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SERIES H: AUDIOVISUAL AND MULTIMEDIA SYSTEMS

Infrastructure of audiovisual services – Transmission multiplexing and synchronization

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Frame structure for a 64 to 1920 kbit/s channel in audiovisual teleservices

ITU-T Recommendation H.221

Superseded by a more recent version

(Previously CCITT Recommendation)

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ITU-T H-SERIES RECOMMENDATIONS

AUDIOVISUAL AND MULTIMEDIA SYSTEMS

Characteristics of transmission channels used for other than telephone purposes	H.10–H.19
Use of telephone-type circuits for voice-frequency telegraphy	H.20–H.29
Telephone circuits or cables used for various types of telegraph transmission or simultaneous transmission	H.30–H.39
Telephone-type circuits used for facsimile telegraphy	H.40–H.49
Characteristics of data signals	H.50–H.99
CHARACTERISTICS OF VISUAL TELEPHONE SYSTEMS	H.100–H.199
INFRASTRUCTURE OF AUDIOVISUAL SERVICES	H.200–H.399
General	H.200–H.219
Transmission multiplexing and synchronization	**H.220–H.229**
Systems aspects	H.230–H.239
Communication procedures	H.240–H.259
Coding of moving video	H.260–H.279
Related systems aspects	H.280–H.299
Systems and terminal equipment for audiovisual services	H.300–H.399

For further details, please refer to ITU-T List of Recommendations.

ITU-T RECOMMENDATION H.221

FRAME STRUCTURE FOR A 64 TO 1920 kbit/s CHANNEL IN AUDIOVISUAL TELESERVICES

Summary

The purpose of this Recommendation is to define a frame structure for audiovisual teleservices in single or multiple B or H_0 channels or a single H_{11} or H_{12} channel which makes the best use of the characteristics and properties of the audio and video encoding algorithms, of the transmission frame structure and of the existing Recommendations. It offers several advantages:

- It takes into account Recommendations such as G.704, X.30/I.461, etc. It may allow the use of existing hardware or software.
- It is simple, economic and flexible. It may be implemented on a simple microprocessor using well-known hardware principles.
- It is a synchronous procedure. The exact time of a configuration change is the same in the transmitter and the receiver. Configurations can be changed at 20 ms intervals.
- It needs no return link for audiovisual signal transmission, since a configuration is signalled by repeatedly transmitted codewords.
- It is very secure in case of transmission errors, since the code controlling the multiplex is protected by a double-error correcting code.
- It allows the synchronization of multiple 64 kbit/s or 384 kbit/s connections and the control of the multiplexing of audio, video, data and other signals within the synchronized multiconnection structure in the case of multimedia services such as videoconference.
- It can be used to derive octet synchronization in networks where this is not provided by other means.
- It can be used in multipoint configurations, where no dialogue is needed to negotiate the use of a data channel.
- It provides a variety of data bit-rates (from 300 bit/s up to almost 2 Mbit/s) to the user.

Source

ITU-T Recommendation H.221 was revised by ITU-T Study Group 16 (1997-2000) and was approved under the WTSC Resolution No. 1 procedure on the 10th of July 1997.

FOREWORD

ITU (International Telecommunication Union) is the United Nations Specialized Agency in the field of telecommunications. The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of the ITU. The ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Conference (WTSC), which meets every four years, establishes the topics for study by the ITU-T Study Groups which, in their turn, produce Recommendations on these topics.

The approval of Recommendations by the Members of the ITU-T is covered by the procedure laid down in WTSC Resolution No. 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

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The ITU draws attention to the possibility that the practice or implementation of this Recommendation may involve the use of a claimed Intellectual Property Right. The ITU takes no position concerning the evidence, validity or applicability of claimed Intellectual Property Rights, whether asserted by ITU members or others outside of the Recommendation development process.

As of the date of approval of this Recommendation, the ITU had received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementors are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database.

CONTENTS

Recommendation H.221

FRAME STRUCTURE FOR A 64 TO 1920 kbit/s CHANNEL IN AUDIOVISUAL TELESERVICES

(revised in 1990, at Helsinki, 1993, in 1995, and in 1997)

1 Basic principle

This Recommendation provides for dynamically subdividing an overall transmission channel of 64 to 1920 kbit/s into lower rates suitable for audio, video, data and telematics purposes. The overall transmission channel is derived by synchronizing and ordering transmissions over from 1 to 6 B-connections, from 1 to 5 H_0 connections, or an H_{11} or H_{12} connection. The first connection established is the initial connection and carries the initial channel in each direction. The additional connections carry additional channels.

The total rate of transmitted information is called the "transfer rate"; it is possible to fix the transfer rate less than the capacity of the overall transmission channel (values listed in Annex A).

A single 64 kbit/s channel is structured into octets transmitted at 8 kHz. Each bit position of the octets may be regarded as a sub-channel of 8 kbit/s (see Figure 1). The eighth sub-channel is called the Service Channel (SC), consisting of several parts as described in 1.1 to 1.4.

An H_0, H_{11} or H_{12} channel may be regarded as consisting of a number of 64 kbit/s Time-Slots (TS) (see Figure 2). The lowest numbered time-slot is structured exactly as described for a single 64 kbit/s channel, while the other TS have no such structure. In the case of multiple B or H_0 channels, all channels have a frame structure; that is, the initial channel controls most functions across the overall transmission, while the frame structure in the additional channels is used for synchronization, channel numbering and related controls.

The term "I-channel" is applied to the initial or only B-channel, to TS1 of initial or only H_0 channel, and to TS1 of H_{11}, H_{12} channels.

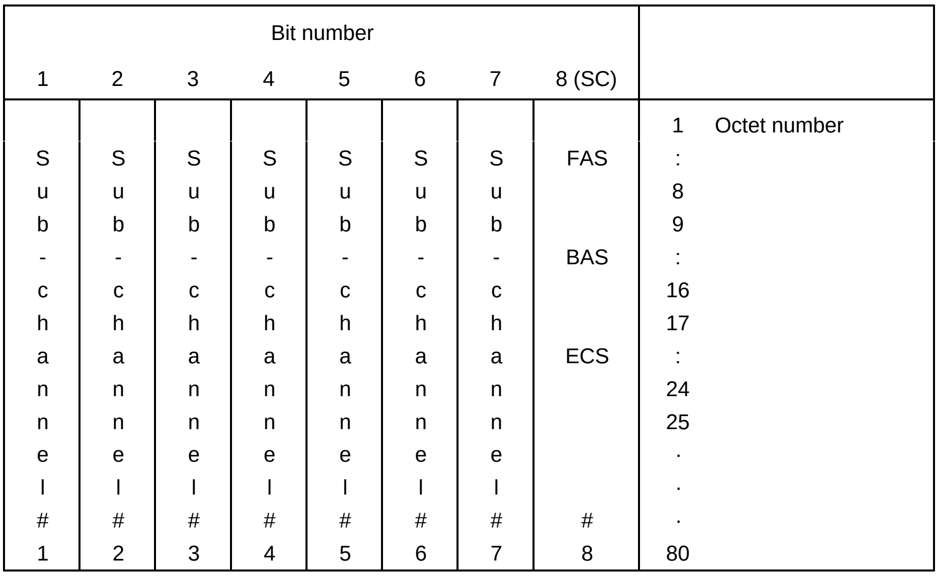
1.1 Frame Alignment Signal (FAS)

This signal structures the I-channel and other framed 64 kbit/s channels into frames of 80 octets each and Multiframes (MF) of 16 frames each. Each multiframe is divided into eight 2-frame Sub-Multiframes (SMF). The term "Frame Alignment Signal" refers to bits 1-8 of the SC in each frame. In addition to framing and multiframing information, control and alarm information may be inserted in the FAS, as well as error check information to control end-to-end error performance and to check frame alignment validity. Other time-slots are aligned to the first.

The bits are transmitted to line in order, bit 1 first.

When an 8 kHz network clock is provided, FAS is transmitted and received in the least significant bit of the octet within each 125 µs, e.g. in an ISDN basic or primary rate interface. It should be noted that, where interworking between the audiovisual terminal and the telephone is required, transmission using the network timing is essential. In the receiver side, FAS should be sought in all bit positions. If received FAS position conflicts with the network octet timing, the FAS position is given priority. This may happen when the receiver utilizes network octet timing while the transmitter does not as in a terminal using codecs separate with ISDN terminal adaptor, or when interworking between 64 kbit/s and 56 kbit/s terminals takes place.

The FAS can be used to derive receive octet timing when it is not provided by the network. However, in the latter case, the terminal cannot transmit FAS with correct alignment into the octet-timed part of the network and cannot intercommunicate with terminals which rely only on network timing for octet alignment.



FAS Frame Alignment Signal
BAS Bit-rate Allocation Signal
ECS Encryption Control Signal

Figure 1/H.221 – Frame structure of a single 64 kbit/s channel (B-channel)

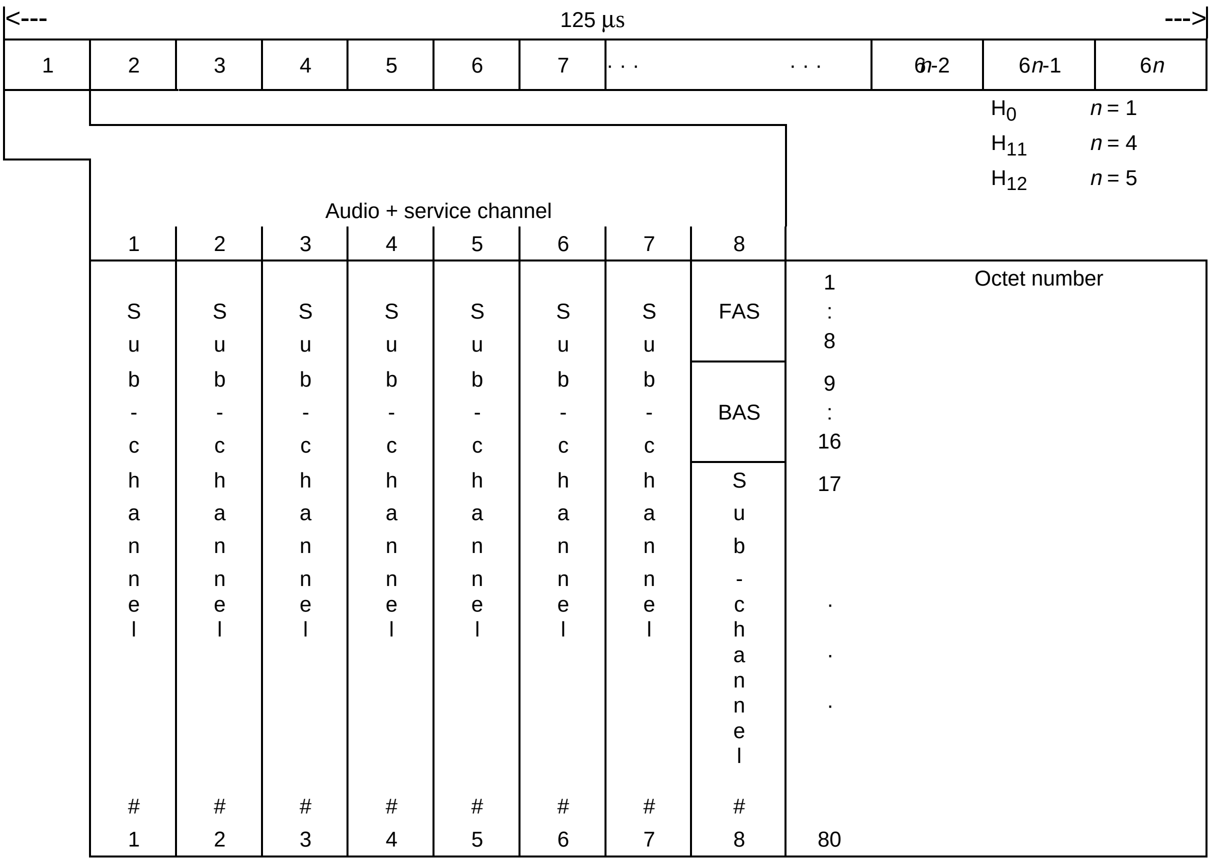


Figure 2/H.221 – Frame structure of higher-rate single channels
(H_0, H_{11}, H_{12} channels)

1.2 Bit-rate Allocation Signal (BAS)

Bits 9-16 of the SC in each frame are referred to as BAS. This signal allows the transmission of codewords to describe the capability of a terminal to structure the capacity of the channel or synchronized multiple channels in various ways, and to command a receiver to demultiplex and make use of the constituent signals in such structures. This signal is also used for controls and indications.

NOTE – For some countries having 56 kbit/s channels, the net available bit rates will be 8 kbit/s less. Interworking between a 64 kbit/s terminal and a 56 kbit/s terminal is established according to the frame structure in Annex B.

1.3 Encryption Control Signal (ECS)

Encryption capability requires a dedicated transmission channel. This is provided when required by allocating the bits 17-24 of the service channel. This reduces variable data and video transmission rates herein by 800 bit/s. The 800 bit/s is referred to as the ECS channel.

1.4 Remaining capacity

The remaining capacity (including the rest of the service channel), carried in bits 1-8 of each octet in the case of a single 64 kbit/s connection, may convey a variety of signals within the framework of a multimedia service, under the control of the BAS. Some examples follow:

– voice encoded at 56 kbit/s using a truncated form of PCM of Recommendation G.711 (A-law or μ-law);

– voice encoded at 16 kbit/s and video at 46.4 kbit/s;

– voice encoded at 56 kbit/s with a bandwidth 50 to 7000 Hz (sub-band ADPCM according to Recommendation G.722); the coding algorithm is also able to work at 48 kbit/s – data can then be dynamically inserted at up to 14.4 kbit/s;

– still pictures coded at 56 kbit/s;

– data at 56 kbit/s inside an audiovisual session (e.g. file transfer for communicating between personal computers).

2 Frame alignment

2.1 General

An 80-octet frame length produces an 80-bit word in the service channel. These 80 bits are numbered 1-80. Bits 1-8 of the service channel in every frame constitute the FAS (see Figure 3), whose content is as follows:

– multiframe structure (see 2.2);

– Frame Alignment Word (FAW);

– A-bit;

– E- and C-bits (see 2.6).

The FAW consists of "0011011" in bits 2-8 of the FAS in even frames, complemented by a "1" in bit 2 of the succeeding odd frame.

The "A-bit" of the I-channel is set to zero whenever the receiver is in multiframe alignment, and is set to "1" otherwise (see 2.3); for additional channels, see 2.7.1.

2.2 Multiframe structure

Each multiframe contains 16-consecutive frames numbered 0 to 15 divided into eight sub-multiframes of two frames each (see Figure 4). The multiframe alignment signal is located in bit 1 of frames 1-3-5-7-9-11 and has the form 001011. Bit 1 of frame 15 remains reserved for future use. The value is fixed at 0.

Successive frames	Bit number 1	2	3	4	5	6	7	8
Even frames	(Note 1)	**0**	**0**	**1**	**1**	**0**	**1**	**1**
		Frame alignment word (Note 2)						
Odd frames	(Note 1)	**1** (Note 2)	**A** (Note 3)	**E** (Note 4)	**C1**	**C2**	**C3**	**C4**

NOTE 1 – See 2.2 and Figure 4.

NOTE 2 – The first seven bits of the frame alignment word are in the even frames. The eighth bit of the FAW in the odd frame is the complement of the first FAW bit in order to avoid simulation of FAW by a frame-repetitive pattern.

NOTE 3 – A-bit: loss of multiframe alignment indication (0 = alignment; 1 = loss).

NOTE 4 – The use of bits E and C1-C4 is described in 2.6 [0 = no error or Cyclic Redundancy Check (CRC) not in use; 1 = error].

Figure 3/H.221 – Assignment of bits 1-8 of the service channel in each frame

Bit 1 of frames 0-2-4-6 may be used for a modulo 16 counter to number multiframes in descending order. The least significant bit is transmitted in frame 0, and the most significant bit in frame 6. The receiver uses the multiframe numbering to equalize out the differential delay of separate connections, and to synchronize the received signals.

The multiframe numbering is mandatory both in initial and additional channels for multiple B or multiple H_0 communications, but it may or may not be inserted for single B or single H_0 or H_{11}/H_{12} for other communications where synchronization between multiple channels is not required.

Bit 1 of frame 8 is set to 1 when multiframes are numbered and is set to 0 when they are not.

Bit 1 of frames 10-12-13 shall be used to number each channel in a multiconnection structure so that the distant receiver can place the octets received in each 125 µs in the correct order.

Information bits in the multiframe should be validated by, for example, being received consistently for three multiframes.

2.3 Loss and recovery of frame alignment

Frame alignment is defined to have been lost when three consecutive frame alignment words have been received with an error.

Frame alignment is defined to have been recovered when the following sequence is detected:

– for the first time, the presence of the correct first seven bits of the frame alignment word;

– the eighth bit of the frame alignment word in the following frame is detected by verifying that bit 2 is a 1;

– for the second time, the presence of the correct first seven bits of the frame alignment word in the next frame.

If frame alignment is achieved but multiframe alignment cannot be achieved, then frame alignment shall be sought at another position.

When the frame alignment is lost, A-bit of the next odd frame is set to 1 in the transmit direction.

	Sub-Multiframe (SMF)	Frame	Bits 1 to 8 of the service channel in every frame							
			1	2	3	4	5	6	7	8
Multiframe	SMF1	0	N1	0	0	1	1	0	1	1
		1	0	1	A	E	C1	C2	C3	C4
	SMF2	2	N2	0	0	1	1	0	1	1
		3	0	1	A	E	C1	C2	C3	C4
	SMF3	4	N3	0	0	1	1	0	1	1
		5	1	1	A	E	C1	C2	C3	C4
	SMF4	6	N4	0	0	1	1	0	1	1
		7	0	1	A	E	C1	C2	C3	C4
	SMF5	8	N5	0	0	1	1	0	1	1
		9	1	1	A	E	C1	C2	C3	C4
	SMF6	10	L1	0	0	1	1	0	1	1
		11	1	1	A	E	C1	C2	C3	C4
	SMF7	12	L2	0	0	1	1	0	1	1
		13	L3	1	A	E	C1	C2	C3	C4
	SMF8	14	TEA	0	0	1	1	0	1	1
		15	R	1	A	E	C1	C2	C3	C4

1-L3 Channel number, least significant bit in L1

Channel	L3	L2	L1
Initial	0	0	1
Second	0	1	0
Third	0	1	1
. . .	. .	. .	. .
Sixth	1	1	0
Seventh and higher-numbered	1	1	1

R Reserved for future use set to 0.

A, E, C1-C4 As in Figure 3.

N1-N4 Used for multiframe numbering as described in 2.2; set to 0 while numbering is inactive.

		N4	N3	N2	N1	
Multiframe number	0	0	0	0	0	(or numbering inactive)
	1	0	0	0	1	
	2	0	0	1	0	
	. .	. .	. .	. .	. .	
	15	1	1	1	1	

N5 Indicates whether multiframe numbering is active (N5 = 1) or inactive (N5 = 0).

TEA The terminal equipment alarm is set to 1 in the outgoing signal while an internal terminal equipment fault exists such that it cannot receive and act on the incoming signal. Otherwise it is set to 0.

Figure 4/H.221 – Assignment of bits 1-8 of the service channel in each frame in a multiframe

2.4 Loss and recovery of multiframe alignment

Multiframe alignment is needed to number and synchronize two or more channels, and possibly also for encryption. Terminals such as those having only single-channel capabilities which have no use for the multiframe structure shall transmit the multiframe structure, but need not check for multiframe alignment on the incoming signal: they may transmit outgoing A = 0 when frame alignment is recovered.

NOTE – Such a terminal cannot transmit TEA (see Figure 4).

After multiframe alignment has been validated, the other functions represented by bit 1 of the service channel can be used. When multiframe alignment of the distant terminal has been signalled (A = 0 received), the distant terminal is expected to have validated BAS codes and to be able to interpret BAS codes.

Multiframe alignment is defined to have been lost when three consecutive multiframe alignment signals have been received with an error. It is defined to have been recovered when the multiframe alignment signal has been received with no error in the next multiframe. When multiframe alignment is lost, even when an unframed mode is received, the A-bit of the next odd frame is set to 1 in the transmit direction. It is reset to 0 when multiframe alignment is regained. It is reset in additional channels when multiframe alignment and synchronism with the initial channel is regained.

2.5 Procedure to recover octet timing from frame alignment

When the network does not provide octet timing, the terminal may recover octet timing in the receive direction from bit timing and from the frame alignment. The octet timing in the transmit direction may be derived from the network bit timing and an internal octet timing.

2.5.1 General rule

The receive octet timing is normally determined from the FAS position. But at the start of the call and before the frame alignment is gained, the receive octet timing may be taken to be the same as the internal transmit octet timing. As soon as a first frame alignment is gained, the receive octet timing is initialized at the new bit position, but it is not yet validated. It will be validated only when frame alignment is not lost during the next 16 frames.

2.5.2 Particular cases

a) When, at the initiation of a call, the terminal is in a forced reception mode, or when the frame alignment has not yet been gained, the terminal may temporarily use the transmit octet timing.

b) When frame alignment is lost after being gained, the receive octet timing shall not change until frame alignment is recovered.

c) As soon as frame and multiframe alignment have been gained once, the octet timing is considered as valid for the rest of the call, unless frame alignment is lost and a new frame alignment is gained at another bit position.

d) When the terminal switches from a framed mode to an unframed mode (by means of the BAS), the octet timing previously gained shall be kept.

e) When a new frame alignment is gained on a new position, different from that previously validated, the receive octet timing is re-initialized to the new position but not yet validated and the previous bit position is stored. If no loss of frame alignment occurs in the next 16 frames, the new position is validated; otherwise, the stored old bit position is re-utilized.

2.5.3 Search for Frame Alignment Signal (FAS)

Two methods may be used: sequential or parallel. In the sequential method, each of the eight possible bit positions for the FAS is tried. When FAS is lost after being validated, the search shall resume starting from the previously validated bit position. In the parallel method, a sliding window, shifting one bit for each bit period, may be used. In that case, when frame alignment is lost, the search shall resume starting from the bit position next to the previously validated one.

2.6 Description of the CRC4 procedure

In order to provide an end-to-end quality monitoring of the connection, a 4-bit Cyclic Redundancy Check (CRC4) procedure may be used and the four bits C1, C2, C3 and C4 computed at the source location are inserted in bit positions 5 to 8 of the odd frames. In addition, bit 4 of the odd frames, the E-bit, is used to transmit an indication as to whether the most recent CRC block, received in the incoming direction, contained errors or not.

When the CRC4 procedure is not used, bit E shall be set to 0, and bits C1, C2, C3 and C4 shall be set to 1 by the transmitter. Provisionally, the receiver may disable reporting of CRC errors after receiving eight consecutive CRCs set to all 1s, and it may enable reporting of CRC errors after receiving two consecutive CRCs each containing a 0 bit.

2.6.1 Computation of the CRC4 bits

The CRC4 bits C1, C2, C3 and C4 are computed for each B/H_0/H_{11}/H_{12} channel[1], for a block made of two frames: one even frame (containing the first seven bits of FAW) followed by one odd frame (containing the eighth bit of FAW). The CRC4 block size is then 160/960/3840/4800 octets for a B/H_0/H_{11}/H_{12} channel and 320/480/640/1280/1920/2880/3680 octets for a 128/192/256/512/768/1152/1472 kbit/s channel and the computation is performed 50 times per second.

NOTE – This is still valid for the case of H_0/H_{11} or 128/192/256/320/512/768/1152/1472 kbit/s transfer rate in restricted networks, the stuffed bits being included in the computation. For restricted B, see Annex B.

2.6.1.1 Multiplication-division process

A given C1-C4 word located in block N is the remainder after multiplication by x^4 and then division (modulo 2) by the generator polynomial $x^4 + x + 1$ of the polynomial representation of block (N – 1).

When representing contents of a block as a polynomial, the first bit in the block shall be taken as being the most significant bit. Similarly, C1 is defined to be the most significant bit of the remainder and C4 the least significant bit of the remainder.

This process can be realized with a four-stage register and two exclusive-ORs.

2.6.1.2 Encoding procedure

i) The CRC bit positions in the odd frame are initially set at zero, i.e. C1 = C2 = C3 = C4 = 0.

ii) The block is then acted upon by the multiplication-division process referred to in 2.6.1.1.

iii) The remainder resulting from the multiplication-division process is stored ready for insertion into the respective CRC locations of the next odd frame.

NOTE – These CRC bits do not affect the computation of the CRC bits of the next block, since the corresponding locations are set at zero before the computation.

2.6.1.3 Decoding procedure

i) A received block is acted upon by the multiplication-division process, referred to in 2.6.1.1, after having its CRC bits extracted and replaced by zeros.

ii) The remainder resulting from this multiplication-division process is then stored and subsequently compared on a bit-by-bit basis with the CRC bits received in the next block.

iii) If the decoded calculated remainder exactly corresponds to the CRC bits sent from the encoder, it is assumed that the checked block is error-free.

2.6.2 Consequent actions

2.6.2.1 Action on bit E

Bit E of block N is set to 1 in the transmitting direction if bits C1-C4 detected in the most recent block in the opposite direction have been found in error (at least one bit in error). In the opposite case, it is set to zero.

[1] If the transfer rate is such that a part of any H_0/H_{11}/H_{12} channel is unoccupied, then the computation is made only for that part covered by the transfer rate.

2.6.2.2 Monitoring for incorrect frame alignment (see Note)

In the case of a long simulation of the FAW, the CRC4 information can be used to re-invite a search for frame alignment. For such a purpose it is possible to count the number of CRC blocks in error within two seconds (100 blocks) and to compare this number with 89. If the number of CRC blocks in error is greater than or equal to 89, a search for frame alignment shall be re-initiated.

The values 100 and 89 have been chosen in order that:

– for a random transmission error rate of 10^{-3}, the probability of incorrectly re-initiating a search for frame alignment, because of 89 or more blocks in error, should be less than 10^{-4};

– in case of simulation of frame alignment, the probability of not reinitiating a search of frame alignment after a two-second period should be less than 2.5%.

NOTE – Values in this and the next subclause exemplify the case of a 64 kbit/s channel. For H_0, H_{11} or H_{12} channels, the details will differ but the principles are still applicable.

2.6.2.3 Monitoring for error performance

The quality of the 64 kbit/s connection can be monitored by counting the number of CRC blocks in error within a period of one second (50 blocks). For instance, a good evaluation of the proportion of seconds without errors as defined in Recommendation G.821 can be provided.

For information purposes, Table 1 gives the proportions of CRC block in error which can be computed for randomly distributed errors of error rate P_e.

By counting the received E-bits, it is possible to monitor the quality of the connection in the opposite direction.

Table 1/H.221

P_e	10^{-3}	10^{-4}	10^{-5}	10^{-6}	10^{-7}
Percentage of CRC blocks in error	70%	12%	1.2%	0.12%	0.012%

2.7 Synchronization of multiple connections

Some audiovisual terminals will be able to communicate over multiple B or H_0 connections (see Note). In this case, a single B or H_0 initial connection is established, the possibility for more connections is determined from the transfer rate capability BAS of Annex A and the additional connections are then established and synchronized by the terminal using the multiframe structure.

NOTE – A connection is an individual call between the terminals. A channel is the transmission in one direction over the connection.

2.7.1 Multiple B-connections

FAS and BAS are transmitted in each B-channel (see Note).

NOTE – The actual bit rates allowed by this Recommendation for these audio codings within a 64 kbit/s I-channel are 64 and 56 kbit/s, commands (000) [4/5 and 18/19], respectively. Thus, in a 2B audiovisual call, it is not permitted to transmit framed G.711 audio in the I-channel and video in the additional channel. The two channels shall be synchronized, the audio shall be set to 56 kbit/s, and when the video is ON, it shall occupy the remaining 68.8 kbit/s.

FAS operation is as follows:

– Multiframe numbering is used to determine relative transmission delay between B-channels as described in 2.2.

– The channel numbers are transmitted in the FAS, as described in 2.2, with the channel of the initial connection being numbered 1 and there being up to twenty-three additional connections.

– The channel numbers of the additional channels are also transmitted in the BAS according to Table A.5.

– The outgoing A-bit is set to 1 in the additional B-channel of the same connection whenever the received additional channel is not synchronized to the initial channel.

– When receive synchronization is achieved between the initial and additional channels by introducing delay to align their respective multiframe signals, the transmitted A-bit is set to 0.

– The E-bit for each additional B-channel is transmitted in the additional B-channel in the same connection, because it relates to a physical condition of the transmission path.

The BAS operation in additional connections is restricted to the transmission of the additional channel number (according to Table A.5) and TIX (see Recommendation H.230) (thus, the channel numbering of any additional connection shall be sent both in BAS according to Annex A and in the FAS as in 2.2), while channel numbering of the initial channel is sent only in FAS.

The distant terminal, upon receiving the A-bit set to zero with respect to sequentially numbered channels, can add their capacity to the initial connection by sending the transfer rate BAS in Annex A. The order of the bits transmitted in the channels is in accordance with the examples given in clause 4.

2.7.2 Multiple H_0 connections

FAS and BAS are transmitted in the first time-slot of each H_0.

FAS operation is as in 2.7.1 except that the channel number is used to order the six octets received each 125 μs with respect to the six octet groups received in other channels.

The BAS operation in additional channels is as specified in 2.7.1.

3 Bit-rate allocation signal

3.1 Encoding of the BAS

The Bit-rate Allocation Signal (BAS) occupies bits 9-16 of the service channel in every frame. An eight bit BAS code (b_0, b_1, b_2, b_3, b_4, b_5, b_6, b_7) is complemented by eight error correction bits (p_0, p_1, p_2, p_3, p_4, p_5, p_6, p_7) to implement a (16.8) double error correcting code. This error correcting code is obtained by shortening the (17.9) cyclic code with generator polynomial:

$$g(x) = x^8 + x^7 + x^6 + x^4 + x^2 + x + 1.$$

The error correction bits are calculated as coefficients of the remainder polynomial in the following equation:

$$\begin{aligned} &p_0x^7 + p_1x^6 + p_2x^5 + p_3x^4 + p_4x^3 + p_5x^2 + p_6x + p_7 \\ &= RES_{g(x)}\,[b_0x^{15} + b_1x^{14} + b_2x^{13} + b_3x^{12} + b_4x^{11} + b_5x^{10} + b_6x^9 + b_7x^8] \end{aligned}$$

where $RES_{g(x)}[f(x)]$ represents the residue obtained by dividing $f(x)$ by $g(x)$.

The BAS code is sent in the even-numbered frame, while the associated error correction bits are sent in the subsequent odd-numbered frame. The bits of the BAS code or the error correction are transmitted in the order shown in Table 2 to avoid emulation of the frame alignment word.

Table 2/H.221

Bit position	Even frame	Odd frame
9	b_0	p_2
10	b_3	p_1
11	b_2	p_0
12	b_1	p_4
13	b_5	p_3
14	b_4	p_5
15	b_6	p_6
16	b_7	p_7

The decoded BAS value is valid if:

– the receiver is in frame and multiframe alignment; and

– the FAW in the same sub-multiframe was received with two or fewer bits in error.

Otherwise, the decoded BAS value is ignored.

When the receiver actually looses frame alignment, it may be advisable to undo any changes caused by the three previously decoded values as they may well have been erroneous even after correction.

3.2 Values of the BAS

The encoding of BAS is made according to an attribute method. The first three bits of an attribute represent its number describing the general command or capability, and the other five bits identify the "value" – the specific command or capability. The BAS codes are defined in this Recommendation, but all procedures governing their use are to be found in Recommendations H.242, H.243, H.244, J.52 or other Recommendations referenced therefrom.

The following attributes are defined in Tables A.1, A.2, A.4 and A.6:

Attribute	Table A.1	Table A.2	Table A.4	Table A.6
000	Audio coding commands	Reserved for commands	Reserved for commands	Reserved for commands
001	Transfer rate commands	Au-ISO commands	Reserved for commands	Reserved for commands
010	Video and other commands	Reserved for commands	Commands	Commands
011	Data commands	HSD/H-MLP commands	Commands	Commands
100	Capabilities	Au-ISO capabilities	Capabilities	Capabilities
101	Capabilities	HSD/H-MLP capabilities	Reserved for capabilities	Capabilities
110	Capabilities	Capabilities	Reserved for capabilities	Reserved for capabilities
111	Escape codes	Forbidden	Forbidden	Forbidden

The values of these attributes are listed and defined in Annex A. They provide for the following facilities:

– transmission at various total rates and on single and multiple channels, on clear channels and on networks subject to restrictions to 56 kbit/s and its multiples;

– audio transmission, digitally encoded to various recommended algorithms;

– video transmission, digitally encoded to various recommended algorithms;

– Low-Speed Data (LSD) within the I-channel, or TS1 of a higher rate initial channel;

– High-Speed Data (HSD) in the highest-numbered 64 kbit/s channel or time-slots (excluding the I-channel);

– data transmission within a standardized protocol, in a logical sub-channel either in the I-channel (MLP) or in capacity other than the I-channel (H-MLP);

– an encryption control signal;

– loopback towards the network for maintenance purposes;

– signalling for control and indications;

– a message system for, *inter alia*, conveying information concerning equipment manufacturer and type.

The command BAS attributes have the following significance: on receipt of a BAS command code in one (even) frame and its error-correcting code in the next (odd), the receiver prepares to accept the stated mode change beginning from the subsequent (even) frame; thus, a mode change can be effected in 20 ms. The command remains in force until countermanded (see clause 12/H.242). The bit positions occupied by combinations of BAS commands are exemplified in Figures 5a to 5g.

The capability BAS attributes have the following significance: they indicate the ability of a terminal to receive and properly treat the various types of signal. It follows that having received a set of capability values from the remote terminal Y, terminal X shall not transmit signals lying outside that declared range.

Value [0] of the attribute (111) is reserved for setting the BAS channel to a new class of operation. Values [1-14] are reserved. Equipment conforming to this Recommendation shall treat these values as unknown SBE, ignoring the following byte and not entering a fault condition. This change from the previous version opens the way to eventual use of these escape codes without entering a new family or class of codes.

The values [15-23] of the attribute (111) are temporary escape BAS codes of Single Byte Extension (SBE), forming a pointer to one of eight possible escape BAS tables of 224 entries each (codes beginning with 111 are not used in the escape BAS tables). Then, the next received BAS indicates the specific entry in the escape BAS table.

The value (111) [24] is the capability marker (see clause 2/H.242) which is followed by normal BAS codes, not by any escape values.

The last seven attribute values of the attribute (111) are of Multiple Byte Extension (MBE) and are used to send messages as specified in A.9.

4 Bit-positions for audio, video and data stream

4.1 LSD streams

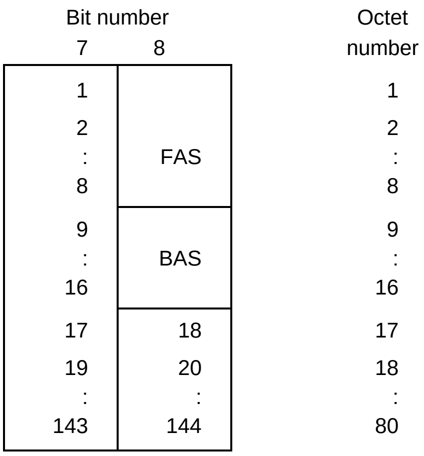


Figure 5a/H.221 – Bit numbering and position for 14.4 kbit/s LSD

				Bit number				Octet number
1	2	3	4	5	6	7	8	
1	2	3	4	5	6	7	FAS	1
:	:	:	:	:	:	:		2
:	:	:	:	:	:	:		:
50	51	52	53	54	55	56		8
57	58	59	60	61	62	63	BAS	9
:	:	:	:	:	:	:		:
:	:	:	:	:	:	:		:
106	107	108	109	110	111	112		16
113	114	115	116	117	118	119	Sub-channel 8	17
120	121	122	123	124	125	126		18
:	:	:	:	:	:	:		:
:	:	:	:	:	:	:		:
554	555	556	557	558	559	560		80

Figure 5b/H.221 – 56 kbit/s LSD

				Bit number				Octet number
1	2	3	4	5	6	7	8	
1	2	3	4	5	6	7	FAS	1
:	:	:	:	:	:	:		2
:	:	:	:	:	:	:		:
50	51	52	53	54	55	56		8
57	58	59	60	61	62	63	BAS	9
:	:	:	:	:	:	:		:
:	:	:	:	:	:	:		:
106	107	108	109	110	111	112		16
113	114	115	116	117	118	119	120	17
121	122	123	124	125	126	127	128	18
:	:	:	:	:	:	:	:	:
:	:	:	:	:	:	:	:	:
617	618	619	620	621	622	623	624	80

Figure 5c/H.221 – 62.4 kbit/s LSD

4.2 Encoded audio streams

Audio bit rate	Bit number							
	1	2	3	4	5	6	7	8
Rec. G.711	MSB	. . .	. . .	. . .	. . .	. . .	. . .	LSB
Rec. G.722, 64 kbit/s	H	H	L	L	L	L	L	L
Rec. G.722, 56 kbit/s	H	H	L	L	L	L	L	–
Rec. G.722, 48 kbit/s	H	H	L	L	L	L	–	–
Others	See below		–	–	–	–	–	–

H High-band audio
L Low-band audio

Figure 5d-1/H.221 – Bit positions for G.711 and G.722 audio

G.728 audio

The LD-CELP 2.5 ms frame consists of the following 40 numbered bits:

Codeword 0, bit 9 (MSB) to bit 0 (LSB): 09,08,07,06,05,04,03,02,01,00

Codeword 1, bit 9 (MSB) to bit 0 (LSB): 19,18,17,16,15,14,13,12,11,10

Codeword 2, bit 9 (MSB) to bit 0 (LSB): 29,28,27,26,25,24,23,22,21,20

Codeword 3, bit 9 (MSB) to bit 0 (LSB): 39,38,37,36,35,34,33,32,31,30

These are packed into two 8 kbit/s H.221 sub-channels by putting odd numbered bits in the first sub-channel and even numbered bits in the second. This structure is repeated four times in each 10 ms H.221 frame as shown below. The first codeword in each H.221 frame is then always the first codeword in the speech coder frame also. The speech coder synchronization can then be derived from H.221 FAS (frame alignment signal).

The 10 ms H.221 frame

Bit number	1	2	3	4	5	6	7	8	Octet number
Speech coder frame 0	09	08						F	1
	07	06						A	2
	05	04						S	3
	03	02							"
	01	00							"
	19	18							"
	17	16							"
	"	"							"
	11	10							"
	29	28							"
	"	"							"
	21	20							"
	39	38							"
	"	"							"
	31	30							"
Speech coder frame 1	09	08							"
	07	06							"
	"	"							"
	33	32							"
	31	30							"
Speech coder frame 2	09	08							"
	07	06							"
	"	"							"
	33	32							"
	31	30							"
Speech coder frame 3	09	08							"
	07	06							"
	"	"							"
	33	32							79
	31	30							80

Figure 5d-2/H.221 – Bit positions for G.728 audio

G.729 audio

The AS-CELP (RIO-1) frame consists of 80 bits.

These 80 bits are packed into a 10 ms H.221 frame shown below. The first codeword in each H.221 frame is always the first codeword in the speech frame. The speech coder synchronisation is derived from FAS.

The 10 ms H.221 frame

Bit number	1	2	3	4	5	6	7	8	Octet number
Speech coder frame	0							F	1
	1							A	2
	2							S	3
	3								4
	4								5
	etc.								etc.
	78								79
	79								80

Figure 5d-3/H.221 – Bit positions for G.729 audio

The order and the assignment of each bit in the codec bit stream is specified in Table 8/G.729. The bit stream starts with the bit named L0 and finishes with the least significant bit of GB2.

G.723.1 audio

There are three types of G.723.1 frame, the type being indicated by the first two bits of the G.723.1 frame itself. The three frame types are "high rate" frames containing 24 octets (192 bits) of data, "low-rate" frames containing 20 octets (160 bits) of data, and "SID" or "Silence Insertion Descriptor" frames containing 4 octets (32 bits) of data. G.723.1 frames contain 30 ms of audio; during silences at the encoder, it is possible that no frames will be produced.

The bit stream for the G.723.1 codec is transmitted in sub-channel 1 of the H.221 multiplex. G.723.1 frames are aligned with H.221 frames. The first octet in sub-channel 1 of each H.221 frame contains audio frame alignment information. This octet is known as the "Alignment Octet" or AO. Each G.723.1 audio frame shall be transmitted in three sequential H.221 frames; the set of frames containing a full G.723.1 audio frame is called a "frame triple".

Audio frame alignment coding occupies the first three bits (starting with MSB) of the AO. The codes for the three frames (leading frame, middle frame, trailing frame) of a triple shall be 100, 010, and 001, respectively. The alignment code "111" indicates that the current H.221 frame is not part of a frame triple and contains no G.723.1 data; such a frame is a "slip frame" used to accommodate clock slip and periods when no audio frames are produced by the encoder. The least significant five bits of the AO are reserved for future use and shall be set to 1.

The G.723.1 data shall immediately follow the AO in each frame of a triple. G.723.1 data shall be packed as specified in Recommendation G.723.1, with the most significant octet transmitted first and all octets transmitted from MSB to LSB. A CRC shall be computed according to the procedure specified for the "AL2 CRC" of Recommendation H.223 for the G.723.1 audio data only, not including the AO or any padding bits, and this one octet value shall immediately follow the G.723.1 audio data with the MSB of the CRC transmitted first. The remainder of the frame triple shall be filled with the padding pattern 11111111. Use of the H.223 AL2 CRC is required for transmission of G.723.1 audio in the H.221 multiplex. Received G.723.1 audio frames for which the computed CRC differs from the received AL2 CRC shall be discarded and treated as erased frames by the G.723.1 decoder.

If start of transmission of a G.723.1 frame is required by audio frame alignment but no G.723.1 encoded audio is available to the H.221 transmitter, the transmitter shall transmit a slip frame. This situation might arise due to clock slip between the encoder clock and transport clock or because the encoder has detected silence and is not producing audio frames. After the AO, a slip frame shall be filled with the pattern "11111111". If no audio frame is available after the transmitter has sent a slip frame, the transmitter shall continue to send slip frames until audio is available. No CRC shall be present in slip frames. Receivers shall seek new G.723.1 alignment with H.221 framing after receiving any number of slip frames.

If the G.723.1 audio encoder generates audio frames more quickly than they can be transmitted in H.221, G.723.1 audio frames shall be discarded and replaced with slip frames as required to accommodate this form of clock slip. Partial G.723.1 frames shall not be transmitted to accommodate clock slip.

Alignment of H.221 audio mode changes with a submultiframe boundary is required by 3.2/H.221. If, upon an audio mode change to start G.723.1 operation a G.723.1 frame is not available at the next submultiframe boundary, the following procedure shall be used. The H.221 transmitter shall send slip frames beginning with the first frame of the first submultiframe after the G.723.1 BAS command and continuing until a G.723.1 audio frame is available.

Figure 5d-4 illustrates the bit allocation of the three G.723.1 frames and of slip frames.

H.221 Frame		Sub-Channel 1						...	Sub-Channel 8
	Bit #	G.723.1 Silence Frame		G.723.1 Low-Rate Frame		G.723.1 High-Rate Frame			
	1	AO	1	AO	1	AO	1		FAS
	2	AO	0	AO	0	AO	0		FAS
	3	AO	0	AO	0	AO	0		FAS
	4	AO	1	AO	1	AO	1		FAS
	5	AO	1	AO	1	AO	1		FAS
	6	AO	1	AO	1	AO	1		FAS
	7	AO	1	AO	1	AO	1		FAS
First H.221 Frame	8	AO	1	AO	1	AO	1		FAS
	9	G.723.1 Frame Octet 1 MSB		G.723.1 Frame Octet 1 MSB		G.723.1 Frame Octet 1 MSB			
	...	...		...		...			
	40	G.723.1 Frame Octet 4 LSB		...		...			
	41	AL2 CRC MSB		...		...			
	...	...		...		...			
	48	AL2 CRC LSB		...		...			
	49	Fill pattern begins	1	...		...			
	...	...	1	...		...			
	80	Fill pattern continues	1	G.723.1 Frame Octet 9 LSB		G.723.1 Frame Octet 9 LSB			
	81	AO	0	AO	0	AO	0		FAS
	82	AO	1	AO	1	AO	1		FAS
	83	AO	0	AO	0	AO	0		FAS
	84	AO	1	AO	1	AO	1		FAS
Second H.221 Frame	85	AO	1	AO	1	AO	1		FAS
	86	AO	1	AO	1	AO	1		FAS
	87	AO	1	AO	1	AO	1		FAS
	88	AO	1	AO	1	AO	1		FAS
	89	Fill pattern continues	1	G.723.1 Frame Octet 10 MSB		G.723.1 Frame Octet 10 MSB			
	...	...	1	...		...			
	160	Fill pattern continues	1	G.723.1 Frame Octet 18 LSB		G.723.1 Frame Octet 18 LSB			
	161	AO	0	AO	0	AO	0		FAS
	162	AO	0	AO	0	AO	0		FAS
	163	AO	1	AO	1	AO	1		FAS
	164	AO	1	AO	1	AO	1		FAS
	165	AO	1	AO	1	AO	1		FAS
	166	AO	1	AO	1	AO	1		FAS
	167	AO	1	AO	1	AO	1		FAS
	168	AO	1	AO	1	AO	1		FAS
	169	Fill pattern continues	1	G.723.1 Frame Octet 19 MSB		G.723.1 Frame Octet 19 MSB			
	...	...	1	...		...			
Third H.221 Frame	184	...	1	G.723.1 Frame Octet 20 LSB		...			
	185	...	1	AL2 CRC MSB (Low-rate)		...			
	...	...	1	...		...			
	192	...	1	AL2 CRC LSB (Low-rate)		...			
	193	...	1	Fill pattern begins	1	...			
	...	...	1	...	1	...			
	216	...	1	...	1	G.723.1 Frame Octet 24 LSB			
	217	...	1	...	1	AL2 CRC MSB (High-rate)			
	...	...	1	...	1	...			
	224	...	1	...	1	AL2 CRC LSB (High-rate)			
	225	...	1	...	1	Fill pattern begins	1		
	...	...	1	...	1	...	1		
	240	Fill pattern ends	1	Fill pattern ends	1	Fill pattern ends	1		

Figure 5d-4/H.221 – Bit positions for G.723.1 audio

4.3 Encoded video streams

Initial channel								Additional channel							
Bit 1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
A1	A2	A3	A4	A5	A6	V1		V2	V3	V4	V5	V6	V7	V8	
A	· ·			· ·	A	V9	FAS	V10						V16	FAS
·					·										
·					·										
							BAS								BAS
						V121		V122						V128	
						V129	V130	V131						V137	V138
						V139									V148
·					·	·									·
·					·	·									·
·					·	·									·
A	· ·			· ·	A	V759	· ·							· ·	V768

Figure 5e/H.221 – Bit positions for video in two B-channels

NOTE – Figure 5e also exemplifies the bit order applicable when MLP-14.4k and H-MLP-62.4k are both in force, forming a single MLP channel.

TS1								TS2	TS3	TS4	TS5	TS6
A	A	A	A	A	A	A	F	V1 V8	V9 V16	V17 V24	D1 D8	D9 D16
							A	V25		V48	D17	D32
							S					
							B					
							A					
							S	V361		V384	D241	D256
							V	V386		V409	D257	
							V	V411				
							·	·				
							·	·				
							·	·		·	·	·
							·	·		·	·	·
							V	V1961 · ·		· · V1984	D1265 · ·	· · D1280

Figure 5f/H.221 – 128 kbit/s HSD in H_0 channel

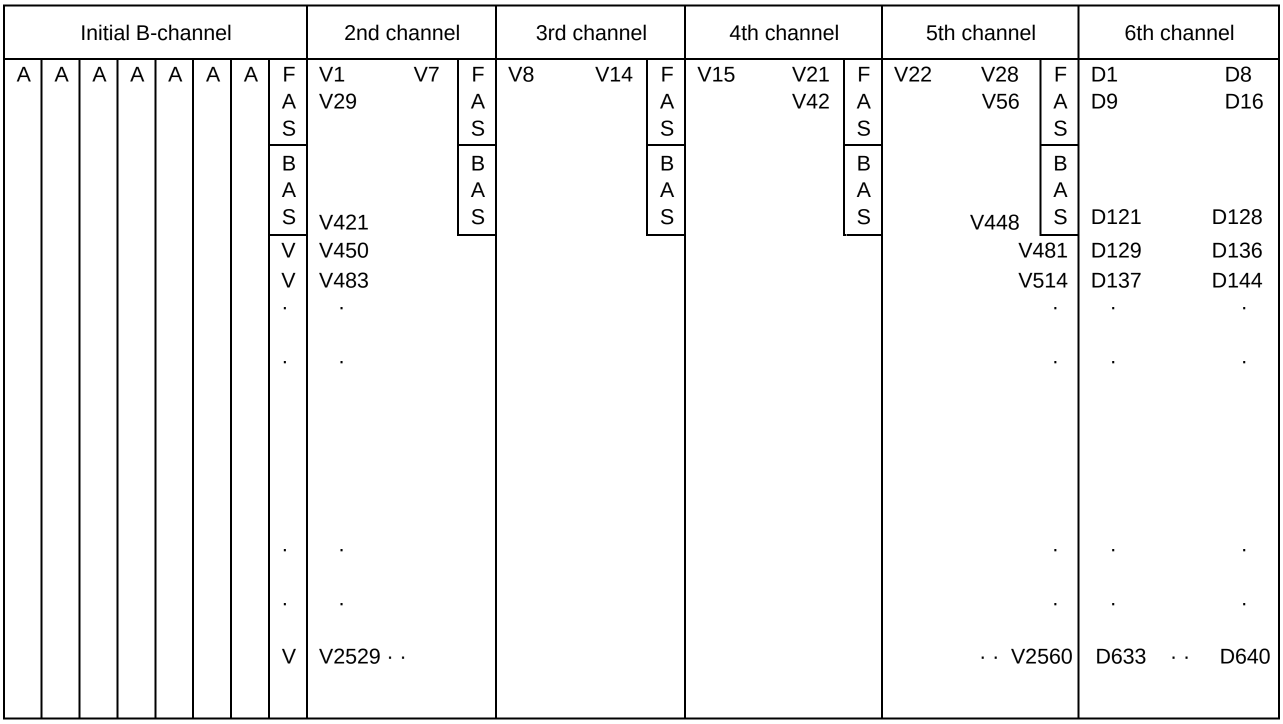
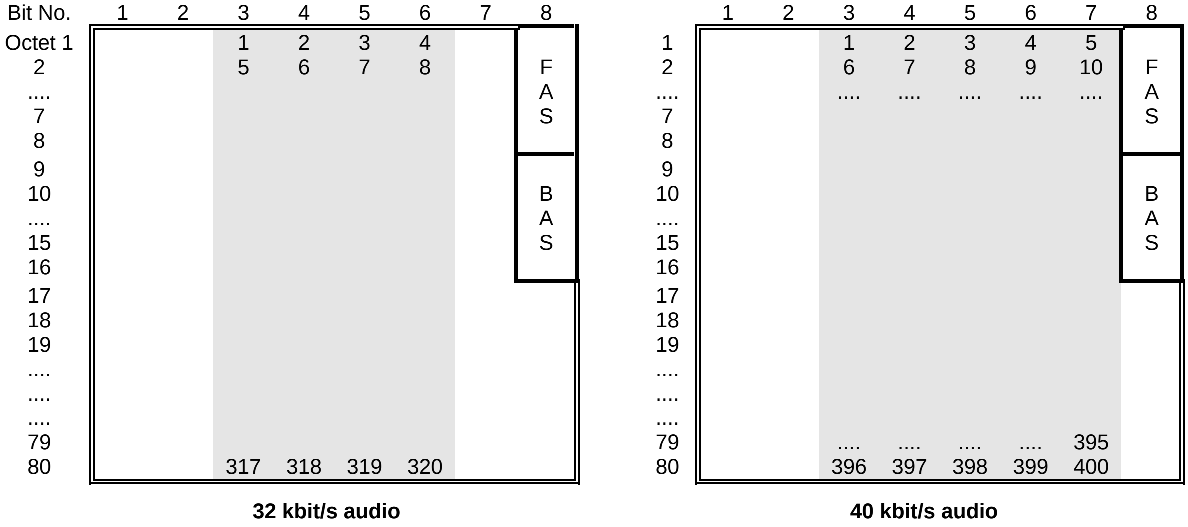


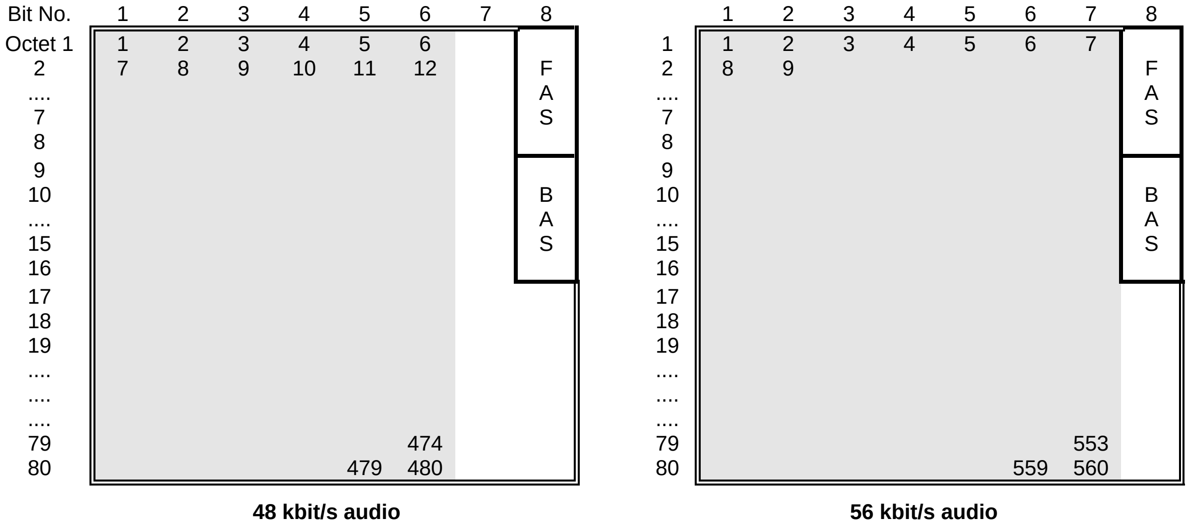
Figure 5g/H.221 – 64 kbit/s HSD in 6 × 64 kbit/s channels

4.4 ISO-encoded audio streams

Figure 6 illustrates the bit positions for ISO/IEC 11172-3 audio in various channels.



NOTE – Bits 1 and 2 are left free so that G.728 may be On simultaneously.



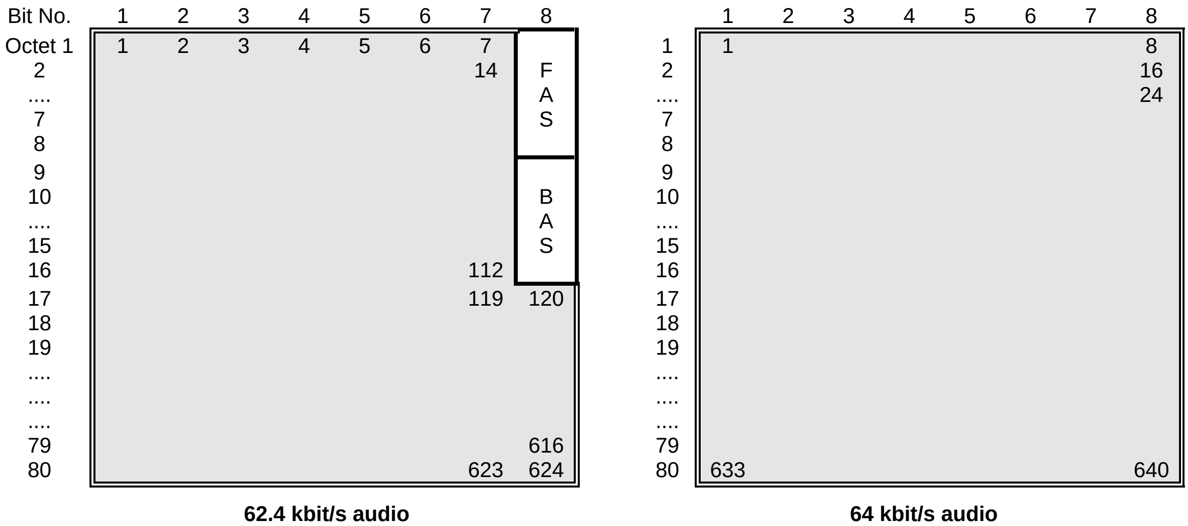


Figure 6/H.221 – Bit positions for ISO/IEC 11172-3 audio in one or two 64 kbit/s channels

	Initial channel								Channel #2							
Bit No.	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
Octet 1					1	2			3	4	5	6	7	8	9	
2					10	11		F	12	13	14	15	16	17	18	F
....								A								A
7								S								S
8																
9																
10								B								B
....								A								A
15								S								S
16					136	137			138	139	140	141	142	143	144	
17					145	146			147	148	149	150	151	152	153	154
18																
....																
40														382	383	384
41					385	386		387	388	389	390	391	392	393	394	395
....																
56					550	551		552	553							560
57					561											570
....																
79																790
80															799	800

80 kbit/s audio in two 64 kbit/s channels

	Initial channel								Channel #2							
Bit No.	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
Octet 1	1	2	3	4	5	6	7		8	9	10	11	12	13	14	
2								F								F
....								A								A
7								S								S
8																
9																
10								B								B
....								A								A
15								S								S
16							217		218						224	
17							231	232	233						239	240
18																
19																
....																
....																
....																
79																
80																1248

124.8 kbit/s audio in two 64 kbit/s channels

NOTE – Bit positions for audio in three or more channels may be derived from the foregoing illustrations for two channels.

Figure 6/H.221 – Bit positions for ISO/IEC 11172-3 audio in one or two 64 kbit/s channels *(concluded)*

Annex A

Definitions and tables of BAS values

The definitions of BAS values are given in this annex, and the corresponding numerical values are listed in the Tables A.1 and A.2. In these tables, the column header gives the attribute designation as bits (b_0, b_1, b_2); the left-hand column gives the decimal value of bits [b_3, b_4, b_5, b_6, b_7]; for example, "Dig-loop" has the value (010) [10100]. All unassigned values are reserved, as are values marked (R).

Table A.1/H.221 – BAS numerical values

	(000)	(001)	(010)	(011)	(100)	(101)	(110)	(111)
[0]	neutral[a)]	64k	Video-off	LSD-off	neutral	var-LSD	Restrict_L	class (R)
[1]	capex	2 × 64k	H.261-on	LSD_300	A-law	LSD_300	Restrict_P	class (R)
[2]	(R)	3 × 64k	H.263-on	LSD_1200	μ-law	LSD_1200	NoRestrict	class (R)
[3]	(R)	4 × 64k	video-MPEG-1-on	LSD_4800	G.722-64	LSD_4800	G.723.1[b)]	class (R)
[4]	A-law, 0U	5 × 64k	(R)	LSD_6400	G.722-48	LSD_6400	G.729	class (R)
[5]	μ-law, 0U	6 × 64k	MLP-8k	LSD_8000	G.728	LSD_8000	(R)	class (R)
[6]	G.722, m1[a)]	384k	encryp-on	LSD_9600	(R)	LSD_9600	(R)	class (R)
[7]	Au-off, U[a)]	2 × 384k	encryp-off	LSD_14.4k	SM-comp	LSD_14.4k	(R)	class (R)
[8]	(R)	3 × 384k	H.262S-on	LSD_16k	128k	LSD_16k	(R)	family (R)
[9]	(R)	4 × 384k	H.262M-on	LSD_24k	192k	LSD_24k	(R)	family (R)
[10]	G.723.1	5 × 384k	(R)	LSD_32k	256k	LSD_32k	(R)	family (R)
[11]	G.729	1536k	(R)	LSD_40k	320k	LSD_40k	(R)	family (R)
[12]	(R) G-4k	1920k	(R)	LSD_48k	512k	LSD_48k	(R)	family (R)
[13]	(R)	128k	(R)	LSD_56k	768k	LSD_56k	(R)	family (R)
[14]	(R)	192k	(R)	LSD_62.4k	Null	LSD_62.4k	(R)	family (R)
[15]	(R)	256k	(R)	LSD_64k	1152k	LSD_64k	(R)	Table_A.6
[16]	(R)	320k	freeze-pic	MLP-off	1B	MLP-4k	(R)	Table_A.2
[17]	(R)	loss i.c.	fast-update	MLP-4k	2B	MLP-6.4k	(R)	H.230
[18]	A-law, 0F[a)]	(R)	Au-loop	MLP-6.4k	3B	var-MLP	(R)	Table_A.4
[19]	μ-law, 0F[a)]	(R)	Vid-loop	var-MLP	4B	MLP_Set 1	(R)	SBE numbers
[20]	A-law, F6[a)]	(R)	Dig-loop	MLP-14.4k	5B	H.261-QCIF	(R)	SBE characters
[21]	μ-law, F6[a)]	(R)	Loop-off	MLP-22.4k	6B	H.261-CIF	(R)	SBE (R)
[22]	(R)	(R)	(R)	MLP-30.4k	restrict	1/29.97	(R)	SBE (R)
[23]	(R)	512k	SM-comp	MLP-38.4k	6B-H0-comp	2/29.97	(R)	SBE (R)
[24]	G.722, m2[a)]	768k	not-SM-comp	MLP-46.4k	H0	3/29.97	(R)	cap-mark
[25]	G.722, m3[a)]	(R)	6B-H0-comp	MLP-16k	2H0	4/29.97	(R)	start-MBE
[26]	Au-40k (R)	1152k	not-6B-H0-comp	MLP-24k	3H0	(R)	(R)	(R)
[27]	Au-32k (R)	(R)	Restrict_Required	MLP-32k	4H0	video-MPEG-1	(R)	(R)
[28]	Au-24k (R)	(R)	derestrict	MLP-40k	5H0	MLP_Set2	(R)	(R)
[29]	G.728[a)]	1472k	(R)	MLP-62.4k	1472k	esc-CF (R)	(R)	(R)
[30]	(R)	(R)	(R)	MLP-64k	H11	encryp.	(R)	ns-cap
[31]	Au-off, F[a)]	(R)	(R)	var-LSD	H12	MBE-cap	(R)	ns-comm

a) Use of these codes in the 56 kbit/s environments is defined in Annex B.

b) Use of H.223 AL2 CRC is required as specified in 4.2.

Table A.2/H.221 – Values reached by escape BAS (111) [16]

	(000)	(001) Au-ISO commands	(010)	(011) HSD/H-MLP commands	(100) Au-ISO capabilities	(101) HSD/H-MLP capabilities	(110) MLP capabilities	(111) Forbidden
[0]		Au-ISO-off		HSD-off			MLP-14.4k	
[1]		Au-ISO-32k		var-HSD	Au-ISO-1B	var-HSD	MLP-22.4k	
[2]		Au-ISO-40k		H-MLP-62.4	Au-ISO-2B	H-MLP-62.4	MLP-30.4k	
[3]		Au-ISO-48k		H-MLP-64k	Au-ISO-3B	H-MLP-64k	MLP-38.4k	
[4]		Au-ISO-56k		H-MLP-128k	Au-ISO-4B	H-MLP-128k	MLP-46.4k	
[5]		Au-ISO-62.4k		H-MLP-192k	Au-ISO-5B	H-MLP-192k	(R)	
[6]		Au-ISO-64k		H-MLP-256k	Au-ISO-6B	H-MLP-256k	MLP-62.4k	
[7]		Au-ISO-80k		H-MLP-320k		H-MLP-320k	MLP-8k	
[8]		Au-ISO-96k		H-MLP-384k		H-MLP-384k	MLP-16k	
[9]		Au-ISO-112k					MLP-24k	
[10]		Au-ISO-2B					MLP-32k	
[11]		Au-ISO-128k					MLP-40k	
[12]		Au-ISO-160k		H-MLP-14.4k		H-MLP-14.4k	(R)	
[13]		Au-ISO-3B		var-H-MLP		var-H-MLP	(R)	
[14]		Au-ISO-192k		H-MLP-off			MLP-64k	
[15]		Au-ISO-224k						
[16]		Au-ISO-4B			Sample-16k			
[17]		Au-ISO-256k		HSD-64k	Sample-22.05k	HSD-64k		
[18]		Au-ISO-288k		HSD-128k	Sample 24k	HSD-128k		
[19]		Au-ISO-5B		HSD-192k	CorrMode-1	HSD-192k		
[20]		Au-ISO-320k		HSD-256k	CorrMode-2	HSD-256k		
[21]		Au-ISO-352k		HSD-320k	CorrMode-3	HSD-320k		
[22]		Au-ISO-6B		HSD-384k		HSD-384k		
[23]		Asynch		HSD-512k		HSD-512k		
[24]		Synch		HSD-768k	AsyncMode	HSD-768k		
[25]		Error-off		HSD-1152k	AuLayer-I	HSD-1152k		
[26]		Error-1		HSD-1536k	AuLayer-II	HSD-1536k		
[27]		Error-2			AuLayer-III			
[28]		Error-3			Sample-32k			
[29]					Sample-44.1k			
[30]					Sample-48k			
[31]								

A.1 Audio command values (000)

For audio bit position illustrations, see 4. Abbreviations "G.711", "G.722" and so on refer to Recommendations.

Neutral	Neutralized I-channel, containing only FAS and BAS; all other bits are to be ignored at the receiver[2].
Capex	Transmitted by a Channel Aggregation Unit (see Recommendation H.244).
Au-off, U	Switches off G.711/722/728 audio (but not Au-ISO as in Table A.2) and switches off the frame structure in the I-channel; all the I-channel is available for use under commands other than (000)[n][2, 3].
Au-off, F	Switches off G.711/722/728 audio (but not Au-ISO as in Table A.2); FAS and BAS in use (mode 9); 62.4 kbit/s in the I-channel available for use under commands other than (000)[n].
A-law, 0U	G.711 audio at 64 kbit/s, A-law, no framing (Mode 0U)[3].
A-law, 0F	G.711 audio at 56 kbit/s, A-law, truncated to 7 bits in bits 1-7, with FAS and BAS in bit 8; bit 8 is set to zero at the PCM audio decoder (Mode 0F).
μ-law, 0U	G.711 audio at 64 kbit/s, μ-law, no framing (Mode 0U)[3].
μ-law, 0F	G.711 audio at 56 kbit/s, μ-law, truncated to 7 bits in bits 1-7, with FAS and BAS in bit 8; bit 8 is set to zero at the PCM audio decoder (Mode 0F).
A-law, F6	Audio according to Recommendation G.711 at 48 kbit/s, A-law truncated to 6 bits, with FAS and BAS in bit 8 (use only according to 13.4/H.242).
μ-law, F6	Audio according to Recommendation G.711 at 48 kbit/s, μ-law truncated to 6 bits, with FAS and BAS in bit 8 (use only according to 13.4/H.242).
G.722, m1	G.722 7 kHz audio at 64 kbit/s, no framing (mode 1)[3].
G.722, m2	G.722 7 kHz audio at 56 kbit/s, in bits 1-7 (mode 2).
G.722, m3	G.722 7 kHz audio at 48 kbit/s, in bits 1-6 (mode 3).
Au-40k	Reserved for audio at less than 48 kbit/s (for example, 40 kbit/s in bits 1-5).
Au-32k	Reserved for audio at less than 48 kbit/s (for example, 32 kbit/s in bits 1-4).
Au-24k	Reserved for audio at less than 48 kbit/s (for example, 24 kbit/s in bits 1-3).
G.728	Audio at 16 kbit/s to Recommendation G.728 in bits 1 and 2 according to clause 4 (mode 7).
G.729	Audio at 8 kbit/s to Recommendation G.729 according to clause 4 (mode 8a).

[2] It is interpreted as a command to shut off all the output of the I-channel demultiplexer except FAS, BAS and ECS (if relevant). Audio is muted accordingly. Release of this shut off is activated by a fixed rate command (namely by a command other than Var-LSD, Var-MLP). Channels other than I-channel (such as additional channel for 2B communications, or the 2nd through 6th time-slot for H_0 communications) remain unchanged.

If video or HSD was set on before this Neutral BAS command is issued, it continues to be on. For example, if video has been on in a 2B communication, and Neutral BAS command is issued, the video is transmitted only in the additional channel. If a fixed rate command for I-channel is then issued, the video also occupies all bit positions of I-channel other than those designated by the fixed rate command, and FAS and BAS positions. In case of 1B communication, video is completely excluded by this Neutral BAS command, but it will recover by, for example, the next 16 kbit/s audio command.

It is noted that no procedures for the use of neutral BAS command have been adopted.

[3] These attribute values designate unframed modes. In the receive direction, reverting to a framed mode can only be achieved by recovering frame and multiframe alignment which might take up to two multiframes (320 ms).

G.723.1	Audio at < 7 kbit/s to Recommendation G.723.1 according to clause 4 (mode 8b).
Au-4k	Reserved for audio at less than 5 kbit/s in bit 1.

A.2 Transfer-rate command values (001)

NOTE – If the transfer-rate command is less than the available connected capacity, the information occupies the lowest-numbered channel(s)/time-slot(s).

64k	Signal occupies one 64 kbit/s channel.
2 × 64k	Signal occupies two 64 kbit/s channels, with FAS and BAS in each.
3 to 6 × 64k	Signal occupies three to six 64 kbit/s channels, with FAS and BAS in each.
384k	Signal occupies 384 kbit/s, with FAS and BAS in the first 64 kbit/s time-slot; the effective channel may be the whole of an H_0 channel or the lowest numbered time-slots of an H_{11} or H_{12} channel.
2 × 384k	Signal occupies two channels of 384 kbit/s, with FAS and BAS in each.
3 to 5 × 384k	Signal occupies three to five 384 kbit/s channels, with FAS and BAS in each.
1536k	Signal occupies 1536 kbit/s, with FAS and BAS in the first 64 kbit/s time-slot. The effective channel occupies the whole of an H_{11} channel or the lowest numbered time-slots of an H_{12} channel.
1920k	Signal occupies 1920 kbit/s, with FAS and BAS in the first 64 kbit/s time-slot. The effective channel occupies the whole of an H_{12} channel.
128/192/256/320k	Signal occupies 128/192/256/320 kbit/s, with FAS and BAS in the first 64 kbit/s time-slot. The effective channel occupies the lowest numbered time-slots of a channel with corresponding or higher capacity.
512/768/1152/1472k	Signal occupies 512/768/1152/1472 kbit/s, with FAS and BAS in the first 64 kbit/s time-slot. The effective channel occupies the lowest numbered time-slots of a channel with corresponding or higher capacity.
Loss-i.c.	Designated "Initial channel", especially used following loss of the channel previously so designated (see Recommendation H.242).

A.3 Video, encryption, loop and other commands (010)

Video-off	No video; video switched off.
H.261-on	Video on, to Recommendation H.261: video occupies all capacity not otherwise allocated by other commands; video cannot be inserted in the I-channel when var-LSD or var-MLP is in force; examples are given in Figure 5e. Specifically, the video rate in initial B-channel (framed) or TS1 is: 62.4 kbit/s – audio rate – {800 bit/s if ECS is ON} – {MLP rate if ON} – {LSD rate if ON} – {8 kbit/s if restricted}.
H.263-on	Video on, to Recommendation H.263: video occupies the same capacity as stipulated for the case of H.261 video.
Video-MPEG-1-on	Video on, to ISO/IEC 11172-2 ("MPEG-1"): video occupies the same capacity as stipulated above for the case of H.261 video.
Freeze-pic.	Freeze-picture request (see Recommendation H.230, VCF).
Fast-update	Fast-update request (see Recommendation H.230, VCU).
Encryp-on	ECS Channel active. NOTE 1 – When encryption is active, it may apply (see H.233) to all information bits in all channels of the connection, except bits 1-24 of the SC in the I-channel and the FAS and BAS positions of the other channels; use of encryption in conjunction with MLP is for further study.

Encryp-off	ECS channel off.
H.262S-on	Video on, to Recommendation H.262 Simple Profile at Main Level: video occupies the same capacity as stipulated for the case of H.261 video.
H.262M-on	Video on, to Recommendation H.262 Main Profile at Main Level: video occupies the same capacity as stipulated for the case of H.261 video.
Au-loop	Audio loop request (see Recommendation H.230, LCA).
Vid-loop	Video loop request (see Recommendation H.230, LCV).
Dig-loop	Digital loop request (see Recommendation H.230, LCD).
Loop-off	Loop off request (see Recommendation H.230, LCO). NOTE 2 – Loopback requests are intended for use by maintenance staff.
SM-comp	"Single<>Multiple Channel Compatibility": to provide for compatibility between terminals connected to single-channel and multiple-64/56-channel accesses, the least significant bits of the first 16 octets of all 64 kbit/s time-slots of the single channel, except TS1, are not used; the single-channel terminal shall discard these bits from the incoming signal on receipt of this command, and shall set the same bits to "1" in the outgoing signal.
Cancel-SM-comp	Negates the command SM-comp (010) [23].
6B-H_0-comp	To provide for compatibility between terminals connected to single H_0 channel and six B-channel accesses, the least significant bits of the first 16 octets of all time-slots of the H_0 channel, except TS1, are not used; the H_0 terminal shall discard these bits from the incoming signal on receipt of this code, and shall set the same bits to "1" in the outgoing signal.
Not-6B-H_0	Negates the command "6B-H_0-comp". NOTE 3 – Used, for example, in testing.
Restrict	To provide for operation on a restricted network, and for interconnection between a terminal on restricted and unrestricted networks: on receipt of this code, a terminal shall treat the SC as being in bit 7 of the I-channel, and discard bit 8 of every other channel and/or time-slot; in the outgoing direction these bits are set to "1".
Derestrict	On receipt of this code, a terminal shall revert to "unrestricted network" operation, treating the SC as being in bit 8 of the I-channel.

A.4 LSD/MLP commands (011)

For bit position illustrations, see Figure 5. When an MLP command is in force at the same time as an H-MLP command from A.11, then a single aggregated MLP stream shall be formed at the demultiplexer output – for bit order, see example of Figure 5e.

#	These LSD rates are not allowed if ECS channel is in use.
*	In restricted cases, the starred bit numbers are reduced by one.
LSD off	LSD switched off.
LSD_300	Low-speed data at 300 bit/s in SC, octets 38-40.
LSD_1200	Low-speed data at 1200 bit/s in SC, octets 29-40.
LSD_4800	Low-speed data at 4800 bit/s in SC, octets 33-80.
LSD_6400	Low-speed data at 6400 bit/s in SC, octets 17-80#.

LSD_8000	Low-speed data at 8000 bit/s in bit 7*.
LSD_9600	Low-speed data at 9600 bit/s in bit 7* and octets 25-40 of SC.
LSD_14.4k	Low-speed data at 14 400 bit/s in bit 7* and octets 17-80 of SC#.
LSD_16k	Low-speed data at 16 kbit/s in bit 6* and bit 7*.
LSD_24k	Low-speed data at 24 kbit/s in bits 5*, 6* and 7*.
LSD_32k	Low-speed data at 32 kbit/s in bits 4*-7*.
LSD_40k	Low-speed data at 40 kbit/s in bits 3*-7*.
LSD_48k	Low-speed data at 48 kbit/s in bits 2*-7*.
LSD_56k	Low-speed data at 56 kbit/s in bits 1-7 (no framing in restricted case).
LSD_62.4k	Low-speed data at 62.4 kbit/s in bits 1-7 and octets 17-80 of SC. If ECS channel is in use, the data rate is reduced to 61.6 kbit/s, but returns to 62.4 kbit/s if ECS channel is closed.
LSD_64k	Low-speed data at 64 kbit/s in bits 1-8, no framing.
Var-LSD	Low-speed data occupying all I-channel capacity not allocated under other fixed-rate commands; cannot be invoked when other LSD is on, or when variable-MLP is on (may also be impractical when video is on in I-channel alone). Exact var-LSD rate: 62.4 kbit/s – audio rate – {800 bit/s if ECS is ON} – {fixed-MLP if ON} – {8000 bit/s if restricted}.
MLP-off	MLP and H-MLP off in all channels.
Var-MLP	MLP occupying all I-channel capacity not allocated under other fixed-rate commands: cannot be invoked when other MLP is on, or when variable-LSD is on (may also be impractical when video is on in I-channel alone). Exact var-MLP rate: 62.4 kbit/s – audio rate – {800 bit/s if ECS is ON} – {fixed-LSD if ON} – {8000 bit/s if restricted}.
Other MLP commands	MLP on at the rate and bit occupancy given in Table A.3 below; where octets 17-24 of Bit 8 are shown as used, then when ECS is on it takes precedence, and the MLP rate is reduced by 800 bit/s, but is restored if the ECS channel is closed. In restricted cases, the starred bit positions are reduced by one. (MLP-4k is insufficient bandwidth for normal T.120 and H.224 applications and should be avoided.)

A.5 Audio capabilities (100)

Neutral	Neutral capability: no change in the current capabilities of the terminal.
A-law	Capable of decoding audio to Recommendation G.711, A-law.
µ-law	Capable of decoding audio to Recommendation G.711, µ-law.
G.722-64	Capable of decoding audio to Recommendation G.722 (mode 1) and to Recommendation G.711.
G.722-48	Capable of decoding audio to Recommendation G.722 (modes 1, 2, 3) and to Recommendation G.711.
G.728	Capable of decoding audio, both to Recommendation G.728 and Recommendation G.711.
G.723.1	Capable of decoding audio, both to Recommendation G.723.1 and Recommendation G.711.

G.729 — Capable of decoding audio, both to Recommendation G.729 (including Annex A) and Recommendation G.711.

Null — Capability having no significance other than as a filler.

NOTE – This value may occur any number of times within a capability set transmitted towards a Single-Channel Equipment – see Recommendation H.244 (Channel Aggregation).

Table A.3/H.221 – Bit occupancy under MLP commands

Table A.1/H.221 reference	Rate	Bit 1	Bit 2	Bit 3*	Bit 4*	Bit 5*	Bit 6*	Bit 7*	Bit 8* (SC)
MLP-4k	4 kbit/s	–	–	–	–	–	–	–	Octets 41-80
MLP-6.4k	6.4 kbit/s	–	–	–	–	–	–	–	Octets 17-80
MLP-8k	8 kbit/s	–	–	–	–	–	–	All	–
MLP-14.4k	14.4 kbit/s	–	–	–	–	–	–	All	Octets 17-80
MLP-16k	16 kbit/s	–	–	–	–	–	All	All	–
MLP-22.4k	22.4 kbit/s	–	–	–	–	–	All	All	Octets 17-80
MLP-24k	24 kbit/s	–	–	–	–	All	All	All	–
MLP-30.4k	30.4 kbit/s	–	–	–	–	All	All	All	Octets 17-80
MLP-32k	32 kbit/s	–	–	–	All	All	All	All	–
MLP-38.4k	38.4 kbit/s	–	–	–	All	All	All	All	Octets 17-80
MLP-40k	40 kbit/s	–	–	All	All	All	All	All	–
MLP-46.4k	46.4 kbit/s	–	–	All	All	All	All	All	Octets 17-80
MLP-62.4k	62.4 kbit/s	All	All	All	All	All	All	All	Octets 17-80
MLP-64k	64 kbit/s	All	All	All	All	All	All	All	All

A.6 Video, MBE and encryption capabilities (101)

H.261-QCIF — Can decode H.261 video to QCIF picture format, but not CIF (see Recommendation H.261) – This code shall be followed by one of the four Minimum Picture Interval (MPI) values below.

H.261-CIF — Can decode H.261 video to CIF and QCIF formats (see Recommendation H.261) – This code shall be followed by two MPI values, the first applicable to QCIF and the other to CIF format.

Minimum Picture Interval (MPI) codes are as follows:

1/29.97 — Can decode video, having a minimum picture interval of 1/29.97 seconds, to Recommendation H.261.

2/29.97 — Can decode video, having a minimum picture interval of 2/29.97 seconds, to Recommendation H.261.

3/29.97 — Can decode video, having a minimum picture interval of 3/29.97 seconds, to Recommendation H.261.

4/29.97	Can decode video, having a minimum picture interval of 4/29.97 seconds, to Recommendation H.261.
Vid-imp(R)	Reserved for future improved recommended video algorithm.
Video-ISO	Can decode video to ISO/IEC 11172-2.
MBE-cap	Can handle multiple-byte extensions messages in the BAS position, those beginning with codes in the range (111) [25-31], in addition to other values.
Esc-CF	Capability to accept escape code (111) [0].
Encryp.	Capable of handling signals on the ECS channel.

A.7 Transfer-rate capabilities (100)

B, H_0	Can accept signals only on one 64 kbit/s channel, one 384 kbit/s channel.
2B	Can accept signals on one or two 64 kbit/s channels, and synchronize them.
. . .	. . .
6B	Can accept signals on one to six 64 kbit/s channels, and synchronize them.
$2 \times H_0$	Can accept signals on one or two 384 kbit/s channels, and synchronize them.
. . .	. . .
$5 \times H_0$	Can accept signals on one to five 384 kbit/s channels, and synchronize them.
H_{11}/H_{12}	Can accept signals on a 1536 kbit/s channel, a 1920 kbit/s channel.
Restrict	Can work only at $p \times 56$ kbit/s, rate-adapted to $p \times 64$ kbit/s by moving the SC to bit position 7 and setting bit 8 to "one" in every channel or time-slot; a constant "one", however, may be set in bit 8 if it is known by out-of-band signalling prior to the connection that the restriction exists; this code has the effect of forcing the remote terminal to work in the $p \times 56$ kbit/s mode (see Annex B).
6B-H_0-comp	Capable of acting upon the corresponding command.
SM-comp	Capable of acting on the corresponding command; applies to all declared single-channel transfer rates; capable also of acting upon the commands [capex] and [AggIN]* (see Recommendation H.244).
128/192/256/320k	Capable of accepting the transfer rate specified by the corresponding command.
512/768/1152/1472k	Capable of accepting the transfer rate specified by the corresponding command.

A.8 LSD/MLP capabilities (101) and other (110)

LSD_300 (to 64k)	Can accept LSD at 300 bit/s (to 64 kbit/s) in the bit positions specified against the corresponding commands.
Var-LSD	Can accept LSD variable rate in the bit positions specified against the corresponding command.
MLP-4k	Can accept MLP in the bit positions specified against the corresponding command.
MLP-6.4k	Can accept MLP in the bit positions specified against the corresponding command.
MLP_Set1	Can accept MLP at 6.4k, 14.4k, 32k and 40k in the bit positions specified against the corresponding commands.
MLP_Set2	Can accept MLP at all fixed rates up to and including 62.4k in the bit positions specified against the corresponding commands.
Var-MLP	Can accept MLP in the I-channel under the corresponding command.

Restrict_P	Can receive and transmit in Restrict_P mode defined in Recommendation H.242.
Restrict_L	Can receive and transmit in Restrict_L mode defined in Recommendation H.242.
NoRestrict	Cannot receive in either Restrict_P or Restrict_L mode.

A.9 Escape table values (111)

Table_A.6	Escape to values listed in Table A.6.
Table_A.2	Escape to values listed in Table A.2.
H.230	Control and indications: see definitions in Recommendation H.230.
SBE numbers	Gives access to a table of SBE numbers – see Recommendation H.230.
SBE characters	Gives access to a table of SBE characters – see Recommendation H.230.
Start-MBE	First byte of ($N + 2$) octet BAS message defined in Recommendation H.230.
NS-cap	First byte of non-ITU capabilities message; the message format is: NS-cap//value of N (max = 255)//country code[4]//manufacturer code*//(N – 4) bytes.
NS-comm	First byte of non-ITU command message; the message format is: NS-comm//value of N (max = 255)//country code[4]//manufacturer code*//(N – 4) bytes.
Cap-mark	Capability marker – the first item in a capability set – see clause 2/H.242.
Table_A.4	Applications within LSD/HSD/MLP channels – see Table A.4.

NOTE 1 – The value of N is coded by its binary representation.

NOTE 2 – The most significant bit of each MBE message byte is transmitted as the b_0 bit of BAS.

A.10 HSD/H-MLP/MLP capabilities (Table A.2)

HSD-64k to 1536k	Can accept HSD at the specified rate in the bit positions specified against the corresponding commands.
Var-HSD	Can accept HSD variable rate in the bit positions specified against the corresponding command.
H-MLP-62.4k	Can accept H-MLP at 62.4 kbit/s in the bit positions specified against the corresponding command.
H-MLP-r	Can accept H-MLP at r = 14.4/64/128/192/256/320/384 kbit/s in the bit positions specified against the corresponding command.
Var-H-MLP	Capability to accept H-MLP variable rate in the bit positions specified against the corresponding command.

MLP-14.4k/16k/22.4k/24k/30.4k/32k/38.4k/40k/46.4k/62.4k/64k

Can accept MLP in the bit positions specified against the corresponding command.

---

[4] Country code consists of two bytes, the first being according to Recommendation T.35. The second byte and the terminal manufacturer code of two bytes are assigned nationally.

Table A.4/H.221 – Numerical values for applications in LSD/HSD/MLP channels – reached by escape BAS (111) [18]

	(010) Commands	**(011) Commands**	**(101) Capabilities**
[0]		Reserved for ISO-SP on in LSD	(R) ISO-SP baseline on LSD
[1]		Reserved for ISO-SP on in HSD	(R) ISO-SP baseline on HSD
[2]			(R) ISO-SP spatial
[3]			(R) ISO-SP progressive
[4]			(R) ISO-SP arithmetic
[5]			
[6]			
[7]			
[8]			
[9]			Still image (Rec. H.261)
[10]		Cursor data on in LSD (R)	Graphics cursor (R)
[11]			
[12]			
[13]			
[14]			
[15]			
[16]		(R) Fax on in LSD	(R) Group 3 fax
[17]		(R) Fax on in HSD	(R) Group 4 fax
[18]			
[19]			
[20]		V.120 LSD	V.120 LSD
[21]		V.120 HSD	V.120 HSD
[22]		V.14_LSD	V.14_LSD
[23]		V.14_HSD	V.14_HSD
[24]	H.224_MLP-off	H.224_MLP-on	H.224_MLP
[25]	H.224_LSD-off	H.224_LSD-on	H.224_LSD
[26]	H.224_HSD-off	H.224_HSD-on	H.224_HSD
[27]	(R)	(R)	H.224-sim
[28]	T.120-off	T.120-on	T.120-cap
[29]			Nil_Data
[30]	H.224-token-off	H.224-token-on	H.224-token
[31]			

Table A.5/H.221 – BAS codes in additional channels

	(001)	**(010)**
[0]		Channel#16
[1]		Channel#17
[2]		Channel#18
[3]		Channel#19
[4]		Channel#20
[5]		Channel#21
[6]		Channel#22
[7]		Channel#23
[8]		Channel#24
[9]		
[10]		
[11]		
[12]		
[13]		
[14]		
[15]		
[16]		
[17]		
[18]	Channel#2	
[19]	Channel#3	
[20]	Channel#4	
[21]	Channel#5	
[22]	Channel#6	
[23]	Channel#7	
[24]	Channel#8	
[25]	Channel#9	
[26]	Channel#10	
[27]	Channel#11	
[28]	Channel#12	
[29]	Channel#13	
[30]	Channel#14	
[31]	Channel#15	

Table A.6/H.221 – BAS numerical values used in Channel Aggregation – reached by escape BAS (111) [15]

	(000)	**(001)**	**(010) Transfer-rate commands**	**(011) Transfer-rate commands**	**(100) Transfer-rate capabilities**	**(101) Transfer-rate capabilities**	**(110)**	**(111) Forbidden**
[0]								
[1]								
[2]								
[3]								
[4]								
[5]								
[6]								
[7]			7 × 64k	7*64k	7 × 64k	7*64k		
[8]			8 × 64k	(R) (Note)	8 × 64k	(R) (Note)		
[9]			9 × 64k	9*64k	9 × 64k	9*64k		
[10]			10 × 64k	10*64k	10 × 64k	10*64k		
[11]			11 × 64k	11*64k	11 × 64k	11*64k		
[12]			12 × 64k	(R) (Note)	12 × 64k	(R) (Note)		
[13]			13 × 64k	13*64k	13 × 64k	13*64k		
[14]			14 × 64k	14*64k	14 × 64k	14*64k		
[15]			15 × 64k	15*64k	15 × 64k	15*64k		
[16]			16 × 64k	16*64k	16 × 64k	16*64k		
[17]			17 × 64k	17*64k	17 × 64k	17*64k		
[18]			18 × 64k	(R) (Note)	18 × 64k	(R) (Note)		
[19]			19 × 64k	19*64k	19 × 64k	19*64k		
[20]			20 × 64k	20*64k	20 × 64k	20*64k		
[21]			21 × 64k	21*64k	21 × 64k	21*64k		
[22]			22 × 64k	22*64k	22 × 64k	22*64k		
[23]			23 × 64k	(R) (Note)	23 × 64k	(R) (Note)		
[24]			24 × 64k	(R) (Note)	24 × 64k	(R) (Note)		
[25]								
[26]								
[27]								
[28]								
[29]								
[30]								
[31]								

Definitions of these codepoints, including the significance of * and ×, are contained in Recommendation H.244.

NOTE – Table A.1 contains values which otherwise would have been assigned these codes.

A.11 HSD/H-MLP commands (Table A.2)

NOTE 1 – In the case of multiple channels, the term "highest-numbered time-slot" refers to the highest-numbered channel.

NOTE 2 – When the "restrict" command is in force, the least significant bit of all octets covered by the HSD and H-MLP commands is set to "1", so the effective data rate is less than that indicated by the command.

NOTE 3 – When an H-MLP command is in force at the same time as an MLP command from A.4, then a single aggregated MLP stream shall be formed at the demultiplexer output – for bit order, see example of Figure 5e.

HSD-off	HSD switched off; FAS and BAS restored in additional channels.
HSD-64k	HSD on, in highest numbered channel/time-slot; FAS and BAS are removed in the case of multiple B-channels.
HSD-128/192/256k	HSD on in highest-numbered time-slots of an H_0 or greater channel.
HSD-320k	HSD on in highest-numbered time-slots of an H_0 or greater channel.
HSD-384k	HSD on in highest-numbered H_0 channel, or highest-numbered time-slots of a greater channel; FAS and BAS are removed in the case of multiple-H_0 channels.
HSD-512/768/1152/1536	HSD on in highest-numbered H_0 channels, or highest-numbered time-slots of a greater channel; FAS and BAS are removed in the case of multiple-H_0 channels.
Var-HSD	High-speed data occupying all capacity, other than in the I-channel, not allocated under other commands: cannot be invoked when other HSD is on, or when var-H-MLP is on (may also be impractical when video is on, the latter then being confined to the I-channel).
H-MLP-off	H-MLP switched off (this does not affect I-channel MLP).
H-MLP-14.4k	H-MLP on at 14.4 kbit/s, occupying bits 7* and 8* of B-channel #2, except FAS and BAS positions. [* When the "restrict" command is in force, bits 6 and 7 apply.]
H-MLP-62.4k	H-MLP on at 62.4 kbit/s, occupying (additional) channel #2, except FAS and BAS positions.
H-MLP-64k H-MLP-128k H-MLP-192k H-MLP-256k H-MLP-320k	H-MLP on at 64/128/192/256/320 kbit/s in the lowest-numbered time-slots, (other than TS1) of an H_0 or greater channel, or at 124.8/187.2 ... in the lowest-numbered additional channels of a multi-channel connection.
H-MLP-384k	H-MLP on at 384 kbit/s in time-slots 2-7 of a greater channel than H_0.
Var-H-MLP	H-MLP occupying all capacity, other than in the I-channel, not allocated under other commands: cannot be invoked when other H-MLP is on, or when var-HSD is on. If video is ON, it is restricted to the I-channel.

NOTE – When the "restrict" command is in force, the least significant bit of all octets covered by the HSD and H-MLP commands is set to "1", so the effective data rate is less than that indicated by the command.

A.12 Au-ISO commands (Table A.2)

For bit position illustrations, see 4.4/H.221. Definition of "audio" and procedures for use of these codes are defined in Recommendation J.52.

Au-ISO-off	Audio switched off (cancellation of any of the commands (111)[10000](001)[1-22] listed in Table A.2).
Error-1/2/3/off	Error correction data of the ancillary data field of the ISO/IEC 11172-3 signal are to mode 1/2/3 or off.
Asynch	Asynchronous mode in use.
Synch	Synchronous mode in use.

Audio-ISO commands of type "Au-ISO-bit rate" are always exact as to audio bit rate.

In the following table:

- A in a cell indicates that all octets of the I-channel carry audio in that bit position, while a shaded cell contains none;
- FB alone indicates that FAS and BAS are carried in octets 1-16 of that bit position in the I-channel but no audio, but FB + number_range shows that additionally audio is carried in the octet range numbered;
- S indicates that bit 8 is stuffed.
- N indicates the number of additional channels or time-slots used, each of which adds 62.4 kbit/s if unrestricted and 54.4 kbit/s if restricted; an additional channel has FAS and BAS in octets 1-16 of the Service Channel, whereas in TS2, 3... octets 1-16 of bit 8 (unrestricted) or bit 7 (restricted) are left vacant.

		Unrestricted									Restricted									
		I-channel									I-channel									
Code name	**Audio rate**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**N**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**N**	
Au-ISO-32k	32k			A	A	A	A		FB				A	A	A	A	FB	S		
Au-ISO-40k	40k		A	A	A	A	A		FB			A	A	A	A	A	FB	S		
Au-ISO-48k	48k	A	A	A	A	A	A		FB		A	A	A	A	A	A	FB	S		
Au-ISO-56k	56k	A	A	A	A	A	A	A	FB		A	A	A	A	A	A	A	S		unframed in restricted case
Au-ISO-62.4k	62.4k	A	A	A	A	A	A	A	FB+ 17-80											unrestricted only
Au-ISO-64k	64k	A	A	A	A	A	A	A	A							A	FB+ 41-56	S	1	unframed in unrestricted case
Au-ISO-80k	80k					A	A		FB+ 41-56	1				A	A	A	FB+ 41-56	S	1	
Au-ISO-96k	96k			A	A	A	A		FB+ 41-56	1		A	A	A	A	A	FB+ 41-56	S	1	
Au-ISO-112k	112k	A	A	A	A	A	A		FB+ 41-56	1							FB+ 41-72	S	2	
Au-ISO-128k	128k								FB+ 41-72	2					A	A	FB+ 41-72	S	2	
Au-ISO-160k	160k			A	A	A	A		FB+ 41-72	2	A	A	A	A	A	A	FB+ 41-72	S	2	
Au-ISO-192k	192k								FB+ 25-72	3			A	A	A		FB+ 25-72		3	
Au-ISO-224k	224k			A	A	A	A		FB+ 25-72	3							FB+ 17-80		4	
Au-ISO-256k	256k								FB+ 17-80	4			A	A	A	A	FB+ 17-80		4	
Au-ISO-288k	288k			A	A	A	A		FB+ 17-80	4					A	A	FB		5	
Au-ISO-320k	320k					A			FB	5	A	A	A	A	A	A	FB		5	
Au-ISO-352k	352k		A	A	A	A	A		FB	5										

NOTE – The previous version of Recommendation H.221 contained an error in the definition of Au-ISO-352k, in that only bits 3-6 of the I-channel were said to contain audio – this does not give 352 kbit/s.

Au-ISO commands of the type "Au-ISO-nB", where n = 2 to 6, are such that all the available bits in the given number of channels (for multiple connections) or time-slots (for a single high-rate channel) are occupied by audio, thus:

- in unrestricted single high-rate connections, TS1 carries FAS and BAS and 62.4 kbit/s of audio, while all other TS carry 64 kbit/s of audio; in unrestricted multiple connections, every 64 kbit/s channel carries FAS and BAS and 62.4 kbit/s of audio;
- in restricted single high-rate connections, TS1 carries FAS and BAS and 54.4 kbit/s of audio, while all other TS carry 56 kbit/s of audio; in restricted multiple connections only Au-ISO-2B is allowed, both 56 kbit/s channels carrying FAS and BAS and 54.4 kbit/s of audio.

The resultant audio rates are as tabulated below:

		Unrestricted				**Restricted**				
		I-channel		**Audio rate**		**I-channel**			**Audio rate**	
Code name	**Number of additional channels or TS**	**Bits 1-7**	**Bit 8**	**Multiple channel**	**Single high-rate channel**	**Bits 1-6**	**Bit 7**	**8**	**Multiple channel**	**Single high-rate channel**
Au-ISO-2B	1	A	FB+ 17-80	124.8k	126.4k	A	FB+ 17-80	S	108.8k	110.4k
Au-ISO-3B	2	A	FB+ 17-80	187.2k	190.4k	A	FB+ 17-80	S		166.4k
Au-ISO-4B	3	A	FB+ 17-80	249.6k	254.4k	A	FB+ 17-80	S		222.4k
Au-ISO-5B	4	A	FB+ 17-80	312.0k	318.4k	A	FB+ 17-80	S		278.4k
Au-ISO-6B	5	A	FB+ 17-80	373.4k	382.4k	A	FB+ 17-80	S		334.4k

A.13 Au-ISO capabilities (Table A.2)

Definition of "audio" and procedures for use of these codes are defined in Recommendation J.52.

Au-ISO-1B — Capability to operate in any of the audio modes listed in the corresponding command table, on a single B-channel[5].

Au-ISO-2B — Capability to operate in any of the audio modes listed in the corresponding command table, on one or two B-channels[5] (or TS1).

Au-ISO-3B — Capability to operate in any of the audio modes listed in the corresponding command table, on one, two or three B-channels[5].

Au-ISO-4B — Capability to operate in any of the audio modes listed in the corresponding command table, on one to four B-channels[5].

Au-ISO-5B — Capability to operate in any of the audio modes listed in the corresponding command table, on one to five B-channels[5].

Au-ISO-6B — Capability to operate in any of the audio modes listed in the corresponding command table, on one to six B-channels[5].

Asynch.mode — Can decode audio data sampled asynchronous to the network clock.

Au-Layer-I — Capable of decoding audio to ISO/IEC 11172-3 Layer I.

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[5] Or the corresponding number of an H_0 or higher channel, from TS1 upwards.

Au-Layer-II	Capable of decoding audio to ISO/IEC 11172-3 Layer II.
Au-Layer-III	Capable of decoding audio to ISO/IEC 11172-3 Layer III.
Sample-16k	Can decode audio sampled with 16 kHz clock frequency.
Sample-22.05k	Can decode audio sampled with 22.05 kHz clock frequency.
Sample-24k	Can decode audio sampled with 24 kHz clock frequency.
Sample-32k	Can decode audio sampled with 32 kHz clock frequency.
Sample-44.1k	Can decode audio sampled with 44.1 kHz clock frequency.
Sample-48k	Can decode audio sampled with 48 kHz clock frequency.
Correction – Modes 1, 2 and 3	Can decode error correction data of the ancillary data field of the ISO/IEC 11172-3 signal, appropriate mode.

A.14 Applications within LSD/HSD channels – Capabilities (Table A.4)

ISO-SP baseline on LSD	Can accept ISO-Still Picture (SP) baseline mode on specified LSD rate (Reserved).
ISO-SP baseline on HSD	Can accept ISO-still picture baseline mode on specified HSD rate (Reserved).
ISO-SP spatial	Can accept ISO-still picture baseline and spatial modes (Reserved).
ISO-SP progressive	Can accept ISO-still picture baseline and progressive modes (Reserved).
ISO-SP arithmetic	Can accept ISO-still picture baseline and arithmetic modes (Reserved).
Still image (H.261)	Can accept still images encoded by the method defined in Annex D/H.261 (see Note). NOTE – Administrations may use this optional procedure as a simple and inexpensive method to transmit still images. However, Recommendation T.81 (formerly J. PEG), as described in Recommendation T.126 and using the T.120 protocol stack in the MLP channel, is preferred.
Graphics cursor	Can handle graphics cursor data (Reserved).
Group 3 fax	Can accept Group 3 fax (Reserved).
Group 4 fax	Can accept Group 4 fax (Reserved).
V.120 LSD	Can accept V.120 terminal adaptation within an LSD channel.
V.120 HSD	Can accept V.120 terminal adaptation within an HSD channel.
V.14_LSD	Can accept V.14 terminal adaptation within an LSD channel.
V.14_HSD	Can accept V.14 terminal adaptation within an HSD channel.
H.224_MLP	Defined in Recommendation H.224.
H.224_LSD	Defined in Recommendation H.224.
H.224_HSD	Defined in Recommendation H.224.
H.224-sim	Defined in Recommendation H.224.
T.120-cap	Can accept the protocol defined in Recommendations T.123, T.122, T.125 and T.124 in the MLP and/or H-MLP channel. Support for other T-series protocols is not implied.

Nil_Data	No data applications available at rates specified by subsequent data capability values within the same capset; if/when data paths are opened, transmitted content is only binary ones, and any received data will be ignored (see clause 9/H.242).

A.15 Applications within LSD/HSD/MLP/H-MLP channels – Commands (Table A.4)

ISO-SP on in LSD	ISO-still picture switched on in specified LSD (Reserved).
ISO-SP on in HSD	ISO-still picture switched on in specified HSD (Reserved).
Cursor data on in LSD	Cursor data switched on in specified LSD (Reserved).
Fax on in LSD	Fax switched on in specified LSD (Reserved).
Fax on in HSD	Fax switched on in specified HSD (Reserved).
V.120_LSD	V.120 switched on in specified LSD.
V.120_HSD	V.120 switched on in specified HSD.
V.14_LSD	V.14 switched on in specified LSD.
V.14_HSD	V.14 switched on in specified HSD.
H.224_LSD-on/off	Defined in Recommendation H.224.
H.224_HSD-on/off	Defined in Recommendation H.224.
H.224_MLP-on/off	Defined in Recommendation H.224.
T.120_on/off	T.120 suite protocol On/Off in MLP and/or H-MLP channels.

A.16 Transfer-rate capabilities and commands used in Channel Aggregation (Table A.6)

n*64	n = 7 to 11, 13 to 17, 19 to 23. Commands: Signal occupies single channel of 448 kbit/s or corresponding higher multiple of 64 kbit/s, with FAS and BAS in the first 64 kbit/s time-slot. The effective channel occupies the lowest numbered time-slots of a channel with corresponding or higher capacity. Capabilities: can accept signals according to the corresponding command.
$N \times 64$	N = 7 to 24. Commands: Signal occupies the given number of 64 kbit/s channels, with FAS and BAS in each. Capabilities: can accept and synchronize signals according to the corresponding command.

Annex B

Frame structure for interworking between a 64 kbit/s terminal and a 56 kbit/s terminal

B.1 Sub-channel arrangement

The sub-channel arrangement is given in Table B.1.

B.2 Operation of the 64 kbit/s terminal

The transmitter fills the eighth sub-channel with "1", while the receiver searches FAS at every sub-channel. It should be noted that at the receiver side stuffing bits "1" appear always at bit number 8, but FAS and BAS appear at any of bit numbers 1-7.

B.3 Restriction against some communication modes

Since the interworking bit-rate becomes 56 kbit/s, the transmission modes using more than 56 kbit/s are forbidden (receivers ignore these command BAS codes). Facilities using the original seventh sub-channel move to the sixth sub-channel.

B.4 Audio command codes (000)

The following are applicable instead of those in Annex A.

Neutral	Neutralized I-channel, containing only FAS and BAS; all other bits are to be ignored at the receiver.
Au-off, U	No audio signal, no framing; bits 1-7 of the I-channel are available.
Au-off, F	No audio signal, FAS and BAS in use; 54.4 kbit/s available for use under other commands.
A-law, U7	G.711 audio at 56 bit/s, A-law truncated to 7 bits, no framing (Mode 0U).
A-law, F6	G.711 audio at 48 kbit/s, A-law truncated to 6 bits, with FAS and BAS in bit 7.
μ-law, U7	G.711 audio at 56 kbit/s, μ-law truncated to 7 bits, no framing (Mode 0U).
μ-law, F6	G.711 audio at 48 kbit/s, μ-law truncated to 6 bits, with FAS and BAS in bit 7.
G.722, U8	Not possible to transmit 8 bits per octet.
G.722, U7	G.722 7 kHz audio in bits 1-7, 56 kbit/s (unframed).
G.722, F6	G.722 7 kHz audio at 48 kbit/s, in bits 1-6 (mode 3).
G.728, G.723.1, G.729	Unchanged from Annex A
[Other]	All other values reserved.

The following (000) values are assigned maintaining the same number of audio bits per octet between the 64 kbit/s and 56 kbit/s environments:

[0]	Neutral	[19]	μ-law, U7
[6]	Not possible	[20]	A-law, F6
[7]	Au-off, U	[21]	μ-law, F6
[10]	G.723.1	[24]	G.722, U7
[11]	G.729	[25]	G.722, F6
[12]	G-4k (R)	[29]	G.728
[18]	A-law, U7	[31]	Au-off, F

Table B.1/H.221 – Transmitter of the 64 kbit/s terminal

Bit number 1	2	3	4	5	6	7 (SC)	8		
							1	1	Octet number
S	S	S	S	S	S	FAS	1	:	
u	u	u	u	u	u		1	8	
b	b	b	b	b	b		1	9	
-	-	-	-	-	-	BAS	1	:	
c	c	c	c	c	c		1	16	
h	h	h	h	h	h		1	17	
a	a	a	a	a	a	(ECS)	1	:	
n	n	n	n	n	n		1	24	
n	n	n	n	n	n		1	25	
e	e	e	e	e	e		1	·	
l	l	l	l	l	l		1	·	
#	#	#	#	#	#	#	1	·	
1	2	3	4	5	6	7	1	80	

NOTE – C1, C2, C3 and C4 in the FAS are computed for the 160 septets, or 1120 bits.

Receiver of the 64 kbit/s terminal

A frame structured by the 56 kbit/s terminal

Bit number[a)] 1	2	3	4	5	6	7	8
							1
							1
					s	s	1
s	s	s	s		u	u	1
u	u	u	u	F[b)]	b	b	1
b	b	b	b	A	-	-	1
-	-	-	-	S	c	c	1
c	c	c	c		h	h	1
h	h	h	h		a	a	1
a	a	a	a		n	n	1
n	n	n	n		n	n	1
n	n	n	n		e	e	1
e	e	e	e	B	l	l	1
l	l	l	l	A	#	#	1
#	#	#	#	S	1	2	1
3	4	5	6				1
							1
				#7			1
							1
							1
							1
							1
							1
							1
							1

a) Synchronized with the octet timing of the network.

b) FAS may appear at any of bit number 1-7.

Superseded by a more recent version

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