Miniaturization and Advances of Bulk Head Mounted EMI Filters: Material, Process, Design

R. Demcko, R. Edily

AVX Corporation
One AVX Boulevard
Fountain Inn, S.C. 29644 USA
Ron.Demcko@avx.com
Outline

• Filter Designs

• Performance

• Miniature Filters & Trends

• Summary
Bulk Head Filters:

Building block = Discoidal insert

Discoidal Cross Section

Terminations

http://www.avx.com
Bulk Head Filters:

Discoidal inserts are inherently low inductance vs MLCCs

Discoidal Cross Section

0805 MLCC
ESL ~525 pH

http://www.avx.com
MLCC advances impact on inserts:

- Smaller size
- More complex patterns
- Increased CV

http://www.avx.com
Bulk Head Filters:

Discoidal used to create 3 Bulk Head styles

- Bolt In
- Solder in
- Plate

http://www.avx.com
Typical use:

System Level Filter

Ideal configuration / efficiency

Impacted positively by MLCC progress
Bulk Head Filters:

General Characteristics

• Hermetic & Non Hermetic
• DC to 26Ghz range
• L,C structure based
• Installation temperatures to +400c
• Operating ranges -55c to +200c
• Commercial, Military & Space

http://www.avx.com
### Bulk Head Filter configurations:

<table>
<thead>
<tr>
<th>Filter Type</th>
<th>Schematic Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacitor</td>
<td>![Capacitor Symbol]</td>
</tr>
<tr>
<td>Inductor</td>
<td>![Inductor Symbol]</td>
</tr>
<tr>
<td>Wire</td>
<td>![Wire Symbol]</td>
</tr>
<tr>
<td>T Configured</td>
<td>![T Configured Symbol]</td>
</tr>
<tr>
<td>Pi Configured</td>
<td>![Pi Configured Symbol]</td>
</tr>
<tr>
<td>L-C</td>
<td>![L-C Symbol]</td>
</tr>
<tr>
<td>C-L</td>
<td>![C-L Symbol]</td>
</tr>
<tr>
<td>Transient Clamp</td>
<td>![Transient Clamp Symbol]</td>
</tr>
</tbody>
</table>

- **Bolt In**
- **Solder in**
- **Plate**

[http://www.avx.com](http://www.avx.com)
Design:

MLCC Discoidal

plus

optional magnetics

MLCC advances yield:
- smaller inserts
- Higher capacitance values

http://www.avx.com
Design:

MLCC advances enable:

smaller discoidal ➞ smaller bulk head filter ➞ higher frequency response

Low loss discoidal inserts ➞ improved response over MLCC based filters

http://www.avx.com
Downsized Filter Performance

- Identical Electrical Responses
- 64% less weight
- 45% less foot print
- 70dB notch still available
- >/ 100v and up to 5amp available

Accelerated progress expected
MLCC advances impact on inserts:

<table>
<thead>
<tr>
<th>Filter Type</th>
<th>Dia, mm</th>
<th>Max Cap nF</th>
<th>Current</th>
<th>Voltage</th>
<th>Frequency</th>
<th>Weight g</th>
<th>Volume cc</th>
<th>Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Miniature Solder in</td>
<td>3.05</td>
<td>50</td>
<td>5 amp</td>
<td>200 v</td>
<td>10mhz – 10 GHz</td>
<td>0.0948</td>
<td>0.0204</td>
<td>C, L</td>
</tr>
<tr>
<td>Miniature Bolt in</td>
<td>2.67</td>
<td>27</td>
<td>5 amp</td>
<td>200 v</td>
<td>10mhz – 10 GHz</td>
<td>0.0143</td>
<td>0.0225</td>
<td>C, L, Pi</td>
</tr>
<tr>
<td>Sub-miniature Solder in</td>
<td>2.67</td>
<td>27</td>
<td>2.5 amp</td>
<td>200 v</td>
<td>10mhz – 10 GHz</td>
<td>0.0796</td>
<td>0.0145</td>
<td>C, L</td>
</tr>
<tr>
<td>Sub-miniature Bolt in</td>
<td>2.18</td>
<td>5</td>
<td>3 amp</td>
<td>200 v</td>
<td>10mhz – 10 GHz</td>
<td>0.0902</td>
<td>0.0139</td>
<td>C, L, Pi</td>
</tr>
<tr>
<td>Micro-Miniature Solder in</td>
<td>1.90</td>
<td>5</td>
<td>1.5 amp</td>
<td>200 v</td>
<td>10mhz – 10 GHz</td>
<td>0.0336</td>
<td>0.0056</td>
<td>C, L</td>
</tr>
<tr>
<td>Micro-Miniature Bolt in</td>
<td>1.85</td>
<td>5</td>
<td>3 amp</td>
<td>200 v</td>
<td>10mhz – 10 GHz</td>
<td>0.0591</td>
<td>0.0097</td>
<td>C, L, Pi</td>
</tr>
</tbody>
</table>
Small Filter performance comparison

<table>
<thead>
<tr>
<th>Filter Type &amp; Size (dia.)</th>
<th>Current (a)</th>
<th>10</th>
<th>30</th>
<th>100</th>
<th>300</th>
<th>1000</th>
<th>10,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small standard</td>
<td>4.19 mm</td>
<td>5</td>
<td>15</td>
<td>34</td>
<td>50</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>Miniature</td>
<td>3.05 mm</td>
<td>5</td>
<td>15</td>
<td>22</td>
<td>35</td>
<td>45</td>
<td>55</td>
</tr>
<tr>
<td>Sub Miniature</td>
<td>2.67 mm</td>
<td>2.5</td>
<td>15</td>
<td>22</td>
<td>35</td>
<td>45</td>
<td>55</td>
</tr>
<tr>
<td>Micro Miniature</td>
<td>1.9 mm</td>
<td>1.5</td>
<td>15</td>
<td>22</td>
<td>35</td>
<td>45</td>
<td>55</td>
</tr>
</tbody>
</table>
Bulk Head Filter Future trends:

- Increased CV / Smaller Size
- Higher & Lowered Q response efforts
- Multiple Response Filter
- Pulse capable – slow & fast (ESD) waveform ratings
- Novel Configurations – Clamp >2kA 8x20us < 5cc volume
Summary

- MLCC progress will continue to drive discoidal capacitors
- Small discoidal capacitors will enable miniature Bulk Head Filters
- Bulk Head filters packaging will broaden – smaller to big
- Filter plate assemblies will become more viable options
- Filter functions expanding – multi response to clamping