INTERNATIONAL TELECOMMUNICATION UNION

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INTERNATIONAL TELEGRAPH SYSTEMS AND PHOTOTELEGRAPH TRANSMISSION

SETTING UP AND LINING UP AN INTERNATIONAL VOICE-FREQUENCY TELEGRAPH LINK FOR PUBLIC TELEGRAPH CIRCUITS (FOR 50, 100 AND 200 BAUD MODULATION RATES)

ITU-T Recommendation M.810

(Extract from the *Blue Book*)

NOTES

1 ITU-T Recommendation M.810 was published in Fascicle IV.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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1 Designation of control stations

1.1 The designation of the control and sub-control stations should follow the principles given in Recommendations M.80 [1] and M.90 [2].

1.2 By agreement between Administrations, one of the terminal international repeater stations will be designated as the voice-frequency telegraph link control station: the other terminal being the terminal sub-control station for the link.

1.3 In making this choice, the location of the circuit control station for any international circuit designated as a reserve for the international voice-frequency telegraph line should also be taken into account, as it is very desirable that the voice-frequency telegraph link control station should be at the same terminal station as the circuit control station for the nominated reserve circuit.

2 Organization

2.1 The maintenance organization arrangements for voice-frequency telegraph links should conform to the general principles given in Recommendation M.70 [3] concerning telephone-type circuits.

3 Setting up and lining up a voice-frequency telegraph link

3.1 In setting up and lining up voice-frequency telegraph links, three types of link are concerned, differing mainly in their constitution and they are referred to as type I, type II and type III links:

- Type I are those links which contain 4-kHz sections;
- Type II are those links which contain one or more 3-kHz sections, or contain a mixture of 3-kHz and 4-kHz sections;
- Type III are those links which are routed over audio-frequency line plant.

3.2 The method to be used and the procedure to be followed in setting up and lining up a voice-frequency telegraph link are the same as those given in Recommendation M.580 [4] for public telephone circuits as far as it applies.

The test signals to be used for these three types of link and the limits of the loss/frequency characteristics at intermediate sub-control stations are the same as those given in Recommendation M.580 [4] for public telephone circuits.

3.3 The overall loss/frequency characteristics of types I, II and III voice-frequency telegraph links are given in Tables 1/M.810, 2/M.810 and 3/M.810 respectively.

3.4 The nominal relative power level of the test signals at the input and output of the link will be those normally used by the Administration concerned.

If the voice-frequency telegraph terminal stations are remote from the terminal international centres, the Administration should arrange the nominal transmission loss of the national section so that the levels at the input and output of the voice-frequency telegraph link are respected, and to permit the conventional national levels to be used at terminal international centres.

3.5 For voice-frequency telegraphy the use of the edge-channels of a group should be avoided if at all possible since these may introduce greater distortion than other channels of the group.

4 Limits for the overall loss of a voice-frequency telegraph link

4.1 *Nominal overall loss at 1020 Hz*

The nominal relative power levels at the extremities of the voice-frequency telegraph link are those levels normally used in the national network of the countries concerned so that it is not possible to recommend a particular nominal value for the overall loss.

The nominal relative power level at the input to the link and the absolute power level of the telegraph signals at this point must be such that the limits concerning the power level per telegraph channel at a zero relative point on carrier systems are respected (see Annex A).

Some Administrations have bilateral agreements to reduce the total mean power level of frequency-shift voice-frequency telegraph systems to –13 dBm0 (50 μW0). The CCITT encourages such reduction where feasible. These Administrations have made their own determination of the feasibility of operating at the reduced level. As a guide, other Administrations may wish to use the line parameters suggested in Annex B.

4.2 *Overall loss/frequency distortion*

The variation with frequency of the overall loss of the link with respect to the loss at 1020 Hz must not exceed the following limits:

4.2.1 *Type I – Links with 4-kHz sections throughout*

TABLE 1/M.810

Frequency range (Hz)	Overall loss relative to that at 1020 Hz
Below 300	Not less than –2.2 dB; otherwise unspecified
300- 400	–2.2 to +4.0 dB
400- 600	–2.2 to +3.0 dB
600-3000	–2.2 to +2.2 dB
3000-3200	–2.2 to +3.0 dB
3200-3400	–2.2 to +7.0 dB
Above 3400	Not less than –2.2 dB; otherwise unspecified

4.2.2 *Type II – Links with one or more 3-kHz sections or with a mixture of 3-kHz and 4-kHz sections*

TABLE 2/M.810

Frequency range (Hz)	Overall loss relative to that at 1020 Hz
Below 300	Not less than –2.2 dB; otherwise unspecified
300- 400	–2.2 to + 4.0 dB
400- 600	–2.2 to +3.0 dB
600-2700	–2.2 to +2.2 dB
2700-2900	–2.2 to +3.0 dB
2900-3050	–2.2 to + 6.5 dB
Above 3050	Not less than –2.2 dB; otherwise unspecified

4.2.3 *Type III – Links on audio-frequency line plant*

TABLE 3/M.810

Frequency range (Hz)	Overall loss relative to that at 1020 Hz
Below 300	Not less than –1,7 dB; otherwise unspecified
300- 400	–1.7 to + 4.3 dB
400- 600	–1.7 to +2.6 dB
600-1600	–1.7 to +1.7 dB
1600-2400	–1.7 to + 4.3 dB
2400-2450	–1.7 to +5.2 dB
2450-2520	–1.7 to +7.0 dB
Above 2520	Not less than –1.7 dB; otherwise unspecified

4.2.4 *Application of Recommendations*

Figure 1/M.810 shows, in respect of loss/frequency distortion, the relationship of the Recommendations relating to international voice-frequency telegraph links. In practice, in the majority of cases, the international line between terminal international centres will be well within the limits of Recommendation M.580 [4] and no additional equalization will be needed to meet the overall requirement of this Recommendation.

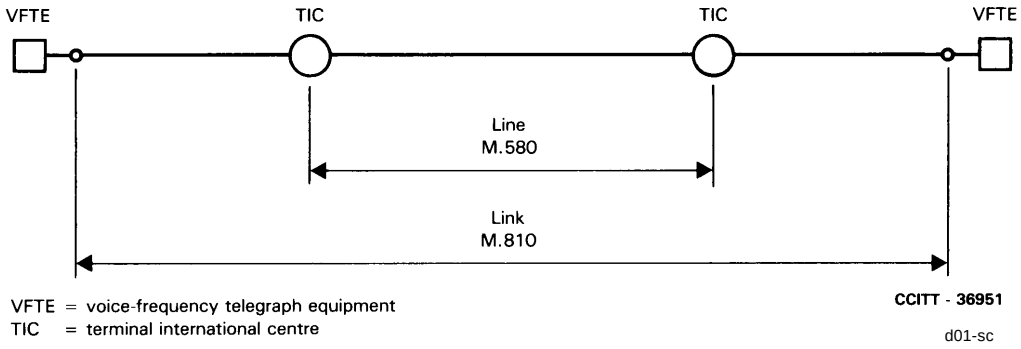

FIGURE 1/M.810

Relationship of Recommendations which apply to international voice-frequency telegraph links in respect of loss/frequency distortion

4.3 *Change of overall loss due to a changeover to the reserve line or section*

4.3.1 The nominal relative power level at 1020 Hz of the normal and reserve lines or sections at the changeover points for a particular direction of transmission should be the same. This level will be that normally used in the national network of the country concerned.

4.3.2 *Change in overall loss at 1020 Hz*

Bearing in mind that the overall loss of the normal line (or section) and the reserve line (or section) are both subject to variations with time, these variations being, in general, uncorrelated, it is not possible to assign a limit to the change of insertion loss at 1020 Hz introduced by the changeover procedure.

4.3.3 *Values of overall loss over the frequency band, relative to the value at 1020 Hz*

The overall-loss/frequency distortion characteristic of the link when established over the normal route should be within 2 dB of that of the link when established over the reserve route. This limit applies over the frequency bands 300-3400 Hz, 300-3050 Hz or 300-2520 Hz as appropriate.

There should ordinarily be no difficulty in achieving the limit when only one portion of the link, for example, the international telegraph line, or one section, has a reserve section. However, when two or more portions of the link are separately associated with reserve portions it becomes administratively difficult to ensure that all combinations of normal and reserve portions comply with the limit. In these circumstances the best that can be done is to ensure that the overall-loss/frequency characteristics of corresponding normal and reserve portions are as much alike as possible. Careful attention should be paid to the impedance of normal and reserve sections at the point where they are connected to the changeover apparatus so that errors due to changing mismatch losses are minimized. A suitable target would be for all impedances concerned to have a return loss against 600 ohms, non-reactive, of not less than 20 dB over the appropriate band of frequencies.

5 Measurement of noise voltage on a voice-frequency telegraph link

5.1 *Uniform-spectrum random noise*

The psophometrically weighted noise voltage should be measured at the ends of the voice-frequency telegraph link in both directions of transmission. The unweighted noise voltage should also be measured using a CCITT psophometer without the weighting network.

The mean psophometric noise power referred to a point of zero relative level should not exceed 80 000 pW (– 41 dBm0p).

Note 1 – If recourse is made to synchronous operation, a higher noise level might be tolerated (such as – 30 dBm0p for a particular telegraph system).

Note 2 – In principle it would be desirable to specify a value of unweighted noise power level. However, such a value cannot be specified in unqualified terms. If the noise power is uniformly distributed over the band 300-3400 Hz and if there is no significant noise power outside this band then the level of the unweighted noise power will be approximately 2.5 dB higher than the value of the weighted noise power, using the weighting filters specified in Recommendation O.41 [5]. However, on a practical telegraph link neither of these conditions is likely to be met. The overall-loss/frequency distortion will affect the within-band noise distribution and, in a telegraph installation, there is likely to be significant noise power outside the band, particularly at low frequencies.

As a consequence, it is not possible to recommend a limit for the unweighted noise power level and the CCITT psophometer with the telephone weighting networks should continue to be the instrument used for specifying and measuring random noise power levels on international voice-frequency telegraph links.

5.2 *Impulsive noise*

Impulsive noise should be measured with an instrument complying with Recommendation O.71 [6] and H.13 [7]. (See also Recommendation V.55 [8].)

The number of counts of impulsive noise which exceeds –18 dBm0 should not exceed 18 in 15 minutes.

6 Crosstalk

6.1 The near-end crosstalk ratio (between the go and return telephone channels) of the link should be at least 43 dB.

6.2 The crosstalk ratio between the link and other carrier circuits is restricted by the Recommendation cited in [9] to not worse than 58 dB.

Crosstalk in any audio cables forming part of the terminal national sections should not normally significantly worsen the crosstalk ratio.

7 Group-delay/frequency distortion

Practical experience obtained up to the present shows that it is not necessary to recommend limits for group-delay/frequency distortion for 50-baud voice-frequency telegraph links even when they are composed of several sections each provided on telephone channels of carrier systems. There is little practical experience with higher-speed telegraph systems.

It may happen that under adverse conditions some telephone channels of the link are of insufficient quality to provide 24 telegraph channels. In such a case a better combination of telephone channels must be chosen for the telegraph service.

8 Frequency error

The frequency error introduced by the link must not be greater than ± 2 Hz.

9 Interference caused by power supply sources

When a sinusoidal test signal is transmitted over the link at a level of 0 dBm0 the level of the strongest unwanted side component should not exceed – 45 dBm0.

Note – The limit of – 45 dBm0 is based on a test-signal level of 0 dBm0, and this level should be used when making this test.

10 Variation of overall loss with time

10.1 Before a voice-frequency telegraph link is placed into service it is desirable that a test signal in each direction of transmission should be monitored at the distant end with a level-recording instrument for a minimum of 24 hours. Where possible the instrument should be capable of detecting level variations of duration as short as 5 ms.

10.1.1 The difference between the mean value and the nominal value of the overall transmission loss should not exceed 0.5 dB.

10.1.2 The standard deviation about the mean value should not exceed 1.0 dB.

However in the case of circuits set up wholly or partly on older-type equipment, and where the international line consists of two or more circuit sections, a standard deviation not exceeding 1.5 dB may be accepted.

11 Amplitude hits, short interruptions in transmission and phase hits

Such impairments to voice-frequency telegraph links reduce the quality of telegraph transmission. For example, phase hits in excess of 110° will cause errors in telegraph transmission. Amplitude hits, short interruptions in transmission and phase hits should be reduced to the minimum possible, bearing in mind the need to meet the error rate objectives given in Recommendations F.10 [10] and R.54 [11].

12 Record of results

All measurements made during the lining-up of the link are reference measurements and should be carefully recorded and a copy sent by the sub-control stations to the control station in accordance with Recommendation M.570 [12].

13 Information concerning voice-frequency telegraph terminal equipment

Information concerning international voice-frequency telegraphy is given in Annex A and Annex B.

14 Marking of circuits used for voice-frequency telegraphy

Any interruption of a voice-frequency telegraph link, even of very short duration, spoils the quality of the telegraph transmission. It is therefore desirable to take great care when making measurements on circuits used for voice-frequency telegraphy. To draw the attention of staff to this, all equipments used for voice telegraphy links should bear a special identification mark in the terminal exchanges and, where necessary, in repeater stations where the circuits are accessible.

ANNEX A

(to Recommendation M.810)

Basic characteristics of telegraph equipments used in international voice-frequency telegraph systems

A.1 *Limiting power per channel*

A.1.1 *Amplitude-modulated voice-frequency telegraph systems at 50 bauds*

Administrations will be able to provide the telegraph services with carrier telephone channels permitting the use of 24 voice-frequency telegraph channels (each capable of 50 bauds) on condition that the power of the telegraph channel signal on each channel, when a continuous marking signal is transmitted, does not exceed 9 microwatts at zero relative level points.

For 18 telegraph channels only, the power so defined may be increased to 15 microwatts per telegraph channel, so that even telephone channels with a relatively high noise level can then be used.

The power per telegraph channel should never exceed 35 microwatts, however few channels there may be.

These limits are summarized in Table A-1/M.810.

TABLE A-1/M.810

Limiting power per telegraph channel when sending a continuous marking signal in amplitude-modulated voice-frequency telegraph systems at 50 bauds

System	Limiting power per telegraph channel when sending a continuous marking signal	
	μW0	dBm0
12 telegraph channels or less	35	–14.5
18 telegraph channels	15	–18.3
24 (or 22) telegraph channels	9	–20.5

A.1.2 *Frequency-shift voice-frequency telegraph systems at 50 bauds*

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

a) For circuits with characteristics not exceeding the limits given in Annex B, the total average power transmitted by all channels of a system should preferably be limited to 50 microwatts 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 A-2/M.810.

b) For other circuits, the total average power transmitted by all channels of a system is limited to 135 microwatts 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 A-3/M.810.

Note – The values in Tables A-2/M.810 and A-3/M.810 assume the provision of a pilot channel on the telegraph bearer.

TABLE A-2/M.810

Normal limits for the power for telegraph channel in FMVFT systems for bearer circuits with caracteristics not exceeding the limits given in Annex B

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	–24
18	2.67	–25.8
24	2	–27

TABLE A-3/M.810

Normal limits for the power per telegraph channel in FMVFT systems for other bearer circuits

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	10.8	–19.7
18	7.2	–21.5
24	5.4	–22.7

A.2 *Telegraph channel carrier frequencies*

For international voice-frequency 24-channel, 50-baud, nonsynchronous telegraph systems the frequency series consisting of odd multiples of 60 Hz has been adopted, the lowest frequency being 420 Hz as shown in Table A-4/M.810 below. In the case of frequency-shift systems, these frequencies are the mean frequencies of the telegraph channels, the frequency of the signal sent to line being 30 Hz (or 35 Hz) above or below the mean frequency according to whether A or Z space is being sent.

TABLE A-4/M.810

Telegraph channel position *n*	Frequency (Hz) *fn*	Telegraph channel position *n*	Frequency (Hz) *fn*
1	420	13	1860
2	540	14	1980
3	660	15	2100
4	780	16	2220
5	900	17	2340
6	1020	18	2460
7	1140	19	2580
8	1260	20	2700
9	1380	21	2880
10	1500	22	2940
11	1620	23	3060
12	1740	24	3180

The carrier frecuency *fn* of the channel is given by the expression:

$$fn = 60\,(2n + 5),$$

where *n* is the number of the channel.

In addition, a pilot channel using a frequency of 300 Hz or 3300 Hz can be used. For details of the normal frequencies used in other types of voice-telegraph systems, see the numbering scheme given in Table 2/R.70 *bis* [13].

ANNEX B

(to Recommendation M.810)

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

B.1 *Loss/frequency distortion*

The variation with frequency of the overall loss of the link with respect to the loss at 1020 Hz must not exceed the limits given in Table B-1/M.810.

TABLE B-1/M.810

Frequency range (Hz)	Overall loss relative to that at 1020 Hz
Below 300	Not less than –2.0 dB; otherwise unspecified
300- 500	–2.0 to + 4.0 dB
500-2800	–1.0 to +3.0 dB
2800-3000	–2.0 to +3.0 dB
3000-3250	–2.0 to + 4.0 dB
3250-3350	–2.0 to +7.0 dB
Above 3350	Not less than –2.0 dB; otherwise unspecified

B.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 O.41 [5].

B.3 *Impulsive noise*

The number of counts of impulsive noise which exceed –28 dBm0 should not exceed 18 in 15 minutes, when measured with an impulsive noise counter in accordance with Recommendation O.71 [6].

B.4 *Error rates*

The telegraph character error rate which may be caused by interruptions and noise in the bearer circuit should not exceed the limits stated in Recommendations R.54 [11] and F.10 [10].

B.5 *Bearer length*

Reduction of power levels from 135 microwatts to 50 microwatts applies only to bearers of length up to 3000 km (see Note).

Note – The study of reduction of levels on longer bearer paths (greater than 3000 km) is continuing.

References

[1] CCITT Recommendation *Control stations*, Vol. IV, Rec. M.80.

[2] CCITT Recommendation *Sub-control stations*, Vol. IV, Rec. M.90.

[3] CCITT Recommendation *Guiding principles on the general maintenance organization for telephone-type international circuits*, Vol. IV, Rec. M.70.

[4] CCITT Recommendation *Setting up and lining up an international circuit for public telephony*, Vol. IV, Rec. M.580.

[5] CCITT Recommendation *Psophometer for use on telephone-type circuits*, Table 1/O.41, Vol. IV, Rec. O.41.

[6] CCITT Recommendation *Impulsive noise measuring equipment for telephone-type circuits*, Vol. IV, Rec. O.71.

[7] CCITT Recommendation *Characteristics of an impulsive-noise measuring instrument for telephone-type circuits*, Orange Book, Vol. III-2, Rec. H.13, ITU, Geneva, 1977.

[8] CCITT Recommendation *Specification for an impulsive noise measuring instrument for telephone-type circuits*, Green Book, Vol. VIII, Rec. V.55, Annex, ITU, Geneva, 1973.

[9] CCITT Recommendation *General performance objectives applicable to all modern international circuits and national extension circuits*, Vol. III, Rec. G.151, § 4.1.

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

[11] CCITT Recommendation *Conventional degree of distortion tolerable for standardized start-stop 50-baud systems*, Vol. VII, Rec. R.54.

[12] CCITT Recommendation *Constitution of the circuit; preliminary exchange of information*, Vol. IV, Rec. M.570.

[13] CCITT Recommendation *Numbering of international VFT channels*, Vol. VII, Rec. R.70 *bis*, Table 2/R.70 *bis*.