Capacitor Types

CS4
CS6

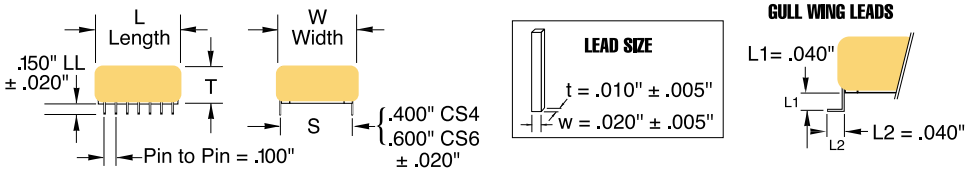
CAPSTICK®

- **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.



Capacitance µF	PF Code	DC Voltage	ESRΩ @ 500 KHz	RMS Current @ 500 KHz	Max Dimensions (inches) W x T x L	# Leads per side	Type
.47	474	500	.011	6.2	.700 x .320 x .625	4	CS6
1.0	105	500	.008	9.5	.700 x .320 x 1.135	8	CS6
.33	334	400	.012	6.0	.700 x .320 x .435	3	CS6
.47	474	400	.011	6.2	.700 x .320 x .460	3	CS6
1.0	105	400	.008	9.5	.700 x .320 x .880	7	CS6
2.0	205	100	.009	8.3	.500 x .250 x .450	3	CS4
4.0	405	100	.007	11.5	.500 x .250 x .450	3	CS4
4.7	475	100	.006	12.2	.500 x .250 x .525	3	CS4
10.0	106	100	.003	15.3	.500 x .250 x .995	7	CS4
10.0	106	50	.003	15.3	.500 x .320 x .620	5	CS4
20.0	206	50	.0025	17.8	.500 x .320 x 1.150	9	CS4

ELECTRICAL

CAPACITANCE RANGE
0.33 µF to 20.0 µF @ 1KHz

VOLTAGE RANGE
50, 100, 400, 500 VDC

TOLERANCE
± 10% (K)

DISSIPATION FACTOR
≤1.0% @ 1KHz

INSULATION RESISTANCE
≥1,000 Megohm x µF.
Need not exceed 1,000 Megohms
Test voltage @ one minute:

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

DIELECTRIC STRENGTH
1.3 x Rated Voltage:
50/100/500 V
1.6 x Rated Voltage: 400 V

TEMPERATURE COEFFICIENT
+6% from -55°C to 85°C

SELF INDUCTANCE
<6nH (Typical) CS6
<4nH (Typical) CS4

PHYSICAL

CONSTRUCTION
Non-inductively constructed with metallized polyester dielectric.
MLP, Multilayer Polymer.

LEAD MATERIAL
Tinned Cu Alloy Lead Frame

LEAD SPACING
.600" (15.0mm) nominal CS6,
.400" (10.0mm) nominal CS4

CASE
UL94V0 Rated Epoxy Coating

COMPONENT MARKING
ITW, Type, Capacitance Code, Tolerance Code, and Voltage

TEMPERATURE RANGE
-55°C to 85°C, with no voltage derating: 50/100 V*
-55°C to 125°C, with no voltage derating: 400/500 V
* For use at 125°C derate voltage by 50%.

PACKAGING
Anti-static Tube

HOW TO ORDER

EXAMPLE: 4.0 µF ±10% 100 VDC =

405	K	100	CS4	
PF CODE	**TOLERANCE**	**VOLTAGE**	**TYPE**	**LEAD STYLE**
334 405	K = ± 10%	050 = 50 VDC	CS4	Add "G" to
474 475		100 = 100 VDC	CS6	part number
105 106		400 = 400 VDC		if Gull-wing
205 206		500 = 500 VDC		leads required

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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

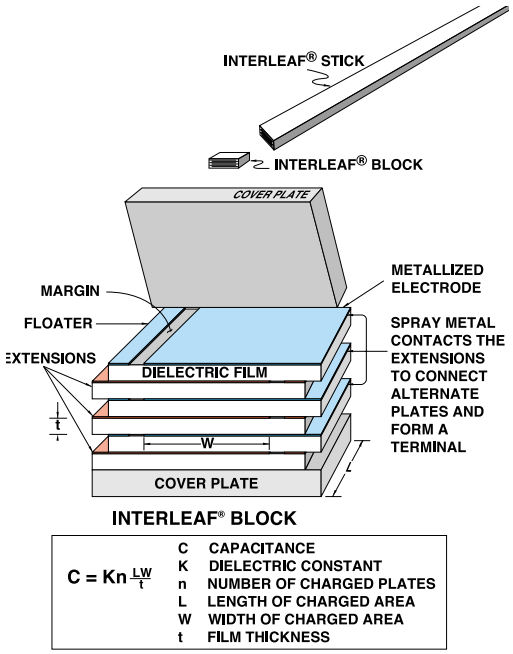


Figure 1

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.

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.

PERFORMANCE TESTING

ACCELERATED DRY LIFE:

Test Conditions

Temperature: 85°C ± 5.0°C

Applied Voltage: 1.25 x Rated Voltage

Test Duration: 1000 hours

Performance Requirements

Capacitance: Δ ≤ 5.0%

Dissipation Factor: ≤ 1.0% @ 1KHz

Insulation Resistance: ≥ 1K Megohms x μF, Need not exceed 1K Megohms

HUMIDITY:

Test Conditions

Temperature: 85°C ± 2.0°C

Applied Voltage: Zero Voltage

Humidity: 85% ± 2% RH

Test Duration: 21 days

Performance Requirements

Capacitance: Δ ≤ 7.0%

Dissipation Factor: ≤ 1.0% @ 1KHz

Insulation Resistance: ≥ 30% of initial limit

SOLDERABILITY:

Test Conditions

Solder Temperature: 250°C ± 5.0°C

Test Duration: 5 seconds ± 1 sec.

Performance Requirements

Capacitance: Δ ≤ 2.0%

Capacitance Drift

≤2.0% over two years at a temperature of between 0°C & 35°C and a RH of between 35% and 65%.

Vibration

Conforms to MIL-STD-202 Method 204D.

Special note: the 400V rating can handle 450V surge and is built to a 640V high potential

CS/CB Performance Characteristics @ 85° C

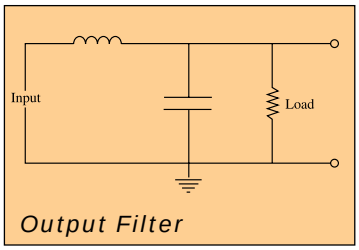
MAXIMUM RMS CURRENT (AMPS) VS. FREQUENCY

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
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
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

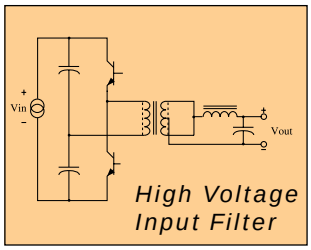
MAXIMUM RMS VOLTAGE VS. FREQUENCY

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
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
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

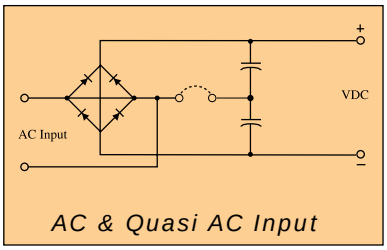
TYPICAL APPLICATIONS



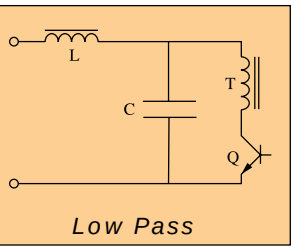
Output Filter



High Voltage Input Filter



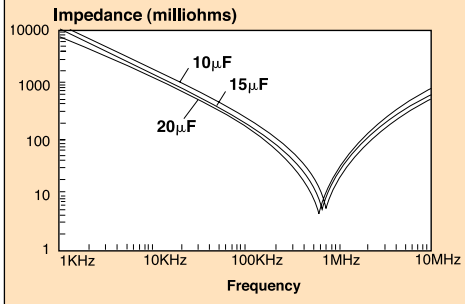
AC & Quasi AC Input



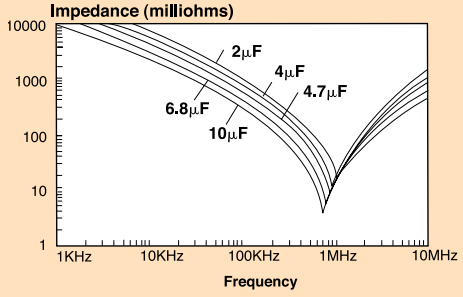
Low Pass

TYPICAL IMPEDANCE VS. FREQUENCY

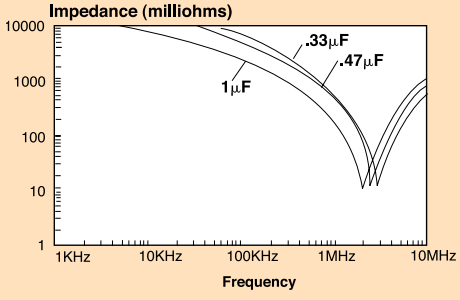
CS4 50 VDC



CS4/CB4 100 VDC

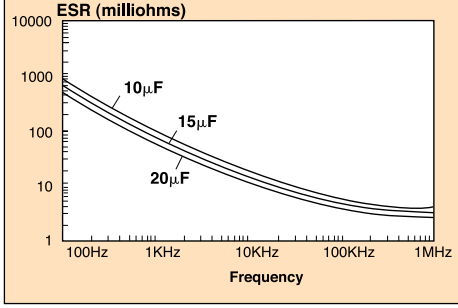


CS6 400/500 VDC

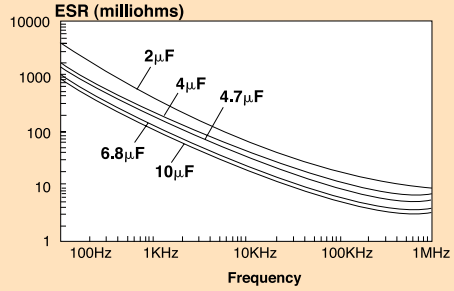


TYPICAL ESR VS. FREQUENCY

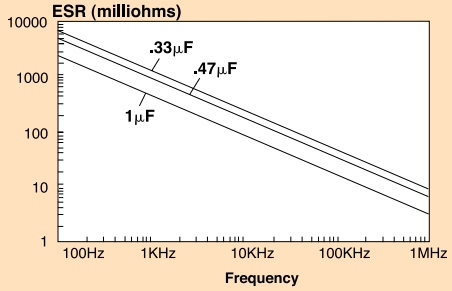
CS4 50 VDC



CS4/CB4 100 VDC



CS6 400/500 VDC



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