Basler sprint Series - 高數據傳輸量與高靈敏度要求的解決方案

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Abstract

The new Basler sprint line scan camera family includes models with resolutions from 2k to 4k pixels and line rates from 20 kHz to 140 kHz. This means that the sprint is the fastest line scan camera on the market!

All sprint variants are based on a next generation dual line CMOS sensor designed exclusively for Basler. The Basler sprint is aimed at applications where high sensitivity, excellent image quality, and the highest speed are required. This high speed and image quality enable sprint camera users to increase efficiency and throughput in many vision applications.

Benefits from the Basler sprint series include:

- Resolutions from 2k to 4k pixels
- The highest speeds, even at 4k resolution, with line rates from 20 kHz to 140 kHz
- Very high sensitivity and an increased signal-to-noise ratio
- A small, rugged new housing design with a novel heat sink system
- A unique automated sensor alignment system for the tightest alignment tolerances
- A Windows setup tool (CCT+) that lets you configure your camera with ease
- 100% quality checked and calibrated to give you consistent performance and reliability

Basler sprint cameras are perfect for use in applications such as:

- Web inspection (wood, paper, foil, etc.)
- Surface inspection (printed circuit boards, flat panels and displays, semiconductors, etc.)
- Document scanning and postal sorting
- Food inspection

Figure 1: sprint Camera

1. Introduction to the New sprint Series

The new Basler sprint line scan family includes models with resolutions from 2k to 4k pixels and line rates from 20 kHz to 140 kHz. This means that it is the fastest line scan camera on the market! These advantages enable machine vision applications to increase throughput and make integration of the lighting system easier.

These extremely high line rates result in short integration times. Thus very high sensitivity and a low noise level are required to achieve excellent image quality. These goals were reached with a new CMOS sensor that was developed exclusively for Basler. This new dual line sensor represents the next generation of CMOS sensor technology and combines the highest speeds with outstanding sensitivity.

When the dual line sensor in the Basler sprint is used to sequentially scan an object, signal-to-noise ratio and sensitivity are significantly improved. A standard Camera Link interface simplifies system integration and provides reliable data transfer at very high rates for various machine vision applications.

2. Hardware Concept

a) Housing System and Board Architecture Scheme

The housing system for the sprint was specially designed to attain highly precise sensor positioning in a new, more modern configuration. The housing is compact and robust and designed for use with an F-mount or M42 adapter (for 2k and 4k). The unique integrated heat sink system dissipates heat directly from the sensor to the outside. This helps to reduce noise that can be induced by heat.

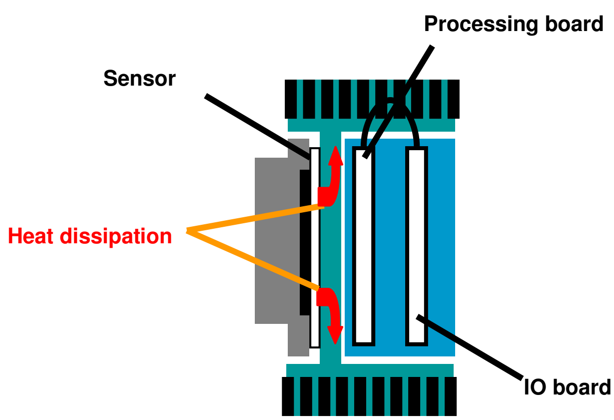


Figure 2: Housing System and Board Architecture

b) Sensor Technology

The new dual line CMOS sensor used in the sprint was developed exclusively for Basler. This sensor incorporates more than the typical strengths of a CMOS sensor; it also includes a combination of the highest speed and outstanding sensitivity. The chip-on-board sensor module allows the sensor to be mounted directly on the sensor board, where a ceramic mount efficiently transfers heat to the outside. To maintain performance stability, an identical coefficient of expansion between the sensor and the mount has been achieved.

i.) Sensor module

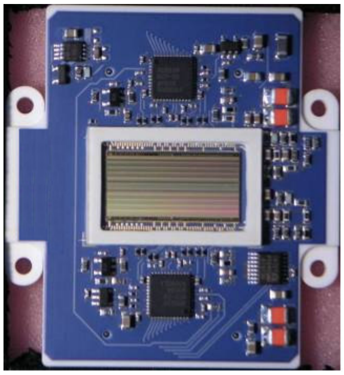
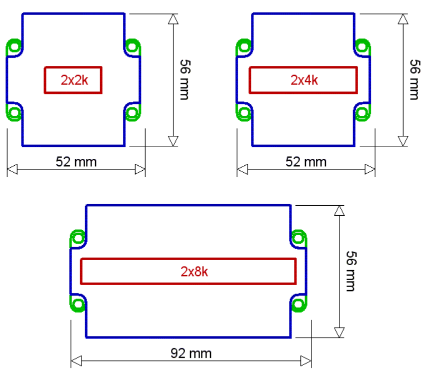


Figure 3: Sensor Module

ii.) Mechanical dimensions



- 2k and 4k have the same dimensions
- 8k has the same width but a longer length

Figure 4: Mechanical Dimensions

iii.) Fill factor

The new dual line sensor was designed to obtain a 100% fill factor and to increase the quantum efficiency of the sensor. Quantum efficiency (QE) is defined as the percentage of photons hitting the photo-reactive surface that will produce an electron-hole pair. As illustrated below, the larger sensitive area on the sprint sensor versus the sensitive area on a CCD sensor or a standard CMOS APS (active pixel sensor) can provide higher sensitivity.

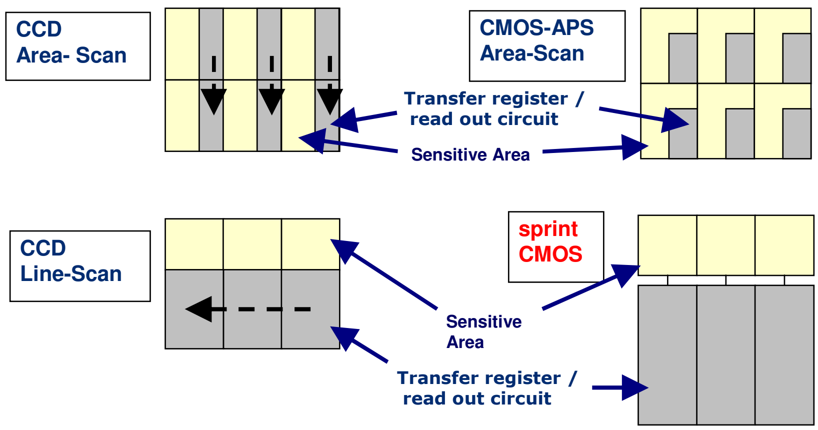


Figure 5: Sensor Sensitive Area

iv.) Sensitivity

In a standard CMOS-APS, the integration and conversion of photons to electrons is accomplished with a large photodiode (high QE) and high capacitance (high Cpd). Since sensitivity is proportional to QE/C, the sensitivity is relatively low. With the sprint CMOS-APS, the excellent sensitivity results from the use of a large photodiode (high QE) and a small capacitance (low Cmem). The capacitor that converts the electrons into voltage is placed outside of the light sensitive area of the pixel and is independent from the photodiode. Sensitivity is proportional to QE/C (i.e., S α QE /C)

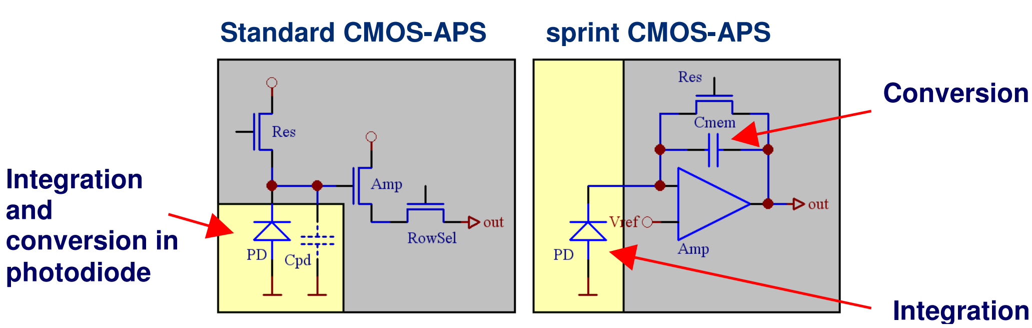


Figure 6: Integration and Conversion Electronics

c) Sensor Operation Modes

Several line capture methods were developed for the new sensor in sprint cameras. Each method is referred to as a line acquisition mode.

Line acquisition modes overview:

- Single line acquisition mode [max 70 kHz]
- Dual line acquisition mode [max 140 kHz]
- Vertical binning acquisition mode
- Time delayed line summing acquisition mode
- Line averaging acquisition mode
- Time delayed line averaging acquisition mode

i.) Single line acquisition mode [max 70 kHz]

When single line acquisition mode is active, for each trigger signal, only line A in the sensor will be exposed. Line B will be inactive during the operation. When line acquisition is completed (i.e., exposure is finished), the pixel values from the single line will be read out of the sensor and transmitted from the camera to the frame grabber.

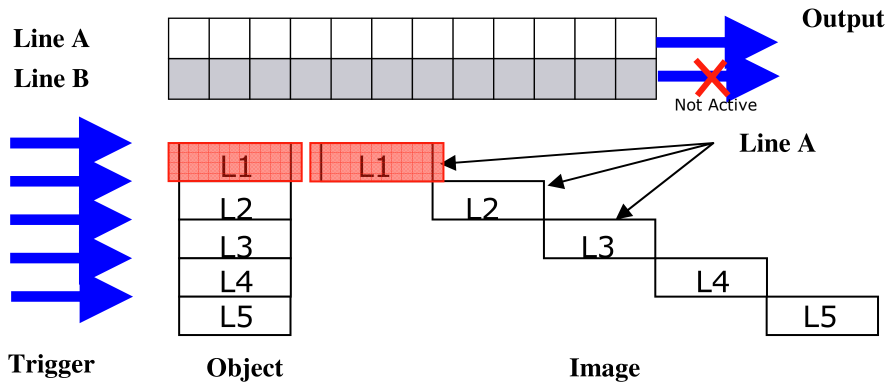


Figure 7: Single Line Acquisition Mode

ii.) Dual line acquisition mode [max 140 kHz]

When dual line acquisition mode is active, the camera will use both line A and line B in the sensor. Each acquisition is made up of 2 trigger cycles. On the first trigger, both lines in the sensor are exposed. When exposure is complete, the pixel values from line A are read out of the sensor and transmitted from the camera. The pixel values from line B are also read out, but they are held in a buffer in the camera. On the second trigger, the buffered pixel values from line B are transmitted.

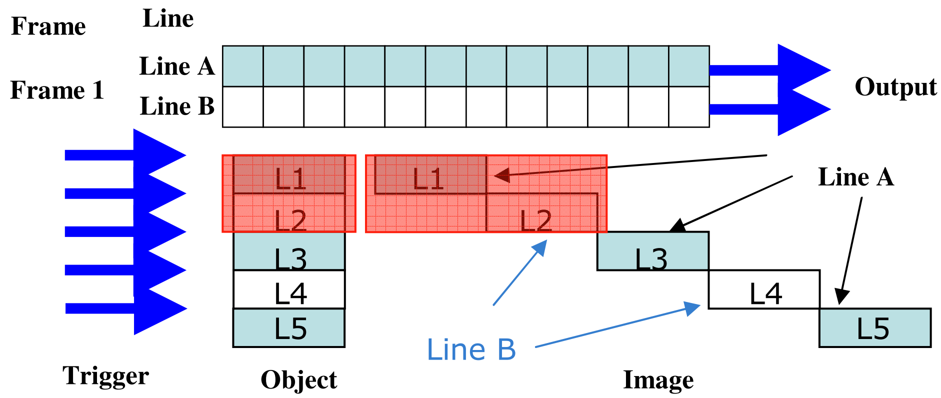


Figure 8: Dual Line Acquisition Mode

iii.) Vertical binning acquisition mode

When the vertical binning acquisition mode is active, for each trigger, the camera will expose both line A and line B. When acquisition is complete (i.e., exposure is finished), the pixel values from line A will be added to pixel values from line B. The summed values for each pair of pixels will be output from the camera as though they were from a single pixel.

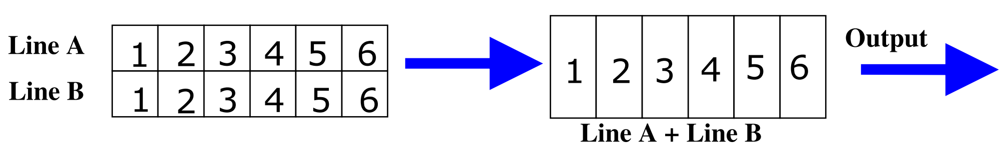


Figure 9: Vertical binning acquisition mode

The pixels in each line of the sensor are 10 µm (H) x 10 µm (V). So when you are using vertical binning, you are getting the same effect as using a single line sensor that has 10 µm (H) x 20 µm (V) pixels.

Vertical binning can be useful if you are capturing images in low light conditions and you want to get an increased response from the camera. Using vertical binning will result in approximately double the response of single line acquisition.

iv.) Time delayed line summing acquisition mode

When the time delayed line summing acquisition mode is active, for each trigger, the camera will expose both line A and line B in the sensor. When line acquisition is complete (i.e., exposure is finished), the pixel values for line A will be read out of the sensor and will be stored in a buffer in the camera. The pixel values for line B will be read out of the sensor and they will be summed with the pixel values for line A that were stored during the previous acquisition cycle. This means that every object line will be scanned twice (once by line A and once by line B) with a time delay. The summed values are transmitted out of the camera as though they were from a single captured line.

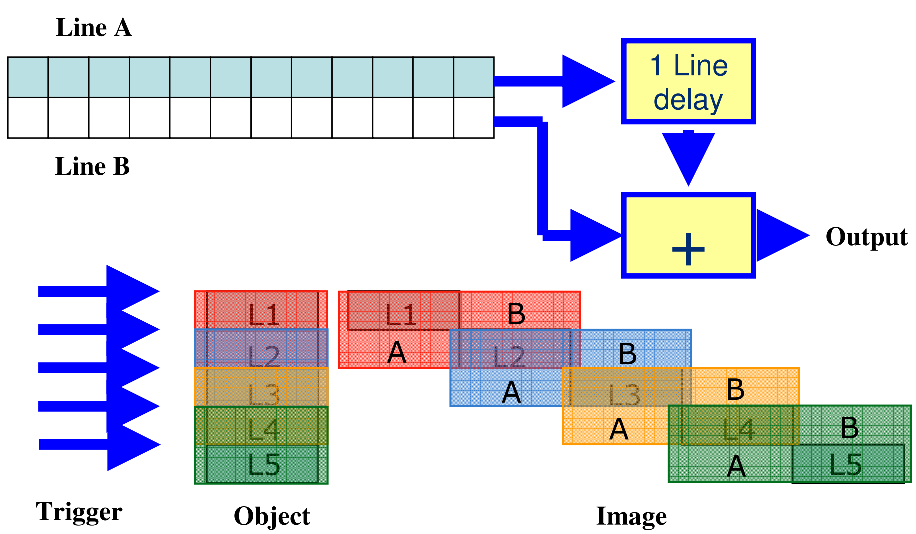
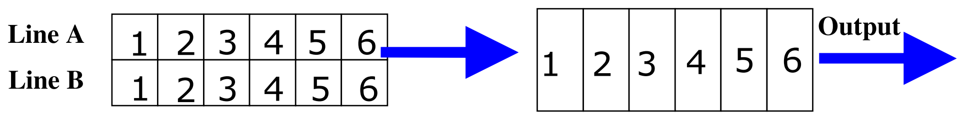


Figure 10: Time Delayed Line Summing Acquisition Mode

Line summing can be useful if you want to decrease the noise level in the pixel values output from the camera. Using line summing will result in an increase of approximately 3 dB in the signal-to-noise ratio.

v.) Line averaging acquisition mode

When the line averaging acquisition mode is active, for each trigger, the camera will expose both line A and line B in the sensor. When acquisition is complete (i.e., exposure is finished), the pixel values from line A will be added to pixel values from line B. After the values are summed, each sum will be divided by 2 (and rounded up if necessary). These averaged values will then be transmitted from the camera as though they were from a single line.



(Line A + Line B)/2

Figure 11: Line Averaging Acquisition Mode

vi.) Time delayed line averaging acquisition mode

The operation of the camera's time delayed line averaging feature is essentially the same as the time delayed line summing feature with one exception: after the pixel values have been summed, each sum is divided by 2.

d) Area of Interest (AOI)

The area of interest feature lets you specify a portion of the sensor lines. During operation, only the pixel information from the specified portion of the lines is read out of the sensor and transmitted from the camera to the frame grabber. The size and position of the area of interest is defined by declaring a starting pixel and a length in pixels. In the case of a 4k sensor, when the area of interest feature is used, the maximum allowed line rate may increase linearly if the AOI is placed in the middle of the sensor. In the case of the 2k sensor, the line rate will increase linearly, regardless of the location of the AOI.

3. Applications of sprint Series Cameras

When selecting the best camera for a given application, in addition to considering specifications such as resolution, speed, size, or interface, it is important to check whether the requirements of the application can be met by the selected camera.

Development of the sprint series was targeted to meet the requirements of high speed line scan applications. Such applications always have the challenge of limited light and short integration times. Due to power limitations, dimensions, or heat dissipation, the available light often cannot be increased.

For a camera to provide good results under such conditions, two main parameters of the sensor are important: the noise and the full well capacity. The full well capacity of the sprint CMOS dual line scan sensor is well placed at 20000e-. Together with its unique architecture, this makes the sprint sensor very sensitive. It also allows the sprint to provide high quantum efficiency because the full capacity can be achieved even under low light conditions. And because the sprint sensor has an extremely low level of dark noise, it can provide a very high signal-to-noise ratio under low light conditions.

The sprint Series is designed to fit well into applications where such properties are needed. Some examples include: postal sorting inspection, silicon wafer inspection, paper and wood inspection, and more.

Postal Sorting Inspection

These inspection systems scan the addresses on envelopes moving at very high speeds, e.g., eight meters per second. As each document passes a sprint, the camera scans it and delivers the captured information to a frame grabber in the system's host PC. The OCR software in the PC will decode the address information and will signal the mechanisms in the sorting system to convey the document to the proper destination in the system so that it can continue on its way to the final receiver.

Silicon Wafer Inspection

Another camera application is the inspection of silicon wafers used for producing solar cells. To increase the throughput of the solar cell production system and to maximize system output, sprint cameras are used to inspect for micro-cracks in the raw wafer material. These micro-cracks are interruptions in the wafer's crystalline structure and can lead to wafer breakage during handling. Such breakage will cause the production line to halt and greatly reduce production efficiency. Also, a micro-crack may allow a wafer to pass through production without incident, but may cause a reduction in the electrical performance of the completed solar cell. Detection of the micro-cracks and the removal of defective raw wafers from the system will increase production efficiency and avoid production of sub-standard products.

Paper and Wood Inspection

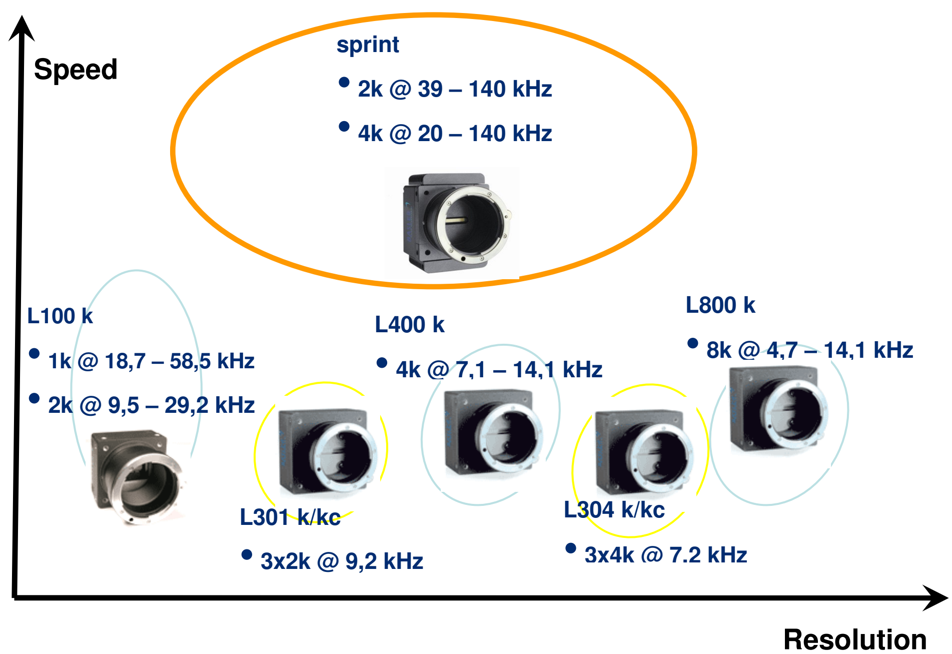
In the paper and wood industry, sprint cameras can scan for defects or particles on an "endless material" production line at high speed.

In saw mills, wood products can be inspected for their dimensions, structures, and possible failure points. The cameras will scan for the desired parameters and after that, the products can be graded according their quality. Continuous sheets of wood veneer or laminates can also be inspected for surface defects with sprint high speed line scan cameras.

In the paper industry, giant paper rolls are used to transport and store products. These paper rolls can weigh several tons. As paper leaves the production line and feeds onto a roll, it is inspected at a speed of several meters per second for defects such as small holes or particles. These small holes and particles can lead to scratches on the paper. When this happens, a huge amount of paper, along with much time and money, can be wasted. So it is important to have a reliable line scan camera like the sprint that runs at the highest speed and detects every defect.

4. The Basler Line Scan Portfolio

a) Line Scan Portfolio Overview



b) The Basler sprint Series Includes:

Camera	Sensor Size (pixels)	Max Line Rate	Taps	Camera Link Frequency
spL2048-39k	2048	38.6 kHz	2/4	40 MHz
spL2048-70k	2048	70 kHz	2/4	80 MHz
spL2048-140k	2048	140 kHz	4	80 MHz
spL4096-20k	4096	19.3 kHz	2/4	40 MHz
spL4096-39k	4096	38.6 kHz	4/8	40 MHz
spL4096-70k	4096	70 kHz	4/8	80 MHz
spL4096-140k	4096	140 kHz	8	80 MHz

Thank you for your attention!

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