Ultra Thin Laminates for Higher Performance PCBs, Modules & Chip Packages

- Embedded Capacitance
The rapid advancements in technology including the newest data phones, tablets, and high definition video streaming are demanding changes in PCBs, modules, and chip package designs. This has significantly impacted the data processing infrastructure from computers, servers, routers, switches, and data storage. The ICs, chipsets, memory, displays, and other components are now performing multi-functions and processing at speeds far greater than ever.

This requires thinner and lighter materials that can provide more power allowing faster data delivery with less power bus noise, enhanced signal integrity, reduced footprint, and more functionality. FaradFlex® is the material solution providing the lowest inductance, for the best high speed power delivery, minimum noise, and optimum signal integrity.
Embedded Capacitance Technology

Embedded capacitance utilizes the technology of placing a capacitor plane inside the PCB to reduce overall inductance of the power distribution network, as well as free up surface real estate by eliminating some discrete capacitors.

It is the reduced inductance that is a key performance factor in delivering the charge as system frequencies increase.

By using ultra thin dielectrics for the power/ground planes high speed switching noise can be reduced. Additionally, the thin power/ground planes can be used as a planar capacitor enabling the removal of surface mount decoupling capacitors along with traces, vias, and pads.

Oak-Mitsui Technologies has developed the FaradFlex® family of thin substrates that is the next generation of embedded capacitance material.

There are two product groups: one based on advanced resin copper clad system and the other on high performance polymer film.

FaradFlex® provides high capacitance, high Dk, and both low & high Df values. Manufacturing process of FaradFlex® is very similar to that of typical PCB. Processing guideline and training are available upon request.
For PCBs

Typical Applications

- High Speed Digital
- Network Telecommunications
- Super Computers
- Security
- Analog & RF
- Automotive
- Aerospace
- Handheld
- Commercial
- Industrial Controls
- Medical Device
- Test & Measurement

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#### Properties

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<td>Dielectric Thickness, µm</td>
<td>Nominal</td>
<td>22</td>
<td>12</td>
<td>8</td>
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<tr>
<td>Cp @ 1 MHz, nF/in² (pF/cm²)</td>
<td>Nominal</td>
<td>1.2 (180)</td>
<td>2.0 (320)</td>
<td>3.1 (480)</td>
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<td>Dk (Dielectric Constant) @ 1 MHz/1 GHz</td>
<td>Mitsui Method</td>
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<td>4.4/3.5</td>
<td>4.4/3.5</td>
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<tr>
<td>Df (Loss Tangent) @ 1 MHz/1 GHz</td>
<td>Mitsui Method</td>
<td>0.015/0.016</td>
<td>0.015/0.020</td>
<td>0.016/0.021</td>
</tr>
<tr>
<td>Peel Strength, kN/m 1 oz Cu</td>
<td>IPC TM-650 2.4.8C*</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td>Breakdown Voltage, V</td>
<td>IPC TM-650 2.5.6.2A*</td>
<td>≥5000</td>
<td>4000</td>
<td>3000</td>
</tr>
<tr>
<td>Tensile Strength, MPa (kpsi)</td>
<td>ASTM D-882</td>
<td>219 (31.8)</td>
<td>194 (28.2)</td>
<td>126 (18.3)</td>
</tr>
<tr>
<td>Elongation, %</td>
<td>ASTM D-882A</td>
<td>36.0</td>
<td>13.5</td>
<td>8.5</td>
</tr>
<tr>
<td>CTE, ppm/°C, x-y, TMA</td>
<td>IPC TM-650 2.4.24.5*</td>
<td>24</td>
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<td>32</td>
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<tr>
<td>Tg, °C, DMA</td>
<td>IPC TM-650 2.4.24.4*</td>
<td>183</td>
<td>187</td>
<td>188</td>
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<tr>
<td>Hi-Pot test (each panel)</td>
<td>IPC TM-650 2.5.7.2*</td>
<td>PASS (500V)</td>
<td>PASS (500V)</td>
<td>PASS (500V)</td>
</tr>
<tr>
<td>Thermal Stress (10 Sec Float @288°C), Times</td>
<td>Mitsui Method</td>
<td>&gt;10</td>
<td>&gt;10</td>
<td>&gt;10</td>
</tr>
<tr>
<td>Moisture Absorption %</td>
<td>TM-650 2.6.2.1*</td>
<td>1.3</td>
<td>1.3</td>
<td>0.5</td>
</tr>
<tr>
<td>THB, 85°C/85% RH/dc bias</td>
<td>Mitsui Method</td>
<td>PASS (50V)</td>
<td>PASS (50V)</td>
<td>PASS (35V)</td>
</tr>
<tr>
<td>HAST, 130°C/85% RH/dc bias</td>
<td>Mitsui Method w/GEA-700G</td>
<td>PASS (50V)</td>
<td>PASS (50V)</td>
<td>PASS (50V)</td>
</tr>
<tr>
<td>Flammability/Temp Rating</td>
<td>UL 94</td>
<td>V0 130°C</td>
<td>V0 130°C</td>
<td>V0 130°C</td>
</tr>
<tr>
<td>PWB Processing</td>
<td>–</td>
<td>Both sides</td>
<td>Both sides</td>
<td>Both sides</td>
</tr>
</tbody>
</table>

**Note:** This chart provides typical values for FaradFlex® products. *Indicates some modifications to test method. For a full list of our products please contact us.

### Material Construction

- copper
- dielectric material

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For a full list of our products please contact us.
## Typical Applications

**Chip Packaging • MEMs**  
**Sensors • Modules**  
**Military • Aerospace • Drones**  
**RF/Wireless • Diplexers • RF Filters**

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<tr>
<td></td>
<td></td>
<td>MC12LD</td>
<td>MC12ST</td>
</tr>
<tr>
<td>Dielectric Thickness, µm</td>
<td>Nominal</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Cp @ 1 kHz/1 MHz, nF/in²</td>
<td>Nominal</td>
<td>- /4.3</td>
<td>10.9/10.5</td>
</tr>
<tr>
<td>Dk (Dielectric Constant) @ 1 kHz/1 MHz</td>
<td>Mitsui Method</td>
<td>7.30/1 MHz</td>
<td>7.94/1 GHz</td>
</tr>
<tr>
<td>Df (Loss Tangent) @ 1 kHz/1 MHz</td>
<td>Mitsui Method</td>
<td>0.002@1 MHz</td>
<td>0.0017@1 GHz</td>
</tr>
<tr>
<td>Peel Strength, kJ/m 0.5 oz Cu</td>
<td>IPC TM-650 2.4.8C*</td>
<td>0.70</td>
<td>0.70</td>
</tr>
<tr>
<td>Breakdown Voltage, V</td>
<td>IPC TM-650 2.5.6.2A*</td>
<td>300</td>
<td>150</td>
</tr>
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<td>Tensile Strength, MPa (kpsi)</td>
<td>ASTM D-882</td>
<td>NA</td>
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<td>CTE, ppm/°C, x-y, TMA</td>
<td>IPC TM-650 2.4.24.5*</td>
<td>55</td>
<td>32 (@1)</td>
</tr>
<tr>
<td>Tg, °C, DMA</td>
<td>IPC TM-650 2.4.24.4*</td>
<td>215</td>
<td>160</td>
</tr>
<tr>
<td>Hi-Pot test (Sampling/Lot)</td>
<td>IPC TM-650 2.5.7.2*</td>
<td>NA</td>
<td>PASS (50V)</td>
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<td>TM-650 2.6.2.1*</td>
<td>0.37</td>
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<td>PASS (10V)</td>
<td>PASS (3.7V)</td>
</tr>
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<td>Mitsui Method w/GEA-700G</td>
<td>NA</td>
<td>PASS (2.8V)</td>
</tr>
<tr>
<td>Flammability/Temp Rating</td>
<td>UL 94</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>PWB Processing</td>
<td>Sequential</td>
<td>Sequential</td>
<td>Both sides</td>
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FaradFlex® Compared to Traditional Material

- **FaradFlex®** is 1/2 to 1/6 the thickness compared to the typical “thinnest” laminate using glass cloth reinforcement
- **FaradFlex®** increases thermal transfer from the PCB due to the ultra thin power/ground substrate
- **FaradFlex®** has 10 times greater dielectric withstanding voltage than the traditional FR-4 laminates and similar materials

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**Graphical Representation**

- **Capacitance Domain**
  - $\frac{1}{wC} = -20 \text{ dB/dec}$

- **Inductance Domain**
  - $wL = 20 \text{ dB/dec}$

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**Target Impedance**

- **Bulk Capacitor**
- **Decoupling Capacitor**
- **Plane Capacitor**
- **On-Chip Capacitor**

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**Impedance Chart**

- **ZBC-2000 -50 micron FR4**
- **BC1000 -25 micron FR4**
- **MC24M**
- **MC16M**
- **MC8M**
- **MC12TM**
- **MC16T**

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**Dk Effect**
Stack-Up Examples

24 Layer Board

L1
L2
L3
L4
Capacitor Core

L21
L22
L23
L24
Capacitor Core

Reduces PCB Noise

Standard FR-4 core with decoupling capacitors
MC24M without decoupling capacitors

FaradFlex® for Enhanced Performance

Oak-Mitsui Technologies’ FaradFlex® is the answer for high speed cutting edge designs that require optimized Power Distribution, lower inductance, reduced EMI, less noise, minimal loss, more design space, better reliability, and improved RF properties.
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