5i’

7.6 Principal characteristics of transcoder and digital circuit multiplication equipments

Recommendation G.761

GENERAL CHARACTERISTICS OF A 60-CHANNEL TRANSCODER EQUIPMENT

(Malaga-Torremolinos, 1984; amended at Melbourne, 1988)

1 General

The 60-channel transcoder implements a conversion between two 30-channel 2048 kbit/s PCM streams and one 60-channel 2048 kbit/s ADPCM stream. In the 30-channel 2048 kbit/s streams, the telephone signals are coded using 64 kbit/s A-law PCM as specified in Recommendation G.711. In the 60-channel 2048 kbit/s stream, the telephone signals are coded using 32 kbit/s ADPCM as specified in Recommendation G.721. Figure 1/G.761 indicates the nomenclature used for the three different signal ports A, B and C.

Note 1 — Administrations should take into account the guidance given in Recommendation G.721 concerning the use and transmission performance of 32 kbit/s ADPCM .

Note 2 — It should be noted that the transcoder equipment described in this Recommendation has a limited capability of transparently transmitting 64 kbit/s data channels and this should be taken into account in the planning of networks which are likely to evolve into an ISDN (see § 3.8).

This Recommendation is divided into two parts:

— § 2 contains the interface requirements associated with the port C. These requirements are not only applicable to the 60-channel transcoder equipment, but could be applied, in the future, to other equipment such as a 60-channel multiplex terminal, a 60-channel terminating unit at a TDM switch, or a TDMA terminal. In these latter cases, the A and B interfaces would be virtual. As well as point-to-point operation, account has been taken of multi-destination operation in TDMA applications.

— § 3 contains the requirements which are specific to a 60-channel transcoder equipment realization.

Figure 1/G.761, p.

2 Characteristics of a 2048 kbit/s signal organized in 64 kbit/s and/or 32 kbit/s time slots (port C)

2.1 *Interface C*

The electrical characteristics of the 2048 kbit/s interface are in accordance with Recommendation G.703, § 6.

2.2 *Frame structure*

The frame structure is in accordance with Recommendation G.704, § 2.3, with bit 1 of time slot 0 used for the cyclic redundancy check (CRC) procedure.

Time slots 1 to 15 and 17 to 31 each corresponds to:

— either two 4-bit samples of telephone signals coded using 32 kbit/s ADPCM originating from the same incoming PCM stream (A or B); the bit ordering of the 32 kbit/s signals is such that the 4-bit words are transmitted in bit order starting with bit 1 (see §§ 4.2.2 and 4.2.3 of Recommendation G.721). Bits 1 to 4 correspond to the first 32 kbit/s signal and bits 5 to 8 correspond to the second 32 kbit/s signal;

— or a digital signal at 64 kbit/s.

Where stream C is transmitting 60 telephone signals, the numbering of the channels and the correspondence between the 64 kbit/s PCM channels in streams A and B and the 32 kbit/s ADPCM channels in stream C are given in Table 1/G.761.

H.T. [T1.761]

TABLE 1/G.761

Organization of 2048 kbit/s frame for 60-channels at 32 kbit/s (stream C)

8-bit time slot number	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Bits 1-4 of channel	—	1A	1B	3A	3B	5A	5B	7A	7B	9A	9B	11A	11B	13A	13B	15A
Bits 5-8 of channel	—	2A	2B	4A	4B	6A	6B	8A	8B	10A	10B	12A	12B	14A	14B	16A

Table 1/G.761 [T1.761], p.

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2.3 *Allocation of bits in time slot 0*

The allocation of the bits in time slot 0 is given in Recommendation G.704, § 2.3, with bit 1 of time slot 0 used for the cyclic redundancy check procedure.

Bits 3 to 8 in TS0 of those frames not containing the frame alignment signal are used to transmit:

— alarm indications associated with PCM streams A or B (see §§ 2.6.2 and 2.6.3 dealing with alarm indications);

— spare bits associated with PCM streams A or B (see § 3.3).

2.4 *Frame alignment and CRC procedures*

The strategy for loss and recovery of frame alignment and CRC multiframe alignment is given in Recommendation G.706, § 4.

2.5 *Allocation of bits in TS16*

TS16 can be used:

— either for signalling purposes; namely channel associated signalling (see § 2.5.1) and common channel signalling (see § 2.5.2);

— or, as envisaged in § 5.1 of Recommendation G.704, for the transmission of telephone signals; in this case two samples of telephone signals each coded with 4 bits. Used in this way, stream C can transmit up to 62 telephone signals. Bits 1 to 4 and 5 to 8 of stream C will correspond to 64 kbit/s PCM signals transmitted in TS16 of PCM streams A and B respectively.

2.5.1 *Channel associated signalling*

The allocation of bits in TS16 will depend on the number of signalling bits per channel.

2.5.1.1 *Two or less signalling bits per channel*

This applies to the digital version of Signalling System R2 (see Recommendation Q.421) specified for international applications. This also applies to a number of national signalling systems.

TS16 is organized in multiframes. Each multiframe contains 16 consecutive frames, numbered from 0 to 15. The multiframe repetition frequency is 500 Hz.

2.5.1.1.1 *Allocation of bits in TS16 frame 0*

Table 2/G.761 indicates the content of TS16 frame 0.

Bits 1 to 4 are fixed at 0 and constitute the multiframe alignment signal.

Bits 5 and 8 are used to indicate ‘‘AIS in TS16’’ of PCM streams A and B (see § 2.6.5).

Bits 6 and 7 are used to transmit the remote alarm indications associated with the multiframe of PCM streams A and B (see § 2.6.6).

H.T. [T2.761]

TABLE 2/G.761
{
Content of TS16 frame 0
}
Bit number

1	2	3	4	5	6	7	8
0	0	0	0	X 5	X 6	X 7	X 8

Table 2/G.761 [T2.761], p.

2.5.1.1.2 *Allocation of bits in TS16 frames 1 to 15*

Table 3/G.761 indicates the content of TS16 in frames 1 to 15.

This allocation of bits provides each 32 kbit/s channel with two signalling channels at 500 bit/s nominated ‘‘a’’ and ‘‘b’’ as defined in Recommendation G.704, § 5.1.3.2.2.

To minimize the risks of simulation of the multiframe alignment signal, special processing of certain signalling bits is carried out as described in § 2.5.1.1.3.

In the case of direct transfer of some 64 kbit/s time slots of PCM streams A or B, the four bits of TS16 associated with the transferred time slots will be transparently transmitted and allocated in accordance with Table 7/G.704. They will not be subject to the special processing described in § 2.5.1.1.3. The four bits of time slot 16 associated with each of the time slots not used in PCM streams A and B because of the direct transfer will be restituted by the transcoder with the following values:

a = 0; b = 1; and d = 1, in conformity with Table 9/G.704.

The signalling distortion of any signalling channel will not be greater than ± | ms.

H.T. [T3.761]

TABLE 3/G.761

Content of TS16 frames 1 to 15

Time slot 16 bit number	1 2	3 4	5 6	7 8
Signalling	Channel a b	Channel a b	Channel a b	Channel a b
Frame 1	1A	2A	15B	16B
Frame 2	1B	2B	17A	18A
Frame 3	3A	4A	17B	18B
Frame 4	3B	4B	19A	20A
Frame 5	5A	6A	19B	20B
Frame 6	5B	6B	21A	22A
Frame 7	7A	8A	21B	22B
Frame 8	7B	8B	23A	24A
Frame 9	9A	10A	23B	24B
Frame 10	9B	10B	25A	26A
Frame 11	11A	12A	25B	26B
Frame 12	11B	12B	27A	28A
Frame 13	13A	14A	27B	28B
Frame 14	13B	14B	29A	30A
Frame 15	15A	16A	29B	30B

Note — The organization of the multiframe ensures consistency with the frame and multiframe organization of Recommendation G.704, § 5.1.3 and allows the possibility of the mixed use in stream C of 32 kbit/s and 64 kbit/s channels with their associated signalling.

Table 3/G.761 [T3.761], p.

2.5.1.1.3 *Special processing of signalling bits*

The signalling bits to be transmitted in bit 2 (respectively 4, 6 and 8) of TS16 (frames 1 to 15) are calculated from $B_{n\backslash d\backslash u(em_1}$, $B_{n\backslash d\backslash u(em_2}$, $B_{n\backslash d\backslash u(em_3}$, $b_{n\backslash d\backslash u(em_1}$ and b_n in accordance with Table 4/G.761 where:

i) b_n is the signalling bit before processing;

ii) B_n is the signalling bit after processing, and

iii) the subscripts n —3, n —2, and n —1 relate to previous signalling bits pertaining to the same telephone channel; more specifically, if b_n is a bit with a given number (2, 4, 6 or 8) in any time slot 16 of frames 1 to 15, then $b_{n\backslash d\backslash u(em_1}$ is the bit with the same number, one multiframe earlier.

Note 1 — It follows from the above that there are 60 individual and independent processing operations at the same time.

The reverse processing (after transmission) is in accordance with Table 5/G.761. The reverse processed value $\hat{b}_n$ is deduced from the successive received bits $B_{n\backslash d\backslash u(em_3}$, $B_{n\backslash d\backslash u(em_2}$, $B_{n\backslash d\backslash u(em_1}$, B_n and from the previous value $\hat{b}_{n\backslash d\backslash u(em_1}$. In the absence of transmission errors in stream C, $\hat{b}_n = b_n$ and there is no increase in signalling distortion. When this is not so, the error multiplication factor lies between 2 and 4.

When, in the case of fault conditions on multiframe A or B (see Table 9/G.761), the signalling bits need to be forced to state 1, this should be implemented on the unprocessed signalling channels (i.e. before the special processing at the send end or after the reverse processing at the receive end). This does not apply to the cases of ‘‘partial AIS stream A (B)’’ considered in § 2.6.2 where the AIS is all 1s, unprocessed.

2.5.1.1.4 *Loss and recovery of multiframe alignment*

The multiframe alignment should be assumed to have been lost when two consecutive multiframe alignment signals have been received in error.

The multiframe alignment should be assumed to have been recovered following detection of an all-zero 4-bit word formed by the first four bits of a time slot 16 and an all-zero 4-bit word one multiframe period later.

2.5.1.2 *More than two signalling bits per channel*

See § 3.8.

2.5.2 *Common channel signalling*

TS16 of stream C can be used for common channel signalling. In this case, its content corresponds, without any modification, to that of TS16 of either PCM stream A or PCM stream B. It should be noted that the simultaneous transfer of TS16 from both streams A and B is not envisaged in this case.

Time slot 16 of PCM stream B (or A) not used because of the direct transfer of time slot 16 of PCM stream A (or B) in time slot 16 of the PCM stream C will be restituted by the transcoder in the form of an all-0s signal or an all-1s signal.

2.6 *Alarm indications*

The following alarm indications can be transmitted in stream C.

2.6.1 *AIS stream C*

This means that a fault, common to the 60 channel has been detected in the send side ‘‘AIS stream C’’ is transmitted as an all ones configuration in stream C.

2.6.2 *AIS stream A (respectively B)*

This means that a fault, common to the 30 channels of stream A (respectively B), has been detected in the send side.

For the send side, the following applies:

When ‘‘AIS stream A’’ and ‘‘AIS stream B’’ are present simultaneously, then ‘‘AIS stream C’’ should be transmitted.

When ‘‘AIS stream A’’ (respectively B) is present, but not ‘‘AIS stream B’’ (respectively A), then the informaiton bits and the signalling bits associated with stream B (respectively A) should be transmitted normally and an all ones configuration should be transmitted in the time slots associated with stream A (respectively B) in stream C and the corresponding bits in TS16. In addition, bit 7 (respectively 8) of TS0 not containing the frame alignment signal in stream C should be set to 1 to indicate the ‘‘AIS stream A’’ (respectively B) (see Table 6/G.761). This configuration in stream C is nominated ‘‘partial AIS stream A’’ (respectively ‘‘partial AIS stream B’’).

For the receive side, the following applies:

Partial AIS stream A (respectively B) will be considered as being present if bit 7 (respectively bit 8) is detected at state 1 on three consecutive occasions.

Partial AIS stream A (respectively B) will be considered as having ceased if bit 7 (respectively 8) is detected at state 0 on three consecutive occasions.

Cuadro 4/G.761 [T4.761], p.

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H.T. [T5.761]

TABLE 5/G.761

Processing of signalling bits (receive side)

Input	State				Output
B	*B — 3*	*B — 2*	*B — 1*	*b — 1*	*b*
0	*0*	*0*	*0*	*0*	*1*
0	*0*	*0*	*0*	*1*	*0*
1	*0*	*0*	*0*	*0*	*0*
1	*0*	*0*	*0*	*1*	*1*
0	*0*	*0*	*1*	*0 or 1*	*0*
1	*0*	*0*	*1*	*0 or 1*	*1*
0	*0*	*1*	*0*	*0 or 1*	*1*
1	*0*	*1*	*0*	*0 or 1*	*0*
0	*0*	*1*	*1*	*0 or 1*	*0*
1	*0*	*1*	*1*	*0 or 1*	*1*
0	*1*	*0*	*0*	*1*	*0*
1	*1*	*0*	*0*	*1*	*1*
0	*1*	*0*	*1*	*0*	*1*
1	*1*	*0*	*1*	*0*	*0*
0	*1*	*1*	*0*	*0*	*1*
1	*1*	*1*	*0*	*0*	*0*
0	*1*	*1*	*1*	*1*	*0*
1	*1*	*1*	*1*	*1*	*1*

Note — Other states may be possible, just after powering-on, which may be avoided by careful design.

Tableau 5/G.761 [T5.761] p.

H.T. [T6.761]

TABLE 6/G.761

{

Use of bits 7 and 8 of TS0 not containing the frame alignment signal in stream C

}

Bit number	7	8	Meaning
States	1	0	AIS stream A
	0	1	AIS stream B

Tableau 6/G.761[T6.761] p.

2.6.3 *Alarm indication to the remote end for stream A (respectively B)*

In the send side, bit 3 of TS0, not containing the frame alignment signal of stream A (respectively B) should be transferred to bit 3 (respectively 4) of the corresponding TS0 of stream C.

In the receive side, bit 3 (respectively 4) of TS0 not containing the frame alignment signal of stream C should be transferred to bit 3 of the corresponding TS0 of stream A (respectively B).

2.6.4 *AIS in TS16 of stream C*

For channel associated signalling, this means that a fault condition, common to the signalling information associated with all 60 channels of stream C has been detected in the send side. ‘‘AIS in TS16 of stream C’’ is transmitted as an all ones configuration in TS16.

2.6.5 *AIS in TS16 stream A (respectively B)*

For channel associated signalling, this means that a fault, common to the 30 channels of stream A (respectively B), has been detected in the send side.

For the send side, the following applies:

When ‘‘AIS in TS16 stream A’’ and ‘‘AIS in TS16 in stream B’’ are present simultaneously, then ‘‘AIS in TS16 of stream C’’ should be transmitted. When ‘‘AIS in TS16 stream A’’ (respectively B) is present, but not ‘‘AIS in TS16 stream B’’ (respectively A), then the signalling information of stream B (respectively A) should be transmitted normally, and the signalling bits of TS16 of stream C associated with stream A (respectively B) should be transmitted as an all ones configuration. In addition, bit 5 (respectively 8) of TS16 frame 0 should be set to 1 to indicate ‘‘AIS in TS16 stream A’’ (respectively B).

For the receive side, the following applies:

AIS in TS16 stream A (respectively B) will be considered as being present if bit 5 (respectively 8) of TS16 frame 0 is detected at state 1 on two consecutive occasions.

AIS in TS16 stream A (respectively B) will be considered as having ceased if bit 5 (respectively 8) is detected at state 0 on two consecutive occasions.

2.6.6 *Remote alarm in TS16 of stream A (respectively B)*

For channel associated signalling, this means that a loss of multiframe alignment in stream A (respectively B) has been detected in the opposite direction of transmission.

Bit 6 (respectively 7) of TS16 frame 0 of stream C should be put to 1 to transmit this remote alarm indication associated with stream A (respectively B).

The simultaneous presence of bits 6 and 7 (of TS16 frame 0 of stream C) in state 1 indicates a remote alarm associated with the signalling information of the 60 channels.

3 Other characteristics of the 60 channel transcoder equipment

3.1 *Interfaces A and B*

The electrical characteristics of the two interfaces A and B are in accordance with Recommendation G.703, § 6.

3.2 *Frame structure of streams A and B*

The frame structure of the 2048 kbit/s streams A and B is given in Recommendation G.704, § 2.3, with bit 1 of time slot 0 used for the CRC procedure. The strategy for loss and recovery of frame alignment and CRC multiframe alignment are given in Recommendation G.706, § 4.

As indicated in Recommendation G.704, § 5.1, TS16 of streams A and B can be used for the transmission of telephone signals, if not used for signalling purposes, providing two supplementary channels nominated 31A and 31B respectively. (See Table 1/G.761.)

3.3 *Transparent transfer of bits of time slot 0 not containing the frame alignment signal*

The transcoder equipment should be capable of providing the following two options, the choice between these to be made by the individual Administration or by mutual agreement of the Administrations concerned:

a) bit 4 of time slot 0 not containing the frame alignment signal of streams A and B should be transparently transmitted in stream C using bits 5 and 6 respectively of time slot 0 not containing the frame alignment signal of stream C;

b) bit 5 should be transmitted in a corresponding way using bits 5 and 6 respectively of stream C.

3.4 *Multiframe structure in TS16 of streams A and B*

When used for channel associated signalling, TS16 of streams A and B is organized in multiframes as defined in Recommendation G.704, § 5.1.3. The definition of the alarm indications and the criteria for multiframe alignment loss and recovery are given in Recommendation G.735.

3.5 *Absolute delay*

The overall absolute delay introduced by a pair of interconnected transcoders (i.e. PCM to PCM) should be less than 500 microseconds for any of the 32 kbit/s channels and for any of the transparently transferred 64 kbit/s channels.

In the case of channel associated signalling, the overall delay introduced by a pair of interconnected transcoders (i.e. PCM to PCM) should be less than 3 milliseconds for any of the signalling channels.

3.6 *Synchronization*

3.6.1 *Send side*

So that the equipment may be inserted into a plesiochronous network, or into a synchronous network operating in degraded conditions, both PCM ports A and B at the send side should be provided with frame and multiframe resynchronizing devices, which initiate controlled sample slips (i.e. sample repetitions or deletions) as required.

It should be possible to synchronize the sending side to any one of the following:

— timing signal associated with incoming PCM stream A;

— timing signal associated with incoming PCM stream B;

— timing signal associated with incoming stream C;

— external 2048 kHz timing signal (see Recommendation G.703, § 10).

In the case of synchronization failure, the consequent action is a prompt maintenance alarm (see Table 8/G.761).

Note — Synchronization failure is assumed in case of a fault condition (see Note 2 to Table 8/G.761) on the incoming signal being used for synchronization.

3.6.2 *Receive side*

The receiving side should be synchronized to the timing signal associated with incoming stream C.

Note — The organization of the network should be such that controlled sample slips are avoided in normal operating conditions. This can lead to the need to synchronize the sending side to the receiving side in remote 30 channel PCM terminals. In circumstances where slips are unavoidable, they will affect both 32 kbit/s channels and directly transferred 64 kbit/s channels.

3.7 *Jitter*

The basic jitter requirements at interfaces are covered by the requirements of §§ 2.1 and 3.1.

When the sending side of the transcoder is synchronized to the incoming PCM stream A or B, and provided both streams A and B are synchronized to each other, slips should not occur when sinusoidal jitter having an amplitude lower then the maximum tolerable input jitter (see Figure 2/G.823) is present at one or both the input ports A and B.

Jitter transfer characteristics between various signal ports are under study.

3.8 *Direct time slot transfer*

It should be possible to manually programme the transcoder to transfer transparently at least two time slots from each of the two incoming PCM streams A and B into stream C.

For national applications, it is sometimes necessary to use more than two signalling bits per channel. In such cases, time slot 16 from PCM streams A and B should be transferred to/from time slots 16 and 17 respectively of stream C. The special processing of signalling bits as described in § 2.5.1.1.3 will not be required.

To be compatible with Recommendation G.735, § 2, at least TS6 and TS22 of each PCM stream A and B should be transferable. The positions of these time slots in the stream C frame are given below:

— TS6 of PCM stream A into TS5 of stream C;

— TS6 of PCM stream B into TS6 of stream C;

— TS22 of PCM stream A into TS22 of stream C;

— TS22 of PCM stream B into TS23 of stream C.

In the case of the transfer of more than two time slots, Table 7/G.761 indicates the allocation up to the maximum possible, taking account of the priority ordering given in Recommendation G.735, § 2.

If (n) 64 kbit/s time slots of PCM stream A (respectively B) are transferred transparently through the transcoder, then the transmission capabilities of PCM stream A (respectively B) will be limited to (30—2n) channels. More precisely, with the frame structure of stream C given in § 2.2:

— when TS6 is transferred transparently, channel 5 of the same PCM stream cannot be used;

— when TS22 is transferred transparently, channel 22 of the same PCM stream cannot be used.

In the case of direct transfer, the transcoder will restitute the binary mark sequence corresponding to amplitude 1 for coding law A (see Recommendation G.712, § 4.3), in the non-usable time slot of PCM output streams A and B.

Note 1 — The need to transmit transparently more than two time slots per incoming PCM stream is under study.

Note 2 — The possibility of remotely controlling the choice of the time slots which are to be transmitted transparently is under study.

Note 3 — The octet sequence integrity is maintained by the transcoder in the case of direct transfer of several time slots at 64 kbit/s.

3.9 *In-service monitoring*

When the PCM to ADPCM and/or the ADPCM to PCM processing functions are multiplexed for 60 channels, in-service monitoring of these processing functions should be provided. This in-service monitoring should be implemented in such a way that it it possible to distinguish between failures affecting the send and receive sides separately.

Since no PCM (respectively ADPCM) signals are transmitted in TS0, the in-service monitoring can be implemented by inserting test signals into extra channels corresponding to TS0 of PCM streams A and B.

3.10 *Safeguarding of one PCM stream A or B*

As an option, safeguarding of one PCM tributary can be provided automatically, or otherwise, when a failure of the transcoder digital processing parts, or of the transcoder power supplies, have been detected. In this case the nominated PCM stream, A or B, should, for both directions of transmission, be made to bypass the transcoder and be connected to the transmission link in place of the normal stream C signal.

The simultaneous presence at state 1 of bits 7 and 8 of TS0 not containing the frame alignment signal in stream C on three consecutive occasions is used to indicate to the remote transcoder that the downstream transcoder has been switched to the safeguarding mode. When the safeguarding option is provided automatically, the procedure for the exchange of information between the two transcoders when switching to and from the safeguarding mode is under study.

Note 1 — The choice of the PCM stream (A or B) which will be safeguarded is made when the equipment is installed. It should be the same at both ends of the transmission link.

Note 2 — The use of the safeguarding facility can result in two 2048 kbit/s interfaces in cascade. It is then necessary to ensure, when installing the transcoder, that the combined attenuation of the station cabling at 1024 kHz on both sides of the transcoder is not greater than the maximum attenuation allowed by the equipment connected to the transcoder.

Note 3 — Before using the safeguarding facility, it should be checked that the bits 7 and 8 of TS0 not containing the frame alignment signal of the PCM stream to be safeguarded are in the idle state 1 as specified in Recommendation G.704, § 3.3.1.3.

3.11 *Fault conditions and consequent actions*

3.11.1 *Without safeguarding*

The fault conditions associated with the frames of streams A, B and C and the consequent actions, when the safeguarding option is not used, are given in Table 8/G.761.

When channel associated signalling is used, the fault conditions associated with the multiframes of streams A, B and C and their consequent actions are given in Table 9/G.761.

3.11.2 *With safeguarding*

When the safeguarding option is provided, Tables 8/G.761 and 9/G.761 must be used, with the exception of the fault condition ‘‘transcoder failure’’ of Table 8/G.761. Instead, the fault conditions and consequent actions given in Table 10/G.761 must be used, with reference to Figure 2/G.761.

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H.T. [T7.761]

TABLE 7/G.761
{
Order of priority for the transfer of 64 kbit/s time slots from streams A or B to stream C
}

Time slot in stream A	Time slot in stream B	Time slot in stream C
6		5
	6	6
22		22
	22	23
14		13
	14	14
30		30
	30	31
2		1
	2	2
18		18
	18	19
10		9
	10	10
26		26
	26	27
4		3
	4	4
20		20
	20	21
12		11
	12	12
28		28
	28	29
8		7
	8	8
24		24
	24	25
17 (Note 1)		15
	17 (Note 1)	17 (Note 2)

Note 1 — This time slot does not comply with the normal priority ordering given in Recommendation G.735, § 2.

Note 2 — Time slot 17 of stream C will not be available for direct transfer of time slot 17 of stream B when the PCM streams employ time slot 16 channel associated signalling with more than two signalling bits per channel (see § 2.5.1.2).

tableau 7/G.761 [T7.761], p. 8

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H.T. [1T8.761]

TABLE 8/G.761
{
Fault conditions on frames A, B and C and consequent actions without safeguarding
}

{

| | | |

TS0 stream C bit 3 to 1 (Note 6) }		1									

{
TS0 stream C bit 4 to 1
(Note 6)
}
			1								

tableau 8/G.761 [1T8.761], p. 9 A L'ITALIENNE

H.T. [2T8.761]

{
TABLE 8/G.761 *(cont.)*
}

{

TS0 stream C bit 7 to 1		Yes	
TS0 stream C bit 8 to 1			Yes
{ Transcoder failure, send side (Note 5) }	Yes		
{ Transcoder failure, receive side (Note 5) }	Yes	Yes	Yes
Power supply failure	Yes	Yes if possible	Yes if possible
{ Synchronization failure of the sending side			

}	Yes								

Note 1 — The fault conditions associated with streams A, B and C are: loss of signal, loss of frame alignment, error ratio greater than 10^{D}lF261^{3} as defined in Recommendation G.735, § 4.1.

Note 2 — Only in time slots and signalling bits associated with PCM stream A (both for 32 and 64 kbit/s channels).

Note 3 — Only in time slots and signalling bits associated with PCM stream B (both for 32 and 64 kbit/s channels).

Note 4 — The prompt maintenance alarm indication must be inhibited if the AIS is detected at the corresponding port.

Note 5 — The fault condition ‘‘transcoder failure’’ is detected by the in-service monitoring unit. The transcoder is equipped with such a unit if the digital signal processing is time-multiplexed between the 60-channels.

Note 6 — These fault conditions are not detected by the transcoder. The indications pass transparently through the transcoder (see § 2.6.3).

tableau 8/G.761 [2T8.761], p. 10 A L’ITALIENNE

H.T. [T9.761]

TABLE 9/G.761
{
Fault conditions on multiframes A, B and C and consequent actions
}

{

| | | |

Bit 5 TS 16 frame 0 stream C to 1 }								Yes				
{ Bit 8 TS 16 frame 0 stream C to 1 }									Yes			

Note 1 — The fault condition associated with the three multiframes is the loss of multiframe alignment.

Note 2 — Only in signalling bits associated with PCM stream A. The 1111.... bits are processed in accordance with § 2.5.1.1.3 and Tables 4/G.761 and 5/G.761.

Note 3 — Only in signalling bits associated with PCM stream B. The 1111.... bits are processed in accordance with § 2.5.1.1.3 and Tables 4/G.761 and 5/G.761.

Note 4 — The prompt maintenance alarm indication must be inhibited if the AIS in TS16 is detected at the corresponding port.

Note 5 — These fault conditions are not detected by the transcoder. The indications pass transparently through the transcoder (see § 2.6.6).

tableau 9/G.761 [T9.761], p. 11 A L'ITALIENNE

H.T. [T10.761]

TABLE 10/G.761

Fault conditions and consequent actions when implementing the safeguarding option

{				
Transcoder failure at (1)	Yes		Yes if possible	Yes
Power supply failure at (1)	Yes		Yes if possible	Yes

{
TS0 stream C from (1) to (2) bits 7 and 8 in state 1
}
		Yes		Yes

Note — The transcoder designations (1) and (2) are indicated in Figure 2/G.761.

tableau 10/G.761 [T10.761], p. 12

figure 2/G.761 p. 13

Recommendation G.762

GENERAL CHARACTERISTICS OF A 48-CHANNEL TRANSCODER EQUIPMENT

(Melbourne, 1988)

1 General

The 48-channel transcoder provides for the conversion between two 24-channel 1544 kbit/s PCM streams and one 48-channel 1544 kbit/s ADPCM stream. In the 24-channel 1544 kbit/s streams, the voice-frequency signals are coded at 64 kbit/s according to the PCM μ-law defined in Recommendation G.711. In the 48-channel 1544 kbit/s stream, the voice-frequency signals are coded at

32 kbit/s according to the ADPCM encoding law defined in Recommendation G.721.

Figure 1/G.762 represents the nomenclature used for the three different signal ports X, Y and Z.

Figure 1/G.762, p.

The 1544 kbit/s stream associated with port Z can be partitioned into four independent 384 kbit/s entities defined as time slot groupings. Each 384 kbit/s time slot grouping consists of twelve 32 kbit/s time slots which can be used to transport up to 12 voice-frequency channels or 11 voice-frequency channels plus their channel associated a-b-c-d signalling information. Therefore, the 1544 kbit/s stream associated with port Z will have a maximum channel capacity of between 44 and 48 voice-frequency channels.

Note 1 — Administrations should take into account the guidance given in Recommendation G.721 concerning the use and transmission performance of 32 kbit/s ADPCM.

Note 2 — It should be noted that the transcoder equipment described in this Recommendation has a limited capability of transparently transporting 64 kbit/s data channels and this should be taken into account in the planning of networks which are likely to evolve into an ISDN (see § 4.4).

This Recommendation is divided into three parts:

— Paragraph 2 contains the interface requirements associated with port Z;

— Paragraph 3 contains the interface requirements associated with ports X and Y;

— Paragraph 4 contains the requirements which are specific to a 48-channel transcoder equipment realization.

2 Characteristics of a 1544 kbit/s signal organized in 32 kbit/s and/or 64 kbit/s time slots (port Z)

2.1 *Interface Z*

The electrical characteristics of the 1544 kbit/s interface are in accordance with § 2 of Recommendation G.703.

2.2 *Frame structure*

2.2.1 *Frame structure at 1544 kbit/s*

Refer to § 3.2.1 of Recommendation G.704 for the frame structure and use of derived channel time slots.

2.2.2 *Frame structure at 384 kbit/s*

Refer to § 3.2.3 of Recommendation G.704 for the frame structure at 384 kbit/s.

2.3 *Loss and recovery of frame and multiframe alignment*

2.3.1 *Loss and recovery of 1544 kbit/s frame and multiframe alignment*

The criteria for loss and recovery of the frame alignment and multiframe alignment signal for port Z are in accordance with § 2.1 of Recommendation G.706 for the 24-frame multiframe and for the 12-frame multiframe.

2.3.2 *Loss and recovery of delta channel multiframe alignment*

The criteria for loss and recovery of the signalling grouping channel multiframe alignment signal are in accordance with § 3.2.6 of Recommendation G.704.

2.4 *Signalling*

Refer to § 3.2.4 of Recommendation G.704 for signalling in the 384 kbit/s stream.

3 Characteristics of ports X and Y

3.1 *Interfaces X and Y*

The electrical characteristics of the 1544 kbit/s interface are in accordance with § 2 of Recommendation G.703.

3.2 *Frame structure*

Refer to § 2.1 of Recommendation G.704 for the frame structure and use of derived channel time slots.

3.3 *Loss and recovery of 1544 kbit/s frame and multiframe alignment*

The criteria for loss and recovery of the frame alignment and multiframe alignment signal for ports X and Y are in accordance with § 2.1 of Recommendation G.706 for the 24-frame alignment and for the 12-frame multiframe.

3.4 *Signalling*

Refer to § 3.1.3 of Recommendation G.704 and § 4.3 below.

4 Other characteristics of the 48-channel transcoder equipment

4.1 *48-channel frame structure*

In the case where streams X and Y are each carrying 24 voice-frequency signals and no channel-associated signalling information is present, stream Z will transmit the full complement of 48 channels. Table 1/G.762 shows the correspondence between the 64 kbit/s PCM channels in streams X and Y and the 32 kbit/s ADPCM channels in stream Z. Time slots 1-12 correspond to channels 1-12 from PCM stream X coded with 4 bits. Time slots 13-24 correspond to channels 13-24 from PCM stream X coded with 4 bits. Time slots 25-36 correspond to channels 1-12 from PCM stream Y coded with 4 bits. Time slots 37-48 correspond to channels 13-24 from PCM stream Y coded with 4 bits.

H.T. [T1.762]

TABLE 1/G.762

Organization of the 1544 kbit/s frame for up to 48 channels at 32 kbit/s in stream Z

lw(42p) | cw(12p) | cw(12p) | cw(12p) | cw(12p) | cw(12p) | cw(12p) | cw(12p) | cw(12p) | cw(12p) | cw(12p) | cw(12p) | lw(42p) , l | c | c | c | c | c | c | c | c | c | c | c | ˆ . 4 bit time slot of stream Z 1 2 3 4 5 6 7 8 9 10 1112Time slot Grouping 1 8 bit channel of stream X 1X 2X 3X 4X 5X 6X 7X 8X 9X 10X 11X12X or SGC lw(186p) . lw(42p) | cw(12p) | cw(12p) | cw(12p) | cw(12p) | cw(12p) | cw(12p) | cw(12p) | cw(12p) | cw(12p) | cw(12p) | cw(12p) | lw(42p) , l | c | c | c | c | c | c | c | c | c | c | c | c | ˆ . 4 bit time slot of stream Z 13 14 15 16 17 18 19 20 21 22 23 24 Time slot Grouping 2 8 bit channel of stream X 13X 14X 15X 16X 17X 18X 19X 20X 21X 22X 23X 24X or SGC lw(186p) . lw(42p) | cw(12p) | cw(12p) | cw(12p) | cw(12p) | cw(12p) | cw(12p) | cw(12p) | cw(12p) | cw(12p) | cw(12p) | cw(12p) | lw(42p) , l | c | c | c | c | c | c | c | c | c | c | c | c | ˆ . 4 bit time slot of stream Z 25 26 27 28 29 30 31 32 33 34 35 36 Time slot Grouping 3 8 bit channel of stream Y 1Y 2Y 3Y 4Y 5Y 6Y 7Y 8Y 9Y 10Y 11Y12Y or SGC lw(186p) . lw(42p) | cw(12p) | cw(12p) | cw(12p) | cw(12p) | cw(12p) | cw(12p) | cw(12p) | cw(12p) | cw(12p) | cw(12p) | cw(12p) | lw(42p) , l | c | c | c | c | c | c | c | c | c | c | c | c | ˆ . 4 bit time slot of stream Z 37 38 39 40 41 42 43 44 45 46 47 48 Time slot Grouping 4 8 bit channel of stream Y 13Y 14Y 15Y 16Y 17Y 18Y 19Y 20Y 21Y 22Y 23Y 24Y or SGC

Table 1/G.762 [T1.762], p.

The signalling grouping channels for time slot groupings 1-4, when present in stream Z, occupy time slots 12, 24, 36 and 48 respectively. As shown in Table 2/G.762, the channel capacity for stream X (respectively Y) is reduced by one for each time slot grouping associated with stream X (respectively Y) configured with a signalling grouping channel. Selection of the time slot grouping format to include the signalling grouping

channel (SGC) is made on a per-time slot grouping basis, independent of the other time slot groupings associated with stream X or Y.

H.T. [T2.762]

TABLE 2/G.762

Unused channels in streams X and Y when the signalling

grouping channel is present in a time slot grouping

{ Signalling grouping channel present }	Unused channel
Time slot grouping 1	Channel 12 in stream X
Time slot grouping 2	Channel 24 in stream X
Time slot grouping 3	Channel 12 in stream Y
Time slot grouping 4	Channel 24 in stream Y

Table 2/G.762 [T2.762], p.

4.1.1 *Unused channels*

As explained in § 4.1, the presence of a signalling grouping channel in a time slot grouping causes a given channel in stream X or Y to be configured as unused.

The unused channels on the receive side of streams X and Y should have their data and signalling bits conditioned in a way that is compatible with downstream equipment.

The unused channels on the send side of streams X and Y are not processed.

4.2 *Selection of 1544 kbit/s multiframe formats*

Selection of either the 24-frame or 12-frame multiframe format at ports X, Y or Z is independent of the multiframe frame formats selected at the other ports.

4.3 *Signalling*

4.3.1 *Common-channel signalling*

A channel being used to convey common-channel signalling information in stream X or Y will not undergo the transcoding function. The signalling channel will be transmitted transparently in stream Z at the 64 kbit/s rate, as can other channels from streams X and Y in accordance with § 4.4.

4.3.2 *Channel-associated signalling*

Refer to Table 1/G.762 and Table 7/G.704 for the association of channel associated a-b-c-d signalling bits between streams X and Y and the signalling grouping channels in stream Z.

4.4 *Direct time slot transfer*

It should be possible to select and pass through 64 kbit/s channels from streams X and Y transparently into stream Z. Furthermore, it should be possible to pass through at least one 64 kbit/s channel in each time slot grouping stream Z.

The priority for selecting which time slots from streams X and Y should be directly transferred and their placement into stream Z is for further study.

4.4.1 *Channel-associated signalling in 64 kbit/s pass-through time slots*

The transcoder should allow for selection of reinsertion or no reinsertion of channel-associated signalling bits into the receive side of streams X and Y for channels which are passed-through transparently at 64 kbit/s.

4.4.2 *Conditioning of unused channels*

When 64 kbit/s channels from stream X (respectively Y) are transferred transparently into stream Z, the transmission capacity of PCM stream X (respectively Y) is reduced. The unused channels in stream X (respectively Y) should be conditioned as described in § 4.1.1.

4.5 *Signalling grouping channel alarm indications*

When signalling grouping channel frame alignment is lost (as per § 3.2.6 of Recommendation G.704), updating of the channel-associated signalling bits on the receive side of streams X and Y should be inhibited for the affected channels until frame alignment is regained.

A time slot grouping alarm is declared when the signalling grouping channel multiframe alignment signal is lost for 2 to 3 seconds.

When signalling grouping channel multiframe alignment is declared (as per § 3.2.6 of Recommendation G.704), updating of the channel-associated signalling bits on the receive side of streams X and Y will be enabled.

The time slot grouping alarm is released when signalling grouping channel multiframe alignment has been reacquired for 10 to 20 seconds.

On the send side, M_1 is set to 1 to transmit a time slot grouping alarm to the remote end when the near end is in time slot grouping alarm. On the receive side, a remote time slot grouping alarm is declared when M_1 has been set for 335 to 1000 milliseconds. Remote time slot grouping alarm is released when M_1 has been reset for 20 to 1000 milliseconds.

On the send side, M_2 is used to indicate a 1544 kbit/s alarm or a 1544 kbit/s AIS has been received on port X (time slot groupings 1 or 2) or port Y (time slot groupings 3 or 4). On the receive side, a signalling grouping channel AIS alarm is declared when M_2 has been set for 335 to 1000 milliseconds. Signalling grouping channel AIS is released when M_2 has been reset for 20 to 1000 milliseconds.

On the send side, M_3 is used to indicate a remote 1544 kbit/s alarm has been received on port X (time slot groupings 1 or 2) or port Y (time slot groupings 3 or 4). On the receive side, a remote signalling grouping channel AIS alarm is declared when M_3 has been set for 335 to 1000 milliseconds. Signalling grouping channel remote AIS alarm is released when M_3 has been reset for 20 to 1000 milliseconds.

4.6 *Fault conditions and consequent actions*

4.6.1 *1544 kbit/s fault conditions associated with stream Z*

A summary of the 1544 kbit/s fault conditions associated with the receive side of stream Z and the consequent actions are listed in Table 3/G.762.

The transcoder shall detect the following 1544 kbit/s fault conditions associated with stream Z:

i) loss of incoming signals at 1544 kbit/s;

ii) loss of 1544 kbit/s frame alignment;

iii) 1544 kbit/s alarm indication signal (AIS) received;

iv) 1544 kbit/s alarm indication received from the remote end.

4.6.2 *Consequent actions associated with stream Z*

Upon detection of 1544 kbit/s fault conditions in stream Z, appropriate actions should be taken which are in accordance with § 3.2 of Recommendation G.733. In addition, the following consequent actions should be taken as indicated in Table 3/G.762:

i) declare a 1544 kbit/s alarm on the receive side of port Z;

ii) send a 1544 kbit/s alarm indication to the remote end on the send side of port Z in accordance with § 4.2.4 of Recommendation G.733;

iii) send a 1544 kbit/s alarm indication signal (AIS) on the receive side of streams X and Y. The AIS consists of an all-1s signal in all channels including the framing bit;

iv) declare 1544 kbit/s AIS on the receive side of port Z;

v) declare a remote 1544 kbit/s alarm on the receive side of port Z;

vi) send a 1544 kbit/s alarm indication to the remote end on the receive side of streams X and Y in accordance with § 4.2.4 of Recommendation G.733.

H.T. [T3.762]

TABLE 3/G.762

1544 kbit/s fault conditions associated with stream Z and consequent actions

{ Consequent actions Fault conditions }	{ Declare 1544 kbit/s alarm on Z }	{ Send 1544 kbit/s alarm indication to remote end on Z }	{ Send 1544 kbit/s AIS on X and Y }	{ Declare remote 1544 kbit/s alarm on Z }	{ Send 1544 kbit/s alarm indication to remote end on X and Y }	
{ Loss of incoming signal at 1544 kbit/s }	Yes	Yes	Yes			
{ Loss of 1544 kbit/s frame alignment }	Yes	Yes	Yes			
1544 kbit/s AIS received		Yes	Yes	Yes		
{ 1544 kbit/s alarm indication received from remote end }					Yes	Yes

Table 3/G.762 [T3.762], p.

4.6.3 *Fault conditions associated with the signalling grouping channel*

A summary of the signalling grouping channel fault conditions associated with the receive side of stream Z and the consequent actions are listed in Table 4/G.762.

The transcoder shall detect the following signalling grouping channel fault conditions associated with stream Z:

i) loss of signalling grouping channel multiframe alignment on a single time slot grouping associated with port X or a single time slot grouping associated with port Y;

ii) loss of signalling grouping channel multiframe alignment on both time slot groupings associated with port X or both time slot groupings associated with port Y;

iii) remote time slot grouping alarm indication (M_1) received from the remote end on a single time slot grouping associated with port X or a single time slot grouping associated with port Y;

iv) remote time slot grouping alarm indication (M_1) received from the remote end on both time slot groupings associated with port X or both time slot groupings associated with port Y;

v) signalling grouping channel AIS (M_2) received from the remote end on a single time slot grouping associated with port X or a single time slot grouping associated with port Y;

vi) signalling grouping channel AIS (M_2) received from the remote end on both time slot groupings associated with port X or both time slot groupings associated with port Y;

vii) remote signalling grouping channel AIS (M_3) received from the remote end on a single time slot grouping associated with port X or a single time slot grouping associated with port Y;

viii) remote signalling grouping channel AIS (M_3) received from the remote end on both time slot groupings associated with port X or both time slot groupings associated with port Y.

4.6.4 *Consequent actions associated with the signalling grouping channel*

Upon detection of signalling grouping channel fault conditions in stream Z, the following consequent actions shall be taken as indicated in Table 4/G.762:

i) declare time slot grouping alarm on the associated time slot grouping;

ii) send a time slot grouping alarm indication to the remote end by forcing the M_1 bit within the affected signalling grouping channel to 1;

iii) condition the data in the affected channels on the receive side of streams X or Y to provide a signal that is compatible with downstream equipment;

iv) condition the channel-associated signalling bits in affected channels on the receive side of streams X or Y to provide a signal that is compatible with downstream equipment. An example for most signalling types would be universal trunk conditioning where the signalling bits should be forced to the idle state for 2 to 3 seconds, and then conditioned to simulate the channel seized condition;

v) send a 1544 kbit/s AIS on the receive side of stream X (for time slot groupings 1 and 2) or stream Y (for time slot groupings 3 and 4). The AIS consists of an all 1s signal in all channels including the framing bit;

vi) declare a remote time slot grouping alarm condition on the associated time slot grouping to indicate the reception of a remote time slot grouping alarm indication in the M_1 bit of the affected signalling grouping channel;

vii) send a 1544 kbit/s alarm indication to the remote end on the receive side of stream X (for time slot groupings 1 and 2) and stream Y (for time slot groupings 3 and 4);

viii) declare a signalling grouping channel AIS condition on the associated time slot grouping to indicate the reception of a signalling grouping channel AIS indication in the M_2 bit of the affected signalling grouping channel;

ix) declare a remote signalling grouping channel AIS condition on the associated time slot grouping to indicate the reception of a remote signalling grouping channel AIS indication in the M_3 bit of the affected signalling grouping channel.

4.6.5 *Fault conditions associated with streams X and Y*

A summary of the fault conditions associated with the frames of streams X and Y and the consequent actions are listed in Table 5/G.762.

The transcoder shall detect the following fault conditions associated with streams X and Y:

i) loss of incoming signals at 1544 kbit/s;

ii) loss of 1544 kbit/s frame alignment;

iii) 1544 kbit/s AIS received from remote end;

iv) 1544 kbit/s alarm indication received from the remote end.

4.6.6 *Consequent actions associated with streams X and Y*

Upon detection of the 1544 kbit/s fault conditions associated with streams X and Y, the following consequent actions shall be taken in Table 5/G.762:

i) declare 1544 kbit/s alarm on the send side of port X and Y;

ii) send a 1544 kbit/s alarm indication to the remote end on the receive side of streams X and Y in accordance with § 4.2.4 of Recommendation G.733;

iii) send a signalling grouping channel AIS to the remote end by forcing the M_2 bit within the affected signalling grouping channel(s) to 1;

iv) condition the affected channels on the send side of stream Z to provide a signal in all channels that is compatible with downstream equipment;

v) declare 1544 kbit/s AIS on the send side of port X or Y;

vi) declare remote 1544 kbit/s alarm on the send side of port X or Y;

vii) send a signalling grouping channel AIS to the remote en

by forcing the M_3bit within the affected signalling grouping channel(s) to a 1.

H.T. [1T4.762]

TABLE 4/G.762
{
Signalling grouping channel fault conditions associated with stream Z and consequent actions
}

{ Consequent actions Fault conditions }	{ Declare time slot grouping alarm }	{ Send time slot grouping alarm indication to remote end }	{ Condition affected channels on X or Y }	{ Condition signalling in affected channels on X or Y }	{ Send 1544 kbit/s AIS on X or Y }	{ Declare remote time slot grouping alarm }	{ Send 1544 kbit/s alarm indication to remote end on X or Y }	{ Declare signalling grouping channel AIS }	{ Declare remote signalling grouping channel AIS }
{ Loss of signalling grouping channel multiframe alignment (single time slot grouping) }	Yes	Yes	Yes	Yes					
{ Loss of signalling grouping channel multiframe alignment (time slot grouping pair) }	Yes	Yes			Yes				
{ Remote time slot grouping alarm indication received (single time slot grouping) }			Yes	Yes		Yes			
{ Remote time slot grouping alarm indication received (time slot grouping pair) }						Yes			

Tableau 4/G.762 [1T4.762], p. 18 A L'ITALIENNE

H.T. [2T4.762]

{
TABLE 4/G.762 *(cont.)*
}

{
Consequent actions
Fault conditions
}
	{						

Declare time slot grouping alarm }	{						
Send time slot grouping alarm indication to remote end }	{						
Condition affected channels on X or Y }	{						
Condition signalling in affected channels on X or Y }	{						
Send 1544 kbit/s AIS on X or Y }	{						
Declare remote time slot grouping alarm }	{						
Send 1544 kbit/s alarm indication to remote end on X or Y }	{						
Declare signalling grouping channel AIS }	{						
Declare remote signalling grouping channel AIS }							

{
Signalling grouping channel AIS received (single time slot grouping)
}
			Yes	Yes			

{
Signalling grouping channel AIS received (time slot grouping pair)
}
					Yes		

{
Remote signalling grouping channel AIS received (single time slot grouping)
}
			Yes	Yes			

{
Remote signalling grouping channel AIS received (time slot grouping pair)
}
							Ye

Tableau 4/G.762 [2T4.762], p. 19 A L'ITALIENNE

H.T. [T5.762]

TABLE 5/G.762
{
1544 kbit/s fault conditions associated with streams X and Y and consequent actions
}

{ Consequent actions Fault conditions }	Send 1544 kbit/s alarm indication to remote end {	Send signalling grouping channel AIS {	Condition affected channels in stream Z {	Declare remote 1544 kbit/s alarm {	Send signalling grouping channel AIS indication to remote end {	
{ Loss of incoming signal at 1544 kbit/s }	Yes	Yes	Yes	Yes		
{ Loss of 1544 kbit/s frame alignment }	Yes	Yes	Yes	Yes		
1544 kbit/s AIS received		Yes	Yes	Yes	Yes	
{ 1544 kbit/s alarm received from remote end }						Yes

Tableau 5/G.762 [T5.762], p. A L'ITALIENNE

4.7 *Synchronization*

It should be possible to currently synchronize the outgoing streams of ports X, Y and Z to any one of the following:

— timing signal associated with incoming PCM stream X;

— timing signal associated with incoming PCM stream Y;

— timing signal associated with incoming stream Z;

— internal 1544 kbit/s timing signal.

4.8 *Absolute delay*

The overall absolute delay introduced by a single transcoder in either direction (PCM to ADPCM or ADPCM to PCM) should be no greater than 750 microseconds for any of the 48 channels.

When a 64kbit/s signal is transparently transferred through a single transcoder, the absolute delay introduced should be no greater than 750 microseconds in either direction. Frame integrity should be maintained for adjacent 64 kbit/s channels (i.e. equal delay).

In the case of channel associated signalling, the overall delay introduced by a single transcoder should be no greater than 5.0 milliseconds.

4.9 *Jitter*

For further study.

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