High Temperature MLCCs
Topics to cover Today

High Temperature Ceramic Capacitors
- How KEMET defines High Temperature
- The need for High Temperature MLCCs
- Dielectric Classification

X8L, Ultra Stable X8R & 200°C C0G Dielectric MLCCs
- Benefits & Features
- Applications

www.kemet.com/HighTemp
How KEMET defines High Temperature

Application Temperatures Greater Than 125°C

Ultra Stable X8R X8L Dielectric

150°C

High Temp. C0G HT/HP

200°C

HV Series ACR/ACA

ARR/ARA

260°C

TCR/TCA TRR/TRA

VCR-C^3 VRR-C^3

www.kemet.com/HighTemp
Why High Temperature?

www.kemet.com/HighTemp
MLCC by Dielectric Code

www.kemet.com/HighTemp
High Temperature Options

X8L SMD 150°C
• Use in higher temperature applications that require TCC +15% / -40%

Ultra Stable X8R SMD 150°C
• Use in higher temperature applications that require TCC ±15%
• No capacitance change with applied voltage.

High Temperature SMD 200°C
• Use in extreme temperature applications.
• Available in C0G dielectric

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X8L Dielectric SMD 150°C

Target Markets
- Automotive (Under The Hood) applications
  - Includes standard & hybrid models
- Down-hole oil exploration
- General high temperature market segments 150°C

Features
- Operating Temperature Range: -55 to 150°C
- Capacitance shift: ±15% (-55 to 125°C)
  +15, -40% (125 to 150°C)
- BME Dielectric System: RoHS Compliant, Pb-free reflow capable

Form Factor     | Surface Mount
---              | ---
Voltage         | 10V, 25V, 50V
Dielectric      | X8L
Cap Range       | Up to 10µF
Case Size       | 0402-1210
Part Number     | C1210C106J8NAC

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X8L EIA Dielectric Classification (Class III)
Temperature Characteristic

Capacitance Shift Limited to (KEMET): ±15% (-55°C to 125°C)
+15, -40% (125°C to 150°C)

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X8L Dielectric
Voltage Characteristic

Capacitance Change vs. DC Bias (Typical) : X8L vs. X7R

X8L Dielectric exhibits improved VCC performance.
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Ultra Stable X8R SMD 150°C

**Target Markets**
- Automotive (Under The Hood) applications
  - Includes standard & hybrid models
- Down-hole oil exploration
- General high temperature market segments 150°C

**Features**
- Operating Temperature Range: -55 to 150°C
- Temperature Coefficient of Capacitance: ±15% (-55 to 150°C)
- No capacitance change with respect to applied rated DC voltage.
- BME Dielectric System: RoHS Compliant, Pb-free reflow capable

<table>
<thead>
<tr>
<th>Form Factor</th>
<th>Surface Mount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage</td>
<td>25V, 50V, 100V</td>
</tr>
<tr>
<td>Dielectrics</td>
<td>X8R</td>
</tr>
<tr>
<td>Cap Range</td>
<td>Up to 0.22μF</td>
</tr>
<tr>
<td>Case Size</td>
<td>0402 - 1812</td>
</tr>
<tr>
<td>Part Number</td>
<td>C1812C224J5HAC</td>
</tr>
</tbody>
</table>

www.kemet.com/HighTemp
Ultra Stable X8R Dielectric Voltage Characteristic

Capacitance Change vs. DC Bias (Typical): Ultra Stable X8R vs. X8R

Ultra Stable X8R exhibits no capacitance change with respect to applied DC voltage.

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Lower capacitance Ultra Stable X8R part types can replace higher capacitance competitor part types.

www.kemet.com/HighTemp
High Temperature SMD 200°C

Target Markets
- Down-Hole
- Military
- Aerospace

Features
- Surface mount MLCC with reliable BME C0G dielectrics featuring world class TCVC characteristics and high reliability.
- C0G SMD’s that exceed X7R max cap at application temperatures.
- Replacement for all existing X7R technology
- 100% Matte Sn plating for excellent solderability.

<table>
<thead>
<tr>
<th>Voltage</th>
<th>16V – 200V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dielectric</td>
<td>C0G/NPO</td>
</tr>
<tr>
<td>Cap Range</td>
<td>0.5pF – 0.22µF</td>
</tr>
<tr>
<td>Case Size</td>
<td>0603-1812</td>
</tr>
<tr>
<td>KPN</td>
<td>C1206H104J3GAC</td>
</tr>
</tbody>
</table>

www.kemet.com/HighTemp
High Temperature SMD 200°C

TCC Performance: BME vs. PME

**No DC Bias**

- 200°C BME C0G
- 200°C PME X7R(BX)
- 150°C X8R

**100% DC Bias (Rated Voltage)**

- 200°C BME C0G
- 200°C PME X7R(BX)
- 150°C X8R
High Temperature SMD 200°C
Benefits, Features & Applications

Benefits and Features:

• No Piezoelectric Noise.
• Extremely low ESR and ESL.
• High Thermal Stability.
• High Ripple Current Capability.
• Preferred capacitance solution at line frequencies and into the MHz range.
• No capacitance change with respect to applied rated DC voltage.
• Minimal capacitance change with respect to temperature from -55ºC to +200ºC.
• No capacitance decay with time (aging).
• Non-polar device.
• No oxygen vacancy concerns.

Applications:

Typical applications include critical timing, tuning, circuits requiring low loss, circuits with pulse, high current, decoupling, by-pass, filtering, transient voltage suppression, blocking and energy storage. For use in extreme environments commonly present in applications such as down-hole exploration, aerospace engine compartments and geophysical probes.

www.kemet.com/HighTemp
# High Temp SMD C0G MLCC Ordering Information

## Part Number and Ordering Information / SMD MLCC / X8L

<table>
<thead>
<tr>
<th>C</th>
<th>1210</th>
<th>C</th>
<th>106</th>
<th>K</th>
<th>8</th>
<th>N</th>
<th>A</th>
<th>C</th>
<th>AUTO</th>
</tr>
</thead>
<tbody>
<tr>
<td>X8L</td>
<td>150°C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Blank = Bulk</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ceramic</td>
<td>Case Size</td>
<td>Specification/Series</td>
<td>Capacitance Code (pF)</td>
<td>Capacitance Tolerance</td>
<td>Voltage</td>
<td>Dielectric</td>
<td>Failure Rate/Design</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0402</td>
<td>C = Standard</td>
<td>2 Sig. Digits + Number of Zeros.</td>
<td>J = ±5%</td>
<td>8 = 10V</td>
<td>N = X8L</td>
<td>A = N/A</td>
<td>C = 100% Matte Sn L = SnPb (5% min)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0603</td>
<td>0805</td>
<td>1206</td>
<td>1210</td>
<td></td>
<td></td>
<td></td>
<td>3 = 25V</td>
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</table>

## Part Number and Ordering Information / SMD MLCC / Ultra-Stable X8R

<table>
<thead>
<tr>
<th>C</th>
<th>1210</th>
<th>C</th>
<th>184</th>
<th>K</th>
<th>3</th>
<th>H</th>
<th>A</th>
<th>C</th>
<th>AUTO</th>
</tr>
</thead>
<tbody>
<tr>
<td>X8R</td>
<td>150°C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Blank = Bulk</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ceramic</td>
<td>Case Size</td>
<td>Specification/Series</td>
<td>Capacitance Code (pF)</td>
<td>Capacitance Tolerance</td>
<td>Voltage</td>
<td>Dielectric</td>
<td>Failure Rate/Design</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0402</td>
<td>C = Standard</td>
<td>2 Sig. Digits + Number of Zeros.</td>
<td>F = ±1%</td>
<td>3 = 25V</td>
<td>H = Ultra Stable X8R</td>
<td>A = N/A</td>
<td>C = 100% Matte Sn L = SnPb (5% min)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0603</td>
<td>0805</td>
<td>1206</td>
<td>1210</td>
<td>1812</td>
<td></td>
<td></td>
<td>5 = 50V</td>
</tr>
</tbody>
</table>

## Part Number and Ordering Information / SMD MLCC / High Temp 200°C C0G

<table>
<thead>
<tr>
<th>C</th>
<th>1210</th>
<th>H</th>
<th>124</th>
<th>J</th>
<th>5</th>
<th>G</th>
<th>A</th>
<th>C</th>
<th>TU</th>
</tr>
</thead>
<tbody>
<tr>
<td>C0G</td>
<td>200°C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Blank = Bulk</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ceramic</td>
<td>Case Size</td>
<td>Specification/Series</td>
<td>Capacitance Code</td>
<td>Capacitance Tolerance</td>
<td>Voltage</td>
<td>Dielectric</td>
<td>Failure Rate/Design</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0603</td>
<td>H = High Temp (200°C)</td>
<td>2 Sig. Digits + Number of Zeros*</td>
<td>C = ±0.25pF</td>
<td>8 = 10V</td>
<td>G = C0G</td>
<td>A = N/A</td>
<td>C = 100% Matte Sn L = SnPb (5% min)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0805</td>
<td>1206</td>
<td>1210</td>
<td>1812</td>
<td></td>
<td></td>
<td></td>
<td>4 = 16V</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>*Use 9 for 1.0 - 9.9pF</td>
<td>D = ±0.5pF</td>
<td>5 = 35V</td>
<td>6 = 35V</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>*Use 8 for 0.5 - .99pF</td>
<td>ex. 2.2pF = 229</td>
<td>G = ±2%</td>
<td>J = ±5%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>ex. 0.5pF = 508</td>
<td>F = ±1%</td>
<td>1 = 100V</td>
<td>2 = 200V</td>
</tr>
</tbody>
</table>

*Blank = Bulk
*TU = 7" Reel Unmarked
*TM = 7" Reel Marked
*AUTO = Automotive Grade
*7" Reel Unmarked
For more information:
http://www.kemet.com/hightemp