SMPTE STANDARD

SMPTE 315M-2004
Revision of
SMPTE 315M-1999

for Television —
Camera Positioning Information Conveyed by Ancillary Data Packets

1 Scope

This standard provides a method for multiplexing camera positioning information into the ancillary data space described in SMPTE 291M. Applications of the standard include the 525-line, 625-line, component or composite, and high-definition digital television interfaces which provide 10-bit ancillary data space. Two types of camera positioning information are defined in this standard: binary and ASCII.

2 Normative reference

The following standard contains provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the edition indicated was 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 edition of the standard indicated below.

SMPTE 291M-1998, Television — Ancillary Data Packet and Space Formatting

3 Overview

3.1 Camera positioning information, as defined in this standard, contains the following parameters. These parameters, and other parameters described in the note, are carried selectively upon the need:

– camera relative position
– camera pan
– camera tilt
– camera roll
– origin of world coordinate longitude
– origin of world coordinate latitude
– origin of world coordinate altitude
– vertical angle of view
– focus distance
– lens opening (iris or *f*-value)
– time address information
– object relative position

NOTE – There may be other parameters, required for other applications, for which data are carried within this type of ancillary data signal, but which are not defined in this standard. Such parameters will have parameter identifications which do not conflict with those used in this standard. When such parameters are received by equipment that does not recognize them, they should be ignored.

Approved
October 8, 2004

3.2 Data for each parameter can be obtained from several kinds of pick-up devices, such as rotary encoders. These data are formatted as an ancillary data packet and multiplexed into the ancillary data space of serial digital video and conveyed to the receiving end. This specification defines the packet structure, word structure, coordinate, range, and accuracy of each parameter, and the method of multiplexing packets.

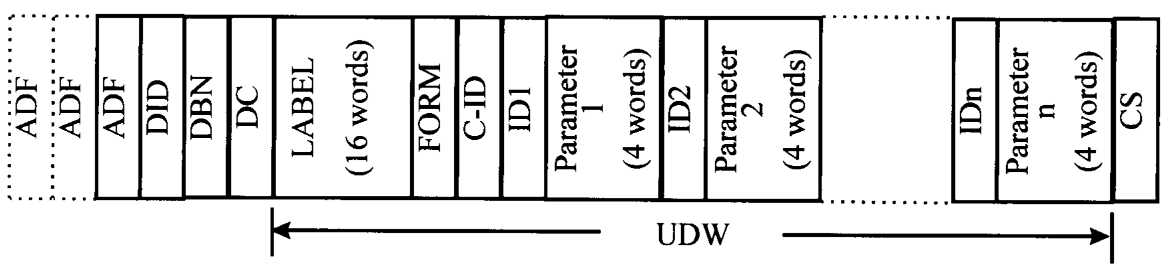
4 Packet structure

4.1 Camera positioning data packet

4.1.1 Camera positioning data packets are formatted in a data stream into one of two types, binary or ASCII. These are identified by the data type identification flag word (FORM) in the user data words and are described in 4.1.2 and 4.1.3.

4.1.2 The structure of a binary-type camera positioning data packet is shown in figure 1.

4.1.3 The structure of an ASCII-type camera positioning data packet is shown in figure 2.

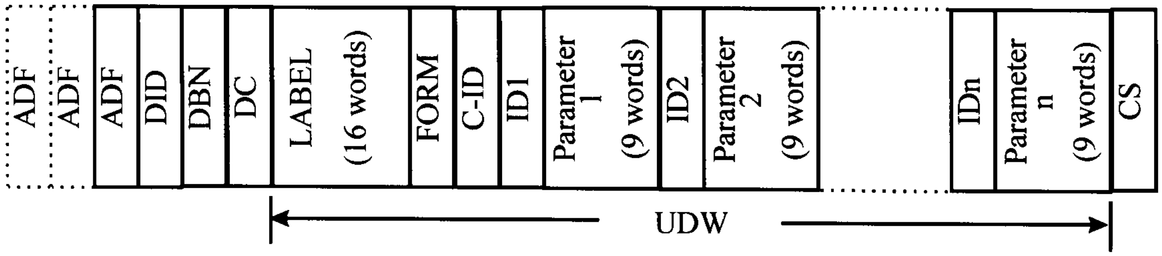


ADF: Ancillary data flag
DID: Data identification word $2F0_h$ (see note)
DBN: Data block number word
DC: Data count word
UDW: User data words (up to 255 words)
- LABEL: SMPTE label for metadata of class camera positioning information (16 words)
- FORM: Data type identification flag word (1 word)
- C-ID: Camera identification word (1 word)
- IDn: Parameter identification word (1 word for each parameter)
- Parameter n: Parameter data words (4 words for each parameter)

CS: Check sum

NOTE – This DID indicates that the UDWs carry metadata. The specific class of metadata is indicated by the LABEL. It is necessary to decode both the DID and the LABEL to identify the UDWs as carrying camera positioning information.

Figure 1 – Binary-type camera positioning data packet



ADF: Ancillary data flag
DID: Data identification word $2F0_h$ (see note)
DBN: Data block number word
DC: Data count word
UDW: User data words (up to 255 words)

LABEL:	SMPTE label for metadata of class camera positioning information (16 words)
FORM:	Data type identification flag word (1 word)
C-ID:	Camera identification words (3 words)
IDn:	Parameter identification words (3 words for each parameter)
Parameter n:	Parameter data words (9 words for each parameter)

CS: Check sum

NOTE – This DID indicates that the UDWs carry metadata. The specific class of metadata is indicated by the LABEL. It is necessary to decode both the DID and the LABEL to identify the UDWs as carrying camera positioning information.

Figure 2 – ASCII-type camera positioning data packet

5 User data words

5.1 SMPTE universal label (LABEL)

The 16 words UDW 0-15 carry the SMPTE-administered universal label to identify the class of metadata camera positioning information.

The label has the value:

{ iso org smpte (52)
registry(1) mpeg(1) rid(1) version1(1)
C(67) A(65) P(80) O(79)
}

and the word sequence is:

06 0E 2B 34 01 01 01 01 43 41 50 4F 00 00 00 00

The 4 words UDW 8-11 are the ISO/IEC 13818-1 (MPEG) registration identifier.

5.2 Data type identification flag word (FORM)

The data type identification flag word (FORM) indicates the data type of the camera identification word (C-ID), parameter identification word (IDn), and parameter data word (parameter n) contained in the packet. Bit assignments of the data type identification flag word and the data type code are shown in tables 1 and 2, respectively.

Table 1 – Bit assignment of data-type identification flag word (DID)

Bit address	Data-type identification flag
b9 (MSB)	Not b8
b8	Even parity for b(0-7)
b7	AUX
b6	AUX
b5	AUX
b4	AUX
b3	AUX
b2	AUX
b1	FORM 1
b0 (LSB)	FORM 0
NOTE – FORM (0-1): Data type code AUX: User defined	

Table 2 – Data-type code

FORM 1	FORM 0	Data type
0	0	Binary
0	1	ASCII
1	0	Reserved
1	1	Reserved

5.3 Camera identification word(s) (C-ID)

The camera identification word(s) indicate(s) the camera number by which the object is shot. It should be noted that the camera number may be any value from 0 through 255, inclusively.

5.3.1 Binary-type camera identification word

The bit assignment of the binary-type camera identification word is shown in table 3.

Table 3 – Bit assignment of binary-type camera identification word

Bit address	Binary-type camera identification
b9 (MSB)	Not b8
b8	Even parity for b(0-7)
b7	C7 (MSB)
b6	C6
b5	C5
b4	C4
b3	C3
b2	C2
b1	C1
b0 (LSB)	C0 (LSB)
NOTE – C(0-7): Camera number data	

5.3.2 ASCII-type camera identification words

Three ASCII-coded characters are used to express the camera number (000 through 255). ASCII-type camera identification is mapped into three contiguous ancillary data words (X, X+1, X+2) as shown in table 4.

Table 4 – Bit assignment of ASCII-type camera identification word

	ASCII-type camera identification		
Bit address	X	X+1	X+2
b9 (MSB)	Not b8	Not b8	Not b8
b8	Even parity for b(0-7)	Even parity for b(0-7)	Even parity for b(0-7)
b7	C7 (MSB)	C15 (MSB)	C23 (MSB)
b6	C6	C14	C22
b5	C5	C13	C21
b4	C4	C12	C20
b3	C3	C11	C19
b2	C2	C10	C18
b1	C1	C9	C17
b0 (LSB)	C0 (LSB)	C8 (LSB)	C16 (LSB)

NOTES

C(0-23): Camera number data

C(0-7): The first character (hundreds) (0, 1, 2)

C(8-15): The second character (tens) (0 through 9, but maximum value is 5 when Word X is 2.)

C(16-23): The third character (units) (0 through 9, but maximum value is 5 when Word X is 2 and Word X+1 is 5)

5.4 Parameter identification word (IDn)

Each parameter datum is preceded by a parameter identification word(s) which indicate(s) the content classification of the parameter.

5.4.1 Binary-type parameter identification word

The bit assignment of the binary-type parameter identification word is shown in table 5. Parameter identification codes are shown in table 6.

Table 5 – Bit assignment of binary-type parameter identification word

Bit address	Binary-type camera identification
b9 (MSB)	Not b8
b8	Even parity for b(0-7)
b7	P7 (MSB)
b6	P6
b5	P5
b4	P4
b3	P3
b2	P2
b1	P1
b0 (LSB)	P0 (LSB)

NOTE – P(0-7): Parameter identification code

Table 6 – Parameter identification code

Identification code				Classification of parameter
Binary type	ASCII type			
00_h	0	0	0	Reserved
01_h 02_h 03_h	0 0 0	0 0 0	1 2 3	Camera relative position Xc Camera relative position Yc Camera relative position Zc
04_h	0	0	4	Camera pan
05_h	0	0	5	Camera tilt
06_h	0	0	6	Camera roll
07_h 08_h 09_h	0 0 0	0 0 0	7 8 9	Origin of world coordinate longitude Origin of world coordinate latitude Origin of world coordinate altitude
$0A_h$	0	1	0	Vertical angle of view
$0B_h$	0	1	1	Focus distance
$0C_h$	0	1	2	Lens opening (iris or *f*-value)
$0D_h$: : $2F_h$	0 : : 0	1 : : 4	3 : : 7	Reserved
30_h	0	4	8	Time address information
31_h : : $4F_h$	0 : : 0	4 : : 7	9 : : 9	Reserved
50_h 51_h 52_h	0 0 0	8 8 8	0 1 2	Object 1 relative position Xo Object 1 relative position Yo Object 1 relative position Zo
53_h : : $7C_h$	0 : : 1	8 : : 2	3 : : 4	Object 2 relative position Xo : : Object 15 relative position Zo
$7D_h$ $7E_h$ $7F_h$	1 1 1	2 2 2	5 6 7	Object 16 relative position Xo Object 16 relative position Yo Object 16 relative position Zo
80_h : : FF_h	1 : : 2	2 : : 5	8 : : 5	User defined

5.4.2 ASCII-type parameter identification words

Three ASCII-coded characters are used to express the parameter identification code (000 through 255). ASCII-type parameter identification is mapped into three contiguous ancillary data words (X, X+1, X+2) as shown in table 7. Parameter identification codes are shown in table 6.

Table 7 – Bit assignment of ASCII-type parameter identification words

	ASCII-type parameter identification		
Bit address	X	X+1	X+2
b9 (MSB)	Not b8	Not b8	Not b8
b8	Even parity for b(0-7)	Even parity for b(0-7)	Even parity for b(0-7)
b7	P7 (MSB)	P15 (MSB)	P23 (MSB)
b6	P6	P14	P22
b5	P5	P13	P21
b4	P4	P12	P20
b3	P3	P11	P19
b2	P2	P10	P18
b1	P1	P9	P17
b0 (LSB)	P0 (LSB)	P8 (LSB)	P16 (LSB)

NOTES
P(0-23): Parameter identification data
P(0-7): The first character (hundreds)
(0, 1, 2)
P(8-15): The second character (tens)
(0 through 9, but maximum value is 5 when Word X is 2.)
P(16-23): The third character (units)
(0 through 9, but maximum value is 5 when Word X is 2 and Word X+1 is 5)

5.5 Parameter data word (Parameter n)

There are two types of parameter data words — the binary type and the ASCI I type.

5.5.1 Binary-type parameter data word

5.1.1 Bit-assignment of binary-type parameter data word (except time address information)

The binary-type parameter data word (except time address information) is mapped into four contiguous ancillary data words (X, X+1, X+2, X+3) as shown in table 8. The data representation conforms to ANSI/IEEE-754, the binary floating-point arithmetic standard.

A 32-bit format for a binary floating-point number Y is divided as shown in figure 3. The component fields of Y are the 1-bit sign s, the 8-bit biased exponent e, and the 23-bit fraction f. Bit D31 corresponds to s, D(30-23) to e, and D(22-0) to f.

5.5.1.2 Bit-assignment for time address information of binary-type parameter data word

The bit-assignment for time address information of binary-type parameter data word is as shown in table 9.

5.5.2 ASCII-type parameter data word

5.5.2.1 Bit-assignment of ASCII-type parameter data word (except time address information)

The ASCII-type parameter data word (except time address information) is mapped into nine contiguous ancillary data words (X, X+1, X+2, ..., X+8) as shown in table 10. These words indicate the symbol (+ or –), integer part, decimal point, and fractional part. The decimal point can be omitted if not required. Table 11 shows the word number to be used for each part.

5.5.2.2 Bit-assignment for time address information of ASCII-type parameter data word

The bit-assignment for time address information of ASCII-type parameter data word is as shown in table 12. Table 13 shows the definition for Word X+6 which identifies field number and drop-frame mode.

Table 8 – Bit assignment of binary-type parameter data word (except time address information)

	Binary-type parameter data			
Bit address	X	X+1	X+2	X+3
b9 (MSB)	Not b8	Not b8	Not b8	Not b8
b8	Even parity for b(0-7)	Even parity for b(0-7)	Even parity for b(0-7)	Even parity for b(0-7)
b7	D7 (MSB)	D15 (MSB)	D23 (MSB)	D31 (MSB)
b6	D6	D14	D22	D30
b5	D5	D13	D21	D29
b4	D4	D12	D20	D28
b3	D3	D11	D19	D27
b2	D2	D10	D19	D26
b1	D1	D9	D17	D25
b0 (LSB)	D0 (LSB)	D8 (LSB)	D16 (LSB)	D24 (LSB)
NOTE – D(0-31): Binary-type parameter data.				

s	e	f
D31	D30 … D23	D22 … D0

Figure 3 – Format of binary floating point (single-precision format)

Table 9 – Bit assignment for time address information of binary-type parameter data word

	Binary-type parameter data			
Bit address	X	X+1	X+2	X+3
b9 (MSB)	Not b8	Not b8	Not b8	Not b8
b8	Even parity for b0-b7	Even parity for b0-b7	Even parity for b0-b7	Even parity for b0-b7
b7	Color frame flag (15)*	Field flag (35)	Reserved (set to zero)	Reserved (set to zero)
b6	Drop frame flag (14)*	Tens of seconds (34)	Tens of minutes (54)	Reserved (set to zero)
b5	Tens of frames (13)	Tens of seconds (33)	Tens of minutes (53)	Tens of hours (73)
b4	Tens of frames (12)	Tens of seconds (32)	Tens of minutes (52)	Tens of hours (72)
b3	Units of frames (5)	Units of seconds (25)	Units of minutes (45)	Units of hours (65)
b2	Units of frames (4)	Units of seconds (24)	Units of minutes (44)	Units of hours (64)
b1	Units of frames (3)	Units of seconds (23)	Units of minutes (43)	Units of hours (63)
b0 (LSB)	Units of frames (2)	Units of seconds (22)	Units of minutes (42)	Units of hours (62)
NOTES 1 The number between parentheses expresses the bit number of the VITC defined in SMPTE 12M. 2 Flags with an asterisk (*) may not be used according to television systems; in this case, they should be set to zero as reserved bits.				

Table 10 – Bit assignment of ASCII-type parameter data word (except time address information)

Bit address	ASCII-type parameter data								
	X	X+1	X+2	X+3	X+4	X+5	X+6	X+7	X+8
b9 (MSB)	Not b8	Not b8	Not b8	Not b8	Not b8	Not b8	Not b8	Not b8	Not b8
b8	P	P	P	P	P	P	P	P	P
b7	A7 (MSB)	A7 (MSB)	A7 (MSB)	A7 (MSB)	A7 (MSB)	A7 (MSB)	A7 (MSB)	A7 (MSB)	A7 (MSB)
b6	A6	A6	A6	A6	A6	A6	A6	A6	A6
b5	A5	A5	A5	A5	A5	A5	A5	A5	A5
b4	A4	A4	A4	A4	A4	A4	A4	A4	A4
b3	A3	A3	A3	A3	A3	A3	A3	A3	A3
b2	A2	A2	A2	A2	A2	A2	A2	A2	A2
b1	A1	A1	A1	A1	A1	A1	A1	A1	A1
b0 (LSB)	A0 (LSB)	A0 (LSB)	A0 (LSB)	A0 (LSB)	A0 (LSB)	A0 (LSB)	A0 (LSB)	A0 (LSB)	A0 (LSB)
NOTE – A0-A7: ASCII code P: Even parity for b0-b7									

Table 11 – Word number used for each part

	Word number	Remarks
Symbol	Word X	+ or –
Integral part	Words X+1 to X+8	ASCII coded 0 should be inserted into the remaining words where active numbers are not assigned.
Decimal part	Words X+2 to X+8 or NOT exist	The decimal point can be omitted if not required. In this case, words X+1 to X+8 represent an integer value. (Word X represents symbol.)
Fractional part	Words X+3 to X+8 or NOT exist	The number of the minimum accuracy should be assigned at word X+8. When the decimal point does not exist, this means that there is no fractional part; namely, words X+1 to X+8 represent an integer value. (Word X represents symbol.)

Table 12 – Bit assignment for time address information of ASCII-type parameter data word

Bit address	ASCII-type parameter data								
	X	X+1	X+2	X+3	X+4	X+5	X+6	X+7	X+8
b9 (MSB) b8	Not b8 P	Not b8 P	Not b8 P	Not b8 P	Not b8 P	Not b8 P	Not b8 P	Not b8 P	Not b8 P
b7 b6 b5 b4 b3 b2 b1 b0 (LSB)	Tens of hours expressed in ASCII code	Units of hours expressed in ASCII code	Tens of minutes expressed in ASCII code	Units of minutes expressed in ASCII code	Tens of seconds expressed in ASCII code	Units of seconds expressed in ASCII code	Field flag and drop-frame flag (See table 13)	Tens of frames expressed in ASCII code	Units of hours expressed in ASCII code
NOTES 1 The MSB of the ASCII code is assigned to b7 and the LSB is assigned to b0. 2 P: Even parity for b0-b7.									

Table 13 – Definition of Word X+6

Character	Definition
, (comma)	Character " , " (comma) is used for drop frame mode and the first field.
; (semicolon)	Character " ; " (semicolon) is used for drop frame mode and the second field.
. (period)	Character " . " (period) is used for non-drop frame mode and the first field.
: (colon)	Character " : " (colon) is used for non-drop frame mode and the second field.
NOTE – A time code for the progressive scan system is still under consideration.	

6 Camera positioning parameters

6.1 Definition of the axes

Two kinds of coordinates are defined in this standard — the world coordinates and the local coordinates to which the camera is related.

6.1.1 World coordinate system

The origin of the world coordinate system is defined by longitude, latitude, and altitude (see figure 4).

The system of axes is right-handed. The Y axis is vertical (opposite direction to gravity) and the X and Z axes are in the horizontal plane.

The positions of the camera (which correspond to the origin of the local coordinate system which is defined in 6.1.2) and the object are defined by this coordinate system.

NOTE – The world coordinate system is first set up appropriately in the physical world. The initial position of the origin of the world coordinate system is defined by the operator at the start of the session, but, in general, X-Z plane is set at ground level.

When the absolute geometric ellipsoid reference is necessary, it should be based on WGS84. This is the datum used by the NAVSTAR Global Positioning System (GPS). (See annex B.)

6.1.2 Local coordinate system

This coordinate system is defined relative to the camera. The origin is the principal point of the camera (see figure 5, A.5, and A.6). The positive direction of the Z axis is along the viewing direction (optical axis) from the camera and that of the y axis is upward. "Upward" means the direction from the bottom to the top of the camera pickup plane. The system of axes is right-handed.

At the start of the session, the world coordinate system and the local coordinate system are set to the same position and direction of axes. In this position, the following parameters are set to zero:

– Camera relative position Xc
– Camera relative position Yc
– Camera relative position Zc
– Camera pan
– Camera tilt
– Camera roll

Figure 6 shows an example of the relationship between the world coordinate and the local coordinate systems after translation, panning, tilting, and rolling have been performed. The movement of the camera is assumed to be performed in the order of translation, panning, tilting, and rolling.

NOTE – A different order of application of the above parameters leads to a different orientation of the camera, even with the same values of each parameter.

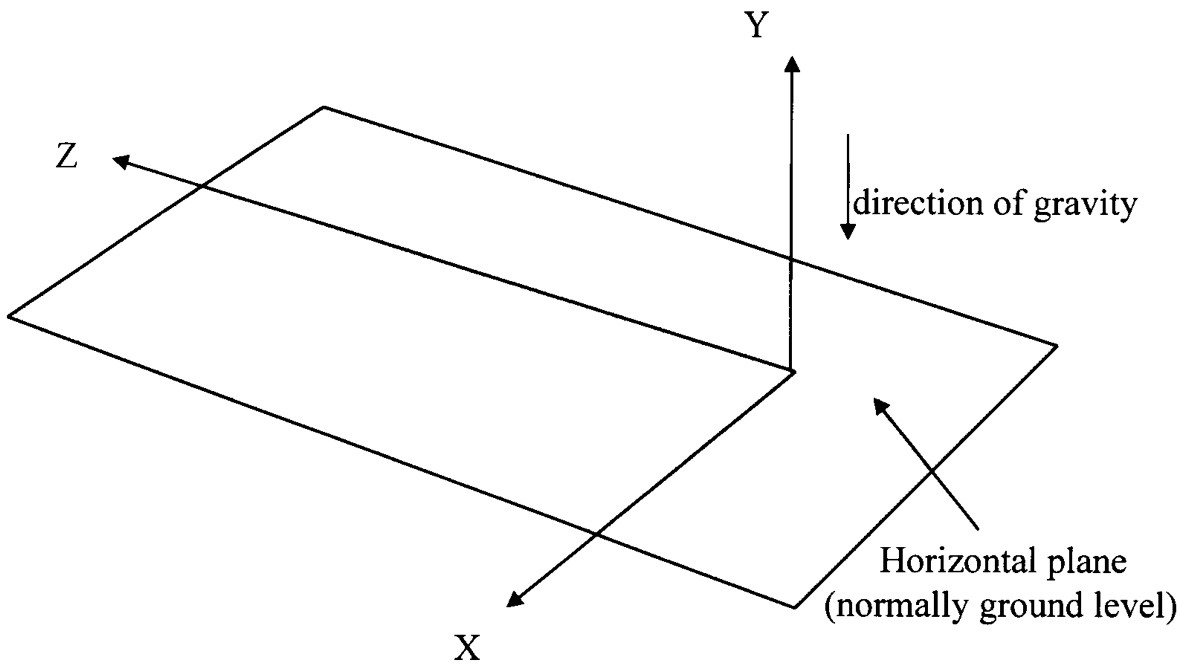


Figure 4 – World coordinate system

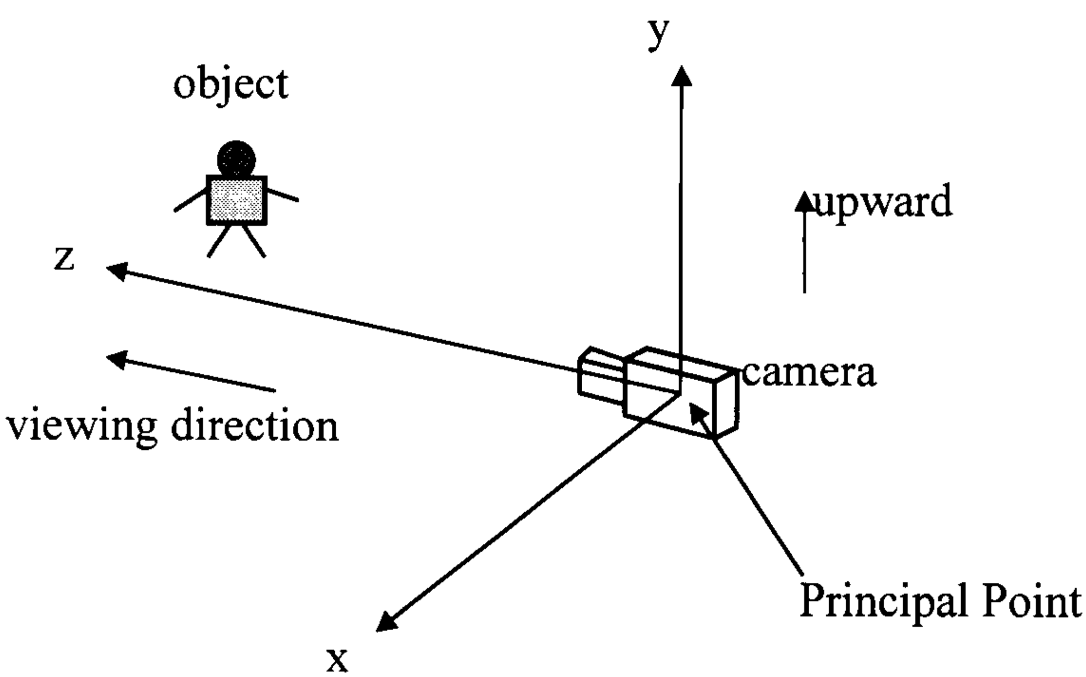


Figure 5 – Local coordinate system

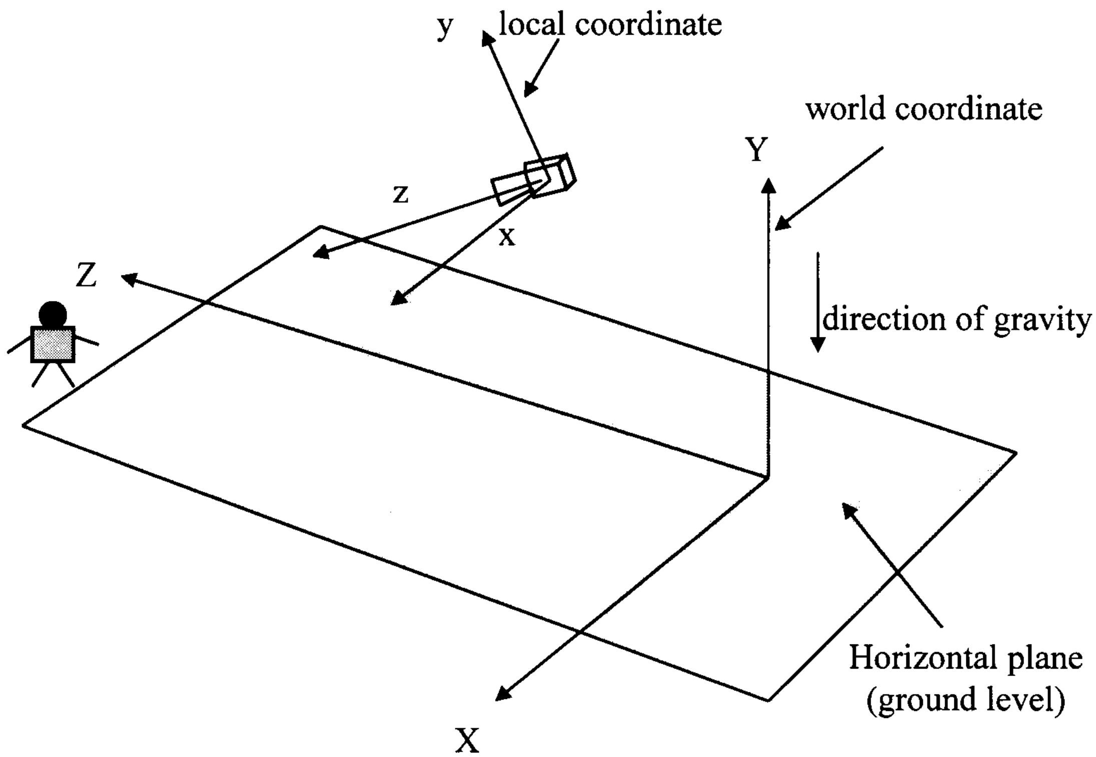


Figure 6 – Relationship between world and local coordinate systems (after translation, panning, tilting, and rolling have been performed)

6.2 Data length of parameters

Each parameter shall be expressed by either 4 words of binary-type data packets or 9 words of ASCII-type data packets.

6.2.1 Camera relative position Xc

Camera relative position Xc is defined by the X translational position of the camera (the origin of the local coordinate) from the origin of the world coordinate. The value shall be expressed in meters having a range of –99,999,999 to +99,999,999 m. Positive values shall indicate translations in which the camera has moved along the X axis in the positive direction of the world coordinate system. The maximum resolution of the data in using ASCII-type data packets is 0.000001 m.

6.2.2 Camera relative position Yc

Camera relative position Yc is defined by the Y translational position of the camera (the origin of the local coordinate) from the origin of the world coordinate. The value shall be expressed in meters having a range of –99,999,999 to +99,999,999 m. Positive values shall indicate translations in which the camera has moved along the Y axis in the positive direction of the world coordinate system. The maximum resolution of the data using the ASCII-type data packets is 0.000001 m.

6.2.3 Camera relative position Zc

Camera relative position Zc is defined by the Z translational position of the camera (the origin of the local coordinate) from the origin of the world coordinate. The value shall be expressed in meters having a range of –99,999,999 to +99,999,999 m. Positive values shall indicate translations in which the camera has moved along the Z axis in the positive direction of the world coordinate system. The maximum resolution of the data using the ASCII-type data packets is 0.000001 m.

6.2.4 Camera pan (horizontal angle of the camera)

Camera pan is defined by the angle of rotation of the camera (and its local coordinates) about the y-axis after translation has been performed. The value shall be expressed in degrees having a range of –360.0000 to +360.0000 degrees. A positive value shall indicate clockwise rotation of the camera about the local y-axis (viewing along the axis in the positive direction from the origin). The maximum resolution of the data using ASCII-type data packets is 0.000001 degree.

6.2.5 Camera tilt (vertical angle of the camera)

Camera tilt is defined by the angle of rotation of the camera (and its local coordinates) about the x-axis after camera panning has been performed. The value shall be expressed in degrees having a range of –360.0000 to +360.0000 degrees. A positive value shall indicate clockwise rotation of the camera about the local x-axis (viewing along the axis in the positive direction from the origin).The maximum resolution of the data using ASCII-type data packets is 0.000001 degree.

6.2.6 Camera roll (angle of the camera lens)

Camera roll is defined by the angle of rotation of the camera (and its local coordinates) about the z-axis after camera tilting has been performed. The value shall be expressed in degrees having a range of –360.0000 to +360.0000 degrees. A positive value shall indicate clockwise rotation of the camera about the z-axis (viewing along the axis in the positive direction from the origin). The maximum resolution of the data using ASCII-type data packets is 0.000001 degree.

6.2.7 Origin of world coordinate longitude

The origin of world coordinate longitude is defined by the longitudinal location of the origin of the world coordinate with respect to the earth's coordinate system. The value shall be expressed in degrees having a range of –180.0000 to +180.0000 degrees. Positive values shall indicate locations east of the zero meridian. The maximum resolution of the data using ASCII-type data packets is 0.000001 degree.

6.2.8 Origin of world coordinate latitude

The origin of world coordinate latitude is defined by the latitudinal location of the origin of the world coordinate with respect to the earth's coordinate system. The value shall be expressed in degrees having a range of –90.00000 to +90.00000 degrees. Positive values shall indicate locations north of the equator. The maximum resolution of the data using ASCII-type data packets is 0.000001 degree.

6.2.9 Origin of world coordinate altitude

The origin of world coordinate altitude is defined by the elevation of the origin of the world coordinate with respect to the earth's geoid. The value shall be expressed in meters having a range of –99,999,999 to +99,999,999 m. Positive values shall indicate elevations in which the origin is above the geoid. The maximum resolution of the data using ASCII-type data packets is 0.000001 m.

6.2.10 Vertical angle of view (zoom)

The vertical angle of view is defined by the angle of view of the camera lens as determined between the top and bottom edges of the production aperture (refer to A.1). The value shall be expressed in degrees having a range of 0 to +360.0000. The maximum resolution of the data using ASCII-type data packets is 0.000001 degree.

6.2.11 Focus distance

The focus distance is defined by the distance between the object and the camera (principal point, refer to A.1 and A.2) as focused by adjusting the focus ring. The value shall be expressed in meters having a range of 0 to +99,999,999 m. The maximum resolution of the data using ASCII-type data packets is 0.000001 m.

6.2.12 Lens opening (iris or *f*-value)

The lens opening is defined by the *f*-value, as commonly used for camera lenses (iris). (See A.3.) The value may have a range of 0 to +99,999,999 without units. The maximum resolution of the data using ASCII-type data packets is 0.000001.

6.2.13 Time address information

The format of time address information here is identical to that of the time address bits and flag bits of VITC defined in SMPTE 12M. This information may be useful when camera positioning information and video data are linked after being recorded or carried separately.

6.2.14 Object relative position Xo

Object relative position Xo is defined by the X translational position of the object from the origin of the world coordinate. The value shall be expressed in meters having a range of –99,999,999 to +99,999,999 m. Positive values shall indicate translations in which the object has moved along the X axis in the positive direction of the world coordinate system. The maximum resolution of the data using ASCII-type data packets is 0.000001 m.

6.2.15 Object relative position Yo

Object relative position Yo is defined by the Y translational position of the object from the origin of the world coordinate. The value shall be expressed in meters having a range of –99,999,999 to +99,999,999 m. Positive values shall indicate translations in which the object has moved along the Y axis in the positive direction of the world coordinate system. The maximum resolution of the data using ASCII-type data packets is 0.000001 m.

6.2.16 Object relative position Zo

Object relative position Zo is defined by the Z translational position of the object from the origin of the world coordinate. The value shall be expressed in meters having a range of –99,999,999 to +99,999,999 m. Positive values shall indicate translations in which the object has moved along the Z axis in the positive direction of the world coordinate system. The maximum resolution of the data using ASCII-type data packets is 0.000001 m.

NOTE – In this standard, up to 16 different objects can be identified by parameter identification codes (see table 6).

6.2.17 User defined parameters

A user can specify any other parameters which are associated with cameras, objects, or the studio environment. Each parameter shall be expressed by either 4 words for binary type data packets or 9 words for ASCII-type data packets.

7 Data space formatting

7.1 Data space of the packets

Camera positioning information packets may be located in any area defined as ANC data space in SMPTE 291M.

NOTE – Transmitter designers should recognize that some existing equipment may be able to receive only the audio data packets defined in ANSI/SMPTE 299M and carried in the horizontal ancillary data space of the C_b/C_r parallel data stream defined in SMPTE 292M. In the case of HDTV, camera positioning data packets should be multiplexed in either the ancillary data space of the Y parallel data stream or the vertical ancillary data space of the C_b/C_r parallel data stream defined in SMPTE 292M.

7.2 Repetition time of packet transmission

The camera positioning data packet shall be transmitted at least once per field.

7.3 Data timing

Parameter data contained in a packet shall be associated with the video field in which the packet is transmitted when time address information is not included in the packet. When time address information is available, parameter data shall be associated with a video field according to the time address information.

Annex A (informative)
Camera model

A.1 Vertical angle of view

When the focus distance (x) is ∞, the vertical angle of view (α) can be calculated as follows:

$$\alpha = 2 \tan^{-1} (H / 2f) \qquad (1)$$

where H is the height of the pick-up plane and f is the focal length.

Figure A.1 shows the relationship among a, H, and f when the focus distance = ∞.

The focal length is the distance between the pick-up plane and the principal point. The principal point is the theoretical position of a pin-hole camera, which is equivalent to a virtual camera position. In the case of a zoom lens, which has two principal points, the primary principal point is used for computer graphics calculation (see A.5).

If the focal distance ≠ ∞, a simplified relationship as described in figure A.1 is not applicable. An actual optical system (see figure A.2) should be considered. The vertical angle of view (a) is a function of the focal length (f), the focus distance (X), and the height of the pick-up plane (H).

$$\alpha = g\ (f, x, H) \qquad (2)$$

In general, g ( ) cannot be expressed in closed form.

A.2 Focus distance

When the focus is adjusted, the distance between the principal point and the object is called the focus distance. It may adjusted to apply a de-focusing effect.

A.3 Lens opening

The lens opening factor is called the iris. It is represented by the *f*-value. By changing the brightness and focusing depth, a de-focusing effect can be obtained.

f-value = focal length / lens active diameter (3)

NOTE – There is no equipment to realize this parameter at this point in time, but future use is expected.

A.4 Object relative position and camera relative position

The same reference point (origin) shall be used for both object relative position and camera relative position. The reference point is a location at the height of the studio floor, usually situated at the center of a target pattern to which the camera pedestal may be moved for calibration.

A.5 Principal point

Figure A.3 shows the characteristics of the two focal points of a thick lens. On the left of the diagram, diverging rays from the primary focal point F are refracted to become parallel to the axis, while on the right of the diagram, parallel incident rays are brought to a focus at the secondary focal point F". In each case, the incident and refracted rays have been extended to their point of intersection between the surfaces. Transverse planes through these intersections constitute primary and secondary principal planes. These planes cross the axis at points H and H", called the principal points. In a virtual studio, the principal point corresponds to the primary principal point in figure A.3. This is equivalent to the theoretical pin-hole camera position.

A.6 Derivation of principal point position

In an actual system, it is quite difficult to derive the position of the principal point mathematically from physical measurements. In virtual studio systems, measurements of principal point and vertical angle of view for each combination of zoom and focus values are conducted beforehand. The relationships are stored in a look-up table. In an actual program production, the principal point is read out from the look-up table for each combination of zoom and focus.

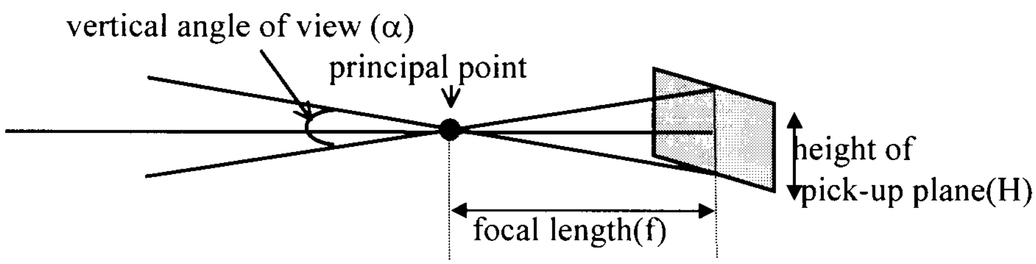


Figure A.1 –Relationship among α, H and f (focus distance = ∞)

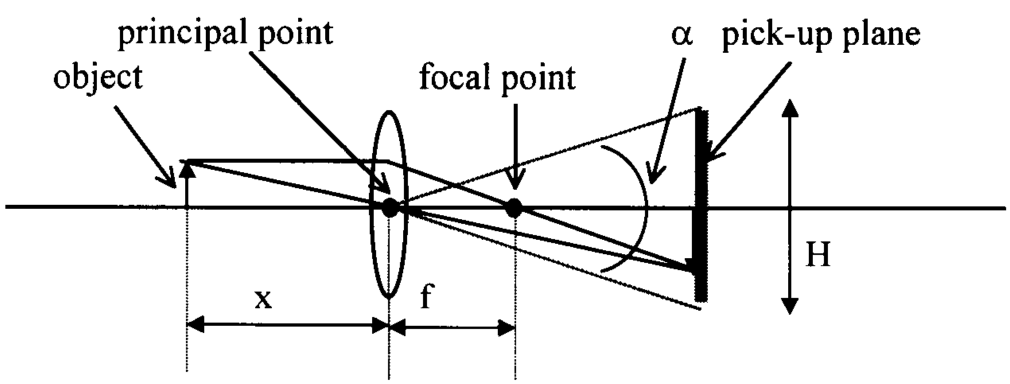


Figure A.2 -- Actual optical system (focus distance ≠ ∞)

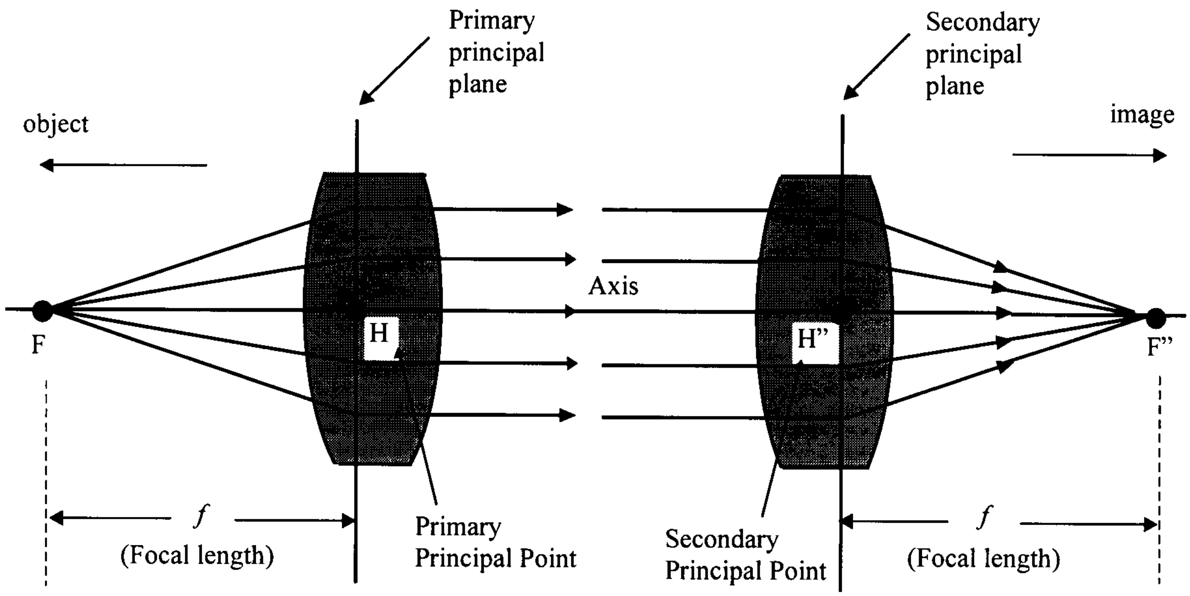


Figure A.3 – Ray diagrams showing the primary and secondary principal points of a thick lens

Annex B (informative)
World coordinate datum

B.1 World coordinate datum

The world coordinate datum can be defined by an ID code value for the reference ellipsoid name. There are two kinds of references to express the datum.

The first reference is the datum codes expressed in A.1 of the United States Defense Mapping Agency Technical Report TR 8350.2. The value shall be expressed as a six-character ASCII text value (NNNNNN). The default ID code shall be OWGS84 for the World Geodetic System 1984. This is the datum used by the NAVSTAR Global Positioning

The second reference is the datum codes expressed in the U.S. Digital Geographic Information Exchange Standard (DIGEST), Part 3 – Codes, Parameters and Tags, Edition 1.1 (October 1992). Specifically, the datum codes in table 9-1 are reproduced as table B.1 in this annex.

B.2 Origin of world coordinate position accuracy

The origin of world coordinate position accuracy can be defined by an ID code value. This entry can define the accuracy of position of world coordinates as a circular error probable (CEP) (50%). The value should be expressed in meters having a range of 0000.00 to 9999.99 meters. The maximum resolution of the data in the ASCII type is 0.01 m.

Table B.1 – Reproduction of table 9-1 of the DIGEST

	Geodetic Datums	Code
1	Adinda	ADI
2	Arc 1950	ARF
3	Australian Geodetic	AUA
4	Bukit Rumpah	BUR
5	Camp Area Astro	CAZ
6	Campo Inchauspe	CAI
7	Chua Astro	CHU
8	Corrego Alegre	COA
9	Djakarta	BAT
10	European 50	EUR
11	G. Segara	GSE
12	G. Serindung	GSF
13	Geodetic 1949	GEO
14	Ghana	GHA
15	Guam 1963	GUA
16	Herat North	HEN
17	Hjorsey	HJO
18	Hu-tzu-shan	HTN
19	Indian	IND
20	Ireland 1965	IRE
21	Kertau	KEA
22	Liberia 1964	LIB
23	Local Astro	LOC
24	Luzon	LUZ
25	Merchich	MER
26	Montjong Lowe	MOL
27	Nigeria	NIG
28	North America 1927	NAS
29	North America 1983	NAX
30	Old Hawaiian	OHA
31	Ordnance Survey of Great Britain	OGB
32	Provisional South American 1956	PRP
33	Qornoq	QUO
34	Sierra Leone 1960	SIB
35	Tananarive Obsv. 1925	TAN
36	Timbalai	TIL
37	Tokyo	TOK
38	Voirol	VOI
39	World Geodetic System 1960	WGA
40	World Geodetic System 1966	WGB
41	World Geodetic System 1972	WGC
42	World Geodetic System 1984	WGE
43	Yacare	YAC
44	Hermannskogel	HER
45	European 79	ENB
46	German	GDA
47	Italian	IDA

Annex C (informative)
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