X and Y Capacitors
Two Major Types: X2 and X1

**X2 capacitors**
- Agency tested with 2,500 volt surge test.
- Satisfies 99% of the applications.

**X1 capacitors**
- Agency tested with 4,000 volt surge test.
- Only used if the safety agency tells the designer it is necessary.
- May be used in X2 applications.
X Capacitor Comparison
Choosing between film and paper caps

Metallized Film
R46 & PHE840M

Met. Impregnated Paper
PME271M
X Capacitor Comparison
Choosing between film and paper caps

Metallized Film
R46 & PHE840M
Less expensive.

Met. Impregnated Paper
PME271M
X Capacitor Comparison
Choosing between film and paper caps

Metallized Film
R46 & PHE840M
Less expensive.

Met. Impregnated Paper
PME271M
Greater surge withstand capability.

Meets agency ____________ requirements.
X Capacitor Comparison

Choosing between film and paper caps

Metallized Film
R46 & PHE840M
Less expensive.

Meets agency ____________ requirements.

Stable.

Met. Impregnated Paper
PME271M
Greater surge withstand capability.

Stable.
X Capacitor Comparison
Choosing between film and paper caps

Metallized Film
R46 & PHE840M
Less expensive.
*Meets agency requirements.*
Stable.
Good self healing. Failure mode is open circuit.

Met. Impregnated Paper
PME271M
Greater surge withstand capability.
Stable.
Excellent self healing. Failure mode is open circuit.
**X Capacitor Comparison**

*Choosing between film and paper caps*

<table>
<thead>
<tr>
<th>Metallized Film</th>
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<td>PME271M</td>
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## X Capacitor Comparison
Choosing between film and paper caps

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</tr>
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<td>Smaller, up to 10µF.</td>
<td>Available up to 0.6µF.</td>
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R46 & PHE840M Features
Benefits for the designer
R46 & PHE840M Features

Benefits for the designer

- Competitive prices, small sizes.
R46 & PHE840M Features

Benefits for the designer

- Competitive prices, small sizes.
- Many values in “standard” lead spacings plus new smaller alternates.
  - 1µF in 27.5mm and new 22.5.
  - 2.2 µF in 37.5mm and new 27.5.
R46 & PHE840M Features
Benefits for the designer

• Competitive prices, small sizes.
• Many values in “standard” lead spacings plus new smaller alternates.
  – 1µF in 27.5mm and new 22.5.
  – 2.2 µF in 37.5mm and new 27.5.
• Max. C-value is 10µF for high power SMPS.
  – Eliminates the need for 2 capacitors in parallel.
• Competitive prices, small sizes.
• Many values in “standard” leadspacings plus new smaller alternates.
  – 1µF in 27.5mm and new 22.5.
  – 2.2 µF in 37.5mm and new 27.5.
• Max. C-value is 10µF for high power SMPS.
  – Eliminates the need for 2 capacitors in parallel.
• PHE840M UL approved at 280VAC.
  – Eases design-ins for 277VAC applications.
R46 & PHE840M Features
Benefits for the designer

- Competitive prices, small sizes.
- Many values in “standard” lead spacings plus new smaller alternates.
  - 1µF in 27.5mm and new 22.5.
  - 2.2 µF in 37.5mm and new 27.5.
- Max. C-value is 10µF for high power SMPS.
  - Eliminates the need for 2 capacitors in parallel.
- PHE840M UL approved at 280VAC.
  - Eases design-ins for 277VAC applications.
- Low loss polypropylene design for high frequency applications. (Polyester caps can heat up too much.)
  - High frequency motor drives, aircraft power (400Hz).
A Product for Every Voltage
X caps for industrial applications

<table>
<thead>
<tr>
<th>AC voltage</th>
<th>Film</th>
<th>Paper</th>
</tr>
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<tr>
<td>275/280</td>
<td>R46, PHE840M</td>
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</tr>
<tr>
<td>300</td>
<td>R46, PHE840E</td>
<td>PME271E</td>
</tr>
<tr>
<td>330</td>
<td>PHE841, R49</td>
<td></td>
</tr>
<tr>
<td>440/480</td>
<td>PHE844, R47</td>
<td>PME278</td>
</tr>
<tr>
<td>600 &amp; up</td>
<td>PHE845</td>
<td>PME264</td>
</tr>
</tbody>
</table>

Use one capacitor of the correct voltage instead of two low-voltage parts in series.
Y Capacitors
Two Major Types: Y2 and Y1

Y2 capacitors
- Agency tested with 5,000 volt surge test.
- Satisfies nearly all the applications.

Y1 capacitors
- Agency tested with 8,000 volt surge test.
- Double insulation / reinforced insulation.
- Only used if the safety agency tells the designer it is necessary.

Because common Y cap C-values are small (for example 4700pF) ceramics are also offered.
IEC950 Push Test
Effect on ceramic Y capacitors

Ceramic Y Capacitor

Boxed Y Capacitor
Ceramic Y Capacitor Solutions to the Push Test Problem

Put an insulating sleeve over the capacitor. Adds to the total cost.
Ceramic Y Capacitor Solutions to the Push Test Problem

- Put an insulating sleeve over the capacitor. Adds to the total cost.
- Leave a “keepout zone” on the power supply. Creates a size penalty.
Y Capacitor Comparison

Ceramic

Metallized paper & film
Y Capacitor Comparison

Ceramic  Metallized paper & film
Less expensive.
Y Capacitor Comparison

Ceramic
Less expensive.
Unstable over time and _______ Stable.

Metallized paper & film
Y Capacitor Comparison

Ceramic

Less expensive.

Unstable over time and _______ Stable.

temperature.

Pushes over (may require _______ Boxed types do not push over.
additional insulation).  (Lower total cost.)
Y Capacitor Comparison

Ceramic

Less expensive.

Unstable over time and temperature.

Pushes over (may require additional insulation).

Maximum capacitance available is ~0.022µF.

Metallized paper & film

Stable.

Boxed types do not push over. (Lower total cost.)

Available up to 1.0µF. (Ideal for industrial apps.)
**Y Capacitor Comparison**

**Ceramic**

- Less expensive.
- Unstable over time and temperature.
- Pushes over (may require additional insulation).
- Maximum capacitance available is ~0.022µF.
- Failure mode tends toward short circuit.

**Metallized paper & film**

- Stable.
- Boxed types do not push over. (Lower total cost.)
- Available up to 1.0µF. (Ideal for industrial apps.)
- Self healing. Failure mode is open circuit.
New film Y cap PHE850
Alternative to ceramics
**New film Y cap PHE850**

*Alternative to ceramics*

- Metallized, self-healing construction.
  - Safer failure mode at near-ceramic prices.
New film Y cap PHE850
Alternative to ceramics

- Metallized, self-healing construction.
  - Safer failure mode at near-ceramic prices.
- Very wide C-value range: 0.001 – 1µF.
  - Higher values excellent for industrial applications.
New film Y cap PHE850

Alternative to ceramics

- Metallized, self-healing construction.
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- Small physical size.
New film Y cap PHE850
Alternative to ceramics

- Metallized, self-healing construction.
  - Safer failure mode at near-ceramic prices.
- Very wide C-value range: 0.001 – 1µF.
  - Higher values excellent for industrial applications.
- Small physical size.
- Does not push over.
  - Can lower total cost to use.
Summary

Choosing X and Y Capacitors

Y Capacitors
X Capacitors

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Summary

Choosing X and Y Capacitors

Y Capacitors

- Use metallized paper PME271Y for commercial & industrial applications.
  - Provides excellent self-healing and flammability performance.

X Capacitors
Choosing X and Y Capacitors

Y Capacitors

- Use metallized paper PME271Y for commercial & industrial applications.
  - Provides excellent self-healing and flammability performance.

- Use metallized film (series PHE850 or R41) as an alternative to ceramics in consumer or low-cost applications.
  - Low cost like ceramics but self-healing and does not push over.

X Capacitors
Summary

Choosing X and Y Capacitors

Y Capacitors

• Use metallized paper PME271Y for commercial & industrial applications.
  – Provides excellent self-healing and flammability performance.

• Use metallized film (series PHE850 or R41) as an alternative to ceramics in consumer or low-cost applications.
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X Capacitors

• Use metallized film R46 or PHE840M for most applications.
Summary

Choosing X and Y Capacitors

Y Capacitors
- Use metallized paper PME271Y for commercial & industrial applications.
  - Provides excellent self-healing and flammability performance.
- Use metallized film (series PHE850 or R41) as an alternative to ceramics in consumer or low-cost applications.
  - Low cost like ceramics but self-healing and does not push over.

X Capacitors
- Use metallized film R46 or PHE840M for most applications.
- Check out higher voltage parts where applicable.
Choosing X and Y Capacitors

**Y Capacitors**
- Use metallized paper PME271Y for commercial & industrial applications.
  - Provides excellent self-healing and flammability performance.
- Use metallized film (series PHE850 or R41) as an alternative to ceramics in consumer or low-cost applications.
  - Low cost like ceramics but self-healing and does not push over.

**X Capacitors**
- Use metallized film R46 or PHE840M for most applications.
- Check out higher voltage parts where applicable.
- Use metallized paper (series PMExxx) in high-rel applications such as critical industrial and telecom infrastructure applications.