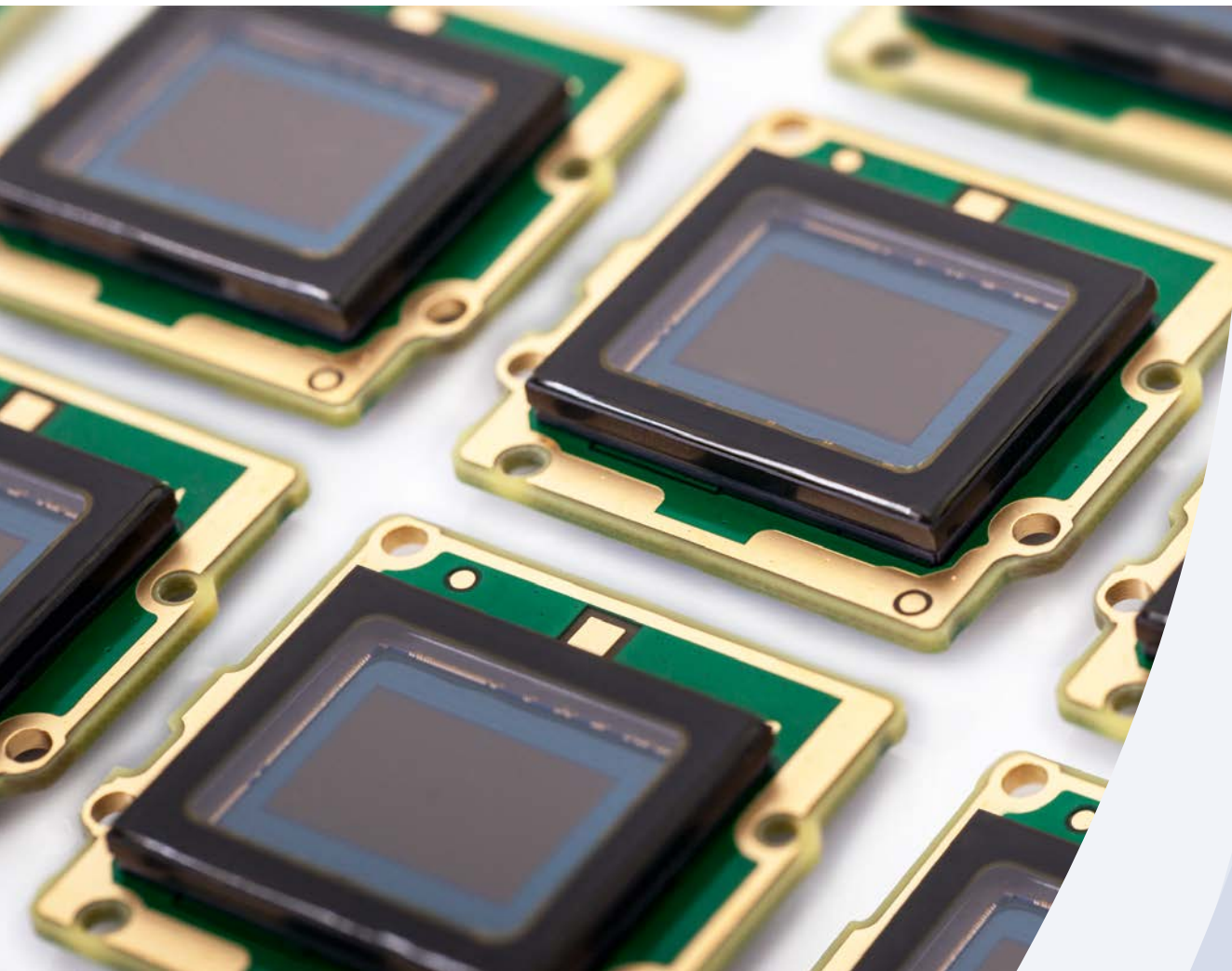


EMVA Data Overview

MONOCHROME AREA SCAN CAMERAS



1288 
EMVA Standard Compliant

BASLER 
the power of sight

The EMVA 1288 Standard has been developed by the European Machine Vision Association with the goal of standardizing image quality and sensitivity measurements for Machine Vision cameras and sensors. Based on this standard our cameras are tested and their EMVA data is generated. This document will give you an overview of the EMVA data of our cameras. Detailed measurement reports for each camera model can be downloaded from our website: www.baslerweb.com/emva-downloads

Functioning of a Sensor

The sensor is the heart of a camera and therefore its most important component. A sensor consists of pixels with photodiodes that convert energy of the incoming photons to an electrical charge which is then converted and processed to generate an image. Sensor or camera properties are described with different parameters. In the following explanation of the most common parameters, we use an example from bottle inspection.

Quantum Efficiency (QE) [%]

The incident photon to converted electron ratio is called quantum efficiency. The QE depends on the wavelength of the light. The bigger the number of electrons produced by a given number of photons, the higher the QE and the more information is available in an image. A high quantum efficiency is especially important in low light conditions.

Temporal Dark Noise [e-]

Even if no light hits the sensor, some electrons are captured by pixels and create a signal that is called dark noise. Those electrons result from the electronics that surround the sensor. The less dark noise, the better the signals can be detected.

Saturation Capacity [ke-]

The number of electrons a pixel can hold is limited and set by the saturation capacity. In a saturated pixel no more photons can be converted into electrons and thus image information is lost. In the example, the fill level of the bottle in fig. 4 is invisible as the saturation capacity of the camera is reached. At a shorter exposure time (fig. 3) the fill level is detectable but at the expense of the barcode visibility.



Fig. 1 Test Setup



Fig. 2 Camera A with good EMVA properties



Fig. 3 Camera B with inferior EMVA properties



Fig. 4 Camera B with longer exposure time

Dynamic Range [dB]

The ratio between maximum and minimum measurable light intensities is described as dynamic range. A high dynamic range is especially important when there are both dark and bright details in an image, or when light conditions are changing. A camera with a higher dynamic range is able to deliver more levels of grey in the images (fig. 2). Details such as barcodes, labels or the fill level can be inspected more accurately.

Signal to Noise Ratio (SNR) [dB]

The SNR compares the level of a desired signal to the level of background noise. In the overview on page 3 the best possible SNR is given.

The barcode example shows the image of a camera with high SNR (fig. 2) and one with lower SNR (fig. 3). For a better result, this camera needs a longer exposure time (fig. 4) or a more efficient illumination.

SENSOR OVERVIEW & EMVA DATA OF BASLER CAMERAS

Manufacturer	Sensor	Type	Shutter	Resolution	Pixel (H × V)	Pixel Size [μm]	Optical Size ["]	Series	Frame Rate USB / GigE / CL / IEEE 1394b				QE @ 545nm [%]	Dark Noise [e-]	Sat. Capacity [ke-]	Dynamic Range [dB]	Max. SNR [dB]
Sony	ICX204	CCD	global	XGA	1034 × 779	4.65	1/3	scout	-	-	-	30	43	10	13.0	62	41
	ICX267	CCD	global	1.4 MP	1392 × 1040	4.65	1/2	scout	-	17	-	17	42	10	11.0	60	40
	ICX274	CCD	global	2 MP	1626 × 1236	4.40	1/1.8	ace	20	20	-	-	50	10	8.4	58	39
								scout	-	14	-	14	51	8	9.0	61	40
								scout	-	28	-	28	51	12	9.2	58	40
	ICX285	CCD	global	1.4 MP	1390 × 1038	6.45	2/3	scout	-	17	-	-	58	8	19.0	68	43
	ICX409	CCD	global	CCIR	752 × 580	6.50	1/3	ace	-	30	-	-	56	14	34.2	68	45
								scout	-	79	-	74	37	21	24.2	61	44
	ICX414	CCD	global	VGA	659 × 494	9.90	1/2	ace	-	100	-	-	37	21	24.2	61	44
	ICX415	CCD	global	CCIR	782 × 582	8.30	1/2	scout	-	79	-	74	38	17	28.0	64	44
								ace	-	75	-	-	41	19	19.0	60	43
	ICX424	CCD	global	VGA	659 × 494	7.40	1/3	scout	-	55	-	58	42	17	21.0	62	43
								ace	90	90	-	-	45	13	14.8	62	42
	ICX445	CCD	global	1.3 MP	1296 × 966	3.75	1/3	scout	-	70	-	71	46	11	14.0	62	42
								ace	-	22	-	-	55	9	6.7	57	38
								scout	30	30	-	-	57	10	6.9	57	38
	ICX618	CCD	global	VGA	659 × 494	5.60	1/4	scout	-	32	-	32	54	9	7.0	58	38
								ace	120	120	-	-	62	12	17.8	64	43
	ICX625	CCD	global	5 MP	2456 × 2058	3.45	2/3	scout	-	122	-	122	60	12	13.5	61	41
								pilot	-	17	-	-	47	13	7.0	55	38
	IMX174	CMOS	global	2.3 MP	1920 × 1200	5.86	1/1.2	ace	164	50	-	-	70	7	31.7	74	45
	IMX178	CMOS	rolling	6 MP	3088 × 2064	2.4	1/1.8	ace	59	16	-	-	81	3	14.3	73	42
	IMX226	CMOS	rolling	12 MP	4024 × 3036	1.85	1/1.7	ace	31	8	-	-	80	3	11.0	71	40
	IMX249	CMOS	global	2.3 MP	1920 × 1200	5.86	1/1.2	ace	41	42	-	-	70	7	32.8	74	45
	IMX250	CMOS	global	5 MP	2448 × 2048	3.45	2/3	ace	75	-	-	-	70	2	10.6	73	40
	IMX252	CMOS	global	3 MP	2048 × 1536	3.45	1/1.8	ace	120	-	-	-	70	2	10.6	73	40
	IMX253	CMOS	global	12 MP	4096 × 3000	3.45	1.1	ace	30	-	-	-	70	2	10.4	73	40
	IMX255	CMOS	global	9 MP	4096 × 2160	3.45	1	ace	40	-	-	-	70	2	10.6	73	40
	IMX264	CMOS	global	5 MP	2448 × 2048	3.45	2/3	ace	35	20	-	-	68	2	10.6	73	40
	IMX265	CMOS	global	3 MP	2048 × 1536	3.45	1/1.8	ace	55	35	-	-	70	2	10.5	73	40
	IMX267	CMOS	global	9 MP	4096 × 2160	3.45	1	ace	30	12	-	-	70	2	10.3	73	40
	IMX304	CMOS	global	12 MP	4096 × 3000	3.45	1.1	ace	20	8	-	-	70	2	10.4	73	40

Please note that only monochrome area scan cameras are listed in this overview. Specifications are subject to change without notice.
All measurements have been taken at 545 nm.

SENSOR OVERVIEW & EMVA DATA OF BASLER CAMERAS

Manufacturer	Sensor	Type	Shutter	Resolution	Pixel (H × V)	Pixel Size [µm]	Optical Size ["]	Series	Frame Rate USB / GigE / CL / IEEE 1394b				QE @ 545nm [%]	Dark Noise [e-]	Sat. Capacity [ke-]	Dynamic Range [dB]	Max. SNR [dB]
CMOSIS	CMV2000	CMOS	global	2 MP	2048 × 1088	5.50	2/3	ace	165	50	340	-	63	14	9.0	57	40
	CMV2000 NIR-enhanced	CMOS	global	2 MP	2048 × 1088	5.50	2/3	ace	165	50	340	-	64	14	12.0	58	41
	CMV4000	CMOS	global	4 MP	2048 × 2048	5.50	1	ace	90	25	180	-	62	14	12.0	59	41
	CMV4000 NIR-enhanced	CMOS	global	4 MP	2048 × 2048	5.50	1	ace	90	25	180	-	62	14	12.0	59	41
	CMV12000	CMOS	global	12 MP	4096 × 3072	5.50	1.75	beat	-	-	62	-	45	14	12.0	59	41
ON Semi-conductor	KAI-0340	CCD	global	VGA	648 × 488	7.40	1/3	pilot	-	210	-	-	46	23	17.0	57	42
	KAI-1020	CCD	global	1 MP	1004 × 1004	7.40	2/3	pilot	-	48	-	-	35	38	24.0	56	44
									-	60	-	-	36	44	25.0	55	44
	KAI-1050	CCD	global	1 MP	1024 × 1024	5.50	1/2	aviator	-	101	120	-	39	12	18.0	64	43
	KAI-2020	CCD	global	2 MP	1608 × 1208	7.40	1	pilot	-	35	-	-	44	22	20.0	59	43
	KAI-2050	CCD	global	2 MP	1600 × 1200	5.50	2/3	aviator	-	55	67	-	40	12	18.5	64	43
	KAI-2093	CCD	global	2 MP	1928 × 1084	7.40	1	pilot	-	32	-	-	36	26	22.3	59	44
	KAI-2150	CCD	global	2 MP	1920 × 1080	5.50	2/3	aviator	-	51	62	-	40	12	18.5	64	43
	KAI-4050	CCD	global	4 MP	2330 × 1750	5.50	1	aviator	26	-	-	-	40	13	18.9	64	43
	MT9J003	CMOS	rolling	10 MP	3840 × 2748	1.67	1/2.3	ace	14	10	-	-	46	6	2.8	54	34
	MT9P031	CMOS	rolling	2 MP	1920 × 1080	2.20	1/3.7	ace	25	25	-	-	57	6	6.7	60	38
				5 MP	2592 × 1944	2.20	1/2.5	ace	14	14	-	-	57	6	6.7	60	38
	MT9V022	CMOS	global	VGA	752 × 480	6.00	1/3	scout	-	64	-	64	42	27	6.0	47	38
	PYTHON 300	CMOS	global	VGA	640 × 480	4.80	1/4	ace	751	376	-	-	54	11	7.7	57	39
	PYTHON 500	CMOS	global	CCIR	800 × 600	4.80	1/3.6	ace	511	240	-	-	54	11	7.8	57	39
	PYTHON 1300	CMOS	global	1.3 MP	1280 × 1024	4.80	1/2	ace	203	88	-	-	55	11	7.8	57	39
	PYTHON 2000	CMOS	global	2.3 MP	1920 × 1200	4.80	2/3	ace	150	50	-	-	54	11	7.8	57	39
	PYTHON 5000	CMOS	global	5 MP	2590 × 2048	4.80	1	ace	60	21	-	-	55	11	8.2	57	39
e2V	EV76C560	CMOS	rolling switchable	1.3 MP	1282 × 1026	5.30	1/1.8	ace	-	60	-	-	55	10	10.0	60	40
				1.3 MP	1282 × 1026	5.30	1/1.8	ace	-	60	-	-	54	25	10.0	52	40
	EV76C570	CMOS	switchable	2 MP	1602 × 1202	4.50	1/1.8	ace	-	60	-	-	47	22	7.0	50	38
	EV76C661	CMOS	switchable	1.3 MP	1280 × 1024	5.30	1/1.8	ace	-	60	-	-	59	23	7.0	50	39

Please note that only monochrome area scan cameras are listed in this overview. Specifications are subject to change without notice.
All measurements have been taken at 545 nm.

WHICH SENSOR IS FEATURED IN WHICH BASLER CAMERA?

Sony

Sensor	Camera
ICX204	scA1000-30fm
ICX267	scA1390-17fm scA1390-17gm
ICX274	acA1600-20gm acA1600-20um scA1600-14fm scA1600-14gm scA1600-28fm scA1600-28gm
ICX285	scA1400-17gm scA1400-30fm scA1400-30gm
ICX409	acA750-30gm
ICX414	acA645-100gm scA640-74fm scA640-74gm
ICX415	acA780-75gm scA780-54fm scA780-54gm
ICX424	acA640-90gm acA640-90um scA640-70fm scA640-70gm
ICX445	acA1300-22gm acA1300-30gm acA1300-30um scA1300-32gm
ICX618	acA640-120gm acA640-120um
ICX625	piA2400-17gm
IMX174	acA1920-50gm acA1920-155um
NEW IMX178	acA3088-16gm acA3088-57um
NEW IMX226	acA4024-8gm acA4024-29um
IMX249	acA1920-40gm acA1920-40um

Sony

Sensor	Camera
IMX250	acA2440-75um
IMX252	acA2040-120um
NEW IMX253	acA4112-30um
NEW IMX255	acA4096-40um
IMX264	acA2440-20gm acA2440-35um
IMX265	acA2040-35gm acA2040-55um
NEW IMX267	acA4096-11gm acA4096-30um
NEW IMX304	acA4112-8gm acA4112-20um

CMOSIS

Sensor	Camera
CMV2000	acA2000-165um acA2000-340km acA2000-50gm
CMV4000	acA2040-180km acA2040-25gm acA2040-90um
CMV2000 NIR	acA2000-165umNIR acA2000-340kmNIR acA2000-50gmNIR
CMV4000 NIR	acA2040-180kmNIR acA2040-25gmNIR acA2040-90umNIR
CMV12000	beA4000-62km

ON Semiconductor

Sensor	Camera
KAI-0340	piA640-210gm
KAI-1020	piA1000-48gm piA1000-60gm
KAI-1050	avA1000-100gm avA1000-120km
KAI-2020	piA1600-35gm
KAI-2050	avA1600-50gm avA1600-65km
KAI-2093	piA1900-32gm
KAI-2150	avA1900-50gm avA1900-60km
KAI-4050	avA2300-25gm avA2300-30km
MT9J003	acA3800-10gm acA3800-14um
MT9P031	acA1920-25gm acA1920-25um acA2500-14gm acA2500-14um
MT9V022	scA750-60fm scA750-60gm

ON Semiconductor

Sensor	Camera
PYTHON 300	acA640-750um acA640-300gm
PYTHON 500	acA800-510um acA800-200gm
PYTHON 1300	acA1300-200um acA1300-75gm
PYTHON 2000	acA1920-150um acA1920-48gm
PYTHON 5000	acA2500-60um acA2500-20gm

e2V

Sensor	Camera
EV76C560	acA1280-60gm acA1300-60gm
EV76C570	acA1600-60gm
EV76C661	acA1300-60gmNIR

How to Read Our Camera Model Names

ac	A	2040	180	k	m	NIR
Model ac = ace av = aviator pi = pilot sc = scout be = Basler beat	Type A = Area Scan L = Line Scan	Resolution Horizontal pixels	Frame Rate Number of frames per second (fps) at full AOI	Interface k = CL g = GigE u = USB 3.0 f = IEEE 1394b	Color m = mono c = color	Spectrum NIR = Near Infrared

OTHER INFORMATION

How Does Basler Measure and Define Image Quality?



Basler is leading the effort to standardize image quality and sensitivity measurement for cameras and sensors. We are giving the EMVA 1288 standard our strongest support because it describes a unified method to measure, compute, and present the specification parameters for cameras and image sensors. Our cameras are characterized and measured in 100% compliance with the EMVA 1288 standard. Measurement reports can be downloaded from our website.

How Does Basler Ensure Superior Quality and Reliable High Performance?

Our approach to quality assurance is rigorous: we continually audit all facets of our business to ensure powerful performance, increase efficiency and reduce costs for our customers. We are compliant with all major quality standards including ISO 9001, CE, RoHS, and more. To ensure consistently high product quality, we employ several quality inspection procedures during manufacturing.

Every Basler camera is subjected to exhaustive optical and mechanical tests before leaving the factory. We have developed a unique combination of optics, hardware, and software tools that can quickly and efficiently calibrate a camera and measure its performance against a set of standard performance criteria. Regardless of what technology or camera model you choose you can be assured of consistent performance.

3-Year Warranty

Basler offers a 3-year warranty for their cameras and the Basler Lenses 1/2.5". We make this unprecedented promise because we have unparalleled confidence in our products. We continually reinvest in research, development and superior manufacturing capabilities so that our customers can fully rely on the products we manufacture.

About Basler

Basler is a leading manufacturer of high-quality digital cameras and accessories for industry, medicine, traffic and a variety of other markets. The company's product portfolio encompasses area scan and line scan cameras in compact housing dimensions, camera modules in board-level variants for embedded solutions, and 3D cameras. The catalog is rounded off by our user-friendly pylon SDK and a broad spectrum of accessories, including a number developed specially for Basler and optimally harmonized for our cameras.

Basler has 30 years of experience in computer vision. The company is home to approximately 500 employees at its headquarters in Ahrensburg, Germany, and its subsidiaries and sales offices in Europe, Asia and the USA.



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