INTERNATIONAL TELECOMMUNICATION UNION

ITU-T R.35

TELECOMMUNICATION
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STANDARDIZATION OF FMVFT SYSTEMS FOR A MODULATION RATE OF 50 BAUDS

ITU-T Recommendation R.35

(Extract from the *Blue Book*)

NOTES

1 ITU-T Recommendation R.35 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.

Recommendation R.35

STANDARDIZATION OF FMVFT SYSTEMS FOR A MODULATION RATE OF 50 BAUDS

(former CCIT Recommendation B.48, Geneva, 1956; amended at New Delhi, 1960, Geneva, 1964, Mar del Plata, 1968, Geneva, 1972, 1976, 1980, Malaga-Torremolinos, 1984 and at Melbourne, 1988)

Note – 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 should be standardized at 50 bauds.

2 For the nominal mean frequencies, the series formed by the odd multiples of 60 Hz should be adopted, the lowest frequency being 420 Hz in accordance with Recommendation R.31, § 1, the mean frequency F_0 being defined as half the sum of the two characteristic frequencies corresponding to the permanent start polarity F_A and stop polarity F_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 2 Hz;

b) for equipment with crystal control 0.5 Hz. [1)]

4 The unbalance due to the modulation process $\delta = 2 \dfrac{|F_0' - F_l|}{F_A' - F_Z'}$ 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 $= 2 \dfrac{F_A' + F_Z'}{2}$;

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

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

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

Error! Bookmark not defined.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 seconds;

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

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

or to subtract:

$$|F_l - F_m| = \frac{1}{4}\,(F_A' - F_Z')\,\delta \approx \frac{1}{4}\,(F_A - F_Z)\,\delta \leq 0.4 \text{ Hz}.$$

The absolute value of the difference between the two frequencies measured, F_l, and F_m, must be less than 0.4 Hz.

5 The difference between the two characteristic frequencies (corresponding to the start and the stop conditions) should be 60 Hz.

6 The maximum tolerance on this difference should be ± 3 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, the total average power transmitted by all channels of a system should preferably be limited to 50 µW at a point of zero relative level. This sets, for the average power of a telegraph channel (at a point of zero relative level), the limits given in Table 1/R.35.

b) For other circuits, the total average power transmitted by all channels of a system is limited to 135 µW at a point of zero relative level. This sets, for the average power of a telegraph channel (at a point of zero relative level), the limits given in Table 2/R.35.

TABLE 1/R.35

Normal limits (nominal values) for the power per telegraph channel in FMVFT systems for bearer circuits with charactistics not exceeding the limits given in Annex A

Number of telegraph channels in the FMVFT system	Allowable power per telegraph channel at a point of zero relative level	
	in microwatts	in absolute power level decibels
12 or less	4.0	–24.0
18	2.7	–25.7
24	2.0	–27.0

TABLE 2/R.35

Normal limits (nominal values) for the power per telegraph channel in FMVFT systems for others bearer circuits

Number of telegraph channel in the FMVFT system	Allowable power per telegraph channel at a point of zero relative level	
	in microwatts	in absolute power level decibels
12 or less	10.8	–19.7
18	7.2	–21.4
24	5.4	–22.7

Note – The figures in Tables 1/R.35 and 2/R.35 assume the provision of a pilot channel on the telegraph bearer at a level of –27 dBm0 and –22,7 dBm0 respectively.

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 given in Table 1/R.35 or Table 2/R.35 as applicable.

9 The frequency for the transmitted condition corresponding to the condition A is the higher of the two characteristic frequencies and that corresponding to the condition Z is the lower.

10 In the absence of a channel-modulator control telegraph current, a frequency should be transmitted within ±5 Hz of the frequency normally transmitted for the start polarity. This frequency need not be sent immediately after interruption of the control current.

11 The frequency spectrum of the emitted signal, when transmitting 1:1 reversals (Definition 31.401, Recommendation R. 140) at the modulation rate of 2 f_p (f_p = frequency of modulation), should be in accordance with the limits specified in Figure 1/R.35, 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 nominal level is the level resulting from the choice of power per channel (see Tables 1/R.35 or 2/R.35 as applicable) depending upon the number of channels (12, 18 or 24) on the circuit. The alarm-control level is left to the choice of each Administration.

13 On delivery by the manufacturer of 50-baud 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 ± 2 Hz;

2) for equipment with crystal control ± 0.5 Hz[2)],

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

of their nominal value (see § 3 above) and the difference between the two characteristic frequencies is within the permitted tolerance of less than 3 Hz (see § 6 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 inter-channel interference is to be included in the measurement. These "unrelated signals" can conveniently be 1:1 signals from different generators at approximately 50 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 condition: 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: 12% 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 being not more than 5 Hz and the initial condition of the test otherwise being preserved:

– for equipment without crystal control
– for equipment with crystal control but without compensation for frequency drift } $(5 + 2.5\,\Delta f\ \text{Hz})\ \%$

– for equipment with crystal control and compensation for frequency drift 7%

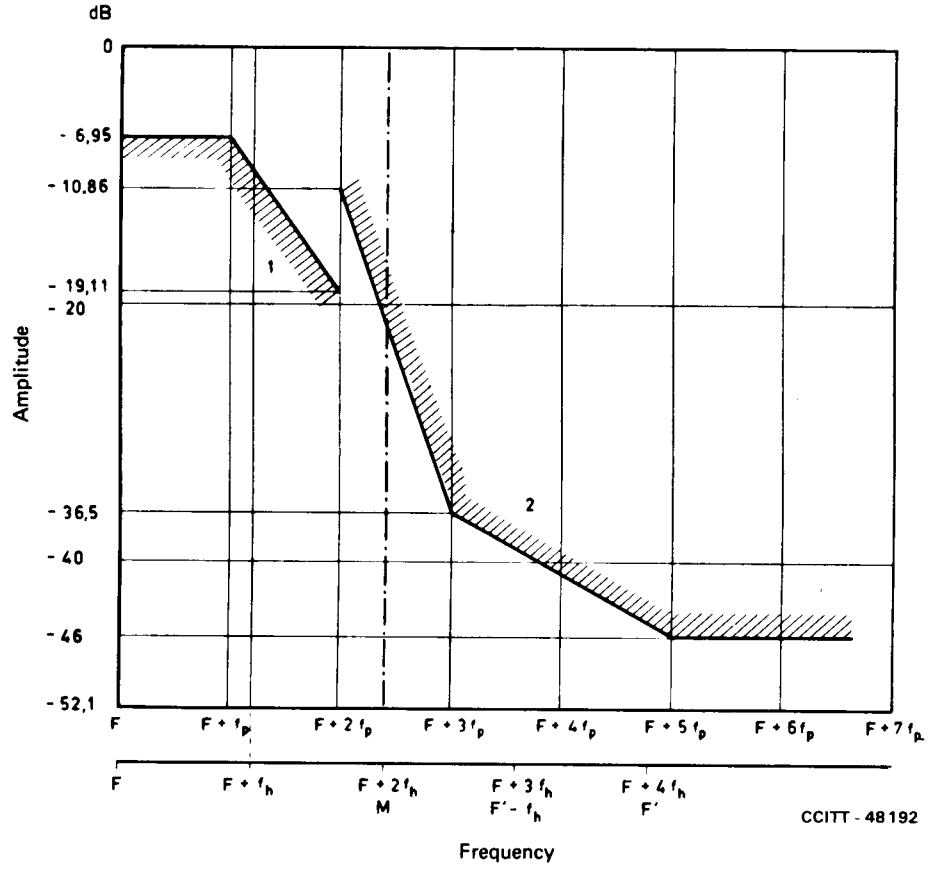
for the degree of inherent isochronous distortion.

By introducing a frequency drift (Δf Hz) of the signals during transmission through the artificial line, Δf being not more than 10 Hz, and the initial conditions of the test otherwise being preserved:

– for equipment with crystal control and compensation for frequency drift 13%

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.



F = carrier frequency of a channel
f_p = frequency of modulation = 25 Hz
f_h = frequency shift = 30 Hz

M = centre line between adjacent channels
F' = carrier frequency of the adjacent channel

Curve 1 = lower limit in the pass band
Curve 2 = upper limit in the stop band

Note — The reference level (0 dB) is the mean value of the levels of the signals corresponding to continuous stop and continuous start polarity, which are measured at the characteristic frequencies F_Z and F_A.

FIGURE 1/R.35

Frequency spectrum for 1:1 signals in 50-baud/120-Hz FMVFT systems

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 guaranted, 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 permitted at the relative zero point on this frequency should not exceed –27.0 dBm0 or –22.7 dBm0 as appropriate (see Table 2/R.35).

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

ANNEX A

(to Recommendation R.35)

Limits required by a bearer circuit for FMVFT application if the total power transmitted by all channels is set at 50 microwatts

A.1 *Loss/frequency distortion*

The variation with frequency of the overall loss of the link with respect to the loss at 800 Hz should not exceed the limits shown in Figure A-1/R.35.

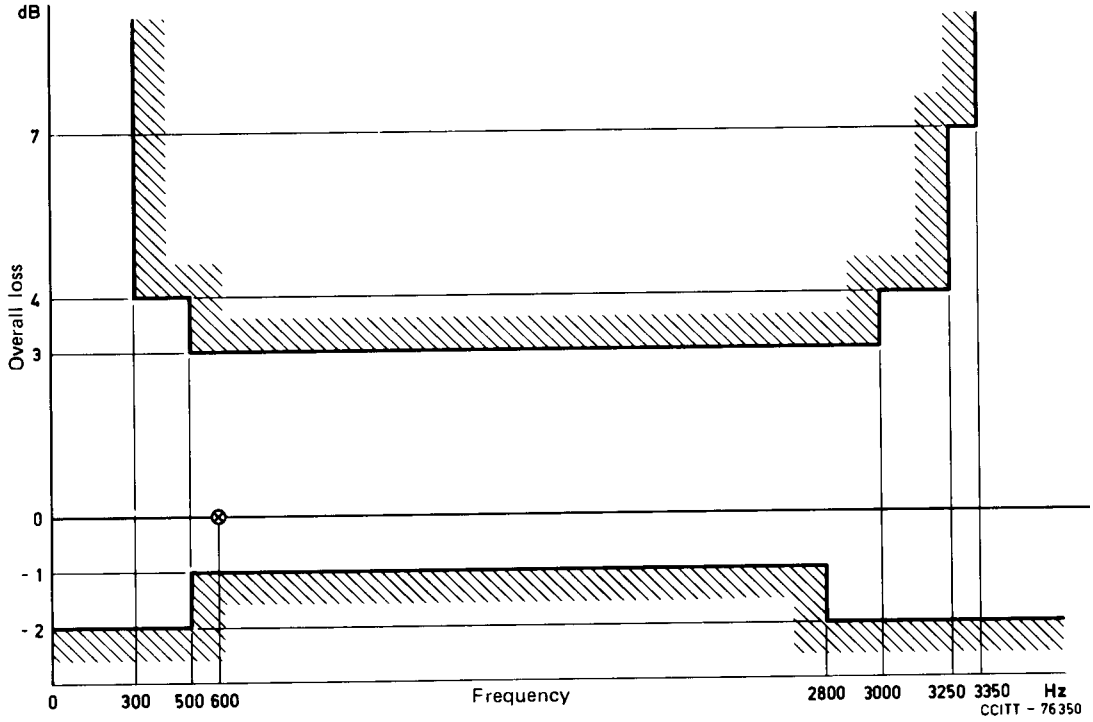


FIGURE A-1/R.35

A.2 *Random noise*

The mean psophometric noise power referred to a point of zero relative level should not exceed 32 000 pW0p (–45 dBm0p), using a psophometer in accordance with Recommendation P.53 [1].

A.3 *Impulsive noise*

The number of counts of impulsive noise that exceeds –28 dBm0 should not exceed 18 in 15 minutes when measured with an impulsive noise counter in accordance with Recommendation O.71 [2].

A.4 *Error rates*

The telegraph character error rate that may be caused by interruptions and noise in the bearer circuit should not exceed the limits stated in Recommendations R.54 and F.10 [3].

References

[1] CCITT Recommendation *Psophometers (apparatus for the objective measurement of circuit noise)*, Rec. P.53.

[2] CCITT Recommendation *Specification for an impulsive noise measuring instrument for telephone-type circuits*, Rec. O.71.

[3] CCITT Recommendation *Character error rate objective for telegraph communication using 5-unit start-stop equipment*, Rec. F.10.