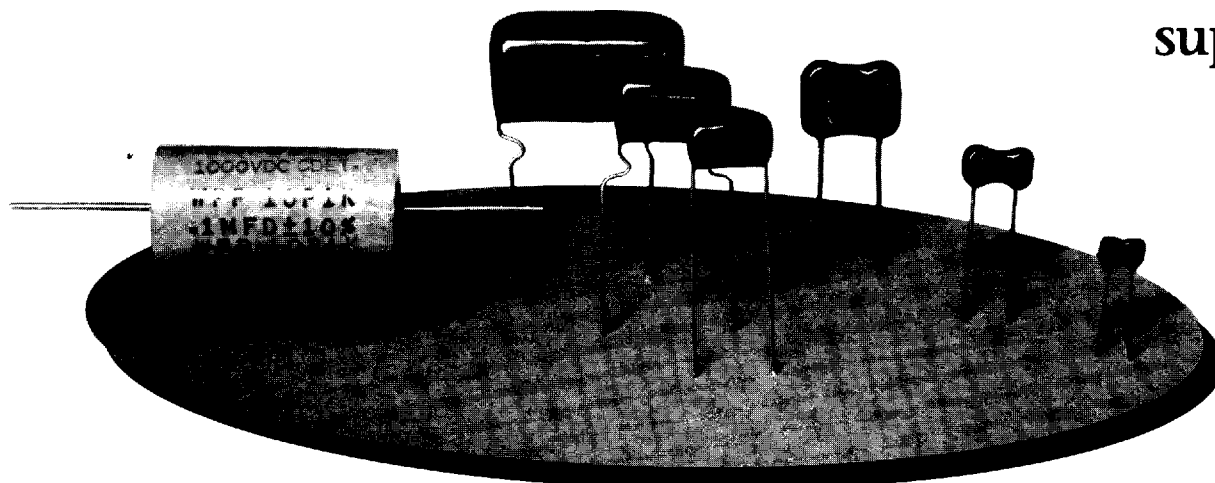


Snubber Capacitors

for high dV/dt snubbers and
resonant power
supplies



High peak current and ac current punish capacitors in snubber circuits and resonant power supplies. These capacitors take it with ease. CDE snubber capacitors are all rated for peak current and rms current in the tables.

How to Choose a Snubber Capacitor

An application note on how to design an RC snubber begins on page 14; so turn to page 14 if snubbers are new to you. However, if you know what capacitance you need, turn directly to the ratings pages guided by these tips: The capacitors here are for circuits which zap capacitors with big current transients or continuous, high-frequency current. For such applications and capacitance

values up to $0.01 \mu\text{F}$ look first at the Snubber Mike dipped mica capacitors. For higher capacitance values, move up to radial-leaded polypropylene, film/foil capacitors looking first at Type DPP for up to 630 Vdc and choosing between Types DPPF and DPPS for higher voltages. For the smallest case size at high voltage—but with significantly lower peak current capability—choose Type DPPM or DPMF.

Performance Highlights

- Capacitance range 100 pF to $3 \mu\text{F}$
- Voltage range 250 to 2,000 Vdc, 140 to 500 Vac
- Up to 100,000 $\text{V}/\mu\text{s}$ dV/dt
- Up to 3,700 amps peak current
- Available from stock

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NEW TYPE CD16

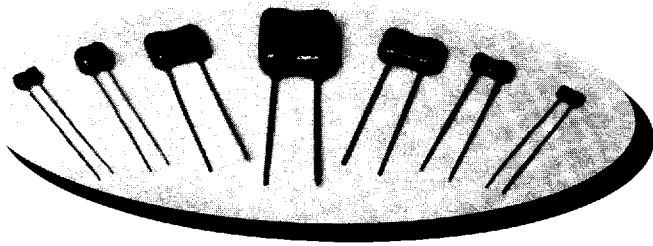
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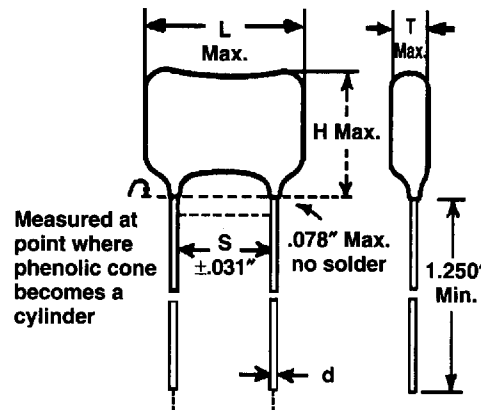
Radial-Leaded Snubber Mike Capacitors



With 75% lower impedance at resonance than ceramic disks and twice the dV/dt capability of our best polypropylene film/foil capacitors, CDE Snubber Mikes are the choice for snubbers and resonant power applications. They're quiet too: There's no piezoelectric buzzing like with high K ceramic capacitors. While the industry standard IEC test procedure permits 3% capacitance change after 10,000 dV/dt pulses, Snubber Mikes show no change after a million shots.

Highlights

- Up to 9.0 amps continuous current
- Up to 3,700 amps peak current
- Up to 1,500 Vdc, 400 Vac
- 100,000 V/ μ s capability minimum
- Quiet—No piezoelectric buzzing
- No capacitance change with voltage, temperature or frequency
- -55°C to +125°C at rated voltage
- Silvered mica dielectric



Copper-clad steel leads	
	AWG
CD16	20
CD30	18
CDV19	20
CDV30	18

Ratings and Dimensions

Cap. pF	Dimensions, in.					Catalog Number	Ipk Amps	I _{rms} , 85°C					
	L	H	T	S	d			100kHz	250kHz	500kHz	1MHz	2.5MHz	5MHz
500 Vdc (300 Vac)													
100	.43	.46	.15	.23	.032	CD16FD101J03	20	.019	.047	.09	.19	.47	.78
120	.43	.46	.15	.23	.032	CD16FD121J03	24	.023	.057	.11	.23	.57	.86
150	.43	.46	.15	.23	.032	CD16FD151J03	30	.028	.071	.14	.28	.71	.96
180	.43	.46	.15	.23	.032	CD16FD181J03	36	.034	.085	.17	.34	.85	1.1
220	.43	.46	.15	.23	.032	CD16FD221J03	44	.041	.10	.21	.41	1.0	1.2
270	.45	.47	.16	.23	.032	CD16FD271J03	54	.051	.13	.25	.51	1.3	1.3
330	.45	.47	.16	.23	.032	CD16FD331J03	66	.062	.16	.31	.62	1.5	1.5
390	.45	.47	.16	.23	.032	CD16FD391J03	78	.074	.18	.37	.74	1.6	1.6
470	.45	.47	.16	.23	.032	CD16FD471J03	94	.089	.22	.44	.89	1.8	1.8
560	.46	.50	.18	.23	.032	CD16FD561J03	110	.11	.26	.53	1.1	2.0	2.0
680	.46	.50	.18	.23	.032	CD16FD681J03	130	.13	.32	.64	1.3	2.3	2.3
820	.46	.50	.18	.23	.032	CD16FD821J03	160	.15	.39	.77	1.5	2.5	2.5
1000	.46	.50	.18	.23	.032	CD16FD102J03	200	.19	.47	.94	1.9	2.7	2.7
1200	.46	.50	.18	.23	.032	CD16FD122J03	240	.23	.57	1.1	2.3	3.0	3.0
1500	.46	.50	.18	.23	.032	CD16FD152J03	300	.28	.71	1.4	2.7	3.3	3.3
1800	.47	.52	.25	.23	.032	CD16FD182J03	360	.34	.85	1.7	3.4	4.1	4.1
2200	.47	.52	.25	.23	.032	CD16FD222J03	440	.41	1.0	2.1	4.1	4.5	4.5
2700	.47	.52	.25	.23	.032	CD16FD272J03	540	.51	1.3	2.5	5.0	5.0	5.0
3000	.47	.52	.25	.23	.032	CD16FD302J03	600	.57	1.4	2.8	5.2	5.2	5.2
3300	.48	.54	.28	.23	.032	CD16FD332J03	600	.57	1.4	2.8	5.7	6.8	6.8
3600	.48	.54	.28	.23	.032	CD16FD362J03	720	.68	1.7	3.4	6.8	7.1	7.1
3900	.48	.54	.28	.23	.032	CD16FD392J03	780	.74	1.8	3.7	7.4	7.4	7.4
4300	.48	.54	.28	.23	.032	CD16FD432J03	860	.81	2.0	4.0	7.0	7.8	7.8
4700	.49	.56	.31	.23	.032	CD16FD472J03	940	.89	2.2	4.4	8.5	8.5	8.5
5600	.49	.56	.31	.23	.032	CD16FD562J03	1100	1.1	2.6	5.3	9.0	9.0	9.0
6800	.50	.58	.35	.23	.032	CD16FD682J03	1300	1.3	3.2	6.4	9.0	9.0	9.0
7500	.50	.58	.35	.23	.032	CD16FD752J03	1500	1.4	3.5	7.1	9.0	9.0	9.0
8200	.79	.88	.32	.43	.040	CD30FD822J03	1200	1.5	3.8	5.4	7.7	7.7	7.7
10000	.80	.89	.34	.43	.040	CD30FD103J03	1500	1.9	4.2	6.0	8.5	8.5	8.5

Radial-Leaded Snubber Mike Capacitors

Cap. pF	Dimensions, in.					Catalog Number	Ipk Amps	I _{rms} , 85°C					
	L	H	T	S	d			100kHz	250kHz	500kHz	1MHz	2.5MHz	5MHz
1000 Vdc (350 Vac)													
100	.43	.46	.15	.23	.032	CDV16FF101J03	23	.022	.055	.11	.22	.55	.92
150	.43	.46	.15	.23	.032	CDV16FF151J03	34	.033	.082	.16	.33	.82	1.1
220	.43	.46	.15	.23	.032	CDV16FF221J03	50	.048	.12	.24	.48	1.2	1.4
330	.45	.47	.16	.23	.032	CDV16FF331J03	74	.073	.18	.36	.73	1.8	1.8
470	.45	.47	.16	.23	.032	CDV16FF471J03	100	.10	.26	.52	1.0	2.1	2.1
680	.46	.50	.18	.23	.032	CDV16FF681J03	150	.15	.37	.75	1.5	2.7	2.7
1000	.46	.50	.18	.23	.032	CDV16FF102J03	220	.22	.55	1.1	2.2	3.2	3.2
1500	.46	.50	.18	.23	.032	CDV16FF152J03	330	.33	.82	1.6	3.3	3.9	3.9
2200	.47	.52	.25	.23	.032	CDV16FF222J03	600	.48	1.2	2.4	4.8	5.3	5.3
3000	.47	.52	.25	.23	.032	CDV16FF302J03	825	.66	1.6	3.3	6.2	6.2	6.2
3300	.72	.59	.38	.34	.032	CDV19FF332J03	700	.73	1.8	3.6	5.5	5.5	5.5
4700	.76	.63	.46	.34	.032	CDV19FF472J03	1000	1.0	2.6	4.6	6.5	6.5	6.5
6800	.80	.89	.36	.44	.040	CDV30FF682J03	2100	1.5	3.7	5.5	7.8	7.8	7.8
8200	.81	.90	.39	.44	.040	CDV30FF822J03	2500	1.8	4.1	5.8	8.2	8.2	8.2
10000	.82	.91	.42	.44	.040	CDV30FF103J03	3000	2.2	4.4	6.2	8.7	8.7	8.7
1500 Vdc (400 Vac)													
100	.77	.85	.25	.43	.040	CDV30FH101J03	46	0.025	0.063	0.13	0.25	0.63	1.3
150	.77	.85	.25	.43	.040	CDV30FH151J03	68	0.038	0.094	0.19	0.38	0.94	1.9
220	.77	.85	.25	.43	.040	CDV30FH221J03	100	0.055	0.14	0.28	0.55	1.4	2.8
330	.77	.85	.25	.43	.040	CDV30FH331J03	150	0.083	0.21	0.41	0.83	2.1	3.1
470	.77	.85	.25	.43	.040	CDV30FH471J03	210	0.12	0.30	0.59	1.2	3.0	3.5
680	.77	.85	.25	.44	.040	CDV30FH681J03	310	0.17	0.43	0.85	1.7	3.9	3.9
1000	.77	.86	.26	.43	.040	CDV30FH102J03	460	0.25	0.63	1.3	2.5	4.4	4.4
1500	.78	.87	.28	.43	.040	CDV30FH152J03	680	0.38	0.94	1.9	3.8	4.9	4.9
2200	.79	.88	.31	.43	.040	CDV30FH222J03	1000	0.55	1.4	2.8	5.5	5.5	5.5
3300	.80	.89	.35	.43	.040	CDV30FH332J03	1500	0.83	2.1	4.1	6.3	6.3	6.3
4700	.81	.90	.38	.43	.040	CDV30FH472J03	2100	1.2	3.0	4.9	7.0	7.0	7.0
6800	.83	.92	.42	.43	.040	CDV30FH682J03	3100	1.7	3.9	5.5	7.8	7.8	7.8
8200	.84	.93	.46	.43	.040	CDV30FH822J03	3700	2.1	4.1	5.8	8.2	8.2	8.2

Snubber-Mike Specifications and Application Guide

Capacitance Tolerance: ±5% is standard. Capacitance is within tolerance when measured at these frequencies:

- 1-1000 pF @ 1 MHz
- > 1000 pF @ 1 kHz

Dissipation Factor is equal to $DF=2\pi fRC$, where f is the test frequency, R is the equivalent series resistance, and C is the capacitance. Limits are

Capacitance	Dissipation Factor
100-1000 pF	0.00075 max at 1 MHz
1200-3300 pF	0.0014 max at 1 kHz
3900-9100 pF	0.0013 max at 1 kHz
10,000 pF	0.0012 max at 1 kHz

Quality Factor Q is the reciprocal of dissipation factor.

Insulation Resistance is no less than 100 GΩ at 25°C and 10 GΩ at 125°C.

Pulse Capability: The brass clips used in Snubber Mike capacitors allow

them to endure huge transient currents. All are capable of withstanding an unlimited number of pulses with a dV/dt of 100,000 V/μs tested per IEC 384-1. dV/dt ratings are below:

Rated Volts	Types		
	CD16 CDV16	CDV19	CD30 CDV30
500	dV/dt maximum, V/μs		
1000	275000	213000	152000
1500			303000
			455000

The peak current rating in amps is the rated capacitance in μF times the dV/dt rating.

$$I_{pk} = C(dV/dt)$$

Maximum Current: Snubber Mike capacitors can handle high ac current and voltage. Capacitors rated 500 Vdc can withstand 300 Vac; 1000 Vdc, 350 Vac; and 1500 Vdc and

higher, 400 Vac. Maximum current is determined by either the voltage rating or temperature rise from power.

Typically voltage rating determines the maximum current for frequencies 500 kHz and lower. The current as a function of voltage is

$$I = 2\pi(Vac)(f)(C)$$

- I = capacitor current, A ac
- Vac = rated ac voltage, V ac
- f = frequency of current, MHz
- C = rated capacitance, μF

For higher frequencies, temperature rise from power dissipation determines maximum current. Case temperature may increase 15°C without affecting performance. Use the table below to calculate the current required for a 15°C rise using rated capacitance, C in pF and frequency, f in MHz.

Radial-Leaded Snubber Mike Capacitors

Type	Current Max A ac
CD15	$0.0073(C^8) \sqrt{f}$
CD19	$0.034(C^6) \sqrt{f}$
CD30	$0.085 \sqrt{Cf}$
CDV19	$0.095 \sqrt{Cf}$
CDV30	$0.55(C^3) \sqrt{f}$

The above applies up to 1 MHz. The 1 MHz current is the absolute maximum rating.

Below is an alternate way to calculate the current required for a 15°C rise, based on case area and Equivalent Series Resistance (ESR).

$$I = 0.12 \sqrt{\Delta T A / R}$$

I = capacitor current, A ac

ΔT = temperature rise, 15°C

A = case area, in²

R = ESR, Ω

The ESR of CDE mica capacitors is quite low, less than 0.1 Ω at 1 MHz for 1000 pF and up. But the ESR varies inversely with frequency and capacitance. Typically, the ESR is less than 60/fC (MHz-pF or kHz-nF) for frequencies below a megahertz. ESR increases 3 to 5% /°C with temperature.

The ratings show voltage-limited maximum current crossing over to temperature-limited maximum current at higher frequencies.

Withstanding Voltage is 2 times the

rated dc voltage, and can be applied up to 5 seconds without damage.

Surge Voltage: Snubber Mike capacitors will withstand 500 Vdc max peak transients above rated voltage. For example, in flyback regulators with less than 500 Vdc bias, you may use 500 Vdc rated capacitors provided that the switching transient peaks are less than 1000 V.

Voltage Coefficient: The change in capacitance from 0 volts to rated voltage is less than 0.1%.

Temperature Coefficient and Capacitance Drift: Measure capacitance at 25°C, -55°C, 25°C, 125°C and at 25°C after stabilizing at each temperature. The temperature coefficient will be 35 \pm 35 ppm/°C and the capacitance will be the initial value \pm (.05% + .1 pF).

Marking: Per EIA RS153 B and includes CD manufacturer's name, Nominal capacitance in pF, Capacitance tolerance, and DC working voltage if other than 500 V.

Solderability: After an 8-hour steam aging, coat leads with rosin flux (R) and immerse in molten 245°C \pm 5°C 60/40 tin lead solder. Solder coverage will be no less than 95% when

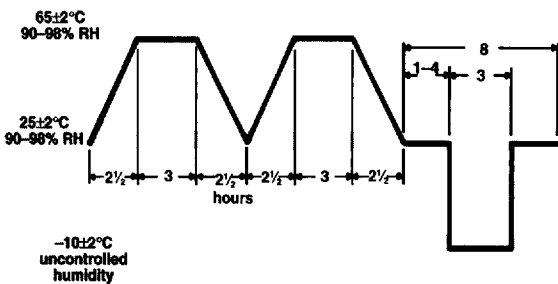
examined at 10X magnification.

Life Test: Subject the capacitors to maximum operating temperature (+125 or +150°C) with 1.5 times rated voltage applied for 2000 hours. There will be no visual damage and the capacitors will meet these after-test limits: Withstanding voltage and insulation resistance initial requirements, capacitance change \pm 1% maximum, and DF 150% initial limit maximum.

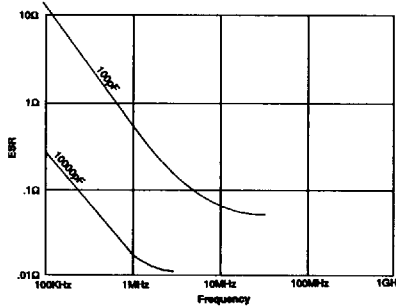
Moisture Resistance: Capacitors will meet the requirements of MIL-STD-202, Method 106F as outlined here and diagrammed below. Refer to MIL-STD-202 for details.

1. Dry capacitors for 24 hours in a 50 \pm 2°C oven and then allow to stabilize at room temperature.
2. Subject the capacitors to 10 24-hour continuous cycles with relative humidity and temperature as shown.
3. 24 hours after completion of the last cycle the capacitors will show no visual damage and will meet these after-test limits: Withstanding voltage initial requirement, insulation resistance 30 G Ω minimum, capacitance change \pm 1% maximum, and DF 150% initial limit maximum.

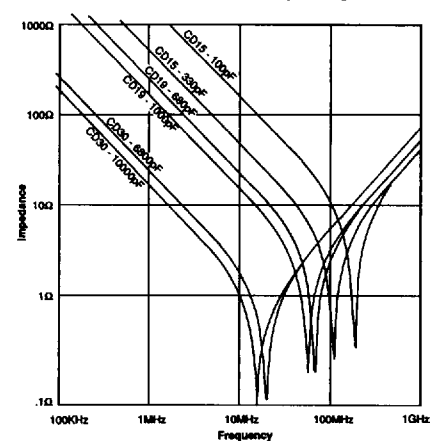
24-Hour Moisture Resistance Cycle



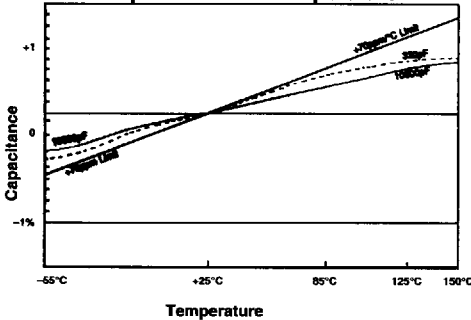
ESR vs. Frequency



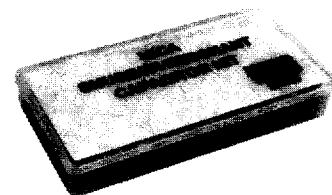
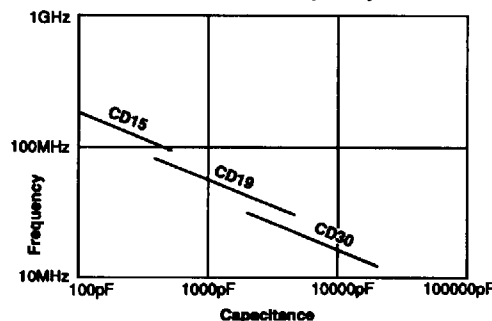
Impedance vs. Frequency



Capacitance vs. Temperature



Self-Resonant Frequency



Kit of 64 popular ratings Kit #5