ThunderClad 3

TU-933
Super Low Loss Material
TUC Product Roadmap

**New Products**

**HF Low Loss CCL / ThunderClad 1**
- Dk 3.2, Df < 0.010 @ 1GHz / Low Signal Loss Board

**HF Very Low Loss / ThunderClad 2**
- Df 0.0050 @ 10GHz / Excellent Signal Integrity

**Super Low Loss CCL / ThunderClad 3**
- Dk 3.4, Df 0.0025 @ 10GHz / High Speed / RF

**HF Mid-Tg Low Dk / TU-787 LK**
- Dk 3.2 ; Df < 0.010 / Anylayer

**HF High Reliability CCL / TU-865**
- Hi-Tg Low CTE / Harsh Environment

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**High Thermal Reliability**

**TU-768/768 F** (Tg180)
- High Layer Count / High Density Multi-layer Board

**TU-662/668** (Tg150)
- High Layer Count / High Density Multi-layer Board

**TU-722** (Tg180)
- High Layer Count / High Density Multi-layer Board

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**Green Materials**

**TU-862 HF** (Tg180)
- Mid-Loss

**TU-84P NF** (Tg150)
- Rigid-Flex

**TU-747 LK** (Tg150)
- Low Dk / Any-layer

**TU-747 HF** (Tg150)
- Consumer / HP / NB

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**Low Loss**

**High Speed / Low Dk/ Df**

**TU-872 SLK / SLK Sp**

**TU-872 LK**
- High Speed / Low Signal Loss Board

**Insulated Metal Substrate**

**TU-322 / TU-362 / TU-351**
- 2 W/mK / 1 W/mK
ThunderClad 3

Features:

- Non-epoxy resin system
- For high speed digital / RF application
- Thermal robust for fine pitch design
- Flat Dk / Df varied with frequency & temperature
- $Dk = 3.4 \, @ \, 10\text{GHz}$ (split post cavity method)
- $Df = 0.0025 \, @ \, 10\text{GHz}$ (split post cavity method)
- $Tg = 170^\circ C/220^\circ C$ (TMA / DMA)

Status: alpha site internal evaluation
# ThunderClad 3

<table>
<thead>
<tr>
<th>Type</th>
<th>ThunderClad 3 (TU-933)</th>
<th>TU-872 SLK</th>
<th>4350B*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Performance</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tg, (DMA), °C</td>
<td>220</td>
<td>220</td>
<td>-</td>
</tr>
<tr>
<td>Tg, (TMA), °C</td>
<td>170</td>
<td>190</td>
<td>-</td>
</tr>
<tr>
<td>Td, (TGA, 5%wt loss) °C</td>
<td>390</td>
<td>340</td>
<td>390</td>
</tr>
<tr>
<td>Z-axis Expansion, (50-260 °C), %</td>
<td>2.7</td>
<td>2.3</td>
<td>1.1</td>
</tr>
<tr>
<td>Dk @ 10GHz (SPC method)</td>
<td>3.4</td>
<td>3.8</td>
<td>3.48</td>
</tr>
<tr>
<td>Df @ 10GHz (SPC method)</td>
<td>0.0025</td>
<td>0.0090</td>
<td>0.0037</td>
</tr>
<tr>
<td>Flammability, UL94</td>
<td>94-V0</td>
<td>94-V0</td>
<td>94-V0</td>
</tr>
<tr>
<td>Peel strength (1oz), lb/in</td>
<td>4~6</td>
<td>5~7</td>
<td>5</td>
</tr>
<tr>
<td>T-260, min</td>
<td>&gt;60</td>
<td>60</td>
<td>&gt;60</td>
</tr>
<tr>
<td>T-288, min</td>
<td>&gt;60</td>
<td>20</td>
<td>&gt;60</td>
</tr>
<tr>
<td>T-300, min</td>
<td>&gt;60</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>PCT/1hr/Dip (288 °C), sec</td>
<td>&gt;120</td>
<td>&gt;120</td>
<td>-</td>
</tr>
</tbody>
</table>

* Data is base on public datasheet information

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MP1312002A
ThunderClad 3 – Rheology

Heat Rise Rate: 2.0 degC/min
ThunderClad 3 – Dk

* Base on Split post Cavity Method
ThunderClad 3 – Df

* Base on Split post Cavity Method

- 10 GHz
- 1 GHz
ThunderClad 3 – Propagation Constant
ThunderClad 3 – Insertion Loss

![Graph showing insertion loss against frequency for different copper thicknesses and materials.](image_url)
ThunderClad 3 – Dk vs Temperature

-50 -30 -10 10 30 50 70 90 degC

1 GHz 5 GHz 10 GHz 20 GHz

Dk

Cu H oz 2116 x 1 H oz RTF 2116x1 Cu H oz
ThunderClad 3 – Loss vs Temperature

![Graph showing the relationship between loss and temperature for ThunderClad 3 at different frequencies (1.0 GHz, 5.0 GHz, 10.0 GHz, 12.5 GHz, 20.0 GHz). The graph includes lines for different materials and thicknesses such as Cu H oz, 2116 x 1 H oz RTF, and 2116x1 Cu H oz. The x-axis represents temperature in degrees Celsius (degC), and the y-axis represents loss in dB/in.](image-url)
ThunderClad 3 – Case Study

Material: ThunderClad 3
Layer count: 26 layer
Board Thickness: 3.2 mm
2 oz copper foil: x 4 layers
Pitch design: 0.65, 0.8 & 1.0 mm
Drilling hole size: 0.3 mm
Pattern design: x 4 types
Test criteria: 260°C reflow 10X
288°C Solder 6x
ThunderClad 3 – Case Study

L1  H oz
PP 2116 HRC × 1
L2/3 3mil 1/1
PP 2116 HRC × 1
L4/5 3mil 1/1
PP 2116 HRC × 1
L6/7 3mil 1/1
PP 2116 HRC × 1
L8/9 3mil 1/1
PP 2116 HRC × 1
L10/11 3mil 1/1
PP 106 HRC × 2
L12/13 6mil 2/2 (2ply)
PP 106 HRC × 3
L14/15 6mil 2/2 (2ply)
PP 106 HRC × 2
L16/17 3mil 1/1
PP 2116 HRC × 1
L18/19 3mil 1/1
PP 2116 HRC × 1
L20/21 3mil 1/1
PP 2116 HRC × 1
L22/23 3mil 1/1
PP 2116 HRC × 1
L24/25 3mil 1/1
PP 2116 HRC × 1
L26  H oz
ThunderClad 3 – 0.8 mm / solder 6x

Solder 6x

D2 design

D3 design
ThunderClad 3 - 0.65 mm / solder 6x

Solder 6x

D2 design

D3 design
ThunderClad 3 – 1.0 mm / reflow 10x
ThunderClad 3 – 0.8 mm / reflow 10x
ThunderClad 3 – 0.65 mm / reflow 10x
## ThunderClad 3 – Case Study

<table>
<thead>
<tr>
<th>Design / Thermal</th>
<th>Pitch 1.0 mm</th>
<th>Pitch 0.8 mm</th>
<th>Pitch 0.65 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solder 6x</td>
<td>Pass</td>
<td>Pass</td>
<td>Pass</td>
</tr>
</tbody>
</table>

- No delamination
- No crack
- No ICD
- No Pad Lifting