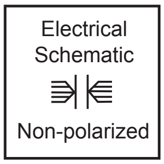
Capacitor Types

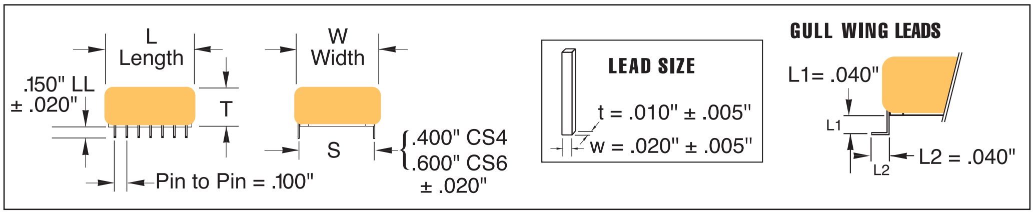
CS4 CS6

- **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 deratings 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.





50 VDC / 35 VAC

PF Code	Value µF	W MAX	T MAX	L MAX	ESR Ω @500 KHz	RMS Current @500 KHz	# Leads per side	Lead Configuration	Case	Part Number
106	10.0	.500 (12.7)	.320 (8.1)	.620 (15.7)	.003	15.3	5	Thru-hole	CS4	106K050CS4 _ _
106	10.0	.500 (12.7)	.320 (8.1)	.620 (15.7)	.003	15.3	5	SMD	CS4G	106K050CS4G _ _
206	20.0	.500 (12.7)	.320 (8.1)	1.150 (29.2)	.0025	17.8	9	Thru-hole	CS4	206K050CS4 _ _
206	20.0	.500 (12.7)	.320 (8.1)	1.150 (29.2)	.0025	17.8	9	SMD	CS4G	206K050CS4G _ _

100 VDC / 80 VAC

PF Code	Value µF	W MAX	T MAX	L MAX	ESR Ω @500 KHz	RMS Current @500 KHz	# Leads per side	Lead Configuration	Case	Part Number
205	2.0	.500 (12.7)	.250 (6.3)	.450 (11.4)	.009	8.3	3	Thru-hole	CS4	205K100CS4 _ _
205	2.0	.500 (12.7)	.250 (6.3)	.450 (11.4)	.009	8.3	3	SMD	CS4G	205K100CS4G _ _
405	4.0	.500 (12.7)	.250 (6.3)	.450 (11.4)	.007	11.5	3	Thru-hole	CS4	405K100CS4 _ _
405	4.0	.500 (12.7)	.250 (6.3)	.450 (11.4)	.007	11.5	3	SMD	CS4G	405K100CS4G _ _
475	4.7	.500 (12.7)	.250 (6.3)	.525 (13.3)	.006	12.2	3	Thru-hole	CS4	475K100CS4 _ _
475	4.7	.500 (12.7)	.250 (6.3)	.525 (13.3)	.006	12.2	3	SMD	CS4G	475K100CS4G _ _
685	6.8	.500 (12.7)	.250 (6.3)	.700 (17.8)	.005	13.7	5	Thru-hole	CS4	685K100CS4 _ _
685	6.8	.500 (12.7)	.250 (6.3)	.700 (17.8)	.005	13.7	5	SMD	CS4G	685K100CS4G _ _
106	10.0	.500 (12.7)	.250 (6.3)	.995 (25.3)	.003	15.3	7	Thru-hole	CS4	106K100CS4 _ _
106	10.0	.500 (12.7)	.250 (6.3)	.995 (25.3)	.003	15.3	7	SMD	CS4G	106K100CS4G _ _

250 VDC / 160 VAC

PF Code	Value µF	W MAX	T MAX	L MAX	ESR Ω @500 KHz	RMS Current @500 KHz	# Leads per side	Lead Configuration	Case	Part Number
105	1.0	.700 (17.8)	.300 (7.5)	.440 (11.2)	.012	5.2	3	Thru-hole	CS6	105K250CS6 _ _
105	1.0	.700 (17.8)	.300 (7.5)	.440 (11.2)	.012	5.2	3	SMD	CS6G	105K250CS6G _ _

400 VDC / 250 VAC

PF Code	Value µF	W MAX	T MAX	L MAX	ESR Ω @500 KHz	RMS Current @500 KHz	# Leads per side	Lead	Case	Part Number
334	.33	.700 (17.8)	.320 (8.1)	.435 (11.0)	.012	6.0	3	Thru-hole	CS6	334K400CS6 _ _
334	.33	.700 (17.8)	.320 (8.1)	.435 (11.0)	.012	6.0	3	SMD	CS6G	334K400CS6G _ _
474	.47	.700 (17.8)	.320 (8.1)	.460 (11.7)	.011	6.2	3	Thru-hole	CS6	474K400CS6 _ _
474	.47	.700 (17.8)	.320 (8.1)	.460 (11.7)	.011	6.2	3	SMD	CS6G	474K400CS6G _ _
105	1.0	.700 (17.8)	.320 (8.1)	.880 (22.4)	.008	9.5	7	Thru-hole	CS6	105K400CS6 _ _
105	1.0	.700 (17.8)	.320 (8.1)	.880 (22.4)	.008	9.5	7	SMD	CS6G	105K400CS6G _ _

500 VDC / 250 VAC

PF Code	Value µF	W MAX	T MAX	L MAX	ESR Ω @500 KHz	RMS Current @500 KHz	# Leads per side	Lead Configuration	Case	Part Number
474	.47	.700 (17.8)	.320 (8.1)	.625 (15.9)	.011	6.2	4	Thru-hole	CS6	474K500CS6 _ _
474	.47	.700 (17.8)	.320 (8.1)	.625 (15.9)	.011	6.2	4	SMD	CS6G	474K500CS6G _ _
105	1.0	.700 (17.8)	.320 (8.1)	1.135 (28.8)	.008	9.5	8	Thru-hole	CS6	105K500CS6 _ _
105	1.0	.700 (17.8)	.320 (8.1)	1.135 (28.8)	.008	9.5	8	SMD	CS6G	105K500CS6G _ _

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 frame pin-outs 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.

Rated Voltage	≤ 100 VDC	> 100 VDC
Test Voltage	10 VDC	100 VDC

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 × Rated VDC
Δ C/C ≤ 5%
DF ≤ 1.0%, 1KHz, 25°C
IR ≥ 1,000 Megohm × µF.
Need not exceed 1,000 Megohms

Moisture/Humidity Test:
85°C / 85% RH / 21 days
Applied Voltage: zero bias
Δ C/C ≤ 7%
DF ≤ 1.0%, 1KHz, 25°C
IR ≥ 30% of initial limit

Long Term Stability:
After 2 years storage, standard environment Δ C/C ≤ 2%

Physical

Vibration:
Mil Std 202 Method 204D

Solder Resistance:
Thru-hole wave: 260°C, 5 Sec. Δ C/C ≤ 2%
SMD reflow: 220°C, 30 Sec. Δ 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:
ITW, type, capacitance code, tolerance code, voltage and date code

Packaging:
Anti-static tube. SMD units dry packed with desiccant in moisture barrier bag. IPC/JEDEC J-STD-020 Moisture Sensitivity Level: MSL 4

LOW ESR, MULTILAYER POLYMER (MLP) CAPACITORS

Miniaturized pass filters made possible by high frequency switching technology need tiny 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 (MLP's) 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.

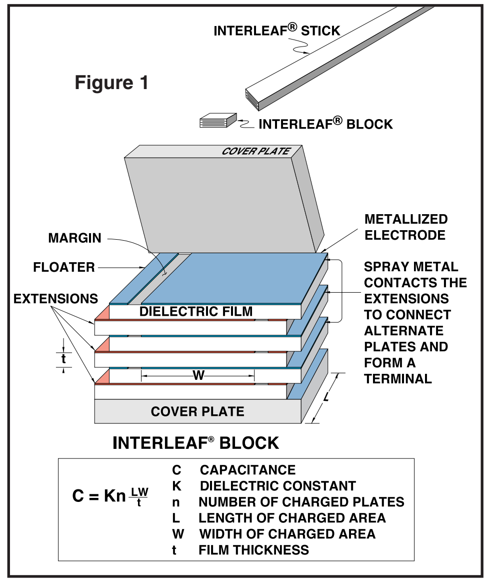
DRIVEN BY HIGH FREQUENCY POWER CONVERSION APPLICATIONS

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 ITW Paktron.

Figure 1

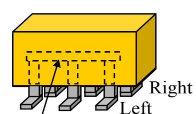


MOUNTING OPTIONS

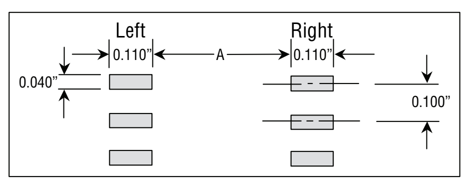
The Capstick can be conditioned for surface mounting (including IR Reflow). Leads can be trimmed to a dimension for butt or through-hole mounting, or configured as gull wing leads. See Appendix for Capstick soldering guidelines.

CS/CB Surface Mount Pad Layout

Typical Recommendations



Note: All left side capacitor leads are joined in common internal to the capacitor and all right side capacitor leads are also joined in common internal to the capacitor.



Part Number	Number of Leads per Side	A
474K500CS6G	4	0.565”
105K500CS6G	8	0.565”
334K400CS6G	3	0.565”
474K400CS6G	3	0.565”
105K400CS6G	7	0.565”
205K100CS4G, 205K100CB4G	3	0.365”
405K100CS4G, 405K100CB4G	3	0.365”
475K100CS4G, 475K100CB4G	3	0.365”
685K100CS4G	5	0.365”
106K100CS4G, 106K100CB4G	7	0.365”
106K050CS4G	5	0.365”
206K050CS4G	9	0.365”

CS/CB Performance Characteristics

over a range of -55°C to +85°C

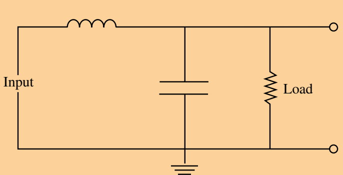
MAXIMUM RMS CURRENT (AMPS) VS. FREQUENCY

Value µF	Rated VDC	1 KHz	10 KHz	100 KHz	500 KHz	1MHz
.47	500	0.8	1.9	3.9	6.2	7.1
1.0	500	1.1	2.4	5.9	9.5	10.6
.33	400	0.7	1.3	3.5	6.0	6.9
.47	400	0.8	1.9	3.9	6.2	7.0
1.0	400	1.1	2.4	5.9	9.5	10.5
1.0	250	0.7	1.6	3.3	5.2	5.9
2.0	100	0.4	2.6	6.0	8.3	8.9
4.0	100	1.9	4.2	10.2	11.5	12.0
4.7	100	2.0	4.5	10.8	12.2	12.6
6.8	100	2.9	6.6	12.5	13.7	14.0
10.0	100	4.3	9.9	14.1	15.3	15.6
10.0	50	4.2	9.7	14.0	15.3	15.6
20.0	50	9.3	13.3	16.7	17.8	18.0

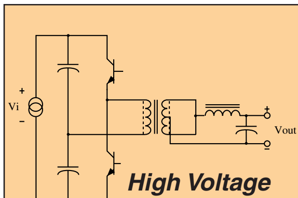
MAXIMUM RMS VOLTAGE VS. FREQUENCY

Value µF	Rated VDC	1 KHz	10 KHz	100 KHz	500 KHz	1MHz
.47	500	250	64	13.1	4.2	2.4
1.0	500	176	38	9.4	3.0	1.6
.33	400	250	64	17.2	6.9	4.0
.47	400	250	64	13.1	4.2	2.4
1.0	400	176	38	9.4	3.0	1.6
1.0	250	94	24	5.0	1.6	0.9
2.0	100	35	21	4.7	1.3	0.7
4.0	100	35	18	4.2	1.0	0.4
4.7	100	35	18	3.7	0.8	0.3
6.8	100	35	18	2.9	0.6	0.3
10.0	100	35	18	2.2	0.5	0.3
10.0	50	35	18	2.2	0.5	0.2
20.0	50	35	18	1.3	0.3	0.1

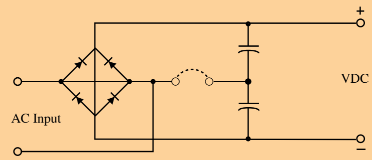
TYPICAL APPLICATIONS



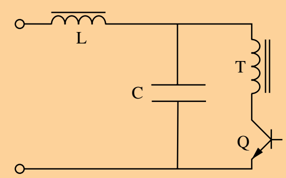
Output Filter



High Voltage Input Filter



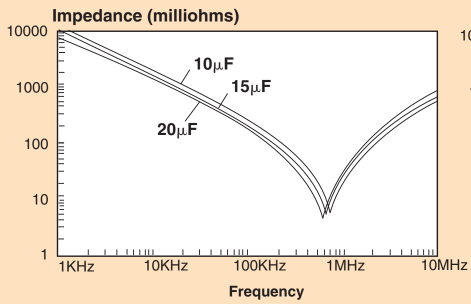
AC & Quasi AC Input Filter



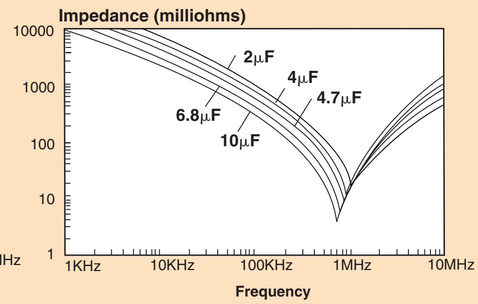
Low Pass Filter

TYPICAL IMPEDANCE VS. FREQUENCY

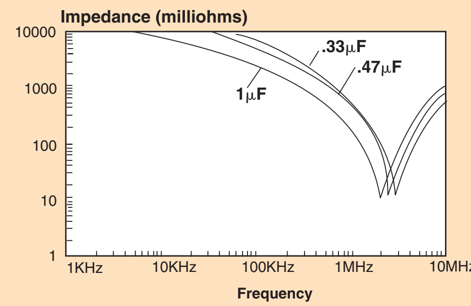
CS4 50 VDC



CS4/CB4 100 VDC

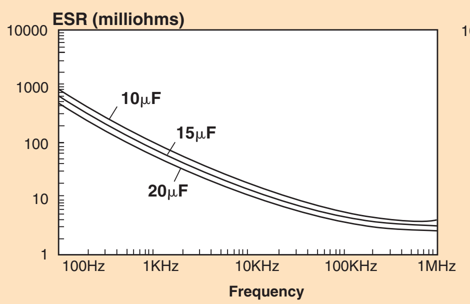


CS6 400/500 VDC

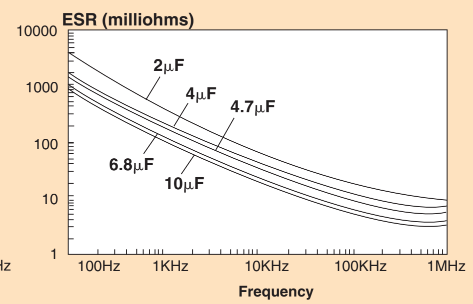


TYPICAL ESR VS. FREQUENCY

CS4 50 VDC



CS4/CB4 100 VDC



CS6 400/500 VDC