

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

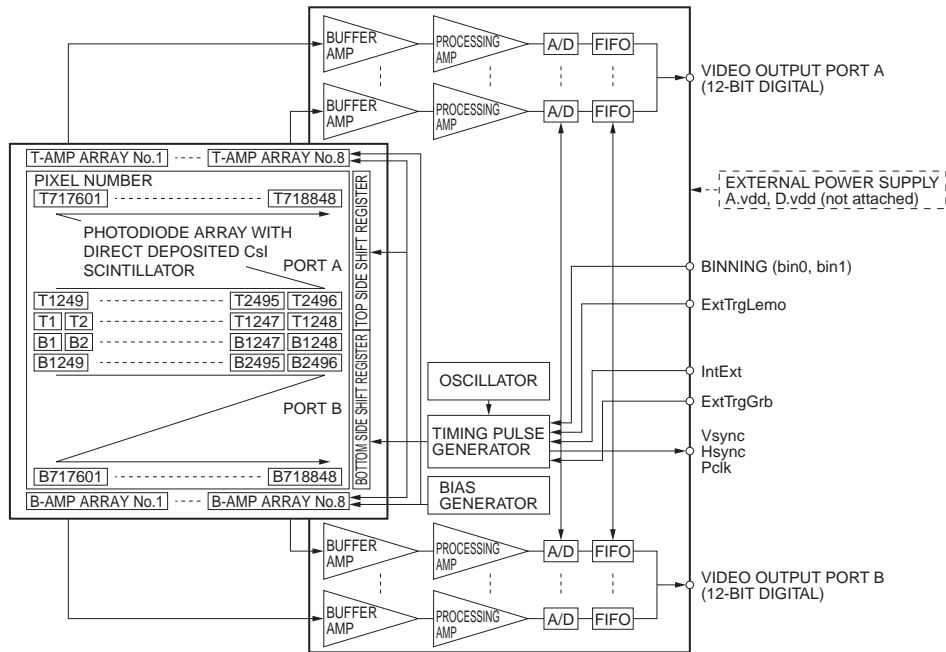
- High sensitivity: 1600 LSB/mR
- High-speed frame rate: 30 frames/s
- 1248 × 1152 pixels
- Flat panel structure without image distortion
- 12-bit digital output

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.

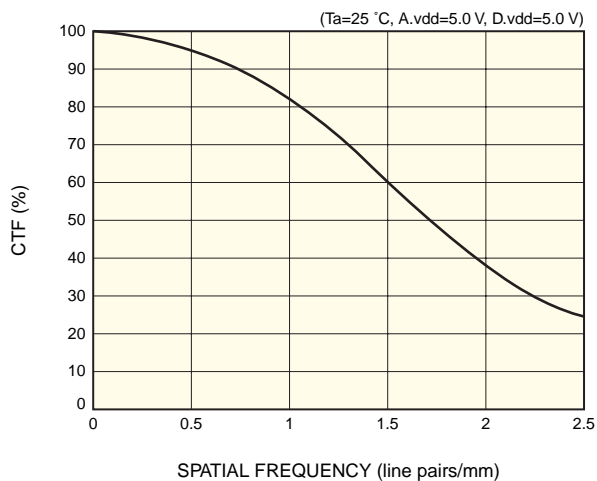
Defective pixels are continuously located, starting from Row 576 toward Row 1151 in the lower half area.

Adjacent defective lines are not allowed in the vertical and horizontal directions.

*6: Average of all effective pixels in single operation at Sf (int)

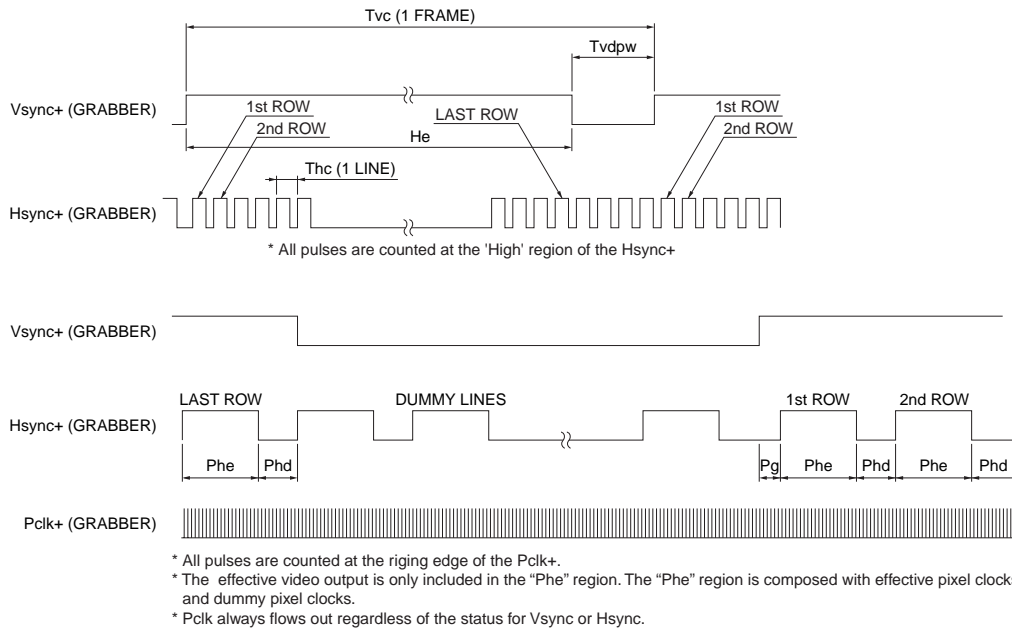
Note: X-ray energy range is 20 k to 80 kVp.

Resolution



■ 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.



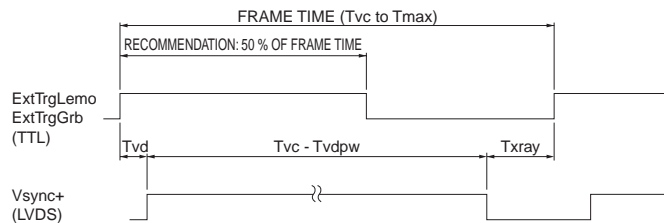
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| Parameter | | 1 × 1 | Fast 2 × 2 | Animation 2 × 2 (30 fps) |
|-----------|----------------|-------|------------|--------------------------|
| He | Dummy | 0 | 0 | 0 |
| | Effective | 560 | 280 | 280 |
| | Dummy | 16 | 8 | 8 |
| Phe | Dummy | 0 | 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 significant 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 extension 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

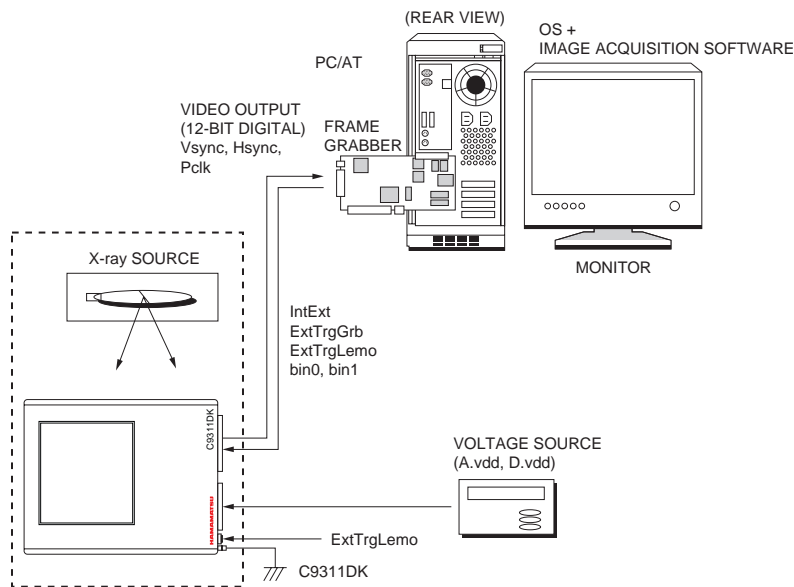
| Pin No. | Signal | Cable color |
|---------|------------|-------------|
| 1 | ExtTrgLemo | Red |
| 2 | GND | Black |

2-pin receptacle: EXP.0S.302.HLN made by LEMO S.A.

Mating plug: FFA.0S.302.CLAC37 made by LEMO S.A.

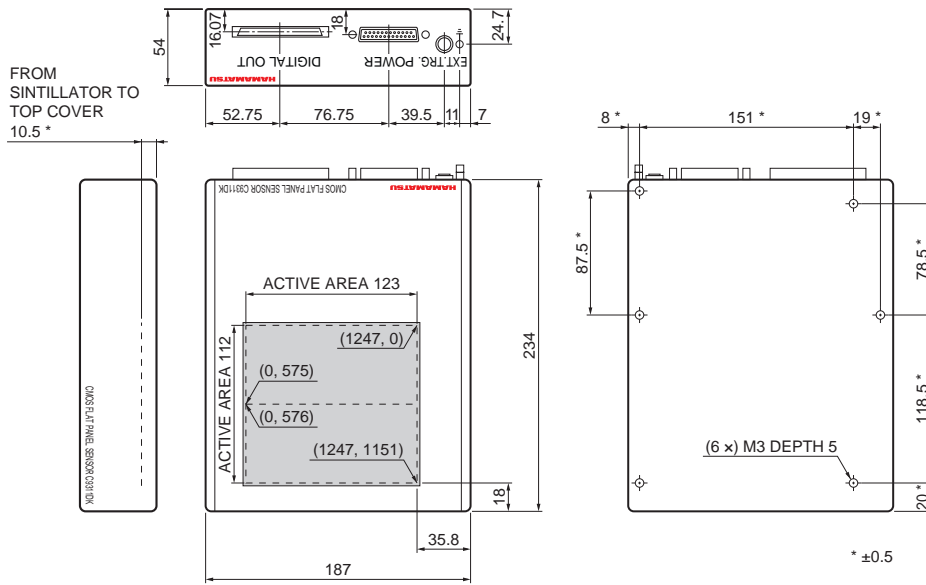
■ Connection

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)

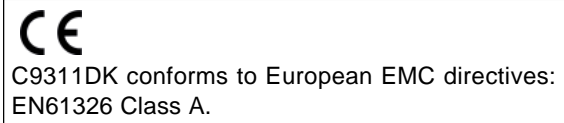


Window material is carbon fiber (1.0 mm thickness).
Weight: 4.0 kg

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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 permanent 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.



■ 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.



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