SMPTE STANDARD

for Television — Packet Format and Transmission Timing of DV-Based Data Streams over IEEE 1394

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1 Scope

This standard specifies the packet format and transmission timing for DV-based 25 Mb/s, 50 Mb/s and 100 Mb/s data streams over an IEEE 1394 interface. This standard covers the source packet structure for transmitting the DIF blocks, the definition of a CIP header, the transmission order and timing, and includes information on both real time and faster than real time transmission.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below.

SMPTE 314M-1999, Television — Data Structure for DV-Based Audio, Data and Compressed Video — 25 and 50 Mb/s

SMPTE 370M-2002, Television — Data Structure for DV-Based Audio, Data and Compressed Video at 100Mb/s — 1080/60i, 1080/50i, 720/60p

IEC 61883-1 (2003-01), Consumer Audio/Video Equipment — Digital Interface — Part 1: General

IEC 61883-2 (1998-02), Consumer Audio/Video Equipment — Digital Interface — Part 2: SD-DVCR Data Transmission

IEEE 1394-1995, Standard for a High Performance Serial Bus

IEEE 1394a-2000, Standard for a High Performance Serial Bus — Amendment 1

Approved
July 15, 2003

3 General description

Real time transmission of video and audio data using the IEEE 1394 interface is achieved by transmitting an isochronous packet defined in IEEE 1394 that carries video and audio data. This packet is transmitted every 125 µsec. The structure of the isochronous packet is defined in IEC 61883-1.

For transmission of a DV-based data stream over an IEEE 1394 interface, the DIF blocks defined in SMPTE 314M and SMPTE 370M are placed into the isochronous packets and transmitted. Figure 1 shows a transmission of DIF blocks present in the isochronous packet payload.

The DIF blocks are combined to form a source packet, which is a basic unit of the video and audio data for isochronous packet transmission.

The structure and length of the source packet changes for different DV-based bit rates (25, 50, 100 Mb/s). The source packet is subsequently divided into one or more data blocks that are then mapped into an isochronous packet.

The isochronous packet consists of a CIP header that contains information on the type of transmitted data and time stamp information for synchronization of a transmitter and receiver, in addition to the payload area. The isochronous receiver after receiving isochronous data reformats the transmitted data blocks and finally reconstructs the source packet.

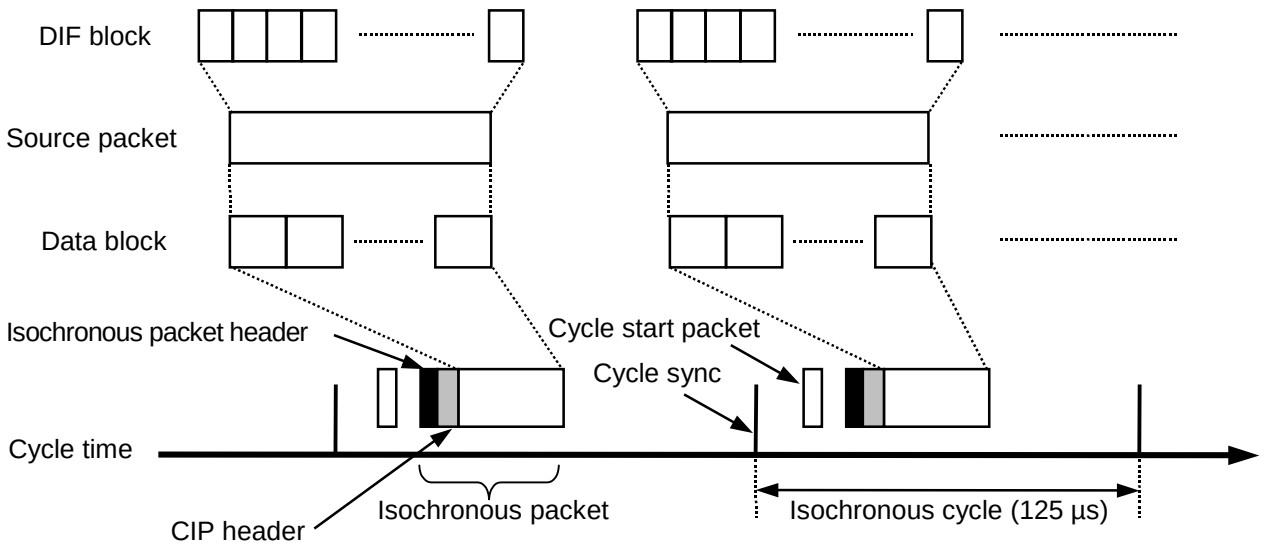


Figure 1 – Transmission of DIF blocks using isochronous packets (informative)

The number of transmitted source packets inside the isochronous packet varies, and depends on the transmission speed. When the video and audio data is transmitted at a “normal” speed (“normal” speed meaning equal to the television system frame rate), a single source packet is transmitted in a single isochronous packet. In faster than real-time transmission, the number of source packets contained in an isochronous packet increases in proportion to the transmission speed.

4 Structure of a 1394 packet

4.1 Source packet structure

For the DV-based data stream, the data structure and transmission order of DIF blocks for 25 Mb/s and 50 Mb/s bit rates is defined in SMPTE 314M, and for a 100 Mb/s rate in SMPTE 370M.

NOTE – The bit rate, including all overhead for a DV-based 25 Mb/s stream, is equal to 28.8 Mb/s (120 kBytes/frame at 59.94 Hz or 144 kBytes/frame at 50 Hz). The bit rate for a DV-based 50 Mb/s stream is double that of a DV-based 25 Mb/s stream and for a 100 Mb/s stream is quadruple that of a 25 Mb/s stream.

The source packet size and the number of DIF blocks that are contained in the source packet are determined according to the DIF structure and bit rate.

A single transmission channel provides a data rate of 25 Mb/s; therefore, a DV-based 25 Mb/s data stream uses one channel, a 50 Mb/s stream uses two channels and a 100 Mb/s stream uses four channels, carried within each video frame. The data from individual channels are always transmitted sequentially.

Each channel consists of 10 DIF sequences in a 60 Hz system, or 12 DIF sequences in a 50 Hz system.

DIF sequences are transmitted in order from DIF sequence 0 to DIF sequence 9(11). Each DIF sequence is composed of 150 DIF blocks. DIF blocks within a DIF sequence are transmitted sequentially from DIF block 0 to DIF block 149 (see annex C).

4.1.1 Source packet structure in a 25 Mb/s DV-based stream

The source packet size for the 25 Mb/s DV-based stream defined in SMPTE 314M shall be 480 bytes; therefore, it consists of 6 DIF blocks. The source packet shall not be sub-divided and is equal in size to a data block. The structure of the source packet and a data block is shown in figure 2.The correspondence between DIF blocks and source packets is shown in figures 3 and 4.

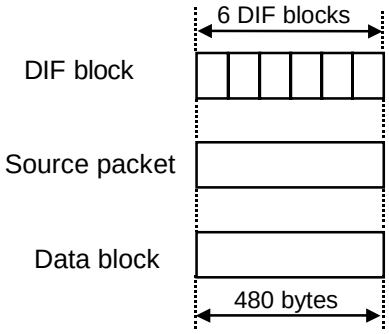


Figure 2 – Structure of a source packet and data block for 25 Mb/s stream

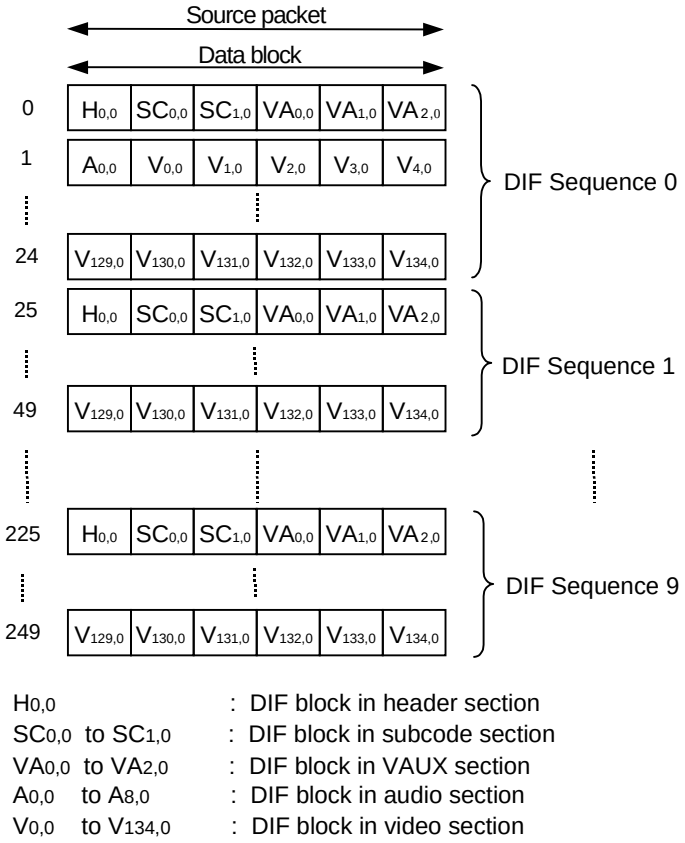


Figure 3 – Source packet structure for 25 Mb/s (525/60 system)

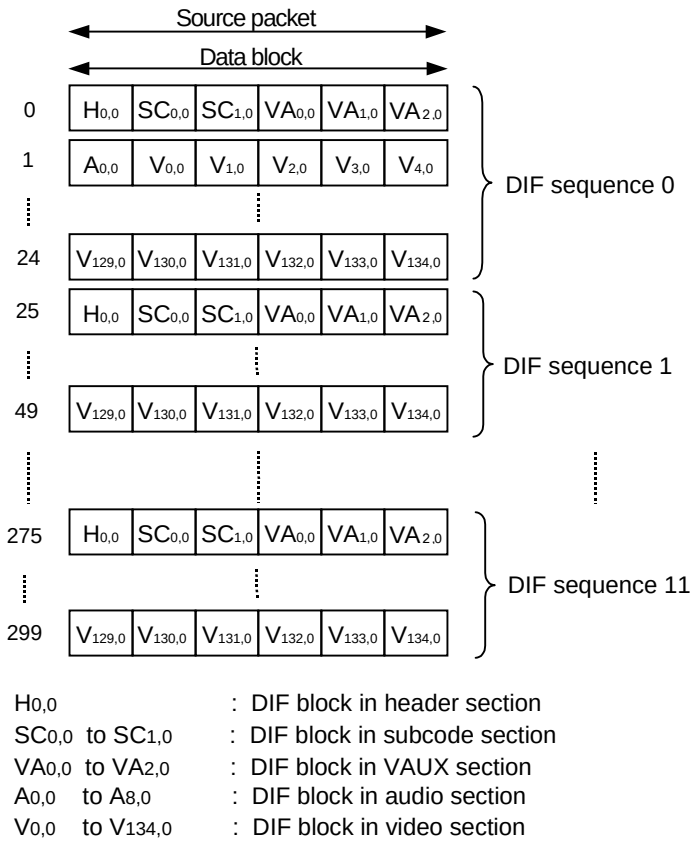


Figure 4 – Source packet structure for 25 Mb/s (625/50 system)

4.1.2 Source packet structure in a 50 Mb/s DV-based stream

The source packet size for the 50 Mb/s DV-based stream defined in SMPTE 314M shall be 960 bytes; therefore, it consists of 12 DIF blocks. The source packet shall be sub-divided into two data blocks. The structure of the source packet and data blocks is shown in figure 5. The correspondence between DIF blocks and source packets is shown in figures 6 and 7.

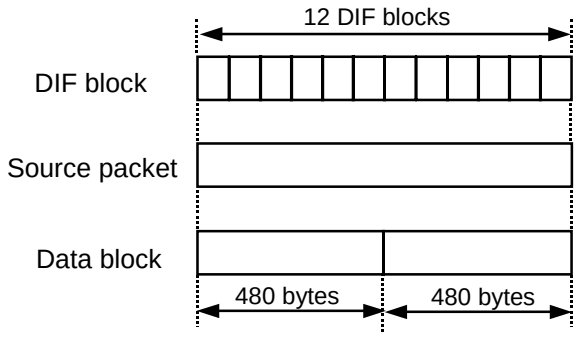
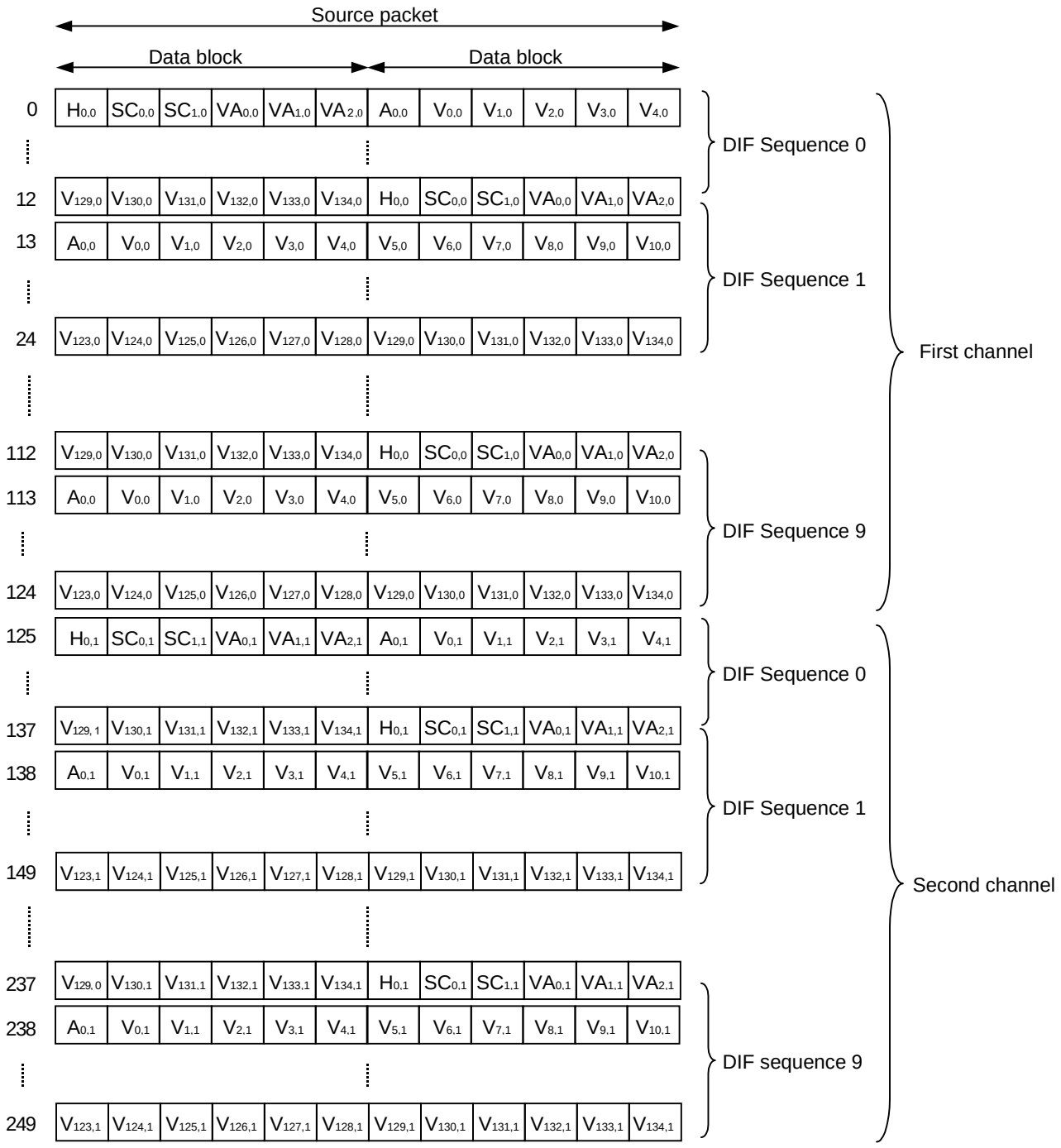
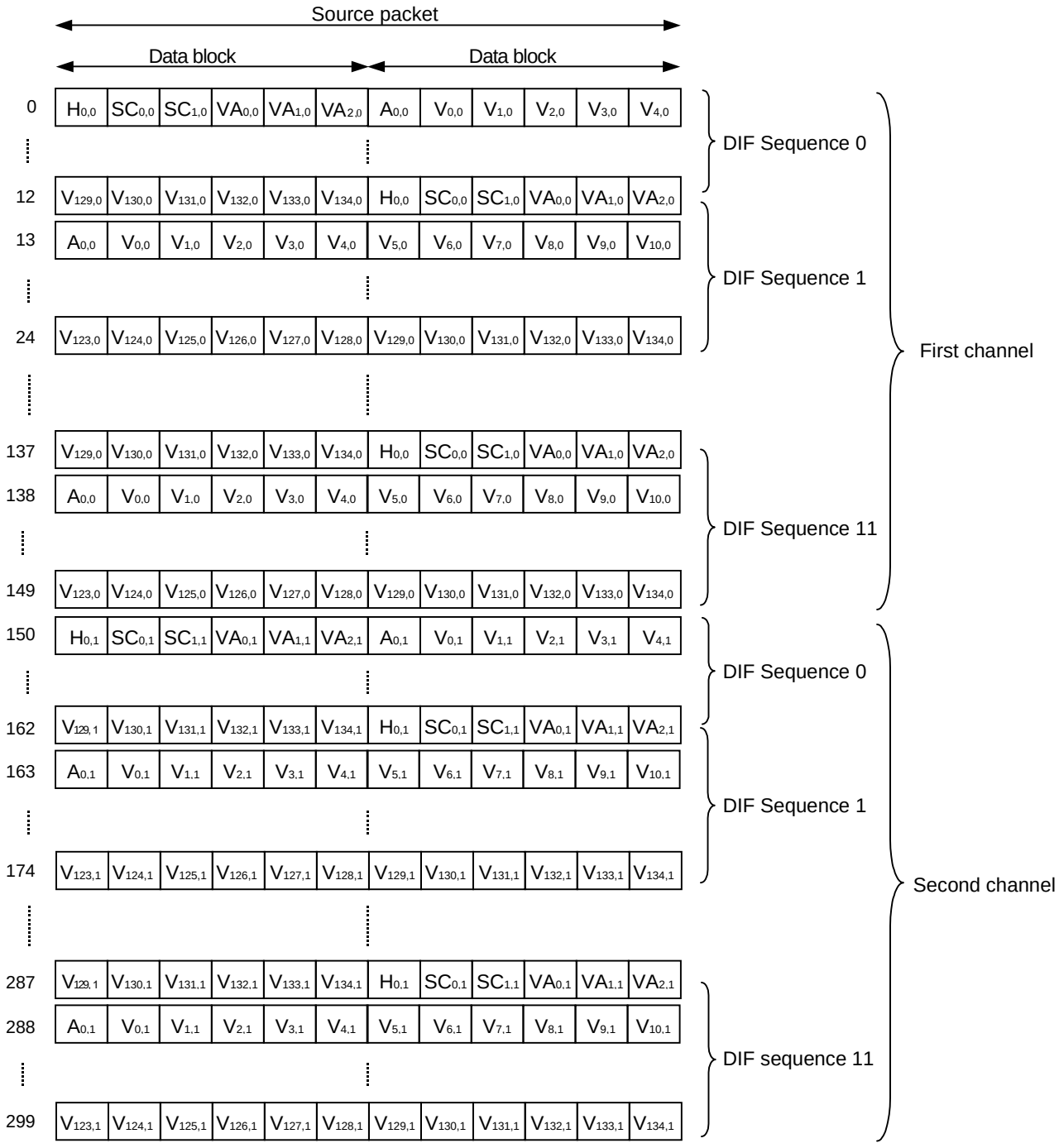


Figure 5 – Structure of a source packet and data blocks for 50 Mb/s stream



i : FSC i = 0, 1
$H_{0,i}$: DIF block in header section
$SC_{0,i}$ to $SC_{1,i}$: DIF block in subcode section
$VA_{0,i}$ to $VA_{2,i}$: DIF block in VAUX section
$A_{0,i}$ to $A_{8,i}$: DIF block in audio section
$V_{0,i}$ to $V_{134,i}$: DIF block in video section

Figure 6 – Source packet structure for 50 Mb/s (525/60 system)



i : FSC i = 0, 1
$H_{0,i}$: DIF block in header section
$SC_{0,i}$ to $SC_{1,i}$: DIF block in subcode section
$VA_{0,i}$ to $VA_{2,i}$: DIF block in VAUX section
$A_{0,i}$ to $A_{8,i}$: DIF block in audio section
$V_{0,i}$ to $V_{134,i}$: DIF block in video section

Figure 7 – Source packet structure for 50 Mb/s (625/50 system)

4.1.3 Source packet structure in a 100 Mb/s DV-based stream

The source packet size for the 100 Mb/s DV-based stream defined in SMPTE 370M shall be 1920 bytes; therefore, it consists of 24 DIF blocks. The source packet shall be sub-divided into four data blocks. The structure of the source packet and data blocks is shown in figure 8. The correspondence between DIF blocks and source packets is shown in figures 9 and 10.

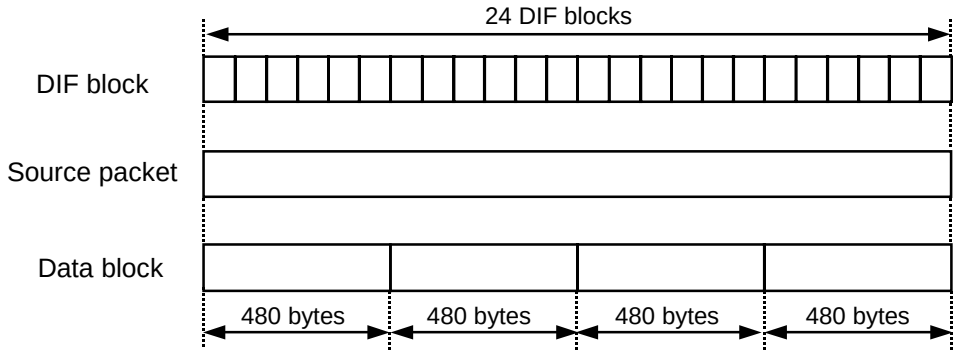
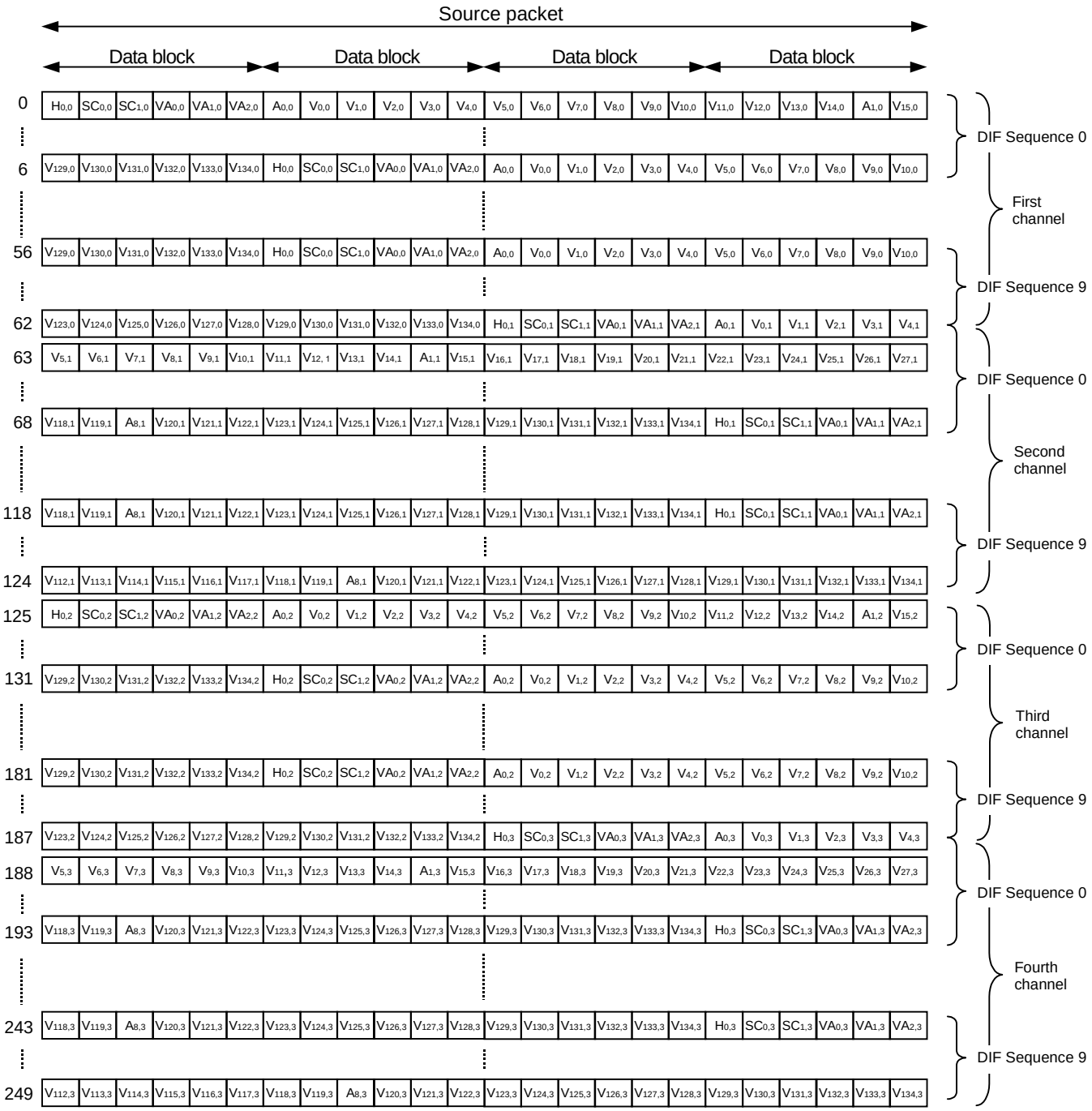
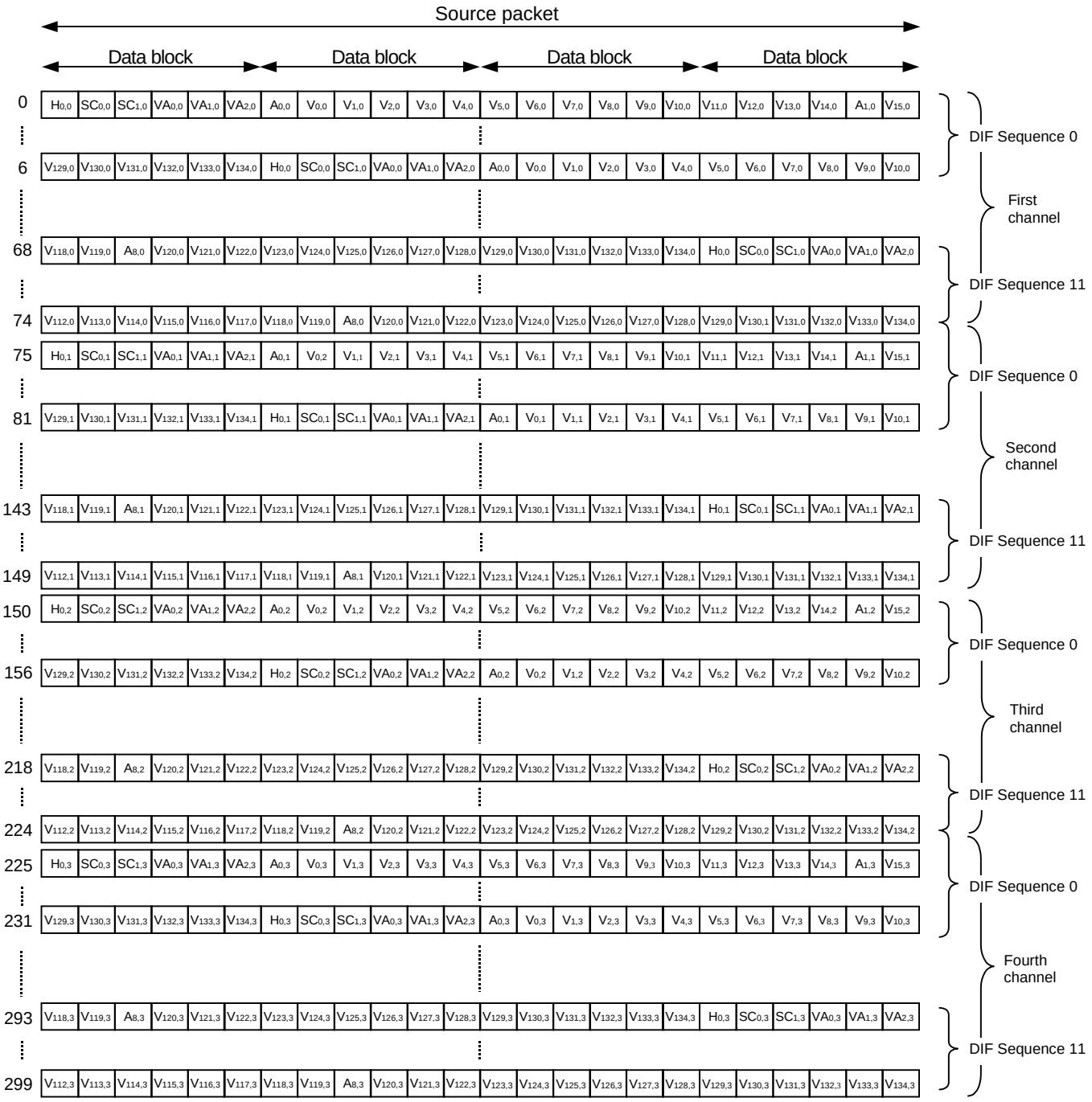


Figure 8 – Structure of a source packet and data block for 100 Mb/s stream



i : DIF channel number i = 0, 1, 2, 3
$H_{0,i}$: DIF block in header section
$SC_{0,i}$ to $SC_{1,i}$: DIF block in subcode section
$VA_{0,i}$ to $VA_{2,i}$: DIF block in VAUX section
$A_{0,i}$ to $A_{8,i}$: DIF block in audio section
$V_{0,i}$ to $V_{134,i}$: DIF block in video section

Figure 9 – Source packet structure for 100 Mb/s (60 Hz system)



i : DIF channel number i = 0, 1, 2, 3
$H_{0,i}$: DIF block in header section
$SC_{0,i}$ to $SC_{1,i}$: DIF block in subcode section
$VA_{0,i}$ to $VA_{2,i}$: DIF block in VAUX section
$A_{0,i}$ to $A_{8,i}$: DIF block in audio section
$V_{0,i}$ to $V_{134,i}$: DIF block in video section

Figure 10 – Source packet structure for 100 Mb/s (50 Hz system)

4.2 Packetization of a source packet over an IEEE 1394 isochronous timing cycle

The number of data blocks transmitted in an IEEE 1394 isochronous packet is determined according to the DIF structure and the transmission rate as indicated below.

In the case of normal transmission, corresponding to the nominal frame rate of a television signal, a single source packet is transmitted within a single isochronous packet.

In the case of a faster than real time transmission, “m” source packets shall be transmitted within an isochronous packet, the transmission rate being equal to “mx”.

An empty isochronous packet without a data block in its payload may be inserted into any IEEE 1394 isochronous timing cycle in order to adjust the transmission timing of source packets as described in 6.2.

25 Mb/s structure: When transmission rate is mx, m data blocks shall be transmitted;
50 Mb/s structure: When transmission rate is mx, 2m data blocks shall be transmitted;
100 Mb/s structure: When transmission rate is mx, 4m data blocks shall be transmitted.

NOTE – "m" is the transmission rate; "x" represents a multiple of a normal transmission rate.

The SYT field of the CIP header (see 5.8) is used to synchronize transmitter and receiver.

4.3 Transmission order of video frames for faster than real time transmission

The transmission order for each frame is indicated in 4.1. In the case of a faster than real time transmission, the transmission order for each frame shall follow the same time sequence as for normal speed transmission.

5 CIP header

5.1 CIP header for DV-based data stream

The structure of an isochronous packet is shown in figure 11. The packet header and header CRC are placed as the first two quadlets of the isochronous packet. The CIP header is placed at the beginning of the data field that forms the payload of the packet. This CIP header contains information on the type of real time data transmitted in the packet.

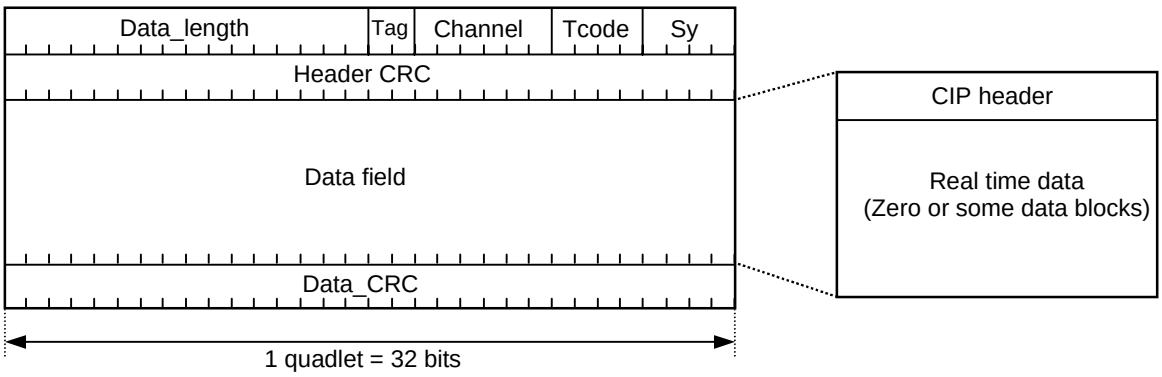


Figure 11 – Structure of an isochronous packet (informative)

The structure of the CIP header for the DV-based data stream is compliant with the two-quadlet CIP header format with SYT time stamp (see 6.2.1 of IEC 61883-1). The complete structure including the details of FDF (Format Dependent Field) is shown in figure 12.

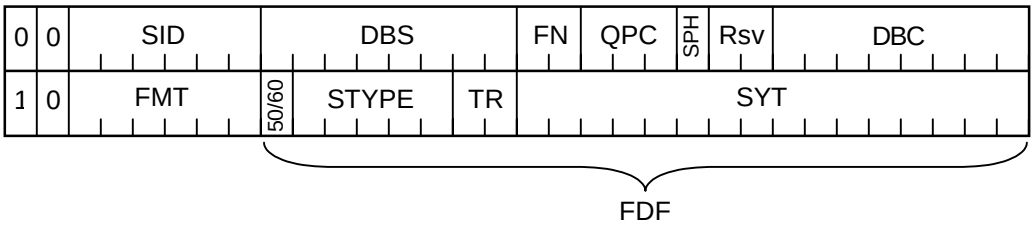


Figure 12 – CIP header for DV-based data stream

5.2 DBS (Data Block Size)

The data block size for the DV-based data stream is 480 bytes for all DIF structures. The DBS value shall be set to 01111000b (120 quadlets).

5.3 FN (Fraction Number)

FN shall be set to the following values according to the DIF structure:

25 Mb/s structure: FN shall be set to 00b to indicate the source packet is not divided;
50 Mb/s structure: FN shall be set to 01b to indicate the source packet is divided into 2 data blocks;
100 Mb/s structure: FN shall be set to 10b to indicate the source packet is divided into 4 data blocks.

5.4 QPC (Quadlet Padding Count)

QPC shall be set to 0 to indicate that dummy quadlets are not padded.

5.5 SPH (Source Packet Header)

SPH shall be set to 0 to indicate the source packet does not contain a source packet header.

5.6 Rsv

Reserved for future extension; the default value shall be set to 0.

5.7 FMT (Format ID)

The value of FMT shall be set to 000000b to indicate a DVCR signal.

5.8 Definition of FDF (Format Dependent Field)

The definition of the components that constitute an FDF field is shown below.

50/60: 50/60 indicates the field/frame frequency with the following values.
0 = 60 Hz (59.94 Hz)
1 = 50 Hz

STYPE: STYPE in the CIP header shall be compliant to the IEC 61883-2 document(see annex D)

TR: TR indicates transmission rate with the following values
00b = 1x (normal transmission rate)
01b = 2x
10b = 4x
11b = Reserved for future application

SYT: SYT indicates a time stamp for video frame synchronization (see 6.2.1 of IEC 61883-1).

5.9 DBC (Data Block Count)

DBC is a continuity counter of data blocks for detecting a loss of data blocks in a receiver. The DBC values are determined according to the number of data blocks transmitted in the isochronous packet (see 4.2).

25 Mb/s structure: When the transmission rate is mx, the DBC value shall be a multiple of m;
50 Mb/s structure: When the transmission rate is mx, the DBC value shall be a multiple of 2m;
100 Mb/s structure: When the transmission rate is mx, the DBC value shall be a multiple of 4m.

6 Transmission timing

6.1 Transmission timing of time stamps

The transmitter shall transmit a time stamp value in the SYT field once every video frame period.

A time stamp should be transmitted in the first isochronous packet in a frame period and should meet the following conditions (see figure 13):

packet_arrival_time_L =< time stamp value

time stamp value – transmission_delay_limit =< packet_arrival_time_F

where:

packet_arrival_time_F is the cycle time when the first bit of the packet that contains the time stamp arrived at the receiver;

packet_arrival_time_L is the cycle time when the last bit of the packet that contains the time stamp arrived at the receiver;

transmission_delay_limit = 450 µs.

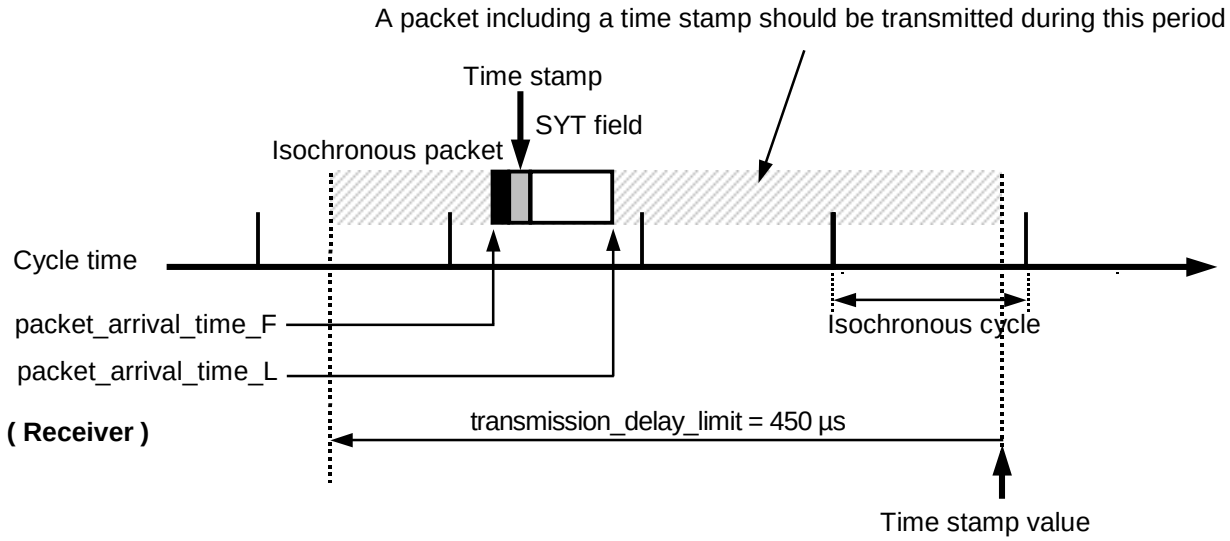


Figure 13 – Transmission timing for a time stamp

6.2 Transmission timing of a source packet

Nominal timing for a source packet should be given in the following equation (see figure 14) .

Nominal timing for a source packet $j = T_M + (T_{M+1} – T_M) * j / (K*m)$. (j = 0, m, 2m, ... (K-1)m)

T_M is the time stamp for video frame period M transmitted in the SYT field.

K is the number of isochronous packets without empty packets in a video frame period and given as follows:

K = 250 for 525/60 or 60 Hz system
K = 300 for 625/50 or 50 Hz system

NOTE – m is the transmission rate (see 4.2).

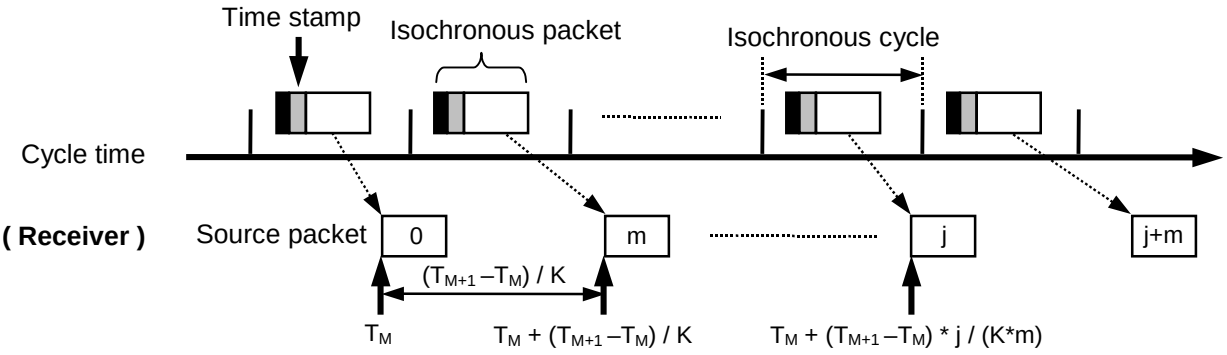


Figure 14 – Nominal timing for a source packet

The source packet j of a video frame period M should be transmitted in an isochronous packet that meets the following conditions (see figure 15):

packet_arrival_time_L =< nominal timing for source packet j

nominal timing for source packet j - transmission_delay_limit =< packet_arrival_time_F

where:

packet_arrival_time_F is the cycle time when the first bit of the packet that includes the source packet j, arrived at the receiver

packet_arrival_time_L is the cycle time when the last bit of the packet that includes the source packet j, arrived at the receiver

transmission_delay_limit = 450 µs.

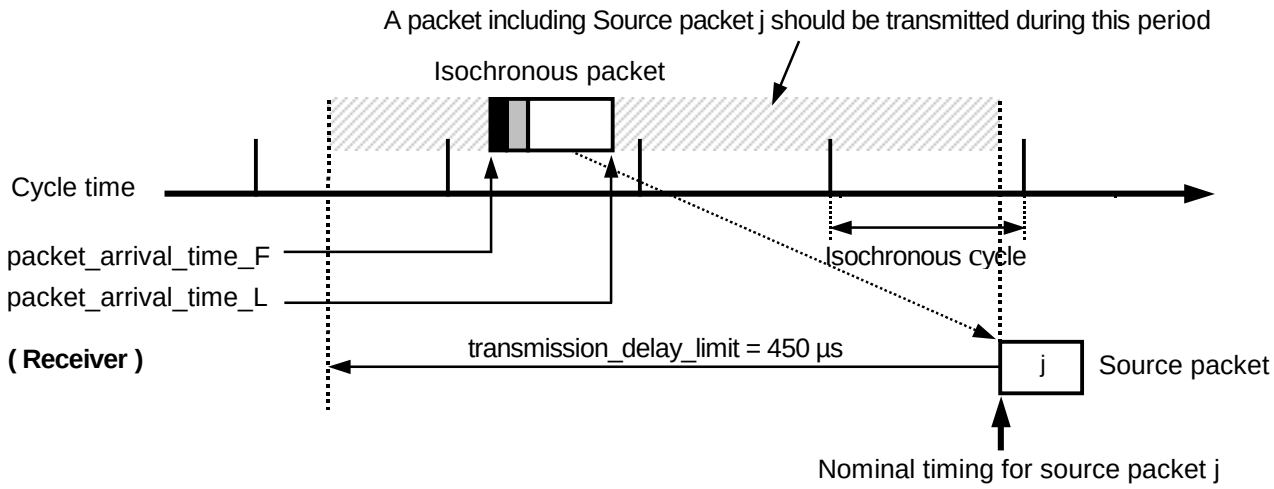


Figure 15 – Transmission timing for a source packet

Annex A (informative)
Abbreviations and acronyms

CIP header	Common isochronous packet header
Data block	A basic unit for isochronous packetization
DBS	Data block size in quadlets
DBC	Data block count
DIF	Digital interface format
DIF block	A basic unit of DIF consisting of a 3 byte ID and 77 bytes of data
DIF Sequence	A sequence of 150 DIF blocks
DVCR	Digital video cassette recorder
FN	Fractional number for dividing a source packet into 2, 4 or 8 data blocks
FMT	Format ID
FDF	Format dependent field defined for each FMT
IEEE	Institute of Electrical and Electronics Engineers, Inc.
Isochronous packet	IEEE 1394 isochronous packet for real-time transmission of application data
Quadlet	Four bytes of data
QPC	Quadlet padding count (0 quadlets to 7 quadlets)
Rsv	Reserved bit for future use
SID	Source node ID (node ID of a transmitter)
Source packet	A basic unit of application data
SPH	Source packet header
STYPE (see note)	Signal type of the isochronous packet
SYT	Sync time corresponding to a time stamp for video frame synchronization
TR	Transmission rate

NOTE – STYPE used in this standard is different from that in SMPTE 314M and SMPTE 370M. STYPE codes of the DIF stream defined in SMPTE 314M and SMPTE 370M are not changed when the DIF stream packets are inserted into the payload area of the 1394 stream.

Annex B (informative)
Structure

Table B.1 – Layered document strucutre

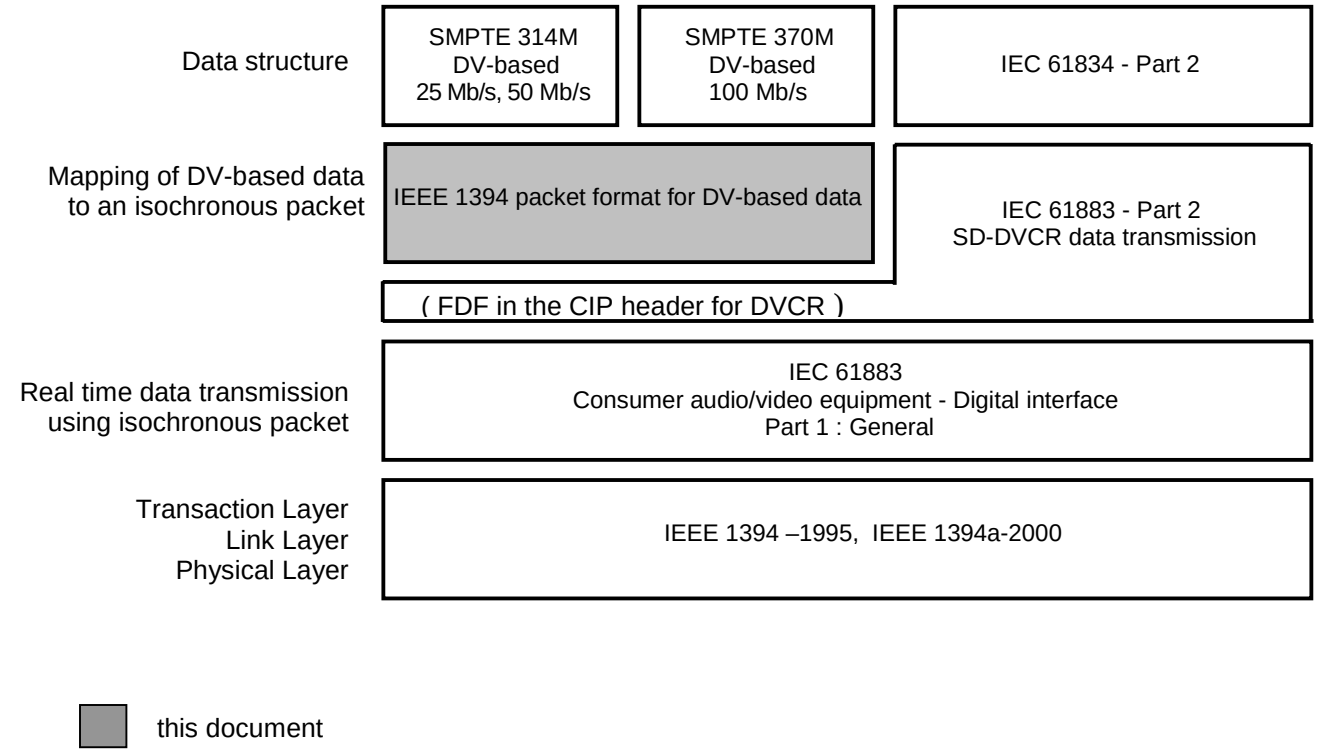


Table B.2 – Comparison of packet structure between DV and DV-based (informative)

		DV-SD IEC 61883-Part 2 / IEC 61834-Part 2	DV-based		
			25 Mb/s structure	50 Mb/s structure	100 Mb/s structure
CIP header	DBS	01111000b (120 quadlet)	Same as DV = 01111000b		
	FN	00b	00b	01b	10b
	QPC	0	Same as DV = 0		
	SPH	0	Same as DV = 0		
	DBC[1)]	Increment with 1	Increment with 1	Multiple of 2	Multiple of 4
	FMT	000000b (DVCR)	Same as DV = 000000b		
	50/60	0 = 60 Hz 1 = 50 Hz	Same as DV		
	STYPE[2)]	00000b	11110b	11101b	11100b
	TR	00b = 1x 01b = 2x 10b = 4x 11b = Rsv	Same as DV		
	SYT	Time stamp	Same as DV		
Source packet size		6 DIF blocks (480 blocks)	6 DIF blocks (480 bytes)	12 DIF blocks (960 bytes)	24 DIF blocks (1920 bytes)
Data block size		480 bytes	Same as DV = 480 bytes		

NOTES

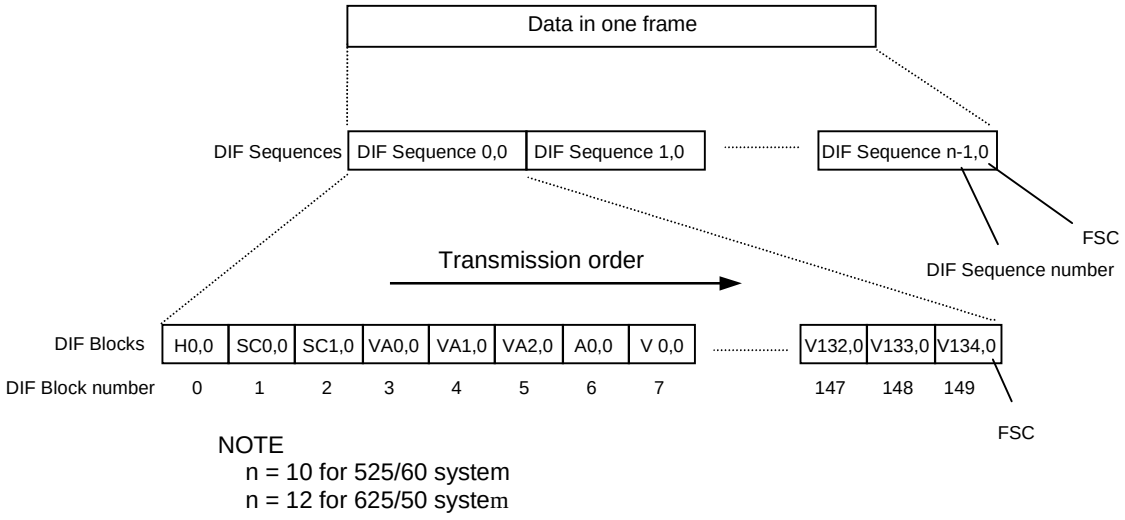
1) In case of normal transmission (1x).

2) See annex D.

The number of isochronous packets transmitted in one video frame period is the same in DV and DV-based streams. Therefore, the number of DIF blocks contained in a source packet increases with data rate.

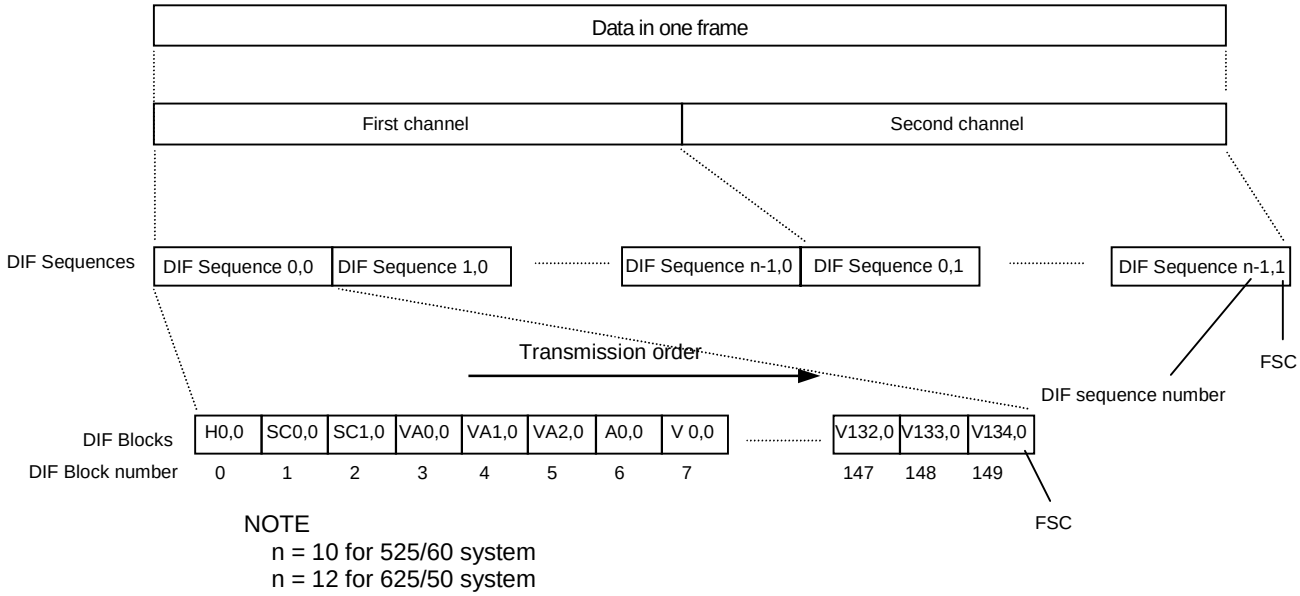
A single source packet in 50 Mb/s and 100 Mb/s streams contains 12 DIF blocks and 24 blocks respectively. The source packet is divided into 2 or 4 data blocks in 50 Mb/s and 100 Mb/s streams respectively by setting the fraction number (FN) accordingly.

Annex C (informative)
Transmission order



NOTE
n = 10 for 525/60 system
n = 12 for 625/50 system

Figure C.1 – Transmission order in one video frame for 25 Mb/s stream



NOTE
n = 10 for 525/60 system
n = 12 for 625/50 system

Figure C.2 – Transmission order in one video frame for 50 Mb/s stream

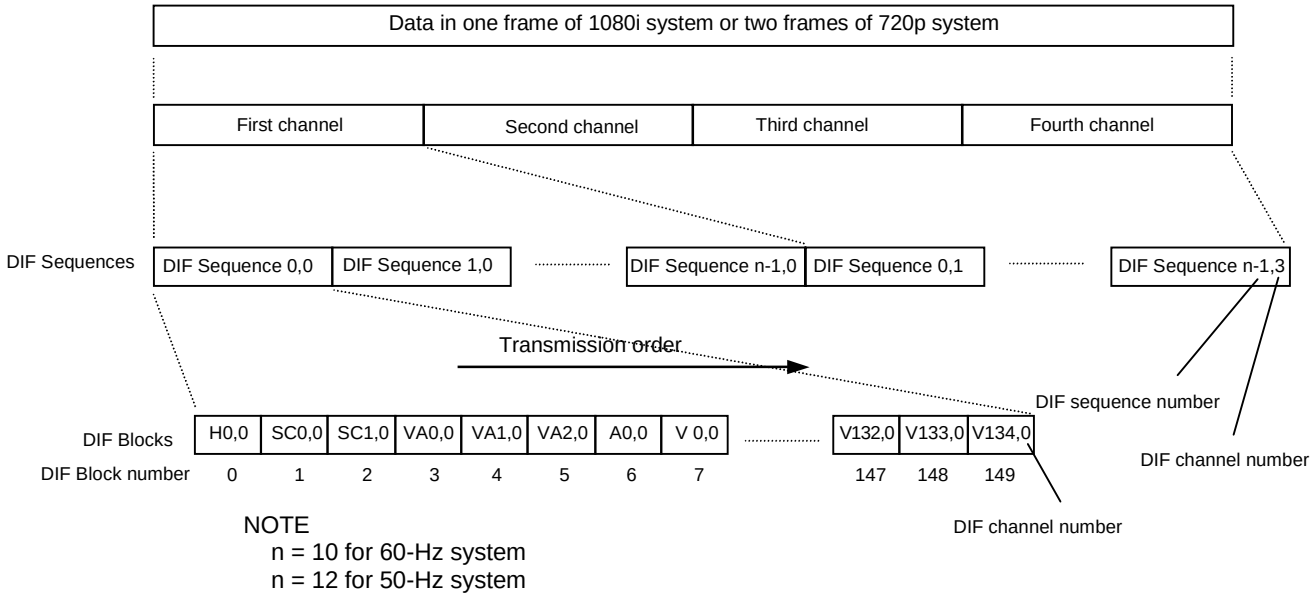


Figure C.3 – Transmission order in one video frame for 100 Mb/s stream

Annex D (informative)
Code allocation

Table D.1 – Code allocation table of 50/60 Hz and STYPE defined in IEC 61883 – Part 2

STYPE	50/60	
	0	1
00000	525/60 system	625/50 system
00001	SDL 525/60 system	SDL 625/50 system
00010	1125/60 system	1250/50 system
00011 ⋮ 11011	Reserved	
11100	SMPTE type D-12 100 Mb/s 60 Hz system	SMPTE type D-12 100 Mb/s 50 Hz system
11101	SMPTE type D-7 50 Mb/s 525/60 system	SMPTE type D-7 50 Mb/s 625/50 system
11110	SMPTE type D-7 25 Mb/s 525/60 system	SMPTE type D-7 25 Mb/s 625/50 system
11111	Reserved	

NOTES
1 SMPTE type D-7 25 Mb/s corresponds to a DV-based 25 Mb/s structure (SMPTE 314M).
2 SMPTE type D-7 50 Mb/s corresponds to a DV-based 50 Mb/s structure (SMPTE 314M).
3 SMPTE type D-12 100 Mb/s corresponds to a DV-based 100 Mb/s structure (SMPTE 370M).