Polymer and Hybrid Capacitor
Product Overview
Capacitor Selection

Capacitors selection, to the uninformed, seems like a simple choice. But the demands, challenges and expectations of modern electronics prove otherwise.

Design Engineers have many considerations when choosing the right capacitor for the job.

- Electrical Characteristics
- Stability
- Life and reliability
- Safety
- Cost

Many conventional capacitor technologies offer strong value propositions while no longer meeting the demands of today’s challenging designs.
The Solution …

Advanced Polymer Capacitors from Panasonic provide solutions to these challenges.
Why Switch to Polymer Technology?

- Requirements and challenges of high performance miniaturized modern electronic design combined with expectations of high reliability and long life
- Conventional capacitors are not up to the challenge
- Advanced Polymer capacitors provide higher performance in a reduced footprint while offering longer life and improved reliability!
Polymer Capacitor Advantages

Polymer capacitors offer distinctive advantages over conventional capacitors in these specific areas:

- Stability
- Life
- Reliability
- Safety
- Component Reduction
Capacitance Stability

Conventional Electrolytic and MLCCs suffer from capacitance drifts of up to 90% in response to temperature and DC bias.

Polymer Capacitors have no such problem.
Stability

Versus MLCC

DC biased characteristic

MLCC: 6.3V 47uF/3216/X5R
POSCAP/SP-Cap/OS-CON: 6.3V 47uF

POSCAP/SP-Cap/OS-CON are stable under actual use condition. (Temperature and DC Bias)
1. Temperature acceleration test (Endurance)

The decrease in capacitance of the OS-CON depends on temperature. The left figure shows the speed of capacitance decrease at each temperature. This graph indicates that temperature coefficient of the OS-CON lifetime is 10 times by 20°C reduction. Compared with this, aluminum capacitor lifetime is 2 times by 10°C reduction.

Estimation of life time

<table>
<thead>
<tr>
<th>OS-CON</th>
<th>Aluminum electrolytic capacitor</th>
</tr>
</thead>
<tbody>
<tr>
<td>105°C  → 2,000h</td>
<td>105°C  → 2,000h</td>
</tr>
<tr>
<td>95°C  → 6,324h</td>
<td>95°C  → 4,000h</td>
</tr>
<tr>
<td>85°C  → 20,000h</td>
<td>85°C  → 8,000h</td>
</tr>
<tr>
<td>75°C  → 63,245h</td>
<td>75°C  → 16,000h</td>
</tr>
</tbody>
</table>

*Guarantee temperature of the OS-CON is 105°C, except for SEQP, SVQP and SVPD series.
*Time is an estimate, not guaranteed.

Though the OS-CON and an aluminum electrolytic capacitors are guaranteed on 2,000 hours at 105°C, the life span results in differences as temperature drops. The OS-CON has a longer life span compared with an aluminum electrolytic capacitor.
Reliability

Figure 9

Hybrid capacitors exhibit high reliability when subjected to high ripple currents. In recent testing, the capacitors had the electrical characteristics at no load and rated ripple current (1300 mA) conditions. At three times the rated ripple current (3600 mA), the capacitor's electrical characteristics did change, but no shortage took place.
Over Voltage Test:
The test capacitors were made to short purposely.
Smoke and ignition were checked by the constant current examination.

This data is an experimental example. A numerical value and a phenomenon are not guaranteed.

Benign failure mode vs. catastrophic failure of tantalum cap (MnO₂)
## Component Reduction

### DC 48V Line Solution

<table>
<thead>
<tr>
<th>Item</th>
<th>Capacitors</th>
<th>Hybrid type Al. Electrolytic</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Capacitors</strong></td>
<td>Al. Electrolytic</td>
<td>Hybrid type Al. Electrolytic</td>
</tr>
<tr>
<td><strong>Item</strong></td>
<td>$\phi12.5 \times 13.5 / 63 \text{ V} / 220 \mu\text{F} \times 4 \text{ pcs.}$</td>
<td>$\phi6.3 \times 7.7 / \text{DC} 63 \text{ V} / 22 \mu\text{F} \times 2 \text{ pcs.}$</td>
</tr>
<tr>
<td><strong>Mounting Area</strong></td>
<td>100% (491 mm²)</td>
<td>13% (62 mm²)</td>
</tr>
<tr>
<td><strong>Endurance</strong></td>
<td>105 °C, 5,000 h</td>
<td>105 °C, 10,000 h</td>
</tr>
<tr>
<td><strong>Total ESR</strong></td>
<td>40 mΩ / 100 kHz</td>
<td>40 mΩ / 100 kHz</td>
</tr>
<tr>
<td><strong>Total Ripple</strong></td>
<td>3200 mA / 100 kHz, 105 °C</td>
<td>3000 mA / 100 kHz, 105 °C</td>
</tr>
<tr>
<td><strong>Life End Failure Modes</strong></td>
<td>Open</td>
<td>Open</td>
</tr>
<tr>
<td><strong>Total Cost</strong></td>
<td>Index: 1</td>
<td>Index: 0.5</td>
</tr>
</tbody>
</table>

### DC 24V Line Solution

<table>
<thead>
<tr>
<th>Item</th>
<th>Capacitors</th>
<th>Hybrid type Al. Electrolytic</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Capacitors</strong></td>
<td>Al. Electrolytic</td>
<td>Hybrid type Al. Electrolytic</td>
</tr>
<tr>
<td><strong>Item</strong></td>
<td>$\phi12.5 \times 13.5 / 35 \text{ V} / 680 \mu\text{F} \times 4 \text{ pcs.}$</td>
<td>$\phi8.0 \times 10.2 / \text{DC} 35 \text{ V} / 150 \mu\text{F} \times 2 \text{ pcs.}$</td>
</tr>
<tr>
<td><strong>Mounting Area</strong></td>
<td>100% (491 mm²)</td>
<td>20% (100 mm²)</td>
</tr>
<tr>
<td><strong>Endurance</strong></td>
<td>105 °C, 5,000 h</td>
<td>105 °C, 10,000 h</td>
</tr>
<tr>
<td><strong>Total ESR</strong></td>
<td>15 mΩ / 100 kHz</td>
<td>13.5 mΩ / 100 kHz</td>
</tr>
<tr>
<td><strong>Total Ripple</strong></td>
<td>4400 mA / 100 kHz, 105 °C</td>
<td>4600 mA / 100 kHz, 105 °C</td>
</tr>
<tr>
<td><strong>Life End Failure Modes</strong></td>
<td>Open</td>
<td>Open</td>
</tr>
<tr>
<td><strong>Total Cost</strong></td>
<td>Index: 1</td>
<td>Index: 0.58</td>
</tr>
</tbody>
</table>

**You can achieve high performance and miniaturization of equipment by adopting Hybrid Capacitor!!**

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**Aluminum Electrolytic Capacitors (SMD)**

- $12.5 \times 13.5 \text{ mm} / 63 \text{ V} / 220 \mu\text{F} \times 4 \text{ pcs.}$
- $12.5 \times 13.5 \text{ mm} / 35 \text{ V} / 680 \mu\text{F} \times 4 \text{ pcs.}$
Panasonic Polymer Capacitor

Panasonic has four Polymer Capacitor alternatives, each with distinct sweet spots that can address ideal voltages, frequency characteristics, environmental conditions and other application requirements that are challenging for conventional capacitors.

- SP-Cap®
  - Layered Polymer Aluminum Capacitors
- POSCAP®
  - Polymer Tantalum Capacitors
- Hybrid
  - Polymer Hybrid Aluminum Capacitors
- OS-CON®
  - Wound Polymer Aluminum Capacitors
Panasonic Polymer Capacitor

SP-Cap®

Layered Polymer Aluminum Capacitor – polymer is used as the electrolyte with an aluminum cathode. SP-Caps are packaged in a molded resin surface mount package.

SP-Caps are available with a voltage rating from 2 to 25V and capacitance of 2.2 to 560μF. The distinguishing electrical characteristic of these polymer capacitors is their extremely low equivalent series resistance (ESR) as low as 3mΩ.
Panasonic Polymer Capacitors

POSCAP®

Polymer Tantalum Capacitors employ a polymer as the electrolyte and have a tantalum cathode. Packaged in a molded resin case, the tantalum polymer capacitors are among the most compact on the market. The M size measures just 1.6 by 0.8 mm.

POSCAP capacitors are available with a voltage rating from 1.8 to 35V and capacitances from 2.7 to 680µF. They, too, have low ESR values as low as 5mΩ.
Panasonic Polymer Capacitors

**OS-CON®**

Wound Polymer Aluminum Capacitors utilize conductive polymer as the electrolyte and wound aluminum as the cathode. The polymer electrolyte yields very low ESR (below 5mΩ) while the wound aluminum cathode provides a large surface area enabling high capacitance.

OS-CON Capacitors are available in a voltage range of 2 to 50 VDC and capacitances from 3.3 to 2700µF.
Life Formula – POSCAP & OS-CON

Calculating formula for the presumption of life

\[ L_x = L_0 \times 10^{\frac{To - Tx}{20}} \]

- \( L_x \): Life expectancy in actual use (temperature \( T_x \)) (h)
- \( L_0 \): Guaranteed life at maximum temperature in use (h)
- \( To \): Maximum operating temperature (°)
- \( T_x \): Temperature in actual use (temperature of POSCAP) (°)

The data to the left shows the results of an endurance. The POSCAP of the conductive polymer capacitor is excellent for heat stability. (The characteristics of each models, please contact us.)

Panasonic
Panasonic Polymer Capacitor

PANASONIC HYBRID

Polymer Hybrid Aluminum Capacitors use a combination of a liquid and polymer to serve as the electrolyte and aluminum as the cathode. This combination attains the best of polymer and electrolytic capacitor technology; low ESR of a polymer (20 to 120mΩ) along with high voltages and higher capacitance of an electrolytic.

Hybrid capacitors are available in a voltage range of 25 to 80V and capacitances between 10 and 330µF.
Aluminum Capacitor Life Calculation

Every -10°C, x 2 life

Liquid electrolyte → Dry-up → Open Failure → Finite Life

24h operation (h) Years
○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 10 ○ 20 ○ 30

8h Op. Years
○ 3 ○ 6 ○ 10 ○ 15 ○ 20 ○ 30
Choosing the Right Polymer Capacitor

- OS-CON and Hybrid vs. Lytic
- POSCAP and SP-Caps vs. Ceramic and/or Tantalum
OS-CON and Hybrid

Key difference with Standard Aluminum Capacitor

- Ultra Low ESR, Low impedance (as low 1/100 of a typical lytic)
- Higher ripple current capability (upwards of 3~5 times)
- Stable characteristics, longer life time (up to 15 years in case of OS-CON)
POSCAP and SP-Cap

Key with Standard Tantalum Capacitor and MLCC

- Ultra Low ESR, Low impedance (as low as 1/100)
- High reliability (does not explode like a Tantalum)
- SP-Cap: no derating.
- No Piezo effect for both POSCAP and SP-Cap (unlike MLCC)
Replacement from MLCC to POSCAP/SP-Cap

**MLCC → POSCAP**

**AntiNoise MLCC**
- Size 3517
- 25V 10uF x 8 pcs
- Murata: KMR31FR61E106KH01K
- Actual Cap. Approx. 15uF
  - (3.5 x 1.7) x 8 pcs = 48mm²

**Benefit**
1. Cost 50% off
2. Space 80% off
3. Same Capacitance

**Condition**
Large current power supply circuit

**MLCC → SP-Cap**

**High Voltage MLCC**
- Size 3225
- 27uF x 5 pcs

**Benefit**
1. Cost 30% off
2. Space 25% off

**Condition**
Large current DC/DC or LSI

**SP-Cap x 1pcs**
- EEFSX0D471E4
- EEFLXoD471R4
- Actual Cap. 1.5V → 470uF
- (7.3 x 4.3) x 1 pcs = 31mm²
Replacement from MLCC to OS-CON

**High Voltage MLCC**

- **size 5750**
- 100V 22uF x 4 pcs

  ![MLCC Component Image]

  - TDK:CKG57NX7S2A226M500JH
  - Actual Cap. Approx. 15uF
  - (6.1 x 5.3) x 4 pcs = 129mm²

- **size 5750**
- 50V 22uF x 5 pcs

  ![MLCC Component Image]

  - TDK:CKG57NX7S1H226M500JH
  - Murata:KRM55WR71H226MH01K

**OS-CON x 1pcs**

- 100SXV15M
- 63SXV33M

  ![OS-CON Component Image]

  - Actual Cap.
  - 100V ➔ 15uF
  - 63V ➔ 33uF
  - (8.3 x 8.3) x 1 pcs = 69mm²

**Condition**

- High voltage & Large current power supply circuit

**BENEFIT**

1. **Cost** 70~80%off
2. **Space** -47%~58% off
3. **Same** Capacitance
Replacement from MLCC + Radial AL to Hybrid

**MLCC + E-CAP → Hybrid**

**High Voltage MLCC +**

**Radial E-CAP**

- *size 5750*
  - 100V 22uF x 4 pcs

- *size φ10x12.5mm*
  - 25V 220uF x 1 pcs

**Hybrid-Cap x1pcs**

- *EEHZC1E221P*
  - *size φ8x10.2mm*

**Condition**

- High voltage & Large current power supply circuit

**BENEFIT**

1. Space -58% off
2. Same Capacitance
3. Low ESR/High ripple

**Mount Area**

<table>
<thead>
<tr>
<th>Component</th>
<th>Mount Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>MLCC + E-CAP</td>
<td>110mm²</td>
</tr>
<tr>
<td>Hybrid-Cap</td>
<td>69mm²</td>
</tr>
</tbody>
</table>

**Specifications**

<table>
<thead>
<tr>
<th>Component</th>
<th>ESR</th>
<th>Ripple</th>
</tr>
</thead>
<tbody>
<tr>
<td>MLCC + E-CAP</td>
<td>110mΩ</td>
<td>680mA</td>
</tr>
<tr>
<td>Hybrid-Cap</td>
<td>20mΩ</td>
<td>1600mA</td>
</tr>
</tbody>
</table>