## Ceramic Capacitor Replacements

- Surface mount capability
- Ideal for high frequency switching power supplies and DC to DC converters
- Low ESR/ESL
- High ripple current/High capacitance
- Operating temperature range: 
  -55°C to 125°C
- Volumetrically efficient
- Made in U.S.A.

### Voltage Ratings Note:
Like all film capacitors, Capstick capacitors have “true” voltage ratings and unlike other dielectric systems require no voltage derating for maximizing reliability (MTBF) or use life. With FIT rates of well under 5 FIT when used at rated voltage, these units provide only a positive contribution to circuit MTBF calculations.

Circuit designers requiring 500 volt ratings in other dielectric systems for their 370 volt input applications are being penalized by that system’s inherent deficiencies. In the film capacitor industry if a device is rated at a certain voltage, then the device is designed to be fully functional and reliable at that voltage for the life of the equipment. Many leading edge circuit designs take advantage of a film capacitor’s inherent reliability at rated voltage to both reduce board size and improve performance.

### Capacitor Types

- **CS4**
- **CS6**

### Electrical Schematic

- Non-polarized

### Capacitor Types

<table>
<thead>
<tr>
<th>PF Code</th>
<th>Value µF</th>
<th>W MAX</th>
<th>T MAX</th>
<th>L MAX</th>
<th>ESR @500 KHz (Ω)</th>
<th>RMS Current @500 KHz (A)</th>
<th># Leads per side</th>
<th>Lead Configuration</th>
<th>Case</th>
<th>Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>106</td>
<td>10.0</td>
<td>0.500 (12.7)</td>
<td>0.320 (8.1)</td>
<td>0.620 (15.7)</td>
<td>0.003</td>
<td>15.3</td>
<td>5</td>
<td>Thru-hole</td>
<td>CS4</td>
<td>106K050CS4 _ _</td>
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<td>106</td>
<td>10.0</td>
<td>0.500 (12.7)</td>
<td>0.320 (8.1)</td>
<td>0.620 (15.7)</td>
<td>0.003</td>
<td>15.3</td>
<td>5</td>
<td>SMD</td>
<td>CS4G</td>
<td>106K050CS4G _ _</td>
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<tr>
<td>206</td>
<td>20.0</td>
<td>0.500 (12.7)</td>
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<td>1.150 (29.2)</td>
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<td>17.8</td>
<td>9</td>
<td>Thru-hole</td>
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<td>206K050CS4 _ _</td>
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<td>206</td>
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### 50 VDC / 35 VAC

### 100 VDC / 80 VAC

### 250 VDC / 160 VAC

- **Surface mount capability**
- **Ideal for high frequency switching power supplies and DC to DC converters**
- **Low ESR/ESL**
- **High ripple current/High capacitance**
- **Operating temperature range:** 
  -55°C to 125°C
- **Volumetrically efficient**
- **Made in U.S.A.**
Type CS4/CS6 Capstick® Capacitor
Metallized Polyester (PET) Dielectric

<table>
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<tr>
<th>PF Code</th>
<th>Value µF</th>
<th>W MAX</th>
<th>T MAX</th>
<th>L MAX</th>
<th>ESR @500 KHz (Ω)</th>
<th>RMS Current @500 KHz (A)</th>
<th># Leads per side</th>
<th>Lead Configuration</th>
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<tbody>
<tr>
<td>334</td>
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<td>0.700 (17.8)</td>
<td>0.320 (8.1)</td>
<td>0.435 (11.0)</td>
<td>0.012</td>
<td>6.0</td>
<td>3</td>
<td>Thru-hole</td>
<td>CS6</td>
<td>334K400CS6 _ _</td>
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<tr>
<td>334</td>
<td>0.33</td>
<td>0.700 (17.8)</td>
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<td>3</td>
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<td>CS6G</td>
<td>334K400CS6G _ _</td>
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<tr>
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<td>0.700 (17.8)</td>
<td>0.320 (8.1)</td>
<td>0.460 (11.7)</td>
<td>0.011</td>
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<td>3</td>
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<td>CS6</td>
<td>474K400CS6 _ _</td>
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<td>474K400CS6G _ _</td>
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<tr>
<td>105</td>
<td>1.0</td>
<td>0.700 (17.8)</td>
<td>0.320 (8.1)</td>
<td>0.880 (22.4)</td>
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<td>CS6</td>
<td>105K400CS6 _ _</td>
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<td>105</td>
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<th>Value µF</th>
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<td>0.625 (15.9)</td>
<td>0.011</td>
<td>6.2</td>
<td>4</td>
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<td>0.320 (8.1)</td>
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<td>CS6</td>
<td>105K500CS6 _ _</td>
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<td>105K500CS6G _ _</td>
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</tbody>
</table>

Dimensions in inches, metric (mm) in parenthesis.
Tolerance: K (±10%) standard

RoHS part number information:

No suffix indicates RoHS-5 compliant standard part number. RoHS-5 product does not contain five of the RoHS banned materials (Hg, CrVI, Cd, PBB and PBDE) in levels exceeding the industry defined limits. Component lead frame pin-outs are plated with Sn / Pb and match conventional SnPb board assembly requirements. For a RoHS-6 compliant part, add a –FA suffix. RoHS-6 product does not contain any of the six RoHS banned materials (Hg, CrVI, Cd, PBB, PBDE and Pb) in levels exceeding the industry defined limits. Component lead wires are plated with Sn.

Electrical
- Capacitance Range: 0.33 µF to 20.0 µF @ 1KHz
- Tolerance: Available in K (±10%) standard
- Voltage Range: 50, 100, 250, 400, 500 VDC
- Dissipation Factor: ≤ 1.0 % @ 25°C, 1KHz
- Insulation Resistance: ≥ 1,000 Megohms x µF
- Need not exceed 1,000 Megohms.

<table>
<thead>
<tr>
<th>Rated Voltage</th>
<th>≤ 100 VDC</th>
<th>&gt;100 VDC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test Voltage</td>
<td>10 VDC</td>
<td>100 VDC</td>
</tr>
</tbody>
</table>

- Temperature Coefficient: +6% from –55°C to 85°C
- Dielectric Strength: 1.3 x rated voltage for 50/100/250/500 volt ratings.
- 1.6 x rated voltage for 400 volt rating
- Self Inductance: < 6nH (Typical) CS6
- < 4nH (Typical) CS4
- Temperature Range: -55°C to 125°C, derate voltage 1.25% / °C above 85°C for 50/100/250 volt ratings.
- -55°C to 125°C, with no voltage derating for 400/500 volt ratings.

Performance
- Accelerated DC Voltage Life Test: 1,000 Hours, 85°C, 1.25 x Rated VDC
  ∆ C/C ≤ 5%
  DF ≤ 1.0%, 1KHz, 25°C
  IR ≥ 1,000 Megohms x µF
- Need not exceed 1,000 Megohms
- Moisture/Humidity Test: 85°C / 85% RH / 21 days
  Applied Voltage: zero bias
  ∆ C/C ≤ 7%
  DF ≤ 1.0%, 1KHz, 25°C
  IR ≥ 30% of initial limit
- Long Term Stability: After 2 years storage, standard environment ∆ C/C ≤ 2%

Physical
- Vibration: Mil Std 202 Method 204D
- Solder Resistance: Thru-hole wave: 260°C, 5 Sec. ∆ C/C ≤ 2%
  SMD reflow: 220°C, 30 Sec. ∆ C/C ≤ 2%
- Construction: Non-inductively constructed with metallized polyester dielectric (polyethylene terephthalate). Parallel plate–multilayer polymer (MLP) design.
- Electrode: Aluminum metallization.
- Case: UL94V-0 rated epoxy coating
- Lead Frame Material: Tinned Cu Alloy Lead Frame
- Lead Spacing: .400” (10.0mm) nominal CS4
  .600” (15.0mm) nominal CS6
- Marking: #TA type, capacitance code, tolerance code; voltage and date code
- Packaging: Anti-static tube. SMD units dry packed with desiccant in moisture barrier bag. JEDEC level on package.
Low ESR, Multilayer Polymer (MLP) Capacitors

Miniaturized pass filters made possible by high frequency switching technology need small but low ESR and ESL capacitors to attenuate ripple and reflected RFI over wide frequency bands. With equivalent series resistance approaching zero, non-polar MLP Capacitors reliably sink high ripple currents in high density converters, run cool and are stable.

The trend toward distributed power management and modular power converters has driven the development of high efficiency, low profile power train components. The conventional capacitors historically used in ripple filtering applications are either too large or not suitable for popular methods of surface mounting. Electrolytic capacitors, while size efficient, do not provide the desired, stable electrical characteristics and reliability. Large value multilayer ceramic capacitors are notoriously fragile, expensive and unstable over voltage and temperature extremes. A novel but proven capacitor technology, built upon selected manufacturing techniques of multilayer ceramic and stacked, plastic film capacitors is now the preferred choice. Now film capacitor reliability can be found in chip and block shaped MLP capacitors that approach the board space sizes of X7R, MLC (Ceramic) types. These unique multilayer polymer capacitors (MLPs) offer excellent electrical stability under AC and DC current loads and are not subject to the cracking, shorting or TC mismatch inherent in Ceramic (MLC) capacitor products. They are suitable as input and output filter capacitors in megahertz frequency switching converters, high power ballasts and inverter drives at ambient temperatures from -55° C to 125° C.

ULTRA LOW IMPEDANCE CONSTRUCTION

Figure 1 illustrates the multiple stacking technique used to make the MLP structures and the cross section which highlights similarities to stacked film and MLC construction. An all aluminum electrode and termination construction results in a low resistance and high current connection. The terminations are gathered to multiple pin lead frames for lowest ESR and ESL current handling. Low loss and frequency stable, ultra thin polyethylene-terephthalate polymer film is used as the dielectric.

DRIVEN BY HIGH FREQUENCY POWER CONVERSION APPLICATIONS

The trend in power conversion is the increase in switching frequency to minimize the size of the magnetic and filter components and boost the wattage per unit volume. Driven by portable computers and the distributed power approaches of both telecom and computer systems, switching frequencies have risen from 20 kilohertz to between 400 KHz and 1 megahertz in high density power converters. The filter capacitors have become an important issue as low impedance and equivalent series resistance are needed for reliable high frequency current handling. The MLP Capstick Capacitor can increase the series current of the converter which translates into higher wattage density at maximum efficiency.

NOTES ON USABILITY AND RELIABILITY

Because of the use of the well known PET dielectric in ultra thin sheet, the reliability of these capacitors is far better than the industry experience with electrolytic or ceramic capacitors. There exists no capacitance drop or aging with time. The dissipation factor is stable over time. The insulation resistance tends to get better under the influence of heat and voltage. We have shown that in-circuit problems are evident immediately and usually the result of mishandling or overheating during mounting assembly. There exist no metal leaching or dielectric diffusion mechanisms to affect the reliability over time. A complete reliability data package on this and other quality MLP capacitor styles may be obtained by contacting Paktron.

MOUNTING OPTIONS

The Capstick can be conditioned for surface mounting (including IR Reflow). Leads can be trimmed to a dimension for butt or through-hole mounting, or configured as gull wing leads. See Appendix for Capstick soldering guidelines.
CS/CB Performance Characteristics over a range of -55°C to +85°C

### Maximum RMS Current (Amps)

<table>
<thead>
<tr>
<th>Value µF</th>
<th>Rated VDC</th>
<th>1 KHz</th>
<th>10 KHz</th>
<th>100 KHz</th>
<th>500 KHz</th>
<th>1MHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.47</td>
<td>500</td>
<td>0.8</td>
<td>1.9</td>
<td>3.9</td>
<td>6.2</td>
<td>7.1</td>
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<tr>
<td>1.0</td>
<td>500</td>
<td>1.1</td>
<td>2.4</td>
<td>5.9</td>
<td>9.5</td>
<td>10.6</td>
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<tr>
<td>0.33</td>
<td>400</td>
<td>0.7</td>
<td>1.3</td>
<td>3.5</td>
<td>6.0</td>
<td>6.9</td>
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<th>Value µF</th>
<th>Rated VDC</th>
<th>1 KHz</th>
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<th>1MHz</th>
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<tbody>
<tr>
<td>0.47</td>
<td>500</td>
<td>250</td>
<td>64</td>
<td>13.1</td>
<td>4.2</td>
<td>2.4</td>
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<tr>
<td>1.0</td>
<td>500</td>
<td>176</td>
<td>38</td>
<td>9.4</td>
<td>3.0</td>
<td>1.6</td>
</tr>
<tr>
<td>0.33</td>
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<td>250</td>
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### Typical Applications

- **Output Filter**
- **High Voltage Input Filter**
- **AC & Quasi AC Input Filter**
- **Low Pass Filter**

### Typical Impedance vs. Frequency

- **CS4 50 VDC**
- **CS4/CB4 100 VDC**
- **CS6 400/500 VDC**

### Typical ESR vs. Frequency

- **CS4 50 VDC**
- **CS4/CB4 100 VDC**
- **CS6 400/500 VDC**

Type CS4/CS6/CB4/CB6 Capstick® Capacitor
Metallized Polyester (PET) Dielectric

www.paktron.com