

# LI8020SA

34.9mm Diagonal 246MP CMOS Sensor on 228pin QFP with 1.5µm Square Pixels at 5.0fps

## DESCRIPTION

LI8020SA is a CMOS type solid-state imaging sensor having a size equivalent to APS-H, and a square pixel arrangement with 246 million effective pixels.

An all pixel progressive reading of 5.0 fps is possible by the 16 channel digital signal outputs.

A rolling electronic shutter function is provided for controlling electric charge accumulation periods.

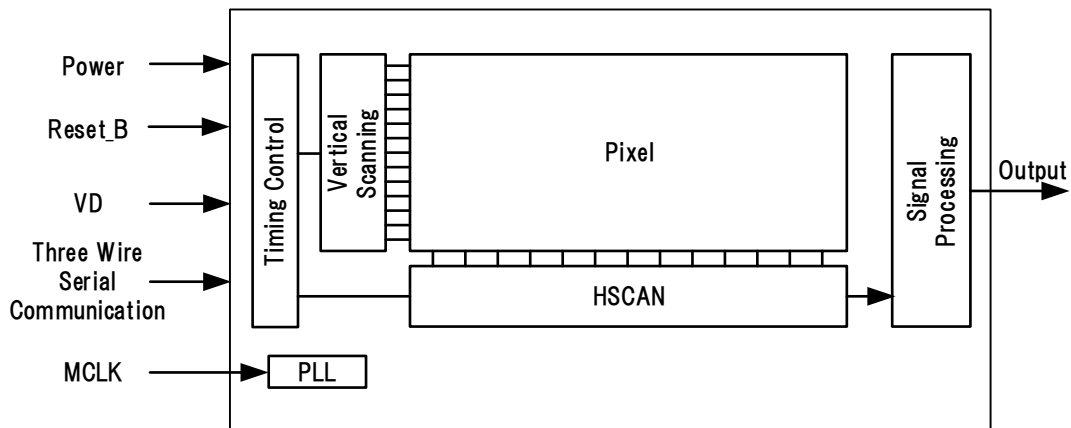
LI8020SA captures stunning detail 125 times greater than full high definition resolution and 30 times that of 4K resolution. This CMOS sensor also supports features such as ROI readout function and sub-sampling readout function, it can realize faster framerate.

\*LI8020SA series consists of LI8020SAM (monochrome), LI8020SAC (color).

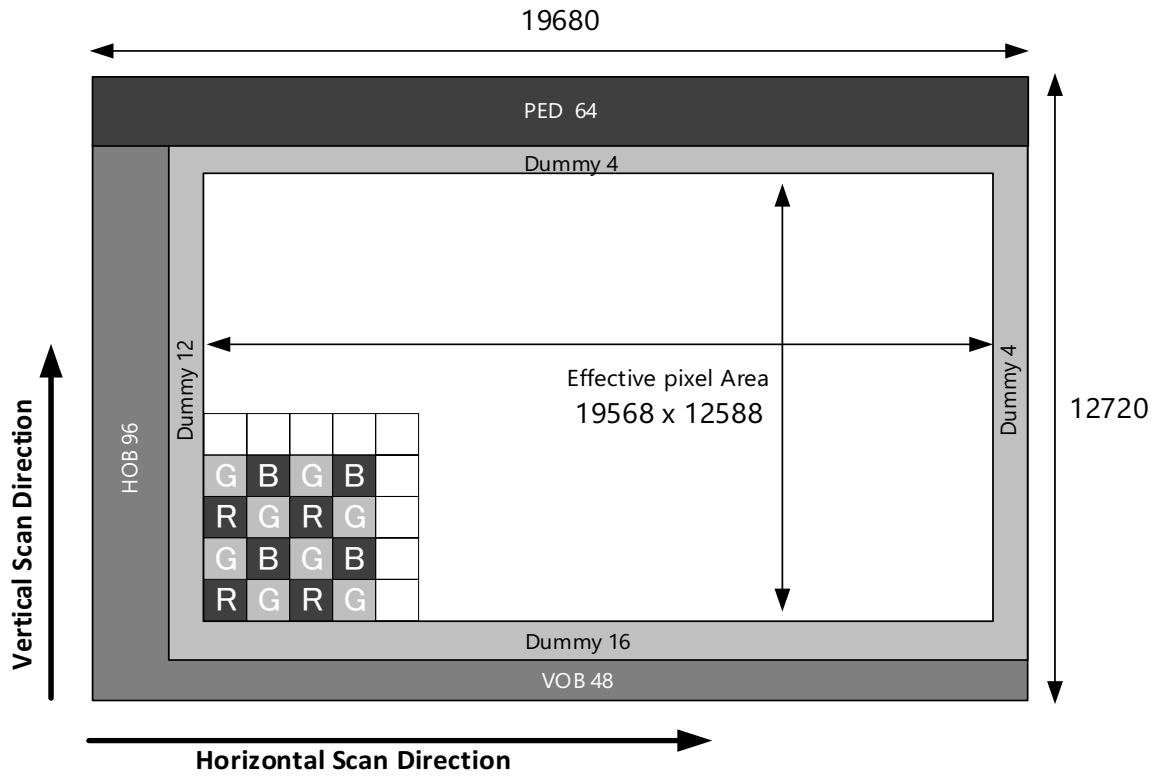
## FEATURES

- LI8020SAM: Monochrome sensor
- LI8020SAC: Color sensor (RGB on-chip color filter)
- Rolling shutter, Slit Rolling shutter
- Recording screen size: APS-H or equivalent (29.35 mm x 18.88 mm)
- Number of effective pixels: 19568 x 12588 (Horizontal x Vertical)
- Pixel size: 1.5 µm x 1.5 µm
- Number of output channels: Data 16 lanes, Clock 4 lanes
- Output format: LVDS/SLVS output, 810 Mbps @10 bit (recommended), 972 Mbps @12 bit
- Main clock frequency: 81 MHz (Recommended)
- Region of Interest (ROI) readout function (Vertically and Horizontally)
- Full area readout: 5 fps\*, 8K4K readout: 24 fps\*, 4K2K readout: 30 fps\*, FHD readout: 60 fps\* (\*@10 bit)
- Vertically sub-sampling readout function (1/1, 1/3, 1/5, 1/7, and 1/9)
- Analog gain: 0 dB, 6 dB, and 12 dB (-6 dB for evaluation)
- Serial communication
- Saturation: 5,400 e
- Sensitivity of LI8020SAM: 11,000 e/lx/sec
- Sensitivity of LI8020SAC (Green): 4,600 e/lx/sec
- Quantum efficiency of LI8020SAM: 61 % @wavelength 513 nm (peak), 60 % @wavelength 525 nm
- Quantum efficiency (Green) of LI8020SAC: 39 % @wavelength 518 nm (peak), 39 % @wavelength 525 nm
- Dark Random Noise: 3.8 e-rms @12 dB
- Dark Current: 0.1 e/sec @0°C, 13 e/sec @60°C
- Power consumption: 2.0 W (under recommended operating conditions)
- Power supply voltage: 1.2 V, 3.3 V and 3.5 V
- 228pin ceramic QFP
- Package size: 43.7 mm x 36.4 mm x 3.97 mm (External electrodes are not included)

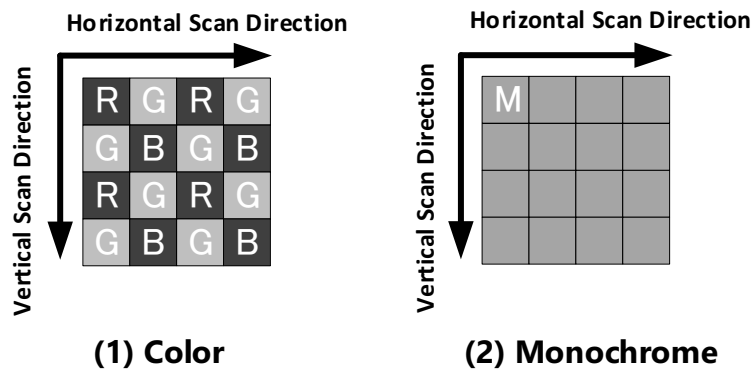
## FUNCTIONAL BLOCK DIAGRAM



### 3. Pixel Arrangement



**Figure 3-1. Pixel Data Format (Physical Arrangement)**



**Figure 3-2. Pixel Color Filter Arrangement**

## 4. Pin Specifications

Table 4-1. Pin Specifications 1

Pin No	Pin Name	Type	Content	Remarks
1	NC	-	-	Non-Connection
2	DGND	G	Digital GND	-
3	DVDD	P	1.2V digital power supply	-
4	AVDDH	P	3.3V analog power supply	-
5	AGND	G	Analog GND	-
6	SGND	G	Sensor GND	-
7	SVDD	P	3.5V sensor power supply	-
8	DVDDH	P	3.3V digital power supply	-
9	DVDD	P	1.2V digital power supply	-
10	DGND	G	Digital GND	-
11	NC	-	-	Non-Connection
12	NC	-	-	Non-Connection
13	NC	-	-	Non-Connection
14	TEST1	O	Test pin	Open
15	TEST2	O	Test pin	Open
16	DGND	G	Digital GND	-
17	DVDD	P	1.2V digital power supply	-
18	RIREFL	I/O	Reference resistance connection	7.5kΩ ±5%
19	AGND	G	Analog GND	-
20	AVDDH	P	3.3V analog power supply	-
21	VREG3	P	3.3V power supply	-
22	VREG5	P	3.4V power supply	-
23	VREG1	P	3.4V power supply	-
24	AGND	G	Analog GND	-
25	VREF1	O	Built-in power supply capacitance connection	-
26	VREF3	O	Built-in power supply capacitance connection	-
27	VREF2	O	Built-in power supply capacitance connection	-
28	VREF4	O	Built-in power supply capacitance connection	-
29	AVDDH	P	3.3V analog power supply	-
30	VREG6	P	1.1V power supply	-
31	VREG4	P	0V power supply	-
32	VREG2	P	-1.2V power supply	-
33	NC	-	-	Non-Connection
34	DVDD	P	1.2V digital power supply	-
35	DGND	G	Digital GND	-
36	RESET_B	I	Digital signal (reset) input	Asynchronous, Low active
37	Reserved	I	-	Connect to GND
38	SCS	I	Digital signal (3-wire serial) input	-
39	SCLK	I	Digital signal (3-wire serial) input	-
40	SDI	I	Digital signal (3-wire serial) input	-
41	DGND	G	Digital GND	-
42	DVDD	P	1.2V digital power supply	-
43	DVDDH	P	3.3V digital power supply	-
44	SVDD	P	3.4V sensor power supply	-
45	SGND	G	Sensor GND	-
46	AGND	G	Analog GND	-
47	AVDDH	P	3.3V analog power supply	-
48	DVDD	P	1.2V digital power supply	-
49	DGND	G	Digital GND	-
50	NC	-	-	Non-Connection

Type G: Ground, P: Power, I: Input, O: Output

Table 4-2. Pin Specifications 2

Pin No	Pin Name	Type	Content	Remarks
51	TEST3	I	Test pin	Open
52	TEST4	I	Test pin	Open
53	NC	-	-	Non-Connection
54	NC	-	-	Non-Connection
55	TEST5	I	Test pin	Open
56	AGND	G	Analog GND	-
57	AVDD	P	1.2V analog power supply	-
58	TEST6	O	Test pin	-
59	TEST7	O	Test pin	-
60	VD1	I	Digital signal (VD) input	Logic input
61	CLK1	I	Digital signal (MCLK) input	Logic input
62	SVDD	P	3.5V sensor power supply	-
63	AVDDH	P	3.3V analog power supply	-
64	AGND	G	Analog GND	-
65	SGND	G	Sensor GND	-
66	DGND	G	Digital GND	-
67	DVDD	P	1.2V digital power supply	-
68	VDDL	P	0.4V digital power supply	-
69	D03N	O	Data output	-
70	D03P	O	Data output	-
71	D02N	O	Data output	-
72	D02P	O	Data output	-
73	LVCK0N	O	LVCK output	-
74	LVCK0P	O	LVCK output	-
75	D01N	O	Data output	-
76	D01P	O	Data output	-
77	D00N	O	Data output	-
78	D00P	O	Data output	-
79	AVDDH	P	3.3V analog power supply	-
80	SVDD	P	3.5V sensor power supply	-
81	DVDD	P	1.2V digital power supply	-
82	AVDD	P	1.2V analog power supply	-
83	AGND	G	Analog GND	-
84	DGND	G	Digital GND	-
85	SGND	G	Sensor GND	-
86	AGND	G	Analog GND	-
87	D10P	O	Data output	-
88	D10N	O	Data output	-
89	D11P	O	Data output	-
90	D11N	O	Data output	-
91	LVCK1P	O	LVCK output	-
92	LVCK1N	O	LVCK output	-
93	D12P	O	Data output	-
94	D12N	O	Data output	-
95	D13P	O	Data output	-
96	D13N	O	Data output	-
97	VDDL	P	0.4V digital power supply	-
98	DVDD	P	1.2V digital power supply	-
99	DGND	G	Digital GND	-
100	SGND	G	Sensor GND	-
101	AGND	G	Analog GND	-
102	AVDDH	P	3.3V analog power supply	-
103	SVDD	P	3.5V sensor power supply	-
104	TEST8	I	Test pin	Open
105	TEST9	I	Test pin	Open
106	AGND	G	Analog GND	-
107	AVDD	P	1.2V analog power supply	-
108	TEST10	O	Test pin	-
109	TEST11	O	Test pin	-
110	VREF5	P	1.0V analog input	-
111	AGND	G	Analog GND	-
112	CR11	I/O	Ramp capacitance connection	2700pF ±1%
113	CR21	I/O	Ramp capacitance connection	2700pF ±1%
114	AVDDH	P	3.3V analog power supply	-

Type G: Ground, P: Power, I: Input, O: Output

**Table 4-3. Pin Specifications 3**

Pin No	Pin Name	Type	Content	Remarks
115	RR1	I/O	Ramp reference resistance connection	3.3kΩ ±1%
116	DGND	G	Digital GND	-
117	DVDD	P	1.2V digital power supply	-
118	AVDDH	P	3.3V analog power supply	-
119	AGND	G	Analog GND	-
120	SGND	G	Sensor GND	-
121	SVDD	P	3.5V sensor power supply	-
122	DVDDH	P	3.3V digital power supply	-
123	DVDD	P	1.2V digital power supply	-
124	DGND	G	Digital GND	-
125	NC	-	-	Non-Connection
126	NC	-	-	Non-Connection
127	NC	-	-	Non-Connection
128	NC	-	-	Non-Connection
129	NC	-	-	Non-Connection
130	DGND	G	Digital GND	-
131	DVDD	P	1.2V digital power supply	-
132	NC	-	-	Non-Connection
133	VREG2	P	-1.2V power supply	-
134	VREG4	P	0V power supply	-
135	VREG6	P	1.1V power supply	-
136	AVDDH	P	3.3V analog power supply	-
137	VREF4	O	Built-in power supply capacitance connection	-
138	VREF2	O	Built-in power supply capacitance connection	-
139	VREF3	O	Built-in power supply capacitance connection	-
140	VREF1	O	Built-in power supply capacitance connection	-
141	AGND	G	Analog GND	-
142	VREG1	P	3.4V power supply	-
143	VREG5	P	3.4V power supply	-
144	VREG3	P	3.3V power supply	-
145	AVDDH	P	3.3V analog power supply	-
146	AGND	G	Analog GND	-
147	RIREFR	I/O	Reference resistance connection	7.5kΩ ±5%
148	DVDD	P	1.2V digital power supply	-
149	DGND	G	Digital GND	-
150	TEST12	O	Test pin	-
151	TEST13	O	Test pin	-
152	NC	-	-	Non-Connection
153	NC	-	-	Non-Connection
154	NC	-	-	Non-Connection
155	DGND	G	Digital GND	-
156	DVDD	P	1.2V digital power supply	-
157	DVDDH	P	3.3V digital power supply	-
158	SVDD	P	3.5V sensor power supply	-
159	SGND	G	Sensor GND	-
160	AGND	G	Analog GND	-
161	AVDDH	P	3.3V analog power supply	-
162	DVDD	P	1.2V digital power supply	-
163	DGND	G	Digital GND	-
164	RR2	I/O	Ramp reference resistance connection	3.3kΩ ±1%

Type G: Ground, P: Power, I: Input, O: Output

**Table 4-4. Pin Specifications 4**

Pin No	Pin Name	Type	Content	Remarks
165	AVDDH	P	3.3V analog power supply	-
166	CR22	I/O	Ramp capacitance connection	2700pF ±1%
167	CR12	I/O	Ramp capacitance connection	2700pF ±1%
168	AGND	G	Analog GND	-
169	VREF5	I	1.0V Analog input	-
170	TEST14	O	Test pin	-
171	TEST15	O	Test pin	-
172	AVDD	P	1.2V analog power supply	-
173	AGND	G	Analog GND	-
174	TEST16	I	Test pin	Open
175	TEST17	I	Test pin	Open
176	SVDD	P	3.5V sensor power supply	-
177	AVDDH	P	3.3V analog power supply	-
178	AGND	G	Analog GND	-
179	SGND	G	Sensor GND	-
180	DGND	G	Digital GND	-
181	DVDD	P	1.2V digital power supply	-
182	VDDL	P	0.4V digital power supply	-
183	D33N	O	Data output	-
184	D33P	O	Data output	-
185	D32N	O	Data output	-
186	D32P	O	Data output	-
187	LVCK3N	O	LVCK output	-
188	LVCK3P	O	LVCK output	-
189	D31N	O	Data output	-
190	D31P	O	Data output	-
191	D30N	O	Data output	-
192	D30P	O	Data output	-
193	AGND	G	Analog GND	-
194	SGND	G	Sensor GND	-
195	DGND	G	Digital GND	-
196	AGND	G	Analog GND	-
197	AVDD	P	1.2V analog power supply	-
198	DVDD	P	1.2V digital power supply	-
199	SVDD	P	3.5V sensor power supply	-
200	AVDDH	P	3.3V analog power supply	-
201	D20P	O	Data output	-
202	D20N	O	Data output	-
203	D21P	O	Data output	-
204	D21N	O	Data output	-
205	LVCK2P	O	LVCK output	-
206	LVCK2N	O	LVCK output	-
207	D22P	O	Data output	-
208	D22N	O	Data output	-
209	D23P	O	Data output	-
210	D23N	O	Data output	-
211	VDDL	P	0.4V digital power supply	-
212	DVDD	P	1.2V digital power supply	-
213	DGND	G	Digital GND	-
214	SGND	G	Sensor GND	-
215	AGND	G	Analog GND	-
216	AVDDH	P	3.3V analog power supply	-
217	SVDD	P	3.5V sensor power supply	-
218	CLK2	I	Digital signal (MCLK) input	Logic input
219	VD2	I	Digital signal (VD) input	Logic input
220	TEST18	O	Test pin	-
221	TEST19	O	Test pin	-
222	AVDD	P	1.2V analog power supply	-
223	AGND	G	Analog GND	-
224	TEST20	I	Test pin	Open
225	NC	-	-	Non-Connection
226	NC	-	-	Non-Connection
227	TEST21	I	Test pin	Open
228	TEST22	I	Test pin	Open

Type G: Ground, P: Power, I: Input, O: Output

## 7. Absolute Maximum Ratings

**Table 7-1. Absolute Maximum Ratings**

Item	Symbol	Min.	Max.	Unit	Notes
Analog Power Supply (3.3V)	AVDDH	-	3.6	V	-
Analog Power Supply (1.2V)	AVDD	-	1.35		-
Digital Power Supply (3.3V)	DVDDH	-	3.6		-
Digital Power Supply (1.2V)	DVDD	-	1.35		-
Sensor Power Supply (3.5V)	SVDD	-	3.6		-
IF Power Supply (0.4V)	VDDL	-	3.6		-
Power Supply (3.4V)	VREG1	-	3.6		-
Power Supply (-1.2V)	VREG2	-1.4	-		-
Power Supply (3.3V)	VREG3	-	3.6		-
Power Supply (0V)	VREG4	-	3.6		-
Power Supply (3.4V)	VREG5	-	3.6		-
Power Supply (1.1V)	VREG6	-	3.6		-
Power Supply (1.0V)	VREF5	-	3.6		-
Input Terminal Voltage	V <sub>in</sub>	DGND-0.3	3.6		-
Storage Temperature	T <sub>str</sub>	-40	100	°C	T <sub>j</sub> : Junction Temperature
Maximum Junction Temperature	T <sub>jmax</sub>	-	100	°C	T <sub>j</sub> : Junction Temperature

## 8. Recommended Operating Temperature

**Table 8-1. Recommended Operating Temperature**

Item	Symbol	Min.	Typ.	Max.	Unit	Notes
Operating Temperature	$T_{opr}$	-20	-	60	°C	Tj: Junction Temperature

Typ.: Typical



## 9. Electrical Specifications

**Table 9-1. Power Supply Voltage Setting**

Item	Symbol	Recommended Supply Voltage (V)			Current Consumption (mA)			Remarks
		Min.	Typ.	Max.	Min.	Typ.	Max.	
Analog Power Supply (3.3V)	AVDDH	3.2	3.3	3.4	-	300	400	-
Analog Power Supply (1.2V)	AVDD	1.1	1.2	1.3	-	40	50	-
Digital Power Supply (3.3V)	DVDDH	3.2	3.3	3.4	-	0	5	-
Digital Power Supply (1.2V)	DVDD	1.1	1.2	1.3	-	95	200	-
Sensor Power Supply (3.5V)	SVDD	3.45	3.50	3.55	-	210	300	-
IF Power Supply (0.4V)	VDDL	0.35	0.40	0.45	-	30	50	-
Power Supply (3.4V)	VREG1	3.35	3.40	3.45	-	0	-	-
Power Supply (-1.2V)	VREG2	-1.3	-1.2	-1.1	-	0	-	-
Power Supply (3.3V)	VREG3	3.2	3.3	3.4	-	0	-	-
Power Supply (0V)	VREG4	-0.1	0	0.1	-	0	-	-
Power Supply (3.4V)	VREG5	3.35	3.40	3.45	-	0	-	-
Power Supply (1.1V)	VREG6	1.0	1.1	1.2	-	0	-	-
Power Supply (1.0V)	VREF5	0.95	1.00	1.05	-	0	-	-

Typ.: Typical

# 15. Package Specification

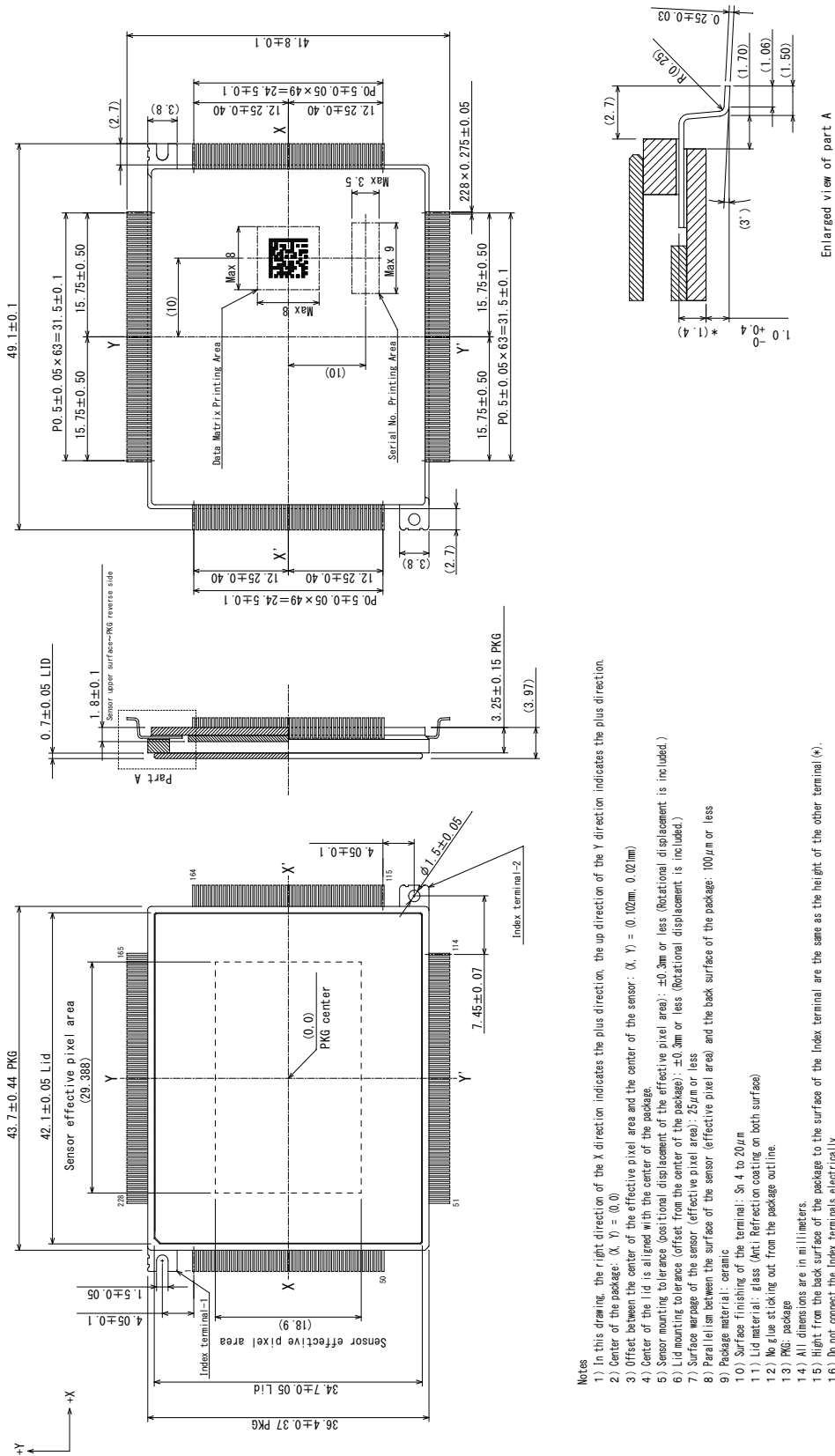


Figure 15-1. Package Specification

- Notes
- 1) In this drawing, the right direction of the X direction indicates the plus direction, the up direction of the Y direction indicates the plus direction.
  - 2) Center of the package: (X, Y) = (0, 0).
  - 3) Offset between the center of the effective pixel area and the center of the sensor: (X, Y) = (0.102mm, 0.021mm)
  - 4) Center of the lid is aligned with the center of the package.
  - 5) Sensor mounting tolerance (positional displacement of the effective pixel area): ±0.3mm or less (Rotational displacement is included.)
  - 6) Lid mounting tolerance (offset from the center of the package): ±0.3mm or less (Rotational displacement is included.)
  - 7) Surface warpage of the sensor (effective pixel area): 25µm or less
  - 8) Parallelism between the surface of the sensor (effective pixel area) and the back surface of the package: 100µm or less
  - 9) Package material: ceramic
  - 10) Surface finishing of the terminal: Sn 4 to 20µm
  - 11) Lid material: glass (Anti Reflection coating on both surface)
  - 12) No glue sticking out from the package outline.
  - 13) PKG: package
  - 14) All dimensions are in millimeters.
  - 15) Height from the back surface of the package to the surface of the index terminal are the same as the height of the other terminal (\*).
  - 16) Do not connect the index terminals electrically.