

Basler racer – The Clever All-Purpose Line Scan Camera

What are the essential features of a line scan camera? In short: High line-scan rates, flexible resolution levels, strong sensitivity and excellent performance in dynamic conditions. The Basler racer achieves that, and more: It delivers frame rates of up to 80 kHz, resolutions ranging from 2k to 12k and the choice between two interfaces – Gigabit Ethernet (GigE) or Camera Link (CL). This makes it the ideal camera solution for a variety of tasks covering a broad range of applications.

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1. What Makes the Basler racer Different

Line scan cameras have a clearly defined role in the world of machine vision. They are typically used in applications where objects are moving quickly and at high volumes along a conveyor system. These applications need camera systems that deliver strong image quality and appropriate frame rates for inspection tasks.

So what makes the Basler racer so special? It's been engineered to fulfill all the expected requirements for a line scan camera. It comes in a robust, compact housing ready for industrial applications, making it a strong candidate for use in multi-camera systems. Most importantly: it offers strong image quality at an outstanding price!

Top line scan speeds of up to 80 kHz for high-speed processing	Compact housing for use in multi-cameras systems and simple integration
Outstanding performance for the price	
Low price for camera and accessories	Good image quality thanks to modern generation of sensors and low heat generation design

2. Wide Range of Applications



Line scan cameras are tasked with capturing high quality images for use in smooth, flawless inspections of products that are traveling past at high speeds. Even the smallest deviations and flaws must be identified reliably. Basler line scan cameras are used in a variety of areas:

- **Surface inspection**
Endless webs of material, including films, papers steel or textiles; surfaces such as glass, displays or solar panels
- **Traffic and Transport**
Inspection of containers (barcodes, damages), rail and overhead lines, vehicle undercarriages
- **Printing industry**
Controlling of printed images, inspections of labels
- **Post and package sorting**
- **Foodstuff industry**
Quality control, bottling

To make clearer just what the Basler racer has to offer, we've selected three exemplary applications to explore in detail.



the minutest defects in various types of material. Thanks to their strong performance in dynamic conditions and high sensitivity, they can identify even low-contrast flaws on the first pass.

One fundamental characteristic of surface inspection, regardless of what kind of material is being checked, is the high speeds involved. The racer features a fast line scan rate, so it has no trouble handling fast-moving materials. These applications are often designed as multi-camera systems. In this case, multiple cameras are arranged to capture what one single camera could not: The entire breadth of the materials moving past.

2.1 The Classic: Surface Inspection

Endless webs of different materials, from plastic films and paper to steel and textiles, can be checked for even the minutest defects using line scan systems. These defects are primarily 'real' flaws in the material – damaged spots that can be detected through visual inspection of the surface material. Beyond these damaged points, the system must also be able to account for 'false positives' that must be differentiated from real errors. Operators need to be able to count on their machine vision system sounding the alarm for real errors but letting false positives pass by without unnecessary interruption.

Flaws of different sizes present different challenges. Basler racer is available in resolutions of 2k, 4k, 6k, 8k and 12k, making it suitable for reliable detection of even

2.2 Sorting

Sorting is performed in a variety of fields – recycling of products, empty bottle returns, trash handling, post and package services, the foodstuff industries, mining operations (stones and debris) and even for bank notes, just to name a few.



These applications rely on the fastest possible identification of the product for sorting based on various criteria. Camera systems used for this purpose must be capable of handling top speeds, meaning line scan rates of up to 80 kHz, despite lighting conditions that are typically poor. Many of these sorting systems and conveyor belts are located outdoors. The Basler racer is prepared for this eventuality: It features a compact, robust, space-saving housing, flexible mounting concept and range of accessories that are both affordable and widely available. It also works 12–24V currents, ensuring even more flexible integration.

2.3 Semiconductor Inspection

Any electronic device, be it a computer, cell phone or television, has circuits with numerous electronic components inside. These must be inspected during and after production using camera systems. The active components are produced on semi-conductor wafers. Every day seems to bring new benchmarks for density and complexity on the wafer structures. The demands for quality control, and thus the camera systems used with it, continue rising as well. Here too the racer wins points for its high speed and resolutions.





3. Seven Good Reasons to Choose the racer

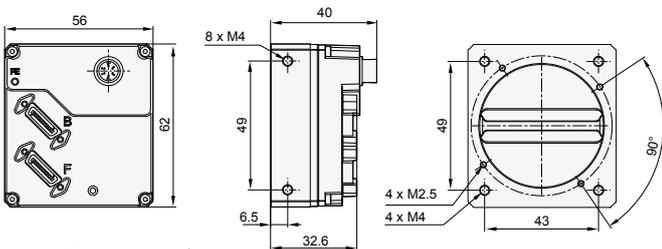
Flexibility

With resolutions of 2k, 4k, 6k, 8k and 12k, as well as the choice between a CameraLink interface (speeds up to 80 kHz) or a GigE interface (up to 51 kHz), the racer has the flexibility needed for a variety of potential applications. They are in fact equally well suited for applications in surface inspection, control of printed materials, web goods inspection and packet/post sorting.

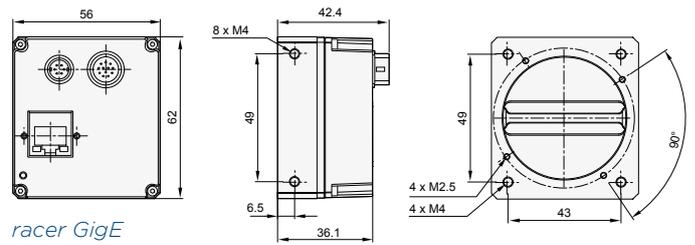
Sensor	Number of Pixels	Pixel size ($\mu\text{m} \times \mu\text{m}$)	Interfaces	Line Scan Rate (kHz)	Mount
2k	1 × 2048	7 × 7	GigE / CL	up to 51/80	C, F, M42
4k	1 × 4096	7 × 7	GigE / CL	up to 26/80	F, M42
6k	1 × 6144	7 × 7	GigE / CL	up to 17/80	F, M42
8k	1 × 8192	3,5 × 3,5	GigE / CL	up to 12/80	F, M42
12k	1 × 12288	3,5 × 3,5	GigE / CL	up to 8/66	F, M42

Simple Integration

The racer's housing measures 62 × 56 mm. The compact dimensions save space and allow for simple integration into the surrounding system hardware.



racer Camera Link



racer GigE

Basler's mounting concept was engineered to reflect its customers' needs and desires. The solution offers just the right amount of flexibility to mount various lenses. The 4-screw setup delivers strong stability, while the ability to access the camera externally keeps handling simple.



C mount, F mount and M42 lenses are always available; no custom lenses required.



The unit comes with the Basler *pylon Camera Software Suite* for simple and convenient configuration and operation of the racer.

Low Costs

All components on the racer, including the sensors, ports and accessories, work with common standards. This means CMOS sensors offering pixel sizes of 3.5 to 7 μm and C-mount, F-mount or M42 adapters on the lenses. For CameraLink models, SDR (mini CL) plugs for Power over Camera Link (PoCL) are available at low cost, while the GigE models use a standard Hirose connector. These standard components help keep overall system costs low.

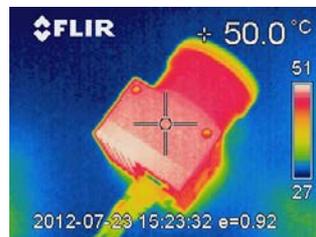
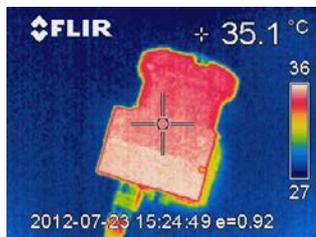
Bad Lighting, Good Results

The interplay between electronics and sensors in the racer ensures low noise levels and strong dynamic performance. As such, they are well suited for applications based on low or limited lighting conditions. The operator can save money on expensive lighting systems, as a standard LED lamp is typically sufficient.

Ideal for Multi-Camera Systems

The racer's handy dimensions make it an ideal model for multi-camera setups. One sample application might be surface inspections, where the entire breadth of a web of material must be recorded. Depending on how wide the conveyor belt, one single line scan camera might not be able to capture everything. In this case, the compact dimensions mean multiple cameras can be aligned next to one another, each capturing a precisely defined (and often slightly overlapping) area of the material web as it moves by quickly. This ensures that no flaws or defects passed unnoticed in the border zones where the different cameras are recording.

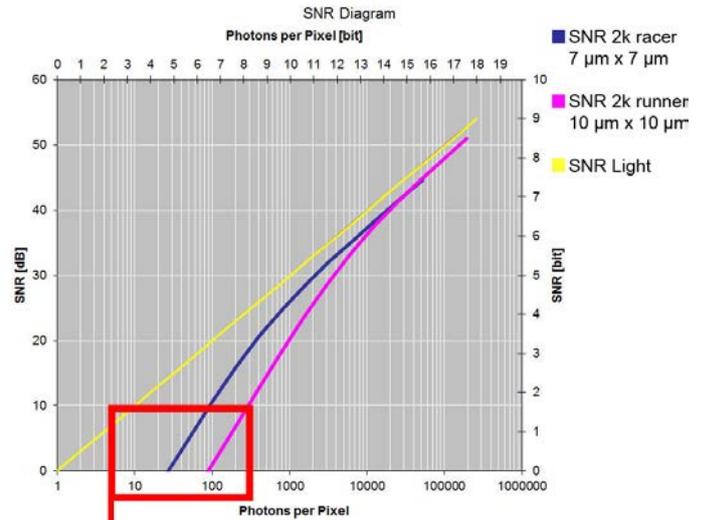
One major benefit of the racer in this regard: The camera low levels of heat generation. When less heat is produced, fewer mechanisms are needed to disperse that heat. This in turn saves space in the camera's housing. Here too the cameras use little energy and produce negligible amounts of heat. They retain their strong and reliable performance even when ambient temperatures rise.



Comparison between Basler runner ruL2048-30gm (CCD sensor) and racer raL2048-48gm: The racer produces significantly less heat than its predecessor runner.

Detail-rich Image Quality

The low heat generation characteristics of the racer are helpful beyond just multi-camera systems. They also lend themselves to less noise and hence better image quality. The lower the noise levels, the easier it is to detect the image signal for conversion into image data. The reverse is also true - the higher the noise levels, the poorer the performance in detecting image signals. The ratio between image signal and noise signal is known as



Logarithmic depiction of the signal/noise ratio on the example of the Basler racer: Because of its very low dark noise, it produces reliable signals, even under the sub-optimal lighting conditions that line camera applications typically face. (The graphic shows interim calculation values.)

the Signal to Noise Ratio, or SNR. The threshold at which the signal is precisely as strong as the noise, meaning the signal is still perceptible, if only barely, is 1. The higher the number, the easier it is to detect an object. The variant of SNR available in the racer comes with 2k resolution at 7.4. That means: Very good images even in low light, good error detection even at high speeds with short shutter speeds or weak lighting equipment.

Another aspect of image quality comes through the dynamic range. It describes the ratio between the strongest and weakest image signal that can be differentiated from the noise. At the same time, it describes a camera's ability to depict both high and low light intensity within an image. The race models are outfitted with modern CMOS sensors that offer a very wide dynamic range. In the 2k variant, for example, this totals 66.0 dB. The noise and dynamic range characteristics for CMOS sensors have come to rough parity with those on CCD sensors. For users, this means detail-rich images in which low-contrast flaws can be reliably identified even in poor ambient lighting conditions.

Outstanding value

Image quality is typically the most discussed aspect of choosing a camera. Yet the price matters too. The racer is unparalleled in this regard, delivering very good image quality at an outstanding price!



4. Summary and Recommendations

The Basler racer is engineered to be a versatile solution for a variety of different applications. It features an optimal combination of high image quality and low price for universal use. Even if none of the specific cases discussed here fit your needs, we nevertheless likely have a suitable racer solution for your specific requirements. Our *Basler Support Team* would be glad to answer your questions and find a solution any time!



Author

Sandra Dekarz is Product Manager for Basler's Large Format products in the aviator, racer, runner and sprint camera series.

She came to Basler in 2004 with a degree in Industrial Engineering and initially worked as a product manager in the Web Inspection department. As part of her current duties she oversees and provides support for cameras in the high end range along their entire product life cycle.

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Basler is a leading developer and manufacturer of high-quality digital cameras for applications in manufacturing, video surveillance, medicine and traffic monitoring. Product development is led by the demands of industry. The cameras offer simple integration, compact sizes and an outstanding price/performance ratio. Basler offers over 25 years of experience in the image processing industry and has been developing and producing high-quality cameras for more than 15 years. The company is home to more than 350 employees at its corporate headquarters in Ahrensburg, Germany and its subsidiaries in the USA, Singapore, Taiwan, China and Korea.



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