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Flat panel sensor

C10500D-42

High sensitivity, high-speed frame rate, bare bone type
Photodiode area: 151 × 6 mm

Flat panel sensor C10500D-42 is a digital X-ray image sensor newly developed as a key device for real-time X-ray imaging.

Features

- **High sensitivity: 7600 LSB/mR**
- **High-speed frame rate: 300 frames/s**
- **Wide dynamic range**
- **1512 × 60 pixels**
- **Flat panel structure wituout image distortion**
- **14-bit digital output**
- **Gigabit Ethernet**
- **For assembly into equipment (supplied without case)**

Applications

- **Rotational digital radiography**
- **Panoramic imaging**

Configuration

The C10500D-42 is comprised of a sensor board and a control board. The sensor mounted on a board is a CMOS image sensor chip made up of a two-dimensional photodiode array, vertical shift register for row scan, and charge amplifier arrays divided into 12 blocks. Each charge amplifier array has a horizontal shift register and consists of 126 ch charge amplifiers with CDS circuit.

CsI scintillator is directly deposited on the two-dimensional photodiode array. X-rays incident on the scintillator are converted to fluorescence, which then enters the two-dimensional photodiode array where electric charge is accumulated in each pixel according to the light intensity. The accumulated charge on each row is sequentially selected by the vertical shift register for row scan, transferred to the amplifiers through the data line, and converted to a voltage signal. Then an analog signal is sent out from each amplifier array by scanning the horizontal shift register.

The control board converts the analog signal into a 14-bit digital signal, which is then output to a PC through the Gigabit Ethernet interface.

This product is bare board type for installation into equipment and is not covered with a metal shielded case. See "Notice" for details on EMC.
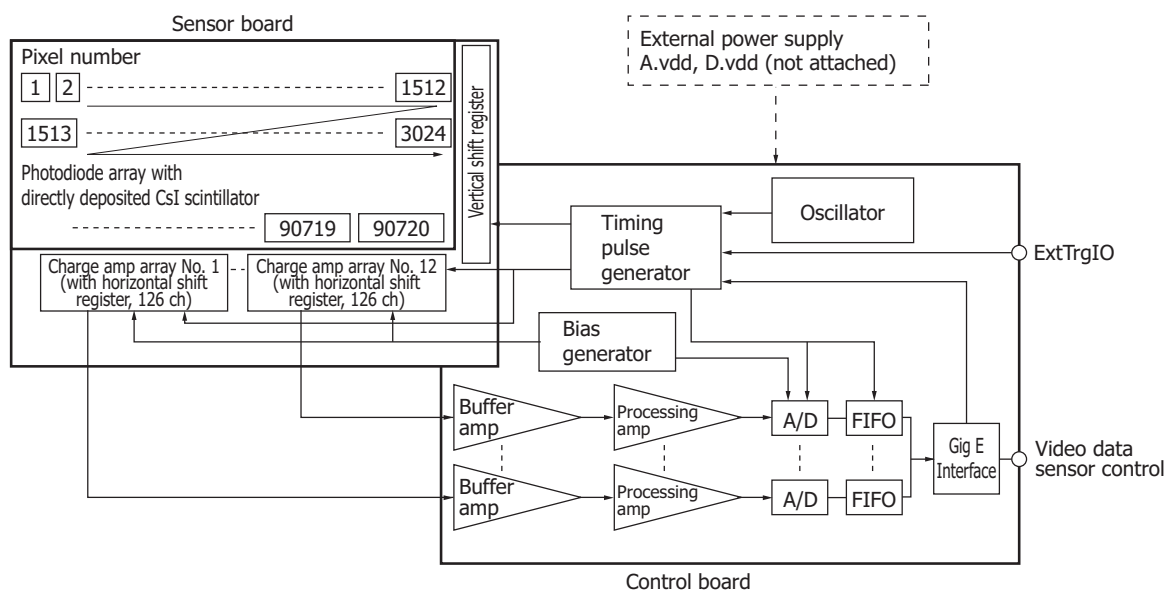
Note: Signals are read out in order of pixel number.

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General ratings

Parameter	Specification	Unit
Pixel size	100 × 100	μm
Photodiode area	151.2 × 6.0	mm
Number of pixels (H × V)	1512 × 60	pixels
Number of active pixels (H × V)	1480 × 60	pixels
Readout	Charge amplifier array	-
Video output interface	Gigabit Ethernet	-
Video data rate	14 bit	-
ExtTrgIO	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
Operating temperature *1	Topr	0 to +40	°C
Storage temperature *1	Tstg	-10 to +60	°C
Incident X-ray energy	-	90	kVp

*1: No condensation

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

Parameter	Symbol	Min.	Typ.	Max.	Unit
Maximum frame rate	Sf(max)	285	300	-	frames/s
Frame rate	Sf	-	50 to Sf(max)	-	frames/s
Noise (rms) *2	N(rms)	-	800	-	electrons
Saturation charge	Csat	-	3.4	-	M electrons
Sensitivity *3	S	6000	7600	-	LSB/mR
Resolution *4	Reso	3.6	4.5	-	line pairs/mm
Dynamic range	-	-	4300	-	-
Defect line *5	-	-	-	5	lines
Blemish *6	-	-	-	600	μm
Non-uniformity of sensitivity *6	-	-	-	4	%
Defect cluster *6	-	Not allowed			-
Bright line output adjacent to a defect line *6	-	-	-	130	%
Output offset *7	-	-	260	800	LSB

*2: Internal trigger mode at maximum frame rate (Typ.)
*3: 80 kVp, acrylic filter 170 mm
*4: Spatial frequency at CTF=5 %
*5: A defect line is a horizontal or vertical line containing 4 or more cosecutive pixels located at the opposite side of an amplifier array or a shift register, that produce 1/8 of the average sensitivity of the surrounding pixels.
   Adjacent defective lines are not allowed in the vertical or horizontal directions.
*6: See P. 6, "Description of terms".
*7: Average of all effective pixels at maximum frame rate (Typ.)
   Note: X-ray energy range is 20 k to 90 kVp.

Resolution

(Ta=25 °C, A.vdd=5.0 V, D.vdd=5.0 V)

CTF (%) vs Spatial frequency (line pairs/mm)
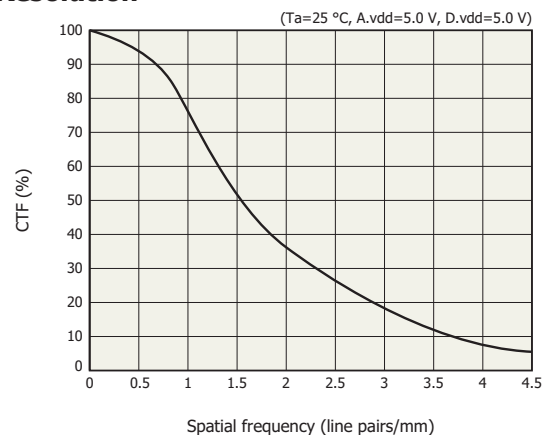
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System requirements

To operate the C10500D-42 at full performance, the following system and peripherals are required.

- PC: See "http://www.dcamapi.com"

- Power source: A.vdd = +5.0 ± 0.1 V (650 mA), D.vdd = +5.0 ± 0.1 V (600 mA)
  - · The voltages described above are specified at the flat panel sensor side.
  - · Please use a low noise series power supply. (Avoid using a switching power supply.)
  - · Install a noise filter on the AC power input line to prevent surges on the AC line.
  - · Always ground the fixing plate to avoid the effects of noise from peripheral devices.

- DCAM-API (digital camera application programming interface): produced by HAMAMATSU
  - · The driver software and DLL are included in DCAM-API. DCAM-SDK which includes function manuals and sample software can be provided to OEM users.
  - · The latest version of DCAM-API can be downloaded from "http://www.dcamapi.com"

- Ethernet protocol : UDP (User Datagram Protocol)

The power cable, Ethernet cable, earth cable, image acquisition software, and image processing libraries are excluded from the flat panel sensor.

[Table 1] Power supply pin assignment

Pin no.	Signal	Pin No.	Signal
1	Digital GND	6	Analog +5 V
2	Digital +5 V	7	Analog +5 V
3	Analog GND	8	Analog +5 V
4	Analog GND	9	Analog GND
5	Analog GND		

Power plug: 53259-0929 (Molex Japan Co., Ltd.)
Power receptacle: 51067-0900 (Molex Japan Co., Ltd.)

[Table 2] External I/O pin assignment

Pin no.	Signal	Function
1	Reserved	-
2	ExtTrgIO (TTL)	Trigger signal input under the external mode (see Table 3).
3	Reserved	-
4	Reserved	-
5	Reserved	-
6	Reserved	-
7	Reserved	-
8	Digital GND	Digital GND

8-pin receptacle: 53048-0810 (Molex Japan Co., Ltd.)
Mating plug: 51021-0800 (Molex Japan Co., Ltd.)

[Table 3] Trigger mode selection by DCAM-API
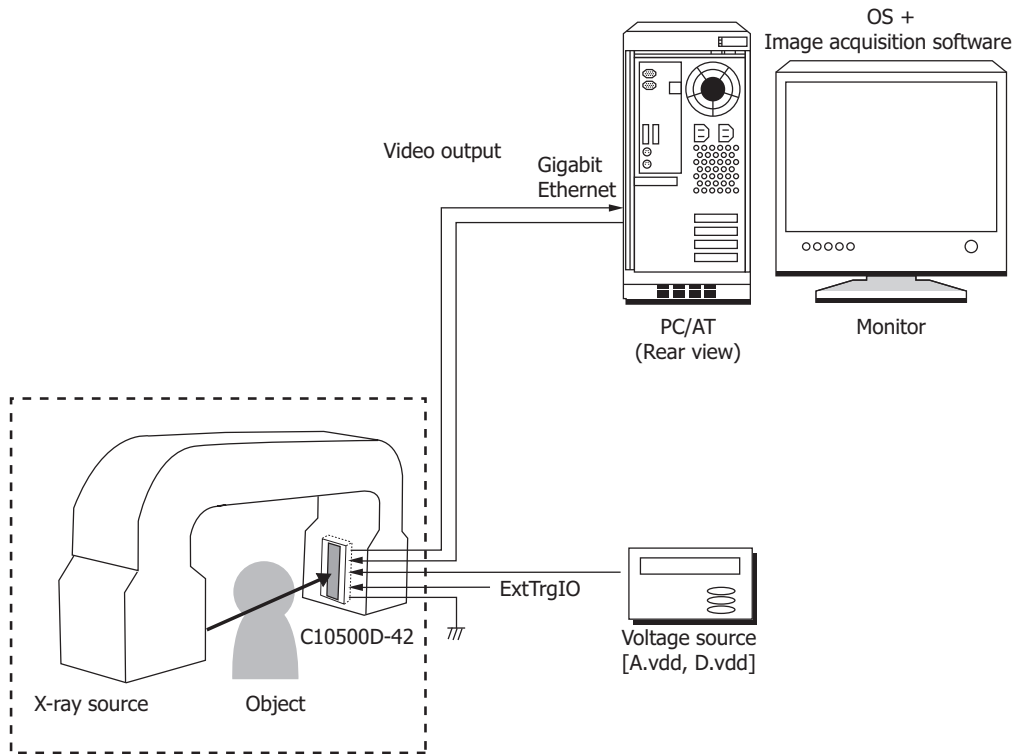Function: BOOL dcam_settriggermode (HDCAM h, int32 mode);

Trigger mode	ExtTrg IO	Note
External trigger (DCAM_TRIGMODE_SYNCREADOUT)	Rectangular signal	The integration time is controlled by the rising edge of ExtTrg IO.
Internal trigger (DCAM_TRIGMODE_INTRENAL)	High or Open	The integration time is controlled by DCAM command.

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Connection

After installing DCAM-API in a PC that supports Gigabit Ethernet, connect the C10500D-42 to that PC.
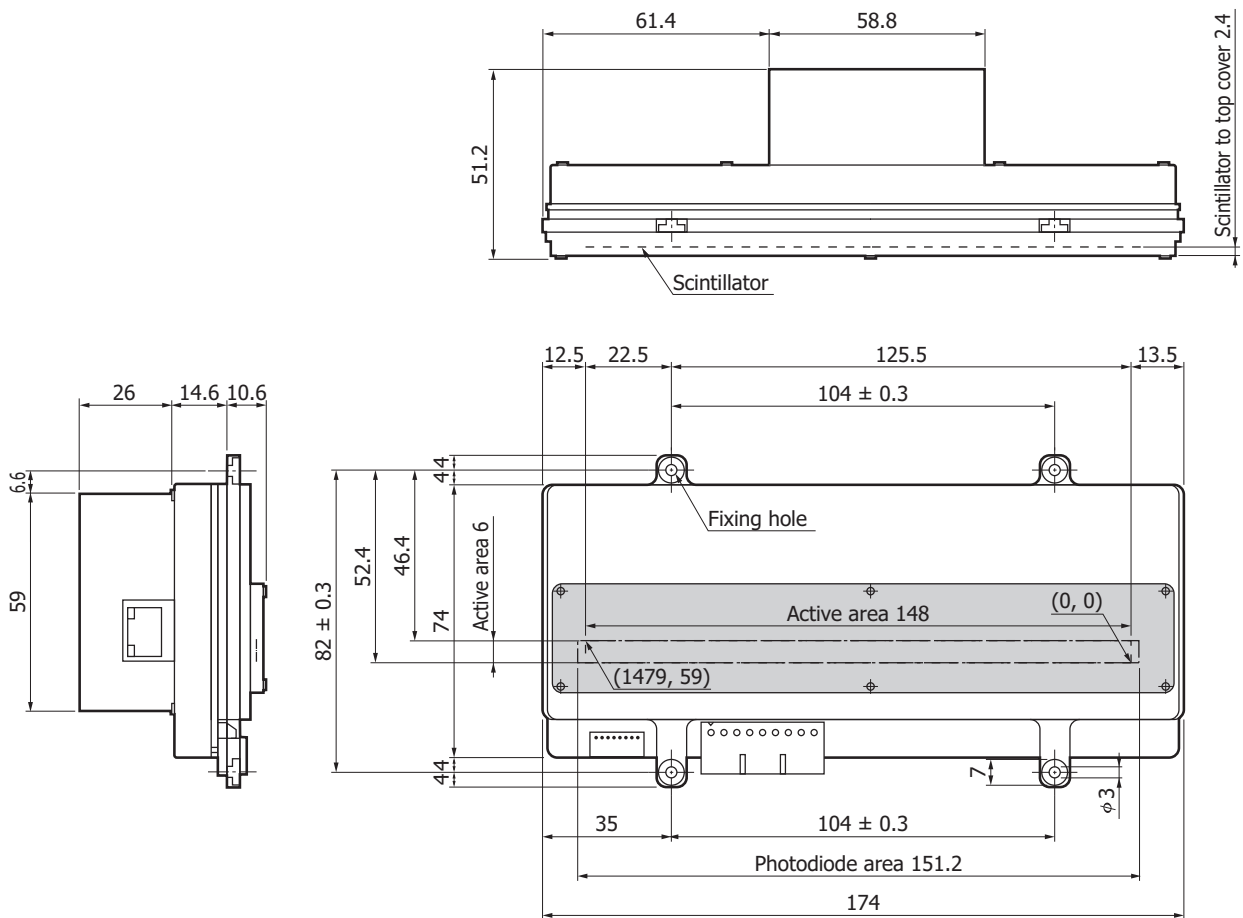The flat panel sensor is designed subject to point-to-point connection. The specification herein mentioned may not be obtained when the flat panel sensor is controlled through network of in-house LAN, etc.
In case of rotating system, depending on the input X-ray flux to the sensor, the rotating speed of the system or the frame rate of the sensor needs to be changed periodically. Please input external trigger signal to ExtTrgIO to control the frame rate of the sensor, in this case.

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

61.4
58.8
51.2
Scintillator to top cover 2.4
Scintillator

26 14.6 10.6
6.6
59
82 ± 0.3
52.4
46.4
74

12.5 22.5
125.5
13.5
104 ± 0.3
4.4
Fixing hole
Active area 6
Active area 148
(0, 0)
(1479, 59)
4.4
7
φ3
35
104 ± 0.3
Photodiode area 151.2
174

Top cover is made of carbon fiber (0.4 mm thickness)
Weight: 0.5 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 was measured 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 (incident X-ray energy: less than 90 kVp) even within the warranty period.
· This product is bare board type for installation into equipment and is not covered with a metal shielded case. When designing an equipment, implement EMC measures such as providing electromagnetic shielding on this product and the connection cables.

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Description of terms

▷ Blemish

Length of pixel cluster which has less than 90 % of the average sensitivity of the surrounding pixels.

▷ Bright line output adjacent to a defect line

The relative sensitivity ratio "a/b" should be 130 % or less for both vertical and horizontal lines, where "a" and "b" are defined as follows:

a: Average sensitivity of bright line (Line A) adjacent to defect line
b: Average sensitivity of standard line (Line B) adjacent to Line A

Note that the average sensitivity of the bright line is calculated from the region adjacent to the defect region in the defect line.

Example: See the right figure

Defect region in defect line: From pixel (J, 1) to pixel (J, 15)
a: Average sensitivity from pixel (I, 1) to pixel (I, 15) or from pixel (K, 1) to pixel (K, 15)
b: Average sensitivity from pixel (H, 1) to pixel (H, 15) or from pixel (L, 1) to pixel (L, 15)
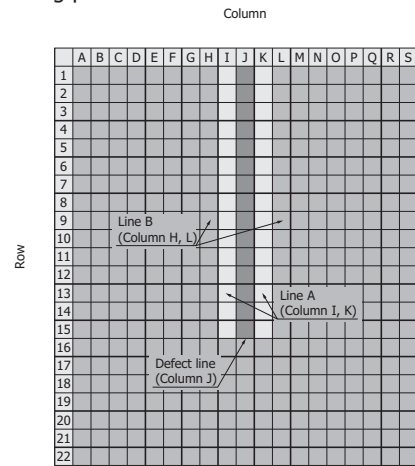
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▷ Defect cluster

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

This is defined as defect cluster.　　This is not defined as defect cluster.
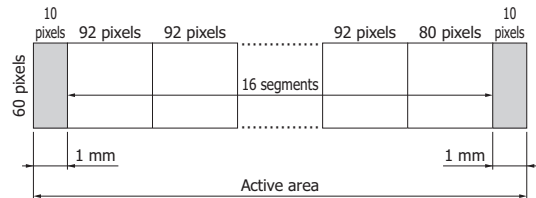
☐ Normal pixel　　☐ Defective pixel

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▷ Non-uniformity of sensitivity

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

$$\text{Non-unifomity of sensitivity} = \frac{\sigma}{\overline{x}}$$

σ: standard deviation of 16 × 1 "Xij"
x̄: average value of 16 × 1 "Xij"

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