About EMVA1288

The EMVA1288 is a standard for the specification and measurement of machine vision sensors and cameras, which has a significant benefit for a CCD, CMOS or sCMOS camera user.

This standard was initiated by the European Machine Vision Association (EMVA)[1]. The initiative was launched to define a unified method to measure, compute and present specification parameters for cameras and image sensors used for machine vision applications, but it is not limited to machine vision association. It has also been further accepted by the American Automated Imaging Association (AIA)[2] and the Japanese Japan Industrial Imaging Association (JIIA)[3].

What is the reason for the EMVA1288 standard?

Choosing a suitable camera for a given imaging application often proves to be a challenging task. The data sheets provided by the manufacturers are difficult to compare. Frequently, vital pieces of information are not available and the user is forced to conduct a costly comparative test which still may fail to deliver all relevant camera parameters. This is where the EMVA 1288 Standard comes in. It creates transparency by defining reliable and exact measurement procedures as well as data presentation guidelines and makes the comparison of cameras and image sensors much easier.

The Standard is elaborated by a consortium of the industry leading sensor and camera manufacturers, distributers and component customers[4]. The Standard is organized in a modular approach. The first module was officially released by the working group member companies in August 2005. Since June 21st 2021 the Standard has been officially extended into two modules, a “Release 4.0 Linear” and a “Release 4.0 General”[5]. The “old” version is now continued in the Release Linear with improvements.

The EMVA1288 standard is continuously improved and missing topics are integrated. To understand how the information is presented and prepared for customers, it is relevant to have a look to the summary sheet of a digital camera. In the following a summary sheet compliant to the linear module of the standard is discussed.

[1] https://www.emva.org/
[2] https://www.visiononline.org/
[3] http://jiia.org/en/
[4] https://www.emva.org/standards-technology/emva-1288/emva-standard-1288-working-group-membership/
[5] https://www.emva.org/standards-technology/emva-1288/emva-standard-1288-downloads-2/

The EMVA1288 Summary Sheet

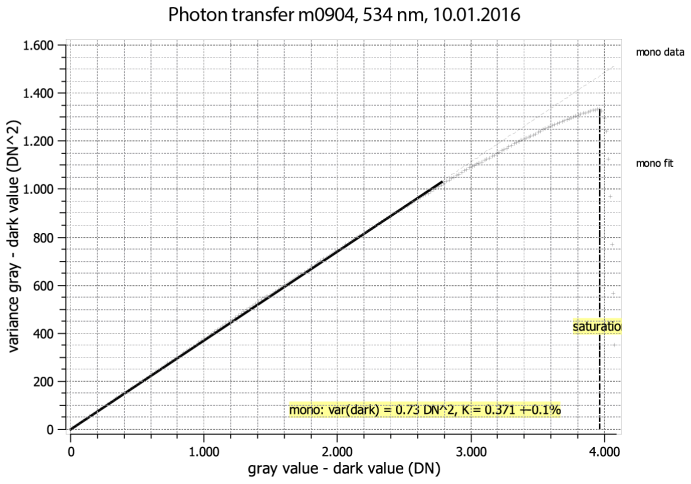
1288 EMVA Standard Compliant

Summary Sheet for Operating Point 1 at a Wavelength of 534 nm

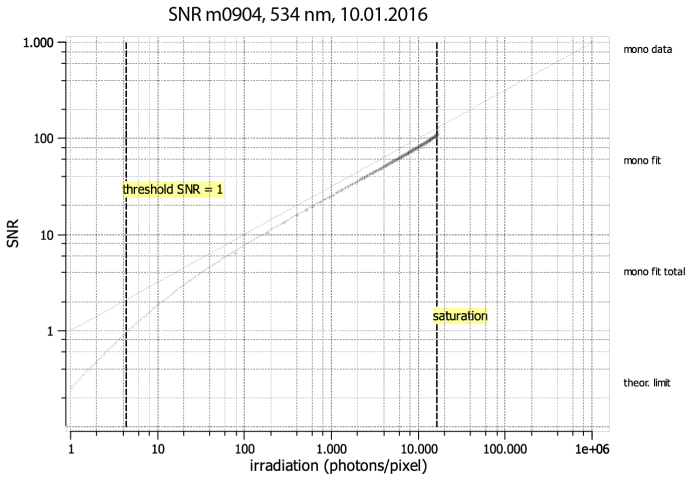
1

Type of data	Single	Gain, black-level	0.0 dB, 0.122
Exposure control	By irradiance	Environmental temperature	20.2° C
Exposure time	1.00 ms	Camera body temperature	30.6° C
Frame rate	38.9 Hz	Internal temperature(s)	—
Data transfer mode	Mono12Packed, Mode 7	Wavelength, centr., FWHM	534 nm, 31.3 nm

2a **Photon Transfer**



2b **Signal-to-Noise Ratio**



3

Quantum efficiency

η	65.2%

a

Overall system gain

K	0.371 DN/e$^-$
$1/K$	2.692 e$^-$ /DN

Temporal dark noise

σ_d	2.17 e$^-$
$\sigma_{y.dark}$	0.86 DN

Signal-to-noise ratio

SNR_{max}	103
	40.3 dB
	6.7 bit
$1/SNR_{max}$	0.97 %

Absolute sensitivity threshold

$\mu_{p.min}$	4.38 p
$\mu_{p.min.area}$	0.368 p/μm^2
$\mu_{e.min}$	2.86 e$^-$
$\mu_{e.min.area}$	0.240 e$^-$ /μm^2

b

Saturation capacity

$\mu_{p.sat}$	16421 p
$\mu_{p.sat.area}$	1380 p/μm^2
$\mu_{e.sat}$	10704 e$^-$
$\mu_{e.sat.area}$	899 e$^-$ /μm^2

c

Dynamic range

DR	3746
	71.5 dB
	11.9 bit

Spatial nonuniformities

$DSNU_{1288}$	0.76 e$^-$
	0.28 DN
$PRNU_{1288}$	0.48 %

Linearity error

LE_{min}	-0.30%
LE_{max}	0.13%

Dark current

$\mu_{c.mean}$	5.8 e$^-$ /s
	2.2 DN/s
$\mu_{c.var}$	6.0 e$^-$ /s
T_d	— ° C

Figure 1: The EMVA1288 summary sheet of a CMOS camera.

The summary data sheet as shown in figure 1 contains three mayor elements.

[1]: **Operating point:** Contains a complete description of the settings of the operating point at which the EMVA 1288 measurements have been acquired. Settings not specified are assumed to be in the factory default mode. If, for instance, the binning factor is not given, the camera was measured without binning. This ensures that the measurements can be repeated anytime under the same conditions.

[2] **Photon transfer and SNR curves:** The upper graph contains the photon transfer curve [2a], i.e., the variance of the image sensor noise versus the mean value. For an ideal linear camera this curve should be linear. Only if the lower 70% of the curve are linear, can the EMVA 1288 performance parameters be estimated accurately. If a camera has any type of deficiencies, these can often be first seen in the photon transfer curve. The double-logarithmic SNR curve [2b] is a nice overall graphical representation of all camera performance parameters except for the dark current. The absolute sensitivity threshold is marked as well as the saturation capacity. In addition, the maximum signal-to-noise ratio and the dynamic range can be read from the graph. The total SNR is plotted as a dashed line. It includes both the variances from the temporal noise and the nonuniformities. If this line lies recognizably below the solid line of the SNR curve, nonuniformities significantly reduce the performance of the camera.

[3] **EMVA 1288 performance parameters:** This column lists all EMVA 1288 performance parameters. Here only some aspects of the three most important are discussed:

[3a] **Quantum efficiency:** Denotes how efficiently a camera converts light into electric charges. Thus, if you have enough light in your application, this parameter is not critical. Be aware that this parameter requires an absolute calibration of the measuring equipment which is typically not more accurate than 3%. So differences in the quantum efficiencies between different data sheets in the range of a few percent are not significant and no decision criterion.

[3b] **Absolute sensitivity threshold:** Tells you the lowest light level the camera can detect. It is given in photons and in photons per area unit (µm²). The latter is important if you compare cameras with different pixel sizes because in most applications the irradiance (photons per time and area) at the image plane is given.

[3c] **Saturation capacity:** Gives the largest irradiation the camera can measure. It also determines the best possible signal quality you can get from an image sensor, the maximum signal-to-noise ratio.

These exemplary considerations clearly indicate how you can find the best camera for your application. Find out the most critical parameter by asking questions like: Do I have enough light? Do I have to see both dark and bright parts in the image with enough resolution? Do I have to detect slight intensity variations? Then take the corresponding EMVA 1288 parameters and compare.

Benefit for a camera users

In case a CCD, CMOS or sCMOS camera should be selected for a scientific application, the customer can ask the manufacturers for an EMVA1288 compliant data sheet, because these data sheets are at the moment the best possible way to compare the performance data of the variety of available cameras prior to an application. However, a demo testing will always give the final arguments for the correct camera system decision.