ULTRA THIN HIGH DENSITY CAPACITORS

1 High density capacitors with different capacitance ranges and size dimensions on circuit board connected by wire bonds.

ULTRA-THIN CAPACITORS

The Fraunhofer IPMS-CNT has developed an ultra-compact capacitor for direct integrated circuit packaging. In addition to available standard types, the design and electrical properties can be adjusted to customer’s requirements covering a large range of capacitance values by using innovative high-k dielectrics and special patterning processes.

This capacitor technology platform is suited for the system in package (SiP) integration as well as for high-end printed circuit boards, interposers or directly in between chip metallization layers for system on chip (SoC) solutions. In cooperation with Fraunhofer IZM-ASSID a variety of customized package integration options are available.

ADVANTAGES

• Wide capacitance range from pF to µF
• Ultra-thin (100 µm)
• Small dimensions (down to 250x250 µm²)
• Customizable outline and values
• Saving external components
• Improved electrical properties

APPLICATIONS

• RF and audio filtering
• Decoupling and buffering
• Energy harvesting systems

INTEGRATION SCHEMES

• System in package (SiP) integration
• Silicon interposer integration
• Embedding in high-end PCB
## TECHNICAL FEATURES

- 3D and planar capacitor integration
- Metal-insulator-metal (MIM) capacitor on silicon substrate
- Silicon wafer processing technology
- Insulating dielectric based on high-k material
- Atomic layer deposition technology (ALD) enabling high accuracy of film thicknesses
- Enhanced voltage linearity compared to MLCC
- High temperature resistance
- Low leakage current and high reliability
- High capacitance densities on small footprint

### OVERVIEW OF TYPICAL CAPACITORS

<table>
<thead>
<tr>
<th>Capacitance</th>
<th>Max. voltage</th>
<th>Technology</th>
<th>Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Footprint</td>
</tr>
<tr>
<td>10 pF</td>
<td>5 V</td>
<td>planar</td>
<td>250 × 250 µm²</td>
</tr>
<tr>
<td>47 pF</td>
<td>5 V</td>
<td>planar</td>
<td>500 × 500 µm²</td>
</tr>
<tr>
<td>100 pF</td>
<td>5 V</td>
<td>planar</td>
<td>1 × 1 mm²</td>
</tr>
<tr>
<td>220 pF</td>
<td>5 V</td>
<td>planar</td>
<td>1 × 1 mm²</td>
</tr>
<tr>
<td>470 pF</td>
<td>5 V</td>
<td>planar</td>
<td>2.5 × 2.5 mm²</td>
</tr>
<tr>
<td>1 nF</td>
<td>5 V</td>
<td>planar</td>
<td>500 × 500 µm²</td>
</tr>
<tr>
<td>10 nF</td>
<td>5 V</td>
<td>planar</td>
<td>1 × 1 mm²</td>
</tr>
<tr>
<td>1 nF</td>
<td>15 V</td>
<td>planar</td>
<td>500 × 500 µm²</td>
</tr>
<tr>
<td>220 nF</td>
<td>3.5 V</td>
<td>3 D</td>
<td>1 × 1 mm²</td>
</tr>
<tr>
<td>1 µF</td>
<td>3.5 V</td>
<td>3 D</td>
<td>2.5 × 2.5 mm²</td>
</tr>
</tbody>
</table>

### CAPACITOR INTEGRATION

**Planar:** Customized capacitors in planar MIM technology are offered at any value in the range of 1 pF to 10 nF. Capacitor scaling to other voltages (max. 50 V) and operation conditions is also possible and is subject to further dielectric optimization and reliability studies.

**3D Capacitors:** Capacitors that are based on three-dimensional structures offer much higher capacitance densities on smaller footprint. The 3.5 V capacitor type can be offered up to 1 µF capacitance.

**Capacitor terminals:** The capacitors are be connected either by two contacts on top-side or by one contact on back-side and one contact on top-side. The appropriate contact solution depends on the assembly technology.

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