# Recommendation T/STI 46-04 (Odense 1986)

## ALTERNATIVE SENDER FOR MULTIFREQUENCY SIGNALLING SYSTEM TO BE USED FOR PUSH-BUTTON TELEPHONES

Recommendation proposed by Working Group T/WG 11
"Signalling systems and telephone networks/ISDN" (STI)

*Text of the Recommendation adopted by the "Telecommunications" Commission:*

"The European Conference of Postal and Telecommunications Administrations,

*considering,*

— that access to the services of the telephone network will be provided by telephone sets equipped with 12 or 16 push-buttons as recommended in CCITT Recommendation Q.11 [1] for multifrequency signalling,

— that the use of these telephone sets and their signalling technique for a simple type of end-to-end data transmission in the international as well as in national networks requires standardisation of the technique to be used,

— that the existing CCITT Recommendations on the subject do not yet assure the required standardisation,

— that the Administrations are in favour of harmonising telecommunications equipment and systems which could lead to a reduction in development and manufacturing cost for those industries that provide equipment for several countries,

— a more economic design may be allowed by means of new technology use of cannon circuits for speech and MFPB which require changed operational parameters with respect to Recommendation T/CS 46-02 [2];

*recommends,*

the use by the CEPT members of the multifrequency signalling system for push-button telephones (including those of private automatic branch exchanges), conforming with the specifications set out hereafter."

## Annex

## 1. SIGNALLING SYSTEM PRINCIPLES AND CODING

### 1.1. General

This Section deals with the general characteristics of the signalling system and conforms to CCITT Recommendation Q.23 [3].

### 1.2. Signal frequencies and codes

1.2.1. *Signal frequencies*

The signal frequencies shall be selected from two separate groups within the speech band (300-3,400 Hz), a low group and a high group, each group providing four signalling frequencies.

These frequencies shall be:
— low group frequencies: 697, 770, 852 and 941 Hz;
— high group frequencies: 1,209, 1,336, 1,477 and 1,633 Hz.

1.2.2. *Signal format*

Each signal shall consist of two and only two of the signalling frequencies; one frequency from each of the low and high groups. Both frequencies shall be applied simultaneously in parallel across the line.

1.2.3. *Signal code*

The 16 discrete signals shall be allocated as shown in Table 1 (T/STI 46-04).

| Hz | High group frequencies | | | |
|---|---|---|---|---|
| | 1,209 | 1,336 | 1,477 | 1,633 |
| 697 | 1 | 2 | 3 | A |
| 770 | 4 | 5 | 6 | B |
| 852 | 7 | 8 | 9 | C |
| 941 | * | 0 | # | D |

Table 1 (T/STI 46-04).

Table 1 (T/STI 46-04) gives the full allocation of signal codes. The system may be utilized with only 10 discrete signals, in which case the signals designated *; #, A, B, C and D will not be used; or with 12 discrete signals, in which case the signals A, B, C and D will not be used.

*Note.* The presentation in Table 1 (T/STI 46-04) corresponds to the actual lay-out of the push-buttons on the terminal equipment. The arrangements and designations of buttons are further specified in Recommendation T/CS 34-01 [4].

## 2. PUSH-BUTTON SENDER

### 2.1. Area of application and general

This Section deals with the multifrequency sender which is used in push-button telephones.

The sender has basically been specified for signalling to the exchange. However, regard has also been taken of the possible use of push-button telephones for end-to-end data transmission when manual operation applies.

The requirements stated in this Section will allow the use of a regulated generator, i.e. a generator in which the output levels are controlled by the line current.

*Note.* For countries that do not allow the use of regulated senders, paragraph 2.3.3.2. is not applicable.

The purpose of the new specification is to make allowances for new semiconductor and other technologies being applied to the design of MF Senders.

However, MF Senders designed to this specification must still be compatible with MF Receivers designed to the Recommendation T/CS 46-02 [2].

## 2.2. Operational conditions

The sender is expected to operate under varying environmental conditions.

(a) A general purpose sender should operate in temperature controlled locations and partly temperature controlled locations, i.e. in normal living and working areas as well as entrances, staircases of buildings, factories and industrial plants; etc. The relevant climate conditions are described in Recommendation T/TR 02-06 and summarised in Figure 4 (T/STI 46-04). The sender must meet the requirements within these conditions.

(b) A wide temperature range sender should operate in open air as well as sites with heat trap, i.e. telephone booths and similar installations. The relevant climatic conditions are described in CEPT Recommendation T/TR 02-06 (Figure 3) [5]. That figure is included as Figure 5 (T/STI 46-04) of this Recommendation. The wide temperature range sender must meet the requirements within these conditions.

## 2.3. Signal output requirements

### 2.3.1. *Frequency tolerance*

The output frequencies shall be maintained within ± 1.5% of their nominal values. This tolerance shall also include the effect of different line impedances offered to the sender.

### 2.3.2. *Sending level*

#### 2.3.2.1. Sending level for unregulated senders

The sending levels with a load resistance of 600 ohms for an unregulated sender shall be for:

Option 1:
— the high frequency group: − 9 dBm ± 2 dB,
— the low frequency group: −11 dBm ± 2 dB.

Option 2:
— the high frequency group: −6 dBm ± 2 dB,
— the low frequency group: −8 dBm ± 2 dB;

with a restriction that the level of the higher frequency component of the compound signal shall be 2 ± 1 dB above the level of the lower frequency component.

#### 2.3.2.2. Sending levels for regulated senders

If an Administration allows the use of regulated senders, the working conditions shall be in mask "a":

for Option 1: as shown in Figure 2A (T/STI 46-04);
for Option 2: as shown in Figure 2B (T/STI 46-04);
with the restrictions that at $I_{LMIN}$ the levels must be as defined in 2.3.2.1. and that the level of the higher frequency component of the compound signal shall be 2 ± 1 dB above the level of the lower frequency components.

$I_{LMIN}$ is taken from Table 2 (T/STI 46-04).

$I_{LMAX}$ is calculated from $\frac{V_{BMAX}}{R_{FMIN}+R_{TMIN}}$,

where $V_{BMAX}$ and $R_{FMIN}$ are taken from Table 2 (T/STI 46-04) and $R_{TMIN}$ is the minimum resistance of the telephone set. "A" is the sensitivity of the receiver.

*Note 1.* In many countries there is a value of current (F) above which current limitation is performed by the exchanges. In addition it should be noted that some modern exchanges have a constant current feed and this may prevent the sender regulation circuit from functioning and the sender will then transmit at maximum level even on short lines.

*Note 2.* Taking into account *Note 1* regulation will become less applicable in the future. The masks in Figures 2A (T/STI 46-04) and 2B (T/STI 46-04) are the limits taking into account existing regulated senders.

*Note 3.* Unregulated senders always fall within the mask "a" of figures 2A (T/STI 46-04) and 2B (T/STI 46-04).

*Note 4.* The use of these masks will allow each Administration which wishes to use regulated senders to define regulation characteristics for MFPB levels which are in line with their speech regulation characteristics.

*Note 5.* The specification for regulated senders are not applicable to push-button telephones for use with private automatic branch exchanges.

2.3.3. *Unwanted frequency components*

2.3.3.1. When a signal is output:

(a)The total power level of all unwanted frequency components shall be at least 20 dB below the level of the low group frequency component of the signal.

(b)The level of any individual unwanted frequency component shall not exceed the following limits:

— in the frequency band 300-4,300 Hz: −33 dBm;
— in the frequency band 4,300-28,000 Hz: −37 dBm at 4,300 Hz, the falling at 12 dB per octave to 28 kHz;
— in the frequency band 28 kHz to 10 MHz: −70 dBm.

2.3.3.2. When the sender unit is active, but there is no tone output, the limits of unwanted frequencies shall not exceed the following:

— psophometric noise: −64 dBmp.

The level of any individual frequency component of the signal shall not exceed:

— in the frequency band 4,300-8,900 Hz: −40 dBm;
— in the frequency band 8,900 Hz to 50 kHz: −40 dBm at 8,900 Hz, falling to −70 dBm at 50 kHz;
— in the frequency band 50 kHz to 10 MHz: −70 dBm.

2.3.4. *Risetime*

The risetime is the time from switching on the sender output to the time when the output level is within the limits of paragraph 2.3.2.

All transients shall have ceased and the signal power shall be within the limits of paragraph 2.3.2. at a time less than 7 ms after the start of signal output.

The risetime is not critical if the duration of the signal tones is controlled by the sender.

2.3.5. *Signal timing*

Soon after a button is depressed, the signal is output to line. It may continue until the button is released.

If the minimum duration of the signal output is controlled by the sender, the duration of the signal shall not be less than 65 ms excluding risetime. In this case, the interdigital pause shall have a minimum value of 65 ms.

*Note 1. Frequency tolerance*

The tolerance specified in CCITT Recommendation Q.23 [3] is 1.8%. However, it was considered that 1.5% could be achieved in practice without any difficulty for the operating conditions specified in Section 2.2.

*Note 2. Sending level*

i) The lower sending levels are based on the application of CCITT Recommendation Q.15 [6] to the use of push-button telephones for end-to-end data transmission. Assumptions were made for average power losses and activity factors.

ii) The pre-emphasis of 2 dB is a compromise between different national requirements. A tolerance of 1 dB was specified because it can be assumed that the drift in the power levels of the two single frequency components will be correlated.

*Note 3. Unwanted frequency components*

In paragraph 2.3.3.1., the requirement (a) is related to the performance of the multifrequency signalling system itself. The requirement (b) is to avoid interference to this and other inband signalling systems and other channels in multiplex systems.

Allowance also needs to be made in both paragraphs 2.3.3.1. and 2.3.3.2. for Data-over-Voice and other systems operating outside the audio band.

The specification in paragraph 2.3.3.2. assures that none of the frequencies is audible during the conversation condition.

*Note 4. Risetime*

While a button is moving from the undepressed to the depressed position, the direct current and alternating current characteristics of the telephone set are changed, which will cause transients. The transients and the characteristics of the two-frequency signal limit the accuracy with which the risetime can be measured. Further, the time at which the button is operated may be difficult to identify. A firmer requirement than 7 ms could therefore hardly be verified in practice. The amplitude of the transients depends upon the characteristics of the sender, the local line and the exchange feeding bridge. Although a limitation of the transients is necessary, it has not yet been possible to specify maximum values. Two factors must be taken into account when specifying the amplitude and duration of transients:

(a) For signalling to the exchange the influence of transients on the receiver performance must be limited.

(b) For the purpose of data transmission, Administrations must ensure that in practice (i.e.: when the telephone, sender, local line and feeding bridge are associated) that amplitude and duration of transients at the output of the exchange feeding bridge does not significantly increase the level of the mean power transmitted to the national network.

*Note 5. Signal timing*

Provision is made here for the timing of signals from the sender to be achieved in either of two ways. Either the signal duration is controlled solely by the length of time the keypad button is depressed, or the sender itself may exert control on the signal duration in the manner specified.

*Note 6. Complex impedance*

If the load is a complex impedance (with the configuration shown in Figure 3 (T/STI 46-04) then the levels are measured as a voltage.

## 2.4. Electrical characteristics

2.4.1. *Impedance*

There may be two versions of the sender impedance:
(a) with the return loss defined against 600 ohms;
(b) with the return loss defined against the complex impedance of the configuration shown in Figure 3 (T/STI 46-04).

For (a) the return loss shall be not less than 14 dB over the frequency range 300-3,400 Hz.

For (b) the return loss is for further study when the complex impedance has been defined.

2.4.2. *Speech suppression*

When a button is depressed the sending efficiency of the telephone set (from microphone to line) shall be decreased by at least 50 dB.

2.4.3. *Impedance unbalance to earth*

The impedance unbalance to earth measured as input longitudinal interference loss, in accordance with the principle of measurement in Recommendation O.121 Figure 5 (shown in Figure 6 (T/STI 46-04) of this Recommendation), shall be not worse than or equal to:
— in the frequency band 40- 300 Hz: 40 dB;
— in the frequency band 300- 600 Hz: 50 dB;
— in the frequency band 600-3,400 Hz: 55 dB.

During the measurement the telephone set shall be placed on a metallic surface which is connected to earth potential.

2.4.4. *Direct current condition*

The sender shall be powered by the line current feed. The sender shall function correctly with either normal or reversed current feed.

2.4.5. *Overvoltage protection*

The sender shall be adequately protected, in accordance with national requirements, against overvoltage, e.g. lightning, with buttons either operated or non-operated.

2.4.6. *Dial tone*

The sender shall operate correctly in the presence of dial tone, over the frequency range 100-480 Hz and of levels up to 0 dBm.

*Note 1. Impedance*

The return loss is specified against a pure resistance of 600 ohms as this is in accordance with international practice and maintains a constant reference impedance throughout the specification. However, it is recognised that higher impedances are more appropriate for a number of national networks.

*Note 2. Direct current conditions*

The current feeding systems used by Administrations can differ significantly to the extent that it is not possible to specify requirements other than those stated in paragraph 2.4.4.

However, in order to facilitate the realisation of a common design of sender to meet the requirements of different direct current feeding systems to be used with push-button telephones, the following information is provided.

i) Minimum and maximum conditions of the feeding systems in different countries are given in Table 2 (T/STI 46-04) below. The column minimum current relates to the current needed to hold the connection.

ii) The minimum and maximum conditions for each system can be represented by straight lines in a U/I diagram, Figure 1 (T/STI 46-04):
maximum condition $U = U_{max} - I.R._{min}$;
minimum condition $U = U_{min} - I.R._{max}$.
The area between these lines represents all possible feeding conditions for the sender. The part of this area with currents smaller than the minimum current should not be entered by the U/I curve of the sender. For the systems in Table 2 (T/STI 46-04), the lowest points of this forbidden area have been calculated, and are shown in Table 3 (T/STI 46-04).

iii) A curve through the lowest points as shown in Figure 1 (T/STI 46-04) represents the lower boundary of the forbidden area B, for a sender which is suitable for all systems in Table 2 (T/STI 46-04). The other boundaries for area B are a vertical line starting in the point with the highest minimum current (25 mA) and lines representing the extremes in minimum feeding conditions ($S_1$ and $S_2$).

iv) Area A in Figure 1 (T/STI 46-04) represents the conditions possible in any of the systems mentioned in Table 2 (T/STI 46-04); the upper limits are determined by the extremes in maximum feeding conditions.

v) Area C represents conditions which will not occur during normal operation.

vi) For a sender suitable for all systems in Table 2 (T/STI 46-04), the meaning of the area is as follows:
— for all conditions represented by the part of the U/I curve in area A, all requirements should be fulfilled;
— the U/I curve should not enter area B;
— in area C there are no requirements.

*Note 3. Overvoltage protection*

The overvoltage protection provided should also take care of the effects of the ringing voltage which might occur with buttons either undepressed or depressed.

*Note 4. Control tone*

If a control tone is required by Administrations when a button is depressed then it is necessary to specify a requirement for the sender such that the tone at the telephone receiver is at an acceptable level, e.g. about 65 to 85 dB relative to 20 μPa measured by a CCITT recommended artificial ear.

| Country | Battery Voltage (V) | | Total resistance of feeding bridge and line (Ω) | | Minimum current (mA) |
|---|---|---|---|---|---|
| | min | max | min | max | |
| Belgium | 44 | 52 | 400 | 1,600 | 20 |
| Denmark | 44 | 56 | 450 | 2,480 | 15.3 |
| Finland 1 | 44 | 53 | 700 | 2,500 | 15 |
| Finland 2 | 56 | 66 | 900 | 2,700 | 18 |
| France 1 | 45 | 53 | 300 | 1,820 | 12 |
| France 2 | 90 | 106 | 1,400 | 2,800 | 12 |
| Fed. Rep. of Germany | 57 | 64 | 1,260 | 3,240 (1) | 17 |
| Ireland | 44 | 52 | 400 | 2,200 | 19 |
| Italy | 44 | 52 | 720 | 3,010 | 12 (2) |
| Norway | 44 | 52 | 500 | 2,400 | 17 |
| Netherlands | 42 | 56 | 640 | 2,140 | 16 |
| Spain 1 | 44 | 52 | 300 | 2,340 | 10 |
| Spain 2 | 44 | 56 | 500 | 1,856 | 15 |
| Sweden 1 | 31 | 45 | 1,000 | 2,200 | 11 |
| Sweden 2 | 42 | 56 | 1,600 | 2,800 | 10 |
| Switzerland 1 | 44 | 54 | 700 | 1,700 | 21 |
| Switzerland 2 | 56 | 66 | 1,000 | 2,000 | 22.5 |
| United Kingdom | 40 | 57 | 360 | 1,450 | 25 |

*Note 1.* This includes the resistance of the telephone.

*Note 2.* This value also ensures the proper functioning of the meter at the subscriber's premises.

Table 2 (T/STI 46-04).

| Country | Current (mA) | Voltage (V) |
|---|---|---|
| Belgium | 20 | 12 |
| Denmark | 15.3 | 6.12 |
| Finland 1 | 15 | 6.5 |
| Finland 2 | 18 | 7.4 |
| France 1 | 12 | 23 |
| France 2 | 12 | 56 |
| Fed. Rep. of Germany | 17 | 9.2 |
| Ireland | 19 | 2.2 |
| Italy | 12 | 7.88 |
| Norway | 17 | 5.45 |
| Netherlands | 16 | 7.76 |
| Spain 1 | 10 | 10.6 |
| Spain 2 | 15 | 16.16 |
| Sweden 1 | 11 | 6.8 |
| Sweden 2 | 10 | 9.7 |
| Switzerland 1 | 21 | 8.3 |
| Switzerland 2 | 22.5 | 11 |
| United Kingdom | 25 | 9.00 |

Table 3 (T/STI 46-04).

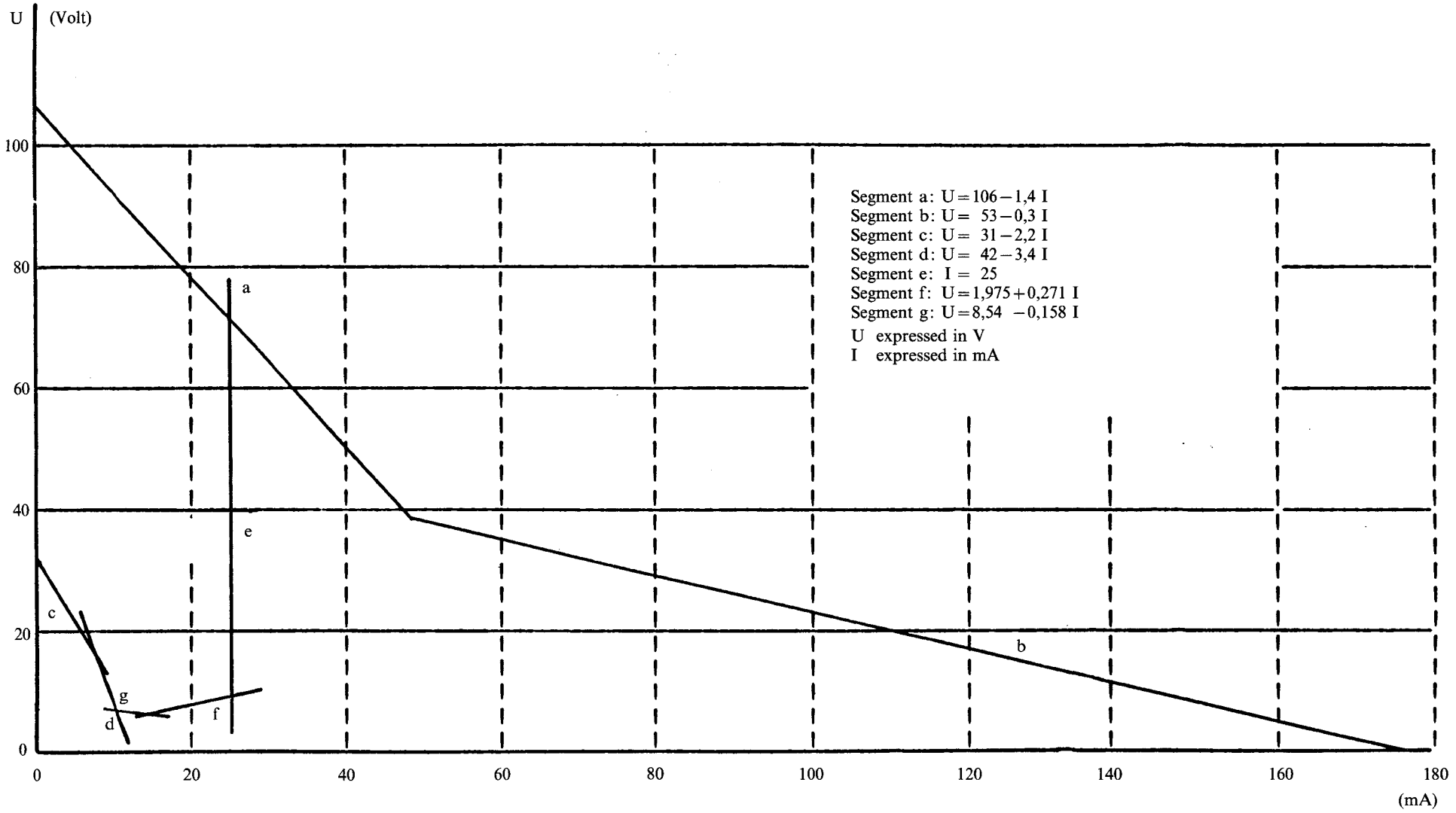



Figure 1 (T/STI 46-04).

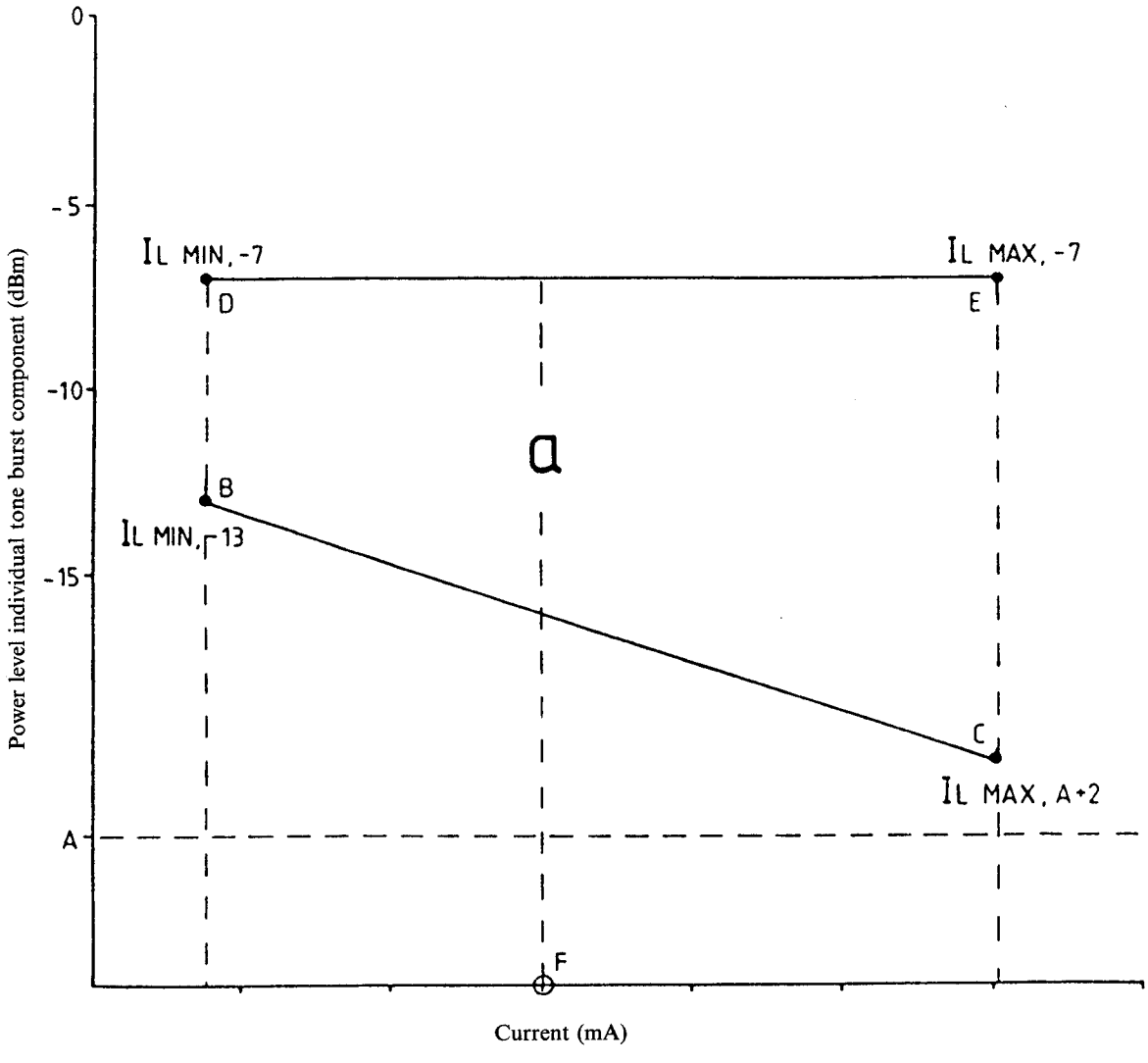



Figure 2A (T/STI 46-04). MF tone power levels regulated sender. OPTION 1.

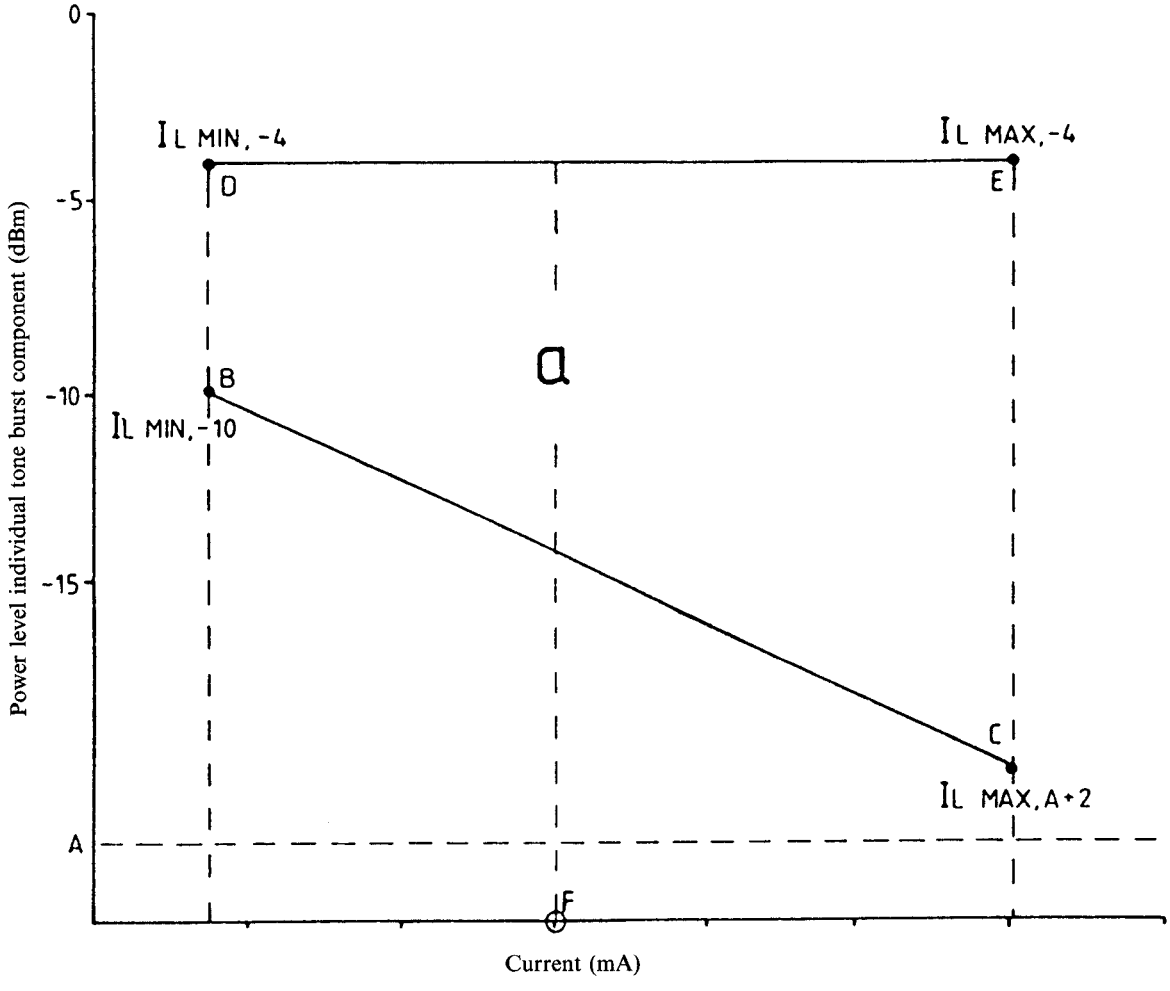



Figure 2B (T/STI 46-04). MF tone power levels regulated sender. OPTION 2.

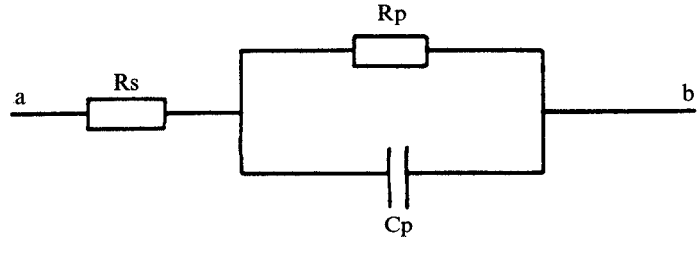



Figure 3 (T/STI 46-04). Impedance reference network (example).

**Climatogram for subscriber's premises**

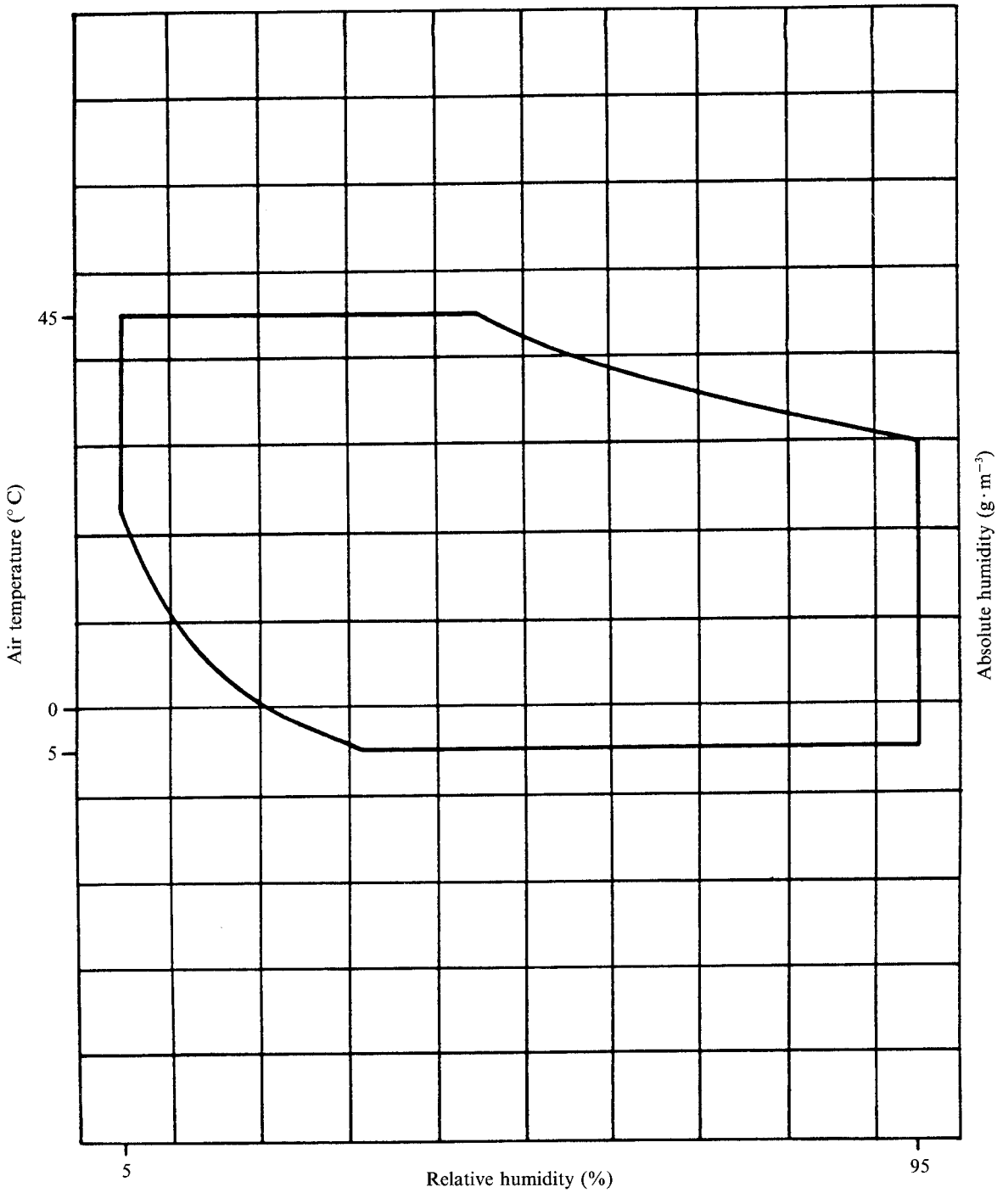



Figure 4 (T/STI 46-04).

**Climatogram for weather-protected locations**
Not temperature controlled, with heat-trap

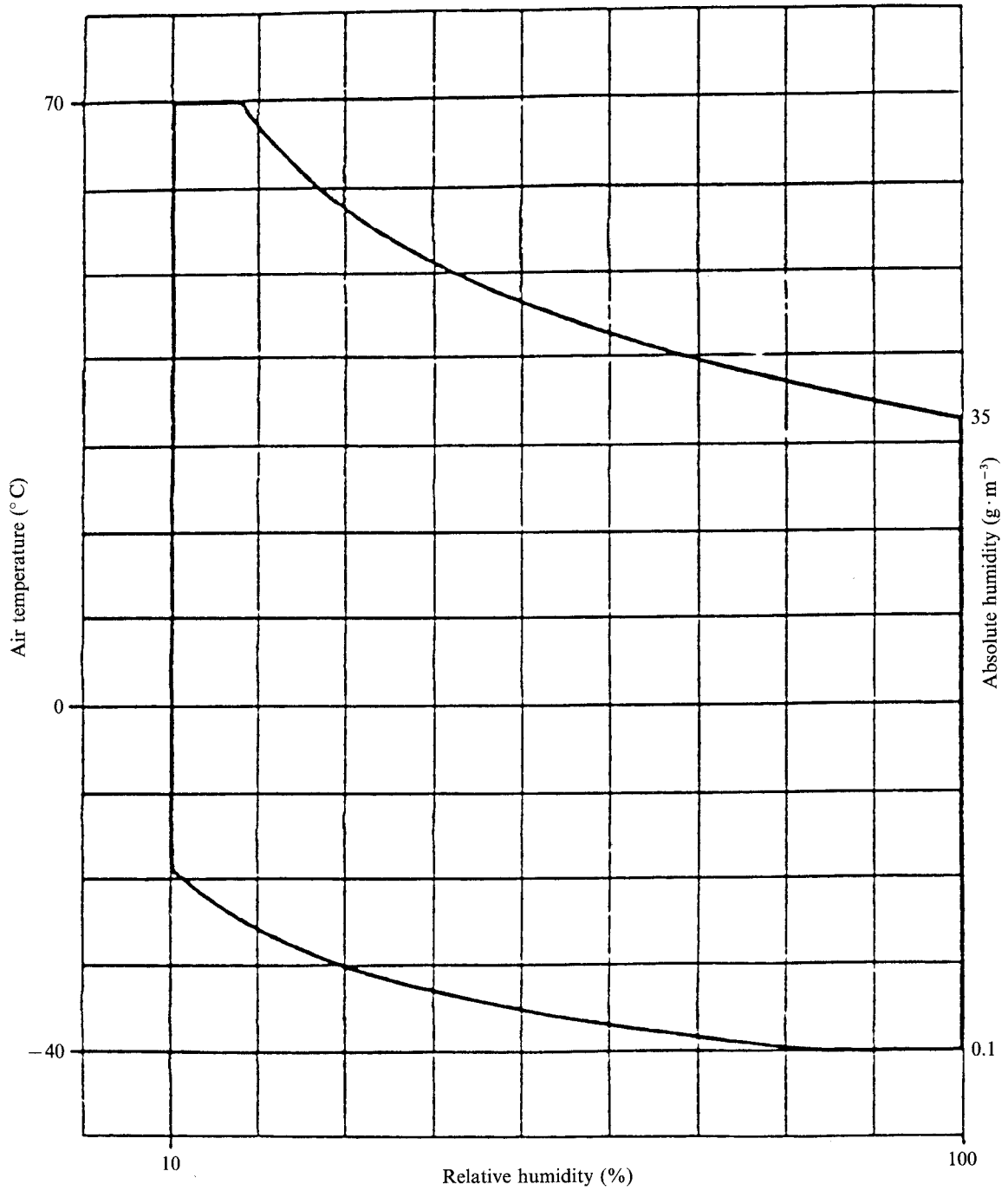
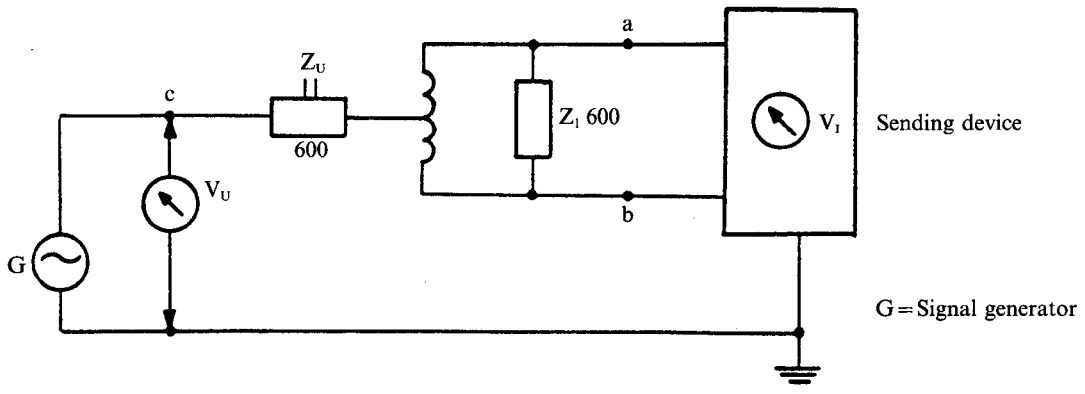



Figure 5 (T/STI 46-04).




Input longitudinal interference loss (ILIL) $= 20 \cdot \log_{10} \left| \frac{V_{LI}}{V_I} \right|$ dB

Figure 6 (T/STI 46-04). Measurement of input longitudinal interference loss.

## References

[1] CCITT Recommendation Q.11. *Numbering and dialling procedures for international service.*
[2] Recommendation T/CS 46-02. *Multifrequency signalling system to be used for push-button telephones.*
[3] CCITT Recommendation Q.23. *Technical features of push-button telephone sets.*
[4] Recommendation T/CS 34-01. *Arrangement of push-buttons and the symbols for their designation.*
[5] Recommendation T/TR 02-06. *Environmental conditions for telecommunication equipment at weather-protected locations (excluding telecommunication centre with temperature and humidity controls) and in the open air.*
[6] CCITT Recommendation Q.15. *Nominal mean power during the busy hour.*
[7] CCITT Recommendation Q.45. *Transmission characteristics of an international exchange.*