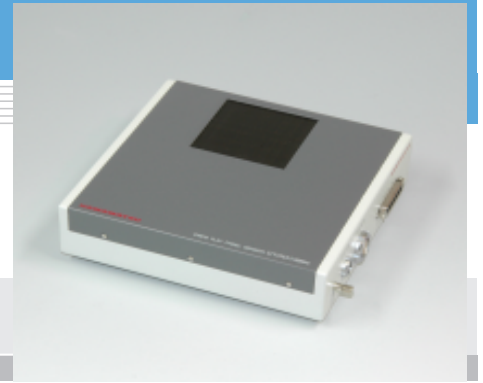# Flat panel sensor
C10013SK

High reliability, high sensitivity

Flat panel sensor C10013SK is a digital X-ray image sensor newly developed as a key device for open-type tube application, radiography and other real-time X-ray imaging applications requiring high resolution and high image quality.

Features

- ● Low noise: 80 electrons
- ● Energy range: 150 kVp Max.
- ● High quality image: 1 Mpixels
- ● Pixel size: 50 × 50 μm
- ● Digital output (12-bits)
- ● High-speed imaging:
  4 frames/s (single binning)
- ● Long life: 150 kVp, 2 MR
- ● Wide dynamic range

Applications

- ● Open type tube application
- ● Radiography

■ Block diagram

C10013SK is a lightweight and compact flat panel sensor consisting of a sensor board and a control board. Each pixel has low noise amplifier. Analog video signals are amplified as the charge on each video line by 1056 ch differential amplifiers with CDS (Correlated Double Sampling) circuits, and are output from each of 8 amplifier arrays. The control board converts the analog video signal into a 12-bit digital signal and outputs it to an external frame grabber through the 12-bit parallel port.
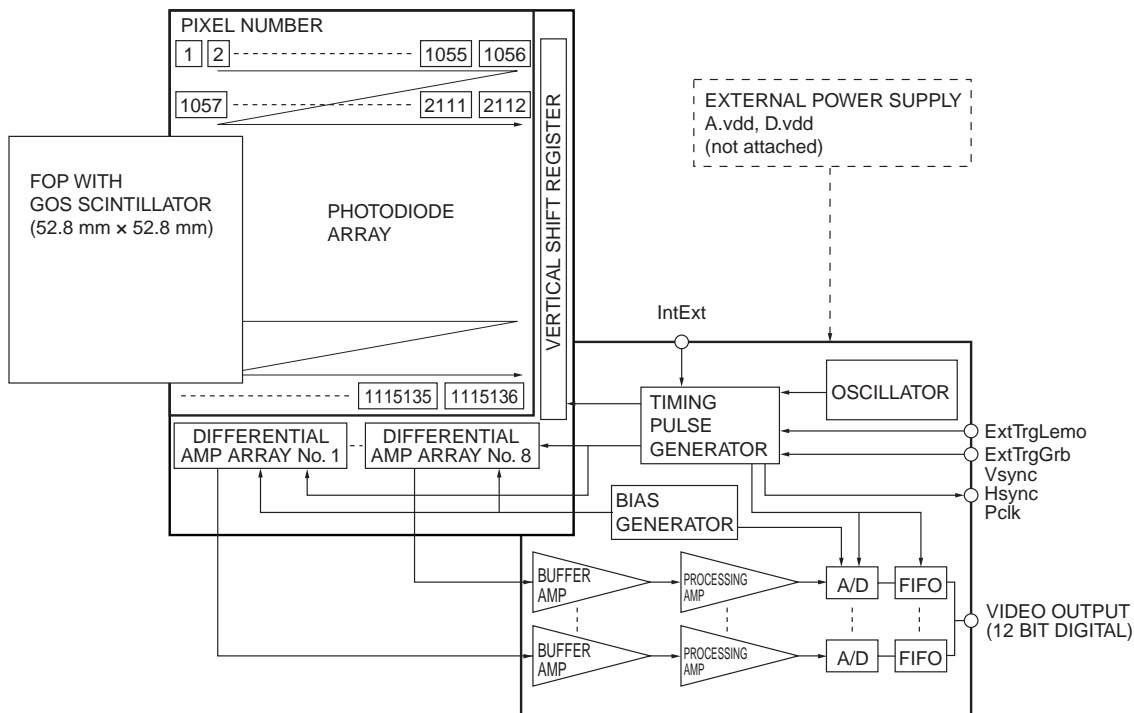
Note: Signals are readout in order of pixel number.

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SOLID STATE *DIVISION*

HAMAMATSU

■ General ratings

Parameter	Specification	Unit
Pixel size	50 × 50	µm
Photodiode area	52.8 × 52.8	mm
Number of pixels	1056 × 1056	pixels
Number of active pixels	1032 × 1000	pixels
Readout	Charge amplifier array	-
Video output (Data1 - 12)	LVDS (differential) 12 bit	-
Output data rate	12.5	MHz
Synchronous signal (Vsync, Hsync, Pclk)	LVDS (differential)	-
ExtTrgGrb, ExtTrgLemo, IntExt	TTL	-
Scintillator	CsI	-

■ Absolute maximum ratings (Ta=25 °C)

Parameter	Symbol	Value	Unit
Supply voltage for digital circuitry (+5 V)	D.vdd	+6.0	V
Supply voltage for analog circuitry (+5 V)	A.vdd	+6.0	V
Input voltage (ExtTrgGrb, ExtTrgLemo, IntExt)	Vin	0 to 6.0	V
Operating temperature [1]	Topr	0 to +35	°C
Storage temperature [1]	Tstg	0 to +50	°C

[1]: No condensation

■ Specification (Ta=25 °C, A.vdd= 5.0 V, D.vdd= 5.0 V)

Parameter	Symbol	Min.	Typ.	Max.	Unit
Frame rate (single operation)	Sf (int)	3.8	4	-	frames/s
Frame rate external (single operation)	Sf (ext)	-	Sf (int) to 1	-	frames/s
Noise (rms) [2]	N (rms)	-	80	-	electrons
Sensitivity [3]	S	120	150	-	LSB/mR
Saturation charge	Csat	-	0.3	-	M electrons
Resolution [4]	Reso	7.1	8	-	line pairs/mm
Dynamic range	-	-	3800	-	-
Defect line [5]	-	-	-	15	lines
Adjacent defect line	-	-	-	1	lines
Output offset [6]	-	-	65	200	LSB

[2]: Internal trigger mode, single operation
[3]: At 150 kVp without filter
[4]: Spatial frequency at CTF=5 %
[5]: A defect line is a horizontal or vertical line containing 4 or more pixels that produce less than 1/8 of the average output from surrounding pixels and are formed continuously from the opposite side of an amplifier array or a vertical shift register.
[6]: Average of all effective pixels in single operation at Sf (int)
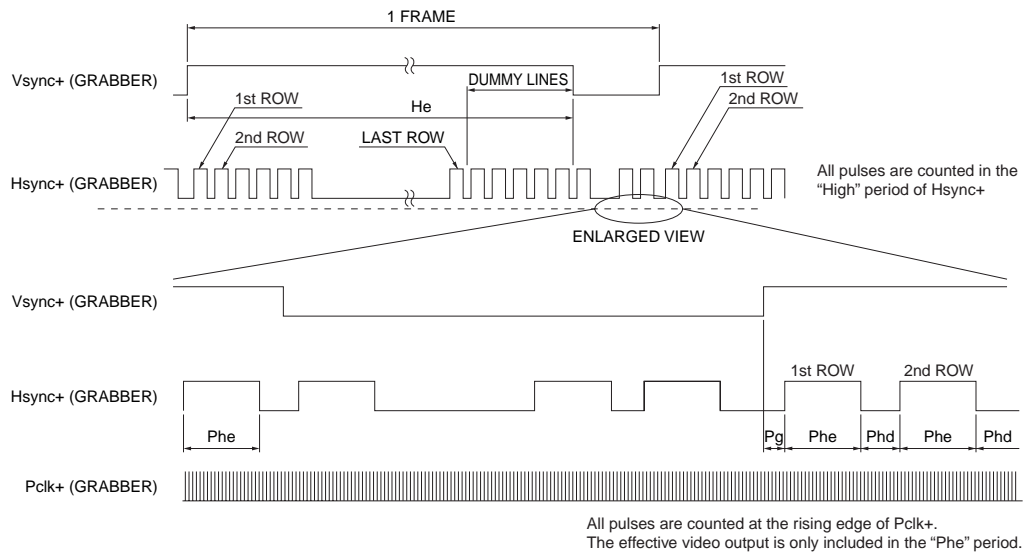Note: X-ray energy range is 20 k to 150 kVp.

■ Resolution

(Ta=25 ˚C, A.vdd=5.0 V, D.vdd=5.0 V)

CTF (%) vs SPATIAL FREQUENCY (line pairs/mm)
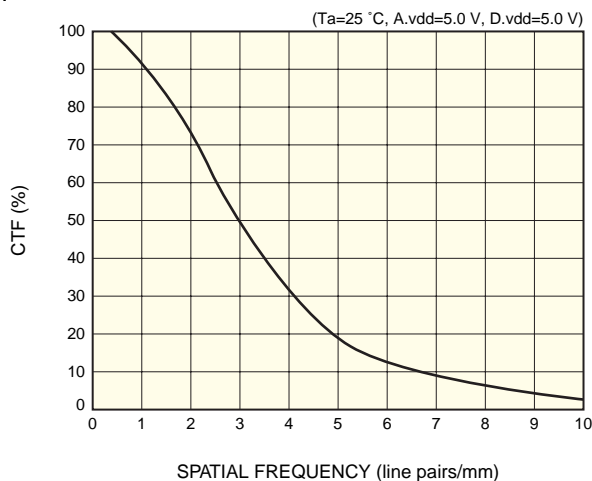
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■ Timing chart

To acquire images through an image grabber board, write parameters in the software program or parameter file by referring to the following timing chart and description.


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Parameter		Count
He	Effective line	1000
	Dummy line	56
Phe	Effective pixel	1032
	Dummy pixel	24
Phd		1870
Pg		1877

Note: "He" is the Hsync count. Phe, Phd and Pg are the Pclk count.

■ External trigger mode

To acquire images in external trigger mode, input an external trigger pulse as shown below. When the time Tvd has passed after the rising edge of the external trigger pulse, synchronous signals and video signals are output.
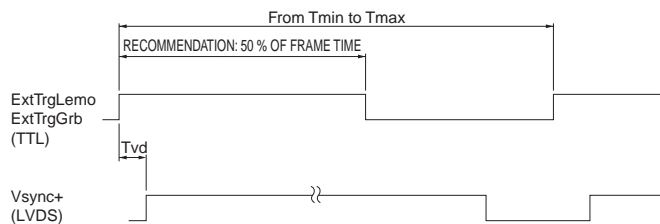
Hsync+, Pclk+ and Data 1-12 are the same as internal trigger mode.
· Tmin is defined as 1/Sf (int).
· Tmax is defined as the reciprocal of the minimum value of Sf (ext).
· Tvd=320 μs

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■ System requirements

To operate C10013SK at full performance, the following system and peripherals are required.

· PC: IBM compatible PC running on Windows XP

· Digital frame grabber card: Monochrome 16 bits or more, pixel clock 13 MHz or more, LVDS interface synchronous signal (See the frame grabber manual.)

The National Instruments IMAQ PCI-1424 (NI parts No. 777662-02) frame grabber has been verified to successfully acquire 12-bit digital images from C10013SK. The IMAQ PCI-1422 (NI pats No. 777959-02) also acquires satisfactory images from C10013SK. You can utilize the demonstration software that comes with the frame grabber as a simple viewer, to acquire and save an image. To do so, refer to the frame grabber user's guide for how to use the camera information file for the demonstration software.

· Power source: A.vdd = +5.0 ± 0.1 V (700 mA), D.vdd = +5.0 ± 0.1 V (600 mA).

Please use of a series power supply. (Avoid using a switching power supply.) A power cable (terminated with an FGG.2B.307.CLAD92Z plug at one end and open at the other end; 2 m; see Table 2.), an external trigger cable (terminated with an FFA.0S.302.CLAC37 plug at one end and open at the other end; 5 m; see table 3.) and an earth cable (AWG 18; 4 m) comes supplied with C10013SK. An optional frame grabber cable for interface with the 40-pin receptacle (see Table 1) on C10013SK is also available for synchronous signal, video output and external control.

The voltages described above are specified at the flat panel sensor side. The impedance of the power cable attached with the flat panel sensor is low enough but it causes 0.1 V approx. drop. Therefore the voltage at the power source side should be set 0.1 V higher than the voltage specified above.

Install a noise filter on the AC power input line to prevent surges on the AC line.

To supply the synchronous signal through ExtTrgGrb, apply high level of TTL to ExtTrgLemo and IntExt, or leave them without connection. On the contrary, to use ExtTrgLemo, set high level to ExtTrgGrb and IntExt, or leave them without connection. The earth terminal must be connected to a stable earth point to eliminate noise from surroundings.

Table 1: Pin assignment of 40-pin receptacle

Pin No.	Signal	Pin No.	Signal
1	Data1+ (LSB)	21	Data1- (LSB)
2	Data2+	22	Data2-
3	Data3+	23	Data3-
4	Data4+	24	Data4-
5	Data5+	25	Data5-
6	Data6+	26	Data6-
7	Data7+	27	Data7-
8	Data8+	28	Data8-
9	Data9+	29	Data9-
10	Data10+	30	Data10-
11	Data11+	31	Data11-
12	Data12+ (MSB)	32	Data12- (MSB)
13	Reserved	33	Reserved
14	Reserved	34	Reserved
15	Reserved	35	GND
16	Reserved	36	GND
17	ExtTrgGrb (TTL)	37	IntExt (TTL)
18	Vsync+	38	Vsync-
19	Hsync+	39	Hsync-
20	Pclk+	40	Pclk-

Unless otherwise noted, signal level is LVDS.
40-pin receptacle: 10240-52B2PL made by 3M Co. Ltd.
Mating plug: 10140-6000EL made by 3M Co. Ltd.

Table 2: Power pin assignment and cable color

Pin No.	Color	Signal
1	Brown	Reserved
2	Red	Reserved
3	Orange	Reserved
4	Yellow	Analog GND
5	Green	Analog +5 V
6	Blue	Digital GND
7	Purple	Digital +5 V
Shield	-	Analog GND

7-pin power receptacle: ECG.2B.307.CLV made by LEMO S. A.
Mating power plug: FGG.2B.307.CLAD92Z made by LEMO S. A.

Table 3: External trigger pin assignment and cable color
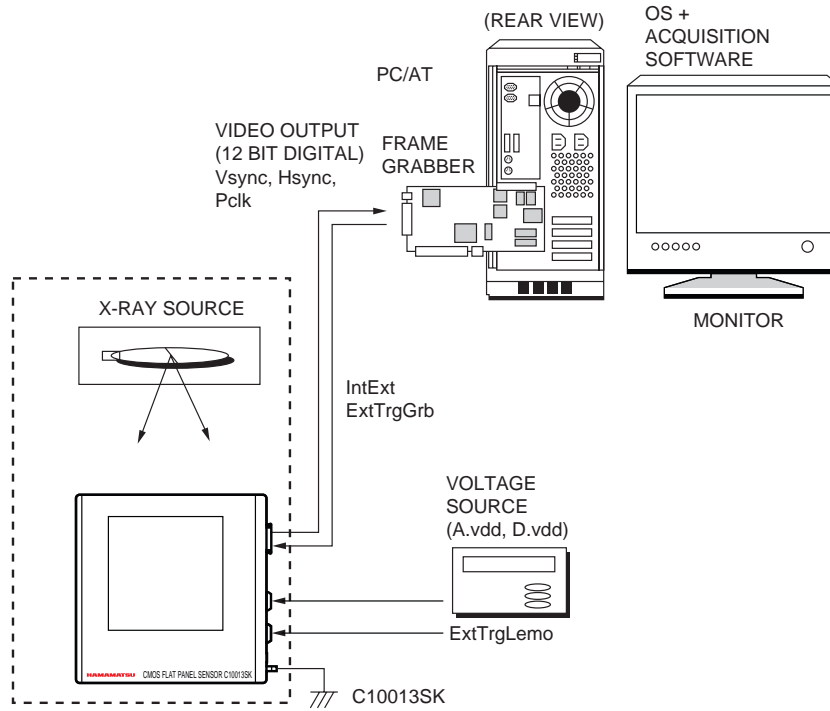
Pin No.	Color	Signal
1	Red	ExtTrgLemo (TTL)
2	Black	Signal GND
Shield	-	Analog GND

2-pin receptacle: ECP.0S.302.CLL made by LEMO S. A.
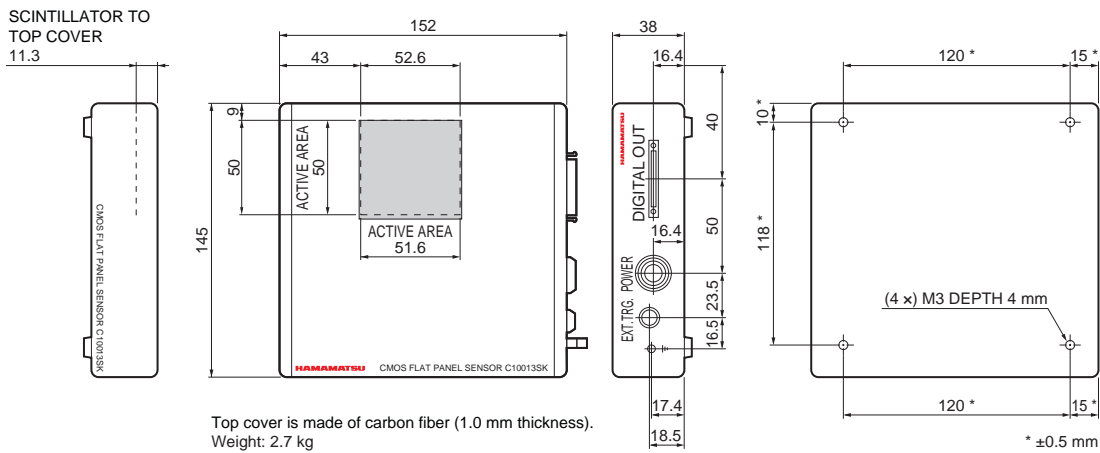Mating plug: FFA.0S.302.CLAC37 made by LEMO S. A.

■ Connection

Install the frame grabber board into the PC by the manufacturer's instructions. When a general-purpose frame grabber board is used, binning or trigger operation for IntExt and ExtTrgGrb can be controlled with its digital I/O control.

(REAR VIEW)

OS +
ACQUISITION
SOFTWARE

PC/AT

VIDEO OUTPUT
(12 BIT DIGITAL)
Vsync, Hsync,
Pclk

FRAME
GRABBER

MONITOR

X-RAY SOURCE

IntExt
ExtTrgGrb

VOLTAGE
SOURCE
(A.vdd, D.vdd)

ExtTrgLemo

CMOS FLAT PANEL SENSOR C10013SK

C10013SK

KACCC0291EB

■ Dimensional outline (unit: mm, tolerance: ±1 mm unless otherwise noted)

SCINTILLATOR TO
TOP COVER
11.3

152

43

52.6

9

ACTIVE AREA
50

50

ACTIVE AREA
51.6

145

CMOS FLAT PANEL SENSOR C10013SK

HAMAMATSU   CMOS FLAT PANEL SENSOR C10013SK

Top cover is made of carbon fiber (1.0 mm thickness).
Weight: 2.7 kg

38

16.4

DIGITAL OUT

40

16.4

50

EXT.TRG. POWER

16.5 23.5

17.4

18.5

120 *

15 *

10 *

118 *

(4 ×) M3 DEPTH 4 mm

120 *

15 *

* ±0.5 mm

KACCA0173EC

5

■ Notice
· Do not subject the Flat Panel Sensors to strong vibration or shock. (Strong shock such as drop impacts may cause permanent damage to these sensors.)
· Users must take responsibility for implementing X-ray shielding safety measures to avoid the risk of X-ray exposure.
· Data listed in this datasheet is defined at the time of shipment. Characteristics may vary somewhat due to exposure to X-rays so take proper coutermeasures such as making periodic image correction.
· This product is warranted for a period of 12 months after the date of the shipment.
The warranty is limited to replacement or repair of any defective product due to defects in workmanship or materials used in manufacture. The warranty does not cover loss or damage caused by natural disaster, misuse (including modifications and any use not complying with the environment, application, usage and storage conditions described in this datasheet), or total radiation dose over 2 million Roentgen (less than 150 kVp) even within the warranty period.
· As described above, flat panel sensors have limited resistance to radiation. This must be taken into account when using a flat panel sensor under continuous irradiation (in-line non-destructive inspection, etc.)
When using flat panel sensors in non-destructive inspection equipment, please contact us and provide information such as irradiation conditions.

CE
C10013SK conforms to European EMC directives:
EN61326 Class A.

■ Optional frame grabber cables

Frame grabber	Cable type No.	Cable length	Cable end	Cable end
General-purpose	A8406-51	5 m	10140-6000EL *8	open
	A8406-56	7 m		
	A8406-57	10 m		
	A8406-58	12 m		
IMAQ PCI-1424 *7	A8406-52	5 m		PCS-XE100MA+ *9
	A8406-53	7 m		
	A8406-54	10 m		
	A8406-55	12 m		

*7: Made by NI (National Instrument Corporation)
*8: Made by 3M Co. Ltd.
*9: Made by Honda Tsushin Kogyo Co. Ltd.
Note: The detailed information for these optional cables is shown in the datasheet of A8406 series.