40 Hz.

FIGURE 3/G.738

7.3.3The jitter transfer function between the 2048 kbit/s input and the64 kbit/s output should not exceed -29.6 dB when measured over the frequency range f_0 to 10 kHz. The frequency f_0 should be less than 20 Hz and as low as possible (e.g., 10 Hz), taking into account the limitations of measuring equipment.

Note 1 - The 2048 kbit/s test signal shall be modulated by sinusoidal jitter. The equivalent binary content of the test signal shall be 1000.

Note 2 - In order to carry out this measurement without invoking AIS at the 64 kbit/s output it will normally be necessary to include a frame alignment signal in the test signal.

Note 3 - The jitter reduction of 1/32 due to demultiplexing is equivalent to -30.1 dB.

7.3.4Since the physical and electrical characteristics of a 320 kbit/s interface are identical to those of 2048 kbit/s interface, the jitter transfer function between 2048 kbit/s input and 320 kbit/s output is the same as that given in 7.3.1 and 7.3.2 above.

Note 1 - The frequency f_0 should be less than 20 Hz and as low as possible (e.g., 10 Hz), taking into account the limitations of measuring equipment.

Note 2 - To achieve accurate measurements, the use of a selective method is recommended with a bandwidth sufficiently small referred to the relevant measurement frequency but not wider that 40 Hz.

Note 3 - For interfaces within national boundaries, this characteristic may be used.

FIGURE 2/G.738

Note 1 - The frequency f_0 should be less than 20 Hz and as low as possible (e.g., 10 Hz), taking into account the limitations of measuring equipment.

Note 2 - To achieve accurate measurement, the use of a selective method is recommended with a bandwidth sufficiently small referred to the relevant measurement frequency but not wider than

the 2048 kbit/s interface, the specification of this parameter is the same as that given in § 7.1.3 above.

7.3Jitter transfer functions

7.3.1The jitter transfer function between the 2048 kbit/s external synchronization signal and the 2048 kbit/s output signal should not exceed the gain/frequency limits given in Figure 2/G.738. The 2 048 kHz signal shall be modulated with sinusoidal jitter.

Some administrations require that equipment is fitted with jitter reducers. In this case, the jitter transfer function should not exceed the gain/frequency limits given in Figure 3/G.738.

7.3.2In the case where the transmitting timing is derived from the incoming signal the jitter transfer function between the 2048 kbit/s input and the 2048 kbit/s output shall be as specified in § 7.3.1.

Note 1 - The 2048 kbit/s test signal shall be modulated by sinusoidal jitter. The equivalent binary content of the test signal shall be 1000.

Note 2 - It may be necessary to include a frame alignment signal in the test signal to enable the measurement to be carried out.

Note to Table 1/G.738 - A "Yes" in the table signifies that an action should be taken as a consequence of the relevant fault condition. An open space in the table signifies that the relevant action should not be taken as a consequence of the relevant fault condition, if this condition is the only one present. If more than one fault condition is simultaneously present, the relevant action should be taken if, for at least one of the conditions, a "Yes" is defined in relation to this action.

7. Jitter

7.1 Jitter at 2048 kbit/s output (see Figure 2/G.823)

7.1.1 In the case where the transmitting timing signal is derived from an internal oscillator, the peak-to-peak jitter at the 2048 kbit/s output should not exceed 0.05 UI when it is measured within the frequency range from f_1 = 20 Hz to f_4 = 100 kHz.

7.1.2 In the case where the transmitting timing signal is derived from an external source having no jitter, the peak-to-peak jitter at the 2048 kbit/s output should not exceed 0.05 UI when it is measured within the frequency range from f_1 = 20 Hz to f_4 = 100 kHz.

7.1.3 In the case where the transmitting timing signal is derived from the incoming 2048 kbit/s signal having no jitter, the peak-to-peak jitter at the 2048 kbit/s output should not exceed 0.10 UI when it is measured within the frequency range from f_1 = 20 Hz to f_4 = 100 kHz. The equivalent binary content of the test signal applied at the 2048 kbit/s input shall be a pseudo-random bit sequence of length 2^{15}-1 as specified in Recommendation 0.151.

Note - It may be necessary to include a frame alignment signal in the test signal to enable the measurement to be carried out.

7.2 Jitter at tributary outputs

7.2.1 Jitter at 64 kbit/s output

In the case where the incoming 2048 kbit/s signal has no jitter, the peak-to-peak jitter at the 64 kbit/s output should not exceed 0.025 UI when it is measured within the frequency range from f_1 = 20 Hz to f_4 = 10 kHz. The equivalent binary content of the test signal applied to the 2048 kbit/s input shall be a pseudo-random bit sequence of length 2^{15}-1 as specified in Recommendation 0.151.

Note - In order to carry out this measurement without invoking AIS at the 64 kbit/s output it will normally be necessary to include a frame alignment signal in the test signal.

7.2.2 Jitter at 320 kbit/s output

Since the physical and electrical characteristics of a 320 kbit/s interface are identical to those of

Equipment part	Fault conditions (see § 4.1)	Consequent actions (see § 3.2)					
		Service alarm	Prompt maintenance indication	Alarm indication	Transmission suppressed at the analogue outputs	AIS applied to 64 kbit/s and 320 kbit/s frequency outputs	AIS applied to the relevant time slot of the 2048 kbit/s composite signal
	Loss of incoming signal at 2048 kbit/s	Yes	Yes	Yes	Yes	Yes	
	Loss of frame alignment (see Note 2 4.2/G.706)	Yes	Yes (see § 4.2.2)	Yes	Yes	Yes	
Demultiplexer only	Error ratio 1 10^{-3}	Yes	Yes (see § 4.2.2)	Yes	Yes	Yes	
	Alarm indication received from the remote end	Yes					

Equipment part	Fault conditions (see § 4.1)	Consequent actions (see § 3.2)					
		Service alarm	Prompt maintenance indication	Alarm indication	Transmission suppressed at the analogue outputs	AIS applied to 64 kbit/s and 320 kbit/s relevant time slot of the 2048 kbit/s composite signal	AIS applied to the frequency outputs
Multiplexer and demultiplexer	Failure of power supply	Yes	Yes	Yes (if practicable)	Yes (if practicable)	Yes (if practicable)	Yes (if practicable)
	Failure of codec	Yes	Yes	Yes	Yes		
Multiplexer only	Loss of incoming signal at 64 kbit/s and/or 320 kbit/s inputs (see note under § 4.1.3)	Yes				Yes	

TABLE 1/G.738 (continued)

Note 1 - The equivalent binary content of the alarm indication signal (AIS) is a continuous stream of binary 1s. The strategy for detecting the presence of the AIS should be such that with a high probability the AIS is detectable even in the presence of random errors having a mean error rate of 1 in 10^3. Nevertheless, a signal in which all the binary elements, with the exception of the frame alignment signal, are in the state 1, should not be taken as an AIS.

Note 2 - All timing requirements quoted apply equally to restoration, subsequent to the fault condition clearing.

5.Signalling

Text as in Recommendation G.732.

6.Interfaces

6.1Audio frequency interface

The analogue audio frequency interfaces should be in accordance with Recommendations G.712, G.713, G.714 and G.715.

6.2Digital interfaces

The digital interfaces at 2048 kbit/s should be in accordance with Recommendation G.703.

The digital interfaces at 64 kbit/s should be of either the codirectional or the contradirectional type specified in Recommendation G.703. The specification for 64 kbit/s interfaces are not mandatory for channel associated signalling. The interface for external synchronization of the transmitting timing signal should be in accordance with Recommendation G.703.

The need to define a digital interface operating at 320 kbit/s is under study.

Note 1 - It should be noted that, according to the principle of minimizing the number of different types of interfaces, the information rate of 320 kbit/s will be offered to customers at the user/network interface level using the 2048 kbit/s interface as defined in Recommendation I.431 and Recommendation G.703.

Note 2 - In the case of the 64 kbit/s codirectional interface, the design of the input ports should take into account the need to provide octet alignment, to allow controlled slips when the tributary timing and that of the multiplexer timing source are plesiochronous, and to absorb jitter and wander up to the limits given in Recommendation G.823.

TABLE 1/G.738

Fault conditions and consequent actions for the PCM multiplex equipment

order of 4 to 5 seconds.

4.1.7Alarm indication received from the remote PCM multiplex equipment (see § 4.2.3).

4.2Consequent actions

Further to the detection of a fault condition, appropriate actions should be taken as specified in Table 1/G.738. The consequent actions are as follows:

4.2.1Service alarm indication generated to signify that the service provided by the PCM multiplex is no longer available. This indication should be forwarded at least to the switching and/or signalling multiplex equipment depending upon the arrangements provided. The indication should be given as soon as possible and not later than 2 ms after detection of the relevant fault condition.

This specification, taking into account the specification given in § 2.5, is equivalent to recommending that the average time to detect a loss of frame alignment or a loss of the incoming 2048 kbit/s signal and to give the relevant indication should not be greater than 3 ms.

When using common channel signalling the indication should be forwarded to the switching equipment by means of a separate interface on the PCM multiplex equipment.

4.2.2Prompt maintenance alarm indication generated to signify that performance is below acceptable standards and maintenance attention is required locally. When the AIS (see general note below to § 4.2) at 2048 kbit/s input is detected the prompt maintenance alarm indication, associated with loss of frame alignment (see § 4.1.5) and excessive error rate (see § 4.1.6), should be inhibited, while the rest of the consequent actions are in accordance with those associated in Table 1/G.738 with the two fault conditions.

Note - The location and provision of any visual and/or audible alarm activated by the alarm indications given in § 4.2.1 and § 4.2.2, is left to the discretion of each administration.

4.2.3Alarm indication to the remote end transmitted by changing bit 3 of channel time slot 0 from the state 0 to the state 1 in those frames not containing the frame alignment signal. This should be effected as soon as possible.

4.2.4Transmission suppressed at the analogue voice-frequency outputs

4.2.5AIS applied to all 64 kbit/s and 320 kbit/s outputs (see general note below to § 4.2). For 64 kbit/s outputs this action should be taken as soon as possible and not later than 2 ms after the detection of the fault condition.

4.2.6AIS applied to relevant time slots in the composite 2048 kbit/s output signal (if suspension of incoming 64 kbit/s and 320 kbit/s signals is provided).

Notes to § 4.2

4.1Fault conditions

The PMC multiplex equipment should detect the following conditions:

4.1.1Failure of power supply.

4.1.2Failure of codec (except when using single channel codecs).

As a minimum requirement, this fault condition should be recognized when for at least one signal level in the range -21 to -6 dBmO, the signal-to-quantizing noise ration performance of the local codec is 18 dB or more below the level recommended in Recommendation G.712.

4.1.3Loss of incoming signals at the 64 kbit/s and 320 kbit/s tributary input ports.

Note 1 - This detection is not mandatory when contradirectional interfaces are used.

Note 2 - The detection of this fault condition is not mandatory for channel time slot 16 when channel associated signalling is used and the signalling multiplex equipment is situated within a few metres of the PCM multiplex equipment.

4.1.4Loss of the incoming signal at 2048 kbit/s.

Note 1 - The detection of this fault condition is required only when it does not result in an indication of loss of frame alignment.

Note 2 - Where separate circuits are used for the digital signal and the timing signal, the loss of either or both should constitute loss of the incoming signal.

4.1.5Loss of frame alignment.

4.1.6Excessive bit error ratio detected by monitoring the frame alignment signal.

4.1.6.1With a random bit error ratio of $\leq 10^{-4}$, the probability of activating the indication of fault condition in a few seconds should be less than 10^{-6}.

With a random bit error ratio of $\geq 10^{-3}$, the probability of activating the indication of fault condition in a few seconds should be higher than 0.95.

4.1.6.2With a random bit error ratio of $\geq 10^{-3}$, the probability of deactivating the indication of fault condition in a few seconds should be almost 0.

With a random bit error ratio of $\leq 10^{-4}$, the probability of deactivating theindication of fault condition in a few seconds should be higher than 0.95.

Note - The activating and deactivating period specified as "a few seconds" is intended to be in the

b) Unidirectional synchronous insertion and extraction of digital sound-programme (DSP) into/out of a 320 kbit/s channel

I,E: insertion side; extraction side

I_1,E_1: 2048 kbit/s interface

I_2,E_2 64 kbit/s interface

I_3,E_3: synchronous; digital sound programme signal access

T: timing signal

FIGURE 1/G.738

PCM multiplex equipment operating at 2048 kbit/s
and offering access to digital sound-programme signals
and/or to synchronous 64 kbit/s data channels

3.Frame alignment and CRC procedures

(An illustration of the procedure is given in Figure 2/G.706.)

3.1Loss of frame alignment

Refer to § 4.1.1. of Recommendation G.706.

3.2Recovery of frame alignment

Refer to § 4.1.2 of Recommendation G.706.

3.3CRC multiframe alignment in TSO

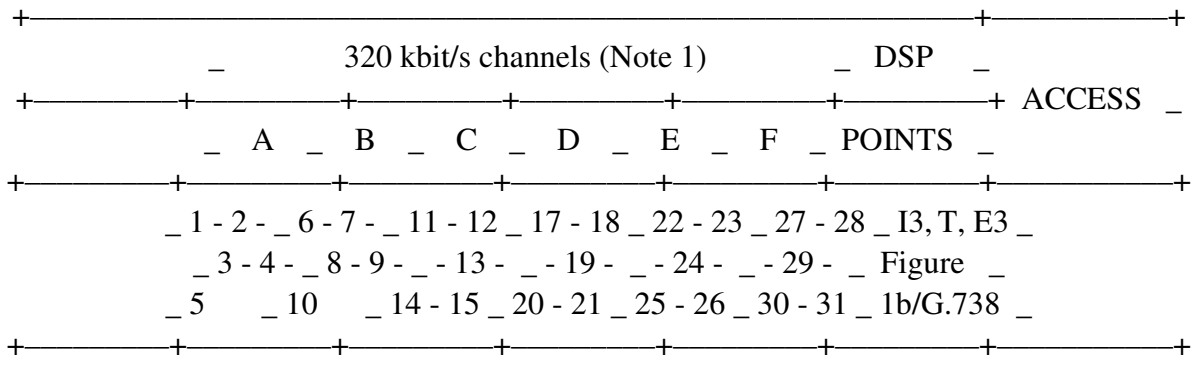
Refer to § 4.2 of Recommendation G.706.

3.4CRC bit monitoring

Refer to § 4.3 of Recommendation G.706.

4.Fault conditions and consequent actions

table:



Note 1 - The six possible 320 kbit/s channels in a 2048 kbit/s stream are numbered A to F. Preferably the channel pairs A-B, C-D, and E-F should be used for stereophonic transmission.

Note 2 - If the channel time slot 16 which is assigned to signalling as covered in § 5 below is not needed for signalling, it may be used for purposes other thana voice channel encoded within the PCM multiplex equipment.

a) Bidirectional synchronous insertion/extraction of 64 kbit/s data channels

c) from an internal oscillator.

Note - The provision of a timing signal output, available for the purpose of synchronizing other equipments, is an option that might be required depending upon national synchronization arrangements.

1.4Types of access

a) access for bidirectional synchronous 64 kbit/s channels (see Figure 1a/G.738);

b) access for unidirectional synchronous 320 kbit/s channels (see Figure 1b/G.738).

Note - The synchronous insertion of a digital sound programme signal into a 320 kbit/s channel requires the internal regeneration of a timing signal T synchronized by the 2048 kbit/s signal I_1. the timing signal is used for synchronizing the sampling frequency of the analogue/digital converters producing the digital sound programme signal.

2.Frame structure and use of derived channel time slot

2.1Frame structure of 2048 kbit/s signal

Refer to § 2.3 of Recommendation G.704. Bit 1 of the frame should be used in accordance with § 2.3.3/6.706, i.e., for a CRC check bit procedure.

2.2Use of derived channel time slots

2.2.1Telephone channels

It should be possible to assign channel time slots 1 to 15 and 17 to 31 to 30 telephone channels numbered from 1 to 30.

2.2.264 kbit/s access

The number of accessible channel time slots should be at least four and the equipment shall allow access to any of channel time slots 1 to 15 and 17 to 31.

Note - Equipment exists which provides access to at least four channel time slots in the following order to priority:

6 - 22 - 14 - 30 - 2 - 18 - 10 - 26 - 4 - 20 - 12 - 28 - 8 - 24 - 5 -21 - 13 - 29 - 1 - 17 - 9 - 25 - 3 - 19 - 11 - 27 - 7 - 23 - 15 - 31.

2.2.3320 kbit/s access

The time slot allocation for digital channels with bit rate at 320 kbit/s is given in the following

8.Recommendation G.738

CHARACTERISTICS OF PRIMARY PCM MULTIPLEX EQUIPMENT OPERATING AT 2048 KBIT/S AND OFFERING SYNCHRONOUS DIGITAL ACCESS AT 320 KBIT/S AND/OR 64 KBIT/S

(Melbourne, 1988)

This Recommendation gives the characteristics of a PCM multiplex equipment operating at 2048 kbit/s and providing one or several of the following internal digital access options:

- bidirectional synchronous 64 kbit/s channels (see Figure 1a/G.738;

- unidirectional synchronous 320 kbit/s channels (see Figure 1b/G.738.

The 320 kbit/s channel is based on the allocation of 5 x 64 kbit/s time slots, e.g., for setting up sound-programme circuits according to Recommendations J.43 and J.44.

Because these circuits are specified as unidirectional, the equipment for insertion/extraction has to be separated as shown in Figures 1b/G.738.

1.General characteristics

1.1Fundamental characteristics for voice channel encoding

The encoding law used is the A-law as specified in Recommendation G.711. The sampling rate, load capacity and the code are also specified in that Recommendation.

The number of quantized values is 256.

Note - The inversion of bits 2, 4, 6 and 8 is covered by the encoding law and is applicable only to voice channel time slots.

1.2Bit rate

The nominal bit rate is 2 048 kbit/s. The tolerance on this rate is $\pm$ 50 parts per million (ppm).

1.3Timing signal

It should be possible to derive the transmit timing signal from any of the following:

a) from the received 2084 kbit/s signal;

b) from an external source at 2 048 kHz (see § 5);