NEW

IMAGE SENSOR

Flat panel sensor
C9252DK-14

Large area with tiling construction, high-speed frame rate

Flat panel sensor C9252DK-14 is a digital X-ray image sensor newly developed as key devices for use in CT imaging, somatology and biochemical application.

Features

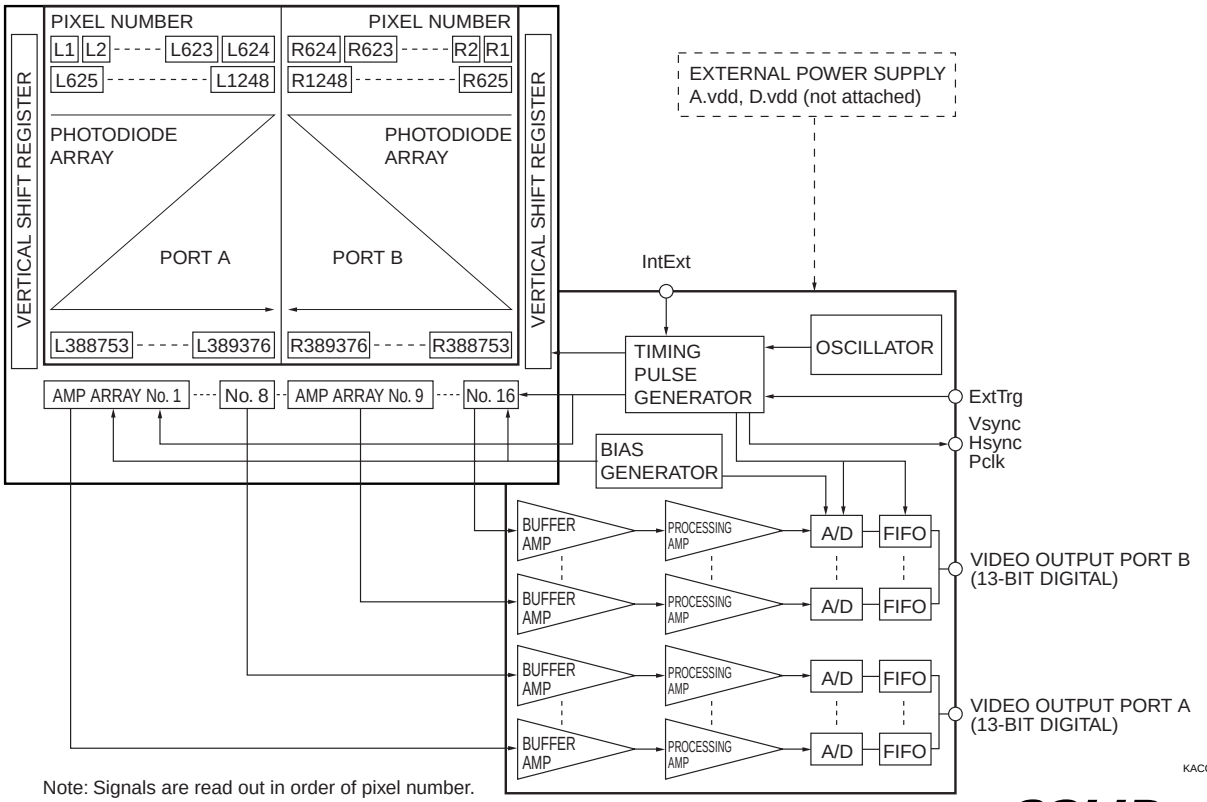
- Large area (12 × 24 cm) with two C10322D chips tiling
- Wide dynamic range
- High sensitivity: 6000 LSB/mR
- High-speed frame rate: 30 frames/s
- Flat panel structure wituout image distortion
- 13-bit digital output (for whole scan mode)
- Whole scan and partial scan mode selectable

Applications

- CT imaging
- Somatology
- Biochemical imaging, etc.

■ Block diagram

C9252DK-14 is a lightweight and compact flat panel sensor consisting of a sensor board and a control board. The sensor board has 16 charge-sensitive amplifier arrays each having 78 ch amplifiers with a horizontal shift register. Analog video signals are amplified as the charge on each video line by 1248 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 13-bit digital signal and outputs it to an external frame grabber through the 13-bit parallel port.



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

PRELIMINARY DATA
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SOLID STATE DIVISION

■ General ratings

Parameter	Specification	Unit
Pixel size	200 × 200	µm
Photodiode area	249.6 × 124.8	mm
Number of pixels	1248 × 624	pixels
Number of active pixels	1216 × 616	pixels
Readout	Charge amplifier array	-
Video output (Data1 - 13)	LVDS (differential) 13-bit for CT, 12-bit for partial mode	-
Output data rate	15.15	MHz
Synchronous signal (Vsync, Hsync, Pclk)	LVDS (differential)	-
ExtTrg, IntExt	TTL	-
Scintillator	Direct deposition 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 (ExtTrg, IntExt)	Vin	0 to 6.0	V
Operating temperature *1	Topr	0 to +35	°C
Storage temperature *1	Tstg	0 to +50	°C

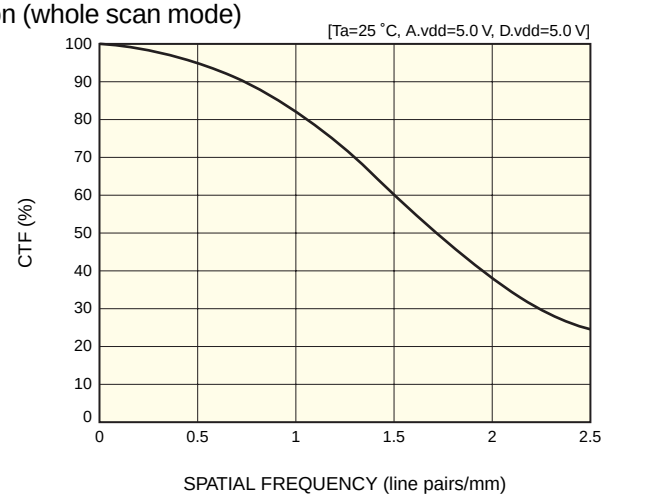
*1: No condensation.

■ 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)	28.5	30	-	frames/s
Frame rate external	Sf (ext)	-	Sf (int) to 10	-	frames/s
Noise (rms) *2	N (rms)	-	2600	-	electrons
Saturation charge	Csat	-	8.3	-	M electrons
Sensitivity *3	S	4800	6000	-	LSB/mR
Resolution *4	Reso	2	2.5	-	line pairs/mm
Dynamic range	-	-	3200	-	-
Defect line *5	-	-	-	20	lines
Blemish *5	-	-	-	600	µm
Uniformity of sensitivity *5	-	-	-	4	%
Defect cluster *5	-	Not allowed			-
Low sensitivity line at tiling edge *5	-	-	-	1	lines
Bright line output adjacent to a defect line *5	-	-	-	120	%
Output offset *6	-	-	130	400	LSB

*2: Internal trigger mode, single operation
*3: 80 kVp, acrylic filter 170 mm
*4: Spatial frequency at CTF=5 %
*5: See P.7, P.8, “Description of Terms”.
*6: Average of all effective pixels in single operation at Sf (int)
Note: X-ray energy range is 20 k to 90 kVp.

■ Resolution (whole scan mode)



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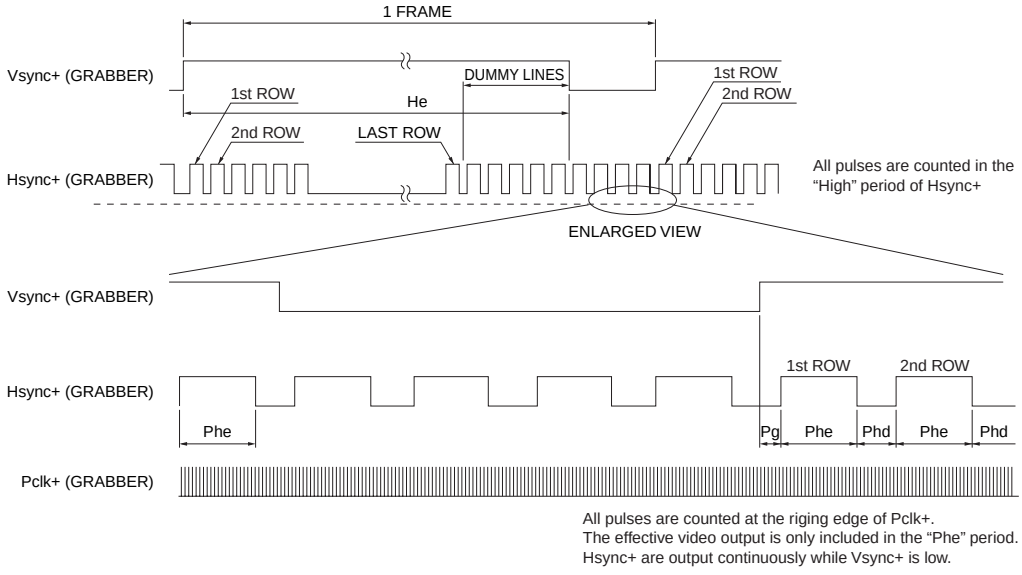
■ Specification of partial scan mode (Typ. Ta=25 °C, A.vdd= 5.0 V, D.vdd= 5.0 V)

Parameter	Symbol	Value	Unit
Pixel size	-	100 × 100	μm
Number of active pixels *7	-	2432 × 100	pixels
Partial frame speed	-	146	frames/s
Noise (rms)	N (rms)	1300	electrons
Saturation charge	Csat	4.2	M electrons
Sensitivity *8	-	1500	LSB/mR
Dynamic range	-	3200	-
Resolution	Reso	4.5	line pairs/mm

*7: The position of the active area under the partial scan mode is described in dimensional outline
*8: 80 kVp, acrylic filter 170 mm
Note: X-ray energy range is from 20 k to 90 kVp.

■ 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.

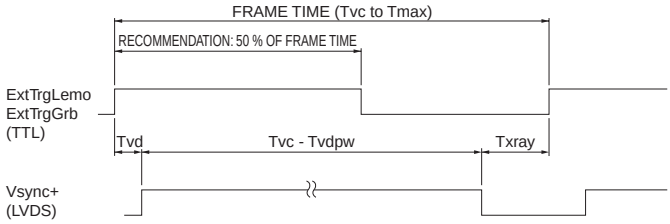


Parameter		Whole scan	Partial scan
		Port A, Port B	Port A, Port B
He	Dummy line	8	0
	Effective line	616	100
	Dummy line	0	0
Phe	Dummy pixel	16	32
	Effective pixel	608	1216
	Dummy pixel	0	0
Phd		576	172
Pg		80	80

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.
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	Value	Unit
Vsync	Delay time (only external trigger mode)	Tvd	127	µs
	Cycle time (internal trigger mode)	Tvc	6.86	ms
	Dummy pulse width	Tvdpw	603	µs

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

■ System requirements

To operate C9252DK-14 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 15.15 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 13-bit or 12-bit digital images from C9252DK-14. 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 (1.6 A), D.vdd = +5.0 ± 0.1 V (400 mA)
Please use a low noise series power supply. (Avoid using a switching power supply.) A power cable (terminated with an DB-25PF-N plug at one end and open at the other end; 2 m; see Table 3.), an external trigger cable (terminated with an ECP.0S.302.CLL plug at one end and open at the other end; 5 m; see Table 4.) and an earth cable (AWG 18; 4 m) come supplied with C9252DK-14. An optional frame grabber cable for interface with the 68-pin receptacle (see Table 1) on C9252DK-14 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 68-pin receptacle

Pin No.	Signal	Pin No.	Signal
1	A_Data1+ (LSB)	35	A_Data1- (LSB)
2	A_Data2+	36	A_Data2-
3	A_Data3+	37	A_Data3-
4	A_Data4+	38	A_Data4-
5	A_Data5+	39	A_Data5-
6	A_Data6+	40	A_Data6-
7	A_Data7+	41	A_Data7-
8	A_Data8+	42	A_Data8-
9	A_Data9+	43	A_Data9-
10	A_Data10+	44	A_Data10-
11	A_Data11+	45	A_Data11-
12	A_Data12+	46	A_Data12-
13	A_Data13+ (MSB)	47	A_Data13- (MSB)
14	Reserved	48	Reserved
15	B_Data1+ (LSB)	49	B_Data1- (LSB)
16	B_Data2+	50	B_Data2-
17	B_Data3+	51	B_Data3-
18	B_Data4+	52	B_Data4-
19	B_Data5+	53	B_Data5-
20	B_Data6+	54	B_Data6-
21	B_Data7+	55	B_Data7-
22	B_Data8+	56	B_Data8-
23	B_Data9+	57	B_Data9-
24	B_Data10+	58	B_Data10-
25	B_Data11+	59	B_Data11-
26	B_Data12+	60	B_Data12-
27	B_Data13+ (MSB)	61	B_Data13- (MSB)
28	Reserved	62	Reserved
29	Reserved	63	GND
30	Scan (TTL)	64	GND
31	ExtTrgGrb (TTL)	65	IntExt (TTL)
32	Vsync+	66	Vsync-
33	Hsync+	67	Hsync-
34	Pclk+	68	Pclk-

Unless otherwise noted, signal level is LVDS.
68-pin receptacle: PCS-XED68RFAG1+ made by Honda Tsushin Kogyo Co., Ltd.
Mating plug: PCS-XE68MA+ made by Honda Tsushin Kogyo Co., Ltd.
Pins described “Reserved” are prepared for an extension in the future. Do not connect any signal, power or GND to this plug.
No. 31 and No. 65 require TTL interface and other signals require LVDS interface. The signal cables is not attached to the flat panel sensor.

Table 2: Mode selection

Mode	Whole scan mode	Partial scan mode
No.30 pin (scan)	Low	High or no connection

Table 3: Power supply pin assignment and cable color

Pin No.	Signal	Cable color	Mark color	Pin No.	Signal	Cable color	Mark color
1	No connection	Brown	-	14	No connection	Red	-
2	No connection	Orange	-	15	A5. GND	Yellow	-
3	A5. GND	Green	-	16	A5. GND	Blue	-
4	A. +5 V	Purple	-	17	A. +5 V	Gray	-
5	A. +5 V	White	-	18	D. GND	Black	-
6	D. GND	Brown	White	19	D. GND	Red	White
7	D. +5 V	Orange	White	20	D. +5 V	Yellow	White
8	D. +5 V	Green	White	21	Reserved	-	-
9	Reserved	-	-	22	Reserved	-	-
10	Reserved	-	-	23	Reserved	-	-
11	Reserved	-	-	24	Reserved	-	-
12	Reserved	-	-	25	Reserved	-	-
13	Reserved	-	-				

25-pin receptacle: DB-25PF-N made by Japan Aviation Electronics Industry, Ltd.
Mating plug: DB-25SF-N made by Japan Aviation Electronics Industry, Ltd.

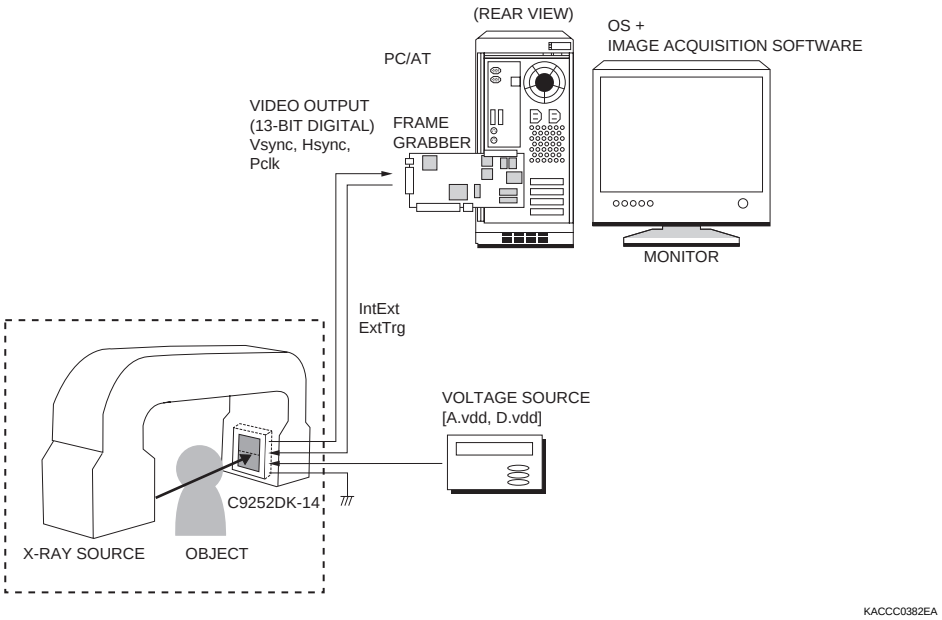
Table 4: External trigger pin assignment and cable color

Pin No.	Color	Signal
1	Red	ExtTrgLemo
2	Black	GND

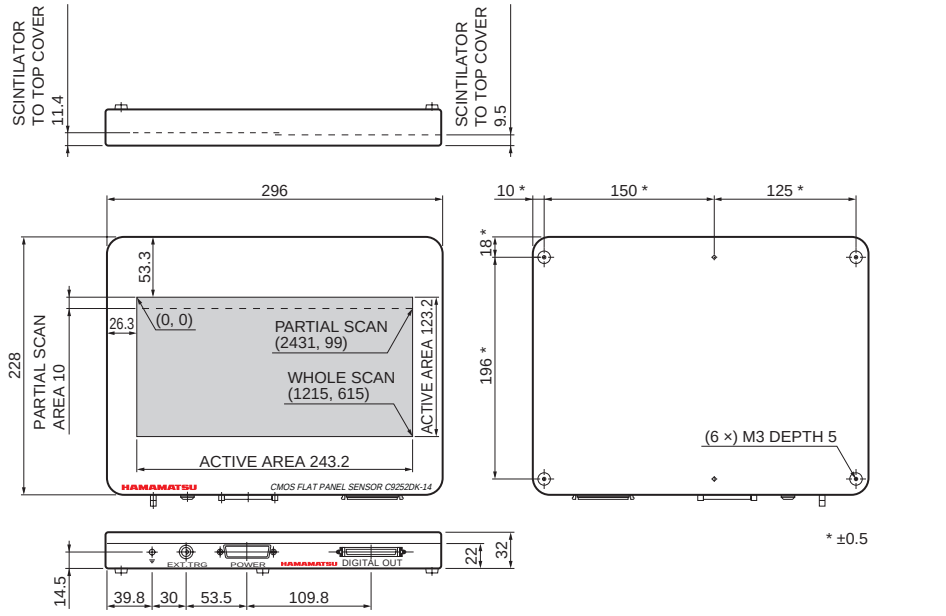
2-pin receptacle: ECP.0S.302.CLL made by LEMO S.A.
Mating plug: FFA.0S.302.CLAC37 made by LEMO S.A.

■ Connection

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



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



Top cover is made of carbon filter (1.0 mm thickness).
Weight: 4.0 kg

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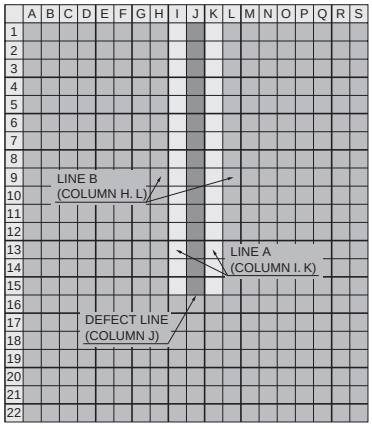
■ Notice

· 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 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.

Description of terms

[Blemish]
Length of pixel cluster which has less sensitivity than 90 % of the average of the surrounding pixels.
Except ±1 mm area from tiling edge.

[Bright line output adjacent to a defect line]
The relative output ratio “a/b” has to be less than 120 % for both horizontal and vertical defect lines, where “a” is the average of the light output (Line A) for the adjacent line to the defect line, and “b” is the average of the light output (Line B) for the normal line next to the line A. The average of the light output should be calculated from only defect region in the defect line. (ex: See the right figure, the defect region in the defect line of x=J is in the range from (J, 1) to (J, 15), “a” on the left is the average of pixel value from (I, 1) to (I, 15). “b” is the average of pixels (H, 1) to (H, 15). [In case of “a” on the right is the average of the pixel value from (K, 1) to (K, 15), “b” is the average of the pixel value from (L, 1) to (L, 15).]



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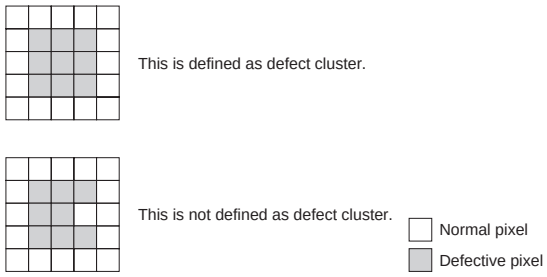
Description of terms

[Defect cluster]
Formed with more than 3 × 3 pixels which have less sensitivity than 1/8 of the average of the surrounding pixels.



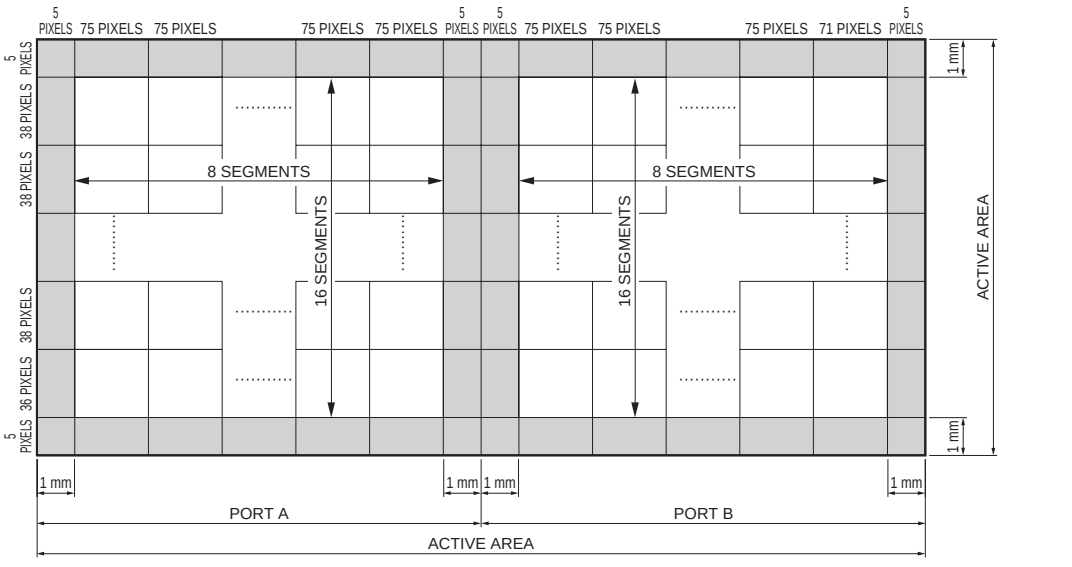
[Defect line]
A defective line is a vertical or horizontal line containing 4 or more consecutive pixels that produce less than 1/8 of the average output from the surrounding pixels.
Adjacent defective lines are not allowed in the vertical or horizontal directions.

[Low sensitivity line at tiling edge]
Number of column lines which has less sensitivity than 1/3 of surrounding.

[Uniformity of sensitivity]
16 × 16 segments are 16 × 16-divided active area excluded 1 mm from the whole edge and tiling edge. Xij is defined as the average pixel output of each segment.
Uniformity of sensitivity is calculated as following equation.

$$\text{Unifomity of sensitivity} = \frac{\sigma}{\bar{x}}$$

σ: standard deviation of 16 × 16 “Xij”
$\bar{x}$: average value of 16 × 16 “Xij”



■ Optical frame grabber cable

Frame grabber	Cable type No.	Cable length	Cable end	Cable end
IMAQ PCI-1424 *9	A8406-62	5 m	PCS-XE68MA+ *10	PCS-XE100MA+ *10
	A8406-64	10 m		

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

HAMAMATSU PHOTONICS K.K., Solid State Division
1126-1 Ichino-cho, Higashi-ku, Hamamatsu City, 435-8558 Japan, Telephone: (81) 53-434-3311, Fax: (81) 53-434-5184, www.hamamatsu.com
U.S.A.: Hamamatsu Corporation: 360 Foothill Road, P.O.Box 6910, Bridgewater, N.J. 08807-0910, U.S.A., Telephone: (1) 908-231-0960, Fax: (1) 908-231-1218
Germany: Hamamatsu Photonics Deutschland GmbH: Arzbergerstr. 10, D-82211 Herrsching am Ammersee, Germany, Telephone: (49) 08152-3750, Fax: (49) 08152-2658
France: Hamamatsu Photonics France S.A.R.L.: 19, Rue du Saule Trapu, Parc du Moulin de Massy, 91882 Massy Cedex, France, Telephone: 33-(1) 69 53 71 00, Fax: 33-(1) 69 53 71 10
United Kingdom: Hamamatsu Photonics UK Limited: 2 Howard Court, 10 Tewin Road, Welwyn Garden City, Hertfordshire AL7 1BW, United Kingdom, Telephone: (44) 1707-294888, Fax: (44) 1707-325777
North Europe: Hamamatsu Photonics Norden AB: Smidesvägen 12, SE-171 41 Solna, Sweden, Telephone: (46) 8-509-031-00, Fax: (46) 8-509-031-01
Italy: Hamamatsu Photonics Italia S.R.L.: Strada della Moia, 1/E, 20020 Arese, (Milano), Italy, Telephone: (39) 02-935-81-733, Fax: (39) 02-935-81-741

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