The 2D array sensors **CSPAD alpha** and **CSPAD3k** are the latest members of the CSPAD sensor family developed by Fraunhofer IMS. They combine the low-noise CMOS-integrated Single-Photon Avalanche Diodes (CSPADs) with wafer bonding technology and Backside-Illumination (BSI) to achieve single-photon sensitivity with high spatial and temporal resolution.

The main features are:
- Photon **timing** and **counting** mode
- Optional on-chip spherical microlens array (MLA)
- Adaptive **background light suppression** by variable coincidence
- **In-pixel** time-to-digital converters (TDC) with continuous monitoring

### Technology
- 0.35 μm CMOS
- Backside-Illumination
- 3D-Integration
- Wafer-to-Wafer Bonding

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### Specifications

<table>
<thead>
<tr>
<th>Sensor</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Chip dimensions</strong></td>
<td>10250 x 9200</td>
<td>µm x µm</td>
</tr>
<tr>
<td><strong>Array size</strong></td>
<td>8320 x 6240</td>
<td>µm x µm</td>
</tr>
<tr>
<td><strong>Pixel size</strong></td>
<td>130 x 130</td>
<td>µm x µm</td>
</tr>
<tr>
<td>**Resolution</td>
<td>CSPAD alpha</td>
<td>Counting mode</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Timing mode</td>
</tr>
<tr>
<td>**Resolution</td>
<td>CSPAD3k</td>
<td>Counting mode</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Timing mode</td>
</tr>
<tr>
<td><strong>SPADs per pixel</strong></td>
<td>4</td>
<td>SPAD</td>
</tr>
<tr>
<td><strong>SPAD diameter</strong></td>
<td>14</td>
<td>µm</td>
</tr>
<tr>
<td><strong>Fill factor</strong></td>
<td>without MLA</td>
<td>3.7</td>
</tr>
<tr>
<td></td>
<td>with MLA</td>
<td>25</td>
</tr>
<tr>
<td>**Framerate</td>
<td>CSPAD alpha**</td>
<td>26</td>
</tr>
<tr>
<td>**Framerate</td>
<td>CSPAD3k**</td>
<td>13</td>
</tr>
</tbody>
</table>

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**CSPAD array sensor family**

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**Turn page**

for more information
CSPAD array sensor family

Easy handling of our sensors allows our evaluation board solution to use a 12 V power supply, providing plug-and-play functionality. The sensors are connected via USB 2.0 by a LabView application file, which provides insight into pixel histograms, allows changing modes, and visualizes the data in different plots. Two delayable trigger signals are provided to control light emitters. The required interface information is also available for custom setup.

**Single SPAD**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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<tbody>
<tr>
<td>Breakdown voltage</td>
<td>23</td>
<td>V</td>
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<tr>
<td>Operation voltage</td>
<td>30</td>
<td>V</td>
</tr>
<tr>
<td>Photon detection probability</td>
<td></td>
<td></td>
</tr>
<tr>
<td>@ 500 nm</td>
<td>15</td>
<td>%</td>
</tr>
<tr>
<td>@ 905 nm</td>
<td>2</td>
<td>%</td>
</tr>
<tr>
<td>Dead time</td>
<td>20</td>
<td>ns</td>
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<tr>
<td>Dark count rate</td>
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<td>Hz/µm²</td>
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**TDC**

<table>
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<tr>
<th>Parameter</th>
<th>Value</th>
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<tbody>
<tr>
<td>Temporal resolution</td>
<td>&lt; 420</td>
<td>ps</td>
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<tr>
<td>Full scale range</td>
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<td>µs</td>
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<tr>
<td>Raw data length</td>
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<td>Bit</td>
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