

PRELIMINARY DATA SHEET

SkiaGraph™ 8

Very Large Area X-Ray Camera



Key Features:

- Active area of 20 cm x 20 cm
- 5 lp/mm (96 μ m) resolution
- Over four million pixels
- 12-bit digital video output
- Thin, flat-panel form factor
- LVDS frame grabber interface with real-time video up to 1.3 fps at full resolution
- Ready-to-run software and drivers

The SkiaGraph8 x-ray camera is a stand-alone, high-resolution radiation-imaging device complete with 12-bit digital interface. The SkiaGraph8 features the Very Large-Area RadEye800 CMOS image sensor module with 5 lp/mm resolution (96 μ m pixel spacing) in a 2000 by 2048 pixel array. The sensor has an integrated direct-contact scintillator and is currently available in the standard (10-50 kV) energy range, making the SkiaGraph8 an ideal choice for low to moderate energy applications including medical diagnostics, industrial inspection (NDT) and scientific imaging.

Description:

The SkiaGraph8 X-ray camera is a complete detection system for high-resolution radiation imaging. At the heart of the SkiaGraph8 is a two-dimensional photodiode array that contains over four million pixels on 96 μm centers. The total active area of the sensor adds up to nearly 20 cm per side. The camera electronics deliver 4000:1 dynamic range (defined as the maximum signal divided by the read noise) at a maximum frame rate of 1.3 frames per second. Sensors operate from a standard 6-8 V desktop power supply and consume less than 5 Watts of power.

The detector array consists of eight of the newly developed RadEye100 sensors that are tiled in a 2x4 matrix and read out through separate electronic channels. The analog signals from the photodiode sensors are digitized to 12-bit resolution in eight parallel A/D channels, and then interleaved for maximum transmission speed across a high-speed parallel digital interface. This interface consists of a 68-pin mini-D (SCSI-3) receptacle and conforms to the AIA (Automated Imaging Association) A15.08 specification. Pixel clock, line enable and frame enable signals are available at the connector to facilitate acquiring the image data with a standard LVDS (EIA-644) digital frame grabber. A custom cable will be required for most frame grabber models.

The CMOS sensor array inside the SkiaGraph8 camera is in direct contact with a $\text{Gd}_2\text{O}_2\text{S}$ (gadox) scintillator such as Min-R[®] 2190 or DRZ-Std. The scintillator converts x-ray photons into visible light that is sensed by the CMOS photodiodes. A thin graphite cover protects the sensor from accidental damage as well as ambient light. The SkiaGraph8 camera also contains steel shielding to protect the camera electronics from the x-ray radiation. The SkiaGraph8 camera is optimized for the standard energy range (10-50 kV). Please refer to our application notes for additional information.

Specifications:

Detector Specifications		Units
Number of active rows	2000	pixels
Number of columns	2048	pixels
Active area height	192	mm
Active area width	196.6	mm
Pixel spacing (pitch)	0.096	mm
Typical fill factor	85	%
Avg. dark current (23°C) ⁽¹⁾	38	ADU/s ⁽²⁾
Read noise (rms)	< 1	ADU
Dynamic range	4000:1	
Digitization	12	bits
Conversion gain	1400	electr/ADU
Readout period ⁽³⁾	735	ms
Max. frame rate	1.36	Hz
Output data rate	6	MHz

⁽¹⁾ dark current doubles approx. every 8°C

⁽²⁾ ADU = Analog-Digital Unit = 1 LSB (Least Significant Bit)

⁽³⁾ time required to transfer image from sensor to camera memory

Camera Specifications		Units
Typical supply voltage	6.5	Volts
Supply voltage range	6.0 to 8.0	Volts
Maximum supply current	750	mA
Typical power dissipation	< 5	Watts
Data interface	EIA-644	
SMA connector interface	TTL	

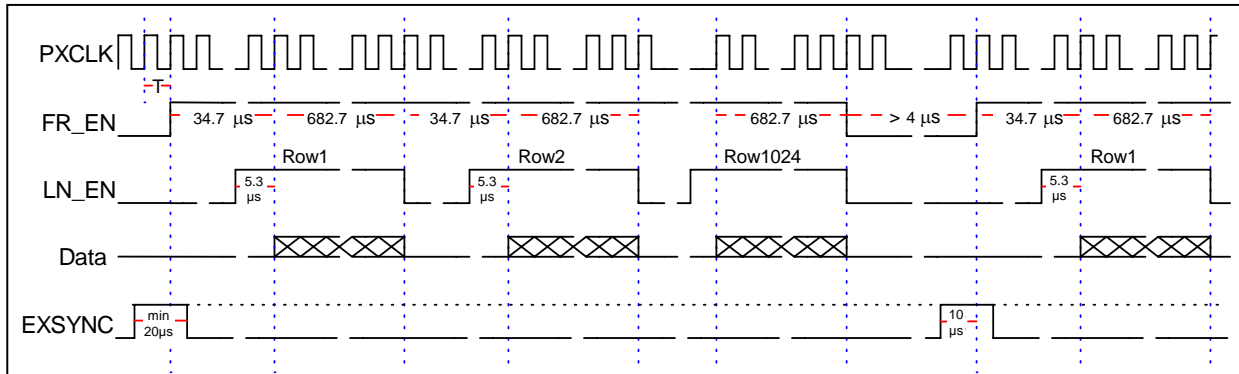
General Specifications		Units
Operating Temperature	0 to 50	°C
Storage Temperature	-25 to +85	°C
Humidity (non-condensing)	10 to 80	% R.H.
Weight	3.5	kg

Software
The SkiaGraph camera ships with our ShadoCam Imaging Software, which runs under Windows [®] 98, 2000, NT, XP, and VISTA. Check with your frame grabber manufacturer for compatibility with these and other operating systems.

Camera Timing:

The camera frame rate can be controlled through the external frame sync inputs on either the parallel interface (EXSYNC) or the separate SMA receptacle. If these inputs are pulled high (SMA not connected) the camera will run continuously at its maximum frame rate of 1.3 fps. To ensure proper synchronization, it is recommended that either one (but not both!) of the frame sync inputs be used to control the frame rate. The camera controller will wait for a rising edge on this input before starting the next frame readout.

The digital data on the parallel interface are valid when the pixel clock (PXCLK) is high. To minimize transmission errors, the data should be sampled on its falling edge. The line enable signal (LN_EN) goes high 32 clock cycles before the first valid pixel. It is low for 176 pixel clock cycles during the horizontal blanking interval. It is also low for a minimum of 200 cycles between frames. Frame enable (FR_EN) goes low during the vertical blanking interval to signal the beginning of a new frame. This signal is also available on one of the SMA connectors and can be used to synchronize external events to the camera.



Signal	Parameter	Value	Unit
EXSYNC	min. pulse width	20	μs
	max. pulse width	730 / 190 [#] / 40 ^{##}	ms
	delay to FR_EN rising edge (typ.)	10	μs
FR_EN	high period (frame active)	734.5 / 192.5 [#] / 43.7 ^{##}	ms
	low period (EXSYNC high)	4.0	μs
	low period (EXSYNC low)	until next edge on EXSYNC	
	delay to LN_EN rising edge	29.3	μs
LN_EN	high period (line active)	688.0 / 346.7 [#] / 13.3 ^{##}	μs
	low period (between lines)	29.3	μs
	low period (between frames)	29.3μs + FR_EN low period	
PXCLK	period (T)	166.7	ns
	duty cycle	50	%

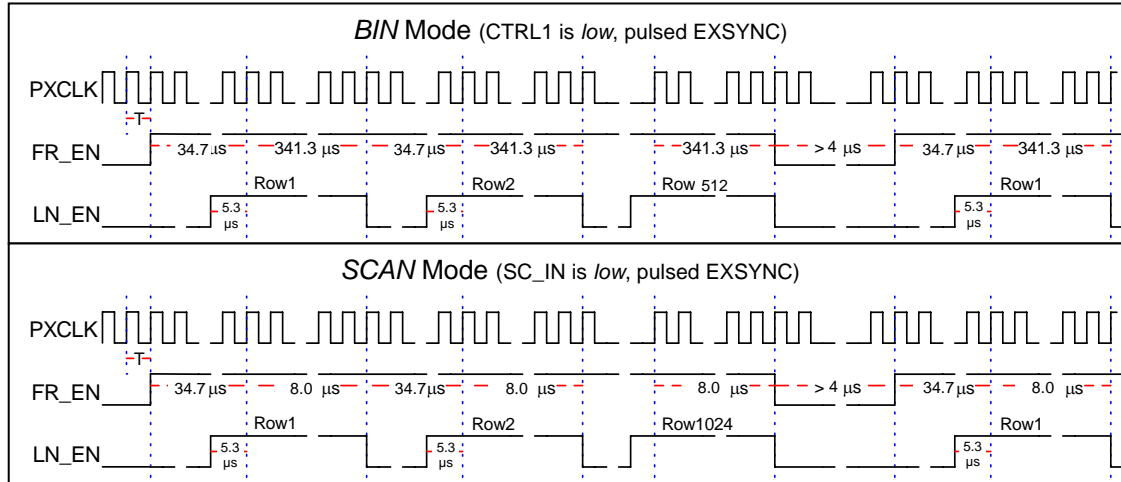
[#]BIN Mode (CTRL1 input low)

^{##}SCAN Mode (SC_IN input low)

The binning (CTRL1) and fast scan (SC_IN) control inputs offer additional functionality in the camera. The bin mode (CTRL1 *low*) causes the readout to skip every other row and column. This shortens the readout time and raises the maximum frame rate of the camera to 5.2 fps. The resulting sub-sampled image contains 1024 columns by 1000 rows.

Camera Timing (cont.):

A low level on the SC_IN input puts the camera into a rapid-readout mode in which only the first six pixels of each sensor row are read. In this mode it is possible to scan all 1000 rows of the sensor in just 44 ms. This feature can be used to rapidly reset the dark signal prior to an exposure.

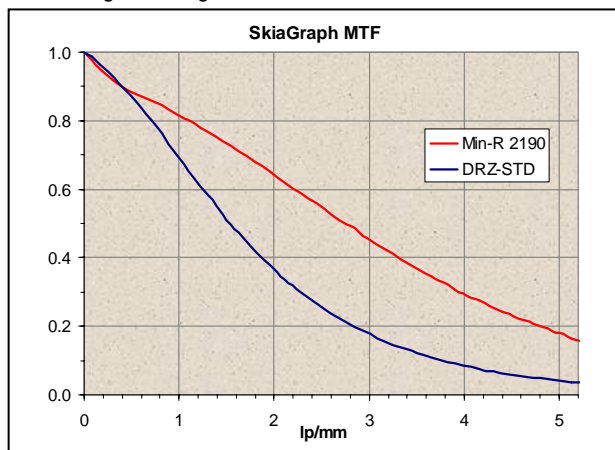


Resolution & Sensitivity:

The SkiaGraph8 detector features a pixel spacing of 96 μm , which corresponds to a resolution of just over 5 line pairs per mm. The actual Modulation Transfer Function (MTF) of the detector depends on the type of scintillator that is installed. A thicker phosphor screen will produce more signal, but at the expense of high-frequency contrast.

Scintillator	Typical Sensitivity ⁽¹⁾
Min-R 2190	98 ADU/mR @ 35kVp 105 ADU/mR @ 50kVp
DRZ-Std	214 ADU/mR @ 35kVp 257 ADU/mR @ 50kVp

⁽¹⁾W target, 2mm glass window, no filtration



Readout Sequence:

The image area of the RadEye8 sensor is scanned through eight parallel channels. The row scan starts at the center of the active area and scans simultaneously toward the top and the bottom. Each line is scanned in eight sections. The four bottom sections scan left to right, and the top sections scan right to left. All eight sections are scanned in parallel and then interleaved for transmission. The data must be deinterlaced in software to restore the image.

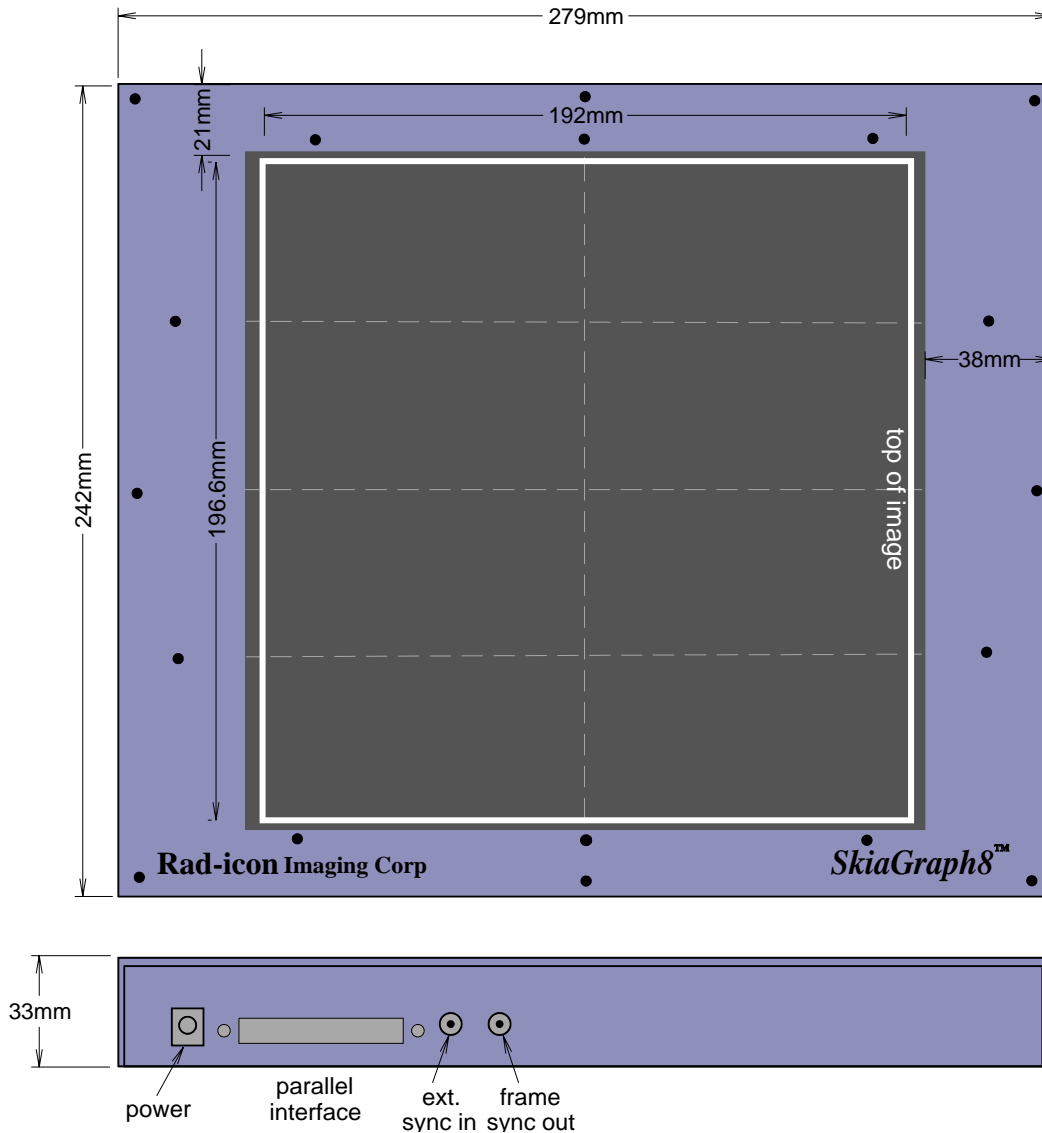
Ordering Information:

SkiaGraph8 cameras are available in a single image quality grade, and can be ordered either with a Kodak Min-R[®] 2190 or a Kasei Optonix DRZ-Std scintillator. Additional scintillators may be available by special order. All cameras ship with a universal input power supply (90-264V, 50-60Hz). For international orders, please specify the type of power cord you require.

P/N	Description
SK1225	SkiaGraph8 Camera (10-50 kV)
-01	Min-R 2190
-02	DRZ Standard

Image Quality: up to 15 correctable line defects allowed

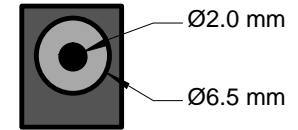
Mechanical Drawing:



Power Connector:

DC power jack, 2.0 mm center pin diameter. Fits standard female power plug with 2.1 mm inside diameter and 5.5 mm outside diameter.

center pin:
6.5 VDC
outside:
ground



Data Connector:

68-pin mini-D (SCSI-3) receptacle



mating connector: AMP 749621-7 (or equiv.)
shell: AMP 786152-3 or 750752-1 (2-56 jackscrews)

Signal	Description	I/O	+pin#	-pin#
D15	Data Bit 15 (tied low)	O	2	36
D14	Data Bit 14 (tied low)	O	3	37
D13	Data Bit 13 (MSB)	O	4	38
D12	Data Bit 12	O	5	39
D11	Data Bit 11	O	6	40
D10	Data Bit 10	O	7	41
D9	Data Bit 9	O	8	42
D8	Data Bit 8	O	9	43
D7	Data Bit 7	O	10	44
D6	Data Bit 6	O	11	45
D5	Data Bit 5	O	13	47
D4	Data Bit 4	O	14	48
D3	Data Bit 3	O	15	49
D2	Data Bit 2 (LSB)	O	16	50
D1	Data Bit 1 (tied low)	O	19	53
D0	Data Bit 0 (tied low)	O	20	54
FR_EN	Frame (vert.) Sync	O	25	59
LN_EN	Line (hor.) Sync	O	26	60
PXCLK	Pixel Clock	O	29	63
EXSYNC	Ext. Frame Sync	I	30	64
SC_IN	Fast Scan Control	I	23	57
SC_OUT	(rsrvd for future use)	O	22	56
CTRL1	Binning Control	I	31	65
CTRL2	(rsrvd for future use)	I	32	66
GND	Signal Ground		pins 1,12,34,35,46,68	

Note: Camera inputs (I) should be tied to logic "high" if not in use.