UL
UNDERWRITERS LABORATORIES
TOPICS
1. WHAT IS UL?
   – UL Standards
   – UL Files for PFC Flexible Circuits
2. UL Tests for Flexible Circuit (FPC) boards
3. Summary of UL – Recognised types for PFC
4. Examples of UL – Recognised designation
What is UL?

• UL stands for "Underwriters Laboratory"

• Independent and non-profit organization to tests electrical components and equipment for potential hazards

• When something is UL - listed, that means that the UL has tested the device, and it meets their requirements for safety

• UL has developed more than 1000 standards for safety
• UL – recognition means products which have been tested and approved by UL to use the UL recognition mark;

or whichever mark is registered with and approved by UL

• Necessary for consumer products in the US & Canada
• Optional elsewhere
• UL Files for PFC Flexible Circuits
  E217146 [with Thermal Shock], Standard Component – Wiring, Printed – Flexible Material Constructions

• UL Standards

<table>
<thead>
<tr>
<th>UL 796</th>
<th>Standard for Printed Wiring Board</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>UL 796F</strong></td>
<td>Standard for Printed Wiring Board includes special classification for flexible printed wiring</td>
</tr>
<tr>
<td>UL 94</td>
<td>Tests for Flammability of Plastic Materials for Parts in Devices and Appliances</td>
</tr>
</tbody>
</table>
For UL 796F standard, 2 categories of the safety test

- Flammability
- Function
  - Adhesion
  - Bending / fatigue
  - Current / voltage limit
• Flammability Test

– UL 94 Standard

– These requirements cover tests for flammability of plastic materials used for parts in devices and appliances.

– There are 3 grades of flammability rating:
  1) Vertical Burning Test; V-0, V-1, or V-2
  2) Thin Material Vertical Burning Test; VTM-0, VTM-1, or VTM-2
  3) Horizontal Burning Test; HB
• UL Tests for Flexible Printed Circuit Boards
  Vertical flammability, 94V

– Test for flammability in which the test material is held vertically, governed by flame rating classification

• 94V-0
• 94V-1
• 94V-2
VERTICAL BURNING TEST FOR 94V-0, 94V-1, 94V-2 CLASSIFICATION

BURNER

COTTON

SPECIMEN

20mm

10mm

300mm

6mm

50mm
• UL Tests for Flexible Printed Circuit Boards
  Vertical flammability, 94VTM

– Test for flammability for thin materials in which the test material is held vertically, governed by flame rating classification

• 94VTM-0
• 94VTM-1
• 94VTM-2
SPECIMEN ORIENTATION

(a) FRONT VIEW OF SPECIMEN LAPPED AT LOWER END
(b) SIDE VIEW OF SPECIMEN LAPPED AT LOWER END
(c) BACK VIEW OF SPECIMEN NOT LAPPED AT LOWER END
• UL Tests for Flexible Printed Circuit Boards
  Horizontal flammability, 94HB
  – Test for flammability in which the test material is held horizontally governed by flame rating classification.
### Standard Vertical Flammability Rating

<table>
<thead>
<tr>
<th>Criteria Condition</th>
<th>94V-0</th>
<th>94V-1</th>
<th>94V-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>After flame time for each individual specimen t1 or t2</td>
<td>&lt;10s</td>
<td>&lt;30s</td>
<td>&lt;30s</td>
</tr>
<tr>
<td>Total after flame time for any condition set (t1 + t2 for the 5 specimens)</td>
<td>&lt;50s</td>
<td>&lt;250s</td>
<td>&lt;250s</td>
</tr>
<tr>
<td>After flame + Afterglow time for each individual specimen after the second flame application (t2 + t3)</td>
<td>&lt;30s</td>
<td>&lt;60s</td>
<td>&lt;60s</td>
</tr>
<tr>
<td>After flame or Afterglow of any specimen up to the holding clamp</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Cotton indicator ignited by flaming particles or drops</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>
### Vertical Flammability Rating – *Thin Materials*

<table>
<thead>
<tr>
<th>Flame Rating Classification</th>
<th>94VTM-0</th>
<th>94VTM-1</th>
<th>94VTM-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>After flame time for each individual specimen t1 or t2</td>
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<td>No</td>
<td>No</td>
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<tr>
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<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>
• **Horizontal Flammability Rating**  
Flame rating classification – 94HB

Must meet the following criteria:

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Materials with thickness range $3.0 &lt; t &lt; 13$ mm</td>
<td>Burning rate $&lt;40$ mm/min over a distance of $75$ mm</td>
</tr>
<tr>
<td>2</td>
<td>Materials with thickness $&lt;3.0$ mm</td>
<td>Burning rate $&lt;75$ mm/min over a distance of $75$ mm</td>
</tr>
<tr>
<td>3</td>
<td>Stop burning before flame covers a distance of $100$ mm</td>
<td></td>
</tr>
</tbody>
</table>