I M A G E   S E N S O R

Flat panel sensor
C9311DK

High sensitivity, high-speed frame rate, high resolution

Flat panel sensor C9311DK is a digital X-ray image sensor newly developed as key devices for real-time imaging applications requiring high resolution X-ray images.

Features

- High sensitivity: 1600 LSB/mR
- High-speed frame rate: 30 frames/s
- 1248 × 1152 pixels
- Flat panel structure wituout image distortion
- 12-bit digital output

Applications

- Digital radiography
- Real time CT

■ Block diagram

C9311DK is a flat panel sensor consisting of a sensor board and a control board. The sensor board also has 16 charge-sensitive amplifier arrays each having 156 ch amplifiers with a horizontal shift register. Analog video signals are amplified as the charge on each video line by 2496 ch charge amplifiers with CDS (Correlated Double Sampling) circuits added, and are output each of 16 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 two 12-bit parallel ports.

Note: Signals are read out in order of pixel number.

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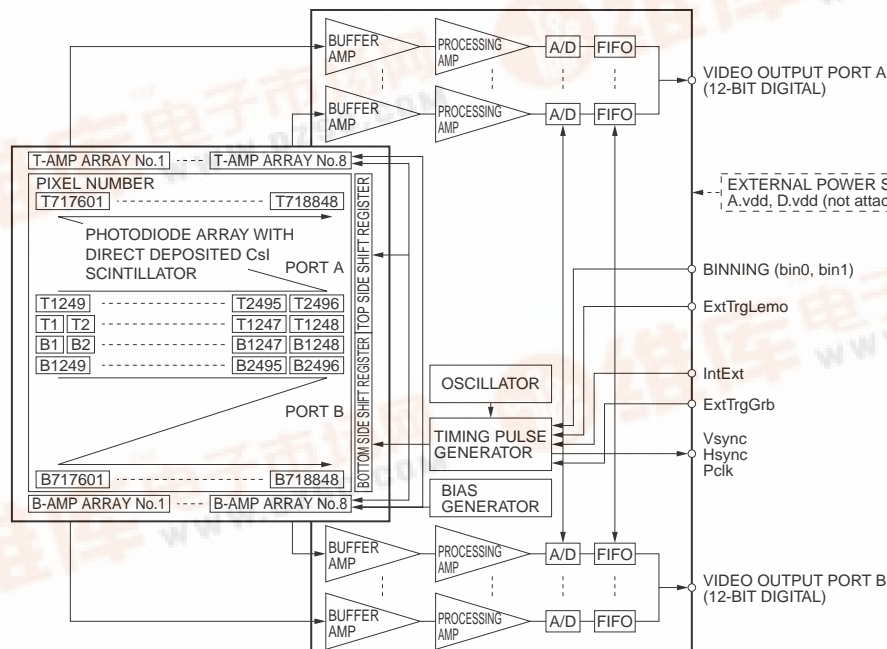
■ General ratings

Parameter	Specification	Unit
Pixel size	100 × 100	µm
Photodiode area	124.8 × 115.2	mm
Number of pixels	1248 × 1152	pixels
Number of active pixels	1232 × 1120	pixels
Readout	Charge amplifier array	-
Video output (Data1 - 12)	LVDS (differential) 2-port, 12-bit	-
Output data rate	33.333	MHz
Synchronous signal (Vsync, Hsync, Pclk)	LVDS (differential)	-
ExtTrgGrb, ExtTrgLemo, IntExt, bin0, bin1	TTL	-
Scintillator	Direct deposition CsI	-

■ Absolute maximum ratings

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, bin0, bin1)	Vin	0 to 6.0	V
Operating temperature *1	Topr	0 to +35	°C
Storage temperature *1	Tstg	-10 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)	28.5	30	-	frames/s
Frame rate (animation 2 × 2 binning)	-	-	30	-	frames/s
Frame rate (fast 2 × 2 mode)	-	-	88	-	frames/s
Frame rate external (single operation)	Sf (ext)	-	Sf (int) to 1	-	frame/s
Noise (rms) *2	N (rms)	-	1500	-	electrons
Saturation charge	Csat	-	3.9	-	M electrons
Sensitivity *3	S	1600	2000	-	LSB/mR
Resolution *4	Reso	3.55	5	-	line pairs/mm
Dynamic range	-	-	2600	-	-
Defect line *5	-	-	-	10	lines
Output offset *6	-	-	65	200	LSB

*2: Internall trigger mode, single operation
*3: 80 kVp, acrylic filter 170 mm.
*4: Spatial frequency at CTF=5 %
*5: A defective line is a vertical or horizontal line containing 4 or more consecutive pixels that produce less than 1/8 of the average output from the surrounding pixels. In this case, one of the following conditions must be met.
   Horizontal defective line: Defective pixels are continuously located from the opposite side of the shift register on the upper side or lower side.
   Vertical defective line : Defective pixels are continuously located, starting from Row 575 toward Row 0 in the upper half area.
           Defective pixels are continuously located, starting from Row 576 toward Row 1151 in the lower half area.
   Adjacent defective lines are not allowed in the vertical and horizontal directions.
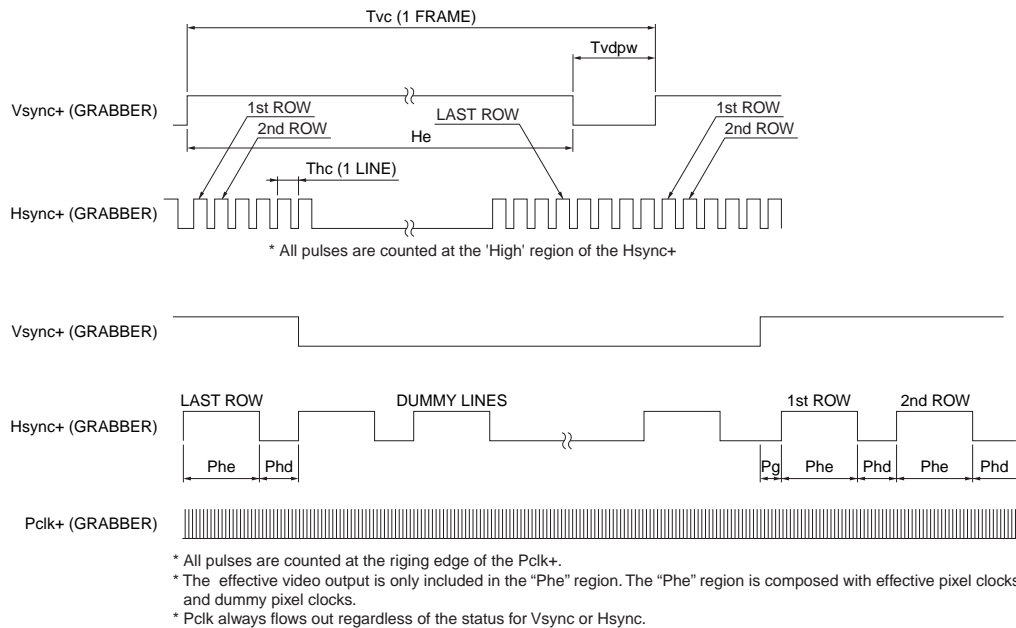*6: Average of all effective pixels in single operation at Sf (int)
Note: X-ray energy range is 20 k to 80 kVp.

■ Resolution

(Ta=25 ˚C, A.vdd=5.0 V, D.vdd=5.0 V)

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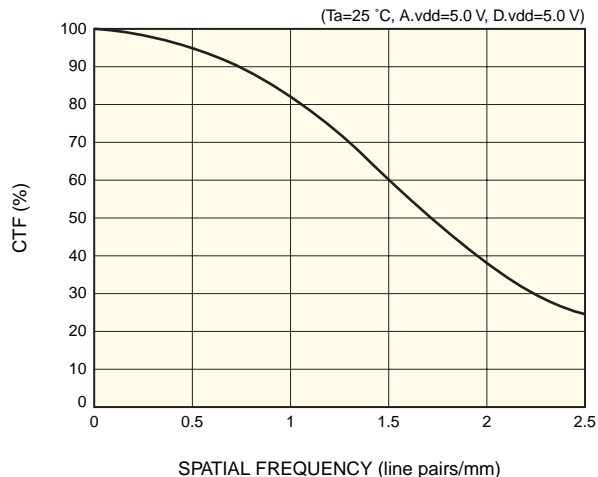
■ Timing chart

To acquire images through an image grabber board, parameters that match the following timing chart should be described in the software program or parameter file.


* All pulses are counted at the 'High' region of the Hsync+

* All pulses are counted at the riging edge of the Pclk+.
* The effective video output is only included in the "Phe" region. The "Phe" region is composed with effective pixel clocks and dummy pixel clocks.
* Pclk always flows out regardless of the status for Vsync or Hsync.

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Parameter		1 × 1	Fast 2 × 2	Animation 2 × 2 (30 fps)
He	Dummy	0	0	0
	Effective	560	280	280
	Dummy	16	8	8
Phe	Dummy	0	0	0
	Effective	1232	616	616
	Dummy	16	8	8
	Dark reference	24	12	12
Phd		642	654	654
Pg		634	646	646

■ External trigger mode (single operation)

To acquire images in external trigger mode, write parameters in the software program or parameter file by referring to the following timing chart and description.

When used in synchronization with a pulsed X-ray source, X-rays should be irradiated during the Txray period.
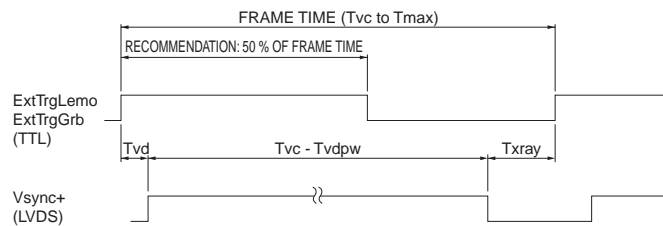
Hsync+, Pclk+ and Data 1-12 are the same as internal trigger mode.
· Tmax is defined as the reciprocal of the minimum value of Sf (ext).
· Txray = FRAME TIME - Tvd - (Tvc - Tvdpw)

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(Typ.)

Parameter		Symbol	1 × 1 mode	Unit
Vsync	Delay time (only external trigger mode)	Tvd	100	µs
	Cycle time (internal trigger mode)	Tvc	33	ms
	Dummy pulse width	Tvdpw	210	µs

Note: The numbers of siginificant figures is two. (except Tvc)

■ System requirements

To operate C9311DK at full performance, the following system and peripherals are required.

· PC: IBM compatible PC running on Windows XP

· Digital frame grabber card: Monochrome 32 bits or more, pixel clock 33.3 MHz or more, LVDS interface synchronous signal (See the frame grabber manual.)

· Power source: A.vdd = +5.0 ± 0.1 V (1800 mA), D.vdd = +5.0 ± 0.1 V (500 mA)

Please use a low noise series power supply. (Avoid using a switching power supply.) A optional power cable (terminated with an DB-25SF-N plug at one end and open at the other end; 2 m; see Table 2.) and an earth cable (AWG 18; 4 m) comes supplied with C9311DK. An optional frame grabber cable for interface with the 80-pin receptacle (see Table 1) on C9311DK 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. The earth terminal must be connected to a stable earth point to eliminate noise from surroundings.

Table 1: Pin assignment of 80-pin receptacle

Pin No.	Signal	Pin No.	Signal
1	A_Data1+ (LSB)	41	B_Data1+ (LSB)
2	A_Data1- (LSB)	42	B_Data1- (LSB)
3	A_Data2+	43	B_Data2+
4	A_Data2-	44	B_Data2-
5	A_Data3+	45	B_Data3+
6	A_Data3-	46	B_Data3-
7	A_Data4+	47	B_Data4+
8	A_Data4-	48	B_Data4-
9	A_Data5+	49	B_Data5+
10	A_Data5-	50	B_Data5-
11	A_Data6+	51	B_Data6+
12	A_Data6-	52	B_Data6-
13	A_Data7+	53	B_Data7+
14	A_Data7-	54	B_Data7-
15	A_Data8+	55	B_Data8+
16	A_Data8-	56	B_Data8-
17	A_Data9+	57	B_Data9+
18	A_Data9-	58	B_Data9-
19	A_Data10+	59	B_Data10+
20	A_Data10-	60	B_Data10-
21	A_Data11+	61	B_Data11+
22	A_Data11-	62	B_Data11-
23	A_Data12+ (MSB)	63	B_Data12+ (MSB)
24	A_Data12- (MSB)	64	B_Data12- (MSB)
25	Reserved	65	Reserved
26	Reserved	66	Reserved
27	Reserved	67	Reserved
28	Reserved	68	Reserved
29	Reserved	69	Reserved
30	Reserved	70	Reserved
31	Reserved	71	Reserved
32	Reserved	72	Reserved
33	IntExt (TTL)	73	ExtTrgGrb (TTL)
34	Reserved	74	Reserved
35	Vsync+	75	bin0 (TTL)
36	Vsync-	76	Reserved
37	Hsync+	77	bin1 (TTL)
38	Hsync-	78	Reserved
39	Pclk+	79	GND
40	Pclk-	80	GND

Unless otherwise noted, signal level is LVDS.

80-pin receptacle: PCS-E80LMD made by Honda Tsushin Kogyo Co., Ltd.

Mating plug: PCS-E80FA made by Honda Tsushin Kogyo Co., Ltd.

Pins described "Reserved" are prepared for an extention of the future. Do not connect any signal or power or GND to this plug.

Table 2: Power pin connection and cable color

Pin No.	Cable color	Signal	Marking color
1	Brown	NC	
2	Orange	NC	
3	Green	Analog GND	
4	Purple	Analog +5 V	
5	White	Analog +5 V	
6	Brown	Digital GND	White
7	Orange	Digital +5 V	White
8	Green	Digital +5 V	White
9	-	Reserved	-
10	-	Reserved	-
11	-	Reserved	-
12	-	Reserved	-
13	-	Reserved	-
14	Red	NC	
15	Yellow	Analog GND	
16	Blue	Analog GND	
17	Gray	Analog +5 V	
18	Black	Digital GND	
19	Red	Digital GND	White
20	Yellow	Digital +5 V	White
21	-	Reserved	-
22	-	Reserved	-
23	-	Reserved	-
24	-	Reserved	-
25	-	Reserved	-

NC: no connection
25-pin receptacle: DBLC-J25PAF-10L6 made by JAE (Japan Aviation Electronics Industry, Limited)
Mating plug: DB25SF-N made by JAE (Japan Aviation Electronics Industry, Limited)

Table 3: Binning setting

Mode	bin0 (Pin No. 75)	bin1 (Pin No. 77)
1 × 1	Low	Low
Animation 2 × 2	Low	High
Fast 2 × 2	High	Low

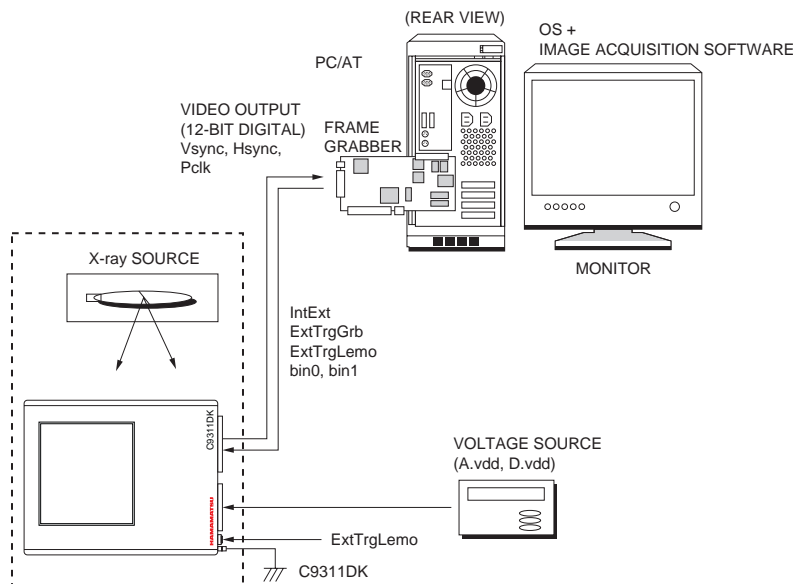Table 4: External synchronous signal

Pin No.	Signal	Cable color
1	ExtTrgLemo	Red
2	GND	Black

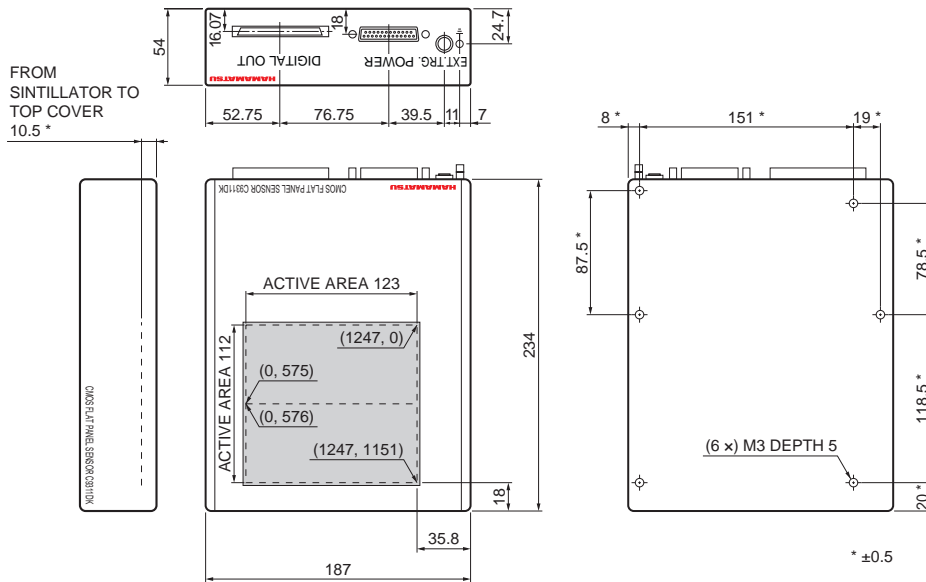2-pin receptacle: EXP.0S.302.HLN made by LEMO S.A.
Mating plug: FFA.0S.302.CLAC37 made by LEMO S.A.

■ Connection

Install the digital frame grabber board into the PC by the manufacture's instructions. When a general-purpose frame grabber board is used, binning or trigger operation for bin0, bin1, IntExt and ExtTrg can be controlled with its digital I/O control.

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

FROM SINTILLATOR TO TOP COVER
10.5 *

DIGITAL OUT

EXT.TRG. POWER

54   16.07   18   24.7

52.75   76.75   39.5   11   7

CMOS FLAT PANEL SENSOR C9311DK

ACTIVE AREA 123

ACTIVE AREA 112

(1247, 0)
(0, 575)
(0, 576)
(1247, 1151)

234

18

35.8

187

8 *   151 *   19 *

87.5 *

78.5 *

118.5 *

20 *

(6 ×) M3 DEPTH 5

* ±0.5

Window material is carbon fiber (1.0 mm thickness).
Weight: 4.0 kg

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■ Notice
· Do not subject the Flat Panel Sensor to strong vibration or shock. (Strong shock such as drop impacts may cause permanenat damage to the sensor.)
· 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 countermeasures 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 25000 Roentgen (90 kV) even within the warranty period.

CE

C9311DK conforms to European EMC directives:
EN61326 Class A.

■ Frame grabber cables

Frame grabber	Cable type No.	Cable length	Cable end	Cable end
General-purpose	A8406-41	5 m	PCS-E80FA *8	open
	A8406-46	7 m		
	A8406-47	10 m		
	A8406-48	12 m		
IMAQ PCI-1424 *7	A8406-42	5 m		PCS-XE100MA+ *8
	A8406-43	7 m		
	A8406-44	10 m		
	A8406-45	12 m		

*7: Made by NI (National Instruments Corporation)
*8: Made by Honda Tsushin Kogyo Co. Ltd.

Note: The detailed information for these optional cables is shown in the datasheet of A8406 series.