The S7199-01 is a front-illuminated FFT-CCD image sensor developed for X-ray imaging. An FOS (Fiber Optic plate with Scintillator) sensitive to X-rays is directly coupled to the CCD chips, allowing X-ray imaging with high sensitivity. Two CCD chips are arranged in close proximity to configure a long photosensitive area (approx. 150 mm).

The S7199-01 CCD image sensor features TDI mode operation that allows capturing clear, sharp X-ray images of objects moving on a belt conveyor, making it ideal for non-destructive X-ray inspection. FOP type not coated with scintillator material is also provided (S7199-01F).

### Features
- 1536 × 128 pixel (× 2 chips)
- Pixel size: 48 × 48 μm
- Buttable structure of 2 chips
- TDI (time delay integration) operation
- 100% fill factor
- Wide dynamic range
- Low dark current
- Low readout noise
- MPP operation

### Specifications

<table>
<thead>
<tr>
<th>Parameter</th>
<th>S7199-01</th>
<th>S7199-01F</th>
</tr>
</thead>
<tbody>
<tr>
<td>CCD structure</td>
<td>Full frame transfer or TDI</td>
<td></td>
</tr>
<tr>
<td>Window</td>
<td>FOS (fiber optic plate with scintillator)</td>
<td>FOP (fiber optic plate)(^*1)</td>
</tr>
<tr>
<td>Photosensitive area (H × V)</td>
<td>73.728 × 6.144 mm (× 2 chips)</td>
<td></td>
</tr>
<tr>
<td>X-ray sensitive area (H × V)</td>
<td>146 × 6 mm</td>
<td></td>
</tr>
<tr>
<td>Pixel size (H × V)</td>
<td>48 × 48 μm</td>
<td></td>
</tr>
<tr>
<td>Number of total pixels (H × V)</td>
<td>1536 × 128 (× 2 chips)</td>
<td></td>
</tr>
<tr>
<td>Number of effective pixels (H × V)</td>
<td>1536 × 128 (× 2 chips)</td>
<td></td>
</tr>
<tr>
<td>Fill factor</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>Vertical clock phase</td>
<td>2 phases</td>
<td></td>
</tr>
<tr>
<td>Horizontal clock phase</td>
<td>2 phases</td>
<td></td>
</tr>
<tr>
<td>Output circuit</td>
<td>Two-stage MOSFET source follower with load resistance</td>
<td></td>
</tr>
<tr>
<td>X-ray resolution</td>
<td>4 to 6 Lp/mm at 60 kVp, 20 μGy</td>
<td></td>
</tr>
<tr>
<td>Total dose irradiation</td>
<td>50 Gy max.</td>
<td></td>
</tr>
<tr>
<td>Package</td>
<td>40-pin ceramic</td>
<td></td>
</tr>
<tr>
<td>Cooling</td>
<td>Non-cooled</td>
<td></td>
</tr>
</tbody>
</table>

\(^*1\): When using this product for X-ray detection, the user needs to affix a phosphor sheet, etc. to the FOP.
Absolute maximum ratings (Ta=25 °C)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
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<tbody>
<tr>
<td>Storage temperature</td>
<td>Tstg</td>
<td>-20</td>
<td>-</td>
<td>+70</td>
<td>°C</td>
</tr>
<tr>
<td>Operating temperature</td>
<td>Topr</td>
<td>0</td>
<td>-</td>
<td>+40</td>
<td>°C</td>
</tr>
<tr>
<td>OD voltage</td>
<td>VOD</td>
<td>-0.5</td>
<td>-</td>
<td>+20</td>
<td>V</td>
</tr>
<tr>
<td>RD voltage</td>
<td>VRD</td>
<td>-0.5</td>
<td>-</td>
<td>+18</td>
<td>V</td>
</tr>
<tr>
<td>ISV voltage</td>
<td>VISV</td>
<td>-0.5</td>
<td>-</td>
<td>+18</td>
<td>V</td>
</tr>
<tr>
<td>IGV voltage</td>
<td>VIGV</td>
<td>-15</td>
<td>-</td>
<td>+15</td>
<td>V</td>
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<tr>
<td>IGH voltage</td>
<td>VIGH</td>
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<td>-</td>
<td>+15</td>
<td>V</td>
</tr>
<tr>
<td>SG voltage</td>
<td>VSG</td>
<td>-15</td>
<td>-</td>
<td>+15</td>
<td>V</td>
</tr>
<tr>
<td>OG voltage</td>
<td>VOG</td>
<td>-15</td>
<td>-</td>
<td>+15</td>
<td>V</td>
</tr>
<tr>
<td>RG voltage</td>
<td>VRG</td>
<td>-15</td>
<td>-</td>
<td>+15</td>
<td>V</td>
</tr>
<tr>
<td>TG voltage</td>
<td>VTC</td>
<td>-15</td>
<td>-</td>
<td>+15</td>
<td>V</td>
</tr>
<tr>
<td>Vertical clock voltage</td>
<td>VP1AV, VP2AV, VP1BV, VP2BV</td>
<td>-15</td>
<td>-</td>
<td>+15</td>
<td>V</td>
</tr>
<tr>
<td>Horizontal clock voltage</td>
<td>VP1AH, VP2AH, VP1BH, VP2BH</td>
<td>-15</td>
<td>-</td>
<td>+15</td>
<td>V</td>
</tr>
</tbody>
</table>

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.

Operating conditions (MPP mode, Ta=25 °C)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
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<tbody>
<tr>
<td>Output transistor drain voltage</td>
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<td>12</td>
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<td>V</td>
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<td>Reset drain voltage</td>
<td>VRD</td>
<td>12</td>
<td>13</td>
<td>14</td>
<td>V</td>
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<tr>
<td>Output gate voltage</td>
<td>VOG</td>
<td>-0.5</td>
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<td>5</td>
<td>V</td>
</tr>
<tr>
<td>Output transistor ground voltage</td>
<td>VSSD</td>
<td>-5</td>
<td>0</td>
<td>-</td>
<td>V</td>
</tr>
<tr>
<td>Vertical input source</td>
<td>VISV</td>
<td>-</td>
<td>-</td>
<td>VRD</td>
<td>V</td>
</tr>
<tr>
<td>Vertical input gate</td>
<td>VIGV</td>
<td>-8</td>
<td>0</td>
<td>-</td>
<td>V</td>
</tr>
<tr>
<td>Horizontal input gate</td>
<td>VIGH</td>
<td>-8</td>
<td>0</td>
<td>-</td>
<td>V</td>
</tr>
<tr>
<td>Vertical shift register clock voltage</td>
<td>VP1AVH, VP2AVH, VP1BVH, VP2BVH</td>
<td>0</td>
<td>3</td>
<td>6</td>
<td>V</td>
</tr>
<tr>
<td>Low</td>
<td>VP1AVL, VP2AVL, VP1BVL, VP2BVL</td>
<td>-9</td>
<td>-8</td>
<td>-7</td>
<td>V</td>
</tr>
<tr>
<td>Horizontal shift register clock voltage</td>
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<td>3</td>
<td>6</td>
<td>V</td>
</tr>
<tr>
<td>Low</td>
<td>VP1AHL, VP2AHL, VP1BHL, VP2BHL</td>
<td>-9</td>
<td>-8</td>
<td>-7</td>
<td>V</td>
</tr>
<tr>
<td>Summing gate voltage</td>
<td>VSG</td>
<td>0</td>
<td>3</td>
<td>6</td>
<td>V</td>
</tr>
<tr>
<td>Low</td>
<td>VSGL</td>
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<td>-8</td>
<td>-7</td>
<td>V</td>
</tr>
<tr>
<td>Reset gate voltage</td>
<td>VRG</td>
<td>0</td>
<td>3</td>
<td>6</td>
<td>V</td>
</tr>
<tr>
<td>Low</td>
<td>VRGL</td>
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<td>-8</td>
<td>-7</td>
<td>V</td>
</tr>
<tr>
<td>Transfer gate voltage</td>
<td>VTH</td>
<td>0</td>
<td>3</td>
<td>6</td>
<td>V</td>
</tr>
<tr>
<td>Low</td>
<td>VTHL</td>
<td>-9</td>
<td>-8</td>
<td>-7</td>
<td>V</td>
</tr>
</tbody>
</table>
Electrical characteristics (Ta=25 °C)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Remark</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
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<tbody>
<tr>
<td>Signal output frequency</td>
<td>fc</td>
<td>-</td>
<td>2</td>
<td>4</td>
<td>-</td>
<td>MHz</td>
</tr>
<tr>
<td>Reset clock frequency</td>
<td>frg</td>
<td>-</td>
<td>2</td>
<td>4</td>
<td>-</td>
<td>MHz</td>
</tr>
<tr>
<td>Vertical shift register capacitance</td>
<td>Cf, AV</td>
<td>-</td>
<td>15000</td>
<td>-</td>
<td>-</td>
<td>pF</td>
</tr>
<tr>
<td>Horizontal shift register capacitance</td>
<td>Cp1AH, Cp2AH, Cp1BH, Cp2BH</td>
<td>-</td>
<td>500</td>
<td>-</td>
<td>-</td>
<td>pF</td>
</tr>
<tr>
<td>Summing gate capacitance</td>
<td>CG</td>
<td>-</td>
<td>15</td>
<td>-</td>
<td>-</td>
<td>pF</td>
</tr>
<tr>
<td>Reset gate capacitance</td>
<td>CRG</td>
<td>-</td>
<td>10</td>
<td>-</td>
<td>-</td>
<td>pF</td>
</tr>
<tr>
<td>Transfer gate capacitance</td>
<td>CTG</td>
<td>-</td>
<td>500</td>
<td>-</td>
<td>-</td>
<td>pF</td>
</tr>
<tr>
<td>Transfer efficiency</td>
<td>CTE</td>
<td>*2</td>
<td>0.99995</td>
<td>0.99999</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>DC output level</td>
<td>Vout</td>
<td>*3</td>
<td>5</td>
<td>8</td>
<td>11</td>
<td>V</td>
</tr>
<tr>
<td>Output impedance</td>
<td>Zo</td>
<td>*3</td>
<td>-</td>
<td>500</td>
<td>-</td>
<td>Ω</td>
</tr>
<tr>
<td>Power dissipation</td>
<td>P</td>
<td>*3 *4</td>
<td>-</td>
<td>60</td>
<td>-</td>
<td>mW</td>
</tr>
</tbody>
</table>

*2: Measured at half of the full well capacity. CTE is defined per pixel.
*3: VOD=15 V
*4: Power dissipation of the on-chip amplifier (each chip)

Electrical and optical characteristics (Ta=25 °C, unless otherwise noted)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Remark</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Signal output frequency</td>
<td>fc</td>
<td>-</td>
<td>2</td>
<td>4</td>
<td>-</td>
<td>MHz</td>
</tr>
<tr>
<td>Reset clock frequency</td>
<td>frg</td>
<td>-</td>
<td>2</td>
<td>4</td>
<td>-</td>
<td>MHz</td>
</tr>
<tr>
<td>Vertical shift register capacitance</td>
<td>Cf, AV</td>
<td>-</td>
<td>15000</td>
<td>-</td>
<td>-</td>
<td>pF</td>
</tr>
<tr>
<td>Horizontal shift register capacitance</td>
<td>Cp1AH, Cp2AH, Cp1BH, Cp2BH</td>
<td>-</td>
<td>500</td>
<td>-</td>
<td>-</td>
<td>pF</td>
</tr>
<tr>
<td>Summing gate capacitance</td>
<td>CG</td>
<td>-</td>
<td>15</td>
<td>-</td>
<td>-</td>
<td>pF</td>
</tr>
<tr>
<td>Reset gate capacitance</td>
<td>CRG</td>
<td>-</td>
<td>10</td>
<td>-</td>
<td>-</td>
<td>pF</td>
</tr>
<tr>
<td>Transfer gate capacitance</td>
<td>CTG</td>
<td>-</td>
<td>500</td>
<td>-</td>
<td>-</td>
<td>pF</td>
</tr>
<tr>
<td>Transfer efficiency</td>
<td>CTE</td>
<td>*2</td>
<td>0.99995</td>
<td>0.99999</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>DC output level</td>
<td>Vout</td>
<td>*3</td>
<td>5</td>
<td>8</td>
<td>11</td>
<td>V</td>
</tr>
<tr>
<td>Output impedance</td>
<td>Zo</td>
<td>*3</td>
<td>-</td>
<td>500</td>
<td>-</td>
<td>Ω</td>
</tr>
<tr>
<td>Power dissipation</td>
<td>P</td>
<td>*3 *4</td>
<td>-</td>
<td>60</td>
<td>-</td>
<td>mW</td>
</tr>
</tbody>
</table>

*2: Measured at half of the full well capacity. CTE is defined per pixel.
*3: VOD=15 V
*4: Power dissipation of the on-chip amplifier (each chip)

- Point defects*11
- White spots
- Black spots
- Cluster defects*12
- Column defects*13
- X-ray resolution (S7199-01)

X-ray resolution (S7199-01) = \( \frac{\text{Fixed pattern noise (peak to peak)}}{\text{Signal}} \) \times 100

*10: Measured at one-half of the saturation output (full well capacity) using LED light (peak emission wavelength: 565 nm)

*11: White spots > 20 times of typ. dark signal (8 ke-/pixel/s)
- Black spots > 50% reduction in response relative to adjacent pixels, measured at half of the full well capacity
*12: Continuous 2 to 9 point defects
*13: Continuous >10 point defects
**Resolution (S7199-01)**

(X-ray source: 60 kVp)

```
<table>
<thead>
<tr>
<th>Spatial frequency (Line pair/mm)</th>
<th>CTF</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1.0</td>
</tr>
<tr>
<td>1</td>
<td>0.9</td>
</tr>
<tr>
<td>2</td>
<td>0.8</td>
</tr>
<tr>
<td>3</td>
<td>0.7</td>
</tr>
<tr>
<td>4</td>
<td>0.6</td>
</tr>
<tr>
<td>5</td>
<td>0.5</td>
</tr>
<tr>
<td>6</td>
<td>0.4</td>
</tr>
<tr>
<td>7</td>
<td>0.3</td>
</tr>
<tr>
<td>8</td>
<td>0.2</td>
</tr>
<tr>
<td>9</td>
<td>0.1</td>
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</tbody>
</table>
```

**Output voltage vs. X-ray response (S7199-01)**

(X-ray source: 70 kVp, filter: aluminum 4 mm)

```
<table>
<thead>
<tr>
<th>X-ray exposure (µGy)</th>
<th>Output voltage (mV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>100</td>
<td>20</td>
</tr>
<tr>
<td>500</td>
<td>40</td>
</tr>
<tr>
<td>1000</td>
<td>10</td>
</tr>
</tbody>
</table>
```

**Device structure**

Left chip

- ISV
- IGV
- P1BV
- P2BV
- P1AV
- P2AV
- TG
- RG
- RD
- SSA
- OS
- OD
- OG
- SG
- A1
- A2
- A3
- A4
- A5
- A6
- A7
- A8
- A9
- A10
- A11
- A12
- A13
- A14
- A15
- A16
- A17
- A18
- A19
- A20
- P2AH
- P1AH
- SSD
- P2H
- P1B
- P2B
- P1H
- P2H
- P1BH
- P2BH
- IGH
- IGH
- B1
- B2
- B3
- B4
- B5
- B6
- B7
- B8
- B9
- B10
- B11
- B12
- B13
- B14
- B15
- B16
- B17
- B18
- B19
- B20

Right chip

- ISV
- IGV
- P1BV
- P2BV
- P1AV
- P2AV
- TG
- RG
- RD
- SSA
- OS
- OD
- OG
- SG
- A1
- A2
- A3
- A4
- A5
- A6
- A7
- A8
- A9
- A10
- A11
- A12
- A13
- A14
- A15
- A16
- A17
- A18
- A19
- A20
- P2AH
- P1AH
- SSD
- P2H
- P1B
- P2B
- P1H
- P2H
- P1BH
- P2BH
- IGH
- IGH
- B1
- B2
- B3
- B4
- B5
- B6
- B7
- B8
- B9
- B10
- B11
- B12
- B13
- B14
- B15
- B16
- B17
- B18
- B19
- B20

S1, ..., S1536: effective pixels

**Pixel format**

<table>
<thead>
<tr>
<th></th>
<th>← Left</th>
<th>Horizontal Direction</th>
<th>→ Right</th>
</tr>
</thead>
<tbody>
<tr>
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<td>0</td>
<td>Optical black</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>Isolation</td>
<td>Effective</td>
</tr>
<tr>
<td>0</td>
<td>1536</td>
<td>Isolation</td>
<td>Optical black</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>Blank</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Top ← Vertical direction</th>
<th>→ Bottom</th>
</tr>
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<tbody>
<tr>
<td>Isolation</td>
<td>Effective</td>
<td>Isolation</td>
</tr>
<tr>
<td>0</td>
<td>128</td>
<td>0</td>
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</table>
Timing chart (TDI operation)
> Timing chart (TDI operation, 2 × 2 pixel binning)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Remark</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
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</thead>
<tbody>
<tr>
<td>P1AV, P1BV, P2AV, P2BV, TG</td>
<td>Pulse width</td>
<td>tpwv</td>
<td>*14, *15</td>
<td>30</td>
<td>60</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Rise and fall times</td>
<td>tprv, tfpv</td>
<td></td>
<td>200</td>
<td>-</td>
<td>-</td>
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<tr>
<td>P1AH, P1BH, P2AH, P2BH</td>
<td>Pulse width</td>
<td>tpwh</td>
<td>*15</td>
<td>125</td>
<td>250</td>
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<tr>
<td></td>
<td>Rise and fall times</td>
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<td></td>
<td>10</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Duty ratio</td>
<td>-</td>
<td></td>
<td>-</td>
<td>50</td>
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<tr>
<td>SG</td>
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<td>125</td>
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<tr>
<td></td>
<td>Rise and fall times</td>
<td>tprs, tpfs</td>
<td></td>
<td>10</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Duty ratio</td>
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<td>RG</td>
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<tr>
<td></td>
<td>Rise and fall times</td>
<td>tpr, tfpr</td>
<td></td>
<td>5</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>TG-P1AH, P1BH</td>
<td>Overlap time</td>
<td>tovr</td>
<td></td>
<td>10</td>
<td>20</td>
<td>-</td>
</tr>
</tbody>
</table>

*14: TG terminal can be short-circuited to P2AV terminal.
*15: Symmetrical clock pulses should be overlapped at 50% of maximum pulse amplitude.
**TDI-CCD area image sensor**

**S7199-01/-01F**

**Dimensional outline (unit: mm)**

---

**S7199-01**

- **X-ray Photosensitive area:** 146.0 (H) × 6.0 (V)

---

**S7199-01F**

- **Distance between the center of photosensitive area and the I/O pins**
  - ±50 µm max.

---

* Distance between the center of photosensitive area and the I/O pins

---

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## Pin connections

<table>
<thead>
<tr>
<th>Pin no.</th>
<th>Symbol</th>
<th>Description</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>RG</td>
<td>Reset gate</td>
<td></td>
</tr>
<tr>
<td>A2</td>
<td>RD</td>
<td>Reset drain</td>
<td></td>
</tr>
<tr>
<td>A3</td>
<td>SSA</td>
<td>Analog ground</td>
<td></td>
</tr>
<tr>
<td>A4</td>
<td>OS</td>
<td>Output transistor source</td>
<td></td>
</tr>
<tr>
<td>A5</td>
<td>OD</td>
<td>Output transistor drain</td>
<td></td>
</tr>
<tr>
<td>A6</td>
<td>OG</td>
<td>Output gate</td>
<td></td>
</tr>
<tr>
<td>A7</td>
<td>SG</td>
<td>Summing gate</td>
<td></td>
</tr>
<tr>
<td>A8</td>
<td>P2AH</td>
<td>CCD horizontal register clock A-2</td>
<td>Same timing as P2AH</td>
</tr>
<tr>
<td>A9</td>
<td>P1AH</td>
<td>CCD horizontal register clock A-1</td>
<td>Same timing as P1AH</td>
</tr>
<tr>
<td>A10</td>
<td>SSD</td>
<td>Digital ground</td>
<td></td>
</tr>
<tr>
<td>A11</td>
<td>P2BH</td>
<td>CCD horizontal register clock B-2</td>
<td>Same timing as P2AH</td>
</tr>
<tr>
<td>A12</td>
<td>P1BH</td>
<td>CCD horizontal register clock B-1</td>
<td>Same timing as P1AH</td>
</tr>
<tr>
<td>A13</td>
<td>IGH</td>
<td>Test point (horizontal input gate)</td>
<td></td>
</tr>
<tr>
<td>A14</td>
<td>ISV</td>
<td>Test point (vertical input source)</td>
<td>Shorted to RD</td>
</tr>
<tr>
<td>A15</td>
<td>IGV</td>
<td>Test point (vertical input gate)</td>
<td></td>
</tr>
<tr>
<td>A16</td>
<td>P1BV</td>
<td>CCD vertical register clock B-1</td>
<td>Same timing as P1AV</td>
</tr>
<tr>
<td>A17</td>
<td>P2BV</td>
<td>CCD vertical register clock B-2</td>
<td>Same timing as P2AV</td>
</tr>
<tr>
<td>A18</td>
<td>P1AV</td>
<td>CCD vertical register clock A-1</td>
<td></td>
</tr>
<tr>
<td>A19</td>
<td>P2AV</td>
<td>CCD vertical register clock A-2</td>
<td></td>
</tr>
<tr>
<td>A20</td>
<td>TG</td>
<td>Transfer gate</td>
<td></td>
</tr>
<tr>
<td>B1</td>
<td>IGH</td>
<td>Test point (horizontal input gate)</td>
<td></td>
</tr>
<tr>
<td>B2</td>
<td>P1BH</td>
<td>CCD horizontal register clock B-1</td>
<td>Same timing as P1AH</td>
</tr>
<tr>
<td>B3</td>
<td>P2BH</td>
<td>CCD horizontal register clock B-2</td>
<td>Same timing as P2AH</td>
</tr>
<tr>
<td>B4</td>
<td>SSD</td>
<td>Digital ground</td>
<td></td>
</tr>
<tr>
<td>B5</td>
<td>P1AH</td>
<td>CCD horizontal register clock A-1</td>
<td></td>
</tr>
<tr>
<td>B6</td>
<td>P2AH</td>
<td>CCD horizontal register clock A-2</td>
<td></td>
</tr>
<tr>
<td>B7</td>
<td>SG</td>
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<td></td>
</tr>
<tr>
<td>B12</td>
<td>RD</td>
<td>Reset drain</td>
<td></td>
</tr>
<tr>
<td>B13</td>
<td>RG</td>
<td>Reset gate</td>
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</tr>
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</tr>
<tr>
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<td>P2BV</td>
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<td>Same timing as P2AV</td>
</tr>
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<td>B19</td>
<td>IGV</td>
<td>Test point (vertical input gate)</td>
<td></td>
</tr>
<tr>
<td>B20</td>
<td>ISV</td>
<td>Test Point (vertical input source)</td>
<td>Shorted to RD</td>
</tr>
</tbody>
</table>
Precautions (electrostatic countermeasures)

- Handle these sensors with bare hands or wearing cotton gloves. In addition, wear anti-static clothing or use an anti-static wrist band, in order to prevent electrostatic damage due to electrical charges from friction.
- Avoid directly placing these sensors on a work-desk or work-bench that may carry an electrostatic charge.
- Provide ground lines or ground connection with the work-floor, work-desk and work-bench to allow static electricity to discharge.
- Ground the tools used to handle these sensors, such as tweezers and soldering irons.

It is not always necessary to provide all the electrostatic measures stated above. Take these measures as needed to prevent electrostatic damage to the sensor.

Notice

- 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 50 Gy (incident X-ray energy: 70 kVp) even within the warranty period.

Information described in this material is current as of February, 2014.
Product specifications are subject to change without prior notice due to improvements or other reasons. This document has been carefully prepared and the information contained is believed to be accurate. In rare cases, however, there may be inaccuracies such as text errors. Before using these products, always contact us for the delivery specification sheet to check the latest specifications.

The product warranty is valid for one year after delivery and is limited to replacement or repair of any defective product due to defects discovered and reported to us within that one year period. However, even if within the warranty period we accept absolutely no liability for any loss caused by natural disasters or improper product use.

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