Capacitor lecture
(Basic)

Aluminum Solid Capacitors with Conductive Polymer
What is OS-CON?
- Structure of OS-CON
- Electrolyte of OS-CON

Features and how to use OS-CON
- Frequency Characteristics
- Low ESR (Impedance) Effect
- Temperature Characteristics
- Low Temperature Characteristics Effect
- Estimated life time calculation
- Endurance test
- Application of OS-CON
What is OS-CON?

Structure of OS-CON

OS-CON resembles Al Electrolytic Cap.
The biggest difference is electrolyte.

<table>
<thead>
<tr>
<th>OS-CON</th>
<th>Solid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Al Electrolytic</td>
<td>Liquid</td>
</tr>
</tbody>
</table>
What is OS-CON?

Electrolyte of OS-CON

- Organic semiconductive electrolyte
- Conductive polymer

<table>
<thead>
<tr>
<th>Type of capacitors</th>
<th>Type of electrolyte</th>
<th>Conductivity(mS/cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-solid electrolyte cap.</td>
<td>electrolyte solution</td>
<td>3</td>
</tr>
<tr>
<td>Solid electrolyte capacitor</td>
<td>manganese dioxide</td>
<td>30</td>
</tr>
<tr>
<td><strong>OS-CON</strong></td>
<td><strong>Organic semiconductor</strong></td>
<td><strong>300</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Conductive polymer</strong></td>
<td><strong>3,000</strong></td>
</tr>
</tbody>
</table>

Features of the electrolyte

- Higher conductivity compared with other electrolyte
  - Ultra low ESR achieved!
- Stable high conductivity regardless of the temperature
  - ESR doesn’t change in low temperatures!

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Features and application of OS-CON

- Frequency characteristics
  - Comparison with other type of capacitors

- Effect of low ESR (Impedance)
  - Comparison with Al electrolytic cap. on the DC/DC converter

- Temperature characteristics
  - ESR change between -55 deg. C and 105 deg. C

- Low temperature characteristics effect
  - Comparison of low temperature characteristics in the DSC.

- Estimated lifetime calculation
  - Comparison of rules of lifetime calculation.

- Endurance test
  - High temperature load test at 105deg.C for 5,000 hours

- How to use OS-CON
  - Main application of OS-CON
Frequency characteristics
Comparison with other type of capacitors

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How to use OS-CON
Main application of OS-CON
Features -Frequency Characteristics-

Comparison with other type of capacitors

- OS-CON
  - Capacity: about 1/20
  - Volume: about 1/15

- Low impedance
Features and application of OS-CON

- Frequency characteristics
  Comparison with other type of capacitors

- **Effect of low ESR (Impedance)**
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- **How to use OS-CON**
  Main application of OS-CON
Features - Effect of Low ESR -

**DC/DC converter**

**Condition**
- SW Frequency (fosc) : 200kHz
- Input Voltage (Vin) : 5V
- Output Voltage (Vout) : 3.3V
- Output ripple voltage (Vripple) : 20mV
- Output current (Iout) : 3.2A
- Inductance (L) : 10uH

\[ ESR < \frac{V_{ripple}}{V_{in} - V_{out} \times \frac{V_{out}}{L} \times \frac{1}{V_{in} \times f_{osc}}} \]

\[ < 35.7 \text{ mOhm} \]

**Selected capacitors**
- OS-CON ➔ 6SVP100M 1 pce.
  - Φ6.3mm x L6mm, ESR = 32mOhm
- Aluminium Electrolytic Capacitor ➔ 6V/680uF 3 pcs.
  - Φ10mm x L8mm, ESR = 128mOhm/pce. Total ESR = 43mOhm
Features -Effect of Low ESR-

- Replacement of Al Electrolytic Cap. to low ESR OS-CON

OS-CON

6SVP100M 1pcs.

Al-Cap.

6V/680uF 3pcs.

Downsizing!

Input ripple current

Inductor current

Output ripple voltage

About 20mV

Electronic Device Company
**Features and application of OS-CON**

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- **How to use OS-CON**
  - Main application of OS-CON
OS-CON’ s ESR does not change with the temperature!
OS-CON is suitable for outdoor equipments.
Features and application of OS-CON

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- **How to use OS-CON**
  - Main application of OS-CON
Features -Low temperature effect-

A DSC with OS-CON and Al Electrolytic Capacitors

OS-CON
10SL47M(2pcs.)
Φ6.3mm x L5.0mm

Al-Cap
10V/330uF(2pcs.)
Φ6.3mm x L11.0mm
Features -Low temperature effect-

OS-CON

Al-Cap.

★Pictures of DSC with OS-CON is clear from -20 deg. C to 25 deg. C., while picture of DSC with Al-cap is blurred at low temperature.

Regarding OS-CON, the characteristic deterioration at low temperature isn’t needed to consider at low temperature.
Features and application of OS-CON

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- How to use OS-CON
  Main application of OS-CON
**Features - Estimated lifetime -**

- **Estimated lifetime:**
  - OS-CON: Twice longer
  - Al-Cap: Twice longer

**Lifetime calculation**

<table>
<thead>
<tr>
<th>Temperature (°C)</th>
<th>OS-CON</th>
<th>Al-Cap</th>
</tr>
</thead>
<tbody>
<tr>
<td>105</td>
<td>2,000 h</td>
<td>2,000 h</td>
</tr>
<tr>
<td>95</td>
<td>6,300 h</td>
<td>4,000 h</td>
</tr>
<tr>
<td>85</td>
<td>20,000 h</td>
<td>8,000 h</td>
</tr>
<tr>
<td>75</td>
<td>63,000 h</td>
<td>16,000 h</td>
</tr>
</tbody>
</table>

- Lx: Life expectancy (h) in actual use (temperature Tx)
- Lo: Guaranteed (h) at maximum temperature in use
- To: Maximum operating temperature
- Tx: Temperature in actual use (Ambient temperature of OS-CON)

**Arrhenius’ s law**

- **10 deg.C reduction**
  - 10 times longer
- **20 deg.C reduction**
  - Estimated lifetime calculation

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Features and application of OS-CON

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Endurance (105 deg.C, 20V, 5000Hr)

Model: 20SVP33M (E7 size)
Q’ty: n = 20pcs.
Condition: 105 deg.C x 20V x 5000h

Not dry up !!!
Features and application of OS-CON

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How to use OS-CON
Main application of OS-CON
Main usage example of OS-CON

- As smoothing usage for power supply
- As back-up usage
- As by-pass usage
- For low-pass filter circuits
THANK YOU FOR
YOUR ATTENTION.