

# Presentation Graphic Stream (SUP files) BluRay Subtitle Format

July 15, 2017 TheScorpius666 Uncategorized



The Presentation Graphic Stream (PGS) specification is defined in the [US Patent US 20090185789 A1](#). This graphic stream definition is used to show subtitles in BluRay movies. When a subtitle stream in PGS format is ripped from a BluRay disc is usually saved in a file with the SUP extension (Subtitle Presentation).

A Presentation Graphic Stream (PGS) is made of several functional segments one after another. These segments have the following header:

| Name         | Size in bytes | Description            |
|--------------|---------------|------------------------|
| Magic Number | 2             | "PG" (0x5047)          |
| PTS          | 4             | Presentation Timestamp |
| DTS          | 4             | Decoding Timestamp     |
| Segment Type | 1             | 0x14: PDS              |
|              |               | 0x15: ODS              |
|              |               | 0x16: PCS              |
|              |               | 0x17: WDS              |
|              |               | 0x80: END              |
| Segment Size | 2             | Size of the segment    |

The DTS should indicate a time when the decoding of the sub picture starts, and the PTS indicates a time when the decoding ends and the sub picture is shown on the screen. DTS is always zero in practice (at least from what I have found so far), so you can freely ignore this value. These timestamps have an accuracy of 90 kHz. This means that for example, if you have a PTS value of 0x0004C11C and you want to know the milliseconds from the start of the movie when the sub picture is shown, you have to divide the decimal value (311,580) by 90, and the result is the value you are looking for: 3,462 milliseconds (or 3.462 seconds).

As you can see, there are five types of segments used in PGS:

- Presentation Composition Segment (PCS)
- Window Definition Segment (WDS)
- Palette Definition Segment (PDS)
- Object Definition Segment (ODS)
- End of Display Set Segment (END)

The Presentation Composition Segment (PCS) is also called the Control Segment because it indicates a new Display Set (DS) definition, composed by definition segments (WDS, PDS, ODS) until an END segment is found.

A Display Set (DS) is a sub picture definition that might look like this:

|     |     |     |     |     |
|-----|-----|-----|-----|-----|
| PCS | WDS | PDS | ODS | END |
|-----|-----|-----|-----|-----|

In a DS there can be several windows, palette and object definitions, and the composition objects define what is going to be shown on the screen.

## Presentation Composition Segment

The Presentation Composition Segment is used for composing a sub picture. It is made of the following fields:

| Name                          | Size in bytes | Description   |
|-------------------------------|---------------|---|
| Width                         | 2             | Video width in pixels (ex. 0x780 = 1920)  |
| Height                        | 2             | Video height in pixels (ex. 0x438 = 1080)   |
| Frame Rate                    | 1             | Always 0x10. Can be ignored.  |
| Composition Number            | 2             | Number of this specific composition. It is incremented by one every time a graphics update occurs.              |
| Composition State             | 1             | Type of this composition. Allowed values are:<br>0x00: Normal<br>0x40: Acquisition Point<br>0x80: Epoch Start   |
| Palette Update Flag           | 1             | Indicates if this PCS describes a Palette only Display Update. Allowed values are:<br>0x00: False<br>0x80: True |
| Palette ID                    | 1             | ID of the palette to be used in the Palette only Display Update   |
| Number of Composition Objects | 1             | Number of composition objects defined in this segment   |

The composition state can be one of three values:

- **Epoch Start:** This defines a new display. The Epoch Start contains all functional segments needed to display a new composition on the screen.
- **Acquisition Point:** This defines a display refresh. This is used to compose in the middle of the Epoch. It includes functional segments with new objects to be used in a new composition, replacing old objects with the same Object ID.
- **Normal:** This defines a display update, and contains only functional segments with elements that are different from the preceding composition. It's mostly used to stop displaying objects on the screen by defining a composition with no composition objects (a value of zero in the Number of Composition Objects flag) but also used to define a new composition with new objects and objects defined since the Epoch Start.

The composition objects, also known as window information objects, define the position on the screen of every image that will be shown. They have the following structure:

| Name                                | Size in bytes | Description  |
|-------------------------------------|---------------|--|
| Object ID                           | 2             | ID of the ODS segment that defines the image to be shown   |
| Window ID                           | 1             | Id of the WDS segment to which the image is allocated in the PCS. Up to two images may be assigned to one window             |
| Object Cropped Flag                 | 1             | 0x40: Force display of the cropped image object<br>0x00: Off   |
| Object Horizontal Position          | 2             | X offset from the top left pixel of the image on the screen  |
| Object Vertical Position            | 2             | Y offset from the top left pixel of the image on the screen  |
| Object Cropping Horizontal Position | 2             | X offset from the top left pixel of the cropped object in the screen. Only used when the Object Cropped Flag is set to 0x40. |
| Object Cropping Vertical Position   | 2             | Y offset from the top left pixel of the cropped object in the screen. Only used when the Object Cropped Flag is set to 0x40. |
| Object Cropping Width               | 2             | Width of the cropped object in the screen. Only used when the Object Cropped Flag is set to 0x40.                            |
| Object Cropping Height Position     | 2             | Height of the cropped object in the screen. Only used when the Object Cropped Flag is set to 0x40.                           |

When the Object Cropped Flag is set to true (or actually 0x40), then the sub picture is cropped to show only a portion of it. This is used for example when you don't want to show the whole subtitle at first, but just a few words first, and then the rest.

## Window Definition Segment

This segment is used to define the rectangular area on the screen where the sub picture will be shown. This rectangular area is called a Window. This segment can define several windows, and all the fields from Window ID up to Window Height will repeat each other in the segment defining each window. You can see it more clearly in the example at the end of this page. Its structure is as follows:

| Name                       | Size in bytes | Description   |
|----------------------------|---------------|---|
| Number of Windows          | 1             | Number of windows defined in this segment                     |
| Window ID                  | 1             | ID of this window   |
| Window Horizontal Position | 2             | X offset from the top left pixel of the window in the screen. |
| Window Vertical Position   | 2             | Y offset from the top left pixel of the window in the screen. |
| Window Width               | 2             | Width of the window   |
| Window Height              | 2             | Height of the window  |

## Palette Definition Segment

This segment is used to define a palette for color conversion. It's composed of the following fields:

| Name                       | Size in bytes | Definition                               |
|----------------------------|---------------|--|
| Palette ID                 | 1             | ID of the palette                        |
| Palette Version Number     | 1             | Version of this palette within the Epoch |
| Palette Entry ID           | 1             | Entry number of the palette              |
| Luminance (Y)              | 1             | Luminance (Y value)                      |
| Color Difference Red (Cr)  | 1             | Color Difference Red (Cr value)          |
| Color Difference Blue (Cb) | 1             | Color Difference Blue (Cb value)         |
| Transparency (Alpha)       | 1             | Transparency (Alpha value)               |

There can be several palette entries, with different palette IDs so the last five fields can repeat.

## Object Definition Segment

This segment defines the graphics object. These are images with rendered text on a transparent background. Its structure is explained in the following table:

| Name                  | Size in bytes | Description  |
|-----------------------|---------------|--|
| Object ID             | 2             | ID of this object  |
| Object Version Number | 1             | Version of this object   |
| Last in Sequence Flag | 1             | If the image is split into a series of consecutive fragments, the last fragment has this flag set. Possible values:<br>0x40: Last in sequence<br>0x80: First in sequence<br>0xC0: First and last in sequence (0x40   0x80) |
| Object Data Length    | 3             | The length of the Run-length Encoding (RLE) data buffer with the compressed image data.  |
| Width                 | 2             | Width of the image   |
| Height                | 2             | Height of the image  |
| Object Data           | variable      | This is the image data compressed using Run-length Encoding (RLE). The size of the data is defined in the Object Data Length field.  |

The Run-length encoding method is defined in the [US 7912305 B1 patent](#). Here's a quick and dirty definition to this method:

| Code                             | Meaning                                      |
|----------------------------------|--|
| CCCCCCCC                         | One pixel in color C                         |
| 00000000 00LLLLLL                | L pixels in color 0 (L between 1 and 63)     |
| 00000000 01LLLLLL LLLLLLL        | L pixels in color 0 (L between 64 and 16383) |
| 00000000 10LLLLLL CCCCCC         | L pixels in color C (L between 3 and 63)     |
| 00000000 11LLLLLL LLLLLLL CCCCCC | L pixels in color C (L between 64 and 16383) |
| 00000000 00000000                | End of line                                  |

### End Segment

The end segment always has a segment size of zero and indicates the end of a Display Set (DS) definition. It appears immediately after the last ODS in one DS.

## Example

Let's see a real world example. Take a look at this section of a SUP file:

|          |   |                |
|----------|---|----------------|
| 00348a10 | 50 47 05 88 fd ec 00 00 00 00 16 00 13 07 80 04 | PG.....        |
| 00348a20 | 38 10 01 ae 80 00 00 01 00 00 00 00 03 05 00 6c | 8.....l        |
| 00348a30 | 50 47 05 88 fd ec 00 00 00 00 17 00 13 02 00 03 | PG.....        |
| 00348a40 | 05 00 6c 01 79 00 2b 01 02 e3 03 a0 01 d8 00 2b | ..l.y.+.....+  |
| 00348a50 | 50 47 05 88 fd ec 00 00 00 00 14 00 9d 00 00 00 | PG.....        |
| 00348a60 | 10 80 80 00 01 10 80 80 ff 02 1f 80 80 ff 03 2d | .....-         |
| 00348a70 | 80 80 ff 04 3c 80 80 ff 05 4a 80 80 ff 06 59 80 | ...<...J...Y.  |
| 00348a80 | 80 ff 07 68 80 80 ff 08 76 80 80 ff 09 85 80 80 | ...h...v.....  |
| 00348a90 | ff 0a 93 80 80 ff 0b a2 80 80 ff 0c b1 80 80 ff | .....          |
| 00348aa0 | 0d bf 80 80 ff 0e ce 80 80 ff 0f dc 80 80 ff 10 | .....          |
| 00348ab0 | eb 80 80 ff 11 10 80 80 11 12 10 80 80 22 13 10 | ....."..       |
| 00348ac0 | 80 80 33 14 10 80 80 66 15 10 80 80 99 16 10 80 | ..3....f.....  |
| 00348ad0 | 80 aa 17 10 80 80 bb 18 10 80 80 55 19 10 80 80 | .....U....     |
| 00348ae0 | 77 1a 10 80 80 cc 1b 10 80 80 88 1c 10 80 80 44 | w.....D        |
| 00348af0 | 1d 10 80 80 dd 1e 10 80 80 ee 50 47 05 88 fd ec | .....PG....    |
| 00348b00 | 00 00 00 00 15 21 c2 00 00 00 c0 00 21 bb 01 79 | ....!.....!..y |
| 00348b10 | 00 2b 00 01 11 00 86 12 00 06 00 87 12 00 12 11 | .+.....        |
| (...)    |   |                |
| 0034acc0 | 0f 11 00 86 12 00 0e 00 00 50 47 05 88 fd ec 00 | .....PG.....   |
| 0034acd0 | 00 00 00 80 00 00                               | .....          |

This is a complete Display Set. These are the segments:

- **First Segment: PCS, offset 0x00348a10**
  - Magic Number: "PG" (0x5047)
  - Presentation Time: 17:11.822 (92,863,980 / 90)
  - Decoding Time: 0
  - Segment Type: **PCS** (0x16)
  - Segment Size: 0x13 bytes
  - Width: 1920 (0x780)
  - Height: 1080 (0x438)
  - Frame rate: 0x10
  - Composition Number: 430 (0x1ae)
  - Composition State: Epoch Start (0x80)
  - Palette Update Flag: false
  - Palette ID: 0
  - Number of Composition Objects: 1
  - Object ID: 0
  - Window ID: 0
  - Object Cropped Flag: false
  - Object Horizontal Position: 773 (0x305)
  - Object Vertical Position: 108 (0x06c)

- **Second Segment: WDS (0x17), offset 0x00348a30**
  - Magic Number: "PG" (0x5047)
  - Presentation Time: 17:11.822 (92,863,980 / 90)
  - Decoding Time: 0
  - Segment Type: **WDS** (0x17)
  - Segment Size: 0x13 bytes
  - Number of Windows: 2
  - Window ID: 0
  - Window Horizontal Position: 773 (0x305)
  - Window Vertical Position: 108 (0x06c)
  - Window Width: 377 (0x179)
  - Window Height 43 (0x02b)
  - Window ID: 1
  - Window Horizontal Position: 739 (0x2e3)
  - Window Vertical Position: 928 (0x3a0)
  - Window Width: 472 (0x1d8)
  - Window Height 43 (0x02b)
- **Third Segment: PDS (0x14), offset 0x00348a50**
  - Magic Number: "PG" (0x5047)
  - Presentation Time: 17:11.822 (92,863,980 / 90)
  - Decoding Time: 0
  - Segment Type: **PDS** (0x14)
  - Segment Size: 0x9d bytes
  - Palette ID: 0
  - Palette Version: 0
  - 31 palette entries
- **Fourth Segment: ODS (0x15), offset 0x00348afa**
  - Magic Number: "PG" (0x5047)
  - Presentation Time: 17:11.822 (92,863,980 / 90)
  - Decoding Time: 0
  - Segment Type: **PDS** (0x15)
  - Segment Size: 0x21c2 bytes
  - Object ID: 0
  - Object Version Number: 0
  - Last in sequence flag: First and last sequence (0xC0)
  - Object Data Length: 0x0021bb bytes
  - Width: 377 (0x179)
  - Height: 43 (0x02b)
- **Fifth Segment: END (0x80), offset 0x0034acc9**
  - Magic Number: "PG" (0x5047)
  - Presentation Time: 17:11.822 (92,863,980 / 90)
  - Decoding Time: 0
  - Segment Type: **END** (0x80)
  - Segment Size: 0 bytes

This Display Set will show an image of 377×43 in size, starting at 17 minutes, 11.822 seconds on the screen at offset 773×108.