MPEG-1 Multiplexed Stream

pack Preceded by pack start code 0x000001BA.

⋮

pack

ISO 11172 end code

0		0
0	ISO 11172 end code	0
0		1
B		9

MPEG-1 Pack

byte	bit 7 6 5 4	bit 3 2 1 0	
0	0	0	
1	0	**pack start code** 0	
2	0	1	
3	B	A	
4	always set to 0010	**system clock reference** bits 32..30	**marker** always set
5	**SCR** bits 29..15 Intended time, in 90 kHz clock cycles, of arrival of byte 8 of this header.		
6	**(cont.)**		**marker** always set
7	**SCR** bits 14..0		
8	**(cont.)**		**marker** always set
9	**marker** always set	**multiplex rate** (This #)* 400 bits/sec is the rate at which this stream ...	
10	... is to be delivered to the decoder.		
11	**(cont.)**		**marker** always set

(Optional)

system header Preceded by system header start code 0x000001BB.

packets Arbitrary number, each preceded by packet start code prefix 0x000001.

MPEG-1 System Header

byte	bit 7	6	5	4	3	2	1	0
0	0				0			
1	0	**system header start code**			0			
2	0				1			
3	B				B			
4	**header length** Bytes in header, from byte 6.							
5	**(cont.)**							
6	**marker** always set	**rate bound** Max value of the multiplex rates of all packs in the stream.						
7	**(cont.)**							
8	**(cont.)**							**marker** always set
9	**audio bound** Max number of audio streams in this ISO stream.						**fixed flag** Set for fixed bitrate.	**CSPS flag** Set for constrained.
10	**system audio lock flag** †	**system video lock flag** †	**marker** always set	**video bound** Max number of video streams in this ISO stream.				
11	**reserved** Currently should be set to FF.							

† Set if there is, for all (audio/video) elementary streams in the ISO multiplexed stream, a constant rational relationship between the (audio sampling rate/video picture rate) and the system clock frequency in the decoder. See §2.4.4.2.

The following stream specs are present only if the first bit is a 1. Any number of stream specs may follow.

byte			
12	**stream id**	See §2.4.4.2 of ISO spec. First bit always set. 110x xxxx for audio, 1110 xxxx for video; LS bits give stream number.	
13	Always set to 11.	**STD buffer bound scale** *	**STD buffer size bound** Largest required buffer over all ...
14	... packets in this stream. If bound scale bit is cleared, units are 128 bytes; if set, 1024 bytes.		

* Cleared for audio stream, set for video; varies for others.

MPEG-1 Packet

byte	bit 7 6 5 4	bit 3 2 1 0
0	0	0
1	0	**packet start code prefix** 0
2	0	1
3	**stream id**	See §2.4.4.2 of ISO spec. First bit always set. 110x xxxx for audio, 1110 xxxx for video; LS bits give stream number.
4	**packet length** Bytes remaining in packet, from byte 6.	
5	**(cont.)**	

(Optional)

stuffing byte Up to 16 of these, if needed for storage medium reasons. Set to FF.

Present only if first two bits are 01. * Cleared for audio stream, set for video; varies for others.

Set to 01.	**STD buffer scale** *	**STD buffer size** Specifies buffer size in target decoder.
If buffer scale bit is cleared, units are 128 bytes; if set, units are 1024 bytes.		

Always set to 00.	**PTS**	**DTS**
	01 not allowed.	

$\underbrace{\textbf{PTS} \quad \textbf{DTS}}_{\textbf{PTS/DTS flags}}$

continued

continued from MPEG-1 Packet

Flag — Data structures specified by the preceding flag bits.

PTS

	Presentation Time Stamp bits 32..30	**marker** always set
PTS bits 29..15 — Intended time of presentation, in 90 kHz clock cycles, of the ...		
... presentation unit corresponding to the first access unit in the packet.		**marker** always set
PTS bits 14..0		
(cont.)		**marker** always set

DTS

Set to 0001.	**Decoding Time Stamp** bits 32..30	**marker** always set
DTS bits 29..15 — Intended time of decoding, in 90 kHz clock cycles, of the ...		
... first access unit commencing in the packet.		**marker** always set
DTS bits 14..0		
(cont.)		**marker** always set

neither

(Present if neither PTS or DTS flags were set.) — Set to 0xF.

packet data bytes — The number of bytes can be derived from the packet length word above.

MPEG-1 Video Sequence

(Skip to next start code)

repeat

Sequence header — Preceded by start code 0x000001B3.

repeat

Group — Preceded by start code 0x000001B8.

Sequence end code

0	0
0	0
0	1
B	7

MPEG-1 Sequence Header

byte \ bit	7	6	5	4	3	2	1	0
0	**Sequence header code**: 0				0			
1	0				0			
2	0				1			
3	B				3			
4	**horizontal size** Width in pixels of the displayable luminance picture. The encoded width. . .							
5	. . . in macroblocks is (displayable + 15) **div** 16.				**vertical size**			
6	**(cont.)**							
7	**pixel aspect ratio** Respectively: forbidden, 1.0, 0.6735, 0.7031, 0.7615, 0.8055, 0.8437, 0.8935, 0.9157, 0.9815, 1.0255, 1.0695, 1.095, 1.1575, 1.2051, rsvd.				**picture rate** Respectively: forbidden, 23.976, 24, 25, 29.97, 30, 50, 59.94, 60, rsvd ... rsvd.			
8	**bit rate** Stream bitrate in units of 400 bits/s. Zero is forbidden; 3FFFF means variable bitrate.							
9	**(cont.)**							
10	**(cont.)**		**marker** Always set.	**VBV buffer size** 16 ∗ 1024 ∗ (this #) is minimum VBV . . .				
11	. . . size in bits required to decode the sequence.					**constrained** Set if true.	**load intra Q matrix**	

continued

continued from MPEG-1 Sequence Header

(If load intra Q matrix is set)

12 - 75: 64 8-bit unsigned integers defining the intra quantizer matrix.

load non-intra Q matrix

(If load non-intra Q matrix is set)

76 - 139: 64 8-bit unsigned integers defining the non-intra quantizer matrix.

(Skip to next start code)

Sequence extension data — Reserved for MPEG-2. Preceded by start code 0x000001B5. End is signaled by the presence of 0x000001.

User data (optional) — Preceded by start code 0x000001B2. End is signaled by the presence of 0x000001.

MPEG-1 Group of Pictures

byte	bit 7 – 0
0	0 0 — Group start code
1	0 0
2	0 1
3	B 8
4	drop frame | hours (0 - 23) | minutes (0 - 59)
5	(cont.) | marker always set | seconds (0 - 59)
6	(cont.) | picture (0 - 59)
7	(cont.) | closed gop * | broken link †

† Cleared during encoding. Set if editing has removed info needed to decode B-pictures after first I-picture of Group.

* Set if the Group is encoded without prediction vectors pointing to the previous Group. A closed Group may more easily be edited after encoding.

(skip to next start code)

Group extension data	Reserved for MPEG-2. Preceded by start code 0x000001B5. End is signaled by the presence of 0x000001.
User data (optional)	Preceded by start code 0x000001B2. End is signaled by the presence of 0x000001.
Pictures	Arbitrary number, preceded by Picture start code 0x00000100.

MPEG-1 Picture

byte	bit 7 – 0
0	0 0 — Picture start code
1	0 0
2	0 1
3	0 0
4	temporal reference — Unsigned integer. Set to zero for first displayed Picture of Group, then in-
5	cremented mod 1024. | coding type — Resp.: forbidden, I, P, B, D, rsvd...rsvd | VBV delay — Time in 90 kHz . . .
6	. . . clock cycles needed to fill VBV buffer from empty state at target bitrate to correct level at start of play.
7	For non-constant bitrate, is set to FFFF. | full pel for-ward vector * | forward f code †
	(cont.) | full back-ward vector * | backward f code †

: For P- or B- pictures only.

: For B-pictures only.

* Full vector flags are set if motion vector values decoded represent integer pixel offsets rather than half-pixels.
† F codes are unsigned non-zero integers describing decoding motion vectors as per §2.4.4.3, ISO 11172.

(Optional arbitrary number of 9-bit extra information structures.)	extra bit (set)	extra information
(Present only if extra bit is set. Always one byte long.)	• • •	extra bit (cleared)

Extra information structures are terminated by a cleared extra bit.

(skip to next start code)

Sequence extension data	Reserved for MPEG-2. Preceded by start code 0x000001B5. End is signaled by the presence of 0x000001.
User data (optional)	Preceded by start code 0x000001B2. End is signaled by the presence of 0x000001.
Slices	Preceded by slice start codes 00000101 - 000001AF.

MPEG-1 Slice

byte	bit 7 – 0
0	0 0 — Slice start code
1	0 0
2	0 1
3	Slice vertical position — In macroblock units, from 01 to AF, of the first Macroblock in the Slice.
4	quantizer scale — 1-31, used to scale reconstruction from DCT.

(Optional arbitrary number of 9-bit extra information structures.)	extra bit (set)	extra information
(Present only if extra bit is set. Always one byte long.)	• • •	extra bit (cleared)

Extra information structures are terminated by a cleared extra bit.

Macroblocks

MPEG-1 Audio Frame Header

byte	bit 7 – 0
0	F syncword F
1	F | **MPEG ID** Always 1 for MPEG. | **layer** 0: rsvd, 1: layer 3, 2: layer 2, 3: layer 1 | **protection** Cleared if CRC word used.
2	**bitrate index** Layer-dependent index specifies compressed bitrate, from 32 - 448 kBits/s. | **sampling frequency** 0: 44.1 kHz, 1: 48 kHz, 2: 32 kHz, 3: rsvd | **padding** Set if frame has pad slot. | **private** Not used by ISO.
3	**mode** 0: stereo, 1: joint stereo, 2: dual ch., 3: single ch. | **mode extension** In mode 1, describes stereo schemes. | **©** Set if copyright applies. | **original** Set if not a copy. | **emphasis** 0: none, 1: 50/15 µs, 2: rsvd, 3: CCITT J.17
4	**CRC check bits**
5	(Parity check is used if protection bit above is cleared.)