ReconFlex™ Camera

Manual

ReconFlex™

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User Manual for the
Recon*Flex*™ Camera Series
Releases: 800, 1920
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1 Table of Contents

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2 Introduction

2.1 General Information

This manual is intended to assist users in the installation, operation and maintenance of the ReconFlex™ 800 and 1920 cameras. It is divided into 6 chapters. The chapter "Introduction" contains a brief description of the cameras. The chapter "Installation" refers to installation and cabling. The final 3 chapters describe the camera layout, its functionalities and the technical details of the camera.

2.2 Safety Instructions

Please read this manual carefully before performing any electrical or electronic operations and strictly follow the safety rules given within this manual. Surface Concept declines all responsibility for damages or injuries caused by an improper use of the module due to negligence on behalf of the User.
Please also respect the Surface Concept Device Safety Instructions Manual in addition and all given safety rules within it.

The following symbols appear throughout the manual:

Note

The "note symbol" marks text passages, which contain important information/ hints about the operation of the cameras. Follow these information to ensure a proper functioning of the detector.

The "caution symbol" marks warnings, which are given to prevent an accidentally damaging of the detector or the readout system. Do NOT ignore these warnings and follow them strictly. Otherwise no guarantee is given for arose damages.

2.3 General Overview of the Cameras

Recon*Flex*™ cameras are unique, very fast, feature rich and multi-configurable CMOS cameras for fast synchronization, for fast peak coordinate counting and for very fast Super Resolution Microscopy.
All models are easy to integrate as they are equipped with two regular and commonly available data interfaces (Gbit LAN and USB 3) and yet enable to make use of very high frame rate imaging.
They were developed for the needs of scientific applications but they are well suitable to any task when automation of data analysis meets the need for excellent frame control and high frame rates.

Most prominent scientific uses are:

- simultaneous light peak position counting in particle detectors at highest rates
- direct super resolution microscopy with STORM, dSTORM or PALM imaging
- monitoring of fast dynamic processes or investigation of weak contrasts in rather short times (e.g. micro-damage analysis, forensic, quality control, machine vision and material inspection)

3 Installation

3.1 Initial Inspection

Visual inspection of the system is required to ensure that no damage has occurred during shipping. Should there be any signs of damage, please contact your provider immediately. Please check the delivery according to the packing list (see Table 1) for completeness.

- ReconFlex™ camera
- 1x USB cable
- 1x Ethernet cable
- 2x BNC - SMA cable (standard version)
- 3x BNC - SMA cable (sub-release A, B and S)
- 1x Wall Power Supply
- Storage Medium with Documentation and Software

Table 1: Packing list for the ReconFlex cameras.

3.2 Cabling

The general connection scheme of the Recon*Flex*™ cameras is given in Figure 1.

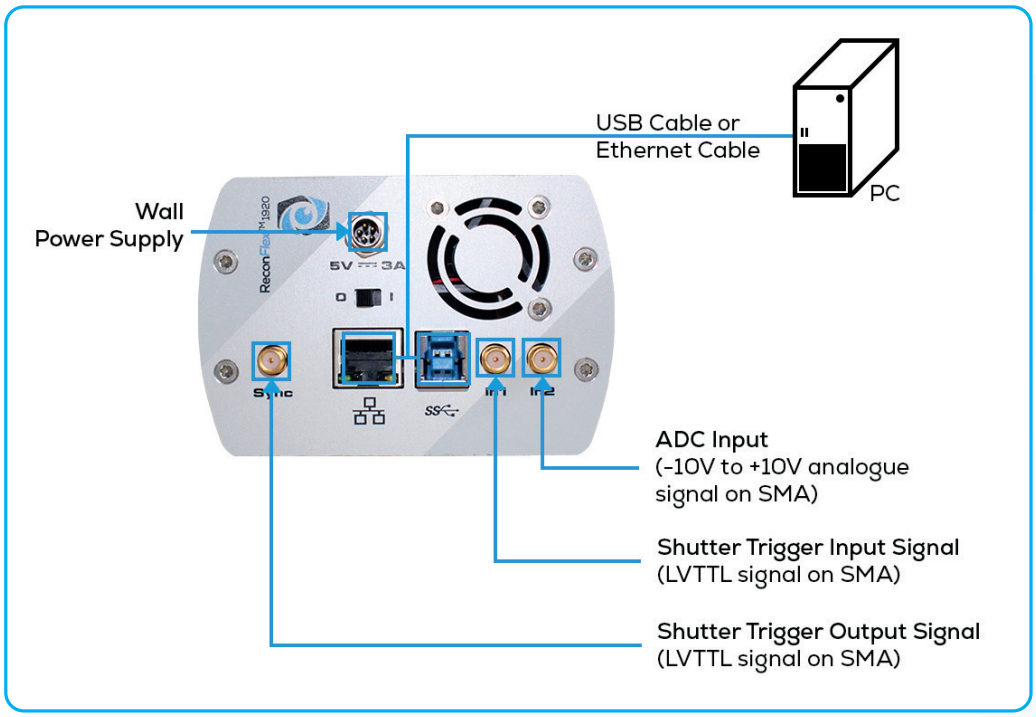

Figure 1: General connection scheme of the Recon*Flex* cameras.

For all release versions

- Use the USB or the Ethernet cable to connect the camera to the PC. Do not use PC front panel USB connectors; they are often restricted in performance.
- To read out the shutter trigger output signal one can connect one of the BNC - SMA cables to the SMA connector named “SYNC”.
- To apply a shutter trigger input signal one can connect one of the BNC - SMA cables to the SMA connector named “IN 1”.
- Connect the wall power supply to the 5 pin connector of the Recon*Flex* camera.
- Install the camera device driver and/or software package prior to switching on the camera.

For sub-release versions A, B and S

- To apply an analogue signal to the ADC one can connect one of the BNC - SMA cables to the SMA connector named “IN 2”.

Finish the complete cabling before the camera is turned on and the GUI software is started.
Also, close the software and turn off the camera before performing any changes to the cabling.

3.3 Software Installation, Requirements and Interface

All operation functions for data readout of the camera are encapsulated in a dynamic linked library (scTDC1.dll). Data processing and presentation on the PC is realized by an end-user software (e.g. GUI). See the corresponding software manual for detailed information on the software package and the DLL interface.

The delivery package of the camera includes a storage medium with hardware drivers and the end-user software. Connect the storage medium to your PC and install the software package as described in the Recon*Flex*™ Software Manual.

Read-out of the camera is done with a standard PC via the USB or Ethernet port. For the PC the following minimum system requirements are highly recommended:

- Processor: Quad Core
- RAM: 4GB
- Windows 10 or higher
- USB (no front panel connector)

Note

Do not use front panel USB connectors as they are typically reduced in performance.

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4 Camera Layout

4.1 Layout of the ReconFlex™ Cameras

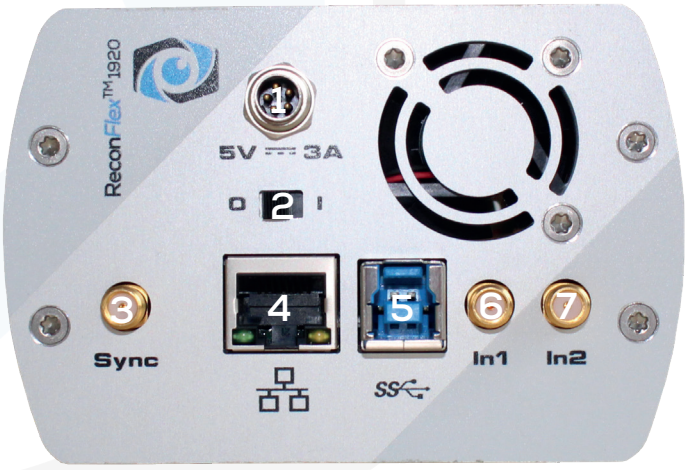

Figure 2: Layout of the Recon*Flex* 1920 and Recon*Flex* 800.

1. Power Socket (5 pin) for wall power supply
2. Power Switch to turn the camera ON/ OFF
3. SMA Socket for Shutter Trigger Output Signal
4. Gbit LAN Connection Socket
5. USB 3 Connection Socket
6. SMA Socket for Shutter Trigger Input Signal
7. SMA Socket for ADC Input

4.1.1 Shutter Trigger Output

The Recon*Flex*™ cameras signalize permanently the current exposure state by a low voltage TTL signal on the SMA connector named “SYNC”.
It provides high-level (› 1.8V) when an exposure is active and low-level (‹ 0.8V) when no active exposure is progressing.

Note

The “SYNC” output may not provide high current, thus the voltage may break down below the regular high level when the receiver resistance is smaller than 10 kOhms).

4.1.2 Shutter Trigger Input

The frame shutters can be controlled by software or by wire using external signals for opening or for closing or for both by applying a low voltage TTL signal to the SMA connector named “IN 1”.
Frame shutter synchronization signals can be applied periodically or in any random order (within the timing limits). The mode is adjustable from the GUI software.
A trigger by wire may also be applied to trigger software defined acquisition of frame groups.

Mode = 0
L→H and H→L signal required at “IN 1”

start and stop by wire
The rising edge starts the exposure time, the falling edge stops the exposure time of each frame.
The hardware dead time between end of a frame and start of the next frame depends on the camera model and the operational mode:
Recon*Flex* 800 (8 bit mode): 45.4 ± 0.1µs
Recon*Flex* 800 (12 bit mode): 57.7 ± 0.2µs
Recon*Flex* 1920 (8 bit mode): 57.1 ± 0.4µs
Recon*Flex* 1920 (12 bit mode): 70.1 ± 0.7µs

Mode = 1
no signals required at “IN 1”

start and stop by software (default mode)
The software triggers the frame start or the start of a frame group and every frame exposure stops after the software specified exposure time.
The dead time between the frames or frame groups may vary, depending on OS timing, particularly on the data interface speed and on the software data extraction delays and display speed.
Depending on software modes, typical values are ~ 20ms – 150ms for single images, higher between groups of multiple frames.
Typical dead times between end of a frame and start of the next frame within the frame groups: 45µs – 70µs.

Mode = 2
L→H signal required at “IN 1”

start by wire and stop by software
The rising edge starts the exposure time of each frame, but every frame exposure stops after the software specified exposure time. Minimum time between end of a frame and start of the next frame: 45µs – 70µs.
Caution: Overhead times due to software data receiving and data operating delays may sum up, so that the system must react on occupied data buffers by inserting appropriate time delays.

Mode = 3
L→H signal required at “IN 1”

start by software and stop by wire
The software triggers the frame start or the start of a frame group, while the rising edge at IN1 stops the exposure time of the active frame exposure.
If a frame group is specified, the following frame starts earliest after the last frame exposure ended.
The hardware dead time between end of a frame and start of the next frame depends on the camera model and the operational mode:
Recon*Flex* 800 (8 bit mode): 45.4 ± 0.1s
Recon*Flex* 800 (12 bit mode): 57.7 ± 0.2µs
Recon*Flex* 1920 (8 bit mode): 57.1 ± 0.4µs
Recon*Flex* 1920 (12 bit mode): 70.1 ± 0.7µs

4.1.3 Frame Group Trigger Mode

This mode is recommended to triggering frame groups.
It provides minimal dead time between the frames in the group together with mode 1.
When combined with modes 0, 2 or 3, the signal at “IN 1” is commonly active also for the shutter control. EXT TRIGGER is ignored during the group acquisition.

L→H signal required at “IN 1” (dual use of the “IN 1” signal)

A software acquisition start is required.
When it appears, the camera state changes to waiting for the next L→H transition on “IN 1”.
This function works independently on and in parallel to the shutter mode (0 - 3).

Note

Note, that the number of frames in the group does not exceed the hardware frame buffer capacity and the single exposure time is short enough to enable the expected frame rate. FIFO memory occupation may pile up when group data are transferred and operated too slow before the next group exposure is started.

4.1.4 Optimal Dynamic Range and Frame Exposure Times

The Recon*Flex*™ cameras are equipped with ultra fast, highly sensitive image sensors, optimized for very short exposure times and low light applications.
Use 2µs as lowest exposure time with Recon*Flex*™ 800 and 4µs with the Recon*Flex*™ 1920 devices.
The high sensitive sensors work only optimal when a single exposure time does not exceed some hundred milliseconds. We recommend to realize high exposure times by using the frame number parameter as a multiplier.
For instance, an exposure time of 1 second can be realized in highest quality with 5 frames at 200ms exposure time each.
The software ensures measurements with negotiable dead times and automatic summing for such settings. In addition, this method reduces noise and provides to collect long exposed images at very high dynamics of 32 bit. As the sensors are very sensitive, grey levels may exceed the used dynamic range (8bit or 12bit) already at exposure times of some milliseconds.
Recon*Flex*™ cameras can work in 8bit or 12bit modes in order to meet demands of different applications.
The 12bit sensor mode can be combined with a 8bit transfer mode for faster data transfer and optimizing frame buffer memory usage. In this case, a bit shift parameter can be defined in order to set which bits out of the 12bit measured at the sensor are transferred. The higher bits provide higher dynamics, the lower bits higher sensitivity.

4.1.5 Memory Management and Hardware Frame Buffers

The image sensors in Recon*Flex*™ cameras are read out internally with rates of 19Gbits per second. The effective transfer speed between hardware buffers and receiving software via USB 3 or Gbit LAN is always much smaller than the internal writing speed into the hardware buffer memory. The transfer also may vary due to the behaviour of the receiving OS, of the used hardware and of the software which all may cause different overhead times for the image reading process.

The data transfer and operation speed may not be sufficient to realize sustainably measuring at high frame rates in combination with large pixel numbers. The frame data can be stored in the camera by a FIFO memory until they can be transferred to the receiving device. All Recon*Flex*™ cameras are equipped with 500Mbyte of such memory holding the internal hardware frame buffers for all normal camera operation. The size of this memory was chosen to be a reasonable compromise between storage capacity and the pile up of reading time when it may become more and more occupied.
The reading pile up time depends on the degree of occupation of the frame buffer memory, on the reading performance of the receiver software and on the interface speed (e.g. the used USB or Ethernet). This causes dead times in the work flow of the camera usage for applications that use the maximum possible frame rates.
Therefore Recon*Flex*™ cameras allow to work with whole frame groups in order to better handle dead times. Beside calculations, it may require proper test measurements in order to find the suitable setup for ROI, exposure time, trigger mode and the number of frames per group for a certain application with high frame rates.

The transfer overhead pile up effects and thus reading dead times and the hardware frame buffer capacity limit may vanish completely when Recon*Flex* cameras are operated in the blob finder mechanism (sub-R B, see Section 4.1.7) and in the super resolution mechanism (sub-R S, see Section 4.1.8). The data transfer bandwidth per frame is reduced in these modes by factors between multiple 10 and several 10000, even for the maximum frame size and rate.

Chapter 5 provides selected values for the highest possible exposure times per frame if the camera is supposed to work at maximum frame rate under different bit modes and line numbers.
Though, the number of frames to store will increase and the pile up of reading times will decrease with smaller pixel numbers per lines. These limits depend on the camera type, the used bit modes and on the used ROI.
The achievable frame rates into the Recon*Flex*™ hardware buffer do not depend on x settings in the ROI but reducing the x setting increases the number of frames that fit into the hardware buffer accordingly.

4.1.6 Exposure time limits and number of storable frames

The following tables (see Table 2 and Table 3) list exposure time limits and number of storable normal frames (not peak finder mode) for different settings for transfer and ROI in x for the ReconFlex™ 1920 and the ReconFlex™ 800 cameras.

Note

Not all values of rows and columns are possible to set for ROIs at the hardware level, the software may correct the user input to the next suitable value.

	ReconFlex™ 1920 8bit mode		ReconFlex™ 1920 12bit mode		ReconFlex™ 1920 12bit mode	
transfer / x-ROI	8bit / 1920		8bit / 1920		12bit / 800	
lines	frame exposure limit [µs]*	frame buffers [N]**	frame exposure limit [µs]*	frame buffers [N]**	frame exposure limit [µs]*	frame buffers [N]**
1400	2276	218	4074	246	4074	149
1200	1967	255	3517	288	3517	175
1024	1694	300	3027	339	3027	205
1000	1657	307	2960	347	2960	211
800	1347	386	2403	437	2403	263
600	1037	518	1846	589	1846	354
512	901	610	1601	695	1601	417
400	728	788	1289	902	1289	539
256	504	1257	888	1463	888	860
200	418	1638	732	1927	732	1121
128	306	2674	531	3257	531	1833
64	207	6130	353	8424	353	4205
32	158	17297	264	40571	264	11877
16	133	188780	219	no limit	219	132983
8	120	no limit	197	no limit	197	no limit

Table 2: Exposure time limits and number of storable normal frames for the ReconFlex 1920.

transfer / x-ROI	ReconFlex™ 800 8bit mode 8bit / 800		ReconFlex™ 800 12bit mode 8bit / 800		ReconFlex™ 800 12bit mode 12bit / 800	
lines	frame exposure limit [µs]*	frame buffers [N]**	frame exposure limit [µs]*	frame buffers [N]**	frame exposure limit [µs]*	frame buffers [N]**
600	567	1286	982	1522	982	883
512	496	1521	858	1812	858	1044
400	407	1979	700	2385	700	1358
256	292	3232	496	4022	496	2215
200	247	4283	417	5485	417	2936
128	189	7362	315	10306	315	5041
64	138	20428	225	47379	225	13944
32	113	186528	180	no limit	180	118281
16	100	no limit	157	no limit	157	no limit
8	93	no limit	146	no limit	146	no limit

Table 3: Exposure time limits and number of storable normal frames for the Recon*Flex* 800.

* Maximum possible frame exposure time in order to still reach the highest possible frame rate. The needed time gap between subsequent shutter open times depends on the camera model and on the used bit mode as follows:
Recon*Flex*™ 800 (8 bit mode): 45.4 ± 0.1µs
Recon*Flex*™ 800 (12 bit mode): 57.7 ± 0.2µs
Recon*Flex*™ 1920 (8 bit mode): 57.1 ± 0.4µs
Recon*Flex*™ 1920 (12 bit mode): 70.1 ± 0.7µs

** The frame numbers which are matching the buffer have been evaluated experimentally for a slow USB 3 reading capability. The typical USB 3 read out times for completely occupied frame buffer memory is 2500ms. The reachable frame numbers vary with the actual readout speed of the PC operation system and the used data interface (USB 3 and Gbit LAN).

4.1.7 ADC Input (sub-R A, B and S only)

The ReconFlex™ cameras can be equipped with an user ADC channel in order to measure shutter synchronously analogue voltages between -10V and +10V.
The analogue voltage must be applied to the SMA connector named “IN 2”.
The ADC works at 16 bits (14 bits real time resolution) and samples with sub-microsecond precision at the time of the shutter opening trigger. The ADC value will be available in the HDF5 data streaming.

4.1.8 Blob Finder Mechanism (sub-R B and S only)

The ReconFlex™ blob finder mechanism is able to localize up to several 10 thousand light peaks in every frame without additional overhead time, literally “on-the-fly”.
The blob finder works simultaneously to the sensor line readout and thus it consumes no overhead time in the readout process. A drastic reduction of transfer bandwidth is achieved when only the blob finder results must be send by LAN or USB. In such a mode, the ReconFlex™ cameras can even work in LAN connections for very long acquisition times at maximum frame rates and image sizes.

4.1.9 Super Resolution Mechanism (sub-R S only)

The ReconFlex™ cameras can be equipped with the nanoFLeye™ super resolution mechanism, which provides easy and fast STORM, dSTORM or PALM imaging even at very high frame rates with 2, 4, 8, or 16 times magnification without reading and processing all the many images. The nanoFLeye mechanism operates extremely swift and simultaneously with the sensor line by line reading and is thus as fast as the normal sensor readout, i.e. it works “on-the-fly” while the observed super resolution images evolve automatically.

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5 Technical Data

ReconFlex 1920

- Small table top housing with C-mount thread (nom.): 100mm x 100mm x 75mm (w/d/h)
- Image sensor type: CMOS (2/3)" monochrome global shutter
- Pixel numbers (max.): 1920 x 1440
- Pixel size: 4.5µm x 4.5µm
- Typical sensor noise: < $3e^-$
- Dynamic range: 80dB
- Frame exposure time range (higher background)*: 4µs - 200ms (up to 10000ms)
- Sensor readout dynamics (configurable): 8bit and 12bit
- Data readout formats (configurable): 12bit, 8bit (any out of 12bit @ sensor) and 8bit (native 8bit @ sensor)
- Max. image dynamics (software accumulated): 32bit
- frame rate @ full-frame into frame buffers (max.): 417fps (8bit @ sensor) and 234fps (12bit @ sensor)
- Frame rate @ hardware ROIs with 512 lines**: 1040fps (8bit) / 597fps (12bit)
- Frame rate @ hardware ROIs with 256 lines**: 1773fps (8bit) / 1041fps (12bit)
- Frame rate @ hardware ROIs with 128 lines**: 2732fps (8bit) / 1685fps (12bit)
- Frame rate @ hardware ROIs with 64 lines**: 3745fps (8bit) / 2352fps (12bit)
- Frame rate @ hardware ROIs with 32 lines**: 4587fps (8bit) / 2976fps (12bit)
- Frame rate @ hardware ROIs with 16 lines**: 5181fps (8bit) / 3436fps (12bit)
- Frame rate @ hardware ROIs with 8 lines**: 5555fps (8bit) / 3717fps (12bit)
- Frame buffer size on camera: 500MByte
- No. of full frame hardware buffers (8bit): > 200
- Shutter Trigger Input: Low voltage TTL on SMA socket
- Shutter Trigger Output: Low voltage TTL on high ohmic SMA socket
- Data interfaces (configurable): USB 3 and Gbit LAN

* The sensor works optimal at short exposure times, thus increase the frame number for use with exposure times that exceed 200ms.

** The frame rate scales not directly with the number of lines as there is a fixed frame overhead time. Line numbers and offsets should be chosen in multiples of 8. The frame rate is independent on the number of pixels per line due to technical reasons, although any horizontal ROI reduction saves frame buffer memory and transfer bandwidth.

Recon*Flex* 1920 A

- Small table top housing with C-mount thread (nom.): 100mm x 100mm x 75mm (w/d/h)
- Image sensor type: CMOS (2/3)" monochrome global shutter
- Pixel numbers (max.): 1920 x 1440
- Pixel size: 4.5µm x 4.5µm
- Typical sensor noise: < $3e^-$
- Dynamic range: 80dB
- Frame exposure time range (higher background)*: 4µs - 200ms (up to 10000ms)
- Sensor readout dynamics (configurable): 8bit and 12bit
- Data readout formats (configurable): 12bit, 8bit (any out of 12bit @ sensor) and 8bit (native 8bit @ sensor)
- Max. image dynamics (software accumulated): 32bit
- frame rate @ full-frame into frame buffers (max.): 417fps (8bit @ sensor) and 234fps (12bit @ sensor)
- Frame rate @ hardware ROIs with 512 lines**: 1040fps (8bit) / 597fps (12bit)
- Frame rate @ hardware ROIs with 256 lines**: 1773fps (8bit) / 1041fps (12bit)
- Frame rate @ hardware ROIs with 128 lines**: 2732fps (8bit) / 1685fps (12bit)
- Frame rate @ hardware ROIs with 64 lines**: 3745fps (8bit) / 2352fps (12bit)
- Frame rate @ hardware ROIs with 32 lines**: 4587fps (8bit) / 2976fps (12bit)
- Frame rate @ hardware ROIs with 16 lines**: 5181fps (8bit) / 3436fps (12bit)
- Frame rate @ hardware ROIs with 8 lines**: 5555fps (8bit) / 3717fps (12bit)
- Frame buffer size on camera: 500MByte
- No. of full frame hardware buffers (8bit): > 200
- Shutter Trigger Input: Low voltage TTL on SMA socket
- Shutter Trigger Output: Low voltage TTL on high ohmic SMA socket
- ADC Input: -10V to +10V analogue on SMA connector
- ADC dynamic: 16bit (14bit real time resolution)
- ADC synchronisation: shutter synchronous measurement with sub-microsecond precision
- Data interfaces (configurable): USB 3 and Gbit LAN

* The sensor works optimal at short exposure times, thus increase the frame number for use with exposure times that exceed 200ms.

** The frame rate scales not directly with the number of lines as there is a fixed frame overhead time. Line numbers and offsets should be chosen in multiples of 8. The frame rate is independent on the number of pixels per line due to technical reasons, although any horizontal ROI reduction saves frame buffer memory and transfer bandwidth.

ReconFlex 1920 B

- Small table top housing with C-mount thread (nom.): 100mm x 100mm x 75mm (w/d/h)
- Image sensor type: CMOS (2/3)" monochrome global shutter
- Pixel numbers (max.): 1920 x 1440
- Pixel size: 4.5µm x 4.5µm
- Typical sensor noise: < $3e^-$
- Dynamic range: 80dB
- Frame exposure time range (higher background)*: 4µs - 200ms (up to 10000ms)
- Sensor readout dynamics (configurable): 8bit and 12bit
- Data readout formats (configurable): 12bit, 8bit (any out of 12bit @ sensor) and 8bit (native 8bit @ sensor)
- Max. image dynamics (software accumulated): 32bit
- frame rate @ full-frame into frame buffers (max.): 417fps (8bit @ sensor) and 234fps (12bit @ sensor)
- Frame rate @ hardware ROIs with 512 lines**: 1040fps (8bit) / 597fps (12bit)
- Frame rate @ hardware ROIs with 256 lines**: 1773fps (8bit) / 1041fps (12bit)
- Frame rate @ hardware ROIs with 128 lines**: 2732fps (8bit) / 1685fps (12bit)
- Frame rate @ hardware ROIs with 64 lines**: 3745fps (8bit) / 2352fps (12bit)
- Frame rate @ hardware ROIs with 32 lines**: 4587fps (8bit) / 2976fps (12bit)
- Frame rate @ hardware ROIs with 16 lines**: 5181fps (8bit) / 3436fps (12bit)
- Frame rate @ hardware ROIs with 8 lines**: 5555fps (8bit) / 3717fps (12bit)
- Frame buffer size on camera: 500MByte
- No. of full frame hardware buffers (8bit): > 200
- Shutter Trigger Input: Low voltage TTL on SMA socket
- Shutter Trigger Output: Low voltage TTL on high ohmic SMA socket
- ADC Input: -10V to +10V analogue on SMA connector
- ADC dynamic: 16bit (14bit real time resolution)
- ADC synchronisation: shutter synchronous measurement with sub-microsecond precision
- Blob finder mechanism to identifying coordinates of local intensity peaks
- Data interfaces (configurable): USB 3 and Gbit LAN

* The sensor works optimal at short exposure times, thus increase the frame number for use with exposure times that exceed 200ms.

** The frame rate scales not directly with the number of lines as there is a fixed frame overhead time. Line numbers and offsets should be chosen in multiples of 8. The frame rate is independent on the number of pixels per line due to technical reasons, although any horizontal ROI reduction saves frame buffer memory and transfer bandwidth.

Recon*Flex* 1920 S

- Small table top housing with C-mount thread (nom.): 100mm x 100mm x 75mm (w/d/h)
- Image sensor type: CMOS (2/3)" monochrome global shutter
- Pixel numbers (max.): 1920 x 1440
- Pixel size: 4.5µm x 4.5µm
- Typical sensor noise: < $3e^-$
- Dynamic range: 80dB
- Frame exposure time range (higher background)*: 4µs - 200ms (up to 10000ms)
- Sensor readout dynamics (configurable): 8bit and 12bit
- Data readout formats (configurable): 12bit, 8bit (any out of 12bit @ sensor) and 8bit (native 8bit @ sensor)
- Max. image dynamics (software accumulated): 32bit
- frame rate @ full-frame into frame buffers (max.): 417fps (8bit @ sensor) and 234fps (12bit @ sensor)
- Frame rate @ hardware ROIs with 512 lines**: 1040fps (8bit) / 597fps (12bit)
- Frame rate @ hardware ROIs with 256 lines**: 1773fps (8bit) / 1041fps (12bit)
- Frame rate @ hardware ROIs with 128 lines**: 2732fps (8bit) / 1685fps (12bit)
- Frame rate @ hardware ROIs with 64 lines**: 3745fps (8bit) / 2352fps (12bit)
- Frame rate @ hardware ROIs with 32 lines**: 4587fps (8bit) / 2976fps (12bit)
- Frame rate @ hardware ROIs with 16 lines**: 5181fps (8bit) / 3436fps (12bit)
- Frame rate @ hardware ROIs with 8 lines**: 5555fps (8bit) / 3717fps (12bit)
- Frame buffer size on camera: 500MByte
- No. of full frame hardware buffers (8bit): > 200
- Shutter Trigger Input: Low voltage TTL on SMA socket
- Shutter Trigger Output: Low voltage TTL on high ohmic SMA socket
- ADC Input: -10V to +10V analogue on SMA connector
- ADC dynamic: 16bit (14bit real time resolution)
- ADC synchronisation: shutter synchronous measurement with sub-microsecond precision
- Blob finder mechanism to identifying coordinates of local intensity peaks
- Super resolution mechanism to achieve up to 16x magnification
- Data interfaces (configurable): USB 3 and Gbit LAN

* The sensor works optimal at short exposure times, thus increase the frame number for use with exposure times that exceed 200ms.

** The frame rate scales not directly with the number of lines as there is a fixed frame overhead time. Line numbers and offsets should be chosen in multiples of 8. The frame rate is independent on the number of pixels per line due to technical reasons, although any horizontal ROI reduction saves frame buffer memory and transfer bandwidth.

ReconFlex 800

- Small table top housing with C-mount thread (nom.): 100mm x 100mm x 75mm (w/d/h)
- Image sensor type: CMOS (1/1.7)" monochrome global shutter
- Pixel numbers (max.): 800 x 624
- Pixel size: 9µm x 9µm
- Typical sensor noise: < $6e^-$
- Dynamic range: 80dB
- Frame exposure time range (higher background)*: 2µs - 200ms (up to 10000ms)
- Sensor readout dynamics (configurable): 8bit and 12bit
- Data readout formats (configurable): 12bit, 8bit (any out of 12bit @ sensor) and 8bit (native 8bit @ sensor)
- Max. image dynamics (software accumulated): 32bit
- frame rate @ full-frame into frame buffers (max.): 1577fps (8bit @ sensor) and 929fps (12bit @ sensor)
- Frame rate @ hardware ROIs with 512 lines**: 1838fps (8bit) / 1087fps (12bit)
- Frame rate @ hardware ROIs with 256 lines**: 2941fps (8bit) / 1798fps (12bit)
- Frame rate @ hardware ROIs with 128 lines**: 4219fps (8bit) / 2666fps (12bit)
- Frame rate @ hardware ROIs with 64 lines**: 5376fps (8bit) / 3508fps (12bit)
- Frame rate @ hardware ROIs with 32 lines**: 6211fps (8bit) / 4166fps (12bit)
- Frame rate @ hardware ROIs with 16 lines**: 6756fps (8bit) / 4608fps (12bit)
- Frame rate @ hardware ROIs with 8 lines**: 7092fps (8bit) / 4854fps (12bit)
- Frame buffer size on camera: 500MByte
- No. of full frame hardware buffers (8bit): > 800
- Shutter Trigger Input: Low voltage TTL on SMA socket
- Shutter Trigger Output: Low voltage TTL on high ohmic SMA socket
- Data interfaces (configurable): USB 3 and Gbit LAN

* The sensor works optimal at short exposure times, thus increase the frame number for use with exposure times that exceed 200ms.

** The frame rate scales not directly with the number of lines as there is a fixed frame overhead time. Line numbers and offsets should be chosen in multiples of 8. The frame rate is independent on the number of pixels per line due to technical reasons, although any horizontal ROI reduction saves frame buffer memory and transfer bandwidth.

Recon*Flex* 800 A

- Small table top housing with C-mount thread (nom.): 100mm x 100mm x 75mm (w/d/h)
- Image sensor type: CMOS (1/1.7)" monochrome global shutter
- Pixel numbers (max.): 800 x 624
- Pixel size: 9µm x 9µm
- Typical sensor noise: < $6e^-$
- Dynamic range: 80dB
- Frame exposure time range (higher background)*: 2µs - 200ms (up to 10000ms)
- Sensor readout dynamics (configurable): 8bit and 12bit
- Data readout formats (configurable): 12bit, 8bit (any out of 12bit @ sensor) and 8bit (native 8bit @ sensor)
- Max. image dynamics (software accumulated): 32bit
- frame rate @ full-frame into frame buffers (max.): 1577fps (8bit @ sensor) and 929fps (12bit @ sensor)
- Frame rate @ hardware ROIs with 512 lines**: 1838fps (8bit) / 1087fps (12bit)
- Frame rate @ hardware ROIs with 256 lines**: 2941fps (8bit) / 1798fps (12bit)
- Frame rate @ hardware ROIs with 128 lines**: 4219fps (8bit) / 2666fps (12bit)
- Frame rate @ hardware ROIs with 64 lines**: 5376fps (8bit) / 3508fps (12bit)
- Frame rate @ hardware ROIs with 32 lines**: 6211fps (8bit) / 4166fps (12bit)
- Frame rate @ hardware ROIs with 16 lines**: 6756fps (8bit) / 4608fps (12bit)
- Frame rate @ hardware ROIs with 8 lines**: 7092fps (8bit) / 4854fps (12bit)
- Frame buffer size on camera: 500MByte
- No. of full frame hardware buffers (8bit): > 800
- Shutter Trigger Input: Low voltage TTL on SMA socket
- Shutter Trigger Output: Low voltage TTL on high ohmic SMA socket
- ADC Input: -10V to +10V analogue on SMA connector
- ADC dynamic: 16bit (14bit real time resolution)
- ADC synchronisation: shutter synchronous measurement with sub-microsecond precision
- Data interfaces (configurable): USB 3 and Gbit LAN

* The sensor works optimal at short exposure times, thus increase the frame number for use with exposure times that exceed 200ms.

** The frame rate scales not directly with the number of lines as there is a fixed frame overhead time. Line numbers and offsets should be chosen in multiples of 8. The frame rate is independent on the number of pixels per line due to technical reasons, although any horizontal ROI reduction saves frame buffer memory and transfer bandwidth.

ReconFlex 800 B

- Small table top housing with C-mount thread (nom.): 100mm x 100mm x 75mm (w/d/h)
- Image sensor type: CMOS (1/1.7)" monochrome global shutter
- Pixel numbers (max.): 800 x 624
- Pixel size: 9µm x 9µm
- Typical sensor noise: < $6e^-$
- Dynamic range: 80dB
- Frame exposure time range (higher background)*: 2µs - 200ms (up to 10000ms)
- Sensor readout dynamics (configurable): 8bit and 12bit
- Data readout formats (configurable): 12bit, 8bit (any out of 12bit @ sensor) and 8bit (native 8bit @ sensor)
- Max. image dynamics (software accumulated): 32bit
- frame rate @ full-frame into frame buffers (max.): 1577fps (8bit @ sensor) and 929fps (12bit @ sensor)
- Frame rate @ hardware ROIs with 512 lines**: 1838fps (8bit) / 1087fps (12bit)
- Frame rate @ hardware ROIs with 256 lines**: 2941fps (8bit) / 1798fps (12bit)
- Frame rate @ hardware ROIs with 128 lines**: 4219fps (8bit) / 2666fps (12bit)
- Frame rate @ hardware ROIs with 64 lines**: 5376fps (8bit) / 3508fps (12bit)
- Frame rate @ hardware ROIs with 32 lines**: 6211fps (8bit) / 4166fps (12bit)
- Frame rate @ hardware ROIs with 16 lines**: 6756fps (8bit) / 4608fps (12bit)
- Frame rate @ hardware ROIs with 8 lines**: 7092fps (8bit) / 4854fps (12bit)
- Frame buffer size on camera: 500MByte
- No. of full frame hardware buffers (8bit): > 800
- Shutter Trigger Input: Low voltage TTL on SMA socket
- Shutter Trigger Output: Low voltage TTL on high ohmic SMA socket
- ADC Input: -10V to +10V analogue on SMA connector
- ADC dynamic: 16bit (14bit real time resolution)
- ADC synchronisation: shutter synchronous measurement with sub-microsecond precision
- Blob finder mechanism to identifying coordinates of local intensity peaks
- Data interfaces (configurable): USB 3 and Gbit LAN

* The sensor works optimal at short exposure times, thus increase the frame number for use with exposure times that exceed 200ms.

** The frame rate scales not directly with the number of lines as there is a fixed frame overhead time. Line numbers and offsets should be chosen in multiples of 8. The frame rate is independent on the number of pixels per line due to technical reasons, although any horizontal ROI reduction saves frame buffer memory and transfer bandwidth.

Recon*Flex* 800 S

- Small table top housing with C-mount thread (nom.): 100mm x 100mm x 75mm (w/d/h)
- Image sensor type: CMOS (1/1.7)" monochrome global shutter
- Pixel numbers (max.): 800 x 624
- Pixel size: 9µm x 9µm
- Typical sensor noise: < $6e^-$
- Dynamic range: 80dB
- Frame exposure time range (higher background)*: 2µs - 200ms (up to 10000ms)
- Sensor readout dynamics (configurable): 8bit and 12bit
- Data readout formats (configurable): 12bit, 8bit (any out of 12bit @ sensor) and 8bit (native 8bit @ sensor)
- Max. image dynamics (software accumulated): 32bit
- frame rate @ full-frame into frame buffers (max.): 1577fps (8bit @ sensor) and 929fps (12bit @ sensor)
- Frame rate @ hardware ROIs with 512 lines**: 1838fps (8bit) / 1087fps (12bit)
- Frame rate @ hardware ROIs with 256 lines**: 2941fps (8bit) / 1798fps (12bit)
- Frame rate @ hardware ROIs with 128 lines**: 4219fps (8bit) / 2666fps (12bit)
- Frame rate @ hardware ROIs with 64 lines**: 5376fps (8bit) / 3508fps (12bit)
- Frame rate @ hardware ROIs with 32 lines**: 6211fps (8bit) / 4166fps (12bit)
- Frame rate @ hardware ROIs with 16 lines**: 6756fps (8bit) / 4608fps (12bit)
- Frame rate @ hardware ROIs with 8 lines**: 7092fps (8bit) / 4854fps (12bit)
- Frame buffer size on camera: 500MByte
- No. of full frame hardware buffers (8bit): > 800
- Shutter Trigger Input: Low voltage TTL on SMA socket
- Shutter Trigger Output: Low voltage TTL on high ohmic SMA socket
- ADC Input: -10V to +10V analogue on SMA connector
- ADC dynamic: 16bit (14bit real time resolution)
- ADC synchronisation: shutter synchronous measurement with sub-microsecond precision
- Blob finder mechanism to identifying coordinates of local intensity peaks
- Super resolution mechanism to achieve up to 16x magnification
- Data interfaces (configurable): USB 3 and Gbit LAN

* The sensor works optimal at short exposure times, thus increase the frame number for use with exposure times that exceed 200ms.

** The frame rate scales not directly with the number of lines as there is a fixed frame overhead time. Line numbers and offsets should be chosen in multiples of 8. The frame rate is independent on the number of pixels per line due to technical reasons, although any horizontal ROI reduction saves frame buffer memory and transfer bandwidth.

6 List of Figures

EC Declaration of Conformity

Manufacturer	Surface Concept GmbH Am Sägewerk 23a 55124 Mainz Germany
	phone: +49 6131 62716 0 fax: +49 6131 62716 29 email: info@surface-concept.de web: www.surface-concept.de
Product	Recon*Flex*™ Camera
Model No.	800 & 1920

The above named products comply with the following European directive:

89/336/EEC	Electromagnetic Compatibility Directive, amended by 91/263/ EEC and 92/31/ EEC and 93/68/EEC
73/23/EEC	Low Voltage Equipment Directive, amended by 93/68/EEC

The compliance of the above named product to which this declaration relates is in conformity with the following standards or other normative documents where relevant:

EN 61000-6-2:2005+AC:2005	Electromagnetic compatibility (EMC): Generic standards - Immunity for industrial environments
EN 61000-6-4:2007+A1:2011	Electromagnetic compatibility (EMC): Generic standards - Emission standard for industrial environments
EN 61010-1: 2010	Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use

For and on behalf of **Surface Concept GmbH**

Mainz,……01.03.2020……. (Date)

Legal Signature…… (Dr. Andreas Oelsner)

This declaration does not represent a commitment to features or capabilities of the instrument. The safety notes and regulations given in the product related documentation must be observed at all times.