

User Manual
HD1-D1312(IE) Series
High Dynamic Range CMOS Area Scan Camera



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Preface

1.1 About Photonfocus

The Swiss company Photonfocus is one of the leading specialists in the development of CMOS image sensors and corresponding industrial cameras for machine vision, security & surveillance and automotive markets.

Photonfocus is dedicated to making the latest generation of CMOS technology commercially available. Active Pixel Sensor (APS) and global shutter technologies enable high speed and high dynamic range (120 dB) applications, while avoiding disadvantages like image lag, blooming and smear.

Photonfocus has proven that the image quality of modern CMOS sensors is now appropriate for demanding applications. Photonfocus' product range is complemented by custom design solutions in the area of camera electronics and CMOS image sensors.

Photonfocus is ISO 9001 certified. All products are produced with the latest techniques in order to ensure the highest degree of quality.

1.2 Contact

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Table 1.1: Photonfocus Contact

1.3 Sales Offices

Photonfocus products are available through an extensive international distribution network and through our key account managers. Details of the distributor nearest you and contacts to our key account managers can be found at www.photonfocus.com.

1.4 Further information



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1.5 Legend

In this documentation the reader's attention is drawn to the following icons:



Important note



Alerts and additional information



Attention, critical warning



Notification, user guide

Product Specification

2.1 Introduction

The Photonfocus HD camera series allows to set different property values for even and odd image rows for the following properties:

- Exposure time
- LinLog® parameters
- Look-up table (LUT)
- Gain (FineGain) and DigitalOffset

The dynamic range of an image can be increased in most Photonfocus cameras using LinLog® without the need of the odd/even HD features. Below is a comparison of using only LinLog® to using the even/odd HDR features:

- With the HDR feature, the dynamic range can be increased with linear pixel response which is required by some application. LinLog® has a non-linear pixel response.
- The dynamic range can be increased even more than just using plain LinLog® by using LinLog® together with the even/odd HDR feature.
- The vertical resolution is cutted in half by the even/odd HDR feature. Rows have to be interpolated in software or an anamorphic lens can be used.
- Computational complexity is higher with the even/odd HDR feature.

An application of this feature is high dynamic range imaging where the exposure time of the even rows is set much higher than the exposure time of the odd rows. Through a suitable Tone Mapping algorithm an image with a high dynamic range can be obtained. The dynamic range can be increased even more by using Linlog®.

Fig. 2.1 shows the result of applying an image fusion and a tone mapping algorithm to the output of a Photonfocus HD camera. The even rows are exposed with a longer exposure time than the odd rows. In the upper part, a zoom of the image shows that the odd rows are darker due to the lower exposure time. In the middle part the even and odd rows are assembled to form an even image and an odd image. Missing rows were interpolated to keep the aspect ratio. The odd and even images are merged to a single HDR image using a fusion algorithm. A tone mapping algorithm is then applied for lower resolution display.



In this manual only the HD-specific features are described. The standard features and technical specifications are described in the manual of the corresponding standard camera (see also Table 2.1).



Figure 2.1: Example for image fusion and tone mapping

2.2 Available camera models

The HD cameras are based on standard Photonfocus cameras and contain all their functionality with the exceptions described in Chapter 3. Please refer to the manual of the standard camera for a description of the standard camera features. Table 2.1 lists the available HD camera models with their underlying standard camera.

HD camera model	Based on	Refer to manual	Interface
HD1-D1312-160-CL-12	MV1-D1312-160-CL-12	MAN041	CameraLink®
HD1-D1312-80-G2-12	MV1-D1312-80-G2-12	MAN049	Gigabit Ethernet

Table 2.1: Available Photonfocus HD cameras

Functionality

3.1 HD mode

The HD mode is enabled by setting the property `EnOddEven` to 1 (True). A drawing of the data path when `EnEvenOdd` is set to 1 (True) is shown in Fig. 3.1. `ExposureTime` and `LinLog` parameters are specified for even and for odd rows. Some data path parameters (`DigitalOffset`, `FineGain`, `LUT`) can also be set for even and odd rows.



If simultaneous read out mode is used together with even/odd HDR mode (`EnOddEven = 1 (True)`) then the brightness of the row where the second exposure starts and the part of the image below this row is slightly different than the upper part of the image. It is therefore recommended to use sequential read out in this case.



"Odd" and "even" refer to the absolute row numbering. Examples: `Y=0, H=1024`: first row of the ROI is an even row. `Y=1, H=1024`: first row of the ROI is an odd row.

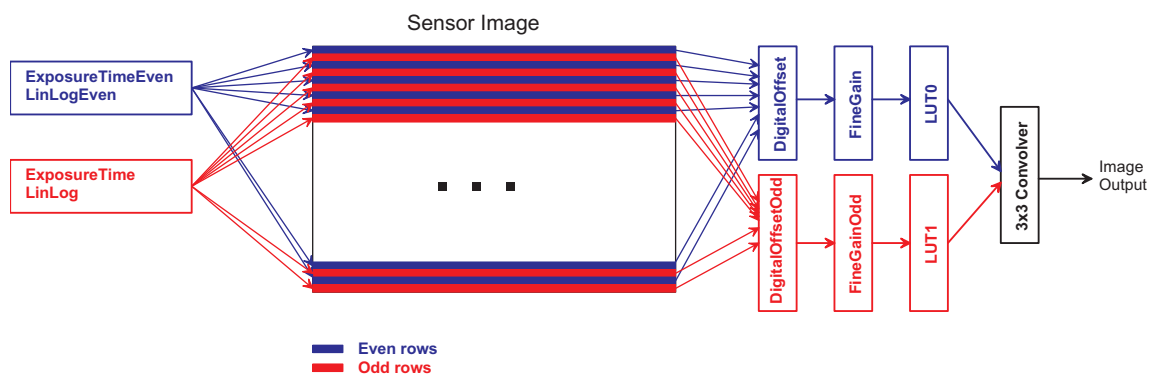




Figure 3.1: Data path in HD camera when `EnEvenOdd=1 (True)`

3.2 Exposure time

If `EnEvenOdd` is set to 1 (True) then the exposure time of the even rows is set by the property `ExposureTimeEven` and the exposure time of the odd rows by the property `ExposureTime`. Exposure of the even rows starts immediately whereas the exposure of the odd rows is started after `OddEvenDelay`. If `EnAutoOddEvenDelay` is set to 1 (True) then `OddEvenDelay` is automatically set to `ExposureTimeEven - ExposureTime`, resulting in the timing shown in Fig. 3.2. This minimizes the dark current as the image is read out immediately after exposure.

 If `EnEvenOdd` is set to 0 (False) then the exposure time of all rows is set by the property `ExposureTime`.

 `ExposureTimeEven` must not be smaller than `ExposureTime`.

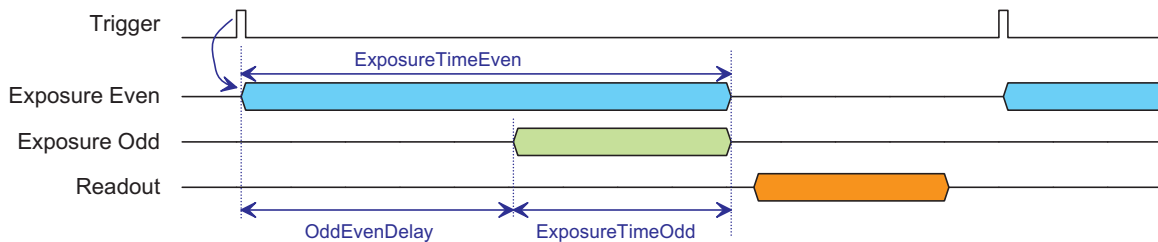


Figure 3.2: Even / odd exposure timing with `EnAutoOddEvenDelay=1` and sequential read out

An example with `EnAutoOddEvenDelay=0` (False) is shown in Fig. 3.3.

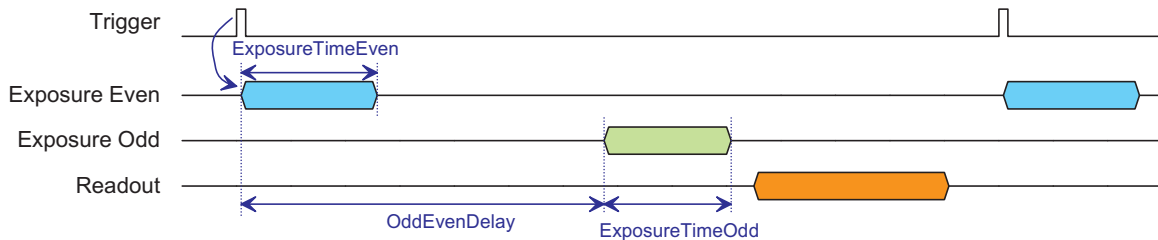


Figure 3.3: Example of even / odd exposure timing with `EnAutoOddEvenDelay=0` and sequential read out

3.3 Maximal frame rate

If `EnEvenOdd` is set to 1 (True) then the maximal frame rate can be calculated by the same formula as in the standard camera, replacing the exposure time by the term $\max(ExposureTimeEven, OddEvenDelay + ExposureTimeOdd)$

3.4 LinLog®

If EnEvenOdd is set to 1 (True) then all LinLog® properties can be set to different values for even and odd rows (see Table 3.1).

Odd rows	Even Rows (EnEvenOdd = '1')	Even Rows (EnEvenOdd = '0')
LinLog.Mode	LinLogEven.Mode	LinLog.Mode
LinLog.Value1	LinLogEven.Value1	LinLog.Value1
LinLog.Value2	LinLogEven.Value2	LinLog.Value2
LinLog.Time1	LinLogEven.Time1	LinLog.Time1
LinLog.Time2	LinLogEven.Time2	LinLog.Time2

Table 3.1: LinLog® properties in HD mode (GigE: dots '.' are replaced by underscores '_')



If EnEvenOdd is set to 0 (False) then the LinLog® values for odd rows are applied to all rows.

3.5 Digital Gain and Offset

FineGain and DigitalOffset can be set independently for odd and even rows (see Table 3.2).

Even rows	Odd Rows (EnEvenOdd = '1')	Odd Rows (EnEvenOdd = '0')
FineGain ¹⁾	FineGainOdd ²⁾	FineGain ¹⁾
DigitalGain	DigitalGain	DigitalGain
DigitalOffset	DigitalOffsetOdd	DigitalOffset

Table 3.2: Offset and gain properties in HD mode (Footnotes: ¹⁾in GigE cameras: set GainSelector to DigitalAll and set Gainproperty (in category AnalogControl). ²⁾in GigE cameras: set GainSelector to DigitalOdd and set Gainproperty.

3.6 Grey Level Transformation (LUT)

If EnEvenOdd is set to 1 (True) then the look-up table (LUT) for the odd rows is set independently of the LUT for even rows: LUT0 is applied to even rows and LUT1 to odd rows.



The RegionLUT feature of the standard cameras is not available in the HD cameras.



If EnEvenOdd is set to 0 (False) then LUT0 is applied to all rows.

References

All referenced documents can be downloaded from our website at www.photonfocus.com.

MAN044 User Manual MV1-D1312(IE) CameraLink® Series, Photonfocus

MAN049 User Manual MV1-D1312(IE)-G2 / DR1-D1312(IE)-G2 Gigabit Ethernet Series,
Photonfocus

4 References

Revision History

Revision	Date	Changes
1.0	May 2012	First version