

Photodiode module



C14093-1241

X-ray detection module with dual energy detection method

This module is equipped with photodiode arrays for X-ray detection. The 32-element photodiode array on the front side of the board detects low-energy X-rays, while the 32-element photodiode array on the back side detects high-energy X-rays. The photodiode arrays come with a scintillator [for low energy: phosphor sheet, for high energy: CsI(Tl)].

Features

- Equipped with 32-element photodiode arrays on the front and back sides of the board
- Scintillator for low energy: phosphor sheet
Scintillator for high energy: CsI(Tl)
We can support the following scintillators as needed.
No scintillator, CsI(Tl), GOS ceramic, phosphor sheet
- 16-bit digital output
- Multiple photodiode modules can be put in a daisy-chain connection for a long and narrow X-ray sensor structure
- Can be controlled with a CameraLink using signal processing unit C13938 (sold separately)

Applications

- X-ray non-destructive inspection (baggage inspection, etc.)

Structure

Parameter	Specification	Unit
Output type	Digital	-
A/D converter resolution	16	bit
Data output	Serial	-
Scintillator*1	For low energy (front side)	Phosphor sheet
	For high energy (back side)	CsI(Tl): 4 mm ^t
Element size	1.3 (W) × 2.0 (H)	mm
Element pitch	1.575	mm
Number of elements	64 (32 + 32)	-

*1: The type no. suffix shows the scintillator. The following scintillators are supported.

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- Specifications of scintillator for low energy
- Scintillator for low energy (0: without scintillator, 1: CsI(Tl), 3: GOS ceramic, 4: phosphor sheet)
- Specifications of scintillator for high energy
- Scintillator for high energy (0: without scintillator, 1: CsI(Tl), 3: GOS ceramic, 4: phosphor sheet)

Absolute maximum ratings (Ta=25 °C)

Parameter	Symbol	Value	Unit
Supply voltage	Vdd	-0.3 to +17	V
Digital input signal terminal voltage	Vi	-0.3 to +2.6	V
Operating temperature*2	Topr	+10 to +50	°C
Storage temperature*2	Tstg	-20 to +70	°C

*2: No dew condensation

When there is a temperature difference between a product and the surrounding area in high humidity environments, dew condensation may occur on the product surface. Dew condensation on the product may cause deterioration in characteristics and reliability.

Note: Exceeding the absolute maximum ratings even momentarily may cause a drop in product quality. Always be sure to use the product within the absolute maximum ratings.

▣ Recommended operating conditions (Ta=25 °C)

Parameter	Symbol	Min.	Typ.	Max.	Unit
Supply voltage	Vdd	9	12	15	V
Clock pulse frequency	f(CLK)	-	20	-	MHz
Data rate	-	-	40	-	MHz
Integration time	-	1	-	100	ms

▣ Electrical characteristics (Ta=25 °C)

Parameter	Symbol	Min.	Typ.	Max.	Unit
Analog input range*3	Qin	0.5	-	127.5	pC
Differential input threshold*4	-	±100	-	-	mV
Output voltage*4	High	VOH	1.375	-	V
	Low	VOL	1.025	-	V
	Offset	-	1.2	1.395	V

*3: The input range is selectable from 0.5 pC to 127.5 pC in 255 steps.

*4: LVDS

▣ Electrical and optical characteristics (Ta=25 °C)

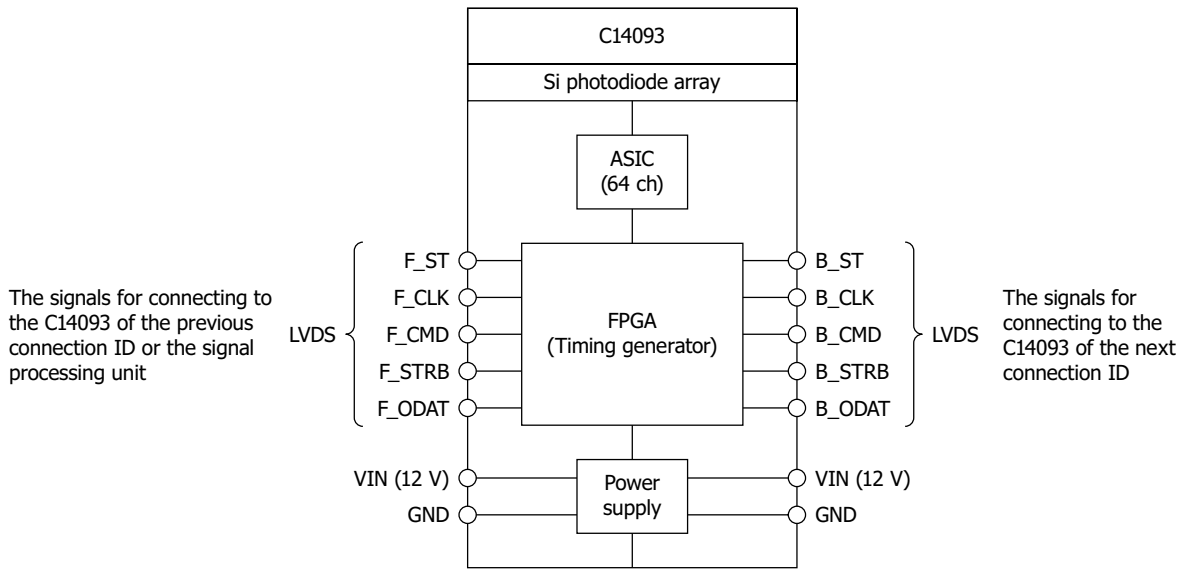
Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Readout noise*5	Nread	Qin=4 pC	-	10	-	ADU rms
		Qin=8 pC	-	6.5	-	
		Qin=16 pC	-	5	-	
		Qin=32 pC	-	4.5	-	
		Qin=64 pC	-	4.2	-	
		Qin=127.5 pC	-	4	-	
Saturation output	Dsat	-	-	-	65535	ADU
Dynamic range*6	Drange	Qin=4 pC	-	6500	-	-
		Qin=8 pC	-	10000	-	
		Qin=16 pC	-	13100	-	
		Qin=32 pC	-	14500	-	
		Qin=64 pC	-	15600	-	
		Qin=127.5 pC	-	16300	-	
Uniformity	-	-	-	±10	-	%
Current consumption*7	-	Line cycle=1 ms Vdd=12 V	-	105	-	mA

*5: Average value of all element readout noise. This value is calculated using the standard deviation of dark output from plural frames.

*6: Drange = Dsat/Nread

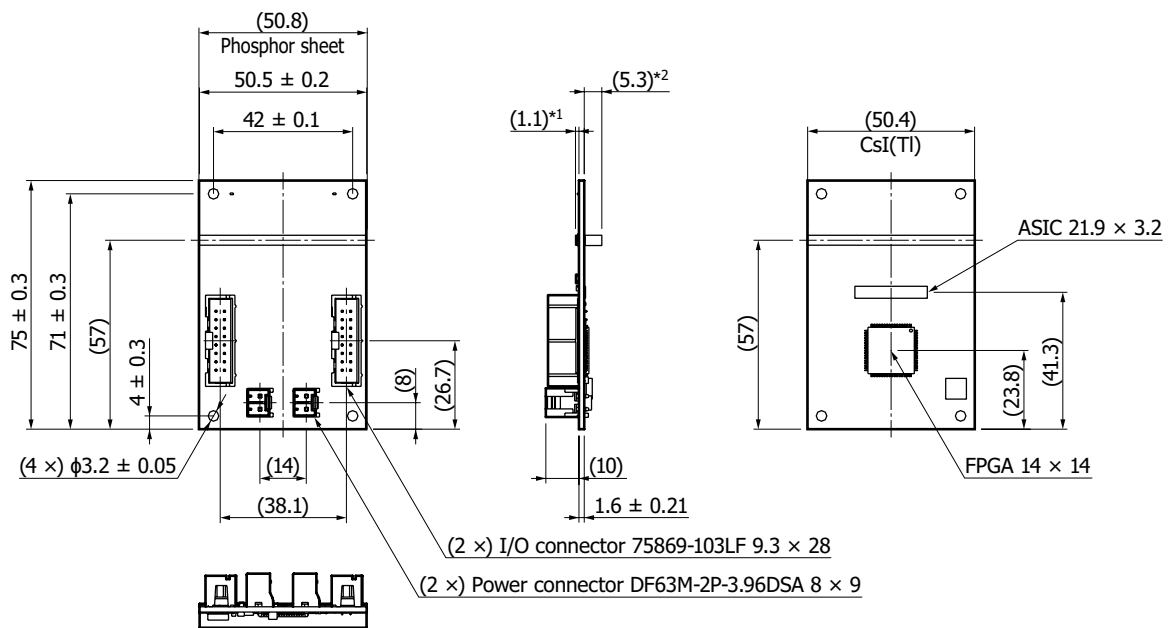
*7: When multiple C14093s are connected and used, the current consumption becomes a multiple.

Block diagram



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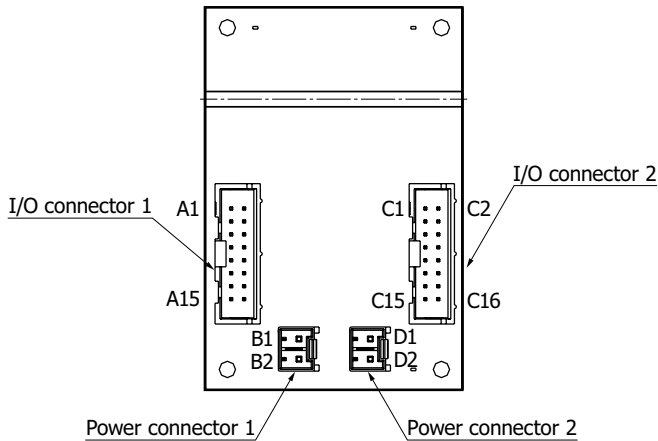
Dimensional outline (unit: mm)



*1: Distance from phosphor sheet top to board
*2: Distance from Csi(Tl) reflector top to board

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Pin connections



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■ I/O connector 1

Pin no.	Name	I/O	Voltage	Function
A1	DGND	-	-	Digital signal ground
A2	F_CMD_P	Input	LVDS	LVDS input for command (positive)
A3	F_CMD_N	Input	LVDS	LVDS input for command (negative)
A4	NC	-	-	No connection
A5	F_STRB_N	Output	LVDS	LVDS output for CH data clock (negative)
A6	F_STRB_P	Output	LVDS	LVDS output for CH data clock (positive)
A7	DGND	-	-	Digital signal ground
A8	F_CLK_P	Input	LVDS	LVDS input for system clock (positive)
A9	F_CLK_N	Input	LVDS	LVDS input for system clock (negative)
A10	NC	-	-	No connection
A11	F_ODAT_N	Output	LVDS	LVDS output for CH data output (negative)
A12	F_ODAT_P	Output	LVDS	LVDS output for CH data output (positive)
A13	DGND	-	-	Digital signal ground
A14	F_ST_P	Input	LVDS	LVDS input for integration time control (positive)
A15	F_ST_N	Input	LVDS	LVDS input for integration time control (negative)
A16	DGND	-	-	Digital signal ground

■ Power connector 2

Pin no.	Name	I/O	Voltage	Function
B1	F_POWER	Input	+12 V	Power supply
B2	F_GND	Input	0 V	Power supply ground

■ I/O connector 2

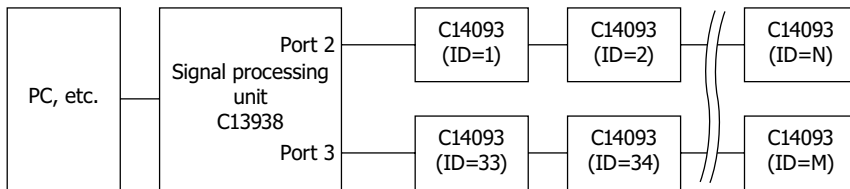
Pin no.	Name	I/O	Voltage	Function
C1	DGND	-	-	Digital signal ground
C2	B_CMD_P	Output	LVDS	LVDS output for command (positive)
C3	B_CMD_N	Output	LVDS	LVDS output for command (negative)
C4	Vref	-	2.5 V	Reference voltage for B_PDA_STRB_P
C5	B_STRB_N	Input	LVDS	LVDS input for CH data clock (negative)
C6	B_STRB_P	Input	LVDS	LVDS input for CH data clock (positive)
C7	DGND	-	-	Digital signal ground
C8	B_CLK_P	Output	LVDS	LVDS output for system clock (positive)
C9	B_CLK_N	Output	LVDS	LVDS output for system clock (negative)
C10	Vref	-	2.5 V	Reference voltage for B_PDA_ODAT_P
C11	B_ODAT_N	Input	LVDS	LVDS input for CH data output (negative)
C12	B_ODAT_P	Input	LVDS	LVDS input for CH data output (positive)
C13	DGND	-	-	Digital signal ground
C14	B_ST_P	Output	LVDS	LVDS output for integration time control (positive)
C15	B_ST_N	Output	LVDS	LVDS output for integration time control (negative)
C16	DGND	-	-	Digital signal ground

■ Power connector 2

Pin no.	Name	I/O	Voltage	Function
D1	B_POWER	Input	+12 V	Power supply
D2	B_GND	Input	0 V	Power supply ground

■ Connection diagram

Maximum 32 modules of the C14093 (maximum 64 for 2 ports total) can be connected in series per port by using a PC and signal processing unit for photodiode module C13938. This feature is convenient when the long and narrow sensor is formed.

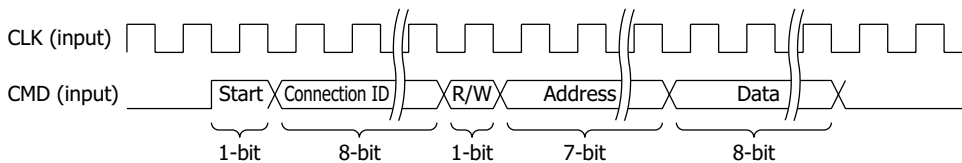


Note: N=32 max., M=64 max.

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■ Command protocol

It sends commands from the CMD pins (A2, A3, C2, C3) and CLK pins (A8, A9, C8, C9). Commands include Start, Connection ID (see the connection diagram), R/W (read/write), Address, and Data (see the register map). Set R/W = 1 for read and R/W = 0 for write.

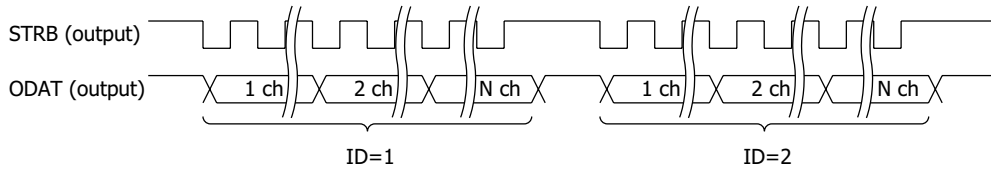


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Data protocol

■ Data timing

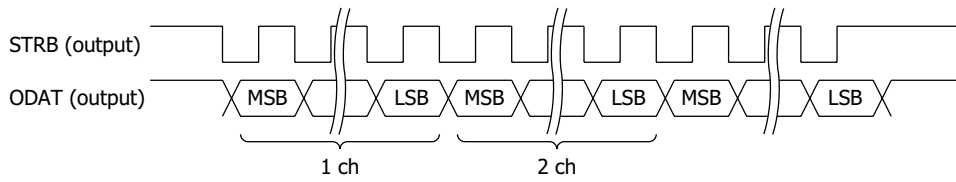
The data from each element is output to the falling edge of the STRB signal (in connection ID order).



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■ Output order of element bit

In 16-bit output order, MSB outputs first and LSB outputs last.



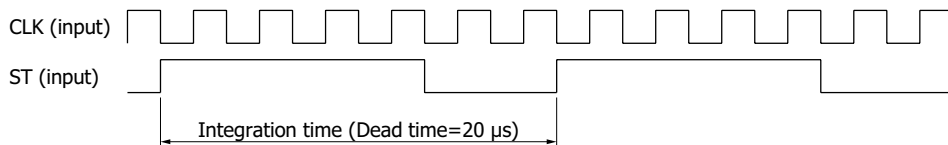
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Register map

Address	Name	Data	Description
0x01	PDA_SYS	Start Bit 7: reset (start: 1) Bit 5: correction (start: 1) Bit 4: initialization (start: 1) Set connection ID=0.	Make sure to initialize and do corrections to the photodiode module after turning on the power supply, resetting, or changing Cf. Command communications cannot be done during initialization. Initialization finishes in 10 μ s.
0x03	PDA_STS	Bit 5: correction (end: 1) Bit 4: initialization (end: 1)	For read
0x1E	PDA_LAST_ID	Maximum value of connection ID	This sets the number of photodiode modules connected to the ports.
0x1F	PDA_ACQ_CTRL	Data acquisition Bit 4: sampling (start: 1) Bit 0: sampling (stop: 1)	During correction, stop sampling.
0x44	ASIC_CF_SEL	Cf value selection C_f [pF] = Set value \times 0.25	Initial setting: 0×19 (=6.25 pF) Analog input range [pC] = $C_f \times 2$

Integration time control

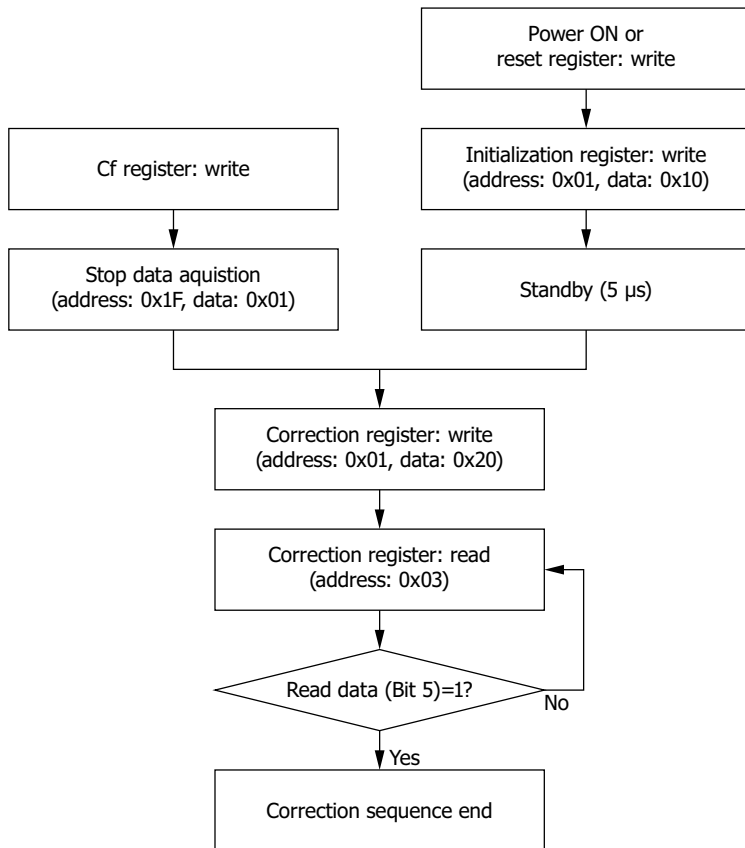
Integration time is defined by the ST signal. The ST signal must be synchronized with the falling edge of CLK. The ST signal is valid only when the PDA_ACQ_CTRL register is set to 0x10. In other cases, the element data will not be output.



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Initialization

After the power supply is turned on to the C14093, it must be initialized and then correction must be done. If correction is not done, then the offset values of the C14093 are different for even and odd frames.



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Accessories

- Power cable (for connecting two C14093s)
- I/O cable (for connecting two C14093s)

Signal processing unit for photodiode module C13938

Features

- **A long and narrow X-ray sensor can be put in a structure in combination with multiple photodiode modules C14093 (sold separately).**
- **Controllable from a PC (CameraLink interface)**

Note: For more details, refer to the C13938 datasheet.



Related information

www.hamamatsu.com/sp/ssd/doc_en.html

- Precautions
- Disclaimer

Information described in this material is current as of July 2021.

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