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TELEVISION AND SOUND TRANSMISSION

CHARACTERISTICS OF EQUIPMENT AND LINES USED FOR SETTING UP 15 kHz TYPE SOUND - PROGRAMME CIRCUITS

ITU-T Recommendation J.31

Superseded by a more recent version

(Extract from the *Blue Book*)

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NOTES

1 ITU-T Recommendation J.31 was published in Fascicle III.6 of the *Blue Book*. This file is an extract from the *Blue Book*. While the presentation and layout of the text might be slightly different from the *Blue Book* version, the contents of the file are identical to the *Blue Book* version and copyright conditions remain unchanged (see below).

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

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

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.

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.

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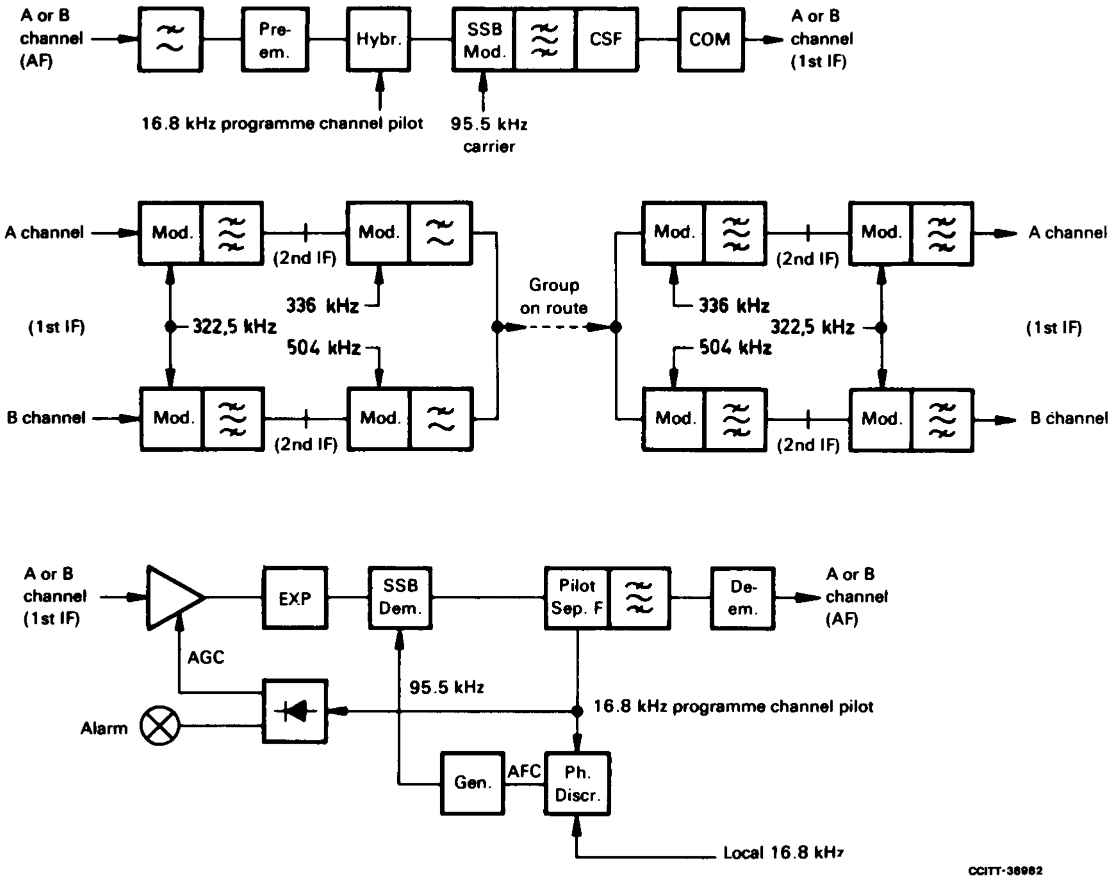
1) This is the objective given in Recommendation J.14 for new design of equipment.



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.

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.

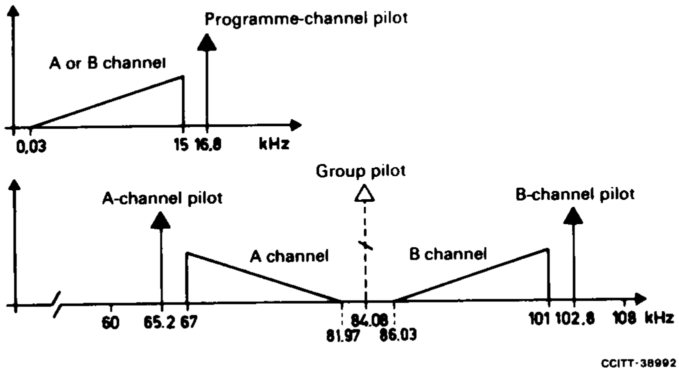


FIGURE 2/J.31

Line-frequency positions of the two-programme channels in the group

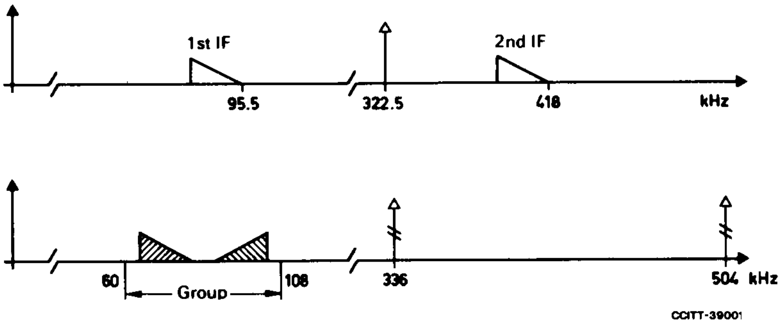


FIGURE 3/J.31

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.

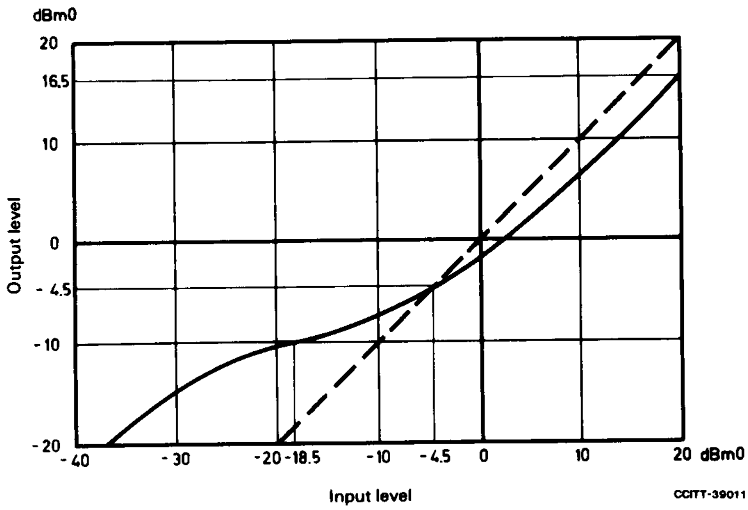


FIGURE 4/J.31

Characteristic of the compressor

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.

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.

2) dBm0(*t*) denotes that the level quoted is referred to a zero relative level point in a telephone channel.

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

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.

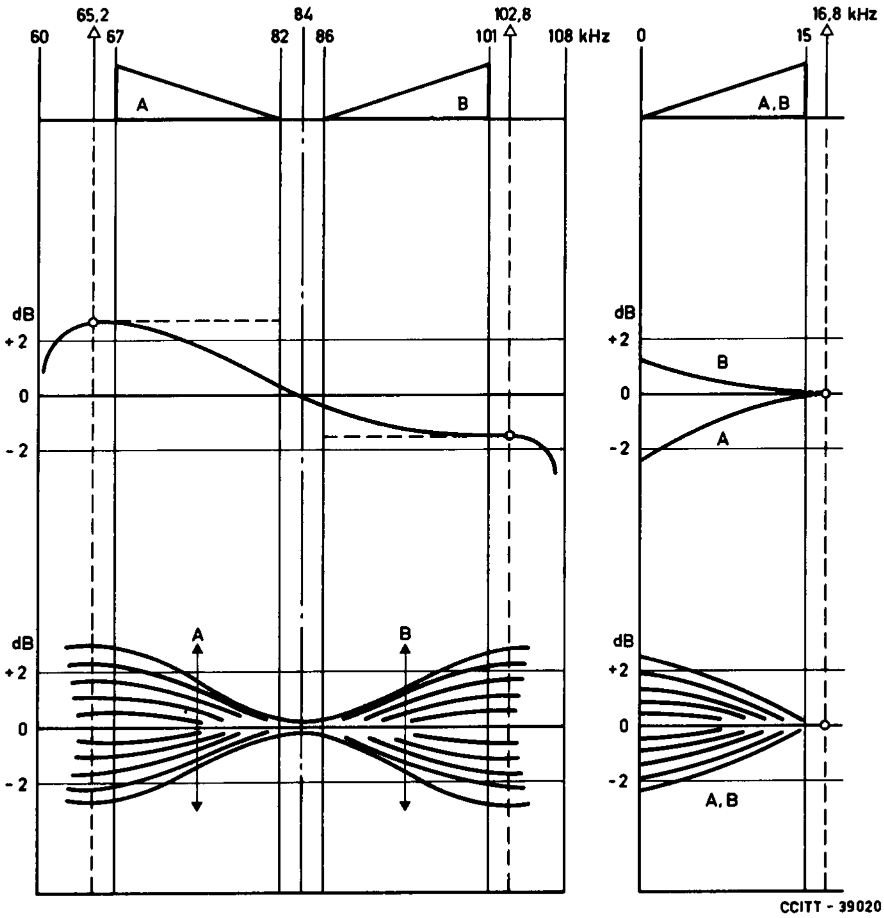
The gain equalizers are required to compensate for the frequency-dependent gain distortions in the lower and upper frequency ranges of the group on which the sound-programme channels are established. By means of the phase-difference equalizers, the phase distortion occurring in the group is increased 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.

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}.

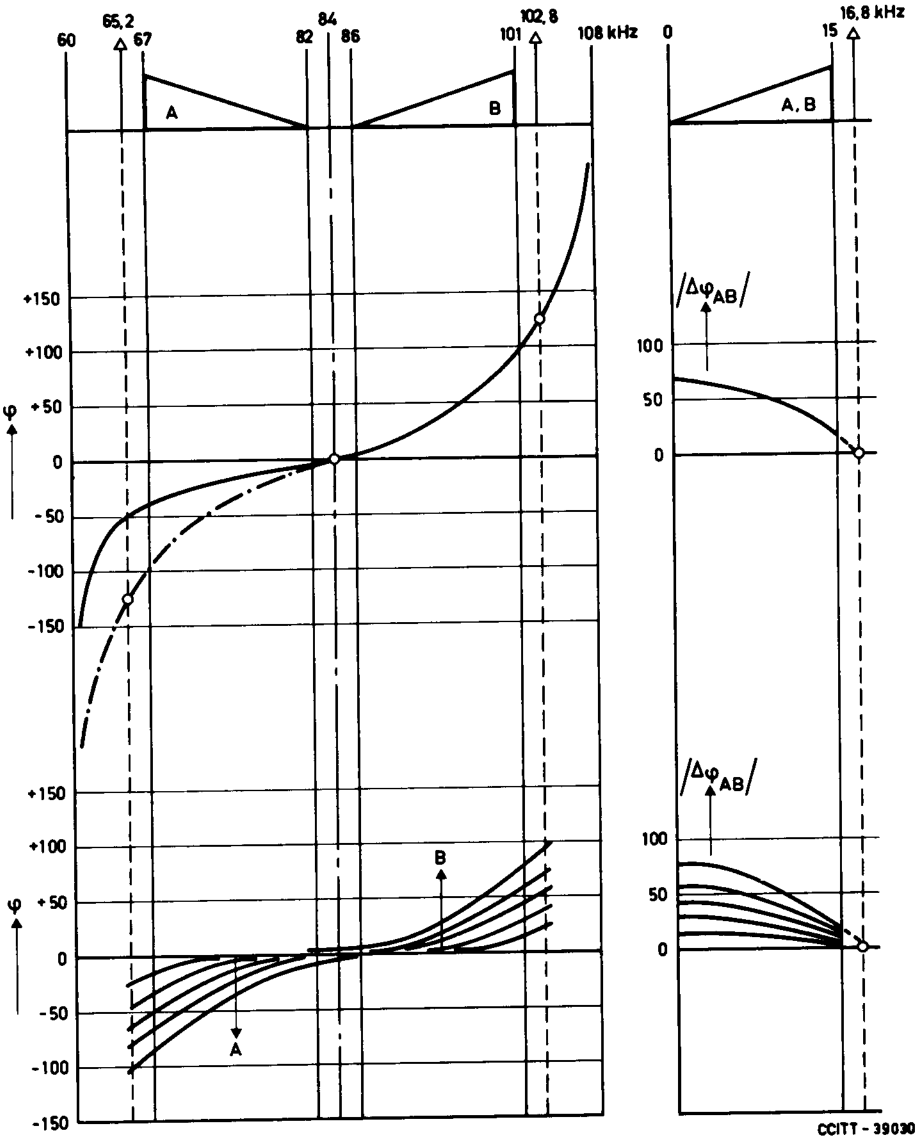
At the receiving end, use is made of a receiver having a calibrated measuring instrument which indicates the level in each of the two sound-programme channels and the phase-difference between them derived from the level of the voltage difference in the two channels. The received measuring frequency is 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.



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

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 [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.

2 Characteristics of a group link used to establish two 15 kHz type carrier-frequency sound-programme circuits

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.

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 sterophonic programmes	+ 3.5	+ 22	programme channels only
10 programme channels			
10 different programmes	+ 4	+ 15	
5 different sterophonic 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).

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 $(-73 - \Delta ps)$ 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:

3) This value has been specified in Recommendation J.21 by CMTT. CCIR Report 493 [10] gives some additional information regarding the subjective impairments produced by interfering frequencies on a circuit using equipment conforming to Recommendation J.31.

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].

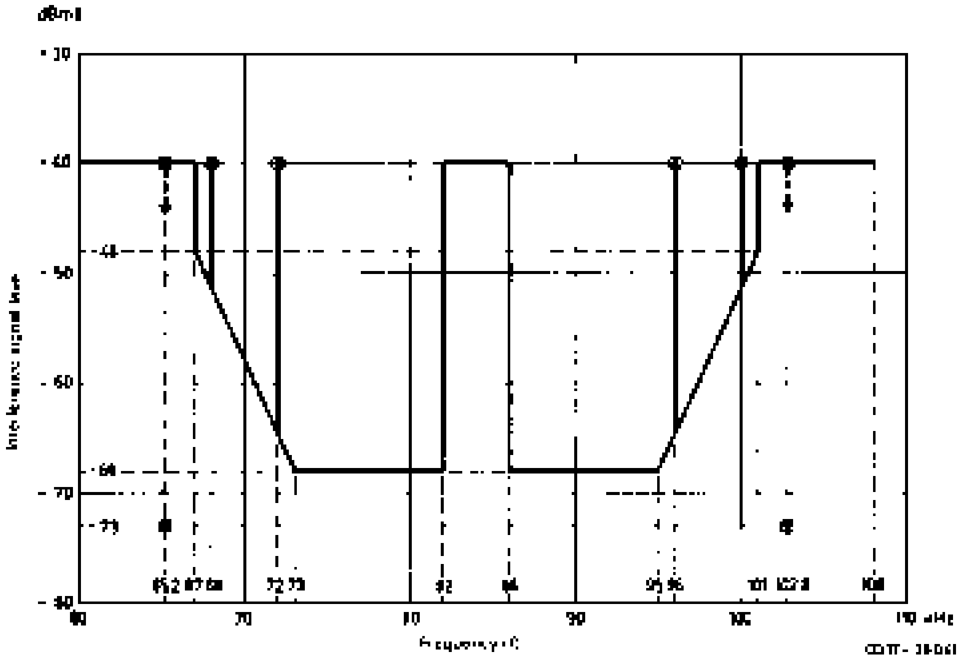
It is necessary to consider whether additional requirements for the characteristics of group links for 15 kHz sound-programme transmission are needed beyond those covered in Recommendation M.460 [9] (for example, group delay distortion in the case of stereophonic transmission bearing in mind the possibility 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.

[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.

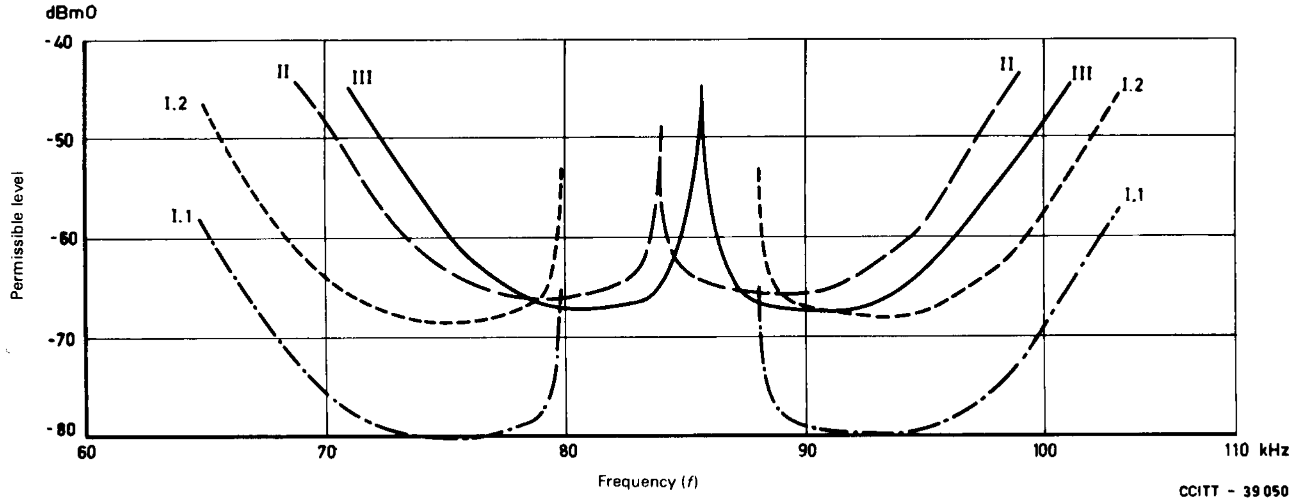


The continuous curve represents the general requirements for single-frequency interfering tones, with the following exceptions:

- 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
– ∞	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 Contribution COM XV-No. 151 (Study Period 1973-1976) 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.

References

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

[2] CCITT Recommendation *Characteristics of compandors for telephony*, Vol. III, Rec. G.162.

[3] CCITT Recommendation *Specification for an automatic measuring equipment for sound-programme circuits*, Vol. IV, Rec. O.31,

[4] CCITT Recommendation *Characteristics of group links for the transmission of wide-spectrum signals*, Vol. III, Rec. H.14.

[5] CCIR Report *Characteristics of signals sent over sound-programme circuits*, Vol. XII, Report 491, ITU, Geneva, 1982.

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

[7] *Ibid.*, § 1.

[8] *Ibid.*, § 6.2.

[9] CCITT Recommendation *Bringing international group, supergroup, etc.. links into service*, Vol. IV. Rec. M.460.

[10] CCIR Report *Compandors for sound-programme circuits*, Vol. XII, Report 493, ITU, Geneva, 1982.

[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, Rec. G.241, §§ 2 and 3.