<table>
<thead>
<tr>
<th>Date</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>May 7, 2018</td>
<td>New Snap In Aluminum Electrolytic Capacitors</td>
</tr>
<tr>
<td>May 28, 2018</td>
<td>Properly Measuring Capacitor Properties</td>
</tr>
<tr>
<td>June 4, 2018</td>
<td>New Aluminum Box Capacitors</td>
</tr>
<tr>
<td>June 11, 2018</td>
<td>KO-CAP: 0805 and 1206 Higher Rated Voltages</td>
</tr>
<tr>
<td>June 18, 2018</td>
<td>Axial Leaded Aluminum Electrolytic Capacitors</td>
</tr>
<tr>
<td>June 18, 2018</td>
<td>Technology Differences in Common Mode Chokes</td>
</tr>
</tbody>
</table>

Check out: [go.kemet.com/emeawebex](go.kemet.com/emeawebex)
• KEMET Polymer General Information
• Polymer Overview
• Features & Benefits
• Application Examples
• Parameters to consider
Why Polymer?

Polymer is the successor of Tantalum MnO₂ Capacitors

- PEDT as cathode counter electrode material
- Low oxygen index - no ignition failure mode
- Single digit ESR in mili-Ω range - less self heating!
- Cost saving potential
KEMET Polymer Capacitors
Capacitance Solution for 3 different Voltage Levels

**Actual Solution**

<table>
<thead>
<tr>
<th>Voltage Level</th>
<th>Capacitor Configuration</th>
<th>Parallel of:</th>
<th>CAP (µF) @ 300kHz</th>
<th>Effective Cap. (µF)</th>
<th>Ripple requirement (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.2V</td>
<td>1 rails at 3A – 3x 100µF/6.3V ceramic X5R, 1206</td>
<td>3</td>
<td>51</td>
<td>150</td>
<td>0.9</td>
</tr>
<tr>
<td>0.9V</td>
<td>0 rails at 6A – 4x 100µF/6.3V ceramic X5R, 1206</td>
<td>4</td>
<td>54</td>
<td>200</td>
<td>1.8</td>
</tr>
<tr>
<td>3.3V</td>
<td>3 rails at 2A - 3x 100µF/6.3V ceramic X5R, 1206</td>
<td>3</td>
<td>30</td>
<td>90</td>
<td>0.6</td>
</tr>
</tbody>
</table>

**DC Bias Impact on Capacitance**

- **1.2V**
- **0.9V**
- **3.3V**
KEMET Polymer capacitors
Capacitance Solution for 3 different Voltage Levels

Possible Savings of 26-36%

1v2 rail at 3A – 3x 100uF/6.3V ceramic X5R, 1206

<table>
<thead>
<tr>
<th>Case Size</th>
<th>CAP (µF)</th>
<th>V</th>
<th>PN</th>
<th>Ripple Capability @ 100kHz (A)</th>
<th>CAP. At 300kHz (µF)</th>
<th>CAP. At 500kHz (µF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B (3528-21)</td>
<td>330</td>
<td>2.5</td>
<td>T520B337M2R5ATE018</td>
<td>2.7</td>
<td>152</td>
<td>110</td>
</tr>
</tbody>
</table>

0v9 rail at 6A – 4x 100uF/6.3V ceramic X5R, 1206

<table>
<thead>
<tr>
<th>Case Size</th>
<th>CAP (µF)</th>
<th>V</th>
<th>PN</th>
<th>Ripple Capability @ 100kHz (A)</th>
<th>CAP. At 300kHz (µF)</th>
<th>CAP. At 500kHz (µF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>V(7343-19)</td>
<td>470</td>
<td>2.5</td>
<td>T520V477M2R5ATE012</td>
<td>3.9</td>
<td>340</td>
<td>235</td>
</tr>
</tbody>
</table>

3v3 rail at 2A - 3x 100uF/6.3V ceramic X5R, 1206

<table>
<thead>
<tr>
<th>Case Size</th>
<th>CAP (µF)</th>
<th>V</th>
<th>PN</th>
<th>Ripple Capability @ 100kHz (A)</th>
<th>CAP. At 300kHz (µF)</th>
<th>CAP. At 500kHz (µF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B (3528-21)</td>
<td>150</td>
<td>4</td>
<td>T520B157M004ATE018</td>
<td>2.7</td>
<td>136</td>
<td>104</td>
</tr>
</tbody>
</table>
## Pricing

### 1.2V Rail

<table>
<thead>
<tr>
<th>No of Caps</th>
<th>Cap (µF) 300kHz</th>
<th>Effective Cap (µF)</th>
<th>Ripple Capability (Arms)</th>
<th>ASP/1 in EUR (Octopart)</th>
<th>ASP/Cap Solution in EUR (Octopart)</th>
<th>Saving</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1206C107M9PACTU</td>
<td>3</td>
<td>51</td>
<td>150</td>
<td>0.9</td>
<td>0.2500</td>
<td>0.7500</td>
</tr>
<tr>
<td>T520B337M2R5ATE018</td>
<td>1</td>
<td>152</td>
<td>152</td>
<td>2.7</td>
<td>0.4789</td>
<td>0.4789</td>
</tr>
</tbody>
</table>

### 0.9V Rail

<table>
<thead>
<tr>
<th>No of Caps</th>
<th>Cap (µF) 300kHz</th>
<th>Effective Cap (µF)</th>
<th>Ripple Capability (Arms)</th>
<th>ASP/1 in EUR (Octopart)</th>
<th>ASP/Cap Solution in EUR (Octopart)</th>
<th>Saving</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1206C107M9PACTU</td>
<td>4</td>
<td>54</td>
<td>200</td>
<td>1.8</td>
<td>0.2500</td>
<td>1.0000</td>
</tr>
<tr>
<td>T520V477M2R5ATE012</td>
<td>1</td>
<td>340</td>
<td>340</td>
<td>3.9</td>
<td>0.6369</td>
<td>0.6369</td>
</tr>
</tbody>
</table>

### 3.3V Rail

<table>
<thead>
<tr>
<th>No of Caps</th>
<th>Cap (µF) 300kHz</th>
<th>Effective Cap (µF)</th>
<th>Ripple Capability (Arms)</th>
<th>ASP/1 in EUR (Octopart)</th>
<th>ASP/Cap Solution in EUR (Octopart)</th>
<th>Saving</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1206C107M9PACTU</td>
<td>3</td>
<td>30</td>
<td>90</td>
<td>0.6</td>
<td>0.2500</td>
<td>0.7500</td>
</tr>
<tr>
<td>T520B157M004ATE018</td>
<td>1</td>
<td>136</td>
<td>136</td>
<td>2.7</td>
<td>0.4979</td>
<td>0.4979</td>
</tr>
</tbody>
</table>
How to Determine a Capacitor’s Performance

K-SIM: KEMET’s primary component simulation tool

Navigate to ksimpl.kemet.com in any browser (even mobile!)

Determine:
- Impedance and ESR
- Capacitance and Inductance
- Cap vs V(DC)
- Current and Voltage
- Temperature Rise
- Scattering Parameters
- SPICE Model
- Effect of Combined Impedances
- Export of SPICE Models
KO-CAP can be used in both input or output

Source: http://www.ti.com/product/TPS51125
KO-CAP Applications
Voltage Regulator Output

Input Capacitor: 10uFx2
- MLCC: X7R or X5R
- KO-CAP: T521 series

Output Capacitor: 330uF
- KO-CAP: T520
- MLCC: X5R Series

Switching Frequency Selection

The switching frequency can be set by the TONSEL pin using JP1 on the EVM. The default setting is 245 kHz for CH1 and 305 kHz for CH2.

Table 2. Switching Frequency Selection

<table>
<thead>
<tr>
<th>TONSEL CONNECTION</th>
<th>SWITCHING FREQUENCY (kHz)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CH1</td>
</tr>
<tr>
<td>GND (SLOW)</td>
<td>200</td>
</tr>
<tr>
<td>VREF (MED1)</td>
<td>245</td>
</tr>
<tr>
<td>VREG3 (MED2)</td>
<td>300</td>
</tr>
<tr>
<td>VREG5 (FAST)</td>
<td>365</td>
</tr>
</tbody>
</table>

Source:
http://www.ti.com/product/TPS51125
Capacitance@363KHz
KOCAP: 330uF/6.3V/E025 x 1 pcs = 126.4uF
MLCC: 100uF/6.3V/X5R x 4 pcs = 36.3x4 = 145.3uF

CH1: 5V/ Switch Frequency: 360KHz
Polymer Capacitors
Cap vs Frequency (RT) – MLCC Reference

At Typical conditions:
- Regulator 300kHz
- 80°C temperature
- 14V battery line
1 single KO AUTO can replace 2 or 5 MLCC's
### 14V Rail - AUTOMOTIVE

<table>
<thead>
<tr>
<th>Part Number</th>
<th>No of Caps</th>
<th>Cap (µF) 300kHz</th>
<th>Effective Cap (µF)</th>
<th>ASP/1 in EUR (Octopart)</th>
<th>ASP/Cap Solution in EUR (Octopart)</th>
<th>Saving</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1210C106K3RACAUTO</td>
<td>2</td>
<td>6.89</td>
<td>13.7</td>
<td>0.5918</td>
<td>1.1836</td>
<td></td>
</tr>
<tr>
<td>T598D106M035ATE120</td>
<td>1</td>
<td>11.6</td>
<td>11.6</td>
<td>0.8374</td>
<td>0.8374</td>
<td>0.3462 EUR / 29%</td>
</tr>
</tbody>
</table>

### 14V Rail - AUTOMOTIVE

<table>
<thead>
<tr>
<th>Part Number</th>
<th>No of Caps</th>
<th>Cap (µF) 300kHz</th>
<th>Effective Cap (µF)</th>
<th>ASP/1 in EUR (Octopart)</th>
<th>ASP/Cap Solution in EUR (Octopart)</th>
<th>Saving</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1210C106K3RACAUTO</td>
<td>5</td>
<td>6.89</td>
<td>34.5</td>
<td>0.5918</td>
<td>2.9590</td>
<td></td>
</tr>
<tr>
<td>T598D336M035ATE065</td>
<td>1</td>
<td>152</td>
<td>38.6</td>
<td>0.8618</td>
<td>0.8618</td>
<td>2.0972 EUR / 71%</td>
</tr>
</tbody>
</table>
Ultra Small Solutions (UD)
Where Space is a concern...

One 0805 Polymer = three 1206 MLCC
One 1206 Polymer = six 1206 MLCC
Polymer Advantages

- High Capacitance
- Low Profile
- Reduced Piece Count
- Miniturization
- Low Profile
- High Capacitance Retention = Reduced Piece Count
- Low ESR
- Improved Voltage Derating
  - $\text{MnO}_2 = 50\%$ Derating
  - Poly = 10-20\% Derating
- Higher Application Voltage Range
  - Application: 31.5V, 45V, 56.7V, 67.5V
- Safe Failure Mode
- Temperature & Humidity Stability
  - 85°C/85%RH/Ur up to 1000h
- Replacement MLCC Piezo Noise
MLCC to Polymer conversion: Parameters to consider (1)

- **Total NET CAPACITANCE**
  - Capacitance of 1 MLCC Capacitor under application conditions (applied voltage, frequency, aging), see also KEMET K-SIM Tool (http://ksim.kemet.com)
  - Number of capacitors in parallel to achieve TOTAL Net capacity - Target MLCC dielectrics X5R/X7R (Class II)

- **It makes sense to consider Polymers for:**
  - **A NET CAPACITANCE**
    - $\geq 10 \mu F$ (for application voltages up to 14.4V)
    - 0.68-10 $\mu F$ (at application voltages of 45V and higher)
  - **Application Voltages**
    - up to 67.5V (60V for Harsh Conditions)
  - **Frequencies**
    - up to 1MHz (higher switching frequencies contact KEMET)
MLCC to Polymer conversion: Parameters to consider (2)

• Application Voltage
  – MLCC capacitors are specified at 0/1V – actual capacitance decreases with applied voltage
  – Polymer Capacitors are stable over applied voltage, but a 10/20% derating needs to be considered

• Ripple Current Requirements
  – Polymer capacitors can easily handle Ripple Currents up to 2 to 3 Arms (higher ripple requirements with Single Digit ESR products or stacked construction)

• Geometry Requirements
  – Max. PCB Board Space available
  – Max. Component Height allowance
Any Questions?
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D-86899 Landsberg am Lech, Germany