Recommendation T/CS 49-12 (Vienna 1982, revised in Montpellier 1984)

SYSTEM L2 SIGNALLING ON EXTRA LONG LINES BETWEEN A TELEPHONE INSTRUMENT OR EQUIVALENT AND A PUBLIC EXCHANGE OR PRIVATE AUTOMATIC BRANCH EXCHANGE

Recommendation proposed by Working Group T/WG 11 "Switching and Signalling" (CS)

Revised text of the Recommendation adopted by the "Telecommunications" Commission:

"The European Conference of Postal and Telecommunications Administrations,

considering

— that there is an increasing need for connection of a telephone instrument or its equivalent to an exchange (public or private automatic branch exchange) where the normal loop limits are exceeded;

— that in certain cases telephone instruments or their equivalent in one country have to be connected to exchanges in another;

— that these extra long connections should permit a fully automatic operation from telephone instruments or their equivalent to exchanges,

recommends

that members, when introducing international connections of telephone instruments or their equivalent in one country to public exchanges or private automatic branch exchanges (PABXs) in another, use the signalling System L2, which is comprised of the signals, signalling procedures, and equipment functions specified in the following."

1. PRINCIPLES AND FIELDS OF APPLICATION

1.1. The system is to provide line supervisory signalling (e.g. loop signalling in one direction and ringing in the other direction) between a telephone instrument or its equivalent and a public exchange or PABX via an extra long line, either in the same or different countries. The use of the system over satellite circuits and over composed terrestrial satellite circuits is possible, provided that echo-suppressors or echo-cancellers needed are installed on the customer side between the hybrid and the 2,280 Hz sending and receiving equipment.

1.2. For the purpose of description, this specification refers to an *instrument signalling unit* (ISU) and an *exchange signalling unit* (ESU). This does not imply that the signalling equipment cannot form an integral part of either the telephone or the exchange.

1.3. The system is intended for use over four-wire circuits but, as an option for national use, may be used over two-wire circuits.

In the four-wire case, forward and backward signals are segregated by utilising the four-wire circuit as two separate signalling paths. The send pair which the signals are applied to is the receive pair at the distant end. Signals shall be sent on the send path and received on the receive path. Figure 1 (T/CS 49-12) shows a termination at one end.

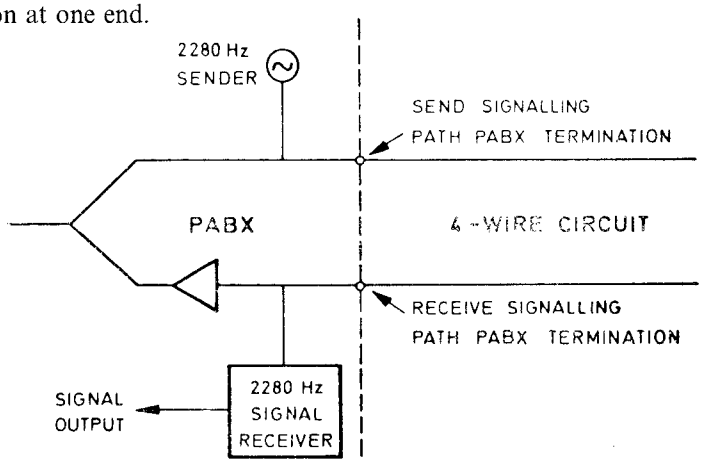

Figure 1 (T/CS 49-12).

1.4. The system is a *single voice frequency (1 vf) line signalling system* using a signalling frequency of:
— 2,280 Hz in both directions on four-wire circuits;
— 2,280 Hz in the direction ISU to ESU and 2,400 Hz in the direction ESU to ISU on two-wire circuits.
The use of voice frequency signals renders the system suitable for all voice transmission media, except those using speech interpolation.

1.5. The line supervisory system may be used to convey digit signals at 10 pulses/second (pps), or as an adjunct to multifrequency push-button (MFPB) signalling.

1.6. Signals are sent as either application of signalling frequency *tone-on* or removal of signalling frequency *tone-off* in continuous or pulsed form.

1.7. When in the idle condition, the signalling frequency applied to the line by the ISU is reduced in power level to conform to the transmission loading requirements of CCITT Recommendation Q.15 [1].

1.8. The signalling system allows through dialling of 10 pps or multifrequency push-button type (MFPB) to subsequent circuits, e.g. to another PABX or public exchange. The line supervisory signals are contained within the ISU-ESU link and not allowed to spill over into the next link.

1.9. When making an outgoing call, a through speech path shall be provided in the ESU-ISU direction of transmission during call set-up.

1.10. Signals may be passed in the direction ISU to ESU while speech or audible indications are being received in the direction ESU to ISU.

1.11. These specifications define the signalling requirements of the system in terms of electrical conditions, and their persistance before they may be regarded as valid signals.

2. SYSTEM L2 SIGNALS

2.1. General

The names and meanings of the signals specified for System L2 are in accordance with Recommendation T/CS 41-01 [2]. According to their use in signalling System L2, some special functions may apply. Therefore, a further description is given in Section 2.3. below.

2.2. Line signals

The signals transmitted over the line are shown in Table 1 (T/CS 49-12). They are divided into two categories:
i) signals that are essential in a basic version: Mandatory (M);
ii) signals which could be used to supply optional facilities when required: Optional (O).

Signals	ISU to ESU	ESU to ISU
Idle	M	—
Calling	—	M
Seizing	M	—
Address information	M	
Answer	M	—
Recall	O	—
Metering	—	O
Clear	M	—

Table 1 (T/CS 49-12). System L2 signals.

2.3. Functions of the signals and states

2.3.1. *Signals sent from ISU to ESU*

2.3.1.1. Mandatory signals

Idle signal

In the idle state the ISU applies a tone-on condition to the line to indicate it is free to accept calls (see Tables 2 (T/CS 49-12) and 3 (T/CS 49-12)).

Seizing signal

When the telephone instrument changes from on-hook to off-hook, the ISU applies a *seizing signal* to the signalling path.

On recognition of the seizing signal, the ESU informs the exchange that the telephone instrument is off-hook.

Address information

Address information (routing digits and telephone number) is sent either in the form of signalling tone pulses (decadic pulses) or as MFPB signals.

Answer signal

When the called telephone instrument changes from the on-hook to the off-hook condition, the ISU applies an answer signal to the signalling path.

On recognition of the answer signal, the ESU informs the exchange that the telephone instrument is in the off-hook condition and that ringing must be stopped.

Clear signal

When the telephone instrument is put in the on-hook condition, the ISU applies a clear signal to the signalling path.

On recognition of the clear signal, the ESU informs the exchange that the telephone instrument has been put on-hook.

2.3.1.2. Optional signals and procedures

Provision of the following optional signals and procedures depends on network requirements, and is subject to mutual agreement by the parties involved.

Recall signals

On receipt of a recall signal from the telephone, the ISU applies a recall signal in the form of a tone-on pulse to the signalling path.

The length of tone-on pulse applied by the ISU depends upon the type of recall employed by the associated telephone, e.g. timed break or earthed loop.

2.3.2. *Signals sent from ESU to ISU*

2.3.2.1. Mandatory signals

Calling signal

The calling signal is sent by the ESU to indicate that ringing current is being sent by the exchange.

The calling signal is sent by the ESU as a series of tone-on pulses, in step with the periods of ringing current that are sent by the exchange.

On recognition of each tone-on pulse of the calling signal, the ISU applies ringing current to the telephone instrument.

2.3.2.2. Optional signals

Provision of the following optional signals and procedures depends on network requirements and is subject to mutual agreement by the parties involved.

Answer signal

The *answer signal* is sent by the ESU to indicate that the called party has answered.

Metering signals

If the public exchange can send metering pulses for call charging, these pulses may be:

i) sent during speech in the voice band with appropriate safeguards to prevent the pulses from being heard;
ii) sent during speech by application of channel splitting equipment (see CCITT Recommendation H.34 [3]), using one of the telegraph channels;
iii) stored or sent, possibly on demand, at the end of the call.

However, the handling of metering signals is outside the scope of this Recommendation.

3. LINE SIGNALLING SENDING AND DETECTING REQUIREMENTS

3.1. Signalling code

The signalling code shall be as shown in Tables 2 (T/CS 49-12) and 2 (T/CS 49-12). Signal sending and detection requirements are given in paragraphs 3.2. and 3.3.

Signal	Conditions from ISU	Conditions from ESU
Idle	Continuous tone-on	Continuous tone-off
Seizing	Continuous tone-off	—
Address information	Decadic pulsing or MFPB	—
Answer (optional)		Tone-on pulse
Recall (optional)	Recall tone-on pulse	—
Clear	Continuous tone-on	—

Table 2 (T/CS 49-12). Calls originated by the telephone instrument.

Signal	Conditions from ESU	Conditions from ISU
Idle	Continuous tone-off	Continuous tone-on
Calling	Calling tone-pulse	—
Answer	—	Continuous tone-off
Recall (optional)	—	Recall tone-on pulse
Clear	—	Continuous tone-on

Table 3 (T/CS 49-12). Calls from the exchange.

3.2. Sending of signals

Tone-on and tone-off conditions referred to in this paragraph shall conform to the requirements of paragraphs 4.1. and 4.3.

Signals are sent by applying either a tone-on or a tone-off condition to the transmit signalling path in a continuous or pulsed form.

3.2.1. *Continuous tone-on signal*

A *continuous tone-on signal* shall be the application of a tone-on condition to the transmit signalling path for a period exceeding 350 ms.

3.2.2. *Continuous tone-off signal*

A *continuous tone-off signal* shall be the application of a tone-off condition to the transmit signalling path for a period exceeding 80 ms.

3.2.3. *Address information*

Address information is conveyed in decadic pulsing or MFPB form, see Recommendation T/CS 46-02 [4].

3.2.3.1. Decadic pulsing

The break periods of decadic pulses shall be applied to the transmit signalling path of the ISU, as pulses of tone-on condition within the limits of Table 4 (T/CS 49-12).

Speed (pps)	7		9		11		12	
Break pulse Duration (ms)	Min	Max	Min	Max	Min	Max	Min	Max
	45	112	45	81	45	61	45	52

Legend: pps = pulses per second.

Table 4 (T/CS 49-12).

Where decadic pulses are generated within the ISU, the speed and break pulse duration applied to the transmit signalling path shall be either:
(a) 10 ± 0.5 pps with break pulse limits of 60-68%;
(b) 10 ± 1 pps with break pulse limits of 59-66%.

Inter-digit pause

Adjacent digits are separated by an inter-digit pause (IDP). The inter-digit pause is a function of the source of the digits, i.e. under control of a dial, or repeated, or generated by a signalling unit.

This period, which will differ depending upon the Administration concerned and the type of equipment, is not specified in this Recommendation and must be mutually agreed upon by the parties involved. During the inter-digit pause, the backward speech path should be re-established.

3.2.3.2. MFPB signals

See CEPT Recommendation T/CS 46-02 [4].

3.2.4. *Tone-on pulse signal*

A tone-on pulse signal shall be the application of a tone-on condition to the send signalling path for a period of 45 to 135 ms.

3.2.5. *Recall tone-on pulse signal*

The length of recall tone-on pulse signal will depend on the type of recall applied by the associated telephone.

A recall tone-on pulse signal, as a consequence of a timed break recall signal from the telephone (see paragraph 2.3.1.2.), shall be the application of tone-on condition to the transmit signalling path for a period of 50-130 ms, see Recommendation T/CS 20-09 [5].

A recall tone-on pulse signal, as a consequence of an earthed loop recall from the telephone (see paragraph 2.1.2.1.), shall be the application of tone-on condition to the transmit signalling path for a period of 210-240 ms.

3.2.6. *Calling tone-on pulse signals*

Calling tone-on pulse signals shall be the application of tone-on condition to the send signalling path, in step with the ringing period of the ringing cadence.

3.3. **Detection of signals**

Electrical conditions conforming to the requirements of paragraphs 4.2. and 4.4. applied to the line termination shall be regarded as a potential signal and referred to in the following as tone-on condition or tone-off condition.

Signals are received as either a tone-on or a tone-off condition on the receive signalling path in a continuous or pulsed form.

To discriminate between signals having similar characteristics and between signals and spurious electrical conditions, it is necessary to state the minimum persistence time for a potential signal.

A signal is not valid until the electrical condition proper to the signal (i.e. tone-on or tone-off) has persisted for a stated period. Until that period expires, only an electrical condition exists.

Paragraphs 3.3.1. to 3.3.6. detail the minimum persistence of a defined electrical condition before it becomes a signal, i.e. a valid electrical condition persisting for less than the stated period shall not be recognised as a signal. The period in which a validated electrical condition must be recognised as a signal is a function of the ISU logic and is not given in these specifications. However, recognition should occur as soon as possible following expiration of the stated persistence check period.

3.3.1. *Continuous tone-on signal*

A *tone-on condition* applied to the receive signalling path line termination is a *continuous tone-on signal* for signalling, when it has persisted for 250 ms.

3.3.2. *Continuous tone-off signal*

A *tone-off condition* applied to the receive signalling path line termination is a *continuous tone-off signal* for signalling, when it has persisted for 40 ms.

3.3.3. *Address information*

Address information is conveyed in decadic or MFPB form.

3.3.3.1. Decadic pulsing

Pulses of tone-on condition applied to the receive signalling path line termination of the ESU, consistent with the speed and duration limits of Table 5 (T/CS 49-12), are break periods of decadic pulses.

Each break pulse is separated from the next by a make pulse, i.e. tone-off condition.

Within a digit, adjacent pulses may differ in speed and duration and any combination of break pulses within the limits of Table 5 (T/CS 49-12) shall be accepted as decadic pulses.

Speed (pps)	7		9		11		12	
Break pulse	Min	Max	Min	Max	Min	Max	Min	Max
Duration (ms)	35	122	35	91	35	71	35	62

Table 5 (T/CS 49-12).

Break pulses persisting for less than 25 ms applied to the line termination shall not be accepted as decadic pulses.

Adjacent digits are separated by an inter-digit pause.

3.3.3.2. MFPB signals

See Recommendation T/CS 46-02 [4].

3.3.4. *Tone-on pulse signal*

A *tone-on condition* applied to the receive signalling path line termination, and persisting for a period of 35-150 ms, is a *tone-on pulse signal* for signalling. A tone-on condition persisting for less than 25 ms shall not be accepted as a tone-on pulse signal.

3.3.5. *Recall tone-on pulse signal*

A tone-on condition applied to the receive signalling path line termination, and persisting for a period of 35-135 ms, is a recall tone-on pulse signal, as a consequence of a timed break recall signal (see paragraph 2.3.1.2.).

A tone-on condition persisting for less than 25 ms shall not be accepted as a recall tone-on pulse signal, as a consequence of a timed break recall signal.

A *tone-on condition* applied to the receive signalling path line termination, and persisting for a period of 200-250 ms, is a *recall tone-on pulse signal*, as a consequence of an earthed loop recall signal.

3.3.6. *Calling tone-on pulse signal*

A tone-on condition applied to the receive signalling path line termination during the unanswered state, persisting for a period of more than 35 ms, is a calling tone-on pulse signal (for each burst of ringing current).

4. LINE SIGNALLING TRANSMISSION REQUIREMENTS (FOUR-WIRE WORKING)

4.1. Signal sender, ESU

Signals are sent by the ESU as either tone-on or tone-off condition applied to the send signalling path.

4.1.1. *Tone-on condition*

Tone-on condition shall be a signalling tone conforming to the following parameters and shall reach a stable state within 5 ms of application.

4.1.1.1. Signal tone frequency

The signalling tone shall be at a frequency of 2,280 ± 5 Hz.

4.1.1.2. Signal tone power

The tone-on condition shall have two power levels—a high level and a low level.

A high level tone shall be sent for the duration of the signal or for a minimum of 300 ms (whichever is shorter), and for a maximum of 550 ms after which it must be reduced to low level.

(a) A *high level tone-on* condition shall be a signalling tone transmitted at a level of −10 dBm0 ± 1 dB.

(b) A *low level tone-on* condition shall be a signalling tone transmitted at a level of −20 dBm0 ± 1 dB.

4.1.1.3. Long-term mean power during signalling

(a) In the frequency band 300-3,400 Hz, the long-term mean power applied to the send path, excluding the signalling tones, shall be at least 35 dB below the signalling tone power.

(b) At frequencies in the range 3.4 to 50 kHz, the short-term mean power level of any spectral component shall not lie above the line shown on Figure 2 (T/CS 49-12).

Note: Short-term here refers to a period not greater than 1 ms.

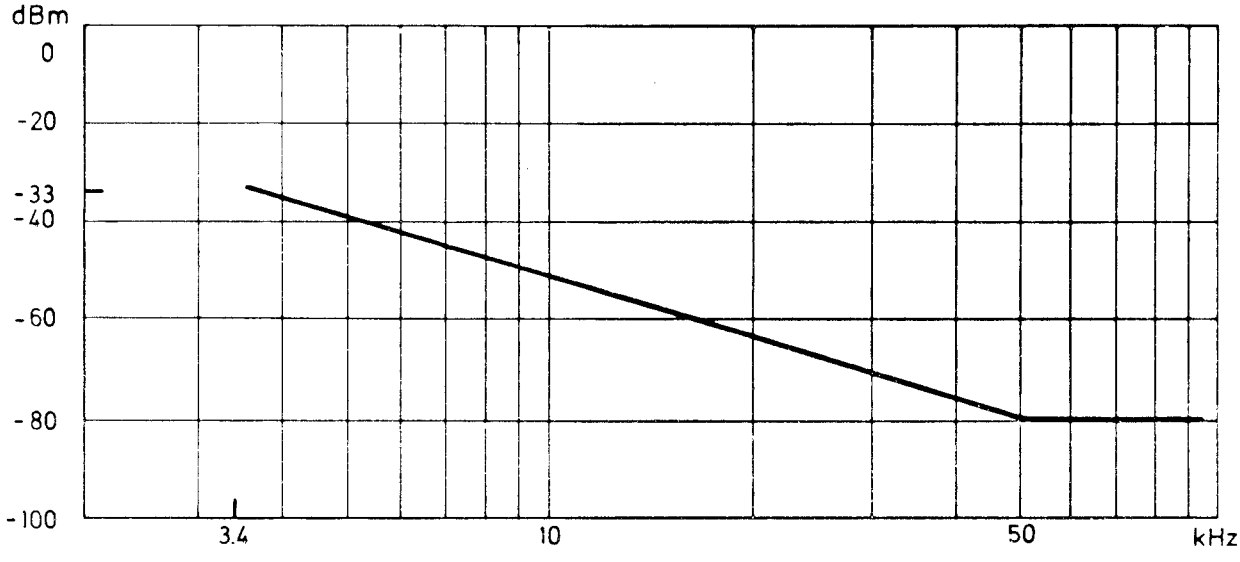

Figure 2 (T/CS 49-12).

(c) In any 3 kHz band contained above 3.4 kHz, the long-term mean power shall not exceed the level which would be permitted in accordance with (b) above for a spectral component at the mid-frequency of that band.

Note: The requirements for the long-term mean exclude any near end noise prior to transmit path isolation, see paragraph 4.1.3., but include noise attributable to the action of transmission path isolation.

4.1.2. *Tone-off condition*

A *tone-off condition* is the removal of signal tone and shall conform to the following.

4.1.2.1. Stable state

A stable state shall be attained within 5 ms of commencement of the tone-off condition.

4.1.2.2. Signal frequency leak

The total power of any signalling tone that may be present in the tone-off condition shall exceed –70 dBm0.

4.1.3. *Transmission path isolation*

When a signal is to be sent, the transmission path shall be isolated from any source of near end speech or noise.

Transmission path isolation shall occur within a period from 20 ms before to 15 ms after application of a tone-on condition.

The transmission path remains isolated until a tone-off signal is to be sent, in which case the transmission path shall be restored within 75 ms-160 ms of the application of a tone-off condition.

Note: As an alternative to the above requirement, the transmission path may be isolated during idle, and when sending the calling signal.

4.1.4. *Signal direction*

When sending a tone-on signal, any period of signalling tone attributable to that signal, that is applied towards the exchange, shall not exceed 15 ms.

4.2. **Signal receiver, ESU**

All electrical conditions applied to the receive signalling path shall be accepted as either tone-on or tone-off signals.

4.2.1. *Signal condition*

4.2.1.1. Tone-on condition

A frequency within the range 2,280 ± 15 Hz at an absolute level N within the range $(-30 + n \leq N \leq -4 + n)$ dBm shall be accepted as a *tone-on condition*; where n is the relative power level at the receive signalling path line termination (see CCITT Recommendation G.171 [6]).

Note: Each tone-on signal is sent as described in paragraph 4.1.1.2.

4.2.1.2. Tone-off condition

Any frequency or combination of frequencies having a total absolute power level of less than $(-40 + n)$ dBm is a *tone-off condition*; where n is the relative power level at the receive signalling path line termination as in paragraph 4.2.1.1.

4.2.2. *Signal interference and simulation*

The conditions defined in paragraph 4.2.1. shall be accepted as potential tone-on or tone-off signals subject to the following requirements.

4.2.2.1. Signal recognition interference

(a) The recognition of tone-on and tone-off signals shall not be affected by the presence of noise at a maximum level of –35 dBm0 and having uniform spectral energy over the range of 300 Hz to 10 kHz.

(b) The recognition of tone-on and tone-off signals at the ESU shall not be affected by speech or other electrical signals, such as audible indications (tones and announcements) and tone-on signals sent simultaneously to the ISU.

4.2.2.2. Signal simulation

(a) False signal simulation rates shall not exceed one false recognition of a clear signal in 1,500 hours of normal speech, and one false recognition of a pulsed signal in 70 hours of normal speech.

(b) Speech or other electrical signals such as audible indications (tones and announcements) at power levels up to + 10 dBm0 shall not cause any false simulation of a tone-off signal.

(c) A frequency outside the range 2,280 ± 75 Hz shall not cause any false simulation of a tone-on signal.

(d) A frequency within the range 2,280 ± 75 Hz shall not cause any false simulation of a tone-on signal, if the total power in the range 2,280 ± 75 Hz does not exceed the total power in any accompanying frequencies by more than as shown in Table 6 (T/CS 49-12).

Accompanying frequency (Hz)	500	750	1,000	1,250	1,500	1,750	2,000	3,000
Total power level by which 2,280 ± 75 Hz exceeds accompanying frequencies (dB)	7	10	12	12	12	12	7	9

Table 6 (T/CS 49-12).

4.2.3. *Spill-over*

On receipt of tone-on condition, any through-transmission to the exchange shall be attenuated by at least 35 dB within 20 ms.

Through-transmission shall be restored within 300 ms of the cessation of the tone-on condition.

Through-transmission shall not be restored during the tone-off periods of multiple pulse signals, e.g. digit pulses.

4.2.4. *Through-transmission interference*

Through-transmission attenuation (see paragraph 4.2.3.) shall not occur for more than one 20 ms period in 2 continuous speech hours, and one 50 ms period in 10 continuous speech hours.

A continuous speech hour is one hour of speech and does not include those quiescent periods that occur in normal conversation.

A method of test is given in Recommendation T/CS 46-02, Annex 1 [4].

4.2.4.1. Data immunity

Through-transmission attenuation (see paragraph 4.2.3.) shall not occur if the total power in the range 2,230 ± 75 Hz does not exceed the total power in the accompanying frequencies by more than shown in Table 6 (T/CS 49-12).

4.3. **Signal sender, ISU**

The signal sender requirements of the ISU are the same as those for the ESU with the following exceptions.

4.3.1. *Transmit and receive path isolation*

When a signal is to be sent, the transmit path shall be isolated from any source of speech or noise, and the receive path shall be isolated from the telephone instrument.

Transmit and receive path isolation shall occur within a period of 20 ms before to 15 ms after application of tone-on condition.

The paths remain isolated until a tone-off signal is to be sent, in which case the paths shall be restored within 75 ms-160 ms of application of tone-off condition.

4.3.2. *Signal direction*

When sending a tone-on signal, any period of signalling tone attributable to that signal and applied towards the telephone shall not exceed 15 ms.

4.4. **Signal receiver, ISU**

The signal receiver requirements of the ISU differ depending upon whether or not the optional signals in the direction ESU to ISU are provided.

Where the optional signals are provided, the requirements of paragraph 4.2. apply, i.e. same as ESU.

Where the optional signals are not provided, tone-on signal detection during speech is not required, and the ISU signal receiver may be simplified as detailed below. When the receiver is simplified as detailed, provision shall be made to prevent application of ringing current toward the telephone instrument when it is off-hook.

When the receiver is simplified as detailed, all electrical conditions applied to the receive signalling path when the associated telephone is on-hook shall be accepted as either tone-on or tone-off signals.

4.4.1. *Signal condition*

4.4.1.1. Tone-on condition

A frequency within the range 2,280 ± 15 Hz at an absolute level N within the range $(-30 + n \leq N \leq -4 + n)$ dBm shall be accepted as a *tone-on condition*; where n is the relative power level at the receive signalling path line termination (see CCITT Recommendation G.171 [6]).

Note: Each tone-on signal is sent as described in paragraph 4.1.1.2.

4.4.1.2. Tone-off condition

Any frequency or combination of frequencies having a total absolute power level of less than $(-40 + n)$ dBm is a *tone-off condition*; where n is the relative power level at the receive signalling path line termination as in paragraph 4.2.1.1.

4.4.2. *Signal interference and simulation*

The conditions defined in paragraph 4.2.1. shall be accepted as potential tone-on or tone-off signals, subject to the following requirements.

4.4.2.1. Signal recognition interference

(a) The recognition of tone-on and tone-off signals shall not be affected by the presence of noise at a maximum level of –35 dBm0, and shall have uniform spectral energy over the range of 300 Hz to 10 kHz.

(b) The recognition of tone-on and tone-off signals at the ISU shall not be affected by tone-on signals transmitted simultaneously to the ESU.

4.4.2.2. Signal simulation

A frequency outside the range 2,280 ± 75 Hz shall not cause any false simulation of a tone-on signal.

5. LINE SIGNALLING TRANSMISSION REQUIREMENTS (TWO-WIRE WORKING)

5.1. **Signal sender, ESU**

The signal sender requirements are the same as those given in paragraph 4.1., except that the frequency 2,280 Hz is replaced by the frequency 2,400 Hz.

5.2. **Signal receiver, ESU**

The signal receiver requirements are the same as those given in paragraph 4.2.

5.3. **Signal sender, ISU**

The signal sender requirements are the same as those given in paragraph 4.3.

5.4. **Signal receiver, ISU**

The signal receiver requirements are the same as those given in paragraph 4.4., except that the frequency 2,280 Hz is replaced by the frequency 2,400 Hz.

References

[1] CCITT Recommendation Q.15. *Nominal mean power during the busy hour.*

[2] Recommendation T/CS 41-01. *Signal and signalling message names and meanings.*

[3] CCITT Recommendation H.34. *Subdivision of the frequency band of a telephone-type circuit between telegraphy and other services.*

[4] Recommendation T/CS 46-02. *Multifrequency signalling system to be used for push-button telephones.*

[5] Recommendation T/CS 20-09. *Register recall.*

[6] CCITT Recommendation G.171. *Transmission characteristics of leased circuits forming part of a private telephone network.*