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STANDARDIZATION OF FMVFT SYSTEM FOR A MODULATION RATE OF 200 BAUDS WITH CHANNELS SPACED AT 480 Hz

ITU-T Recommendation R.38 A

(Extract from the *Blue Book*)

NOTES

1 ITU-T Recommendation R.38 A was published in Fascicle VII.1 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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STANDARDIZATION OF FMVFT SYSTEM FOR A MODULATION RATE OF 200 BAUDS WITH CHANNELS SPACED AT 480 Hz

(Geneva, 1964; amended at Mar del Plata, 1968, Geneva, 1972, 1976, 1980, Malaga-Torremolinos, 1984 and at Melbourne, 1988)

Note 1 – This is the standardized system for operation at 200 bauds.

Note 2 – In this Recommendation frequency-modulated voice-frequency telegraph (FMVFT) equipment with and without crystal control are distinguished. In order to improve the quality of transmission and to minimize maintenance costs, the application of equipment with crystal control is recommended.

1 The nominal modulation rate is fixed at 200 bauds.

2 The nominal mean-frequencies are 600 + (n – 1) 480 Hz, n being the channel position number. The mean frequency is defined as half the sum of the characteristic frequencies corresponding to conditions A and Z. For the numbering of channels that has been adopted in the international service see Recommendation R.70 *bis*.

3 The mean frequencies at the sending end should not deviate from their nominal value by more than:

a) for equipment without crystal control 4 Hz;

b) for equipment with crystal control 0.8 Hz[1)].

4 The difference between the two characteristic frequencies in the same channel is fixed at 240 Hz.

5 The maximum tolerance on this difference should be ± 6 Hz.

6 The unbalance due to the modulation process $\delta = 2\,\dfrac{\left|F_0' - F_l\right|}{F_A' - F_Z'}$ should not exceed 2%,

where

F_A' and F_Z' are the two characteristic frequencies measured over a period of 10 s;

F_0' is the mean static frequency measured $\dfrac{F_A' + F_Z'}{2}$;

F_l is the mean dynamic frequency measured with 1:1 rectangular signals during 10 signals.

Measurement should be made applying to the input of the transmitter 1:1 rectangular signals with the build-up and hangover time below 1 µs and with the unbalance below 0.1%. In the event that in service the transmitter is controlled by an electromechanical relay (with a certain transit time), the measurement should also be made with that type of relay inserted between the 1:1 signal generator and the input to the transmitter. Both forms of measurements need not necessarily be included in the maintenance procedure but should be included in laboratory type tests.

Note – To determine the unbalance due to the modulation process by the method indicated above, it is necessary to measure the frequencies F_A', F_Z' and F_l and to calculate the mean frequency F_0' and the unbalance

$$\delta = 2\,\frac{\left|F_0' - F_l\right|}{F_A' - F_Z'}$$

1) The tightening of this tolerance is for further study.

A more rapid method for checking whether or not the unbalance is less than the limit fixed is to measure:

– the mean dynamic frequency F_l with 1:1 signals during 10 s;

– the mean dynamic frequency F_m with 2:2 signals during 10 s:

$$\delta = 2\,\frac{|F_0' - F_l|}{F_A' - F_Z'} = 4\frac{|F_0' - F_m|}{F_A' - F_Z'}$$

or to subtract:

$$|F_l - F_m| = \frac{1}{4}(F_A' - F_Z')\delta \approx \frac{1}{4}(F_A - F_Z)\,\delta \leq 1.8 \text{ Hz}$$

The absolute value of the difference between the two frequencies measured, F_l and F_m must be less than 1.8 Hz.

7 The total average power transmitted to the telephone-type circuit is normally dependent on the transmission characteristics of the circuit as follows:

a) For circuits with characteristics not exceeding the limits given in Annex A to Recommendation R.35, the mean power per channel at a point of relative zero level should not be more than 8.0 µW (–21.0 dBm0). The pilot channel, where employed, should have a level of not more than 2.0 µW (–27.0 dBm0).

b) For other circuits, the mean power per channel at a point of relative zero level should not be more than 21.6 µW (–16.7 dBm0). The pilot channel, where employed, should have a level of not more than 5.4 µW (–22.7 dBm0).

8 In service, the levels of the signals corresponding to continuous condition Z and continuous condition A should not differ by more than 1.7 dB in the same channel. Both of these levels must lie between ± 1.7 dB with reference to the level in § 7 above.

9 The condition A frequency is the higher of the two characteristic frequencies, and the condition Z frequency is the lower one (see Recommendation V.1 [1]).

10 In the absence of a channel-modulator control telegraph current, a frequency shall be transmitted that shall be within ± 20 Hz of the frequency normally transmitted for the condition A. It is not necessary for this transmission to take place immediately after the control current has been cut.

11 The frequency spectrum of the emitted signal, when transmitting 1:1 reversals (Definition 31.401, Recommendation R.140) at the modulation rate of $2f_p$ (f_p = frequency of modulation) should be in accordance with the limits specified in Figure 1/R.37, which shows the levels of the spectra of different components with respect to the amplitude of the non-modulated carrier as ordinates and the frequencies as abscissae.

12 The receiving equipment should operate satisfactorily when the receiving level falls to 17.4 dB below the nominal level. The receiving equipment should have been restored to condition A when the receiving level has fallen to 23.5 dB below the nominal level. The alarm-control level is left to the choice of each Administration.

13 On delivery by the manufacturer of 200-baud/480-Hz frequency-modulated voice-frequency telegraph (FMVFT) equipment, the following values must not be exceeded for the degree of distortion on a telegraph channel. These values correspond to closed circuit measurements, made with the audio-frequency line terminals of the sending and receiving equipments connected together through an artificial line. Before the series of measurements taken in accordance with Recommendation R.51, the levels are adjusted to their normal values, the mean frequencies are checked to see whether they are within:

1) for equipment without crystal control ± 4 Hz;

2) for equipment with crystal control ± 0.8 Hz,

of their nominal value (see § 3 above) and the difference between the two characteristic frequencies is within the permitted tolerance of less than 6 Hz (see § 5 above). Bias distortion is eliminated by adjustment in the channel receivers. The other channels of the system are modulated with unrelated signals when the effect of interchannel interference is to be included in the measurement. These "unrelated signals" can conveniently be 1:1 signals from different generators at approximately 200 bauds but not synchronous to each other or to the signal on the channel under test.

a) The transmission levels being normal, the artificial line introducing no frequency drift, but the measured channel being subject to fortuitous distortion due to interchannel interference: 5% for the degree of inherent isochronous distortion.

b) The level being maintained constant, but at a value different from the normal level, for all constant levels between 8.7 dB above the normal reception level and 17.4 dB below the normal reception level, the other conditions being the original measurement conditions: 7% for the degree of inherent isochronous distortion.

c) In the presence of interference by a single sine-wave frequency equal first to one and then to the other characteristic frequency, with a level of 20 dB below the signal level, the other conditions for the start of measurements being maintained: 10% for the degree of inherent isochronous distortion (i.e. total distortion including the increase due to the interfering frequency, not distortion due to the interfering frequency alone).

d) By introducing a frequency drift (Δf Hz) of the signals during transmission through the artificial line, Δf in Hz being not more than 10, and the initial conditions of the test otherwise being preserved: $(5 + 0.7\ \Delta f$ Hz)% for the degree of inherent isochronous distortion; the measurements shall be made after the transient effects of changing frequency have ceased.

e) Equipment with crystal control, with any climatic conditions specified for the tested equipment, the initial condition of the test otherwise being preserved: 8% for the degree of inherent isochronous distortion. The bias distortion caused by changes of climatic conditions should not be eliminated.

14 Frequency drifts on modern telephone-type circuits are generally less than 2 Hz. Hence it is not necessary to recommend frequency drift control. For circuits on which a maximum frequency drift of not greater than ± 2 Hz cannot be guaranteed, and on which the distortion resulting from the frequency drift is not acceptable, compensation seems necessary. Two methods can be used:

a) compensation for each channel up to about 15 Hz;

b) compensation for all the channels by using a pilot. In this case, the receiving end must be able to request and obtain a pilot frequency. Administrations should agree among themselves on the advisability of sending the pilot and the choice of frequency. The frequencies 3300 Hz or, preferably, 300 Hz are recommended for this pilot, with a tolerance of:

   1) for equipment without crystal control ± 1 Hz

   2) for equipment with crystal control ± 0.2 Hz.

   The mean power emitted at the relative zero point on this frequency should not exceed –27.0 dBm0 or –22.7 dBm0 as appropriate (see § 7 and Tables 1/R.35 and 2/R.35 in Recommendation R.35, which are also applicable to equipment to this Recommendation).

15 The number of significant conditions of the modulation is fixed at two; this number may be increased, if necessary, by agreement between the Administrations concerned.

Reference

[1] CCITT Recommendation *Equivalence between binary notation symbols and the significant conditions of a two-condition code*, Rec. V.1.