INTERNATIONAL TELECOMMUNICATION UNION

ITU-T G.332

TELECOMMUNICATION
STANDARDIZATION SECTOR
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INTERNATIONAL ANALOGUE CARRIER SYSTEMS

INDIVIDUAL CHARACTERISTICS OF INTERNATIONAL CARRIER TELEPHONE SYSTEMS ON METALLIC LINES

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12 MHz SYSTEMS ON STANDARDIZED 2.6/9.5 mm COAXIAL CABLE PAIRS

ITU-T Recommendation G.332

(Extract from the *Blue Book*)

NOTES

1 ITU-T Recommendation G.332 was published in Fascicle III.2 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 G.332

12 MHz SYSTEMS ON STANDARDIZED 2.6/9.5 mm COAXIAL CABLE PAIRS

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

This Recommendation defines a coaxial cable system providing 2700 telephony channels in the frequency band 0.3 MHz to about 12.4 MHz which, according to the provisions of Recommendation J.73 [1], can alternatively be used to provide 1200 telephone channels in the frequency band 0.3 MHz to about 5.6 MHz and one TV-channel in the band of about 6 MHz to 12.3 MHz for the transmission of a vestigial sideband television signal with an effectively transmitted video-frequency band up to 5.5 MHz. The repeaters should be spaced at about 4.5 km.

1 Arrangement of line frequencies for telephony

The arrangement of the line frequencies for telephony shall conform to Plans 1A, 1B or 2 described below. Plan 1A is to be preferred to Plan 1B. In international relations between countries using different modulation procedures (see Recommendation G.211) and in the absence of any special arrangement between the Administrations concerned including, if necessary, the Administrations of transit countries, Plans 1 are to be preferred to Plan 2.

1.1 *Frequency arrangement of Plan 1A*

Plan 1A uses the first modulation procedure described in Recommendation G.211.

The telephone channels should first be assembled into basic supermastergroups. Three supermastergroups are transmitted to line in accordance with the frequency arrangement of Figure 1/G.332.

In this figure the virtual carrier frequencies of the two lower supermastergroups are shown.

1.2 *Frequency arrangement of Plan 1B*

Frequencies below 4287 kHz

For frequencies below 4287 kHz, Plan 1B uses the second modulation procedure described in Recommendation G.211.

The telephone channels should first be assembled into supergroups. Fifteen supergroups are transmitted to line in accordance with the frequency arrangement of Figure 2/G.332 (frequencies below 4287 kHz). These fifteen supergroups comprise the basic 15-supergroup assembly (No. 1) described in Recommendation G.233; the carrier frequencies are shown in that Recommendation. Figure 3/G.332 gives further details of the frequency arrangement below 4287 kHz.

Frequencies above 4287 kHz

For frequencies above 4287 kHz, Plan 1B, uses the first modulation procedure described in Recommendation G.211.

For frequencies above 4287 kHz, the frequency arrangement of Figure 2/G.332 is identical with that of Figure 1/G.332.

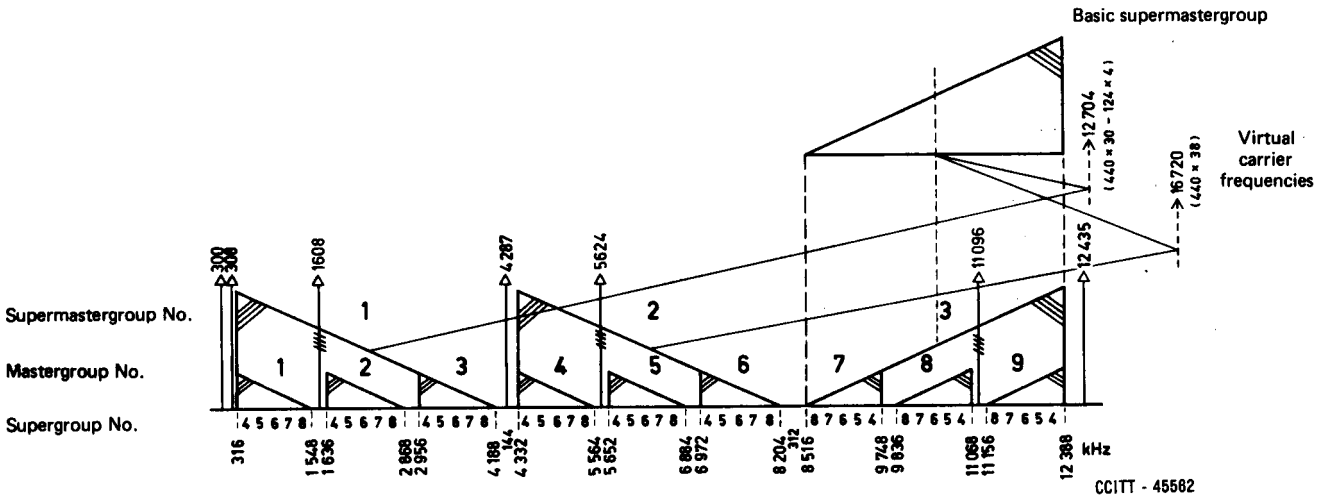


FIGURE 1/G.332

Plan 1A frequency arrangement for 12 MHz systems

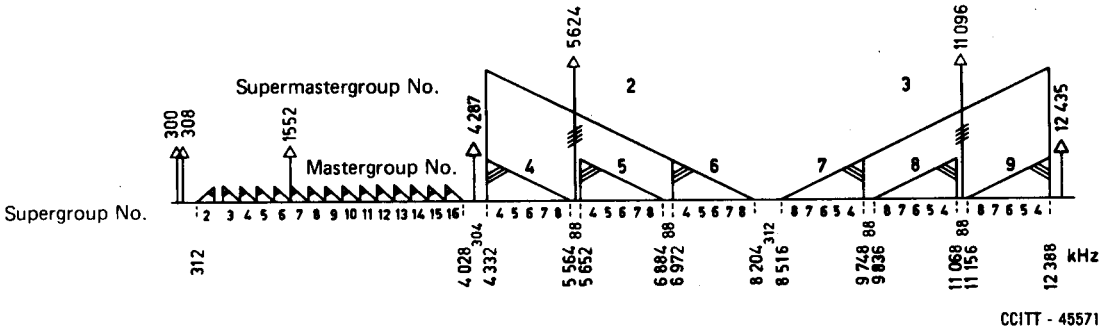


FIGURE 2/G.332

Plan 1B frequency arrangement for 12 MHz system

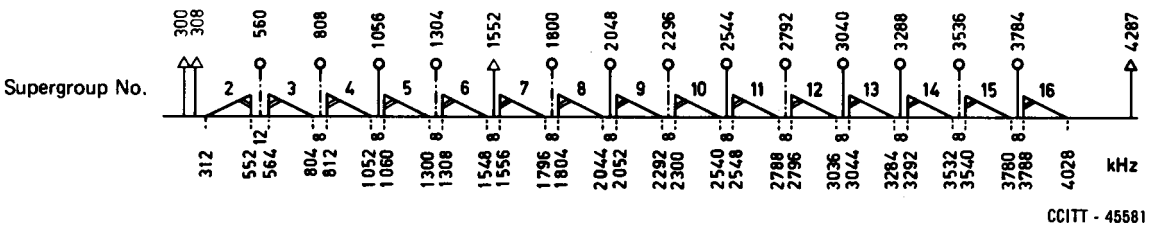


FIGURE 3/G.332

Plan 1B frequency arrangement for 12 MHz systems: frequencies below 4287 kHZ

1.3 *Frequency arrangement of Plan 2*

This plan uses the second modulation procedure described in Recommendation G.211.

The telephone channels should be assembled into basic (No. 1) 15-supergroup assemblies. Three 15-supergroup assemblies are transmitted to line in accordance with the frequency arrangement shown in Figure 4/G.332. In this figure, the virtual carrier frequencies of 15-supergroup assemblies Nos. 2 and 3 are shown.

2 Pilots and additional measuring frequencies

2.1 *Line-regulating pilots*

The CCITT recommends that 12 435 kHz be used for the main line-regulating pilot.

In any regulated-line section crossing a frontier, it is recommended that in both directions of transmission the Administration on the sending side should permanently transmit one or two auxiliary line-regulating pilots at 308 and/or 4287 kHz, at the choice and request of the Administration on the receiving side so as to provide for additional regulation, for example.

The frequency accuracy recommended for the pilots is $\pm 1 \times 10^{-5}$.

The power level of the main and auxiliary line-regulating pilots should be adjusted at the point of injection to have a value of -10 dBm0. The harmonics of the 308 and 4287 kHz pilot should each have a level not higher than -70 dBm0.

Equipment should be designed in such a way that these pilots may be blocked at the end of a regulated-line section, so that their level shall be at least 40 dB below that of the pilots used on other sections.

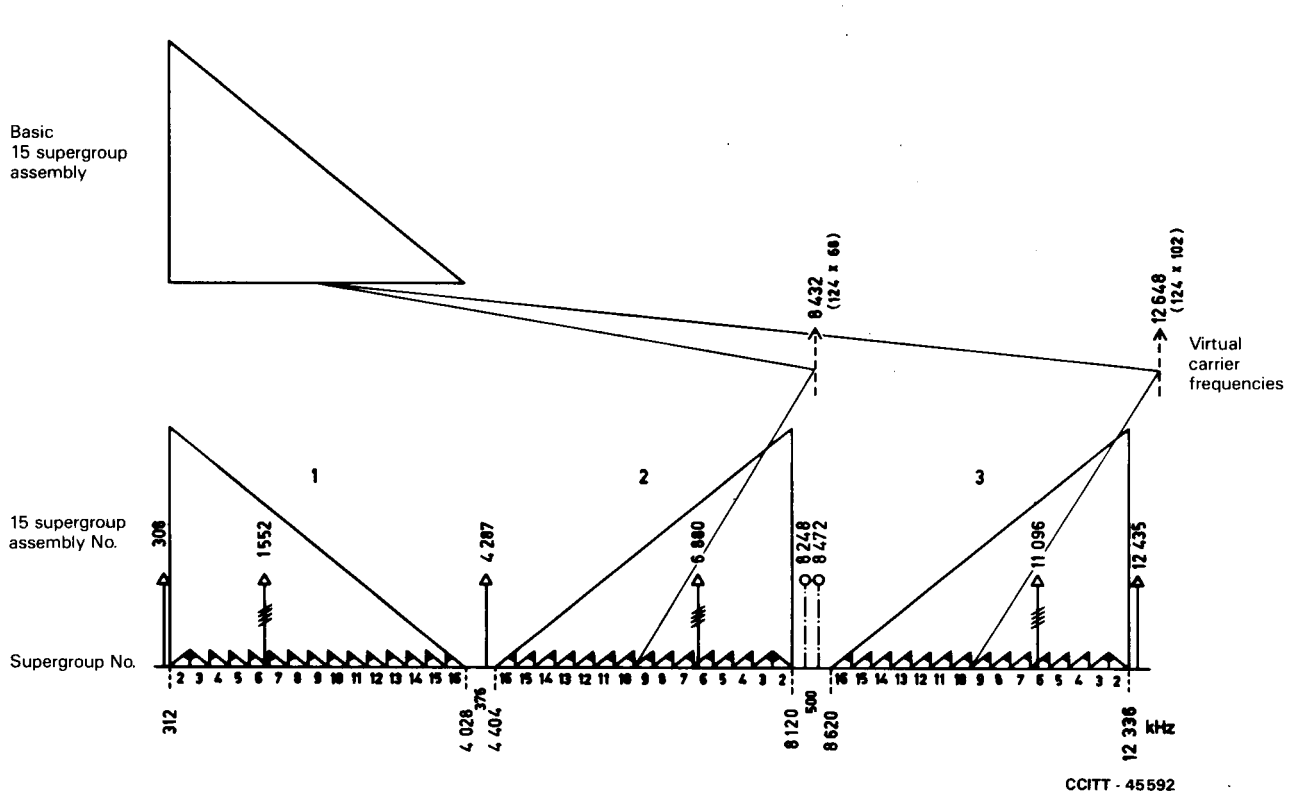


FIGURE 4/G.332

Plan 2 frequency arrangement for 12 MHz systems

The following tolerances for the level of these pilots are recommended:

1) The design of equipment should be such as to allow the error in the level of any pilot as transmitted, due to finite level adjustment steps, to be kept within ± 0.1 dB.

2) The change in output level of the pilot generator with time (which is a factor included in equipment specifications) must not exceed ± 0.3 dB during the interval between two maintenance adjustments, e.g. in one month.

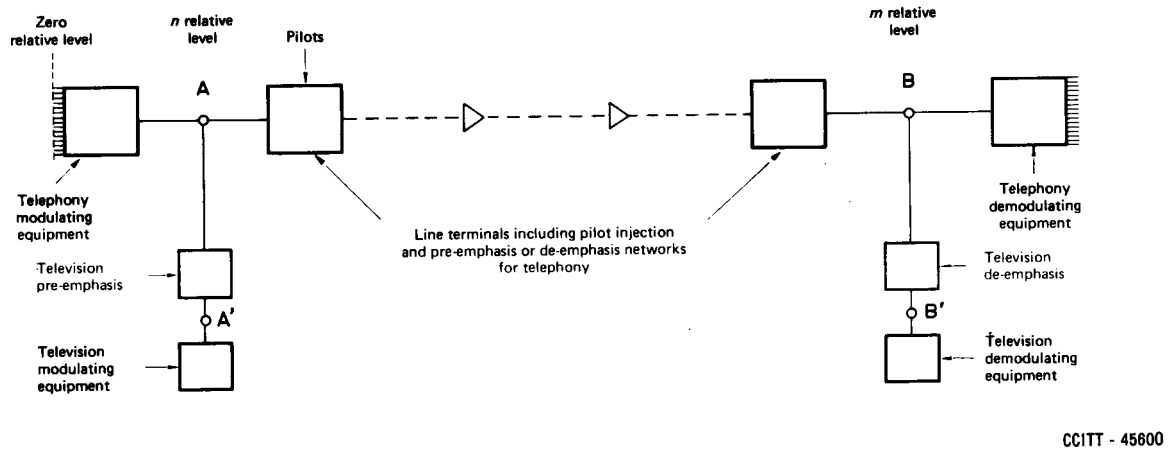
3) To reduce pilot level variations with time, it is advisable to have a device to give an alarm when the variation at the generator output exceeds ± 0.5 dB, the zero of the warning device being aligned as accurately as possible with the lining-up level of the transmitted pilot.

The attention of Administrations is drawn to the difficulty which could result from an appreciable reduction in the absolute power level of the pilot sent to line; such a reduction is liable to cause "near singing", resulting from the operation of the automatic gain-control amplifiers. It would be desirable to make arrangements for overcoming this difficulty if it should arise.

Note - When pre-emphasis and de-emphasis is applied on the line link, it is necessary to define the line pilot level with reference to a point, possibly hypothetical, at the input to or output from the line, at which the relative levels of all telephone channels are equal over the whole of the line-frequency band. When a part of the line-frequency band is to be used to provide a television channel, different pre-emphasis and de-emphasis networks may be required but this will not affect the definition of line pilot levels. Figures 5/G.332 and 6/G.332 show two hypothetical arrangements for the purpose of this definition.

2.2 *Frequency comparison pilots*

Administrations wishing to make an international frequency comparison shall choose the frequency 300, 808 or 1552 kHz for this purpose, when it is impossible to use 308 or 1800 kHz. International comparison of national standards is relatively rare. During a specified period of time, it will always be possible to use for such comparisons one of the frequencies mentioned above, even though it may normally be used as an additional measuring frequency.



Note - Between points A and B, the gain/frequency response of the high-frequency line is uniform for telephony. At these points, all telephone channels are at equal relative level. Between points A' and B', the gain/frequency response of the high-frequency line is uniform for television.

FIGURE 5/G.332

To illustrate the definition of line-regulating pilot levels on a line suitable for carrying both telephony and television

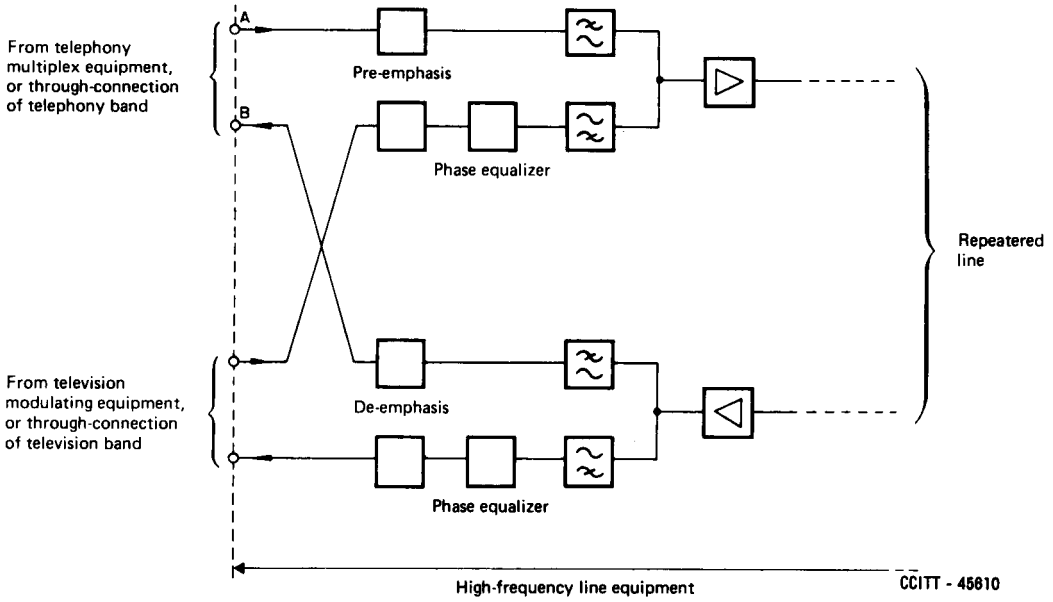


FIGURE 6/G.332

An example of high-frequency line equipment for a 12-MHz "mixed" system for simultaneous telephony and television transmission. The relative levels for telephony would be defined for the points A and B

A frequency of 300 kHz can be used for national comparisons when Administrations do not wish to use the 308 kHz pilot for this purpose. In this case, it is recommended that the 300 kHz be transmitted at a power level of -10 dBm0. The harmonics of the frequency comparison pilots should each have a level not higher than -70 dBm0.

2.3 *Additional measuring frequencies*

If the frequency allocation without mastergroups is used at frequencies below 4 MHz (Figures 3/G.332 and 4/G.332), the following frequencies *may* be used for additional measuring frequencies:

560, 808, 1056, 1304, 1552, 1800, 2048, 2296,

2544, 2792, 3040, 3288, 3536 and 3784 kHz.

Any Administration using 12-MHz working on a line crossing a frontier should, at the request of any other Administration concerned, transmit or measure the measuring frequencies appearing in the following preferred list:

560, 808, 1304, 1800, 2296, 2792 and 3536 kHz.

Administrations should likewise transmit or measure, at the request of corresponding Administrations, any measuring frequency which may be used in other circumstances, namely:

- at frequencies below 4 MHz, if frequency allocation with mastergroups indicated in Plan 1A (Figure 1/G.332) is used:

  560, 808, 1304, 1592 and 2912 kHz;

- at frequencies above 4 MHz, if Plan 1A (Figure 1/G.332) or 1B (Figure 2/G.332) is used:

  5608, 6928, 8248[1)] , 8472, 9792 and 11 112 kHz.

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1) A frequency of 8248 kHz can be used as a radio-relay link line-regulating pilot. In such a case, the precautions shown in Recommendation G.423 should be applied.

Plan 2 (Figure 4/G.332) is used under the conditions described in Recommendation G.211 for the application of the second modulation process, the additional frequencies above 4 MHz are:

5392, 7128, 8248, 8472, 8864, 9608 and 11 344 kHz.

All these frequencies are recapitulated in Table 1/G.332.

TABLE 1/G.332

Frequencies that are available for use as additional measuring frequencies on 12 MHz systems

Frequency band	Frequency arrangement	Additional measuring frequency to be sent or measured on request	Other additional measuring frequencies which can be sent
< 4 MHz	in supergroups (Figures 3/G.332 and 4/G.332)	560, 808, 1034, 1800, 2296, 2792 and 3536 kHz	1056, 1552, 2048, 2544, 3040, 3288 and 3784 kHz
	all mastergroups (Figures 1/G.332)	560, 808, 1304, 1592 and 2912 kHz	
> 4 MHz	in mastergroups (Figures 1/G.332 and 2/G.332)	5608, 6928, 8248[a)] , 8472, 9792 and 11 112 kHz	
	in 15-supergroup assemblies (Figure 4/G.332)	5392, 7128, 8248, 8472, 8864, 9608 and 11 344 kHz	

[a)] A frequency of 8248 kHz can be used as a radio-relay link line-regulating pilot. In such a case, the precautions shown in Recommendation G.423 should be applied.

The absolute frequency variation of additional measuring frequencies below 4 MHz should never be outside limits of ± 40 Hz from their nominal value. For frequencies above 4 MHz, the relative frequency variation referred to the nominal value should never exceed $\pm 1 \times 10^{-5}$.

The power level[2)] of the additional measuring frequencies should be adjusted at the point of injection to have a value of -10 dBm0. The harmonics of additional measuring frequencies below 6 MHz should each have a level at this point not higher than -70 dBm0.

The additional measuring frequencies should not be permanently transmitted. They will only be transmitted for as long as is necessary for actual measurement purposes.

Arrangements should be made in equipment for the 12-MHz system, so that the 308-kHz line-regulating pilot is protected from disturbances from a pilot or additional measuring frequency of the same frequency coming from a 4-MHz system when this protection is not already provided by the equipment of the 4-MHz system.

Note - Some Administrations use new manual or automatic methods of equalizing attenuation distortion, e.g. equalizers based on the Cosine function, using frequencies which do not appear in the list of additional measuring frequencies recommended by the CCITT.

Obviously, no additional measuring frequency which might leave the national network should be sent at the same frequency as one of the pilots recommended by the CCITT.

3 Hypothetical reference circuit

This hypothetical reference circuit is 2500 km long and is divided into nine sections of 280 km each. The three line frequency arrangement plans recommended in § 1 require modulation stages of different number to carry a voice signal in the line frequency position. This is bound to affect the constitution of the hypothetical reference circuit. In these circumstances, the CCITT recommends the hypothetical reference circuits represented in Figures 7/G.332 and 8/G.332.

3.1 *Hypothetical reference circuit for the Plans 1A and 1B frequency allocations*[3)]

This is shown in Figure 7/G.332. It has, for each direction of transmission, a total of:

- two pairs of channel modulators, each pair including translation from the audio-frequency band to the basic group and vice versa;
- three pairs of group modulators, each pair including translation from the basic group to the basic supergroup and vice versa;
- five pairs of supergroup modulators, each pair including translation from the basic supergroup to the the basic mastergroup and vice versa;
- seven pairs of mastergroup modulators, each pair including translation from the basic mastergroup to the basic supermastergroup and vice versa;
- nine pairs of mastergroup modulators, each pair including translation from the basic mastergroup to the frequency band transmitted on the coaxial cable and vice versa.

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2) The Note of § 2.1 still applies.

3) In the case of plan 1B, this hypothetical reference circuit is not valid for the frequency band 312-4028 kHz.

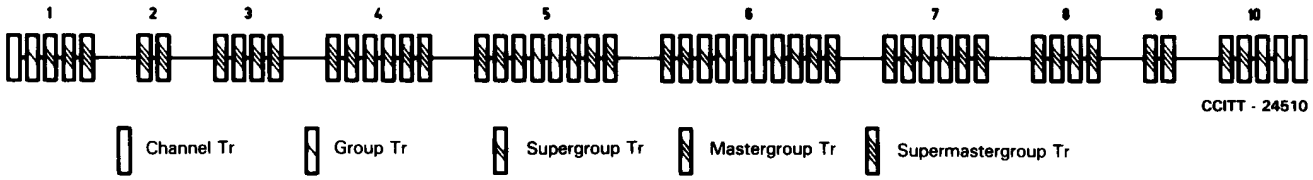

FIGURE 7/G.332

Diagram of a hypothetical reference circuit for 12 MHz systems (Plans 1A and 1B)

3.2 *Hypothetical reference circuit for the Plan 2 frequency allocation*

This is shown in Figure 8/G.332. It has, for each direction of transmission, a total of:

- two pairs of channel modulators, each pair including translation from the audio-frequency band to the basic group and vice versa;
- three pairs of group modulators, each pair including translation from the basic group to the basic supergroup and vice versa;
- six pairs of supergroup modulators, each pair including translation from the basic supergroup to the basic 15-supergroup assembly and vice versa;
- nine pairs of 15-supergroup modulators, each pair including translation from the basic 15-supergroup assembly to the frequency band transmitted on the coaxial cable and vice versa.

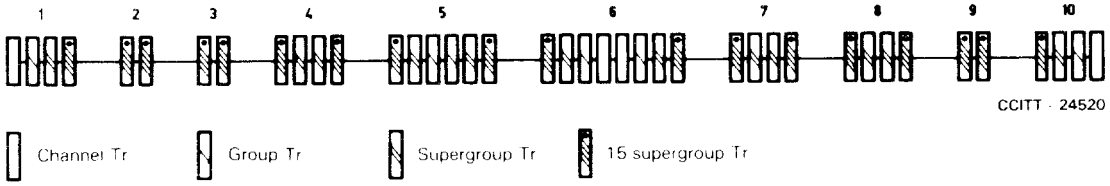

FIGURE 8/G.332

Diagram of a hypothetical reference circuit for 12 MHz systems (Plan 2)

4 Design objectives for circuit noise

The objectives given in Recommendation G.222 are applicable to the hypothetical reference circuit for 12-MHz systems on coaxial cable, in the circumstances indicated in Recommendation G.223.

In practice, it is sufficient to check for each telephone channel as defined by the hypothetical reference circuit, that the mean psophometric power at the end of the channel referred to a zero relative level point does not exceed 10 000 pW0p during any period of one hour.

The subdivision of the total noise between basic noise and intermodulation noise is left entirely to the designer of the system, within the limits of 2500 pW0p for the terminal equipment and 7500 pW0p for the line.

5 Matching of the impedance of a coaxial pair and the impedances of the repeaters

Z_L is the characteristic impedance of the line (for any frequency *f* effectively transmitted), this impedance being the ordinate for the frequency *f* of a smooth curve, agreed by the Administrations concerned as being representative of the average impedance/frequency characteristic of the type of coaxial cable concerned;

Z_R is the worst value of the input impedance (for the frequency *f*) of the equipment of a repeater station, as seen from the line (see Figure 9/G.332);

Z_E is the worst value of the output impedance (for the frequency *f*) of the equipment of a repeater station, as seen from the line;

$A =$ *al* the total image attenuation (at the frequency *f*) of the line between two adjacent repeater stations, *a* being the average attenuation of the coaxial cable per unit length and *l* the average length between two adjacent repeater stations.

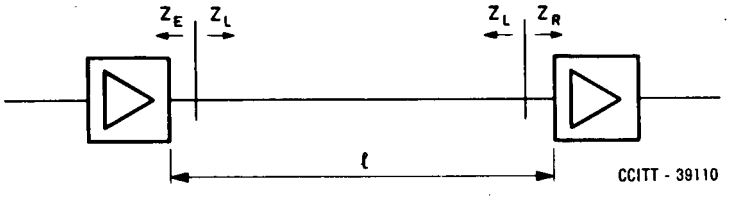

FIGURE 9/G.332

Elementary coaxial cable section

Then the factor *N* is defined by the formula:

$$N = 2A + 20 \log_{10} \left| \frac{Z_E + Z_L}{Z_E - Z_L} \right| + 20 \log_{10} \left| \frac{Z_L + Z_R}{Z_L - Z_R} \right| \quad \text{(dB)}$$

The present Recommendation refers only to 12-MHz systems on 2.6/9.5-mm coaxial pairs having repeaters with a nominal spacing of about 4.5 km.

The sum *N* of the three terms defined above must in this case be equal to at least 48 dB at 300 kHz and to at least 55 dB at all frequencies above 800 kHz. Between 300 and 800 kHz the permissible limit in decibels varies linearly with the frequency.

Note - The CCITT has defined the permissible limits for *N*, as a sum of the three terms (see the above formula). It is recommended that Administrations concerned with a coaxial cable section crossing a frontier should agree on permissible values in this particular case for each of these three terms to meet the above condition, that is to say, agree on the use of as good a match as possible or of a methodical mismatch at the ends of the repeater section.

6 Relative levels and interconnection in a frontier section

6.1 *Interconnection in a frontier section*

In an elementary cable section which crosses a frontier, the relative level at the input of the cable section (output of the repeater equipment) should be equal to -13 dBr at 12 435 kHz.

Note 1 - This recommendation is based on the assumption that the attenuation in the frontier section is approximately 37 to 38 dB. This should be taken into consideration in determining the actual length of the frontier section.

Note 2 - When the pre-emphasis curves of the two systems are different, Recommendation G.352 should be applied.

6.2 *Relative levels in any elementary cable section*

It has not been possible to standardize a single value.

6.3 *Pre-emphasis*

From the information supplied by various Administrations, the pre-emphasis generally lies between 9 and 12 dB.

7 Power-feeding and alarm systems

7.1 *Power feeding across a frontier*

7.2 *Power-feeding systems*

The text of Recommendation G.341, §§ 7.1 and 7.2, applicable to all 1.2/4.4-mm pair systems, still applies for 12-MHz transistor systems on 2.6/9.5-mm pairs.

7.3 *Supervision and alarms in a frontier section* (see Annex A)

8 Use of 12 MHz systems for television transmission

8.1 *General*

This § summarizes all the additional conditions recommended for the transmission of television on a 12 MHz system. The characteristics of the television signal are discussed in Recommendation J.73 [1].

8.2 *Circuit noise*

When a 12 MHZ system is used for a television transmission on the basis of a hypothetical reference circuit 2500 km in length, the mean value of the thermal line noise should not exceed 1 pW0p/km. Experience has shown that a mean value of 1.5 pW0p/km for the total line noise is sufficient when the noise is measured in normal telephony conditions.

8.3 *Matching of repeater and line impedance*

For the transmission of a television programme, it is recommended that number *N* defined in § 5 of the present Recommendation should be at least 70 dB in the band occupied by the television signal.

8.4 *Arrangement of frequencies transmitted in line*

The 12 MHz system provides a television channel and 1200 telephone channels. Figure 10/G.332 shows the frequency arrangement recommended for television transmission. The television channel is capable of transmitting the signals of all television systems defined by the CCIR with a video bandwidth not exceeding 5.5 MHz.

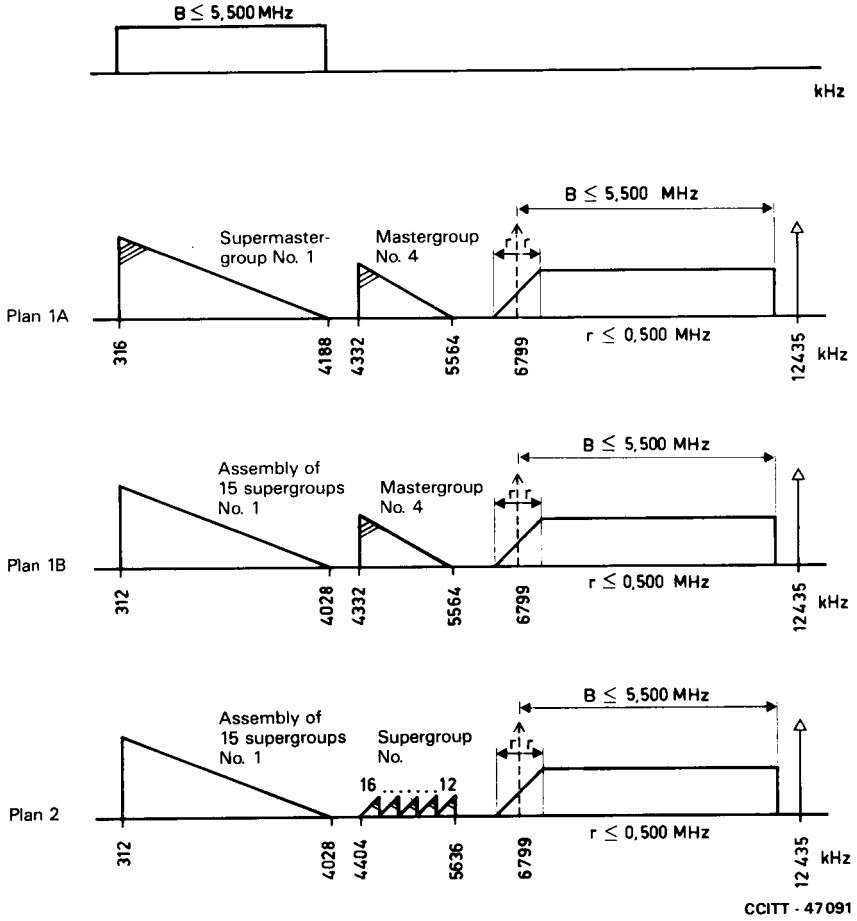

FIGURE 10/G.332

Plan of line frequency arrangement for the transmission of a television signal at 5.5 MHz on a 12 MHz system

ANNEX A

(to Recommendation G.332)

Frequencies used for supervision or fault location

The frequencies or frequency bands used in various countries for supervising or for locating faults are given in Table A-1/G.332 for information.

TABLE A-1/G.332

Country	Band (kHz)
Belgium	280 and 12 700 and 170 to 210 regulation
Japan	13 000 to 13 180
France	12 700 to 12 800
Netherlands	280 and 170 to 210 for regulation
F.R. of Germany	269 and (13 300 ± 75)
United Kingdom	13 500 + 12,5
Sweden	12 700 to 13 000

Note - A fault-tracing system was used by the Chile Telephone Company using direct currents transmitted over interstitial pairs of the cable, which obviates any risk of interference with the systems mentioned above.

Reference

[1] CCITT Recommendation *Use of a 12-MHz system for the simultaneous transmission of telephony and television*, Vol. III, Rec. J.73.