

# User Manual



## Photonfocus User Manual Hyperspectral Series

CMOS camera with GigE interface

MV1-D2048x1088-HS01-96-G2-10

MV1-D2048x1088-HS02-96-G2-10

MV1-D2048x1088-HS03-96-G2-10

MV1-D2048x1088-HS04-96-G2-10

MV1-D2048x1088-HS05-96-G2-10

MV0-D2048x1088-C01-HS02-160-G2-10

MV0-D2048x1088-C01-HS03-160-G2-10

MAN068 10/2019 V1.3

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## Preface

### 1.1 IMPORTANT NOTICE!

READ THE INSTRUCTIONS FOR USE BEFORE  
OPERATING THE CAMERA

STORE THE INSTRUCTIONS FOR USE FOR  
FURTHER READING

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## 1.2 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.

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' 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.

## 1.3 Contact

Photonfocus AG, Bahnhofplatz 10, CH-8853 Lachen SZ, Switzerland

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Support	Phone: +41 55 451 00 00	Email: support@photonfocus.com

Table 1.1: Photonfocus Contact

## 1.4 Sales Offices

Photonfocus products are available through an extensive international distribution network and through our key account managers. Find your local Photonfocus contact at our homepage ([www.photonfocus.com](http://www.photonfocus.com)) or contact us via email at [sales@photonfocus.com](mailto:sales@photonfocus.com).

## 1.5 Further information



Photonfocus reserves the right to make changes to its products and documentation without notice. Photonfocus products are neither intended nor certified for use in life support systems or in other critical systems. The use of Photonfocus products in such applications is prohibited.



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Photonfocus can not be held responsible for any technical or typographical errors.

## 1.6 Legend

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



Important note, additional information



Important instructions



General warning, possible component damage hazard



Warning, electric shock hazard



Warning, fire hazard





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## Introduction

### 2.1 Overview

This manual describes the Photonfocus hyperspectral cameras that contain an image sensor with hyperspectral filters from IMEC.

### 2.2 Camera List

Table 2.1 shows the available Photonfocus hyperspectral cameras. Cameras based on other hyperspectral image sensors from IMEC are available upon request.

Name	IMEC Sensor	Filter Layout
MV1-D2048x1088-HS01-96-G2-10	CMV2K-LS100 NIR	Linescan Wedge
MV1-D2048x1088-HS02-96-G2-10	CMV2K-SM5x5	Snapshot Mosaic
MV1-D2048x1088-HS03-96-G2-10	CMV2k-SM4x4	Snapshot Mosaic
MV1-D2048x1088-HS04-96-G2-10	CMV2K-SM2x2 RGB+NIR	Snapshot Mosaic
MV1-D2048x1088-HS05-96-G2-10	CMV2K-LS150 VNIR	Linescan Wedge
MV0-D2048x1088-C01-HS02-160-G2-10	CMV2K-SM5x5	Snapshot Mosaic
MV0-D2048x1088-C01-HS03-160-G2-10	CMV2K-SM4x4	Snapshot Mosaic

Table 2.1: MV1-D2048 Hyperspectral Camera models

### 2.3 Functionality

The MV1-D2048x1088-HS cameras have the same functionality as the MV1-D2048x1088 version 3 cameras (see [MAN055] and Appendix A). This manual only describes topics that are not covered in these manuals.

Information about the hyperspectral filters are available in [TR\_hyperspectral\_sensors]. This publication can be obtained from Photonfocus if you purchased or loaned a Photonfocus MV1-D2048x1088-HS camera. Please mail a request to support@photonfocus.com and specify the serial number of your camera in the request.

### 2.3.1 MV1-D2048x1088-HS01 Region of Interest

The binning block is of special interest in the MV1-D2048x1088-HS01-96-G2-10 camera. A possible configuration to detect all the 128 bands on the whole sensor width is shown in Table 2.2. The advantage of using vertical binning is the high frame rate (see also Table 2.3) and the availability of only one value per band for every column.

There are possibilities to increase the frame rate even more:

- The "Multiple Regions of Interest (MROI)" feature can be used to choose only the bands of interest. Reading out fewer rows increases the frame rate in all pixel formats.
- Horizontal resolution can be reduced by choosing a smaller width or by using horizontal binning. Note that this does not increase the frame rate for pixel format Mono8 if BinningVertical=8 is used, as sensor is already read out at full speed. In all other pixel formats this increases the frame rate.



The property Height specifies the height at the image output. Example: BinningVertical=8 and Height=128: height of output image is 128; Height on sensor before binning is 1024 (8\*128). The MROI\_H and MROI\_Htot settings on the other hand, specify the height on the sensor before binning.

Property	Setting	Notes
OffsetX	0	Modify if not the whole sensor width is required
Width	2048	Modify if not the whole sensor width is required
OffsetY	36	First hyperspectral band filter starts at this row (see the calibration file for this information)
Height	128	Modify if not all bands are required
BinningHorizontal	1	Full horizontal resolution
BinningVertical	8	Combine the 8 rows of a band to one value

Table 2.2: Possible ROI setting of HS01 camera for full horizontal resolution

Width	Output Height	BinningVertical	Pixel Format	Max. Frame Rate
2048	1024	1	Mono8	45 fps
2048	1024	1	Mono12Packed	34 <sup>1)</sup> fps
2048	128	8	Mono8	358 fps
2048	128	8	Mono12Packed	274 <sup>1)</sup> fps
2048	128	8	Mono16	180 fps

Table 2.3: Maximal Frame Rate at minimal exposure time (Footnotes: <sup>1)</sup> max. frame rate to reach no more than 864 Mbit/s, adjust trigger frequency or set AcquisitionFrameRate accordingly (AcquisitionFrameRateEnable=True))

## 2.4 Sensor XML Files

The specifications of the hyperspectral filters are not exactly the same for every sensor due to variations in the production process. For every camera, there are corresponding XML files that detail the calibration values. The structure of the XML file is described in section 1.5.1 "Sensor calibration files" of [TR\_hyperspectral\_sensors] and in more detail in [TR\_hyperspectral\_calibration]. You should have received the calibration files corresponding to your camera by e-mail. If you have not received them then please request the files by sending an e-mail to support@photonfocus.com and specifying the serial number of the camera.



Accurate measurements can only be obtained if the information in the calibration file is taken into account.



The images of the camera are vertically flipped and therefore the calibration files can be applied without modification.

## 2.5 Lens and Filters

It is important that a suitable lens is used. The most important aspects of the lens choice are described in section 2.1 of [TR\_hyperspectral\_sensors].

Factors to consider are

- An appropriate anti-reflective coating: must have good transmission in the wavelength range of choice
- Lens should be image side telecentric
- F-number of the lens: use a small F-number (i.e. F/2.8) to improve the transmission and have an accurate spectrum.
- Small focus error in the sensor spectral range: apochromat or superapochromat lenses are most suitable

Rejection filters must be used to retain only the wavelengths in the sensor's active range used for hyperspectral imaging. The filters reduce the spectral leaking and they are needed to obtain the corrected reflectance values.

Examples of lenses and filters for all camera models can be found in the document [TR\_hyperspectral\_sensors] and some practices are listed here [How to get started]

## 2.6 Spectral and Reflectance Correction

The document [TR\_hyperspectral\_sensors] describes why second order harmonics are generated and how they can be corrected.



It is very important to remind that only after spectral correction, the images have absolute reflectance values.

The calibration process for the raw images is the following:

- Use the camera's XML correction file and select the rejection filters used to apply spectral correction correctly. Each set of rejection filters have an associated correction matrix that is used to compute the corrected 'virtual bands'.
- Get a dark reference at the images exposure time: the dark reference image is an image captured with the lens closed and that only contains bias noise.
- Get a white reference image: an image of a white uniform surface that reflects the light uniformly and it is used to maximize the dynamic range of the camera and characterize the system.



To help the user in the correction process of raw hyperspectral images, Photonfocus have developed an SDK for the Hyperspectral cameras. There is a document [HSI\_WIZARD], which guides users through the complete correction process. Also the document [HSI\_HOW\_TO\_GET\_STARTED] helps to get started.

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## Warranty

The manufacturer alone reserves the right to recognize warranty claims.

### 3.1 Warranty Terms

The manufacturer warrants to distributor and end customer that for a period of two years from the date of the shipment from manufacturer or distributor to end customer (the "Warranty Period") that:

- the product will substantially conform to the specifications set forth in the applicable documentation published by the manufacturer and accompanying said product, and
- the product shall be free from defects in materials and workmanship under normal use.

The distributor shall not make or pass on to any party any warranty or representation on behalf of the manufacturer other than or inconsistent with the above limited warranty set.

### 3.2 Warranty Claim



The above warranty does not apply to any product that has been modified or altered by any party other than manufacturer, or for any defects caused by any use of the product in a manner for which it was not designed, or by the negligence of any party other than manufacturer.



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## References

All referenced documents can be downloaded from our website at [www.photonfocus.com](http://www.photonfocus.com).

**GEVQS** GEVPlayer Quick Start Guide, Pleora Technologies. Included in eBUS installer.

**PFVIEWER\_QUICK\_START\_GUIDE** PFViewer Quick Start Guide.

**TR\_hyperspectral\_sensors** Technical report Hyperspectral Sensors Technology Overview. This report is located in the HyperSpectralSDK install directory (<install folder>\Photonfocus\HyperSpectralSDK\doc\technical reports\TR\_hyperspectral\_sensors.pdf)

**TR\_hyperspectral\_calibration** Technical report Hyperspectral Sensor Calibration Files. This report is located in the HyperSpectralSDK install directory (<install folder>\Photonfocus\HyperSpectralSDK\doc\technical reports\TR\_sensor\_calibration\_files.pdf)

**TR\_hyperspectral\_calibration\_change\_log** Technical report Hyperspectral Sensor Calibration Files Change Logs. This report is located in the HyperSpectralSDK install directory (<install folder>\Photonfocus\HyperSpectralSDK\doc\technical reports\TR\_sensor\_calibration\_files\_changelogs.pdf)

**TR\_speed\_synchronization** Technical report Speed Synchronization. This report is located in the HyperSpectralSDK install directory (<install folder>\Photonfocus\HyperSpectralSDK\doc\technical reports\TR\_speed\_synchronization.pdf)

**HSI\_USER\_GUIDE** Hyperspectral Imaging User Guide. This report is located in the HyperSpectralSDK install directory (<install folder>\Photonfocus\HyperSpectralSDK\doc\Hyperspectral Imaging.pdf)

**HSI\_HOW\_TO\_GET\_STARTED** Hyperspectral Imaging How to get started Best Practice. This report is located in the HyperSpectralSDK install directory (<install folder>\Photonfocus\HyperSpectralSDK\doc\Hyperspectral Imaging - How to get started.pdf)

**HSI\_WIZARD** Hyperspectral Imaging Wizard Reference Manual. This report is located in the HyperSpectralSDK install directory (<install folder>\Photonfocus\HyperSpectralSDK\doc\Hyperspectral Imaging - Wizard Manual.pdf)

**MAN051** Manual "Photonfocus GigE Quick Start Guide", Photonfocus

**MAN055** Manual "User Manual D/L-2048 Camera Series, CMOS camera with GigE interface", Photonfocus

**MAN078** Manual "User Manual MV0 CMOSIS Camera Series, CMOS camera series with GigE Interface", Photonfocus

**PLC** iPORT Programmable Logic Controller Reference Guide, Pleora Technologies. Included in GigE software package.

#### 4 References

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## Camera Revisions

### A.1 General Remarks

This chapter lists differences between the revisions of the camera models. The HS01/HS02 cameras have the same functionality as the standard V3 cameras.

List of terms used in this chapter:

**Standard Trigger** Standard trigger features. Trigger Source: Free running, Software Trigger, Line1 Trigger, PLC\_Q4 Trigger. Exposure Time Control: Camera-controlled, Trigger-controlled. Additional features: Trigger Delay, Burst Trigger and Strobe.

**Status Line V1.1** All fields of Status Line V1.0 plus additional fields: Encoder Position and Trigger Level. Values are sampled at the start of exposure.

**Counter Reset External** Reset of image counter and real time counter by an external signal.



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## Document Revision History

Revision	Date	Changes
1.0	May 2015	First version
1.1	August 2015	Reference to documents [IMEC_CAL] and [IMEC_SCORR] added
1.2	July 2017	Chapter "Lens and Filter" and camera calibration modified. Information for camera model HS03 added
1.3	October 2019	References modified, MV0 HSI series added