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PART I

Recommendations Q.1 and Q.2

SIGNALLING IN THE INTERNATIONAL MANUAL SERVICE

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MONTAGE: PAGE 2 = PAGE BLANCHE

Recommendation Q.1

SIGNAL RECEIVERS FOR MANUAL WORKING

In 1934 (CCIF *White Book* , Volume III, Xth Plenary Assembly, Budapest, 1934), a signalling current having a frequency of 500 Hz ± 2%, interrupted at a frequency of 20 Hz ± 2% was provisionally chosen for manually-operated international circuits.

500 Hz was chosen as the frequency to be transmitted, under normal conditions, by carrier terminal equipment and line repeaters. To avoid false operation due to speech currents, it was also considered desirable to interrupt the 500 Hz signalling current at low frequency. The use of a uniform interruption frequency of 20 Hz enables a high degree of selectivity to be obtained in signal receivers.

The effective power produced by the signalling current, when not interrupted, is fixed at 1 milliwatt at a zero relative level or an absolute power level of zero (with a tolerance of ± | decibel) which corresponds to an average power for the interrupted signalling current of 0.5 milliwatt, with a tolerance of ± | decibel.

The power levels specified above were chosen in 1954 (XVIIth CCIF Plenary Assembly, Geneva, 1954) on the basis of the limit imposed for the maximum energy which can be transmitted by signals during the busy hour; it must not exceed 2.5 microwatthours or 9000 microwattseconds at a zero relative level point. A reasonable value for the number of calls, or attempted calls, on a circuit during the busy hour was assumed and 2 seconds was assumed to be the sending duration of the signalling current to line by operation of the operator's ringing key.

On outgoing circuits from an international exchange, where the 500/20 Hz signals are liable to be sent over wideband carrier systems (coaxial carrier systems) it is desirable, to avoid overloading the repeaters, that the duration of the 500/20 Hz signals sent to line should not exceed 2 seconds and they should be limited to this value by automatic means.

Since, in general, the *Instructions for the International Telephone Service* | Article 32) [1] require the signalling current sent over an international circuit to have a duration of at least 2 seconds to avoid the risk of signals being undetected at the incoming end, the means for limiting the sending duration of the signalling current will generally consist of an arrangement which controls the sending duration independently of the time the ringing key is operated and which automatically fixes that duration at 2 seconds.

Note — In the case of short 2-wire circuits, it may be economical to use, by agreement between the Administrations concerned, a low-frequency signalling current (either between 16 and 25 Hz or 50 Hz).

ANNEX A
(to Recommendation Q.1)

Basic technical clauses of a model specification for the provision of 500/20-Hz voice-frequency signalling sets (signal transmitters and receivers) intended for manually-operated circuits

A.1 *Sending of signals*

Power — The signal transmitted shall supply a sinusoidal current at a frequency of 500 Hz ± 2% interrupted at a frequency of 20 Hz ± 2%.

The effective mean power of the 500/20-Hz current is fixed at 0.5 milliwatt or an absolute power level of —3 dBm (with a tolerance of ± | dB) at a zero relative level point.

Every precaution should be taken to avoid unbalance effects in the circuit during the transmission of a 500/20-Hz signalling current.

A.2 *Reception of signals*

Sensitivity — The signal receiver shall operate correctly when the 500/20-Hz current at the input to the signal receiver is within the following limits:

$$-8.5 + n \quad N \quad +2.5 + n \ \text{dB}$$

where n is the relative power level at the point of the circuit at which the signal receiver is connected.

The limits take account of the tolerances indicated above for the transmitted power level and include a margin of ± | .5 decibels on the nominal absolute power level of the 500/20 Hz current received at the input to the signal receiver. This margin allows for variations in transmission conditions on international circuits.

Tuning — Tuning should be such that the signal receiver operates only at a frequency of 500 Hz guaranteed to within ± | % and at an interrupting frequency of 20 Hz guaranteed to within ± | %.

Delay — The delay, i.e. the time which elapses between the application of the signalling voltage and the operation of the signal receiver, must be long enough for the signal receiver to remain insensitive to all speech currents which normally flow in the circuit to which it is connected. The duration of this delay must, however, be less than 1200 milliseconds. (In other words, 1200 milliseconds is the maximum signal recognition time within which a signal has to be recognized.)

Selectivity (resulting from the tuning of the resonant circuit and the delay mentioned above) — The receipt of a speech (or noise) current circulating in the circuit must not give rise to a current liable to cause the operation of the signalling equipment and, in consequence, to cause a wrong indication to be given on the international positions even though the speech (or noise) voltage reaches the maximum value likely to be met in practice. In particular, the signal receiver must not operate when a speech power not exceeding 6 milliwatts is applied at a zero relative level point.

Insertion loss — The insertion loss introduced by the signal receiver in the circuit with which the signalling set is associated must be less than 0.3 dB for any frequency effectively transmitted by the circuit.

Reference

[1] CCITT *Instructions for the international telephone service (1 October 1985)*, ITU, Geneva, 1985.

Recommendation Q.2

SIGNAL RECEIVERS FOR AUTOMATIC AND SEMI-AUTOMATIC WORKING, USED FOR MANUAL WORKING

The directives relating to 500/20-Hz signalling sets are provisional. An Administration intending to purchase new signalling sets for use on international circuits which for the time being are to be operated on a manual basis, may find it advantageous, by agreement with the Administrations interested in the operation of the circuits concerned, to use signal receivers and transmitters conforming to the specifications for international automatic equipment. This will permit a greater technical uniformity of installations and will avoid having to replace the signal receivers when, ultimately, these circuits are operated on an automatic or semi-automatic basis.

The signal receivers must therefore conform with the specifications for the applicable recommended CCITT systems.

Sending of signals

The frequency and power level of the signalling current must be in accordance with the specifications for international automatic equipment. If two-frequency signal receivers are concerned, the two frequencies (compound signal) must be transmitted simultaneously.

The nominal duration of a signal sent to line is fixed at 2 seconds so as to be the same as that specified for 500/20 Hz signalling.

Reception of signals

At the receiving end, provision must be made for a splitting arrangement conforming to the specifications for international automatic equipment. This splitting arrangement can be:

— either an integral part of the signal receivers, or

— placed at the end of the circuit after the signal receiver.

The signalling equipment (at the output of the signal receiver) which causes the lighting of the calling and clearing lamps shall have a signal recognition time of between 100 and 1200 milliseconds:

— 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 1200 ms has been chosen so as to permit the partial use of 500/20-Hz signal-receiver equipment.

Note 1 — The characteristics of signal receivers of the types used for automatic or semi-automatic working could possibly also be used to provide signals and supplementary facilities for operators if the Administrations concerned consider that the operational advantages to be obtained justify the equipment modifications involved at the international exchanges.

Note 2 — The time quoted in this Recommendation for the signal length and the signal recognition times would also be appropriate for out-band signalling systems using discontinuous signals for a manual service.

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PART II

Recommendations Q.4 to Q.49

GENERAL RECOMMENDATIONS RELATING TO SIGNALLING AND SWITCHING

IN THE AUTOMATIC AND SEMI-AUTOMATIC SERVICES

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MONTAGE: PAGE 8 = PAGE BLANCHE

SECTION 1

CCITT BASIC RECOMMENDATIONS ON INTERNATIONAL

AUTOMATIC AND SEMI-AUTOMATIC WORKING

Recommendation Q.4

AUTOMATIC SWITCHING FUNCTIONS FOR USE | IN NATIONAL NETWORKS

1 Preamble

The CCITT,

considering

(1) that a large amount of switching equipment will be installed in the next few years, especially in areas of low subscriber density;

(2) the continuous rapid development of new switching techniques results in different generations of equipment having to co-exist;

(3) that some degree of compatibility in the installed switching equipment is required in the world-wide automatic network;

(4) that the introduction of newly developed switching systems presents Administrations with an ever increasing number of engineering, staff training, maintenance and other operational considerations,

and also considering

(5) that Recommendations originally intended for international application only are increasingly being applied to national networks, or could be so applied;

(6) that many current studies are aimed at producing Recommendations primarily applicable to national networks,

recommends

the following guidelines for use by Administrations establishing national switching standards or, if desired, for updating existing standards. Each Administration may select those guidelines it deems applicable to its own situation.

2 Automatic switching functions for use in national networks

Table 1/Q.4 lists the functional switching capabilities of an exchange which will, or may in some instances, according to the role of the exchange in a network, need to be technically specified in order that the Administration concerned can be assured that the exchange will satisfy existing and foreseen future needs of the network. For the required capabilities, references are given to CCITT texts which should be taken into account when decisions on national standards are taken; some make positive recommendations, others give guidelines or background information. Table 2/Q.4 provides full titles for those referenced texts, and for others applicable to national switching, in order to provide more specific information about the subject matter.

Some of the functions listed are required in all types of exchanges. Others may or may not be, according to the role of the exchange, e.g. local, combined local/transit, transit, international, etc.

It is not always necessary that a precise technical specification be given, e.g., in a tender specification, for each switching function. In some instances, it may be sufficient to state the requirements broadly, possibly including desired ranges of parameter values, and to invite a tenderer to make his own specific proposals for evaluation.

3 Requirements for ISDN

As Recommendations for the ISDN are being developed concurrently, it is difficult to reference them in this Recommendation. All Recommendations relevant to the ISDN will be published in a single volume at the end of this Study Period 1981-1984 (Fascicle III.5).

4 Requirements other than automatic switching functions

The technical specifications of the required automatic switching functions of an exchange do not, in themselves, consitute a complete specification. Other aspects possibly needing to be covered, which are particular to an exchange or to a group of exchanges and not included within the scope of automatic switching functions are:

— traffic (dimensioning and service performance);

— specifications dictated by the equipment environment (building constraints, power supplies, climatic conditions, etc.);

— installation, including testing, acceptance, post-acceptance technical support, etc.;

— training and documentation;

— support of system design and software, e.g., CCITT Recommendation Z.100 (SDL) series and CCITT Recommendation Z.200 (CHILL) series.

5 Technical cooperation possibilities

The CCITT Recommendations already established so far do not themselves suffice to cover all the points of a specification dealing with the functions to be performed by switching equipment. It is unavoidable, if national standards are to match the requirements and circumstances of a particular network, that the responsible Administration itself exercise a number of choices.

An Administration seeking advice or guidance beyond that indicated in CCITT texts may, by approaching the ITU Secretariat, obtain information on the standards adopted by other Administrations.

6 Definition of requirements in terms of services and facilities

6.1 Fundamental decisions as to range of service(s) and facilities to be provided must be made by the Administration. Descriptions and other information on the various services normally provided by a switching system may be found as indicated in the following:

— types of services (GAS 6, Chapter II, § 3; Chapter III, § 3.2),

— basic services (GAS 6, Chapter IV, § 1.2),

— supplementary services (GAS 6, Chapter IV, § 1.4); Recommendations E.130, E.132, E.151; Supplement No. 1 to Series E Recommendations.

6.2 A list of possible telephony subscriber services and facilities has been extracted from the GAS 6 Handbook, Chapter IX, § 1.3.2 and is shown in Annex A.

Blanc

H.T. [1T1.4]

TABLE 1/Q.4

CCITT texts (Recommendations and GAS Handbooks) relevant to the

technical specification of automatic switching functions of exchanges

in national networks

Item	Reference
A. *Switching*	
{	
Type of switch:	
| analogue (2- or 4-wire)/digital,	
space or time division	
}	{
GAS 6 II 1, VI 1.1	
GAS 3 III, Annex 1	
Recs. Q.501, Q.511	
}	
{	
Type of control:	
| distributed/centralized	
}	GAS 6 VI 1.2
{	
Subscriber classification	
}	GAS 6 VI 1.2.1
{	
B.	
Routing and selection	
}	
{	
Classification of exchange inlets and outlets:	
| according	
to types of inter-exchange circuits to be connected: taking into account	
the line, inter-register, etc., signalling arrangements and the	
transmission, operating, testing, network management, etc., requirements	
}	{
GAS 6	
IV 5.6-7	
VI 1.4.1 and 4	
Recs.	
E.543	
Q.7, Q.48, Q.49, Q.108, Q.110,	
Q.251-Q.300, Q.310-Q.331, Q.400-Q.480,	
Q.501-Q.507, Q.511-Q.517	
}	
{	
Number analysis functions:	
| required capacity and depth of	
analysis for routing, determination of number length, barring, digit	
insertion/deletion, charging, echo control, etc.	
}	{
GAS 6 IV 6, VI 1.4.6	
Recs.	
E.160, E.161, E.163	
Q.103, Q.105, Q.106, Q.107,	
Q.107 | fIbis	
,	
Q.115	
}	
{	
Choice of outgoing circuit:	
search procedure, dual seizures,	
alternative routing, repeat attempts, etc.	
}	{
GAS 6 VI 1.4.2, 3 and 5	
Recs.	
E.170, E.171	
Q.12	
, Q.263	

}
{
Network management functions:
| circuit group denial, alternative
routing cancellation, exchange load control, etc.
} {
GAS 6 VI 1.4.7
Recs.
E.170, E.410, E.411, E.412, E.413
Q.506, Q.516
}
C. *Charging*
{
Methods:
| local, long-distance, international, non-chargeable,
payphone, etc., calls
} {
GAS 6 IV 7.1-2, VI 1.5.1
Recs. E.230-E.232
}
{
Charge determination:
| principles and parameters

} GAS 6 IV 7.3, VI 1.5.2
{
D.
Transmission characteristics
}
{
Interfaces:
| specification of the transmission characteristics of
the interfaces, or the identification of the standard interfaces, at
which the exchange is to interconnect with external facilities
and systems
} {
GAS 3 III
Recs.
G.703, G.704, G.705, G.731-G.739,
G.741-G.746,
Q.502, Q.512
}
{
Exchange transmission performance:
| Limits for the levels of
transmission impairments attributable to the exchange and for
characteristics affecting performance, taking account of all possible
types of connection through the exchange

} {
GAS 6 VI 1.8
Recs.
G.121, G.122, G.123
Q.45, Q.507, Q.517
}
{
E.
Synchronization and timing
} {
Recs.
G.811, G.822
Q.502, Q.503, Q.512, Q.513
}

{ F. *Tones and recorded announcements* } { Scope and applications; tones; announcements } GAS 6 VI 1.7 Recs. E.180 (Q.35), E.181 (Q.36), E.182 Supplement No. 2 to Series E Recommendations Rec. Q.24 }	{

TABLEAU 1/Q.4 [1T1.4], p. 1

H.T. [2T1.4]

TABLE 1/Q.4 *(cont.)*

Item	Reference

{
G.
Subscriber line characteristics
}
{
1.
Analogue subscriber line
}
{
Subscriber line standards:
limits for loop resistance,
loop insulation, overall line attenuation, etc.
} {
GAS 2 V 3.2, 3.3
GAS 6 VI 1.3.1
GAS 3 II 3.1
Recs. G.120-G.123
}
{
Subscriber line signals:
supervision address
information, ringing, metering, tones, etc.
} {
GAS 2 V 6.2
GAS 6 IV 8, VI 1.3.2
Recs.
E.131
Q.16, Q.23, Q.35 (E.180), Q.118
}
{
2.
Digital subscriber line
}
{
Exchange interfaces signalling for digital
access
} {
Recs.
I.412
Q.512, Q.920, Q.921, Q.930, Q.931
}
{
H.
Inter-exchange signalling
}
{
Specification of required exchange functions by identification
of existing and planned inter-exchange signalling
arrangements
}
{
Signalling philosophies and types of signalling

} {
GAS 6 II 2, IV 8, VI 1.6
GAS 3 II 3.2
Recs. Q.7, Q.21
Supplement No. 3 to
Series Q Recommendations
}
{

Signalling system specifications
| channel associated and
common channel, as appropriate)

}
{
Recs.
Q.101-Q.103, Q.105-Q.118 | fIbis
,
Q.251-Q.300, Q.310-Q.331, Q.400-Q.490,
Q.701-Q.795
}
{
Interworking of signalling systems
}
Recs. Q.601-Q.685
I. *Operation*
{
The specification of exchange features designed to facilitate
the operation of the exchange with respect to the administrations
of:
— subscribers
— routing
— traffic
— tariffs and charging
— recording and billing
— system control
taking into account remote control possibilities
}
{
GAS 6
IV 7.4-7, 9.1-2
VI 1.5.3-4, 1.9
Recs.
E.500
Q.505, Q.506, Q.515, Q.516
Z.331-Z.333
}
J. *Maintenance*
{
The specification, with respect to maintenance,
of:
— subscriber lines
— inter-exchange circuits
— switching network
— control system
the specification of testing and maintenance features, taking into
account the objectives of:
—
minimization of the fault rate
—
simplification of maintenance activities
—
adequate equipment repair facilities
—
maximization of immunity to failures
—
optimizing maintenance centralization
}
{
GAS 6 IV 9.1, 9.3, VI 1.10
Recs.
G.231
M.565
O.22 (Q.49)
Q.506, Q.516
Z.301, Z.331-Z.333

}
{
L.
Input/output devices for operation and maintenance
}
GAS 6 VI 1.11
Recs.
E.220, E.221
Z.301-Z.302, Z.311-Z.317,
Z.321-Z.323
}
	{

TABLEAU 1/Q.4 [2T1.4], p. 2

TABLE 2/Q.4

Titles of CCITT texts (Recommendations and GAS Handbooks) relevant to national switching applications

CCITT Manual *Local telephone networks* , ITU, Geneva, 1968 (Gas 2 Handbook).

CCITT Manual *Transmission planning of switched telephone networks* , ITU, Geneva, 1976 (Gas 3 Handbook).

CCITT Manual *Economic and technical aspects of the choice of telephone switching systems* , ITU, Geneva, 1981 (GAS 6 Handbook).

CCITT Manual *Economic and technical aspects of the transition from analogue to digital telecommunication networks* , ITU, Geneva, 1984 (GAS 9 Handbook).

CCITT Rec. E.130 *Choice of the most useful and desirable supplementary telephone services* .

CCITT Rec. E.131 *Subscriber control procedures for supplementary services* .

CCITT Rec. E.132 *Standardization of elements of control procedures for supplementary telephone services* .

CCITT Rec. E.151 *Conference calls* .

CCITT Rec. E.160 *Definitions relating to national and international numbering plans* .

CCITT Rec. E.161 *Arrangement of figures, letters and symbols on rotary dials and pushbutton telephone sets* .

CCITT Rec. E.163 *Numbering plan for the international telephone service* .

CCITT Rec. E.170 *Overflow — alternative routing — rerouting — automatic repeat attempt* .

CCITT Rec. E.171 *International routing plan* .

CCITT Rec. E.180 *Characteristics of the dial tone, ringing tone, busy tone, congestion tone, special information tone and warning tone* .

CCITT Rec. E.181 *Customer recognition of foreign tones* .

CCITT Rec. E.182 *Application of tones and recorded announcements in telephone services* .

CCITT Rec. E.211 *Numbering and dialling procedures for VHF/UHF and maritime mobile satellite services* .

CCITT Rec. E.220 *Ergonomic aspects of visual display terminals* .

CCITT Rec. E.221 *Human interface to visual display terminals* .

CCITT Recs. E.230-E.232 *Charging (determination of collection charges) in the international telephone service* .

CCITT Rec. E.500 *Measurement and recording of traffic* .

CCITT Rec. E.521 *Calculation of the number of circuits in a group carrying overflow traffic* .

CCITT Rec. E.543 *Grades of service in analogue/digital international telephone exchanges* .

CCITT Rec. E.410, E.411, E.412 and E.413 *Network management* .

CCITT Series E. Recommendations Supplement No. 1 *List of possible supplementary telephone services which may be offered to subscribers* .

CCITT Series E. Recommendations Supplement No. 2 *Various tones used in national networks* .

CCITT Recs. G.120-G.123 *General characteristics of national systems forming part of international connections* .

CCITT Rec. G.121 *Corrected reference equivalents (CREs) of national systems* .

CCITT Rec. G.122 *Influence of national networks on stability and echo losses in national systems* .

CCITT Rec. G.123 *Circuit noise in national networks* .

CCITT Rec. G.231 (2) *Use of standard components in transmission equipment* .

CCITT Rec. G.703 *General aspects of interfaces* .

CCITT Rec. G.704 *Functional characteristics of interfaces associated with network nodes* .

CCITT Rec. G.705 *Characteristics required to terminate digital paths on a digital exchange* .

CCITT Recs. G.731-G.739 *Principal characteristics of primary multiplex equipment* .

CCITT Recs. G.741-G.746 *Principal characteristics of second order multiplex equipments* .

CCITT Rec. G.811 *Performance of clocks suitable for plesiochronous operation of international digital links* .

CCITT Rec. G.822 *Controlled slip rate objectives on an international digital connection* .

CCITT Rec. I.412 *ISDN user-network interfaces-channel structures and access capabilities* .

CCITT Rec. M.565 *Access point for international telephone circuits* .

CCITT Rec. O.22 *Specification for the CCITT automatic transmission measuring and signalling testing equipment ATME No. 2* .

CCITT Rec. Q.7 *Signalling systems to be used for international automatic and semi-automatic telephone working* .

CCITT Rec. Q.12 *Overflow-alternative routing — rerouting — automatic repeat attempt* .

CCITT Rec. Q.14 *Means to control the number of satellite links in an international telephone connection* .

CCITT Rec. Q.15 *Nominal mean power during the busy hour* .

CCITT Rec. Q.16 *Maximum permissible value for the absolute power level of a signalling pulse* .

CCITT Rec. Q.21 *Systems recommended for out-band signalling* .

CCITT Rec. Q.23 *Technical features of push-button telephone sets* .

CCITT Rec. Q.24 *Multi-frequency push-button signal reception* .

CCITT Rec. Q.33 *Protection against the effects of faulty transmission on groups of circuits* .

CCITT Rec. Q.35 *Characteristics of the dial tone, ringing tone, busy tone, congestion tone, special information tone and warning tone* .

CCITT Rec. Q.45 *Transmission characteristics of an international exchange* .

CCITT Rec. Q.48 *Demand assignment signalling systems* .

CCITT Rec. Q.49 *Specification for the CCITT automatic transmission measuring and signalling testing equipment ATME No. 2* .

CCITT Recs. Q.101-Q.103, Q.105-Q.118 *bis Clauses applicable to CCITT standard systems* .

CCITT Rec. Q.103 *Numbering used* .

CCITT Rec. Q.105 *National (significant) number* .

CCITT Rec. Q.106 *The sending-finished signal* .

CCITT Rec. Q.107 *Standard sending sequence of forward address information* .

CCITT Rec. Q.107 *bis Analysis of forward address information for routing* .

CCITT Rec. Q.108 *One-way or both-way operation of international circuits* .

CCITT Rec. Q.110 *General aspects of the utilization of standardized CCITT signalling systems on PCM links* .

CCITT Rec. Q.115 *Control of echo suppressors* .

CCITT Recs. Q.118 *Special release arrangements* .

CCITT Recs. Q.251-Q.300 *Specifications of Signalling System No. 6* .

CCITT Rec. Q.263 *Double seizing with both-way operation* .

CCITT Recs. Q.310-Q.331 *Specifications of Signalling System R1* .

CCITT Recs. Q.400-Q.490 *Specifications of Signalling System R2* .

CCITT Recs. Q.500-Q.554 *Digital local, transit, combined and international exchanges in integrated digital networks and mixed analogue-digital networks* .

CCITT Recs. Q.601-Q.685 *Interworking of signalling systems* .

CCITT Recs. Q.701-Q.795 *Specifications of Signalling System No. 7* .

CCITT Rec. Q.920 *ISDN user-network interface data link layer — General aspects* .

CCITT Rec. Q.921 *ISDN user-network interface data link layer specification* .

CCITT Rec. Q.930 *ISDN user-network interface layer 3 — General aspects* .

CCITT Rec. Q.931 *ISDN user-network interface layer 3 specification for basic call control* .

CCITT Series Q. Recommendations Supplement No. 3 *Information received on national voice-frequency signalling systems* .

CCITT Rec. Z.100 Series *Functional specification and description language (SDL)* .

CCITT Rec. Z.200 Series *CCITT high level language (CHILL)* .

CCITT Rec. Z.300 Series *Man-machine language (MML)* .

CCITT Recs. Z.301-Z.302 *General principles* .

CCITT Rec. Z.301 *Introduction to the CCITT man-machine language* .

CCITT Recs. Z.311-Z.317 *Basic syntax and dialogue procedures* .

CCITT Recs. Z.321-Z.323 *Extended MML for visual display terminals* .

CCITT Recs. Z.331-Z.333 *Specification of man-machine interface*

ANNEX A

(to Recommendation Q.4)

List of possible subscriber services and facilities

Subscriber services

Basic services

— subscriber dialled local, long distance, and international calling with automatic charging
— PBX line hunting, night service, and direct dialling-in
— payphone
— access to operators for assistance and information
— access to community services (police, fire brigade, etc.)
— access to recorded announcements
— call barring
— malicious call trace
— interception of calls
— absent subscriber
— line observation

Supplementary services

— abbreviated dialling
— alarm call
— hot line
— outgoing service restriction
— call diversion
— call waiting
— do not disturb
— call completion to busy subscribers
— switching-in not permitted
— call charge indicator at subscriber's premises
— immediate call charge announcement
— priority line
— two party line
— multiparty line

— multifrequency push-button (MFPB) dialling

— mobile subscriber

— conference service

— Centrex services

— other services

Recommendation Q.5

ADVANTAGES OF SEMI-AUTOMATIC SERVICE

IN THE INTERNATIONAL TELEPHONE SERVICE

(Geneva, 1954)

The CCITT,

considering

(a) the large economies in personnel that can result from the introduction of semi-automatic service at the incoming exchange;

(b) the very small number of faults due to the equipment used for the international semi-automatic service;

(c) the improvement in the ‘‘efficiency’’ (ratio of chargeable time to total holding time) of circuits using semi-automatic service compared with the efficiency of manual circuits operated on a demand basis;

(d) the improvement in the quality of the service given to users due to the reduction in the time of setting up a call;

(e) the fact that any type of call can be set up without difficulty over semi-automatic circuits, so that semi-automatic circuits can be used exclusively on an international relation;

draws the attention | f Administrations

to the advantages of semi-automatic service from the point of view of economy and of the quality of service given to subscribers.

Recommendation Q.6

ADVANTAGES OF INTERNATIONAL AUTOMATIC WORKING

(New Delhi, 1960)

The CCITT,

considering

(a) that the advantages of semi-automatic working mentioned in Recommendation Q.5 apply as well to automatic working in respect of reliability, circuit efficiency and the satisfaction given to subscribers;

(b) that the advantages of automatic working are even greater as regards staff economy, since outgoing operators are dispensed with;

(c) that the changeover from semi-automatic to automatic working may be accomplished without any major modification to the international circuits or to the switching equipment at transit and incoming

exchanges;

(d) that by 1960 the above advantages had been widely confirmed by experience on a number of international relations which had been using automatic service up to that time;

(e) that such experience has also shown that when a relation changes from demand working (manual or semi-automatic) to automatic working, there is a considerable increase in traffic;

(f) that the introduction of an international automatic service follows logically on the introduction of a national automatic service;

draws the attention | f Administrations

to the additional advantages resulting from the introduction of an international automatic service.

Recommendation Q.7

SIGNALLING SYSTEMS TO BE USED FOR INTERNATIONAL AUTOMATIC AND SEMI-AUTOMATIC TELEPHONE WORKING

(Geneva, 1954 and 1964, Mar del Plata, 1968,

Geneva, 1976 and 1980)

The CCITT,

considering

(a) that standardization of the signalling systems to be used for international automatic and semi- automatic telephone working is necessary to keep to a minimum the number of different types of equipment serving the various routes at any one exchange;

(b) that the following signalling systems have been standardized and are applicable for *general use* in international automatic and semi-automatic working:

— Signalling System No. 4, standardized by the CCIF in 1954;

— Signalling System No. 5, standardized by the CCITT in 1964;

— Signalling System No. 6, standardized by the CCITT in 1968;

— Signalling System No. 7, standardized by the CCITT in 1980;

(c) that the following signalling systems have been standardized and are applicable for *regional use* in international automatic and semi-automatic telephone working:

— Signalling System R1 (Regional Signalling System No. 1, formerly called the North American System), standardized by the CCITT in 1968;

— Signalling System R2 (Regional Signalling System No. 2, formerly called the MFC Bern System), standardized by the CCITT in 1968;

(d) that, under the conditions and subject to the reservations stated below, these signalling systems may be expected to give acceptable results for international automatic and semi-automatic telephone working;

desiring

that the CCITT Recommendation concerning the signalling systems for international automatic and semi-automatic telephone working be generally applied by all Administrations;

unanimously recommends

that, under the conditions and subject to the reservations stated below, Administrations should use, for international automatic and semi-automatic telephone working, one or more of the standard signalling systems mentioned in (b) and (c) above.

1 Criteria for selecting a signalling system

Many factors influence the selection of a given signalling system for a particular application. Factors that should be considered include:

1.1 *Satellite systems* | ecause of long round-trip propagation delays (540 ± 40 ms)

The inclusion of one satellite link in a telephone connection requires subscribers to keep more discipline than usual during a conversation. If use is made of two satellite links in tandem, requirements are even more stringent. In addition, there is the question of what transmission objectives are attainable on such a connection.

According to Recommendation Q.13 the inclusion of two satellite links in a connection should be avoided in all but exceptional cases. To facilitate the observance of this Recommendation, it is advisable to inform the subsequent transit centres by means of signalling that a satellite link is already included in the connection. During the following routing process the transit centre(s) should select a terrestrial link.

1.2 *Echo suppressors*

Both long terrestrial telephone links and satellite links call for the insertion of echo suppressors. Recommendations G.131 [1] and Q.115 include basic requirements for the insertion of echo suppressors.

Therefore, signalling systems should be arranged to act in cooperation with switching equipment to achieve the goals covered by Recommendations G.131 [1] and Q.115. This would be facilitated where the signalling system to be used provides the possibility of controlling the inclusion of echo suppressors.

In the future, the use of echo cancellers may need to be considered (see Recommendation G.165 [2]).

1.3 *Speech interpolation systems (e.g. TASI)*

In the case of a transmission system with speech interpolation, it must be ensured that the signalling system to be used is compatible with speech interpolation.

2 Further criteria for selecting a signalling system

Once Administrations decide to establish a route, they will have to specify the general requirements to be met by the signalling system.

In the following, some questions are drawn up which may serve as a guideline:

a) Does the transmission system provide for sufficient bandwidth (e.g. for outband line signalling)?

b) Is the signal capacity sufficient to allow the setting-up of an ordinary connection?

c) Is an additional exchange of information required, e.g.:

— for echo suppressor control,

— to increase routing facilities,

— to obtain or to offer detailed information on congestion,

— to obtain or to offer information on the condition of the called subscriber line,

— to obtain or to offer information on the nature of the call:

i) for identification or

ii) for management purposes?

d) What requirements have to be set for the speed of the signalling system? What post-dialling and answering delays are to be tolerated?

e) Is there any interdependence between the minimum bundle size and signalling (e.g., as in the case of pilot interruption control of Signalling System R2)?

f) In the case of satellite systems, does the earth station require an extra interface between the terrestrial access circuits and the satellite links?

g) Is it necessary to introduce a new signalling system?

h) Is the signalling system suitable for application to the particular exchange type, e.g., electro- mechanical exchanges?

3 Characteristics of the standard CCITT Signalling Systems for general use

3.1 *Signalling System No. 4*

Described and specified in Fascicle VI.2.

Suitable for one-way operation.

Suitable for terminal and transit working; in the latter case two or three circuits equipped with Signalling System No. 4 may be switched in tandem.

Signalling System No. 4 is used in Europe and the Mediterranean Basin.

It makes use of a two-frequency code within the speech band.

A four-element binary code is employed for interregister signalling. Each of these elements consists of one of the two signal frequencies.

Each digit is acknowledged. In the case of long propagation times, these acknowledgements have an adverse effect because the propagation time is included twice in one signalling cycle. This disadvantage is more or less compensated for by the overlap mode of operation.

Signalling System No. 4 has a signal capacity of 16 codes for forward interregister signals and no register signals in the backward direction other than the acknowledgement signals.

One signal is provided for echo suppressor control on mutual agreement.

A signal is not provided to indicate whether the connection already includes a satellite link.

Not suitable for operation on transmission systems with speech interpolation.

3.2 *Signalling System No. 5*

Described and specified in Fascicle VI.2.

Suitable for both-way operation.

Suitable for terminal and transit working; in the latter case two or three circuits equipped with Signalling System No. 5 may be switched in tandem.

A multifrequency code (MFC: 2 out of 6) within the speech band is used for interregister signalling. The line signals consist of 1 or 2 frequencies within the speech band.

The entire address information is stored up to the last signal. It is then transmitted en bloc as a rapid sequence of pulsed multifrequency code signals.

The application of the en bloc mode of operation may result in an increased post-dialling delay, especially if the ST condition is determined by time out.

Signalling System No. 5 has a signal capacity of 15 codes for forward interregister signals and no backward interregister signals.

Signals are not provided either for echo suppressor control or for indicating whether the connection already includes a satellite link.

Suitable for operation on transmission systems with speech interpolation and on satellite links.

3.3 *Signalling System R1*

Described and specified in Fascicle VI.4.

Signalling System R1 is mainly used in North America.

Suitable for both-way operation.

Specified for terminal working.

A multifrequency code (MFC: 2 out of 6) within the speech band is used for interregister signalling.

In the analogue version of the Signalling System R1 line signalling, one frequency within the speech band is used. In the digital version of the Signalling System R1 line signalling, the two resultant signalling channels per speech circuit may be regarded as out-band channels.

The following three modes of operation can be used to transmit the address information:

— en bloc,

— en bloc/overlap, or

— overlap.

The mode of operation selected influences:

— the seizing time of the next link, as well as

— the post-dialling delay.

The address information is transmitted as pulsed MFC signals.

Signalling System R1 has a signal capacity of 15 codes for forward interregister signals but no backward interregister signals.

Signals are not provided either for echo suppressor control or for indicating whether the connection already includes a satellite link.

Signalling System R1 can be used on satellite links. A variant of Signalling System R1 may be suitable for operation on transmission systems with digital speech interpolation, provided that the systems are designed and engineered to be transparent to pulsed interregister signals.

3.4 *Signalling System R2*

Described and specified in Fascicle VI.4.

Used for one-way operation on analogue transmission systems. Both-way operation is possible on digital transmission systems.

Suitable for terminal and transit working.

Signalling System R2 is used in both national and international telephone networks in several regions of the world.

A multifrequency code (MFC: 2 out of 6) within the speech band is used for interregister signalling. Since two different sets of six frequencies in separate bands are defined for forward and backward interregister signals, Signalling System R2 interregister signalling is suitable for use on 2-wire circuits as well as on 4-wire circuits.

For the analogue version of the Signalling System R2 line signalling, use is made of a low-level tone-on-idle method out of band. In addition, pilot interruption control is used.

The digital version of the line signalling uses two signalling channels to transmit the signalling information and for circuit supervision. For 2048 kbit/s PCM systems, the signalling information of the 30 speech circuits is transmitted in the Time Slot 16 (see Recommendation G.732 [3]).

It should be noted that the analogue version of the line signalling can be used on digital links; the signalling states are sent coded on one signalling channel. This use of the analogue version on digital links is not recommended on international circuits.

When a circuit is composed of both digital and analogue links, a conversion between the two versions of the line signalling can occur at the interface (see Recommendation Q.430).

Compelled signalling is used to transmit the address information in the overlap mode as multifrequency code signals, i.e., each forward interregister signal is acknowledged by a backward interregister signal. Considering that four times the propagation time is to be included in one signalling cycle, the exchange of signals is rather slow if the propagation time is long. This disadvantage is more or less compensated for by the overlap mode of operation.

Signalling System R2 has a higher signalling capacity than Signalling Systems No. 4, No. 5 and R1. The interregister signals allow, amongst others:

— improved routing,

— detailed information on congestion,

— information on:

i) the nature of call,

ii) the condition of the called subscriber line,

— no-charge calls, and

— address-complete information.

Signalling System R2 includes both forward and backward interregister signals for echo suppressor control.

In Signalling System R2, two signals are specified which indicate whether *or not* | he connection already includes a satellite link.

Signalling System R2 may be suitable for use on satellite circuits, especially when it is already employed in the national or regional telephone networks concerned.

When Signalling System R2 is to be used on satellite links, the following must be borne in mind:

— In the case of analogue line signalling, intervals T1 and T2 have to be adapted.

— Pilot interruption control requires bundles comprising a multiple of 12 speech circuits.

— The register at the incoming end of a satellite link using Signalling System R2 shall be operated as an outgoing R2 register.

— The guard time for blocking and recognition of forward signals when pulsed signals are transmitted should be adapted to the propagation time on the satellite link.

Signalling System R2 may be suitable for operation on transmission systems with digital speech interpolation, provided the systems are designed and engineered to be transparent to pulsed interregister signals.

With 3 kHz spaced channels, the interregister signalling of Signalling System R2 may be used with the line signalling of Signalling System No. 4.

3.5 *Signalling System No. 6*

Fully described and specified in Fascicle VI.3.

Suitable for both-way operation.

Suitable for terminal and transit working.

During the period from 1970 to 1972 Signalling System No. 6 was tested internationally.

Some Administrations have introduced it for international telephone traffic. A variant of Signalling System No. 6 is employed in the national telephone network of the United States.

A common signalling link is used for signalling.

May be used in either an associated or quasi-associated mode of operation. Use in a quasi-associated mode may be more economic for small bundles of circuits.

Signalling is performed by means of signal units. Each unit is 28 bits in length, including 8 check bits. Transmission is at a speed of 2400 bit/s

for the analogue version and 4 kbit/s (optionally 56 kbit/s) for the digital version.

Each signal unit within a block of 11 signal units is acknowledged and retransmitted in case of errors.

The address information can be transmitted en bloc and in the overlap mode. Because the transmission speed of Signalling System No. 6 is considerably higher than that of channel-associated signalling systems, the influence of the mode of operation on the post-dialling delay is reduced substantially.

The signal capacity (including the spare codes) of Signalling System No. 6 is much higher than that of Signalling Systems No. 4, No. 5, R1 and R2.

Signalling System No. 6 contains signals for echo suppressor control as well as signals indicating whether a satellite link is already included in the connection.

Signalling System No. 6 can be used for all types of telephone circuits including those with speech interpolation.

Signalling System No. 6 can be used on satellite links.

3.6 *Signalling System No. 7*

Fully described and specified in Fascicles VI.7, VI.8 and VI.9.

Suitable for both-way operation.

Suitable for terminal and transit working.

A common signalling link is used for signalling.

Signalling System No. 7 can be used in national and international telecommunication networks.

Signalling System No. 7 can be used for dedicated networks (e.g. data transmission, telephone) and within an integrated services digital network. It is the preferred signalling system between Integrated Digital Network (IDN) exchanges and within the Integrated Services Digital Network (ISDN).

Signalling System No. 7 may be used in either an associated or quasi-associated mode of operation. Use in a quasi-associated mode may be more economical for small bundles of circuits.

Variable length signal units with an integer number of octets are used of which 6 perform message transfer part functions. Signalling System No. 7 is optimized for a digital bearer with transmission speed of 64 kbit/s, but operation at lower speeds (e.g. 4.8 kbit/s) on analogue bearers is possible.

Two error control methods (basic and preventive cyclic retransmission) are specified, each with its own field of application. In the basic method each signal unit is acknowledged and retransmitted in case of errors while in the preventive cyclic retransmission method no negative acknowledgements occur and error correction is performed by retransmission during idle periods of not yet acknowledged signal units.

The address information can be transmitted en bloc and in the overlap mode. Because the transmission speed of Signalling System No. 7 is considerably higher than that of channel-associated signalling systems, the influence of the mode of operation on the post-dialling delay is reduced substantially.

The signal capacity (including the spare codes) of Signalling System No. 7 is much higher than that of Signalling Systems No. 4, No. 5, R1 and R2.

Signalling System No. 7 contains signals for echo suppressor control as well as signals indicating whether a satellite link is already included in the connection.

Signalling System No. 7 can be used for all types of telephone circuits including those with speech interpolation.

Signalling System No. 7 can be used on satellite links.

References

[1] CCITT Recommendation *Stability and echo* , Vol. III, Rec. G.131.

[2] CCITT Recommendation *Echo cancellers* , Vol. III, Rec. G.165.

[3] CCITT Recommendation *Characteristics of primary PCM multiplex equipment operating at 2048 kbit/s* , Vol. III, Rec. G.732.

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* | f 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 continous 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 continous 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 be 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 ± | 5 Hz at a level of —12 ± | 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 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 | fIter 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*
| here 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 ± | Hz.

A.1.2 *Transmitted signal level*

—13 ± | 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* *N* —7 + *n*) dBm where *n* is the relative power level at the receiver input.

The limits give a margin of ± | 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 ± | 5 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 falls 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 ± | Hz.

B.1.2 *Transmitted signal level*

The transmitted signal level shall be —8 ± | 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 ± | 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 ± | 5 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* *N* —1 + *n*) dBm where *n* is the relative power level at the input to the receiving equipment.

B.2.2 *Non-operate limits*

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 line 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.

H.T. [T1.8]
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

Tableau C-1/Q.8 [T1.8] p. 3

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 ± | 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 ± | dB.

b) A low level tone-on condition shall be a signalling tone transmitted at a level of —20 dBm0 ± | 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 N —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 | | 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 | | 11 12

MIN MAX MIN MAX MIN MAX MIN MAX

DURATION (ms)

35 122 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.

H.T. [T2.8]

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-1/Q.8 [T2.8], p. 4

H.T. [T3.8]

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

Table E-2/Q.8 [T3.8], p. 5

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) ± | 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 ± | dB.

b) A low level tone-on condition shall be a signalling tone transmitted at a level of —20 dBm0 ± | 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) ± | 5 Hz at an absolute level N , within the range (—30 + n N —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 | | 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 | | 11 12

MIN MAX MIN MAX MIN MAX MIN MAX

DURATION (ms)

35 122 35 91 35 71 35 62

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