INTERNATIONAL TELECOMMUNICATION UNION

ITU-T Q.8

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

GENERAL RECOMMENDATIONS ON TELEPHONE SWITCHING AND SIGNALLING

INTERNATIONAL AUTOMATIC AND SEMI-AUTOMATIC WORKING

SIGNALLING SYSTEMS TO BE USED FOR INTERNATIONAL MANUAL AND AUTOMATIC WORKING ON ANALOGUE LEASED CIRCUITS

ITU-T Recommendation Q.8

(Extract from the *Blue Book*)

NOTES

1 ITU-T Recommendation Q.8 was published in Fascicle VI.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 Q.8

SIGNALLING SYSTEMS TO BE USED FOR INTERNATIONAL MANUAL AND AUTOMATIC WORKING ON ANALOGUE LEASED CIRCUITS

The CCITT,

considering

(a) that standardization of signalling systems to be used for international manual and automatic working on analogue leased circuits brings advantages to Administrations, manufacturers and users;

(b) that manual and automatic operation of international leased circuits require different technical arrangements;

(c) that the standard signalling systems set out in Recommendation Q.7 are primarily intended for the public service;

(d) that the national circuit sections of international leased circuits may need to conform to local regulations of the Administration(s) concerned;

(e) that the method of signalling will be affected by the type of transmission and vice versa;

(f) that the method of signalling will be affected by the characteristics of the service(s) carried on the

circuit;

recommends

that Administrations should use for manual international analogue leased circuits the standard signalling system specified in § 1 below;

and *draws the attention* of Administrations

to the guidance clauses and related annexes concerning automatic signalling on international analogue leased circuits, as set out in § 2 below.

1 Signalling on manual international analogue leased circuits

1.1 Signalling shall take place by the transmission of a single frequency signalling current, analogous to the signalling method used in the international manual service and specified in Recommendations Q.1 and Q.2.

1.2 The signalling current shall have a nominal frequency of either 2280 Hz or 2600 Hz. One of these frequencies shall be chosen for both directions of transmission by bilateral agreement between the Administrations concerned. Failing such an agreement, each Administration shall determine which of the two frequencies it wishes to receive.

1.3 The duration of the transmitted tone shall be between 300 ms and 2 seconds. The upper limit of 2 seconds allows the partial use of signalling equipment designed for 500/20 Hz working according to Recommendation Q.1.

1.4 The signal recognition time shall be between 100 ms and 200 ms:

- The minimum duration of 100 ms has been chosen so as to avoid the recognition of false signals due to imitation by speech currents;
- The maximum duration of 200 ms has been chosen so as to allow a safe margin between this time and the minimum transmission time.

Exceptionally, a maximum signal recognition time of 1200 ms may be used where it is known that the transmitted signal has a 2 second duration. Such arrangements allow the partial use of signalling equipment designed for 500/20 Hz working according to Recommendation Q.1.

1.5 Other technical clauses for 2280 Hz signalling are set out in Annex A to this Recommendation.

1.6 Other technical clauses for 2600 Hz signalling are set out in Annex B to this Recommendation.

2 Signalling on automatic international analogue leased circuits

2.1 This section refers to international analogue leased circuits employing automatic signalling. Such circuits are considered to form part of a private network extending across international frontiers and linking exchanges carrying out the switching function in a private network. The exchanges may be Private Automatic Branch Exchanges (PABXs). Private tandem exchanges, or switching equipments provided by the Administration to carry out switching functions in a private network. Where the exchanges are privately owned, part of the signalling function may be provided by the Administration.

This Recommendation does not cover the case of international leased circuits directly connecting subscriber lines to remote switching equipment. However, most of the following text is equally applicable to this case. Annex D, § D.3 and Annex E give further information on such signalling.

2.2 Many Administrations have regulations concerning the use of signalling frequencies on leased circuits and these may apply to international leased circuits also. These regulations are intended to ensure non-interference between parts of the voice spectrum used for signalling and those available for use by subscriber apparatus. This does not create exceptional difficulties for manual working since the frequencies used (2280 Hz, 2600 Hz) can be converted to other acceptable frequencies at the Terminal International Centre. However, for automatic circuits it should be the aim to provide an uninterrupted path between the ends of the leased circuit.

Some World regions have existing or proposed signalling systems which meet the regulatory arrangements in those regions and a summary of two such systems are given in Annexes C and D to this Recommendation. Administrations are invited to note these existing systems that may meet their needs for automatic signalling on analogue leased circuits.

2.3 In order to reduce the cost of providing leased circuits some inter-regional leased circuits may be provided with various forms of bandwidth economizing systems, such as speech interpolation systems and digital voice compression. These systems usually have their own internal digital signalling capability and these are not covered by this Recommendation, except that the effect that speech interpolation equipment has on analogue signalling is discussed.

2.4 In the most general case, the choice of signalling and transmission in a private network will be determined by the availability of suitable equipment, and by the decisions of the network user and the Administrations concerned. The following sections give guidance on transmission factors which affect signalling, the important characteristics of signalling systems which could affect the choice of transmission medium, and the interaction between signalling and non-voice services.

2.5 *Transmission factors*

2.5.1 Recommendations for the transmission characteristics of leased circuits forming part of a private telephone network are given in Recommendation G.171.

2.5.2 Where large groups of circuits are concerned and the transmission multiplex equipment is on the renter's premises, it is advisable to protect against the effects of faulty transmission on groups of circuits. Recommendation Q.33 gives details of such measures.

2.5.3 *Satellite systems*

i) Some signalling systems will not function correctly over satellite links since the long propagation delay (270 ± 20 ms one way) exceeds that assumed by the line signalling specification. Amongst the standard systems for public telephony, Signalling System R2 incorporates special precautions because of this delay. In addition the speed of multi-frequency compelled interregister signalling is affected, which may cause undesirable post-dialling delay. If signalling systems based on R2 are used in private networks then reference should be made to information contained in Recommendations Q.7 and Q.400 to Q.490.

ii) Consideration should be given to the possibility that two satellite links may, in some cases, need to be connected in tandem. Means to prevent this may also need to be considered. (Further information is contained in Recommendations E.171, G.131, Q.14 and Q.115.)

iii) If satellite links via Time Division Multiple Access Systems with Digital Speech Interpolation (TDMA/DSI) are used, then guidance on circuit supervision signalling arrangements can be found in Recommendation Q.33. However, Digital Non-Interpolated (DNI) channels are usually assigned for leased circuits and these exhibit fewer problems for signalling.

iv) If satellite links via Single Channel Per Carrier (SCPC) systems are used, then it should be noted that these systems employ voice activated carriers for telephony type circuits. On transmission systems of this type, the use of tone-on-idle signalling systems should be avoided, since such signalling systems would override the voice activation feature of SCPC systems.

2.5.4 *Echo control*

Paragraph 9 of Recommendation G.171 should be observed concerning the location of echo control devices where these are required. All analogue channel associated signalling systems operate more effectively if the line signal receiver, and often the line signal sender also, are located on the line side of any echo control device. In addition, some signalling systems require echo control devices to be locally disabled during interregister signalling. For these reasons, the echo control device should be located at the private renter's premises and not the terminal international centre.

2.5.5 *Speech interpolation*

Some signalling systems may not be compatible with speech interpolation systems for the following

reasons:

i) Signalling systems employing continuous state tone signalling will cause permanent operation of the speech detectors and thus permanent trunk to channel association. This prevents the correct operation of the interpolation process.

ii) The speech interpolation equipment may not be transparent to out-band signalling.

iii) The speech interpolation equipment may cause excessive clipping of pulse signals resulting in their non-recognition by the distant signalling equipment.

iv) The speech interpolation equipment may not provide sufficient speech detector hangover to allow the successful transmission of some signals, e.g. en bloc multi-frequency signals.

Information on the characteristics of some speech interpolation systems is given in Supplement No. 2 of Fascicle V1.1, though different systems may also be used on leased circuits.

In the case of continuous state tone signalling, compatibility with speech interpolation systems can be achieved by converting the tone signalling to interface with any in-built signalling capability the system may provide. If the transmission difficulty only exists in the interregister signalling phase, then this can be obviated by the simultaneous transmission of a speech interpolation locking tone, e.g. 2800 Hz.

Note that fully compelled signalling techniques are compatible with speech interpolation systems.

2.6 *Characteristics of signalling systems*

2.6.1 *Line signalling systems*

Analogue line signalling systems can be divided into in-band and out-band systems. In addition, two signalling techniques may be employed: pulse signalling or continuous signalling.

Information on the comparative advantages of in-band and out-band systems can be found in Recommendation Q.20. General requirements for signalling equipment are contained in Recommendations Q.112 to Q.114.

i) *In-band systems*

According to Recommendation Q.22, signalling frequencies above 2000 Hz should be used (but see also §§ 2.7.1 and 2.7.2 below).

The preferred power level for in-band signalling is -9 dBm0 for pulsed signals and -20 dBm0 for continuous signals (also see Recommendation Q.16).

In-band systems require the use of a guarding characteristic to prevent false operation of the signalling equipment by speech currents. Even so, occasional receiver misoperation by speech can occur, and thus in the speech phase a suitable minimum signal recognition time should be chosen.

In-band systems require the use of splitting techniques in order to confine the signalling frequencies to the link concerned, and this has an impact on minimum signal recognition times. Further information can be found in Recommendation Q.25.

If the leased circuit contains a digital transmission system in the terminal national section and this connects directly to a renter's digital PABX using a first order PCM system, then the detection of in-band signalling requires digital filtering techniques.

ii) *Out-band systems*

Recommendation G.171 does not provide for the use of out-band signalling on leased circuits. Because of the frequencies used, out-band signalling requires the use of a transparent 4 kHz bandwidth between the two signalling equipments. Part of the signalling equipment is usually provided within the transmission equipment.

Nevertheless, where the required transmission facilities can be assured, out-band signalling may provide a useful alternative to in-band signalling. Preferred signalling frequencies and power levels for out-band signalling are set out in Recommendation Q.21.

iii) *Pulsed signalling*

Pulsed signalling allows a greater signal repertoire than continuos signalling, but requires more complex signal recognition arrangements. In general, the signalling tone is recognized by the signal receiver but requires persistence checking and correlation with the circuit state before the signal is validated.

iv) *Continuous signalling*

Usually continuos signalling is arranged to operate with *"tone-on-idle"*. Such systems have the inherent advantage of allowing immediate identification of circuit availability.

Since only two signal states are available in each direction, the possible signal repertoire is lower than pulsed systems, but recognition arrangements are simpler. A single persistence timing is usually provided to validate changes of signalling state.

Where continuous in-band signalling uses the *"tone-on"* condition after the interregister signalling phase, means must be provided to prevent the calling or called parties from hearing the signalling tone without undue interference to the transmission of speech currents and tones. A band stop filter as used in Signalling System R1 (see Recommendation Q.313, § 2.3.4) may be suitable. Alternatively, to obviate these difficulties, pulsed signalling could be used in the speech phase.

2.6.2 *Interregister signalling*

The following types of interregister signalling may be suitable for use on leased circuits:

i) *Decadic signalling*

Signalling takes place using the same frequency and sender/receiver equipment as the line signalling. Forward signals are composed of a sequence of tone pulses analogous to subscriber line signalling employing rotary dials. Backward signals may not always be provided, but *proceed-to-send* and *address complete* signals can be used to advantage.

ii) *Multi-frequency signalling*

Multi-frequency (MF) signalling has the advantage of greater speed and signal repertoire than decadic systems. To provide both an adequate repertoire and signalling reliability, signals are composed of two frequencies from a set of 4, 5, 6 or 8 frequencies. Different frequencies may be used for signalling in the backward direction. The frequencies used for MF signalling should lie below 2000 Hz in order that they do not interfere with in-band line signalling.

MF systems may transmit signals in pulse form, or in a compelled sequence with signals in the opposite direction. The preferred signal power level is -9 dBm0 for each constituent tone.

Three existing MF systems may be suitable as the basis for signalling on leased circuits. These are:

1) The dual tone multi-frequency system as specified in Recommendation Q.23 and modified to act as an interregister signalling system. (See also Recommendation Q.24.)

2) Signalling System R1. See Recommendations Q.7 and Q.310 to Q.331.

3) Signalling System R2. See Recommendations Q.7 and Q.400 to Q.490.

2.6.3 *Overall signalling repertoire*

Consideration should be given to providing a set of signals capable of being adapted for different situations to provide a signal capability for extending the scope of PABX supplementary services to encompass the private network as a whole, and to provide other network facilities. This is best achieved by the inclusion in the signalling repertoire of a set of auxiliary signals that are separate from the basic call set-up and supervisory signals and can therefore be allocated in a flexible manner to the required function.

2.6.4 *Position of signalling equipment*

Normally all signalling equipment for automatic leased circuits will be located at the renter's premises. Some Administrations may wish or may be able to provide part of the signalling equipment at the Terminal National Centre or the Terminal International Centre. In these cases, suitable signalling arrangements need to be made to interconnect the exchange at the renter's premises with the remote elements of the signalling equipment. This will be determined by the Administration concerned. Any echo control device could in this case also be remote, but see Recommendation G.171, § 9.2.

2.7 *Interaction between signalling and non-voice services*

As well as normal speech transmission, leased circuits can he used to provide for other types of service (see Recommendation M.1015).

The most common types are:

- Voice-frequency telegraphy,
- Data transmission,
- Facsimile,
- Phototelegraphy.

Since these services use in-band frequencies, there is a possibility of interaction with signalling, and the following general guidance is given below.

2.7.1 *Voice-frequency telegraphy*

Where voice-frequency telegraphy is carried on a telephone-type leased circuit it will be by one of two methods:

- *Alternate use* (see Recommendation M.1015). The circuit is switched at both ends between the telephone equipment and the photo-telegraph equipment.
- Subdivision of the frequency band between telephone and telegraph services. (See Recommendation H.34.)

In the former case, the signalling equipment is disconnected during telegraph use and no interaction can take place. (Outgoing telephone circuits should be removed from service and blocked prior to service switching).

In the latter case, the in-band telephone signalling must be confined to frequencies below 2500 Hz since the attenuation at higher frequencies due to the separation filter cannot provide a reliable signalling path.

2.7.2 *Data transmission*

Data transmission systems for use over leased circuits are specified in Recommendations V.16, V.19 to V.23, V.26 and V.27. These systems do not interact with the Standard Systems for the following reasons:

i) In most cases, the data carriers lie below 2000 Hz and thus below the range for voice frequency line signalling. However, when the carrier is modulated, energy may be present in the signalling band but false receiver operation is prevented by there being at all times a greater energy in the pass-band of the guard circuit.

ii) In some cases, the carriers do lie in the signalling band above 2000 Hz, but with constant phase modulation the guard circuit will operate as outlined in i) above. In the case of 1200 bits/sec duplex transmission according to Recommendation V.22, a guard tone of 1800 Hz is required in order to ensure guard circuit operation.

For signalling systems on automatic leased circuits therefore, providing the signalling frequency is above 2000 Hz and that a guard circuit with a pass-band covering the common data carrier frequencies is used, no problems are foreseen with interaction.

In order that duplex data transmission can take place on circuits equipped with echo control devices, the data set will transmit a tone disabling signal with the following characteristics (see also Recommendation G.164).

2100 ± 15 Hz at a level of -12 ± 6 dBm0

Duration greater than 400 ms

In order that false operation of signalling equipment does not take place, it is essential that the lowest possible operating frequency of the signalling receiver be above the highest possible tone disabling frequency. This requires that the lowest usable signalling frequency be higher than the 2000 Hz referred to above in § 2.6.1.

For example:

Highest tone disabling frequency	=	2115 Hz
Allowance for frequency deviation in channel	=	5 Hz
Margin of safety	=	30 Hz
Typical maximum receiver deviation for operation	=	75 Hz
		———
Giving		2225 Hz

Thus on the basis of this example, frequencies above 2225 Hz should be suitable for signalling.

Since the tone disabling circuit of echo control devices may respond in the range 1900-2350 Hz, the unintentional disabling of echo control devices may occur during signalling if this frequency range is used. However, this is not considered detrimental since the echo control device serves no essential function during the time when signalling tones are present on the circuit.

2.7.3 *Facsimile*

Facsimile apparatus for use on telephone circuits are specified in Recommendations T.2, T.3, T.4 and T.10.

i) *Group 1 apparatus* (Recommendation T.2)

Since leased circuits in an automatic private network form part of a switched connection, the centre frequency f_o should be 1700 Hz as used on the public switched network. This implies, for frequency modulation, a transmitted frequency between 1300 Hz (white) and 2100 Hz (black). With a maximum frequency deviation of 32 Hz, and by analogy with the calculations in § 2.7.2 above, frequencies above 2242 Hz should be suitable for signalling. This must be carefully observed since facsimile transmission may result in a single tone for a significant period, and without energy in the pass-band of the guard circuit.

ii) *Group 2 apparatus* (Recommendation T.3)

The transmission method for Group 2 machines uses vestigal sideband amplitude modulation. The 2100 Hz carrier frequency is permanently modulated and the effect of this and the vestigial sideband filter is such that the energy spectrum of the transmitted signal is biased towards frequencies in the pass-band of the guard circuit and receiver misoperation should not occur.

iii) *Group 3 apparatus* (Recommendation T.4)

The transmission method for Group 3 machines uses the data transmission method of Recommendation V.27 *ter* or V.29. False operation should not occur for the reasons described in § 2.7.2 above.

2.7.4 *Phototelegraphy*

For Phototelegraphy on leased circuits, Recommendations T.1 and T.11 apply.

The transmitted centre frequency is 1900 Hz with deviation (in the case of frequency modulation) from 1500 Hz (white) to 2300 Hz (black). For amplitude modulated systems the carrier may be between 1300 and 1900 Hz.

In many cases a phototelegraph circuit is derived by *alternate use* where the telephone signalling equipment is disconnected. However, where automatic switching of phototelegraph circuits is required, the guidance of Recommendation T.11, § 3.2 applies; that is, a guard tone (*blocking signal*) should be transmitted in order to prevent false receiver operation on single-frequency signalling systems.

2.7.5 *Interference of service signals*

With the systems referred to in §§ 2.7.1-2.7.4 above, the precautions included to prevent false recognition of service signals will usually be reliable. However, where the precautions are dependent on the statistical probability of the transmitted power spectrum operating the guard circuit, there is always a small risk of receiver operation for very short periods (in a similar fashion to the occasional false operation by speech). It should be noted that if such operation persists long enough, then the receiver splitting function will operate and thus cause a discontinuity in the service signal. This should be borne in mind when deciding the minimum receiver splitting time. In the call connected phase it is advisable that the minimum tone recognition time for a valid signal should be chosen such that occasional short receiver operation does not cause a change of signalling state.

ANNEX A

(to Recommendation Q.8)

Technical clauses for 2280 Hz signalling on manual circuits

A.1 *Signal sender*

A.1.1 *Signalling frequency*

2280 ± 5 Hz.

A.1.2 *Transmitted signal level*

-13 ± 1 dBm0.

The permissible noise level measured at the output of the signal sender shall be as low as practicable, but in any event at least 35 dB below signal level.

The level of leak current transmitted to line should be at least 50 dB below signal level.

A.2 *Signal receiver*

A.2.1 *Operating limits*

The signal receiver must operate satisfactorily if a signal is received satisfying the following conditions:

a) the frequency received is within 2280 ± 15 Hz;

b) the absolute power level N of each unmodulated signal shall be within the limits $(-19 + n \leq N \leq -7 + n)$ dBm where n is the relative power level at the receiver input.

The limits give a margin of ± 6 dB on the nominal absolute power level of the 2280 Hz signal received at the receiver input, to allow for variations in transmission conditions on the international circuits.

A.2.2 *Non-operate conditions*

a) *Selectivity*

The signal receiver shall not operate on a signal having an absolute power level at the receiving end within the limits specified in § 2.1 b) when the frequency is outside: 2280 ± 75 Hz.

b) *Maximum sensitivity of the signal receiver*

The signal receiver shall not operate on a signal in the range 2280 ± 15 Hz whose absolute power level at the point of connection of the receiver is (-29 -13 + n) dBm, n being the relative power level at this point.

A.2.3 *Guard circuit*

A.2.3.1 *Efficiency of the guard circuit*

The signal receiver must be protected by a guard circuit against false operation due to speech currents, circuit noise, or other currents of miscellaneous origin circulating in the line.

The purpose of the guard circuit is to prevent signal imitation, and operation of the splitting device by interfering speech.

To minimize signal imitation by speech current it is advisable that the guard circuit be tuned as follows:

To minimize signal interference by low-frequency noise it is advisable that the response of the guard circuit fails off towards the lower frequencies and that the sensitivity of the guard circuit at 200 Hz is at least 10 dB less than at 1000 Hz.

An indication of the efficiency of the guard circuit is given by the following:

a) during 10 hours of speech, normal speech currents should not, on average, cause more than one false operation of the receiver lasting more than the minimum recognition time of the signal;

b) the number of false splits of the speech path caused by speech currents should not cause an appreciable reduction in the transmission quality of the circuit.

A.2.3.2 *Guard circuit limits*

Considering:

a) that unweighted noise of a level -40 dBm0 and uniform spectrum energy may arise on the longest international circuit;

b) that an oversensitive guard circuit might give rise to signalling difficulties.

It is recommended that, the guard circuit shall not operate in the presence of noise at a level of less than -35 dBm0 and uniform spectral energy over the frequency range 300-3400 Hz.

A.3 *Splitting arrangements*

Sending and receiving line splitting shall be provided.

A.3.1 *Sending line split*

a) the sending line transmission path of the signalling termination shall be disconnected 30-50 ms before a voice-frequency signal is sent over the circuit;

b) the sending line transmission path of the signalling termination will not be reconnected for 30-50 ms following the end of the sending of a voice-frequency signal over the circuit.

A.3.2 *Receiving line split*

a) the receiving line transmission path of the signalling termination shall be split when the 2280 Hz signal is received. The splitting time should be less than 20 ms;

b) the split must be maintained for the duration of the signal but must cease within 25 ms of the cessation of the 2280 Hz signal;

c) the splitting device may be any suitable arrangement for example, physical line disconnection, insertion of a bandstop filter, etc. The level of leak current transmitted to the subsequent circuit should be at least 40 dB below the received signal level.

ANNEX B

(to Recommendation Q.8)

Technical clauses for 2600 Hz signalling on manual circuits

B.1 *Signalling sender*

B.1.1 *Signalling frequency*

2600 ± 5 Hz.

B.1.2 *Transmitted signal level*

The transmitted signal level shall be -8 ± 1 dBm0 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 the level of the signal shall be reduced to - 20 ± 1 dBm0.

B.1.3 *Signal frequency leak*

The level of signal frequency leak power transmitted to the line should not exceed -70 dBm0, during the tone-off condition.

B.1.4 *Extraneous frequency components*

The total extraneous frequency components accompanying a tone signal should be at least 35 dB below the fundamental signal power.

B.1.5 *Sending line split*

The following splitting arrangements are required when transmitting line signals to prevent incorrect operation of the receiving equipment:

a) when a tone-on signal is to be transmitted, the sending line transmission path shall be split, within an interval from 20 ms before, to 5 ms after tone is applied to the line, and remain split for a minimum of 350 ms and a maximum of 750 ms;

b) when a tone-off signal is to be transmitted, the sending line transmission path shall be split, within an interval from 20 ms before, to 5 ms after tone is removed from the line, and remain split for a minimum of 75 ms and a maximum of 160 ms after the tone is removed.

Further details are given in § 2.2.6 of Recommendation Q.312.

B.2 *Signal receiver*

B.2.1 *Operating limits*

The receiving equipment shall operate on a received tone signal that meets the conditions listed below:

a) 2600 ± 15 Hz;

b) to ensure proper operation in the presence of noise, the signal level of the initial portion of each tone-on signal is augmented by 12 dB. The absolute power level of the signal shall be within the limits ($-27 + n \leq N \leq -1 + n$) dBm where n is the relative power level at the input to the receiving equipment.

B.2.2 *Non-operate limitsEF*

a) The receiving equipment shall neither operate on signals originating from subscriber stations (or other sources) if the total power in the band from 800 Hz to 2450 Hz equals or exceeds the total power present at the same time in the band from 2450 Hz to 2750 Hz as measured at the station, nor degrade these signals.

b) The receiving equipment shall not operate on any tone or signal whose absolute power level at the point of connection of the receiving equipment is ($- 17 - 20 + n$) dBm or less, n being the relative power level at this point.

On average during 10 hours of speech, normal speech currents should not cause more than one operation lasting more than 50 ms.

B.2.3 *Receiving line split*

To prevent line signals of the signalling system from causing disturbances to signalling systems on subsequent circuit sections, the receiving line transmission path should be split when the signal frequency is received to ensure that no portion of any signal exceeding 20 ms duration may pass out of the circuit section.

This should be achieved by use of a bandstop filter in which case the level of signal leak current transmitted to the subsequent circuit section with the bandstop filter inserted should be at least 35 dB below the received signal level. In addition, the bandstop filter must not introduce more than 5 dB loss at frequencies 200 Hz or more above or below the midband frequency nor more than 0.5 dB loss at frequencies 400 Hz or more above or below the midband frequency.

The receiving line split must be maintained for the duration of the incoming tone signal, but must cease within 300 ms of tone removal.

Note - In some existing designs, the initial cut may be a physical line disconnection but the filter must be inserted within 100 ms of tone reception.

ANNEX C

(to Recommendation Q.8)

The standard European inter-PABX signalling system

C.1 *Introduction*

Recognizing the increasing use of leased lines between private automatic branch exchanges (PABXs) in the European telecommunication networks, a specification has been developed covering the need for signalling on such lines. The system emerged is called Signalling System L1. Distinction is made between line signalling (call supervisory signals) and interregister signalling (set-up including routing and additional service control). Taking into account different applications, existing interregister signalling techniques have been adopted for use with the basic line signalling as follows:

- decadic pulsing (DP);
- multi-frequency push-button (MFPB) type signalling;
- System R2 multi-frequency code (MFC) type signalling.

C.2 *Principles and field of application*

C.2.1 The line signalling system is to provide automatic and semi-automatic working between PABXs in different countries.

C.2.2 The signalling system is a single voice frequency (1 vf) tone-on-idle line signalling system using a signalling frequency of 2280 Hz. The use of voice frequency signals renders the system suitable for all voice transmission media, except those using speech interpolation.

C.2.3 The system is intended for use on bothway inter-PABX circuits, with first party clearing.

C.2.4 Either decadic pulsing or multi-frequency interregister signalling may be used with the line signalling system. The provision of particular line signals will depend upon the requirements of the associated interregister signalling system.

C.2.5 The system operates on a four-wire basis, forward and backward signals being segregated by utilizing the four-wire circuits as two separate signalling paths.

C.2.6 In addition to the application or removal of signalling frequency (tone-on and tone-off) in continuous form, the transmission of pulses of signalling frequency is applied.

C.2.7 When in the idle condition, the signalling frequency applied to the line is reduced in power level to conform to the transmission loading requirements of Recommendation Q.15.

C.2.8 The line signalling operates on a link-by-link basis and may be used to establish a multi-link tandem connection using one or more private automatic exchange(s) as a transit switch. In accordance with Recommendation Q.25 sending fine and receiving line splitting arrangements are provided so that signals are contained within the appropriate link and are not allowed to spill over into subsequent or preceding links.

C.3 *Line signal conditions and signalling codes*

C.3.1 The line signal conditions and the signalling codes shall be as shown in Table C-1/Q.8. Signal sending and detection requirements are given in §§ C.3.2 and C.3.3.

C.3.2 A continuous tone-on condition shall be the application of the signalling frequency to the send signalling path for a period exceeding 300 ms.

A tone-on pulse signal shall be the application of the signalling frequency to the send signalling path for a period of 45-135 ms. A continuous tone-off condition shall exist when any signalling frequency is absent from the send signalling path for a period exceeding 80 ms.

TABLE C-1/Q.8

Line signal conditions and signalling codes

Signal	From outgoing PABX	From incoming PABX
Idle	Continuous tone-on	Continuous tone-on
Seizing	Continuous tone-off	Continuous tone-on
Seizing-acknowledgement or proceed-to-send	Continuous tone-off	Continuous tone-off
Answer	Continuous tone-off	Single tone-on pulse
Clear-forward	Continuous tone-on	Continuous tone-on or tone-off
Clear-back	Continuous tone-off	Continuous tone-on

C.3.3 A tone-on condition applied to the receive signalling path PABX termination may be recognized as a continuous tone-on condition for signalling when it has persisted for 150 ms, while for a tone-off condition a value of 40 ms has to be taken into account.

A tone-on condition applied to the receive signalling path PABX termination and persisting for 35-150 ms, followed by a tone-off condition longer than 200 ms, may be recognized as a pulse tone-on signal.

C.4 *Line signalling transmission requirements*

C.4.1 *Signal sender*

C.4.1.1 The signalling tone shall be at a frequency of 2280 ± 5 Hz.

C.4.1.2 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.

C.4.2 *Signal receiver*

C.4.2.1 A frequency within the range 2280 ± 15 Hz at an absolute level N, within the range $(-30 + n \leq N \leq -4 + n)$ dBm, shall be recognized as a tone-on condition; where n is the relative power level at the receive signalling path PABX termination (see Recommendation G.171).

C.4.2.2 Any frequency or combination of frequencies having a total absolute power level or less than $(-40 + n)$ dBm shall be recognized as a tone-off condition; where n is the relative power level at the receive signalling path PABX termination as in § C.4.2.1.

C.5 *General line signal transfer procedures*

C.5.1 Depending upon the capabilities of the incoming PABX, recognition of the seizing signal will initiate either proceed-to-send or seizing acknowledgement. The sending of the latter signal does not imply that the incoming PABX is ready to receive address information.

C.5.2 Some PABXs do not use the answer signal, others require it for correct operation. Therefore the answer signal is optional and subject to mutual agreement,

C.5.3 A continuous tone-on signal shall be applied when, after recognition of a seizing signal, no address or incomplete address information is received and the incoming PABX times-out.

A continuous tone-on signal may be applied when an incoming PABX encounters congestion or an engaged extension.

C.6 *Decadic pulsing*

For decadic pulsing interregister signalling the 2280 Hz line signalling is used. Some characteristics are given below.

C.6.1 The break periods of dial pulses shall be applied to the send signalling path as pulses of tone-on condition within the following limits.

SPEED (pulses per sec.)								
BREAK PULSE	7		9		11		12	
	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
DURATION (ms)	45	112	45	81	45	61	45	52

C.6.2 Pulses of tone-on condition applied to the receive signalling path PABX termination and consistent with the following speed and duration limits, are break periods of dial pulses (address signal).

SPEED (pulses per sec.)

BREAK PULSE	7		9		11		12	
	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
DURATION (ms)	35	112	35	91	35	71	35	62

ANNEX D

(to Recommendation Q.8)

A typical North American private analogue network signalling system

D.1 *Introduction*

D.1.1 A Private Switched Network is a common control switching arrangement which provides interconnections of subscriber locations via dedicated access lines and inter-exchange circuits and shared common control switching with the Public Switched Telephone Network. The Private Switched Networks are terminated at the subscriber location by directly-homed telephone sets, multi-line telephone systems or by main PBX or PABXs. This annex describes the signalling on a typical North American switched private network.

D.2 *General signalling applications*

D.2.1 The line signalling system provides for semi-automatic and automatic working between subscribers on the private network and the ability to go off network to the Public Switched Network.

D.2.2 In general, four-wire transmission links employing an in-band single frequency of 2600 Hz, tone-on-idle, are used on the inter-exchange circuits, directly-homed stations and PBX access lines.

D.2.3 Signalling on an inter-exchange circuit is in accordance with Recommendations Q.310 to Q.331 - System R1 signalling.

D.2.4 Either decadic pulsing (DP) or multi-frequency pushbutton is used for address signalling on access lines.

D.2.5 Multi-frequency pushbutton signalling is in accordance with Recommendation Q.23. (See also Recommendation Q.24.)

D.2.6 Address signalling on inter-exchange circuits is multi-frequency (MF) using a combination of two out of six frequencies in accordance with Recommendations Q.320 to Q.326.

D.2.7 Interregister signalling techniques are used for controlling outpulsing to accommodate different equipment

designs and to improve register usage.

D.3 *Signalling on access lines*

D.3.1 Either decadic pulsing (DP) or multi-frequency push-button (MFPB) is used on access lines for address signalling.

D.3.2 Supervisory signalling may use either the single frequency 2600 Hz or direct current loop.

D.3.3 Called party ringing is controlled by the terminating exchange or PABX in a conventional manner.

D.4 *Signalling on inter-exchange trunks*

D.4.1 Supervisory signalling is single frequency 2600 Hz in accordance with Recommendations Q.310 to Q.313, Q.317 and Q.318.

D.4.2 Register signalling uses multi-frequency (MF) signals consisting of two out of six frequencies in accordance with Recommendation Q.320.

D.5 *Decadic pulsing*

The decadic pulsing represents the numeric value of each digit by the number of on-hook intervals in a train of pulses.

D.5.1 The general characteristics of decadic pulsing are shown below:

Equipment	*Pulsing Speed (PPS)*	*Percent Break (BK)*
Customer Dial	8-11 PPS	58-64 BK
10-PPS PBX	10 ± 0.3 PPS	62-66 BK
Sender Pulsing	10 ± 1 PPS	57-64 BK

D.6 *Multi-frequency pushbutton*

See Recommendations Q.11, Q.23 and Q.24. Signal combinations A-D are not usually used in North American private switched networks.

ANNEX E

(to Recommendation Q.8)

The standard European signalling system for leased circuits connecting subscribers to remote PABXs and public exchanges

E.1 *Introduction*

Recognizing the increasing use of leased lines for interconnection of telephone instruments and public exchanges or private automatic branch exchanges (PABXs) in the European telecommunication networks, a specification has been developed covering the need for signalling on such lines. The system emerged is called Signalling System L2. Distinction is made between line signalling (call supervisory signals) and interregister signalling (set-up including routing and additional service control). Taking into account different applications, existing interregister signalling techniques have been adopted for use with the basic line signalling as follows:

- decadic pulsing (DP);
- multi-frequency pushbutton (MFPB) type signalling.

E.2 *Principles and fields of application*

E.2.1 The line signalling system is to provide supervisory signals (e.g. loop signalling in one direction and ringing in the other) between a telephone instrument or its equivalent and a public exchange or PABX in different countries, via an extra long line.

E.2.2 For the purpose of description, this specification refers to an instrument signalling unit (ISU) and an exchange signalling unit (ESU).

E.2.3 The system is intended for use over four-wire circuits but, as an option for national use, it may be used over two-wire circuits. In the four-wire case, forward and backward signals are segregated by utilizing the four-wire circuit as two separate signalling paths.

E.2.4 The system is a single voice frequency (1 vf) line signalling system using a signalling frequency of:

- 2280 Hz in both directions on four-wire circuits;
- 2280 Hz in the direction ISU to ESU and 2400 Hz in the direction ESU to ISU on two-wire circuits (national).

The use of voice frequency signals renders the system suitable for all voice transmission media, except those using speech interpolation.

E.2.5 In addition to the application or removal of signalling frequency (tone-on and tone-off) in continuous form, the transmission of pulses of signalling frequency is applied.

E.2.6 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 Recommendation Q.15.

E.2.7 In accordance with Recommendation Q.25, sending and receiving line splitting arrangements are provided so that signals are contained within the ISU-ESU link and not allowed to spill over into the next link.

E.2.8 When making an outgoing call, a through speech path shall be provided in the direction ESU-ISU prior to the answered state.

E.2.9 Signals may be passed in the direction ISU to ESU while speech or audible indications are being received in the direction ESU to ISU.

E.3 *Line signal conditions and signalling codes*

E.3.1 The line signal conditions and the signalling codes shall be as shown in Tables E-1/Q.8 and E-2/Q.8. Signal sending and detection requirements are given in §§ E.3.2 and E.3.3.

TABLE E-1/Q.8

Calls originated by the telephone instrument

Signal	Conditions from ISU	Conditions from ESU
Idle	Continuous tone-on	Continuous tone-off
Seizing	Continuous tone-off	Continuous tone-off
Answer	Continuous tone-off	Tone-on pulse
Recall	Recall tone-on pulse	Continuous tone-off
Clear	Continuous tone-on	Continuous tone-off

TABLE E-2/Q.8

Calls from the exchange

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

E.3.2 A continuous tone-on condition shall be the application of the signalling frequency to the send signalling path for a period exceeding 350 ms. A tone-on pulse signal shall be the application of the signalling frequency to the send signalling path for a period of 45-135 ms or 210-240 ms (see § E.5.2).

A continuous tone-off condition shall exist when any signalling frequency is absent from the send signalling path for a period exceeding 80 ms.

E.3.3 A tone-on condition applied to the receive signalling path line termination may be recognized as a continuous tone-on condition for signalling, when it has persisted for 250 ms, while for a tone-off condition a value of 40 ms has to be taken into account.

A tone-on condition applied to the receive signalling path line termination, and persisting for a period of 35-150 ms or 200-250 ms (see § E.5.2) may be recognized as a tone-on pulse signal.

E.4 *Line signalling transmission requirements*

E.4.1 *Signal sender*

E.4.1.1 The signalling tone shall be at a frequency of 2280 (2400 Hz in the ESU for two-wire working) ± 5 Hz.

E.4.1.2 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.

E.4.2 *Signal receiver*

E.4.2.1 A frequency within the range 2280 (2400 Hz in the ISU for two-wire working) ± 15 Hz at an absolute level N, within the range $(-30 + n \leq N \leq -4 + n)$ dBm shall be recognized as a tone-on condition; where n is the relative power level at the receive signalling path line termination (see Recommendation G.171).

E.4.2.2 Any frequency or combination of frequencies having a total absolute power level of less than $(-40 + n)$ dBm shall be recognized as a tone-off condition; where n is the relative power level at the receive signalling path line termination as in § E.4.2.1.

E.5 *General line signal transfer procedures*

E.5.1 The calling signal is a series of tone-on pulses with a duration of each pulse according to the length of the original ringing pulse and in step with the period of the ringing signal.

E.5.2 As an option and subject to mutual agreement by the parties involved, 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.

E.5.3 As an option and subject to mutual agreement by the parties involved, the answer signal is sent by the ESU.

E.6 *Decadic pulsing*

For decadic pulsing interregister signalling, the 2280 Hz line signalling is used. Some characteristics are given below.

E.6.1 The break periods of decadic pulses shall be applied to the send signalling path of the ISU, as pulses of tone-on condition within the following limits.

SPEED (pulses per sec.)								
BREAK PULSE	7		9		11		12	
	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
DURATION (ms)	45	112	45	81	45	61	45	52

E.6.2 Pulses of tone-on condition applied to the receive signalling path line termination of the ESU, consistent with the following speed and duration limits, are break periods of dial pulses (address signal).

SPEED (pulses per sec.)								
BREAK PULSE	7		9		11		12	
	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
DURATION (ms)	35	122	35	91	35	71	35	62