Class I Dielectrics

Multilayer Ceramic Capacitors are generally divided into classes which are defined by the capacitance temperature characteristics over specified temperature ranges. These are designated by alpha numeric codes. Code definitions are summarised below and are also available in the relevant national and international specifications.

Capacitors within this class have a dielectric constant range from 10 to 100. They are used in applications which require ultra stable dielectric characteristics with negligible dependence of capacitance and dissipation factor with time, voltage and frequency. They exhibit the following characteristics:

a) Time does not significantly affect capacitance and dissipation factor (Tan δ) – no ageing.
b) Capacitance and dissipation factor are not affected by voltage.
c) Linear temperature coefficient.

<table>
<thead>
<tr>
<th>Class I Dielectrics</th>
</tr>
</thead>
<tbody>
<tr>
<td>COG/NP0 (Porcelain)</td>
</tr>
<tr>
<td>IECQ-CECC</td>
</tr>
<tr>
<td>EIA</td>
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<tr>
<td>MIL</td>
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<tr>
<td>DLI</td>
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<tr>
<td>Novacap</td>
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<tr>
<td>Syfer</td>
</tr>
<tr>
<td>Voltronics</td>
</tr>
</tbody>
</table>

Ordering code

- Rated temperature range
  -55ºC to +125ºC

Maximum capacitance change over temperature range

- No DC voltage applied
  - 0 ± 15 ppm/ºC
  - 0 ± 20 ppm/ºC
  - 0 ± 30 ppm/ºC

- Rated DC voltage applied
  - >50pF ≤0.0015 (15 + 0.7)
  - >50pF ≤0.0015

Tangent of loss angle (Tan δ)

- ≤0.05
- ≤0.0005
- ≤0.05
- ≤0.0015
- ≤0.001

Insulation resistance (Ri)

- Time constant (Ri x Cr)
  - @25ºC = 10¹ MΩ min
  - @125ºC = 10¹ MΩ min

Capacitance Tolerance

- Cr <4.7pF
  - ±0.05pF, ±0.10pF, ±0.25pF, ±0.5pF

- Cr ≥4.7 to <10pF
  - ±0.10pF, ±0.25pF, ±0.5pF

- Cr ≥10pF
  - ±1%, ±2%, ±5%, ±10%

Dielectric strength

- Voltage applied for 5 seconds. Charging current limited to 50mA maximum.
- ≤200V
  - 2.5 times

- >200V to <500V
  - 2.5 times

- 500V to ≤1kV
  - 2.5 times

- >1kV to ≤1.2kV
  - N/A

- >1.2kV
  - 1.2 times

- >1.2kV
  - 1.2 times

Climatic category (IEC)

- Chip
  - 55/125/56

- Dipped
  - -

- Discoidal
  - -

Ageing characteristic (Typical)

- Zero

Approvals

- Syfer Chip
  - -

- QC-32100
  - -
### Class II Dielectrics

Capacitors of this type have a dielectric constant range of 1000-4000 and also have a non-linear temperature characteristic which exhibits a dielectric constant variation of less than ±15% (2R1) from its room temperature value, over the specified temperature range. Generally used for by-passing (decoupling), coupling, filtering, frequency discrimination, DC blocking and voltage transient suppression with greater volumetric efficiency than Class I units, whilst maintaining stability within defined limits.

<table>
<thead>
<tr>
<th>Class II Dielectrics</th>
<th>X5R</th>
<th>X7R</th>
<th>X8R</th>
<th>Class II High Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>X5R</td>
<td>Stable</td>
<td>Stable</td>
<td>Stable</td>
<td>Stable</td>
</tr>
<tr>
<td>X7R</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>X8R</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Class II High Temperature</td>
<td>IECQ-CECC</td>
<td>EIA</td>
<td>MIL</td>
<td>DLI</td>
</tr>
</tbody>
</table>

#### Dielectric characteristics

- **Dielectric classifications**
  - X5R: ±15%
  - X7R: ±15%
  - X8R: ±15%

- **Ordering code**
  - BW - B X S G E: Novacap
  - P R X B N - X: Syfer
  - - X - - - -: Voltronics

- **Rated temperature range**
  - -55ºC to +85ºC
  - -55ºC to +125ºC
  - -55ºC to +150ºC
  - -55ºC to +200ºC

- **Maximum capacitance change over temperature range**
  - +15% -45%
  - ±15% -15% -45%

- **Rated DC voltage applied**
  - No DC voltage applied

- **Tangent of loss angle (tan δ)**
  - >25V: ≤0.025
  - ≤25V: ≤0.035

- **Time constant (Ri x Cr):**
  - 100Ω or 1000s (whichever is the least)

- **Insulation resistance (Ri):**
  - ±5%, ±10%, ±20%

- **Capacitance Tolerance**
  - 2.5 times
  - 1.5 times
  - 1.2 times
  - 55/85/56
  - 55/125/56
  - 55/150/56

- **Voltage applied**
  - Rated voltage + 250V
  - 50V to <1kV

- **Dielectric strength**
  - Voltage applied for 5 seconds.
  - Charging current limited to 50mA maximum.

- **Climatic category (IEC)**
  - 55/125/21
  - 55/125/56

- **Ageing characteristic (Typical)**
  - <2% per time decade

* Refer to page 34 for details of Dissipation Factor.

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## Dielectric termination combinations

<table>
<thead>
<tr>
<th>Dielectric</th>
<th>Code</th>
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<td>C0G - Hi Q/Low ESR</td>
<td>DLI - UL</td>
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<tr>
<td></td>
<td>Syfer - Q, U</td>
</tr>
<tr>
<td>C0G - Hi Q/Low ESR BME</td>
<td>Syfer - H</td>
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<tr>
<td>C0G/NP0</td>
<td>Novacap - N/RN</td>
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<td></td>
<td>Syfer - A</td>
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<tr>
<td></td>
<td>Syfer - C, F</td>
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<tr>
<td>C0G/NP0 - BME</td>
<td>Syfer - G, K</td>
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<tr>
<td>C0G/NP0 - Non-Mag</td>
<td>Novacap - M</td>
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<tr>
<td></td>
<td>Syfer - C, Q</td>
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<tr>
<td></td>
<td>Voltronics - Q</td>
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<tr>
<td>X5R</td>
<td>Syfer - P</td>
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<tr>
<td></td>
<td>Novacap - BW</td>
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<tr>
<td>X7R</td>
<td>Novacap - B/RB</td>
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<tr>
<td></td>
<td>Syfer - E</td>
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<tr>
<td></td>
<td>Syfer - X, D</td>
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<tr>
<td>X7R - BME</td>
<td>Novacap - BB</td>
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<tr>
<td></td>
<td>Syfer - J</td>
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<td>Syfer - S</td>
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<tr>
<td>BX</td>
<td>Novacap - X</td>
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<td></td>
<td>Syfer - B</td>
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<tr>
<td>R2D (Pulse Energy)</td>
<td>Novacap - R</td>
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<tr>
<td>BZ</td>
<td>Syfer - R</td>
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<tr>
<td>X7R - Non-Mag</td>
<td>Novacap - C</td>
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<tr>
<td></td>
<td>Syfer - X</td>
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<tr>
<td></td>
<td>Voltronics - X</td>
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<tr>
<td>X8R</td>
<td>Novacap - S</td>
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<td></td>
<td>Syfer - N</td>
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<tr>
<td></td>
<td>Syfer - T</td>
</tr>
<tr>
<td>C0G/NP0 (160ºC)</td>
<td>Novacap - F</td>
</tr>
<tr>
<td>C0G/NP0 (200ºC)</td>
<td>Novacap - D</td>
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<tr>
<td>C0G/NP0 (200ºC)</td>
<td>Novacap - RD</td>
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<tr>
<td></td>
<td>Syfer - G</td>
</tr>
<tr>
<td>Class II (160ºC)</td>
<td>Novacap - G</td>
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<tr>
<td>Class II (200ºC)</td>
<td>Novacap - E</td>
</tr>
<tr>
<td></td>
<td>Novacap - RE</td>
</tr>
</tbody>
</table>

**Recommended for Solder Attachment**
- Palladium Silver
- Nickel Barrier (100% matte tin plating)
- Nickel Barrier Gold flash
- FlexCap™ with Nickel Barrier 100% tin
- FlexCap™ with Nickel Barrier 90/10% tin/lead
- FlexCap™ with Copper Barrier 100% tin
- FlexCap™ with Copper Barrier 90/10% tin/lead
- Copper Barrier 100% tin
- Copper Barrier 90/10% tin/lead

**Recommended for Conductive Epoxy Attachment**
- Palladium Silver
- Nickel Barrier 90/10% tin/lead
- FlexiCap™ with Nickel Barrier 100% tin
- FlexiCap™ with Nickel Barrier 90/10% tin/lead
- FlexiCap™ with Copper Barrier 100% tin
- FlexiCap™ with Copper Barrier 90/10% tin/lead
- Copper Barrier 100% tin
- Copper Barrier 90/10% tin/lead

Dielectric codes in **Red** - AEC-Q200 qualified. Dielectric codes in **Green** - IECQ-CECC.