INTERNATIONAL TELECOMMUNICATION UNION

ITU-T G.334

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

INTERNATIONAL ANALOGUE CARRIER SYSTEMS

INDIVIDUAL CHARACTERISTICS OF INTERNATIONAL CARRIER TELEPHONE SYSTEMS ON METALLIC LINES

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

ITU-T Recommendation G.334

(Extract from the *Blue Book*)

NOTES

1 ITU-T Recommendation G.334 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.334

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

(Geneva, 1980)

Introduction

Amplifier design technique has made it possible to provide a usable band of about 18 MHz while still keeping the repeater spacing of about 4.5 km as defined in Recommendation G.332; the CCITT has therefore defined an 18 MHz system which offers a transmitting capacity of 3600 telephone channels in the case of pure telephone application. Alternatively, the system may be used for the transmission of up to two TV channels or one TV signal plus 1800 telephone channels. Another possibility is that the bandwidth above 12 435 kHz could be used for the provision of an 8448 kbit/s digital path.

1 Arrangement of line frequencies for telephony

The arrangement of line frequencies most suitable for the network of a particular Administration depends to a high degree on the organization of this network with respect to the interconnection with and through connection to the other systems existing in this network. On the other hand, it is very desirable to limit the number of different frequency plans for the 18 MHz system.

The CCITT therefore recommends that in any case one of the following three plans should be applied. However, in international connections between countries which use different modulation procedures (see Recommendation G.211) and in the absence of any special arrangements between the interested Administrations including, if necessary, the Administrations of transit countries, Plan 1 is to be preferred.

1.1 *Frequency arrangement of Plan 1*

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

The telephone channels should first be assembled into basic supermastergroups. The four supermastergroups are transmitted to line in accordance with the frequency arrangement of Figure 1/G.334.

Note - The arrangement of the supermastergroups No. 1, 2 and 3 is the same as in Plan 1A of the 12-MHz system (Recommendation G.332) and supermastergroup No. 4 corresponds to its arrangement in Plan 1 of the 60-MHz system (Recommendation G.333).

1.2 *Frequency arrangement of Plan 2*

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

The telephone channels should first be assembled into basic (No. 1) 15-supergroup assemblies. Four 15-supergroup assemblies are transmitted to line in accordance with the frequency arrangement shown in Figure 2/G.334.

Note - The arrangement of the 15-supergroup assemblies Nos. 1, 2 and 3 is the same as in Plan 2 of the 12 -MHz system (Recommendation G.332).

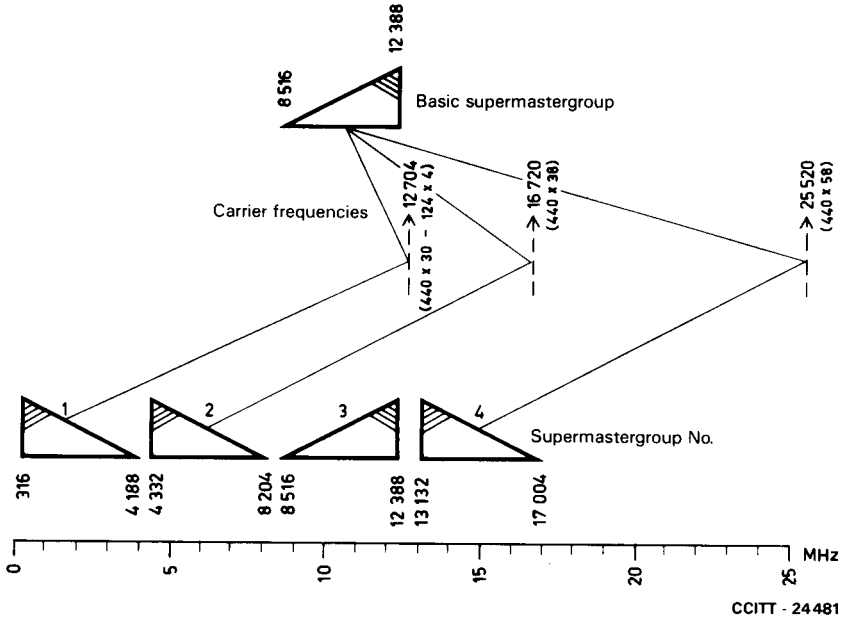

FIGURE 1/G.334

Plan 1 frequency arrangement for 18 MHz systems

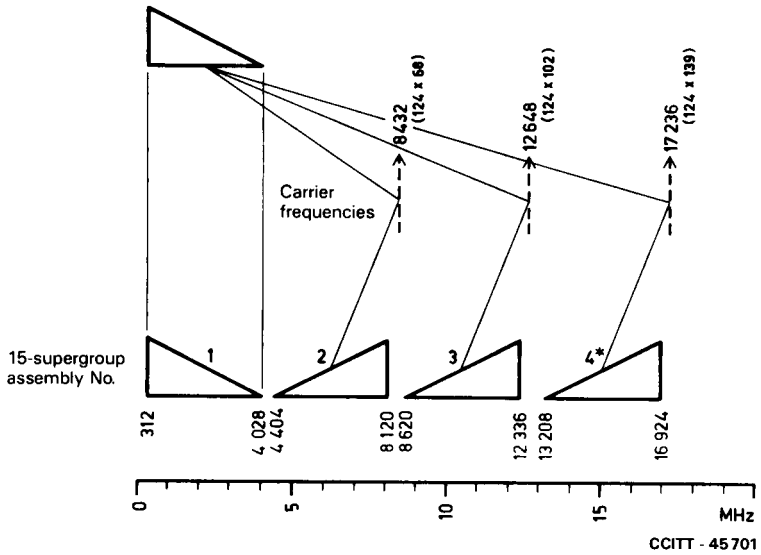

FIGURE 2/G.334

Plan 2 frequency arrangement for 18 MHz systems

1.3 *Frequency arrangement of Plan 3*

This Plan uses the first modulation procedure described in Recommendation G.211, but adds a further intermediate frequency position.

The telephone channels should first be assembled into basic supermastergroups. The four supermastergroups are then translated into the position of the supermastergroups Nos. 6-9 as in Plan 1 of the 60-MHz system (Recommendation G.333).

By translating with an additional 40 480 kHz carrier frequency, these supermastergroups are transmitted to line in accordance with the frequency arrangement of Figure 3/G.334.

Note 1 - This arrangement is best suited to those networks which need frequent direct through-connections between the 18-MHz and 60-MHz systems. It therefore makes use of a wider frequency band for through-connection than the basic supermastergroup. The arrangement is also suitable for the interconnection of 18-MHz systems and for the interconnection between 18-MHz systems and 60-MHz systems via the basic supermastergroup 8516-12 388 kHz, because the relatively large frequency space between the supermastergroups permits the use of simpler through supermastergroup filters.

Note 2 - This arrangement can handle also 15-supergroup assemblies by bringing them first into the frequency band of the basic supermastergroup (15-supergroup assembly No. 3).

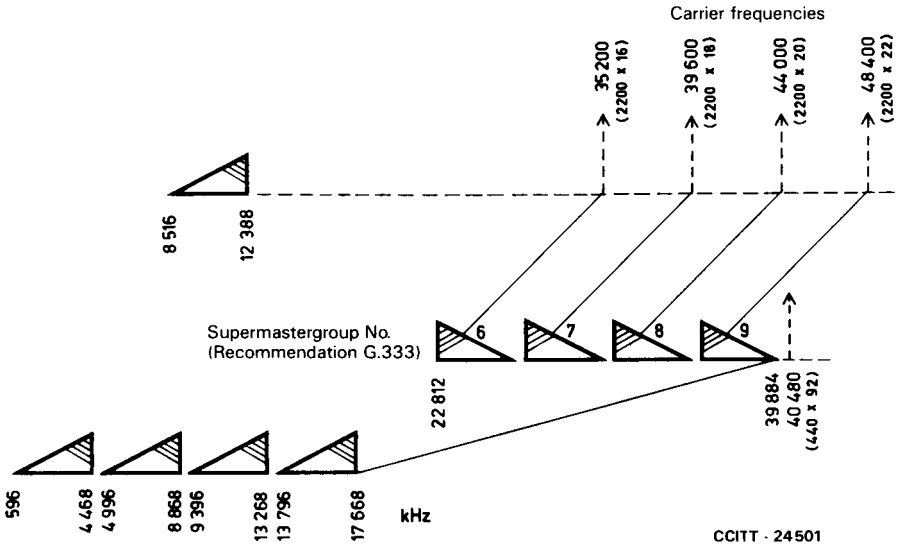

FIGURE 3/G.334

Plan 3 frequency arrangement for 18 MHz systems

2 Pilots and additional measuring frequencies

2.1 *Line-regulating pilots*

It is recommended that 18 480 kHz be used for the main line regulating pilot[1)].

In any regulated-line section crossing a frontier, it is recommended that in both directions of transmission the Administration on the sending side should, if requested, permanently transmit an auxiliary line-regulating pilot at 308 kHz to provide facilities for additional regulation, for example.

For Frequency Plans 1 and 2 as defined under § 1 above, 4287 kHz and/or 12 435 kHz may be used as additional auxiliary line-regulating pilots on request of the Administration on the receiving side.

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 kHz and 4287 kHz pilots should each have a level not greater than -70 dBm0.

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1) 18 480 kHz is a multiple of 308 kHz (60×308) and of 440 kHz (42×440).

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.

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

2.1.1 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.

2.1.2 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.

2.1.3 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.

2.2 *Frequency comparison pilots*

Administrations wishing to make an international frequency comparison shall choose the frequency 300, 308 or (for Plans 1 and 2 only) 4200 kHz for this purpose. 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 for other purposes.

It is recommended that the frequency comparison 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.334.

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 of the additional measuring frequencies should be adjusted at the point of injection to have a value of -10 dBm0. The harmonics of the additional measure frequencies below 9 MHz should each have a level not higher than -70 dBm0 as transmitted to the line. 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.

TABLE 1/G.334

Frequency plan 1 (kHz)	Frequency plan 2		Frequency plan 3 (kHz)
	(see Note 1) (kHz)	(see Note 2) (kHz)	
	560		552
	808	1056	
	1 304	1 552	
1 592	1 800	2 048	1 872
	2 296	2 544	
2 912	2 792	3 040	
		3 288	3 192
	3 536	3 784	4 758
5 608	5 392		6 272
6 928	7 128		7 592
8 248 (see Note 3)	8 248		
8 472	8 472		
	8 864		9 158
9 792	9 608		10 672
11 112	11 344		
	12 776		11 992
12 678	13 452		13 558
14 408	14 940		15 072
15 728	16 676		16 392

Note 1 - Additional measuring frequencies to be sent or measured on request.

Note 2 - Other additional measuring frequencies which can be sent.

Note 3 - 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.

3 Hypothetical reference circuit

3.1 *General considerations*

The hypothetical reference circuit is 2500 km long and is divided into nine homogeneous sections of 280 km each.

3.2 *Modulation*

The three line-frequency allocations recommended in § 1 above need different numbers of modulating stages to bring an audio signal into the line-frequency position. This has to be reflected in the constitution of the hypothetical reference circuit.

On the above basis, the hypothetical reference circuits, as shown in Figure 4/G.334 and Figure 5/G.334, are recommended by the CCITT.

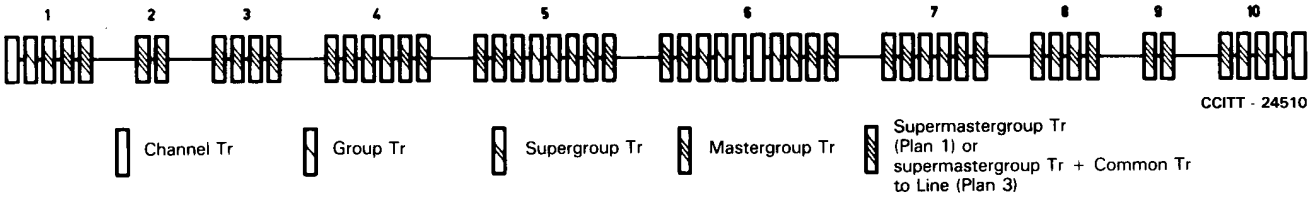


FIGURE 4/G.334

Diagram of a hypothetical reference circuit for 18 MHz systems (Plan 1 and Plan 3)

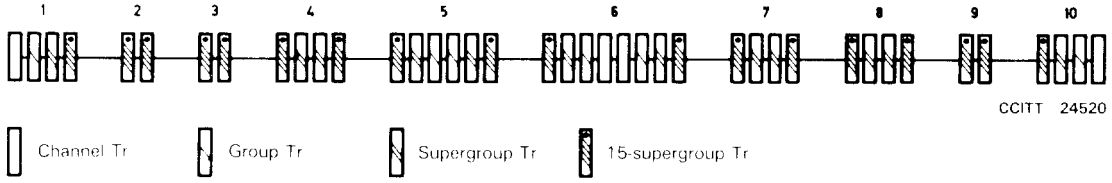


FIGURE 5/G.334

Diagram of a hypothetical reference circuit for 18 MHz systems (Plan 2)

3.2.1 *Hypothetical reference circuit for the Plan 1 frequency allocation*

This is shown in Figure 4/G.334. 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 basic mastergroup and vice versa;
- seven pairs of mastergroup modulators, each pair including translation from basic mastergroup to the basic supermastergroup and vice versa;
- nine pairs of supermastergroup modulators, each pair including translation from basic supermastergroup to the frequency band transmitted on the coaxial cable and vice versa.

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

This is shown in Figure 5/G.334. 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 assembly modulators, each pair including translation from the basic 15-supergroup assembly to the frequency band transmitted on the coaxial cable and vice versa.

3.2.3 *Hypothetical reference circuit for the Plan 3 frequency allocation*

This is shown in Figure 4/G.334. It differs from that for Plan 1 only by the fact that the supermastergroup modulators consist of two translating stages.

4 Circuit noise

In accordance with Recommendation G.222 the system is to be designed in such a way as to obtain a mean psophometric noise power of 3 pW0p per km of line or less as a design objective for the worst telephone channel in the 2500-km hypothetical reference circuit as defined under § 3 above.

5 Matching of repeater and line impedances

The present Recommendation refers only to 18-MHz systems on 2.6/9.5-mm coaxial pairs in which the nominal spacing between repeaters is approximately 4.5 km.

The sum *N* of the three terms defined as in G.332, § 5 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.

6 Relative levels

Levels in the 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.

7 Power feeding

Recommendation G.341, §§ 7.1 and 7.2, applies.

8 Monitoring and fault tracing bands

Frequency bands for monitoring and fault tracing signals should be situated below 300 kHz and/or above 18 480 kHz, that is, leaving a clear band for traffic signals.

9 Use of 18-MHz systems for television transmission

9.1 *General remarks*

In § 9 all additional requirements are summarized which are recommended in the case of television transmission on the 18-MHz system. The characteristics of the television signal in the first intermediate frequency allocation (transmit side conditions) are dealt with in Recommendation J.77 [1].

9.2 *Circuit noise*

If the 18-MHz system is used for television transmission on the basis of a hypothetical reference circuit 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.

9.3 *Matching of repeater impedances and line impedance*

For television programme transmission a value of at least 70 dB for the magnitude *N*, defined in Recommendation G.332 § 5, is recommended in the band occupied by television signals.

9.4 *Line-frequency allocation of the television channels*

9.4.1 *TV transmission only*

The 18-MHz system can provide two television channels. The line-frequency allocation is shown in Figure 6/G.334. The television channels are capable of transmitting the signals of all television systems defined by the CCIR having a video bandwidth not exceeding 6 MHz.

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 two carrier frequencies, i.e. 9570 kHz (3×3190 kHz). It is recommended that this pilot be transmitted at a power level of -10 dBm0. The harmonics should have a level of not higher than -50 dBm0.

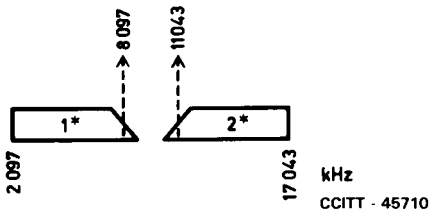


FIGURE 6/G.334

Line-frequency allocation of two television channels on the 18 MHz system

9.4.2 *Mixed telephone-television transmission*

One television channel and a maximum of two 900-channel groups can be provided. Two line-frequency allocations are possible:

a) the upper television channel 2* of Figure 6/G.334;

b) the lowest television channel (TV channel No. 1) of the 60-MHz television line-frequency allocation of Figure 4/G.333.

Note 1 - The modulation methods for a) and b) conform to the first modulation steps of Figure A-1/G.334 and Figure A-2/G.334 respectively in Annex A.

9.5 *Pilots and additional measuring frequencies*

Pilots and additional measuring frequencies (mentioned in § 2), outside the television channels can be used.

ANNEX A

(to Recommendation G.334)

Modulation methods for television transmission on the 18-MHz system

Two recommended modulating methods are shown in Figure A-1/G.334 and Figure A-2/G.334 respectively. The modulation methods are compatible with those of the 60-MHz system (see Annex A to Recommendation G.333).

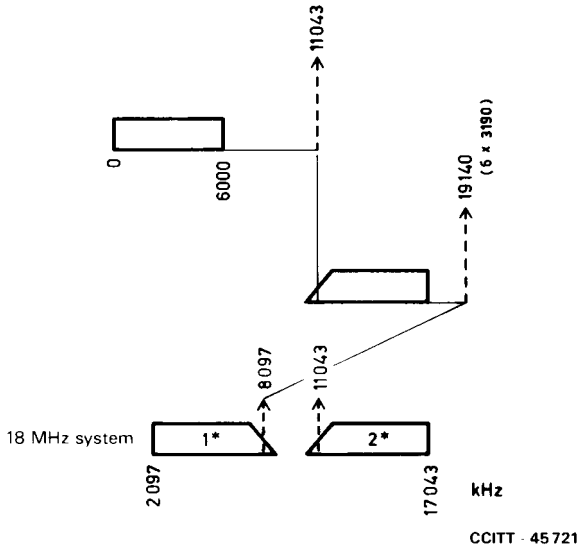
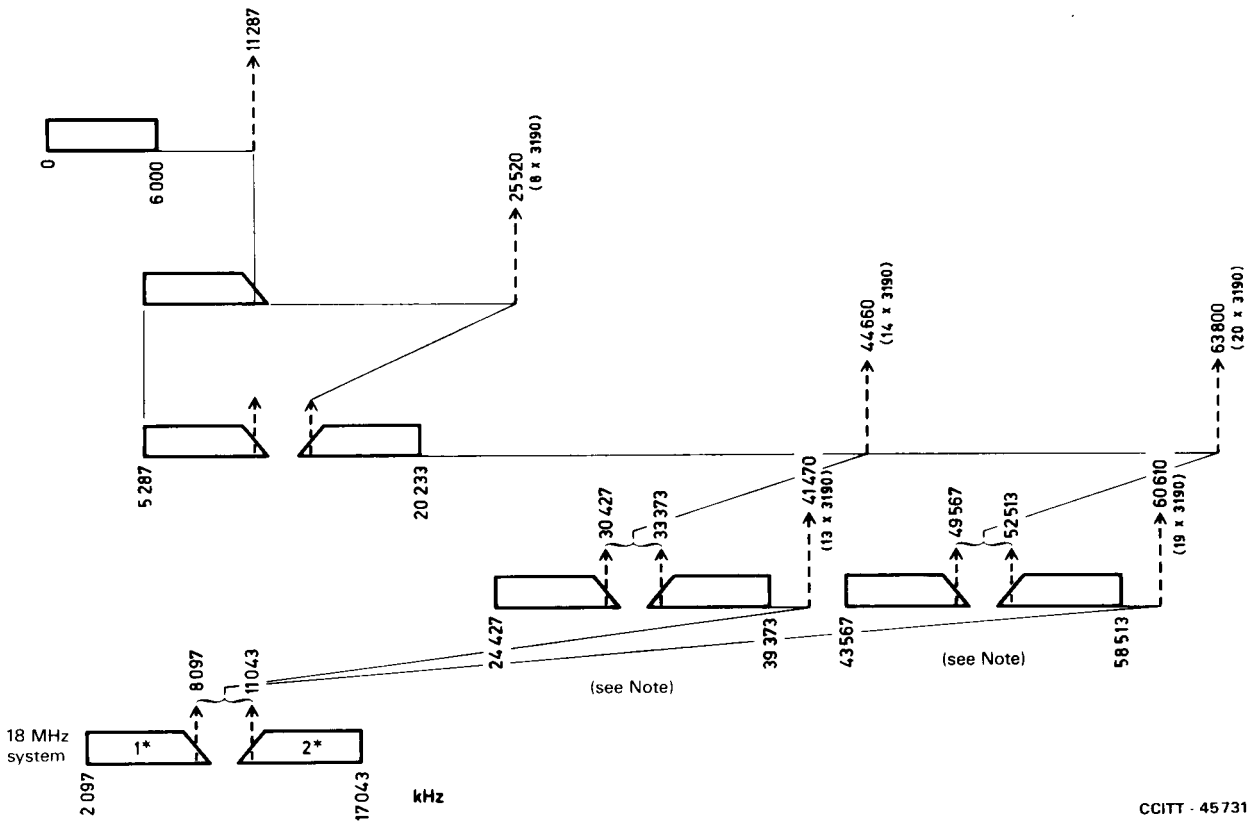


FIGURE A-1/G.334

Modulation method for television transmission on the 18 MHz system
Modulation method 1



Note - Either of these pairs of TV channels can be modulated to work via the 18 MHz system.

FIGURE A-2/G.334

Modulation method for television transmission on the 18 MHz system
Modulation method 2

Reference

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