be needed and there will be no possibility of using simplified through-group filters.

Note 3 – 84 kHz is the reference frequency for the purposes of specifying and measuring attenuation/frequency distortion. This is not in contradiction with the use of the group reference pilot at 104.08 kHz.

2.3 *Carrier leaks*

The leak from a carrier in the 60-108 kHz band shall not exceed –40 dBm0.

Note 1 – Although this value is an objective, it may in some cases prove impossible to achieve owing to the composition of the link, which will generally involve the use of both old and new types of equipment. In any case, no carrier leak in the band 60-108 kHz should exceed –35 dBm0.

Note 2 – For group links used in data transmission with modems in line with Recommendation V.36 [3], problems may arise if the total carrier leak power exceeds –35 dBm0.

2.4 *Variations in level*

The following limits should not be exceeded:

- short-term variations
  (for a few seconds) . . . . ± 3 dB
- long-term variations
  (during long periods, including seasonal and daily variations) . . . . ± 4 dB

relative to the nominal level.

2.5 *Background noise*

This can be expected to be substantially uniformly distributed over the group band, and to have a value calculated in accordance with Recommendations G.222 [4] and G.223 [5]. For an actual link, a margin should be allowed as indicated in Recommendation G.226 [6].

2.6 *Impulsive noise*

Under study.

2.7 *Frequency error*

Maximum frequency error shall not exceed 5 Hz.

Note – According to Recommendation G.225 [7], this condition should readily be met in practice.

2.8 *Phase changes with time*

The interfering phase modulation and phase jitter should meet the conditions set forth in Recommendation G.229 [8].

2.9 *Power handling capability*

Applied signals should be within the limits given in Recommendation H.52.

3 **Characteristics of uncorrected group links (formerly Part C)**

This type of link may be used, for example, for data transmission, the equalization taking place in the terminal equipment.

As a general rule, a group pilot at 104.08 kHz should be used. The possible existence of pilot blocking filters has not been taken into account in the characteristics given here in § 3.

Only Groups 2 and 4 should be used.

As far as possible, these groups should alternate in such a way that the number of Group 2 sections and the number of Group 4 sections do not differ by more than one.

3.1 *Hypothetical reference circuit*

Figure 3/H.14 represents a hypothetical reference circuit used to calculate the group-delay distortion.

Three types of circuit have been taken into account, all with 8 through-group filters.

Note – The number "8" chosen for through-group filters should be confirmed or amended after subsequent studies. It is possible that the choice of the number "8" corresponds to a case too unfavourable and that this number should be reduced.

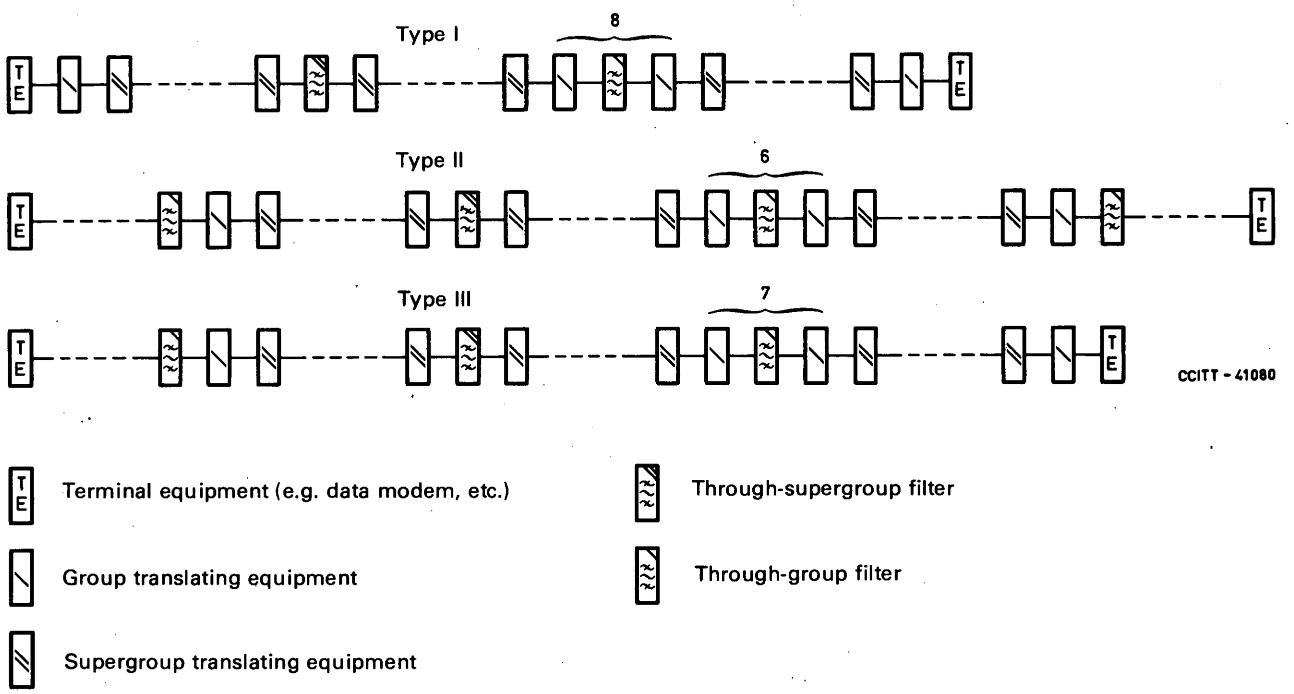


FIGURE 3/H.14

Hypothetical reference circuit for a leased group link

Type I: Terminal equipment at both sides in the repeater station.

Type II: Terminal equipment at both sides at the renter's premises.

Type III: Terminal equipment at one side in a repeater station and at the other side at the renter's premises.

For information, Table 1/H.14 shows the number of different types of equipment found on the link for a range of through-group connections.

Note 1 – The through-group filters are all of the type recommended in Recommendation G.242 [2].

Note 2 – In Type II, through-group filters are planned to ensure the privacy of adjacent groups and to protect them from interference from the local network.

TABLE 1/H.14

Number of through-group connections	Type I	Type II	Type III
	0 1 2 3 4 5 6 7 8	0 1 2 3 4 5 6	0 1 2 3 4 5 6 7
Number of through-group filters	0 1 2 3 4 5 6 7 8	2 3 4 5 6 7 8	1 2 3 4 5 6 7 8
Number of through-supergroup filters	1 2 4 6 7 9 10 12 14	1 2 4 6 7 9 10	1 2 4 6 7 9 10 12
Number of group modulator and demodulator pairs	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7	1 2 3 4 5 6 7 8
Number of supergroup modulator and demodulator pairs	2 3 5 7 8 10 11 13 15	2 3 5 7 8 10 11	2 3 5 7 8 10 11 13

3.2 *Loss/frequency distortion*

Under study.

3.3 *Group-delay distortion*

The group-delay distortion for a specific type of circuit (I, II or III) and for a specific number of sections can be calculated from the values in Table 2/H.14.

TABLE 2/H.14

Values for the mean curves of group-delay distorsion (in μs) as a function of frequency for various equipments

Frequencies (in kHz)	62	64	66	68	70	72	76	80	84	88	92	96	98	100	102	104	106
Through-group filter	250	104	60	37	25	16	7	2	0	2	7	16	25	37	60	104	250
Group translating equipment	8.0	6.7	5.6	4.8	4.0	3.3	1.8	0.6	0.0	0.0	0.6	1.2	1.7	2.2	2.8	3.6	4.6
Through-supergroup filter 2	0.0	0.1	0.2	0.3	0.5	0.6	0.9	1.2	1.6	2.0	2.4	2.9	3.2	3.5	3.8	4.2	4.6
Through-supergroup filter 4	4.7	4.2	3.7	3.3	2.9	2.6	2.0	1.6	1.2	0.9	0.6	0.4	0.3	0.2	0.2	0.1	0.0
Supergroup translating equipment 2	0.0	0.0	0.1	0.1	0.1	0.2	0.3	0.3	0.4	0.5	0.6	0.7	0.8	0.8	0.9	0.9	1.0
Supergroup translating equipment 4	1.0	0.9	0.9	0.8	0.8	0.7	0.6	0.5	0.4	0.3	0.3	0.2	0.1	0.1	0.1	0.0	0.0

Note 1 – The curves derived from these values are mean curves as far as through-group and through-supergroup filters are concerned.

Note 2 – The curves derived from these values for translating equipment are mean curves for the majority of the equipment in use. For the remaining equipment, the mean curve can be obtained by multiplying by two.

Note 3 – For group 2 in supergroup translating equipment for 120-channel systems, one can expect a curve equal to the curve in Table 2/H.14 multiplied by 3.

Note 4 – The group-delay distortion of the terminal extensions of group links has not been taken into account in Table 2/H.14. A provisional value for this group-delay distortion in each terminal group section is less than 2.5 μs.

Note 5 – The characteristic limits of group-delay distortion may be derived from the values given in Recommendations G.233 [9] and G.242 [2].

3.4 *Carrier leaks*

See § 2.3.

3.5 *Variations in level*

See § 2.4.

3.6 *Background noise*

See § 2.5.

3.7 *Impulsive noise*

Under study.

3.8 *Frequency error*

See § 2.7.

3.9 *Phase changes with time*

See § 2.8.

3.10 *Power handling capacity*

See § 2.9.

References

[1] CCITT Recommendation *Setting up and lining up an international leased group link for wide-spectrum signal transmission*, Vol. IV, Fascicle IV.2, Rec. M.910.

[2] CCITT Recommendation *Through-connection of groups, supergroups, etc.*, Vol. III, Fascicle III.2, Rec. G.242.

[3] CCITT Recommendation *Modems for synchronous data transmission using 60-108 kHz group band circuits*, Vol. VIII, Fascicle VIII.1, Rec. V.36.

[4] CCITT Recommendation *Noise objectives for design of carrier-transmission systems of 2500 km*, Vol. III, Fascicle III.2, Rec. G.222.

[5] CCITT Recommendation *Assumptions for the calculation of noise on hypothetical reference circuits for telephony*, Vol. III, Fascicle III.2, Rec. G.223, § 4.

[6] CCITT Recommendation *Noise on a real link*, Vol. III, Fascicle III.2, Rec. G.226.

[7] CCITT Recommendation *Recommendations relating to the accuracy of carrier frequencies*, Vol. III, Fascicle III.2, Rec. G.225.

[8] CCITT Recommendation *Unwanted modulation and phase jitter*, Vol. III, Fascicle III.2, Rec. G.229.

[9] CCITT Recommendation *Recommendations concerning translating equipments*, Vol. III, Fascicle III.2, Rec. G.233.

Recommendation H.15

CHARACTERISTICS OF SUPERGROUP LINKS FOR THE TRANSMISSION OF WIDE-SPECTRUM SIGNALS

(Mar del Plata, 1968; amended at Geneva, 1972 and 1976)

1 Constitution of a link and terminology (formerly Part A)

The constitution [1] and terminology for supergroup links are analogous to those for group links described in Recommendation H.14.

[1] *Note by the Secretariat* – Although this point was not discussed, it does not seem likely that the local telephone cable network could be used to extend a supergroup link, as is envisaged for a group link in Recommendation H.14, § 1.

2 Characteristics of corrected supergroup links (formerly Part B)

2.1 *Group-delay distortion*

Provisionally, the rule (1 + 2 *n*) µs over the band 352-512 kHz is recommended as the limit for a supergroup link with *n* through-supergroup connection equipments (i.e. *n* modulating, demodulating and through-supergroup filter equipments). Supergroup links with corrected group-delay distortion should be restricted to supergroups 5, 6 and 7 in a mastergroup.

2.2 *Attenuation/frequency distortion*

Over the band 352-512 kHz the attenuation/frequency distortion should not exceed ± 2 dB with respect to the attenuation at 412 kHz.

Note – The reference frequency for the purposes of defining *distortion* should be 412 kHz even if the supergroup reference pilot used for *regulating* purposes is 547.92 kHz.

2.3 *Carrier leaks*

The leak from a carrier in the 352-512 kHz band shall not exceed −40 dBm0.

Note – Although this value is an objective, it may in some cases prove impossible to achieve owing to the composition of the link, which will generally involve the use of both old and new types of equipment. At all events, no carrier leak in the 352-512 kHz band should exceed −35 dBm0.

2.4 *Variations in level*

The following limits should not be exceeded:

- short-term variations
  (for a few seconds) . . . . ± 3 dB
- long-term variations
  (during long periods, including seasonal and daily variations) . . . . ± 4 dB

relative to the nominal level.

2.5 *Background noise*

This can be expected to be substantially uniformly distributed over the supergroup band, and to have a value calculated in accordance with Recommendations G.222 [1] and G.223 [2]. For an actual link, a margin should be allowed as indicated in Recommendation G.226 [3].

2.6 *Impulsive noise*

Under study [2)].

2.7 *Frequency error*

Maximum frequency error shall not exceed 5 Hz.

Note – According to Recommendation G.225 [4], this condition should readily be met in practice.

2.8 *Phase changes with time*

Under study [2)].

2.9 *Power handling capability*

Applied signals should be within the limits given in Recommendation H.53.

3 Characteristics of uncorrected supergroup links (formerly Part C)

Under study [2)].

---

2) Under Questions 28/XV [5] and 10/XVII [6].

References

[1] CCITT Recommendation *Noise objectives for design of carrier-transmission systems of 2500 km*, Vol. III, Fascicle III.2, Rec. G.222.

[2] CCITT Recommendation *Assumptions for the calculation of noise on hypothetical reference circuits for telephony*, Vol. III, Fascicle III.2, Rec. G.223, § 4.

[3] CCITT Recommendation *Noise on a real link*, Vol. III, Fascicle III.2, Rec. G.226.

[4] CCITT Recommendation *Recommendations relating to the accuracy of carrier frequencies*, Vol. III, Fascicle III.2, Rec. G.225.

[5] CCITT Question 28/XV, COM XV – Contribution No. 1, Study Period 1981-1984, Geneva, 1981.

[6] CCITT Question 10/XVII, COM XVII – Contribution No. 1, Study Period 1981-1984, Geneva, 1981.

Recommendation H.16

CHARACTERISTICS OF AN IMPULSIVE-NOISE MEASURING INSTRUMENT FOR WIDEBAND DATA TRANSMISSION

(Geneva, 1972 and 1980)

The CCITT,

considering

that impulsive noise is of interest in wideband data transmission and that there is a need for a simple pulse counter suitable for field use,

provisionally *recommends*

that the instrument for impulsive-noise measurements should have the following characteristics:

1 Types of measurements

For the measurement of impulsive noise, the instrument should register a count whenever the instantaneous level applied to the input exceeds an adjustable threshold. This operation should be independent of the sense (or polarity) of the applied impulse.

For the measurement of circuit noise the instrument should provide means for indicating the average noise power.

2 Input impedance

The instrument should permit the measurements designated above on either balanced or unbalanced circuits at the nominal impedances which are used in wideband data transmission. On balanced circuits, the instrument should also be arranged to measure impulsive or circuit noise which is common to the two sides of the circuit with respect to earth.

Nominal input impedances should be provided as follows:

a) 75 ohms unbalanced;

b) 135 or 150 ohms balanced;

c) 135 or 150 ohms balanced with 20 000 ohms from each side of the circuit to a common 600 ohms which is returned to earth (the noise measurement is made across the 600-ohm resistor).

For the balanced input impedance [b) above] the balance of the input circuit in relation to earth should be such that when a 25-kHz sine wave, whose level is 70 dB higher than the instrument's threshold setting, is applied between the midpoint of the source impedance and the earth terminal of the instrument, the counter should not operate. Similarly, a 560-kHz sine wave, whose level is 42 dB higher than the threshold, when applied between the source impedance and the earth terminal of the instrument should not operate it. The above balance requirements shall hold for signal levels ranging up to 30 volts r.m.s.

Input arrangement c) above is provided for use in measuring impulsive and circuit noise which is common to the two sides of a balanced circuit with respect to earth.

3 Bandwidth and filter characteristics

For the condition of maximum bandwidth, the response should be within ± 1 dB of that at 25 kHz in the frequency range 275 Hz to 552 kHz, and should provide attenuation of at least 10 dB (with respect to that at 25 kHz) at frequencies below 50 Hz and above 1500 kHz.

Provision should be made for measurements on other specific bandwidths such as group or supergroup bands. These bandwidths may be obtained by means of plug-in or external filters, the characteristics of which should be as described in §§ 3.1 to 3.3 below.

3.1 For measurements on basic group-band circuits, the attenuation of the filter with reference to that at 84 kHz should lie on or within the limits shown in Figure 1/H.16.

3.2 For measurements on supergroup-band circuits, the attenuation of the filter with reference to that at 412 kHz should lie on or within the limits shown in Figure 2/H.16.

3.3 For measurements on baseband circuits with an upper frequency limit of 48 kHz, the attenuation of the filter with reference to that at 25 kHz should lie on or within the limits shown in Figure 3/H.16.

Note – When measuring in basic group and basic supergroup bands, one may use through-connection filters.

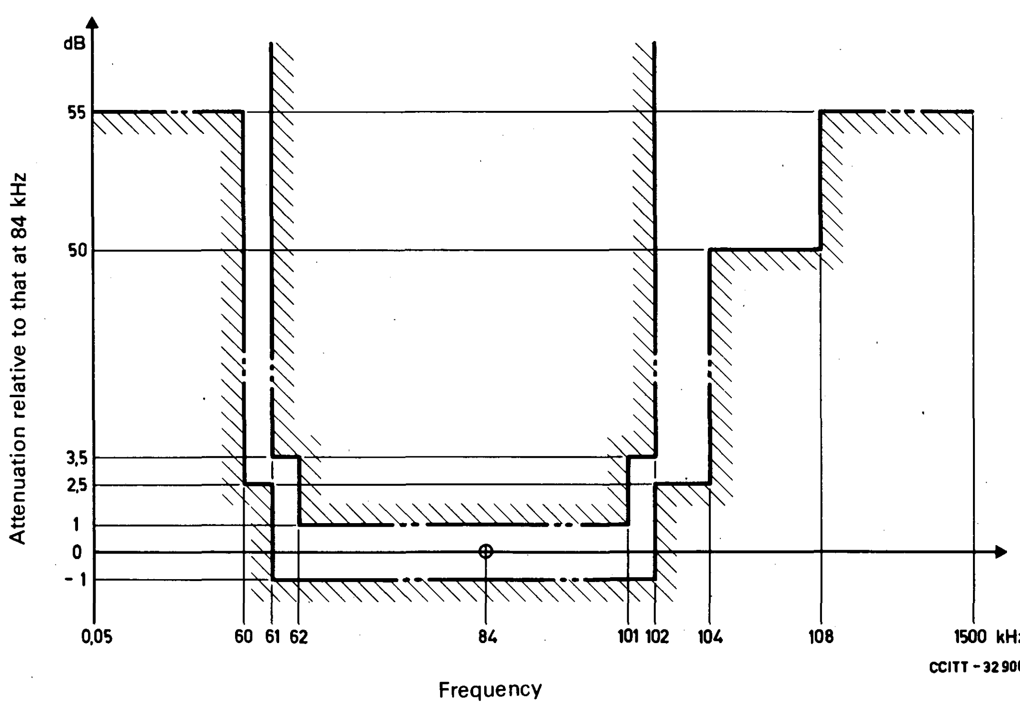


FIGURE 1/H.16

Permissible limits for the attenuation, relative to that at 84 kHz, of the filter for impulsive-noise measurements on a basic group band

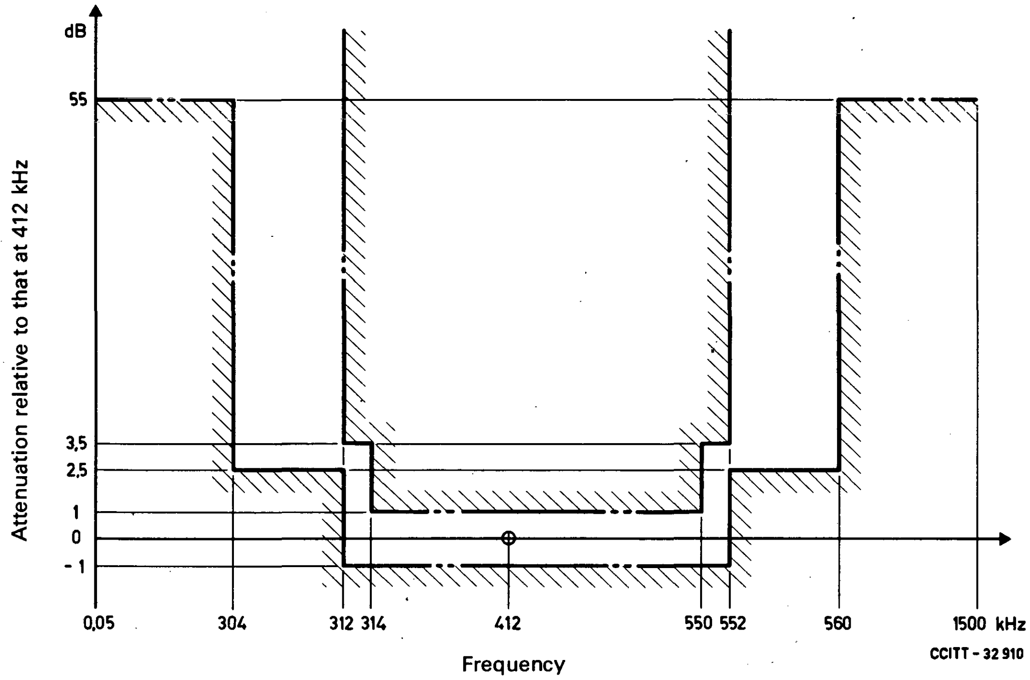


FIGURE 2/H.16

Permissible limits for the attenuation, relative to that at 412 kHz, of the filter for impulsive-noise measurements on a basic supergroup band

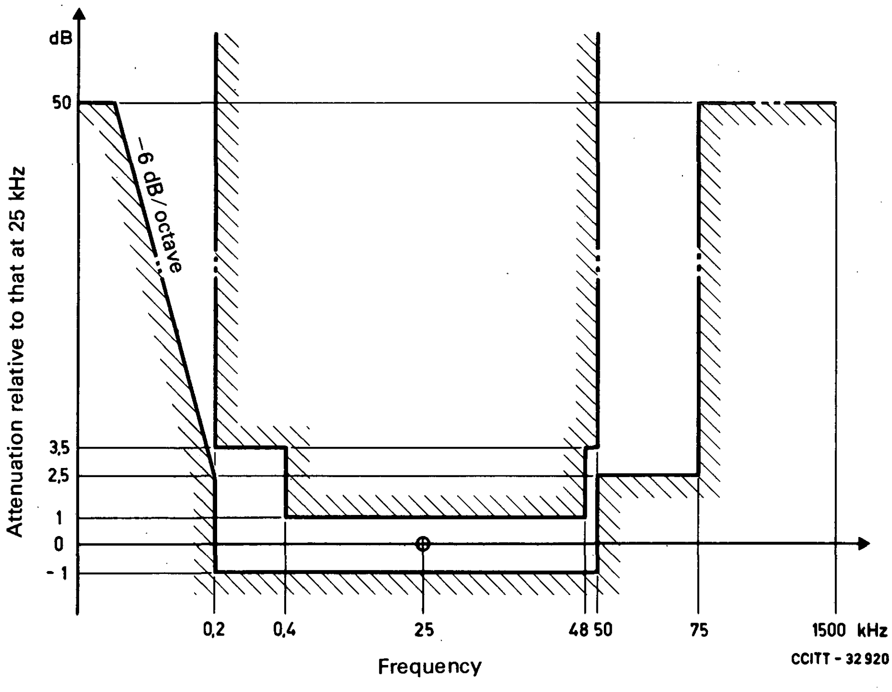


FIGURE 3/H.16

Permissible limits for the attenuation, relative to that at 25 kHz, of the filter for impulsive-noise measurements on a 48-kHz baseband circuit

4 Sensitivity and accuracy

For the measurement of impulsive noise, the threshold should be adjustable in steps of 1 dB for instantaneous levels from -60 to $+20$ dBm. For the measurement of circuit noise the sensitivity of the instrument should be -90 to $+10$ dBm at the calibration frequency. The accuracy of the instrument shall be $\pm$ 0.5 dB for any threshold setting or input polarity. The relative response to other signals should depend only on the attenuation characteristics for the maximum bandwidth or other selected bandwidths. The sensitivity of the instrument may be 30 dB less when used in the condition to measure circuit noise and impulsive noise common to the two sides of a balanced circuit with respect to earth.

5 Counting rate

Dead-time is defined as the time from the start of an impulse being registered until the counter is ready to register another impulse. A dead-time of 125 $\pm$ 25 ms shall be provided within the instrument.

Thus, the maximum counting rate is nominally eight impulses per second. The capacity of the counter shall be at least 999.

6 Calibration

Calibration should be possible from an internal signal or from the peaks of an externally applied sine-wave signal. For measurement of impulsive noise the calibration should be such that with the threshold adjusted to $+3$ dBm, the peaks of a 0 dBm sine wave will just operate the counter.

7 Timer

A built-in timer, continuously adjustable from 5 to 60 minutes, shall be provided. The accuracy shall be within $\pm$ 10% of the setting.

8 Temperature stability

All of the preceding clauses shall be satisfied when the ambient temperature varies between $+10\,^{\circ}$C and $+40\,^{\circ}$C.

PAGE INTENTIONALLY LEFT BLANK

PAGE LAISSEE EN BLANC INTENTIONNELLEMENT

SECTION 2

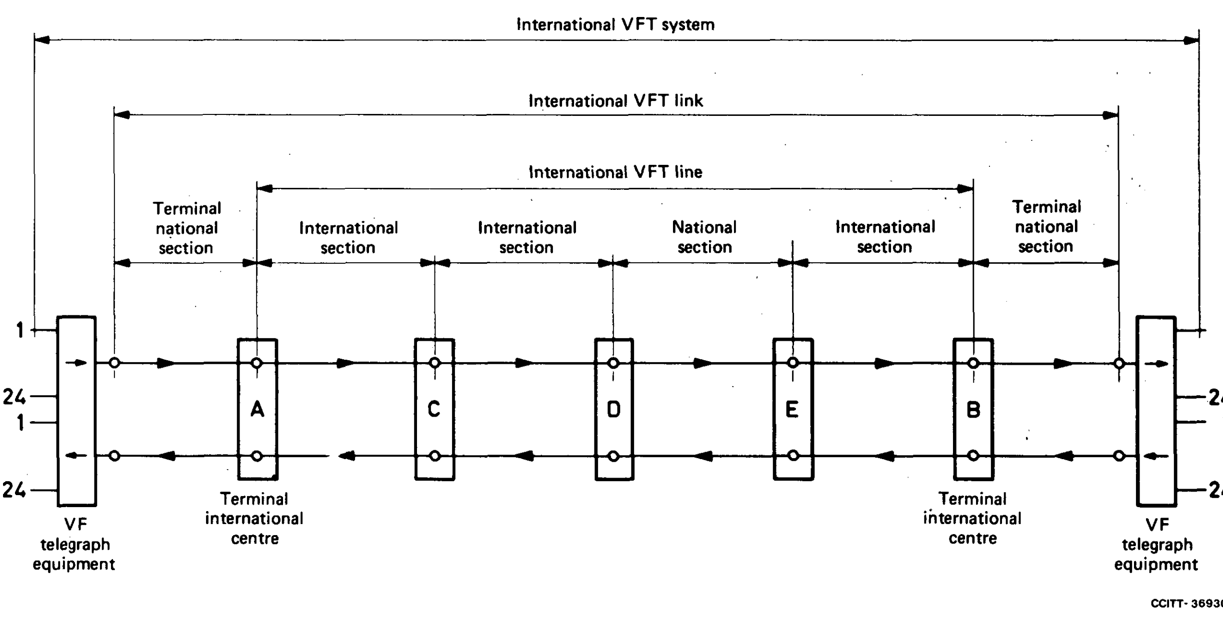
USE OF TELEPHONE-TYPE CIRCUITS FOR VOICE-FREQUENCY TELEGRAPHY

Recommendation H.21

COMPOSITION AND TERMINOLOGY OF INTERNATIONAL VOICE-FREQUENCY TELEGRAPH SYSTEMS

(Mar del Plata, 1968)

Figure 1/H.21 illustrates the composition of an international voice-frequency telegraph (VFT) system and the terminology used.



(At the intermediate centres C, D and E and at the terminal international centres A and B, the signals transmitted are at audio frequencies. At these points it is possible to make measurements.)

FIGURE 1/H.21

The components of an international VFT system

1 International voice-frequency telegraph system

This is the whole of the assembly of apparatus and lines including the terminal VFT equipment. In Figure 1/H.21 the system illustrated provides 24 duplex international telegraph circuits, but other numbers of telegraph circuits can be provided.

2 International VFT link

(sometimes referred to as the bearer circuit)

2.1 Four-wire telephone-type circuits are used for VFT links. The link comprises two unidirectional transmission paths, one for each direction of transmission, between the terminal VFT equipments.

2.2 The VFT link consists of an international telegraph line together with any terminal national sections connecting the international telegraph line to the VFT telegraph terminal equipment and may be constituted entirely on carrier channels (on symmetric pair, coaxial pair or radio-relay systems) or on audio-frequency lines or combinations of such lines.

2.3 The normal links for VF telegraphy have no terminating units, signalling equipment or echo suppressors.

3 International VFT line

3.1 The international VFT line may be constituted by using a channel in a carrier group or channels in tandem on a number of groups. National and international sections can be interconnected to set up an international telegraph line. See Figure 1/H.21, but note that § 3.2 below details the preferred method.

The international telegraph line could equally well be set up between, for example, only A and C or between C and D, in which case A and C, or C and D would be the terminal international centres.

3.2 Wherever possible an international telegraph line for a VFT link should be provided on channels of a single carrier group, thereby avoiding intermediate audio-frequency points. In some cases, such a group may not exist or, for special routing reasons, it may not be possible to set up the international telegraph line in the preferred way. In such cases, the international telegraph line will consist of channels in tandem on two or more groups with or without audio sections, depending on the line available and the routing requirements.

4 Terminal national sections connected to the international telegraph line

In many cases the VFT terminal equipment is remote from the terminal international centre of the international telegraph line (Figure 1/H.21), and such cases necessitate the provision of terminal national sections in order to establish international VFT links. These sections may be in short-distance local audio cables, amplified or unamplified, or may be routed in long-distance carrier groups or amplified audio plant as available.

Recommendation H.22

TRANSMISSION REQUIREMENTS OF INTERNATIONAL VOICE-FREQUENCY TELEGRAPH LINKS (AT 50, 100 AND 200 BAUDS)

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

1 Links routed on carrier systems (formerly Part A)

Figure 1/H.21 shows the composition of an international circuit for voice-frequency (VF) telegraphy. The limits specified in the present Recommendation are based on the values between international terminal centres which are indicated in Recommendation G.151 [1] for an international telephone circuit and which are applied approximately to the international line in Figure 1/H.21. A slight increase has been made to certain characteristics to allow for unloaded national sections connecting the centres to the VF telegraph equipments since most telegraph installations belonging to public services are fairly close to the international maintenance centres.

1.1 *Nominal insertion loss at 800 Hz*

The nominal insertion loss of the link at 800 Hz depends on the nominal relative power levels at the extremities of the telegraph link. These levels will be those normally used in the national network of the countries concerned so that it is not possible to recommend a particular nominal value for the insertion loss.

The nominal relative power level at the input to the link and the absolute power level of the telegraph signals at this point must be such that the limits concerning the power level per telegraph channel at a zero relative point on carrier systems are respected.

1.2 *Variation of insertion loss with time*

In accordance with Recommendation M.160 [2]:

a) the difference between the mean value and the nominal value of the transmission loss should not exceed 0.5 dB;

b) the standard deviation from the mean value should not exceed 1 dB.

However, in the case of circuits set up wholly or partly on older equipment, where the international line consists of two or more circuit sections, a standard deviation not exceeding 1.5 dB may be accepted.

1.3 *Sudden variations of insertion loss and short interruptions*

Such defects of the transmission path impair the quality of the telegraph transmission and should be reduced to the minimum possible.

1.4 *Overall loss/frequency distortion*

The variation with frequency of the 600-ohm insertion loss of the link with respect to the loss at 800 Hz must not exceed the following limits:

1.4.1 *Links with 4-kHz sections throughout* (see Table 1/H.22)

TABLE 1/H.22

Frequency range (Hz)	Overall loss relative to that at 800 Hz
Below 300	Not less than −2.2 dB, otherwise unspecified
300- 400	−2.2 to +4.0 dB
400- 600	−2.2 to +3.0 dB
600-3000	−2.2 to +2.2 dB
3000-3200	−2.2 to +3.0 dB
3200-3400	−2.2 to +7.0 dB
Above 3400	Not less than −2.2 dB, otherwise unspecified

Overall loss limits are given in Table 1/H.22 and are shown hatched in Figure 1/H.22.

Note – The hatched limits in Figure 1/H.22 have been derived from the corresponding limits in Recommendation G.151 [1] by adding a margin to allow for the presence of unloaded national sections and also for the fact that the composition of the international line may be more complicated. This will permit the establishment of most international circuits for VF telegraphy without additional equalization.

In favourable cases it will be possible to respect the limits in the graph in Recommendation G.151 [1] which is shown as a broken line in Figure 1/H.22.

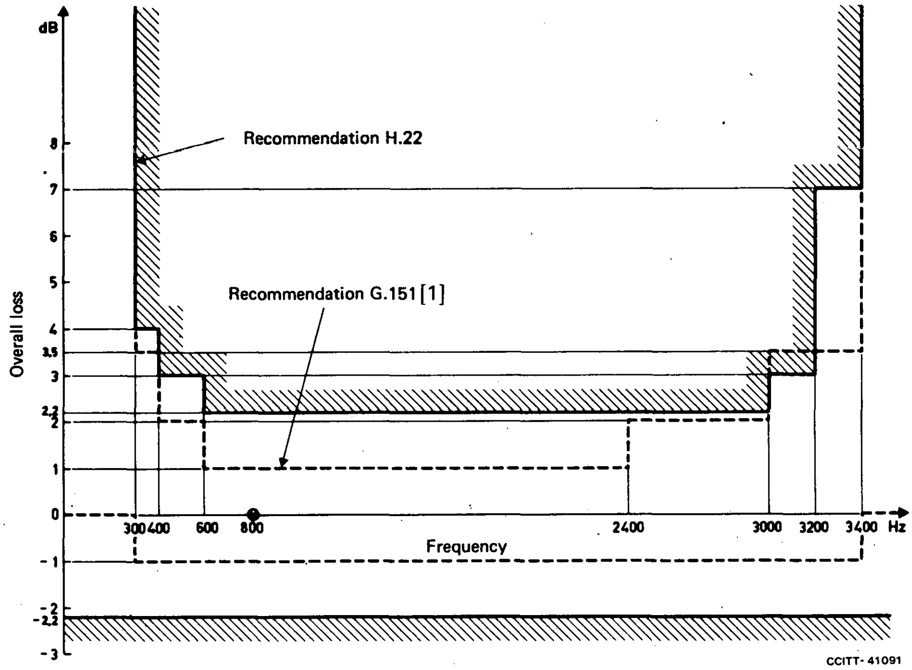


FIGURE 1/H.22

Variation with frequency of the overall loss relative to the value measured at 800 Hz with 4 kHz end-to-end sections

1.4.2 *Links with one or more 3-kHz sections* (see Table 2/H.22)

TABLE 2/H.22

Frequency range (Hz)	Overall loss relative to that at 800 Hz
Below 300	Not less than −2.2 dB, otherwise unspecified
300- 400	−2.2 to +4.0 dB
400- 600	−2.2 to +3.0 dB
600-2700	−2.2 to +2.2 dB
2700-2900	−2.2 to +3.0 dB
2900-3050	−2.2 to +6.5 dB
Above 3050	Not less than −2.2 dB, otherwise unspecified

1.5 *Noise*

1.5.1 *Uniform-spectrum random noise*

The mean psophometric noise power referred to a point of zero relative level should not exceed 80 000 pW0p (−41 dBm0p) [1].

Note – It was not possible to recommend a limit for the unweighted noise level. The CCITT psophometer with the telephone weighting network should continue to be the instrument used for specifying and measuring random noise power levels on telegraph links.

[1] If recourse be had to synchronous operation, a higher noise level might be tolerated (such as −30 dBm0p for a particular telegraph system).

1.5.2 *Impulsive noise*

Impulsive noise should be measured with an instrument complying with Recommendation H.13 and used in the "flat" condition.

As a provisional limit for maintenance purposes, the number of impulsive noise peaks exceeding −18 dBm0 should not be more than 18 in 15 minutes.

Note – Final values are still under study.

1.6 *Crosstalk*

a) The crosstalk ratio between the go and return channels of the link should be at least 43 dB.

b) The crosstalk ratio between the link and other carrier circuits is restricted by the Recommendation cited in [3] to be not worse than 58 dB.

Crosstalk in any audio cables forming part of the terminal national sections should not normally significantly worsen the crosstalk ratio.

1.7 *Mean one-way propagation time*

The one-way propagation time referred to is the group delay as defined in [4] calculated at a frequency of about 800 Hz.

It should be noted that VFT links routed over high-altitude satellite communication systems introduce mean one-way propagation times in excess of 260 ms.

1.8 *Group-delay distortion*

Practical experience obtained up to the present shows that it is not necessary to recommend limits for group-delay distortion for 50-baud VFT links even when they are composed of several sections each provided on telephone channels of carrier systems. There is little practical experience with higher speed telegraph systems.

It may happen that under adverse conditions some telephone channels of the link are of insufficient quality to provide 24 telegraph channels. In such a case, a better combination of telephone channels must be chosen for the telegraph service.

1.9 *Frequency drift*

The frequency drift introduced by the link must not be greater than 2 Hz. According to Recommendation G.225 [5], this condition is fully met in practice even when the international line for VF telegraphy has the same composition as the 2500-km hypothetical reference circuit for the transmission system used.

1.10 *Interference caused by power supply sources*

When a sinusoidal measuring signal is transmitted over the link at a level of 0 dBm0, the level of the strongest unwanted side component should not exceed −45 dBm0 (see also Recommendation G.151 [1] and Question 11/XV [6]).

1.11 *Variation introduced by changeover to the reserve line or section*

1.11.1 *Change in insertion loss at 800 Hz*

Bearing in mind that the insertion loss of the normal line (or section) and the reserve line (or section) are both subject to variations with time, which in general will be uncorrelated, it is not possible to assign a limit to the change of insertion loss at 800 Hz introduced by the changeover procedure.

1.11.2 *Change in the insertion loss at other frequencies relative to that introduced at 800 Hz*

The insertion-loss distortion characteristic of the link when established over the normal route should be within 2 dB or less of that of the link when established over the reserve route. This limit applies over the frequency bands 300-3400 Hz or 200-3050 Hz as appropriate.

There should ordinarily be no difficulty in achieving the limit when only one portion of the link – for example, the international telegraph line or one section – has a reserve section. However, when two or more portions of the link are separately associated with reserve portions, it becomes difficult to ensure that all combinations of normal and reserve portions comply with the limit. In these circumstances, the best that can be done is to ensure that the insertion-loss characteristics of corresponding normal and reserve portions are as much alike as possible. Careful attention should be paid to the impedance of normal and reserve sections at the point where they are connected to the changeover apparatus so that errors due to changing mismatch losses are minimized. A suitable target would be for all impedances concerned to have a non-reactive return loss against 600 ohms exceeding 20 dB over the appropriate band of frequencies.

1.11.3 The nominal relative power level at 800 Hz of the normal and reserve lines or sections at the changeover points for a particular direction of transmission should be the same. This level will be that normally used in the national network of the country concerned.

2 Links via audio-frequency line plant (formerly Part B)

2.1 *Attenuation/frequency distortion*

Graph No. 6, Figure 2/H.22, shows the variations with frequency of the difference between the relative power levels at the origin and extremity of the link relative to the measured value at 800 Hz.

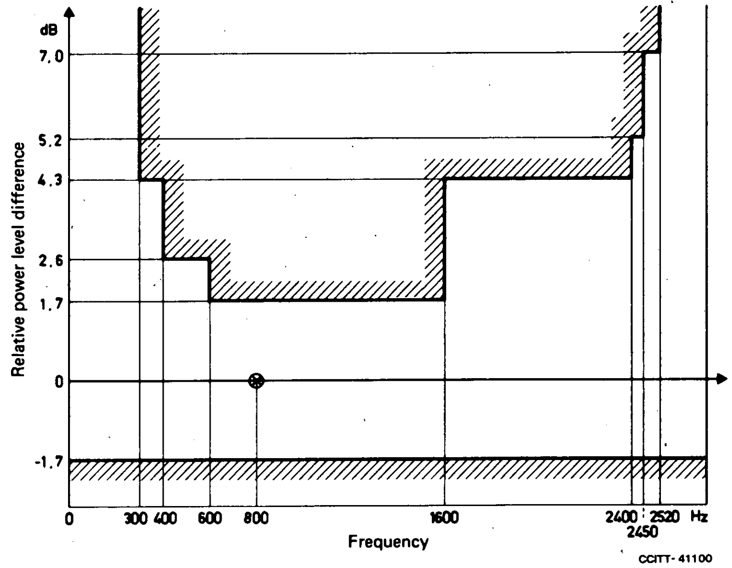


FIGURE 2/H.22.

Graph No. 6 – **Limits for the variation with frequency, relative to the value at 800 Hz, of the difference in relative power levels (in dB) between the input and output of a link used for VF telegraphy (set up on a telephone circuit using the band 300-2600 Hz)**

The permissible tolerances for the relative power level at the output of frontier repeaters are the same as those for 4-wire repeaters, if maintenance measurements are made by sending a power giving 1 mW at a zero relative level point (as found from the telephone circuit level diagram) to the input of the link for VF telegraphy. These tolerances are shown in Graph No. 7, Figure 3/H.22.

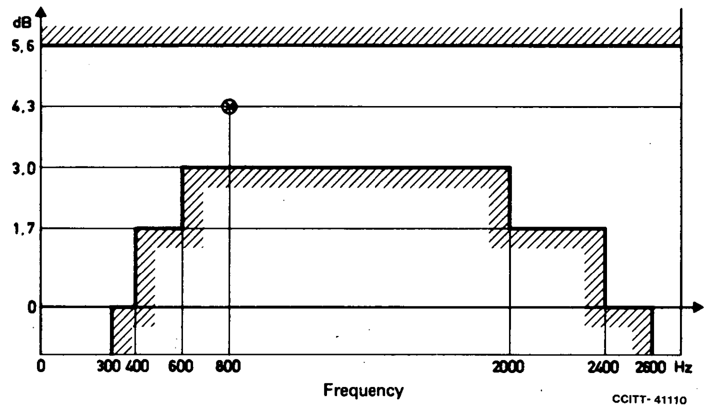


FIGURE 3/H.22.

Graph No. 7 – Maintenance limits for the absolute power level (in dB) at the output of a frontier repeater (frontier side) for an international circuit with a bandwidth of 300-2600 Hz and used for VF telegraphy (to be measured with a sent power at the origin of the VFT link such as to give 1 mW at a zero relative level point, deduced from the level diagram of the telephone circuit)

It does not appear necessary to fix particular limits for the variations with frequency of the level measured at the output of the frontier repeater since these may be calculated easily from the limits allowed for the relative power level.

2.2 *Level variations with time*

The relative power level at the point at the receiving end where the changeover between the VFT telegraph circuit and its reserve circuit takes place must be as constant as possible with time. Furthermore, any interruption in the circuit, even for a very short duration, spoils the quality of the telegraph transmission. Great care must therefore be taken when measurements are made on circuits and repeaters, when changing-over batteries, etc. To draw the attention of the staff to this matter, it is desirable for circuits used for VFT to be specially marked at the terminal stations and in the intermediate repeater stations.

2.3 *Freedom from modulation*

It is desirable to make special arrangements to avoid any modulation on the circuits and in the repeaters. Such modulation may in particular be caused by the variation in battery voltages or by the connection of equipment for sub-audio telegraphy to the cable pairs.

References

[1] CCITT Recommendation *General performance objectives applicable to all modern international circuits and national extension circuits*, Vol. III, Fascicle III.1, Rec. G.151.

[2] CCITT Recommendation *Stability of transmission*, Vol. IV, Fascicle IV.1, Rec. M.160.

[3] CCITT Recommendation *General performance objectives applicable to all modern international circuits and national extension circuits*, Vol. III, Fascicle III.1, Rec. G.151, § 4.

[4] CCITT Definition: *Group delay*, Terms and Definitions, Volume X, Fascicle X.1.

[5] CCITT Recommendation *Recommendations relating to the accuracy of carrier frequencies*, Vol. III, Fascicle III.2, Rec. G.225.

[6] CCITT Question 11/XV, COM XV – Contribution No. 1, Study Period 1980-1984, Geneva, 1981.

BASIC CHARACTERISTICS OF TELEGRAPH EQUIPMENTS USED IN INTERNATIONAL VOICE-FREQUENCY TELEGRAPH SYSTEMS [1)]

(Mar del Plata, 1968; amended at Geneva, 1976)

1 Limiting power per channel (formerly Part A)

1.1 *Amplitude-modulated voice-frequency telegraph (AMVFT) systems at 50 bauds*

Administrations will be able to provide the telegraph services with carrier telephone channels permitting the use of 24 VFT channels (each capable of 50 bauds) on condition that the power of the telegraph channel signal on each channel, when a continuous marking signal (Z polarity) is transmitted, does not exceed 9 μW0.

For 18 telegraph channels only, the power so defined may be increased to 15 μW0 per telegraph channel so that even telephone channels with a relatively high noise level can then be used.

The power per telegraph channel should never exceed 35 μW0, however few channels there may be.

These limits are summarized in Table 1/H.23.

TABLE 1/H.23

Limiting power per telegraph channel when sending a continuous marking signal in AMVFT systems at 50 bauds

System	Limiting power at zero relative level point per telegraph channel when sending a continuous marking signal	
	μW0	dBm0
12 telegraph channels or less	35	−14.5
18 telegraph channels	15	−18.3
24 telegraph channels	9	−20.5

1.2 *Frequency-modulated voice-frequency telegraphy (FMVFT) systems at 50 bauds*

The mean power transmitted to line by 50-baud FMVFT systems is limited to 135 μW0 when all channels of the system are sending. This gives the limits shown in Table 2/H.23 for the mean permissible power per telegraph channel at a zero relative level point.

Some Administrations have bilateral agreements to reduce the total mean power level of FMVFT systems to −13 dBm0 (50 μW0). The CCITT encourages such reduction where feasible. The above Administrations have made their own determination of the feasibility of operating at the reduced level. As a guide, other Administrations may wish to use the suggested parameters provided by Study Group IX as given in Annex A to this Recommendation.

---

1) This Recommendation reproduces, for information, some characteristics given in Recommendations R.31 [1] and R.35 [2].

TABLE 2/H.23

Normal limiting power per telegraph channel in 50-baud FMVFT systems

System	Permissible mean power at zero relative level point per telegraph channel	
	μW0	dBm0
12 telegraph channels or less	11.25	−19.5
18 telegraph channels	7.5	−21.3
24 telegraph channels	5.6	−22.5

2 Telegraph channel frequencies (formerly Part B)

For international VF 24-channel, 50-baud, non-synchronous telegraph systems the frequency series consisting of odd multiples of 60 Hz has been adopted, the lowest frequency being 420 Hz as shown in Table 3/H.23. In the case of frequency-modulated systems, these frequencies are the centre frequencies of the telegraph channels, the frequency of the signal sent to line being 30 Hz (or 35 Hz) above or below the centre frequency according to whether A or Z polarity is being sent.

TABLE 3/H.23

Telegraph channel position	Frequency (Hz)	Telegraph channel position	Frequency (Hz)
1	420	13	1860
2	540	14	1980
3	660	15	2100
4	780	16	2220
5	900	17	2340
6	1020	18	2460
7	1140	19	2580
8	1260	20	2700
9	1380	21	2820
10	1500	22	2940
11	1620	23	3060
12	1740	24	3180

In addition a pilot channel using a frequency of 300 Hz (or 3300 Hz) can be used. For details of the normal frequencies used in other types of telegraph system, see Recommendations R.37 [3], R.38 A [4] and R.38 B [5].

ANNEX A

(to Recommendation H.23)

Limits required by Study Group IX in respect of the bearer circuit for FMVFT if the total telegraph power is to be reduced to 50 microwatts (from 135 microwatts)

A.1 *Loss/frequency distortion*

The variation with frequency of the overall loss of the link with respect to the loss at 800 Hz should not exceed the limits given in Table A-1/H.23.

TABLE A-1/H.23

Frequency range (Hz)	Overall loss relative to that at 800 Hz
Below 300	Not less than −2.0 dB, otherwise unspecified
300- 500	−2.0 to +4.0 dB
500-2800	−1.0 to +3.0 dB
2800-3000	−2.0 to +3.0 dB
3000-3250	−2.0 to +4.0 dB
3250-3350	−2.0 to +7.0 dB
Above 3350	Not less than −2.0 dB, otherwise unspecified

A.2 *Random noise*

The mean psophometric noise power referred to a point of zero relative level should not exceed 32 000 pW0p (−45 dBm0p), using a psophometer in accordance with Recommendation P.53 [6].

A.3 *Impulsive noise*

The number of impulsive noise peaks exceeding −28 dBm0 should not be more than 18 in 15 minutes when measured with an impulsive noise counter in accordance with the Recommendation cited in [7].

References

[1] CCITT Recommendation *Standardization of AMVFT systems for a modulation rate of 50 bauds*, Vol. VII, Fascicle VII.1, Rec. R.31.

[2] CCITT Recommendation *Standardization of FMVFT systems for a modulation rate of 50 bauds*, Vol. VII, Fascicle VII.1, Rec. R.35.

[3] CCITT Recommendation *Standardization of FMVFT systems for a modulation rate of 100 bauds*, Vol. VII, Fascicle VII.1, Rec. R.37.

[4] CCITT Recommendation *Standardization of FMVFT systems for a modulation rate of 200 bauds with channels spaced at 480 Hz*, Vol. VII, Fascicle VII.1, Rec. R.38A.

[5] CCITT Recommendation *Standardization of FMVFT systems for a modulation rate of 200 bauds with channels spaced at 360 Hz usable on long intercontinental bearer circuits generally used with a 3-kHz spacing*, Vol. VII, Fascicle VII.1, Rec. R.38B.

[6] CCITT Recommendation *Psophometers (apparatus for the objective measurement of circuit noise)*, Vol. V, Rec. P.53.

[7] CCITT Recommendation *Characteristics of an impulsive-noise measuring instrument for telephone-type circuits*, Orange Book, Vol. III-2, Rec. H.13, § h), ITU, Geneva, 1977.

SECTION 3

TELEPHONE CIRCUITS OR CABLES USED FOR VARIOUS TYPES OF TELEGRAPH TRANSMISSION OR FOR SIMULTANEOUS TRANSMISSIONS

Recommendation H.32 [1)]

SIMULTANEOUS COMMUNICATION BY TELEPHONY AND TELEGRAPHY ON A TELEPHONE-TYPE CIRCUIT [2)]

The CCITT,

considering

(a) that the use of a leased telephone-type circuit for simultaneous communication by telephony and telegraphy is envisaged in Recommendations D.1 [2] and H.32;

(b) that the CCITT has indicated conditions under which the simultaneous use of telephone-type circuits for telephony and telegraphy is technically tolerable;

(c) that standardization of the characteristics of equipment permitting simultaneous use of a telephone-type circuit for telephony and telegraphy is not justified, but that it is necessary to limit the power of the signals transmitted and to avoid the use of frequencies that will interfere with any telephone signalling equipment that may remain connected to the telephone-type circuit;

(d) that new demands for the allocation of particular frequencies for special purposes frequently arise and the number of frequencies used for any one purpose should not be unnecessarily extended;

(e) that the systems described below may be useful when the more modern systems advocated in Recommendation H.34 are not feasible,

unanimously recommends

(1) that, in the case of the simultaneous use of a telephone-type circuit for telephony and telegraphy, the resulting maximum permissible 1-minute mean power loading shall not exceed 50 μW0 (i.e. -13 dBm0);

(2) that, where frequency division multiplexing is employed, the general principle concerning the allocation of level to each type of service should be that the allowable mean signal power is proportional to the bandwidth assigned. This case is considered in more detail in Recommendation H.34, resulting in the total power of the telegraph signals being set at a level not exceeding 10 μW0 (i.e. approximately -20 dBm0);

(3) that there should not be more than three circuits of this type in a group of 12 telephone-type circuits and that the number of circuits of this type set up on a wideband carrier system should not exceed the number of supergroups in the system;

---

1) Recommendation H.31, Volume III *Green Book* has been deleted.

2) Recommendation H.32 corresponds to Recommendation R.43 [1].

(4) that the telegraph signals transmitted must not interfere with any signalling equipment that may remain connected to the telephone-type circuit,

and notes

that some Administrations have permitted the use, for simultaneous telephony and telegraphy, of the frequencies 1680 Hz and 1860 Hz both for amplitude and for frequency modulation.

Note – If circuits equipped in accordance with the present Recommendation are used in a private network, it will be impossible to use push-button telephone sets or multifrequency signalling (e.g. Signalling System R2) in the network.

References

[1] CCITT Recommendation *Simultaneous communication by telephone and telegraph on a telephone-type circuit*, Vol. VII, Fascicle VII.1, Rec. R.43.

[2] CCITT Recommendation *General principles for the lease of international (continental and intercontinental) private leased telecommunication circuits*, Vol. II, Fascicle II.1, Rec. D.1.

Recommendation H.34 [1)]

SUBDIVISION OF THE FREQUENCY BAND OF A TELEPHONE-TYPE CIRCUIT BETWEEN TELEGRAPHY AND OTHER SERVICES

(Geneva, 1972)

1 General

The specific case considered here is that of frequency subdivision at 2700 Hz of a 4-wire circuit into a main band (which can be used for telephony, data, phototelegraphy or facsimile transmission) and a secondary band, above the main band, reserved for frequency-modulation (FM) telegraphy.

The solution described in this Recommendation is recommended when the equipments are supplied by the Administration and also in cases where the circuit established on the main channel can be connected to the public telephone network. It should be pointed out that, in accordance with the Recommendation cited in [1], Administrations are not obliged to guarantee the quality of transmission of calls sent to, or received from, users on the public network over a leased circuit.

It is understood that any other system may be used on a leased circuit, provided the conditions concerning levels set forth in § 5 below are observed; in this case, Administrations can give no guarantee concerning the quality of circuits, even between the users of a leased circuit.

2 Main channel

With the upper part limited in this way, the main channel can be used for:

a) telephone calls of a reduced quality plus an appropriate signalling system;

b) data transmission in accordance with Recommendation V.21 [2], V.23 [3] or V.30 [4] with a return channel;

c) phototelegraph transmission in accordance with the normal conditions described in Recommendation T.1 [5] (60 rpm with amplitude modulation; frequency modulation in any case is not advisable on circuits in land cables; amplitude modulation on submarine cables is still under study);

d) black-and-white facsimile transmission in accordance with Recommendation T.2 [6] (120 rpm only, amplitude modulation or frequency modulation).

For services b), c) and d) above, the filter should be designed to keep the group-delay distortion within tolerable limits for these services; the level condition stated in § 5 below must also be complied with at all times.

With regard to service a), where applicable, account should be taken of the telephony impairment (about 2 dB) due to the limitation of the frequency band (see Recommendation G.113 [7]).

[1)] Recommendation H.33, Volume III, *Green Book* has been deleted.

3 Telegraph channels

The following are the preferred arrangements of telegraph channels in the secondary band in the case of a normal 300-3400 Hz telephone-type circuit:

a) four 120-Hz spaced channels (Nos. 121, 122, 123, and 124);

b) two 120-Hz channels and one 240-Hz channel (Nos. 123, 124 and 211);

c) two 240-Hz channels (Nos. 211 and 212);

d) one 480-Hz channel (No. 406).

The numbering, modulation and other characteristics of the telegraph channels should comply with Recommendations R.35 [8], R.37 [9], R.38 A [10] and R.70 *bis* [11], as far as possible, considering the reduced transmission level which may result in substandard performance.

Where the upper limit is reduced to 3050 Hz (as in telephone channels complying with Recommendation G.235 [12]) it will only be possible to use two 120-Hz channels (Nos. 121 and 122) or one 240-Hz channel (No. 211) with the recommended frequency subdivision.

With the same subdivision, the main channel may be used for:

- telephone calls,
- facsimile (including phototelegraphy),

and the secondary channel for:

- data transmission by telegraph channel up to 200 bauds (100 bauds on submarine cables).

However, any private system may be used, depending on the characteristics of the portion of the band available.

4 Filters

For the protection of the telegraph channels from interference by speech components in the upper frequency range a filter must be used at the sending end. The recommended filter-attenuation characteristic is defined by the limits shown in Figure 1/H.34.

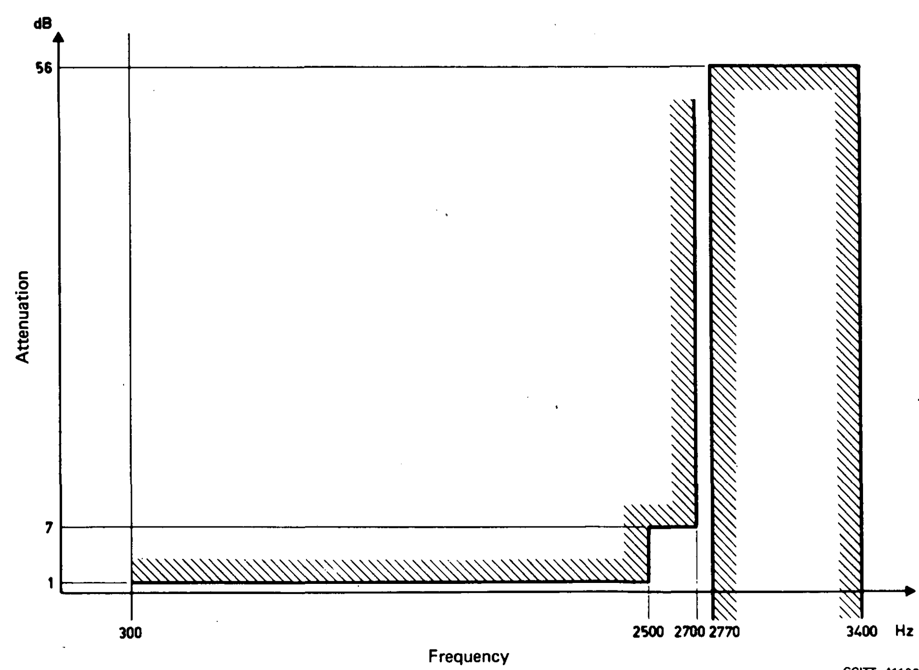


FIGURE 1/H.34

Limits for the attenuation characteristic of the separation filter at 2700 Hz

Note – This filter protects the telegraph channels from the signals transmitted on the main channel. The filters mentioned in Recommendation R.35 [8] for protection in the opposite direction can be relied on; when the secondary channel is used for other purposes, special precautions should be taken to protect the main channel.

When non-speech transmission is required in the main band, the peak-to-peak delay distortion of this filter should not exceed 0.15 ms over the range 1100 to 2300 Hz. The maximum absolute delay in the range 300-2300 Hz should not exceed 3 ms.

Sufficient protection of the main band from interference by the telegraph signals in the secondary band is assured by a similar filter at the receiving end. It is assumed that the telegraph channels are provided with filters so as to meet the provisions of Recommendations R.35 [8], R.37 [9] or R.38 A [10].

5 Levels

The general principle concerning levels for each type of service is that the allowable mean signal power is proportional to the bandwidth assigned.

Of the maximum permissible 1-minute mean loading of 50 μW0 (– 13 dBm0), 10 μW0 are allocated to the secondary band and the remaining 40 μW0 to the main band. In the case of telephony this implies that normal levels for speech and signalling can be retained (given in Recommendation G.223 [13] as 32 μW).

6 Limitation of amplitude

It may be desirable to impose a limit in the main band path so that the onset of nonlinearity in the common transmission path will not cause intermodulation and possible interference with the telegraph channels.

References

[1] CCITT Recommendation *General principles for the lease of international (continental and intercontinental) private leased telecommunication circuits*, Vol. II, Fascicle II.1, Rec. D.1, § 6.8.

[2] CCITT Recommendation *300 bits per second duplex modem standardized for use in the general switched telephone network*, Vol. VIII, Fascicle VIII.1, Rec. V.21.

[3] CCITT Recommendation *600/1200-baud modem standardized for use in the general switched telephone network*, Vol. VIII, Fascicle VIII.1, Rec. V.23.

[4] CCITT Recommendation *Parallel data transmission modems standardized for universal use in the general switched telephone network*, Green Book, Vol. VIII, Rec. V.30, ITU, Geneva, 1973.

[5] CCITT Recommendation *Standardization of phototelegraph apparatus*, Vol. VII, Fascicle VII.2, Rec. T.1.

[6] CCITT Recommendation *Standardization of Group 1 facsimile apparatus for document transmission*, Vol. VII, Fascicle VII.2, Rec. T.2.

[7] CCITT Recommendation *Transmission impairments*, Vol. III, Fascicle III.1, Rec. G.113.

[8] CCITT Recommendation *Standardization of FMVFT systems for a modulation rate of 50 bauds*, Vol. VII, Fascicle VII.1, Rec. R.35.

[9] CCITT Recommendation *Standardization of FMVFT systems for a modulation rate of 100 bauds*, Vol. VII, Fascicle VII.1, Rec. R.37.

[10] CCITT Recommendation *Standardization of FMVFT systems for a modulation rate of 200 bauds with channels spaced at 480 Hz*, Vol. VII, Fascicle VII.1, Rec. R.38A.

[11] CCITT Recommendation *Numbering of international VFT channels*, Vol. VII, Fascicle VII.1, Rec. R.70 *bis*.

[12] CCITT Recommendation *16-channel terminal equipments*, Vol. III, Fascicle III.2, Rec. G.235.

[13] CCITT Recommendation *Assumptions for the calculation of noise on hypothetical reference circuits for telephony*, Vol. III, Fascicle III.2, Rec. G.223.

SECTION 4

TELEPHONE-TYPE CIRCUITS USED FOR FACSIMILE TELEGRAPHY

Recommendation H.41 [1)]

PHOTOTELEGRAPH TRANSMISSIONS ON TELEPHONE-TYPE CIRCUITS

Note – As far as carrier circuits are concerned, this Recommendation applies only to systems established on the basis of 12-channel groups; systems using 16-channel groups will form the subject of a later study.

When carrier circuits are used, frequency modulation offers advantages over amplitude modulation in that it does not overload carrier systems and avoids the influence of sudden level variations or noise. It is therefore to be preferred. The provisions of Recommendation T.1 [2] should be applied.

For these reasons, the CCITT

unanimously recommends

that phototelegraph transmissions over telephone circuits require that the following conditions be observed, according to the way in which the circuits are used for phototelegraphy:

1 Circuits permanently used for phototelegraphy (formerly Part A)

It seems that these circuits are few. In any case, they should even more easily meet the characteristics given in § 2 below.

2 Circuits used normally (and preferentially) for phototelegraphy (formerly Part B)

2.1 *Types of circuit to be used*

Two-wire circuits have no practical value for phototelegraphy because of feedback phenomena.

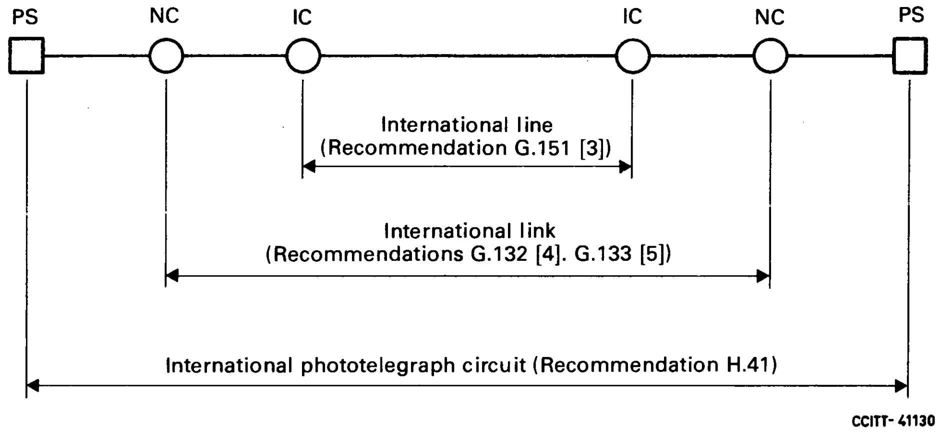
For the same reason, 4-wire circuits should be extended to the phototelegraph stations at the appropriate amplifier stations, the terminating units and echo suppressors always being disconnected.

The constitution of a phototelegraph circuit is given in Figure 1/H.41.

2.2 *Overall loss*

The same conditions apply to the overall transmission loss of 4-wire circuits used for phototelegraphy as apply, in general, for telephony.

1) Recommendation H.41 corresponds to Recommendation T.11 [1].



IC Terminal international centre
NC Terminal national centre
PS Phototelegraph station

Note — The phototelegraph circuit is set up on lines according to the terminology used by Study Group IV in Recommendations M.1010 [6] and M.1015 [7].

FIGURE 1/H.41

Constitution of a phototelegraph circuit

2.3 *Sent signal power*

The emission voltage for the phototelegraph signal corresponding to maximum amplitude should be so adjusted that the maximum power level of the signal at the zero relative level point is −13 dBm0 for frequency-modulation phototelegraph transmissions and that the peak signal power level for amplitude-modulation phototelegraph transmissions in principle should be −3 dBm0. In the case of amplitude modulation, the level of the signal corresponding to black is usually about 30 dB lower than that of the signal corresponding to white.

2.4 *Relative levels*

If phototelegraph transmissions take place simultaneously from a transmitting station to several receiving stations, arrangements shall be made at the junction point so that, on the circuits following the junction point, the same power levels are maintained as those prescribed for individual transmissions.

2.5 *Attenuation/frequency distortion*

The limits for attenuation/frequency distortion on international circuits used for phototelegraphy are given in Recommendation G.151 [3] concerning telephone circuits. The attenuation/frequency distortion between two terminal national centres shall therefore not exceed the limits indicated in Recommendation G.132 [4] and it will not normally be necessary to compensate the distortion of the lines linking the phototelegraph stations to the terminal national centres in order to obtain, for amplitude-modulated phototelegraph transmission, an attenuation/frequency distortion between phototelegraph stations of less than 8.7 dB in the wanted band.

2.6 *Variation of circuit overall loss with time* [2), 3)]

2.6.1 The objective is that:

2.6.1.1 the difference between the mean value and the nominal of the transmission loss value should not exceed 0.5 dB;

2.6.1.2 the standard deviation from the mean value should not exceed 1 dB.

However, in the case of circuits set up wholly or partly on older equipment, where the international line consists of two or more circuit sections, a standard deviation not exceeding 1.5 dB may be accepted.

2) See Recommendation M.160 [8] and [9].

3) The provisions specified under § 2.6 are provisional and need further study from the facsimile transmission point of view.

2.6.2 The method for achieving the above objective values is left to the discretion of Administrations (better maintenance, fitting of automatic regulators, etc.).

2.6.3 The assumption is made that these limits for the variation of loss with time of a single circuit may be compared to limits for loss measurements made on a set of circuits at a given time. Experience indicates that such a comparison has a practical validity although it has not been fully demonstrated at this time. Administrations are encouraged to use this Recommendation as giving currently practical limits for sets of circuits. This does not preclude the application of these limits to single circuits, should this prove practical at any time.

2.7 *Phase distortion*

Phase distortion limits the range of satisfactory phototelegraph transmissions. Differences between the group delays of a telephone circuit, in the interval of the phototelegraph transmission, should not exceed

$$\Delta t \leqslant \frac{1}{2f_p}$$

f_p = maximum modulating frequency corresponding to the definition and scanning speed. (See Recommendation H.42.)

2.8 *Interference*

Interfering currents, whatever their nature, should not exceed the CCITT recommended limits for telephone circuits.

3 Telephone circuits rarely used for phototelegraphy (formerly Part C)

3.1 *Transmission characteristics*

It seems that the majority of the characteristics specified by the CCITT for modern telephone circuits are sufficient to permit phototelegraph transmissions on a circuit chosen at random in a group of circuits normally used for telephone working. However, it is not certain that such a circuit would have a sufficiently low phase distortion for such use, particularly channels 1 and 12 of a 12-circuit group, use of which is not advised. The influence of phase distortion is more noticeable in frequency modulation.

With amplitude modulation there is a further risk that phototelegraph transmissions will be subject to faulty modulation because the special precautions applied to circuits regularly used for phototelegraphy (see § 2.6 above) cannot be applied to circuits taken at random.

3.2 *Precautions concerning signalling*

As long as automatic switching for phototelegraph circuits is not envisaged, the signal receiver can be disconnected so that no signalling disturbances can occur even when frequency modulation is used. However, if frequency modulation is used for phototelegraph transmission and if it is impracticable to disconnect the signal receiver, then it would be desirable, in the case of the single-frequency system, that a blocking signal be transmitted along with the picture signal to operate the guard circuit and render the receiver inoperative.

It is also apparent that the frequency of such a blocking signal should lie well outside the range of frequencies involved in the picture transmission and the frequency and the level of the blocking signal must depend on the characteristics of the VF receiver (or receivers in the case of a tandem international connection), as designed by different Administrations to meet the specification to be prescribed for international signalling.

In the case of the two-frequency international signalling system, the CCITT has indicated its view that no interference will take place.

References

[1] CCITT Recommendation *Phototelegraph transmission on telephone-type circuits*, Vol. VII, Fascicle VII.2, Rec. T.11.

[2] CCITT Recommendation *Standardization of phototelegraph apparatus*, Vol. VII, Fascicle VII.2, Rec. T.1.

[3] CCITT Recommendation *General performance objectives applicable to all modern international circuits and national extension circuits*, Vol. III, Fascicle III.1, Rec. G.151.

[4] CCITT Recommendation *Attenuation distortion*, Vol. III, Fascicle III.1, Rec. G.132.

[5] CCITT Recommendation *Group-delay distortion*, Vol. III, Fascicle III.1, Rec. G.133.

[6] CCITT Recommendation *Constitution and nomenclature of international leased circuits*, Vol. IV, Fascicle IV.2, Rec. M.1010.

[7] CCITT Recommendation *Types of transmission on leased circuits*, Vol. IV, Fascicle IV.2, Rec. M.1015.

[8] CCITT Recommendation *Stability of transmission*, Vol. IV, Fascicle IV.1, Rec. M.160.

[9] *Statistical theory requirements*, Green Book, Vol. IV.2, Supplement No. 1.6, ITU, Geneva, 1973.

Recommendation H.42

RANGE OF PHOTOTELEGRAPH TRANSMISSIONS ON A TELEPHONE-TYPE CIRCUIT

Note – In case of carrier circuits, this Recommendation applies only to systems established on the basis of 12-channel group links. Systems using 16-channel group links will be the subject of subsequent study.

(a) The differences between the group delays of the various frequencies and the width of the transmission band actually usable on a circuit for telephony give rise, when phototelegraph signals are started or stopped, to transient phenomena which limit the phototelegraph transmission speed.

(b) The range of phototelegraph calls of satisfactory quality, for a given transmission speed, depends especially on the constitution of the circuit, i.e. on:

- the loading and length, in the case of audio-frequency circuits;
- the number of 12-channel group links used in the case of carrier circuits, and on the choice of the carrier frequency for amplitude-modulated phototelegraph transmission, or on the mean frequency in the case of frequency modulation.

(c) Phototelegraph transmission of satisfactory quality requires that the limits of difference between the group delays in the transmitted frequency band, as shown in Figure 1/H.42, are not to be exceeded.

Note – The spot is assumed to have the same dimensions in both directions (square or circular).

(d) The CCITT has recommended group-delay distortion limits for international telephone circuits (see Recommendation G.133 [1]).

For these reasons, the CCITT

unanimously recommends

that, as regards the effect of phase distortion on phototelegraph transmission quality, the carrier frequency (where amplitude modulation is used) or the mean frequency (when frequency modulation is used) must be chosen in such a way that it is as near as possible to the frequency which has the minimum group delay on the telephone circuit.

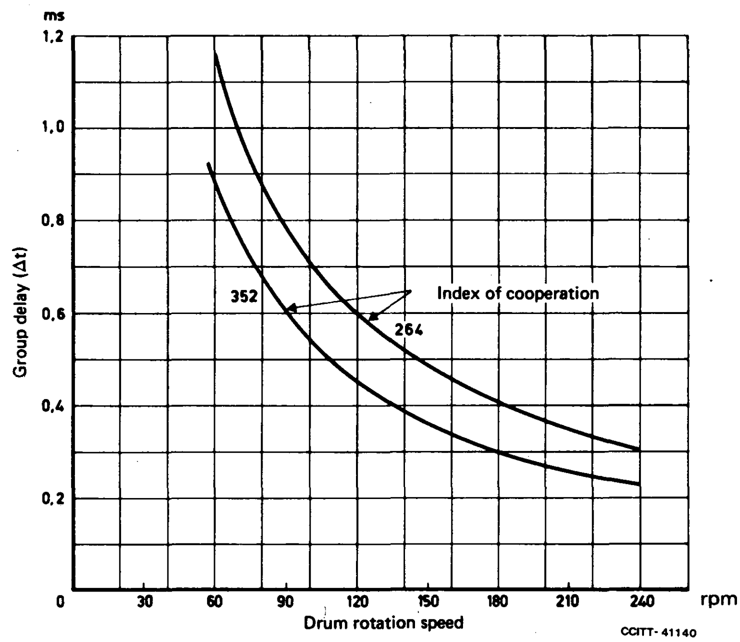


FIGURE 1/H.42

Permissible group-delay distortion in the transmitted frequency band as a function of the phototelegraph transmission speed

1 Circuits permanently used for phototelegraphy (formerly Part A)

1.1 It will generally be possible, by agreement between Administrations, to choose a circuit satisfying stricter limits than those specified above from the point of view of phase distortion.

1.2 Moreover, it will be possible to compensate phase distortions by inserting phase equalizers and to effect phototelegraph transmissions occupying the whole nominal band of the circuit.

2 Circuits normally (or preferentially) used for phototelegraphy (formerly Part B)

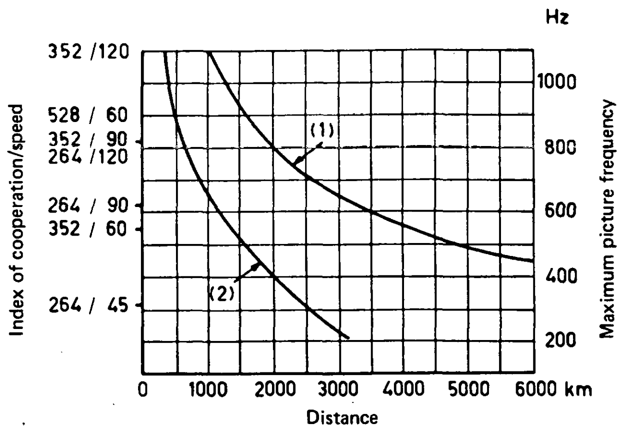
2.1 The greater the differences between the delays in the transmission intervals, the narrower should be the bandwidth chosen (leading to a lower phototelegraph definition or transmission speed).

2.2 Hence, audio-frequency circuits should in any case have only small loads.

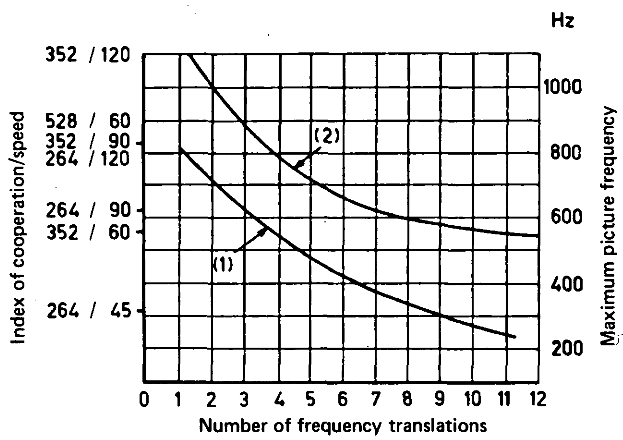
2.3 Phase distortion is well within the limits indicated above, in the case of carrier circuits, if a single modern-type carrier system is considered (and considering especially the telephone channels in the middle of a 12-channel group of such a system).

2.4 Nevertheless, it would be unjustifiable from the financial point of view to make the aforementioned recommendation concerning phase distortion stricter, simply with a view to the occasional use of only a few circuits for high-speed phototelegraph transmissions.

2.5 The curves of Figure 2/H.42 give information on the relative performances of amplitude- and frequency-modulated phototelegraph transmissions over audio-frequency and carrier telephone circuits.



a) *Audio circuits*



b) *Carrier circuits*

Curves (1) – AM carrier = 1300 Hz

Curves (2) – { FM = 1900 ± 400 Hz; AM carrier = 1900 Hz }

FIGURE 2/H.42

Range of phototelegraph transmissions

3 Telephone circuits rarely used for phototelegraphy (formerly Part C)

If phototelegraph connections are set up on circuits selected at random from modern-type groups of telephone circuits (for example, by automatic switching), a circuit may be taken which has too high a degree of phase distortion, particularly if it has been set up on channel 1 or 12 of a 12-channel group, the use of which is deprecated. It is impossible, in this case, to draw up general information on the range of phototelegraph transmissions; however, it will be possible to meet the conditions for a transmission of adequate quality if the phototelegraph connection comprises only one 12-channel group link and if transmission is effected in normal conditions as outlined in Recommendation T.1 [2].

References

[1] CCITT Recommendation *Group-delay distortion*, Vol. III, Fascicle III.1, Rec. G.133.

[2] CCITT Recommendation *Standardization of phototelegraph apparatus*, Vol. VII, Fascicle VII.2, Rec. T.1.

Recommendation H.43 [1)]

DOCUMENT FACSIMILE TRANSMISSIONS ON LEASED TELEPHONE-TYPE CIRCUITS

(Geneva, 1964, amended at Mar del Plata, 1968, and at Geneva, 1972, 1976 and 1980)

1 Type of circuits to be used

The telephone-type circuits used should have characteristics as recommended in Recommendation H.12.

Note – If the leased circuit is used alternately for telephone conversation and facsimile transmission and if the latter is unidirectional, it is not necessary to provide for disabling echo suppressors located on the long-distance leased circuit. However, when such a circuit is used for the simultaneous operation in both directions, appropriate measures should be taken to disable echo suppressors before the actual facsimile transmission takes place.

2 Modulation

Equipment conforming to Recommendation T.2 [2] or Recommendation T.3 [3] may be used. In the case of Recommendation T.2 [2] equipment, either amplitude or frequency modulation may be chosen.

3 Power

The maximum power output of the transmitting apparatus into the line shall not exceed 1 mW whatever the frequency.

For frequency modulation equipment conforming to Recommendation T.2 [2] the level at the transmitter output shall be so adjusted that the level of the facsimile and control signals on the trunk circuit does not exceed −13 dBm0 regardless of the type of operation (duplex or simplex).

For amplitude modulation equipment conforming to Recommendation T.2 [2], higher black levels may be used provided the mean power in any hour, in one direction of transmission, does not exceed 32 μW (−15 dBm0) at a zero relative level point of the trunk circuit.

For equipment conforming to Recommendation T.3 [3], higher white levels may be used provided the mean power in any hour, in one direction of transmission, does not exceed 32 μW (−15 dBm0) at a zero relative level point of the trunk circuit.

4 Multipoint transmission

If facsimile transmissions take place simultaneously from a transmitting station to several receiving stations, arrangements shall be made at the junction points so that, on the circuits following the junction points, the same power levels are maintained as those prescribed for individual transmissions.

1) Recommendation H.43 corresponds to Recommendation T.10 [1].

5 Phase distortion

Equipment conforming to Recommendation T.2 [2] should not require any special treatment. However, equipment conforming to Recommendation T.3 [3] may require phase distortion correction in some cases.

References

[1] CCITT Recommendation *Document facsimile transmission on leased telephone-type circuits*, Vol. VII, Fascicle VII.2, Rec. T.10.

[2] CCITT Recommendation *Standardization of Group 1 facsimile apparatus for document transmission*, Vol. VII, Fascicle VII.2, Rec. T.2.

[3] CCITT Recommendation *Standardization of Group 2 facsimile apparatus for document transmission*, Vol. VII, Fascicle VII.2, Rec. T.3.

SECTION 5

CHARACTERISTICS OF DATA SIGNALS

Recommendation H.51 [1)]

POWER LEVELS FOR DATA TRANSMISSION OVER TELEPHONE LINES

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

The objectives in specifying data signal levels are as follows:

a) To ensure satisfactory transmission and to permit coordination with devices such as signalling receivers or echo suppressors, the data signal levels on international circuits should be controlled as closely as possible.

b) To ensure correct performance of multichannel carrier systems from the point of view of loading and noise, the mean power of data circuits should not differ much from the conventional value of channel loading (−15 dBm0 for each direction of transmission, see Note below). This conventional value makes allowance for a reasonable proportion *P* (dependent on the transmission systems and probably less than 50%; the value will have to be specified in subsequent studies) of the channels in a multichannel system being used for non-speech applications at fixed power levels at about −13 dBm0 for each direction of transmission.

   If the proportion of non-speech applications (including data) does not exceed the above value *P*, the mean power of −13 dBm0 for each direction of transmission would be allowable for data transmission also.

   However, assuming that the proportion of non-speech circuits is appreciably higher than *P* (due to the development of data transmission) on international carrier systems, a reduction of this power by 2 dB might be reasonable. (These values require further study).

   Note – The distribution of long-term mean power among the channels in a multichannel carrier telephone system (conventional mean value of −15 dBm0), probably has a standard deviation in the neighbourhood of 4 dB (see [2]).

c) It is probable that Administrations will wish to fix specific values for the signal power level of data modulators either at the subscribers' line terminals or at the local exchanges. The relation between these values and the power levels on international circuits depends on the particular national transmission plan; in any case, a wide range of losses among the possible connections between the subscriber and the input to international circuits must be expected.

d) Considerations a) to c) suggest that specification of the maximum data signal level only is not the most useful form. One alternative proposal would be to specify the nominal power at the input to the international circuit. The nominal power would be the statistically estimated mean power obtained from measurement on many data transmission circuits.

1) Recommendation H.51 corresponds to Recommendation V.2 [1].

For these reasons, the CCITT

unanimously recommends:

1 Data transmission over leased telephone-type circuits set up on carrier systems (formerly Part A)

1.1 The maximum power output of the subscriber's apparatus into the line shall not exceed 1 mW.

1.2 For systems transmitting tones continuously, e.g. frequency modulation systems, the maximum power level at the zero relative level point shall be −13 dBm0. When transmission of data is discontinued for any appreciable time, the power level should preferably be reduced to −20 dBm0 or lower.

1.3 For systems not transmitting tones continuously, e.g. amplitude-modulation systems, the signal characteristics *should meet all of the following requirements*:

i) The maximum value of the 1-minute mean power shall not exceed −13 dBm0.

ii) Provisionally, the maximum value of the instantaneous power shall not exceed a level corresponding to that of a sine wave signal of 0 dBm0. This limit should be confirmed or amended after further study.

iii) Provisionally, the maximum signal power determined for a 10-Hz bandwidth centred at any frequency shall not exceed −10 dBm0. This limit should be confirmed or amended after further study.

Note 1 – It is estimated that the proportion of international circuits which are carrying data transmissions is approximately 20%. If the proportion should reach a high level (approximately 50% or even less in the case of high-usage systems), the limits now proposed would need to be reconsidered.

Note 2 – Supplement No. 16 gives information on the out-of-band power of signals applied to leased telephone-type circuits.

2 Data transmission over the switched telephone network (formerly Part B)

2.1 The maximum power output of the subscriber's equipment into the line shall not exceed 1 mW at any frequency.

2.2 For systems transmitting tones continuously, such as frequency- or phase-modulation systems, the output power level of the subscriber's equipment should be fixed at the time of installation to allow for loss between his equipment and the point of entry to an international circuit, so that the corresponding nominal level of the signal at the international circuit input shall not exceed −13 dBm0.

2.3 For systems not transmitting tones continuously, e.g., amplitude-modulation systems, the signal characteristics *should meet all of the following requirements* (see also Note 1 to § 1.3):

i) The maximum value of the 1-minute mean power shall not exceed −13 dBm0.

ii) Provisionally, the maximum value of the instantaneous power shall not exceed a level corresponding to that of a sinewave signal of 0 dBm0. This limit should be confirmed or amended after further study.

iii) Provisionally, the maximum signal power determined for a 10-Hz bandwidth centred at any frequency shall not exceed −10 dBm0. This limit should be confirmed or amended after further study.

Note 1 – In practice, it is no easy matter to assess the loss between a subscriber's equipment and the international circuit, so that § 2 of the present Recommendation should be taken as providing general planning guidance.

Note 2 – In switched connections, the loss between subscribers' telephones may be high: 30 to 40 dB. The level of the signals received will then be very low, and these signals may suffer disturbance from, for example, the dialling pulses sent over other circuits.

If there is likely to be a heavy demand for international connections for data transmission over the switched network, some Administrations might want to provide special 4-wire subscriber lines. If so, the levels to be used might be those proposed for leased circuits.

References

[1] CCITT Recommendation *Power levels for data transmission over telephone lines*, Vol. VIII, Fascicle VIII.1, Rec. V.2.

[2] *Measurement of the load of telephone circuits*, Green Book, Vol. III-2, Supplement No. 5, ITU, Geneva, 1973.

Recommendation H.52

TRANSMISSION OF WIDE-SPECTRUM SIGNALS (DATA, FACSIMILE, ETC.) ON WIDEBAND GROUP LINKS

(Mar del Plata, 1968; amended at Geneva, 1972, 1976 and 1980)

Links meeting the provisions of Recommendation H.14 should be used.

1 Power level

1.1 The mean power level of the wideband signal over the range 60-108 kHz should not exceed $-15 + 10 \log_{10} 12 = -4$ dBm0.

1.2 In order to limit cross-modulation effects in wideband systems, the power level of any individual spectral component in the band 60-108 kHz should not exceed -10 dBm0 except for spectral components which are at multiples of 4 kHz (see the Recommendation cited in [1]).

With regard to its effect on non-telephone type signals, a discrete component is defined as a signal of sinusoidal form with a minimum duration of about 100 ms.

1.3 To protect the group or supergroup link pilots (used to establish wideband circuits) against other wide-spectrum signals (data, facsimile, etc.), it is recommended that the power spectrum emitted about the pilot frequency be limited in the equipment which transmits these signals (see Figure 1/H.52).

For continuous spectrum signals, the spectral density in the band $f_0 \pm 25$ Hz should not exceed -70 dBm0/Hz.

Other indications are given in the Recommendation cited in [2].

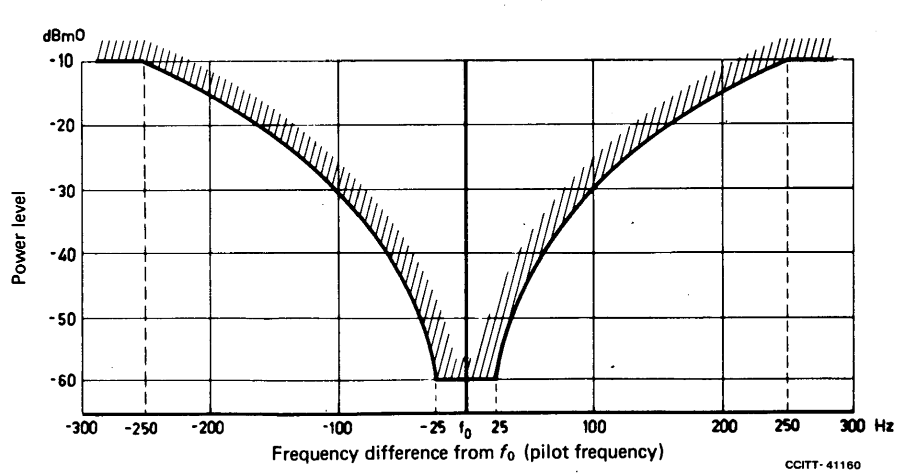


FIGURE 1/H.52

Maximum permissible level of discrete frequency components of wide-spectrum signals (group and supergroup signals) in the vicinity of group and supergroup pilot frequencies

2 Limitation of the power spectrum outside the band 60-108 kHz

The power level produced by the terminal equipment connected to the wideband group link shall not exceed -73 dBm0p in any 4-kHz band outside the range 60-108 kHz.

However, for the frequencies 48 and 56 kHz, with a precision of $\pm$ 1 Hz, an unweighted value of -50 dBm0 is permitted.

If the terminal equipment itself does not meet these conditions (e.g. a modem which just complies with the provisions of Recommendation V.35 [3]), an additional filter must be applied before the point of connection to the leased group link.

References

[1] CCITT Recommendation *Overall recommendations relating to carrier-transmission systems,* Vol. III, Fascicle III.2, Rec. G.221, § 2.2.

[2] CCITT Recommendation *Pilots on groups, supergroups, etc.*, Vol. III, Fascicle III.2, Rec. G.241, § 7.

[3] CCITT Recommendation *Data transmission at 48 kilobits per second using 60-108 kHz group band circuits,* Vol. VIII, Fascicle VIII.1, Rec. V.35.

Recommendation H.53

TRANSMISSION OF WIDE-SPECTRUM SIGNALS (DATA, ETC.) OVER WIDEBAND SUPERGROUP LINKS

(Mar del Plata, 1968; amended at Geneva, 1972, 1976 and 1980)

Links meeting the provisions of Recommendation H.15 should be used.

1 Power level

1.1 The mean power level of the wideband signal over the range 312-552 kHz should not exceed $-15 + 10 \log_{10} 60 = +3$ dBm0.

1.2 In order to limit cross-modulation effects in wideband systems, the power level of any individual spectral component in the band 312-552 kHz should not exceed -10 dBm0, except for spectral components which are at multiples of 4 kHz, (see the Recommendation cited in [1]).

With regard to its effect on non-telephone type signals, a discrete component is defined as a signal of sinusoidal form with a minimum duration of about 100 ms.

1.3 In addition to § 1.2 above, the energy spectrum transmitted in the neighbourhood of the pilot frequencies should be limited in accordance with the Recommendation cited in [2].

2 Limitation of the power spectrum outside the band 312-552 kHz

The power level produced by the terminal equipment connected to the wideband supergroup link shall not exceed -73 dBm0p in any 4-kHz band outside the range 304-560 kHz.

If the terminal equipment itself does not meet these conditions, an additional filter must be applied before the point of connection to the leased supergroup link.

References

[1] CCITT Recommendation *Overall recommendations relating to carrier-transmission systems,* Vol. III, Fascicle III.2, Rec. G.221, § 2.2.

[2] CCITT Recommendation *Pilots on groups, supergroups, etc.*, Vol. III, Fascicle III.2, Rec. G.241, § 7.

SECTION 6

CHARACTERISTICS OF VISUAL TELEPHONE SYSTEMS

Recommendation H.61

VISUAL TELEPHONE SYSTEMS

(Geneva, 1980)

1 Definition of visual telephone service

The visual telephone service is generally a bidirectional telecommunication service which uses a switched network of broadband analogue and/or digital circuits to establish connections among subscriber terminals, primarily for the purpose of transmitting live or static pictures.

Special application unidirectional systems, e.g. surveillance and some information retrieval systems, or a nonswitched videoconference service, can be regarded as degenerate cases of the visual telephone service.

The visual telephone service also includes the associated speech.

2 Facilities to be offered

The design of the visual telephone service shall be such as to offer at least the following basic facilities:

a) transmission of live pictures, such as head and shoulders of one person or a small group of persons, with moderate definition;

b) transmission of the associated speech;

c) transmission of graphic information such as drawings and documents with high definition (e.g. 625 lines or 525 lines);

d) video conference service, with or without the use of split-screen techniques.

The above-mentioned facilities shall, in general, be bi-directional, although unidirectional operation should be possible. Also, some of the facilities can be omitted if not required, in order to minimize costs.

Note 1 – For the moment, the visual telephone service will be in black and white. The possibility of adding colour is, however, a desired feature.

Note 2 – At the subscriber terminal the use of ancillary equipments, e.g. for document reproduction, video tape recordings, etc. shall be possible.

3 System parameters

3.1 *Picture standards*

3.1.1 The video standards of the subscriber sets shall be compatible with, readily convertible to, or identical to, the local broadcast television standards.

3.1.2 Two classes of picture standards are recommended for the visual telephone system. They are given in Table 1/H.61.

TABLE 1/H.61

Picture standards

Class	Items	Regions	
		Where TV broadcasting uses 25 pictures per second	Where TV broadcasting uses 30 pictures per second
a	Number of horizontal scanning lines	625	525
	Pictures per second	25 (2:1 interleaved)	30 (2:1 interleaved)
	Aspect ratio	4:3	4:3
	Video bandwidth	5 MHz	4 MHz
b	Number of horizontal scanning lines	313	263
	Pictures per second	25 (2:1 interleaved)	30 (2:1 interleaved)
	Aspect ratio	4:3	4:3
	Video bandwidth	1 MHz	1 MHz

Class *a* standards are identical to the local broadcast video standards and will, in most cases, give sufficient definition for real-time picture transmission of a group of people (e.g. for conferencing) and of graphic material.

Class *b* standards give sufficient definition for real-time transmission of a head-and shoulder picture of one person or a small group. For the transmission of graphic information or other still pictures with high definition, a slow-scan technique has to be applied, for instance, a system using 625 or 525 horizontal scanning lines and 5, or less, pictures per second which gives a Class *a* definition in the 1-MHz bandwidth. Further study is required to define slow scanning parameters.

Note 1 – Although the preferred bandwidth for long-distance transmission is 1 MHz, local transmission to and from the subscriber terminal may be of 1-MHz bandwidth or a higher bandwidth compatible with that of the local broadcast standard (or digital equivalents).

Note 2 – Studies of other systems are in progress and other compatible standards may emerge during the next Study Period.

4 Characteristics relating to split-screen techniques for 625-line television conference systems [1)]

In television conference systems which use split-screen techniques to make more effective use of the picture area, the following features for the terminals and transmitted signals are recommended. Preferred seating arrangements for such systems are given in Annex A. The line numbers quoted apply to 625-line television systems. All characteristics for other television standards are a matter for further study.

4.1 The entrance pupils of the TV camera optical system should be as near as possible to the centre of the TV display showing remote conferees, in order to minimize errors in eye contact angle.

Unless means are employed to place these pupils in line with the display, e.g. by use of half-silvered mirrors, the camera system should be sited above the display and central to it.

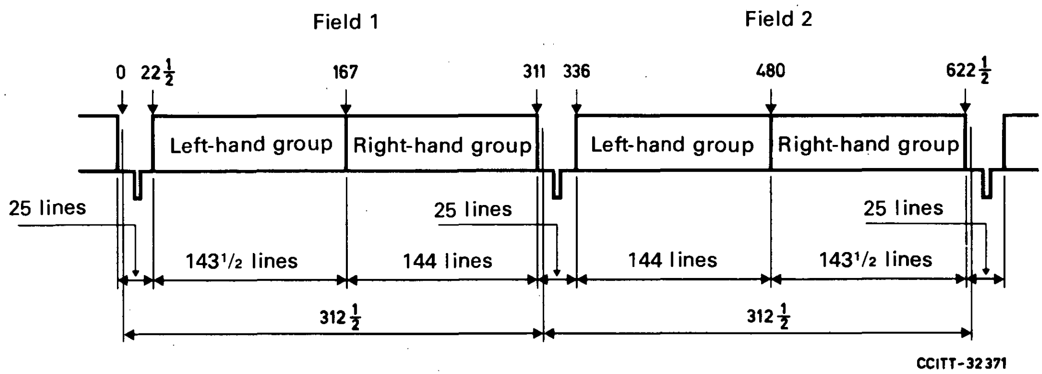
1) Split-screen techniques for systems using Class *b* standards require further study.

In order to keep the maximum horizontal errors as small as possible, the cameras used should be in a cross-fire system as for example in Figure A-1/H.61 and the camera/display assembly should be sited on the central axis of the terminal.

4.2 The transmitted picture should have a 4:3 aspect ratio, split into upper and lower halves corresponding to the groups of seats. Viewed from the camera systems, the left hand group should be in the upper half and the right hand group in the lower half.

The split should occur at the end of lines 166 and 479 as shown in Figure 1/H.61.

Before display, the receive equipment may discard half lines (e.g. line 23) and first and last lines (e.g. lines 24, 166, 167 and 310) which are liable to be averaged during standards conversion or vertical aperture correction of mixed signals.



Note 1 — Left-hand group: first complete lines: 24 and 336
last complete lines: 166 and 479.
Right-hand group: first complete lines: 167 and 480
last complete lines: 310 and 622.

Note 2 — Lines 16 to 20 inclusive and 329 to 333 inclusive may contain identification, control or test signals.

FIGURE 1/H.61

Vertical format of split-screen video signal

ANNEX A

(to Recommendation H.61)

Seating arrangements when applying split-screen techniques for class *a* system at 625 lines

referred arrangements for video conferences using split-screen techniques are:

1) The conference terminal accommodation should be for 6 primary seats in two adjacent groups of 3 as shown in Figure A-1/H.61. Provision for additional seating behind may be made, so long as allowance is made for the central gap between the two halves. For example, 4 additional persons may be seated in a second row as shown in Figure A-1/H.61.

2) The chairman's position should be in the centre of the left-hand group of seats (viewed from the camera) with user controls accessible from both this position and the one on the chairman's left. Consequently, when split-screen pictures are displayed, stacked as received (i.e. shown as 3 over 3), the chairman's position is standardized as top centre.

The suite of 3 chairs containing the chairman's position should also be regarded as the primary position for occasions when only half of a studio is in use. Such standardization is necessary for connection of 3 studios in conference using time division multiplex of pairs of TV signals to share a common trunk between two studios.

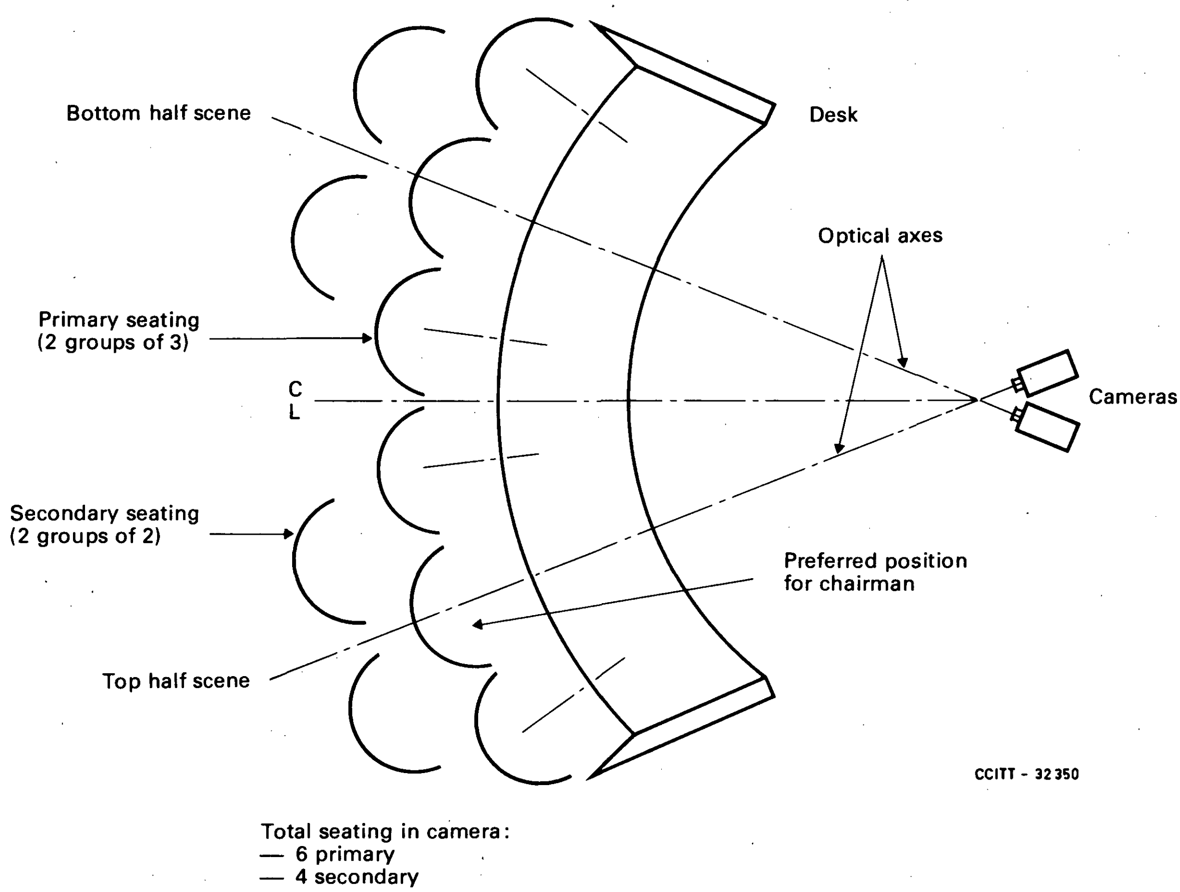


FIGURE A-1/H.61

Studio plan view

PART II

Series J Recommendations

SOUND-PROGRAMME AND TELEVISION TRANSMISSIONS

PAGE INTENTIONALLY LEFT BLANK

PAGE LAISSEE EN BLANC INTENTIONNELLEMENT

SECTION 1

GENERAL RECOMMENDATIONS CONCERNING SOUND-PROGRAMME TRANSMISSIONS

Recommendation J.11

HYPOTHETICAL REFERENCE CIRCUITS FOR SOUND-PROGRAMME TRANSMISSIONS [1), 2), 3)]

(Geneva, 1972; amended at Geneva, 1976)

Terrestrial systems and systems in the fixed-satellite service

The CCITT,

considering

(a) that there is a need to define a hypothetical reference circuit to enable design performance standards to be set;

(b) that the hypothetical reference circuit should allow the different types of sound-programme circuits to be compared on a common basis;

recommends

(1) that the hypothetical reference circuit for sound-programme transmissions over a terrestrial system (shown in Figure 1/J.11) which may be provided by either radio or cable, should be characterized principally by:

- the overall length between audio points (B and C) of 2500 km;
- two intermediate audio points (M and M′) dividing the circuit into three sections of equal length;
- the fact that the three sections are lined up individually and then interconnected without any form of overall adjustment or correction;

(2) that the hypothetical reference circuit for sound-programme transmissions over a system in the fixed-satellite service (shown in Figure 2/J.11) should be characterized principally by:

- one link, earth station – satellite – earth station,
- one pair of modulation and demodulation equipments for translation from baseband to radio frequency, and vice-versa.

---

1) Corresponding to CCIR Recommendation 502-1 [1].

2) The hypothetical reference circuits defined in this Recommendation are based on analogue systems. The application to digital systems is for study under Study Programme 18A/CMTT [2].

3) For maintenance purposes there may be a need to define other circuits of which an illustration is shown in the Annex A.

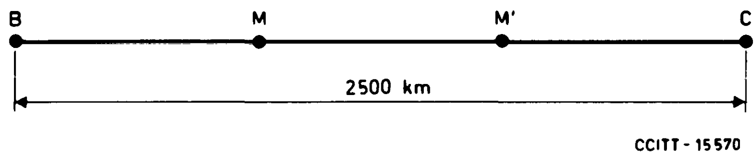


FIGURE 1/J.11

Hypothetical reference circuit for sound-programme transmissions over a terrestrial system

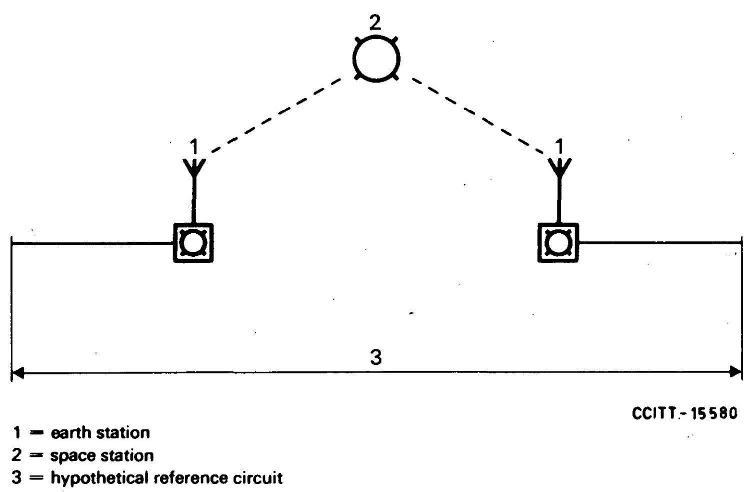


FIGURE 2/J.11

Hypothetical reference circuit for sound-programme transmissions over a system in the fixed-satellite service

ANNEX A

(to Recommendation J.11)

Illustration of an international sound-programme connection

Figure A-1/J.11 illustrates a typical international sound-programme connection in which:

- point A, to be considered as the sending end of the international sound-programme connection, may be the point at which the programme originates (studio or outside location);
- point D, to be considered as the receiving end of the international sound-programme connection, may be a programme-mixing or recording centre or a broadcasting station;
- the local sound-programme circuit AB connects point A to the sending terminal station, point B, of the international sound-programme circuit BC;
- the local sound-programme circuit CD connects point C, the receiving terminal station of the international sound-programme circuit BC, to the point D.

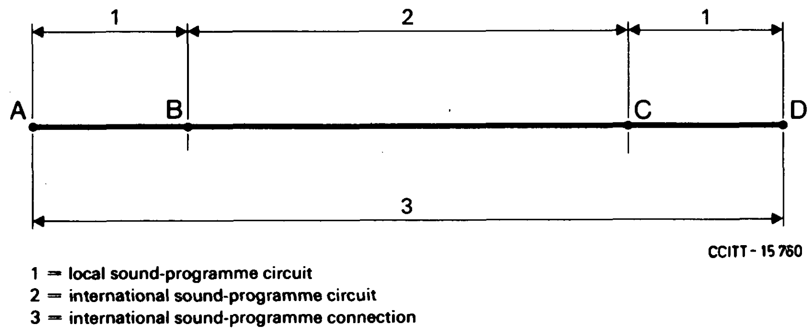


FIGURE A-1/J.11

An international sound-programme connection

The hypothetical reference circuit must not be considered identical to any of the sound-programme circuits illustrated in Figure A-1/J.11, or defined for maintenance purposes in Volume IV. However, some of these circuits may display the same structure as the hypothetical reference circuit. Such types of circuits are:

- an international sound-programme connection comprising three audio sections;
- a single sound-programme circuit made up of three audio sections.

In this case, the performance standards set for the hypothetical reference circuit may be applied to these circuits.

References

[1] CCIR Recommendation *Hypothetical reference circuits for sound-programme transmissions,* Vol. XII, Rec. 502-1, ITU, Geneva, 1978.

[2] CCIR Study Programme 18A/CMTT *Standards for the digital transmission of sound-programme signals,* Vol. XII, ITU, Geneva, 1978.

Recommendation J.12

TYPES OF SOUND-PROGRAMME CIRCUITS ESTABLISHED OVER THE INTERNATIONAL TELEPHONE NETWORK

(former Recommendation J.11; amended at Geneva, 1972 and 1980)

The CCITT recognizes the types of sound-programme circuits defined below.

Note – For the purposes of this Recommendation and other Recommendations in the Series J, sound-programme circuits have been classified in terms of the nominal effectively transmitted bandwidth. For convenience, the corresponding type of circuit from the administrative point of view (see Recommendation D.180 [1]) is given under each type of equipment in the following paragraphs.

1 15-kHz type sound-programme circuit

This type of circuit is recommended for high-quality monophonic programme transmission and in certain arrangements is also recommended for stereophonic transmissions. This type of circuit corresponds to the "very wideband circuit" or "stereophonic pair", as appropriate, referred to in Recommendation D.180 [1].

The performance characteristics of 15-kHz type sound-programme circuits suitable for both monophonic and stereophonic transmissions are defined in Recommendation J.21 and suitable methods of provision are given in Recommendation J.31.

2 10-kHz type sound-programme circuit

This type of circuit, previously known as the "normal programme circuit, type A", is recommended for monophonic transmission only. Originally regarded as suitable for high-quality transmissions, it may continue to be used for many years to come to provide a good quality of sound-programme transmission. This type of circuit corresponds to the "wideband circuit" referred to in Recommendation D.180 [1]. The performance characteristics of 10-kHz type sound-programme circuits are defined in Recommendation J.22 and suitable methods of provision are given in Recommendation J.32.

3 Narrow bandwidth sound-programme circuit (7, 6.4 and 5-kHz type sound-programme circuit)

These types of circuits are recommended:

- for setting up a large number of temporary sound-programme circuits for the transmission of commentaries and reports on events of large interest (e.g. sporting events); and
- for permanent sound-programme circuits which are used primarily for speech transmission or as connection between studio outputs and long-, medium- or short-wave broadcast-transmitter inputs.

The performance characteristics of narrow bandwidth sound-programme circuits are defined in Recommendation J.23, and methods of provision are given in Recommendations J.33 and J.34.

Note – These types of circuits fall within the category of "medium-band circuits" referred to in Recommendation D.180 [1] for tariff purposes.

4 Use of ordinary telephone circuits

For this type of transmission of special programmes such as speech, some operational aspects are given in Recommendation N.15 [2].

References

[1] CCITT Recommendation *International sound- and television-programme transmissions*, Vol. II, Fascicle II.1, Rec. D.180.

[2] CCITT Recommendation *Maximum permissible power during an international sound-programme transmission*, Vol. IV, Fascicle IV.3, Rec. N.15.

Recommendation J.13

DEFINITIONS FOR INTERNATIONAL SOUND-PROGRAMME CIRCUITS

(former Recommendation J.12; amended at Geneva, 1972 and 1980)

Definition of the constituent parts of an international sound-programme connection

The following definitions apply to international sound-programme transmissions.

1 international sound-programme transmission

The transmission of sound over the international telecommunication network for the purpose of interchanging sound-programme material between broadcasting organizations in different countries. Such a transmission includes all types of programme material normally transmitted by a sound broadcasting service, for example, speech, music, sound accompanying a television programme, etc.

2 broadcasting organization (send)

The broadcasting organization at the sending end of the sound programme being transmitted over the international sound-programme connection.

3 **broadcasting organization (receive)**

The broadcasting organization at the receiving end of the sound programme being transmitted over the international sound-programme connection.

4 **international sound-programme centre (ISPC)**

A centre at which at least one international sound-programme circuit terminates and in which international sound-programme connections can be made by the interconnection of international and national sound-programme circuits.

The ISPC is responsible for setting up and maintaining international sound-programme links and for the supervision of the transmissions made on them.

5 **international sound-programme connection**

5.1 The unidirectional path between the broadcasting organization (send) and the broadcasting organization (receive) comprising the international sound-programme link extended at its two ends over national sound-programme circuits to the broadcasting organizations (see Figure 2/J.13).

5.2 The assembly of the "international sound-programme link" and the national circuits between the broadcasting organizations, constitutes the "international sound-programme connection". Figure 3/J.13 illustrates, by way of example, an international sound-programme connection as it might be encountered in practice.

6 **international sound-programme link** (Figure 2/J.13)

The unidirectional path for sound-programme transmissions between the ISPCs of the two terminal countries involved in an international sound-programme transmission. The international sound-programme link comprises one or more international sound-programme circuits interconnected at intermediate ISPCs. It can also include national sound-programme circuits in transit countries.

7 **international sound-programme circuit** (Figure 1/J.13)

The unidirectional transmission path between two ISPCs and comprising one or more sound-programme circuit sections (national or international), together with any necessary audio equipment (amplifiers, compandors, etc.).

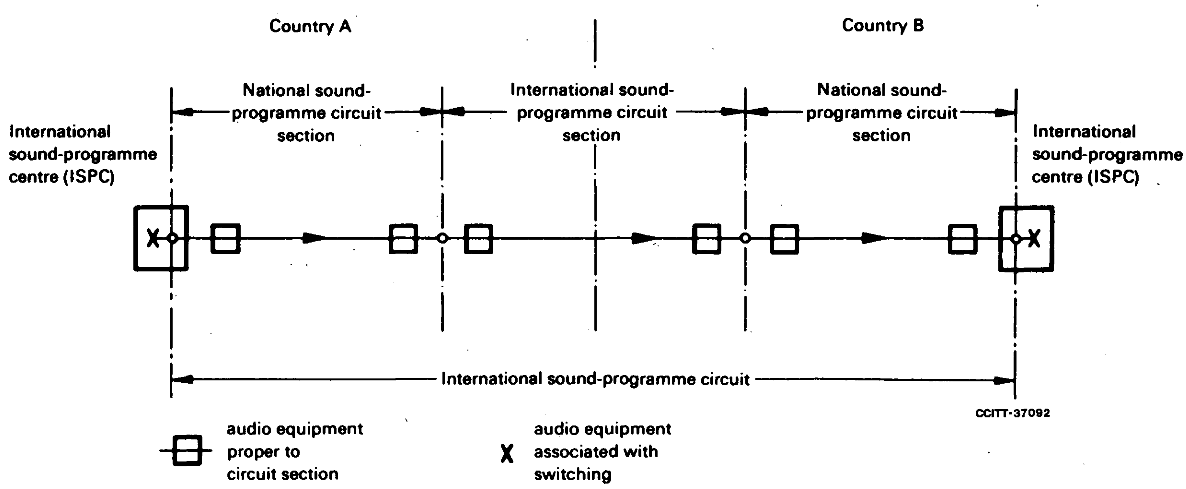


FIGURE 1/J.13

An international sound-programme circuit composed of two national and one international sound-programme circuit-section

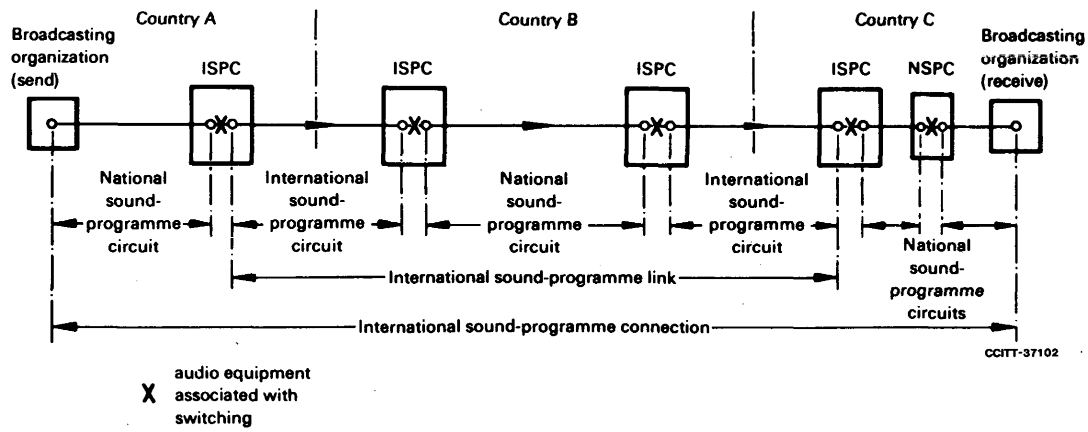
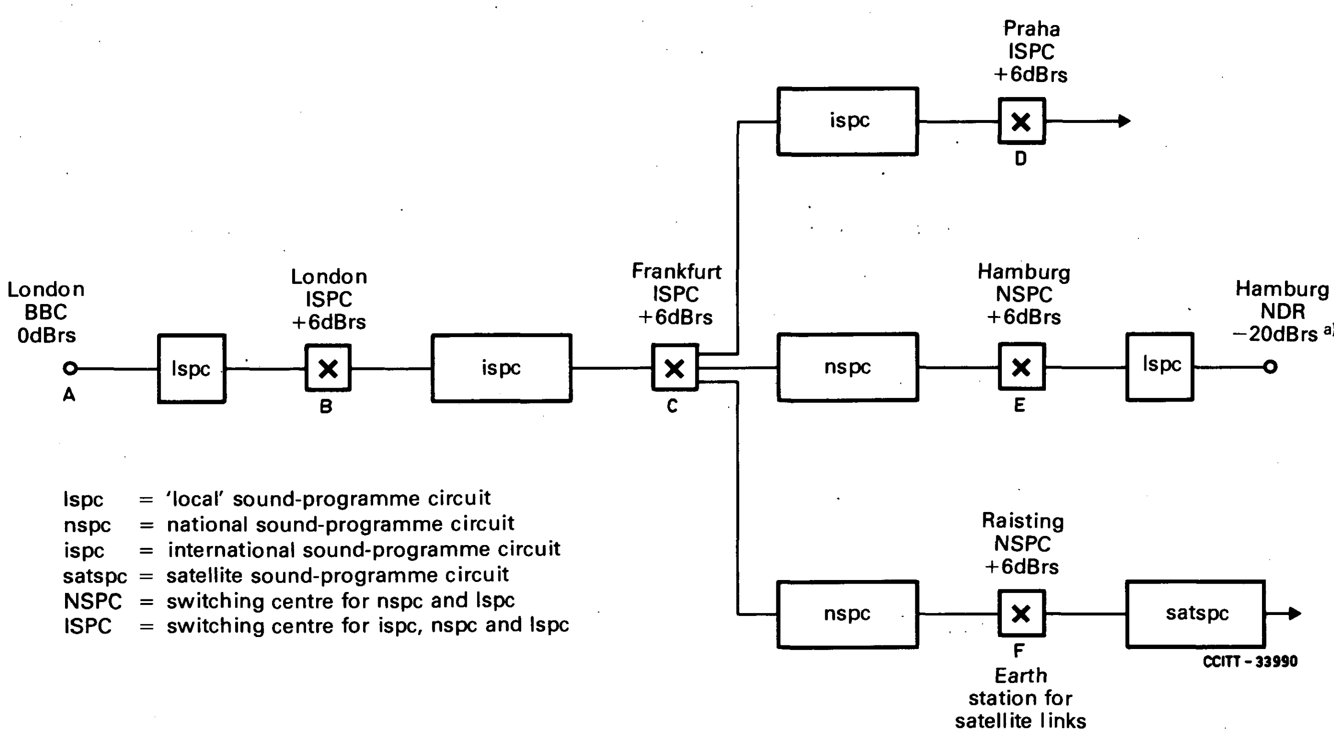


FIGURE 2/J.13

An international sound-programme link composed of international and national sound-programme circuits and extended on a national sound-programme circuit at each end to form an international sound-programme connection



Note – Maximum level of sound programme signals: +9dBm0s (this means +9dBms at a 0dBrs relative level point and +15dBms at a +6dBrs relative level point respectively). The value of +9dBms corresponds to a peak voltage of 3.1 V which is the maximum value of a sine-wave signal of 2.2 V r.m.s.

a) Other values can be chosen by the relevant Administration on a national basis.

FIGURE 3/J.13

Diagram of an international sound-programme circuit

8 sound-programme circuit-section (Figure 1/J.13)

Part of an international sound-programme circuit between two stations at which the programme is transmitted at audio frequencies.

The normal method of providing a sound-programme circuit section in the international network will be by the use of carrier sound-programme equipment. Exceptionally sound-programme circuit sections will be provided by other means, for example, by using amplified unloaded or lightly loaded screened-pair cables or by using the phantoms of symmetric-pair carrier cables.

9 national circuit

The national circuit connects the ISPC to the broadcasting authority; this applies both at the sending and at the receiving end. A national circuit may also interconnect two ISPCs within the same country.

10 effectively transmitted signals in sound-programme transmission

For sound-programme transmission, a signal at a particular frequency is said to be effectively transmitted if the nominal overall loss at that frequency does not exceed the nominal overall loss at 800 Hz by more than 4.3 dB. This should not be confused with the analogous definition concerning telephony circuits given in [1].

For sound-programme *circuits*, the overall loss (relative to that at 800 Hz) defining effectively transmitted frequency is 1.4 dB, i.e. about one-third of the allowance.

Reference

[1] CCITT Recommendation *General performance objectives applicable to all modern international circuits and national extension circuits*, Vol. III, Fascicle III.1, Rec. G.151, § 1, Note 1.

Recommendation J.14

RELATIVE LEVELS AND IMPEDANCES ON AN INTERNATIONAL SOUND-PROGRAMME CONNECTION

(former Recommendation J.13; amended at Geneva, 1972, 1976 and 1980)

1 Level adjustment on an international sound-programme connection

The CCITT recommends the use of the *constant voltage* method. If, to a zero relative level point of the international sound-programme connection, a zero absolute voltage level is applied (sine-wave signal of 0.775 volts r.m.s.) at one of the frequencies given in the maintenance instructions of Recommendation N.12 [1], the absolute voltage level at the output of the last amplifier of each sound-programme circuit (Points B, C, D . . . F of Figure 3/J.13) should be +6 dB (i.e. 1.55 volts r.m.s.) at 800 Hz, and should be within the given limits at other frequencies (see the appropriate Recommendations J.21, J.22, etc., for the limits applicable to the particular type of sound-programme circuit under consideration).

The zero relative level point is, in principle, the origin of the international sound-programme connection (Point A in Figure 3/J.13). Different conventions may be agreed between the telephone Administration and the broadcast organization within a country, provided that the levels on the international sound-programme link are unchanged.

A zero relative level point is, in principle, a point at which the sound-programme signals correspond exactly with those at the origin of the international sound-programme connection. At a point of zero relative levels, signals have been controlled in level by the broadcasting organization such that the peak levels very rarely exceed +9 dB relative to the peak values reached by a sine-wave signal of 0.775 volts r.m.s. (for a 600-ohm resistor load, when levels are expressed in terms of dBm).

2 Diagram of signal levels on an international sound-programme connection

The signal levels given below are expressed in terms of r.m.s. values of sine-wave signals with reference to 0.775 volts.

The voltage level diagram for an international sound-programme connection, however made up, should be such that the voltage levels shown are not such as to exceed the maximum undistorted power which an amplifier can deliver to a sound-programme link when a peak voltage (i.e. +9 dB) is applied to a zero relative level point on the international sound-programme connection.

With these conditions, +6 dB is the nominal voltage level at the output of the terminal amplifiers of the sound-programme circuits making up the international sound-programme link (Points B, C, D ... F of Figure 3/J.13).

The line amplifiers of the international sound-programme link should be capable of handling an upper voltage limit of at least +17 dB, when using the constant voltage method for lining-up.

From the statement above, that the voltage level at a zero relative level point can reach +9 dB, the relative level obtained at the output of an amplifier would be $+17 - 9 = +8$ dB. Assuming the maximum variation of this level with time to be ± 2 dB, a nominal relative level at the output of these amplifiers of $+8 - 2 = +6$ dB is obtained.

If a sound-programme circuit which is part of the international sound-programme link is set up on a group in a carrier system, the objective for a new design of equipment is that the relative level of the sound-programme circuit, with respect to the relative level of the telephone channel, should be chosen such that the mean value and the peak value of the load presented by the sound-programme channel should be no higher than that of the telephone channels which are replaced by the sound-programme channel. The effects of pre-emphasis and compandors should, where present, be taken into consideration.

It is recognized that this condition may not be observed in all cases, particularly in certain existing types of equipments. It is recommended that in those cases the zero relative level points of the sound-programme circuit and of the telephone channels should coincide.

It might be as well, however, if the equipment could, where possible, tolerate a maximum difference of ± 3 dB between the relative levels of the sound-programme and telephone transmissions, so that the best adjustment can be obtained, depending on any noise or intermodulation present, but at the same time observing the constraints imposed by the considerations on loading.

Note – The relative level at which the modulated sound-programme signal is applied to the group link is given in Recommendation J.31 for 15-kHz type circuits, and in the Annex to Recommendation J.22 for 10-kHz and 6.4-kHz type circuits when pre-emphasis is employed.

3 Definitions and abbreviations for new sound-programme signals

Definitions and symbols are in current use to define relative levels for telephony. However, additional definitions and symbols are necessary for the absolute and relative levels in respect of sound-programme signals. The corresponding definitions and symbols for telephony and sound-programme signals are given below.

3.1 dBm0 [1)]

The absolute (power) level, in decibels, referred to a point of zero relative level.

3.2 dBr [1)]

The relative (power) level, in decibels.

3.3 dBm0s

The absolute (power) level, in decibels, referred to a point of zero relative sound-programme level.

3.4 dBrs

The relative (power) level, in decibels, with respect to sound-programme signals. (This abbreviation is only applicable at points in a sound-programme circuit where the signals can nominally be related to the input by a simple scaling factor.)

---

1) These symbols traditionally relate to telephony relative levels.

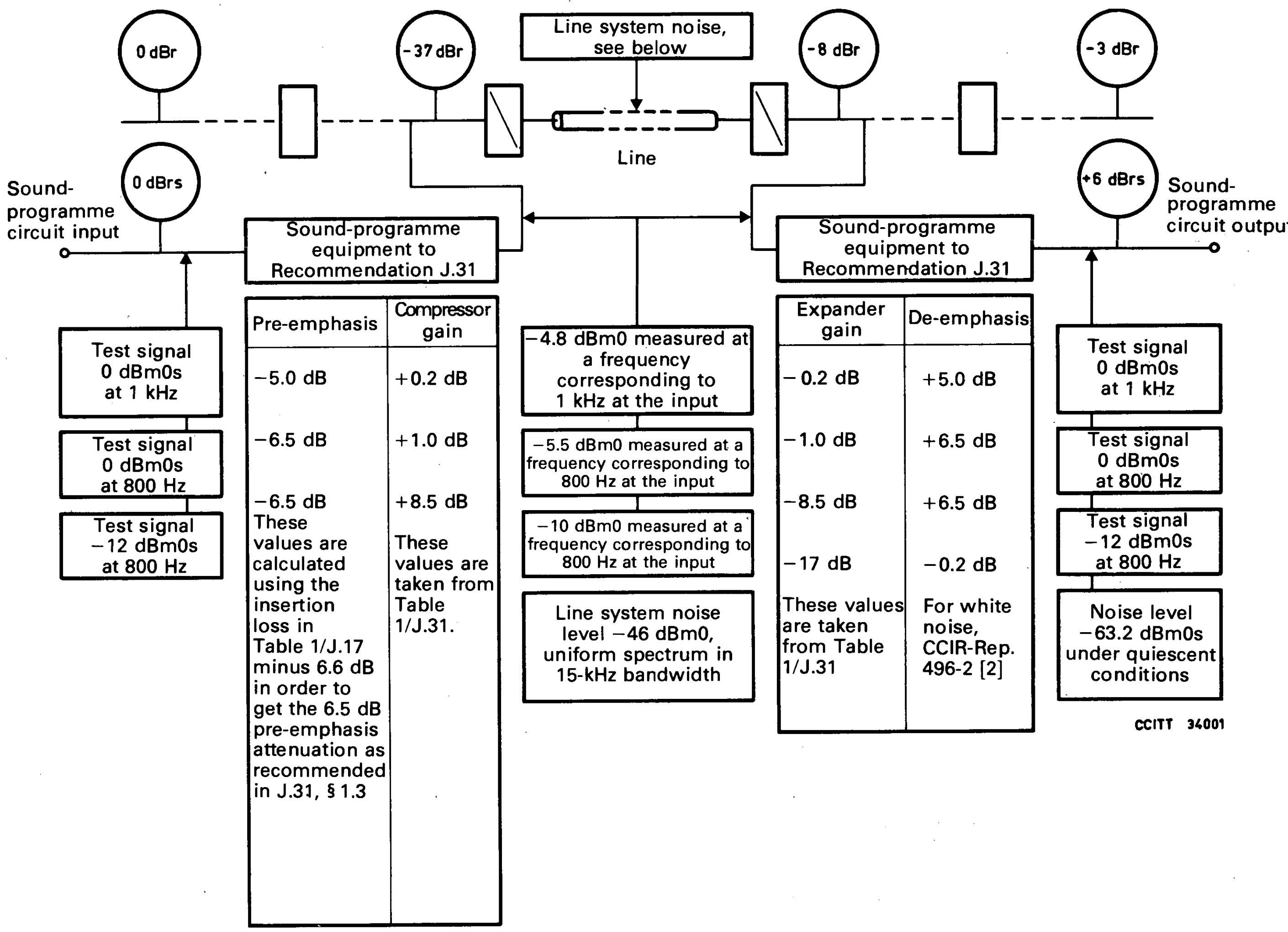


FIGURE 1/J.14

Example illustrating the use of the symbols dBm0, dBr, dBrs, dBm0s for a sound-programme transmission circuit set up on a group link using equipment conforming to Recommendation J.31

4 Examples of the use of symbols for levels of sound-programme signals

As an example, Figure 1/J.14 illustrates three different test conditions applied to equipment in conformance with Recommendation J.31, which includes pre-emphasis and compandors. It also shows how random noise, originating on the line system, can be expressed in relation to the sound-programme circuit under quiescent conditions.

References

[1] CCITT Recommendation *Measurements to be made during the line-up period that precedes a sound-programme transmission*, Vol. IV, Fascicle IV.3, Rec. N.12.

[2] CCIR Report *Circuits for high-quality monophonic and stereophonic transmission*, Vol. XII, Report 496-2, ITU, Geneva, 1978.

Recommendation J.15

LINING-UP AND MONITORING AN INTERNATIONAL SOUND-PROGRAMME CONNECTION

(former Recommendation J.14; amended at Geneva, 1972 and 1980)

To comply with the provisions of Recommendation J.14, the lining-up and monitoring of an international sound-programme connection should ensure that, during the programme transmission, the peak voltage at a zero relative level point will not exceed 3.1 volts, which is that of a sinusoidal signal having an r.m.s. value of 2.2 volts. The methods for achieving this condition as well as the relevant performance requirements are given in Recommendations N.10 to N.18 (see references [1] to [8]).

Some indication of the volume or of the peaks of the signals during programme transmission may be obtained by monitoring at the studio, in the repeater stations, or at the transmitter. One of the instruments, the characteristics of which are summarized in Table 1/J.15, may be used.

Since there is no simple relation between the readings given by two different instruments for all types of programme transmitted, it is desirable that the broadcast organization controlling the studio and the telephone Administration(s) controlling the sound-programme circuit should use the same type of instrument so that their observations are made on a similar basis.

In general the telephone Administration and the broadcast organization of a country agree to use the same type of instrument. It is desirable to reduce to a minimum the number of different types of instrument and to discourage the introduction of new types which only differ in detail from those already in service. The unified use of the peak indicator specified in reference [9] is under study.

During programme transmission, the signal level at the output of the last amplifier controlled by the sending broadcast organization (Point A of Figure 3/J.13) should be monitored to see that the meter deflection of the measuring instrument is always lower than the peak voltage for the overall line-up, allowance being made for the peak factor of the programme involved.

It should be remembered that the amplitude range from a symphony orchestra is of the order of 60 to 70 dB, while the specification for sound-programme circuits is based on a range of about 40 dB. Before being passed to the sound-programme circuit, therefore, the dynamic ratio of the studio output needs to be compressed.

TABLE 1/J.15

Principal characteristics of the various instruments used for monitoring the volume or peaks during telephone conversations or sound-programme transmission

Type of instrument	Rectifier characteristic (see Note 3)	Time to reach 99% of final reading (milliseconds)	Integration time (milliseconds) (see Note 4)	Time to return to zero (value and definition)
(1) "Speech voltmeter" UK Post Office type 3 (S.V.3) identical to the speech power meter of the ARAEN	2	230	100 (approx.)	equal to the integration time
(2) vu meter (United States of America) (see Note 1)	1.0 to 1.4	300	165 (approx.)	equal to the integration time
(3) Speech power meter of the "SFERT volume indicator"	2	around 400 to 650	200	equal to the integration time
(4) Peak indicator for sound-programme transmissions used by the British Broadcasting Corporation (BBC Peak Programme Meter) (see Note 2)	1		10 (see Note 5)	3 seconds for the pointer to fall 26 dB
(5) Maximum amplitude indicator used by the Federal Republic of Germany (type U 21)	1	around 80	5 (approx.)	1 or 2 seconds from 100% to 10% of the reading in the steady state
(6) OIRT – Programme level meter: type A sound meter type B sound meter		for both types: less than 300 ms for meters with pointer indication and less than 150 ms for meters with light indication	 10 ± 5 60 ± 10	for both types: 1.5 to 2 seconds from the 0 dB point which is at 30% of the length of the operational section of the scale
(7) E.B.U. standard peak programme meter (see Note 7)	1	–	10	2.8 seconds for the pointer to fall 24 dB

Note 1 – In France a meter similar to the one defined in line (2) of the table has been standardized.

Note 2 – In the Netherlands a meter (type NRU-ON301) similar to the one defined in line (4) of the table has been standardized.

Note 3 – The number given in the column is the index n in the formula $V_{(output)} = [V_{(input)}]^n$ applicable for each half-cycle.

Note 4 – The "integration time" was defined by the CCIF as the "minimum period during which a sinusoidal voltage should be applied to the instrument for the pointer to reach to within 0.2 neper or nearly 2 dB of the deflection which would be obtained if the voltage were applied indefinitely". A logarithmic ratio of 2 dB corresponds to 79.5% and a ratio of 0.2 neper to 82%.

Note 5 – The figure of 4 milliseconds that appeared in previous editions was actually the time taken to reach 80% of the final reading with a d.c. step applied to the rectifying integrating circuit. In a new and somewhat different design of this programme meter using transistors, the performance on programme remains substantially the same as that of earlier versions and so does the response to an arbitrary, quasi-d.c. test signal, but the integration time, as defined in Note 4, is about 20% greater at the higher meter readings.

Note 6 – In Italy a programme meter with the following characteristics is in use:

Rectifier characteristic: 1 (see Note 3)
Time to reach 99% of final reading: approx. 20 ms
Integration time: approx. 1.5 ms
Time to return to zero: approx. 1.5 s from 100% to 10% of the reading in the steady state.

Note 7 – This meter is intended specifically for use in monitoring sound signals transmitted internationally, and therefore incorporates a scale conforming to CCITT Recommendation N.15[5], calibrated in dB from −12 to +12 relative to a level marked "TEST" corresponding to 0 dBm at a zero relative level point. In addition to the normal mode of operation having the characteristics shown above, the meter may be operated temporarily in a "slow" mode facilitating the comparison of observations made at widely separate points. The peak values indicated in this mode have no absolute significance, and may only be used for such comparisons.

References

[1] CCITT Recommendation *Limits for international sound-programme links and connections*, Vol. IV, Fascicle IV.3, Rec. N.10.

[2] CCITT Recommendation *Essential transmission performance objectives for international sound-programme centres (ISPC)*, Vol. IV, Fascicle IV.3, Rec. N.11.

[3] CCITT Recommendation *Measurements to be made during the line-up period that precedes a sound-programme transmission*, Vol. IV, Fascicle IV.3, Rec. N.12.

[4] CCITT Recommendation *Measurements to be made by the broadcasting organizations during the preparatory period*, Vol. IV, Fascicle IV.3, Rec. N.13.

[5] CCITT Recommendation *Maximum permissible power during an international sound-programme transmission*, Vol. IV, Fascicle IV.3, Rec. N.15.

[6] CCITT Recommendation *Identification signal*, Vol. IV, Fascicle IV.3, Rec. N.16.

[7] CCITT Recommendation *Monitoring the transmission*, Vol. IV, Fascicle IV.3, Rec. N.17.

[8] CCITT Recommendation *Monitoring for charging purposes, releasing*, Vol. IV, Fascicle IV.3, Rec. N.18.

[9] IEC Publication 268-10A.

Recommendation J.16

MEASUREMENT OF WEIGHTED NOISE IN SOUND-PROGRAMME CIRCUITS

(Geneva, 1972; amended at Geneva, 1976 and 1980)

The noise objectives for sound-programme circuits are defined in terms of psophometrically weighted noise power levels at a zero relative level point. Psophometric weighting is used to ensure that the objectives and the results of measurements are directly related to the disturbing effect of the noise on the human ear. The psophometric weighting for sound-programme circuits consists of two operations:

– a frequency-dependent weighting of the noise signal, and

– a weighting of the time function of the noise signal to take account of the disturbing effect of noise peaks.

To achieve results which are comparable, it is recommended that for the measurement of noise in sound-programme circuits a measuring set should be used which conforms to the characteristics laid down in CCIR Recommendation 468-2, which is reproduced at the end of this Recommendation.

The following Annex gives symbols and definitions used in noise measurements.

ANNEX A

(to Recommendation J.16)

Symbols and definitions used in noise measurements

A clear distinction should be made between measurements performed with equipment conforming to the Recommendation cited in [1] and those with equipment conforming to CCIR Recommendation 468-2.

It is recommended that the definitions and symbols in Table A-1/J.16 be used.

For noise measurements on sound-programme circuits, it is clear that the terms dBm0ps and dBm0s will ultimately fall into disuse, but the term dBm0s will continue to have a useful meaning with regard to signal power levels.

For specifications of sound-programme circuits, only the symbols shown in Table A-1/J.16 are needed. However, for other purposes such as investigations of prototypes or bibliographic references, it might be more desirable to use r.m.s. values with the weighting curve of CCIR Recommendation 468-2 or quasi-peak values according to the weighting curve of the Recommendation cited in [1]. To this purpose the symbols dBm0ps (up to 15 kHz) and dBq0ps (up to 10 kHz) can be used.

TABLE A-1/J.16

Definitions and symbols for the specification of noise measured on sound-programme circuits

Definitions	Symbols
Unweighted noise power level, measured with an r.m.s. instrument and referred to a point of zero relative sound-programme level	dBm0s
Weighted noise power level, measured with an r.m.s. instrument and weighting characteristic complying with the Recommendation cited in [1] and referred to a point of zero relative sound-programme level	dBm0ps
Unweighted noise level, measured with a quasi-peak measuring instrument complying with CCIR Recommendation 468-2 and referred to a point of zero relative sound-programme level	dBq0s
Weighted noise level, measured with a quasi-peak measuring instrument complying with CCIR Recommendation 468-2 and referred to a point of zero relative sound-programme level	dBq0ps

CCIR RECOMMENDATION 468-2 *

MEASUREMENT OF AUDIO-FREQUENCY NOISE IN BROADCASTING, IN SOUND-RECORDING SYSTEMS AND ON SOUND-PROGRAMME CIRCUITS **

(1970 - 1974 - 1978)

The CCIR,

CONSIDERING

(a) that it is desirable to standardize the methods of measurement of audio-frequency noise in broadcasting, in sound-recording systems and on sound-programme circuits;

(b) that such measurements of noise should provide satisfactory agreement with subjective assessments ***

UNANIMOUSLY RECOMMENDS that the measurement system defined below should be used:

1. Weighting network

The nominal response curve of the weighting network is defined in Fig. 1 (b) which is the theoretical response of the passive network shown in Fig. 1 (a). Table I gives the values of this response at various frequencies.

The permissible differences between the response curve of measuring networks and this nominal curve are shown in the last column of Table I and in Fig. 2.

Note 1. – It is considered unnecessary to use different networks for circuits covered by Recommendations 505-1, 504-1 and 503-1.

Note 2. – The whole instrument is calibrated at 1 kHz (see § 2.6). In order to enable accurate measurements at frequencies giving maximum gain it would be useful to reduce the tolerance at 1 kHz (for instance: ± 0.2 dB).

* This Recommendation replaces Report 398-2, which is hereby cancelled.

** This Recommendation is also of interest to the CMTT.

*** If, for technical reasons, it is desirable to measure unweighted noise, the method described in Annex 1 should be used.

TABLE I

Frequency (Hz)	Response (dB)	Proposed tolerance (dB)
31.5	−29.9	±2.0
63	−23.9	±1.4 [1]
100	−19.8	±1.0
200	−13.8	±0.85 [1]
400	− 7.8	±0.7 [1]
800	− 1.9	±0.55 [1]
1 000	0	±0.5
2 000	+ 5.6	±0.5 [1]
3 150	+ 9.0	±0.5 [1]
4 000	+10.5	±0.5 [1]
5 000	+11.7	±0.5
6 300	+12.2	0
7 100	+12.0	±0.2 [1]
8 000	+11.4	±0.4 [1]
9 000	+10.1	±0.6 [1]
10 000	+ 8.1	±0.8 [1]
12 500	0	±1.2 [1]
14 000	− 5.3	±1.4 [1]
16 000	−11.7	±1.65 [1]
20 000	−22.2	±2.0
31 500	−42.7	{ +2.8 [1] / −∞

[1] This tolerance is obtained by a linear interpolation on a logarithmic graph on the basis of values specified for the frequencies used to define the mask, i.e., 31.5, 100, 1000, 5000, 6300 and 20 000 Hz.

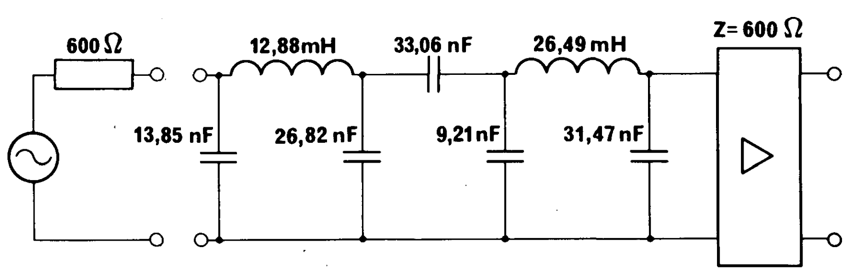


FIGURE 1*a* – *Weighting network*

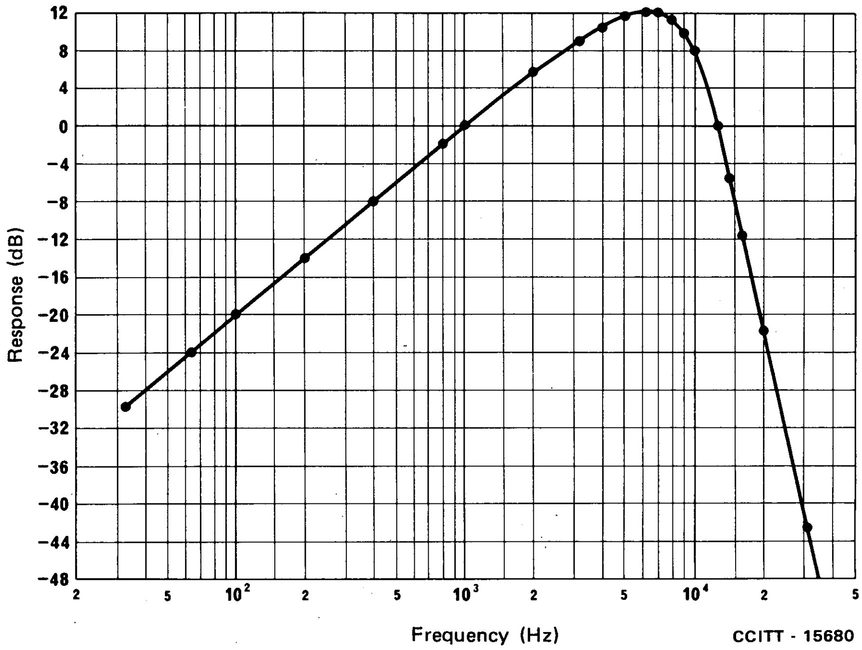


FIGURE 1*b* – *Frequency response of the weighting network shown in Fig. 1 a*

(A tolerance of at most 1% on the component values and a Q-factor of at least 200 at 10 000 Hz are sufficient to meet the tolerances given in Table I)

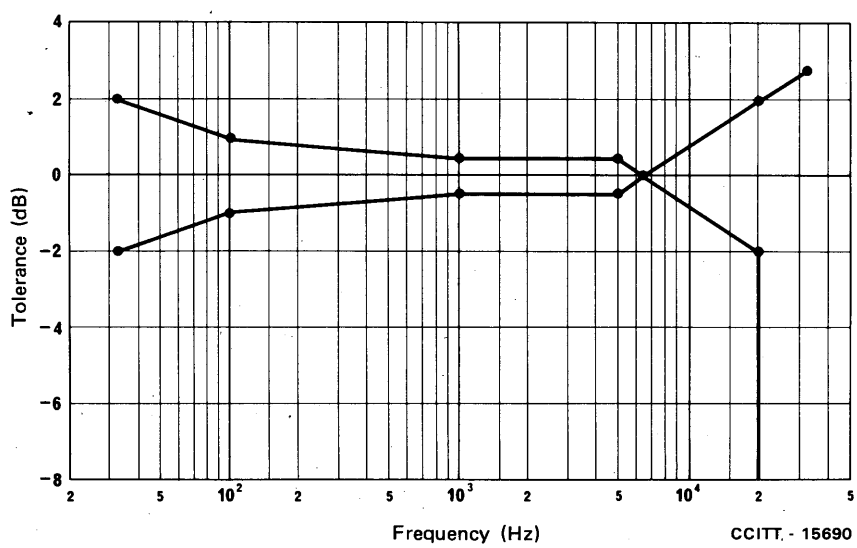


FIGURE 2 – *Maximum tolerances for the frequency response of the weighting network alone*

2. Characteristics of the measuring device *

A quasi-peak value method of measurement shall be used. The required dynamic performance of the measuring set may be realized in a variety of ways. It is defined by the performance of the measuring set as described by the following characteristics.

Note. – After full wave rectification of the input signal, a possible arrangement would consist of two peak rectifier circuits of different time constants connected in tandem (see [CCIR, 1974-78]).

* Unless otherwise specified measurements should be made through the weighting network.

2.1 *Dynamic characteristic in response to single tone-bursts*

Method of measurement

Single bursts of 5 kHz tone are applied to the input at an amplitude such that the steady signal would give a reading of 80% of full scale. The burst should start at the zero-crossing of the 5 kHz tone and should consist of an integral number of full periods. The limits of reading corresponding to each duration of tone burst are given in Table II.

TABLE II

Burst duration (ms)	1[1]	2	5	10	20	50	100	200
Amplitude reference steady signal reading (%)	17.0	26.6	40	48	52	59	68	80
(dB)	−15.4	−11.5	−8.0	−6.4	−5.7	−4.6	−3.3	−1.9
Limiting values:								
– lower limit (%)	13.5	22.4	34	41	44	50	58	68
(dB)	−17.4	−13.0	−9.3	−7.7	−7.1	−6.0	−4.7	−3.3
– upper limit (%)	21.4	31.6	46	55	60	68	78	92
(dB)	−13.4	−10.0	−6.6	−5.2	−4.4	−3.3	−2.2	−0.7

[1] The Administration of the U.S.S.R. intends to use burst durations ⩾5 ms.

The tests should be performed both without adjustment of the attenuators, the readings being observed directly from the instrument scale, and also with the attenuators adjusted for each burst duration to maintain the reading as nearly constant at 80% of full scale as the attenuator steps will permit.

2.2 *Dynamic characteristic in response to repetitive tone-bursts*

Method of measurement

A series of 5 ms bursts of 5 kHz tone starting at zero-crossing is applied to the input at an amplitude such that the steady signal would give a reading of 80% of full scale. The limits of the reading corresponding to each repetition frequency are given in Table III.

The tests should be performed without adjustment of the attenuators but the characteristic should be within tolerance on all ranges.

TABLE III

Number of bursts per second	2	10	100
Amplitude reference steady signal reading (%)	48	77	97
(dB)	−6.4	−2.3	−0.25
Limiting values:			
– lower limit (%)	43	72	94
(dB)	−7.3	−2.9	−0.5
– upper limit (%)	53	82	100
(dB)	−5.5	−1.7	−0.0

2.3 *Overload characteristics*

The overload capacity of the measuring set should be more than 20 dB with respect to the maximum indication of the scale at all settings of the attenuators. The term "overload capacity" refers both to absence of clipping in linear stages and to retention of the law of any logarithmic or similar stage which may be incorporated.

Method of measurement

Isolated 5 kHz tone-bursts of 0.6 ms duration starting at zero-crossing are applied to the input at an amplitude giving full scale reading using the most sensitive range of the instrument. The amplitude of the tone-bursts is decreased in steps by a total of 20 dB while the readings are observed to check that they decrease by corresponding steps within an overall tolerance of ± 1 dB. The test is repeated for each range.

2.4 *Reversibility error*

The difference in reading when the polarity of an asymmetrical signal is reversed shall not be greater than 0.5 dB.

Method of measurement

1 ms rectangular d.c. pulses with a pulse repetition rate of 100 pulses per second or less are applied to the input in the unweighted mode, at an amplitude giving an indication of 80% of full scale. The polarity of the input signal is reversed and the difference in indication is noted.

2.5 *Overswing*

The reading device shall be free from excessive overswing.

Method of measurement

1 kHz tone is applied to the input at an amplitude giving a steady reading of 0.775 V or 0 dB (see § 2.6). When this signal is suddenly applied there shall be less than 0.3 dB momentary excess reading.

2.6 *Calibration*

The instrument shall be calibrated such that a steady input signal of 1 kHz sine-wave at 0.775 V r.m.s., having less than 1% total harmonic distortion, shall give a reading of 0.775 V, 0 dB. The scale should have a calibrated range of at least 20 dB with the indication corresponding to 0.775 V (or 0 dB) between 2 and 10 dB below full scale.

2.7 *Input impedance*

The instrument should have an input impedance ⩾ 20 kΩ and if an input termination is provided then this should be 600 Ω ± 1%.

3. Presentation of results

The meter measures dBq or dBqp but measurement should normally be presented using the following unit symbols in accordance with CCITT Recommendations J.14 and J.16.

Unweighted: dBq0s
(see Annex I)

Weighted: dBq0ps

REFERENCE

CCIR Documents

[1974-78] 10/28 (United Kingdom).

BIBLIOGRAPHY

BBC Research Department Report No. EL-17 [1968] The assessment of noise in audio-frequency circuits.

DEUTSCHE NORMEN DIN 45 405.

STEFFEN, E. [1972] Untersuchungen zur Geräuschspannungsmessung, *Tech. Mitteil. RFZ*, Heft 3.

WILMS, H. A. O. [December, 1970] Subjective or psophometric audio noise measurement: A review of standards. *Journal of the Audio Engineering Society*, Vol. 18, 6.

ANNEX I

(to CCIR Recommendation 468-2)

UNWEIGHTED MEASUREMENTS

Frequency response

The frequency response shall be within the limits given in Fig. 3.

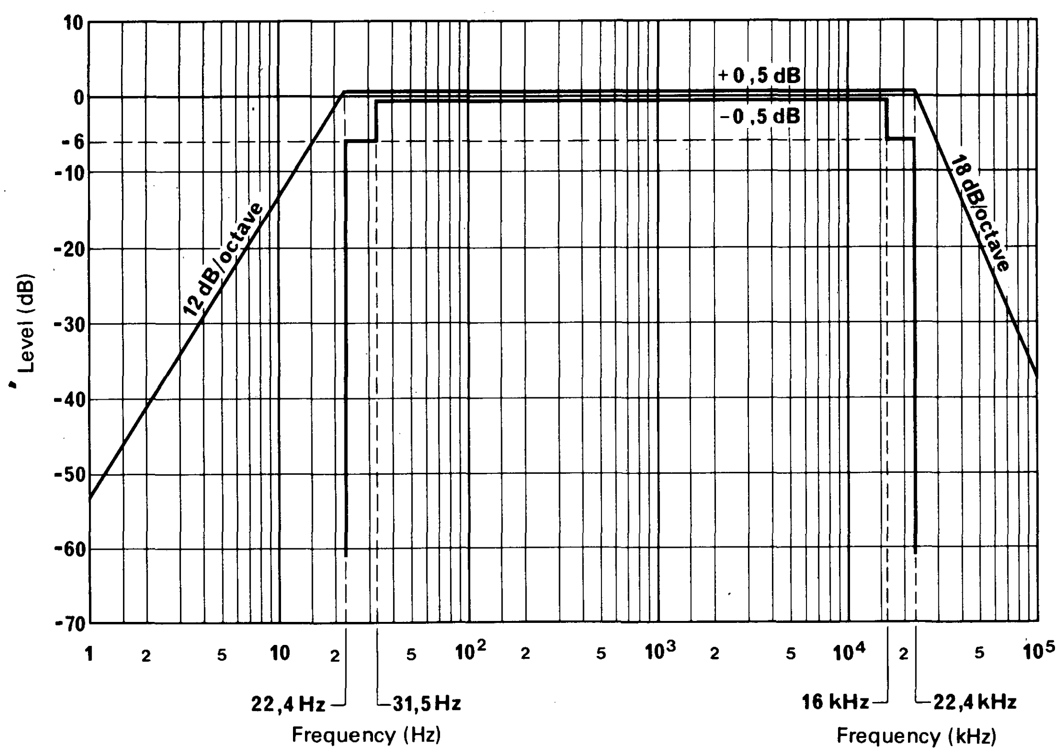


FIGURE 3

Reference

[1] CCITT Recommendation *Psophometers (apparatus for the objective measurement of circuit noise)*, Green Book, Vol. V, Rec. P.53, Part B, ITU, Geneva, 1973.

PRE-EMPHASIS USED ON SOUND-PROGRAMME CIRCUITS IN GROUP LINKS

(Geneva, 1972)

The noise spectrum in group links is usually uniformly distributed, i.e. all parts of the frequency band are equally disturbed by the noise signal. Sound-programme signals, on the other hand, are not of uniform distribution. The mean power density of the signals tends to decrease towards higher frequencies. Furthermore, the sensitivity of the receiving part (consisting of the radio receiver, the loudspeaker and the human ear) in respect of noise is very dependent on the frequency. (This can be seen from the psophometric weighting curve which is a measure of the sensitivity of the complete receiving part.)

Taking these three facts together it appears to be advantageous to use pre-emphasis on sound-programme circuits set up on carrier systems.

The advantages which could be gained by using different pre-emphasis curves are rather small. It is recommended, therefore, that a single pre-emphasis curve should be used whenever pre-emphasis is applied to sound-programme circuits in group links.

It is futher recommended that the pre-emphasis attenuation curve should be that given by the following formula:

$$\text{Insertion loss between nominal impedances} = 10\log_{10}\frac{75+\left(\frac{\omega}{3000}\right)^2}{1+\left(\frac{\omega}{3000}\right)^2}\ (\text{dB})$$

where ω is the angular frequency corresponding to frequency f. Some values are given in Table 1/J.17.

TABLE 1/J.17

f(kHz)	Insertion loss (dB)
0	18.75
0.05	18.70
0.2	18.06
0.4	16.48
0.8	13.10
2	6.98
4	3.10
6.4	1.49
8	1.01
10	0.68
∞	0

The de-emphasis network should have a complementary curve.

The pre-emphasis curve calculated from this formula passes through the following points:

The measured pre-emphasis and de-emphasis curves should not depart by more than ± 0.25 dB from the theoretical curves when the measured levels at 800 Hz are made to coincide with the theoretical levels.

Note – The formula given above defines only the "insertion-loss/frequency" characteristic. The level at which the modulated programme signal is given to the group link is different for the various types of sound-programme equipments and it depends on the modulation method and the type of compandors used. This information is given in the appropriate Recommendations (J.22, J.31).

CROSSTALK IN SOUND-PROGRAMME CIRCUITS SET UP ON CARRIER SYSTEMS

(Geneva, 1972; amended at Geneva, 1980)

This Recommendation outlines the principles followed by the CCITT in determining what limits are appropriately set for sources of crosstalk affecting sound-programme circuits and other principles which Administrations might apply to ensure that the objectives for intelligible crosstalk in sound-programme circuits are achieved in practice.

1 The causes of crosstalk arising in the transmission parts of telecommunications networks occur in:

a) frequency translating equipments at all levels, viz. audio, group, supergroup, and higher order translating equipments;

b) group, supergroup, etc., through-connection equipments (i.e. filter characteristics);

c) transmission systems, both the line (including repeater) and station equipments.

Different crosstalk mechanisms, e.g. inductive, capacitive and other couplings, intermodulation involving continuous fixed-frequency tones such as pilots, etc., operate in these equipments and systems. A particular channel may thus be disturbed by intelligible crosstalk from a number of potential disturbing sources.

However, because of the interconnections which occur at distribution points along the length of a sound-programme circuit, the same disturbing and disturbed signals are rarely involved in more than one exposure.

2 Only the more important crosstalk mechanisms are the subject of Recommendations (e.g. coaxial and balanced pair cable repeater section FEXT limits of the Series J Recommendations, Section 3); the limits are such that at least the objectives for intelligible crosstalk ratio between *telephone* circuits (generally 65 dB, Recommendation G.151 [1]) may be met. In some cases it is practicable to take into account the more stringent objectives for *sound-programme* circuits (Recommendations J.21, J.22 and J.23). Certain crosstalk mechanisms, because they are not significant for telephony (e.g. near-end crosstalk limits for cable repeater sections), are not the subject of Recommendations; nevertheless, they may be significant in relation to sound-programme circuit objectives.

In principle, a probability of exposure can be attributed to each source of crosstalk, not all potential sources exerting their influence in every case. Given the respective probabilities and distributions, the risk of encountering low values of crosstalk attenuation could be calculated.

Without carrying out this analysis it is estimated that the risk of encountering adverse systematic addition for some sources is small and the allocation of the complete overall objective to a single source of crosstalk as the minimum value of crosstalk attenuation appears justifiable. For other sources, particularly where the equipments involved are specifically intended for sound-programme transmission, it is appropriate to require some higher minimum attenuation values so as to allow for some adverse addition (Recommendation G.242 [2] specifying through-connection filter discrimination requirements against out-of-band components in the band occupied by sound-programme circuits is an example).

3 For these reasons meeting intelligible crosstalk objectives on sound-programme circuits in practice depends on:

a) reasonable care in the allocation of plant for sound-programme circuits, so that the principal crosstalk mechanisms, a single exposure to any of which may itself suffice to exceed the objective, are avoided.

Among these mechanisms are:

- far-end and near-end crosstalk at certain frequency bands in line-repeater sections (e.g. the lowest and highest frequency bands of coaxial systems);

- systematic addition of near-end crosstalk between go and return channels of a group link;

b) readiness to change allocated plant in the few cases where crosstalk is excessive because of systematic addition of two or more disturbing sources.

4 The CCITT limits agreed for crosstalk ratios between bands potentially occupied by sound-programme circuits are in terms of effects at single frequencies. The following factors need to be taken into account when assessing from such limits the probability of encountering intelligible crosstalk into real sound-programme circuits:

a) no methods of assessing the subjective effects of intelligible crosstalk in the bands occupied by sound-programme circuits have as yet been standardized;

b) the intelligibility of crosstalk can be affected by:

- the use of emphasis in the disturbed circuit;
- noise masking effects;
- modulation arrangements (e.g. double sideband) in the disturbed circuit;
- frequency offsets and inversions;
- the use of compandors;

c) the mechanisms most liable to cause excessive intelligible crosstalk are, in general, highly frequency-dependent. These cases are those readily prevented by selective plant allocation advocated in § 3 above;

d) crosstalk attenuation can, as a rule, be characterized by a mean value and a standard deviation; the mean value is usually several decibels higher than the worst value, which occurs with only a very small probability.

5 Go-return crosstalk

The assumptions made in the course of the CCITT study of go-return crosstalk in sound-programme circuits, and which served as the basis for the crosstalk limits prescribed in respect of group and higher-order translation equipments (Recommendation G.233 [3]) are given in the following:

a) the nominal maximum distance of the exposure to go-return crosstalk of two sound-programme circuits occupying opposite directions of the same group link is 560 km, i.e. 2/9 of the hypothetical reference circuit distance;

b) the equipments assumed to contribute to such go-return crosstalk are:

- 560 km of line;
- one pair of channel translations;
- one pair of group translations;
- three pairs of higher-order translations;
- two through connections.

The corresponding calculation is given in the Annex.

It was considered that the contribution of the line to go-return crosstalk can be limited to the range of values indicated in the Annex, given that precautions outlined in § 3 above are exercised.

It is possible that, in the study of new transmission systems, the CCITT will be able to take such account of sound-programme circuit crosstalk objectives that these precautions may be relaxed somewhat. This study is in progress in the CCITT with respect to 60 MHz systems.

ANNEX A

(to Recommendation J.18)

Calculations of overall go-return crosstalk between two sound-programme circuits occupying opposite directions of the same group link

Equipment	Crosstalk ratio limit (dB)	Crosstalk power per exposure in the disturbed circuit arising from a signal of 0 dBm0 on the disturbing circuit (pW)	Number of exposures	Total crosstalk power (pW)	Crosstalk ratio (dB)
Line	80 to 85 (single homogeneous section)	10 to 3	2 (2/9 h.r.c)	20 to 6	77 to 82
Channel translation	85	3	2	6	82
Group translation	80	10	2	20	77
Supergroup and higher translations	85	3	6	18	77.5
Through filters (cabling)	85	3	2	6	82
Totals (without compandors)				70 to 56	71.5 to 72.5
Totals (with programme-circuit compandors with a minimum companding advantage of 10 dB)				7 to 6	81.5 to 82.5

References

[1] CCITT Recommendation *General performance objectives applicable to all modern international circuits and national extension circuits*, Vol. III, Fascicle III.1, Rec. G.151.

[2] CCITT Recommendation *Through-connection of groups, supergroups, etc.*, Vol. III, Fascicle III.2, Rec. G.242.

[3] CCITT Recommendation *Recommendations concerning translating equipments*, Vol. III, Fascicle III.2, Rec. G.233.

Recommendation J.19 [1)]

A CONVENTIONAL TEST SIGNAL SIMULATING SOUND-PROGRAMME SIGNALS FOR MEASURING INTERFERENCE IN OTHER CHANNELS

(Geneva, 1980)

The CCITT,

considering

(a) that on FDM systems nonlinear crosstalk may cause mutual interference between the several types of transmission channels;

(b) that the interference depends on the total loading of the FDM system;

(c) that the interference in a channel can be measured as a noticeable deterioration of the signal-to-noise ratio;

(d) that for setting realistic performance limits of interference, a conventional test signal imitating the sound-programme channel loading is desirable,

unanimously recommends

that for simulating sound-programme signals a conventional test signal with the following parameters should be used:

(1) a uniform spectrum energizing signal covering the frequency band up to at least 15 kHz shall be shaped according to the nominal insertion loss/frequency shown in Table 1/J.19 and Figure 1/J.19;

(2) the conventional test signal can be produced from a Gaussian white noise generator associated with a shaping network conforming with Figure 2/J.19;

(3) the total test signal power applied to a sound-programme circuit under test shall be cyclically changed in level according to Table 2/J.19.

TABLE 1/J.19

Frequency (Hz)	Relative insertion-loss (dB)	Tolerance (±dB)
31.5	10.9	0.5
63	3.4	0.3
100	0.4	0.2
(122)	(0.0)	(0)
200	1.5	0.2
400	5.7	0.3
800	8.7	0.3
1 000	9.2	0.3
2 000	10.6	0.5
3 150	13.0	0.5
4 000	15.7	0.5
5 000	18.8	0.5
6 300	22.5	0.5
7 100	24.6	0.5
8 000	26.6	0.5
9 000	28.6	0.5
10 000	30.4	1.0
12 500	34.3	1.0
14 000	36.3	1.0
16 000	38.6	1.0
20 000	42.5	1.0
31 500	50.4	1.0

1) This Recommendation corresponds to CCIR Recommendation 571 [1], which was derived from studies given in CCIR Report 497-2 [2].

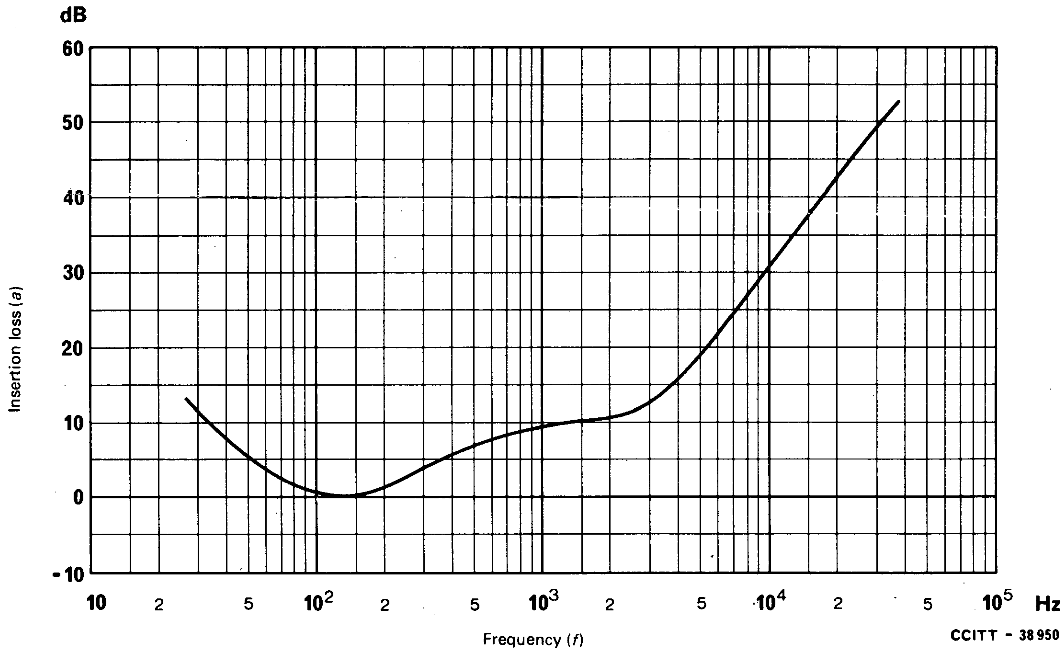


FIGURE 1/J.19
Insertion loss/frequency

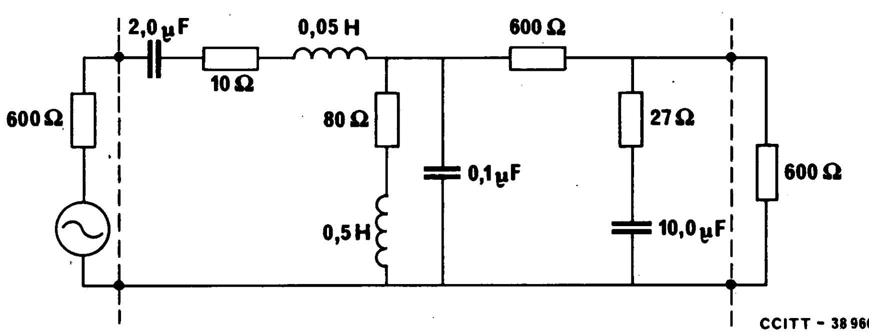


FIGURE 2/J.19

TABLE 2/J.19

Step	Level	Time for which signal is applied
1	−4 dBm0s	4 s
2	+ 3 dBm0s	2 s
3	no signal	2 s

References

[1] CCIR Recommendation *A conventional test signal simulating sound-programme signals for measuring interference in other channels,* Vol. XII, Rec. 571, ITU, Geneva, 1978.

[2] CCIR Report *A conventional test signal simulating sound-programme signals for measuring interference in other channels,* Vol. XII, Report 497-2, ITU, Geneva, 1978.

SECTION 2

PERFORMANCE CHARACTERISTICS OF SOUND-PROGRAMME CIRCUITS

Recommendation J.21

PERFORMANCE CHARACTERISTICS OF 15-kHz TYPE SOUND-PROGRAMME CIRCUITS [1)]

(Geneva, 1972; amended at Geneva, 1976 and 1980)

Circuits for high-quality monophonic and stereophonic transmissions

The CCITT

unanimously recommends

that, taking account of the definition in § 1 below, high-quality monophonic and stereophonic sound-programme transmissions should satisfy the requirements laid down in §§ 2 and 3 below.

1 Definition

When the hypothetical reference circuit defined in Recommendation J.11 is composed of three "sound-programme carrier sections" the requirements indicated below should be met.

2 Requirements at audio interconnection points

2.1 *Measurement of characteristics*

When making measurements of the characteristics of a circuit, these should be made with the output terminated with a 600-ohm non-reactive load.

2.2 *Impedance and matching conditions*

The audio-frequency input impedance should be 600 ohms balanced; the tolerance on this value is a matter for further study.

1) This Recommendation corresponds to CCIR Recommendation 505-1 [1].

It is provisionally recommended that the output impedance be balanced with respect to earth and be so low that the output level in the nominal transmission range does not decrease by more than 0.3 dB if the open-circuit output is loaded with 600 ohms. This output impedance is intended for connection to a nominal load impedance of 600 ohms.

This clause alone would not, however, rule out a large difference in the reactive parts of the output impedances of a stereophonic pair, and this in turn could lead to difficulties in meeting the limits of § 3.2.2 below. This aspect needs further study.

For amplifiers which are intended for direct connection to audio frequency sound-programme lines, the reactive part of the output impedance should be restricted. A maximum value of 100 ohms for the series reactance part of the output impedance at frequencies in the transmitted range is provisionally recommended.

2.3 *Relative level*

The relative level on a sound-programme circuit at the audio-frequency amplifier output should be fixed at +6 dBrs [2].

3 Performance of the hypothetical reference circuit for 15 kHz-type sound-programme circuits

The values given correspond to circuits operating with analogue techniques and are expected to be met on such transmission systems. Special additional parameters concerning digital techniques are under study (see § 4 below).

3.1 *Parameters for monophonic sound-programme transmission*

3.1.1 Nominal bandwidth: 0.04 to 15 kHz.

3.1.2 Insertion gain at 0.8 or 1 kHz: this parameter should be measured at a sending level equivalent to −12 dBm0 as specified by the CCITT for setting up sound-programme circuits.

3.1.2.1 Adjustment error: not to fall outside the range ± 0.5 dB.

3.1.2.2 Variation during 24 hours: not to exceed ± 0.5 dB.

If the broadcasting organizations wish to have closer tolerances, it is necessary for the receiving broadcasting organizations to insert additional timing attenuators.

3.1.3 The gain/frequency response referred to 0.8 or 1 kHz should comply with the following limits:

0.04	to 0.125	kHz:	+0.5 to −2.0 dB
0.125	to 10	kHz:	+0.5 to −0.5 dB
10	to 14	kHz:	+0.5 to −2.0 dB
14	to 15	kHz:	+0.5 to −3.0 dB

For the combined effect of three modulator and demodulator equipments, a tolerance of ± 0.5 dB from 0.125 to 10 kHz is considered the closest that can be met by equipments in practice. If broadcasting organizations wish to have closer tolerances, it is necessary for the receiving broadcasting organization to insert additional equalizers.

This response should be measured using a test level of −12 dBm0.

3.1.4 The difference between group delay at the given frequency and the minimum value of group delay should not exceed the following limits:

0.04	kHz:	55 ms
0.075	kHz:	24 ms
14	kHz:	8 ms
15	kHz:	12 ms

2) See the definition of zero-relative level in Recommendation J.14.

3.1.5 *Maximum weighted noise level*

−42 dBq0ps.

This parameter is defined in terms of a weighting network and a quasi-peak measuring instrument in accordance with CCIR Recommendation 468-2, which is reproduced at the end of Recommendation J.16.

Note 1 – If an r.m.s. measuring instrument is used the measured value will be about 5 dB less than for the quasi-peak measurement.

Note 2 – If the weighting network defined in the Recommendation cited in [2] is used, the measured value will be about 4 dB less. More details are given in [3].

Note 3 – Suitable values for unweighted noise cannot be recommended with precision because such values depend upon characteristics of the circuit noise. However, if an unweighted noise measurement is performed upon a sound-programme circuit just complying with the requirements of §§ 3.1.5 and 3.1.6 then the worst values expected to be found are −41 dBm0s and/or −36 dBq0s, and in most cases the values obtained will be several decibels better.

CCIR Report 493-2 [4] indicates that if a compandor is used, then with some programme material an improved signal-to-noise ratio is necessary to avoid objectionable effects.

When using radio-relay systems, the values given for both the weighted and unweighted noise should not be exceeded for more than 20% of any month. For 1% and 0.1% of any month, limits 4 dB higher and 12 dB, respectively, seem to be acceptable.

3.1.6 The single-tone interference, measured selectively, should not exceed (−73 – Δps) dBm0s, in which Δps is the correction for the frequency being measured, given by the weighting characteristics in CCIR Recommendation 468-2 (which is reproduced at the end of Recommendation J.16).

For sound-programme transmissions over carrier systems, occurrence of carrier leaks can be expected. For this reason, stop filters may be provided in the carrier frequency path which can be switched in, if required, to suppress the tones otherwise audible in the upper frequency range from 8 to 15 kHz. For a hypothetical reference circuit, a 3-dB bandwidth of less then 3% for stop filters, referred to the mid-frequency, is recommended. The use of stop filters influencing frequencies below 8 kHz should be avoided.

3.1.7 *Disturbing modulation by power supply*

The highest-level unwanted side-component due to modulation of a sound-programme signal caused by interference from conventional a.c. line power supply sources, should not be greater than −45 dB, relative to the level of a sine-wave measuring signal applied to the sound-programme circuit (in accordance with CCIR Recommendation 474 [5]). The value for higher frequencies has to be determined (see CCIR Study Programme 17F/CMTT [6]).

3.1.8 *Nonlinear distortion*

There are certain difficulties in giving a general recommendation on nonlinearity, due to restrictions imposed by the CCITT on the levels and durations of test tones (see especially Recommendations N.21 [7] and N.23 [8]). Pending progress with other test methods, the following tests are recommended.

3.1.8.1 Harmonic distortion factors measured with single-tone test signals at +9 dBm0s should not exceed the limits given in Table 1/J.21.

TABLE 1/J.21

Frequency of test-tone (kHz)	Total harmonic distortion (%)	Second harmonic and third harmonic measured selectively (%)
0.04 to 0.125	1	0.7
0.125 to 7.5	0.5	0.35

The duration for which a single tone is to be transmitted at this level should be restricted in accordance with the appropriate Series N Recommendations.

3.1.8.2 The difference-tone factors [3)] selectively measured with double-tone send signals each at +3 dBm0 should not exceed the following limits:

3.1.8.2.1 Frequencies 0.8 and 1.42 kHz corresponding to those prescribed in Recommendation O.31 [9], for a 3rd-order difference-tone measured at 0.18 kHz: 0.5%

3.1.8.2.2 Frequencies 5.6 and 7.2 kHz for a 2nd-order difference-tone measured at 1.6 kHz: 0.5%

3.1.8.2.3 Frequencies 4.2 and 6.8 kHz for a 3rd-order difference-tone measured at 1.6 kHz: 0.5%

The measurements of §§ 3.1.8.2.2 and 3.1.8.2.3 are intended for baseband transmissions on physical circuits only and on modulation equipment in the local loops.

3.1.9 *Error in reconstituted frequency*

Not to be greater than 1 Hz.

Note – A maximum error of 1 Hz is in principle acceptable where there is only a single transmission path between the signal source and the listener.

When the broadcast network is composed of two or more parallel paths, e.g. commentary and separate sound channels, or radio broadcasts from different transmitters on the same frequency, unacceptable beats may occur unless zero error can be assured. The CCITT is studying methods of effecting this in all recommended systems.

3.1.10 *Intelligible crosstalk ratio*

3.1.10.1 The intelligible crosstalk ratio from other sound-programme circuits or from a telephone circuit into a sound-programme circuit should be measured selectively in the disturbed circuit at the same frequencies as those of the sinusoidal test signal applied to the disturbing circuit, and should not be less than the following values:

0.04 kHz:	50 dB
0.04 to 0.5 kHz:	oblique straight-line segment on linear-decibel and logarithmic-frequency scales
0.5 to 5 kHz:	74 dB
5 to 15 kHz:	oblique straight-line segment on linear-decibel and logarithmic-frequency scales
15 kHz:	60 dB.

3.1.10.2 The near- or far-end crosstalk ratio between a sound-programme circuit (disturbing circuit) and a telephone circuit (disturbed circuit) should be at least 65 dB.

Notes to § 3.1.10

Note 1 – It is understood that these values are defined between the relative levels applicable to telephony. An explanation for the relation between the relative levels for sound-programme circuits and telephone circuits is given in the Annex to Recommendation J.22.

[3)] Attention is drawn to the fact that in transmission systems using compandors, a 3rd-order difference-tone may occur which exceeds the specified limit of 0.5%. This may occur when the difference between the two fundamental frequencies is less than 200 Hz. Thus, the components due to 3rd-order distortion will have frequencies which correspond to the difference between the two test frequencies. However, in these cases the subjective masking is such that a distortion up to 2% is acceptable.

Note 2 – The CCITT draws the attention of Administrations to the fact that it is in some cases difficult or impossible to meet these limits. This may occur when unscreened pairs are used for a long audio-frequency circuit (e.g. about 1000 km or longer), or in certain carrier systems on symmetric pair cables, or in the low frequency range (e.g. below about 100 kHz) in certain carrier systems on coaxial cables. When such difficulties arise, such systems or parts of systems should be avoided, if possible, for setting up programme channels.

Note 3 – When a minimum noise level of at least 4000 pW0p is always present in the telephone channel (this may be the case in satellite systems, for example) a reduced crosstalk ratio of 58 dB between a sound-programme circuit and a telephone circuit is acceptable.

Note 4 – The CCITT draws the attention of Administrations to the fact that, because of crosstalk which may occur in terminal modulating and line equipment, special precautions may have to be taken to meet the above crosstalk limits between two sound-programme circuits, simultaneously occupying the go and return channels respectively of a carrier system (the most economical arrangement), because in those circumstances they occupy the same position in the line-frequency band (see Recommendation J.18).

Note 5 – The value indicated is based on the assumption that sine-wave test signals are used. The use of the test signal as described in Recommendation J.19 is under study.

Note 6 – The effect of crosstalk from a sound-programme circuit into a telephone circuit is not a question of secrecy, but rather of subjective disturbance by an interfering signal whose character is noticeably different from random noise or babble.

The frequency offset adopted for some sound-programme equipment allows a reduction of crosstalk from a telephone circuit into a sound-programme circuit. However in the reverse direction, this reduction of crosstalk remains only for speech material, but is practically ineffective for music material.

3.1.11 *Error in amplitude/amplitude response*

When the level of a 0.8 or 1-kHz test signal is changed from +6 to −6 dBm0s or vice versa, the level difference at the receiving end should not lie outside the range 12 ± 0.5 dB. This level change of the test signal corresponds to that prescribed in Recommendation O.31 [9].

3.2 *Additional parameters for stereophonic programme transmission*

3.2.1 The difference in gain between A and B channels should not exceed the following values:

0.04	to	0.125	kHz: 1.5 dB
0.125	to	10	kHz: 0.8 dB
10	to	14	kHz: 1.5 dB
14	to	15	kHz: 3 dB

3.2.2 The phase difference between the A and B channels should not exceed the following values:

0.04 kHz:	30°
0.04 to 0.2 kHz:	oblique straight-line segment on linear-degree and logarithmic-frequency scales
0.2 to 4 kHz:	15°
4 to 14 kHz:	oblique straight-line segment on linear-degree and logarithmic-frequency scales
14 kHz:	30°
15 kHz:	40°

3.2.3 The crosstalk ratio between the A and B channels should not be less than the following limits:

3.2.3.1 Intelligible crosstalk ratio, measured with sinusoidal test signal from 0.04 to 15 kHz: 50 dB.

3.2.3.2 Nonlinear crosstalk ratio [4)] from 0.04 to 15 kHz: 60 dB.

4) The CMTT is requested to produce a definition for this expression.

4 Transmission performance of the hypothetical reference circuit for 15 kHz-type sound-programme circuits with particular reference to digital methods of transmission

This section will deal with special additional parameters for digital systems. CCIR Report 649 [10] and Study Programme 14A/CMTT [11] refer.

Note – The CCIR has issued Recommendation 572 [12] which deals with the transmission of one sound-programme associated with an analogue television signal by means of time-division multiplex in the line synchronizing pulse. The system recommended is a digital one, using pulse code modulation. A sound-programme bandwidth of 14 kHz is provided.

5 Estimation of transmission performance of circuits shorter or longer than the hypothetical reference circuit

CCIR Study Programme 17D/CMTT [13] refers.

Note – For further work, CCIR Report 496-2 [14] may be consulted. This Report also draws attention to certain differences between the above Recommendation and one drawn up by the OIRT.

References

[1] CCIR Recommendation *Characteristics of 15 kHz-type sound-programme circuits*, Vol. XII, Rec. 505-1, ITU, Geneva, 1978.

[2] CCITT Recommendation *Psophometers (apparatus for the objective measurement of circuit noise)*, Green Book, Vol. V, Rec. P.53, Part B, ITU, Geneva, 1973.

[3] CCIR Report *Circuits for high-quality monophonic and stereophonic transmissions*, Vol. XII, Report 496-2, Table II, ITU, Geneva, 1978.

[4] CCIR Report *Compandors for sound-programme circuits*, Vol. XII, Report 493-2, ITU, Geneva, 1978.

[5] CCIR Recommendation *Modulation of signals carried by sound-programme circuits by interfering signals from power supply sources*, Vol. XII, Rec. 474, ITU, Geneva, 1978.

[6] CCIR Study Programme 17F/CMTT *Noise in sound-programme circuits from the power supply*, Vol. XII, ITU, Geneva, 1978.

[7] CCITT Recommendation *Limits and procedures for the lining-up of a sound-programme circuit*, Vol. IV, Fascicle IV.3, Rec. N.21.

[8] CCITT Recommendation *Routine maintenance measurements to be made on international sound-programme circuits*, Vol. IV, Fascicle IV.3, Rec. N.23.

[9] CCITT Recommendation *Specification for an automatic measuring equipment for sound-programme circuits*, Vol. IV, Fascicle IV.4, Rec. O.31.

[10] CCIR Report *Transmission performance of the hypothetical reference circuit for high quality sound-programme circuits with particular reference to digital methods of transmission*, Vol. XII, Report 649, ITU, Geneva, 1978.

[11] CCIR Study Programme 14A/CMTT *Digital transmission of television signals*, Vol. XII, ITU, Geneva, 1978.

[12] CCIR Recommendation *Transmission of one sound-programme associated with an analogue television signal by means of time-division multiplex in the line synchronizing pulse*, Vol. XII, Rec. 572, ITU, Geneva, 1978.

[13] CCIR Study Programme 17D/CMTT *Estimation of transmission performance of sound-programme circuits shorter or longer than the hypothetical reference circuit*, Vol. XII, ITU, Geneva, 1978.

[14] CCIR Report *Circuits for high-quality monophonic and stereophonic transmissions*, Vol. XII, Report 496-2, ITU, Geneva, 1978.

PERFORMANCE CHARACTERISTICS OF 10-kHz TYPE SOUND-PROGRAMME CIRCUITS [1)]

(former Recommendation J.21; amended at Geneva, 1972, 1976 and 1980)

The CCITT

unanimously recommends

that, when the hypothetical reference circuit defined in Recommendation J.11 is assumed to be made of three 10-kHz type sound-programme circuit sections, the characteristics given below apply with the following reservations:

1) For an audio-frequency circuit, all the characteristics are valid, except for intelligible crosstalk.

2) For a circuit on a carrier system, all the characteristics are valid, except for intelligible crosstalk and noise. (See Annex A.)

1 Requirements at audio-frequency interconnection points

1.1 *Measurement of characteristics*

When measuring the characteristics of a circuit, the output should be terminated with a 600-ohm nonreactive load.

1.2 *Impedance and matching conditions*

The audio input impedance should be 600 ohms balanced; the tolerance on this value is a matter for further study.

It is provisionally recommended that the output impedance be balanced with respect to earth and be so low that the output level in the nominal transmission bandwidth does not decrease by more than 0.3 dB if the open-circuit output is loaded with 600 ohms. This output impedance is intended for connection to a nominal load impedance of 600 ohms.

For amplifiers which are intended for direct connection to sound-programme lines, the reactive part of the output impedance should be restricted. A maximum value of 100 ohms for the series reactance part of the output impedance at frequencies in the transmitted bandwidth is provisionally recommended.

1.3 *Relative level*

The relative level of a sound-programme circuit at the audio-frequency amplifier output should be fixed at +6 dBrs (see Recommendation J.14).

2 Nominal bandwidth

The nominal bandwidth is 0.05 to 10 kHz.

3 Attenuation distortion

Figure 1/J.22 shows the permissible limits for the variation of the received level with frequency (relative to the value measured at 800 Hz). The method of measuring this level variation with frequency is shown in Recommendation N.21 [2].

1) This Recommendation corresponds to CCIR Recommendation 504-1 [1].

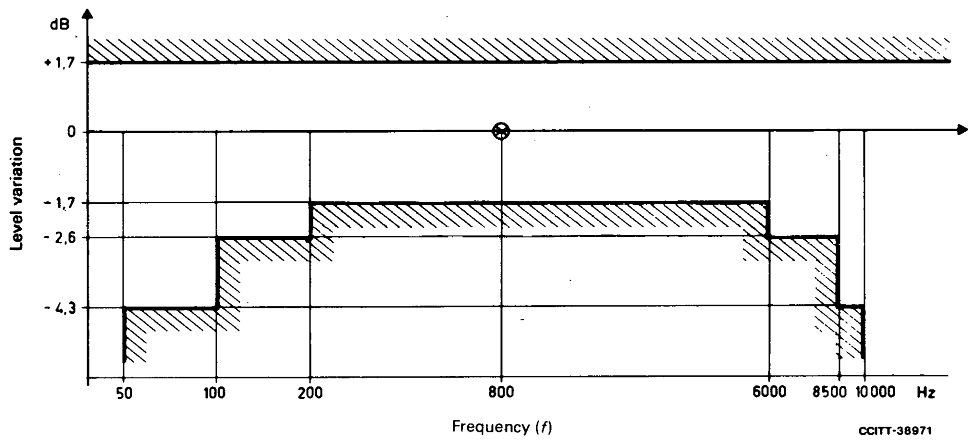


FIGURE 1/J.22

Variation of the received level with frequency relative to the value at 800 Hz

When the circuit is set up on a carrier system, the curve applies to the combined three pairs of equipments for modulation from, and demodulation to, audio frequencies, as included in the hypothetical reference circuit for programme transmision.

4 Group-delay distortion

The difference between the group delay t_f, for the frequency f considered, and the minimum group delay t_{min}, should not exceed the following values:

$$\begin{aligned} 8 \text{ ms for } & t_{10\,000} - t_{min} \\ 20 \text{ ms for } & t_{100} - t_{min} \\ 80 \text{ ms for } & t_{50} - t_{min} \end{aligned}$$

5 Maximum weighted noise level [2)]

−39 dBq0ps

This parameter is defined in terms of a weighting network and a quasi-peak measuring instrument in accordance with CCIR Recommendation 468-2 (which is reproduced at the end of Recommendation J.16).

Note 1 – If an r.m.s. measuring instrument is used the measured value will be about 5 dB less than for the quasi-peak measurement.

Note 2 – If the weighting network defined in the Recommendation cited in [3] is used the measured value will be about 4 dB less. More details are given in Table II of CCIR Report 496-2 [4].

Note 3 – Suitable values for unweighted noise cannot be recommended with precision because such values depend upon characteristics of the circuit noise. However, if an unweighted noise measurement is performed upon a sound-programme circuit just complying with the requirements of § 5, then the worst value expected to be found is −28 dBm0s and/or −23 dBq0s, and in most cases the values obtained will be several decibels better.

6 Intelligible crosstalk ratio

6.1 The near- or far-end crosstalk ratio (for speech) between two sound-programme circuits or between a telephone circuit (disturbing circuit) and a sound-programme circuit (disturbed circuit) should be at least 74 dB.

2) For circuits on carrier systems, it is not always possible in the absence of special precautions to meet the limits recommended in § 5 (see Annex A).

6.2 The near- or far-end crosstalk ratio between a sound-programme circuit (disturbing circuit) and a telephone circuit (disturbed circuit) should be at least 65 dB.

Notes to § 6

Note 1 — It is understood that these values are defined between the relative levels applicable to telephony. An explanation of the relation between the relative levels for sound-programme ciruits and telephone circuits is given in Annex A.

Note 2 — The CCITT draws the attention of Administrations to the fact that it is in some cases difficult or impossible to meet these limits. This may occur when unscreened pairs are used for a long audio-frequency circuit (e.g. about 1000 km or longer), or in certain carrier systems on symmetric pair cables, or in the low frequency range (e.g. below about 100 kHz) in certain carrier systems on coaxial cables. When such difficulties arise, such systems or parts of systems should be avoided, if possible, for setting up programme channels.

Note 3 — Where a minimum noise level of at least 4000 pW0p is always present in the telephone channel (this may be the case in satellite systems, for example) a reduced crosstalk ratio of 58 dB between a sound-programme circuit and a telephone circuit is acceptable.

Note 4 — The CCITT draws the attention of Administrations to the fact that, because of crosstalk which may occur in terminal modulating and line equipment, special precautions may have to be taken to meet the above crosstalk limits between two sound-programme circuits, simultaneously occupying the go and return channels respectively of a carrier system (the most economical arrangement), because in those circumstances they occupy the same position in the line-frequency band (see Recommendation J.18).

Note 5 — The value indicated is based on the assumption that sine-wave test signals are used. The use of the test signal as described in Recommendation J.19 is under study.

Note 6 — The effect of crosstalk from a sound-programme circuit into a telephone circuit is not a question of secrecy, but rather of subjective disturbance by an interfering signal whose character is noticeably different from random noise or babble.

The frequency offset adopted for some sound-programme equipment allows a reduction of crosstalk from a telephone circuit into a sound-programme circuit. However, in the reverse direction, this reduction of crosstalk remains only for speech material, but is practically ineffective for music material.

7 Change of relative level with time

The 800-Hz relative level at the far end of the circuit should meet the defined conditions for attenuation distortion, and also during a given programme transmission should not change from its nominal value by more than ± 2 dB. Also, for sound-programme circuits on special pairs or on the phantom circuits of unloaded symmetric pairs, the 800-Hz relative level at the output of a frontier amplifier should not change from its nominal value by more than ± 1 dB during a given programme transmission.

8 Nonlinear distortion

The total harmonic distortion coefficient for the 2500-km hypothetical reference circuit for programme transmissions should not exceed 4% (harmonic distortion attenuation of 28 dB) at any frequency within the band to be transmitted, the measurement being made with a sinusoidal signal (fundamental frequency) of +9 dBm0 connected to the origin of the circuit. The total harmonic distortion coefficient, k, is calculated from the formula.

$$k = \sqrt{k_2^2 + k_3^2}$$

where

k_2 is the 2nd order harmonic distortion coefficient and
k_3 is the 3rd order harmonic distortion coefficient.

However, the following values should be considered as desirable design objectives for future developments:

3% (30 dB), at fundamental frequencies below 100 Hz,
2% (34 dB), at fundamental frequencies above 100 Hz.

Note – Precautions should be taken in the measurement of harmonic distortion on circuits equipped with pre-emphasis networks. (See Recommendation N.21 [2].

9 Interference from the power supply

The most intense unwanted side component due to modulation of a sound-programme signal caused by interfering signals from power supply sources should not be of greater than –45 dB relative to the level of a sine-wave test signal applied to the sound-programme circuit.

10 Error in reconstituted frequency

The difference between the initial and reconstituted frequencies should not exceed 2 Hz.

Note – When the broadcast network is composed of two or more parallel paths, e.g. commentary and separate sound channels, or radio broadcast from different transmitters on the same frequency, unacceptable beats may occur unless zero error can be assured. The CCITT is studying methods of effecting this in all recommended systems.

11 Single-tone interference

Under study. (The subjective assessment of single-tone interference on high-quality circuits will be carried out by a method described in CCIR Report 623 [5].)

ANNEX A

(to Recommendation J.22)

Values of noise expected in practice on 2500 km circuits

A.1 *Estimated noise power levels*

Table A-1/J.22 shows the noise values arising when sound-programme circuits (using pre-emphasis and de-emphasis in accordance with Recommendation J.17) are set up in place of three telephone channels, each of which conforms to the general noise objectives given in Recommendation G.222 [6]. The assumptions made for the purpose of the noise calculations are shown at the end of this Annex.

TABLE A-1/J.22

	One-minute mean value	
	for not more than 20% of a month	for not more than 0.1% of a month
Noise power level weighted with the network of the Recommendation cited in [3]	–44.5 dBm0ps	–37.5 dBm0ps

Note – The increased noise level shown as occurring for not more than 0.1% of a month applies when the carrier circuit is established over a radio-relay system.

A.2 *Performance of 10-kHz sound-programme circuits*

When 10 kHz and 6.4 kHz-type sound-programme circuits which include emphasis and de-emphasis networks, are set up on a carrier system it is recommended that, for reasons of overload, the relative level at 800 Hz on such a circuit at a zero-relative level point (deduced from the level diagram of telephone circuits set up on the same 12-circuit group) should lie between a maximum of −1.5 dB and a minimum of −4.5 dB.

The level of −1.5 dB could be considered as normal. A further 3-dB adjustment to permit a decrease down to −4.5 dB should, however, be included to cover the case of exceptional overloading if operational experience shows that in fact this is necessary.

Note – Certain problems connected with the use of pre-emphasis on carrier systems have not yet been satisfactorily resolved. These are:

– the limitation of the level of testing tones, which is of concern to Study Group IV;

– the effect of pre-emphasis on the harmonic distortion requirements which the programme circuit should meet at high frequencies [3].

A.3 *Use of compandors*

Provided the compressor and the expander are of the same make, it is possible to obtain overall transmission characteristics as regards noise which conform to the CCITT Recommendations for the 2500-km hypothetical reference circuit, without introducing other factors that might impair transmission performance. The CCITT is now examining recommendations on the compressor and the expander, considered separately, so as to achieve the same result.

A.4 *Assumptions and conventional terms*

The expression dBm0ps is used to indicate noise power levels in a sound-programme circuit which have been psophometrically weighted according to the Recommendation cited in [3], and measured in decibels relative to 1 mW at a point of zero relative sound-programme level (0 dBrs), in that circuit. The CCITT practice in the past has been to quote noise level for sound-programme circuits relative to "peak programme" or "maximum voltage" which is defined as a voltage of 2.2 volts r.m.s. (measured at the terminals of an impedance of 600 ohms) at a point of zero relative sound-programme level. The signal-to-noise ratio objective of 57 dB (previously given in the Recommendation cited in [7] is thus equivalent to a noise power level of −48 dBm0ps.

The value for not more than 20% of a month was calculated for 10-kHz type circuits on the following assumptions:

– noise on one telephone channel (including the multiplex equipment) according to Recommendation G.222 [6], weighted for telephony	−50 dBm0ps
– Bandwidth correction from 3.1 to 10 kHz	+ 5 dB
– Suppression of weighting for telephony (in the case of a uniform-spectrum noise) . .	+ 2.5 dB
– Improvement due to pre-emphasis [4] (see Recommendation J.17)	− 9 dB
– Effect of the relative level shifted by −1.5 dB at 800 Hz	+ 1.5 dB
– Weighting for sound-programme transmissions according to the Recommendation cited in [3]	+ 5.5 dB
Total	−44.5 dBm0ps

The value for not more than 0.1% of a month was calculated on the basis of the noise variations to be expected on a radio-relay link used mainly for providing telephone circuits and conforming with Recommendation G.222 [6].

[3] Measurements of harmonic distortion on programme circuits having pre-emphasis must be treated with reserve. This point is being studied by the CCITT.

[4] Set to have zero loss at 800 Hz.

References

[1] CCIR Recommendation *Performance characteristics of 10 kHz type sound-programme circuits*, Vol. XII, Rec. 504-1, ITU, Geneva, 1978.

[2] CCITT Recommendation *Limits and procedures for the lining-up of a sound-programme circuit*, Vol. IV, Fascicle IV.3, Rec. N.21.

[3] CCITT Recommendation *Psophometers (apparatus for the objective measurement of circuit noise)*, Green Book, Vol. V, Rec. P.53, Part B, ITU, Geneva, 1973.

[4] CCIR Report *Circuits for high-quality monophonic and stereophonic transmissions*, Vol. XII, Report 496-2, ITU, Geneva, 1978.

[5] CCIR Report *Method proposed for the subjective assessment of the quality of sound in broadcasting and of the performance of sound-programme systems*, Vol. XII, Report 623, ITU, Geneva, 1978.

[6] CCITT Recommendation *Noise objectives for design of carrier-transmission systems of 2500 km*, Vol. III, Fascicle III.2, Rec. G.222.

[7] CCITT Recommendation *10-kHz type sound-programme circuits*, Green Book, Vol. III, Rec. J.22, § e), ITU, Geneva 1973.

Recommendation J.23 1), 2)

PERFORMANCE CHARACTERISTICS OF NARROW-BANDWIDTH SOUND-PROGRAMME CIRCUITS

(amended at Geneva, 1980)

Circuits of medium quality for monophonic transmission

The CCITT

unanimously recommends

that, taking into account the definitions in § 1, narrow-bandwidth sound-programme circuits should satisfy the requirements for monophonic transmission laid down in §§ 2 and 3.

1 Definitions

In this Recommendation the narrow-bandwidth sound-programme circuits include:

7 kHz type circuits,
6.4 kHz type circuits,
5 kHz type circuits. 3)

The requirements in § 3 should be met by the hypothetical reference circuit as defined in CCIR Recommendation 502-1 [3].

2 Requirements at audio interconnection points

2.1 *Measurement of characteristics*

When measuring the characteristics of a circuit, the output should be terminated with a 600 ohm nonreactive load.

1) This Recommendation corresponds to CCIR Recommendation 503-1 [1].

2) CCIR Report 641 [2] was considered in renewing this Recommendation.

3) Sound-programme circuits of the 5-kHz type are widely used in North America.

2.2 *Impedance and matching conditions*

The audio-frequency input impedance should be 600 ohms balanced; the tolerance on this value is a matter for further study.

It is provisionally recommended that the output impedance be balanced with respect to earth and be so low that the output level in the nominal transmission range does not decrease by more than 0.3 dB if the open-circuit output is loaded with 600 ohms. This output impedance is intended for connection to a nominal load impedance of 600 ohms.

For amplifiers which are intended for direct connection to audio programme lines, the reactive part of the output impedance should be restricted. A maximum value of 100 ohms for the series reactance part of the output impedance at frequencies in the transmitted range is provisionally recommended.

2.3 *Relative level*

The relative level on a sound-programme circuit at the audio-frequency amplifier output should be fixed at +6 dBrs. [4)]

3 Performance of the hypothetical reference circuit

The values given should be met by circuits operating with analogue techniques. However, the international circuits which have equipments designed before the adoption of this Recommendation may have parameters different from those given here in § 3.

Special additional parameters concerning digital transmission are under study.

3.1 *Nominal bandwidth*

7 kHz type circuits: 0.05 to 7 kHz
6.4 kHz type circuits: 0.05 to 6.4 kHz
5 kHz type circuits: 0.07 to 5 kHz

3.2 *Insertion gain at 0.8 or 1 kHz*

This parameter is defined at a sending level of −12 dBm0 in accordance with Recommendation N.21 [4].

a) *Adjustment error*

Less than ± 0.5 dB

b) *Daily variation*

Less than ± 0.5 dB

3.3 *Gain/frequency response referred to 0.8 or 1 kHz*

This parameter is defined at a sending level of −12 dBm0 in accordance with Recommendation N.21 [4].

a) *7 kHz type circuits*

0.05 to 0.1 kHz: +1 to −3 dB
0.1 to 6.4 kHz: +1 to −1 dB
6.4 to 7 kHz: +1 to −3 dB

b) *6.4 kHz type circuits*

0.05 to 0.1 kHz: +1 to −3 dB
0.1 to 5 kHz: +1 to −1 dB
5 to 6.4 kHz: +1 to −3 dB

c) *5 kHz type circuits*

0.07 to 0.2 kHz: +1 to −3 dB
0.2 to 4 kHz: +1 to −1 dB
4 to 5 kHz: +1 to −3 dB

4) See the definition of zero-relative level in Recommendation J.14.

3.4 *Difference of group delay between the minimum value and the values at given frequencies*

a) *7 kHz type circuits*

0.05 kHz: < 80 ms
0.1 kHz: < 20 ms
6.4 kHz: < 5 ms
7 kHz: < 10 ms

b) *6.4 kHz type circuits*

0.05 kHz: < 80 ms
0.1 kHz: < 20 ms
5 kHz: < 5 ms
6.4 kHz: < 10 ms

c) *5 kHz type circuits*

0.07 kHz: < 60 ms
5 kHz: < 15 ms

3.5 *Maximum weighted noise level*

This parameter is defined by terms of a weighting network and a quasi-peak measuring instrument in accordance with CCIR Recommendation 468-2 (which is reproduced at the end of Recommendation J.16):

7 kHz type circuits −44 dBq0ps
6.4 kHz type circuits −39 dBq0ps
5 kHz type circuits −32 dBq0ps

Note 1 – If an r.m.s. measuring instrument is used, the measured value will be about 5 dB less than that for the quasi-peak measurement.

Note 2 – If the weighting network defined in the Recommendation cited in [5] is used, the measured value will be about 4 dB less.

Note 3 – Suitable values for unweighted noise cannot be recommended with precision, because such values depend upon the characteristics of the circuit noise. However, if an unweighted noise measurement is performed upon a sound-programme circuit just complying with the requirements for weighted noise and single tone interference, then the worst values expected to be found are −35 dBq0s or −40 dBm0s, and in most cases the values obtained will be several decibels better.

3.6 *Single tone interference*

This parameter (measured selectively) should not exceed (−73 − Δps) dBm0s. Δps is the correction for the frequency being considered which is given by the weighting characteristic in CCIR Recommendation 468-2 (which is reproduced at the end of Recommendation J.16).

3.7 *Disturbing modulation by power supply*

The highest-level unwanted side-component due to modulation of a sound-programme signal caused by interference from conventional a.c. line power supply sources should not be greater than −45 dB relative to the level of a sine-wave measuring signal applied to the sound-programme circuit (in accordance with CCIR Recommendation 474 [6]). The value for higher frequencies has to be determined (see CCIR Report 495-1 [7] and Study Programme 17F/CMTT [8]).

3.8 *Non-linear distortion*

Total harmonic distortion measured with fundamental signals at +9 dBm0:

– below 0.1 kHz: < 2%

– above 0.1 kHz: < 1.4%.

Third order difference tone measured at 0.18 kHz using signals of 0.8 and 1.42 kHz each at +3 dBm0: < 1.4%.

Note – If harmonic distortion is measured selectively the total harmonic distortion coefficient k should be calculated from the formula:

$$k = \sqrt{k_2^2 + k_3^2}$$

where

k_2 is the second order harmonic distortion coefficient and
k_3 is the third order harmonic distortion coefficient.

3.9 *Error in reconstituted frequency*

Less than 1 Hz.

Note – A maximum error of 1 Hz is in principle acceptable where there is only a single transmission path between the signal source and the listener.

When the broadcast network is composed of two or more parallel paths, e.g. commentary and separate sound channels, or radio broadcast from different transmitters on the same frequency, unacceptable beats may occur unless zero error can be assured. The CCITT is studying methods of effecting this in all recommended systems.

3.10 *Intelligible crosstalk ratio*

3.10.1 The near- or far-end crosstalk ratio (for speech) between two sound-programme circuits or between a telephone circuit (disturbing circuit) and a sound-programme circuit (disturbed circuit) should be at least 74 dB for the range 0.5 kHz to 3.2 kHz. For the range below 0.5 kHz and above 3.2 kHz it should be 74 dB reducing in value at a rate of 6 dB per octave.

3.10.2 The near- or far-end crosstalk ratio between a sound-programme circuit (disturbing circuit) and a telephone circuit (disturbed circuit) should be at least 65 dB.

Notes to § 3.10

Note 1 – It is understood that these values are defined between the relative levels applicable to telephony. An explanation of the relation between the relative levels for sound-programme circuits and telephone circuits is given in Annex A to Recommendation J.22.

Note 2 – The CCITT draws the attention of Administrations to the fact that it is in some cases difficult or impossible to meet these limits. This may occur when unscreened pairs are used for a long audio-frequency circuit (e.g. about 1000 km or longer), or in certain carrier systems on symmetric pair cables, or in the low frequency range (e.g. below about 100 kHz) in certain carrier systems on coaxial cables. When such difficulties arise, such systems or parts of systems should be avoided, if possible, for setting up programme channels.

Note 3 – Where a minimum noise level of at least 4000 pW0p is always present in the telephone channel (this may be the case in satellite systems, for example) a reduced crosstalk ratio of 58 dB between a sound-programme circuit and a telephone circuit is acceptable.

Note 4 – The CCITT draws the attention of Administrations to the fact that, because of crosstalk which may occur in terminal modulating and line equipment, special precautions may have to be taken to meet the above crosstalk limits between two sound-programme circuits, simultaneously occupying the go and return channels respectively of a carrier system (the most economical arrangement) because in those circumstances they occupy the same position in the line-frequency band (see Recommendation J.18).

Note 5 – The value indicated is based on the assumption that sine-wave test signals are used. The use of the test signal as described in Recommendation J.19 is under study.

Note 6 – The effect of crosstalk from a sound-programme circuit into a telephone circuit is not a question of secrecy, but rather of subjective disturbance by an interfering signal whose character is noticeably different from random noise or babble.

The frequency offset adopted for some sound-programme equipment allows a reduction of crosstalk from a telephone circuit into a sound-programme circuit. However in the reverse direction, this reduction of crosstalk remains only for speech material, but is practically ineffective for music material.

3.11 *Error in amplitude/amplitude response*

This parameter is defined by a step level signal $-6/+6$ dBm0 at 0.8 or 1 kHz: < 0.5 dB.

4 Estimations of transmission performance of circuits shorter or longer than the hypothetical reference circuit are under study (Study Programme 17D/CMTT [8]).

References

[1] CCIR Recommendation *Performance characteristics of narrow-bandwidth sound-programme circuits*, Vol. XII, Rec. 503-1, ITU, Geneva, 1978.

[2] CCIR Report *Performance characteristics of 5 kHz type sound-programme circuits*, Vol. XII, Report 641, ITU, Geneva, 1974.

[3] CCIR Recommendation *Hypothetical reference circuits for sound-programme transmissions*, Vol. XII, Rec. 502-1, ITU, Geneva, 1978.

[4] CCITT Recommendation *Limits and procedures for the lining-up of a sound-programme circuit*, Vol. IV, Fascicle IV.3, Rec. N.21.

[5] CCITT Recommendation *Psophometers (apparatus for the objective measurement of circuit noise)*, Green Book, Vol. V, Rec. P.53, Part B, ITU, Geneva, 1973.

[6] CCIR Recommendation *Modulation of signals carried by sound-programme circuits by interfering signals from power supply sources*, Vol. XII, Rec. 474, ITU, Geneva, 1978.

[7] CCIR Report *Noise from the power supply*, Vol. XII, Report 495-1, ITU, Geneva, 1974.

[8] CCIR Study Programme 17F/CMTT *Noise in sound-programme circuits from the power supply*, Vol. XII, ITU, Geneva, 1978.

[9] CCIR Study Programme 17D/CMTT *Estimation of transmission performance of sound-programme circuits shorter or longer than the hypothetical reference circuit*, Vol. XII, ITU, Geneva, 1978.

SECTION 3

CHARACTERISTICS OF EQUIPMENT AND LINES USED FOR SETTING UP SOUND-PROGRAMME CIRCUITS

Recommendation J.31

CHARACTERISTICS OF EQUIPMENT AND LINES USED FOR SETTING UP 15-kHz TYPE SOUND-PROGRAMME CIRCUITS

(Geneva, 1972; amended at Geneva, 1976 and 1980)

It is recognized that the overall objective given in Recommendation J.21 can be met by many different types of systems and that some solutions may be preferable to others for national networks, the choice depending on the particular requirements of an Administration.

It is, however, a basic objective of the CCITT to standardize a single solution to be adopted for international circuits. Furthermore, several Administrations have indicated that a single solution for international circuits will considerably ease the problem of providing these circuits.

The CCITT therefore recommends for international circuits the use of the solution described in § 1 below, in the absence of any other arrangement between the interested Administrations, including if necessary the Administrations of the transit countries. Other solutions which have been considered and are capable of meeting the recommended characteristics of Recommendation J.21 are described in Annexes A, B and C.

The characteristics of the group links, which have to be used in any case, are given in § 2 below.

1 Characteristics of an equipment allowing two 15-kHz type carrier-frequency sound-programme circuits to be established on a group (formerly Part A)

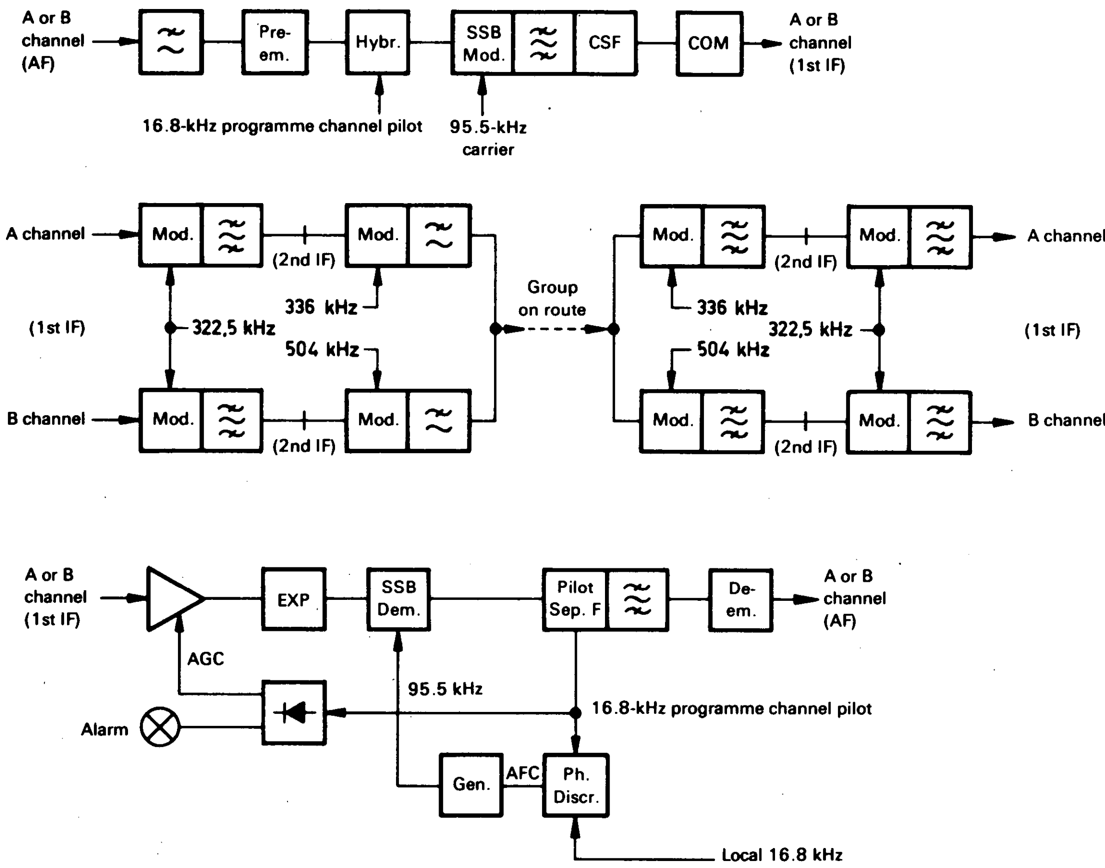
Introduction

An equipment allowing the establishment of 15-kHz type sound-programme circuits (in accordance with Recommendation J.21) on carrier telephone systems which conform to the noise objectives in Recommendation G.222 [1] is defined here. The use of this equipment does not cause either a mean or a peak load higher than that of the telephone channels which it replaces [1]. The two sound-programme circuits set up on one group can be used either as two independent monophonic circuits or as a pair of circuits for stereophonic transmissions.

[1] This is the objective given in Recommendation J.14 for new design of equipment.

The following, covering frequency position, pre-emphasis, compandor and programme-channel pilot, are to be considered as integral parts of the Recommendation, forming the complete definition of the equipment covered by this Recommendation.

The block schematic of a suitable equipment is given in Figure 1/J.31.



Pre-em.	=	pre-emphasis	Pilot Sep. F.	=	pilot separating filter
Hybr.	=	hybrid	De-em.	=	de-emphasis
Mod.	=	modulator	Ph. Discr.	=	phase discriminator
SSB mod.	=	single sideband modulator	AFC	=	automatic frequency control
CSF	=	carrier suppression filter	AGC	=	automatic gain control
EXP	=	expander	IF	=	intermediate frequency
COM	=	compressor	AF	=	audio frequency
SSB dem.	=	single sideband demodulator			

FIGURE 1/J.31

First modulation, auxiliary modulations and demodulation of the two-channel programme system

1.1 *Frequency position in the basic group 60-108 kHz*

The frequency position in the basic group is shown in Figure 2/J.31. For both programme channels, the tolerance on the virtual carrier frequency is ± 3 Hz and the programme-channel pilot is fed in as 16 800 ± 0.1 Hz in the audio-frequency position.

Note – Programme channel B can be replaced by telephone channels 1 to 6.

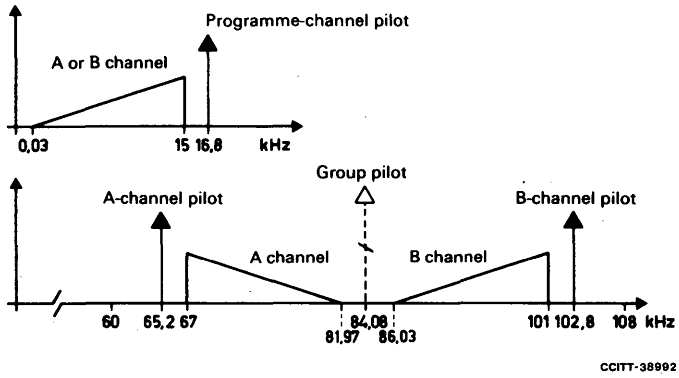


FIGURE 2/J.31

Line-frequency positions of the two-programme channels in the group

1.2 *Intermediate frequency position* (see 1st IF in Figure 3/J.31)

Figure 3/J.31 gives an example of a modulation scheme which is suitable for deriving the line frequency positions shown in Figure 2/J.31, and in which two intermediate frequency stages are used. It is recommended that the first intermediate frequency (1st IF) be identical for each of the sound-programme channels A and B, and the inverted sideband be used based on suppressed carrier of 95.5 kHz.

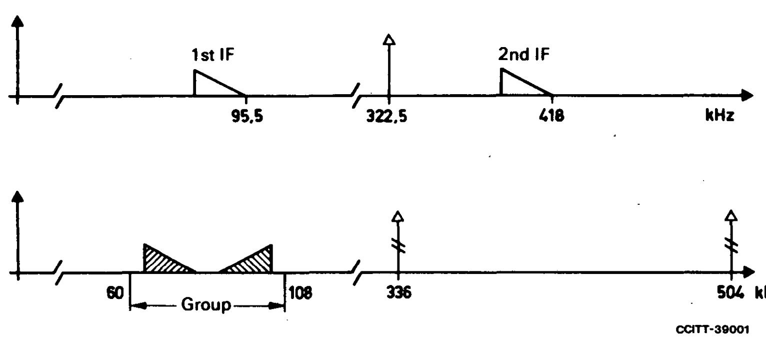


FIGURE 3/J.31

Modulation scheme for the two-channel programme system

It is possible to interconnect sound-programme channels at the 1st IF, but each of the two programme channels must be individually connected. At the intermediate frequency point the sound-programme signal has already been pre-emphasized and compressed, and sound-programme circuits may thus be interconnected at the 1st IF without introducing additional compandors.

The relative level at the interconnection point is similar to the relative level in the carrier telephone system in the basic group at the receiving end (−30.5 dBr). The absolute level is determined by the pre-emphasis and compressor; the long-term mean power of the sound signal (A or B channel) is about 250 μW0.

The nominal impedance chosen in this example is 150 ohms balanced with a 26-dB return loss.

The programme channel pilot is through connected at 95.5 − 16.8 = 78.7 kHz, at a level of −12 dBm0 in the absence of a programme signal.

Special through-connection filters for the sound-programme channel are not required. The bandpass filters at the output of the second modulation stage (receiving end) have sufficient stopband rejection.

1.3 *Pre-emphasis and de-emphasis*

Pre-emphasis and de-emphasis should be applied before the compressor and after the expander respectively in accordance with Recommendation J.17, the 800-Hz attenuation of the pre-emphasis being set to 6.5 dB.

1.4 *16.8-kHz pilot signal*

At the sending end the 16.8-kHz pilot signal is fed in after the pre-emphasis and before the following modulator and compressor with a level of −29 dBm0 ± 0.1 dB. In the absence of a programme signal, this pilot level is increased by 17 dB by the compressor to −12 dBm0(*t*) [2] on the carrier transmission path. After having passed through the expander, the pilot is branched off for control purposes after the demodulator and before the de-emphasis via a 16.8-kHz bandpass filter and is then suppressed in the transmission channel.

The control functions of the pilot are as follows: frequency and phase correction of the demodulator and compensation of the transmission loss deviations between compressor and expander. In view of the need to transmit stereophonic signals, the phase control should be sufficiently accurate so that the phase difference between the two channels does not exceed 1° even if the frequencies corresponding to the frequencies of the received pilots are in error by ± 2 Hz due to the carrier system.

1.5 *Compandor*

1.5.1 As shown in Figure 4/J.31 the compressor characteristic has a transition from the range of constant gain at low input levels to a range of constant loss at high input levels. Table 1/J.31 indicates the precise dependence of the compressor amplification as a function of the input level. The compressor and expander are controlled by the r.m.s. value of the sum of the voltages of programme and pilot signals.

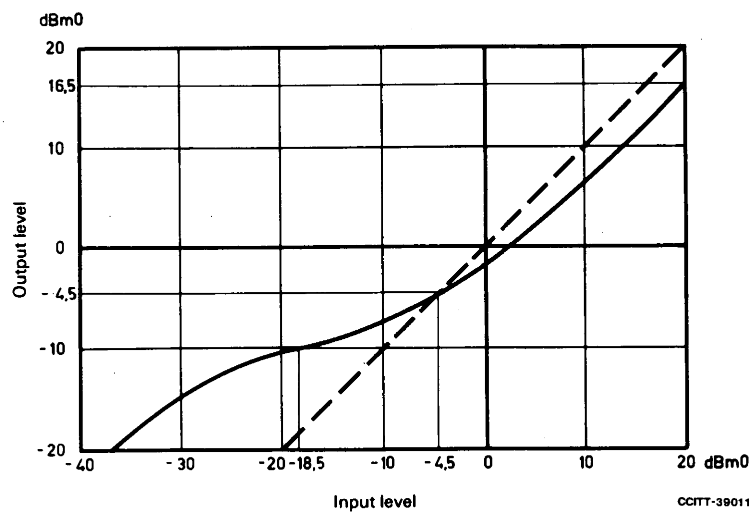


FIGURE 4/J.31

Characteristic of the compressor

---

2) dBm0(*t*) denotes that the level quoted is referred to a zero relative level point in a telephone channel.

In Table 1/J.31, the compressor is pre-loaded by the pilot; in the absence of both programme and pilot, the gain of the compressor reaches the value of 22 dB.

The amplification of the expander is complementary to that of the compressor. The tolerance should also be ± 0.5 dB, or ± 0.1 dB as shown in Table 1/J.31.

TABLE 1/J.31

Compressor characteristic

Programme signal level at the compressor input (dBm0)	Compressor gain (dB) (tolerance ± 0.5 dB except at the point marked * where the tolerance is ± 0.1 dB)
−∞	+ 17.0 *
−40.0	+ 16.9
−35.0	+ 16.5
−30.0	+ 15.6
−25.0	+ 13.2
−20.0	+ 9.7
− 15.0	+ 6.0 *
− 10.0	+ 2.7
− 5.0	+ 0.2
− 4.5	0.0
0.0	− 1.3
+ 3.0	− 2.0 *
+ 5.0	− 2.3
+ 10.0	− 2.9
+ 15.0	− 3.2
+20.0	− 3.5

1.5.2 The attack and recovery times of the compressor are measured in 12-dB steps (see Recommendations G.162 [2] and O.31 [3]) between the point of the unaffected level of − 4.5 dBm0 and the level of − 16.5 dBm0 and vice versa. In order to obtain as pronounced an envelope as possible in the oscillogram, the pilot is disconnected during this measurement and a test frequency is chosen which gives rise to an intermediate frequency that is approximately in the middle of the IF band. The attack and recovery times of the compressor are, as in Recommendation G.162 [2], the times between the instant when the output voltage of the compressor is suddenly changed and the instant when, after the sudden change, the output voltage passes the arithmetic mean value between initial and final values.

The nominal values of the times so measured are:

– attack time: 1 ms;

– recovery time: 2.8 ms.

The subject of tolerances for these values is a matter for further study.

The transient behaviour of the expander is observed with the compressor and expander interconnected. If the same steps are then applied to the compressor input, the signal at the expander output should not deviate from the final steady-state value by more than ± 10%.

Note – Since the initial and final values of the compressor output voltage in the case of this compandor are not in a 1:2 ratio because of the curved characteristic, the arithmetic means here are not 1.5 and 0.75, respectively, as in the case of the telephone compandor.

1.6 *Impedance at audio points*

The audio input-impedance should be 600 ohms balanced with a minimum return loss of 26 dB.

1.7 *Attenuation/frequency distortion due to the sending and receiving equipments*

The total attenuation distortion introduced by a sending and a receiving equipment should not exceed the following ranges:

40 to 125 Hz: +0.5 to −0.7 dB
125 Hz to 10 kHz: +0.3 to −0.3 dB
10 to 15 kHz: +0.5 to −0.7 dB

relative to the gain at 800 or 1000 Hz.

1.8 *Suppression of carrier leaks at 10 kHz and 14 kHz*

Since, according to Recommendation H.14 [4], carrier leaks may be of the order of −40 dBm0 and that Recommendation J.21, 3.1.6 requires a suppression to (−73 − Δps) dBm0s for single-tone interference, narrow-band crystal stop-filters should be available for insertion if required, and should have the following specifications:

1-dB bandwidth of the stopband

at 10 kHz: ⩽ ± 150 Hz
at 14 kHz: ⩽ ± 210 Hz

Attenuation for the midfrequencies

at 10 kHz: ⩾ 36 dB
at 14 kHz: ⩾ 22 dB

Note – The attenuation of these bandstop filters is sufficient without taking account of the compandor advantage.

The stopband attenuations should be maintained within ± 2 Hz referred to the above midfrequencies, in order to allow for the normal frequency variation of the carrier leaks.

In order to be able to use crystal bandstop filters of a simple design, it is recommended to assign them not to the AF position but to the corresponding IF position, additional allowance having to be made for the carrier frequencies used in the terminal equipment:

10 kHz corresponding to 85.5 kHz and
14 kHz corresponding to 81.5 kHz.

Note – Contribution COM XV-No. 31 (Study Period 1973-1976) from the Federal Republic of Germany gives details of the calculation and numerical data for a possible filter characteristic.

1.9 *Interconnection*

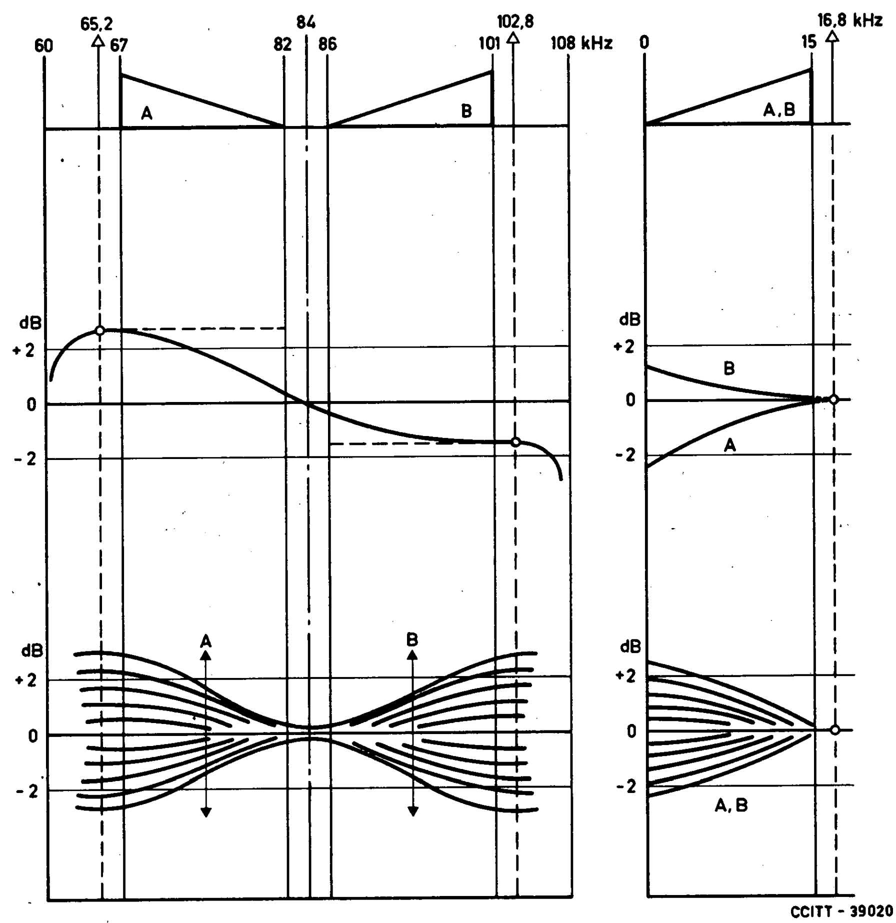
When sound-programme circuits employing equipment in conformity with this Recommendation are interconnected, it is recommended that, where possible, the through connection should be performed either in the group-frequency position or in the position of the 1st IF. As described in § 1.2 above, interconnection in these positions will exclude unnecessary compandor stages from the through connection.

1.10 *Equalizers for gain and phase difference*

In order to be able to meet the quality parameters specified in Recommendation J.21, § 3.1.3, for monophonic and §§ 3.2.1 and 3.2.2 for stereophonic sound-programme transmissions, gain and phase-difference equalizers in the group-frequency position have to be assigned to the sound-programme channel equipment before the hybrid at the receiving end. These equalizers can be switched in steps and their characteristics are adapted to the typical distortions by making them fan-shaped.

The gain equalizers are required to compensate for the frequency-dependent gain distortions in the lower and upper frequency ranges of the group on which the sound-programme channels are established. By means of the phase-difference equalizers, the phase distortion occurring in the group is increased in the upper or lower half of the group-frequency band to such an extent that a characteristic which is skew-symmetric about the centre frequency of the group is obtained, i.e. phase coincidence between the sound-programme channel positions.

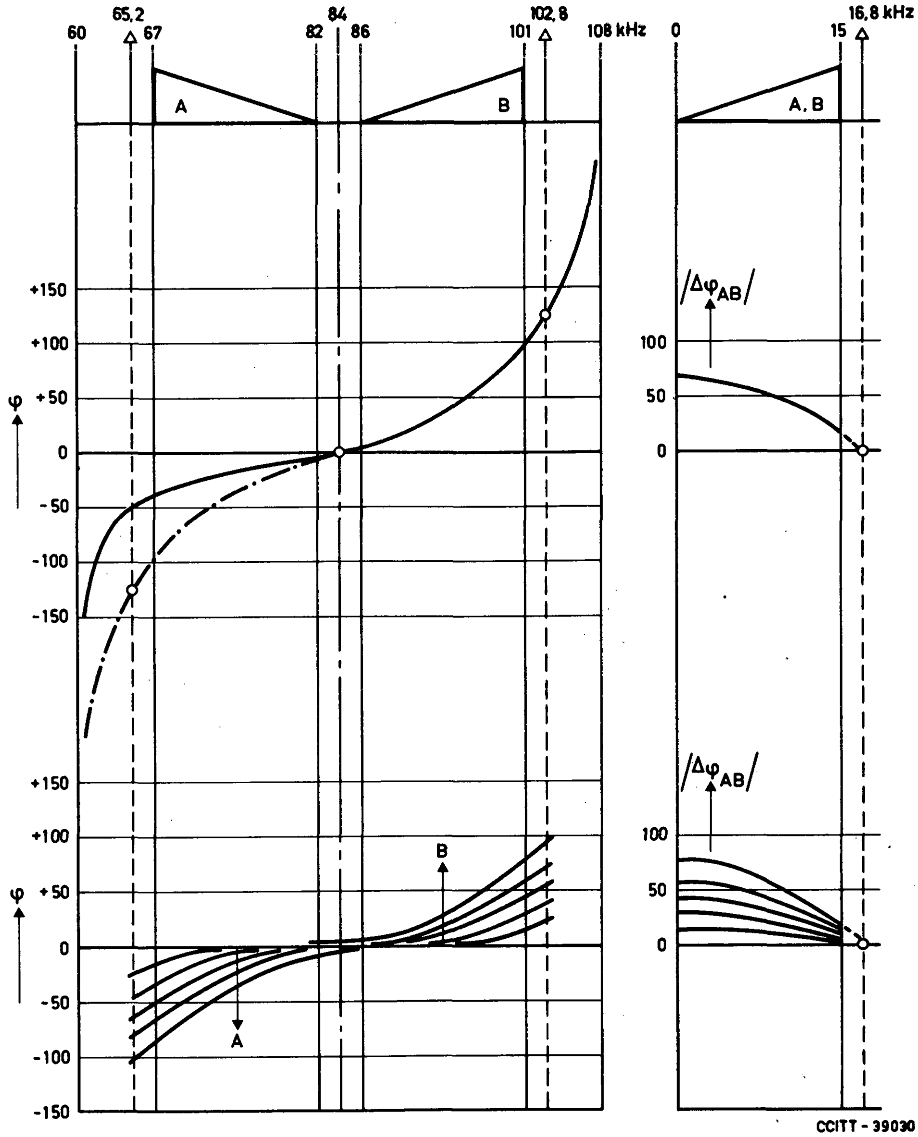
Figures 5/J.31 and 6/J.31 show the effectiveness of the gain and phase-difference equalizers within the frequency band of the group and their effects on gain and phase-difference of the sound-programme channels in the AF position. Here, allowance is made for the fact that deviations at the pilot frequency of 16.8 kHz in the AF position are always automatically adjusted to zero by means of the pilot regulation.



Top: Example of a gain distortion.
Bottom: Fan-shaped characteristics of the two gain equalizers.

FIGURE 5/J.31

Principle of gain equalization in the group-frequency position and its effect on the sound-programme channels in the AF position, allowance being made for the pilot regulation



Top: Example of phase symmetry distortion. Ideal skew-symmetric phase characteristic shown.
Bottom: Fan-shaped characteristics of the phase-symmetry equalizers.

FIGURE 6/J.31

Principle of phase-symmetry equalization in the group-frequency position and its effect on the phase difference between the sound-programme channels in the AF position, allowance being made for the pilot phase regulation

In order to facilitate international cooperation in determining the optimum equalizer setting within a very short time, the lining-up procedure and arrangement of measuring equipment detailed below is recommended.

At the sending end, this arrangement consists of a signal generator with a high level accuracy and a very low output impedance, which produces the measuring frequencies of 0.525 kHz (= 1/32) and 8.4 kHz (= 1/2) derived from the pilot frequency of 16.8 kHz. The two measuring frequencies should be transmitted simultaneously over both sound-programme channels, individually or at automatically alternating 3.9-second intervals. In the latter case the clock is obtained by a further division of 0.525 kHz by 2^{12}.

At the receiving end, use is made of a receiver having a calibrated measuring instrument which indicates the level in each of the two sound-programme channels and the phase-difference between them derived from the level of the voltage difference in the two channels. The received measuring frequency is indicated by a lamp. Since the frequency-dependent characteristic of the so-called fan equalizer used for gain and phase-difference equalization is defined for the individual steps, it is possible to confine oneself to the two measuring frequencies considered to be sufficiently representative when determining the optimum equalizer setting.

1.11 *Usable power reserve*

1.11.1 *Audio-frequency parts of the equipment* (before pre-emphasis and after de-emphasis):

1.11.1.1 *Peak power level*

The equivalent power level of the peak of sound-programme signals, when they are controlled in accordance with Recommendations J.14 and J.15 so as to have a quasi-peak power of +9 dBm0s, exceeds a level of about +12 dBm0s with a probability of 10^{-5}, as is documented by several Administrations (see CCIR Report 491-2 [5]). For the telephone service, the level with a probability of 10^{-5}, i.e. the level of +12 dBm0s, should be respected in any case.

1.11.1.2 *Margin against saturation*

A margin of 3 dB should be maintained between the peak power level in § 1.11.1.1 and the overload point, to allow for level variations.

1.11.1.3 *Overload point, definitions*

First definition – The **overload point** or overload level of an amplifier is at that value of absolute power level at the output, at which the absolute power level of the third harmonic increases by 20 dB when the input signal to the amplifier is increased by 1 dB.

This first definition does not apply when the test frequency is so high that the third harmonic frequency falls outside the useful bandwidth of the amplifier. The following definition may then be used:

Second definition – The **overload point** or overload level of an amplifier is 6 dB higher than the absolute power level in dBm, at the output of the amplifier, of each of two sinusoidal signals of equal amplitude and of frequencies A and B respectively, when these absolute power levels are so adjusted that an increase of 1 dB in both of their separate levels at the input to the amplifier causes an increase, at the output of the amplifier, of 20 dB in the intermodulation product of frequency 2A-B.

1.11.1.4 *Value of the overload point*

The overload point of these audio-frequency parts therefore should be higher than +15 dBm0s.

1.11.2 *Carrier-frequency parts of the programme modulating equipment (between compressor and telephone multiplex and between telephone multiplex and expander)*

The overload point, as defined in § 1.11.1.3 should have a margin of 2 dB against the equivalent peak power value of a group channel (+19 dBm0). The overload point of these carrier-frequency parts therefore should be higher than +21 dBm0.

1.11.3 *Complete equipment, back to back*

Test measurements should be possible without degradation visible on an oscilloscope:

– with one or two sine-wave test signals of any frequency with peak power levels up to +12 dBm0s,

– with tone pulses of any frequency with levels up to 0 dBm0s.

1.12 *Loading of groups and supergroups*

Table 2/J.31 gives some observed figures for the loading of groups and supergroups in the most essential cases.

TABLE 2/J.31

Loading of groups and supergroups in the case of sound-programme transmission with the carrier programme system recommended in CCITT Recommendation J.31, § 1

	n_m (dBm0)	n_p (dBm0)
Group		
12 telephone channels (as in Recommendation G.223 [6])	−4	+19
1 programme channel only	−6	+12
1 programme channel + 6 telephone channels	−3.5	+12 programme channel only
2 programme channels (different monophonic programmes)	−3	+13
1 stereophonic pair [a)]	−3	+17
2 programme channels (identical monophonic programmes)	−3	+17
Supergroup		
60 telephone channels (as in Recommendation G.223 [6])	+3	+21
4 programme channels in 2 groups + 36 telephone channels:		
4 different programmes	+3,5	+14 } programme channels only
2 different stereophonic programmes	+3.5	+18 } programme channels only
2 equal stereophonic programmes	+3.5	+22 } programme channels only
10 programme channels		
10 different programmes	+4	+15
5 different stereophonic programmes	+4	+19
2 equal stereophonic programmes + 6 different monophonic programmes	+4	+22

n_m Long-term mean power level [7].

n_p Equivalent peak power level [8] (= level of equivalent sine-wave whose amplitude is exceeded by the peak voltage of the multiplex signal only with a bilateral probability of 10^{-5}).

a) Loading by one stereophonic programme is treated as loading by two identical monophonic programmes (worst case).

2 Characteristics of a group link used to establish two 15-kHz type carrier-frequency sound-programme circuits (formerly Part B)

The lining-up of international group links is described in Recommendation M.460 [9] in which information is given on the attenuation/frequency characteristics which should be obtained. To comply with the attenuation/frequency characteristics of sound-programme circuits in accordance with Recommendation J.21, it may be necessary to include a small amount of additional equalization.

Group links for programme transmission have to meet special requirements concerning carrier leaks and other interfering frequencies so that programme transmission conforms to the standard as defined in Recommendation J.21.

The basic requirement is that interfering frequencies appearing in the programme bands have to be suppressed to (-73 – Δps) dBm0s on the programme circuit [3]. For frequencies corresponding to audio frequencies above 8 kHz, additional suppression is possible by special spike filters in the terminal equipment of the programme circuit.

Group links to be used for programme transmission according to Recommendation J.21 and using programme terminal equipment according to Recommendation J.31 have to meet, therefore, the following requirements:

a) Carrier leaks [4] at 68, 72, 96 and 100 kHz and any single-tone interference signal falling outside the band of frequencies used for sound-programme transmission including the pilots (see Figure 2/J.31) should not be higher than -40 dBm0. This allows the necessary suppression to (-73 – Δps) dBm0s taking account of the amount of the narrow-band crystal stop-filter attenuation.

b) Carrier leaks at 76, 80, 88 and 92 kHz and any other single-tone interference signal falling within the band of frequencies used for sound-programme transmission including the pilots (see Figure 2/J.31), should not be higher than:

   – for frequencies between 73 kHz and 95 kHz: -68 dBm0,

   – for frequencies at 67 kHz and 101 kHz: -48 dBm0.

   In the bands 67 to 73 kHz and 95 to 101 kHz the requirement is given by straight lines (linear frequency and dB scales) interconnecting the requirements given above [5].

It is necessary to consider whether additional requirements for the characteristics of group links for 15-kHz sound-programme transmission are needed beyond those covered in Recommendation M.460 [9] (for example, group delay distortion in the case of stereophonic transmission bearing in mind the possibility of changeover to stand-by paths).

The above requirements are illustrated in Figure 7/J.31.

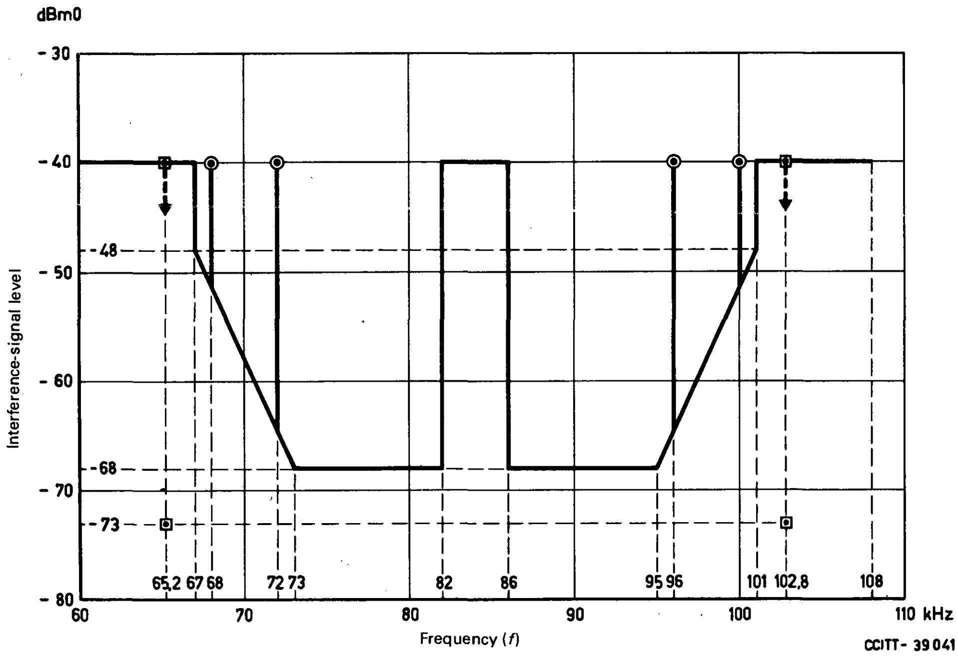
Note – Figure 8/J.31 gives the permissible level of single-tone interference for the systems described in Annexes A, B and C, such that the basic requirement of (-73 – Δps) dBm0s mentioned above is met.

---

3) This value has been specified in Recommendation J.21 by CMTT. CCIR Report 493-2 [10] gives some additional information regarding the subjective impairments produced by interfering frequencies on a circuit using equipment conforming to Recommendation J.31.

4) Having the frequency precision of carriers.

5) These values are still under study. It has been assumed that the compandor gives a subjective improvement of at least 12 dB. CMTT is asked to confirm that this assumption is valid.



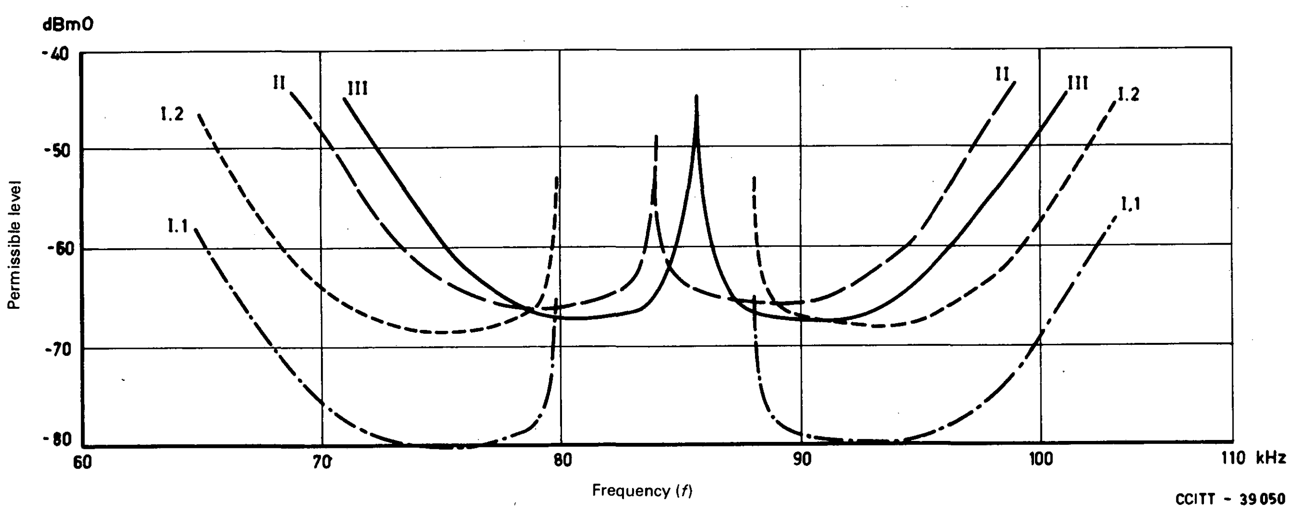
The continuous curve represents the general requirements for single-frequency interfering tones, with the following exceptions:

◉ carrier-leak frequencies at which the requirements are relaxed to −40 dBm0 are shown thus.

◘ at frequencies of A- and B-channel pilots, 65.2 and 102.8 kHz ±300 Hz interfering signals should be at least 40 dB below the lowest possible level of the pilots (i.e. −29 dBm0 −3.5 dB when compressor input signal is large).

FIGURE 7/J.31

Mask for the carrier leaks and any other tone-interference signal falling within the group band



Curve I.1: requirement for the system of Annex A, *without* compandor gain.
Curve I.2: requirement for the system of Annex A, *with* compandor gain.
Curve II: requirement for the DSB system of Annex B.
Curve III: requirement for the system of Annex C.

FIGURE 8/J.31

Permissible level of a single-frequency interference on the group link

ANNEX A

(to Recommendation J.31)

Single sideband system

(Contribution of the N.V. Philips Telecommunicatie Industrie)

This Annex concerns a single-sideband sound-programme transmission equipment incorporating pre- and de-emphasis combined with a compandor characterized by a separate FM control channel.

The equipment operates on group links of carrier telephone systems.

Both peak and average loads to the group are compatible with those of the replaced telephone channels.

A.1 *Frequency allocation in the group*

TABLE A-1/J.31

	Modulated programme frequencies	Compandor control channel	Synchronizing pilot
Channel A (inverted)	65 . . . . . 79.96 kHz	81.39 . . . 83.18 kHz	84 kHz
Channel B (erect)	88.04 . . . 103 kHz	84.82 . . . 86.61 kHz	

Channels A and B (see Table A-1/J.31) can be used for independent monophonic sound-programme circuits or combined into a stereophonic pair. Either channel A or B can be deleted and substituted by the corresponding telephone channels.

Group pilots at 84.08, 84.14 and 104.08 kHz and telephone channels 1 and 12 are compatible with this frequency allocation.

A.2 *Pre-emphasis*

Pre-emphasis takes place before compression by means of a network according to Recommendation J.17. The insertion loss at 800 Hz is 6.5 dB.

A.3 *Compandor*

A.3.1 *Steady-state characteristics*

The compandor has a separate frequency-modulated control channel containing the information on the degree of compression, as indicated in Table A.2/J.31.

For the lowest programme levels, the total improvement in signal-to-noise ratio will be 19.8 dB (when weighting by means of a psophometer according to the Recommendation cited in [11]).

TABLE A-2/J.31

Compressor input level (dBm0)[a]	Compressor gain (dB)	Control channel frequency (kHz)	
		Channel A	Channel B
$-\infty$	17	81.39	86.61
-40	17	81.39	86.61
-35	16.9	81.40	86.60
-30	16.7	81.41	86.59
-25	15.9	81.43	86.57
-20	13.5	81.52	86.48
-15	9.5	81.70	86.30
-10	4.8	81.94	86.06
-5	0	82.24	85.76
0	-4.9	82.56	85.44
$+5$	-9.6	82.90	85.10
$+10$	-11.8	83.18	84.82
$+15$	-11.8	83.18	84.82

[a] The relative level at the compressor input to be considered is 6.5 dB higher than that corresponding to an 800-Hz audio-frequency test-tone. With pre-emphasis and compressor, an audio input level of e.g. +6.5 dBm0s at 800 Hz will thus give rise to a compressor input level of 0 dBm0 and hence to a group level of -4.9 dBm0(t).

The level in the control channel is -17 dBm0(t).

The expander gain tracks that of the compressor with a tolerance of ± 0.5 dB.

dBm0(t) denotes that the level quoted is referred to a 0 relative level point in a telephone channel.

dBm0s denotes that the level quoted is referred to the sound-programme circuit.

A.3.2 *Transient behaviour of the compressor*

Considering a 12-dB level step at the compressor input from -17 dBm0 to -5 dBm0 (point of unaffected level), the compressor attack time is defined as the time interval needed for the compressor output voltage to reach the arithmetical mean between initial and final values.

Taking the sudden level variation in the opposite direction yields the definition of the compressor recovery time.

The nominal values of attack and recovery time are respectively 2.4 and 4 ms.

A.3.3 *Transient behaviour of the expander*

With compressor and expander interconnected and when applying at the compressor input sudden level variations from -17 dBm0 to -5 dBm0 and vice versa, the expander output voltage should not deviate by more than 10% from the steady-state values.

A.4 *Synchronizing pilot*

A synchronizing pilot at 84 kHz with a level of -20 dBm0(t) is used in order to reduce frequency and phase errors due to the group link.

Frequency offset is reduced by a factor of 21.

At the transmitting and receiving terminals, the modulating and demodulating carriers should be phase-coherent with the synchronizing pilot in such a way that a frequency offset of 2 Hz does not give rise to a phase difference between the two channels of the stereophonic pair exceeding 1°.

ANNEX B

(to Recommendation J.31)

Double-sideband system

(Contribution of L.M. Ericsson, ITT and Telettra)

B.1 *Frequency allocation*

Double-sideband modulation of a carrier frequency of 84.080 kHz. The sidebands are located in the band 69.080-99.080 kHz. The carrier is reduced in level, so that it can be used in the normal way for a group pilot.

B.2 *Pre-emphasis*

The pre-emphasis curve given in Recommendation J.17 should be used.

B.3 *Compandors*

Compandors are not an integral part of these systems.

B.4 *Levels of programme signal in carrier system*

The levels are such that a sine wave of 800 Hz applied at the audio input with a level of 0 dBm0s will appear at the group output, having been through a pre-emphasis network, as two sideband frequencies each with a level of +2 dB compared to the relative level of the telephone channels, that is +2 dBm0(t). This level should be adjustable over a range of about ± 3 dB.

B.5 *Group regulation*

Normal group regulation is available using 84.080 kHz. This frequency had the normal level and tolerances for a pilot as given in the Recommendation cited in [12].

B.6 *Carrier regeneration*

Different versions of this system rely respectively on the correct phase of the group pilot or on the use of an auxiliary pilot above the programme band (16.66 kHz or 16.8 kHz, for example, has been proposed for national systems); a frequency of 16.8 kHz should be reconsidered for international use; the sending terminal should, where necessary, be adapted to meet the needs of the receiving terminal in either respect. The level of any auxiliary pilot should not exceed −20 dBm0(t), i.e. referred to the telephone channel level in the group.

ANNEX C

(to Recommendation J.31)

Transmitting of six sound-programme circuits on a supergroup link

(Contribution of Società Italiana Telecomunicazioni Siemens SpA)

A system for setting up on group links one monophonic programme circuit or two circuits combined into a stereophonic programme, is described in [13] and is widely used in Italy.

A new type of equipment for the transmission of six programme channels allocated in the band of a basic supergroup has been developed and successfully adopted experimentally.

The essential characteristic of this system is the utilization of a single sideband, modulated in amplitude, with a suppressed carrier of 86 kHz and a synchronous demodulation using a 16.8-kHz pilot in order to have no errors in the transmitted frequencies and no errors in the phase relation between the signals A and B for stereophonic programmes.

The carrier of 86 kHz is suitable for allocating the programme signal to that sideband which is unaffected by telephone carrier leaks and for avoiding intelligible crosstalk between telephone and programme channels.

The single-sideband modulation employs the phase-shift technique. By means of this the programme channel is allocated either to the lower sideband between 71 and 86 kHz or to the upper sideband between 86 and 101 kHz.

In a second modulation procedure the six sound-programmes are allocated to the band of the basic supergroup 312-552 kHz with the carriers 346 kHz, 382 kHz, 418 kHz, 454 kHz, 490 kHz and 526 kHz.

The measurements carried out show that the system complies with the values recommended in Recommendation J.21 for the high-quality circuits with equipments whose price renders the system economical, even for distances of some hundreds of kilometres.

Note – The system is described in Contribution COM XV-No. 151 (Study Period 1973-1976).

References

[1] CCITT Recommendation *Noise objectives for design of carrier-transmission systems of 2500 km*, Vol. III, Fascicle III.2, Rec. G.222.

[2] CCITT Recommendation *Characteristics of compandors for telephony*, Vol. III, Fascicle III.1, Rec. G.162.

[3] CCITT Recommendation *Specification for an automatic measuring equipment for sound-programme circuits*, Vol. IV, Fascicle IV.4, Rec. O.31.

[4] CCITT Recommendation *Characteristics of group links for the transmission of wide-spectrum signals*, Vol. III, Fascicle III.4, Rec. H.14.

[5] CCIR Report *Characteristics of signals sent over sound-programme circuits*, Vol. XII, Report 491-2, ITU, Geneva, 1978.

[6] CCITT Recommendation *Assumptions for the calculation of noise on hypothetical reference circuits for telephony*, Vol. III, Fascicle III.2, Rec. G.223.

[7] *Ibid.*, § 1.

[8] *Ibid.*, § 6.2.

[9] CCITT Recommendation *Bringing international group, supergroup, etc., links into service*, Vol. IV, Fascicle IV.1, Rec. M.460.

[10] CCIR Report *Compandors for sound-programme circuits*, Vol. XII, Report 493-2, ITU, Geneva, 1978.

[11] CCITT Recommendation *Psophometers (apparatus for the objective measurement of circuit noise)*, Green Book, Vol. V, Rec. P.53, Part B, ITU, Geneva, 1973.

[12] CCITT Recommendation *Pilots on groups, supergroups, etc.*, Vol. III, Fascicle III.2, Rec. G.241, §§ 2 and 3.

[13] CCITT Recommendation *Performance characteristics of equipment and lines used for setting up sound-programme circuits*, Green Book, Vol. III-2, Rec. J.31, Annex 3, ITU, Geneva, 1973.

CHARACTERISTICS OF EQUIPMENT AND LINES USED FOR SETTING UP 10-kHz TYPE SOUND-PROGRAMME CIRCUITS

(former Recommendation J.22; amended at Geneva, 1964, and Mar del Plata, 1968)

10-kHz type sound-programme circuits can be provided in wideband cables by the following methods:

1 Special pairs for sound broadcasting

If a broadcast programme is to be distributed to a number of intermediate points along the line (if this includes carrier telephone systems), it may be necessary to use a pair of conductors with a special screen for programme transmissions; or it may happen that it is preferable to transmit the broadcast programme over the carrier system itself or on the phantom of the unloaded pairs.

It should be remembered, however, that interstice pairs in a coaxial cable are principally intended for the maintenance and supervision of the telephone carrier system routed over the coaxial pairs.

2 10-kHz sound-programme circuits routed over channels of a carrier telephone system in cable

It is recommended to use the frequency band corresponding to three telephone channels of a carrier system to form a 10-kHz type sound-programme circuit. One such assembly of three channels may be used in this matter in a 12-circuit group.

The CCITT has already recommended the position defined below as Position I for this assembly of three channels to provide programme transmission in basic group B.

Position I: Frequency band used: 84-96 kHz
Virtual carrier frequency: 96 kHz

The CCITT no longer recommends the use of Position II, defined in the old Recommendation (*Red Book*, Volume III), in the international service.

The CCITT recommends also the following frequency arrangements in the basic Group B:

Position III: Frequency band used: 84-96 kHz
Virtual carrier frequency: 95.5 kHz

This position may be adopted whether a compandor is used or not.

Supplement No. 12 of the *Green Book* [1] indicates the improvement in crosstalk to be expected from offset of the carrier frequency and in particular from the use of Position III.

Note – Some Administrations use a pilot inserted in the audio-frequency part of the sound-programme modulation equipment for the purpose of regulating the equivalent and supervising the link as a whole.

While, generally speaking, the provision of automatic group regulation should suffice to ensure satisfactory stability of the equivalent, a pilot like the one suggested by one of these Administrations might be useful when compandors (which increase variations of the equivalent) are used, or when the switching of sound-programme circuits to RF is envisaged or when frequency synchronization is required between the ends of the circuit.

With the limit that has been given in Recommendation J.14 for the "peak voltage" transmitted by one such assembly of three channels, these assemblies (used for sound-programme transmissions) may be placed in any basic group (or in all the basic groups) of a supergroup (or in all supergroups) of a carrier system on coaxial cable.

The CCITT has not limited the possible positions (in the basic supergroup) of the groups over which 10-kHz type sound-programme circuits can be routed, but it can be said that the basic groups (in a supergroup) which appear most appropriate for such circuits are groups 2, 3 and 4. These groups are subject to less attenuation distortion at the edges (produced by certain filters in the supergroup) than groups 1 and 5. The most appropriate supergroups in which to place the sound-programme circuits are those which are transmitted on the coaxial cable with the lowest carrier frequencies, because the frequency deviation (due to instability of the frequency generators) on the channels of these groups will be proportionately lower than the deviation on channels in supergroups transmitted at a high frequency. Supergroup 2 (the basic supergroup) has the additional advantage of having one stage of modulation less than the other supergroups.

In the case of a carrier system on symmetric pairs, it may be necessary to make a special choice of the group of the system and the pairs to be used in order that the conditions concerning crosstalk for the complete sound-programme circuit will be satisfied. (See Recommendations J.18 and J.22.)

3 Use of phantom circuits on unloaded symmetric pairs equipped with carrier systems

Experience has shown that the phantom circuits of symmetric pairs in cables equipped with carrier systems may allow transmission (as defined in Recommendation J.22, § 1) from 50 Hz to 10 000 Hz. These circuits have the advantage that derivations at various repeater stations of the carrier system can easily be made, thus allowing the distribution of a radio programme or the picking up of a supplementary programme at various points along the line.

When such phantom circuits are used over long distances, it may be necessary to provide manual or automatic regulation to compensate for changes of attenuation with time.

4 Use of the band of frequencies below 12 kHz

The use of phantom circuits (see § 3 above) naturally depends on a multiple twin or a star quad cable being available. If only a pair cable is available, a possible solution would be to place the sound-programme transmission in the frequency band below 12 kHz, i.e. below the frequency band used for the carrier telephone channels; but this solution involves difficulties with filters or with crosstalk balancing frames, if any exist.

Reference

[1] *Intelligibility of crosstalk between telephone and sound-programme circuits*, Green Book, Vol. III-2, Supplement No. 12, ITU, Geneva, 1973.

Recommendation J.33

CHARACTERISTICS OF EQUIPMENT AND LINES USED FOR SETTING UP 6.4-kHz TYPE SOUND-PROGRAMME CIRCUITS

(former Recommendation J.31, A; amended at Geneva, 1972)

The CCITT recommends that, when an Administration wishes to provide a sound-programme circuit transmitted on a carrier system using a frequency band corresponding to two telephone channels, the circuit should occupy the frequency range 88 kHz to 96 kHz in the basic 12-channel group B frequency band and the virtual carrier frequency within this range should be 96 kHz, or as an alternative, 95.5 kHz [1)].

1) For the choice of groups and supergroups used, see Recommendation J.32.

CHARACTERISTICS OF EQUIPMENT USED FOR SETTING UP 7-kHz TYPE SOUND-PROGRAMME CIRCUITS

(Geneva, 1980)

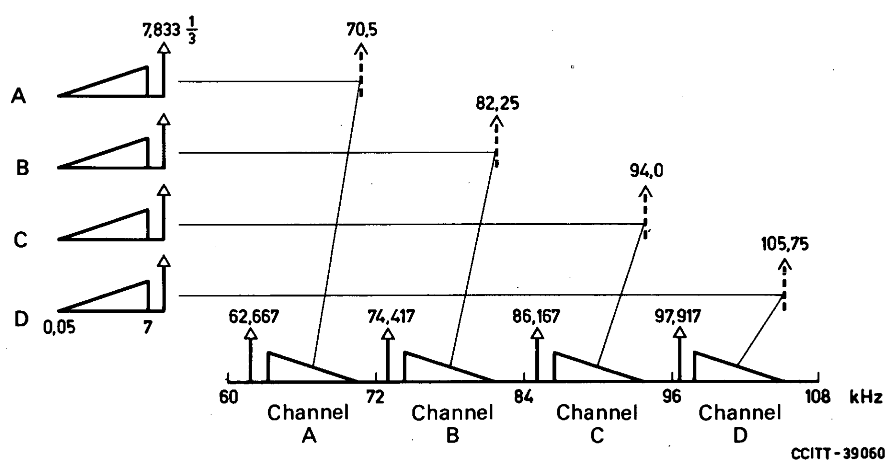
Introduction

An equipment allowing the establishment of 7-kHz type sound-programme circuits (in accordance with CCIR Recommendation 503-1 [1]) on carrier telephone systems which conform to the noise objectives in Recommendation G.222 [2] is defined here. The use of this equipment does not cause either a mean or a peak load higher than that of the telephone channels which it replaces. The sound-programme circuits set up on one group can be used only as monophonic circuits.

The following recommendations, covering frequency position, pre-emphasis, compandor and programme-channel pilot, are to be considered as integral parts of the Recommendation, forming the complete definition of the equipment covered by this Recommendation.

1 Frequency position in the basic group 60-108 kHz

The frequency position in the basic group is shown in Figure 1/J.34. For the programme channels, the stability of the virtual carrier frequency is $\pm 10^{-5}$ and the programme-channel pilot is fed in as 7833 1/3 Hz (stability better than $\pm 10^{-5}$) in the audio-frequency position.



Note – The carrier frequencies are multiples of 11.75 kHz and can be derived from a common generator frequency.

FIGURE 1/J.34
Frequency allocation for four 7-kHz type sound-programme channels set up on one group

Note 1 – Programme channel D can be replaced by telephone channels 1 to 3; programme channel C by telephone channels 4 to 6; programme channel B by telephone channels 7 to 9; programme channel A by telephone channels 10 to 12.

Note 2 – The use of programme channel D is only compatible with group pilots at 84.14 and 84.08 kHz, but not at 104.08 kHz. Moreover, this channel cannot be used in Group 3 of a supergroup with a 411.92-kHz pilot or a 411.86-kHz pilot.

The frequency positions are as shown in Table 1/J.34.

TABLE 1/J.34

Channel range (kHz)	Virtual carrier frequency [a] (kHz)
60 to 72	70.5 Inverted position
72 to 84	82.25 Inverted position
84 to 96	94 Inverted position
96 to 108	105,75 Inverted position

[a] The carrier frequencies are multiples of 11.75 kHz and can be derived from a common generator frequency.

2 Pre-emphasis and de-emphasis

Pre-emphasis and de-emphasis should be applied before the compressor and after the expander respectively in accordance with Recommendation J.17, the 800-Hz attenuation of the pre-emphasis being set to 6.5 dB.

3 7833 1/3-Hz pilot signal

At the sending end, the 7833 1/3-Hz pilot signal is fed in after the pre-emphasis and before the following modulator and compressor with a level of -29 dBm0 $\pm$ 0.1 dB (the relative level at this point being defined under the assumption that the compressor is switched off and replaced by 0 dB loss). In the absence of a programme signal, this pilot level is increased by 14 dB by the compressor to -15 dBm0 on the carrier transmission path. After having passed through the expander, the pilot is branched off for control purposes after the demodulator and before the de-emphasis via a 7833 1/3-Hz bandpass filter and is then suppressed in the transmission channel.

The control functions of the pilot are frequency regeneration of the demodulator and compensation of the transmission loss deviations between compressor and expander. The frequency regeneration of the demodulator should be sufficiently accurate so that the frequency offset between the audio-frequency (AF) programmes at the transmit end and at the receive end is less than 0.6 Hz even if the frequency offset of the group connection is 2 Hz.

4 Compandor

The characteristic of the compressor is the same as in Recommendation J.31, § 1.5.1 with the only exception that the output level is decreased by 3 dB. The maximum compressor gain is 14 dB, the minimum compressor gain is -6.5 dB. With an input level of -18.5 dBm0, its output level is -13 dBm0.

The tolerance of the compressor gain is $\pm$ 0.5 dB, but it is $\pm$ 0.1 dB at programme signal levels at the compressor input of $-\infty$, -15 and $+3$ dBm0 (in agreement with Table 1/J.31).

The amplification of the expander is 3 dB larger than that given in Recommendation J.31, § 1.5.1.

5 Attenuation/frequency distortion due to the sending and receiving equipments

The total attenuation/frequency distortion introduced by a sending and a receiving equipment should not exceed the following preliminarily recommended ranges:

0.05 to 0.1 kHz: +0.7 to −1.0 dB
0.1 to 6.4 kHz: +0.5 to −0.5 dB
6.4 to 7 kHz: +0.7 to −1.0 dB

relative to the gain at 800 or 1000 Hz.

Note – These values are still under study. Three carrier sections with two intermediate audio points according to the hypothetical reference circuit (h.r.c.) (Recommendation J.11) should comply with the CCIR Recommendation cited in [3].

6 Suppression of carrier leaks

Carrier leaks which, after demodulation, fall into the AF programme band should have a level lower than −68 dBm0 in the carrier frequency position.

A carrier leak at, and residuals from pilots in the vicinity of, 64 kHz with a level above −68 dBm0 will generate an intolerable single-tone interference at 6.5 kHz in channel A. If required, it may be suppressed sufficiently with a lowpass filter at the AF output of channel A. Then this channel can be used for a 5-kHz type sound-programme circuit.

References

[1] CCIR Recommendation *Performance characteristics of narrow-bandwidth sound-programme circuits*, Vol. XII, Rec. 503-1, ITU, Geneva, 1978.

[2] CCITT Recommendation *Noise objectives for design of carrier-transmission systems of 2500 km*, Vol. III, Fascicle III.2, Rec. G.222.

[3] CCIR Recommendation *Performance characteristics of narrow-bandwidth sound-programme circuits*, Vol. XII, Rec. 503-1, § 3.3.1, ITU, Geneva, 1978.

SECTIONS 4 AND 5

Sections 4 and 5 have not yet been allocated.

PAGE INTENTIONALLY LEFT BLANK

PAGE LAISSEE EN BLANC INTENTIONNELLEMENT

SECTION 6

CHARACTERISTICS OF CIRCUITS FOR TELEVISION TRANSMISSIONS

Former Recommendations J.61 and J.62 of Volume III-2 of the *Orange Book* have been cancelled. The corresponding CCIR Recommendations have been combined into the new CCIR Recommendation 567, which refers to all television standards and colour systems. This new Recommendation 567 and some other texts from CCIR may be very useful for television transmissions via cable, and reference is given to the following CCIR Recommendations, published in Volume XII (of the XIV Plenary Assembly of the CCIR), ITU, Geneva, 1978.

Recommendation J.61

TRANSMISSION PERFORMANCE OF TELEVISION CIRCUITS DESIGNED FOR USE IN INTERNATIONAL CONNECTIONS

(Geneva, 1980)

(See CCIR Recommendation 567)

Recommendation J.62

SINGLE VALUE OF THE SIGNAL-TO-NOISE RATIO FOR ALL TELEVISION SYSTEMS

(Geneva, 1980)

(See CCIR Recommendation 568)

Recommendation J.63

INSERTION OF TEST SIGNALS IN THE FIELD-BLANKING INTERVAL OF MONOCHROME AND COLOUR TELEVISION SIGNALS

(Geneva, 1980)

(See CCIR Recommendation 473-2)

Recommendation J.64

DEFINITIONS OF PARAMETERS FOR AUTOMATIC MEASUREMENT OF TELEVISION INSERTION TEST SIGNALS

(Geneva, 1980)

(See CCIR Recommendation 569)

Recommendation J.65

STANDARD TEST SIGNAL FOR CONVENTIONAL LOADING OF A TELEVISION CHANNEL

(Geneva, 1980)

(See CCIR Recommendation 570)

Recommendation J.66

TRANSMISSION OF ONE SOUND PROGRAMME ASSOCIATED WITH ANALOGUE TELEVISION SIGNAL BY MEANS OF TIME DIVISION MULTIPLEX IN THE LINE SYNCHRONIZING PULSE

(Geneva, 1980)

(See CCIR Recommendation 572)

SECTION 7

GENERAL CHARACTERISTICS OF SYSTEMS FOR TELEVISION TRANSMISSION OVER METALLIC LINES AND INTERCONNECTION WITH RADIO-RELAY LINKS

Recommendation J.73 [1)]

USE OF A 12-MHz SYSTEM FOR THE SIMULTANEOUS TRANSMISSION OF TELEPHONY AND TELEVISION

(amended at Geneva, 1964 and 1980)

The 12-MHz system on 2.6/9.5-mm coaxial cable pairs and its use for telephony transmission is defined in Recommendation G.332 [1]. The corresponding 12-MHz system on 1.2/4.4-mm coaxial pairs is defined in Recommendation G.345 [2].

Any 12-MHz system equipped for television transmission should be capable of transmitting the signals used in all those television systems defined in CCIR Report 624-1 [3] having a video bandwidth up to 5.5 MHz [if necessary, by means of the switching (in terminal equipments only) of certain components].

1 Carrier frequency

The CCITT recommends the use of a carrier frequency of 6799 kHz with a tolerance of ± 100 Hz for the transmission of all the television signals indicated above. The video band transmitted over the cable should be 5.5-MHz wide, whatever television system is to be used. The level provisionally recommended for this carrier has been defined for the interconnection points and is shown in Figures 1/J.73 and 2/J.73 (see Note 3 to these figures).

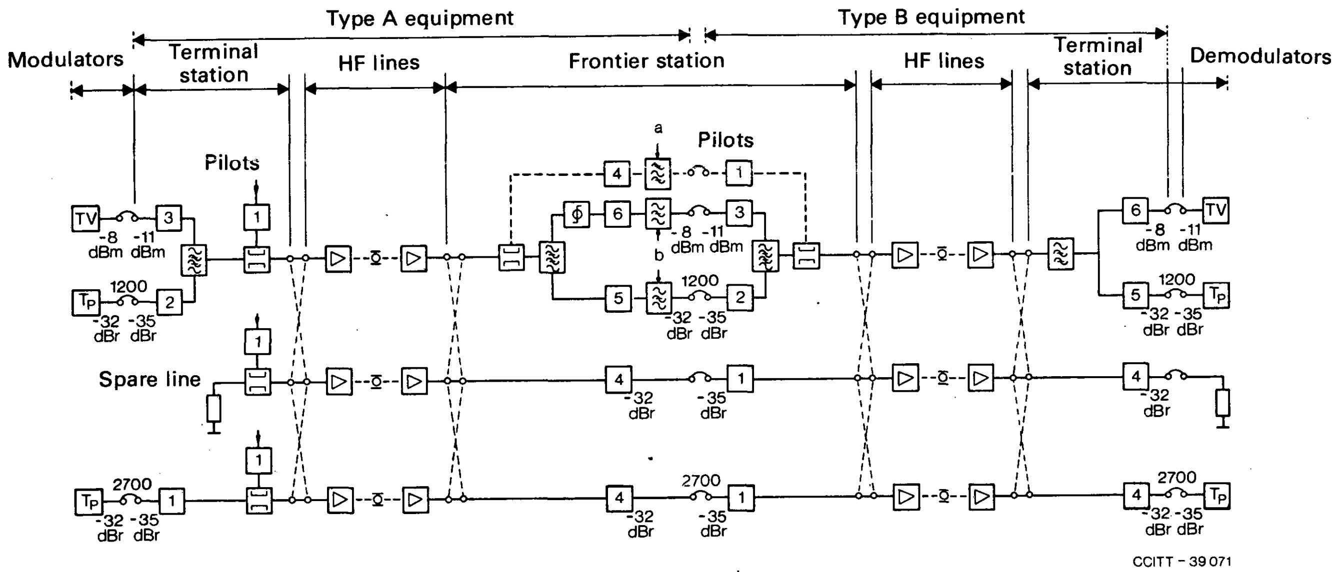
2 Modulation ratio

Amplitude modulation has to be used. The modulation ratio has to be higher than 100% (as indicated in Figure 3/J.73), so that, when the carrier is modulated by a signal corresponding to blanking level its amplitude is equal to that of the carrier when it is modulated by a signal corresponding to the white level, assuming that the d.c. component is transmitted.

When Test Signal No. 2 is applied at a video junction point, the nominal peak voltage of the modulated carrier, at a point where the relative level for the television transmission is zero, should be as follows:

- for white or blanking level, 0.387 volt (i.e. the peak voltage of a sine-wave signal dissipating a power of 1 mW in a resistance of 75 ohms);
- for the synchronizing signals, 0.719 volt (i.e. the peak voltage of a sine-wave signal dissipating a power of 3.45 mW in a 75-ohm resistance).

1) Recommendations J.71 and J.72 of Volume III-2 of the *Orange Book* have been deleted.



1 4 pre-emphasis (respectively de-emphasis) for telephony 2700 channels

2 5 pre-emphasis (respectively de-emphasis) for telephony 1200 channels } simultaneous transmission

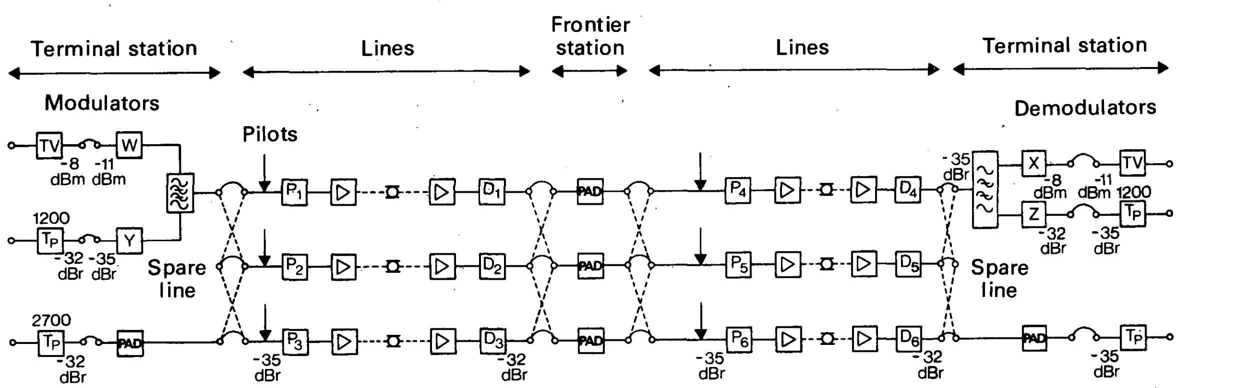
3 6 pre-emphasis (respectively de-emphasis) for television

a pilot pass-filter

b pilot stop-filter

FIGURE 1/J.73

General case of interconnection of 12-MHz lines



Complement of line

Nominal relative levels on the line for each telephone channel in the "all-telephony" case

W X differential pre-emphasis and de-emphasis for television

Y Z differential pre-emphasis and de-emphasis for telephony 1200 channels } common for all types of 12-MHz line

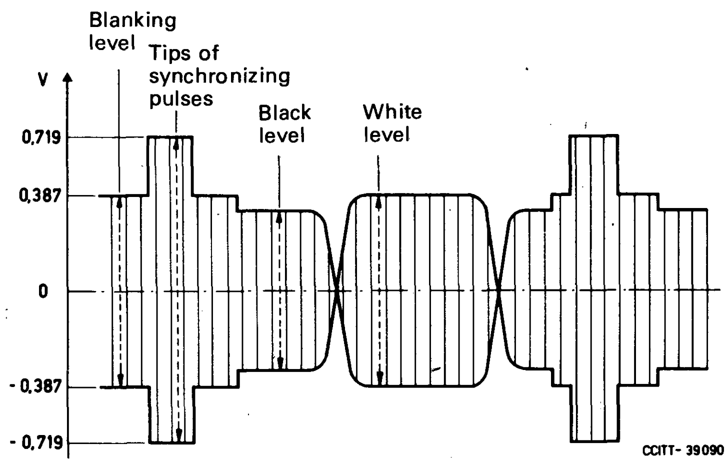
P1 D1 pre-emphasis and de-emphasis for telephony, 2700 channels, particular to each design of 12-MHz line

Notes to Figures 1/J.73 and 2/J.73

1. Interconnection of pilots, e.g. blocking and re-injecting or by-passing, should be agreed between Administrations.
2. The level of the line pilots is fixed at – 10 dBm0 for the all-telephony case. When the line is used to transmit telephony and television simultaneously, different values of pre-emphasis may be required; although the absolute levels of the pilots will remain the same, they may no longer be at – 10 dBm0.
3. The television levels shown are those of the modulated carrier, relative to the white or blanking level (0dBm) of the idealized reference signal described in § 2 of this Recommendation. This means that the television levels are indicated in dBm values.
4. The characteristics of the filters in Figure 1/J.73 (used for separating and combining the telephony and television bands so that the necessary arrangements for pre-emphasis and de-emphasis can be made) must be agreed between Administrations.

FIGURE 2/J.73

Showing use of differential emphasis networks to simplify interconnection of 12-MHz lines of different designs



Note – The voltages shown are the values measured at a zero relative level point for television transmission in the 12-MHz system.

FIGURE 3/J.73
Envelope of carrier modulated by Test Signal No. 2

3 Vestigial-sideband shaping

The shaping of the vestigial-sideband signal has to be carried out entirely at the transmit point. Provisionally, the vestigial sideband should not exceed a width of 500 kHz. Figure 4/J.73 shows the frequency arrangement recommended for television transmission over the 12-MHz system.

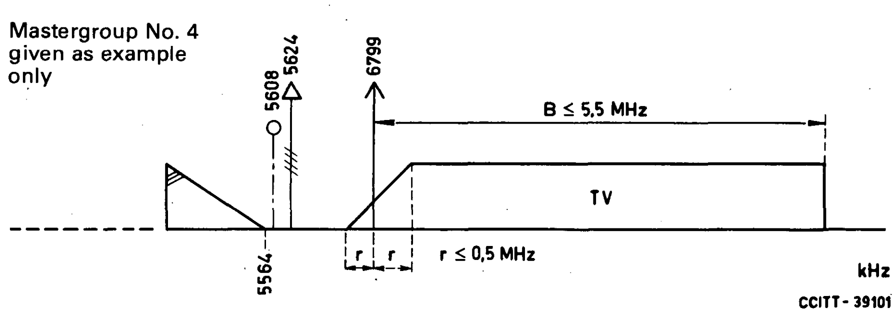


FIGURE 4/J.73
Frequency allocation for television on a 12-MHz system

4 Relative power levels and interconnection at a frontier section

It is not possible to recommend relative power levels at the output of intermediate repeaters since they are very closely linked to the inherent design of each Administration's system.

When interconnection between two telephone systems is effected via a cable section that crosses a frontier, in accordance with Recommendation G.352 [4], each Administration should accept, on the receiving side, the level conditions which normally apply to the incoming system used in the other country. It may be possible to comply with this condition simply by insertion of a correcting network at the receiving end. The repeater section crossing the frontier should then be less than 4.5 km long, the details being agreed directly between the Administrations concerned before the repeater stations are sited.

Where a line is to be used alternatively for "all-telephony" or for "telephony-plus-television", such a solution is not generally applicable. In this case, one of the frontier stations may act as a main station having the necessary types of pre-emphasis and de-emphasis networks to permit interconnection at flat points at the recommended levels. Figure 1/J.73 shows how this may be done in the general case and also shows how, at terminal stations, the same interconnections levels are used when connecting the line to telephony and television translating equipment.

However, if a common differential characteristic can be agreed for all types of 12-MHz line, then free interconnection of the full line-bandwidth becomes possible, both nationally (e.g. between working and spare lines) and internationally (between national systems of different designs). This method leads to the simpler interconnection arrangement of Figure 2/J.73.

In this arrangement, the circuit is always lined up for "all-telephony". For telephony-plus-television, the emphasis characteristic used for the "all-telephony" case is modified by the insertion, at the terminal equipment stations only, of differential pre-emphasis and de-emphasis networks additional to those used for "all-telephony" transmission.

5 Matching of repeater to the line

The return loss between repeater input and output impedances and a non-reactive resistance of 75 ohms should be at least 20 dB at the carrier frequency used for television.

The limit permitted for such return loss may decrease progressively to 15 dB at the upper and lower edges of the band of frequencies transmitted for television.

Note – Under these conditions, at the 6799-kHz carrier frequency and at adjacent frequencies, the overall resultant value of echo in a single repeater section of normal length (sum of the three terms as defined in Annex A) that is obtained is considerably better than the value of 70 dB recommended. The value of 70 dB is, in fact, easily achieved throught the transmitted band.

6 Interference

Recommendation J.61, § 3.3 [5] indicates the overall values relative to the hypothetical reference circuit for television transmissions which are taken as objectives for design projects.

In the experience of certain Administrations, the weighted psophometric power can be distributed between the terminal equipment and the line in the ratio of 1 to 4.

In particular, the Administration of the Federal Republic of Germany uses, for the 12-MHz system, the following signal-to-weighted noise ratio:

- for terminal modulation equipment: 70 dB
- for terminal demodulation equipment: 64 dB
- for a line 840 km in length: 58 dB

These values result in a signal-to-noise ratio of 52 dB at the end of the reference circuit.

ANNEX A

(to Recommendation J.73)

Impedance matching between repeaters and coaxial pair in television transmission

Such impedance matching, for television systems having repeater sections of about 9 km, was formerly specified by stating an overall limit, as follows (taken from pages 269 and 270 of Volume III *bis* of the CCIF *Green Book*, Geneva, 1956).

"Let:

Z_L be the measured line impedance at frequency f see from a repeater station (see Figure 1);

Z_E the measured output impedance at frequency f of the repeater station equipment seen from the line;

Z_R be the measured input impedance at frequency f of the repeater station equipment seen from the line;

A be the total line attenuation al, at frequency f, between two adjacent repeater stations, a being the measured attenuation coefficient of the coaxial pair and l the distance between the two adjacent repeater stations concerned.

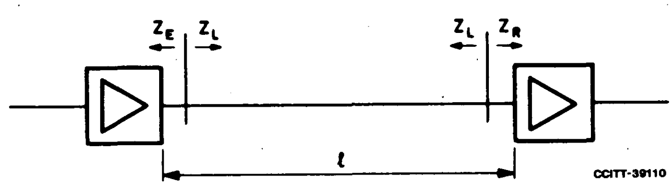


FIGURE 1

Repeater section of a coaxial pair

Then the value N is defined by the formula

$$N = 2A + 20 \log_{10} \left| \frac{Z_E + Z_L}{Z_E - Z_L} \right| + 20 \log_{10} \left| \frac{Z_L + Z_R}{Z_L - Z_R} \right| \text{ (dB)}$$

Provisionally the condition indicated below should be met.

In the case of a television transmission system, N should be of the order of 70 dB at frequencies adjacent to the virtual carrier frequency used for the line transmission. At frequencies remote from the carrier frequency, lower values of N might be acceptable."

Since then, the CCITT has recommended limits for return loss at the input and output of repeaters, as given in the following Recommendations:

- Recommendation J.71 [6], for the 4-MHz system and Recommendation J.72 [7], for the 6-MHz system both of which have approximately 9-km repeater sections and a carrier frequency of 1056 kHz;

- Recommendation J.73, § 5, for the 12-MHz system, with approximately 4.5-km repeater sections and a carrier frequency of 6799 kHz.

These give more stringent limits than the overall limit shown above, which becomes redundant for these systems. However, if in the future the CCITT should define other television transmission systems having a large number of closely spaced repeaters, this overall limit may again become important; in that case it will be necessary to revise and correct the old recommendation quoted above, using more precise terms to specify the impedances concerned.

References

[1] CCITT Recommendation *12-MHz systems on standardized 2.6/9.5-mm coaxial cable pairs,* Vol. III, Fascicle III.2, Rec. G.332.

[2] CCITT Recommendation *12-MHz systems on standardized 1.2/4.4-mm coaxial cable pairs,* Vol. III, Fascicle III.2, Rec. G.345.

[3] CCIR Report *Characteristics of television systems,* Vol. XI, Report 624-1, ITU, Geneva, 1978.

[4] CCITT Recommendation *Interconnection of coaxial carrier systems of different types,* Vol. III, Fascicle III.2, Rec. G.352.

[5] CCITT Recommendation *Specifications for a long-distance television transmission (system I excepted),* Orange Book, Vol. III-2, Rec. J.61, § 3.3, ITU, Geneva, 1977.

[6] CCITT Recommendation *4-MHz system for television transmission,* Orange Book, Vol. III-2, Rec. J.71, f), ITU, Geneva, 1977.

[7] CCITT Recommendation *6-MHz system for television transmission,* Orange Book, Vol. III-2, Rec. J.72, g), ITU, Geneva, 1977.

Recommendation J.74

METHODS FOR MEASURING THE TRANSMISSION CHARACTERISTICS OF TRANSLATING EQUIPMENTS

1 No special measuring method is necessary for the carrier.

2 An oscilloscope can be used, for example, to measure the modulation ratio.

3 No special method is recommended for measuring pre-emphasis.

4 An oscilloscope can be used, for example, to measure the voltages at the input to the modulating equipment and the output from the demodulating equipment.

5 The following is an example of a method which can be used to measure the random noise at the modulator output:

The input and output video terminals of the modulator are closed with 75-ohm resistances and the modulator is set to give an output carrier power of 1 mW. The random noise power can then be measured with a selective measuring instrument, and the result is given relative to the video-frequency bandwidth for the television system concerned.

To measure noise produced by the demodulator, 1 mW of carrier power is sent to its input, and the random noise at the output is measured at the output terminals with a selective measuring instrument.

This method can also be used to measure parasitic noise having a recurrent waveform.

Note – Methods for measuring parasitic noise in television are being studied.

INTERCONNECTION OF SYSTEMS FOR TELEVISION TRANSMISSION ON COAXIAL PAIRS AND ON RADIO-RELAY LINKS

1 Television transmission only

Direct video transmission over long, e.g. more than about 15 km, coaxial cables is unsatisfactory, because of the likelihood of picking up interference and the difficulties of low-frequency equalization: it is therefore necessary to transmit the television signal as a modulated carrier transmission, usually with a vestigial sideband.

On the other hand, the television signal can be transmitted directly in the baseband of a radio-relay system as a video signal; in general it is advantageous to do so, since this minimizes distortion and enables a better signal-to-noise ratio to be obtained as compared with a modulated signal with vestigial sideband, transmitted in the baseband. This procedure is recommended by the CCIR.

Interconnection between television channels on radio-relay and cable systems will therefore normally take place at video frequencies.

Levels and impedances at interconnection points should then conform to Recommendation J.61 [1].

Exceptionally, in special cases, the video signal can be transmitted over short cables or a vestigial-sideband television signal can be transmitted on short radio-relay links, to allow direct interconnection at line frequencies (radio-relay link baseband). Special arrangements may be necessary in such cases in respect of signal level, pre-emphasis and pilots, to maintain the recommended standard of transmission performance.

2 Telephony and television transmission, alternatively or simultaneously, on coaxial pairs or radio-relay links

2.1 *Interconnection between a coaxial cable system having alternative transmission of telephony and television and a radio-relay link with the same alternative transmission*

It is recommended that the following conditions should be met at the interconnection point:

- For telephony transmission, the frequency arrangements, the relative power levels of the telephone channels and the frequency of the pilots should be as indicated in Recommendation G.423 [2].
- For television transmission, interconnection should generally be made at video frequencies. Levels and impedances at interconnection points should then conform to Recommendation J.61 [1].

2.2 *Interconnection between a coaxial system having simultaneous telephony and television transmission and a radio-relay link with the same simultaneous transmission*

On all radio-relay links designed for such simultaneous transmission it is intended to transmit video-frequency television signals in the lower part of the baseband and telephony signals in the upper part. Since these arrangements are incompatible with those which are recommended by the CCITT for simultaneous telephony and television transmission on coaxial cables (Recommendation J.73), it will normally be possible to consider interconnection at video frequencies only for the television channel, and interconnection at group, supergroup, mastergroup or supermastergroup points for telephony.

However, by agreement between the Administrations concerned, direct interconnection may be achieved in special cases on a short system (on cable or radio) by using a frequency allocation recommended for the other type of system.

References

[1] CCITT Recommendation *Specifications for a long-distance television transmission (system I excepted)*, Orange Book, Vol. III-2, Rec. J.61, ITU, Geneva, 1977.

[2] CCITT Recommendation *Interconnection at the baseband frequencies of frequency-division multiplex radio-relay systems*, Vol. III, Fascicle III.2, Rec. G.423.

Recommendation J.77 [1)]

CHARACTERISTICS OF THE TELEVISION SIGNALS TRANSMITTED OVER 18-MHz AND 60-MHz SYSTEMS

(Geneva, 1980)

For television transmission on 18-MHz and 60-MHz systems, a modulation procedure has to be used which is independent of the structure of the signal to be transmitted. This is achieved by a reference carrier which defines the phase relationship between the transmit and receive side.

The transmission channel is capable of transmitting the signals used in all those television systems defined by the CCIR, in accordance with Report 624-1 [1].

The requirements to be met by the 18-MHz and 60-MHz transmission systems are to be found in Recommendations G.334 [2] and G.333 [3].

It is recommended that the following conditions be met:

1 Vestigial sideband shaping

The shaping of the vestigial sideband signal has to be carried out entirely at the transmit side. The vestigial sideband shall not exceed a width of 1 MHz, i.e. the width of the Nyquist slope shall not exceed 2 MHz.

2 Video pre-emphasis

With regard to a more uniform loading of the coaxial line systems, it is recommended to use a video pre-emphasis network. The video pre-emphasis curve and the corresponding formula are shown in Figure 1/J.77. The video pre-emphasis amounts to 9 dB.

3 Nominal reference level of the modulated video signal

As a consequence of using a video pre-emphasis network, it is necessary to define a reference level at a suitable video frequency. It is recommended that this reference level be derived from the level of a single sideband measured after the Nyquist filter when a 1-kHz sine wave is transmitted having a peak-to-peak amplitude of 0.7 volt at the video interconnection point. The reference level is this measured level plus 6 dB. The reference level is recommended to be +11 dBm0.

4 Accuracy of carrier frequencies

The carrier frequency of the first modulation stage should have a tolerance not exceeding 11 Hz. Tolerances of the carrier frequencies for the higher modulation stages can be ignored if either Recommendation G.225 [4] is met or if the carriers are derived from the relevant TV channel-pair pilots (see [5] and [6]).

5 Reference carrier

In order to enable accurate demodulation of the signal at the receive side, it is necessary to transmit a reference carrier.

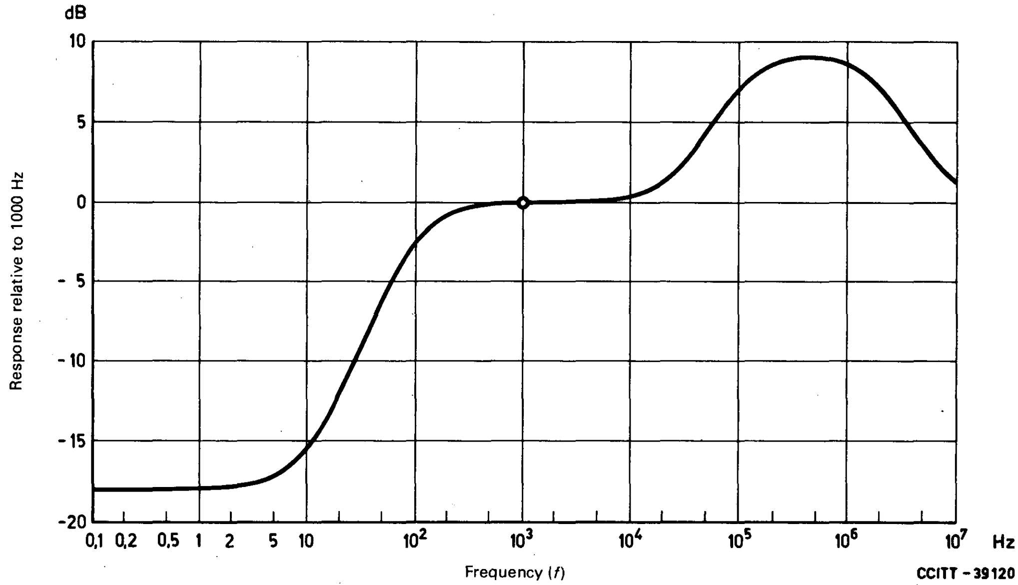
The following characteristics are recommended:

- carrier frequency of the first modulation stage corresponding to the video frequency of 0 Hz;
- polarity negative, i.e. such that the amplitude of the modulated video signal is greater at black than at white;
- nominal power level: +10 dBm0, independent of signal level.

6 Low frequency suppression

In order to prevent disturbance of the reference carrier by the low frequency components of the video signal, it is necessary to reduce the level of the low frequency components. A low frequency suppression of 18 dB is recommended. The low frequency suppression curve and the corresponding formula are shown in Figure 1/J.77.

1) Recommendation J.76 of Volume III-2 of the *Orange Book* has been deleted.



Video pre-emphasis: $10\log_{10}(1+a) + 10\log_{10}\left[1 + \dfrac{a}{\left(\dfrac{Q}{V}\right)^2 + 1}\right]$

where

$V = \dfrac{f}{f_0} - \dfrac{f_0}{f}$ $\qquad Q = 14.5$

$a = 7$ $\qquad f_0 = 450$ kHz

Low frequency suppression: $-10\,_{10}\,\dfrac{b^2 + (2\pi\tau f)^2}{1 + (2\pi\tau f)^2}$

where

$b = 8$
$\tau = 14$ ms

FIGURE 1/J.77

Frequency response of video pre-emphasis and low frequency suppression relative to the value at 1 kHz

References

[1] CCIR Report *Characteristics of television systems*, Vol. XI, Report 624-1, ITU, Geneva, 1978.

[2] CCITT Recommendation *18-MHz systems on standardized 2.6/9.5-mm coaxial pairs*, Vol. III, Fascicle III.2, Rec. G.334.

[3] CCITT Recommendation *60-MHz systems on standardized 2.6/9.5-mm coaxial cable pairs*, Vol. III, Fascicle III.2, Rec. G.333.

[4] CCITT Recommendation *Recommendations relating to the accuracy of carrier frequencies*, Vol. III, Fascicle III.2, Rec. G.225.

[5] CCITT Recommendation *60-MHz systems on standardized 2.6/9.5-mm coaxial cable pairs*, Vol. III, Fascicle III.2, Rec. G.333, § 8.4, Note 2.

[6] CCITT Recommendation, *18-MHz systems on standardized 2.6/9.5-mm coaxial pairs*, Vol. III, Fascicle III.2, Rec. G.334, § 9.4.2, Note.

PAGE INTENTIONALLY LEFT BLANK

PAGE LAISSEE EN BLANC INTENTIONNELLEMENT

PART III

SUPPLEMENTS TO H AND J SERIES RECOMMENDATIONS

PAGE INTENTIONALLY LEFT BLANK

PAGE LAISSEE EN BLANC INTENTIONNELLEMENT

Supplement No. 5

MEASUREMENT OF THE LOAD OF TELEPHONE CIRCUITS

(Referred to in Recommendations G.223 and H.51; this supplement is to be found in Fascicle III.2)

Supplement No. 12

INTELLIGIBILITY OF CROSSTALK BETWEEN TELEPHONE AND SOUND-PROGRAMME CIRCUITS

(Referred to in Recommendation J.32; this supplement is to be found on page 610 of Volume III of the *Green Book*, Geneva, 1972.)

Supplement No. 16

OUT-OF-BAND CHARACTERISTICS OF SIGNALS APPLIED TO LEASED TELEPHONE-TYPE CIRCUITS

(Geneva, 1980; referred to in Recommendation H.51)

Joint Working Party LTG collected for information some data on the out-of-band power of signals applied to leased telephone-type circuits.

The following constitutes a summary of the data collected so far.

1 Out-of-band components accompanying signals applied to voice-band leased circuits (Contribution of the United Kingdom Post Office)

In the United Kingdom it is considered essential to restrict the level of out-of-band components accompanying voice-band signals for the following purposes:

1) to allow the harmonious coexistence (as far as possible) in the local paired network of an increasing variety of services, e.g., subscriber carrier systems, visual telephone, data, etc., all of which are susceptible to crosstalk from wanted (or unwanted) signals applied to other pairs in the local network;

2) to reduce interference with adjacent channels where voice-band signals are extended over normal carrier telephone systems;

3) to reduce the amount of out-of-band interference thrown back into voice-band signals when these are extended over PCM systems.

The out-of-band components considered can originate in several ways: for example, as out-of-band components generated along with the voice-band signals themselves, such as harmonics, or as insufficiently suppressed by-products of encoding processes.

Taking into account the effect of the factors described above and the characteristics of the signals concerned, limits have been derived for the spectral distribution of energy for the out-of-band components with which voice-band attachments must comply before they are allowed to be connected to the network. The same limits serve to indicate the level of unrelated out-of-band signals which may be presented to the receiving attachment. The limits currently used in the United Kingdom are shown in Figure 1 and these illustrate one way of specifying limiting values derived from such studies.

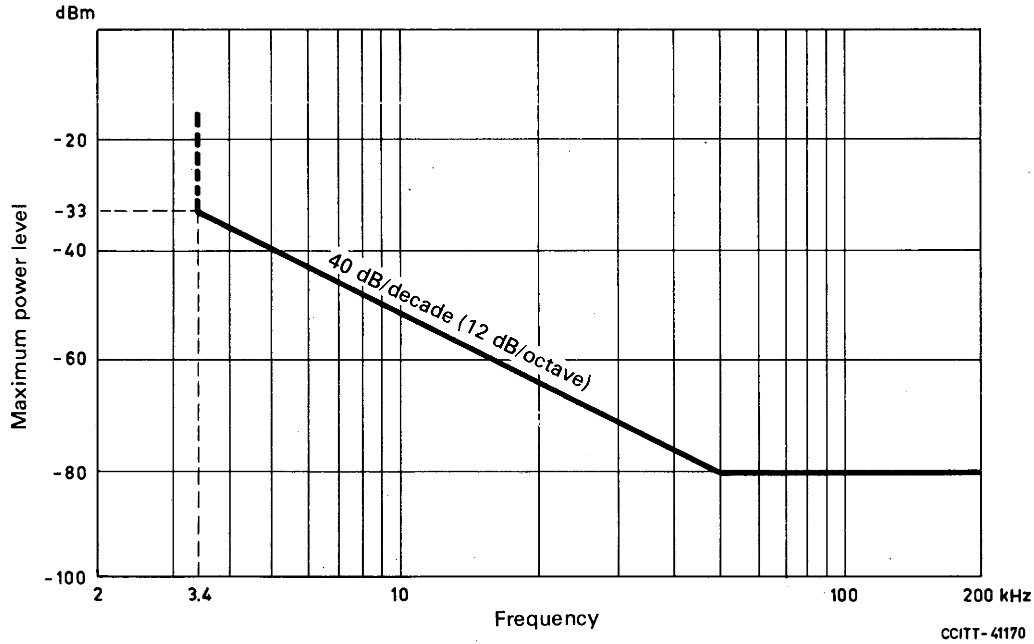


FIGURE 1

Maximum power level of individual spectral components above 3.4 kHz of the output signal from apparatus connected to voice-band circuits

As an example of a particular study (but one which is not claimed as exhaustive), consideration is given here to the implicit interaction of PCM channelling equipment with some other services and systems, arising from the limits given in the Recommendation cited in [1].

Some comments arising from this example are also included.

It is assumed that the audio input/output terminals of PCM equipment may be connected:

i) to a local distribution pair,

ii) to another PCM multiplex, or

iii) to an FDM multiplex.

The connection may be permanent (in the case of private circuits) or switched for the duration of a call. In the case of the distribution pair this may be carrying at the same time an HF service such as a 1 + 1 subscriber carrier system.

2 Rule adopted on the French network concerning limitation of the out-of-band power for transmission of signals of services other than telephony (Contribution of the French Administration)

The rule at present applied on the French network regarding the out-of-band send power spectrum of signals of services other than telephony (facsimile, phototelegraphy, data, telegraphy, etc.) transmitted on telephone-type circuits is as follows:

P_{0-4} the power of the signal transmitted to the line by the subscriber equipment in the 0-4 kHz band

P_{4-8} the power in the 4-8 kHz band

P_{8-12} the power in the 8-12 kHz band

$P_{4n-4(n+1)}$ the power in the band 4n-4 (n+1) kHz.

The power spectrum measured at the sending end, in the most unfavourable case, i.e., for the signal transmitted to the line with the widest spectrum, must be such that:

$$10 \log_{10} \frac{P_{0-4}}{P_{4-8}} \geq 20 \text{ dB}$$

$$10 \log_{10} \frac{P_{0-4}}{P_{8-12}} \geq 35 \text{ dB}$$

$$10 \log_{10} \frac{P_{0-4}}{P_{4n-4(n+1)}} \geq 55 \text{ dB}$$

for n integer ≥ 3.

These conditions are shown in Figure 2.

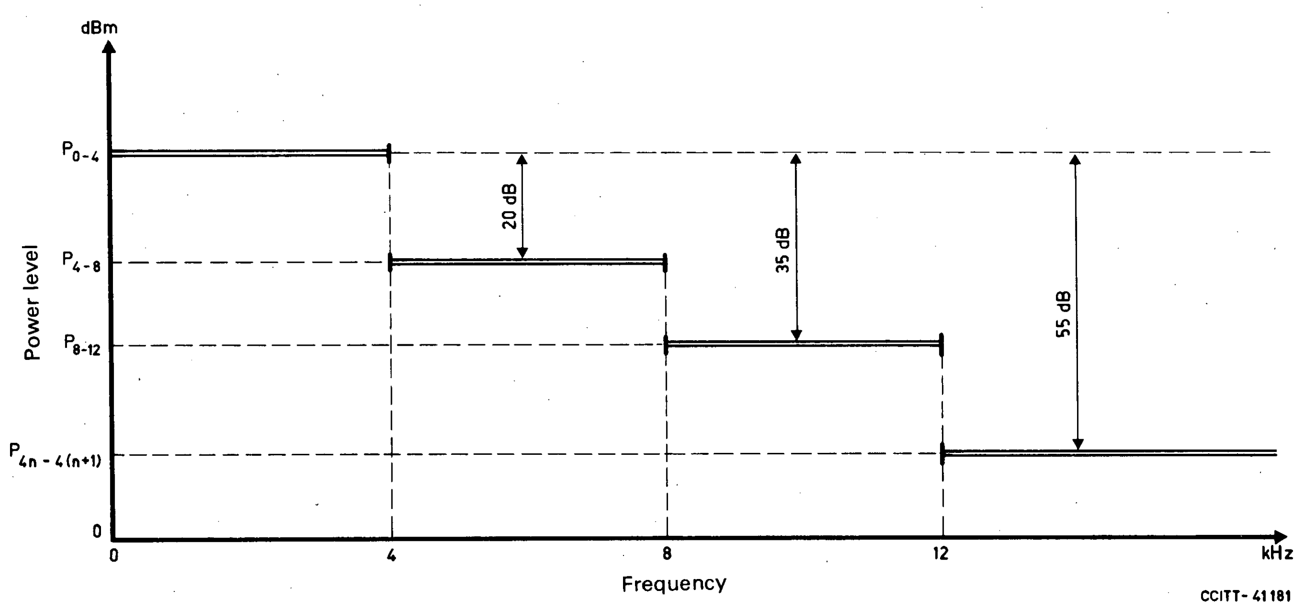


FIGURE 2

3 **Limitation of the out-of-band power spectrum of signals transmitted over telephone-type circuits** (Contribution of the Nippon Telegraph and Telephone Public Corporation)

3.1 *General*

Recommendation V.15 [2] gives limits for signal power outside the 0-4 kHz band from acoustic coupling equipments for data transmission.

NTT considers that these limits can also be complied with by terminal equipments other than acoustic coupling equipments.

Therefore, the rule applied by NTT for both digital and analogue circuits in this connection is based on Recommendation V.15 [2].

3.2 *The rule*

The rule is as follows:

The signal power outside the 0-4 kHz band shall not exceed the following values:

p – 20 dB in the 4-8 kHz band

p – 40 dB in the 8-12 kHz band

p – 60 dB in any 4 kHz band above 12 kHz

where p is the signal power in the 0-4 kHz band.

3.3 *Remark*

NTT is of the opinion that the rule under discussion should be basically in accordance with Recommendation V.15 [2].

References

[1] CCITT Recommendation *Performance characteristics of PCM channels at audio frequencies*, Vol. III, Fascicle III.3, Rec. G.712, §§ 5.1, 6.1, 6.2, 7.1 and 7.2.

[2] CCITT Recommendation *Use of acoustic coupling for data transmission*, Vol. VIII, Fascicle VIII.1, Rec. V.15.

Printed in Switzerland — ISBN 92-61-00991-3