MONTAGE: REC. Q.31 EN T | TE DE CETTE PAGE

REDUCTION OF THE RISK OF INSTABILITY BY SWITCHING MEANS

For any connection between two-wire terminations, the transmission plan admits a certain risk of instability. In an international connection, Recommendation G.122 defines for each national network its responsibility in this respect.

It is recognized in § 2 of that Recommendation that during certain phases of the call, the risk of instability could in certain circumstances become excessive; this refers in particular to conditions other than that of an established connection, viz. during set-up, clear-down and changes in a connection. Appropriate precautions must then be taken by the switching services.

Recommendation Q.32

Techniques applicable to analogue exchanges which will afford a reduction of the risk of instability for a national network have been shown in earlier versions of Recommendation Q.32 (*Red Book* 1985 and earlier). For digital exchanges these methods are as a rule not equally suitable, however, it should be noted that, with today's digital networks giving 4-wire transmission down to the local exchanges and with corresponding terminating losses, the transmission plan may often not require extra loss during setting-up, etc., conditions.

Recommendation G.121, § 6.2 calls for a sum of losses round the a-t-b path of at least 6 dB; calculating according to Recommendation G.122, § 2.2, this would be some four times the standard deviation, corresponding to a risk of about 3 in 10 000. (The six calls per thousand risk called for in Recommendation G.122 corresponds to about 3.25 times the standard deviation.) The switching services thus only need to maintain this minimum loss in cases where it is reduced in the conditions mentioned.

The use of a restricted value of loss (rather than total interruption of the 4-wire loop) allows the passage of information tones or recorded announcements or of communication with an operator, and of national use for non-chargeable calls. Although as a rule digital pads are deprecated, the reasons for this are all concerned with their presence in an established connection, and do not apply to their use for the present purpose.

Recommendation Q.33

PROTECTION AGAINST THE EFFECTS OF FAULTY TRANSMISSION ON GROUPS OF CIRCUITS

1 General

1.1 Although certain signalling systems may have the capability to provide an indication when an individual circuit is faulty, in order to maintain the required availability of the public network, it is considered necessary to provide alarm facilities to alert maintenance staff when a group of circuits provided by a multiplex transmission system is faulty.

1.2 An alarm indication can be initiated on failure of a FDM system by means of pilot supervision. On failure of a PCM system, and alarm indication initiated at both ends by the loss of frame alignment (or multiframe alignement as appropriate) [1], [2].

These failure indicators provide the means whereby the faulty circuits can be removed from service automatically and, when the fault condition no longer exists, be restored automatically by the switching control of an international exchange (see § 1.4 below).

Additionally, the existence of such failure indications allow an end-to-end indication of circuit availability which is a prerequisite to the operation of Signalling System No. 7 without a per call continuity check [see Recommendations Q.724 (TUP) and Q.764 (ISUP)].

1.3 Where transmission links comprise several transmission systems in tandem, the protection against the effects of faulty transmission on groups of circuits can only be maintained if the primary multiplex structure is maintained from end-to-end together with a transparency of alarm indications. In other cases the provisions of §§ 2 and 3 below apply.

1.4 Following a transmission failure a number of specific signalling actions are required to be carried out by the switching control of an international exchange. These actions are designed to:

a) prevent failure of new call attempts;

b) provide appropriate failure indications on established calls;

c) provide a means of releasing circuit connections beyond the point of transmission failure.

Paragraph 4 below details the actions to be taken for circuits employing Signalling Systems Nos. 5, 6 and 7 (TUP and ISUP). For circuits employing Signalling System R2, Recommendation Q.416 details the actions to be taken.

1.5 The recognition time used by the international exchange to validate the alarm ON/alarm OFF states shall be 20 ± 10 milliseconds. The recognition time is defined as the duration that signals representing the alarm ON/OFF states must be present at the input of the exchange terminal equipment.

Following recognition of the alarm ON or alarm OFF states the exchange shall carry out the actions detailed in § 4.

2 Mixed transmission systems

2.1 Some transmission links comprise differing transmission systems which for maintenance purposes are treated separately (see Recommendation G.704). Examples of such transmission links are those with:

— analogue/digital conversion via transmultiplexers;

— conversion between 24 and 30 channel PCM systems;

— links via TDMA/DSI satellite systems.

In these cases, failure indications from the local multiplex equipment can be used, but alone these do not provide an end-to-end indication of circuit availability. Since the multiplex systems use different standards, it is usually impossible to provide a ready conversion of alarms from one system to another. In order to retain the benefits of the alarm indications for groups of circuits it is necessary to carry the fault indications on a circuit basis. This may be inherent in the normal circuit signalling (as in the case of the digital version of Signalling System R2) but in the general case some form of individual circuit supervision is required.

2.2 *Circuit supervision for digital systems*

2.2.1 *2048 kbit/s systems* (Recommendations G.732, G.734)

8448 kbit/s systems (Recommendation G.744)

In these systems there are two frame structure possibilities. One supports channel associated signalling, and the other is intended for common channel signallig which allows extra time-slots to be used for speech circuits. In order to provide circuit supervision it is necessary to use the frame strcuture for channel associated signalling, even in the case of voice frequency and common channel signalling systems. This implies a number of restrictions:

— in the 2048 kbit/s system time slot 16 is not available for speech. Additionally, the common channel signalling links of Systems No. 6 and No. 7 must use a time slot other than number 16;

— similarly, in the 8448 kbit/s system time slots 67-70 are required for the circuit supervision and cannot be used for speech.

Other systems of transmitting circuit supervision information (for example, using a common channel) are for further study.

2.2.2 *1544 kbit/s systems* (Recommendations G.733, G.735)

In this system the S bit is used for circuit supervision in a similar manner to its use for channel associated signalling.

2.2.3 *Non-standard systems*

In non-standard transmission systems it will often be necessary to provide a discrete signalling path for the transmission of circuit supervision indications. Annex A to this Recommendation describes the arrangements used for circuit supervision on TDMA/DSI satellite systems together with the interfacing with the terrestrial channels.

3 Signalling of circuit supervision indications

3.1 In integrated digital transmission systems interfacing directly with exchanges (e.g. Recommendations G.734, G.744) and where systems connect to the other Administrations, it is recommended that a standard form of circuit supervision be used. This is detailed below for 2048 kbit/s PCM systems and 1544 kbit/s PCM systems.

3.2 *2048 kbit/s PCM systems*

Signalling bits ‘‘a’’ and ‘‘b’’ of time slot 16 are used. Under abnormal (alarm) conditions both a and b bits are set to 1. The normal (no-alarm) condition is when ‘‘a’’ and ‘‘b’’ bits are not both equal to 1.

3.3 *1544 kbit/s PCM systems*

In this system the circuit supervision information is generated:

— by forcing bit 2 in every channel time slot to the value 0, or

— by modifying the S bit as described in § 3.1.3.2.2 of Recommendation G.704 for the 12 frame multiframe, or

— by sending a frame alignment alarm sequence (1111111100000000) as described in § 3.1.1.3 of Recommendation G.704 for the 24 frame multiframe

4 **Actions in Signalling Systems Nos. 5, 6 and 7 when a transmission alarm occurs**

This section details the actions which should be taken on circuits using Signalling Systems No. 5, No. 6 and No. 7 when a transmission alarm occurs concerning the speech path. This annex is intended to be applied to new exchange equipment only.

It is split into two broad areas dealing firstly with Signalling System No. 5 and then with Signalling Systems No. 6 and No. 7. This split is required because the actions taken for inband signalling systems is slightly different to that taken for common channel signalling systems.

4.1 *Signalling System No. 5*

The action taken if a transmission alarm occurs during the states shown below is as follows:

4.1.1 *Outgoing circuit failure*

4.1.1.1 *IDLE STATE*

Take the circuit out of service to outgoing traffic. Return to service when transmission is restored.

4.1.1.2 *REGISTER STATE*

The register state is assumed to start with sending of seizure signal and to end with sending of end of pulsing signal (ST).

— Send clear forward.

The third method proposed cannot ensure a proper end to end supervision if a TDMA system with multidestination of multiplexes or a CME is involved in the connection.

— Send a call unsuccessful indication on incoming circuit or possibly carry out a repeat attempt.

— If clear forward release guard sequence fails, inhibit the repeat clear forward sequence. Resume the repeat clear forward sequence when the transmission is restored limiting the number of simultaneous signals to a value which will prevent overload of the transmission system.

— If the clear forward release guard sequence is successful, take the circuit out of service to outgoing traffic.

4.1.1.3 *SEIZED BUT AFTER REGISTER STATE*

— Wait for calling party to clear and send clear forward.

— If answer signal has not been returned from called party, send a call unsuccessful indication on incoming circuit.

— If clear forward release guard sequence fails, inhibit the repeat clear forward sequence. Resume the repeat clear forward sequence when the transmission is restored limiting the number of simultaneous signals to a value which will not overload the transmission system.

— If clear forward release guard sequence is successful take the circuit out of service to outgoing traffic.

4.1.1.4 *BLOCKED*

— No special action required.

4.1.2 *Incoming circuit failure*

4.1.2.1 *IDLE STATE*

— No special action required, respond to incoming call as normal.

4.1.2.2 *ALL OTHER STATES*

— In answered state no special action to be taken, send all signals as normal.

— If answer signal has not been returned from called party, start a time out device which after a certain interval clears the chain beyond the faulty circuit.

4.1.3 *Bothway circuit*

4.1.3.1 *IDLE STATE*

— Take the circuit out of service to outgoing traffic, respond normally to incoming signals.

— Return to outgoing service when transmission is restored.

4.1.3.2 *OUTGOING REGISTER STATE*

— See § 4.1.1.2.

4.1.3.3 *OUTGOING AFTER REGISTER STATE*

— See § 4.1.1.3.

4.1.3.4 *INCOMING ANY STATE*

— See § 4.1.2.

4.1.3.5 *BLOCKED*

— See § 4.1.1.4.

4.2 *Signalling System No. 6 or Signalling System No. 7*

The action taken per speech circuit is as follows.

4.2.1 *Outgoing circuit failure*

4.2.1.1 *IDLE STATE*

— Take the circuit out of service to outgoing traffic. Return to service when the transmission is restored.

4.2.1.2 *REGISTER STATE*

The register state is assumed to start with sending of Initial Address Message and to end with the receipt of an address complete message.

— Send clear forward.

— Send a call unsuccessful indication on incoming circuit or possibly carry out a repeat attempt to set up the call on another circuit.

— Following receipt of release guard signal, take the circuit out of service to outgoing traffic. Return to service when transmission is restored.

— Inhibit any repeat continuity check which may be taking place.

4.2.1.3 *SEIZED BUT AFTER REGISTER STATE*

— If answer signal has not been received from called party, send a call unsuccessful indication on incoming circuit.

— If answer signal received, no special action required.

— Take the circuit out of service when it becomes idle. Return to service when the transmission is restored.

4.2.1.4 *BLOCKED*

— No special action required.

4.2.2 *Incoming circuit failure*

4.2.2.1 *CIRCUIT IN ANY STATE*

— If answer signal has not been returned from called party, start a time out device which after a certain interval clears the chain beyond the faulty circuit.

— If answer has been received no special action is required, the transmission of blocking messages when end to end alarm continuity is not provided should be for further study.

4.2.3 *Bothway circuit failure*

4.2.3.1 *IDLE STATE*

— Take the circuit out of service to outgoing traffic, the transmission of blocking messages when end to end alarm continuity is not provided should be for further study.

— Return to outgoing service when transmission is restored.

4.2.3.2 *OUTGOING REGISTER STATE*

— See § 4.2.1.2 above.

4.2.3.3 *OUTGOING AFTER REGISTER STATE*

— See § 4.2.1.3 above.

4.2.3.4 *INCOMING CIRCUIT IN ANY STATE*

— See § 4.2.2 above.

4.2.3.5 *BLOCKED*

— No special action required.

ANNEX A
(to Recommendation Q.33)

Circuit supervision via TDMA/DSI satellite systems

A.1 *General*

A.1.1 When satellite systems employ Time Division Multiple Access (TDMA) transmission techniques with Digital Speech Interpolation (DSI) equipment at an earth station, the integrity of multiplex transmission systems, FDM as well as PCM, used for terrestrial access to the satellite system cannot be maintained within the satellite system. For exemple, time slots 0 and 16 of a 2048 kbit/s PCM system of the group pilot of a FDM system may not be available between earth stations for the transfer of signalling or transmission alarm information. The provision of equivalent facilities over the satellite section therefore needs special consideration.

A.1.2 Although not necessarily a fault condition, an increase in circuit activity on a TDMA/DSI system may lead to an overload condition, e.g. ‘‘bit stealing’’ in the DSI equipment. Conveyance of overload indicators to the associated ISC may be used to initiate appropriate network management actions to reduce or eliminate the overload conditions on groups of circuits routed on the TDMA/DSI systems.

Implementation of this capability is at the discretion of individual Administrations.

A.1.3 In accordance with Recommendation Q.7, specified signalling systems considered to be suitable for international application via TDMA/DSI satellite systems are:

— System R2, provided that the satellite system is designed to be transparent to pulsed inter-register signals;

— System No. 5;

— Systems Nos. 6 and 7.

A.2 *Circuit supervision*

Possible methods of passing circuit supervision information for these signalling systems via a TDMA/DSI satellite system are as follows:

A.2.1 *Signalling System R2*

A.2.1.1 In the case of System R2, only the digital version of line signalling (Recommendations Q.421-Q.424) is specified for use on international digital links.

A.2.1.2 A satellite Line Signalling Channel (LSC) is required to convey the System R2 digital line signalling code. Two signalling bits, ‘‘a’’ and ‘‘b’’ are required in the LSC for each System R2 terrestrial circuit accessing the satellite section. Under transmission failure conditions, bits ‘‘a’’ and ‘‘b’’ are set to State 1, so that the line signalling protocols of digital R2 will eventually block the circuit.

Appendix I shows a typical format and organization of the LSC for System R2 line signalling.

A.2.1.3 Fault conditions detected at the earth station and the consequent actions to be taken are given: in Tables A-1/Q.33 and A-2/Q.33 when terrestrial access is via a 2048 kbit/s PCM system or via an FDM system with signalling conversion employed at the earth station, respectively.

The application of actions given in these tables enables appropriate end-to-end supervision to be provided on a per-circuit basis.

A.2.2 *Signalling System No. 5*

A.2.2.1 It should be noted that on circuits employing System No. 5 signalling, some administrations utilize a repeat forward clear procedure as a means of achieving clear down under failure conditions. This procedure, which may involve periodic sending of forward clear signals synchronously on a number of circuits, can result in severe periodic overloading of DSI channels. In order to avoid this possible overloading of DSI channels it is preferable to limit the number of simultaneous forward clear signals on the circuits involved.

A.2.2.2 In order to convey circuit supervision information via the satellite system, it will be necessary to provide a satellite signalling channel.

The preferred method of conveying circuit supervision information by use of a satellite digital non-interpolated (DNI) channel is described in § A.2.2.3.

If an LSC, as provided for in System R2, is available, then a second method of passing circuit supervision information is as described in § A.2.2.4.

A.2.2.3 *Use of a DNI supervision channel*

When a DNI channel is utilized for circuit supervision purposes, detection by an earth station of circuit failures on its terrestrial sector will result in the setting of bits in the DNI channel to ‘‘1’’, in accordance with the information contained in Appendix II.

Thus, if the failed circuits are digital, the detection of failure conditions, such as loss of frame alignment, described in Table A-3/Q.33 will result in the setting to ‘‘1’’ of bits in the DNI channel associated with the affected circuits.

When the affected circuits are analogue, the failure will be detected at the earth station, e.g. by the loss of pilot, or if appropriate, by receipt of a pulsed bakward pilot. Fault conditions and consequent actions when analogue access links are employed are given in Table A-4/Q.33.

The alarm information passed over the DNI channel can be forwarded by the receiving earth station to its associated ISC as described in Recommendation Q.33.

An Administration may utilize the alarm information at its ISC to block or busy affected circuits, or, for example, to inhibit the sending of repeat forward clear signals.

Appendix II shows the format and organization of the DNI supervisory channel.

A.2.2.4 *Use of System R2 LSC*

In this case the ‘‘a’’ and ‘‘b’’ signalling bits in the LSC corresponding to the Terrestrial Channels (TCs) for which supervision is applied shall assume the following meaning:

Under normal conditions:

b = 0 indicates that the relevant TC is in a normal condition. The b = 0 state may be established either within the TDMA terminal or at the ISC.

The ‘‘a’’ signalling bit contained in the same slot shall be set, as convenient, either to zero or ‘‘1’’.

Under abnormal conditions:

a = b = 1 indicates that the relevant TC is in an abnormal condition.

Thus, for effective application, the failure of a distant terrestrial transmission system (FDM or PCM) in either direction between an earth station and its associated ISC should result in the sending of a = b = 1 for each affected circuit backward over the satellite section. The alarm information passed via the LSC is transferred from the receiving earth station to its associated ISC as follows:

— when digital access circuits are provided, bits a and b, in Time Slot 16 corresponding to the faulty circuits, are set to ‘‘1’’;

— when analogue access circuits are employed receipt by the earth station of bits a = b = 1 for 6 or more circuits in an analogue group should result in the removal of the group pilot towards the ISC.

This method of using two signalling bits to convey circuit supervision information for System No. 5 circuits is inefficient in the utilization of satellite channel capacity. However, Administrations may need to take into account the possible advantages of such utilization, for example, a common terrestrial interface module for both System R2 and System No. 5 circuits may be employed at the earth station.

Appendix I shows the format and organization of the LSC for System R2 line signalling. Where appropriate to such use of circuits employing System No. 5 signalling, the fault conditions and consequent actions given in Tables A-1/Q.33 and A-2/Q.33 also apply.

A.2.3 *Signalling System No. 6 and No. 7*

A.2.3.1 These signalling systems employ a common signalling channel which may be conveyed via the satellite system (for example, via a 64 kbit/s signalling channel) or via a terrestrial transmission path.

A.2.3.2 The provision of transmission alarm information for circuit supervision purposes is necessary because:

a) Although a speech path continuity check, where used, will remove faulty circuits from service, a faster method is required if severe operational problems at the ISC are to be avoided when a large number of circuits are affected by a transmission system failure.

b) In the case of circuits employing System No. 7, end-to-end circuit supervision is required in accordance with Recommendation Q.724.

c) It is not mandatory for an ISC recognizing a transmission system failure to send a blocking signal for each affected circuit.

A.2.3.3 If the common signalling channel and associated circuits are routed via the same satellite system, methods of conveying circuit supervision information are identical to those described for System No. 5. This will require a DNI satellite channel to carry circuit supervision information in addition to the common signalling channel. Digital terrestrial access systems will also require a time slot for circuit supervision purposes besides that required for common channel signalling.

A.2.3.4 Methods of utilizing the common signalling channel in lieu of the DNI channel for the purpose of conveying information on the status of the transmission path of the speech circuits require further study.

A.2.3.5 Fault conditions and consequent actions to be taken at earth stations when system No. 6 or No. 7 is employed, via digital and analogue access links, are given in Tables A-3/Q.33 and A-4/Q.33, respectively.

H.T. [1T1.33]

TABLE A-1/Q.33
{
Fault conditions and consequent actions at earth stations
with 2048 kbit/s digital access links for System R2 circuits
}

{	{ Prompt maintenance alarm	{			
	{ Yes	Yes Note 1	Yes	Yes	Yes
	Yes	{			
	Yes if possible	Yes	Yes if possible	Yes if possible	Yes
	Yes if possible	Yes	Yes if possible		
Loss of reference timing	Yes	Yes	Yes	Yes	{
BER exceeded in satellite path }	Yes	Yes	Yes	Yes	{
Backward alarm indication from remote ES concerning BER in satellite path }	Yes	Yes Note 2	Loss of data unique word		
Yes	Yes	Yes	Yes		

Table A-1/Q.33 [1T1.33], p.

{
TABLE A-1/Q.33 *(cont.)*
}

{	{ Prompt maintenance alarm	{				
{ Backward alarm indication from remote ES concerning data unique word }	Yes	Yes Note 2	Yes Note 3	{		
Loss of alignment or BER exceeded in satellite signalling channel }	Yes	Yes	Yes	{		
Backward alarm indication from remote ES concerning satellite signalling channel }	Yes	Yes Note 2	{			
Power supply failure — TDMA/DSI }	Yes if possible	Yes if possible				
Yes Power supply failure — satellite signalling equipment }	Yes if possible Yes if possible	{ Yes	Yes if possible			

Note 1 — Prompt maintenance alarm is inhibited if AIS is present.

Note 2 — Prompt maintenance alarm shall be inhibited if the backward alarm is received from only one origin if the interface concerned is working to more than one destination. It is not inhibited when working to a single destination.

Note 3 — If prompt maintenance alarm according to Note 2 is not inhibited.

POUR MONTAGE:

Consequent actions	Transmitting part	Receiving part

Consequent actions	Transmitting part	Receiving part

Table A-1/Q.33 (cont.) [2T1.33], p.

H.T. [1T2.33]

TABLE A-2/Q.33

{

Fault conditions and consequent actions at earth stations with analogue access links for System R2 circuits and signalling conversion at the earth station

}

{	{ Prompt maintenance alarm	{			
	{ Yes Yes if possible Yes if possible Yes	Yes Yes { Yes	Yes Yes if possible Note 5	Note 4 Note 4	Yes
{	{ Yes if possible Note 6		Yes if possible	Yes if possible	Yes if p
Loss of reference timing BER exceeded in satellite path } Backward alarm indication from remote ES concerning BER in satellite path }	Yes Yes Note 6	Yes Yes Yes	Yes Yes Yes Note 2	{ {	
Loss of data unique word	Yes	Yes	Yes		

0

Table A-2/Q.33 [1T2.33], p.

H.T. [2T2.33]

{
TABLE A-2/Q.33 *(cont.)*
}

{	{ Prompt maintenance alarm	{				
{ Backward alarm indication from remote ES concerning data unique word }	Yes	Yes Note 2	Yes Note 3	{		
Loss of alignment or BER exceeded in satellite signalling channel }	Yes	Yes	Yes	{		
Backward alarm indication from remote ES concerning satellite signalling channel }	Note 6	Yes	Yes Note 2			
{ Power supply failure — TDMA/DSI }	Yes if possible	Yes	Yes if possible	{		
Power supply failure — satellite signalling equipment }	Yes if possible	Yes	Yes if possible			

Note 1 — The ''relevant blocking signal'' is that signal which the Recommendation for analogue R.2 line signalling calls for in the event of interruption control or it may be the defined blocking condition resulting from busying equipment (Orange Book, Recommendation Q.416 and Q.424).

Note 2 — Prompt maintenance alarm shall be inhibited if the backward alarm is received from only one origin if the interface concerned is working to more than one destination. It is not inhibited when working to a single destination.

Note 3 — If prompt maintenance alarm according to Note 2 is not inhibited.

Note 4 — In this case the line signalling converter shall apply this condition. It is assumed that power supply failure on FDM transmission equipment will result in a group pilot failure.

Note 5 — The line signalling converter should comply with the principles described in Recommendation Q.422.

Note 6 — A relevant blocking signal will be generated by the converter in the analogue part.

Pour Montage

Receiving part	Transmitting part	Consequent actions

Receiving part	Transmitting part	Consequent actions

Table A-2/Q.33 (cont.) [2T2.33], p.

TABLE A-3/Q.33
{
Fault conditions and consequent actions at earth stations using DNI supervision channel for circuits using in-band and common channel signalling with digital access links
}

{	{ Prompt maintenance alarm	{			
{	Yes Note 4 Yes if possible Yes if possible	Yes Note 1 Yes Yes	Yes Yes if possible Yes if possible	Yes Yes if possible	Yes Yes if po

{
Loss of reference timing or burst
}
	Yes	Yes	Yes	Yes	{

BER exceeded in satellite path }	Yes	Yes	Yes	Yes	{
Backward alarm indication from remote ES concerning BER in satellite path }	Yes	Yes Note 2			
Loss of data unique word	Yes	Yes	Yes	Yes	

Table A-3/Q.33 [1T3.33], p.

H.T. [2T3.33]

{
TABLE A-3/Q.33 *(cont.)*
}

{	{ Prompt maintenance alarm	{		
{ Backward alarm indication from remote ES concerning data unique word } Power supply failure — TDMA/DSI } Power supply failure — service supervision signalling equipment }	Yes Yes if possible	Yes Note 2 Yes if possible	Yes Note 3 Yes	Loss of TDMA fram Yes if possible
Yes if possible Indication of remote end transmission failure via circuit supervision channel }	Yes Yes	Yes if possible	{	

Note 1 — Prompt maintenance alarm is inhibited if AIS is present.

Note 2 — Prompt maintenance alarm shall be inhibited if the backward alarm is received from only one origin. If the interface concerned is working to more than one destination. It is not inhibited when working to a single destination.

Note 3 — If prompt maintenance alarm according to Note 2 is not inhibited.

Note 4 — For a 2048 kbit/s digital access, bit 3 (TS 0, even frames) could be used for this indication. For a 1544 kbit/s digital access, fault indication as described in G.733, § 4.2.4 could be used for this indication.

Pour Montage

Consequent actions Receiving part Transmitting part

Consequent actions Receiving part Transmitting part

Table A-3/Q.33 (cont.) [2T3.33], p.

H.T. [1T4.33]

TABLE A-4/Q.33

{

Fault conditions and consequent actions at earth stations using DNI supervision channel for circuits using in-band and common channel signalling with analogue access links

}

{	{ Prompt maintenance alarm	{		

{
Loss of forward signal (group pilot failure) or supergroup
}
Power supply failure from trans. equip.
}
Power supply failure — TDMA/DSI
}
	Yes
	Yes
		Yes
		Yes if possible
			Yes
			Yes
				Yes
				Yes if possible

Yes Power supply failure — service supervision signalling equipment }	Yes if possible Yes	Yes if possible Yes if possible	Yes if possible	{

{
Loss of reference timing or burst
}
BER exceeded in satellite path
}
Backward alarm indication from remote ES concerning BER in satellite path
}
	Yes
	Yes
	Yes
		Yes
		Yes
		Yes Note 1
			Yes
			Yes
				{
				{

Loss of data unique word	Yes	Yes	Yes	

Table A-4/Q.33 [1T4.33], p.

H.T. [2T4.33]

{
TABLE A-4/Q.33 *(cont.)*
}

{	{ Prompt maintenance alarm	{		
{ Backward alarm indication from remote ES concerning data unique word }	Yes	Yes Note 1	Yes Note 2	Loss of TDMA fran
Power supply failure — TDMA/DSI }	Yes	Yes	Yes if possible	
{ Power supply failure — service supervision signalling equipment }	Yes	Yes	Yes if possible	{
Indication of remote end transmission failure via circuit supervision channel }	Yes Note 4			

Note 1 — Prompt maintenance alarm shall be inhibited if the backward alarm is received from only one origin if the interface concerned is working to more than one destination. It is not inhibited when working to a single destination.

Note 2 — If prompt maintenance alarm according to Note 1 is not inhibited.

Note 3 — Apart from the requirements concerning the loss of group or supergroup pilots and indication of remote and transmission failure, all other fault conditions and subsequent actions are optional.

Note 4 — An Administration’s decision to remove group or supergroup pilot is dependent on the number of failed circuits in the group or supergroup.

Pour Montage

Consequent actions Receiving part Transmitting part

Consequent actions Receiving part Transmitting part

Table A-4/Q.33 (cont.) [2T4.33], p.

APPENDIX I
(to Annex A of Recommendation Q.33)

Format of each 64 kbit/s unit forming

a satellite line signalling channel (LSC)
for System R2 line signalling

H.T. [T5.33]

vide

Symbol N	1	2	3	4	5	6	7	63	64
P channel	0	1	Y 1	Y 3	a_{x+1}	a_{x+2}	a_{x+3}	a_{x+59}	a_{x+60}
Q channel	1	0	Y 2	Y 4	b_{x+1}	b_{x+2}	b_{x+3}	b_{x+59}	b_{x+60}

Symbols 1 and 2 carry the fixed pattern shown.

Symbols 3 and 4 carry Backward Alarm Indications related to the satellite system.

a_n and b_n are the signalling bits relating to the terrestrial channel connected to International Circuit (IC) number n.

Indicated by the subscript, where:

x =   0 in the first 64 kbit/s unit,

x = 60 in the second 64 kbit/s unit,

x = 120 in the third 64 kbit/s unit,

x = 180 in the fourth 64 kbit/s unit.

Tableau I-A/Q.33 [T5.33], p. 9

APPENDIX II
(to Annex A of Recommendation Q.33)

End-to-end circuit supervision

for in-band and common channel signalling systems

End-to-end circuit supervision between corresponding Administrations may be provided using a pre-assigned digital non-interpolated (DNI) supervisory channel allocated for the purpose.

A recommended method of providing such supervision, which uses the binary information content of the DNI supervisory channel, is shown below. It should be noted that multi-destination operation requires a DNI supervisory channel from each destination.

H.T. [T6.33]
Format of satellite circuit supervision channel
(non-interpolated)

Symbol No.	1	2	3	4	5	6	7	—	63	64
P Channel	0	1	1	0	a 1	a 3	a 5	—	a_{117}	a_{119}
Q Channel	1	0	1	0	a 2	a 4	a 6	—	a_{118}	a_{120}

Symbols 1, 2, 3 and 4 are not used and carry the fixed sequence shown.

Symbols 5 to 64 represent supervision conditions, with bit a n being used for supervision of the Terrestrial Channels (TCs) 2n and (2n—1), connected to international circuits.

The meaning of each bit a n is shown below:

a n = 0 Indicates that both of the relevant TCs are in a normal condition.

a n = 1 Indicates that either or both of the relevant TCs are in an abnormal or fault condition.

Tableau II-A/Q.33 [T6.33], p. 10

References

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

[2] CCITT Recommendation *Characteristics of primary PCM multiplex equipment operating at 1544 kbit/s* , Vol. III, Rec. G.733.

SECTION 5

TONES FOR USE IN NATIONAL SIGNALLING SYSTEMS

Recommendation Q.35

TECHNICAL CHARACTERISTICS OF TONES

FOR THE TELEPHONE SERVICE

1 General

Administrations are reminded of the advantages of standardizing audible tones as far as possible so that subscribers and operators may quickly recognize any tone transmitted of whatever origin

Guidance on the application of tones and recorded announcements in various situations is given in Recommendation E.182 [2].

In considering the degree of standardization, the CCITT took account of the nature of the various tones already in use. It was also considered that Administrations introducing new tones would find it helpful to know the preferred limits of cadence frequency and level.

Limits for tone cadences and frequencies are set forth below, all working tolerances being included in the limits.

Besides the limits applying to specifications, limits have been laid down for application to existing exchanges.

These latter limits are herein called *accepted* limits, while those for new equipment are called *recommended* limits.

The present Recommendation covers the case where audible tones are applied within the network. However, the same frequencies and cadences are to be applied if, in the ISDN, the audible tones are generated at the terminal equipment.

2 Electrical levels for tones

For international purposes, the levels of the ringing tone , the busy tone , the congestion tone , the special information tone and the warning tone have to be defined at a zero relative level point at the incoming (in the traffic direction) end of the international circuit.

The level of tones so defined must have a nominal value of —10 dBm0. The recommended limits should be not more than —5 dBm0 nor less than —15 dBm0 measured with continuous tone.

This Recommendation is also included in the Series E Recommendations under the number E.180 (Fascicle II.2)

See [1] for particular values of tone cadences and frequencies in actual use.

Recommendation E.181 [3] specifies the information which could be given to users to facilitate recognition of foreign tones.

For the special information tone, a difference in level of 3 dB is tolerable between any two of the three frequencies which make up the tone.

For the power level of the dial tone the point of reference is the local exchange, where the subscriber line is connected. In the existing networks the absolute power at the 2-wire access in the direction towards the subscriber station is normally in the range of —10 dBm ± | dB. However, with respect to interference with multifrequency pushbutton (MFPB) receivers dial tone levels higher than —10 dBm should be avoided.

Note — The relative level of local exchanges in an analogue network is not fixed. For digital local exchanges the relative levels are given in Recommendation Q.552 [4]. A preferred level range of digital tone generators is —8 dBm0 to —3 dBm0 corresponding with the above level range at the output of local exchanges.

3 Acoustical levels for tones

When tones are generated by a source within a network, e.g. by a telephone exchange, the power level as perceived by the user will be influenced by the characteristics of the subscriber's line and the equipment between the source and the user's ear.

Furthermore, tones can be generated within the user's equipment, triggered by signals from the exchange. In these circumstances it is necessary to define the tone level in terms of the preferred range of sound pressure levels as heard by the listener.

Research has shown that the preferred listening level for information tones is substantially independent of room noise, circuit noise and tone cadence, but does vary over a range of tone frequencies. Figure 1/Q.35 shows the recommended sound pressure levels, with upper and lower limits of the recommended range, over a range of tone frequencies, based on these experiments.

Figure 1/Q.35, p.

It is emphasized that there is no one-to-one relationship between electrical and acoustical power levels on various parameters such as the characteristics of the user's equipment.

It should be noted that the recommended sound pressure levels apply only to the most common situation of a user listening via a telephone handset, held reasonably close to the ear so that normal ''ear coupling loss'' values apply.

When using a loudspeaking telephone or a headset, the preferred sound pressure level is generally lower than the recommended levels.

4 Dial tone

4.1 It is recommended that dial tone should be a continuous tone.

4.2 It is recommended that dial tone should be:

— *either* | a single frequency tone in the range 400-450 Hz,

— *or* | a combined tone composed of up to three frequencies, with at least one frequency in each of the ranges 340-425 Hz and 400-450 Hz. The difference between any two frequencies should be at least 25 Hz.

4.3 Recognizing the local nature of ''normal'' use of dial tone, as well as the technical and economic consequences and consequences on customer habits of changes in dial tone, the full range of existing dial tones, including non-continuous tones as in Supplement No. 2 at the end of Fascicle II.2 [1], are considered acceptable. However, when adopting a new single frequency dial tone, Administrations are recommended to use 425 Hz.

4.4 Where digital tone generation is applied, the frequencies for dial tone should be the same as those recommended for analogue generated tones (see Annex A).

4.5 In order to prevent interference of harmonics or spurious components of the dial tone with the frequencies recommended for pushbutton telephone sets in Recommendation Q.23 and the MFPB signal reception specified in Recommendation Q.24, the maximum permissible power level of harmonics or quantizing noise of the dial tone has to be limited in a suitable way, depending on the specific characteristics of the implementations of the dial tone generator and the MFPB receivers within the same exchange. Examples of such limitations for the dial tone generator are given in Annex B.

Note — In cases of digital generation of the dial tone, the quantizing noise is composed of a number of spectral lines which depend on the number of samples in the generating pattern. In order to reduce the amplitude of the quantizing components, the number of samples should be chosen sufficiently high, thus spreading the quantizing distortion power more evenly over the whole spectrum.

5 Ringing tone

5.1 Ringing tone is a slow period tone, in which the tone period is shorter than the silent period.

The *recommended* | limits for the tone period (including tolerances) are from 0.67 to 1.5 seconds. For existing exchanges, the *accepted* upper limit for the tone period is 2.5 seconds.

The *recommended* | limits for the silent period separating two tone periods are 3 to 5 seconds. For existing exchanges, the *accepted* upper limit is 6 seconds.

The first tone period should start as soon as possible after the called subscriber's line has been found.

Figure 2/Q.35 shows the recommended and accepted limits for the ringing tone periods.

Figure 2/Q.35, p.

5.2 The ringing tone cadence should be similar to the cadence used for applying ringing current to the called subscriber’s telephone set, but these two cadences need not be synchronized. The electrical parameters of the ringing current must be evaluated by the Administration concerned to prevent shock hazard.

5.3 The recommended frequency for the ringing tone is between 400 and 450 Hz. The accepted frequency should be not less than 340 Hz, nor more than 500 Hz. Frequencies between 450 and 500 Hz in the accepted frequency range should, however, be avoided. Administrations adopting a new single frequency ringing tone are recommended to use 425 Hz.

The ringing tone frequency may be modulated by a frequency between 16 and 100 Hz, but such modulation is not recommended for new equipment. If the accepted frequency is more than 475 Hz, no modulation by a lower frequency is allowed.

5.4 Where digital tone generation is applied, the frequency for ringing tone should be the same as that recommended for analogue generated tones (see Annex A).

6 Busy tone and congestion tone

6.1 The (subscriber) busy tone and the (equipment or circuit group) congestion tone are *quick* period tones in which the tone period is theoretically equal to the silent period complete cycle (tone period E + silent period S) should be between 300 and 1100 milliseconds.

The ratio E/S of the tone period to the silent period should be between 0.67 and 1.5 (*recommended* values).

For existing exchanges, or for tones to be used in a special way, it is *accepted* that the tone period may be up to 500 milliseconds shorter than the silent period ($E \geq S - 500$ milliseconds). In no circumstances should the tone period be shorter than 100 milliseconds.

Figure 3/Q.35 shows the recommended and the accepted areas for the busy tone and the congestion tone periods.

Figure 3/Q.35, p.

6.2 The busy tone (of the called subscriber) and the congestion tone (of switching equipment or circuit groups) can be identical or almost identical, providing that this does not create any serious problems for the network and does not cause the subscriber to become confused. However, a distinction between these two tones is desirable:

— to allow Administrations to assess the quality of service,

— for the convenience of experienced subscribers.

6.3 Where a distinct congestion tone is used, it is recommended that:

a) the same *frequency* | should be used for the busy tone and the congestion tone;

b) the busy tone should have a slower cadence than the congestion tone, but both cadences should be within the limits mentioned in § 5.1 above.

6.4 The *recommended* | frequency for the busy tone and for the congestion tone must be between 400 and 450 Hz. The *accepted* frequency must not be less than 340 nor more than 500 Hz. Frequencies between 450 and 500 Hz in the accepted frequency range should, however, be avoided. Administrations adopting a new single frequency for busy and congestion tones are recommended to use 425 Hz.

6.5 Where digital tone generation is applied, the frequency for busy and congestion tones should be the same as that recommended for analogue generated tones (see Annex A).

7 Special information tone

7.1 The special information tone is provided for all cases in which neither the busy nor the congestion tone can give the required information to the calling subscriber in the case of call failure. There are three ways in which it may be used:

a) when in special cases no provision is made for recourse either to a recorded announcement or to an operator, the equipment at the point which the calls have reached must:

1) *either* | connect the special information tone to the call,

2) *or* | preferably, if technically available, send an appropriate backward signal such that connection to the special information tone will be made by equipment which is nearer to the caller;

b) when the call is connected to a recorded voice machine; the tone is then given during the silent intervals between transmissions of the announcement;

c) under arrangements made at manual positions serving lines which have been abnormally routed so that by operating a key the operators may send the special information signal when, for example, the calling subscriber fails to understand the operator.

When the special information tone is applied with or without a recorded announcement, it should be recognized that customers may refer to an operator if they fail to understand the meaning of the recorded announcement and/or the special information tone.

7.2 The special information tone has a tone period theoretically equal in length to the silent period.

Tone period — The tone period consists of three successive tone signals, each lasting for 330 ± 70 milli seconds. Between these tone signals there may be a gap of up to 30 milliseconds.

Silent period — This lasts for 1000 ± 250 milliseconds.

7.3 The frequencies used for the three tone signals are: 950 ± 50 Hz; 1400 ± 50 Hz; 1800 ± 50 Hz, sent in that order.

8 Warning tone to indicate that a conversation is being recorded

Where a conversation is being recorded at a subscriber’s station, it is recommended that the Administration require the use of a warning tone to indicate that the conversation is being recorded. When such a tone is applied, it is recommended that:

a) it consists of a 350-500 ms pulse every 15 ± 3 seconds of recording time, and

b) the frequency of the tone should be 1400 Hz ± 1.5%.

9 Payphone recognition tone

9.1 Where Administrations see the necessity of application of a payphone recognition tone in order to allow operators to recognize that a call originates at a payphone station or that the called number belongs to a payphone station it is recommended to use a payphone recognition tone.

The application of the tone will depend on the operational requirements of individual Administrations, e.g. in some cases the tone will only be required on an incoming call to the payphone, whilst in others there may be a requirement for the tone to be present on originating calls and throughout the period of the call.

9.2 The tone is a combination of two frequencies f_1 and f_2 in the range:

f_1: 1100-1750 Hz

f_2: 750-1450 Hz

with the ratio: f_1/f_2= 1.2 to 1.5 and with a cadence (frequency sequence) as follows:

f_1 on 200 ms, silence 200 ms, f_2 on 200 ms, silence 2 s (one cycle is therefore 2.6. s).

9.3 *Duration and level*

9.3.1 A principal purpose of the payphone recognition tone in international telephony is to identify a called station as a payphone where the possibility exists of attempted fraud on a collect call. For this purpose the tone must be produced as soon as a payphone answers a call, it must be clearly audible to an operator, and it must cease before it can seriously interfere with conversation.

When the tone is used on an incoming call to a payphone, it should have, in addition to those characteristics defined in § 9.2, a duration of 5 complete cycles (13 s).

9.3.2 If the tone is used to identify payphones which are originating calls, its duration is not specified.

9.3.3 The specification in § 9.3.1 applies only to the first five cycles of the tone when the payphone is the receiving station.

For use throughout a call or during conversation, the level and duration of the tone have to meet two contradictory requirements:

— the public exchange operator should be able to detect and recognize the tone in the presence of the highest expected levels of speech;

— the tone should not interfere unduly with normal conversation.

Experience of customer reaction to the tone requires that the time during which the tone is applied should be as short as possible, subject to operational requirements. Similarly the level of the tone should be as low as possible and significantly lower than the recommended levels for other tones (e.g. —20 dBm at the payphone output). The duration of the tone and the level at which it is applied are interdependent factors, the shorter the duration the higher the level and vice versa. (Further studies on the recommended levels and duration will be carried out.)

10 Call waiting tone

10.1 The call waiting tone is used to advise a subscriber who is engaged on a call that another subscriber is attempting to call.

10.2 The tone is intended to be sufficiently alerting to succeed in its purpose without interfering with existing conversation.

10.3 The *recommended* | specification of the tone is one or more cycles defined by a frequency *f* in the range:

f : 400 to 450 Hz

and with a cadence (frequency sequence) as follows:

a) *f* on 300 to 500 ms, silence 8 to 10s; (*f* = 300 ms is preferable to the longer tone since the ongoing conversation would be interrupted for a briefer interval), or

b) *f* on 100 to 200 ms, silence 100 to 200 ms, *f* on 100 to 200 ms (the total to be no more than 500 ms); 8 to 10 s silence.

Other tones may be *acceptable*

10.4 The second and subsequent cycles may be at a lower level than the initial tone.

10.5 Where the tone continues for more than one cycle, it should preferably cease when it is no longer possible to accept the waiting call.

11 Caller waiting tone

11.1 This tone advises a caller that a called station, though busy, has a call waiting service active.

11.2 It is intended that, if this tone is not correctly interpreted by subscribers, it be misinterpreted as the ringing tone.

11.3 To dissuade a caller from waiting indefinitely, the tone may cease 30 seconds after it starts and may be replaced by busy tone, or an Administration may decide to disconnect the calling station.

The specification of this time needs further study.

11.4 The caller waiting tone consists of a ringing tone followed after a silent interval of 0 to 200 ms, by one of the following:

(a) the tone defined in § 10.3 a),

(b) the pair of tones defined in § 10.3 b), or

(c) another call waiting tone in use by an Administration, provided that it can be appended to each sounded part of the ringing tone.

11.5 The caller waiting tone, as defined in § 11.4, should be distinguishably different from the ringing tone when directly compared with it.

12 Machine recognition of tones

The CCITT appreciates the value of machine recognition of tones for the purpose of service observations, maintenance, testing or for the collection of statistics where equivalent electrical signals do not exist. However, the CCITT considered, at Mar del Plata in 1968, that such machine recognition should not be a substitute for electrical signals. Where machine recognition of audible tones is to be introduced, the tone frequencies and cadences must be within close limits of precision.

For dial tone, ringing tone, busy and congestion tones a working frequency tolerance of ± | % should be met.

Note — The figure of 1% is taken as a compromise out of several national specifications which vary between ± | .5% and ± | .5%. (See also Supplement No. 3 in Fascicle II.2.)

ANNEX A
(to Recommendation Q.35)

Digital generation of tones

The practice of several Administrations and equipment designers for digital generation of tones is known to deviate largely:

— in the frequency chosen within the recommended range;

— in the power level which varies with the national application;

— in the mechanism of generation of tones and signal frequencies where, in part, the same equipment is used.

Therefore, it was found difficult to standardize on a fixed number of samples with a coded bit-stream, which represents one frequency with one distinct power level.

On the other hand there is no necessity for standardizing digital generated tones in a more stringent way than analogue generated tones for the following reasons:

— It is to the interest of Administrations that subscribers should not be confused by hearing different tones for the same purpose within their national networks. Consequently the practice already in use for analogue generated tones should be maintained for reasons associated with the human factor.

— The advantages that can be achieved by standardizing the code words for the tones in order to allow automatic recognition of tones by monitoring the bit stream seem to be so small that they do not justify a stringent restriction on all possible methods for digital generation of any frequency allocated with any level.

— For a long period of time a mixture of analogue and digital networks will exist. Thus, machine recognition of tones will have to be performed also with analogue receivers.

However, when Administrations have full freedom to make new decisions about tones in future networks, especially with respect to an all-digital network, they may consider a preferred solution for the digital generation of dial tone, busy tone, congestion tone and ringing tone having a uniform frequency of 425 Hz, as recommended by CCITT.

ANNEX B

(to Recommendation Q.35)

**Examples for
limitation of spurious components of the dial
tone**

**with respect to interference with the frequencies
recommended
for
pushbutton telephone sets in Recommendation Q.23**

B.1 *Method A* | (used by ATT)

The total distortion power should be at least 33 dB less than the dial tone power, and the distortion power in any 100 Hz band above 500 Hz should be at least 40 dB less than the dial tone power.

B.2 *Method B* | (used by the Federal Republic of Germany)

In the frequency range from 500 to 2000 Hz [i.e. the range of multifrequency pushbutton (MFPB) frequencies] the distortion power in any 100 Hz band should be at least 40 dB below the dial tone power. In addition, in the frequency range above 2000 Hz up to 4000 Hz the total distortion power should be at least 25 dB below the dial tone power.

References

[1] *Various tones used in national networks* , Vol. II, Supplement No. 2.

[2] CCITT Recommendation *Application of tones and recorded announcements in telephone services* , Vol. II, Rec. E.182.

[3] CCITT Recommendation *Customer recognition of foreing tones* , Vol. II, Rec. E.181.

[4] CCITT Recommendation *Transmission characteristics at 2-wire analogue interfaces of a digital exchange* , Vol. VI, fascicle VI.5, Rec. Q.552.

Recommendation Q.36

CUSTOMER RECOGNITION OF FOREIGN TONES

1 In order to facilitate recognition of foreign ringing and busy tones by a subscriber dialling an automatic international call, the information given to subscribers should:

1) emphasize that a slow repetition rate of the tone means ‘‘ringing’’ whereas a rapid repetition rate means ‘‘busy’’;

2) indicate that in some countries the ringing tone may be heard as a sequence of two short tones, pause, two more short tones, pause, and so on.

In addition, it may be useful for the purpose of educating subscribers:

— to provide auditory samples of such tones by tape recording or other means, or

This Recommendation is also included in the Series E Recommendations under the number E.181.

— to include detailed descriptions of tones in directories.

2 Modern international signalling systems are capable of exchanging signals corresponding to indications normally given to subscribers by means of audible tones (busy, congestion, ringing, etc.). Administrations are encouraged to arrange their networks so that these information signals can be sent between countries in order that they can be recognized and converted into tones or announcements as near to the calling subscriber as practical. This procedure could significantly reduce the language problems arising from the growing use of recorded announcements.

Note — This Recommendation is complementary to Recommendation E.180 on the standardization of tones in the international telephone network. Whilst standardization is of primary importance, telephone users need information to assist them in recognizing foreign tones until such time as standardization is complete.

This is the purpose of § 1 of the present Recommendation which, as extensive human factor experiments show, should greatly reduce subscriber confusion.

The measure mentioned in § 2 does not eliminate the need for tone standardization as well, but can reduce customer difficulties in cases where standardization may be impractical for a long period but sophisticated exchanges arrangements are available.

SECTION 6

GENERAL CHARACTERISTICS FOR INTERNATIONAL TELEPHONE CONNECTIONS AND INTERNATIONAL TELEPHONE CIRCUITS

6.0 General

Recommendation Q.40

THE TRANSMISSION PLAN

1 Principles

The transmission plan of the CCITT established in 1964 was drawn up with the object of making use, in the international service, of the advantages offered by 4-wire switching. It is referred to in the Recommendations appearing in Part I, Section 1 of the Series G Recommendations. However, the recommendations in the plan are to be considered as met if the use of technical means other than those described below gives an equivalent performance at the international exchange.

Recommendations G.121 [1] and G.122 [2] describe the conditions to be fulfilled by a national network for this transmission plan to be put into effect.

Note 1 — From the point of view of the transmission plan, no distinction is made between intercontinental circuits and other international circuits.

Note 2 — Short trans-frontier circuits are not covered by this plan and should be the subject of agreement between the Administrations concerned.

2 Definition of the constituent parts of a connection

2.1 *The international chain of circuits and the national systems*

A complete **international telephone connection** consists of three parts, as shown in Figure 1/Q.40. The division between these parts is determined by the *virtual analogue switching points* in the originating/terminating international switching centres (ISCs). These are theoretical points with specified relative levels (see Figure 2/Q.40 and §§ 5.1 and 5.2 of Recommendation G.101).

This Recommendation is an extract of Recommendation G.101 [3]. The suspensive points show where a passage in Recommendation G.101 has not been reproduced under Q.40.

The three parts of the connection are:

— Two national systems, one at each end. These may comprise one or more 4-wire national trunk circuits with 4-wire interconnection, as well as circuits with 2-wire connection up to the local exchanges and the subscribers sets with their subscriber lines.

— An international chain made up of one or more 4-wire international circuits. These are interconnected on a 4-wire basis in the international centres which provide for transit traffic and are also connected on a 4-wire basis to national systems in the international centres.

— An international 4-wire circuit is delimited by its virtual analogue switching points in an international switching centre.

Note 1 — In principle the choice of values of the relative levels at the virtual analogue switching points on the side of a national system is a national matter. In practice, several countries have chosen —3.5 dBr for receiving as well as for sending. These are theoretical values; they need not actually occur at any specific equipment item; however they serve to determine the relative levels at other points in the national network. If, for instance, the loss ‘‘*t -b* ’’ or ‘‘*a -t* ´then it follows that the relative levels at point *t* are 0 dBr (input) and —7 dBr (output).

Note 2 — The virtual analogue switching points may not be the same as the points at which the circuit terminates physically in the switching equipment. These latter points are known as the *circuit terminals* ; the exact position of these terminals is decided in each case by the Administration concerned.

FIGURE 1/Q.40 p.

2.2 *National extension circuits: 4-wire chain*

When the maximum distance between an international exchange and a subscriber who can be reached from it does not exceed about 1000 km or, exceptionally, 1500 km, the country concerned is considered as of average size. In such countries, in most cases, not more than three national circuits are interconnected on a 4-wire basis between each other and to international circuits. These circuits should comply with the Recommendations of Subsection 1.2 [4] of Volume III, Fascicle III.1 (Recs. G.120, G.121, G.122, G.123 and G.125).

In a large country, a fourth and possibly a fifth national circuit may be included in the 4-wire chain, provided it has the nominal transmission loss and the characteristics recommended for international circuits used in a 4-wire chain (see Recommendation G.141, § 1, § 4 of this Recommendation and the Recommendations in Subsection 1.5 of Volume III, Fascicle III.1, Recs. G.151 [5], G.152 [6] and G.153 [7]).

Note — The abbreviation ‘‘a **4-wire chain** ’’ (see Figure 3/Q.40) signifies the chain composed of the international chain and the national extension circuits connected to it, either by 4-wire switching or by some equivalent procedure (as understood in § 1 above).

FIGURE 2/Q.40, p.

Figure 3/Q.40 p.

3 Number of circuits in a connection

3.1 *National circuits*

It seems reasonable to assume that in most countries any *local exchange* | can be connected to the international network by means of a chain of four (or less) national circuits. Five national circuits may be needed in some countries, but it is unlikely that any country may need to use more than five circuits. Hence the CCITT has reached the conclusion that four circuits is a representative figure to assume for the great majority of international connections.

In most modern national networks, the four circuits will probably include three 4-wire amplified circuits (usually set up on FDM carrier systems) and one 2-wire circuit, probably unamplified. However, cases in which local exchanges are reached by four amplified circuits, among them usually at least one PCM circuit, are becoming more and more frequent. All these circuits may be 4-wire circuits.

3.2 *International circuits*

According to the International Telephone Routing Plan (Recommendation E.171), the number of international circuits is restricted to four.

3.3 *Hypothetical reference connections*

(See Recommendation G.103 [9].)

References

[1] CCITT Recommendation *Loudness ratings (LRs) of national systems* , Vol. III, Rec. G.121.

[2] CCITT Recommendation *Influence of national systems on stability, talker echo, and listener echo in international connections* , Vol. III, Rec. G.122.

[3] CCITT Recommendation *The transmission plan* , Vol. III, Rec. G.101.

[4] CCITT Recommendations G.120, G.121, G.122, G.123 and G.124; Subsection 1.2: *General characteristics of national systems forming part of international connections* of Volume III.

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

[6] CCITT Recommendation *Characteristics appropriate to long-distance circuits of a length not exceeding 2500 km* , Vol. III, Rec. G.152.

[7] CCITT Recommendation *Characteristics appropriate to international circuits more than 2500 km in length* , Vol. III, Rec. G.153.

[8] CCITT Recommendation *Pulse code modulation (PCM) of voice frequencies* , Vol. III, Rec. G.711.

[9] CCITT Recommendation *Hypothetical reference connections* , Vol. III, Rec. G.103.

6.1 General recommendations on the transmission quality for an entire international telephone connection

Recommendation Q.41

MEAN ONE-WAY PROPAGATION TIME

The times in this Recommendation are the means of the propagation times in the two directions of transmission in a connection. When opposite directions of transmission are provided by different media (e.g. a satellite channel in one direction and a terrestrial channel in the other) the two times contributing to the mean may differ considerably.

1 Limits for a connection

It is necessary in an international telephone connection to limit the propagation time between two subscribers. As the propagation time is increased, subscriber difficulties increase, and the rate of increase of difficulty rises, see b) below. Relevant evidence is given in the bibliography of Recommendation G.114 [1].

As a network performance objective, CCITT therefore *recommends* the following limitations on mean one-way propagation times when echo sources exist and appropriate echo control devices, such as echo suppressors and echo cancellers, are used:

a) 0 to 150 ms, acceptable.

Note — Echo suppressors specified in Reference [2] may be used for delays not exceeding 50 ms (see Reference [3]).

b) 150 to 400 ms, acceptable, provided that increasing care is exercised on connections as the mean one-way propagation time exceeds about 300 ms, and provided that echo control devices, such as echo suppressors and echo cancellers, designed for long delay circuits are used.

c) Above 400 ms, unacceptable. Connections with these delays should not be used except under the most exceptional circumstances.

This Recommendation is an extract of Recommendation G.114 [1]. The suspensive points show where a passage in Recommendation G.114 has not been reproduced under Q.41.

2 Values for circuits

In the establishment of the general interconnection plan within the limits in § 1 the one-way propagation time of both the national extension circuits and the international circuits must be taken into account. The propagation time of circuits and connections is the aggregate of several components; e.g. group delay in cables and in filters encountered in FDM modems of different types. Digital transmission and switching also contribute delays. The conventional planning values given in § 2.1 may be used to estimate the total propagation time of specified assemblies which may form circuits or connections.

2.1 *Conventional planning values of propagation time*

Provisionally, the conventional planning values of propagation time in Table 1/Q.41 may be used.

2.2 *National extension circuits*

The main arteries of the national network should consist of high-velocity propagation lines. In these conditions, the propagation time between the international centre and the subscriber farthest away from it in the national network will probably not exceed:

a) In purely analogue networks

$$12 + (0.004 \times \text{distance in kilometres}) \text{ ms.}$$

Here the factor 0.004 is based on the assumption that national trunk circuits will be routed over high-velocity plant (250 km/ms). The 12 ms constant term makes allowance for terminal equipment and for the probable presence in the national network of a certain quantity of loaded cables (e.g. three pairs of channel translating equipments plus about 160 km of H 88/36 loaded cables). For an average-sized country (see Figure 2/G.103) the one-way propagation time will be less than 18 ms.

b) In mixed analogue/digital networks the propagation time can generally be estimated by the equation given for purely analogue networks. However, under certain unfavourable conditions increased delay may occur compared with the purely analogue case. This occurs in particular when digital exchanges are connected with analogue transmission systems through PCM/FDM equipments in tandem, or transmultiplexers. With the growing degree of digitisation the propagation time will gradually approach the condition of purely digital networks.

c) In purely digital networks between exchanges (e.g. an IDN) the propagation time as defined above will probably not exceed:

$$3 + (0.004 \times \text{distance in kilometres}) \text{ ms.}$$

The 3 ms constant term makes allowance for one PCM coder or decoder and five digitally switched exchanges.

Note — The value 0.004 is a mean value for coaxial cable systems and radio-relay systems; for optical fibre systems 0.005 is to be used.

d) In purely digital networks between subscribers (e.g. an ISDN) the delay of c) above has to be increased by up to 3.6 ms if burst-mode (time compression multiplexing) transmission is used on 2-W local subscriber lines.

2.3 *International circuits*

International circuits will use high-velocity transmission systems, e.g. terrestrial cable or radio-relay systems, submarine systems or satellite systems. The planning values of § 2.1 may be used.

The magnitude of the mean one-way propagation time for circuits on high altitude communication satellite systems makes it desirable to impose some routing restrictions on their use. Details of these restrictions are given in Recommendation Q.13. (See also

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For short nearby links, telecommunications cables operated at voice frequencies may also be used in the conditions set out in the introduction to Sub-section 5.4 of Fascicle III.2.

Annex A to Recommendation G.114.)

H.T. [T1.41]

TABLE 1/Q.41

Transmission medium Contribution to one-way propagation time }	{ Remarks	
{ Terrestrial coaxial cable or radio relay system; FDM and digital transmission } Allows for delay in repeaters and regenerators }	4 µs/km	{
{ Optical fibre cable system; digital transmission } Allows for delay in repeaters and regenerators }	5 µs/km	{
{ Submarine coaxial cable system }	6 µs/km	
Satellite system { — 14 | 00 km altitude — 36 | 00 km altitude }	110 ms 260 ms	Between earth stations only
{ FDM channel modulator or demodulator } Half the sum of propagation times in both directions of transmission }	0.75 ms | ua)	

a) These values allow for group-delay distortion around frequencies of peak speech energy and for delay of intermediate higher order multiplex and through-connecting equipment.

b) This value refers to FDM equipments designed to be used with a compandor and special filters.

c) For satellite digital communications where the transmultiplexer is located at the earth station, this value may be increased to 3.3 ms.

d) These are mean values; depending on traffic loading, higher values can be encountered, e.g. 0.75 ms (1.950 ms, 1.350 ms or 1.250 ms respectively with 0.95 probability of not exceeding). (For details see Recommendation Q.551).

e) Echo cancellers, when placed in service, will add a one-way propagation time of up to 1 ms in the send path of each echo canceller. This delay excludes the delay through any codec in the echo canceller. No significant delay should be incurred in the receive path of the echo canceller.

} 0.5 ms | ub) PCM coder or decoder 0.3 ms | ua) PCM/ADPCM/PCM transcoding 0.5 ms | ua) Transmultiplexer 1.5 ms | uc)
{ Digital transit exchange, digital-digital
} 0.45 ms | ud)
{ Digital local exchange, analogue-analogue
} 1.5 ms | ud)
{ Digital local exchange, analogue subscriber line-digital junction
} 0.975 ms | ud)
{ Digital local exchange, digital subscriber line-digital junction
} 0.825 ms | ud) Echo cancellers 1 | ms | ue) _

Tableau 1/Q.41 [T1.41] p. (à traiter comme tableau MEP)

References

[1] CCITT Recommendation *Mean one-way propagation time* , Vol. III, Rec. G.114.

[2] CCITT Recommendation *Definitions relating to echo suppressors and characteristics of a far-end operated, differential, half-echo suppressor* , Blue Book, Vol. III, Rec. G.161, ITU, Geneva, 1965.

[3] CCITT Recommendation *Stability and echo* , Vol. III, Rec. G.131, § 2.2.

6.2 General characteristics of national systems forming part of international connections

(See Recommendations G.120 to G.125, Fascicle III.1.)

6.3 General characteristics of the ‘‘4-wire chain’’ formed by the international circuits and national extension circuits

(Overall characteristics for the 4-wire chain are defined in Recommendation Q.40, § 2.)

Recommendation Q.42

STABILITY AND ECHO (ECHO SUPPRESSORS)

(See Recommendation G.131 in Fascicle III.1 and
Recommendation Q.115)

6.4 General characteristics of the 4-wire chain of international circuits; international transit

Recommendation Q.43

TRANSMISSION LOSSES, RELATIVE LEVELS

5.3 *Definitions*

5.3.1 **transmission reference point**

F: point de r´ef´erence pour la transmission

This Recommendation is an extract of Recommendation G.101 [1]. The suspensive points show where a passage in Recommendation G.101 has not been reproduced under Q.43.

S: punto de referencia para la transmisi´on

A hypothetical point used as the zero relative level point in the computation of nominal relative levels. At those points in a telephone circuit the nominal mean power level (—15 dBm) defined in the Recommendation G.223 [2] shall be applied when checking whether the transmission system conforms to the noise objectives defined in Recommendation G.222 [3].

Note — For certain systems, e.g. submarine cable systems (Recommendation G.371 [4]), other values apply.

Such a point exists at the sending end of each channel of a 4-wire switched circuit preceding the virtual switching point; on an international circuit it is defined as having a signal level of +3.5 dB above that of the virtual switching point.

In frequency division multiplex equipment, a hypothetical point of flat zero relative level (i.e. where all channels have the same relative level) is defined as a point where the multiplex signal, as far as the effect of intermodulation is concerned, can be represented by a uniform spectrum random noise signal with a mean power level as defined in the Recommendation cited in [5]. The nominal mean power level in each telephone channel is —15 dBm as defined in the Recommendation cited in [2].

5.3.2 **relative (power) level**

F: niveau relatif de puissance

S: nivel relativo (de potencia)

5.3.2.1 *Basic significance of relative level in FDM systems*

The relative level at a point in a transmission system characterizes the signal power handling capacity at this point with respect to the conventional power level at a zero relative level point

If, for example, at a particular point in an FDM system designed for a large number of channels the mean power handling capacity per telephone channel corresponds to an absolute power level of *S* dBm, the relative level associated with this point is (*S* + 15) dBr. In particular, at a 0 dBr point, the conventional mean power level referred to one telephone channel is —15 dBm.

5.3.2.2 *Definition of relative level, generally applicable to all systems*

The relative level at a point on a circuit is given by the expression 10 $\log_{10}(P/P_0)$ dBr, where *P* represents the power of a sinusoidal test signal at the point concerned and P_0 to the power of that signal at the transmission reference point. This is numerically equal to the composite gain (definition in *Yellow Book* , Fascicle X.1) between the transmission reference point and the point concerned, for a nominal frequency of 1000 Hz. For example, if a reference signal of 0 dBm at 1000 Hz is injected at the transmission reference point, the level at a point of *x* dBr will be *x* dBm (apparent power $P_x = 10^{x/10}$ mW). In addition, application of a digital reference sequence (DRS, § 5.3.3) will give a level of *x* dBm at a point of *x* dBr. The voltage of 0 dBm0 tone at any voiceband frequency at a point of *x* dBr is given by the expression:

$$V = \sqrt{10^{x/10} \times 1\ \mathrm{W} \times 10^{-3} \left| Z_R \right|_{1000}}\ \text{volts}$$

where $\left| Z_R \right|_{1000}$ is the modulus of the nominal impedance of the point at a nominal frequency of 1000 Hz.

Note 1 — The nominal reference frequency of 1000 Hz is in accordance with Recommendation G.712, § 16. For existing (analogue) transmission systems, one may continue to use a reference frequency of 800 Hz.

Note 2 — The relative levels at particular points in a transmission system (e.g. input and output of distribution frames or of equipment like channel translators) are fixed by convention, usually by agreement between manufacturers and users.

The Recommendations of the CCITT are elaborated in such a way that the absolute power level of any testing signal to be applied at the input of a particular transmission system, to check whether it conforms to these recommendations, is clearly defined as soon as the relative level at this point is fixed.

Note 3 — The impedance Z_R may be resistive or complex; in the latter case the power P_x is an apparent power.

Note 4 — It is assumed that between the virtual analogue switching points of a circuit, established over international transmission systems, only points of equal relative level are interconnected in those systems, so that the transmission loss of the circuit will be equal to the difference in relative levels at the virtual analogue switching points (see § 5.2 of this Recommendation).

5.3.2.3 *Relation between corrected send reference equivalents, loudness ratings and relative levels*

Taking into account such aspects as (basic) noise, intermodulation noise, peak power, etc. (see Recommendation G.223).

The relationship between the 0 dBr point and the level of T_{max} in PCM encoding/decoding processes standardized by the CCITT is set forth in Recommendation G.711 [6]. In particular, if the minimum nominal corrected send reference equivalent (CSRE) of local systems referred to a point of 0 dBr of a PCM encoder is not less than 3.5 dB, or the minimum nominal send loudness rating (SLR) under the same conditions is not less than —1.5 dB, and the value of T_{max} of the process is set at +3 dBm0 (more accurately 3.14 dBm0 for A-law and 3.17 for μ-law), then in accordance with § 3 of Recommendation G.121 [7], the peak power of the speech will be suitably controlled.

5.3.2.4 *Compatibility of relative levels of analogue and digital systems*

When the signal load is controlled as outlined in § 5.3.2.3, points of equal relative levels of FDM and PCM circuits may be directly connected together and each will respect the other's design criteria. This is of particular importance when points in the two multiplex hierarchies are connected together by means of transmultiplexers, codecs or modems.

5.3.2.5 *Determination of relative level*

Figure 1/Q.43 illustrates the principle of how the relative level at the input and output analogue points of a ''real'' codec can be determined.

Figure 1/Q.43, p.

When using Figure 1/Q.43 to determine the relative levels of a ''real'' codec with non-resistive impedances at the analogue input and output ports, the following precautions must be observed:

i) the test frequency should be 1000 Hz with a suitable offset;

ii) the power at points *s* and *r* is expressed as apparent power , i.e.:

$$\text{Apparent power level} = 10 \log_{10} \left[\frac{(\mathit{Voltage\ at\ point})^2 \times 10^3}{(\mathit{Modulus\ of\ nominal\ impedance\ at\ } 1000\ \mathit{Hz})(1\ W)} \right] \text{dBm}$$

iii) point r is terminated with the nominal design impedance of the decoder to avoid significant impedance mismatch errors.

Note — Precautions ii), iii) above are, of course equally applicable to the case of resistive input and output impedances and would generally be observed by conventional test procedures. Standardizing the reference frequency as in i) above is, however, essential for complex impedances because of the variation of nominal impedance with the test frequency.

5.3.2.6 *Relative level of a point in a digital link*

The relative level to be associated with a point in a digital path carrying a digital bit stream generated by a coder lined-up in accordance with the principles of § 5.3.2.3 above is determined by the value of the digital loss or gain between the output of the coder and the point considered. If there is no such loss or gain the relative level at the point considered is, by convention, said to be 0 dBr.

The equivalent absolute power level of a digital link may be established as in Figure 2/Q.43 by using an ideal decoder by comparing the power at the output of the ideal decoder with that at the analogue zero relative level point originating the digital signal.

Figure 2/Q.43, p.

5.3.3 PCM digital reference sequence (DRS)

F: s´equence num´erique de r´ef´erence MIC

S: secuencia de referencia digital MIC (SRD)

5.3.3.1 A PCM digital reference sequence is one of the set of possible PCM code sequences that, when decoded by an ideal decoder, produces an analogue sinusoidal signal at the agreed test reference frequency (i.e. a nominal 800 or 1000 Hz signal suitably offset) at a level of 0 dBm0.

Conversely, an analogue sinusoidal signal at 0 dBm0 at the test reference frequency applied to the input of an ideal coder will generate a PCM digital reference sequence.

Some particular PCM digital reference sequences are defined in Recommendation G.711 [6] in respect to A-law and µ-law codecs.

5.3.3.2 In studying circuits and connections in mixed analogue/digital networks, use of the digital reference sequence can be helpful. For example, Figure 3/Q.43 shows the various level relationships that one obtains (conceptually) on a Type 2 international circuit where one end terminates at a digital exchange and the other end at an analogue exchange. In the example of Figure 3/Q.43, the analogue portion is assumed to require a loss of 0.5 dB and that provision for this loss is made by introducing a 1.0 dB pad (0.5 dB for each direction of transmission) in the receive direction at the analogue exchange. This has been deliberately chosen to illustrate the utility of the concept of a digital reference sequence.

Figure 3/Q.43 gives an example where all the analogue loss is introduced in the output direction at the analogue exchange. In this case the relative levels at the various codecs can be derived from either the DRS or the transmission reference point at the input of the international circuit with no ambiguity.

If, however, in Figure 3/Q.43 the analogue circuit section is lined up so as to give an overall loss in the direction b_1-a_2, care must be taken in the use of the DRS. In this case the 0 dBm0 sinusoidal reference signal and DRS may result in different levels at the point a_2. Account should be taken of this effect when designing lining-up procedures for mixed analogue/digital circuits.

As a general principle, the relative levels on a mixed analogue/digital circuit should be referred to the transmission reference point at the input of the circuit.

5.3.4 **circuit test access point**

The CCITT has defined circuit test access points as being ‘‘4-wire test-access points so located that as much as possible of the international circuit is included between corresponding pairs of these access points at the two centres concerned’’. These points, and their relative level (with reference to the transmission reference point), are determined in each case by the Administration concerned. They are used in practice as points of known relative level to which other transmission measurements will be related. In other words, for measurement and lining-up purposes, the relative level at the appropriate circuit test access point is the relative level with respect to which other levels are adjusted.

5.3.5 *Measurement frequency*

For all international circuits 800 Hz is the recommended frequency for single-frequency maintenance measurements between the Administrations concerned, 1000 Hz may be used for such measurements.

A frequency of 1000 Hz is in fact now widely used for single-frequency measurements on some international circuits.

Multifrequency measurements made to determine the loss/frequency characteristic will include a measurement at 800 Hz and the frequency of the reference measurement signal for such characteristics can still be 800 Hz.

Note 1 — Definitions of §§ 5.3.1 and 5.3.2 are used in the work of Study Group XII. Definitions of §§ 5.3.4 and 5.3.5, taken from Recommendations M.565 [10] and M.580 [11], are included for information.

Note 2 — In order to take account of PCM circuits and circuit sections, the nominal frequencies 800 Hz and 1000 Hz are in fact offset by appropriate amounts to avoid interaction with the sampling frequency. Details can be found in Supplement No. 3.5 to Volume IV [12].

Figure 3/Q.43, p.

5.4 *Interconnection of international circuits in a transit centre*

In a transit centre, the virtual analogue switching points of the two international circuits to be interconnected are considered to be connected together directly without any additional loss or gain. In this way a chain of international circuits has a nominal transmission loss in transit equal to the sum of the individual circuit losses.

References

[1] CCITT Recommendation *The transmission plan* , Vol. III, Rec. G.101.

[2] CCITT Recommendation *Assumptions for the calculation of noise on hypothetical reference circuits for telephony* , Vol. III, Rec. G.223, § 1.

[3] CCITT Recommendation *Noise objectives for design of carrier-transmission systems of 2500 km* , Vol. III, Rec. G.222.

[4] CCITT Recommendation *FDM carrier systems for submarine cable* , Vol. III, Rec. G.371.

[5] CCITT Recommendation *Assumptions for the calculation of noise on hypothetical reference circuits for telephony* , Vol. III, Rec. G.223, § 2.

[6] CCITT Recommendation *Pulse code modulation (PCM) of voice frequencies* , Vol. III, Rec. G.711.

[7] CCITT Recommendation *Loudness ratings (LRs) of national systems* , Vol. III, Rec. G.121, § 3.

[8] CCITT Recommendation *12-channel terminal equipments* , Vol. III, Rec. G.232, § 11.

[9] CCITT Recommendation *The transmission plan* , Vol. III, Rec. G.101, Figure 5/G.101.

[10] CCITT Recommendation *Access points for international telephone circuits* , Vol. IV, Rec. M.565.

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

[12] *Test frequencies on circuit routed over PCM systems* , Vol. IV, Supplement No. 3.5.

Recommendation Q.44

ATTENUATION DISTORTION

1 Attenuation distortion

1.1 *All-analogue conditions*

The design objectives recommended for carrier terminal equipment by the Recommendation cited in [3] are such that for a chain of six circuits, each equipped with a single pair of channel translating equipments in accordance with that Recommendation, the network performance objective for the attenuation distortion given by Figure 1/G.132 [2] will in most cases be met. The distortion contributed by the seven international centres is thereby included.

Note — To assess the attenuation distortion of the international chain, the limits indicated for international circuits in Recommendation G.151, § 1 [4] must not be added to the limits for international centres mentioned in Recommendation Q.45. In fact, on the one hand, some exchange equipment would be counted twice if this addition were made; on the other, the specification limits of Recommendation Q.45 apply to the worst possible connection through an international exchange, while the maintenance limits of Recommendation G.151, § 1 apply to the poorest international circuit. The specifications of the various equipments are such that the mean performance will be appreciably better than could be estimated by the above-mentioned addition.

1.2 *Mixed analogue/digital conditions*

In the mixed analogue/digital period, it is expected that the attenuation/frequency characteristics of the analogue carrier terminal equipment that is to be used in international telephone connections will continue to be governed by existing Recommendations that are relevant to this type of circuit.

Where unintegrated PCM digital processes are to be included in international telephone connections, it is recommended that the attenuation/frequency characteristic of the bandpass filters associated with such processes should comply with the more stringent version of Figure 1/G.712 [5]. The latter Recommendation applies specifically to cases where integrated PCM digital processes are associated with trunk junctions (toll connecting trunks), trunk circuits (intertoll trunks), and international circuits.

With regard to the incoporation of unintegrated PCM digital processes in local telephone networks, the required attenuation/frequency characteristics of the bandpass filters involved are still under study.

2 The network performance objectives for the variation with frequency of transmission loss in terminal condition of a worldwide 4-wire chain of 12 circuits (international plus national extensions), each one routed over a single group link, are shown in Figure 1/Q.44 which assumes that no use is made of high-frequency radio circuits or 3-kHz channel equipment.

Figure 1/Q.44 p.

References

[1] CCITT Recommendation *Transmission losses, relative levels and attenuation distortion* , Vol. III, Rec. G.141.

[2] CCITT Recommendation *Attenuation distortion* , Vol. III, Rec. G.132.

[3] CCITT Recommendation *12-channel terminal equipments* , Vol. III, Rec. G.232, § 1.

[4] CCITT Recommendation *General performance objectives applicable to all modern international circuits and national extension circuits* , Vol. III, Rec. G.151, § 1.

[5] CCITT Recommendation *Performance characteristics of the PCM multiplex at audio frequencies* , Vol. III, Rec. G.712.

Recommendation Q.45

TRANSMISSION CHARACTERISTICS OF AN ANALOGUE INTERNATIONAL EXCHANGE

A new Recommendation Q.45 | fIbis is published in the *Blue Book* with terminology and structure consistent with Recommendations Q.551-Q.554. There are no changes of technical substance. Recommendation Q.45 in the *Red Book* is adequate for existing references to Q.45.