# SER format description version 3

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2014 Feb 06

## Overview

Ser format consist of three parts:

- Header
  with fixed size of 178 Byte
- Image frame data
  with variable byte size of:
  <BytePerPixel> **x** <Image width> **x** <Image height> **x** <Total amount of Images>
- Trailer
  Optional. Byte size of 8 **x** <Total amount of Images>

## Header

### 1_FileID

Format: String
Length: 14 Byte (14 ASCII characters)
Content: "LUCAM-RECORDER" (fix)

### 2_LuID

Format: Integer_32 (little-endian)
Length: 4 Byte
Content: Lumenera camera series ID (currently unused; default = 0)

### 3_ColorID

Format: Integer_32 (little-endian)

Length: 4 Byte
Content:

| | |
|---|---|
| MONO | = 0 |
| BAYER_RGGB | = 8 |
| BAYER_GRBG | = 9 |
| BAYER_GBRG | = 10 |
| BAYER_BGGR | = 11 |
| BAYER_CYYM | = 16 |
| BAYER_YCMY | = 17 |
| BAYER_YMCY | = 18 |

| | |
|---|---|
| BAYER_MYYC | = 19 |
| RGB | = 100 |
| BGR | = 101 |

## 4_LittleEndian

Format: Integer_32 (little-endian)
Length: 4 Byte
Content: 0 (FALSE) for big-endian byte order in 16 bit image data
1 (TRUE) for little-endian byte order in 16 bit image data

## 5_ImageWidth

Format: Integer_32 (little-endian)
Length: 4 Byte
Content: Width of every image in pixel

## 6_ImageHeight

Format: Integer_32 (little-endian)
Length: 4 Byte
Content: Height of every image in pixel

## 7_PixelDepthPerPlane

Format: Integer_32 (little-endian)
Length: 4 Byte
Content: True bit depth per pixel per plane

| 3_ColorID | NumberOfPlanes |
|---|---|
| MONO … BAYER_MYYC | 1 |
| RGB, BGR | 3 |

| 7_PixelDepthPerPlane | BytesPerPixel |
|---|---|
| **1..8** | 1 * NumberOfPlanes |
| **9..16** | 2 * NumberOfPlanes |

### Pixel data organization:

8 bit unsigned integer (7_PixelDepthPerPlane = **1..8**)

| 3_ColorID | Pixel data [Byte] |
|---|---|
| MONO … BAYER_MYYC | [M] |
| RGB | [R] [G] [B] |
| BGR | [B] [G] [R] |

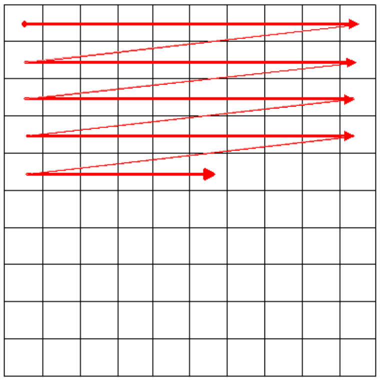
16 bit unsigned integer (7_PixelDepthPerPlane = **9..16**)

| 3_ColorID | Pixel data [Byte] |
|---|---|
| MONO … BAYER_MYYC | [M][M] |
| RGB | [R][R] [G][G] [B][B] |
| BGR | [B][B] [G][G] [R][R] |

Byte order in 16 bit format (Lo / Hi byte) depends on 4_LittleEndian.

Image data organization:

Start pixel is the upper left pixel of the image.



Data of between 1 and 8 bits should be stored aligned with the most significant bit (MSB). For example:

| | MSB ->LSB |
|---|---|
| 1-bit data | b0000000 |
| 2-bit data | bb000000 |
| 3-bit data | bbb00000 |
| 4-bit data | bbbb0000 |
| 5-bit data | bbbbb000 |
| 6-bit data | bbbbbb00 |
| 7-bit data | bbbbbbb0 |
| 8-bit data | bbbbbbbb |

Data between 9 and 16 bits should be stored aligned with the least significant bit (LSB). For example:

| | MSB -> LSB |
|---|---|
| 9-bit data | 0000000bbbbbbbbb |
| 10-bit data | 000000bbbbbbbbbb |
| 11-bit data | 00000bbbbbbbbbbb |
| 12-bit data | 0000bbbbbbbbbbbb |
| 13-bit data | 000bbbbbbbbbbbbb |
| 14-bit data | 00bbbbbbbbbbbbbb |
| 15-bit data | 0bbbbbbbbbbbbbbb |

| | |
|---|---|
| 16-bit data | bbbbbbbbbbbbbbbb |

8_FrameCount

Format: Integer_32 (little-endian)
Length: 4 Byte
Content: Number of image frames in SER file

9_Observer

Format: String
Length: 40 Byte (40 ASCII characters {32…126 dec.}, fill unused characters with 0 dec.)
Content: Name of observer

10_Instrument

Format: String
Length: 40 Byte (40 ASCII characters {32…126 dec.}, fill unused characters with 0 dec.)
Content: Name of used camera

11_Telescope

Format: String
Length: 40 Byte (40 ASCII characters {32…126 dec.}, fill unused characters with 0 dec.)
Content: Name of used telescope

12_DateTime

Format: Date / Integer_64 (little-endian)
Length: 8 Byte
Content: Start time of image stream (local time)
If 12_DateTime <= 0 then 12_DateTime is invalid and the SER file does not contain a Time stamp trailer.

13_DateTime_UTC

Format: Date / Integer_64 (little-endian)
Length: 8 Byte
Content: Start time of image stream in UTC

## Image Data

Image data starts at File start offset decimal 178
Size of every image frame in byte is: 5_ImageWidth x 6_ImageHeigth x BytePerPixel

## Trailer in detail

Trailer starts at byte offset: 178 + 8_FrameCount x 5_ImageWidth x 6_ImageHeigth x BytePerPixel.

Trailer contains Date / Integer_64 (little-endian) time stamps **in UTC** for every image frame.

According to Microsoft documentation the used time stamp has the following format:

“Holds IEEE 64-bit (8-byte) values that represent dates ranging from January 1 of the year 0001 through December 31 of the year 9999, and times from 12:00:00 AM (midnight) through 11:59:59.9999999 PM. Each increment represents 100 nanoseconds of elapsed time since the beginning of January 1 of the year 1 in the Gregorian calendar. The maximum value represents 100 nanoseconds before the beginning of January 1 of the year 10000.”

According to the findings of Raoul Behrend, Université de Genève, the date record is not a 64 bits unsigned integer as stated, but a 62 bits unsigned integer. He got no information about the use of the two MSB.

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