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ITU-T

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STANDARDIZATION SECTOR
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INTERNATIONAL ANALOGUE CARRIER SYSTEMS

INDIVIDUAL CHARACTERISTICS OF INTERNATIONAL CARRIER TELEPHONE SYSTEMS ON METALLIC LINES

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

ITU-T Recommendation G.333

(Extract from the *Blue Book*)

NOTES

1 ITU-T Recommendation G.333 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.333

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

Introduction

This Recommendation defines a coaxial cable pair system providing 10 800 telephone channels in the frequency band of approximately 4 to 60 MHz. The system may be used for the transmission of six television signals without any telephone signal or for a mixed transmission of telephone and television signals. The nominal repeater spacing is approximately 1.5 km and can be obtained by dividing the repeater spacing of 12 MHz systems by three.

1 Line frequencies

The allocation of line frequencies for telephony should be in conformity with one of the two plans given below.

1.1 *Plan 1 - Line-frequency allocation and modulation stages for 60-MHz systems* (Figure 1/G.333)

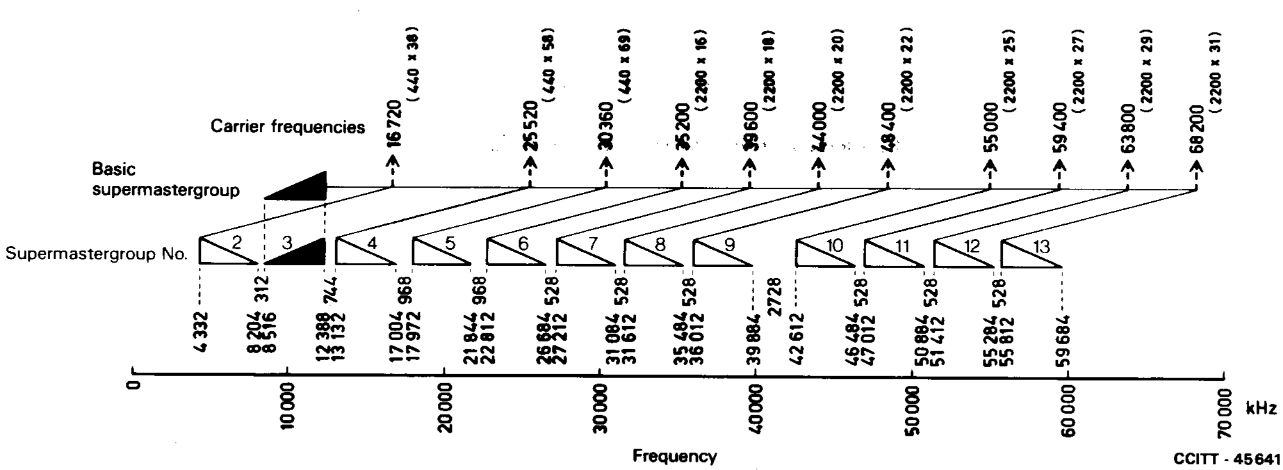


FIGURE 1/G.333

Line-frequency allocation recommended for 60 MHz systems on 2.6/9.5 mm coaxial cable pairs using Plan 1

In this plan, the basic block for interconnection is the supermastergroup of 8516 to 12 388 kHz recommended by the CCITT in Recommendation G.211. It thus contains the three mastergroups constituting the basic supermastergroup, but the same frequency band could contain a 15-supergroup assembly (see Plan 2).

All modulation and demodulation between the basic supermastergroup and the line-frequency band is carried out in one modulation step. The carrier frequencies for this modulation are shown in Figure 1/G.333. They are all low multiples of 440 kHz, or multiples of 2200 kHz. These two fundamental frequencies are both closely related to frequencies normally used in the 12-MHz systems.

The extraction of blocks directly from the line-frequency band can be carried out individually for the four lowest supermastergroups. Higher supermastergroups can only be extracted in the form of an assembly of four supermastergroups. This method is chosen to save frequency bandwidth.

The two lowest supermastergroups are identical with supermastergroups Nos. 2 and 3 shown in Figure 1/G.332.

1.2 *Plan 2 - Line-frequency allocation and modulation stages for 60-MHz systems* (Figure 2/G.333)

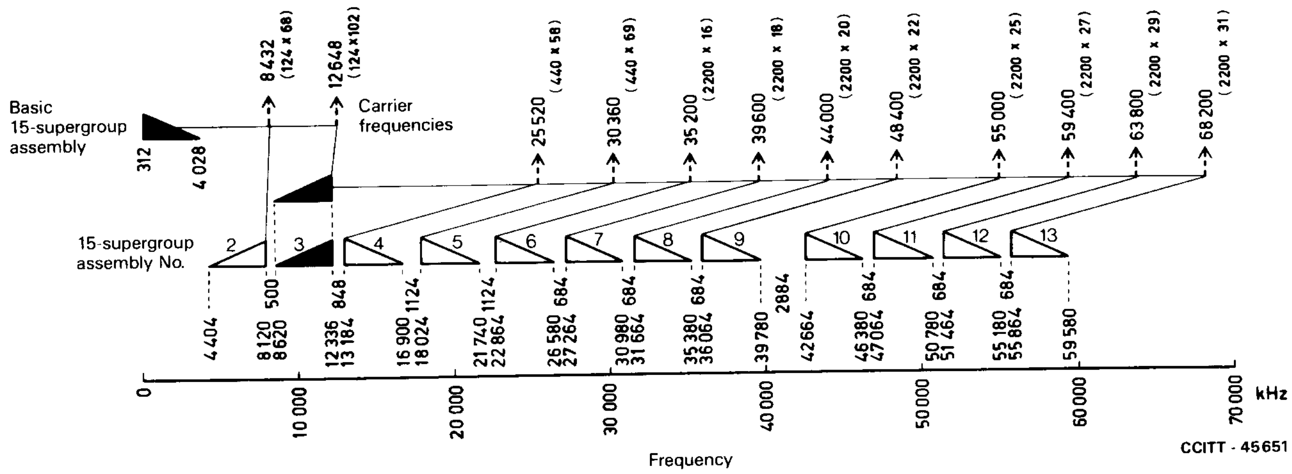


FIGURE 2/G.333

Line-frequency allocation recommended for 60 MHz systems on 2.6/9.5 mm coaxial cable pairs using Plan 2

According to Plan 2, eleven assemblies of 15 supergroups are translated into the frequency band 8620 to 12 336 kHz which lies within the frequency band of the basic supermastergroup.

The 15-supergroup assemblies transmitted to line and numbered 3 to 13, are obtained in the same way as the corresponding supermastergroups of Plan 1 above. The assembly of 15 supergroups numbered 2 is obtained by modulation of a 15-supergroup assembly in the band 312-4028 kHz, the carrier frequency being 68 x 124 = 8432 kHz.

The facilities for extracting blocks directly from the basic-frequency band are identical to those of Plan 1.

The two lowest 15-supergroup assemblies are identical with the second and third 15-supergroup assemblies in Figure 4/G.332.

Note - It is understood that Plan 1 would be chosen in those countries whose national networks are based upon the use of basic mastergroup and supermastergroups, whereas Plan 2 could be adopted in those countries whose national networks are based on the use of supergroup assemblies only.

In international connections between countries using the same plan in their national networks, i.e. both using Plan 1 or both using Plan 2, the plan common to these two countries would naturally be used.

However, in international connections between countries which use different plans in their national networks and in the absence of any special agreement, between the interested Administrations, including Administrations of transit countries, use of Plan l is recommended.

2 Pilots and additional measuring frequencies

2.1 *Line-regulating pilots*

The CCITT recommends that 61 160 kHz should be used for the main line-regulating pilot on all regulated-line sections crossing a frontier. The main line-regulating pilot is used for automatic temperature correction of the cable attenuation.

In any regulated-line section crossing a frontier, it is recommended that in both directions of transmission the Administration on the transmitting side should permanently transmit so as to provide, for example, for additional regulation, one or more auxiliary line-regulating pilots chosen by the Administration on the receiving side from the following list:

4287 kHz, 12 435 kHz, 22 372 kHz and 40 920 kHz.

The power level of these pilots should be regulated, at the output of the transmit amplifier, to a nominal value of -10 dBm0. The harmonics of the 4287, 12 435, 22 372 kHz pilots should each have a level not higher than -70 dBm0.

The frequency stability recommended for pilots is better than $\pm 1 \times 10^{-5}$.

The tolerances for this level are the same as those given in Recommendation G.332, § 2.1.

2.2 *Frequency comparison pilots*

Since international comparison of frequencies is rarely carried out, the CCITT recommends that Administrations choose one of the following two frequencies:

- 4200 kHz, which is a multiple of 300 kHz and a neighbouring value of 4400 kHz,
- 8316 kHz (27×308 kHz) which can easily be included in the free intervals of the two frequency arrangements proposed (Figures 1/G.333 and 2/G.333).

It is recommended that this pilot 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*

Frequencies that may be used as additional measuring frequencies are given in Table 1/G.333.

The power level of these additional measuring pilots should be adjusted at the output of the transmit amplifier, to obtain a nominal value of the line pilot of -10 dBm0. The harmonics of additional measuring frequencies below 30 MHz should each have a level at this point not higher than -70 dBm0.

The frequency stability recommended is better than **Error! Reference source not found.** 1×10^{-5}.

The additional measuring pilots should not be permanently transmitted. They will be transmitted only for as long as is necessary for actual measurement purposes. This does not apply when the frequency is used as a line pilot.

2.4 *Band reserved for monitoring and fault-tracing signals*

These signals should be below the 4200 kHz frequencies comparison pilot.

3 Hypothetical reference circuit

3.1 *General considerations*

The reference circuit has to reflect what is expected to be the practical application of the system. The spacing of main stations is the same as in earlier systems, e.g. the 12 MHz system. A length of 2500 km, divided into 9 sections each of 280 km with a total of 10 main stations, has therefore been adopted.

3.2 *Modulation*

With either of the line-frequency allocations recommended in § 1 above, five modulation stages are generally needed to place a particular channel in its position in the line-frequency band.

On the above basis, the hypothetical reference circuits shown in Figures 3/G.333 and 4/G.333 are recommended by the CCITT.

3.3 *Direct through-connection at line frequencies*

It was agreed that direct through-connection was envisaged not for points intermediate between the main stations as defined above, but rather at these stations themselves so that demodulation would be avoided. While this would be an advantage from the point of view of the amount of modulation equipment, it would involve more severe requirements on line equipment.

TABLE 1/G.333

Frequency (see Note 1) kHz (1)	Frequency (see Note 2) kHz (2)
	4 200 (see Note 3) or 4 287 (see Note 4)
	8 316 (see Note 3)
8 472	
12 678	
17 488	
	22 302 (see Note 5)
	22 372 (see Note 4)
26 922	
31 322	
35 722	
40 122 (see Note 6)	40 920 (see Note 4)
42 322	
46 722	
51 122	
55 522	
	59 922

Note 1- (Applies to all frequencies in column 1.) Use of then frequencies will ensure that interference is not caused to the following fine-regulated section. They can therefore be transmitted at any time.

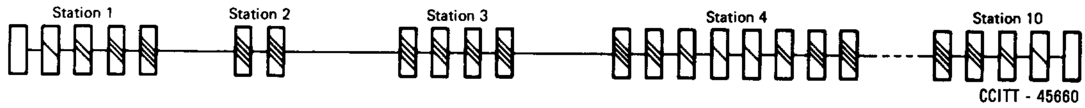
Note 2 - (Applies to all frequencies in column 2.) These frequencies will be provided when the Administration at the receiving end so requests. They should not be sent without the agreement of the Administration at the receiving end.

Note 3 - These frequencies may also be used as frequency-comparison pilots.

Note 4 - In accordance with Recommendation M.500 [1], Administrations choosing to use these frequencies must ensure that interference is not caused to a following line-regulated section which may be using these frequencies as line pilots.

Note 5 - If the frequency 22 372 kHz is used as an auxiliary line regulating pilot it should be ensured that no disturbance is caused to this pilot.

Note 6 - It may be unnecessary to use this frequency if an adjacent auxiliary line-pilot is used for regulation.



Channel translation to form a basic group.

Group translation to form a basic supergroup.

Supergroup translation to form a basic mastergroup.

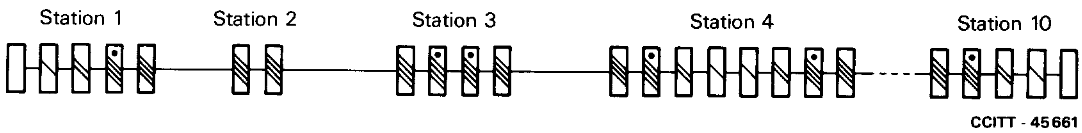
Mastergroup translation to form a basic supermastergroup.

Supermastergroup translation to the line-frequency allocation (except for supermastergroup 3).

Note – Stations 5 and 8 are identical with Station 2 – Stations 6 and 9 are identical with Station 3 – Station 7 is identical with Station 4.

FIGURE 3/G.333

Diagram of a hypothetical reference circuit for 60 MHz system on 2.6/9.5 mm coaxial cable pairs (Plan 1)



Channel translation to form a basic group.

Group translation to form a basic supergroup.

Supergroup translation to form a basic 15-supergroup assembly in the band 312-4028 kHz.

Modulation of the basic 15-supergroup assembly to place it within the frequency band of the basic supermaster-group or, in the case of assembly No. 2, within the line-frequency band.

Modulation of the 15-supergroup assembly situated within the frequency band of the basic supermastergroup to obtain the line-frequency allocation.

Note – Stations 5 and 8 are identical with Station 2 – Stations 6 and 9 are identical with Station 3 – Station 7 is identical with Station 4.

FIGURE 4/G.333

Diagram of a hypothetical reference circuit for 60 MHz system on 2.6/9.5 mm coaxial cable pairs (Plan 2)

It has, however, been found possible to use restricted through-connection at main repeater stations with equipment designed to meet the normal noise objectives defined in connection with a hypothetical reference circuit for the 60-MHz system on coaxial pairs (see Figure 3/G.333) without incurring a noise penalty.

The necessary restrictions are as follows:

1) The frequency band containing supermastergroups 6 to 9 inclusive may be directly through-connected over a total length which must not exceed 830 km, but the adjacent frequency bands in the sections concerned must be homogeneous sections which are not abnormally long.

2) It is in principle also possible to use direct through-connection for the frequency band containing supermastergroups 2-5 inclusive provided that the adjacent frequency bands containing supermaster-groups 6-9 and 10-13 are transmitted on normal length homogeneous sections. In practice it may be necessary to restrict the through-connection to supermastergroups which have a sufficiently low impedance mismatch effect (§ 7) to permit the extension without excessive accumulation of attenuation roll effect.

4 Circuit noise

It is recommended that the system be designed on the basis of Recommendation G.222, i.e. in such a way as to obtain a mean psophometric power of about 3 pW per km of line, on the worst telephone channel having the same composition as the 2500-km hypothetical reference circuit.

5 Matching of repeater impedances and line impedance

A value of 65 dB is recommended for the magnitude *N* defined in Recommendation G.332, § 5.

6 Interconnection

Levels in a main station (see Recommendation G.213)

When one part of the frequency band is transmitted without demodulation, the same value of -33 dBr is recommended at the output of the direct through-connection filter.

The level at the repeater output on the highest channel should be - 19 ± 1 dBr.

Note - Values for pre-emphasis ranging from 7 to 10 dB are commonly used.

7 Power-feeding and alarm systems

7.1 *Power feeding across a frontier*

In the absence of a special agreement between the Administrations concerned with a power-feeding section crossing a frontier, it is recommended that each Administration power-feed only those repeater stations in its own country. Many Administrations used looped power-feeding on the two sides of a power-feeding station, half of each of the sections between this station and the adjacent power stations being so fed; they can close the loop at their frontier stations. Agreements will be necessary if, for example, the frontier is very far from the mid-point between the two nearest feeding stations, or if the Administrations concerned use looped power-feeding on the entire section between two feeding stations.

If repeater stations in a country are fed from another country, special precautions will be required to protect the staff working on the cables.

7.2 *Remote power-feeding systems*

Although CCITT does not recommend the use of a specific remote power-feeding system for the 60-MHz coaxial line system, in practice only the constant current d.c. feeding via the inner conductors of the two coaxial pairs of a system is used.

The 60-MHz coaxial cable system may be subject to induced voltages and currents caused by lightning, power lines, railways, etc.

Precautions must be taken to protect the staff from any possible danger arising from the normal operating voltages and remote power-feed currents as well as from the induced voltages and currents.

Many national Administrations have issued detailed rules and regulations for the protection of persons. It is obligatory in most cases to meet these rules and regulations. In addition the CCITT Directives [2] give guidance on these problems.

Precautions are also needed for the protection of the equipment against induced voltages and currents. The equipment should therefore be designed in such a way that it passes the tests specified in Recommendation K.17 [3].

7.3 *Supervision and alarms in a frontier section*

This should be governed by agreement between the Administrations concerned. In particular, it is necessary at the points of interconnection between two systems that if frequencies are used for monitoring or for locating faults, they be attenuated to a level of -50 dBm0 on the receiving sides to prevent any disturbance to similar frequencies used in the system farther down the line.

Note - Frequencies sent only over a system already withdrawn from service because of a fault may be selected by each Administration on the national level.

8 Use of 60-MHz systems for television transmission

8.1 *General remarks*

In § 8 all additional requirements are summarized which are recommended in the case of television transmission on the 60-MHz system. The characteristics of the television signal in the first intermediate frequency allocation (transmit side conditions) are dealt with in Recommendation J.77 [4].

8.2 *Circuit noise*

If the 60-MHz system is used for television transmission on the basis of a hypothetical reference circuit (HRC) of a length of 2500 km, the mean value of the thermal noise of the line should not exceed 1 pW0p/km. Experience has shown that a mean value of 1.5 pW0p/km total noise of the line is sufficient when measured according to normal telephone conditions. In making through-connections between homogeneous sections of an HRC, different transmission bands may be used. As different transmission bands give different distributions of basic noise and intermodulation noise, it seems justified to assign noise limits which are average values within the whole transmission band, i.e., among the five measuring channels recommended in Recommendation G.228.

8.3 *Matching of repeater impedances and line impedance*

For television programme transmission a value of at least 72 dB for the magnitude *N*, defined in Recommendation G.332, § 5, has been agreed to in the band occupied by television signals.

8.4 *Number, nature and position of line television channels*

Television signals may be transmitted without any other wanted signals or simultaneously with telephone channels. In the first case, there are six television channels. In the case of mixed transmission, the attention of Administrations is drawn to the fact that, if there are more than two television channels, harmful interference may occur between the two types of signal, especially interference to telephony from television. This clause is therefore limited to cases where the number of channels is less than or equal to two.

Whether or not the 60 MHz system is allocated wholly or partially to television, television channels are capable of transmitting the signals of all television systems defined by the CCIR having a video bandwidth not exceeding 6 MHz.

When a 60 MHz system is used entirely for television, it can provide six television channels, arranged in three pairs each of which extends over the bandwidth of four supermastergroups. The line-frequency allocation is shown in Figure 5/G.333.

When transmission is mixed, a distinction should be made according to whether the number of television channels is two or one.

If there are two, the use of channels 3 and 4 is recommended.

In the case of a single television channel, there are two possibilities:

- first alternative: channel 3 or channel 4, the choice being immaterial;
- second alternative: channel 1.

The first alternative has the advantage of low group delay distortion and is suitable for long links. The second allows the use of simple modulation equipment, if modulation method No. 2 is applied (see Note 1 below). On the other hand, it has the disadvantage of a higher group delay distortion, requiring the use of correctors whose complexity increases with the length of exceeds a certain limit.

Note 1 - Two recommended modulating methods are shown in Annex A.

Note 2 - A television channel-pair pilot can be provided at the mean of the carrier frequencies of each television channel pair, i.e. 12 760 kHz (4 × 3190 kHz), 31900 kHz (10 × 3190 kHz) and 51 040 kHz (16 × 3190 kHz). It is recommended that these pilots be transmitted at a power level of -10 dBm0. The harmonies of the pilot 12 760 kHz should have a level of not higher than -70 dBm0; the level of the harmonics of the other pilots should not exceed -50 dBm0.

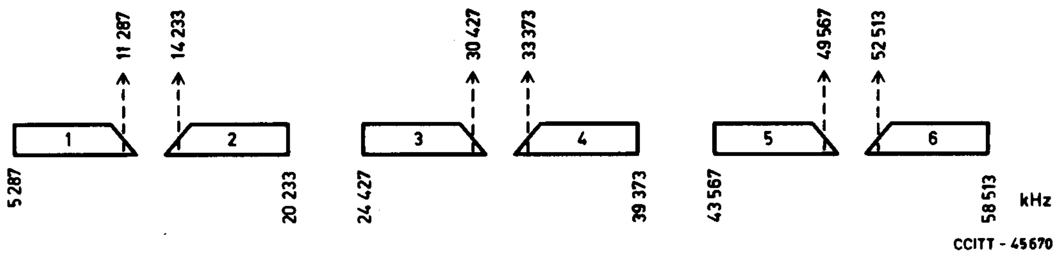


FIGURE 5/G.333

Line-frequency allocation of six television channels on the 60 MHz system

8.5 *Pilots and additional measuring frequencies*

Those pilots and additional measuring frequencies (mentioned in § 2), falling in gaps between TV channels, can be used.

ANNEX A

(to Recommendation G.333)

Modulation methods for television transmission on the 60-MHz system

Two recommended modulating methods are shown in Figure A-1/G.333 and Figure A-2/G.333 respectively. The modulation methods are compatible with those of the 18-MHz system (see Annex A to Recommendation G.334).

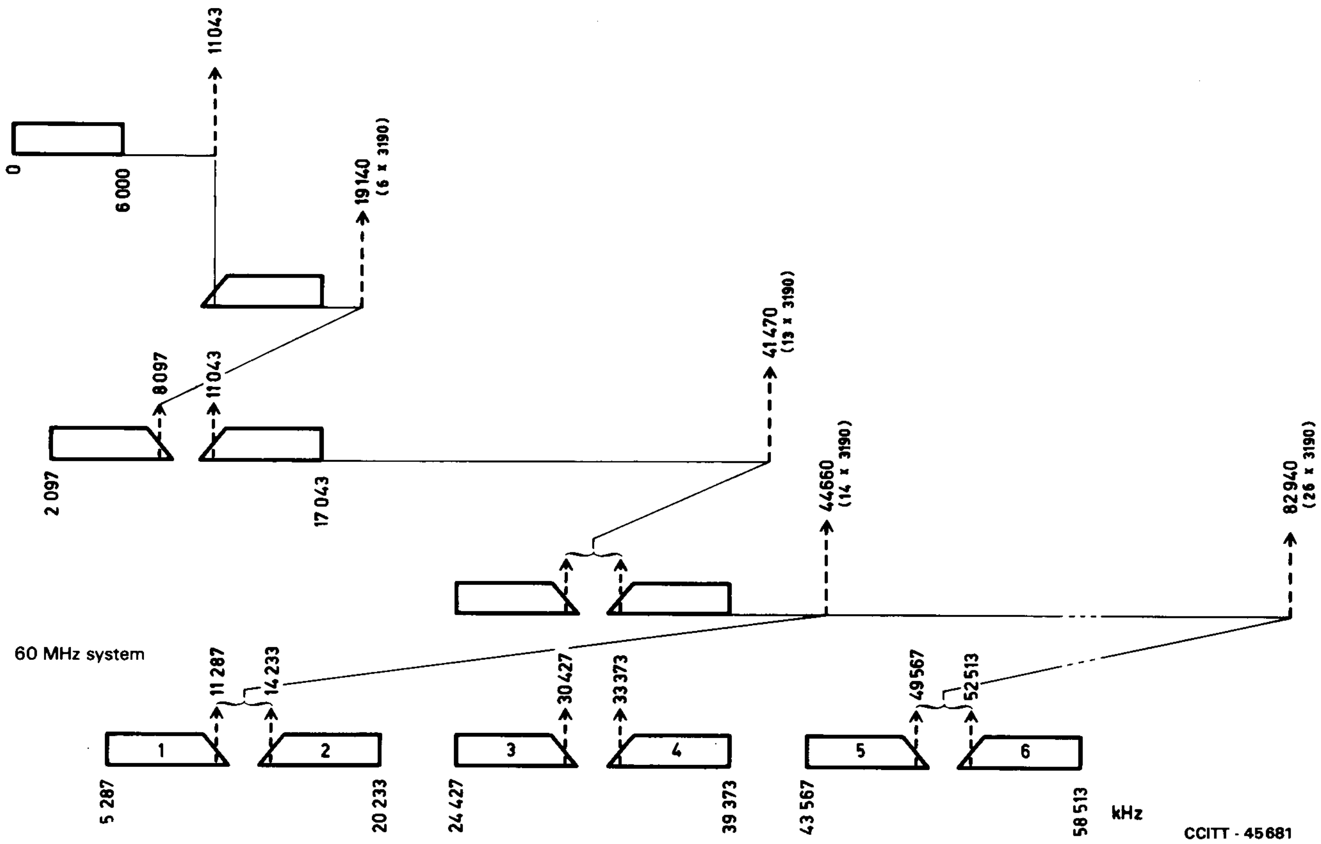


FIGURE A-1 /G.333

Modulation method for television transmission on the 60 MHz system
Modulation method 1

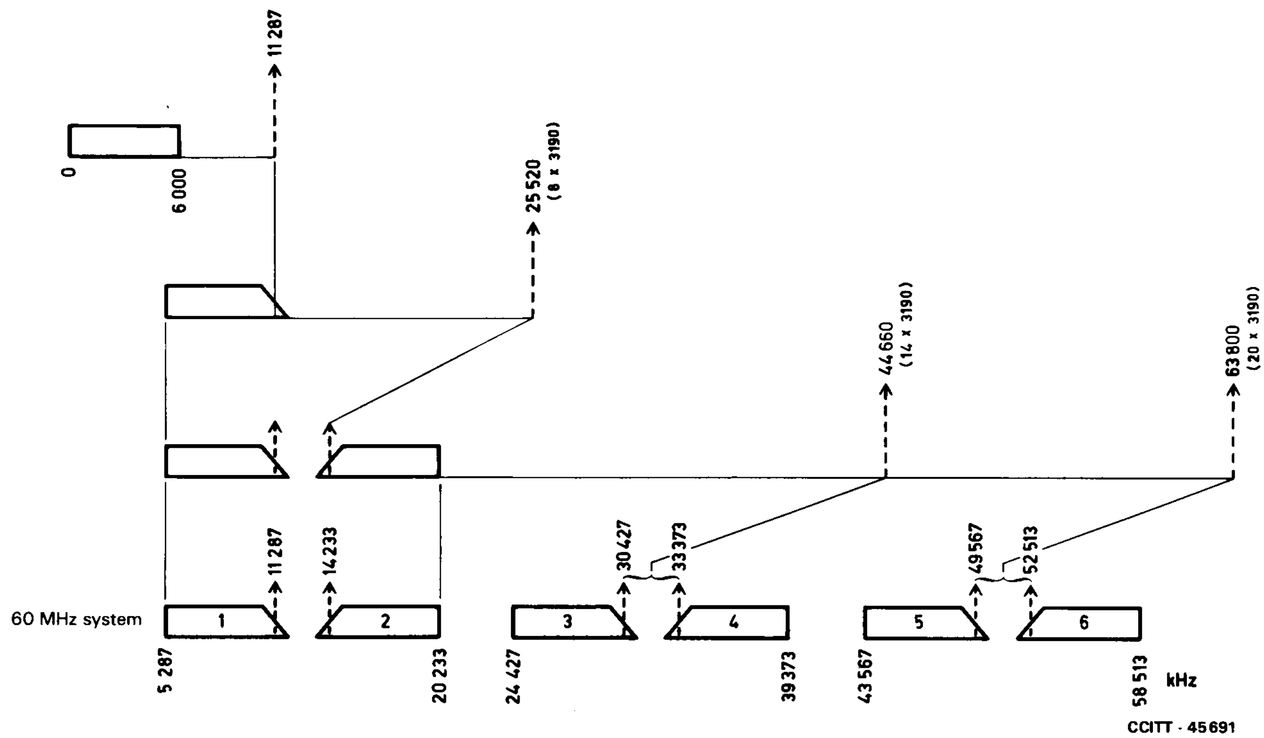


FIGURE A-2/G.333

Modulation method for television transmission on the 60 MHz system
Modulation method 2

References

[1] CCITT Recommendation *Routine maintenance measurements to be made on regulated line sections,* Vol. IV, Rec. M.500.

[2] CCITT manual *Directives concerning the protection of telecommunication lines against harmful effects from electricity lines,* ITU, Geneva, 1963, 1965, 1974 and 1978.

[31 CCITT Recommendation *Tests on power-fed repeaters using solid state devices in order to check the arrangements for protection from external interference,* Vol. IX, Rec. K. 17.

[41 CCITT Recommendation *Characteristics of the television signals transmitted over 18-MHz and 60-MHz systems*, Vol. III, Rec. J.77.