INTERNATIONAL TELECOMMUNICATION UNION

ITU-T G.225

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

INTERNATIONAL ANALOGUE CARRIER SYSTEMS

GENERAL CHARACTERISTICS COMMON TO ALL ANALOGUE CARRIER-TRANSMISSION SYSTEMS

RECOMMENDATIONS RELATING TO THE ACCURACY OF CARRIER FREQUENCIES

ITU-T Recommendation G.225

(Extract from the *Blue Book*)

NOTES

1 ITU-T Recommendation G.225 as 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.

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Recommendation G.225

RECOMMENDATIONS RELATING TO THE ACCURACY OF CARRIER FREQUENCIES

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

1 Accuracy of the virtual carrier frequencies on an international circuit or on a chain of circuits

As the channels of any international telephone circuit should be suitable for voice-frequency telegraphy, the accuracy of the virtual carrier frequencies should be such that the difference between an audio-frequency applied to one end of the circuit and the frequency received at the other end should not exceed 2 Hz, even when there are intermediate modulating and demodulating processes.

To attain this objective, the CCITT recommends that the channel and group carrier frequencies of the various stages should have the following accuracies:

Virtual channel carrier frequencies in group..... $\pm 10^{-6}$

Group and supergroup carrier frequencies..... $\pm 10^{-7}$

Mastergroup and supermastergroup carrier frequencies:

- for the 12-MHz system..... $\pm 5 \cdot 10^{-8}$
- for the 60-MHz system (above 12 MHz)..... $\pm 10^{-8}$

Experience shows that, if a proper check is kept on the operation of oscillators designed to these specifications, the difference between the frequency applied at the origin of a telephone channel and the reconstituted frequency at the other end hardly ever exceeds 2 Hz if the channel has the same composition as the 2500-km hypothetical reference circuit for the system concerned.

Calculations indicate that, if these recommendations are followed, in the 4-wire chain forming part of the hypothetical reference connection defined in Figure 1/G.103[1)] there is about 1 % probability that the frequency difference between the beginning and the end of the connection will exceed 3 Hz and less than 0.1% probability that it will exceed 4 Hz.

Note 1 - In small stations, i.e. in stations which do not need supergroup carrier frequencies, the accuracy of the group carrier may be $\pm 10^{-6}$, which is the same as for channel carrier frequencies.

Note 2 - The modulating frequencies appropriate to (n + n) systems should have the accuracies recommended in the relevant Recommendations:

Recommendation G.311 for 12-channel open-wire systems;

Recommendation G.361 for 3-channel open-wire systems;

Recommendations G.326 and G.327 [3] for (12 + 12) cable systems.

2 Measure of alignment of the master oscillators

The recommendation in § 1 above cannot be met without some measure of alignment of the master oscillators at the various stations in which modulation occurs.

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1) In fact, the chain considered for these calculations comprised 16 (instead of 12) modulator/demodulator pairs to allow for the possibility that submarine cables with equipments in conformity with Recommendation G.235 might form part of the chain. No allowance was made, however, for the effects of Doppler frequency-shift due to inclusion of a non-stationary satellite; values for this shift are given in CCIR Report 214 [2].

Carrier-transmission systems are formed into "partial networks" extending over the whole or a part of a country. Synchronization of the master oscillators of a partial network is ordinarily based on national frequency comparisons; international comparisons may be made if necessary.

2.1 *National frequency comparisons*

It is necessary that, within the same partial network of coaxial carrier systems, the master oscillators in stations where frequencies are generated should be "coordinated". This "coordination" can consist of a control of one oscillator with respect to another to give one of the following three conditions:

1) synchronization, i.e. identical frequency and fixed phase relationship;

2) isochronization, i.e. identical frequency only;

3) differential control to correct differences between the frequencies at intervals.

Also, automatic devices can be used to give an alarm if the difference in frequency between the checking pilot and a local oscillator exceeds a certain fixed value.

The CCITT has not recommended any particular method of comparing or controlling the master oscillators at different stations, and "routine frequency comparison" of the master oscillators may be thought sufficient; this comparison being followed if necessary by automatic or manual regulation, the master oscillators in each partial network being compared periodically with a national frequency standard, if possible.

The routine comparison of the frequencies generated by the master oscillators is made by means of a "frequency check pilot" transmitted to line for this purpose. It is not necessary to compare phases.

2.2 *International frequency comparisons*

The case may arise, either of a country that has a national frequency standard with no facilities for distributing it throughout the country (particularly in an area in which a coaxial carrier system is to be set up), or of a country that has no national frequency standard. Recommendation M.540 [4], describes methods by which such countries may obtain a standard frequency by radio, or may have a controlled frequency sent over a telephone circuit.

References

[1] CCITT Recommendation *Hypothetical reference connections,* Vol. III, Rec. G.103, Figure 1/G.103.

[2] CCITT Report *The effects of doppler frequency-shifts and switching discontinuities in the fixed satellite service,* Vol. IV, Report 214, Dubrovnik, 1986.

[3] CCITT Recommendation *Valve-type systems offering 12 telephone carrier circuits on a symmetric cable [(12 + 12) systems],* Orange Book, Vol. III-1, Rec. G.327, ITU, Geneva, 1977.

[4] CCITT Recommendation *Routine maintenance of carrier and pilot generating equipment,* Vol. IV, Rec. M.540.