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 40 Hz.

FIGURE 3/G.739

Section 7.6 - Principal characteristics of transcoder and digital circuit multiplication equipment.

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 than 40 Hz.

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

FIGURE 2/G.739

6.3Jitter transfer functions

6.3.1The jitter transfer function between the 2048 kbit/s input (I_0, E_1) and the output (I_1, E_0) should not exceed the gain/frequency limits given in Figure 2/G.739.

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.739.

Note 1 - The 2 048 kHz signal shall be modulated with 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.

6.3.2The jitter transfer function between the 2048 kbit/s input (E_1) and the E_2 (64 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.

6.3.3Since the physical and electrical characteristics of a 320 kbit/s interface are identical to those of the 2048 kbit/s interface, the jitter transfer function between the 2048 kbit/s input (E_1) and E_3 (synchronous 320 kbit/s) output is according to 6.3.1 above.

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

The digital interfaces at 64 kbit/s should be either of the codirectional or the contradirectional type specified in 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 Recommendations I.431 and 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.

6.Jitter

6.1Jitter at 2048 kbit/s output

When there is no jitter on the 2048 kbit/s inputs (I_0, E_1) the peak-to-peak jitter at the 2048 kbit/s outputs (I_1, E_0) 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. See Figure 2/G.823.

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

6.2Jitter at E_2, E_3 outputs

The jitter at the E_2 (64 kbit/s) output when there is no jitter at the 2048 kbit/s input (E_1) should not exceed 0.025 UI when 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 - 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.

6.2.2Since the physical and electrical characteristics of a 320 kbit/s interface are identical to those of the 2048 kbit/s interface, the jitter at the E_3 (synchronous 320 kbit/s) output when there is no jitter at the 2048 kbit/s input (E_1) is according to 6.1 above.

_ alignment +———————+———————+———————+———————
+———————+———————+———————+
_ (see Ins.s _ Yes (see _ _ Yes _ _ _ _ Yes _
_ Note 2 of (I_0) _ § 4.2.1) _ _ _ _ _ _ _ _
_ 4.2/G.706) _ _ _ _ _ _ _ _
+———————+———————+———————+———————+———————+———
———+———————+———————+———————+
_ Error Extr.s._ Yes (see _ Yes _ _ _ _ Yes _ _
_ ratio (E_1) _ § 4.2.1) _ _ _ _ _ _ _ _
_ 1.10^{-3} _ _ _ _ _ _ _ _
_ on the _ _ _ _ _ _ _ _
_ frame +———————+———————+———————+———————
+———————+———————+———————+
_ alignment Ins.s._ Yes (see _ _ Yes _ _ _ _ Yes _
_ signal (I_0) _ § 4.2.1) _ _ _ _ _ _ _ _
_ (see note _ _ _ _ _ _ _ _
_ under _ _ _ _ _ _ _ _
_ (§ 4.1.5) _ _ _ _ _ _ _ _
+———————+———————+———————+———————+———————+———
———+———————+———————+———————+

Note - 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.

4.2.7 AIS applied to the 2048 kbit/s output, insertion side (I_1)

Note - The provision of this consequent action depends on the type of this equipment in a network and therefore is not mandatory.

General note to § 4.2 - 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 ratio 1.10^{-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 - All timing requirements quoted apply equally to restoration, subsequent to the fault condition clearing.

5. Interfaces

Loss of incoming signal at I_2, I_3 inputs (see note under § 4.1.2)	Yes			Yes				
Loss of incoming signal	Extr.s. (E_1)	Yes	Yes				Yes	
at 2048 kbit/s	Ins.s. (I_0)	Yes		Yes				Yes

TABLE 1/G.739 (continued)

Fault conditions (see § 4.1)	Consequent actions (see § 4.2)				Both 2048 kbit/s	AIS applied to the 2048 kbit/s output,	AIS applied to the insertion side
	Prompt maintenance alarms indication	AIS applied to E_2, E_3 outputs generated	Inhibition of digital information I_2 , I_3 composite signal at insertion side (I_0)	AIS applied to the relevant time slot of the 2048 kbit/s composite signal	signal are bypassed (see Note under § 4.2.7)		
Loss of frame	Extr.s. (E_1)	Yes (see § 4.2.1)			Yes		

4.2.3AIS applied to relevant time slots in the composite 2048 kbit/s output signalat insertion side (I_1) if supervision of the incoming I_2, I_3 signal is provided.

4.2.4Inhibition of I_2, I_3 digital information insertion

4.2.5Both 2048 kbit/s signals are bypassed

Note - The provision of this consequent action depends on the type of application of this equipment in a network and therefore is not mandatory.

4.2.6AIS applied to the 2048 kbit/s output, extraction side (E_0)

Note - The provision of this consequent action depends on the type of application of this equipment in a network and therefore is not mandatory.

TABLE 1/G.739

Fault conditions and consequent actions for the external access equipment

Fault conditions (see § 4.1)	Consequent actions (see § 4.2)						
	Prompt maintenance alarms indication generated	AIS applied to E_2, E_3 outputs	Inhibition of digital information I_2 , I_3	Both 2048 kbit/s signals are bypassed (see Note under § 4.2.5)	AIS applied to the 2048 kbit/s output, extraction side (E_O) (see note under § 4.2.6)	AIS applied to the 2048 kbit/s output, insertion side (I_1) (see note under § 4.2.7)	AIS applied to relevant time slots of the composite 2048 kbit/s signal at insertion side (I_0)
Failure of power supply	Yes			Yes	Yes (if practicable)	Yes (if practicable)	

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.

4.1.4Loss of frame alignment both at insertion (I_0) and extraction (E_1) sides.

4.1.5Excessive bit error ratio detected by monitoring the frame alignment signal at both the insertion (I_0) and extraction (E_1) sides.

Note - The detection of this fault condition at insertion side (I_0) depends on the type of application of this equipment in a network and therefore is not mandatory.

4.1.5.1With 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.

4.1.5.2With 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 the indication of fault condition in a few seconds should be higher than 0.95.

Note - The activating and deactivating period specified as "as few seconds" is intended to be in the order to 4 to 5 seconds.

4.2Consequent actions

Further to the detection of fault condition, appropriate actions should be taken as specified in Table 1/G.739. The consequent actions are as follows:

4.2.1Prompt maintenance alarm indication generated to signify that performance is below acceptable standards and maintenance attention is required locally. When the AIS at the 2048 kbit/s inputs (I_0, E_1) is detected (see general note below to § 4.2) the prompt maintenance alarm indication associated with loss of frame alignment (see § 4.1.4) and excessive error rate (see § 4.1.5), should be inhibited, while the rest of the consequent actions are in accordance with those associated in Table 1/G.739 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, is left to the discretion of each administration.

4.2.2AIS applied to I_2, I_3 outputs (see general note below to § 4.2). This action should be taken as soon as possible and not later than 2 ms after the detection of the fault condition.

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

I_0,I_1: insertion side

E_0,E_1: extraction side

I_2,E_2 64 kbit/s interface

I_3,E_3: synchronous; digital sound programme signal access

T: timing signal

FIGURE 1/G.739

External access equipment for 64 and 320 kbit/s channels

4. Fault conditions and consequent actions

4.1 Fault conditions

The equipment should detect the following conditions:

4.1.1 Failure of power supply.

4.1.2 Loss of incoming signal.

Note - This detection is not mandatory when contra-directional interfaces are used.

4.1.3 Loss of the incoming signal at 2048 kbit/s both at insertion (I_0) and extraction (E_1) sides.

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 - 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 than a voice channel encoded within the PCM multiplex equipment.

3.Frame alignment and CRC procedures both at insertion (I_0) and extraction (E_1) sides

(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.

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

of the synchronous insertion equipment is used for synchronizing the sampling frequency of the analogue/digital converter.

2.Frame structure and use of derived channel time slots

2.1Frame structure of the 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/G.704, i.e., for a CRC check bit procedure.

2.2Use of derived channel time slots

Time slots not accessed flow transparently through the equipment.

Note - Further study is required as to whether the binary content of time slots used at the access points should be replaced, after extraction from the composite signal, by the AIS.

2.2.164 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 of 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

2.2.2320 kbit/s access

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

320 kbit/s channels (Note 1)						DSP ACCESS POINTS
A	B	C	D	E	F	
1 - 2 - 3 - 4 - 5	6 - 7 - 8 - 9 - 10	11 - 12 - 13 - 14 - 15	17 - 18 - 19 - 20 - 21	22 - 23 - 24 - 25 - 26	27 - 28 - 29 - 30 - 31	I3, T, E3 Figure 1b/G.739

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.

9.Recommendation G.739

CHARACTERISTICS OF AN EXTERNAL ACCESS EQUIPMENT OPERATING AT 2048 KBIT/S OFFERING SYNCHRONOUS DIGITAL ACCESS AT 320 KBIT/S AND/OR 64 KBIT/S

This Recommendation gives the characteristics of equipment (external to PCM muldexes) operating at 2048 kbit/s and providing one or several of the following tributaries into/from channel time slots of a 2048 kbit/s composite signal:

-bidirectional synchronous 64 kbit/s access (Figure 1a/G.739);

- unidirectional synchronous 320 kbit/s access (Figure 1b/G.739).

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 Figure 1b/G.739.

1.General characteristics

1.1Bit rate

The nominal bit rate is 2048 kbit/s. The tolerance on this rate is $\pm$ 50 parts per million (ppm).

1.2Types of external access

a)Bidirectional synchronous insertion/extraction of 64 kbit/s data channels (see Figure 1a/G.739).

Note 1 - The timing signal for the insertion side should be derived from the 2048 kbit/s incoming signal at the insertion side (I_0); the timing signal for the extraction side should be derived from the 2048 kbit/s incoming signal at the extraction side (E_1).

Note 2 - 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.

Note 3 - Further study is required on the possible need for an internal clock.

b) Unidirectional synchronous insertion and extraction of a digital sound-programme signal into/out of 320 kbit/s channel (see Figure 1b/G.739).

Note - The synchronous insertion equipment for 320 kbit/s signals requires the internal regeneration of a timing signal synchronized by the 2048 kbit/s input signal I_0. This timing signal output