

## Merger Box SK9195

- Synchronization of up to five digital CCD line scan cameras with a single PC interface board
- Individual integration control adjustable for each connected camera
- Several merger boxes can be cascaded • 19" cassette 3HE/10TE
- Can optionally be used as digital signal amplifier (doubles the maximum possible cable length)
- No configuration necessary



**Figure 1: Sample application:**  
Synchronous data acquisition by five line scan cameras **C1** to **C5**. The 2D measurement is extended to an additional dimension, such as depth, oscillation or bending, by two superposing laserspots **L1** and **L2**.



The line scan signals of the attached digital CCD line scan cameras are merged to a combined line scan signal. To the PC interface board, the merger box appears as a virtual line scan camera with the aggregated pixel numbers.

The combined cameras are operated synchronously and with identical exposure period. An individual integration time adjust of each camera is possible.

### Advantages of the Merger Box SK9195

- Parallel and synchronous data acquisition with several line scan cameras (no multiplex operation)
- Only one interface board is required by which costs and computer resources are reduced.
- Diminished programming expenditure.
- In operation mode 2: faster data acquisition. The line signals are temporarily stored and transmitted with higher pixel frequency to the PC interface board (Details see S. 2).

### Application fields

- Synchronous capture of separated processes, e.g., during the acceleration phase on the engine test bench
- Online process control of extrusions
- Continuous and high-resolution inspection of endless production in real-time
- Pixel-synchronous simultaneous inspection from various perspectives
- Multi-point glass thickness measurement

### Function

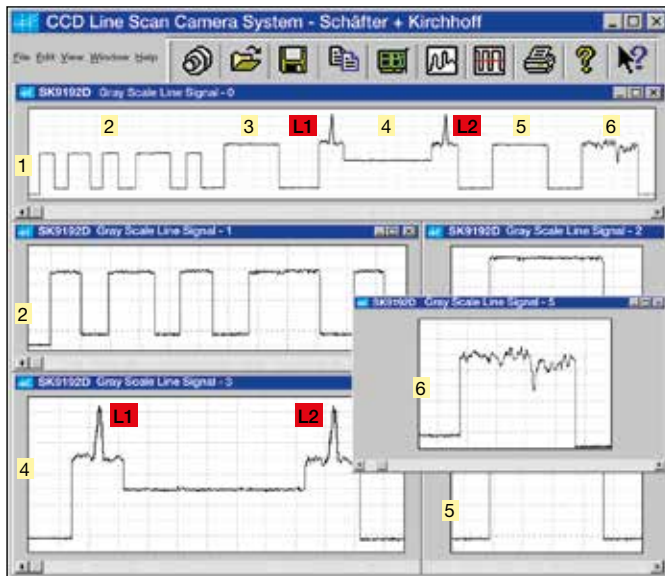
The line data of the connected cameras are stored temporarily and then put out sequentially. Each line scan camera has a defined position within the combined signal. For processing the data the individual camera signals can be separated in the computer and associate unambiguously.

This applies for linewise as well as for the block-wise evaluation of the camera signals. For the temporary storage of the line signal of each camera an 8 kByte internal memory (FIFO) is available inside the merger box. The FIFO size and the adjusted operation mode of the merger box determine the maximum pixel number of each single camera and those of the sum signal.

After adjusting the operation mode (ex Schäfter+Kirchhoff or by the user) the merger box configures itself. The type of the connected line scan cameras is automatically identified.

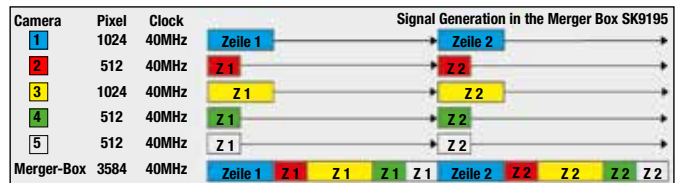
For the connection of more than five line scan cameras several boxes can be cascaded. A special extension connector (input of camera 5) can be configured that all cameras of the first and of the cascaded merger boxes are exposed at the same time and thus a pixel-synchronous data acquisition is also achieved with cascaded boxes.

**An external power supply is necessary if the added power consumption of all connected cameras exceeds the allowed power supply values of the PC interface board (see page 2).**

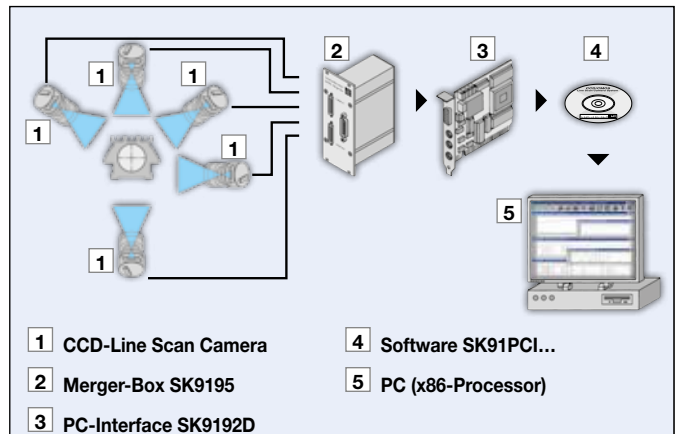


**Figure 2:** Screenshots of the concatenated merged signal and the separate displays of the deconvoluted individual signals from each camera for comparison. 4 CCD line signal with superposing laserspots L1 and L2.

- |  |   |
|--|---|
| 1 Line-(summary-)signal of Merger-Box (3584 Pixel)     | 4 Signal camera 3 (1024 Pixel) Pixeladdress 2049 - 2560 |
| 2 Signal camera 1 (1024 Pixel) Pixeladdress 1 - 1024   | 5 Signal camera 4 (512 Pixel) Pixeladdress 2561 - 3072  |
| 3 Signal camera 2 (512 Pixel) Pixeladdress 1025 - 2048 | 6 Signal camera 5 (512 Pixel), Pixeladdress 3073 - 3584 |



**Figure 3:** Timing diagram. The line signals of the single cameras are buffered in the Merger Box and joined (Timing diagram for operation mode 1).



**Figure 4:** System components of a CCD line scan camera measuring system with Merger Box SK9195.

## Operation Modes of the Merger Box SK9195

The pixel frequency of the PC interface board determines the pixel frequency of the Merger Box SK9195 (max. 40 MHz). At this speed the sum signal of the Merger Box will transmit to the interface board. The pixel frequency of the connected line scan cameras is determined by the selected operation mode of the Merger Box.

In operation mode 1 all line scan cameras work with the programmed pixel frequency of the PC interface board. In operation mode 2 a frequency divider reduces the pixel frequency of the cameras by a factor 2, 3 or 4. The operation mode and the frequency divider are adjustable by a jumper.

### Operation Mode 1: Single Buffered

All connected cameras operate with the pixel frequency specified by the programmed pixel frequency of the pc interface board. The pixel frequencies of the line scan cameras and the sum signal of the Merger Box are identical. Data of camera 1 are directly transmitted to the interface board, Subsequently the buffered data of the other cameras follow (see example in fig. 5).

#### Line frequency of the sum signal

The line frequency  $f$ , equal for all cameras, calculates:

$$f = \frac{\text{Pixel frequency of the out put signal}}{\text{totalized line length} + 64}$$

The maximum line frequency is determined by the camera(s) with the lowest tolerable pixel frequency and by the maximum pixel frequency of the interface board.

#### Maximum pixel number

The maximum pixel number of the connected cameras as well as of the sum signal, is limited by the capacity of the Merger Box memory. For buffering the line signals as a standard each camera disposes of 8 kByte FIFO memory (optionally 16 or 32 kByte).

In operation mode 1 the signal of the first camera is not buffered, thus the maximum pixel number of the sum signal  $L_{\max}$  with  $n$  connected

cameras ( $n \leq 5$ ) is

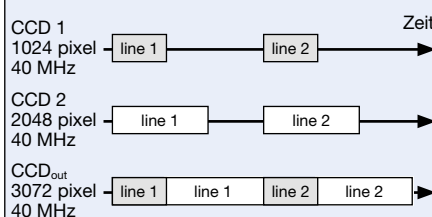
$$L_{\max} = (n-1) \cdot 8192 + (\text{pixel number of camera 1})$$

The pixel number of the first camera is not limited by the existing FIFO memory, to the other camera inputs line scan cameras with up to 8192 pixel each (with 8 bit video signal and 8 kByte FIFO memory) can be connected

Attention: PC interface boards with full functional range (incl. Shading Correction) can process line signals with a maximum number of 32768 pixel.

#### Example:

Combination of a 1024-pixel line scan camera with a 2048-pixel line scan camera with pixel frequency of 40 MHz



**Figure 5:** Timing diagram of two CCD line scan cameras connected to a Merger Box in operation mode 1.

$$\text{Line Frequency} = 40 \text{ MHz} / (3072+64) = 12,8 \text{ kHz}$$

**Operation Mode 2: Double Buffered**

The connected cameras operate with half, a third, or fourth of the programmed pixel frequency of the pc interface. The signals of all cameras are completely buffered and transmitted during the next line clock.

The sum signal arrives at the output of the Merger Box with a delay of one exposure time (see example in fig. 6). An advantage of this operation mode is the possibility of connecting line scan cameras with a lower pixel frequency specification to the Merger-Box and to transmit the sum signal to the pc interface board with a pixel frequency two, three or four times higher.

**Line frequency of the sum signal**

The line frequency f, equal for all cameras, with n cameras calculates:

$$f = \frac{\text{pixel frequency of the output signal}}{(\text{longest line length} + 64) \cdot n}$$

For efficient signal transmission the usage of line scan cameras mit identical pixel numbers is appropriate.

**Maximum pixel number**

The maximum pixel number of the connectable line scan cameras in operation mode 2 corresponds to the half FIFO length in bytes, e.g.

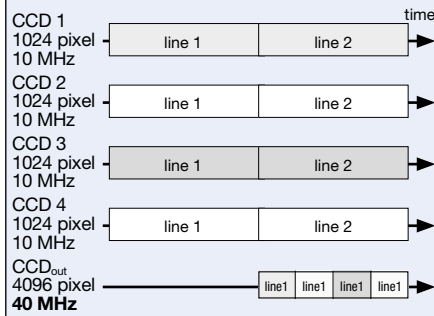
4096 pixel with a standard FIFO capacity of 8 kByte. If a camera with a greater pixel number is to be connected to one of the inputs of the merger box, a version with 16 or 32 kByte, respectively, has to be selected.

The maximum length of the sum signal at the Merger Box output with an 8 kByte FIFO memory calculates

$$L_{max} = n \times (\text{FIFO in Bytes}) / 2 = n \times 4096$$

n = number of cameras.

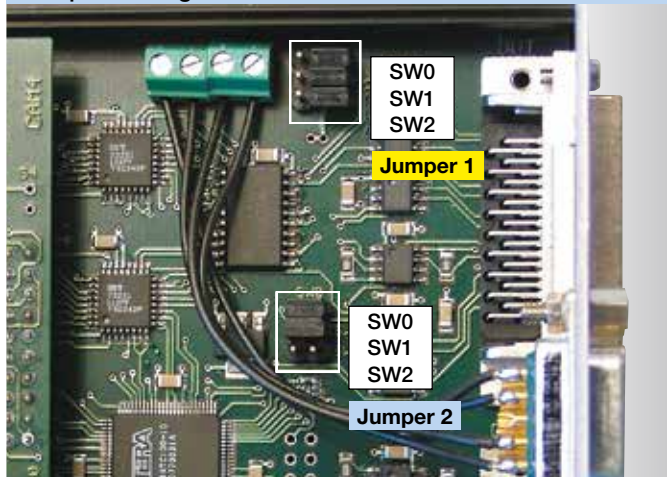
**Example:** Connection of four 1024-pixel line scan cameras, frequency divider 4.



**Figure 6:** Timing diagram of four CCD line scan cameras connected to a Merger Box with operation mode 2

line frequency = 40 MHz / (4 x 1088) = 9,2 kHz

**Jumper-Settings**



**Jumper 1: Selection internal (PC) or external power supply**

	SW0	SW1	SW2
Power supply internal (via PC)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
external (SXI-30)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

= left,   = right

With internal power supply power of up to 1A and +5V is admitted. Power requirement of the cameras is specified in the camera manual. The Merger Box itself requires up to 150 mA.

**Jumper 2: Selection operation mode and divider**

**Camera 1 - 4**

Operation mode	divider	SW0	SW1
1	1	<input type="checkbox"/>	<input type="checkbox"/>
2	2	<input type="checkbox"/>	<input type="checkbox"/>
2	3	<input type="checkbox"/>	<input type="checkbox"/>
2	4	<input type="checkbox"/>	<input type="checkbox"/>

**Camera 5**

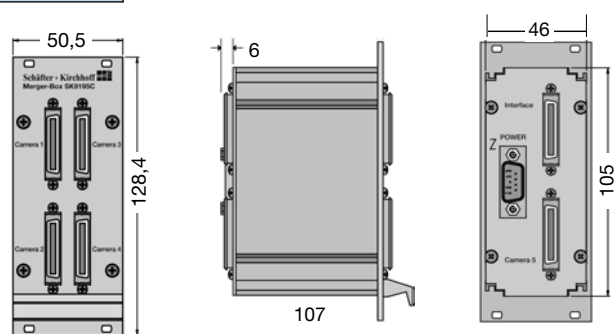
Operation mode	divider	SW2
1	1	<input type="checkbox"/>
wie Kamera 1 - 4		<input type="checkbox"/>

= inserted,  = open

With SW2 inserted, camera 5 is being operated in mode 1 and the line frequency divider is set to 1.

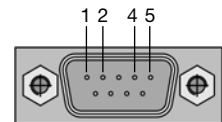
This is the normal setting when an additional Merger Box is connected to input 5, see configuration sample 4.

**Dimensions 19"-Cassette 3HE/10TE**



Pinbelegung ext. Power supply

- Pin 1 +15 V
- Pin 2 -15 V
- Pin 4 +5V
- Pin 5 GND



**Order-Codes**

**Merger Box SK9195...**

**SK9195-P-8-1**

**Order-Code**

- default operation mode and divider
- 1 - op. mode1, frequency divider 1
- 2 - op. mode2, frequency divider 2
- 3 - op. mode2, frequency divider 3
- 4 - op. mode2, frequency divider 4

**FIFO memory for each camera**

- 8 - 8 kByte (default)
- 16 - 16 kByte
- 32 - 32 kByte

**default power supply**

- P - PC power supply
- E - external power supply

- 5 - number of camera inputs 5 max.
- 4 - number of camera inputs 3 max.

**Connection cable SK 9019...**

**SK 9019.3 FF**

**Order-Code**

- cable length in m
- 3 = 3 m (def. length), 1 = 1 m
- x = length determined by customer

**External power supply SXI-30**

**SXI-30**

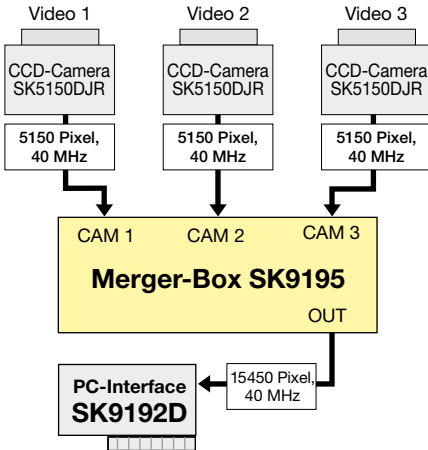
**Order-Code**



**Configuration 1**

**Components:**

- 3 x CCD-Line scan camera SK5150DJR (5150 Pixel), Pixel-Clock 40 MHz
- 1 x Merger Box SK9195
- 1 x PC-Interface SK9192D
- 4 x Connecting cable SK9019.xFF
  - e.g. 3 x SK9019.3FF - length 3 m
  - 1 x SK9019.1FF - length 1 m

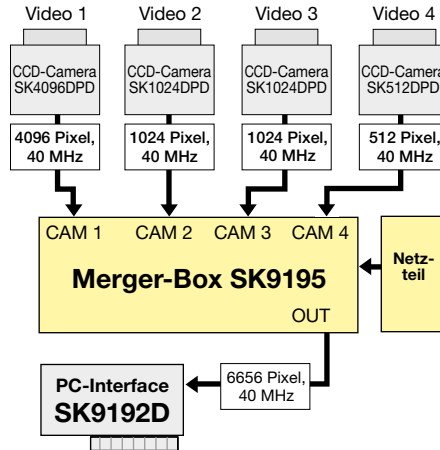


**Pixels per line:** 15450 (3 x 5150)  
**max. Pixel frequency:** 40 MHz  
**Line frequency:**  
 $f = 40\text{MHz}/(3 \times 5150 + 64) = 2,5 \text{ kHz}$   
**Power consumption:**  
 +5V (40 MHz):  $3 \times 260 + 150 = 930 \text{ mA} < 1 \text{ A}$   
 Power via PC-Interface is possible  
**Merger Box settings:**  
 Jumper 1: Power supplied from PC (SW0,SW1,SW2: all 2-3 closed)  
 Jumper 2: Mode 1, single buffered (SW0,SW1: all closed)

**Configuration 2**

**Components:**

- 1 x CCD-Line scan camera SK4096DPD (4096 Pixel), Pixel-Clock 40 MHz
- 2 x CCD-Line scan camera SK1024DPD (1024 Pixel), Pixel-Clock 40 MHz
- 1 x CCD-Line scan camera SK512DPD (512 Pixel), Pixel-Clock 40 MHz
- 1 x Merger Box SK9195
- 1 x PC-Interface SK9192D
- 1 x External Power supply SXI-30
- 5 x Connecting cable SK9019.xFF
  - e.g. 4 x SK9019.3FF - length 3 m
  - 1 x SK9019.1FF - length 1 m

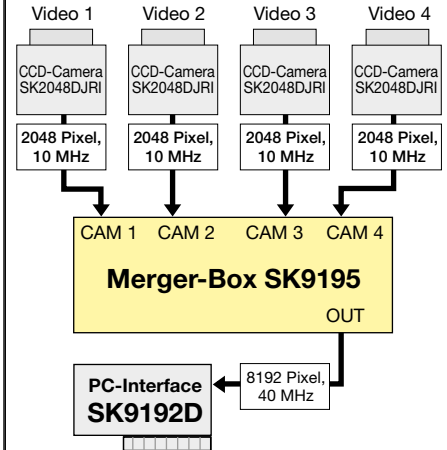


**Pixels per line:** 6656 (4096+2x1024+512)  
**max. Pixel frequency:** 40 MHz  
**Line frequency:**  
 $f = 20\text{MHz}/(6656 + 64) = 5,95 \text{ kHz}$   
**Power consumption:**  
 +5V (40 MHz):  $320 + 3 \times 280 + 150 = 1310 \text{ mA} > 1 \text{ A}$   
 External power supply necessary  
**Merger Box settings:**  
 Jumper 1: Power supplied externally (SW0,SW1,SW2: all 1-2 closed)  
 Jumper 2: Mode 1, single buffered (SW0,SW1: all closed)

**Configuration 3**

**Components:**

- 4 x CCD-Line scan camera SK2048DJRI (2048 Pixel), Pixel-Clock 10 MHz
- 1 x Merger Box SK9195
- 1 x PC Interface SK9192D
- 5 x Connecting cable SK9019.xFF
  - e.g. 4 x SK9019.3FF - length 3 m
  - 1 x SK9019.1FF - length 1 m



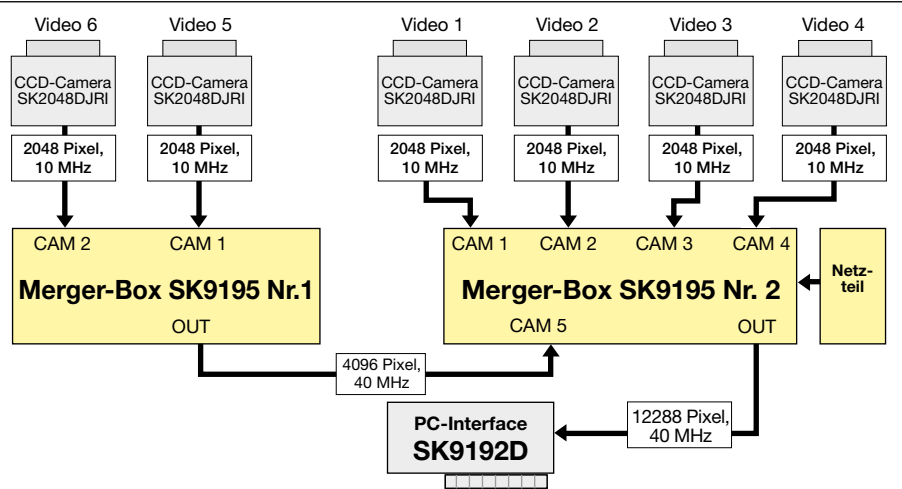
**Pixels per line:** 8192 (4 x 2048)  
**max. Pixel frequency:** 40 MHz  
**Line frequency:**  
 $f = 40\text{MHz}/((2048 + 64) \cdot 4) = 4,37 \text{ kHz}$   
**Power consumption:**  
 +5V (10 MHz):  $4 \times 120 + 150 = 630 \text{ mA} < 1 \text{ A}$   
 Power via PC-Interface is possible  
**Merger Box settings:**  
 Jumper 1: Power supplied from PC (SW0,SW1,SW2: all 2-3 closed)  
 Jumper 2: Mode 2, double buffered (SW0,SW1: all open, divider 4)

**Configuration 4**

**Components:**

- 6 x CCD-Line scan camera SK2048DJRI (2048 Pixel), Pixel-Clock 10 MHz
- 2 x Merger Box SK9195
- 1 x PC-Interface SK9192D
- 8 x Connecting cable SK9019.xFF
  - e.g. 6 x SK9019.3FF - length 3 m
  - 2 x SK9019.1FF - length 1 m

**Pixels per line:** 12288 (6 x 2048)  
**max. Pixel frequency:** 40 MHz  
**Line frequency:**  
 $f = 40\text{MHz}/(2048+64) \cdot 6 = 3,17 \text{ kHz}$   
**Power consumption:**  
 +5V (10 MHz):  $6 \cdot 120 + 150 + 150 = 1020\text{mA} > 1\text{A}$   
 External power supply necessary  
**Merger Box Nr. 1 settings:**  
 Jumper 1: SW0,SW1,SW2: all 2-3 closed  
 Jumper 2: Mode 2, double buffered, SW0, SW1: open, divider 4 SW2: closed  
**Merger Box Nr. 2 settings:**  
 Jumper 1: SW0, SW1,SW2: all 1-2 closed  
 Jumper 2: Mode 2, double buffered, SW0, SW1: open, divider 4 SW2: closed



The Merger Box SK9195 Nr. 1 concatenates the signals from camera 5 (CAM 1) and 6 (CAM 2) into a virtual line scan camera with 4096 pixels. The pixel frequency of the output is 40 MHz.  
 The Merger Box SK9195 Nr. 2 takes the output from Merger Box Nr.1 and concatenates the signals from cameras 1 to 4 into a virtual line camera signal of 12288 pixels, which is output at 40 MHz.