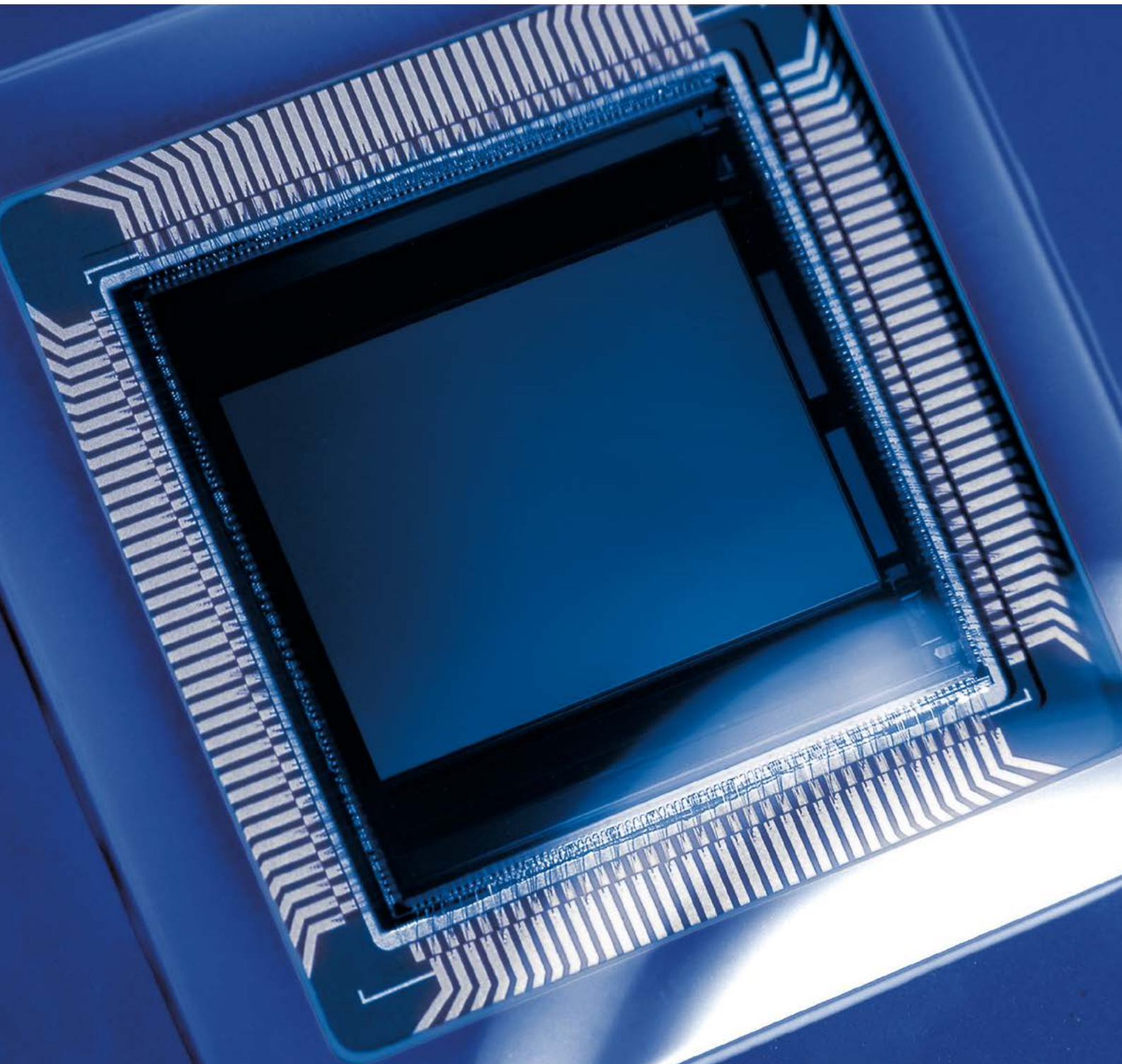


EMVA DATA OVERVIEW

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 bar-codes, 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.

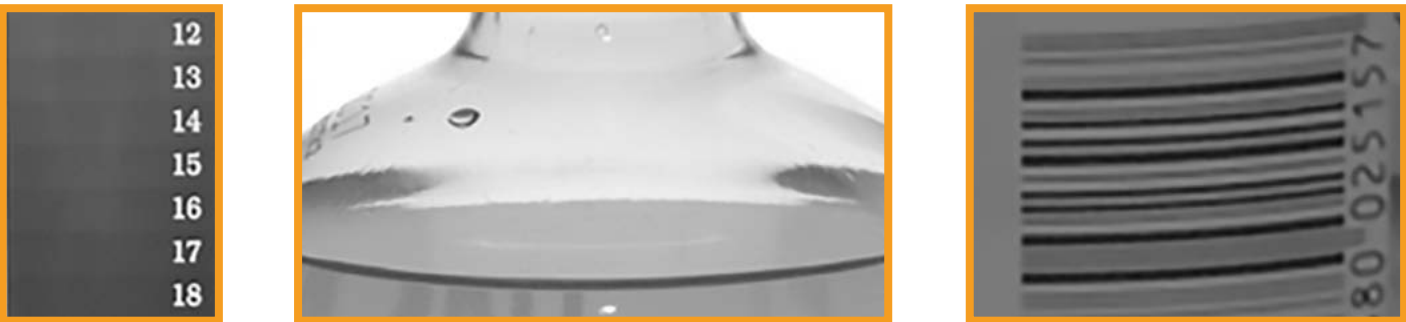


Fig. 2 Camera A with good EMVA properties

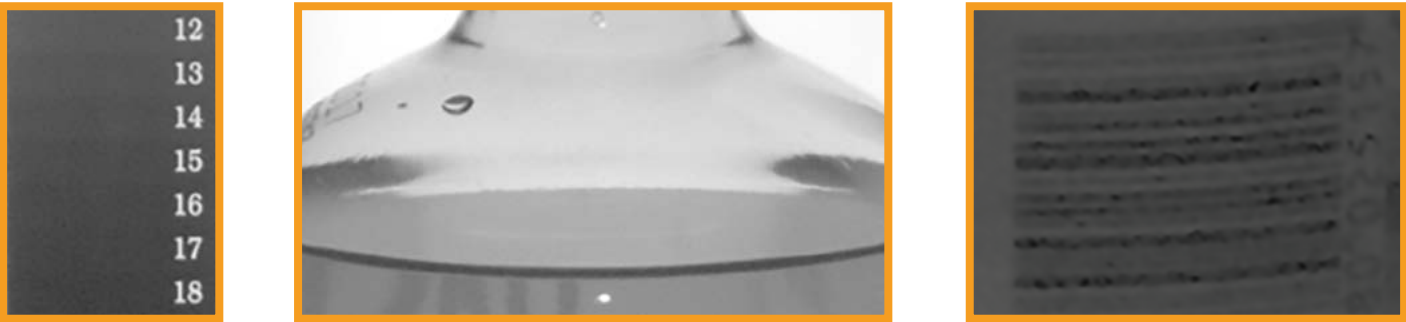


Fig. 3 Camera B with inferior EMVA properties



Fig. 4 Camera B with longer exposure time

Sensor	Type	Shutter	Resolution	Pixel [H × V]	Pixel Size [µm]	Optical Size ["]	Series	Frame Rate				QE [%]	Dark Noise [e-]	Sat. Capacity [ke-]	Dynamic Range [dB]	Max. SNR [dB]
								USB	GIGE	5GIGE	CXP-12					
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 MP	1920 × 1200	5.86	1/1.2	ace	164	50	-	-	70	7	31.8	74	45
IMX178	CMOS	rolling	6 MP	3088 × 2064	2.4	1/1.8	ace	59	16	-	-	81	3	14.3	73	42
IMX183	CMOS	rolling	20 MP	5472 × 3648	2.4	1	ace	17	5	-	-	75	3	13.8	71	41
IMX226	CMOS	rolling	12 MP	4024 × 3036	1.85	1/1.7	ace	31	8	-	-	83	3	11.0	70	40
IMX249	CMOS	global	2.3 MP	1920 × 1200	5.86	1/1.2	ace	41	42	-	-	70	7	31.9	74	45
IMX250	CMOS	global	5 MP	2448 × 2048	3.45	2/3	ace	75	-	-	-	68	2	10.7	73	40
IMX252	CMOS	global	3 MP	2048 × 1536	3.45	1/1.8	ace	120	-	-	-	69	2	10.5	73	40
IMX253	CMOS	global	12 MP	4096 × 3000	3.45	1.1	ace boost	30 -	- -	-	- 68	70	2	10.5	73	40
IMX255	CMOS	global	9 MP	4096 × 2160	3.45	1	ace boost	40 -	- -	-	- 93	70	2	10.5	73	40
IMX264	CMOS	global	5 MP	2448 × 2048	3.45	2/3	ace	35	20	-	-	68	2	10.4	73	40
IMX265	CMOS	global	3 MP	2048 × 1536	3.45	1/1.8	ace	55	35	-	-	68	2	10.4	73	40
IMX267	CMOS	global	9 MP	4096 × 2160	3.45	1	ace	30	12	-	-	68	2	10.2	73	40
IMX273	CMOS	global	1.6 MP	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 MP	4096 × 3000	3.45	1.1	ace	20	8	-	-	68	2	10.2	73	40
IMX334	CMOS	rolling	5 MP	2592 × 1944	2.0	1/2.8	ace 2	60	22	-	-	73	2	7.2	69	39
			8.3 MP	3840 × 2160	2.0	1/1.8	ace 2	45	13			72	2	7.2	69	39
IMX392	CMOS	global	2.3 MP	1920 × 1200	3.45	1/2.3	ace 2	160	51	168	-	62	3	10.4	72	40
IMX421	CMOS	global	3 MP	1936 × 1464	4.5	2/3	boost	-	-	-	400	69	5	24.6	72	44
IMX530	CMOS	global	24.4 MP	5328 × 4608	2.74	1.2	boost	-	-	-	100	66	2	9.6	71	40
IMX531	CMOS	global	20 MP	4504 × 4504	2.74	1.1	boost	-	-	-	100	67	2	9.7	71	40
IMX532	CMOS	global	16.1 MP	5320 × 3032	2.74	1.1	boost	-	-	-	150	65	2	9.6	71	40
IMX535	CMOS	global	12 MP	4096 × 3000	2.74	1/1.1	boost	-	-	-	180	66	3	10	70	40
IMX536	CMOS	global	8 MP	2832 × 2840	2.74	2/3	boost	-	-	-	190	65	2	10	71	40
IMX537	CMOS	global	5 MP	2448 × 2048	2.74	1/1.8	boost	-	-	-	250	66	2	10	72	40
IMX540	CMOS	global	24.4 MP	5328 × 4608	2.74	1.2	ace 2	15	4	22	-	66	2	9.6	71	40
IMX541	CMOS	global	20.2 MP	4504 × 4504	2.74	1.1	ace 2	18	5	27	-	66	2	9.7	71	40
IMX542	CMOS	global	16.1 MP	5320 × 3032	2.74	1.1	ace 2	23	7	34	-	66	2	9.7	71	40
IMX545	CMOS	global	12.3 MP	4096 × 3000	2.74	1/1.1	ace 2	30	9	44	-	65	3	9.9	70	40
IMX546	CMOS	global	8 MP	2840 × 2840	2.74	2/3	ace 2	48	14	67	-	66	2	9.8	70	40
IMX547	CMOS	global	5 MP	2448 × 2048	2.74	1/1.8	ace 2	75	23	106	-	66	3	9.9	70	40

Please note that only monochrome area scan cameras are listed in this overview. Specifications are subject to change without notice.
For further information on the EMVA measurements and the EMVA 1288 standard (release 3.1), please visit: baslerweb.com/emva-1288-standard

SENSOR	TYPE	SHUTTER	RESOLUTION	PIXEL [H × V]	PIXEL SIZE [μm]	OPTICAL SIZE ["]	SERIES	FRAME RATE USB / GIGE / 5GIGE / CXP-12			QE [%]	DARK NOISE [E-]	SAT. CAPACITY [KE-]	DYNAMIC RANGE [DB]	MAX. SNR [DB]
ams															
CMV2000	CMOS	global	2 MP	2048 × 1088	5.50	2/3	ace	165	50	340	63	14	9.4	57	40
CMV4000	CMOS	global	4 MP	2048 × 2048	5.50	1	ace	90	25	180	62	14	12.4	59	41
CMV4000 NIR-enhanced	CMOS	global	4 MP	2048 × 2048	5.50	1	ace	90	25	180	62	14	11.9	59	41
CMV12000	CMOS	global	12 MP	4096 × 3072	5.50	1.75	beat	-	-	62	45	14	11.6	59	41
e2V															
EV76C560	CMOS	rolling switchable	1.3 MP	1282 × 1026	5.30	1/1.8	ace	-	60	-	55	10	9.5	60	40
			1.3 MP	1282 × 1026	5.30	1/1.8	ace	-	60	-	54	24	9.2	52	40
EV76C570	CMOS	switchable	2 MP	1602 × 1202	4.50	1/1.8	ace	-	60	-	47	22	6.8	50	38
EV76C661	CMOS	switchable	1.3 MP	1280 × 1024	5.30	1/1.8	ace	-	60	-	59	23	7.4	50	39
onsemi															
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
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	12	8.2	57	39
XGS 20000	CMOS	global	20 MP	4500 × 4500	3.2	1.3	boost	-	-	45	55	4	9.2	66	40
XGS 32000	CMOS	global	32.4 MP	6580 × 4935	3.2	APS-C	boost	-	-	35	56	4	9.3	65	40
XGS 45000	CMOS	global	44.7 MP	8192 × 5460	3.2	35 mm	boost	-	-	15	55	4	9.0	65	39
Gpixel															
GMAX2505	CMOS	global	5.6 MP	2600 × 2160	2.5	1/2	ace 2	64	20	-	51	1	5.6	72	37
GMAX2509	CMOS	global	9.1 MP	4200 × 2160	2.5	2/3	ace 2	12	40	-	50	1	4.5	69	37
GMAX2518	CMOS	global	18 MP	4508 × 4096	2.5	1	ace 2	20	6	-	50	1	4.5	69	37

Please note that only monochrome area scan cameras are listed in this overview. Specifications are subject to change without notice.
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SONY CMOS	SONY CMOS
ICX618 Replacement acA640-121gm	IMX334 a2A2590-22gmBAS/PRO a2A2590-60umBAS/PRO a2A3840-13gmBAS/PRO a2A3840-45umBAS/PRO
IMX174 acA1920-50gm acA1920-155um	IMX392 a2A1920-51gmBAS/PRO a2A1920-160umBAS/PRO a2A1920-165g5mBAS
IMX178 acA3088-16gm acA3088-57um	IMX421 boA1936-400cm
IMX183 acA5472-5gm acA5472-17um	IMX530 boA5328-100cm
IMX226 acA4024-8gm acA4024-29um	IMX531 boA4504-100cm
IMX249 acA1920-40gm acA1920-40um	IMX532 boA5320-150cm
IMX250 acA2440-75um	IMX535 boA4096-180cm
IMX252 acA2040-120um	IMX536 boA2832-190cm
IMX253 acA4112-30um boA4112-68cm	IMX537 boA2448-250cm
IMX255 acA4096-40um boA4096-93cm	IMX540 a2A5328-4gmBAS/PRO a2A5328-15umBAS/PRO a2A5328-22g5mBAS
IMX264 acA2440-20gm acA2440-35um	IMX541 a2A4504-5gmBAS/PRO a2A4504-18umBAS/PRO a2A4504-27g5mBAS
IMX265 acA2040-35gm acA2040-55um	IMX542 a2A5320-7gmBAS/PRO a2A5320-23umBAS/PRO a2A5320-34g5mBAS
IMX267 acA4096-11gm acA4096-30um	IMX545 a2A4096-9gmBAS/PRO a2A4096-30umBAS/PRO a2A4096-44g5mBAS
IMX273 acA1440-73gm acA1440-220um	IMX546 a2A2840-14gmBAS/PRO a2A2840-48umBAS/PRO a2A2840-67g5mBAS
IMX287 acA720-290gm acA720-520um	IMX547 a2A2448-23gmBAS/PRO a2A2448-75umBAS/PRO a2A2448-105g5mBAS
IMX304 acA4112-8gm acA4112-20um	

AMS	E2V
CMV2000 acA2000-165um acA2000-340km acA2000-50gm	EV76C560 acA1280-60gm acA1300-60gm
CMV4000 acA2040-180km acA2040-25gm acA2040-90um	EV76C570 acA1600-60gm
CMV4000 NIR acA2040-180kmNIR acA2040-25gmNIR acA2040-90umNIR	EV76C661 acA1300-60gmNIR
CMV12000 beA4000-62km	
GPIXEL	ONSEMI
GMAX2505 a2A2600-20gmBAS/PRO a2A2600-64umBAS/PRO	MT9J003 acA3800-10gm acA3800-14um
GMAX2509 a2A4200-12gmBAS/PRO a2A4200-40umBAS/PRO	MT9P031 acA1920-25gm acA1920-25um acA2500-14gm acA2500-14um
GMAX2518 a2A4508-6gmBAS/PRO a2A4508-20umBAS/PRO	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
	XGS 20000 boA4500-45cm
	XGS 32000 boA6500-36cm
	XGS 45000 boA8100-16cm

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 more than 1,000 people at its headquarters in Ahrensburg, Germany, as well as other sales and development locations throughout Europe, Asia, and North America.



Markets We Focus on



How to Read Our Camera Model Names

AC	A	2040	180	K	M	NIR
Model a2 = ace 2 ac = ace be = Basler beat bo = boost da = dart pu = pulse ra = racer	Type A = Area scan L = Line scan	Resolution Horizontal pixels	Frame Rate Number of frames per second (fps) at full AOI	Interface k = CL c = CoaXPress g = GigE g5= 5GigE u = USB 3.0 m = BCON for MIPI	Color m = mono c = color	Spectrum NIR = Near Infrared Product Line BAS = Basic PRO = Pro ISP i = Internal ISP for MIPI cameras

Specifications are subject to change without notice.
Latest specifications and availability can be found on our website baslerweb.com/products.
Please visit baslerweb.com/manuals for the detailed camera User's Manual and baslerweb.com/thirdparty for information on third party software.



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

