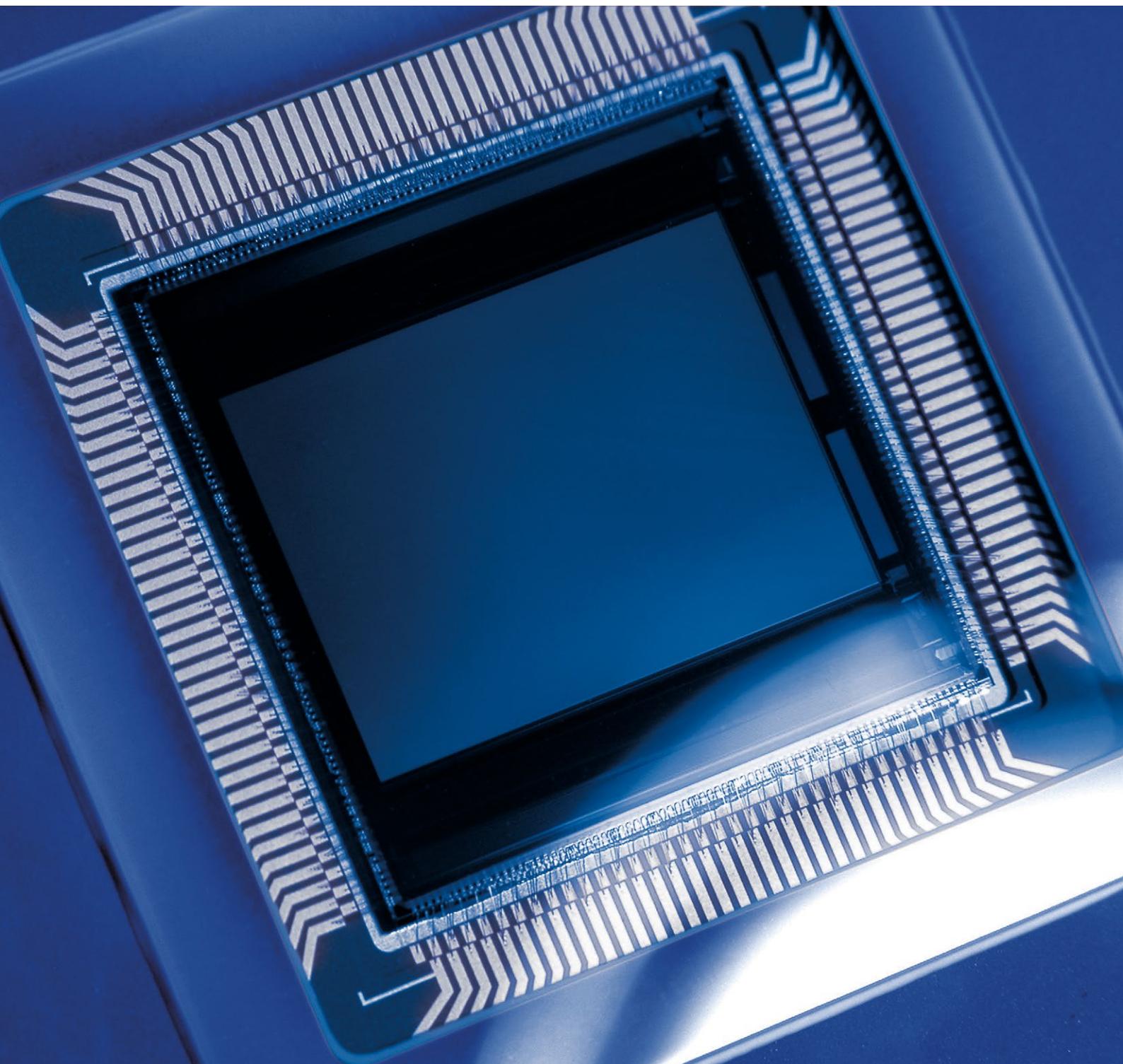


EMVA DATA OVERVIEW

MONOCHROME AREA SCAN CAMERAS



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: 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 measured with different parameters. For 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 clearer the image and the better the signals can be detected.

Saturation Capacity [ke-]

The number of electrons a pixel can hold is limited and given 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.

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 as barcodes, labels or the bottle cap 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 the following pages 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.



Fig. 1 Test Setup

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.



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.

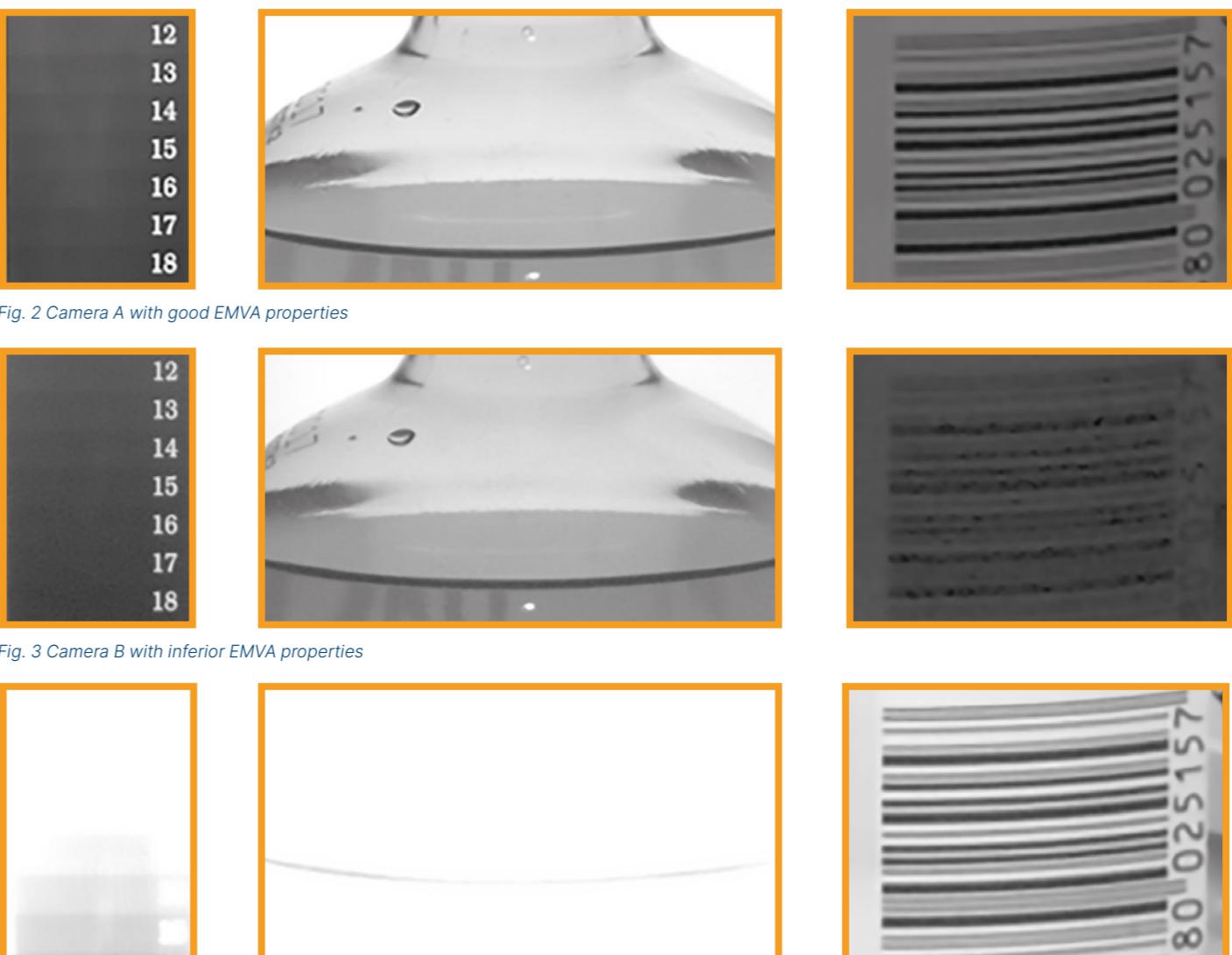


Fig. 2 Camera A with good EMVA properties



Fig. 3 Camera B with inferior EMVA properties

Fig. 4 Camera B with longer exposure time

SENSOR OVERVIEW & EMVA DATA OF BASLER CAMERAS

SENSOR	TYPE	SHUTTER	RESOLUTION [MP]	PIXEL [H × V]	PIXEL SIZE [µm]	OPTICAL SIZE ["]	SERIES	USB		FRAME RATE [fps]	GIGE		5GIGE		CXP-12	QE [%]	DARK NOISE [e ⁻]	SAT. CAPACITY [ke ⁻]	DYNAMIC RANGE [dB]	MAX. SNR [dB]
Sony																				
ICX618 Replacement	CMOS	global	VGA	659 × 494	5.6	1/4	ace	–	134	–	–	–	63	5	28.0	75	45			
IMX174	CMOS	global	2.3	1920 × 1200	5.86	1/1.2	ace	164	50	–	–	70	7	31.8	74	45				
IMX178	CMOS	rolling	6	3088 × 2064	2.4	1/1.8	ace	59	16	–	–	81	3	14.3	73	42				
IMX183	CMOS	rolling	20	5472 × 3648	2.4	1	ace	17	5	–	–	75	3	13.8	71	41				
IMX226	CMOS	rolling	12	4024 × 3036	1.85	1/1.7	ace	31	8	–	–	83	3	11.0	70	40				
IMX249	CMOS	global	2.3	1920 × 1200	5.86	1/1.2	ace	41	42	–	–	70	7	31.9	74	45				
IMX250	CMOS	global	5	2448 × 2048	3.45	2/3	ace ace 2	75 –	– –	– 98	–	68	2	10.7	73	40				
IMX252	CMOS	global	3	2048 × 1536	3.45	1/1.8	ace	120	–	–	–	69	2	10.5	73	40				
IMX253	CMOS	global	12	4096 × 3000	3.45	1.1	ace boost	30 –	– –	– –	68	70	2	10.5	73	40				
IMX255	CMOS	global	9	4096 × 2160	3.45	1	ace boost	40 –	– –	– –	93	70	2	10.5	73	40				
IMX264	CMOS	global	5	2448 × 2048	3.45	2/3	ace	35	20	–	–	68	2	10.4	73	40				
IMX265	CMOS	global	3	2048 × 1536	3.45	1/1.8	ace	55	35	–	–	68	2	10.5	73	40				
IMX267	CMOS	global	9	4096 × 2160	3.45	1	ace	30	12	–	–	69	2	10.2	73	40				
IMX273	CMOS	global	1.6	1440 × 1080	3.45	1/2.9	ace	227	73	–	–	63	3	10.5	71	40				
IMX287	CMOS	global	VGA	720 × 540	6.9	1/2.9	ace	525	291	–	–	63	7	21.0	74	43				
IMX304	CMOS	global	12	4096 × 3000	3.45	1.1	ace	20	8	–	–	69	2	10.2	73	40				
IMX334	CMOS	rolling	5 8.3	2592 × 1944 3840 × 2160	2.0 2.0	1/2.8 1/1.8	ace 2 ace 2	60 45	22 13	–	–	73	2	7.2	69	39				
IMX392	CMOS	global	2.3	1920 × 1200	3.45	1/2.3	ace 2	160	51	168	–	62	3	10.5	72	40				
IMX421	CMOS	global	3	1936 × 1464	4.5	2/3	boost	–	–	–	400	69	6	24.6	72	44				
IMX530	CMOS	global	24.4	5328 × 4608	2.74	1.2	boost	–	–	–	100	66	2	9.6	71	40				
IMX531	CMOS	global	20	4504 × 4504	2.74	1.1	boost	–	–	–	100	67	2	9.7	71	40				
IMX532	CMOS	global	16.1	5320 × 3032	2.74	1.1	boost	–	–	–	150	65	2	9.6	71	40				
IMX535	CMOS	global	12	4096 × 3000	2.74	1/1.1	boost	–	–	–	180	66	3	10	70	40				
IMX536	CMOS	global	8	2832 × 2840	2.74	2/3	boost	–	–	–	190	66	3	9.6	70	40				
IMX537	CMOS	global	5	2448 × 2048	2.74	1/1.8	ace 2 boost	– –	– –	– –	212 250	66	3	9.8	70	40				
IMX540	CMOS	global	24.4	5328 × 4608	2.74	1.2	ace 2	15	4	22	35	66	2	9.7	71	40				
IMX541	CMOS	global	20.2	4504 × 4504	2.74	1.1	ace 2	18	5	27	42	66	2	9.7	71	40				
IMX542	CMOS	global	16.1	5320 × 3032	2.74	1.1	ace 2	23	7	34	52	66	2	9.7	71	40				
IMX545	CMOS	global	12.3	4096 × 3000	2.74	1/1.1	ace 2	30	9	44	67	67	3	9.9	70	40				
IMX546	CMOS	global	8	2840 × 2840	2.74	2/3	ace 2	48	14	67	86	66	2	9.8	70	40				
IMX547	CMOS	global	5	2448 × 2048	2.74	1/1.8	ace 2	75	23	106	122	66	2	9.9	70	40				
IMX676	CMOS	rolling	12.5	3536 × 3536	2	1/1.6	ace 2	31	9	42	–	92	4	11.2	68	40				

Please note that only monochrome area scan cameras are listed in this overview. Specifications are subject to change without notice.

SENSOR OVERVIEW & EMVA DATA OF BASLER CAMERAS

SENSOR	TYPE	SHUTTER	RESOLUTION [MP]	PIXEL [H × V]	PIXEL SIZE [µm]	OPTICAL SIZE ["]	SERIES	USB	FRAME RATE [fps]	GIGE	5GIGE	CXP-12	CL	QE [%]	DARK NOISE [e-]	SAT. CAPACITY [ke-]	DYNAMIC RANGE [dB]	MAX. SNR [dB]
ams																		
CMV2000	CMOS	global	2	2048 × 1088	5.50	2/3	ace	165	50	–	340	–	63	14	9.3	57	40	
CMV4000	CMOS	global	4	2048 × 2048	5.50	1	ace	90	25	–	180	–	62	14	11.9	59	41	
CMV4000 NIR-enhanced	CMOS	global	4	2048 × 2048	5.50	1	ace	90	25	–	180	–	62	14	12.4	59	41	
CMV12000	CMOS	global	12	4096 × 3072	5.50	1.75	beat	–	–	–	–	62	45	14	11.6	59	41	
e2v																		
EV76C560	CMOS	rolling switchable	1.3	1282 × 1026	5.30	1/1.8	ace	–	60	–	–	–	55	10	9.5	60	40	
			1.3	1282 × 1026	5.30	1/1.8	ace	–	60	–	–	–	54	25	9.5	52	40	
EV76C570	CMOS	switchable	2	1602 × 1202	4.50	1/1.8	ace	–	60	–	–	–	47	22	6.8	50	38	
EV76C661 NIR-enhanced	CMOS	switchable	1.3	1280 × 1024	5.30	1/1.8	ace	–	60	–	–	–	59	23	7.4	50	39	
onsemi																		
MT9J003	CMOS	rolling	10	3840 × 2748	1.67	1/2.3	ace	14	10	–	–	–	46	6	2.8	54	34	
MT9P031	CMOS	rolling	2	1920 × 1080	2.20	1/3.7	ace	25	25	–	–	–	57	6	6.7	60	38	
			5	2592 × 1944	2.20	1/2.5	ace	14	14	–	–	–	57	6	6.7	60	38	
PYTHON 300	CMOS	global	VGA	640 × 480	4.80	1/4	ace	751	376	–	–	–	52	11	7.1	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	1280 × 1024	4.80	1/2	ace	203	88	–	–	–	53	11	6.9	56	38	
PYTHON 2000	CMOS	global	2.3	1920 × 1200	4.80	2/3	ace	150	50	–	–	–	54	11	7.8	57	39	
PYTHON 5000	CMOS	global	5	2590 × 2048	4.80	1	ace	60	21	–	–	–	55	12	8.2	57	39	
XGS 20000	CMOS	global	20	4500 × 4500	3.2	1.3	boost	–	–	–	45	–	55	4	9.2	66	40	
XGS 32000	CMOS	global	32.4	6580 × 4935	3.2	APS-C	boost	–	–	–	35	–	57	4	9.3	66	40	
XGS 45000	CMOS	global	44.7	8192 × 5460	3.2	35 mm	boost	–	–	–	15	–	55	5	9.0	65	40	
Gpixel																		
GMAX0505	CMOS	global	25	5120 × 5120	2.5	1.1	boost	–	–	–	150	–	51	4	4.3	60	36	
GMAX2505	CMOS	global	5.6	2600 × 2160	2.5	1/2	ace 2	64	20	–	–	–	53	1	4.8	70	37	
GMAX2509	CMOS	global	9.1	4200 × 2160	2.5	2/3	ace 2	12	40	–	–	–	53	1	4.6	69	37	
GMAX2518	CMOS	global	18	4508 × 4096	2.5	1	ace 2	20	6	–	–	–	56	3	6.7	66	38	
GMAX3265	CMOS	global	65	9344 × 7000	3.2	2.3	boost	–	–	–	30 or 70	–	52	8	10.4	61	40	
GSPRINT4521	CMOS	global	21	5120 × 4096	4.5	APS-C	boost	–	–	–	230	–	53	33	31.6	59	45	

Please note that only monochrome area scan cameras are listed in this overview. Specifications are subject to change without notice.

The **UV sensor** listed below should not be directly compared to other CMOS sensors since it is sensitive in another spectral range.

If you have any questions, please contact our sales team: baslerweb.com/sales.

SENSOR	TYPE	SHUTTER	RESOLUTION [MP]	PIXEL [H × V]	PIXEL SIZE [µm]	OPTICAL SIZE ["]	SERIES	USB	FRAME RATE [fps]	GIGE	5GIGE	CXP-12	QE [%]	DARK NOISE [e-]	SAT. CAPACITY [ke-]	DYNAMIC RANGE [dB]	MAX. SNR [dB]
Sony																	
IMX487	CMOS	global	8.1	2856 × 2848	2.74	2/3	ace 2	48	14	67	–	51	3	9.9	70	40	

Contrary to the requirements of the EMVA1288 standard, the wavelength of 541 nm may not meet the sensitivity maximum for sensors that are also sensitive outside the visible spectral range.

SENSOR	TYPE	SHUTTER	RESOLUTION [MP]	PIXEL [H × V]	PIXEL SIZE [µm]	OPTICAL SIZE ["]	SERIES	USB	FRAME RATE [fps]	GIGE	5GIGE	CXP-12	QE [%]	DARK NOISE [e-]	SAT. CAPACITY [ke-]	DYNAMIC RANGE [dB]	MAX. SNR [dB]
Basler specific																	
E2525A	CMOS	global	25	5060 × 5060	2.5	1.1	ace 2	15	4	21	35	66	3	8.1	68	39	

Please note that only monochrome area scan cameras are listed in this overview. Specifications are subject to change without notice.

WHICH SENSOR IS FEATURED IN WHICH BASLER CAMERA?

SONY	SONY	SONY	E2V
ICX618 Replacement acA640-121gm	IMX392 a2A1920-51gmBAS/PRO	IMX676 a2A3536-9gmBAS/PRO	EV76C560 acA1280-60gm
IMX174 acA1920-50gm	a2A1920-160umBAS/PRO	a2A3536-31umBAS/PRO	acA1300-60gm
aca1920-155um	a2A1920-165g5mBAS	a2A3536-42g5mBAS	EV76C570 acA1600-60gm
IMX178 acA3088-16gm	IMX421 boA1936-400cm	SONY UV	EV76C661 acA1300-60gmNIR
aca3088-57um	IMX530 boA5328-100cm	IMX487 a2A2840-14gmUV	
IMX183 acA5472-5gm	IMX531 boA4504-100cm	a2A2840-48umUV	
aca5472-17um	IMX532 boA5320-150cm	a2A2840-67g5mUV	
IMX226 acA4024-8gm	IMX535 boA4096-180cm	BASLER SPECIFIC	
aca4024-29um	IMX536 boA2832-190cm	E2525A a2A5060-4gmBAS	MT9J003 acA3800-10gm
IMX249 acA1920-40gm	IMX537 boA2448-250cm	a2A5060-15umBAS	acA3800-14um
aca1920-40um	IMX540 a2A5328-4gmBAS/PRO	a2A5060-21g5mBAS	MT9P031 acA1920-25gm
IMX250 acA2440-75um	IMX541 a2A5328-15umBAS/PRO	a2A5060-35cm	acA1920-25um
aca2440-98g5mBAS	IMX542 a2A5328-22g5mBAS	AMS	acA2500-14gm
IMX252 acA2040-120um	IMX543 a2A5328-35cm	CMV2000 acA2000-165um	acA2500-14um
IMX253 acA4112-30um	IMX544 a2A4504-5gmBAS/PRO	PYTHON 300 acA640-750um	PYTHON 300 acA640-300gm
boA4112-68cm	IMX545 a2A4504-18umBAS/PRO	acA2000-340km	
IMX255 acA4096-40um	IMX546 a2A4504-27g5mBAS	acA2000-50gm	PYTHON 500 acA800-510um
boA4096-93cm	IMX547 a2A4504-42cm	CMV4000 acA2040-180km	acA800-200gm
IMX264 acA2440-20gm	IMX548 a2A5320-7gmBAS/PRO	acA2040-25gm	PYTHON 1300 acA1300-200um
aca2440-35um	IMX549 a2A5320-23umBAS/PRO	acA2040-90um	acA1300-75gm
IMX265 acA2040-35gm	IMX550 a2A5320-34g5mBAS	CMV4000 NIR acA2040-180kmNIR	PYTHON 2000 acA1920-150um
aca2040-55um	IMX551 a2A5320-52cm	acA2040-44g5mBAS	acA1920-48gm
IMX267 acA4096-11gm	IMX552 a2A4096-9gmBAS/PRO	GPIXEL	PYTHON 5000 acA2500-60um
aca4096-30um	IMX553 a2A4096-30umBAS/PRO	GMAX0505 boA5120-150cm	acA2500-20gm
IMX273 acA1440-73gm	IMX554 a2A4096-44g5mBAS	GMAX2505 a2A2600-20gmBAS/PRO	XGS 20000 boA4500-45cm
aca1440-220um	IMX555 a2A4096-67cm	a2A2600-64umBAS/PRO	XGS 32000 boA6500-36cm
IMX287 acA720-290gm	IMX556 a2A2840-14gmBAS/PRO	GMAX2509 a2A4200-12gmBAS/PRO	GMAX4500 boA8100-16cm
aca720-520um	IMX557 a2A2840-48umBAS/PRO	a2A4200-40umBAS/PRO	
IMX304 acA4112-8gm	IMX558 a2A2840-67g5mBAS	GMAX2518 a2A4508-6gmBAS/PRO	
aca4112-20um	IMX559 a2A2448-23gmBAS/PRO	a2A4508-20umBAS/PRO	
IMX334 a2A2590-22gmBAS/PRO	IMX560 a2A2448-75umBAS/PRO	GMAX3265 boA9344-30cm	
a2A2590-60umBAS/PRO	IMX561 a2A2448-105g5mBAS	boA9344-70cm	
a2A3840-13gmBAS/PRO	IMX562 a2A2448-120cm	GSPRINT4521 boA5120-230cm	
a2A3840-45umBAS/PRO			

OTHER INFORMATION

About Basler

Basler AG is an international leader and experienced expert in computer vision. The company offers a broad coordinated portfolio of vision hardware and software. In addition, it enables customers to solve their vision application issues by developing customer-specific products or solutions. Founded in 1988, the Basler Group employs around 850 people at its headquarters in Ahrensburg, Germany, as well as other sales and development locations throughout Europe, Asia, and North America.



How to Read Our Camera Model Names

ac	A	2040	180	k	m	NIR
Model	Type	Resolution	Frame Rate	Interface	Color	Spectrum
a2 = ace 2	A = Area scan	Horizontal pixels	Number of frames per second (fps) at full AOI	k = CL	m = mono	NIR = Near Infrared
ac = ace	L = Line scan			c = CoaXPress	c = color	SWIR = Short Wavelength Infrared
bo = boost				g = GigE		UV = Ultraviolet
da = dart				g5 = 5GigE		
dm = dart M				u = USB 3.0		
pu = pulse				m = BCON for MIPI		
ra = racer						
r2 = racer 2						

Specifications are subject to change without notice.

©Basler AG • No. 16 • 12/2024 • ID 2200000136

Basler AG
Germany, Headquarters
Tel. +49 4102 463 500
sales.europe@baslerweb.com

Basler, Inc.
USA
Tel. +1 610 280 0171
sales.usa@baslerweb.com

Basler Asia Pte Ltd.
Singapore
Tel. +65 6367 1355
sales.asia@baslerweb.com

Please visit our website to find further Basler offices and representatives close to you: baslerweb.com/sales

