Universal Serial Bus Device Class Definition for Video Devices: DV Payload

Revision 1.1

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Contributors

Abdul R. Ismail	Intel Corp.
Allison Hicks	Texas Instruments
Akihiro Tanabe	Canon Inc.
Anand Ganesh	Microsoft Corp.
Andy Hodgson	STMicroelectronics
Anshuman Saxena	Texas Instruments
Bertrand Lee	Microsoft Corp.
Charng Lee	Sunplus Technology Co., Ltd
David Goll	Microsoft Corp.
Eric Luttmann	Cypress Semiconductor Corp.
Fernando Urbina	Apple Computer Inc.
Geert Knapen	Philips Electronics
Geraud Mudry	Logitech Inc.
Hiro Kobayashi	Microsoft Corp.
Jean-Michel Chardon	Logitech Inc.
Jeff Zhu	Microsoft Corp.
Ken-ichiro Ayaki	Fujifilm
Mitsuo Niida	Canon Inc.
Nobuo Kuchiki	Sanyo Electric Co., Ltd
Olivier Lechenne	Logitech Inc.
Paul Thacker	STMicroelectronics
Remy Zimmermann	Logitech Inc.
Shinichi Hatae	Canon Inc.
Steve Miller	STMicroelectronics
Tachio Ono	Canon Inc.
Takashi Sato	Philips Semiconductors
Yoichi Hirata	Matsushita Electric Industrial Co., Ltd

Revision History

Version	Date	Description
1.0	September 4, 2003	Initial release
1.1	June 1st, 2005	Corrected SCR definition for DV Payload (RR0023) Clarifications in SCR definition Support for multiple clock frequencies (RR0033) RTP Reference Removal (RR0065). Deprecated the field **dwMaxVideoFrameBufferSize** in Table 3-1. (RR0064)

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1 Introduction

1.1 Purpose

This document defines the DV payload format for devices that are compliant with the *USB Device Class Definition for Video Devices* document.

1.2 Scope

The payload format and associated header information is fully specified in this document. This includes:

- USB Video Class stream header
- Payload-specific header
- Error detection and recovery

1.3 Related Documents

USB Specification Revision 2.0, April 27, 2000, www.usb.org
USB Device Class Definition for Video Devices, www.usb.org
IEC61834-1 Recording - Helical-scan digital video cassette recording system using 6,35 mm magnetic tape for consumer use (525-60, 625-50, 1125-60 and 1250-50 systems) - Part 1: General specifications.
IEC61834-2 (1998-08) Recording - Helical-scan digital video cassette recording system using 6,35 mm magnetic tape for consumer use (525-60, 625-50, 1125-60 and 1250-50 systems) - Part 2: SD format for 525-60 and 625-50 systems.
IEC61834-3 (1999-11) Recording - Helical-scan digital video cassette recording system using 6,35 mm magnetic tape for consumer use (525-60, 625-50, 1125-60 and 1250-50 systems) - Part 3: HD format for 1125-60 and 1250-50 systems.
IEC61834-6 (2000-08) Recording - Helical-scan digital video cassette recording system using 6,35 mm magnetic tape for consumer use (525-60, 625-50, 1125-60 and 1250-50 systems) - Part 6: SDL format.
IEC 61883-1: Consumer Audio/Video Equipment-Digital Interface –Part 1: General.
IEC 61883-2: Consumer Audio/Video Equipment-Digital Interface –Part 2: SD-DVCR Data Transaction.
IEC 61883-3: Consumer Audio/Video Equipment - Digital Interface - Part 3: HD-DVCR Data Transmission
IEC 61883-5: Consumer Audio/Video Equipment - Digital Interface - Part 5: SDL-DVCR Data Transmission

1.4 Terms and Abbreviations

The following table defines terms and abbreviations used throughout this document.

Term	Description
ADU	Application data unit
UVC	USB Video Class
SD-DV	Standard definition digital video
SDL-DV	Standard definition digital video for high compression mode
HD-DV	High definition digital video

525-60 system	525-line system with a frame frequency of 29.97 Hz
625-50 system	625-line system with a frame frequency of 25.00 Hz
1125-60system	1125-line system with a frame frequency of 30.00 Hz
1250-50system	1250-line system with a frame frequency of 25.00 Hz

2 Video Class-Specific Information

2.1 Compression Class

This specification describes the following three classes, SD-DV, SDL-DV, and HD-DV class, which are based on IEC 61834-2 Clause 11(SD), -3 Clause 10 (HD), and -6 Clause 10(SDL). Throughout this specification, we will make extensive use of the ISOIEC/ standards terminology. The reader should consult the original references mentioned in section 1.3 "Related Documents" for definitions of these terms.
The USB isochronous payload consists of the header block and the source data block.
The header block definition of a DV stream is described in section 2.2 "Stream Header".
The source data blocks are placed into the USB isochronous payload immediately after the DV stream header block.

A frame of DV format data is divided into several DIF block sequences. A DIF sequence consists of a number of DIF blocks in 80 bytes. There are five types of DIF blocks:

- DIF sequence header
- Subcode
- Video auxiliary information (VAUX)
- Audio
- Video

The relationship between each DIF block/DIF sequence and the source data blocks in the USB isochronous payload for the 525-60 system and the 625-50 system are described in section 3.2 "Video Samples".
The source data block size in payload for the SD-DV class is 480 bytes fixed size, and consists of 6 DIF blocks.
The source data block size in payload for the SDL-DV class is 240 bytes fixed size, and consists of 3 DIF blocks.
The source data block size in payload for the HD-DV class is 960 bytes fixed size, and consists of 12 DIF blocks.

2.2 Stream Header

The following is description of the header for DV format.

BFH[0]: Bit Field Header

- FID: Frame ID
- EOF: End of Frame
- PTS: Presentation Time Stamp
- SCR: Source Clock Reference
- RES: Reserved
- STI: Still Image
- ERR: Error Bit
- EOH: End of Header

USB VC header definition for DV format.

Table 2-1 VC Header Definition for DV Format

HLE	Header Length							
BFH [0]	EOH	ERR	STI	RES	SCR	PTS	EOF	FID
	PTS [7:0]							
	PTS [15:8]							
	PTS [23:16]							
	PTS[31:24]							
	SCR [7:0]							
	SCR [15:8]							
	SCR [23:16]							
	SCR [31:24]							
	SCR [39:32]							
	SCR [47:40]							

Header Length: Size: 1Byte, Value: unit number in bytes
The header length field specifies the length of the header, in bytes.

FID: Frame ID
This ID should toggle between 0 and 1 for successive DV frames.

EOF: End of Frame
This term has no meaning in DV class. It shall be set to zero.

PTS: Presentation Time Stamp
This flag shall be set to one when this payload header contains the 4-byte PTS field.

SCR: Source Clock Reference
This flag shall be set to one when this payload header contains the 6-byte SCR field.

RES: Reserved
This flag shall be set to zero.

STI: Still Image
This flag shall be set to zero.

ERR: Error Bit
This flag shall be set to one when there is an error in the payload.

EOH: End of Header
This flag shall be set to one.

PTS: Presentation Time Stamp, Size: 4 bytes, Value: Number

For DV applications PTS indicates the time (based on STC) at which each video frame period begins, which is used for synchronizing the video frame frequency between media transport mechanisms of the transmitter and the receiver.
The transmitter shall transmit a PTS field once every video frame period and only with the first source data block (n = 0) of a video frame.

The PTS value shall indicate at most 450 µs in the future relative to the STC when it is generated at the transmitter.

SCR: Source Clock Reference, Size: 6 bytes, Value: Number
The format and value of the SCR shall be as defined in the *USB Device Class Definition for Video Devices* document. The resolution of the STC field (D31..D0) of the SCR shall be based on the 13.5 MHz clock, and the device shall set the **dwClockFrequency** field of the Video Probe Control response to 0x00CDFE60 (which represents 13.5 MHz) when the DV payload format is selected by the host. The SCR values are used for synchronizing timing information between the transmitter and the receiver, and shall be sent at least every 100 ms.

3 Payload-Specific Information

3.1 Descriptors

3.1.1 DV Format Descriptor

The DV Format Descriptor defines the characteristics of a specific DV stream. A Terminal corresponding to a USB IN or OUT endpoint, and the interface it belongs to, supports one or more format definitions. To select a particular format, host software sends control requests to the corresponding interface.

DV format streams must support the Presentation Time and Source Clock fields in the packet header. DV Format Descriptors have no accompanying Frame Descriptors.

A DV Format Descriptor identifies the following:

Table 3-1 DV Format Descriptor

Offset	Field	Size	Value	Description
0	**bLength**	1	Number	Size of this Descriptor, in bytes: 9
1	**bDescriptorType**	1	Constant	CS_INTERFACE Descriptor type
2	**bDescriptorSubtype**	1	Constant	VS_FORMAT_DV Descriptor subtype
3	**bFormatIndex**	1	Number	Index of this Format Descriptor
4	**dwMaxVideoFrameBufferSize**	4	Number	Use of this field has been deprecated. Specifies the maximum size of a single DV frame, in bytes. This will vary according to the format (SD/SDL/HD) and standard (NTSC/PAL). The **dwMaxVideoFrameSize** field of the Video Probe and Commit control replaces this descriptor field. A value for this field shall be chosen for compatibility with host software that implements an earlier version of this specification.
8	**bFormatType**	1	Number	D7: 0 = 50 Hz, 1 = 60 Hz D6..0: 0: SD-DV 1: SDL-DV 2: HD-DV All other values are reserved.

3.2 Video Samples

The scope of this specification is the following video format based on IEC 61834, in Parts 2, 3, and 6. All the DIF blocks specified in IEC 61834 include the DV system data. DV streaming has DV system data into "source" and "source control" packs in a DIF block, such as aspect ratio, picture position, quantization of audio sampling, number of audio channels and so on. It will be transmitted via isochronous streaming data. Therefore, this information is not included in this specification.

3.2.1 Source Blocks in a Data Payload of SD-DV 525-60 System in a Frame

0	H_0	SC_0	SC_1	VA_0	VA_1	VA_2	DIF sequence 0
1	A_0	V_0	V_1	V_2	V_3	V_4	
⋮			:				
23	V_{123}	V_{124}	V_{125}	V_{126}	V_{127}	V_{128}	
24	V_{129}	V_{130}	V_{131}	V_{132}	V_{133}	V_{134}	
25	H_0	SC_0	SC_1	VA_0	VA_1	VA_2	DIF sequence 1
⋮				:			
49	V_{129}	V_{130}	V_{131}	V_{132}	V_{133}	V_{134}	
⋮				:			⋮
225	H_0	SC_0	SC_1	VA_0	VA_1	VA_2	DIF sequence 9
⋮	:						
249	V_{129}	V_{130}	V_{131}	V_{132}	V_{133}	V_{134}	

H_i : Header DIF block
Sc_i :Subcode DIF block I (I=0,1)
VA_i :VAUX DIF block I (I=0,1,2)
A_i : Audio DIF block I(I=0..8)
V_i :Video DIF block I (I=0..134)

3.2.2 Source Blocks in a Data Payload of SD-DV 625-50 System in a Frame

0	H_0	SC_0	SC_1	VA_0	VA_1	VA_2	DIF sequence 0
1	A_0	V_0	V_1	V_2	V_3	V_4	
⋮				:			
23	V_{123}	V_{124}	V_{125}	V_{126}	V_{127}	V_{128}	
24	V_{129}	V_{130}	V_{131}	V_{132}	V_{133}	V_{134}	
25	H_0	SC_0	SC_1	VA_0	VA_1	VA_2	DIF sequence 1
⋮				:			
49	V_{129}	V_{130}	V_{131}	V_{132}	V_{133}	V_{134}	
⋮				:			⋮
				:			
275	H_0	SC_0	SC_1	VA_0	VA_1	VA_2	DIF sequence 11
⋮				:			
299	V_{129}	V_{130}	V_{131}	V_{132}	V_{133}	V_{134}	

H_i : Header DIF block
Sc_i :Subcode DIF block I (I=0,1)
VA_i :VAUX DIF block I (I=0,1,2)
A_i : Audio DIF block I(I=0..8)
V_i :Video DIF block I (I=0..134)

3.2.3 Source Blocks in a Data Payload of SDL-DV 525-60 System in a Frame

0	H_0	SC_0	SC_1	
1	VA_0	VA_1	VA_2	
2	A_0	V_0	V_1	
3	V_2	V_3	V_4	
⋮		:		DIF sequence 0
	V_{123}	V_{124}	V_{125}	
	V_{126}	V_{127}	V_{128}	
	V_{129}	V_{130}	V_{131}	
49	V_{132}	V_{133}	V_{134}	
50	H_0	SC_0	SC_1	
51	VA_0	VA_1	VA_2	
		:		DIF sequence 1
98	V_{129}	V_{130}	V_{131}	
99	V_{132}	V_{133}	V_{134}	
⋮		:		⋮
		:		
200	H_0	SC_0	SC_1	
201	VA_0	VA_1	VA_2	
		:		DIF sequence 4
248	V_{129}	V_{130}	V_{131}	
249	V_{132}	V_{133}	V_{134}	

H_i : Header DIF block
Sc_i :Subcode DIF block I (I=0,1)
VA_i :VAUX DIF block I (I=0,1,2)
A_i : Audio DIF block I(I=0..8)
V_i :Video DIF block I (I=0..134)

3.2.4 Source Blocks in a Data Payload of SDL-DV 625-50 System in a Frame

0	H_0	SC_0	SC_1	DIF sequence 0
1	VA_0	VA_1	VA_2	
2	A_0	V_0	V_1	
3	V_2	V_3	V_4	
⋮				
	V_{123}	V_{124}	V_{125}	
	V_{126}	V_{127}	V_{128}	
	V_{129}	V_{130}	V_{131}	
49	V_{132}	V_{133}	V_{134}	
50	H_0	SC_0	SC_1	DIF sequence 1
51	VA_0	VA_1	VA_2	
98	V_{129}	V_{130}	V_{131}	
99	V_{132}	V_{133}	V_{134}	
⋮				
250	H_0	SC_0	SC_1	DIF sequence 5
251	VA_0	VA_1	VA_2	
298	V_{129}	V_{130}	V_{131}	
299	V_{132}	V_{133}	V_{134}	

H_i : Header DIF block
Sc_i :Subcode DIF block I (I=0,1)
VA_i :VAUX DIF block I (I=0,1,2)
A_i : Audio DIF block I(I=0..8)
V_i :Video DIF block I (I=0..134)

3.2.5 Source Blocks in a Data Payload of 1125-60 System in a Frame

0	$H_{0,0}$	$H_{0,1}$	$SC_{0,0}$	$SC_{0,1}$	$SC_{1,0}$	$SC_{1,1}$	$VA_{0,0}$	$VA_{0,1}$	$VA_{1,0}$	$VA_{1,1}$	$VA_{2,0}$	$VA_{2,0}$	DIF sequence 0
⋮						:							
24	$V_{129,0}$	$V_{129,1}$	$V_{130,0}$	$V_{130,1}$	$V_{131,0}$	$V_{131,1}$	$V_{132,0}$	$V_{132,1}$	$V_{133,0}$	$V_{133,1}$	$V_{134,0}$	$V_{134,1}$	
⋮						:							⋮
225	$H_{0,0}$	$H_{0,1}$	$SC_{0,0}$	$SC_{0,1}$	$SC_{1,0}$	$SC_{1,1}$	$VA_{0,0}$	$VA_{0,1}$	$VA_{1,0}$	$VA_{1,1}$	$VA_{2,0}$	$VA_{2,0}$	DIF sequence 9
⋮						:							
249	$V_{129,0}$	$V_{129,1}$	$V_{130,0}$	$V_{130,1}$	$V_{131,0}$	$V_{131,1}$	$V_{132,0}$	$V_{132,1}$	$V_{133,0}$	$V_{133,1}$	$V_{134,0}$	$V_{134,1}$	

$H_{0,k}$: Header DIF block 0, section k (k=0,1)
Sc_{ik} :Subcode DIF block i, section k (i=0,1), section k (k=0,1)
$VA_{i\,k}$:VAUX DIF block i, section k (i=0,1,2), section k (k=0,1)
$A_{i\,k}$: Audio DIF block i, section k (i=0..8), section k (k=0,1)
$V_{i\,k}$:Video DIF block i, section k (i =0..134), section k (k=0,1)

3.2.6 Source Blocks in a Data Payload of 1250-50 System in a Frame

0	$H_{0,0}$	$H_{0,1}$	$SC_{0,0}$	$SC_{0,1}$	$SC_{1,0}$	$SC_{1,1}$	$VA_{0,0}$	$VA_{0,1}$	$VA_{1,0}$	$VA_{1,1}$	$VA_{2,0}$	$VA_{2,0}$	DIF sequence 0
⋮						:							
24	$V_{129,0}$	$V_{129,1}$	$V_{130,0}$	$V_{130,1}$	$V_{131,0}$	$V_{131,1}$	$V_{132,0}$	$V_{132,1}$	$V_{133,0}$	$V_{133,1}$	$V_{134,0}$	$V_{134,1}$	
⋮						:							⋮
275	$H_{0,0}$	$H_{0,1}$	$SC_{0,0}$	$SC_{0,1}$	$SC_{1,0}$	$SC_{1,1}$	$VA_{0,0}$	$VA_{0,1}$	$VA_{1,0}$	$VA_{1,1}$	$VA_{2,0}$	$VA_{2,0}$	DIF sequence 11
⋮						:							
299	$V_{129,0}$	$V_{129,1}$	$V_{130,0}$	$V_{130,1}$	$V_{131,0}$	$V_{131,1}$	$V_{132,0}$	$V_{132,1}$	$V_{133,0}$	$V_{133,1}$	$V_{134,0}$	$V_{134,1}$	

$H_{0,k}$: Header DIF block 0, section k (k=0,1)
Sc_{ik} :Subcode DIF block i, section k (i=0,1), section k (k=0,1)
$VA_{i\,k}$:VAUX DIF block i, section k (i=0,1,2), section k (k=0,1)
$A_{i\,k}$: Audio DIF block i, section k (i=0..8), section k (k=0,1)
$V_{i\,k}$:Video DIF block i, section k (i =0..134), section k (k=0,1)

3.2.7 Payload Transmission Timing in DV Format

This section specifies the transmission timing of each packet to reduce buffer size.

The transmitter shall never pad the source data packet in a frame interval time, even if the maximum bit rate would be satisfied in the Video Frame Descriptor described.
The source data block n of video frame M shall be transmitted in a packet, which meets the following conditions:

Nominal timing for the source data block n $=T_M+(T_{M+1}-T_M)*n/K$
T_M is the time stamp for video frame M transmitted in the PTS field.
n=0..K-1
K=250 (525-60 system and 1125-60 system)
K=300 (625-50 system and 1250-50 system)

4 Examples

4.1 Isochronous Transfer IN

The following example shows the relationship between Payload Transfers, the token and data packets when receiving isochronous transfers from the device. This example shows high-speed, high-bandwidth transfers of the DV stream format. payload format. The actual bandwidth usage will vary according to the requirements of the device.

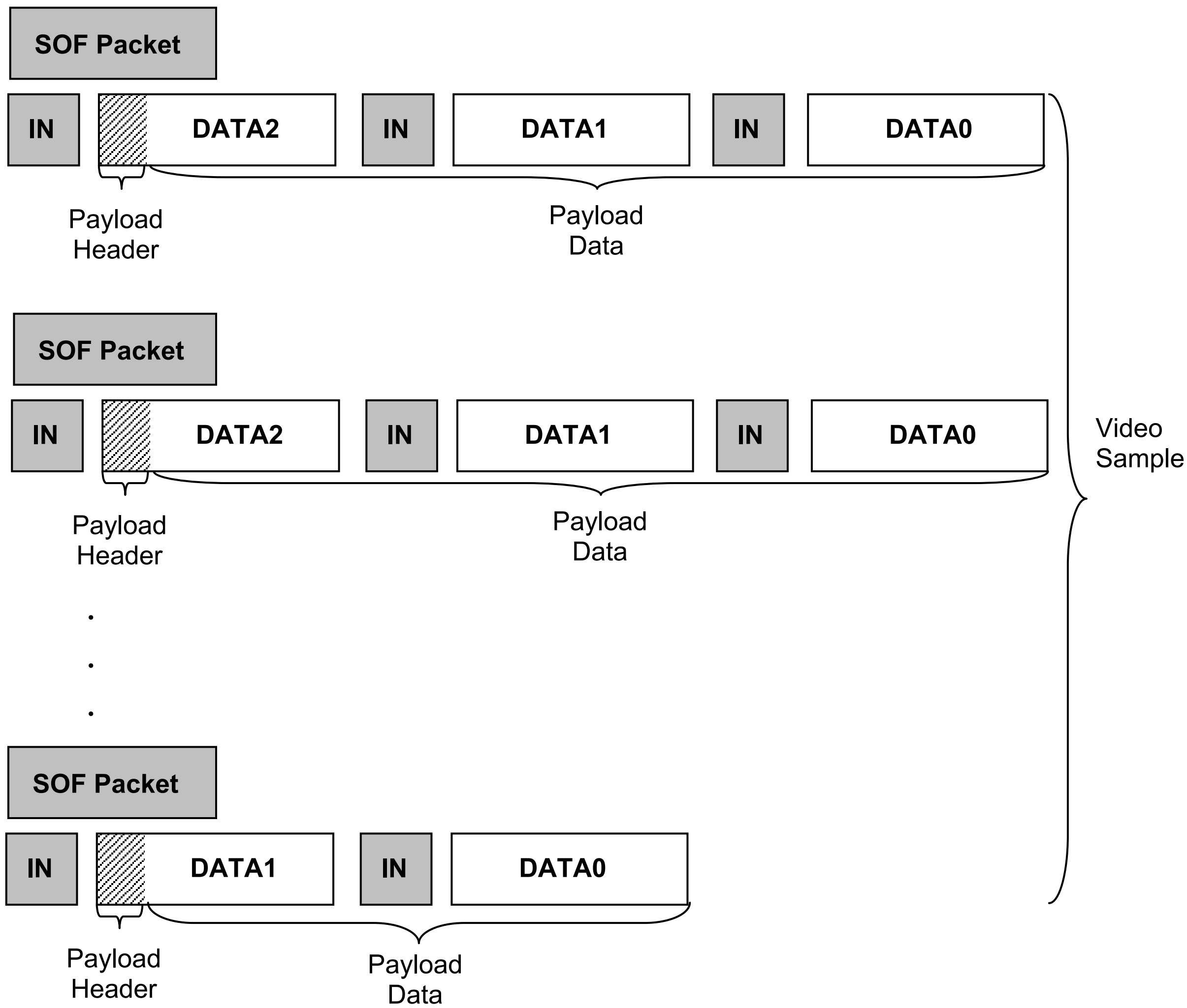

Figure 4-1 Example DV Isochronous Transfer, IN Endpoint

4.2 Isochronous Transfer OUT

The following example shows the relationship between Payload Transfers, the token and data packets when sending isochronous transfers to the device. This example shows high-speed, high-bandwidth transfers of the DV payload format. The actual bandwidth usage will vary according to the requirements of the device.

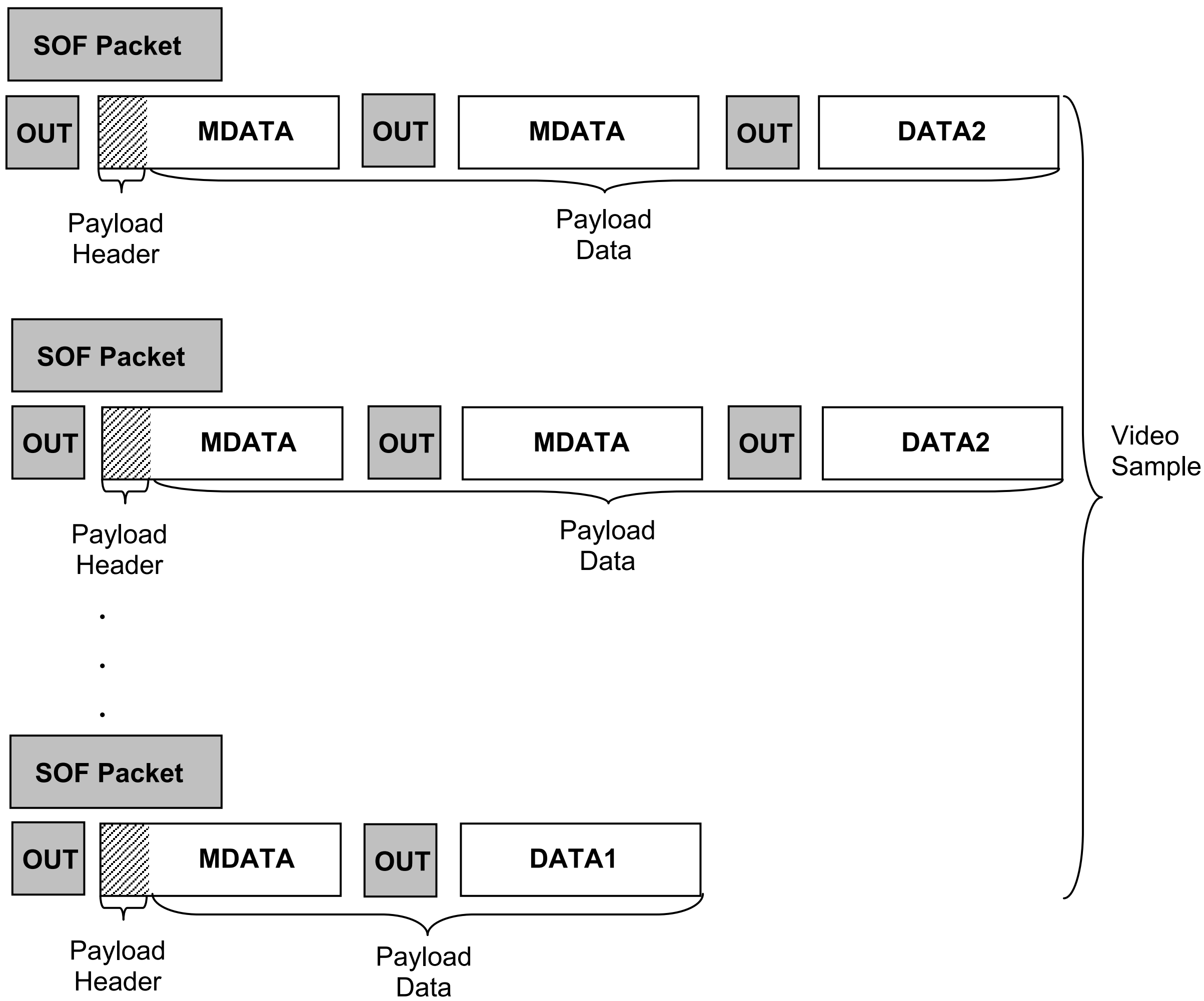

Figure 4-2 Example DV Isochronous Transfer, OUT Endpoint

4.3 Bulk Transfer IN

The following example shows the relationship between Video Samples, Payload Transfers and the token and data packets of the DV payload format when receiving bulk transfers from a device. Handshake packets are not shown for the sake of clarity.

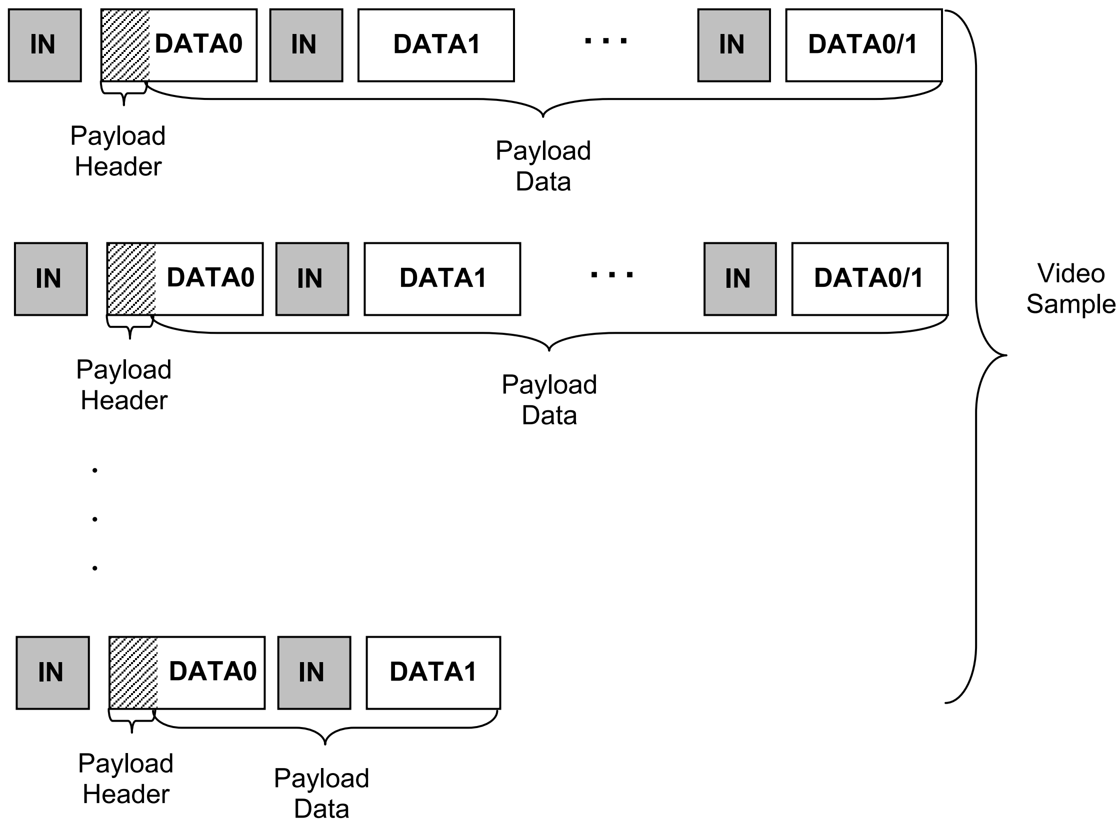

Figure 4-3 Example DV Bulk Transfer, IN Endpoint

4.4 Bulk Transfer OUT

The following example shows the relationship between Video Samples, Payload Transfers and the token and data packets of the DV payload format when sending bulk transfers to the device. Handshake packets are not shown for the sake of clarity.

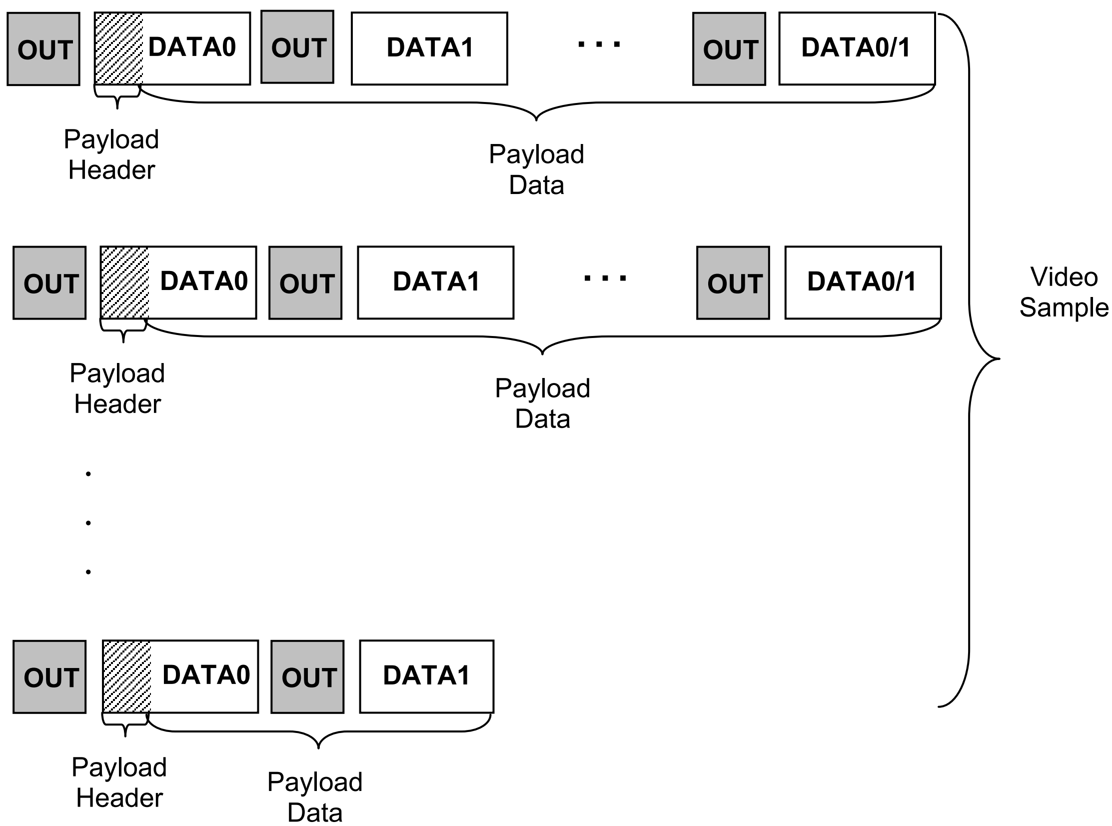

Figure 4-4 Example DV Bulk Transfer, OUT Endpoint