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| **Recommendation ITU-R BT.1618-1**  **(03/2011)** |
| **Data structure for DV-based audio, data  and compressed video at data rates of 25 and 50 Mbit/s** |
| **BT Series**  **Broadcasting service**  **(television)** |

Foreword

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| **SF** | Frequency sharing and coordination between fixed-satellite and fixed service systems |
| **SM** | Spectrum management |
| **SNG** | Satellite news gathering |
| **TF** | Time signals and frequency standards emissions |
| **V** | Vocabulary and related subjects |

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| ***Note***: *This ITU-R Recommendation was approved in English under the procedure detailed in Resolution ITU-R 1.* |

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RECOMMENDATION ITU-R BT.1618-1

Data structure for DV-based audio, data and compressed  
video at data rates of 25 and 50 Mbit/s

(Question ITU-R 12/6)

(2003-2011)

Scope

This Recommendation defines the DV-based data structure for the interface of digital audio, sub-code data and compressed video with the following parameters:

– 525/60 system − 4:1:1 image sampling structure, 25 Mbit/s data rate

– 525/60 system − 4:2:2 image sampling structure, 50 Mbit/s data rate

– 625/50 system − 4:1:1 image sampling structure, 25 Mbit/s data rate

– 625/50 system − 4:2:2 image sampling structure, 50 Mbit/s data rate.

The ITU Radiocommunication Assembly,

considering

a) that applications within professional television production and post‑production have been identified where DV-based video compression can offer operational and economic advantages;

b) that three data rates have been proposed within the same compression family to serve different applications (25 Mbit/s, 50 Mbit/s and 100 Mbit/s);

c) that the sampling rasters for each of the three applications are different;

d) that audio, auxiliary data and metadata elements form an integral part of these applications;

e) that these elements are multiplexed into a single data stream for transport and further processing;

f) that the compression quality and functional characteristics must be identical and reproducible in complex production chains;

g) that for this purpose all details of parameters used for coding and multiplexing must be defined,

recommends

**1** that for applications in professional television production and post-production using DV‑based compression at 25 and 50 Mbit/s, the parameters given in Annex 1 shall be used;

**2** that compliance with this Recommendation is voluntary. However, the Recommendation may contain certain mandatory provisions (to ensure, e.g., interoperability or applicability) and compliance with the Recommendation is achieved when all of these mandatory provisions are met. The words “shall” or some other obligatory language such as “must” and the negative equivalents are used to express requirements. The use of such words shall in no way be construed to imply partial or total compliance with this Recommendation.

Annex 1

# 1 Interface

## 1.1 Introduction

As shown in Fig. 1, processed audio, video, and subcode data are output for different applications through a digital interface port.

## 1.2 Data structure

The data structure of the compressed stream at the digital interface is shown in Figs 2 and 3. Figure 2 shows the data structure for a 50 Mb/s structure, and Fig. 3 shows the data structure for a 25 Mb/s structure.

In the 50 Mb/s structure, the data of one video frame are divided into two channels. Each channel is divided into 10 DIF sequences for the 525/60 system and 12 DIF sequences for the 625/50 system.

In the 25 Mb/s structure, the data of one video frame are divided into 10 DIF sequences for the 525/60 system and 12 DIF sequences for the 625/50 system.

Each DIF sequence consists of a header section, subcode section, VAUX section, audio section, and video section with the following DIF blocks respectively:

Header section: 1 DIF block

Subcode section: 2 DIF blocks

VAUX section: 3 DIF blocks

Audio section: 9 DIF blocks

Video section: 135 DIF blocks.

As shown in Figs 2 and 3, each DIF block consists of a 3-byte ID and 77 bytes of data. DIF data bytes are numbered 0 to 79. Figure 4 shows the data structure of a DIF sequence for a 50 or 25 Mb/s structure.

Figure 1

Block diagram on digital interface



Figure 2

Data structure of one video frame for 50 Mb/s structure



Figure 3

Data structure of one video frame for 25 Mb/s structure



Figure 4

Data structure of a DIF sequence



where:

i: FSC

i = 0 for 25 Mb/s structure

i = 0,1 for 50 Mb/s structure

H0,i: DIF block in header section

SC0,i to SC1,i: DIF blocks in subcode section

VA0,i to VA2,i: DIF blocks in VAUX section

A0,i to A8,i: DIF blocks in audio section

V0,i to V134,i: DIF blocks in video section.

## 1.3 Header section

### 1.3.1 ID

The ID part of each DIF block in the header section, shown in Figs 2 and 3, consists of 3 bytes (ID0, ID1, ID2). Table 1 shows the ID content of a DIF block.

TABLE 1

ID data of a DIF block

|  |  |  |  |
| --- | --- | --- | --- |
|  | Byte position number | | |
|  | Byte 0 (ID0) | Byte 1 (ID1) | Byte 2 (ID2) |
| MSB | SCT2 | Dseq3 | DBN7 |
|  | SCT1 | Dseq2 | DBN6 |
|  | SCT0 | Dseq1 | DBN5 |
|  | Res | Dseq0 | DBN4 |
|  | Arb | FSC | DBN3 |
|  | Arb | Res | DBN2 |
|  | Arb | Res | DBN1 |
| LSB | Arb | Res | DBN0 |

ID contains the following:

SCT: Section type (see Table 2)

Dseq: DIF sequence number (see Tables 3 and 4)

FSC: Identification of a DIF block in each channel 50 Mb/s structure

FSC = 0: first channel

FSC = 1: second channel 25 Mb/s structure

FSC = 0

DBN: DIF block number (see Table 5)

Arb: Arbitrary bit

Res: Reserved bit for future use

Default value shall be set to 1.

TABLE 2

Section type

|  |  |  |  |
| --- | --- | --- | --- |
| SCT2 | SCT1 | SCT0 | Section type |
| 0 | 0 | 0 | Header |
| 0 | 0 | 1 | Subcode |
| 0 | 1 | 0 | VAUX |
| 0 | 1 | 1 | Audio |
| 1 | 0 | 0 | Audio |
| 1 | 0 | 1 | Reserved |
| 1 | 1 | 0 |
| 1 | 1 | 1 |

TABLE 3

DIF sequence number for 525/60 system

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Dseq3 | Dseq2 | Dseq1 | Dseq0 | Meaning |
| 0 | 0 | 0 | 0 | DIF sequence number 0 |
| 0 | 0 | 0 | 1 | DIF sequence number 1 |
| 0 | 0 | 1 | 0 | DIF sequence number 2 |
| 0 | 0 | 1 | 1 | DIF sequence number 3 |
| 0 | 1 | 0 | 0 | DIF sequence number 4 |
| 0 | 1 | 0 | 1 | DIF sequence number 5 |
| 0 | 1 | 1 | 0 | DIF sequence number 6 |
| 0 | 1 | 1 | 1 | DIF sequence number 7 |
| 1 | 0 | 0 | 0 | DIF sequence number 8 |
| 1 | 0 | 0 | 1 | DIF sequence number 9 |
| 1 | 0 | 1 | 0 | Not used |
| 1 | 0 | 1 | 1 | Not used |
| 1 | 1 | 0 | 0 | Not used |
| 1 | 1 | 0 | 1 | Not used |
| 1 | 1 | 1 | 0 | Not used |
| 1 | 1 | 1 | 1 | Not used |

TABLE 4

DIF sequence number for 625/50 system

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Dseq3 | Dseq2 | Dseq1 | Dseq0 | Meaning |
| 0 | 0 | 0 | 0 | DIF sequence number 0 |
| 0 | 0 | 0 | 1 | DIF sequence number 1 |
| 0 | 0 | 1 | 0 | DIF sequence number 2 |
| 0 | 0 | 1 | 1 | DIF sequence number 3 |
| 0 | 1 | 0 | 0 | DIF sequence number 4 |
| 0 | 1 | 0 | 1 | DIF sequence number 5 |
| 0 | 1 | 1 | 0 | DIF sequence number 6 |
| 0 | 1 | 1 | 1 | DIF sequence number 7 |
| 1 | 0 | 0 | 0 | DIF sequence number 8 |
| 1 | 0 | 0 | 1 | DIF sequence number 9 |
| 1 | 0 | 1 | 0 | DIF sequence number 10 |
| 1 | 0 | 1 | 1 | DIF sequence number 11 |
| 1 | 1 | 0 | 0 | Not used |
| 1 | 1 | 0 | 1 | Not used |
| 1 | 1 | 1 | 0 | Not used |
| 1 | 1 | 1 | 1 | Not used |

TABLE 5

DIF block number

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Dseq7 | Dseq6 | Dseq5 | Dseq4 | Dseq3 | Dseq2 | Dseq1 | Dseq0 | Meaning |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | DIF sequence number 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | DIF sequence number 1 |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | DIF sequence number 2 |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | DIF sequence number 3 |
| : : : | : : : | : : : | : : : | : : : | : : : | : : : | : : : | : : : |
| 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | DIF block number 134 |
| 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | Not used |
| : | : | : | : | : | : | : | : | : |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | Not used |

### 1.3.2 Data

The data part (payload) of each DIF block in the header section is shown in Table 6. Bytes 3 to 7 are active and bytes 8 to 79 are reserved.

TABLE 6

Data (payload) in the header DIF block

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Byte position number of header DIF block | | | | | | | |
|  | 3 | 4 | 5 | 6 | 7 | 8 | – | 79 |
| MSB | DSF | Res | TF1 | TF2 | TF3 | Res | Res | Res |
|  | 0 | Res | Res | Res | Res | Res | Res | Res |
|  | Res | Res | Res | Res | Res | Res | Res | Res |
|  | Res | Res | Res | Res | Res | Res | Res | Res |
|  | Res | Res | Res | Res | Res | Res | Res | Res |
|  | Res | APT2 | AP12 | AP22 | AP32 | Res | Res | Res |
|  | Res | APT1 | AP11 | AP21 | AP31 | Res | Res | Res |
| LSB | Res | APT0 | AP10 | AP20 | AP30 | Res | Res | Res |

DSF: DIF sequence flag

DSF = 0: 10 DIF sequences included in a channel (525/60 system)

DSF = 1: 12 DIF sequences included in a channel (625/50 system)

APTn, AP1n, AP2n, AP3n: These data shall be identical as track application IDs (APTn = 001, AP1n = 001, AP2n = 001, AP3n = 001), if the source signal comes from a digital VCR. If the signal source is unknown, all bits for these data shall be set to 1.

TF: Transmitting flag:

TF1: Transmitting flag of audio DIF blocks

TF2: Transmitting flag of VAUX and video DIF blocks

TF3: Transmitting flag of subcode DIF blocks

TFn = 0: Data shall be valid

TFn = 1: Data shall be invalid

Res: Reserved bit for future use

Default value shall be set to 1.

## 1.4 Subcode section

### 1.4.1 ID

The ID part of each DIF block in the subcode section is described in § 1.3.1. The section type shall be 001.

### 1.4.2 Data

The data part (payload) of each DIF block in the subcode section is shown in Fig. 5. The subcode data consists of 6 SSYBs, each 8 bytes long, and a reserved area of 29 bytes in each relevant DIF block. SSYBs in a DIF sequence are numbered 0 to 11. Each SSYB is composed of SSYB ID equal to 2 bytes, FFh, and an SSYB data payload of 5 bytes.

Figure 5

Data in the subcode section



#### 1.4.2.1 SSYB ID

Table 7 shows SSYB ID (ID0, ID1). These data contain FR ID, application ID (AP32, AP31, AP30), and SSYB number ( Syb3, Syb2 Syb1, Syb0).

FR ID is an identification for the first or second half of each channel:

FR = 1: the first half of each channel

FR = 0: the second half of each channel

The first half of each channel

DIF sequence number 0, 1, 2, 3, 4 for the 525/60 system

DIF sequence number 0, 1, 2, 3, 4, 5 for the 625/50 system

The second half of each channel

DIF sequence number 5, 6, 7, 8, 9 for the 525/60 system

DIF sequence number 6, 7, 8, 9. 1 0, 11 for the 625/50 system

If information is not available, all bits shall be set to 1.

TABLE 7

SSYB ID

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Bit position | SSYB number 0 and 6 | | SSYB number 1 to 5 and 7 to 10 | | SSYB number 11 | |
| ID0 | ID1 | ID0 | ID1 | ID0 | ID1 |
| b7 (MSB) | FR | Arb | FR | Arb | FR | Arb |
| b6 | AP32 | Arb | Res | Arb | APT2 | Arb |
| b5 | AP31 | Arb | Res | Arb | APT1 | Arb |
| b4 | AP30 | Arb | Res | Arb | APT0 | Arb |
| b3 | Arb | Syb3 | Arb | Syb3 | Arb | Syb3 |
| b2 | Arb | Syb2 | Arb | Syb2 | Arb | Syb2 |
| b1 | Arb | Syb1 | Arb | Syb1 | Arb | Syb1 |
| b0 (LSB) | Arb | Syb0 | Arb | Syb0 | Arb | Syb0 |
| NOTE 1 – Arb = arbitrary bit. | | | | | | |

#### 1.4.2.2 SSYB data

Each SSYB data payload consists of a pack of 5 bytes as shown in Fig. 6. Table 8 shows pack header table (PCO byte organization). Table 9 shows the pack arrangement in SSYB data for each channel.

Figure 6

Pack in SSYB



TABLE 8

Pack header table

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| UPPER LOWER | 0000 | 0001 | 0010 | 0011 | 0100 | 0101 | 0110 | 0111 | – | 1111 |
| 0000 |  |  |  |  |  | SOURCE | SOURCE |  |  |  |
| 0001 |  |  |  |  |  | SOURCE CONTROL | SOURCE CONTROL |  |  |  |
| 0010 |  |  |  |  |  |  |  |  |  |  |
| 0011 |  | TIME CODE |  |  |  |  |  |  |  |  |
| 0100 |  | BINARY GROUP |  |  |  |  |  |  |  |  |
| 0101 |  |  |  |  |  |  |  |  |  |  |
| | |  |  |  |  |  |  |  |  |  |  |
| 1111 |  |  |  |  |  |  |  |  |  | NO INFO |

TABLE 9

Mapping of packet in SSYB data

|  |  |  |
| --- | --- | --- |
| SSYB number | First half of each channel | Second half of each channel |
| 0 | Reserved | Reserved |
| 1 | Reserved | Reserved |
| 2 | Reserved | Reserved |
| 3 | TC | TC |
| 4 | BG | Reserved |
| 5 | TC | Reserved |
| 6 | Reserved | Reserved |
| 7 | Reserved | Reserved |
| 8 | Reserved | Reserved |
| 9 | TC | TC |
| 10 | BG | Reserved |
| 11 | TC | Reserved |
| NOTE 1 − TC = time code pack.  NOTE 2 − BG = binary group pack.  NOTE 3 − Reserved = default value of all bits shall be set to 1.  NOTE 4 − TC and BG data are the same within a single video frame. The time code data are an LCT type. | | |

##### 1.4.2.2.1 Time code pack

Table 10 shows a mapping of the time code (TC) pack. Time code data mapped to the time code packs remain the same within each video frame.

TABLE 10

Mapping of time code pack

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 525/60 system | | | | | | | | |
|  | **MSB** |  |  |  |  |  |  | **LSB** |
| **PC0** | **0** | **0** | **0** | **1** | **0** | **0** | **1** | **1** |
| PC1 | CF | DF | TENS of FRAMES | | UNITS of FRAMES | | | |
| PC2 | PC | TENS of SECONDS | | | UNITS of SECONDS | | | |
| PC3 | BGF0 | TENS of MINUTES | | | UNITS of MINUTES | | | |
| PC4 | BGF2 | BGF1 | TENS of HOURS | | UNITS of HOURS | | | |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 625/50 system | | | | | | | | |
|  | **MSB** |  |  |  |  |  |  | **LSB** |
| **PC0** | **0** | **0** | **0** | **1** | **0** | **0** | **1** | **1** |
| PC1 | CF | Arb | TENS of FRAMES | | UNITS of FRAMES | | | |
| PC2 | BGF0 | TENS of SECONDS | | | UNITS of SECONDS | | | |
| PC3 | BGF2 | TENS of MINUTES | | | UNITS of MINUTES | | | |
| PC4 | PC | BGF1 | TENS of HOURS | | UNITS of HOURS | | | |

NOTE 1 – Detailed information is given in Recommendation ITU-R BR.780-2.

CF: Colour frame

0 = unsynchronized mode

1 = synchronized mode

DF: Drop frame flag

0 = Nondrop frame time code

1 = Drop frame time code

PC: Biphase mark polarity correction

0 = even

1 = odd

BGF: Binary group flag

Arb: Arbitrary bit

##### 1.4.2.2.2 Binary group pack

Table 11 shows the mapping of the binary group (BG) pack. Binary group data mapped to the binary group packs remain the same within each video frame.

TABLE 11

Mapping of binary group pack

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | MSB |  |  |  |  |  |  | LSB |
| PC0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 |
| PC1 | BINARY GROUP 2 | | | | BINARY GROUP 1 | | | |
| PC2 | BINARY GROUP 4 | | | | BINARY GROUP 3 | | | |
| PC3 | BINARY GROUP 6 | | | | BINARY GROUP 5 | | | |
| PC4 | BINARY GROUP 8 | | | | BINARY GROUP 7 | | | |

## 1.5 VAUX section

### 1.5.1 1D

The ID part of each DIF block in the VAUX section is described in § 1.3.1. The section type shall be 010.

### 1.5.2 Data

The data part (payload) of each DIF block in the VAUX section is shown in Fig. 7. This figure shows the VAUX pack arrangement for each DIF sequence.

There are 15 packs, each 5 bytes long, and two reserved bytes in each VAUX DIF block payload. A default value for the reserved byte is set to FFh.

Therefore, there are 45 packs in a DIF sequence. VAUX packs of the DIF blocks are sequentially numbered 0 to 44. This number is called a video pack number.

Table 12 shows the mapping of the VAUX packs of the VAUX DIF blocks. A VAUX source pack (VS) and a VAUX source control pack (VSC) must be present in each of the video compressed frames. The remaining VAUX packs of the DIF blocks in a DIF sequence are reserved and the value of all reserved words is set to FFh.

If VAUX data are not transmitted, a NO INFO pack, which is filled up by FFh, shall be transmitted.

Figure 7

Data in the VAUX section



TABLE 12

Mapping of VAUX pack in a DIF sequence

|  |  |  |
| --- | --- | --- |
| Pack number | | Pack data |
| Even DIF sequence | Odd DIF sequence |
| 39 | 0 | VS |
| 40 | 1 | VSC |

where:

Even DIF sequence:

DIF sequence number 0, 2, 4, 6, 8 for 525/60 system

DIF sequence number 0, 2, 4, 6, 8, 10 for 625/50 system

Odd DIF sequence:

DIF sequence number 1, 3, 5, 7, 9 for 525/60 system

DIF sequence number 1, 3, 5, 7, 9, 11 for 625/50 system

#### 1.5.2.1 VAUX source pack (VS)

Table 13 shows the mapping of a VAUX source pack.

TABLE 13

Mapping of VAUX source pack

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | MSB |  |  |  |  |  |  | LSB |
| **PC0** | **0** | **1** | **1** | **0** | **0** | **0** | **0** | **0** |
| PC1 | Res | Res | Res | Res | Res | Res | Res | Res |
| PC2 | B/W | EN | CLF | | Res | Res | Res | Res |
| PC3 | Res | Res | 50/60 | STYPE | | | | |
| PC4 | VISC | | | | | | | |

B/W: Black-and-white flag

0 = Black and white

1 = Colour

EN: Colour frames enable flag

0 = CLF is valid

1 = CLF is invalid

CLF: Colour frame identification code (see ITU-R BT.1700)

For 525/60 system

00b = Colour frame A

01b = Colour frame B

Others = Reserved

For 625/50 system

00b = 1st, 2nd field

01b = 3rd, 4th field

10b = 5th, 6th field

11b = 7th, 8th field

50/60:

0 = 60-field system

1 = 50-field system

STYPE: STYPE defines a signal type of video signal.

00000b = 4:1:1 compression

00001b = Reserved

| |

00011b = Reserved

00100b = 4:2:2 compression

00101b = Reserved

| |

11111b = Reserved

VISC:

10001000b = –180

| |

00000000b = 0

| |

01111000b = 180

01111111b = No information

Other = Reserved

Res: Reserved bit for future use

Default value shall be set to 1

#### 1.5.2.2 VAUX source control pack (VSC)

Table 14 shows the mapping of a VAUX source control pack.

TABLE 14

Mapping of VAUX source control pack

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | MSB |  |  |  |  |  |  | LSB |
| **PC0** | **0** | **1** | **1** | **0** | **0** | **0** | **0** | **1** |
| PC1 | CGMS | | Res | Res | Res | Res | Res | Res |
| PC2 | Res | Res | 0 | 0 | Res | DISP | | |
| PC3 | FF | FS | FC | IL | Res | Res | 0 | 0 |
| PC4 | Res | Res | Res | Res | Res | Res | Res | Res |

CGMS: Copy generation management system

|  |  |
| --- | --- |
| CGMS | Copy possible generation |
| 0 0 | Copy free |
| 0 1 | | Reserved |
| 1 0 | |
| 1 1 | |

DISP: Display select mode

|  |  |  |
| --- | --- | --- |
| DISP | Aspect ratio and format | Position |
| 0 0 0 | 4:3 full format | Not applicable |
| 0 0 1 | Reserved | |
| 0 1 0 | 16:9 full format (squeeze) | Not applicable |
| 0 1 1  |  1 1 1 | Reserved | |

FF: Frame/field flag

FF indicates whether two consecutive fields are delivered, or one field is repeated twice during one frame period.

0 = Only one of two fields is delivered twice

1 = Both fields are delivered in order.

FS: First/second field flag

FS indicates a field which is delivered during the field one period.

0 = Field 2 is delivered

1 = Field 1 is delivered.

|  |  |  |
| --- | --- | --- |
| FF | FS | Output field |
| 1 | 1 | Field 1 and field 2 are output in this order (1, 2 sequence) |
| 1 | 0 | Field 2 and field 1 are output in this order (2, 1 sequence) |
| 0 | 1 | Field 1 is output twice |
| 0 | 1 | Field 2 is output twice |

FC: Frame change flag

FC indicates whether the picture of the current frame is repeated based on the immediate previous frame.

0 = Same picture as the previous frame

1 = Different picture from the previous frame

IL: Interlace flag

0 = Noninterlaced

1 = Interlaced

Res: Reserved bit for future use

Default value shall be set to 1.

## 1.6 Audio section

### 1.6.1 ID

The ID part of each DIF block in the audio section is described in § 1.3.1. The section type shall be 011.

### 1.6.2 Data

The data part (payload) of each DIF block in the audio section is described in Fig. 8. The data of a DIF block in the audio DIF block are composed of 5 bytes of audio auxiliary data (AAUX) and 72 bytes of audio data which are encoded and shuffled by the process shown in §§ 1.6.2.1 and 1.6.2.2.

Figure 8

Data in the audio section



#### 1.6.2.1 Audio encoding

##### 1.6.2.1.1 Source coding

Each audio input signal is sampled at 48 kHz, with 16-bit quantization. The system provides two channels of audio for 25 Mb/s structure or four channels of audio for 50 Mb/s structure. Audio data for each audio channel are located in an audio block respectively.

An audio block consists of 45 DIF blocks (9 DIF blocks × 5 DIF sequences) for the 525/60 system; and 54 DIF blocks (9 DIF blocks × 6 DIF sequences) for the 625/50 system.

##### 1.6.2.1.2 Emphasis

Audio encoding is carried out with the first order preemphasis of 50/15 µs. For analogue input recording, emphasis shall be off in the default state.

##### 1.6.2.1.3 Audio error code

In the encoded audio data, 8000h shall be assigned as an audio error code to indicate an invalid audio sample. This code corresponds to negative full-scale value in ordinary twos complement representation. When the encoded data includes 8000h, it shall be converted to 8001h.

##### 1.6.2.1.4 Relative audio-video timing

The audio frame duration equals a video frame period. An audio frame begins with an audio sample acquired within the duration of minus 50 samples relative to zero samples from the first pre-equalizing pulse of the vertical blanking period of the input video signal. The first pre-equalizing pulse means the start of line number 1 for the 525/60 system, and the middle of line number 623 for the 625/50 system.

##### 1.6.2.1.5 Audio frame processing

This Recommendation provides audio frame processing in the locked mode.

The sampling frequency of the audio signal is synchronous with the video frame frequency. Audio data are processed in frames. For an audio channel, each frame contains 1 602 or 1 600 audio samples for the 525/60 system or 1 920 audio samples for the 625/50 system. For the 525/60 system, the number of audio samples per frame shall follow the five-frame sequence as shown below:

1 600, 1 602, 1 602, 1 602, 1 602 samples.

The sample audio capacity shall be capable of 1 620 samples per frame for the 525/60 system or 1 944 samples per frame for the 625/50 system. The unused space at the end of each frame is filled with arbitrary values.

#### 1.6.2.2 Audio shuffling

The 16-bit audio data word is divided into two bytes; the upper byte which contains MSB, and the lower byte LSB, as shown in Fig. 9. Audio data shall be shuffled over DIF sequences and DIF blocks within a frame. The data bytes are defined as Dn (n = 0, 1, 2, ...) which is sampled at nth order within a frame and shuffled by each Dn unit.

The data shall be shuffled through a process expressed by the following equations:

525/60 system:

DIF sequence number:

(INT (n/3) + 2 × (n mod 3)) mod 5 for CH1, CH3

(INT (n/3) + 2 × (n mod 3)) mod 5 + 5 for CH2, CH4

Audio DIF block number:

3 × (n mod 3) + INT ((n mod 45) / 15)

where FSC = 0: CH1, CH2

FSC = 1: CH3, CH4

Byte position number:

8 + 2 × INT(n/45) for the most significant byte

9 + 2 × INT(n/45) for the least significant byte

where n = 0 to 1619

625/50 system:

DIF sequence number:

(INT (n/3) + 2 × (n mod 3)) mod 6 for CH1, CH3

(INT (n/3) + 2 × (n mod 3)) mod 6 + 6 for CH2, CH4

Audio DIF block number:

3 × (n mod 3) + INT ((n mod 54) / 18)

where FSC = 0: CH1, CH2

FSC = 1: CH3, CH4

Byte position number:

8 + 2 × INT(n/54) for the most significant byte

9 + 2 × INT(n/54) for the least significant byte

where n = 0 to 1943

Figure 9

Conversion of audio sample to audio data bytes



#### 1.6.2.3 Audio auxiliary data

Audio auxiliary data (AAUX) shall be added to the shuffled audio data as shown in Figs 8 and 10. The AAUX pack shall include an AAUX pack header and data (AAUX payload). The length of the AAUX pack shall be 5 bytes as shown in Fig. 10, which depicts the AAUX pack arrangement. Packs are numbered from 0 to 8 as shown in Fig. 10. This number is called an audio pack number.

Figure 10

Arrangement of AAUX packs in audio auxiliary data



Table 15 shows the mapping of an AAUX pack. An AAUX source pack (AS) and an AAUX source control pack (ASC) must be included in the compressed stream.

TABLE 15

Mapping of AAUX pack in a DIF sequence

|  |  |  |
| --- | --- | --- |
| Audio pack number | | Pack data |
| Even DIF sequence | Odd DIF sequence |
| 3  4 | 0  1 | AS  ASC |

where:

Even DIF sequence:

DIF sequence number 0, 2, 4, 6, 8 for 525/60 system

DIF sequence number 0, 2, 4, 6, 8, 10 for 625/50 system

Odd DIF sequence:

DIF sequence number 1, 3, 5, 7, 9 for 525/60 system

DIF sequence number 1, 3, 5, 7, 9, 11 for 625/50 system

##### 1.6.2.3.1 AAUX source pack

The AAUX source pack (AS) is configured as shown in Table 16.

TABLE 16

Mapping of AAUX source pack

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **MSB** |  |  |  |  |  |  | **LSB** |
| **PC0** | **0** | **1** | **0** | **1** | **0** | **0** | **0** | **0** |
| PC1 | LF | Res | AF SIZE | | | | | |
| PC2 | 0 | CHN | | Res | AUDIO MODE | | | |
| PC3 | Res | Res | 50/60 | STYPE | | | | |
| PC4 | Res | Res | SMP | | | QU | | |

LF: Locked mode flag

Locking condition of audio sampling frequency with video signal

0 = Locked mode; 1 = Reserved

AF SIZE: The number of audio samples per frame

010100b = 1 600 samples/frame (525/60 system)

010110b = 1 602 samples/frame (525/60 system)

011000b = 1 920 samples/frame (625/50 system)

Others = Reserved

CHN: The number of audio channels within an audio block

00b = One audio channel per audio block

Others = Reserved

The audio block is composed of 45 DIF blocks of the audio section in five consecutive DIF sequences for the 525/60 system, and 54 DIF blocks of the audio section in six consecutive DIF sequences for the 625/50 system.

AUDIO MODE: The contents of the audio signal on each audio channel

0000b = CH1 (CH3)

0001b = CH2 (CH4)

1111b = Invalid audio data

Others = Reserved

50/60:

0 = 60-field system

1 = 50-field system

STYPE: STYPE defines audio blocks per video frame

00000b = 2 audio blocks

00010b = 4 audio blocks

Others = Reserved

SMP: Sampling frequency

000b = 48 kHz

Others = Reserved

QU: Quantization

000b = 16 bits linear

Others = Reserved

Res: Reserved bit for future use

Default value shall be set to 1.

##### 1.6.2.3.2 AAUX source control pack

The AAUX source control pack (ASC) is configured as shown in Table 17.

TABLE 17

Mapping of AAUX source control pack

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **MSB** |  |  |  |  |  |  | **LSB** |
| **PC0** | **0** | **1** | **0** | **1** | **0** | **0** | **0** | **1** |
| PC1 | CGMS | | Res | Res | Res | Res | EFC | |
| PC2 | REC ST | REC END | FADE ST | FADE END | Res | Res | Res | Res |
| PC3 | DRF | SPEED | | | | | | |
| PC4 | Res | Res | Res | Res | Res | Res | Res | Res |

CGMS: Copy generation management system.

|  |  |
| --- | --- |
| CGMS | Copy possible generation |
| 0 0 | Copy free |
| 0 1 | | Reserved |
| 1 0 | |
| 1 1 | |

EFC: Emphasis audio channel flag

00b = emphasis off

01b = emphasis on

Others = reserved

EFC shall be set for each audio block.

REC ST: Recording start point

0 = recording start point

1 = not recording start point

At a recording start frame, REC ST 0 lasts for a duration of one audio block which is equal to 5 or 6 DIF sequences for each audio channel.

REC END: Recording end point

0 = recording end point

1 = not recording end point

At a recording end frame, REC END 0 lasts for a duration of one audio block which is equal to 5 or 6 DIF sequences for each audio channel.

FADE ST: Fading of recording start point

0 = fading off

1 = fading on

The information of FADE ST shall be effective only at the recording start frame (REC ST = 0). If FADE ST is 1 at the recording start frame, the output audio signal should be faded in from the first sampling signal of the frame. If FADE ST is 0 at the recording start frame, the output audio signal should not be faded.

FADE END: Fading of recording end point

0 = fading off

1 = fading on

The information of FADE END shall be effective only at the recording end frame (REC END = 0). If FADE END is 1 at the recording end frame, the output audio signal should be faded out to the last sampling signal of the frame. If FADE END is 0 at the recording end frame, the output audio signal should not be faded.

DRF: Direction flag

0 = reverse direction

1 = forward direction

SPEED: Shuttle speed of VTR

|  |  |  |
| --- | --- | --- |
|  | Shuttle speed of VTR | |
| SPEED | 525/60 system | 625/50 system |
| 0000000 | 0/120 (=0) | 0/100 (=0) |
| 0000001 | 1/120 | 1/100 |
| : | : | : |
| 1100100 | 100/120 | 100/100 (=1) |
| : | : | Reserved |
| 1111000 | 120/120 (=1) | Reserved |
| : | Reserved | Reserved |
| 1111110 | Reserved | Reserved |
| 1111111 | Data invalid | Data invalid |

RES: Reserved bit for future use.

Default value shall be set to 1.

## 1.7 Video section

### 1.7.1 ID

The ID part of each DIF block in the video section is described in § 1.3.1. The section type shall be 100.

### 1.7.2 Data

The data part (payload) of each DIF block in the video section consists of 77 bytes of video data which shall be sampled, shuffled, and encoded. Video data of every video frame are processed as described in § 2.

#### 1.7.2.1 DIF block and compressed macro block

Correspondence between video DIF blocks and video compressed macro blocks is shown in Tables 18 and 19. Table 18 shows correspondence between video DIF blocks for 50 Mb/s structure and video compressed macro blocks of 4:2:2 compression. Table 19 shows correspondence between the video DIF blocks for 25 Mb/s structure and video compressed macro blocks of 4:1:1 compression.

The rule defining the correspondence between video DIF blocks and compressed macro blocks is shown below:

50 Mb/s structure – 4:2:2 compression

if (525/60 system) n = 10 else n = 12;

for (i = 0; i<n; i++){

a = i;

b = (i-6) mod n;

c = (i-2) mod n;

d = (i-8) mod n;

e = (i-4) mod n;

p = a;

q = 3;

for (j = 0; j<5; j++){

for (k = 0; k<27; k++){

V (5 × k + q),0 of DSNp = CM 2i,j,k;

V (5 × k + q),1 of DSNp = CM 2i + 1,j,k;

}

if (q == 3) {p = b; q = 1;}

else if (q == 1) {p = c; q = 0;}

else if (q == 0) {p = d; q = 2;}

else if (q == 2) {p = e; q = 4;}

}

}

25 Mb/s structure -- 4:1:1 compression

if (525/60 system) n = 10 else n = 12;

for (i = 0; i<n; i++){

a = i;

b = (i-6) mod n;

c = (i-2) mod n;

d = (i-8) mod n;

e = (i-4) mod n;

p = a;

q = 3;

for (j = 0; j<5; j++){

for (k = 0; k<27; k++){

V (5 × k + q), 0 of DSNp = CM i,j,k;

}

if (q == 3) {p = b; q = 1;}

else if (q == 1) {p = c; q = 0;}

else if (q == 0) {p = d; q = 2;}

else if (q == 2) {p = e; q = 4;}

}

}

TABLE 18

Video DIF blocks and compressed macro blocks for  
50 Mb/s structure – 4:2:2 compression

|  |  |  |
| --- | --- | --- |
| DIF sequence number | DIF block | Compressed macro block |
| 0 | V0,0 | CM 4,2,0 |
| V0,1 | CM 5,2,0 |
| V1,0 | CM 12,1,0 |
| V1,1 | CM 13,1,0 |
| V2,0 | CM 16,3,0 |
| V2,1 | CM 17,3,0 |
| : | : |
| V134,0 | CM 8,4,26 |
| V134,1 | CM 9,4,26 |
| 1 | V0,0 | CM 6,2,0 |
| V0,1 | CM 7,2,0 |
| V1,0 | CM 14,1,0 |
| V1,1 | CM 15,1,0 |
| V2,0 | CM 18,3,0 |
| V2,1 | CM 19,3,0 |
| : | : |
| V134,0 | CM 10,4,26 |
| V134,1 | CM 11,4,26 |
| : : : | : : : | : : : |
| n-1 | V0,0 | CM 2,2,0 |
| V0,1 | CM 3,2,0 |
| V1,0 | CM 10,1,0 |
| V1,1 | CM 11,1,0 |
| V2,0 | CM 14,3,0 |
| V2,1 | CM 15,3,0 |
| : | : |
| V134,0 | CM 6,4,26 |
| V134,1 | CM 7,4,26 |
| NOTE 1 – n = 10 for 525/60 system; n = 12 for 625/50 system. | | |

TABLE 19

Video DIF blocks and compressed macro blocks for  
25 Mb/s structure – 4:1:1 compression

|  |  |  |
| --- | --- | --- |
| DIF sequence number | DIF block | Compressed macro block |
| 0 | V0,0 | CM 2,2,0 |
| V1,0 | CM 6,1,0 |
| V2,0 | CM 8,3,0 |
| V3,0 | CM 0,0,0 |
| V4,0 | CM 4,4,0 |
| : | : |
| V133,0 | CM 0,0,26 |
| V134,4 | CM 4,4,26 |
| 1 | V0,0 | CM 3,2,0 |
| V1,0 | CM 7,1,0 |
| V2,0 | CM 9,3,0 |
| V3,0 | CM 1,0,0 |
| V4,0 | CM 5,4,0 |
| : | : |
| V133,0 | CM 1,0,26 |
| V134,0 | CM 5,4,26 |
| : : : | : : : | : : : |
| n-1 | V0,0 | CM 1,2,0 |
| V1,0 | CM 5,1,0 |
| V2,0 | CM 7,3,0 |
| V3,0 | CM n – 1,0,0 |
| V4,0 | CM 3,4,0 |
| : | : |
| V133,0 | CM n – 1,0,26 |
| V134,0 | CM 3,4,26 |
| NOTE 1 – n = 10 for 525/60 system; n = 12 for 625/50 system. | | |

# 2 Video compression

This clause includes video compression processing for 4:2:2 and 4:1:1 compression.

NOTE 1 – Values Y, CR, CB used in this clause are equivalent to values Y’, CR’, CB’ that have non-linear transfer characteristic commonly described as gamma corrected.

## 2.1 Video structure

The video signal is sampled with a frequency of 13.5 MHz for luminance (Y) and 6.75 MHz for colour difference (CR, CB). The data of the vertical blanking area and the horizontal blanking area are discarded, then the remainder of the video data is shuffled in the video frame. The original quantity of video data shall be reduced by use of bit-rate reduction techniques which adopt DCT and VLC.

The process of the bit-rate reduction is as follows: Video data are assigned to a DCT block (8×8 samples). Two luminance DCT blocks and two colour-difference DCT blocks form a macro block for 4:2:2 compression. For 4:1:1 compression, four luminance DCT blocks and two colour-difference DCT blocks form a macro block. Five macro blocks constitute a video segment. A video segment is further compressed into five compressed macro blocks by use of the DCT and VLC techniques.

### 2.1.1 Sampling structure

The sampling structure is identical to the sampling structure of 4:2:2 component television signals described in Recommendation ITU-R BT.601. Sampling of luminance (Y) and two colour-difference signals (CR, CB) in the 4:2:2 structure are described in Table 20.

TABLE 20

Construction of video signal sampling (4:2:2)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | 525/60 system | 625/50 system | |
| Sampling frequency | Y | 13.5 MHz | | |
| CR, CB | 6.75 MHz | | |
| Total number of pixels per line | Y | 858 | 864 | |
| CR, CB | 429 | 432 | |
| Number of active pixels per line | Y | 720 | | |
| CR, CB | 360 | | |
| Total number of lines per frame | | 525 | 625 | |
| Number of active lines per frame | | 480 | 576 | |
| Active line numbers | Field 1 | 23 to 262 | 23 to 310 | |
| Field 2 | 285 to 524 | 335 to 622 | |
| Quantization | | Each sample is linearly quantized to 8 bits for Y, CR, CB | | |
| Relation between video signal level and quantization level | Scale | 1 to 254 | | |
| Y | Video signal level of white: 235 | | Quantized level 220 |
| Video signal level of black: 16 | |
| CR, CB | Video signal level of gray: 128 | | Quantized level 225 |

Line structure in one frame

For the 525/60 system, 240 lines for Y, CR, and CB signals from each field shall be transmitted. For the 625/50 system, 288 lines for Y, CR, and CB signals from each field shall be transmitted. The transmitted lines on a TV frame are defined in Table 20.

Pixel structure in one frame

4:2:2 compression:

All sampled pixels, 720 luminance pixels per line and 360 colour-difference pixels, are retained for processing as shown in Figs 11 and 12. The sampling process starts simultaneously for both luminance and colour-difference signals. Each pixel has a value from –127 to +126 which is obtained by the subtraction of 128 from the input digitized video signal level.

4:1:1 compression:

All sampled luminance pixels, 720 pixels per line, are retained for processing. Of 360 colour‑difference pixels sampled per line, every other pixel is discarded, leaving 180 pixels for processing. The sampling process starts simultaneously for both luminance and colour-difference signals. Figures 13 and 14 show the sampling process in detail. Each pixel has a value in range from –127 to +126 which is obtained by the subtraction of 128 from the input digitized video signal level.

Figure 11

Transmitting samples of 525/60 system for 4:2:2 compression



Figure 12

Transmitting samples of 625/50 system for 4:2:2 compression



Figure 13

Transmitting samples of 525/60 system for 4:1:1 compression



Figure 14

Transmitting samples of 625/50 system for 4:1:1 compression



### 2.1.2 DCT block

The Y, CR, and CB pixels in one frame shall be divided into DCT blocks as shown in Fig. 15. All DCT blocks for 4:2:2 compression and DCT blocks for 4:1:1 compression, with the exception of the rightmost DCT blocks in CR and CB for 4:1:1 compression, are structured as a rectangular area of eight vertical lines and eight horizontal pixels for each DCT block. The value of x shows the horizontal coordinate from the left and the value of y shows the vertical coordinate from the top.

In the 4:1:1 compression mode, the rightmost DCT blocks in CR and CB are structured with 16 vertical lines and four horizontal pixels. The rightmost DCT block shall be reconstructed to eight vertical lines and eight horizontal pixels by moving the lower part of eight vertical lines and four horizontal pixels to the higher part of eight vertical lines and four horizontal pixels as shown in Fig. 16.

DCT block arrangement in one frame for 525/60 system.

The arrangement of horizontal DCT blocks in one frame in the 4:2:2 compression mode is shown in Fig. 17, and in the 4:1:1 compression mode in Fig. 18. The same horizontal arrangement is repeated with 60 DCT blocks in the vertical direction. Pixels in one frame are divided into 10 800 DCT blocks for 4:2:2 compression and 8,100 DCT blocks for 4:1:1 compression.

4:2:2 compression:

Y: 60 vertical DCT blocks × 90 horizontal DCT blocks = 5 400 DCT blocks

CR: 60 vertical DCT blocks × 45 horizontal DCT blocks = 2 700 DCT blocks

CB: 60 vertical DCT blocks × 45 horizontal DCT blocks = 2 700 DCT blocks

4:1:1 compression:

Y: 60 vertical DCT blocks × 90 horizontal DCT blocks = 5 400 DCT blocks

CR: 60 vertical DCT blocks × 22.5 horizontal DCT blocks = 1 350 DCT blocks

CB: 60 vertical DCT blocks × 22.5 horizontal DCT blocks = 1 350 DCT blocks

DCT block arrangement in one frame for 625/50 system.

The arrangement of horizontal DCT blocks in one frame for the 4:2:2 compression mode is shown in Fig. 17, and for the 4:1:1 compression mode in Fig. 18. The same horizontal arrangement is repeated to 72 DCT blocks in the vertical direction. Pixels in one frame are divided into 12 960 DCT blocks for 4:2:2 compression and 9 720 DCT blocks for 4:1:1 compression.

4:2:2 compression

Y: 72 vertical DCT blocks × 90 horizontal DCT blocks = 6 480 DCT blocks

CR: 72 vertical DCT blocks × 45 horizontal DCT blocks = 3 240 DCT blocks

CB: 72 vertical DCT blocks × 45 horizontal DCT blocks = 3 240 DCT blocks

4:1:1 compression

Y: 72 vertical DCT blocks × 90 horizontal DCT blocks = 6 480 DCT blocks

CR: 72 vertical DCT blocks × 22.5 horizontal DCT blocks = 1 620 DCT blocks

CB: 72 vertical DCT blocks × 22.5 horizontal DCT blocks = 1 620 DCT blocks

### 2.1.3 Macro block

As shown in Fig. 19, each macro block in the 4:2:2 compression mode consists of four DCT blocks. As shown in Fig. 20, each macro block in the 4:1:1 compression mode consists of six DCT blocks. In the 4:1:1 compression mode, each macro block consists of four horizontally adjacent DCT blocks of Y, one DCT block of CR, and one DCT block of CB on a television screen. The rightmost macro block on the television screen consists of four vertically and horizontally adjacent DCT blocks of Y, one DCT block of CR, and one DCT block of CB.

Figure 15

DCT block and pixel coordinates



Figure 16

Rightmost DCT block in colour-difference signal for 4:1:1 compression mode



Figure 17

DCT block arrangements for 4:2:2 compression



Figure 18

DCT block arrangement for 4:1:1 compression



Figure 19

Macro block and DCT blocks for 4:2:2 compression



Figure 20

Macro block and DCT blocks for 4:1:1 compression



Macro block arrangement in one frame for 525/60 system:

The arrangement of macro blocks in one frame is shown in Fig. 21 for 4:2:2 compression and Fig. 22 for 4:1:1 compression. Each small rectangle shows a macro block. Pixels in one frame are distributed into 2 700 macro blocks for 4:2:2 compression and 1 350 macro blocks for 4:1:1 compression.

4:2:2 compression:

60 vertical macro blocks × 45 horizontal macro blocks = 2 700 macro blocks

4:1:1 compression:

60 vertical macro blocks × 22.5 horizontal macro blocks = 1 350 macro blocks

Macro block arrangement in one frame for 625/50 system:

The arrangement of macro blocks in one frame is shown in Fig. 23 for 4:2:2 compression and Fig. 24 for 4:1:1 compression. Each small rectangle shows a macro block. Pixels in one frame are distributed into 3 240 macro blocks for 4:2:2 compression and 1 620 macro blocks for 4:1:1 compression.

4:2:2 compression:

72 vertical macro blocks × 45 horizontal macro blocks = 3 240 macro blocks

4:1:1 compression:

72 vertical macro blocks × 22.5 horizontal macro blocks = 1 620 macro blocks

Figure 21

Super blocks and macro blocks in one television frame  
for 525/60 system for 4:2:2 compression



Figure 22

Super blocks and macro blocks in one television frame  
for 525/60 system for 4:1:1 compression



Figure 23

Super blocks and macro blocks in one television frame  
for 625/50 system for 4:2:2 compression



Figure 24

Super blocks and macro blocks in one television frame  
for 625/50 system for 4:1:1 compression



### 2.1.4 Super block

Each super block consists of 27 macro blocks.

Super block arrangement in one frame for 525/60 system.

The arrangement of super blocks in one frame is shown in Fig. 21 for 4:2:2 compression and Fig. 22 for 4:1:1 compression. Each super block consists of 27 adjacent macro blocks, and its boundary is marked by a heavy line. The total number of pixels in a frame is distributed into 100 super blocks for 4:2:2 compression or 50 super blocks for 4:1:1 compression.

4:2:2 compression:

– 20 vertical super blocks × 5 horizontal super blocks = 100 super blocks

4:1:1 compression:

– 10 vertical super blocks × 5 horizontal super blocks = 50 super blocks.

Super block arrangement in one frame for 625/50 system.

The arrangement of super blocks in one frame is shown in Fig. 23 for 4:2:2 compression and Fig. 24 for 4:1:1 compression. Each super block consists of 27 adjacent macro blocks, and its boundary is marked by a heavy line. The total number of pixels in a frame is distributed into 120 super blocks for 4:2:2 compression or 60 super blocks for 4:1:1 compression.

4:2:2 compression:

– 24 vertical super blocks × 5 horizontal super blocks = 120 super blocks

4:1:1 compression:

– 12 vertical super blocks × 5 horizontal super blocks = 60 super blocks.

### 2.1.5 Definition of a super block number, a macro block number and value of the pixel

Super block number

The super block number in a frame is expressed as S i, j as shown in Figs 21, 22, 23, and 24.

S i, j where i: the vertical order of the super block

i = 0, ..., n-1

where:

n: the number of vertical super blocks in a video frame

n = 10 x m for the 525/60 system

n = 12 x m for the 625/50 system

m: the compression type

m = 1 for 4:1:1 compression

m = 2 for 4:2:2 compression

j: the horizontal order of the super block

j = 0, ..., 4

Macro block number

The macro block number is expressed as M i, j, k. The symbol k is the macro block order in the super block as shown in Fig. 25 for 4:2:2 compression and Fig. 26 for 4:1:1 compression. The small rectangle in these figures shows a macro block and a number in the small rectangle indicates k.

M i, j, k where i, j: the super block order number

k: the macro block order in the super block

k = 0, ..., 26

Figure 25

Macro block order in a super block for 4:2:2 compression



Figure 26

Macro block order in a super block for 4:1:1 compression



Pixel location

Pixel location is expressed as P i, j, k, I (x, y). The pixel is indicated as the suffix of i, j, k, I (x, y). The symbol is the DCT block order in a macro block as shown in Figs 19 and 20. The rectangle in the figure shows a DCT block, and a DCT number in the rectangle expresses I. Symbol x and y are the pixel coordinate in the DCT block as described in § 2.1.2.

P i, j, k, I (x, y) where i, j, k: the macro block number

I: the DCT block order in the macro block

(x, y): the pixel coordinate in the DCT block

x = 0, ..., 7

y = 0, ..., 7

### 2.1.6 Definition of video segment and compressed macro block

A video segment consists of five macro blocks assembled from various areas within the video frame:

Ma, 2, k where a = (i + 2m) mod n

Mb, 1, k where b = (i + 6m) mod n

Mc, 3, k where c = (i + 8m) mod n

Md, 0, k where d = (i + 0) mod n

Me, 4, k where e = (i + 4m) mod n

where:

i: the vertical order of the super block

i = 0, ..., n-1

n: the number of vertical super blocks in a video frame

n = 10 × m for the 525/60 system

n = 12 × m for the 625/50 system

m: the compression type

m = 1 for 4:1:1 compression

m = 2 for 4:2:2 compression

k: the macro block order in the super block

k = 0, ..., 26

Each video segment before the bit-rate reduction is expressed as V i, k which consists of Ma, 2, k; Mb, 1, k; Mc, 3, k; Md, 0, k; and Me, 4, k.

The bit-rate reduction process is operated sequentially from Ma, 2, k to Me, 4, k. The data in a video segment are compressed and transformed to a 385-byte data stream. A compressed video data consists of five compressed macro blocks. Each compressed macro block consists of 77 bytes and is expressed as CM. Each video segment after the bit-rate reduction is expressed as CV i, k which consists of CM a, 2, k; CM b, 1, k; CM c, 3, k; CM d, 0, k; and CM e, 4, k as shown below.

CMa, 2, k:

This block includes all parts or most parts of the compressed data from macro block Ma, 2, k and may include the compressed data of macro block Mb, 1, k; or Mc, 3, k; or Md, 0, k; or Me, 4, k.

CMb, 1, k:

This block includes all parts or most parts of the compressed data from macro block Mb, 1, k and may include the compressed data of macro block Ma, 2, k; or Mc, 3, k; or Md, 0, k; or Me, 4, k.

CMc, 3, k:

This block includes all parts or most parts of the compressed data from macro block Mc, 3, k and may include the compressed data of macro block Ma, 2, k; or Mb, 1, k; or Md, 0, k; or Me, 4, k.

CMd, 0, k:

This block includes all parts or most parts of the compressed data from macro block Md, 0, k and may include the compressed data of macro block Ma, 2, k; or Mb, 1, k; or Mc, 3, k; or Me, 4, k.

CMe, 4, k:

This block includes all parts or most parts of the compressed data from macro block Me, 4, k and may include the compressed data of macro block Ma, 2, k; or Mb, 1, k; or Mc, 3, k; or Md, 0, k.

## 2.2 DCT processing

DCT blocks are comprised of two fields; each field providing pixels from 4 vertical lines and 8 horizontal pixels. In this clause, the DCT transformation from 64 pixels in a DCT block whose numbers are i, j, k, I (x, y) to 64 coefficients whose numbers are i, j, k, I (h, v) is described. P i, j, k, I (x, y) is the value of the pixel and C i, j, k, I (h, v) is the value of the coefficient.

For h = 0 and v = 0, the coefficient is called DC coefficient. Other coefficients are called AC coefficients.

### 2.2.1 DCT mode

Two modes, 8-8-DCT and 2-4-8-DCT, are selectively used to optimize the data-reduction process, depending upon the degree of content variations between the two fields of a video frame. The two DCT modes are defined:

8-8-DCT mode

DCT

7 7

C, i, j, k, l (h, v) = C (v) C (h) Σ Σ

y = 0 x = 0

(P i, j, k, l (x, y) COS(πv(2y + 1)/16) COS (πh(2x + 1)/16))

Inverse DCT:

7 7

P, i, j, k, l (x, y) = Σ Σ (C (v) C (h)

v = 0 h = 0

C, i, j, k, l (h, v) COS (πv(2y + 1)/16) COS (πh(2x + 1)/16))

where:

C(h) = 0, 5 / √2 for h = 0

C(h) = 0, 5 for h = 1 to 7

C(v) = 0, 5 / √2 for v = 0

C(v) = 0, 5 for v = 1 to 7

2-4-8 DCT mode

DCT

3 7

C, i, j, k, l (h, u) = C (u) C (h) Σ Σ

z = 0 x = 0

((P i, j, k, l (x, 2z) + P i, j, k, l (x, 2z + 1)) KC)

3 7

C, i, j, k, l (h, u + 4) = C (u) C (h) Σ Σ

z = 0 x = 0

((P i, j, k, l (x, 2z) – P i, j, k, l (x, 2z + 1)) KC)

Inverse DCT:

3 7

P, i, j, k, l (x, 2 z) = Σ Σ

u = 0 h = 0

(C i, j, k, l (h, u) + C, i, j, k, l (h, u + 4)) KC)

3 7

P, i, j, k, l (x, 2 z + 1) = Σ Σ (C (u) C (h)

u = 0 h = 0

(C i, j, k, l (h, u) – C, i, j, k, l (h, u + 4)) KC)

where:

u = 0, ..., 3

z = INT (y / 2)

KC = COS (πu(2z + 1)/ 8) COS (πh(2x + 1)/16)

C(h) = 0, 5 / √2 for h = 0

C(h) = 0, 5 for h = 1 to 7

C(u) = 0, 5 / √2 for u = 0

C(u) = 0, 5 for u = 1 to 7

### 2.2.2 Weighting

DCT coefficients shall be weighted by the process as described below. W(h, v) expresses weight for C i, j,

k, l (h, v) of the DCT coefficient

8-8-DCT mode

For h = 0 and v = 0 W(h, v) = 1 / 4

For others W(h, v) = w(h) w(v) / 2

2-4-8- DCT mode

For h = 0 and v = 0 W(h, v) = 1 / 4

For v < 4 W(h, v) = w(h) w(2 v) / 2

For others W(h, v) = w(h) w(2 (v-4)) / 2

where:

w(0) = 1

w(1) = CS4 / (4 × CS7 × CS2)

w(2) = CS4 / (2 × CS6)

w(3) = 1 / (2 × CS5)

w(4) = 7 / 8

w(5) = CS4 / CS3

w(6) = CS4 / CS2

w(7) = CS4 / CS1

where CSm = COS (mπ / 16) m = 1 to 7

### 2.2.3 Output order

Figure 27 shows the output order of the weighted coefficients.

Figure 27

Output order of weighted DCT block



### 2.2.4 Tolerance of DCT with weighting

Output error between the reference DCT and the tested DCT should satisfy the tolerances of the following cases:

– Probability of occurrence of error.

– Mean square errors for all coefficients.

– Maximum value of mean square error for each DCT block.

– All input pixel values of a DCT block are the same.

## 2.3 Quantization

### 2.3.1 Introduction

Weighted DCT coefficients are first quantized to 9-bit words, then divided by quantization in order to limit the amount of data in one video segment to five compressed macro blocks.

### 2.3.2 Bit assignment for quantization

Weighted DCT coefficients are represented as follows:

DC coefficient value (9 bits):

b8 b7 b6 b5 b4 b3 b2 b1 b0

twos complement (–255 to 255)

AC coefficient value (10 bits):

s b8 b7 b6 b5 b4 b3 b2 b1 b0

1 sign bit + 9 bits of absolute value (–511 to 511).

### 2.3.3 Class number

Each DCT block shall be classified into four classes by the definitions as described in Table 21. For selecting the quantization step, the class number is used. Both c1 and c0 express the class number and are stored in the DC coefficient of compressed DCT blocks as described in § 2.5. For reference, Table 22 shows an example of the classification.

### 2.3.4 Initial scaling

Initial scaling is an operation for AC coefficients to transform from 10 bits to 9 bits. Initial scaling shall be done as follows:

For class number = 0, 1, 2

input data s b8 b7 b6 b5 b4 b3 b2 b1 b0

output data s b7 b6 b5 b4 b3 b2 b1 b0

For class number = 3

input data s b8 b7 b6 b5 b4 b3 b2 b1 b0

output data s b8 b7 b6 b5 b4 b3 b2 b1

TABLE 21

Class number and the DCT block

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Class number | | | DCT block | |
|  | c1 | c0 | Quantization noises | Maximum absolute value of AC coefficient |
| 0 | 0 | 0 | Visible | Less than or equal to 255 |
| 1 | 0 | 1 | Lower than class 0 |
| 2 | 1 | 0 | Lower than class 1 |
| 3 | 1 | 1 | Lower than class 2 |
| – | Greater than 255 |

TABLE 22

An example of the classification for reference

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Maximum absolute value of AC coefficient | | | |
| 0 to 11 | 12 to 23 | 24 to 35 | >35 |
| Y | 0 | 1 | 2 | 3 |
| CR | 1 | 2 | 3 | 3 |
| CB | 2 | 3 | 3 | 3 |

### 2.3.5 Area number

An area number is used for selection of the quantization step. AC coefficients within a DCT block shall be classified into four areas with area number as shown in Fig. 28.

### 2.3.6 Quantization step

The quantization step shall be decided by the class number, area number, and quantization number (QNO) as specified in Table 23. QNO is selected in order to limit the amount of data in one video segment to five compressed macro blocks.

## 2.4 Variable length coding

Variable length coding (VLC) is an operation for transforming from quantized AC coefficients to variable length codes. One or more successive AC coefficients within a DCT block are coded into one variable length code according to the order as shown in Fig. 27. Run length and amplitude are defined as follows:

Run length: The number of successive AC coefficients quantized to 0 (run = 0, ..., 61).

Amplitude: Absolute value just after successive AC coefficients quantized to 0 (amp = 0, ..., 255).

(run, amp): The pair of run length and amplitude.

Table 24 shows the length of code words corresponding to (run, amp). In the table, sign bit is not included in the length of code words. When the amplitude is not zero, the code length shall be plus 1 because sign bit is needed. For empty columns, the length of code words of the (run, amp) equals that of the (run – 1, 0) plus that of the (0, amp).

Variable length code shall be as shown in Table 25. The leftmost bit of code words is MSB and the rightmost bit of code words is LSB in Table 25. The MSB of a subsequent code word is next to the LSB of the code word just before. Sign bit “s” shall be as follows:

– When the quantized AC coefficient is greater than zero, s = 0.

– When the quantized AC coefficient is less than zero, s = 1.

When the values of all of the remaining quantized coefficients are zero within a DCT block, the coding process is ended by adding EOB (end of block) code word of 0110b to just after the last code word.

Figure 28

Area numbers



TABLE 23

Quantization step

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Class number | | | | Area number | | | |
| Quantization number (QNO) | 0 | 1 | 2 | 3 | 0 | 1 | 2 | 3 |
| 15 |  |  |  | 1 | 1 | 1 | 1 |
| 14 |  |  |  | 1 | 1 | 1 | 1 |
| 13 |  |  |  | 1 | 1 | 1 | 1 |
| 12 | 15 |  |  | 1 | 1 | 1 | 1 |
| 11 | 14 |  |  | 1 | 1 | 1 | 1 |
| 10 | 13 |  | 15 | 1 | 1 | 1 | 1 |
| 9 | 12 | 15 | 14 | 1 | 1 | 1 | 1 |
| 8 | 11 | 14 | 13 | 1 | 1 | 1 | 2 |
| 7 | 10 | 13 | 12 | 1 | 1 | 2 | 2 |
| 6 | 9 | 12 | 11 | 1 | 1 | 2 | 2 |
| 5 | 8 | 11 | 10 | 1 | 2 | 2 | 4 |
| 4 | 7 | 10 | 9 | 1 | 2 | 2 | 4 |
| 3 | 6 | 9 | 8 | 2 | 2 | 4 | 4 |
| 2 | 5 | 8 | 7 | 2 | 2 | 4 | 4 |
| 1 | 4 | 7 | 6 | 2 | 4 | 4 | 8 |
| 0 | 3 | 6 | 5 | 2 | 4 | 4 | 8 |
|  | 2 | 5 | 4 | 4 | 4 | 8 | 8 |
|  | 1 | 4 | 3 | 4 | 4 | 8 | 8 |
|  | 0 | 3 | 2 | 4 | 8 | 8 | 16 |
|  |  | 2 | 1 | 4 | 8 | 8 | 16 |
|  |  | 1 | 0 | 8 | 8 | 16 | 16 |
|  |  | 0 |  | 8 | 8 | 16 | 16 |

TABLE 24

Length of codewords

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Amplitude | | | | | | | | | | | | | | | | | | | | | | | | | |
| Run  length | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | – | 255 |
| 0 | 11 | 2 | 3 | 4 | 4 | 5 | 5 | 6 | 6 | 7 | 7 | 7 | 8 | 8 | 8 | 8 | 8 | 8 | 9 | 9 | 9 | 9 | 9 | 15 | – | 15 |
| 1 | 11 | 4 | 5 | 7 | 7 | 8 | 8 | 8 | 9 | 10 | 10 | 10 | 11 | 11 | 11 | 12 | 12 | 12 |  |  |  |  |  |  |  |  |
| 2 | 12 | 5 | 7 | 8 | 9 | 9 | 10 | 12 | 12 | 12 | 12 | 12 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3 | 12 | 6 | 8 | 9 | 10 | 10 | 11 | 12 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4 | 12 | 6 | 8 | 9 | 11 | 12 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 5 | 12 | 7 | 9 | 10 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 6 | 13 | 7 | 9 | 11 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 7 | 13 | 8 | 12 | 12 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 8 | 13 | 8 | 12 | 12 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 9 | 13 | 8 | 12 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 10 | 13 | 8 | 12 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 11 | 13 | 9 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 12 | 13 | 9 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 13 | 13 | 9 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 14 | 13 | 9 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 15 | 13 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| |  | | |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 61 | 13 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| NOTE 1 – Sign bit is not included.  NOTE 2 – The length of EOB = 4. | | | | | | | | | | | | | | | | | | | | | | | | | |  |

TABLE 25

Codewords of variable-length coding

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| (Run, amp) | | Code | Length | (Run, amp) | | Code | Length | (Run, amp) | | Code | | | Length |
| 0 | 1 | 00s | 2+1 | 11 | 1 | 111100000s | 9+1 | 7 | 2 | 111110110000s | | | 12+1 |
| 0 | 2 | 010s | 3+1 | 12 | 1 | 111100001s | 8 | 2 | 111110110001s | | |
| EOB | | 0110 | 4 | 13 | 1 | 111100010s | 9 | 2 | 111110110010s | | |
| 1 | 1 | 0111s | 4+1 | 14 | 1 | 111100011s | 10 | 2 | 111110110011s | | |
| 0 | 3 | 1000s | 5 | 2 | 111100100s | 7 | 3 | 111110110100s | | |
| 0 | 4 | 1001s | 6 | 2 | 111100101s | 8 | 3 | 111110110101s | | |
| 2 | 1 | 10100s | 5+1 | 3 | 3 | 111100110s | 4 | 5 | 111110110110s | | |
| 1 | 2 | 10101s | 4 | 3 | 111100111s | 3 | 7 | 111110110111s | | |
| 0 | 5 | 10110s | 2 | 4 | 111101000s | 2 | 7 | 111110111000s | | |
| 0 | 6 | 10111s | 2 | 5 | 111101001s | 2 | 8 | 111110111001s | | |
| 3 | 1 | 110000s | 6+1 | 1 | 8 | 111101010s | 2 | 9 | 111110111010s | | |
| 4 | 1 | 110001s | 0 | 18 | 111101011s | 2 | 10 | 111110111011s | | |
| 0 | 7 | 110010s | 0 | 19 | 111101100s | 2 | 11 | 111110111100s | | |
| 0 | 8 | 110011s | 0 | 20 | 111101101s | 1 | 15 | 111110111101s | | |
| 5 | 1 | 1101000s | 7+1 | 0 | 21 | 111101110s | 1 | 16 | 11111011110s | | |
| 6 | 1 | 1101001s | 0 | 22 | 111101111s | 1 | 17 | 11111011111s | | |
| 2 | 2 | 1101010s | 5 | 3 | 1111100000s | 10+1 | 6 | 0 | 1111110000110 | | | 13 |
| 1 | 3 | 1101011s | 3 | 4 | 1111100001s | 7 | 0 | 1111110000111 | | |
| 1 | 4 | 1101100s | 3 | 5 | 1111100010s | |  R  | | |  0  | | 1111110 | Binary notation of R  R = 6 to 61 |  |
| 0 | 9 | 1101101s | 2 | 6 | 1111100011s |
| 0 | 10 | 1101110s | 1 | 9 | 1111100100s |
| 0 | 11 | 1101111s | 1 | 10 | 1111100101s | 61 | 0 | 1111110111101 | | |
| 7 | 1 | 1110000s | 8+1 | 1 | 11 | 1111100110s | 0 | 23 | 111111100010111s | | | 15+1 |
| 8 | 1 | 1110001s | 0 | 0 | 11111001110 | 11 | 0 | 24 | 111111100011000s | | |
| 9 | 1 | 11100010s | 1 | 0 | 11111001111 | |  0  | | |  A  | | 1111111 | Binary notation of A A = 23 to 255 | s |
| 10 | 1 | 11100011s | 6 | 3 | 11111010000s | 11+1 |
| 3 | 2 | 11100100s | 4 | 4 | 11111010001s |
| 4 | 2 | 11100101s | 3 | 6 | 11111010010s |
| 2 | 3 | 11100110s | 1 | 12 | 11111010011s | 0 | 255 | 111111111111111s | | |
| 1 | 5 | 11100111s | 1 | 13 | 11111010100s |  |  |  | | |  |
| 1 | 6 | 11101000s | 1 | 14 | 11111010101s |  |  |  | | |  |
| 1 | 7 | 11101001s | 2 | 0 | 111110101100 | 12 |  |  | | |  |
| 0 | 12 | 11101010s | 3 | 0 | 111110101101 |  |  | | |  |
| 0 | 13 | 11101011s | 4 | 0 | 111110101110 |  |  | | |  |
| 0 | 14 | 11101100s | 5 | 0 | 111110101111 |  |  |  | | |  |
| 0 | 15 | 11101101s |  |  |  |  |  |  |  | | |  |
| 0 | 16 | 11101110s |  |  |  |  |  |  |  | | |  |
| 0 | 17 | 11101111s |  |  |  |  |  |  |  | | |  |
| NOTE 1 – (R, 0): 1111110 r5 r4 r3 r2 r1 r0, where 32r5 + 16r4 + 8r3 +4r2 + 2r1 + r0 = R.  NOTE 2 – (0, A): 1111111 a7 a6 a5 a4 a3 a2 a1 a0 s, where 128a7 + 64a6 + 32a5 + 16a4 + 8a3 + 4a2 + 2a1 + a0 = A.  NOTE 3 – S is sign bit. EOB means end of block. | | | | | | | | | | | | | |

## 2.5 Arrangement of a compressed macro block

A compressed video segment consists of five compressed macro blocks. Each compressed macro block has 77 bytes of data. The arrangement of the compressed macro block shall be as shown in Fig. 29 for 4:2:2 compression and in Fig. 30 for 4:1:1 compression. Each compressed macro block of 4:2:2 compression includes a two-byte data area (X0, X1). The data arrangement is shown in Fig. 29. The data format of the reserved area is not defined except 100000000000.

Figure 29

Arrangement of a compressed macro block for 4:2:2 compression



Figure 30

Arrangement of a compressed macro block for 4:1:1 compression



STA: Error status

QNO: Quantization number

DC: DC component

AC: AC component

EOB: End of block (0110)

mo: DCT mode

co, c1: Class number

STA (status of the compressed macro block)

STA expresses the error and concealment of the compressed macro block and consists of four bits: s3, s2, s1, s0. Table 26 shows the definitions of STA.

QNO (quantization number)

QNO is the quantization number applied to the macro block. Code words of the QNO shall be as shown in Table 27.

TABLE 26

Definition of STA

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| STA | | | | Information of the compressed macro block | | |
| s3 | s2 | s1 | s0 | Error | Error concealment | Continuity |
| 0 | 0 | 0 | 0 | No error | Not applied | – |
| 0 | 0 | 1 | 0 | Type A | Type a |
| 0 | 1 | 0 | 0 | Type B |
| 0 | 1 | 1 | 0 | Type C |
| 0 | 1 | 1 | 1 | Error exists | – | – |
| 1 | 0 | 1 | 0 | No error | Type A | Type b |
| 1 | 1 | 0 | 0 | Type B |
| 1 | 1 | 1 | 0 | Type C |
| 1 | 1 | 1 | 1 | Error exists | – | – |
| Others | | | | Reserved | | |
| where:  Type A: Replaced with a compressed macro block of the same compressed macro block number in the immediate previous frame.  Type B: Replaced with a compressed macro block of the same compressed macro block number in the next immediate frame.  Type C: This compressed macro block is concealed, but the concealment method is not specified.  Type a: The continuity of the data processing sequence with other compressed macro blocks whose s0 = 0 and  s3 = 0 in the same video segment is guaranteed.  Type b: The continuity of the data processing sequence with other compressed macro blocks is not guaranteed. | | | | | | |
| NOTE 1 – For STA = 0111b, the error code is inserted in the compressed macro block. This is an option.  NOTE 2 – For STA = 1111b, the error position is unidentified. | | | | | | |

TABLE 27

Codewords of the QNO

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| q3 | q2 | q1 | q0 | QNO |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 1 | 1 |
| 0 | 0 | 1 | 0 | 2 |
| 0 | 0 | 1 | 1 | 3 |
| 0 | 1 | 0 | 0 | 4 |
| 0 | 1 | 0 | 1 | 5 |
| 0 | 1 | 1 | 0 | 6 |
| 0 | 1 | 1 | 1 | 7 |
| 1 | 0 | 0 | 0 | 8 |
| 1 | 0 | 0 | 1 | 9 |
| 1 | 0 | 1 | 0 | 10 |
| 1 | 0 | 1 | 1 | 11 |
| 1 | 1 | 0 | 0 | 12 |
| 1 | 1 | 0 | 1 | 13 |
| 1 | 1 | 1 | 0 | 14 |
| 1 | 1 | 1 | 1 | 15 |

DC

DCI (where I is the DCT block order in the macro block, I = 0, ..., 3 for 4:2:2 compression, I = 0, ..., 5 for 4:1:1 compression) consists of a DC coefficient, the DCT mode, and the class number of the DCT block.

MSB LSB

DCI: b8 b7 b6 b5 b4 b3 b2 b1 b0 mo c1 c0

where:

b8 to b0: DC coefficient value

mo: DCT mode mo = 0 for 8-8-DCT mode

mo = 1 for 2-4-8-DCT mode

c1 c0: class number

AC

AC is a generic term for variable length coded AC coefficients within the video segment V i, k. For 4:2:2 compression, the areas of Y0, Y1, CR, and CB are defined as compressed-data areas and each of Y0 and Y1 consists of 112 bits and each CR and CB consists of 80 bits as shown in Fig. 29. For 4:1:1 compression, the areas of Y0, Y1, Y2, Y3, CR, and CB are defined as compressed-data areas and each of Y0, Y1, Y2, and Y3 consists of 112 bits and each CR and CB consists of 80 bits as shown in Fig. 30. DCI and variable length code for AC coefficients in the DCT block whose DCT block number is i, j, k, l are assigned from the beginning of the compressed-data area in the compressed macro block CM i, j, k. In Figs 29 and 30, the variable length code word is located starting from the MSB which is shown in the upper left side, and the LSB shown in the lower right side. Therefore, AC data are distributed from the upper left corner to the lower right corner.

## 2.6 Arrangement of a video segment

In this clause, the distribution method of quantized AC coefficients is described. Figures 31 and 32 show the arrangement of a video segment CV i, k after bit-rate reduction. Each row contains a compressed macro block. Columns F i, j, k, l express the compressed data area for DCT blocks whose DCT block numbers are i, j, k, l. Symbol E i, j, k, l expresses an additional AC area for recording remaining data from the fixed AC area.

Figure 31

Arrangement of a video segment after the bit-rate reduction for 4:2:2 compression



Figure 32

Arrangement of a video segment after the bit-rate reduction for 4:1:1 compression



where:

a = (i + 2) mod n i: the vertical order of the super block

b = (i + 6) mod n i = 0, ..., n-1.

c = (i + 8) mod n n: the number of vertical super blocks in a video frame

d = (i + 0) mod n n = 10 for the 525/60 system

e = (i + 4) mod n n = 12 for the 625/50 system

k: the macro block order in the super block

k = 0, ..., 26

Bit sequence, defined as Bi, j, k, l, shall consist of the following concatenated data: DC coefficient, DCT mode information, class number, and AC coefficient code words for DCT blocks numbered i, j, k, l. Code words for AC coefficients of B i, j, k, l shall be concatenated according to the order as shown in Fig. 27 and the last code word shall be EOB. The MSB of the subsequent code word shall be next to the LSB of the code word just before.

The arrangement algorithm of a video segment shall be composed of three passes:

Pass 1: The distribution of B i, j, k, l to the compressed-data area;

Pass 2: The distribution of the overflow B i, j, k, l which are the remainder after the pass 1 operation in the same compressed macro block;

Pass 3: The distribution of the overflow B i, j, k, l which are the remainder after the pass 2 operation in the same video segment.

Arrangement algorithm of a video segment

4:2:2 compression:

if (525/60 system) n = 20 else n = 24;

for (i = 0; i < n; i++){

a = (i + 4) mod n;

b = (i + 12) mod n;

c = (i + 16) mod n;

d = (i + 0) mod n;

e = (i + 8) mod n;

for (k = 0; k < 27; k++){

q = 2;

p = a;

VR = 0

/\* VR is the bit sequence for the data which are not distributed to video segment CV i, k by pass 2. \*/

/\* pass 1 \*/

for (j = 0; j < 5; j++) {

MRq = 0;

/\* MRq is the bit sequence for the data which are not distributed to macro block M i, q, k by pass 1. \*/

for (l = 0, l < 4; l ++) {

remain = distribute (B p, q, k, l, F p, q, k, l);

MRq = connect (MRq, remain);

}

if (q == 2) {q = 1; p = b;}

else if (q == 1) {q = 3; p = c;}

else if (q == 3) {q = 0; p = d;}

else if (q == 0) {q = 4; p = e;}

else if (q == 4) {q = 2; p = a;}

}

/\* pass 2 \*/

for (j = 0; j < 5; j++) {

for (l = 0; l < 4; l ++) {

MRq = distribute (MRq, F p, q, k, l);

if ((l == 0) || (l == 1))

MRq = distribute (MRq, E p, q, k, l);

}

VR = connect (VR, MRq);

if (q == 2) {q = 1; p = b;}

else if (q == 1) {q = 3; p = c;}

else if (q == 3) {q = 0; p = d;}

else if (q == 0) {q = 4; p = e;}

else if (q == 4) {q = 2; p = a;}

}

/\* pass 3 \*/

for (j = 0; j < 5; j++) {

for (l = 0; l < 4; l ++) {

VR = distribute (VR, F p, q, k, l);

if ((l == 0) || (l == 1))

VR = distribute (VR, E p, q, k, l);

}

if (q == 2) {q = 1; p = b;}

else if (q == 1) {q = 3; p = c;}

else if (q == 3) {q = 0; p = d;}

else if (q == 0) {q = 4; p = e;}

else if (q == 4) {q = 2; p = a;}

}

}

}

4:1:1 compression

if (525/60 system) n = 10 else n = 12;

for (i = 0; i < n ; i++){

a = (i + 2) mod n;

b = (i + 6) mod n;

c = (i + 8) mod n;

d = (i + 0) mod n;

e = (i + 4) mod n;

for (k = 0; k < 27; k++){

q = 2;

p = a;

VR = 0

/\* VR is the bit sequence for the data which are not distributed to video segment CV i, k by pass 2 \*/

/\* pass 1 \*/

for (j = 0; j <5; j++) {

MRq = 0;

/\* MRq is the bit sequence for the data which are not distributed to macro block M i, q, k by pass 1. \*/

for (l = 0, l < 6; l ++) {

remain = distribute (B p, q, k, l, F p, q, k, l);

MRq = connect (MRq, remain);

}

if (q == 2) {q = 1; p = b;}

else if (q == 1) {q = 3; p = c;}

else if (q == 3) {q = 0; p = d;}

else if (q == 0) {q = 4; p = e;}

else if (q == 4) {q = 2; p = a;}

}

/\* pass 2 \*/

for (j = 0; j < 5; j++) {

for (l = 0; l < 6; l ++) {

MRq = distribute (MRq, F p, q, k, l);

}

VR = connect (VR, MRq);

if (q == 2) {q = 1; p = b;}

else if (q == 1) {q = 3; p = c;}

else if (q == 3) {q = 0; p = d;}

else if (q == 0) {q = 4; p = e;}

else if (q == 4) {q = 2; p = a;}

}

/\* pass 3 \*/

for (j = 0; j < 5; j++){

for (l = 0; l < 6; l ++) {

VR = distribute (VR, F p, q, k, l);

}

if (q == 2) {q = 1; p = b;}

else if (q == 1) {q = 3; p = c;}

else if (q == 3) {q = 0; p = d;}

else if (q == 0) {q = 4; p = e;}

else if (q == 4) {q = 2; p = a;}

}

}

}

where:

distribute (data 0, area 0) {

/\* Distribute data 0 from MSB into empty area of area 0. \*/

/\* The area 0 is filled starting from the MSB. \*/

remain = (remaining\_data);

/\* Remaining\_data are the data which are not distributed. \*/

return (remain);

}

connect (data 1, data 2) {

/\* Connect the MSB of data 2 with the LSB of data 1. \*/

data 3 = (connecting\_data)

/\* Connecting\_data are the data which are connected. \*/

/\* data 2 with data 1. \*/

return (data 3);

}

The remaining data which cannot be distributed within the unused space of the macro block will be ignored. Therefore, when error concealment is performed for a compressed macro block, some distributed data by pass 3 may not be reproduced.

Video error code processing

If errors are detected in a compressed macro block which is reproduced and processed with error correction, the compressed-data area containing these errors should be replaced with the video error code. This process replaces the first two bytes of data of the compressed-data area with the code as follows:

MSB LSB

1000000000000110b

The first 9 bits are the DC error code, the next 3 bits are the information of the DCT mode and class number, and the last 4 bits are the EOB as shown in Fig. 33.

When the compressed macro blocks, after error code processing, are input to the decoder which does not operate with video error code, all data in this compressed macro block should be processed as invalid.

Figure 33

Video error code



Appendix A  
(Informative)  
  
Differences between IEC 61834 and Recommendation ITU-R BT.1618

TABLE 28

Abstract of differences between IEC 61834 and ITU-R BT.1618

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | DV IEC 61834 | DV-BASED ITU-R BT.1618 | |
| 25 Mb/s structure | 50 Mb/s structure |
| Data structure | | IEC 61834 | Same as IEC 61834 | See Fig. 2 |
| Header | Bit name APT AP1 AP2 AP3 | 000 000 000 000 | 001 001 001 001 | |
| ID | FSC | FSC is not defined (set to 0) | See § 1.3.1 | |
| Video | Sampling structure | 525: 4:1:1 625: 4:2:0 | 525: 4:1:1 625: 4:1:1 | 525: 4:2:2 625: 4:2:2 |
| VAUX | VS VSC Other | IEC 61834 IEC 61834 IEC 61834 | See § 1.5.2.1 See § 1.5.2.2 Reserved | |
| Audio | Sampling    Locked mode | 48 kHz (16 bits, 2ch) 44.1 kHz (16 bits, 2ch) 32 kHz (16 bits, 2ch) 32 kHz (12 bits, 4ch) Locked / unlocked | 48 kHz (16 bits, 2ch)    Locked | 48 kHz (16 bits, 4ch)    Locked |
| AAUX | AS ASC Other | IEC 61834 IEC 61834 IEC 61834 | See § 1.6.2.3.1 See § 1.6.2.3.2 Reserved | |
| Subcode | SSYB ID TC BG Other | IEC 61834 IEC 61834 IEC 61834 IEC 61834 | See § 1.4.2.1 See § 1.4.2.2.1 Same as IEC 61834 Reserved | |

Appendix B  
  
Terms and Acronyms

AAUX Audio auxiliary data

AP1 Audio application ID

AP2 Video application ID

AP3 Subcode application ID

APT Track application ID

Arb Arbitrary

AS AAUX source pack

ASC AAUX source control pack

B/W Black-and-white flag

CGMS Copy generation management system

CM Compressed macro block

DBN DIF block number

DCT Discrete cosine transform

DIF Digital interface

DRF Direction flag

Dseq DIF sequence number

DSF DIF sequence flag

DV Identification of a compression family

EFC Emphasis audio channel flag

EOB End of block

FR Identification for the first or second half of each channel

FSC Identification of a DIF block in each channel

LF Locked mode flag

QNO Quantization number

QU Quantization

Res Reserved for future use

SCT Section type

SMP Sampling frequency

SSYB Subcode sync block

STA Status of the compressed macro block

STYPE Signal type (see note)

Syb Subcode sync block number

TF Transmitting flag

VAUX Video auxiliary data

VLC Variable length coding

VS VAUX source pack

VSC VAUX source control pack

NOTE 1 – STYPE as used in this Recommendation is different from that in ANSI/IEEE 1394.