# High Voltage Ceramic Capacitors 500 V to 20 KV





Space Level

Military Aircraft and Ground Based Systems

Commercial Aerospace

Commercial and Industrial Applications

Medical Imaging

Pulse Discharge and High Repetition Rate Applications

Geophysical and Geothermal 200° C High Temp





Partnering with our clients for combined success.



**CalRamic Technologies LLC** manufactures High Voltage Ceramic Capacitors. Applications of our products are Space Level, Military Aircraft and Ground Based Systems, Commercial Aerospace, Medical Imaging, High Temperature (Geophysical and Geothermal), Pulse Discharge and High Repetition Rate and a variety of Commercial and Industrial applications.

Our products range from Radial Leaded Multilayer and Disc to Surface Mount Chip capacitors in a variety of dielectrics to suit your application. We can produce large or small production quantities. Our lean manufacturing process and discipline offer the shortest lead times in the industry with out-of-stock same day delivery.

We also offer our "Fast Track" delivery for those special delivery needs. Custom designs and variations are welcome.

### **BASIC APPLICATIONS**

It is the basic ability of a capacitor to store energy for controlled release that makes it an extremely valuable tool for use in a wide range of applications in the electronics industry. Typical applications would include:

### Energy / Pulse Discharge

The energy stored in the capacitor can be discharged for use in an ignition, firing or triggering circuit or as a power source.

### **Direct Current Blockage**

A fully charged capacitor acts as a high impedance device and can block the passage of DC current while still allowing AC current to pass to a specified portion of the circuit.

### **Coupling of Circuit Components**

With the ability to pass AC signals, a capacitor is able to couple one section of an AC circuit to another circuit.

### **Decoupling of Circuit Components**

Capacitors are often used in integrated circuits (IC's) to minimize noise in the logic signal by providing an additional current source.

### **Filter Capacitors**

The reactance of a capacitor is inversely proportional to the frequency thereby offering decreased resistance to current flow at higher frequency levels. This ability to decrease or increase the impedance of the circuit allows the capacitor to discriminate and filter out undesired frequencies.

### **By-Pass Capacitor**

The ability to block DC current and allow the passage of AC current permits the capacitor to be placed in parallel with other components to by-pass the AC at a certain frequency without allowing the DC component of the signal to pass.

### **Snubber Capacitors**

Capacitors can be used to protect sensitive components in a circuit by limiting the energy associated with high voltage transients generated by the opening of relays or silicon controlled rectifiers (SCR) used to drive high inductance loads.



# **PRODUCTS**

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High Temperature - High Voltage Leaded Capacitors 



# **High Voltage Radial Leaded Capacitors** Military & Commercial Grade - 500 Vdc to 10 KVdc





# **Performance Characteristics**

Specification	Dielectric Type (	EIA Designation)
Specification	NPO (COG)	X7R
Material Classification	Type I, Ultra Stable, K90	Type II, Stable, K2500
Coefficient of Thermal Expansion	9 x 10 <sup>-6</sup> / °C	11 x 10 <sup>-6</sup> / °C
Density	67 g	) / in <sup>3</sup>
Operating Temperature Range	-55 to	+125°C
Aging Rate	0	-2% Max per decade hour
Temperature Coefficient	±30 PPM / °C	±15%
Voltage Coefficient	Negligible	Range -35% to -55% Max @ WVDC
Capacitance Range	10 pF to 0.33 μF	150 pF to 5.6 μF
Voltage Range	500 Vdc t	o 10KVdc
Insulation Resistance @ +25°C	100,000 MΩ or 1000	MΩ - μF, W/E is less
Insulation Resistance @ +125°C	10,000 MΩ or 100 N	/Ω - μF,  W/E is less
Dissipation Factor	0.1% Max	2.5% Max
DWV	1.5 x WVDC @ WVDC = 500 Vdc	/ 1.2 x WVDC @ WVDC > 500 Vdc

# **Mechanical Dimensions**

Dimensions						Pro	oduct S	tyle					
inches [mm]	HV01	HV02	HV03	HV10	HV04	HV11	HV05	HV06	HV07	HV13	HV14	HV15	HV16
Width - Max	0.250	0.320	0.370	0.450	0.470	0.550	0.570	0.670	0.770	0.850	1.050	1.250	1.450
	[6.35]	[8.13]	[9.40]	[11.43]	[11.94]	[13.97]	[14.48]	[17.02]	[19.56]	[21.59]	[26.67]	[31.75]	[36.83]
Height - Max	0.220	0.280	0.300	0.220	0.400	0.280	0.500	0.600	0.720	0.400	0.500	0.600	0.720
	[5.59]	[7.11]	[7.62]	[5.59]	[10.16]	[7.11]	[12.70]	[15.24]	[18.29]	[10.16]	[12.70]	[15.24]	[18.29]
Thickness -	0.200	0.250	0.250	0.200	0.270	0.270	0.270	0.270	0.270	0.270	0.270	0.270	0.270
Max	[5.08]	[6.35]	[6.35]	[5.08]	[6.86]	[6.86]	[6.86]	[6.86]	[6.86]	[6.86]	[6.86]	[6.86]	[6.86]
Lead Spacing	0.170	0.220	0.275	0.300	0.375	0.400	0.475	0.575	0.675	0.700	0.975	1.175	1.300
±0.030 [0.762]	[4.32]	[5.59]	[6.99]	[7.62]	[9.53]	[10.16]	[12.07]	[14.61]	[17.15]	[17.78]	[24.77]	[29.85]	[33.02]

# **Military & Commercial**



(775) 851-3580 / calramic.com / 5462 Louie Lane / Reno, NV 89511 USA





CalRamic Technologies LLC manufactures a series of highly reliable, military / commercial grade high voltage, radial leaded ceramic capacitors that are designed specifically for those conditions where the assembly may be exposed to high levels of thermal and / or mechanical shock. In addition, these assemblies are packaged in a high resistance conformal coating that provides enhanced electrical isolation and added environmental protection.

Intended for continuous operation at full rated voltage and across the entire operating temperature range, these capacitors utilize a special internal design specifically intended to reduce electric field stresses, thereby providing a device that exhibits very low ESR characteristics and no reduction in insulation resistance with life.

Available with ultra stable Class I, NPO and stable Class II, X7R dielectric materials, these capacitors are ideally suited for timing / precision circuitry, energy storage, DC blocking, snubbers, transient suppression, decoupling, resonators and EMI filtering applications.



Military & Commercial Grade - 500 Vdc to 10 KVdc

# **High Voltage Radial Leaded Capacitors**

Military & Commercial Grade - 500 Vdc to 10 KVdc

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Performance Charts (Typical)

### **Electrical Characteristics**

						NPO Ca	apacita	nce Rai	nge					
St	yle	HV01	HV02	HV03	HV04	HV05	HV06	HV07	HV10	HV11	HV13	HV14	HV15	HV16
Min	Сар	120	220	270	270	180	270	470	100	100	120	180	330	560
	500	472	822	103	223	563	823	104	103	183	823	104	224	334
DC	1000	152	392	682	183	333	473	683	472	123	393	563	104	154
	2000	271	821	102	222	472	682	103	102	152	562	103	223	253
	3000	151	561	681	152	392	562	822	471	821	472	562	153	183
₹	4000	•	•	•	681	152	272	392	221	561	152	332	562	822
3	5000	•	•	•	•	102	222	272	•	391	122	182	392	562
	7000	•	٠	•	•	٠	•	•	•	•	471	102	182	272
	10000	•	٠	•	•	٠	•	٠	•	•	•	821	122	222

						X7R C	apacita	nce Va	lue					
St	yle	HV01	HV02	HV03	HV04	HV05	HV06	HV07	HV10	HV11	HV13	HV14	HV15	HV16
Min	Сар	271	561	681	271	471	681	821	151	271	221	471	821	122
	500	823	184	224	564	125	185	255	224	394	155	225	395	565
	1000	183	683	823	274	474	684	105	563	154	684	105	155	225
	2000	332	123	183	333	683	104	184	822	223	823	154	254	334
ă	3000	•	392	562	153	333	393	823	222	822	273	563	823	124
l ≷	4000	•	•	•	682	103	153	273	122	472	123	273	473	683
-	5000	٠	•	٠	٠	682	103	153	•	272	822	223	273	393
	7000	•	•	•	•	•	•	•	•	•	332	472	103	183
	10000	•	•	•	•	•	•	•	•	•	•	392	562	103

### Notes

- 1. Product designed and manufactured to be drop in replacements for DSCC HV designs.
- 2. Group A screening available to MIL-PRF-49467.
- 3. Special testing including SLAM / CSAM and Partial Discharge (Corona) is available. See Space Level HS catalog CRT-0009 for more information.
- 4. Custom voltages, package sizes and capacitance values available. Contact factory
- 5. X7R dielectrics are not intended for AC line filtering applications.
- 6. Large ceramic capacitors, even leaded devices are susceptible to damage when exposed to thermal and / or mechanical shock. Refer to Technical Bulletin AN103 for handling and installation recommendations.
- 7. High voltage products may require additional conformal coating to prevent possible arc over.



# **Part Number / Ordering Information**



# X7R Temperature Coefficient



Voltage Coefficient



**ESR Vs Frequency** 

### CRT-0010 Rev 1410

# DF Vs Frequency





# NPO Temperature Coefficient





# **High Voltage Surface Mount Capacitors**

Military & Commercial Grade - 500 Vdc to 10 KVdc



CalRamic Technologies LLC manufactures a series of highly reliable, military / commercial grade high voltage, surface mount, ceramic chip capacitors, that are intended for those applications where the assembly may be exposed to high levels of thermal and / or mechanical shock. Conservatively designed, they are ideal for use in demanding high voltage, high current environments.

Intended for continuous operation at full rated voltage and across the entire operating temperature range, these capacitors utilize a special internal design specifically intended to reduce electric field stresses, thereby providing a device that exhibits very low ESR characteristics and no reduction in insulation resistance with life.

Available with ultra stable Class I, NPO and stable Class II, X7R dielectric materials, these capacitors are ideally suited for timing / precision circuitry, energy storage, DC blocking, snubbers, transient suppression, decoupling, resonators and EMI filtering applications.

### **Performance Characteristics**

Specification	Dielectric Type(	EIA Designation)
opecification	NPO (COG)	X7R
Material Classification	Type I, Ultra Stable, K90	Type II, Stable, K2500
Coefficient of Thermal Expansion	9 x 10 <sup>-6</sup> / °C	11 x 10⁻⁵ / °C
Density	67 g	/ in <sup>3</sup>
Operating Temperature Range	-55 to	+125°C
Aging Rate	0	-2% Max per decade hour
Temperature Coefficient	±30 PPM / °C	±15%
Voltage Coefficient	Negligible	Range -35% to -55% Max @ WVDC
Capacitance Range	10 pF to 0.33 μF	150 pF to 5.6 μF
Voltage Range	500 Vdc t	o 10KVdc
Insulation Resistance @ +25°C	100,000 MΩ or 1000	MΩ - μF, W/E is less
Insulation Resistance @ +125°C	10,000 MΩ or 100 M	IΩ - μF,  W/E is less
Dissipation Factor	0.1% Max	2.5% Max
DWV	1.5 x WVDC @ WVDC = 500 Vdc	/ 1.2 x WVDC @ WVDC > 500 Vdc

### **Mechanical Dimensions**

Dimensions						Р	roduct Sty	le					
Inches [mm}	S M01	S M02	S M03	S M04	S M05	S M06	S M07	S M10	S M11	S M13	S M14	S M15	S M16
Length [L]	0.150 ± 0.015 [3.81 ± 0.38]	0.200 ± 0.020 [5.08 ± 0.51]	0.250 ± 0.025 [6.35 ± 0.64]	0.350 ± 0.030 [8.89 ± 0.76]	0.450 ± 0.030 [11.43 ± 0.76]	0.550 ± 0.030 [14.00 ± 0.76]	0.650 ± 0.030 [16.50 ± 0.76]	0.300 ± 0.030 [7.62 ± 0.76]	0.400 ± 0.030 [10.20 ± 0.76]	0.700 ± 0.030 [17.80 ± 0.76]	0.900 ± 0.030 [22.90 ± 0.76]	1.150 ± 0.030 [27.90 ± 0.76]	1.300 ± 0.030 [33.02 ± 0.76]
Width [W]	0.150 ± 0.015 [3.81 ± 0.38]	0.200 ± .020 [5.08 ± 0.51]	0.200 ± 0.020 [5.08 ± 0.51]	0.300 ± 0.030 [7.62 ± 0.76]	0.400 ± 0.030 [10.16 ± 0.76]	0.500 ± 0.030 [12.70 ± 0.76]	0.600 ± 0.030 [10.20 ± 0.76]	0.150 ± 0.015 [3.81 ± 0.38]	0.200 ± 0.020 [5.08 ± 0.51]	0.300 ± 0.030 [7.62 ± 0.76]	0.400 ± 0.030 [10.16 ± 0.76]	0.500 ± 0.030 [12.70 ± 0.76]	0.600 ± 0.030 [10.20 ± 0.76]
Thickness [T] [Max]	0.130 [3.30]	0.180 [4.57]	0.180 [4.57]	0.220 [5.59]	0.220 [5.59]	0.220 [5.59]	0.220 [5.59]	0.140 [3.55]	0.130 [3.30]	.180 [4.57]	0.220 [5.59]	0.220 [5.59]	0.220 [5.59]
Tab [A]	0.100 [2.54]	0.100 [2.54]	0.100 [2.54]	0.200 5.08]	0.300 [7.62]	0.400 [10.2]	0.500 [12.7]	0.100 [2.54]	0.100 [2.54]	0.200 5.08]	0.300 [7.62]	0.400 [10.2]	0.500 [12.7]

# **High Voltage Surface Mount Capacitors**

Military & Commercial Grade - 500 Vdc to 10 KVdc

# **Electrical Characteristics**

						NPO Ca	apacita	nce Rai	nge					
St	yle	S M01	S M02	S M03	S M04	S M05	S M06	S M07	S M10	S M11	S M13	S M14	S M15	S M16
Min	Сар	120	220	270	270	180	270	470	100	100	120	180	330	560
	500	472	822	103	223	563	823	104	103	183	823	104	224	334
	1000	152	392	682	183	333	473	683	472	123	393	563	104	154
0	2000	271	821	102	222	472	682	103	102	152	562	103	223	253
ğ	3000	151	561	681	152	392	562	822	471	821	472	562	153	183
ξ	4000	•	•	•	681	152	272	392	221	561	152	332	562	822
-	5000	•	•	•	•	102	222	272	•	391	122	182	392	562
	7000	•	•	•	•	•	•	•	٠	•	471	102	182	272
	10000	•	•	•	•	•	•	•	•	•	•	821	122	222

						X7R C	apacita	nce Va	ue					
St	yle	S M01	S M02	S M03	S M04	S M05	S M06	S M07	S M10	S M11	S M13	S M14	S M15	S M16
Min	Сар	271	561	681	271	471	681	821	151	271	221	471	821	122
	500	823	184	224	564	125	185	255	224	394	155	225	395	565
	1000	183	683	823	274	474	684	105	563	154	684	105	155	225
	2000	332	123	183	333	683	104	184	822	223	823	154	254	334
ğ	3000	•	392	562	153	333	393	823	222	822	273	563	823	124
l≷	4000	٠	•	•	682	103	153	273	122	472	123	273	473	683
-	5000	•	•	•	•	682	103	153	•	272	822	223	273	393
	7000	•	•	٠	•	•	٠	•	•	•	332	472	103	183
	10000	•	•	•	•	•	•	•	•	•	•	392	562	103

### Notes

1. Group A screening available to MIL-PRF-49467.

- 2. Special testing including Ultrasound (SLAM / CSAM) and Partial Discharge (Corona) is available. See Space Level Surface Mount catalog page CRT-0022 for more information or contact factory.
- 3. Custom voltages, package sizes and capacitance values available. Contact factory.
- 4. X7R dielectrics are not intended for AC line filtering applications.
- 5. Large ceramic capacitors, even leaded devices are susceptible to damage when exposed to thermal
- and /or mechanical shock. Refer to Technical Bulletin AN101 for handling and installation recommendations.
- 6. High voltage products may require conformal coating to prevent possible arc over.



# **High Voltage Surface Mount Capacitors**

Military & Commercial Grade - 500 Vdc to 10 KVdc

# **High Voltage Multi-Layer Chip Capacitors** Military & Commercial Grade - 500 Vdc to 10 KVdc



ESR Vs Frequency





**DF Vs Frequency** 



**Performance Characteristics** 

Specification	Dielectric Type (	EIA Designation)
Specification	NPO (COG)	X7R
Material Classification	Type I, Ultra Stable, K90	Type II, Stable, K2500
<b>Coefficient of Thermal Expansion</b>	9 x 10 <sup>-6</sup> / °C	11 x 10 <sup>-6</sup> / <sup>°</sup> C
Density	67 g	/ in <sup>3</sup>
Operating Temperature Range	-55 to	+125°C
Aging Rate	0	-2% Max per decade hour
Temperature Coefficient	±30 PPM / °C	±15%
Voltage Coefficient	Negligible	Range -35% to -55% Max @ WVDC
Capacitance Range	10 pF to 0.33 μF	150 pF to 5.6 μF
Voltage Range	500 Vdc t	o 10KVdc
Insulation Resistance @ +25°C	100,000 MΩ or 1000	MΩ - μF, W/E is less
Insulation Resistance @ +125°C	10,000 MΩ or 100 M	IΩ - μF,  W/E is less
Dissipation Factor	0.1% Max	2.5% Max
DWV	1.5 x WVDC @ WVDC = 500 Vdc	/ 1.2 x WVDC @ WVDC > 500 Vdc

### **Mechanical Dimensions**

Dimensions								F	Product Sty	le							
in [mm]	HV1515	HV1812	HV1825	HV2020	HV2225	HV2520	HV3333	HV3530	HV4040	HV4540	HV5440	HV5550	HV6560	HV7030	HV9040	HV11050	HV13060
Length [L]	0.150 [3.81]	0.180 [4.57]	0.180 [4.57]	0.200 [5.08]	0.220 [5.59]	0.250 [6.35]	0.330 [8.38]	0.350 [8.89]	0.400 [10.2]	0.450 [11.43]	0.540 [13.7]	0.550 [14.0]	0.650 [16.5]	0.700 [17.8]	0.900 [22.9]	1.100 [27.9]	1.300 [33.0]
Tol ±	0.015 [0.38]	0.020 [0.51]	0.020 [0.51]	0.020 [0.51]	0.020 [0.51]	0.020 [0.51]	0.030 [0.76]	0.030 [0.76]	0.030 [0.76]	0.030 [0.76]	0.030 [0.76]	0.030 [0.76]	0.030 [0.76]	0.030 [0.76]	0.030 [0.76]	0.030 [0.76]	0.030 [0.76]
Width [W]	0.150 [3.81]	0.120 [4.57]	0.250 [6.35]	0.200 [5.08]	0.250 [6.35]	0.200 [5.08]	0.330 [8.38]	0.300 [7.62]	0.400 [10.2]	0.400 [10.2]	0.400 [10.2]	0.500 [12.7]	0.600 [15.2]	0.300 [7.62]	0.400 [10.2]	0.500 [12.7]	0.600 [15.2]
Tol ±	0.015 [0.38]	0.015 [0.38]	0.020 [0.51]	0.020 [0.51]	0.020 [0.51]	0.020 [0.51]	0.030 [0.76]	0.030 [0.76]	0.030 [0.76]	0.030 [0.76]	0.030 [0.76]	0.030 [0.76]	0.030 [0.76]	0.030 [0.76]	0.030 [0.76]	0.030 [0.76]	0.030 [0.76]
Thickness [T]	0.140	0.100	0.160	0.180	0.200	0.180	0.220	0.220	0.220	0.220	0.220	0.220	0.220	0.220	0.220	0.220	0.220
Max	[3.55]	[2.54]	[4.07]	[4.57]	[5.08]	[4.57]	[5.59]	[5.59]	[5.59]	[5.59]	[5.59]	[5.59]	[5.59]	[5.59]	[5.59]	[5.59]	[5.59]
EB	0.010 - 0.030	0.010 - 0.040	0.010 0.040	0.010 - 0.040	0.010 0.040	0.020 - 0.060	0.020 - 0.060	0.020 - 0.060	0.020 - 0.060	0.020 - 0.060	0.020 - 0.060	0.020 - 0.060	0.020 - 0.060	0.020 - 0.060	0.020 - 0.060	0.020 - 0.060	0.020 - 0.060
Min - Max	[0.254 - 0.762]	[0.254 - 1.02]	[0.254 1.02]	[0.254 - 1.02]	[0.254 1.02]	[0.51 - 1.52]	[0.51 - 1.52]	[0.51 - 1.52]	[0.51 - 1.52]	[0.51 - 1.52]	[0.51 - 1.52]	[0.51 - 1.52]	[0.51 - 1.52]	[0.51 - 1.52]	[0.51 - 1.52]	[0.51 - 1.52]	[0.51 - 1.52]

CalRamic Technologies LLC manufactures a series of highly reliable, military / commercial grade high voltage, multilayer ceramic chip capacitors that are conservatively designed and intended specifically for use in demanding high voltage, high current environments.

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- Intended for continuous operation at full rated voltage and across the entire operating temperature range, these capacitors utilize a special internal design specifically intended to reduce electric field stresses, thereby providing a device that exhibits very low ESR characteristics and no reduction in insulation resistance with life.
- Available with ultra stable Class I, NPO and stable Class II, X7R dielectric materials, these capacitors are ideally suited for timing / precision circuitry, energy storage, DC blocking, snubbers, transient suppression, decoupling, resonators and EMI filtering applications.

# **High Voltage Multi-Layer Chip Capacitors**

Military & Commercial Grade - 500 Vdc to 10 KVdc

# **High Voltage Multi-Layer Chip Capacitors** Military & Commercial Grade - 500 Vdc to 10 KVdc

### **Electrical Characteristics**

								NPO C	Capacitar	nce Rang	je							
HV	Style	1515	1812	1825	2020	2225	2520	3333	3530	4040	4540	5440	5550	6560	7030	9040	11050	13060
Min	Сар	120	120	220	220	270	270	270	270	180	180	270	270	470	120	180	330	560
	500	472	272	822	822	123	103	153	223	393	563	823	823	104	823	104	224	334
	1000	152	122	392	392	822	682	123	183	223	333	333	473	683	393	563	104	154
	2000	271	271	821	821	102	102	222	222	392	472	562	682	103	562	103	223	253
DC DC	3000	151	121	561	561	681	681	122	152	222	392	472	562	822	472	562	153	183
≩	4000	•	•	•	•	•	•	681	681	122	152	222	272	392	152	332	562	822
	5000	•	•	•	•	•	•	•	•	•	122	•	222	272	122	182	392	562
	7000	•	•	•	•	•	•	•	•	•	•	•	•	•	471	102	182	272
	10000	•	•	•	•	•	•	•	•	•	•	•	•	•	•	821	122	222

								X7R C	apacitar	nce Rang	е							
HV	Style	1515	1812	1825	2020	2225	2520	3333	3530	4040	4540	5440	5550	6560	7030	9040	11050	13060
Min	Сар	271	271	561	561	681	681	471	271	471	471	681	681	821	221	471	821	122
	500	823	563	184	184	224	224	474	564	824	125	155	185	255	155	225	395	565
	1000	183	183	473	683	823	823	254	274	394	474	684	684	105	684	105	155	225
	2000	332	252	822	123	153	183	333	333	473	683	563	104	184	823	154	254	334
ğ	3000	•	•	272	392	472	562	123	153	183	333	333	393	823	273	563	823	124
≩	4000	•	•	•	•	•	•	•	682	•	103	103	153	273	123	273	473	683
	5000	•	•	•	•	•	•	•	•	•	682	-	103	153	822	223	273	393
	7000	•	•	•	•	•	•	•	•	•	•	•	•	•	332	472	103	273
	10000	•	•	•	•	•	•	•	•	•	•	•	•	•	•	392	562	103

### Notes

- 1. Group A screening available to MIL-PRF-49467.
- 2. Special testing including Ultrasound (SLAM / CSAM) and Partial Discharge (Corona) is available. Reference CRT-0021, Space Level, HV MLCC catalog, or contact factory for more information.
- 3. Custom voltages, package sizes and capacitance values available. Contact factory.
- 4. X7R dielectrics are not intended for AC line filtering applications.
- 5. Large ceramic capacitors are susceptible to damage when exposed to thermal and / or mechanical shock. Refer to technical bulletin AN101 for handling and installation recommendations or consider selecting radial leaded or surface mount alternatives as detailed in catalogs CRT-0010 and CRT-0017.
- 6. High voltage products may require conformal coating to prevent possible arc over.











Voltage Coefficient



**ESR Vs Frequency** 

# Performance Charts (Typical)



NPO Temperature Coefficient



Capacitance Vs Frequency



**DF Vs Frequency** 



# **High Voltage Radial Leaded Capacitors** Space Level - 500 Vdc to 10 KVdc



# Performance Characteristics

Specification	Dielectric Type (	EIA Designation)	
Specification	NPO (COG)	X7R [BR]	
Material Classification	Type I, Ultra Stable, K90	Type II, Stable, K2500	
Coefficient of Thermal Expansion	9 x 10 <sup>-6</sup> / °C	11 x 10⁻⁶ / °C	
Density	67 g	/ in <sup>3</sup>	
Operating Temperature Range	-55 to	+125°C	
Aging Rate	0	-2% Max per decade hour	
Temperature Coefficient	±30 PPM / °C	±15%	
Voltage Coefficient	Negligible	Range -40% Max @ WVDC	
Capacitance Range	12 pF to 0.22 μF	270 pF to 2.2 μF	
Voltage Range	500 Vdc t	o 10KVdc	
Insulation Resistance @ +25°C	100,000 MΩ or 1000	MΩ - μF, W/E is less	
Insulation Resistance @ +125°C	10,000 MΩ or 100 M	IΩ - μF,  W/E is less	
Dissipation Factor	0.1% Max	2.5% Max	
DWV	1.5 x WVDC @ WVDC = 500 Vdc	/ 1.2 x WVDC @ WVDC > 500 Vdc	

# **Mechanical Dimensions**

Dimensions		Product Style													
inches [mm]	HS01	HS02	HS03	HS10	HS04	HS11	HS05	HS06	HS07	HS13	HS14	HS15	HS16		
Width - Max	0.250	0.320	0.370	0.450	0.470	0.550	0.570	0.670	0.770	0.850	1.050	1.250	1.450		
	[6.35]	[8.13]	[9.40]	[11.43]	[11.94]	[13.97]	[14.48]	[17.02]	[19.56]	[21.59]	[26.67]	[31.75]	[36.83]		
Height - Max	0.220	0.280	0.300	0.220	0.400	0.280	0.500	0.600	0.720	0.400	0.500	0.600	0.720		
	[5.59]	[7.11]	[7.62]	[5.59]	[10.16]	[7.11]	[12.70]	[15.24]	[18.29]	[10.16]	[12.70]	[15.24]	[18.29]		
Thickness -	0.200	0.250	0.250	0.200	0.270	0.270	0.270	0.270	0.270	0.270	0.270	0.270	0.270		
Max	[5.08]	[6.35]	[6.35]	[5.08]	[6.86]	[6.86]	[6.86]	[6.86]	[6.86]	[6.86]	[6.86]	[6.86]	[6.86]		
Lead Spacing	0.170	0.220	0.275	0.300	0.375	0.400	0.475	0.575	0.675	0.700	0.975	1.175	1.300		
±0.030 [0.762]	[4.32]	[5.59]	[6.99]	[7.62]	[9.53]	[10.16]	[12.07]	[14.61]	[17.15]	[17.78]	[24.77]	[29.85]	[33.02]		

# **Space Level**



(775) 851-3580 / calramic.com / 5462 Louie Lane / Reno, NV 89511 USA



CalRamic Technologies LLC manufactures a series of highly reliable, mission critical, high voltage, radial leaded ceramic capacitors that are designed specifically for those non-repairable, space applications where the assembly may be exposed to high levels of thermal and / or mechanical shock.

In addition, these assemblies are packaged in a high resistance conformal coating that provides enhanced electrical isolation and added environmental protection.

Intended for continuous operation at full rated voltage and across the entire operating temperature range, these capacitors utilize a special internal design specifically intended to reduce electric field stresses, thereby providing a device that exhibits very low ESR characteristics and no reduction in insulation resistance with life.

Available with ultra stable Class I, NPO and stable Class II, X7R / BR dielectric materials, these capacitors are ideally suited for timing / precision circuitry, energy storage, DC blocking, snubbers, transient suppression, decoupling, resonators and EMI filtering applications.

Space Level - 500 Vdc to 10 KVdc

# **High Voltage Radial Leaded Capacitors** Space Level - 500 Vdc to 10 KVdc

### **Electrical Characteristics**

Notes

	NPO Capacitance Range													
St	yle	HS01	HS02	HS03	HS04	HS05	HS06	HS07	HS10	HS11	HS13	HS14	HS15	HS16
Min	Сар	120	220	270	270	180	270	470	100	100	120	180	330	560
	500	392	682	822	183	473	683	823	123	223	104	124	184	224
~	1000	122	272	472	153	253	393	473	332	682	473	563	823	124
	2000	561	681	821	252	562	822	183	681	182	822	123	183	223
ğ	3000	•	•	471	122	272	472	562	271	681	392	472	123	153
۵ ۸	4000	•	•	•	•	102	182	272	•	561	152	332	472	822
\$	5000	•	•	•	•	561	152	222	•	251	122	222	392	392
	7000	•	•	•	•	•	•	•	•	•	102	821	122	222
	10000	•	•	•	•	•	•	•	•	•	•	•	102	152

	X7R Capacitance Range													
St	yle	HS01	HS02	HS03	HS04	HS05	HS06	HS07	HS10	HS11	HS13	HS14	HS15	HS16
Min	Сар	271	561	681	271	471	681	122	151	271	221	471	821	122
	500	273	823	104	274	474	684	105	823	154	684	105	155	225
	1000	682	223	273	823	154	224	334	183	473	224	274	474	684
	2000	122	472	682	153	273	473	683	332	103	333	683	104	154
ğ	3000	•	•	•	562	123	223	333	122	392	153	273	473	683
≥	4000	•	•	•	•	472	822	123	•	222	682	154	223	333
-	5000	•	•	•	•	392	472	522	•	152	392	822	123	223
	7000	•	•	•	•	•	•	•	•	•	472	332	472	822
	10000	•	•	•	•	•	•	•	•	•	•	•	332	562

1. Product receives 100% Group A Inspection in accordance with MIL-PRF-49467 including Corona.

2. Special testing including 100% SLAM / CSAM is available upon request.

4. X7R dielectrics are not intended for AC line filtering applications.

no degradation in insulation resistance.

3. Custom voltages, package sizes and capacitance values available. Contact factory.

### 2% Change [%] \_\_\_\_\_ -69 -8% -10% Cap -12% -14% -16% -55 -35 -15 5 25 45 65 105 125 Temperature [Deg C]

**X7R** Temperature Coefficient



Voltage Coefficient [BR]



**ESR Vs Frequency** 

# **Part Number / Ordering Information**

5. Space level products are capable of meeting a minimum of 4000 hours life at full rated conditions with

and / or mechanical shock. Refer to Technical Bulletin AN103 for handling and installation recommendations.

6. Large ceramic capacitors, even leaded devices are susceptible to damage when exposed to thermal

7. High voltage products may require additional conformal coating to prevent possible arc over.



# Performance Charts (Typical)



# **NPO Temperature Coefficient**



Capacitance Vs Frequency



# **DF Vs Frequency**

CRT-0009 Rev 1410

# **High Voltage Surface Mount Capacitors**

Space Level - 500 Vdc to 10 KVdc



2. SM01, SM02, SM03 @ 0.040 ± 0.010 [1.02 ± 0.26]

Performance Characteristics

CalRamic Technologies LLC manufactures a series of highly reliable, mission critical, high voltage, surface mount tab leaded ceramic capacitors that are designed specifically for those non-repairable, space applications, where the assembly may be exposed to high levels of thermal and / or mechanical shock. Conservatively designed, they are ideal for use in demanding high voltage, high current environments.

Intended for continuous operation at full rated voltage and across the entire operating temperature range, these capacitors utilize a special internal design specifically intended to reduce electric field stresses, thereby providing a device that exhibits very low ESR characteristics and no reduction in insulation resistance with life.

Available with ultra stable Class I, NPO and stable Class II, X7R / BR dielectric materials, these capacitors are ideally suited for timing / precision circuitry, energy storage, DC blocking, snubbers, transient suppression, decoupling, resonators and EMI filtering applications.

2.5% Max

1.5 x WVDC @ WVDC = 500 Vdc / 1.2 x WVDC @ WVDC > 500 Vdc

**Dielectric Type (EIA Designation)** Specification NPO (COG) X7R [BR] **Material Classification** Type I, Ultra Stable, K90 Type II, Stable, K2500 **Coefficient of Thermal Expansion** 9 x 10<sup>-6</sup> / °C 11 x 10<sup>-6</sup> / °C 67 g / in<sup>3</sup> Density -55 to +125°C **Operating Temperature Range** -2% Max per decade hour Aging Rate 0 ±30 PPM / °C **Temperature Coefficient** ±15% Voltage Coefficient Negligible Range -40% Max @ WVDC **Capacitance Range** 12 pF to 0.22 µF 270 pF to 2.2 µF 500 Vdc to 10KVdc Voltage Range 100,000 MΩ or 1000 MΩ - μF, W/E is less Insulation Resistance @ +25°C 10,000 M $\Omega$  or 100 M $\Omega$  -  $\mu$ F, W/E is less Insulation Resistance @ +125°C

# **Mechanical Dimensions**

**Dissipation Factor** 

DWV

Dimensions Inches [mm}		Product Style													
	S M01	S M02	S M03	S M04	S M05	S M06	S M07	S M10	S M11	S M13	S M14	S M15	S M16		
Length [L]	0.150 ± 0.015 [3.81 ± 0.38]	0.200 ± 0.020 [5.08 ± 0.51]	0.250 ± 0.025 [6.35 ± 0.64]	0.350 ± 0.030 [8.89 ± 0.76]	0.450 ± 0.030 [11.43 ± 0.76]	0.550 ± 0.030 [14.00 ± 0.76]	0.650 ± 0.030 [16.50 ± 0.76]	0.300 ± 0.030 [7.62 ± 0.76]	0.400 ± 0.030 [10.20 ± 0.76]	0.700 ± 0.030 [17.80 ± 0.76]	0.900 ± 0.030 [22.90 ± 0.76]	1.150 ± 0.030 [27.90 ± 0.76]	1.300 ± 0.030 [33.02 ± 0.76]		
Width [W]	0.150 ± 0.015 [3.81 ± 0.38]	0.200 ± .020 [5.08 ± 0.51]	0.200 ± 0.020 [5.08 ± 0.51]	0.300 ± 0.030 [7.62 ± 0.76]	0.400 ± 0.030 [10.16 ± 0.76]	0.500 ± 0.030 [12.70 ± 0.76]	0.600 ± 0.030 [10.20 ± 0.76]	$\begin{array}{c} 0.150 \pm 0.015 \\ [3.81 \pm 0.38] \end{array}$	0.200 ± 0.020 [5.08 ± 0.51]	0.300 ± 0.030 [7.62 ± 0.76]	0.400 ± 0.030 [10.16 ± 0.76]	0.500 ± 0.030 [12.70 ± 0.76]	0.600 ± 0.030 [10.20 ± 0.76]		
Thickness [T] [Max]	0.130 [3.30]	0.180 [4.57]	0.180 [4.57]	0.220 [5.59]	0.220 [5.59]	0.220 [5.59]	0.220 [5.59]	0.140 [3.55]	0.130 [3.30]	.180 [4.57]	0.220 [5.59]	0.220 [5.59]	0.220 [5.59]		
Tab [A]	0.100 [2.54]	0.100 [2.54]	0.100 [2.54]	0.200 5.08]	0.300 [7.62]	0.400 [10.2]	0.500 [12.7]	0.100 [2.54]	0.100 [2.54]	0.200 5.08]	0.300 [7.62]	0.400 [10.2]	0.500 [12.7]		

0.1% Max

# **High Voltage Surface Mount Capacitors** Space Level - 500 Vdc to 10 KVdc

### Electrical Characteristics

	NPO Capacitance Range													
HSS	Style	SM01	SM02	SM03	SM04	SM05	SM06	SM07	SM10	SM11	SM13	SM14	SM15	SM16
Min	Сар	120	220	270	270	180	270	470	100	100	120	180	330	560
	500	392	682	822	183	473	683	823	123	223	104	124	184	224
	1000	122	272	472	153	253	393	473	332	682	473	563	823	124
	2000	561	681	821	252	562	822	183	681	182	822	123	183	223
	3000	•	•	471	122	272	472	562	271	681	392	472	123	153
≥	4000	•	•	•	•	102	182	272	•	561	152	332	472	822
\$	5000	•	•	•	•	561	152	222	•	251	122	222	392	392
	7000	•	•	•	•	•	•	•	•	•	102	821	122	222
	10000	•	•	•	•	•	•	•	•	•	•	•	102	152

	X7R Capacitance Range													
HS S	Style	SM01	SM02	SM03	SM04	SM05	SM06	SM07	SM10	SM11	SM13	SM14	SM15	SM16
Min	Сар	271	561	681	271	471	681	122	151	271	221	471	821	122
	500	273	823	104	274	474	684	105	823	154	684	105	155	225
	1000	682	223	273	823	154	224	334	183	473	224	274	474	684
	2000	122	472	682	153	273	473	683	332	103	333	683	104	154
B	3000	•	•	•	562	123	223	333	122	392	153	273	473	683
≥	4000	•	•	•	•	472	822	123	•	222	682	154	223	333
>	5000	•	•	•	•	392	472	522	•	152	392	822	123	223
	7000	•	•	•	•	•	•	٠	•	•	472	332	472	822
	10000	•	•	•	•	•	•	•	•	•	•	•	332	562

### Notes

1. Product receives 100% Group A Inspection in accordance with MIL-PRF-49467 including Corona.

- 2. Special testing including 100% SLAM / CSAM is available upon request.
- 3. Custom voltages, package sizes and capacitance values available. Contact factory.
- 4. X7R dielectrics are not intended for AC line filtering applications.
- 5. Space level products are capable of meeting a minimum of 4000 hours life at full rated conditions with no degradation in insulation resistance.
- 6. Large ceramic capacitors, even leaded devices are susceptible to damage when exposed to thermal and / or mechanical shock. Refer to Technical Bulletin AN101 for handling and installation recommendations.
- 7. High voltage products may require conformal coating to prevent possibility of arc over.



# **Part Number / Ordering Information**

# **High Voltage Surface Mount Capacitors**

Performance Charts (Typical)

Space Level - 500 Vdc to 10 KVdc

# **High Voltage Multi-Layer Chip Capacitors** Space Level Grade - 500 Vdc to 10 KVdc



ESR Vs Frequency



NPO Temperature Coefficient



Capacitance Vs Frequency



**DF Vs Frequency** 



**Performance Characteristics** 

Specification	Dielectric Type (	EIA Designation)
opecification	NPO (COG)	X7R [BR]
Material Classification	Type I, Ultra Stable, K90	Type II, Stable, K2500
Coefficient of Thermal Expansion	9 x 10 <sup>-6</sup> / °C	11 x 10 <sup>-6</sup> / °C
Density	67 g	/ in <sup>3</sup>
Operating Temperature Range	-55 to	+125°C
Aging Rate	0	-2% Max per decade hour
Temperature Coefficient	±30 PPM / °C	±15%
Voltage Coefficient	Negligible	Range -40% Max @ WVDC
Capacitance Range	12 pF to 0.22 μF	270 pF to 2.2 μF
Voltage Range	500 Vdc t	o 10KVdc
Insulation Resistance @ +25°C	100,000 MΩ or 1000	MΩ - μF, W/E is less
Insulation Resistance @ +125°C	10,000 MΩ or 100 M	IΩ - μF,  W/E is less
Dissipation Factor	0.1% Max	2.5% Max
DWV	1.5 x WVDC @ WVDC = 500 Vdc	/ 1.2 x WVDC @ WVDC > 500 Vdc

### Mechanical Dimensions

Dimensions		Product Style												
in [mm]	HS 1515	HS 2020	HV2520	HS 3530	HS 4040	HS 4540	HS 5550	HS 6560	HS 7030	HS 9040	HS 11050	HS 13060		
Length [L]	0.150 [3.81]	0.200 [5.08]	0.250 [6.35]	0.350 [8.89]	0.400 [10.2]	0.450 [11.43]	0.550 [14.0]	0.650 [16.5]	0.700 [17.8]	0.900 [22.9]	1.100 [27.9]	1.300 [33.0]		
Tol ±	0.015 [0.38]	0.020 [0.51]	0.020 [0.51]	0.030 [0.76]	0.030 [0.76]	0.030 [0.76]	0.030 [0.76]	0.030 [0.76]	0.030 [0.76]	0.030 [0.76]	0.030 [0.76]	0.030 [0.76]		
Width [W]	0.150 [3.81]	0.200 [5.08]	0.200 [5.08]	0.300 [7.62]	0.400 [10.2]	0.400 [10.2]	0.500 [12.7]	0.600 [15.2]	0.300 [7.62]	0.400 [10.2]	0.500 [12.7]	0.600 [15.2]		
Tol ±	0.015 [0.38]	0.020 [0.51]	0.020 [0.51]	0.030 [0.76]	0.030 [0.76]	0.030 [0.76]	0.030 [0.76]	0.030 [0.76]	0.030 [0.76]	0.030 [0.76]	0.030 [0.76]	0.030 [0.76]		
Thickness [T]	0.140	0.180	0.180	0.220	0.220	0.220	0.220	0.220	0.220	0.220	0.220	0.220		
Max	[3.55]	[4.57]	[4.57]	[5.59]	[5.59]	[5.59]	[5.59]	[5.59]	[5.59]	[5.59]	[5.59]	[5.59]		
EB	0.010 - 0.030	0.010 - 0.040	0.020 - 0.060	0.020 - 0.060	0.020 - 0.060	0.020 - 0.060	0.020 - 0.060	0.020 - 0.060	0.020 - 0.060	0.020 - 0.060	0.020 - 0.060	0.020 - 0.060		
Min - Max	[0.254 - 0.762]	[0.254 - 1.02]	[0.51 1.52]	[0.51 1.52]	[0.51 1.52]	[0.51 - 1.52]	[0.51 1.52]	[0.51 1.52]	[0.51 1.52]	[0.51 1.52]	[0.51 1.52]	[0.51 - 1.52]		

CalRamic Technologies LLC manufactures a series of highly reliable, mission critical, high voltage, multi-layer ceramic chip capacitors that are intended specifically for nonrepairable, space applications. Conservatively designed they are ideal for use in demanding high voltage, high current environments.

Intended for continuous operation at full rated voltage and across the entire operating temperature range, these capacitors utilize a special internal design specifically intended to reduce electric field stresses, thereby providing a device that exhibits very low ESR characteristics and no reduction in insulation resistance with life.

Available with ultra stable Class I. NPO and stable Class II. X7R dielectric materials, these capacitors are ideally suited for timing / precision circuitry, energy storage, DC blocking, snubbers, transient suppression, decoupling, resonators and EMI filtering applications.

# **High Voltage Multi-Layer Chip Capacitors**

Space Level Grade - 500 Vdc to 10 KVdc

### **Electrical Characteristics**

	NPO Capacitance Range													
HS S	Style	1515	2020	2520	3530	4540	5550	6560	4040	7030	9040	11050	13060	
Min	Сар	120	220	270	270	180	270	470	100	120	180	330	560	
	500	392	682	822	183	473	683	823	223	104	124	184	224	
	1000	122	272	472	153	253	393	473	682	473	563	823	124	
	2000	561	681	821	252	562	822	183	182	822	123	183	223	
DC	3000	•	•	471	122	272	472	562	681	392	472	123	153	
≥	4000	•	•	•	٠	102	182	272	561	152	332	472	822	
>	5000	•	•	•	٠	561	152	222	251	122	222	392	392	
	7000	•	•	•	٠	•	•	٠	•	102	821	122	222	
	10000	•	٠	•	•	•	•	•	•	•	•	102	152	

	X7R Capacitance Range													
HS	Style	1515	2020	2520	3530	4540	5550	6560	4040	7030	9040	11050	13060	
Min	Сар	271	561	681	271	471	681	122	271	221	471	821	122	
	500	273	823	104	274	474	684	105	154	684	105	155	225	
	1000	682	223	273	823	154	224	334	473	224	274	474	684	
	2000	122	472	682	153	273	473	683	103	333	683	104	154	
8	3000	•	٠	•	562	123	223	333	392	153	273	473	683	
≥	4000	•	•	•	•	472	822	123	222	682	154	223	333	
>	5000	•	٠	•	•	392	472	522	152	392	822	123	223	
	7000	•	•	•	•	•	•	•	•	472	332	472	822	
	10000	•	•	•	•	•	•	•	•	•	•	332	562	

### Notes

1. Product receives 100% Group A Inspection in accordance with MIL-PRF-49467 including Corona.

2. Special testing including 100% SLAM / CSAM is available upon request.

3. Custom voltages, package sizes and capacitance values available. Contact factory.

4. X7R dielectrics are not intended for AC line filtering applications.

- 5. Space level products are capable of meeting a minimum of 4000 hours life at full rated conditions with no degradation in insulation resistance.
- 6. Large ceramic capacitors are susceptible to damage when exposed to thermal and / or mechanical shock. Refer to technical bulletin AN101 for handling and installation recommendations or consider selecting radial leaded or surface mount alternatives as detailed in catalogs CRT-0009 and CRT-0022.
- 7. High voltage capacitors may require conformal coating to prevent arc over.



Note: Ultrasound (SLAM / C-SAM) is not included unless designated in part number.



Space Level Grade - 500 Vdc to 10 KVdc





**X7R** Temperature Coefficient



Voltage Coefficient [BR]



**ESR Vs Frequency** 





NPO Temperature Coefficient



Capacitance Vs Frequency



**DF Vs Frequency** 

# Space Level - 3 kVDC to 20 kVDC

# **High Voltage Radial Leaded Disc Capacitors** Space Level - 3 kVDC to 20 kVDC



- 1. Lead Size: D30, D40 @ 0.025" ø (#22 AWG) [0.64 mm] D50 & larger @ 0.32" ø (#20 AWG) [0.81 mm]
- 2. Lead Finish: Solder Plate Standard / RoHS 100% Tin Plate
- 3. Order of marking may vary depending on size of capacitor

CalRamic Technologies LLC manufactures a series of highly reliable, mission critical, single layer, conformally coated, leaded ceramic disc capacitors that are designed and manufactured under strict quality control guidelines to ensure unparalleled performance in high voltage space level applications.

These capacitors, which draw on thirty plus years of proven design and process experience, utilize double action pressing to minimize gradients within the dielectric powder and produce a finished capacitor with a uniform fired ceramic density.

Capacitors are available with ultra stable Class I, NPO dielectrics, essential where low losses and tight capacitance tolerances are critical and stable Class II, X5R, X7R, X5U and Z5U dielectric materials, which are intended for those applications where added dielectric losses and less precision can be tolerated.

These capacitors are ideally suited as snubbers for switching power supplies, coupling and decoupling capacitors, inverter circuitry, lighting ballasts, and other high voltage pulse applications.

Specification		Die	electric Type (EIA Designati	on)				
Specification	NPO (COG)	X7R	X5R	X5U	Z5U			
Material Classification	Type I, Ultra Stable, K76	Type II, Stable, K2350	Type II, Stable, K2500	Type II, Stable, K5000	Type II, Stable, K10000			
Coefficient of Thermal Expansion	9 x 10 <sup>-6</sup> / °C	11 x 10 <sup>-6</sup> / °C	11 x 10 <sup>-6</sup> / °C	11 x 10 <sup>-6</sup> / °C	11 x 10 <sup>-6</sup> / °C			
Density								
Operating Temperature Range	-55 to -	+125°C	-55 to	+85°C	+10 to +85°C			
Aging Rate	0	-2% Max per	decade hour	-3% Max per	decade hour			
Temperature Coefficient	±30 PPM / °C	±1	5%	+22 /	-56%			
Voltage Coefficient	Negligible	-20% Max	a @ WVDC	-35% Max	a @ WVDC			
Capacitance Range	1.4 pF to 350 pF	42 pF to 0.012 μF	44 pF to 0.012 μF	80 pF to 0.022 μF	150 pF to 0.045 μF			
Voltage Range			3 kVDC to 20 kVDC					
Insulation Resistance @ +25°C	100,000 MΩ or 1000 MΩ - μF, W/E is less							
Insulation Resistance @ T Max	x 10,000 MΩ or 100 MΩ - μF, W/E is less							
Dissipation Factor	0.1% Max		2.5%	Max				
DWV	1.5 x WVDC							

# **General Information**

- 1. Capacitors receive 100% Group A Inspection including Partial Discharge (Corona).
- 2. Ultrasonic examination (SLAM / CSAM) is available. Contact factory.
- 3. Group A testing and Group B Inspection when required, is performed in accordance with applicable requirements of MIL-PRF-49467, DSCC 87125, DSCC 89087 and NASA GSFC S-311-15C.
- 4. Custom voltages, package sizes and capacitance values available. Contact factory.
- 5. Higher voltage parts may require further encapsulation to prevent surface arc over and breakdown. When required, parts should first be cleaned and oven dried at +85°C. Care should be taken to select a suitable epoxy that will not apply mechanical stress to the part and de-airing of encapsulates is recommended.
- 6. Testing of higher voltage parts before installation and / or supplemental encapsulation, may be done in a suitable, non-contaminating dielectric fluid like FC-40.
- 7. Large ceramic capacitors, even leaded devices are susceptible to damage when exposed to thermal and / or mechanical shock. Refer to Technical Bulletin AN103 for handling and installation recommendations.

# **Electrical / Mechanical Characteristics**

Working	Disc	D	imens	ions [i	ns [in] Capacitance Range [pF]										
Voltage	Style	D Max	S±	TMax	MMax	N	PO	X	5R	Х	7R	Х	5U	Z	5U
	-	Diviax	0.030	IWAX	WI WIAX	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
	D30	0.300	0.250	0.210	0.125	8.4	12	270	370	260	350	500	670	1000	1300
	D40	0.400	0.250	0.210	0.125	12	24	410	780	380	730	730	1400	1500	2900
	D50	0.500	0.375	0.210	0.125	28	46	920	1500	870	1400	1700	2700	3400	5600
	D60	0.600	0.375	0.210	0.125	38	61	1300	2000	1200	1900	2200	3600	6000	7300
		0.700	0.500	0.210	0.125	63	95	2100	3100	2000	2900	3700	5600	7500	11000
¥		0.000	0.500	0.210	0,125	94	160	3700	5300	2900	5000	6600	9500	13000	10000
<u>ب</u>	D100	1 000	0.500	0.210	0.125	150	200	5000	6500	4700	6200	9000	12000	18000	13000
	D120	1,200	0.500	0.210	0.125	200	310	6600	10000	6200	9500	12000	18000	24000	36000
	D140	1.400	0.625	0.210	0.125	310	350	10000	12000	9600	12000	19000	22000	37000	45000
	D30	0.300	0.250	0.250	0.125	5,1	6.9	160	220	150	210	300	400	600	820
	D40	0.400	0.250	0.250	0.125	7.3	15	250	473	230	440	440	850	900	1700
	D50	0.500	0.375	0.250	0.125	17	28	560	920	520	860	1000	1600	2100	3300
U U	D60	0.600	0.375	0.250	0.125	23	37	760	1200	700	1100	1400	2200	3600	4300
6	D70	0.700	0.500	0.250	0.125	38	57	1300	1800	1200	1800	2300	3400	4500	6700
2	D80	0.800	0.500	0.250	0.125	57	69	1900	2300	1800	2100	3400	4000	6800	8200
2	D90	0.900	0.500	0.250	0.125	69	97	2200	3100	2100	3000	4000	5700	8100	11000
	D100	1.000	0.500	0.250	0.125	92	120	3000	3900	2900	3700	5500	7100	11000	14000
	D120	1.200	0.500	0.250	0.125	120	180	3900	6100	3800	5700	7200	11000	14000	22000
	D140	1.400	0.625	0.250	0.125	190	230	6200	7500	5800	7000	11000	13000	22000	27000
	D30	0.300	0.250	0.310	0.150	3.4	4.6	110	150	100	150	200	270	400	540
	D40	0.400	0.250	0.310	0.150	5	9.6	1/0	310	150	300	300	5/0	600	1100
U	D50	0.500	0.375	0.310	0,150	12	19	510	800	350	280	000	1450	2400	2200
6	D00	0.000	0.375	0.310	0.150	15	20	910 920	1200	470	1200	900	2200	2400	2900
2	D80	0.700	0.500	0.310	0.150	37	46	1300	1200	1200	1200	2200	2200	4500	5400
5	D90	0.900	0.500	0.310	0.150	45	65	1500	2100	1400	2000	2700	3800	5400	7600
۷.	D100	1,000	0,500	0,310	0,150	60	80	2000	2600	1900	2500	3700	4700	7300	9500
	D120	1.200	0.500	0.310	0.150	80	120	2600	3300	2500	3800	4800	7400	9500	14000
	D140	1,400	0.625	0.310	0.150	120	150	4100	5000	3800	4700	7400	9000	15000	18000
	D30	0.300	0.250	0.440	0.170	2.5	3.5	84	110	78	110	150	200	300	410
	D40	0.400	0.250	0.440	0.170	3.8	7.2	120	230	110	220	220	420	450	850
	D50	0.500	0.375	0.440	0.170	8.5	14	280	480	260	430	500	820	1000	1600
	D60	0.600	0.375	0.440	0.170	12	18	380	600	350	560	680	1000	1800	2100
	D70	0.700	0.500	0.440	0.170	19	28	620	940	580	880	1100	1700	2300	3400
×	D80	0.800	0.500	0.440	0.170	28	34	930	1100	870	1100	1700	2000	3400	4100
9	D90	0.900	0.500	0.440	0.170	34	48	1100	1600	1000	1500	2000	2900	4000	5700
_	D100	1.000	0.500	0.440	0.170	46	60	1500	2000	1400	1800	2700	3500	5500	7100
	D120	1,200	0.500	0.440	0.170	60	93	2000	3000	1900	2800	3600	5500	7200	11000
	D140	0.200	0.025	0.440	0.170	94	22	5100	3700	2900	3500	100	120	200	270
	D30	0.300	0.250	0.545	0.175	2.4	4.8	52	160	76	150	100	280	300	570
	D40	0.400	0.250	0.545	0.175	5.7	94	180	300	180	290	330	550	700	1100
U U	D60	0.600	0.375	0.545	0.175	7.7	12	250	400	230	370	450	720	1200	1400
e e	D70	0.700	0.500	0.545	0.175	12	20	410	620	390	590	750	1100	1500	2200
2	D80	0.800	0.500	0.545	0.175	19	23	620	760	580	710	1100	1360	2300	2700
5	D90	0.900	0.500	0.545	0.175	23	32	740	1000	690	1000	1300	1900	2700	3800
-	D100	1.000	0.500	0.545	0.175	30	40	1000	1300	950	1200	1800	2400	3700	4700
	D120	1.200	0.500	0.545	0.175	40	60	1300	2000	1300	1900	2400	3600	4800	7300
	D140	1.400	0.625	0.545	0.175	60	77	2100	2500	1900	2300	3700	4500	7500	9000
	D50	0.500	0.375	0.650	0.175	4.6	6.8	150	220	140	210	270	400	500	830
	D60	0.600	0.375	0.650	0.175	6.2	8.9	200	290	190	270	360	520	890	1000
	D70	0.700	0.500	0.650	0.175	10	14	330	450	310	430	600	820	1200	1700
	D80	0.800	0.500	0.650	0.175	15	17	500	550	470	520	900	1000	1700	2000
L X	D90	0.900	0.500	0.650	0.175	18	23	600	770	560	720	1100	1400	2000	2800
50	D100	1.000	0.500	0.650	0.175	24	30	800	960	760	900	1500	1700	2800	300
	D120	1.200	0.500	0.650	0.175	32	45	1000	1500	1000	1400	1900	2600	3600	5500
	D140	1.400	0.625	0.650	0.175	50	56	1700	1800	1600	1700	3000	3300	5600	6800

**Performance Characteristics** 

Space Level - 3 kVDC to 20 kVDC



Performance Charts (Typical)



Class II Temperature Coefficient



Voltage Coefficient



NPO Temperature Coefficient



Capacitance Vs Frequency







(775) 851-3580 / calramic.com / 5462 Louie Lane / Reno, NV 89511 USA

# **High Voltage Radial Leaded Disc Capacitors** Military & Commercial Grade - 3 kVDC to 20 kVDC



- 1. Lead Size: D30, D40 @ 0.025" ø (#22 AWG) [0.64 mm] D50 & larger @ 0.32" ø (#20 AWG) [0.81 mm]
- Lead Finish: Solder Plate Standard / RoHS 100% Tin Plate 2.
- 3. Order of marking may vary depending on size of capacitor

# **Performance Characteristics**

		5		}					
Specification		Die	electric Type (EIA Designati	on)					
opecification	NPO (COG)	X7R	X5R	esignation)           X5U         Z5U           (2500         Type II, Stable, K5000         Type II, Stable, K100           2         11 x 10 <sup>-6</sup> / °C         11 x 10 <sup>-6</sup> / °C           -55 to +85°C         +10 to +85°C           -3% Max per decade hour         +22 / -56%           -35% Max @ WVDC         #F           80 pF to 0.022 μF         150 pF to 0.045 μI           VDC         #F, W/E is less           WE is less         WE is less	Z5U				
Material Classification	Type I, Ultra Stable, K76	Type II, Stable, K2350	Type II, Stable, K2500	Type II, Stable, K5000	Type II, Stable, K10000				
Coefficient of Thermal Expansion	9 x 10 <sup>-6</sup> / °C	11 x 10 <sup>-6</sup> / °C	11 x 10 <sup>-6</sup> / °C	11 x 10 <sup>-6</sup> / °C	11 x 10 <sup>-6</sup> / °C				
Density			72 g / in <sup>3</sup>						
Operating Temperature Range	-55 to	+125°C	-55 to	+85°C	+10 to +85°C				
Aging Rate	0	-2% Max per	decade hour	-3% Max per	decade hour				
Temperature Coefficient	±30 PPM / °C	±1	5%	+22 /	-56%				
Voltage Coefficient	Negligible	-20% Max	a @ WVDC	-35% Max	a @ WVDC				
Capacitance Range	1.4 pF to 350 pF	42 pF to 0.012 μF	44 pF to 0.012 μF	80 pF to 0.022 μF	150 pF to 0.045 μF				
Voltage Range			3 kVDC to 20 kVDC						
Insulation Resistance @ +25°C		100,00	00 MΩ or 1000 MΩ - μF, W/E	is less					
Insulation Resistance @ T Max		10,000 ΜΩ or 100 ΜΩ - μF, W/E is less							
Dissipation Factor	0.1% Max		2.5%	Max					
DWV			1.5 x WVDC						

# **General Information**

- 1. Standard inspection and Group A testing, when required, is performed in accordance with applicable requirements of MIL-PRF-49467, DSCC 87125, DSCC 89087 and NASA GSFC S-311-15C.
- 2. Special testing including 100% Partial Discharge (Corona) is available upon request. Contact factory.
- 3. Custom voltages, package sizes and capacitance values available. Contact factory.
- 4. Higher voltage parts may require further encapsulation to prevent surface arc over and breakdown. When required, parts should first be cleaned and oven dried at +85°C. Silicone rubbers or a suitable epoxy may be used and de-airing of encapsulates is recommended.
- 5. Testing of higher voltage parts before installation and / or supplemental encapsulation, may be done in a suitable, non-contaminating dielectric fluid like FC-40.
- 6. Large ceramic capacitors, even leaded devices are susceptible to damage when exposed to thermal and / or mechanical shock. Refer to Technical Bulletin AN103 for handling and installation recommendations.

# **Military & Commercial**



(775) 851-3580 / calramic.com / 5462 Louie Lane / Reno, NV 89511 USA





CalRamic Technologies LLC manufactures a series of highly reliable, single layer, conformally coated, ceramic disc capacitors, designed with leaded terminals and intended for those applications where the capacitor may be exposed to higher levels of thermal and mechanical shock.

These capacitors are manufactured under strict quality control guidelines to ensure unparalleled performance in high voltage applications.

These capacitors, which draw on thirty plus years of proven design and process experience, utilize double action pressing to minimize gradients within the dielectric powder and produce a finished capacitor with a uniform fired ceramic density.

Capacitors are available with ultra stable Class I, NPO dielectrics, essential where low losses and tight capacitance tolerances are critical and stable Class II, X5R, X7R, X5U and Z5U dielectric materials, which are intended for those applications where added dielectric losses and less precision can be tolerated.

These capacitors are ideally suited as snubbers for switching power supplies, coupling and decoupling capacitors, inverter circuitry, lighting ballasts, and other high voltage pulse applications.

Military & Commercial Grade - 3 kVDC to 20 kVDC

### **Electrical / Mechanical Characteristics**

Nome         Sing         Date         Sing         Thot         M MA         PP<	Working	Disc	D	imensi	ions [i	n]				Capa	citance	Range	e [pF]			
Org         Data         Data <thd< td=""><td>Voltage</td><td>Style</td><td>D May</td><td>S ±</td><td>T May</td><td>M Max</td><td>N</td><td>°0</td><td>X</td><td>5R</td><td>X</td><td>7R</td><td>X</td><td>5U</td><td>Z</td><td>5U</td></thd<>	Voltage	Style	D May	S ±	T May	M Max	N	°0	X	5R	X	7R	X	5U	Z	5U
OTHER         Dial         Dial <thdial< th="">         Dial         Dial         <th< td=""><td></td><td></td><td>Dimax</td><td>0.030</td><td>T Max</td><td>WI WIAX</td><td>Min</td><td>Max</td><td>Min</td><td>Max</td><td>Min</td><td>Max</td><td>Min</td><td>Max</td><td>Min</td><td>Max</td></th<></thdial<>			Dimax	0.030	T Max	WI WIAX	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
OTA         Dial         Dial <thdial< th="">         Dial         Dial         D</thdial<>		D30	0.300	0.250	0.210	0.125	8.4	12	270	370	260	350	500	670	1000	1300
OTAL         DB0         0.080         0.375         0.470         0.126         0.84         0.1100         0.200         0.		D40	0.400	0.250	0.210	0.125	28	<u></u> 	920	1500	380	1400	1700	2700	3400	2900
OT         D.70         D	U	D60	0.600	0.375	0.210	0.125	38	61	1300	2000	1200	1900	2200	3600	6000	7300
Yet         U <thu< th="">         U         U         U</thu<>	ŏ	D70	0.700	0.500	0.210	0.125	63	95	2100	3100	2000	2900	3700	5600	7500	11000
OP         Desc         Desc <thdesc< th="">         Desc         <thdes< td=""><td>Ž</td><td>D80</td><td>0.800</td><td>0.500</td><td>0.210</td><td>0.125</td><td>94</td><td>110</td><td>3100</td><td>3800</td><td>2900</td><td>3500</td><td>5500</td><td>6800</td><td>11000</td><td>13000</td></thdes<></thdesc<>	Ž	D80	0.800	0.500	0.210	0.125	94	110	3100	3800	2900	3500	5500	6800	11000	13000
D100         1.000         0.300         1.210         0.725         1.80         2000         1.000         1.2000         1.0000         1.2000	3	D90	0.900	0.500	0.210	0.125	110	160	3700	5300	3500	5000	6600	9500	13000	19000
D124         1.120         0.200         0.110         0.125         1.000         0.000         1.0000         2.000         1.0000         4.000         1.0000         4.000         1.0000         4.000         1.0000         4.000         1.0000         4.000         1.0000         4.000         1.0000         4.000         1.0000         4.000         1.0000         4.000		D100	1.000	0.500	0.210	0.125	150	200	5000	6500	4700	6200	9000	12000	18000	23000
OTO         OTO <thot< th=""> <thoto< th=""> <thoto< th=""></thoto<></thoto<></thot<>		D120	1.200	0.500	0.210	0.125	200	310	10000	12000	9600	9500	12000	22000	24000	36000
OT         D <thd< th="">         D         <thd< th=""> <thd< th=""></thd<></thd<></thd<>		D30	0.300	0.250	0.250	0.125	5.1	6.9	160	220	150	210	300	400	600	820
D50         0.500         0.376         0.230         0.126         17         28         580         120         1800         1600         1600         1200         3300           D70         0.770         0.576         0.230         0.126         133         37         7760         1200         1800         2300         1400         2300         6000         6300         700         1000         1300         6300         700         11000         1400         200         770         1100         1400         200         770         1100         1400         200         770         1100         1400         200         1300         1300         1300         1300         1300         1300         1300         1300         1300         1300         1300         1300         1300		D40	0.400	0.250	0.250	0.125	7.3	15	250	473	230	440	440	850	900	1700
OF         0.600         0.375         0.250         0.125         23         37         760         1200         1700         1100         1400         2200         3800         4500           050         0.550         0.550         0.125         57         69         1900         2200         1800         1800         4800 <td></td> <td>D50</td> <td>0.500</td> <td>0.375</td> <td>0.250</td> <td>0.125</td> <td>17</td> <td>28</td> <td>560</td> <td>920</td> <td>520</td> <td>860</td> <td>1000</td> <td>1600</td> <td>2100</td> <td>3300</td>		D50	0.500	0.375	0.250	0.125	17	28	560	920	520	860	1000	1600	2100	3300
DT0         0.700         0.500         0.250         0.125         38         57         1300         1800         1200         1400         4500         6700         8200           D90         0.800         0.500         0.250         0.125         69         97         2200         3100         2100         3000         4800         6800         8200         8200           D10         1.000         0.500         0.250         0.125         120         180         3900         6100         3000         3900         4900         4500         700         11000         14000         14000         14000         14000         14000         14000         14000         14000         14000         14000         14000         14000         14000         14000         14000         14000         14000         14000         1400	U U	D60	0.600	0.375	0.250	0.125	23	37	760	1200	700	1100	1400	2200	3600	4300
Ye         D80         0.800         0.500         0.220         0.121         67         68         1900         2000         2100         2100         2400         48	5	D70	0.700	0.500	0.250	0.125	38	57	1300	1800	1200	1800	2300	3400	4500	6700
OP         D300         C3000         C3000 <thc300< th=""> <thc300< th=""> <thc300< td="" th<=""><td>Ř</td><td>D80</td><td>0.800</td><td>0.500</td><td>0.250</td><td>0.125</td><td>57</td><td>69</td><td>1900</td><td>2300</td><td>1800</td><td>2100</td><td>3400</td><td>4000</td><td>6800</td><td>8200</td></thc300<></thc300<></thc300<>	Ř	D80	0.800	0.500	0.250	0.125	57	69	1900	2300	1800	2100	3400	4000	6800	8200
D120         1.200         0.500         0.229         0.125         120         180         3900         1500         3800         7700         7200         11000         14001         22000         22000           D140         1.400         0.226         0.210         0.115         190         220         6200         7800         3800         7000         11000         13000         22000         2700           D140         1.400         0.226         0.310         0.150         5         9.6         170         310         150         3800         700         300         1400         1400         22001         2700         1400         1400         22001         2700         460         340         340         340         310         150         15         25         510         800         700         3000         4400         340         3000         4500         3000         4500         3000         4500         3000         4500         300         300         300         300         300         300         300         300         300         300         300         300         300         300         300         300         300         300 <td>5</td> <td>D90</td> <td>1 000</td> <td>0.500</td> <td>0.250</td> <td>0.125</td> <td>92</td> <td>97</td> <td>3000</td> <td>3900</td> <td>2100</td> <td>3700</td> <td>5500</td> <td>5700 7100</td> <td>11000</td> <td>14000</td>	5	D90	1 000	0.500	0.250	0.125	92	97	3000	3900	2100	3700	5500	5700 7100	11000	14000
D140         1.400         0.425         0.250         0.125         190         230         6200         7500         5800         7000         1100         1300         2200         2700           D30         0.300         0.280         0.310         0.150         3.4         4.6         110         190         190         180         200         270         400         540           D40         0.400         0.280         0.310         0.150         12         19         370         610         380         580         670         1100         1400         2200         3200         4200         2200         300         570         660         1100         1400         2200         300         4500         5400           D50         0.500         0.310         0.150         45         65         1500         1400         2200         3000         4500         5400         780         1200         1600         2000         2700         3800         5400         7800         9500         1400         100         1400         200         700         700         950         1400         100         1400         1400         100         1400		D100	1.200	0.500	0.250	0.125	120	180	3900	6100	3800	5700	7200	11000	14000	22000
PY         0.300         0.280         0.310         0.190         1.50         200         270         400         5400           PY         0         0.280         0.310         0.150         5         354         170         310         150         300         570         600         1100         1100         1100         120         270         610         350         380         470         170         1700		D140	1.400	0.625	0.250	0.125	190	230	6200	7500	5800	7000	11000	13000	22000	27000
PA0         0.400         0.280         0.310         0.190         12         130         130         130         300         570         600         1100           POR         0.500         0.537         0.310         0.150         12         13         370         610         350         580         570         100         1400         2200         2200           DF0         0.500         0.375         0.310         0.150         12         25         38         830         1200         780         1200         1200         2200         2000         2000         4600		D30	0.300	0.250	0.310	0.150	3.4	4.6	110	150	100	150	200	270	400	540
OP         D50         0.500         0.375         0.310         0.150         12         19         370         610         350         580         670         1100         1400         2200           D70         0.500         0.337         0.510         15         22         38         830         1200         1200         1400         2200         2700         4500         2500           D80         0.800         0.500         0.310         0.150         27         46         1300         1500         1200         1400         2200         2700         4500         5500           D80         0.800         0.500         0.310         0.150         42         1500         2100         1400         2200         2700         4500         5500           D100         1.000         0.500         0.310         0.150         120         120         1200         1400         2000         3700         4700         7400         9500           D100         1.400         0.602         0.310         0.170         2.5         3.5         84         110         150         120         220         220         220         420         450		D40	0.400	0.250	0.310	0.150	5	9.6	170	310	150	300	300	570	600	1100
Prod         0.700 <th< td=""><td>Ö</td><td>D50</td><td>0.500</td><td>0.375</td><td>0.310</td><td>0.150</td><td>12</td><td>19</td><td>370</td><td>610</td><td>350</td><td>580</td><td>670</td><td>1100</td><td>1400</td><td>2200</td></th<>	Ö	D50	0.500	0.375	0.310	0.150	12	19	370	610	350	580	670	1100	1400	2200
Product         0.700         <	ğ	D60	0.600	0.375	0.310	0.150	15	25	510	800	470	750	900	1450	2400	2900
D00         0.000         0	Ş		0.700	0.500	0.310	0.150	25	38	830	1200	1200	1200	2200	2200	3000	4500
D100         1.000         0.500         0.310         0.150         60         80         2000         2600         1900         2200         3700         4700         7300         9500           D120         1.200         0.500         0.310         0.150         80         120         2600         3300         2500         3800         4800         7400         9500         14000           D140         1.400         0.622         0.310         0.150         120         150         110         78         110         150         200         3000         4400           D30         0.400         0.250         0.440         0.170         2.5         3.5         84         110         78         110         150         200         300         410           D50         0.500         0.375         0.440         0.170         18         72         120         230         110         130         200         300         420         430         300         140         200         300         200         1300         700         200         1400         1400         1400         1400         200         1400         200         200         <	5	D90	0.900	0.500	0.310	0.150	45	40 65	1500	2100	1400	2000	2700	3800	4300 5400	7600
D120         1.200         0.500         0.310         0.150         80         120         2800         3300         2800         3800         4800         7400         9800         14000           D140         1.400         0.625         0.310         0.150         120         1100         5000         3800         4700         7400         9000         15000         18000           D40         0.400         0.250         0.440         0.170         2.5         3.5         84         110         78         110         120         220         420         450         850           D50         0.500         0.375         0.440         0.170         12         18         380         600         350         680         1000         1800         2100         2300         1100         1700         2300         4400         580         880         1100         1700         2300         4400         580         880         1100         1700         2300         4400         580         580         580         580         580         580         580         580         580         580         580         580         580         580         580	7.	D100	1.000	0.500	0.310	0.150	60	80	2000	2600	1900	2500	3700	4700	7300	9500
D140         1.400         0.625         0.310         0.150         120         150         4100         5000         3800         4700         7400         9000         15000         16000           D30         0.300         0.256         0.440         0.170         2.5         3.5         84         110         78         110         150         200         300         410           D40         0.400         0.256         0.440         0.170         8.5         14         280         480         260         430         500         820         1000         1600         1600         210         <		D120	1.200	0.500	0.310	0.150	80	120	2600	3300	2500	3800	4800	7400	9500	14000
D30         0.300         0.250         0.440         0.170         2.5         3.5         84         110         78         110         150         200         300         410           D40         0.400         0.250         0.440         0.170         3.8         7.2         120         210         110         220         420         450         850           D50         0.500         0.375         0.440         0.170         8.5         14         280         480         260         430         500         820         1000         1600         2100         2100         2100         2400         430         2100         100         1500         2000         3400         440         2100         3400         4100         1600         1000         100         100         1000         1000         1000         1000         1000         1000         1000         0.440         0.170         28         34         930         1100         1500         2000         3400         4100         100         1500         2000         3400         4100         1000         1500         2000         3400         1700         1000         1000         1000		D140	1.400	0.625	0.310	0.150	120	150	4100	5000	3800	4700	7400	9000	15000	18000
D40         0.400         0.250         0.440         0.170         3.8         7.2         120         230         110         220         420         450         650           D50         0.500         0.375         0.440         0.170         8.5         14         280         480         260         430         500         820         1000         1600           D60         0.600         0.375         0.440         0.170         12         18         380         600         350         560         680         1000         1800         2100           D70         0.700         0.500         0.440         0.170         28         34         930         1100         1700         1700         2300         3400           D80         0.500         0.440         0.170         28         34         930         1100         1500         2000         3500         5500         7100           D100         1.000         0.500         0.440         0.170         60         93         2000         300         1800         2700         3500         5500         7100           D100         1.400         0.625         0.4440		D30	0.300	0.250	0.440	0.170	2.5	3.5	84	110	78	110	150	200	300	410
Provide         Disol         0.300         0.315         0.440         0.170         8.5         14         280         480         260         430         500         820         1000         1600           D60         0.600         0.375         0.440         0.170         12         18         380         600         350         560         680         1000         1800         2300         3400           D70         0.700         0.500         0.440         0.170         28         34         930         1100         1700         2300         3400         4100           D80         0.800         0.500         0.440         0.170         28         34         930         1100         1700         2000         3400         4100         1800         2700         3500         500         700         700         1000         1.000         1300         2700         3500         500         500         710         44         110         3100         3700         2800         3600         5500         7200         11000         1300         1300         1300         2800         3600         5500         7200         11000         1300         130		D40	0.400	0.250	0.440	0.170	3.8	7.2	120	230	110	220	220	420	450	850
Dir         Dir <thdir< th=""> <thdir< th=""> <thdir< th=""></thdir<></thdir<></thdir<>	U	D50	0.500	0.375	0.440	0.170	8.5	14	280	480	260	430	500 680	820	1000	2100
Prop         D80         0.500         0.440         0.170         28         34         930         1100         870         1100         1700         200         3400         4100           D90         0.900         0.500         0.440         0.170         34         48         1100         1600         1000         1500         2000         2000         3600         5700           D100         1.000         0.500         0.440         0.170         46         60         1500         2000         1800         2700         3500         5500         7100           D120         1.200         0.500         0.440         0.170         94         110         3100         3700         2900         3500         5500         7200         11000         1300         200         270         3500         570         770         720         11000         1300         200         270         350         570         770         770         12         250         400         230         370         450         720         1100         1300         200         270         300         780         770         122         250         400         230	Q	D00	0.700	0.500	0.440	0.170	12	28	620	940	580	880	1100	1700	2300	3400
D90         0.900         0.500         0.440         0.170         34         48         1100         1600         1500         2000         2900         4000         5700           D100         1.000         0.500         0.440         0.170         46         60         1500         2000         1400         1800         2700         3500         5500         7100           D120         1.200         0.500         0.440         0.170         94         110         3100         3700         2800         3600         5500         7200         1300         1300         1300         2700         2800         3600         5500         7200         1300         1300         1300         270         2800         3600         5500         7200         1300         1300         270         270         270         270         2800         3600         5500         765         52         71         100         130         200         270         120         1400         1300         130         2800         3600         550         700         1100         130         200         270         120         1400         1300         2800         370         450 <td>X</td> <td>D80</td> <td>0.800</td> <td>0.500</td> <td>0.440</td> <td>0.170</td> <td>28</td> <td>34</td> <td>930</td> <td>1100</td> <td>870</td> <td>1100</td> <td>1700</td> <td>2000</td> <td>3400</td> <td>4100</td>	X	D80	0.800	0.500	0.440	0.170	28	34	930	1100	870	1100	1700	2000	3400	4100
D100         1.000         0.500         0.440         0.170         46         60         1500         2000         1400         1800         2700         3500         5500         7100           D120         1.200         0.500         0.440         0.170         66         93         2000         3000         1900         2800         3600         5500         7200         11000           D140         1.400         0.625         0.440         0.175         1.6         2.3         55         76         52         71         100         130         200         2700           D40         0.400         0.250         0.545         0.175         2.4         4.8         52         160         76         150         150         280         300         570           D50         0.500         0.375         0.545         0.175         7.7         12         220         400         230         370         450         720         1200         1400           D70         0.700         0.500         0.545         0.175         12         20         410         620         390         590         750         1100         1500 <td< td=""><td>0</td><td>D90</td><td>0.900</td><td>0.500</td><td>0.440</td><td>0.170</td><td>34</td><td>48</td><td>1100</td><td>1600</td><td>1000</td><td>1500</td><td>2000</td><td>2900</td><td>4000</td><td>5700</td></td<>	0	D90	0.900	0.500	0.440	0.170	34	48	1100	1600	1000	1500	2000	2900	4000	5700
D120         1.200         0.500         0.440         0.170         60         93         2000         3000         1900         2800         3600         5500         7200         11000           D140         1.400         0.625         0.440         0.170         94         110         3100         3700         2900         3500         5600         6800         11000         13000           D30         0.300         0.250         0.545         0.175         1.6         2.3         55         76         52         71         100         130         200         270           D40         0.400         0.250         0.545         0.175         5.7         9.4         180         300         180         290         330         550         700         1100           D60         0.600         0.375         0.545         0.175         7.7         12         250         400         230         370         450         720         1200         1400           D70         0.700         0.500         0.545         0.175         12         20         410         620         380         790         1100         1300         2300	~	D100	1.000	0.500	0.440	0.170	46	60	1500	2000	1400	1800	2700	3500	5500	7100
D140         1.400         0.625         0.440         0.170         94         110         3100         3700         2900         3500         5600         6800         11000         13000           D30         0.300         0.2550         0.545         0.175         1.6         2.3         55         76         52         71         100         130         200         270           D40         0.400         0.250         0.545         0.175         2.4         4.8         52         160         76         150         150         280         300         270         200         330         550         700         1100           D50         0.500         0.375         0.545         0.175         7.7         12         250         400         230         370         450         720         1200         1400           D70         0.700         0.500         0.545         0.175         12         20         410         620         390         590         750         1100         1500         2200           D80         0.800         0.500         0.545         0.175         13         32         740         1000         690<		D120	1.200	0.500	0.440	0.170	60	93	2000	3000	1900	2800	3600	5500	7200	11000
D30         0.300         0.230         0.345         0.175         1.6         2.3         55         76         52         71         100         130         200         270           D40         0.400         0.250         0.545         0.175         2.4         4.8         52         160         76         150         150         280         300         570           D50         0.500         0.375         0.545         0.175         5.7         9.4         180         300         180         290         330         550         700         1100           D60         0.600         0.375         0.545         0.175         7.7         12         250         400         230         370         450         720         1200         1400           D70         0.700         0.500         0.545         0.175         12         20         410         620         390         590         750         1100         1500         2300         2700           D80         0.800         0.500         0.545         0.175         23         32         740         1000         690         1000         1300         2300         3700		D140	1.400	0.625	0.440	0.170	94	110	3100	3700	2900	3500	5600	6800	11000	13000
Dire         0.000		D30 D40	0.300	0.250	0.545	0.175	24	<u> </u>	52	160	52 76	/1 150	100	280	200	570
Discurs         Discurs         0.545         0.175         7.7         12         250         400         230         370         450         720         1200         1400           D70         0.700         0.500         0.545         0.175         12         20         410         620         390         590         750         1100         1500         2200           D80         0.800         0.500         0.545         0.175         19         23         620         760         580         710         1100         1360         2300         2700           D90         0.900         0.500         0.545         0.175         13         32         740         1000         690         1000         1300         1900         2700         3800           D100         1.000         0.500         0.545         0.175         40         60         1300         2000         1300         1900         2400         3600         4800         7300           D140         1.400         0.625         0.545         0.175         4.6         6.8         150         220         140         210         270         400         500         830		D40 D50	0.500	0.375	0.545	0.175	5.7	9.4	180	300	180	290	330	550	700	1100
DT0         0.700         0.500         0.545         0.175         12         20         410         620         390         590         750         1100         1500         2200           D80         0.800         0.500         0.545         0.175         19         23         620         760         580         710         1100         1360         2300         2700           D90         0.900         0.500         0.545         0.175         23         32         740         1000         690         1000         1300         1900         2700         3800           D100         1.000         0.500         0.545         0.175         23         32         740         1000         690         1000         1300         1900         2300         3800           D100         1.000         0.500         0.545         0.175         40         60         1300         200         1300         1900         2400         3600         4800         7500         900           D120         1.400         0.625         0.545         0.175         6.2         8.9         200         290         1900         270         360         520	с С	D60	0.600	0.375	0.545	0.175	7.7	12	250	400	230	370	450	720	1200	1400
Y         D80         0.800         0.500         0.545         0.175         19         23         620         760         580         710         1100         1360         2300         2700           D90         0.900         0.500         0.545         0.175         23         32         740         1000         690         1000         1300         1900         2700         3800           D100         1.000         0.500         0.545         0.175         23         32         740         1000         690         1000         1300         1900         2700         3800           D100         1.000         0.500         0.545         0.175         30         40         1000         1300         950         1200         1800         2400         3600         4700           D120         1.200         0.500         0.545         0.175         60         77         2100         2500         1900         2300         3700         4500         7500         9300           D50         0.500         0.375         0.650         0.175         6.2         8.9         200         290         190         270         360         520		D70	0.700	0.500	0.545	0.175	12	20	410	620	390	590	750	1100	1500	2200
D90         0.900         0.500         0.545         0.175         23         32         740         1000         690         1000         1300         1900         2700         3800           D100         1.000         0.500         0.545         0.175         30         40         1000         1300         950         1200         1800         2400         3700         4700           D120         1.200         0.500         0.545         0.175         40         60         1300         2000         1300         1900         2400         3600         4800         7300           D140         1.400         0.625         0.545         0.175         60         77         2100         2500         1900         2300         3600         4500         7300           D50         0.500         0.375         0.650         0.175         6.2         8.9         200         290         190         270         360         520         890         1000           D60         0.600         0.375         0.650         0.175         10         14         330         450         310         430         600         820         1200         1700	X	D80	0.800	0.500	0.545	0.175	19	23	620	760	580	710	1100	1360	2300	2700
D100         1.000         0.500         0.545         0.175         30         40         1000         1300         950         1200         1800         2400         3700         4700           D120         1.200         0.500         0.545         0.175         40         60         1300         2000         1300         1900         2400         3600         4800         7300           D140         1.400         0.625         0.545         0.175         60         77         2100         2500         1900         2300         3600         4800         7300           D50         0.500         0.375         0.650         0.175         6.2         8.9         200         290         190         270         360         520         890         1000           D60         0.600         0.375         0.650         0.175         6.2         8.9         200         290         190         270         360         520         890         1000           D70         0.700         0.500         0.650         0.175         10         14         330         450         310         430         600         820         1200         1700	15	D90	0.900	0.500	0.545	0.175	23	32	740	1000	690	1000	1300	1900	2700	3800
D120         1.200         0.300         0.343         0.175         40         600         1300         2000         1300         2400         3000         4800         7300           D140         1.400         0.625         0.343         0.175         60         77         2100         2500         1900         2300         3700         4500         7500         9000           D50         0.500         0.375         0.650         0.175         4.6         6.8         150         220         140         210         270         400         500         830           D60         0.600         0.375         0.650         0.175         6.2         8.9         200         290         190         270         360         520         890         1000           D70         0.700         0.500         0.650         0.175         10         14         330         450         310         430         600         820         1200         1700           D80         0.800         0.500         0.650         0.175         15         17         500         550         470         520         900         1000         1700         2000		D100	1.000	0.500	0.545	0.175	30	40	1000	1300	950	1200	1800	2400	3700	4700
D50         0.500         0.375         0.650         0.175         4.6         6.8         150         2200         1400         2100         7000         7000         7000         5000         830           D60         0.600         0.375         0.650         0.175         6.2         8.9         200         290         190         270         360         520         890         1000           D70         0.700         0.500         0.650         0.175         10         14         330         450         310         430         600         820         1200         1700         2000           D80         0.800         0.500         0.650         0.175         15         17         500         550         470         520         900         1000         1700         2000           D90         0.900         0.500         0.650         0.175         18         23         600         770         560         720         1100         1400         2000         2000           D100         1.000         0.500         0.650         0.175         18         23         600         770         560         720         1100 <th< td=""><td></td><td>D120</td><td>1 400</td><td>0.500</td><td>0.545</td><td>0.175</td><td>60</td><td>77</td><td>2100</td><td>2500</td><td>1900</td><td>2300</td><td>3700</td><td>4500</td><td>7500</td><td>9000</td></th<>		D120	1 400	0.500	0.545	0.175	60	77	2100	2500	1900	2300	3700	4500	7500	9000
D60         0.600         0.375         0.650         0.175         6.2         8.9         200         290         190         270         360         500         000           D70         0.700         0.500         0.650         0.175         10         14         330         450         310         430         600         820         1200         1700           D80         0.800         0.500         0.650         0.175         15         17         500         550         470         520         900         1000         1700         2000           D90         0.900         0.500         0.650         0.175         18         23         600         770         560         720         1100         1400         2000         2800           D90         0.900         0.500         0.650         0.175         18         23         600         770         560         720         1100         1400         2000         2800           D100         1.000         0.500         0.650         0.175         32         45         1000         1500         1500         1500         300         3600         5500         5500		D50	0.500	0.375	0.650	0.175	4.6	6.8	150	220	140	210	270	400	500	830
D70         0.700         0.500         0.650         0.175         10         14         330         450         310         430         600         820         1200         1700           D80         0.800         0.500         0.650         0.175         15         17         500         550         470         520         900         1000         1700         2000           D90         0.900         0.500         0.650         0.175         18         23         600         770         560         720         1100         1400         2000         2800           D100         1.000         0.500         0.650         0.175         24         30         800         960         760         900         1500         1700         2800         300           D120         1.200         0.500         0.650         0.175         32         45         1000         1500         1400         1900         2600         3600         5500           D140         1.400         0.625         0.650         0.175         50         56         1700         1800         1600         1700         3000         3300         5600         6800		D60	0.600	0.375	0.650	0.175	6.2	8.9	200	290	190	270	360	520	890	1000
D80         0.800         0.500         0.650         0.175         15         17         500         550         470         520         900         1000         1700         2000           D90         0.900         0.500         0.650         0.175         18         23         600         770         560         720         1100         1400         2000         2800           D100         1.000         0.500         0.650         0.175         24         30         800         960         760         900         1500         1700         2800         300         300         3600         5500         1500         1500         1500         1500         1500         1500         1500         1500         1500         3600         5500         5500         5500         5500         5500         5500         5500         5500         5500         5500         5500         5500         5500         5600         5500         5600         5600         5600         5600         5600         5600         5600         5600         5600         5600         5600         5600         5600         5600         5600         5600         5600         5600	2 2	D70	0.700	0.500	0.650	0.175	10	14	330	450	310	430	600	820	1200	1700
Y         D90         0.900         0.500         0.650         0.175         18         23         600         770         560         720         1100         1400         2000         2800           D100         1.000         0.500         0.650         0.175         24         30         800         960         760         900         1500         1700         2800         300           D120         1.200         0.500         0.650         0.175         32         45         1000         1500         1400         1900         2600         3600         5500           D140         1.400         0.625         0.650         0.175         50         56         1700         1800         1600         1700         3000         3300         5600         6800	7	D80	0.800	0.500	0.650	0.175	15	17	500	550	470	520	900	1000	1700	2000
D100         1.000         0.500         0.650         0.175         24         30         800         960         760         900         1500         1700         2800         300           D120         1.200         0.500         0.650         0.175         32         45         1000         1500         1400         1900         2600         3600         5500           D140         1.400         0.625         0.650         0.175         50         56         1700         1800         1600         1700         3000         3300         5600         6800	X	D90	0.900	0.500	0.650	0.175	18	23	600	770	560	720	1100	1400	2000	2800
D140 1.400 0.625 0.650 0.175 50 56 1700 1800 1600 1700 3000 3300 5600 6800	20	D100	1,000	0.500	0.650	0.175	24	30	800 1000	960	760	900	1500	2600	2800	300
		D140	1.400	0.625	0.650	0.175	50	56	1700	1800	1600	1700	3000	3300	5600	6800



Performance Charts (Typical)



**Class II Temperature Coefficient** 



Voltage Coefficient



# NPO Temperature Coefficient



# Capacitance Vs Frequency

CRT-0006 Rev 1410

Negative TC Low Loss - 3 kVDC to 20 kVDC

# **High Voltage Radial Leaded Disc Capacitors** Negative TC Low Loss - 3 kVDC to 20 kVDC



- 1. Lead Size: D30, D40 @ 0.025" Dia (#22 AWG) [0.64 mm] D50 & larger @ 0.32" Dia (#20 AWG) [0.81 mm]
- 2. Lead Finish: Sn60 / Pb40 Solder

**Performance Characteristics** 

3. Order of marking may vary depending on size of capacitor

CalRamic Technologies LLC manufactures a series of highly reliable, single layer, conformally coated, negative temperature compensating, leaded ceramic disc capacitors that deliver both very stable and predictable performance characteristics typically associated with low loss dielectrics.

These capacitors, which draw on thirty plus years of proven design and process experience, are manufactured under strict quality control guidelines and utilize a double action press to minimize gradients within the dielectric powder, producing a finished capacitor with a uniform fired ceramic density and unparalleled performance in high voltage applications. Leaded construction limits risk for damage due to exposure to mechanical and thermal stress.

Essential where low losses and tight capacitance tolerances are critical, these capacitors are ideally suited as snubbers for switching power supplies, coupling and decoupling capacitors, inverter circuitry, lighting ballasts, and other high voltage pulse applications.

Creatification			Dielectric Type		
Specification	CR01	CR03	CR09	CR17	CR22
Material Classification	N750 (U2J)	N1500 (P3K)	N2200 (R3L)	N4700 (T3M)	N5600 (U3N)
Coefficient of Thermal Expansion	11 x 10 <sup>-6</sup> / °C	11 x 10 <sup>-6</sup> / °C	11 x 10 <sup>-6</sup> / °C	11 x 10 <sup>-6</sup> / °C	11 x 10 <sup>-6</sup> / °C
Density			- 72 g / in <sup>3</sup>		
Operating Temperature Range			-55 to +125°C		
Aging Rate			0		
Temperature Coefficient	-750 PPM / °C ±10% Max	-1500 PPM / °C ±17% Max	-2200 PPM / °C ±24% Max	-4700 PPM / °C ±52% Max	-5600 PPM / °C ±59% Max
Voltage Coefficient	-4% Max	@ WVDC		-7% Max @ WVDC	
Capacitance Range	2.0 pF to 600 pF	5.5 pF to 1699 pF	15 pF to 4500 pF	29 pF to 8500 pF	34 pF to 0.010 μF
Voltage Range			3 kVDC to 20 kVDC		-
Insulation Resistance @ +25°C		100,0	00 MΩ or 1000 MΩ - μF, W/E i	s less	
Insulation Resistance @ +125°C		10,0	00 MΩ or 100 MΩ - μF,W/E is	ess	
Dissipation Factor			0.2% Max		
DWV			1.5 x WVDC		

- 1. Standard inspection and Group A testing, when required, is performed in accordance with applicable requirements of MIL-PRF-49467, DSCC 87125, DSCC 89087 and NASA GSFC S-311-15C.
- 2. Group B Inspection is available upon request.
- 3. Special testing including 100% Partial Discharge (Corona) is available upon request. Contact factory.
- 4. Custom voltages, package sizes and capacitance values available. Contact factory.
- 5. Higher voltage parts may require further encapsulation to prevent surface arc over and breakdown. When required, parts should first be cleaned and oven dried at +85°C. Silicone rubbers or a suitable epoxy may be used and de-airing of encapsulates is recommended.
- 6. Testing of higher voltage parts before installation and / or supplemental encapsulation, may be done in a suitable, non-contaminating dielectric fluid like FC-40.
- 7. Large ceramic capacitors, even leaded devices are susceptible to damage when exposed to thermal and / or mechanical shock. Refer to Technical Bulletin AN103 for handling and installation recommendations.

# Electrical / Mechanical Characteristics

Wortage         Syde         Dmax         Syde         T Max         M Max         CRU         CCRU         More         Mine	Working	Disc	D	imensi	ions [i	n]				Сара	citance	e Rang	e [pF]			
Org         Data         Data <thdata< th="">         Data         Data         D</thdata<>	Voltage	Style		S±	т Мах	M Max	CF	R01	CF	R03	CF	R09	CF	817	CF	22
OPAR         0.33         0.33         0.10         0.10         10	•	-		0.030	I WIAX		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Pade         e.a.         o.g.         c.a.         c.a. <thc.a.< th="">         c.a.         c.a.</thc.a.<>		D30	0.3	0.25	0.210	0.125	14	18	37	50	100	130	190	250	230	300
OPA         D <thd< th="">         D         <thd< th=""> <thd< th=""></thd<></thd<></thd<>		D40	0.4	0.25	0.210	0.125	20	37	55	100	150	280	280	530	330	630
OTO         DE6         0.6         0.22         0.210         0.175         0.0         0.00         1200         1300         1400         1600         1200         1300         1200         1300         1200         1		D50	0.5	0.375	0.210	0.125	45	73	130	200	340	550	640	1000	750	1200
Drag         Drag <thdrag< th="">         Drag         Drag         <thd< td=""><td>Ö</td><td>D60</td><td>0.6</td><td>0.375</td><td>0.210</td><td>0.125</td><td>80</td><td>96</td><td>220</td><td>260</td><td>600</td><td>720</td><td>1200</td><td>1300</td><td>1400</td><td>1600</td></thd<></thdrag<>	Ö	D60	0.6	0.375	0.210	0.125	80	96	220	260	600	720	1200	1300	1400	1600
VE         BB0         0.4         0.5         0.110         0.112         130         140         420         500         1200         1200         2200 </td <td>2</td> <td>D70</td> <td>0.7</td> <td>0.5</td> <td>0.210</td> <td>0.125</td> <td>100</td> <td>150</td> <td>280</td> <td>410</td> <td>750</td> <td>1100</td> <td>1500</td> <td>2100</td> <td>1700</td> <td>2500</td>	2	D70	0.7	0.5	0.210	0.125	100	150	280	410	750	1100	1500	2100	1700	2500
OP0         0.9.0         0	Ϋ́	D80	0.8	0.5	0.210	0.125	150	180	420	500	1200	1300	2200	2500	2500	3000
PIAO         1         0.3         0.201         0.112         220         310         610         1300         1300         1300         1400         1400	3	D90	0.9	0.5	0.210	0.125	180	250	500	/00	1400	1900	2600	3600	3000	4200
D120         13         0.0.3         0.0.30 <th0.30< th="">         0.0.30         0.0.30</th0.30<>		D100	1	0.5	0.210	0.125	200	310	890	0/U 1200	2400	2300	3500	6000	4100 5200	9100
Of All         Li         0.22         1.2 <th1.2< th=""> <th1.2< t<="" td=""><td></td><td>D120</td><td>1.2</td><td>0.5</td><td>0.210</td><td>0.125</td><td>500</td><td>400 600</td><td>1400</td><td>1600</td><td>3800</td><td>4500</td><td>7100</td><td>8500</td><td>8300</td><td>10000</td></th1.2<></th1.2<>		D120	1.2	0.5	0.210	0.125	500	400 600	1400	1600	3800	4500	7100	8500	8300	10000
Of No         0.3         0.23         0.23         0.24         0.12         22         33         62         86         170 </td <td></td> <td>D140</td> <td>1.4</td> <td>0.025</td> <td>0.250</td> <td>0.125</td> <td>8</td> <td>10</td> <td>22</td> <td>30</td> <td>60</td> <td>82</td> <td>120</td> <td>150</td> <td>140</td> <td>180</td>		D140	1.4	0.025	0.250	0.125	8	10	22	30	60	82	120	150	140	180
Org         Dist         Dist <thdist< th="">         Dist         Dist         D</thdist<>		D30	0.3	0.25	0.250	0,125	12	22	33	62	89	170	170	320	200	370
Of No         0.6         0.33         0.230         0.122         44         57         140         150         830         830         820         800         920         920         930           D10         0.3         0.250         0.123         90         100         220         300         450         670         880         820         820         100         100           D20         0.3         0.250         0.123         100         100         230         420         100         100         100         100         100         100         100         100         200         420         100         100         200         420 <th< td=""><td></td><td>D40</td><td>0.4</td><td>0.375</td><td>0.250</td><td>0.125</td><td>27</td><td>44</td><td>74</td><td>120</td><td>210</td><td>330</td><td>390</td><td>620</td><td>450</td><td>730</td></th<>		D40	0.4	0.375	0.250	0.125	27	44	74	120	210	330	390	620	450	730
OF         0.7         0.3         0.220         0.122         0.9         170         240         450         670         850         1200         1000         1500 <td>U</td> <td>D60</td> <td>0.6</td> <td>0.375</td> <td>0.250</td> <td>0.125</td> <td>48</td> <td>57</td> <td>140</td> <td>150</td> <td>360</td> <td>430</td> <td>680</td> <td>820</td> <td>800</td> <td>960</td>	U	D60	0.6	0.375	0.250	0.125	48	57	140	150	360	430	680	820	800	960
P30         0.8         0.8         0.5         0.200         0.128         90         100         280         300         480         820         1300         1500         1900         1900         280           P30         0.9         0.9         0.9         0.9         0.9         0.9         0.9         0.9         0.9         0.9         0.9         0.9         0.9         0.9         0.9         0.9         0.9         0.9         0.90         200         1000         1000         2000	Ō	D70	0.7	0.5	0.250	0.125	60	90	170	240	450	670	850	1200	1000	1500
pg0         0.9         0.9         0.9         0.9         0.9         0.9         0.9         0.9         0.9         0.9         0.9         0.90         100         1100         1100         1100         1100         1100         1100         1100         1100         1100         1100         1000         200         200         400         200         200         400         200         200         400         200         400         200         400         200         400         200         400         200         400         400         200         400         400         200         400       <	Š	D80	0.8	0.5	0.250	0.125	90	100	250	300	680	820	1300	1500	1500	1800
D100         1         0.5         0.250         0.125         190         290         530         680         1500         1200         120         140         120         120         140         120         140         120         140         120         140         120         140         120         140         120         140         120         140         120         140         140         120         140         140         120         140         140         120         140         140         120         140         140         120         140         140         120         140         140         120         140         140         120         140         140         120         140         140         120         140         140         120         140         140         120         140         140         120         140         14	5	D90	0.9	0.5	0.250	0.125	110	150	300	420	810	1100	1600	2100	1800	2500
D120         1.2         0.5         0.230         0.125         190         230         800         1800         2200         2700         4100         3200         6000           D140         1.4         0.635         0.230         0.150         5.5         7         15         20         40         54         76         100         100         120         210         4300         540         500         4600           D40         0.4         0.55         0.310         0.150         8         12         24         41         60         110         120         200         410         300         480           D50         0.5         0.310         0.150         18         22         30         817         100         280         450         540         530         640           D50         0.5         0.310         0.150         660         172         110         200         280         540         850         1100         1200         120         120         120         120         120         120         120         120         120         120         120         120         120         120         120		D100	1	0.5	0.250	0.125	150	190	410	520	1100	1400	2100	2600	2500	3100
D140         1.4         0.625         0.726         0.0125         300         360         820         990         2200         2700         4300         5100         500         600         6000         6000         6000         6000         6000         6000         6000         6000         6000         6000         6000         6000         600<		D120	1.2	0.5	0.250	0.125	190	290	530	800	1500	2200	2700	4100	3200	4800
OP         0.30         0.33         0.25         0.310         0.150         85.5         7         15         20         40         84         76         100         88         120           D50         0.5         0.337         0.310         0.150         18         229         50         81         140         220         260         410         300         460           D50         0.6         0.6         0.737         0.310         0.150         32         38         87         100         240         280         450         540         850         670         1000         1200           D80         0.8         0.310         0.150         60         72         170         200         450         540         850         1000         1000         1200     <		D140	1.4	0.625	0.250	0.125	300	360	820	990	2300	2700	4300	5100	5000	6000
PA0         0.4         0.23         0.310         0.150         18         129         50         110         120         120         140         220         440         220         130         110         120         120         140         220         440         220         120         120         120         140         220         440         220         220         440         220         440         420         220         440         530         640         130         1400         1400         1400         1400         1400         1400         1400         1400         1400         1400         1400         1400         1400         1400         1400         1400		D30	0.3	0.25	0.310	0.150	5.5	7	15	20	40	54	76	100	89	120
OF         0.50         0.57         0.310         0.150         18         23         30         81         140         220         200         440         500         440         500         440         500         440         500         440         500         440         500         450         540         550         660         570         1000         1200<		D40	0.4	0.25	0.310	0.150	8	15	22	41	60	110	120	210	140	250
Prop         0.5.6         0.375         0.310         0.130         3.2         3.8         0.7         100         2.40         2.80         4.30         3.40         3.30         0.00           PT         0.70         0.5         0.310         0.150         60         72         170         200         450         550         670         1000         1000         1200         1200         1200         130         1300	C	D50	0.5	0.375	0.310	0.150	18	29	50	81	140	220	260	410	300	490
Prof.         0.70         0.9         0.310         0.130         0.100         100         100         100         100         100         1000         1	Ó	D60	0.6	0.375	0.310	0.150	32	38 60	87 110	100	240	280	450	940 850	530 670	1000
Date         Date <thdate< th="">         Date         Date         <thd< td=""><td>Ž</td><td>D70</td><td>0.7</td><td>0.5</td><td>0.310</td><td>0.150</td><td>40 60</td><td>72</td><td>170</td><td>200</td><td>450</td><td>430 540</td><td>370 850</td><td>1000</td><td>1000</td><td>1200</td></thd<></thdate<>	Ž	D70	0.7	0.5	0.310	0.150	40 60	72	170	200	450	430 540	370 850	1000	1000	1200
D         D <thd< th=""> <thd< th=""> <thd< th=""> <thd< th=""></thd<></thd<></thd<></thd<>	2	080	0.8	0.5	0.310	0.150	72	100	200	280	540	760	1100	1400	1200	1700
D100         1.2         0.5         0.30         0.150         130         190         350         530         950         1400         1800         2700         2200         320           D140         1.4         0.625         0.310         0.150         200         240         550         660         1800         2900         3400         3300         4000           D40         0.4         0.25         0.440         0.170         6         11         17         31         45         85         84         160         99         180           D50         0.5         0.375         0.440         0.170         14         22         37         60         110         160         200         310         230         360           D60         0.6         0.375         0.440         0.170         24         28         66         79         180         210         340         410         400         707         757         910           D90         0.9         0.5         0.440         0.170         75         140         210         410         500         410         400         200         1300         1300	7.	D90	0.9	0.5	0.310	0.150	98	120	270	340	730	950	1400	1700	1700	2100
D140         1.4         0.625         0.310         0.150         200         240         550         660         1500         1800         2900         3400         3300         4000           D30         0.3         0.25         0.440         0.170         4         5         11         15         30         41         57         77         67         91           D40         0.4         0.25         0.440         0.170         14         22         37         60         110         160         200         310         230         360           D50         0.5         0.375         0.440         0.170         14         22         37         60         110         160         200         310         230         360           D60         0.6         0.375         0.440         0.170         24         28         66         79         180         210         340         440         400         480         50         750         910         130         1300         1300         1300         1300         1300         1300         1300         1300         1300         1300         1300         1200         1300		D100	12	0.5	0.310	0.150	130	190	350	530	950	1400	1800	2700	2200	3200
D30         0.3         0.25         0.440         0.170         4         5         11         15         30         41         57         77         67         91           D40         0.4         0.25         0.440         0.170         6         11         17         31         45         85         84         160         99         180           D50         0.5         0.375         0.440         0.170         24         28         66         79         180         210         340         410         400         480           D60         0.6         0.375         0.440         0.170         24         28         66         79         180         210         340         440         400         480           D70         0.7         0.5         0.440         0.170         54         76         150         210         410         570         760         1000         1000         1200         1200         1300         1200         1300         1300         1200         1300         1300         1300         1200         1300         200         2500         2500         3000         1300         1200         1		D140	1.4	0.625	0.310	0.150	200	240	550	660	1500	1800	2900	3400	3300	4000
Dial         0.4         0.25         0.440         0.170         6         11         17         31         45         85         84         160         99         180           DS0         0.5         0.375         0.440         0.170         14         22         37         60         110         160         200         310         230         360           D50         0.5         0.375         0.440         0.170         24         28         66         79         180         210         340         410         400         480           D70         0.7         0.5         0.440         0.170         30         45         83         120         230         330         430         640         500         750           D80         0.8         0.5         0.440         0.170         73         95         210         210         410         570         760         100         1300         1300         1300         1300         1300         1300         1300         1300         1300         1300         1300         1300         1300         1300         1300         1300         1300         1300         1300		D30	0.3	0.25	0.440	0.170	4	5	11	15	30	41	57	77	67	91
D50         0.5         0.375         0.440         0.170         14         22         37         60         110         160         200         310         230         360           D60         0.6         0.375         0.440         0.170         24         28         66         79         180         210         340         410         400         480           D70         0.7         0.5         0.440         0.170         45         54         130         150         340         410         640         770         750         910           D80         0.8         0.5         0.440         0.170         45         54         130         150         340         410         640         770         750         910           D90         0.9         0.5         0.440         0.170         95         140         270         400         720         1100         1400         200         230         230         250         250         250         250         250         250         250         250         250         250         250         250         250         250         250         250         250         25		D40	0.4	0.25	0.440	0.170	6	11	17	31	45	85	84	160	99	180
DGQ         0.6         0.375         0.440         0.170         24         28         66         79         180         210         340         410         400         480           D70         0.7         0.5         0.440         0.170         30         45         83         120         230         330         430         640         500         750           D80         0.8         0.5         0.440         0.170         45         54         130         150         340         410         640         770         750         910           D90         0.9         0.5         0.440         0.170         73         95         210         280         550         710         1100         1300         1300         1300         1300         1300         1300         2200         250         250	43	D50	0.5	0.375	0.440	0.170	14	22	37	60	110	160	200	310	230	360
D70         0.7         0.5         0.440         0.170         30         45         83         120         230         330         430         640         500         750           D80         0.8         0.5         0.440         0.170         45         54         130         150         340         410         640         770         750         910           D90         0.9         0.5         0.440         0.170         73         95         210         260         550         710         1100         1300         <	õ	D60	0.6	0.375	0.440	0.170	24	28	66	79	180	210	340	410	400	480
DR0         0.8         0.5         0.440         0.170         45         54         130         150         340         410         640         770         750         910           D90         0.9         0.5         0.440         0.170         54         76         150         210         440         570         760         1100         900         900         1200           D100         1         0.5         0.440         0.170         73         95         120         260         550         710         1100         1300         1300         2200         2500         2500         260           D140         1.4         0.625         0.440         0.170         150         180         410         490         1200         1300         2200         2500         2500         300           D40         0.4         0.25         0.545         0.175         3         3.5         7.5         10         20         277         38         51         45         610           D50         0.5         0.545         0.175         20         30         55         82         150         220         200         450	5	D70	0.7	0.5	0.440	0.170	30	45	83	120	230	330	430	640	500	750
D90         0.9         0.5         0.440         0.170         54         76         150         210         410         570         760         1000         900         1200           D100         1         0.5         0.440         0.170         73         95         210         260         550         710         1100         1300         1300         1200           D120         1.2         0.5         0.440         0.170         150         140         270         400         720         1100         1400         2000         2500         2500         3000           D140         1.4         0.625         0.440         0.175         3         3.5         7.5         10         20         27         38         51         45         66           D40         0.4         0.25         0.545         0.175         4         7.5         11         20         30         56         56         100         66         120           D50         0.5         0.545         0.175         16         19         44         53         120         140         230         270         420         340         500         66	×	D80	0.8	0.5	0.440	0.170	45	54	130	150	340	410	640	770	750	910
D100         1         0.5         0.440         0.170         73         95         210         260         550         710         1100         1300         1300         1500           D120         1.2         0.5         0.440         0.170         95         140         270         400         720         1100         1400         2000         1600         2400           D140         1.4         0.625         0.440         0.170         150         180         410         490         1200         1200         1200         1200         1400         200         200         2500         2500         2500         300         66         160         160         410         490         1200         130         45         600           D40         0.4         0.25         0.545         0.175         4         7.5         11         20         30         56         56         100         66         120           D50         0.5         0.375         0.545         0.175         20         30         55         82         150         220         230         270         270         320         36         33         100	10	D90	0.9	0.5	0.440	0.170	54	76	150	210	410	570	760	1000	900	1200
D120         1.2         0.5         0.440         0.170         95         140         270         400         720         1100         1400         2000         1600         2400           D140         1.4         0.625         0.440         0.170         150         180         410         490         1200         1300         2200         2500         2500         3000           D30         0.3         0.25         0.545         0.175         3         3.5         7.5         10         200         1300         2200         2500         2500         3000           D40         0.4         0.25         0.545         0.175         4         7.5         11         20         30         56         56         100         66         120           D50         0.5         0.375         0.545         0.175         16         19         44         53         120         140         230         270         270         270         320           D60         0.6         0.375         0.545         0.175         30         36         83         100         230         270         430         510         500 <th< td=""><td></td><td>D100</td><td>1</td><td>0.5</td><td>0.440</td><td>0.170</td><td>73</td><td>95</td><td>210</td><td>260</td><td>550</td><td>710</td><td>1100</td><td>1300</td><td>1300</td><td>1500</td></th<>		D100	1	0.5	0.440	0.170	73	95	210	260	550	710	1100	1300	1300	1500
D140         1.4         0.625         0.440         0.176         130         160         410         430         1200         1300         2200         2500         2		D120	1.2	0.5	0.440	0.170	95	140	2/0	400	1200	1200	2200	2000	2500	2400
QQ         0.3         0.25         0.540         0.115         0         0.30         10		D140	1.4	0.625	0.440	0.175	3	3.5	7.5	490	20	27	38	2300	45	60
VI         0.12         0.11         111         11         111 <td></td> <td>D30</td> <td>0.3</td> <td>0.25</td> <td>0.545</td> <td>0.175</td> <td>4</td> <td>7.5</td> <td>11</td> <td>20</td> <td>30</td> <td>56</td> <td>56</td> <td>100</td> <td>66</td> <td>120</td>		D30	0.3	0.25	0.545	0.175	4	7.5	11	20	30	56	56	100	66	120
Disc         0.375         0.545         0.175         16         19         44         53         120         140         230         270         270         320           Digo         0.6         0.375         0.545         0.175         20         30         55         82         150         220         290         420         340         500           Digo         0.7         0.5         0.545         0.175         30         36         83         100         230         270         430         510         500         600           Digo         0.9         0.5         0.545         0.175         36         51         99         140         270         380         510         500         600         850           Di00         1         0.5         0.545         0.175         49         63         140         170         370         470         690         890         810         1000           Di100         1         0.5         0.545         0.175         64         97         180         260         480         730         900         1300         1100         1600         220         320		D40	0.4	0.25	0.545	0.175	9	14	25	40	68	110	130	200	150	240
Dro         0.7         0.5         0.545         0.175         20         30         55         82         150         220         290         420         340         500           Dro         0.7         0.5         0.545         0.175         20         30         55         82         150         220         290         420         340         500           D80         0.8         0.5         0.545         0.175         30         36         83         100         230         270         430         510         500         600           D90         0.9         0.5         0.545         0.175         36         51         99         140         270         380         510         720         600         850           D100         1         0.5         0.545         0.175         49         63         140         170         370         470         690         890         810         1000           D120         1.2         0.5         0.545         0.175         99         120         280         330         750         900         1500         1700         1700         200           D140 <td>Ö</td> <td>D60</td> <td>0.5</td> <td>0.375</td> <td>0.545</td> <td>0.175</td> <td>16</td> <td>19</td> <td>44</td> <td>53</td> <td>120</td> <td>140</td> <td>230</td> <td>270</td> <td>270</td> <td>320</td>	Ö	D60	0.5	0.375	0.545	0.175	16	19	44	53	120	140	230	270	270	320
Y         D80         0.8         0.5         0.545         0.175         30         36         83         100         230         270         430         510         500         600           D90         0.9         0.5         0.545         0.175         36         51         99         140         270         380         510         720         600         850           D100         1         0.5         0.545         0.175         49         63         140         170         370         470         690         890         810         1000           D120         1.2         0.5         0.545         0.175         64         97         180         260         480         730         900         1300         1100         1600           D140         1.4         0.625         0.545         0.175         7         11         19         30         51         83         96         150         120         180           D60         0.6         0.375         0.650         0.175         12         14         33         39         89         100         170         200         200         240         220	2	D70	0.7	0.5	0.545	0.175	20	30	55	82	150	220	290	420	340	500
Pg0         0.9         0.5         0.545         0.175         36         51         99         140         270         380         510         720         600         850           D100         1         0.5         0.545         0.175         49         63         140         170         370         470         690         890         810         1000           D120         1.2         0.5         0.545         0.175         64         97         180         260         480         730         900         1300         1100         1600           D140         1.4         0.625         0.545         0.175         7         11         19         30         51         83         96         150         120         200           D50         0.5         0.375         0.650         0.175         7         11         19         30         51         83         96         150         120         180           D60         0.6         0.375         0.650         0.175         12         144         33         39         89         100         170         200         200         200         200         200	k	D80	0.8	0.5	0.545	0.175	30	36	83	100	230	270	430	510	500	600
D100         1         0.5         0.545         0.175         49         63         140         170         370         470         690         890         810         1000           D120         1.2         0.5         0.545         0.175         64         97         180         260         480         730         900         1300         1100         1600           D140         1.4         0.625         0.545         0.175         99         120         280         330         750         900         1500         1700         1700         2000           D50         0.5         0.375         0.650         0.175         7         11         19         30         51         83         96         150         120         180           D60         0.6         0.375         0.650         0.175         12         144         33         39         89         100         170         200         200         240           D70         0.7         0.5         0.650         0.175         15         22         42         62         120         160         220         320         380         340         450 <td< td=""><td>5</td><td>D90</td><td>0.9</td><td>0.5</td><td>0.545</td><td>0.175</td><td>36</td><td>51</td><td>99</td><td>140</td><td>270</td><td>380</td><td>510</td><td>720</td><td>600</td><td>850</td></td<>	5	D90	0.9	0.5	0.545	0.175	36	51	99	140	270	380	510	720	600	850
D120         1.2         0.5         0.545         0.175         64         97         180         260         480         730         900         1300         1100         1600           D140         1.4         0.625         0.545         0.175         99         120         280         330         750         900         1500         1700         2000           D50         0.5         0.375         0.650         0.175         7         11         19         30         51         83         96         150         120         240           D60         0.6         0.375         0.650         0.175         12         144         33         39         89         100         170         200         200         240           D70         0.7         0.5         0.650         0.175         15         22         42         62         120         160         220         320         250         370           D80         0.8         0.5         0.650         0.175         23         27         62         75         170         200         320         380         340         450         630         630         63	-	D100	1	0.5	0.545	0.175	49	63	140	170	370	470	690	890	810	1000
D140         1.4         0.625         0.545         0.175         99         120         280         330         750         900         1500         1700         2000           D50         0.5         0.375         0.650         0.175         7         11         19         30         51         83         96         150         120         180           D60         0.6         0.375         0.650         0.175         12         144         33         39         89         100         1700         200         200         240           D70         0.7         0.5         0.650         0.175         15         22         42         62         120         160         220         320         250         370           D80         0.8         0.5         0.650         0.175         23         27         62         75         170         200         320         380         450           D90         0.9         0.5         0.650         0.175         27         38         74         100         210         280         380         540         450         630           D100         1         0.5		D120	1.2	0.5	0.545	0.175	64	97	180	260	480	730	900	1300	1100	1600
D50         0.5         0.375         0.650         0.175         7         11         19         30         51         83         96         150         120         180           D60         0.6         0.375         0.650         0.175         12         14         33         39         89         100         170         200         200         240           D70         0.7         0.5         0.650         0.175         15         22         42         62         120         160         220         320         250         370           D80         0.8         0.5         0.650         0.175         23         27         62         75         170         200         320         380         380         450           D90         0.9         0.5         0.650         0.175         27         38         74         100         210         280         380         540         450         630           D100         1         0.5         0.650         0.175         37         47         110         130         280         350         520         670         610         790           D120		D140	1.4	0.625	0.545	0.175	99	120	280	330	750	900	1500	1700	1700	2000
D60         0.6         0.375         0.650         0.175         12         14         33         39         89         100         170         200         200         240           D70         0.7         0.5         0.650         0.175         15         22         42         62         120         160         220         320         250         370           D80         0.8         0.5         0.650         0.175         23         27         62         75         170         200         320         380         380         450           D90         0.9         0.5         0.650         0.175         27         38         74         100         210         280         380         540         450         630           D100         1         0.5         0.650         0.175         37         47         110         130         280         350         520         670         610         790           D120         1.2         0.5         0.650         0.175         75         90         210         240         560         670         610         790           D140         1.4         0.625		D50	0.5	0.375	0.650	0.175	7	11	19	30	51	83	96	150	120	180
D70         0.7         0.5         0.650         0.175         15         22         42         62         120         160         220         320         250         370           D80         0.8         0.5         0.650         0.175         23         27         62         75         170         200         320         380         380         450           D90         0.9         0.5         0.650         0.175         27         38         74         100         210         280         380         540         450         630           D100         1         0.5         0.650         0.175         37         47         110         130         280         380         540         450         630           D120         1.2         0.5         0.650         0.175         37         47         110         130         280         350         520         670         610         790           D120         1.2         0.5         0.650         0.175         75         90         210         240         560         670         1100         1200         1300         1500	Ö	D60	0.6	0.375	0.650	0.175	12	14	33	39	89	100	170	200	200	240
D80         0.8         0.5         0.650         0.175         23         27         62         75         170         200         320         380         380         450           D90         0.9         0.5         0.650         0.175         27         38         74         100         210         280         380         540         450         630           D100         1         0.5         0.650         0.175         37         47         110         130         280         350         520         670         610         790           D120         1.2         0.5         0.650         0.175         48         73         140         200         360         550         680         1000         800         1200           D140         1.4         0.625         0.650         0.175         75         90         210         240         560         670         1100         1200         1300         1500	ă	D70	0.7	0.5	0.650	0.175	15	22	42	62	120	160	220	320	250	370
D90         0.9         0.5         0.000         0.115         27         30         74         100         210         280         380         540         450         630           D100         1         0.5         0.650         0.175         37         47         110         130         280         350         540         450         630           D120         1.2         0.5         0.650         0.175         48         73         140         200         360         550         680         1000         800         1200           D140         1.4         0.625         0.650         0.175         75         90         210         240         560         670         1100         1200         1300         1500	S	D80	0.8	0.5	0.650	0.175	23	21	62 74	100	1/0	200	320	38U 540	380	450
D100         1         0.5         0.000         0.115         37         47         110         130         260         330         320         670         610         790           D120         1.2         0.5         0.650         0.175         48         73         140         200         360         550         680         1000         800         1200           D140         1.4         0.625         0.650         0.175         75         90         210         240         560         670         1100         1200         1300         1500	10	D90	0.9	0.5	0.000	0.175	27	38	110	130	210 280	<u>∠80</u> 350	520	540 670	400	790
D120 1.2 0.5 0.650 0.175 75 90 210 240 560 670 1100 1200 1300 1500	5	D100	1	0.5	0.650	0.175	48	73	140	200	360	550	680	1000	800	1200
		D120	1.4	0.625	0.650	0.175	75	90	210	240	560	670	1100	1200	1300	1500

Negative TC Low Loss - 3 kVDC to 20 kVDC



Performance Charts (Typical)

N22

60%

09

-20%

-40%

-60%

-809

-55 -35 -15 5 25 45 65 85 105 125

Temperature [Deg C]

Temperature Coefficient [% Vs Temp]

[%] 40%

Change 209

Capacitance

# 



### 1. Termination Type: 100% fired-on silver

**Performance Characteristics** 

Specification		Dielectric Type (	EIA Designation)	
opecification	NPO (COG)	X7R	X5R	X5U
Material Classification	Type I, Ultra Stable, K76	Type II, Stable, K2350	Type II, Stable, K2500	Type II, Stable, K5000
<b>Coefficient of Thermal Expansion</b>	9 x 10 <sup>-6</sup> / °C	11 x 10⁻⁰ / °C	11 x 10⁻ <sup>6</sup> / °C	11 x 10 <sup>-6</sup> / °C
Density		72 g	/ in <sup>3</sup>	
Operating Temperature Range	-55 to -	+125°C	-55 to	+85°C
Aging Rate	0	-2% Max per	decade hour	-3% Max per decade hour
Temperature Coefficient	±30 PPM / °C	±1:	5%	+22 / -56%
Voltage Coefficient	Negligible	-20% Max	@ WVDC	-35% Max @ WVDC
Capacitance Range	1.6 pF to 310 pF	52 pF to 9500 pF	55 pF to 0.010 μF	100 pF to 0.018 μF
Voltage Range		3 kVDC to	o 20 kVDC	
Insulation Resistance @ +25°C		100,000 MΩ or 1000	MΩ - μF, W/E is less	
Insulation Resistance @ T Max		10,000 MΩ or 100 N	IΩ - μF,  W/E is less	
Dissipation Factor	0.1% Max		2.5% Max	
DWV		1.5 x V	WVDC	

- 1. Standard inspection and Group A testing, when required, is performed in accordance with applicable requirements of MIL-PRF-49467, DSCC 87125, DSCC 89087 and NASA GSFC S-311-15C.
- 2. Special testing including 100% Partial Discharge (Corona) is available upon request.
- 3. Custom voltages, package sizes and capacitance values available. Contact factory.
- 4. Higher voltage parts may require encapsulation to prevent surface arc over and breakdown. When required, parts should first be cleaned and oven dried at +85°C. Silicone rubbers or a suitable epoxy may be used and de-airing of encapsulates is recommended.
- 5. Testing of higher voltage parts before installation and / or application of supplemental encapsulation, may be done in a suitable, non-contaminating dielectric fluid like FC-40.
- 6. Large ceramic capacitors are susceptible to damage when exposed to thermal and / or mechanical shock. Ensure care is taken while handling and during installation, or consider selecting leaded alternatives as detailed in catalog page CRT-0006.

-4000 ·600 +25 Temperature [Deg C]

6000

-2000

ge 4000

Σ 2000

6

Temperature Coefficient [PPM / °C]



Voltage Coefficient



N150 **—** N220

N470

N560

# **High Voltage Single Layer Bare Disc Capacitors** Military & Commercial Grade - 3 kVDC to 10 kVDC

CalRamic Technologies LLC manufactures a series of highly reliable, single layer, ceramic disc capacitors that are designed and manufactured under strict quality control guidelines to ensure unparalleled performance in high voltage applications.

These capacitors, which draw on thirty plus years of proven design and process experience, utilize double action pressing to minimize gradients within the dielectric powder and produce a finished capacitor with a uniform fired ceramic density.

Capacitors are available with ultra stable Class I, NPO dielectrics, essential where low losses and tight capacitance tolerances are critical and stable Class II, X5R, X7R and X5U dielectric materials, which are intended for those applications where added dielectric losses and less precision can be tolerated.

These capacitors are ideally suited as snubbers for switching power supplies, coupling and decoupling capacitors, inverter circuitry, lighting ballasts, and other high voltage pulse applications.

# High Voltage Single Layer Bare Disc Capacitors

Military & Commercial Grade - 3 kVDC to 10 kVDC

### **Electrical / Mechanical Characteristics**

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Mandalan a		Dim	ensions	[in]			Ca	pacitance	Range	pF1		1
Working	Disc Style			<u>1</u>	N	20	X	5R	x	7R	X	50
voltage		DMax	INOM	I Max	Min	Max	Min	Max	Min	Max	Min	Max
	D0606	0.220	0.060	0.075	8.4	10	270	340	260	320	500	600
	D0706	0.245	0.060	0.075	9.7	12	320	370	300	350	570	670
	D0806	0.275	0.060	0.075	12	15	410	500	380	470	730	900
	D1006	0.330	0.060	0.075	20	24	640	780	600	730	1200	1400
	D1206	0.400	0.060	0.075	28	34	920	1100	870	1100	1700	2000
с С	D1406	0.460	0.060	0.075	38	46	1600	2000	1200	1400	3000	3600
5	D1806	0.590	0.060	0.075	63	77	2100	2500	2000	2400	3700	4600
×	D2006	0.650	0.060	0.075	78	95	2600	3100	2400	2900	4600	5600
3	D2206	0.710	0.060	0.075	94	110	3100	3800	2900	3500	5600	6800
	D2406	0.775	0.060	0.075	110	140	3700	4500	3500	4200	6600	8100
	D2606	0.840	0.060	0.075	130	160	4300	5300	4100	5000	7800	9500
	D2906	0.930	0.060	0.075	150	200	5000	6500	4700	6200	9000	12000
	D3206	1.030	0.060	0.075	200	240	6600	8000	6200	7500	12000	14000
	D3606	0.220	0.060	0.073	5.1	5.2	160	200	150	190	300	370
	D0710	0.245	0.100	0.125	5.8	6.9	100	220	180	210	350	400
	D0810	0.275	0.100	0.125	7.3	9.2	250	300	230	280	410	540
	D1010	0.330	0.100	0.125	12	15	390	473	370	440	700	850
	D1210	0.400	0.100	0.125	17	21	560	680	520	640	1000	1200
	D1410	0.460	0.100	0.125	23	28	760	920	700	860	1400	1600
õ	D1610	0.525	0.100	0.125	30	37	990	1200	930	1100	1800	2200
N	D1810	0.590	0.100	0.125	38	47	1300	1500	1200	1400	2300	2800
X	D2010	0.650	0.100	0.125	47	57	1500	1800	1500	1800	2800	3400
47	D2410	0.775	0.100	0.125	69	83	2200	2300	2100	2600	4000	4900
	D2610	0.840	0.100	0.125	79	97	2600	3100	2500	3000	4700	5700
	D2910	0.930	0.100	0.125	92	120	3000	3900	2900	3700	5500	7100
	D3210	1.030	0.100	0.125	120	150	3900	4800	3800	4500	7200	8700
	D3610	1.150	0.100	0.125	140	180	4500	6100	4200	5700	8000	11000
	D4010	1.280	0.100	0.125	190	230	6200	7500	5800	7000	11000	13000
	D0615	0.220	0.150	0.180	3.4	4.1	110	140	110	130	200	240
	D0715	0.245	0.150	0.180	3.9	4.6	130	150	120	150	230	270
	D0815	0.275	0.150	0.180	5	6.1	170	200	150	190	300	360
	D1015	0.330	0.150	0.180	7.8	9.6	260	310	240	300	460	820
	D1213	0.460	0.150	0.180	12	14	510	610	470	580	900	1100
2 2	D1415	0.525	0.150	0.180	20	25	660	800	620	750	1200	1450
5	D1815	0.590	0.150	0.180	25	31	830	1000	780	960	1500	1800
¥	D2015	0.650	0.150	0.180	31	38	1000	1200	970	1200	1900	2200
<u>.</u> .	D2215	0.710	0.150	0.180	37	46	1300	1500	1200	1400	2200	2700
7	D2415	0.775	0.150	0.180	45	55	1500	1800	1400	1700	2700	3300
	D2615	0.840	0.150	0.180	53	65	1700	2100	1600	2000	3100	3800
	D2915	0.930	0.150	0.180	60	80	2000	2600	1900	2500	3700	4700
	D3215	1.030	0.150	0.180	80	98	2600	3200	2500	3000	4800	5800
	D3015	1.130	0.150	0.180	120	120	4100	5000	2800	4700	7400	9000
	D4013	0.220	0.200	0.235	2.5	3.1	84	100	78	95	150	180
	D0720	0.245	0.200	0.235	2.9	3.5	96	110	90	110	170	200
	D0820	0.275	0.200	0.235	3.8	4.6	120	150	110	140	220	270
	D1020	0.330	0.200	0.235	5.9	7.2	190	230	180	220	350	420
	D1220	0.400	0.200	0.235	8.5	10	280	340	260	320	500	610
U	D1420	0.460	0.200	0.235	12	14	380	480	350	430	680	820
õ	D1620	0.525	0.200	0.235	15	18	500	600	470	560	890	1000
2 Z	D1820	0.590	0.200	0.235	19	23	770	940	730	880	1400	1400
0	D2020	0.710	0.200	0.235	28	34	930	1100	870	1100	1700	2000
-	D2420	0.775	0.200	0.235	34	41	1100	1400	1000	1300	2000	2400
	D2620	0.840	0.200	0.235	40	48	1300	1600	1200	1500	2400	2900
	D2920	0.930	0.200	0.235	46	60	1500	2000	1400	1800	2700	3500
	D3220	1.030	0.200	0.235	60	73	2000	2400	1900	2300	3600	4300
	D3620	1.150	0.200	0.235	68	93	2200	3000	2100	2800	4000	5500
	D4020	1.280	0.200	0.235	94	110	3100	3700	2900	3500	5600	5800
	D0830	0.220	0.300	0.350	1.0	2.1	64	76	52	71	120	130
	D0830	0.275	0.300	0.350	2.4	3.1	52	100	76	94	150	180
	D1030	0.330	0.300	0.350	3.9	4.8	130	160	120	150	230	280
	D1230	0.400	0.300	0.350	5.7	6.9	180	230	180	210	340	410
0	D1430	0.460	0.300	0.350	7.7	9.4	250	300	230	290	450	550
ă	D1630	0.525	0.300	0.350	10	12	330	400	310	370	600	720
Ş	D1830	0.590	0.300	0.350	12	16	410	510	390	480	750	920
2	D2030	0.650	0.300	0.350	16	20	520	620	490	590	930	1100
<del>~</del>	D2230	0.775	0.300	0.350	23	25	740	910	690	850	1300	1600
	D2630	0.840	0.300	0.350	26	32	870	1000	820	1000	1600	1900
	D2930	0.930	0.300	0.350	30	40	1000	1300	950	1200	1800	2400
	D3230	1.030	0.300	0.350	40	49	1300	1600	1300	1500	2400	2900
	D3630	1.150	0.300	0.350	45	60	1500	2000	1400	1900	2700	3600
	D4030	1.280	0.300	0.350	60	77	2100	2500	1900	2300	3700	4500
	D1040	0.330	0.400	0.460	3.2	3.5	100	110	98	100	190	200
	D1240	0.400	0.400	0.460	4.6	5	150	170	140	160	270	300
	D1440	0.460	0.400	0.460	6.2	6.8	200	220	190	210	360	400
~	D1640	0.525	0.400	0.460	8.1	8.9	270	290	250	270	480	520
ă	D2040	0.650	0.400	0.460	13	14	410	450	390	430	750	820
2	D2240	0.710	0.400	0.460	15	17	500	550	470	520	900	1000
P K	D2440	0.775	0.400	0.460	18	20	600	660	560	620	1100	1200
2(	D2640	0.812	0.400	0.460	21	23	700	770	660	720	1300	1400
	D2940	0.930	0.400	0.460	24	30	810	960	760	900	1500	1700
	D3240	1.030	0.400	0.460	32	36	1000	1200	1000	1100	1900	2100
	D3640	1.150	0.400	0.460	36	45	1200	1500	1100	1400	2200	2600
	D4040	1.280	0.400	0.460	50	56	1700	1800	1600	1700	3000	3300







**Class II Temperature Coefficient** 



Voltage Coefficient

CRT-0001 Rev 1410



NPO Temperature Coefficient



Capacitance Vs Frequency

C

# **High Voltage Single Layer Bare Rectangular Capacitors**

Military & Commercial Grade - 3 kVDC to 10 kVDC

1. Termination Type: 100% fired-on silver

**Performance Characteristics** 

CalRamic Technologies LLC manufactures a series of highly reliable, single layer, rectangular ceramic capacitors that are designed and manufactured under strict quality control guidelines to ensure unparalleled performance in high voltage applications.

These capacitors, which draw on thirty plus years of proven design and process experience, utilize double action pressing to minimize gradients within the dielectric powder and produce a finished capacitor with a uniform fired ceramic density.

Capacitors are available with ultra stable Class I, NPO dielectrics, essential where low losses and tight capacitance tolerances are critical and stable Class II, X5R, X7R and X5U dielectric materials, which are intended for those applications where higher losses and less precision can be tolerated.

These capacitors are ideally suited as snubbers for switching power supplies, coupling and decoupling capacitors, inverter circuitry, lighting ballasts, and other high voltage pulse applications.

### Dielectric Type (EIA Designation) Specification NPO (COG) X7R X5R X5U Material Classification Type I, Ultra Stable, K76 Type II, Stable, K2350 Type II, Stable, K2500 Type II, Stable, K5000 **Coefficient of Thermal Expansion** 9 x 10<sup>-6</sup> / °C 11 x 10<sup>-6</sup> / °C 11 x 10<sup>-6</sup> / °C 11 x 10<sup>-6</sup> / °C Density 72 g / in<sup>3</sup> -55 to +125°C -55 to +85°C Operating Temperature Range -2% Max per decade hour -3% Max per decade hour Aging Rate 0 Temperature Coefficient ±30 PPM / °C ±15% +22 / -56% -20% Max @ WVDC Negligible -35% Max @ WVDC Voltage Coefficient Capacitance Range 5.2 pF to 300 pF 120 pF to 9000 pF 140 pF to 10,200 pF 270 pF to 0.020 µF 3 kVDC to 20 kVDC Voltage Range 100,000 MΩ or 1000 MΩ - μF, W/E is less Insulation Resistance @ +25°C 10,000 MΩ or 100 MΩ - μF, W/E is less Insulation Resistance @ T Max Dissipation Factor 0.1% Max 2.5% Max DWV 1.5 x WVDC

1. Standard inspection and Group A testing, when required, is performed in accordance with applicable requirements of MIL-PRF-49467, DSCC 87125, DSCC 89087 and NASA GSFC S-311-15C.

- 2. Special testing including 100% Partial Discharge (Corona) is available upon request.
- 3. Custom voltages, package sizes and capacitance values available. Contact factory.
- 4. Higher voltage parts may require encapsulation to prevent surface arc over and breakdown. When required, parts should first be cleaned and oven dried at +85°C. Silicone rubbers or a suitable epoxy may be used and de-airing of encapsulates is recommended.
- 5. Testing of higher voltage parts before installation and / or application of supplemental encapsulation, may be done in a suitable, non-contaminating dielectric fluid like FC-40.
- 6. Large ceramic capacitors are susceptible to damage when exposed to thermal and / or mechanical shock. Ensure care is taken while handling and during installation, or consider selecting a leaded alternative.

# **High Voltage Single Layer Bare Rectangular Capacitors** Military & Commercial Grade - 3 kVDC to 10 kVDC

### Electrical / Mechanical Characteristics

			Dimens	ions [in]		Capacitance Range [pF]							
Voltage	Style	L	w	т	т	N	РО	X	5R	X	7R	X	5U
Voltage		± 0.010	± 0.010	Max	Nom	Min	Max	Min	Max	Min	Max	Min	Max
	3408	0.340	0.080	0.075	0.060	6.8	8.1	230	275	200	240	460	550
о С	5625	0.560	0.250	0.075	0.060	35	42	1200	1400	1000	1200	2400	2900
Ň	5439	0.540	0.390	0.075	0.060	53	64	1800	2200	1600	1900	3600	4300
3	7050	0.700	0.500	0.075	0.060	88	106	3000	3600	2600	3100	6000	7100
	100100	1.000	1.000	0.075	0.060	250	300	8500	10200	7500	9000	17000	20000
	3408	0.340	0.080	0.125	0.100	4	5	140	170	120	150	270	340
2 2	5625	0.560	0.250	0.125	0.100	21	26	700	870	620	7700	1400	1700
N N	5439	0.540	0.390	0.125	0.100	32	39	1100	1300	940	1200	2100	2600
5	7050	0.700	0.500	0.125	0.100	52	65	1800	2200	1500	1900	3500	4400
	100100	1.000	1.000	0.125	0.100	150	184	5000	6200	4400	5500	10000	12400
	3408	0.340	0.080	0.180	0.150	٠	•	٠	•	٠	•	•	•
DG D	5625	0.560	0.250	0.180	0.180	14	17	470	580	410	500	940	1200
Ž	5439	0.540	0.390	0.180	0.180	21	26	700	870	620	760	1400	1700
7.5	7050	0.700	0.500	0.180	0.180	35	43	1200	1400	100	1300	2300	2900
	100100	1.000	1.000	0.180	0.180	100	120	3400	4100	2900	3600	6700	8200
	3408	0.340	0.080	0.235	0.200	•	•	•	•	•	•	•	•
L C	5625	0.560	0.250	0.235	0.200	11	13	350	430	310	380	710	870
Ž	5439	0.540	0.390	0.235	0.200	16	19	530	650	470	570	1100	1300
10	7050	0.700	0.500	0.235	0.200	26	32	880	1100	780	950	1800	2200
	100100	1.000	1.000	0.235	0.200	75	92	2500	3100	2200	2700	5000	6200
	3408	0.340	0.080	0.350	0.300	•	•	•	•	•	•	•	•
С С	5625	0.560	0.250	0.350	0.300	7	8.5	240	290	210	250	470	580
₹	5439	0.540	0.390	0.350	0.300	11	13	350	430	310	380	710	870
15	7050	0.700	0.500	0.350	0.300	17	21	590	720	520	630	1200	1400
	100100	1.000	1.000	0.350	0.300	50	60	1700	2100	1500	1800	3400	4100
	3408	0.340	0.080	0.460	0.400	•	•	•	•	•	•	•	•
l 2	5625	0.560	0.250	0.460	0.400	5.2	6.4	180	220	160	190	350	430
Ž	5439	0.540	0.390	0.460	0.400	7.9	9.6	270	330	230	290	530	650
20	7050	0.700	0.500	0.460	0.400	13	16	440	540	390	470	880	1100
	100100	1.000	1.000	0.460	0.400	37	46	1300	1500	1100	1400	2500	3100

# **Part Number / Ordering Information**



# High Voltage Single Layer Bare Rectangular Capacitors

Military & Commercial Grade - 3 kVDC to 10 kVDC

Performance Charts (Typical)



Class II Temperature Coefficient



Voltage Coefficient



NPO Temperature Coefficient



Capacitance Vs Frequency



# **High Voltage Radial Leaded Disc Capacitors** High Temperature +200°C Rated - 3 kVDC to 20 kVDC



- 1. Lead Size: D30, D40 @ 0.025" Dia (#22 AWG) [0.64 mm] D50 & larger @ 0.32" Dia (#20 AWG) [0.81 mm]
- 2. Lead Finish: Solder
- 3. Order of marking may vary depending on size of capacitor

### Performance Characteristics

Creatification	Dielectric Type (	EIA Designation)			
Specification	HTNPO (COG)	HTX7R			
Material Classification	Type I, Ultra Stable, K76	Type II, Stable, K2350			
Coefficient of Thermal Expansion	9 x 10 <sup>-6</sup> / °C	11 x 10 <sup>-6</sup> / °C			
Density	76 g	/ in <sup>3</sup>			
Operating Temperature Range	-55 to	+200°C			
Aging Rate	0	-2% Max per decade hour			
Temperature Coefficient	±30 PPM / °C	+15 / -70%			
Capacitance Range	1.4 pF to 350 pF	42 pF to 0.012 μF			
Voltage Range	3 kVDC to	o 20 kVDC			
Insulation Resistance @ +25°C	100,000 MΩ or 1000	MΩ - μF, W/E is less			
Insulation Resistance @ +200°C	1000 MΩ or 10 MΩ	Ω - μF, W/E is less			
Dissipation Factor	0.1% Max	2.5% Max			
DWV	1.5 x WVDC				

- 1. Standard inspection and Group A testing, when required, is performed in accordance with applicable requirements of MIL-PRF-49467, DSCC 87125, DSCC 89087 and NASA GSFC S-311-15C.
- 2. Special testing including 100% Partial Discharge (Corona) is available upon request.
- 3. Custom voltages, package sizes, lead configurations and capacitance values available. Contact factory.
- 4. Higher voltage parts may require encapsulation to prevent surface arc over and breakdown. When required, parts should first be cleaned and oven dried at +85°C. A suitable encapsulant, capable of withstanding the extreme conditions associated with these applications, may be used and de-airing of coatings is recommended.
- 5. Testing of higher voltage parts before installation and / or supplemental encapsulation, may be done in a suitable, non-contaminating dielectric fluid like FC-40.
- 6. Large ceramic capacitors, even leaded devices are susceptible to damage when exposed to thermal and / or mechanical shock. Refer to Technical Bulletin AN103 for handling and installation recommendations.

# High Temp, 200°C



(775) 851-3580 / calramic.com / 5462 Louie Lane / Reno, NV 89511 USA



CalRamic Technologies LLC manufactures a series of highly reliable, single layer, leaded ceramic disc capacitors that are designed and manufactured under strict quality control guidelines to ensure unparalleled performance in high temperature, high voltage applications.

These capacitors, which draw on thirty plus years of proven design and process experience, utilize double action pressing to minimize gradients within the dielectric powder and produce a finished capacitor with a uniform fired ceramic density.

Capacitors are available with ultra stable Class I, NPO dielectrics, essential where low losses and tight capacitance tolerances are critical and stable Class II, X7R type dielectric materials, which are intended for those applications where higher losses and less precision can be tolerated.

These capacitors are ideally suited as snubbers for switching power supplies, coupling and decoupling capacitors, inverter circuitry, lighting ballasts, and other high voltage pulse applications intended for the high temperature down-hole, automotive and industrial markets.

High Temperature +200°C Rated - 3 kVDC to 20 kVDC

### **Electrical / Mechanical Characteristics**

Notinge         Disc Style         Disk         S ± 0.03         T Max         HTMPO         HTMR           030         0.330         0.230         <	Working		Di	mensions [	[in]	C	apacitance	e Range [pF	]
Of Min.         Max.	Voltage	Disc Style	D Max	S + 0 030	T Max	HTH	NPO	НТХ	(7R
D30         0.300         0.230         0.210         12         24         360         730           D40         0.400         0.325         0.210         12         24         360         730           D50         0.500         0.375         0.210         38         61         1200         1840           D50         0.500         0.375         0.210         38         61         1200         1840           D70         0.700         0.500         0.216         38         61         1200         1860         3800         3800         3800         3800         3800         590			Diwiax	5 ± 0.050	T WIAX	Min	Max	Min	Max
D40         0.400         0.230         270         12         24         380         739           D50         0.509         0.575         0.276         38         61         1200         1900           D50         0.509         0.775         0.276         38         61         1200         1900           D50         0.509         0.276         63         95         2000         2900         3500           D90         0.098         0.698         0.216         140         140         3500         3500           D10         1.098         0.598         0.216         150         280         4700         6200           D120         1.208         0.208         0.2171         280         310         6200         990         120		D30	0.300	0.250	0.210	8.4	12	260	350
DS0         0.000         0.375         0.210         28         46         570         14001           D50         0.500         0.375         0.210         53         95         2000         29001           D70         0.700         0.500         0.210         53         95         2000         29001           D80         0.600         0.210         140         1100         1600         2000         98001           D100         1.060         0.500         0.210         110         160         2000         98001           D100         1.060         0.500         0.210         110         150         200         98001           D100         1.060         0.500         0.210         110         130         6200         98001           D100         1.060         0.580         0.210         120         130         7000         1100           D80         0.480         0.220         0.200         70         90         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000		D40	0.400	0.250	0.210	12	24	380	730
DG0         0.000         0.073         0.210         38         61         1200         1990           DG0         0.000         0.000         0.000         0.210         16         55         2000         2990           DB0         0.000         0.000         0.200         0.210         110         160         3500         5900           D100         1.000         0.000         0.210         200         310         6200         5900           D100         1.000         0.000         0.210         200         310         6200         5900           D100         1.000         0.000         0.210         200         310         6200         6200           D60         0.000         0.250         0.250         7.3         15         210         100           D60         0.600         0.77         0.250         23         977         1200         1000           D80         0.600         0.250         0.250         120         100         1000         1000           D90         0.600         0.250         0.250         120         1000         1000         1000         1000           D100		D50	0.500	0.375	0.210	28	46	870	1400
Dro         0.70         0.80         0.210         63         55         2000         2000           Dg0         0.300         0.500         0.210         110         160         3500         3500           Dg0         0.300         0.500         0.210         110         160         3500         4500           D100         1.300         0.500         0.210         130         350         9560         1200           D100         0.400         0.523         0.255         5.1         6.3         15         230         444           D50         0.500         0.373         0.256         17         28         520         860           D60         0.500         0.373         0.256         17         28         1800         2100           D70         0.500         0.500         0.258         38         57         1800         2100           D100         0.500         0.258         120         1800         2100         1800         2100           D100         0.500         0.326         120         1800         2100         1800         2100           D100         0.500         0.310	S	D60	0.600	0.375	0.210	38	61	1200	1900
OPA         DB0         0.000         0.000         0.210         110         1100         1200         3500         5500           D100         1.000         0.000         0.210         1100         1600         3500         5500           D110         1.000         0.000         0.210         200         310         6500         9500           D110         1.000         0.000         0.210         200         310         6500         9500           D110         1.000         0.000         0.210         200         310         6500         9500           D100         0.000         0.250         0.250         7.3         15         230         #60           D100         0.000         0.250         0.250         17         28         520         #60           D100         0.000         0.250         0.250         120         100         1000         1000           D100         1.000         0.250         0.250         120         100         1000         1000           D100         1.000         0.250         0.250         120         100         1000         1000         1000         1000	2	D70	0.700	0.500	0.210	63	95	2000	2900
OP         0.000         0.	k/	D80	0.800	0.500	0.210	94	110	2900	3500
D100         1.000         0.000         0.210         150         200         4700         6200           D120         1.200         0.860         0.210         310         6200         1200         1200           D140         1.400         0.625         0.210         310         6200         1200	3	D90	0.900	0.500	0.210	110	160	3500	5000
D120         1,200         0,200         200         310         6200         9900           D140         1,400         0,865         0,210         310         100         1200         1200           D140         0,300         0,250         0,210         310         160         1200         1200           D140         0,400         0,250         0,210         17         28         520         440           D50         0,500         0,375         0,220         17         28         520         860           D70         0,700         0,500         0,250         38         07         1200         1800           D100         1,600         0,500         0,250         92         173         2200         3700           D100         1,600         0,500         0,250         92         173         2300         3700           D100         1,600         0,500         0,250         92         173         320         5900           D140         1,400         0,625         0,310         34         4.6         100         190           D140         1,400         0,625         0,310         34		D100	1.000	0.500	0.210	150	200	4700	6200
Of No         Dial         1,400         0,622         0,210         310         300         3000         1,200           Dial         0,300         0,300         0,220         0,220         7,3         15         210         440           Dial         0,400         0,220         0,220         7,3         15         220         440           Dial         0,500         0,375         0,220         177         28         520         660           Dial         0,500         0,375         0,220         23         37         700         1100           Dial         0,500         0,220         69         97         2100         3000         2100         3000         3700         3700         3700         3700         3700         3700         3700         3700         3700         3700         3700         3700         3700         3700         3700         3800         3700         3700         3700         3700         3700         3700         370         370         380         8800         3800         3700         370         370         370         370         370         370         370         370         370         370		D120	1.200	0.500	0.210	200	310	6200	9500
OGA         0.30         0.200         0.220         0.220         7.3         15         120         140           D50         0.300         0.273         0.280         17         28         520         860           D50         0.300         0.373         0.280         17         28         520         860           D70         0.700         0.500         0.281         38         57         1200         1800           D90         0.300         0.250         69         97         2100         3000           D100         1.000         0.500         0.250         69         97         2100         3000           D110         1.000         0.500         0.250         190         230         5800         760           D110         1.000         0.500         0.310         3.4         4.6         100         150         580           D30         0.300         0.250         0.310         5         9.6         150         590         150         590         150         590         150         150         150         150         150         150         150         150         150         150		D140	0.200	0.025	0.210	510	330	9600	12000
DAU         DAU <thdau< th=""> <thdau< th=""> <thdau< th=""></thdau<></thdau<></thdau<>		D30	0.300	0.250	0.250	5.1 7.2	6.9	150	210
DOC         DOC <thdoc< th=""> <thdoc< th=""> <thdoc< th=""></thdoc<></thdoc<></thdoc<>		D40	0.400	0.250	0.250	1.3	15	230 520	440 860
Dro         0.700         0.500         0.250         35         57         1280         1800           Dro         0.600         0.500         0.250         57         1280         1800           Dro         0.600         0.500         0.250         69         1800         2100           Dro         0.000         0.500         0.250         92         120         2000         3700           Dro         0.000         0.500         0.250         120         1800         2700           Dro         0.000         0.500         0.250         120         1800         3000           Dro         0.000         0.500         0.250         120         180         380           Dro         0.000         0.500         0.310         3.4         4.6         100         150           Dro         0.400         0.250         0.310         15         9.8         180         300           Dro         0.500         0.376         0.310         15         25         470         790           Dro         0.500         0.300         0.310         460         1800         2000           Dro <th< td=""><td>0</td><td>D50</td><td>0.600</td><td>0.375</td><td>0.250</td><td>23</td><td>37</td><td>700</td><td>1100</td></th<>	0	D50	0.600	0.375	0.250	23	37	700	1100
DB0         0.000         0.500         0.250         57         89         1800         2100           D90         0.900         0.500         0.250         62         120         1800         3700           D100         1.000         0.500         0.250         92         120         1800         3700           D110         1.200         0.500         0.250         192         120         1800         3700           D110         1.200         0.500         0.250         190         230         500         7000           D30         0.300         0.250         0.310         3.4         4.6         100         150           D30         0.300         0.250         0.310         5         9.6         150         390         390           D50         0.500         0.375         0.310         12         19         350         380           D60         0.800         0.500         0.310         37         46         1200         1200           D10         1.000         0.500         0.310         80         120         2500         380           D110         1.000         0.500	Ď	D70	0.700	0.500	0.250	38	57	1200	1800
D90         0.900         0.500         0.250         69         97         2100         3000           D100         1.000         0.500         0.250         92         120         2800         3700           D120         1.200         0.500         0.250         120         160         3800         5700           D140         1.400         0.625         0.250         1190         230         5800         7000           D30         0.300         0.270         0.310         3.4         4.6         100         150           D40         0.400         0.280         0.310         12         19         350         380           D50         0.500         0.375         0.310         15         25         470         780           D80         0.500         0.310         25         38         780         1200           D90         0.500         0.310         45         65         1400         2000           D100         1.000         0.500         0.310         45         65         1400         2000           D100         1.000         0.500         0.365         2.5         3.5         7	2 2	D80	0.800	0.500	0.250	57	69	1800	2100
D100         1.000         0.500         0.250         92         120         1300         3700           D120         1.200         0.500         0.250         120         1800         3800         5700           D140         1.400         0.625         0.250         190         230         5800         7700           D30         0.300         0.260         0.310         3.4         4.6         100         150           D50         0.500         0.375         0.310         15         25         470         750           D70         0.700         0.500         0.310         25         38         780         1200           D90         0.800         0.500         0.310         25         38         780         1200           D100         1.000         0.500         0.310         45         65         1400         2000           D100         1.000         0.500         0.310         60         80         1900         2500           D30         0.300         0.250         0.365         2.5         3.5         78         110           D40         0.400         0.250         0.365         <	<u>×</u>	D90	0.900	0.500	0.250	69	97	2100	3000
D120         1.200         0.500         0.250         120         180         3800         5700           D140         1.400         0.625         0.250         190         230         5800         7000           D30         0.300         0.250         0.310         3.4         4.6         100         150           D40         0.400         0.250         0.310         5         9.6         180         300           D50         0.500         0.375         0.310         12         19         350         560           D50         0.600         0.375         0.310         15         25         470         750           D70         0.700         0.500         0.310         15         65         1400         200           D90         0.800         0.500         0.310         10         80         1900         2500           D140         1.400         0.625         0.310         120         150         3800         4700           D30         0.300         0.250         0.365         2.5         3.5         76         110           D40         0.400         0.250         0.365         8.	47	D100	1.000	0.500	0.250	92	120	2900	3700
D140         1.400         0.625         0.250         190         230         5800         7000           D30         0.300         0.259         0.310         3.4         4.6         100         150           D40         0.400         0.250         0.310         5         9.6         150         300           D50         0.500         0.375         0.310         15         25         470         750           D70         0.700         0.500         0.310         25         38         780         1200           D80         0.800         0.500         0.310         45         65         1400         2000           D100         1.000         0.500         0.310         45         65         1400         2000           D100         1.000         0.500         0.310         80         120         2500         3800         4700           D100         1.000         0.625         0.365         3.5         7.8         110         220           D30         0.300         0.250         0.365         3.5         14         260         430           D50         0.500         0.365         12<		D120	1.200	0.500	0.250	120	180	3800	5700
Dial         0.300         0.250         0.310         3.4         4.6         100         150           Dial         0.400         0.250         0.310         5         9.6         156         300           Diso         0.400         0.250         0.310         12         19         350         580           Diso         0.600         0.375         0.310         12         19         350         580           Diso         0.500         0.310         15         25         38         780         1200           Diso         0.500         0.310         310         46         1200         1400           Diso         0.500         0.310         45         65         1400         2000           Dito         1.000         0.500         0.310         80         120         2500         3800           Dito         1.000         0.500         0.365         2.5         3.5         78         110           Diso         0.500         0.375         0.365         14         260         430           Diso         0.500         0.365         18         34         160         1600		D140	1.400	0.625	0.250	190	230	5800	7000
DQ         0.400         0.250         0.310         5         9.6         150         300           D50         0.500         0.375         0.310         12         19         350         580           D60         0.600         0.375         0.310         15         25         470         750           D70         0.700         0.500         0.310         25         38         780         1200           D80         0.800         0.500         0.310         37         46         1200         1400           D90         0.800         0.500         0.310         80         120         2500         3800           D100         1.000         0.500         0.310         80         120         2500         3800           D140         1.400         0.625         0.316         3.8         7.2         110         220           D50         0.500         0.375         0.365         12         18         350         560           D100         0.500         0.365         12         18         350         560           D70         0.700         0.500         0.365         34         48		D30	0.300	0.250	0.310	3.4	4.6	100	150
Diam         0.500         0.375         0.310         12         19         380         580           Diam         0.600         0.375         0.310         15         25         470         750           Diam         0.600         0.375         0.310         25         38         780         1200           Diam         0.600         0.500         0.310         37         46         1200         1400           Diam         0.600         0.500         0.310         45         65         1400         2500           Diam         1.000         0.500         0.310         60         80         1900         2500           Diam         1.400         0.625         0.310         80         120         2500         3800           Diam         0.300         0.250         0.365         2.5         3.5         78         110         220           Diam         0.400         0.250         0.365         2.8         34         870         1100           Diam         0.500         0.375         0.365         28         34         870         1100           Diam         0.600         0.375		D40	0.400	0.250	0.310	5	9.6	150	300
DOLY 5':         D60         0.000         0.375         0.310         15         25         470         750           D70         0.700         0.500         0.310         25         38         780         1200           D80         0.800         0.500         0.310         37         46         1200         1400           D90         0.900         0.500         0.310         45         65         1400         2000           D100         1.000         0.500         0.310         60         80         1900         2500           D120         1.200         0.500         0.310         80         120         2500         3800           D140         1.400         0.625         0.310         120         180         3800         4700           D50         0.500         0.375         0.365         2.5         3.5         78         110         220           D50         0.500         0.375         0.365         8.5         14         280         430           D50         0.500         0.365         19         28         580         880           D60         0.600         0.500         0.3	0	D50	0.500	0.375	0.310	12	19	350	580
Dro         0.70         0.700         0.500         0.310         25         38         780         1200           D80         0.800         0.500         0.310         37         46         1200         1400           D90         0.800         0.500         0.310         45         65         1400         2000           D100         1.000         0.500         0.310         60         80         1900         2800           D100         1.000         0.500         0.310         80         120         2500         3800           D140         1.400         0.625         0.310         120         150         3800         4700           D40         0.400         0.250         0.365         3.8         7.2         110         220           D50         0.500         0.375         0.365         12         18         350         560           D70         0.700         0.500         0.385         28         34         680         880           D80         0.800         0.500         0.365         19         28         580         880           D80         0.800         0.500         0.365	ă	D60	0.600	0.375	0.310	15	25	470	750
Y         D80         0.800         0.500         0.310         37         46         1200         1400           D90         0.800         0.500         0.310         45         65         1400         2000           D100         1.000         0.500         0.310         60         80         1900         2500           D120         1.200         0.500         0.310         80         120         2500         3800           D140         1.400         0.625         0.310         120         150         3800         4700           D30         0.300         0.250         0.365         2.5         3.5         78         110           D40         0.400         0.250         0.365         3.8         7.2         110         220           D50         0.500         0.375         0.365         8.5         14         260         430           D90         0.900         0.500         0.385         19         28         560         880           D80         0.800         0.500         0.365         344         44         1000         1500           D100 <th1000< th="">         0.500         0.365</th1000<>	$\overline{>}$	D70	0.700	0.500	0.310	25	38	780	1200
D90         0.900         0.500         0.310         45         65         1400         2000           D100         1.000         0.500         0.310         60         80         1900         2500         3800           D140         1.400         0.625         0.310         80         120         2500         3800         4700           D30         0.300         0.250         0.365         2.5         3.5         78         110           D40         0.400         0.250         0.365         3.8         7.2         110         220           D50         0.500         0.375         0.365         12         18         350         560           D70         0.700         0.500         0.365         19         28         580         880           D80         0.800         0.500         0.365         28         34         870         1100           D100         1.000         0.500         0.365         46         60         1400         1800           D110         1.000         0.620         0.475         5.7         9.4         180         290           D110         1.000         0.620	k K	D80	0.800	0.500	0.310	37	46	1200	1400
D100         1.000         0.500         0.310         60         80         1900         2500           D120         1.200         0.500         0.310         80         120         150         3800         4700           D140         1.400         0.625         0.310         120         150         3800         4700           D30         0.300         0.250         0.385         2.5         3.5         78         110           D40         0.400         0.250         0.365         8.5         14         260         430           D50         0.500         0.375         0.365         12         18         350         560           D70         0.700         0.500         0.365         12         18         350         560           D80         0.800         0.500         0.365         28         34         370         1100           D100         1.000         0.500         0.365         46         60         1400         1800           D110         1.000         0.500         0.365         93         1900         2800           D140         1.400         0.625         0.385	.5	D90	0.900	0.500	0.310	45	65	1400	2000
D120         1.200         0.800         0.310         80         120         2800         3800           D140         1.400         0.625         0.310         120         150         3800         4700           D30         0.300         0.250         0.365         2.5         3.5         78         110           D40         0.400         0.250         0.365         8.5         14         260         430           D50         0.500         0.375         0.365         12         18         350         560           D60         0.600         0.375         0.365         12         18         350         560           D70         0.700         0.500         0.365         28         34         870         1100           D90         0.900         0.500         0.365         60         93         1900         2800           D100         1.000         0.500         0.365         94         110         290         3800           D100         1.000         0.250         0.475         5.7         9.4         180         290           D50         0.500         0.375         0.475         19<	-	D100	1.000	0.500	0.310	60	80	1900	2500
D140         1.400         0.625         0.310         120         150         3800         4700           D30         0.300         0.250         0.365         2.5         3.5         78         110         120           D40         0.400         0.250         0.365         3.8         7.2         110         220           D50         0.500         0.375         0.365         8.5         14         260         430           D60         0.600         0.375         0.365         12         18         350         560           D70         0.700         0.500         0.365         19         28         580         880           D80         0.800         0.500         0.365         46         60         1400         1800           D100         1.000         0.500         0.365         94         110         290         3500           D140         1.400         0.625         0.365         94         110         290         3500           D30         0.300         0.250         0.474         1.6         2.3         52         71           D40         0.400         0.250         0.475 <td></td> <td>D120</td> <td>1.200</td> <td>0.500</td> <td>0.310</td> <td>80</td> <td>120</td> <td>2500</td> <td>3800</td>		D120	1.200	0.500	0.310	80	120	2500	3800
D30         0.300         0.250         0.365         2.5         3.5         78         110           D40         0.400         0.250         0.365         3.8         7.2         110         220           D50         0.500         0.375         0.365         8.5         14         260         430           D60         0.600         0.375         0.365         12         18         350         560           D70         0.700         0.500         0.365         19         28         580         880           D80         0.800         0.500         0.365         28         34         870         1100           D90         0.900         0.500         0.365         60         93         1900         2800           D100         1.000         0.500         0.365         60         93         1900         2800           D40         0.400         0.250         0.475         2.4         4.8         76         150           D50         0.500         0.375         0.475         12         20         390         590           D40         0.400         0.250         0.475         12		D140	1.400	0.625	0.310	120	150	3800	4700
Dia         0.400         0.200         0.365         3.8         7.2         110         220           D50         0.500         0.375         0.365         8.5         14         260         430           D60         0.600         0.375         0.365         12         18         350         560           D70         0.700         0.500         0.365         19         28         580         880           D80         0.800         0.500         0.365         34         48         1000         1500           D90         0.900         0.500         0.365         46         60         1400         1800           D100         1.000         0.500         0.365         94         110         290         3500           D110         1.400         0.620         0.474         1.6         2.3         52         71           D40         0.400         0.250         0.475         2.4         4.8         76         150           D50         0.500         0.375         0.475         7.7         12         230         370           D70         0.700         0.500         0.475         19		D30	0.300	0.250	0.365	2.5	3.5	78	110
DS0         0.300         0.375         0.365         12         18         350         560           D70         0.700         0.500         0.365         19         28         580         880           D80         0.800         0.500         0.365         28         34         870         1100           D90         0.900         0.500         0.365         28         34         480         1000         1500           D100         1.000         0.500         0.365         60         93         1900         2800           D120         1.200         0.500         0.365         60         93         1900         2800           D140         1.400         0.625         0.365         94         110         290         3500           D50         0.500         0.375         0.475         2.4         4.8         76         150           D50         0.500         0.375         0.475         7.7         12         230         370           D70         0.700         0.500         0.475         19         23         580         710           D80         0.800         0.500         0.475		D40	0.400	0.250	0.365	3.8	7.2	110	220
Disc         0.000         0.010         0.000         12         18         330         300           Disc         0.700         0.500         0.385         19         28         580         880           Disc         0.800         0.500         0.385         28         34         870         1100           Disc         0.900         0.500         0.365         28         34         48         1000         1500           Disc         0.100         0.500         0.365         66         93         1900         2800           Dito         1.200         0.500         0.365         66         93         1900         2800           Dito         1.400         0.625         0.365         94         110         2900         3500           Dito         0.400         0.250         0.474         1.6         2.3         52         71           Dito         0.400         0.250         0.475         2.4         4.8         76         150           Dito         0.500         0.375         0.475         7.7         12         230         370           Dito         0.600         0.500         0.4	с U	D50	0.500	0.375	0.365	8.5	14	260	430
Y         D/0         0.100         0.000         0.300         13	Õ	D60	0.000	0.375	0.365	12	10	580	880
D00         0.000         0.000         0.000         0.000         0.000         0.000         100           D90         0.900         0.500         0.365         34         48         1000         1800           D100         1.000         0.500         0.365         46         60         1400         1800           D120         1.200         0.500         0.365         60         93         1900         2800           D140         1.400         0.625         0.365         94         110         2900         3500           D30         0.300         0.250         0.474         1.6         2.3         25         71           D40         0.400         0.250         0.475         2.4         4.8         76         150           D50         0.500         0.375         0.475         7.7         12         230         370           D70         0.700         0.500         0.475         19         23         580         711           D90         0.900         0.500         0.475         19         23         580         710           D90         0.900         0.500         0.475         4	Ş	D70	0.700	0.500	0.365	28	34	870	1100
D30         D250         D474         1.6         D33         D30         D30         D30         D30         D30         D30         D30         D30         D250         D474         1.6         D33         D52         T1           D40         0.400         0.250         0.475         2.4         4.8         76         150           D50         0.500         0.375         0.475         5.7         9.4         180         290           D60         0.600         0.375         0.475         7.7         12         230         370           D70         0.700         0.500         0.475         19         23         580         710           D90         0.900         0.500         0.475         30         40         950         1200           D100         1.000         0.625         0.475         40         60 <td>0</td> <td>D00</td> <td>0.900</td> <td>0.500</td> <td>0.365</td> <td>34</td> <td>48</td> <td>1000</td> <td>1500</td>	0	D00	0.900	0.500	0.365	34	48	1000	1500
D120         1.200         0.500         0.365         60         93         1900         2800           D140         1.400         0.625         0.365         94         110         2900         3500           D30         0.300         0.250         0.474         1.6         2.3         52         71           D40         0.400         0.250         0.475         2.4         4.8         76         150           D50         0.500         0.375         0.475         5.7         9.4         180         290           D60         0.600         0.375         0.475         12         20         390         590           D70         0.700         0.500         0.475         12         20         390         590           D80         0.800         0.500         0.475         19         23         580         710           D90         0.900         0.500         0.475         30         40         950         1200           D100         1.000         0.500         0.475         30         40         950         1200           D100         1.000         0.500         0.575         6.0	7	D100	1.000	0.500	0.365	46	60	1400	1800
D140         1.400         0.625         0.365         94         110         2900         3500           D30         0.300         0.250         0.474         1.6         2.3         52         71           D40         0.400         0.250         0.475         2.4         4.8         76         150           D50         0.500         0.375         0.475         5.7         9.4         180         290           D60         0.600         0.375         0.475         7.7         12         230         370           D70         0.700         0.500         0.475         12         20         390         590           D80         0.800         0.500         0.475         12         20         390         590           D90         0.900         0.500         0.475         19         23         580         710           D90         0.900         0.500         0.475         23         32         690         1000           D100         1.000         0.500         0.475         30         40         950         1200           D100         1.000         0.500         0.575         60		D120	1,200	0,500	0.365	60	93	1900	2800
D30         0.300         0.250         0.474         1.6         2.3         52         71           D40         0.400         0.250         0.475         2.4         4.8         76         150           D50         0.500         0.375         0.475         5.7         9.4         180         290           D60         0.600         0.375         0.475         7.7         12         230         370           D70         0.700         0.500         0.475         19         23         580         710           D90         0.800         0.500         0.475         19         23         580         710           D90         0.900         0.500         0.475         30         40         950         1000           D120         1.200         0.500         0.475         30         40         950         1000           D140         1.400         0.625         0.475         60         77         1900         2300           D50         0.500         0.375         0.575         4.6         6.8         140         210           D60         0.600         0.375         0.575         10		D140	1.400	0.625	0.365	94	110	2900	3500
D40         0.400         0.250         0.475         2.4         4.8         76         150           D50         0.500         0.375         0.475         5.7         9.4         180         290           D60         0.600         0.375         0.475         7.7         12         230         370           D70         0.700         0.500         0.475         12         20         390         590           D80         0.800         0.500         0.475         19         23         580         710           D90         0.900         0.500         0.475         23         32         690         1000           D100         1.000         0.500         0.475         30         40         950         1200           D100         1.000         0.500         0.475         40         60         1300         1900           D1100         1.400         0.625         0.475         60         77         1900         2300           D50         0.500         0.375         0.575         4.6         6.8         140         210           D60         0.600         0.375         0.575         15		D30	0.300	0.250	0.474	1.6	2.3	52	71
DSO         0.500         0.375         0.475         5.7         9.4         180         290           D60         0.600         0.375         0.475         7.7         12         230         370           D70         0.700         0.500         0.475         12         20         390         590           D80         0.800         0.500         0.475         19         23         580         710           D90         0.900         0.500         0.475         23         32         690         1000           D100         1.000         0.500         0.475         30         40         950         1200           D100         1.000         0.500         0.475         30         40         950         1200           D100         1.000         0.500         0.475         30         40         950         1200           D100         1.000         0.500         0.475         40         60         1300         1900           D100         1.000         0.625         0.475         60         77         1900         2300           D100         0.500         0.575         0.575         6.2 <td></td> <td>D40</td> <td>0.400</td> <td>0.250</td> <td>0.475</td> <td>2.4</td> <td>4.8</td> <td>76</td> <td>150</td>		D40	0.400	0.250	0.475	2.4	4.8	76	150
D60         0.600         0.375         0.475         7.7         12         230         370           D70         0.700         0.500         0.475         12         20         390         590           D80         0.800         0.500         0.475         19         23         580         710           D90         0.900         0.500         0.475         23         32         690         1000           D100         1.000         0.500         0.475         30         40         950         1200           D100         1.000         0.500         0.475         30         40         950         1200           D100         1.000         0.500         0.475         30         40         950         1200           D100         1.000         0.500         0.475         40         60         1300         1900           D140         1.400         0.625         0.475         60         77         1900         2300           D50         0.500         0.375         0.575         4.6         6.8         140         210           D60         0.600         0.375         0.575         10		D50	0.500	0.375	0.475	5.7	9.4	180	290
D70         0.700         0.500         0.475         12         20         390         590           D80         0.800         0.500         0.475         19         23         580         710           D90         0.900         0.500         0.475         23         32         690         1000           D100         1.000         0.500         0.475         30         40         950         1200           D120         1.200         0.500         0.475         30         40         950         1200           D140         1.400         0.625         0.475         60         77         1900         2300           D50         0.500         0.375         0.575         4.6         6.8         140         210           D60         0.600         0.375         0.575         10         14         310         430           D80         0.800         0.500         0.575         15         17         470         520           D90         0.900         0.500         0.575         18         23         560         720           D100         1.000         0.500         0.575         32	S	D60	0.600	0.375	0.475	7.7	12	230	370
D80         0.800         0.500         0.475         19         23         580         710           D90         0.900         0.500         0.475         23         32         690         1000           D100         1.000         0.500         0.475         23         32         690         1000           D100         1.000         0.500         0.475         30         40         950         1200           D120         1.200         0.500         0.475         40         60         1300         1900           D140         1.400         0.625         0.475         60         77         1900         2300           D50         0.500         0.375         0.575         4.6         6.8         140         210           D60         0.600         0.375         0.575         10         14         310         430           D80         0.800         0.500         0.575         15         17         470         520           D90         0.900         0.500         0.575         18         23         560         720           D90         0.900         0.500         0.575         32		D70	0.700	0.500	0.475	12	20	390	590
D90         0.900         0.500         0.475         23         32         690         1000           D100         1.000         0.500         0.475         30         40         950         1200           D120         1.200         0.500         0.475         30         40         60         1300         1900           D140         1.400         0.625         0.475         60         77         1900         2300           D50         0.500         0.375         0.575         4.6         6.8         140         210           D60         0.600         0.375         0.575         10         14         310         430           D70         0.700         0.500         0.575         15         17         470         520           D80         0.800         0.500         0.575         18         23         560         720           D90         0.900         0.500         0.575         32         44         30         760         900           D100         1.000         0.500         0.575         18         23         560         720           D1100         1.200         0.500	<b>k</b>	D80	0.800	0.500	0.475	19	23	580	710
D100         1.000         0.500         0.475         30         40         950         1200           D120         1.200         0.500         0.475         40         60         1300         1900           D140         1.400         0.625         0.475         60         77         1900         2300           D50         0.500         0.375         0.575         4.6         6.8         140         210           D60         0.600         0.375         0.575         6.2         8.9         190         270           D70         0.700         0.500         0.575         10         14         310         430           D80         0.800         0.500         0.575         15         17         470         520           D90         0.900         0.500         0.575         18         23         560         720           D100         1.000         0.500         0.575         32         45         1000         1400           D120         1.200         0.500         0.575         50         56         1600         1700	15	D90	0.900	0.500	0.475	23	32	690	1000
D120         1.200         0.500         0.475         40         60         1300         1900           D140         1.400         0.625         0.475         60         77         1900         2300           D50         0.500         0.375         0.575         4.6         6.8         140         210           D60         0.600         0.375         0.575         6.2         8.9         190         270           D70         0.700         0.500         0.575         10         14         310         430           D80         0.800         0.500         0.575         15         17         470         520           D90         0.900         0.500         0.575         18         23         560         720           D100         1.000         0.500         0.575         32         45         1000         1400           D120         1.200         0.500         0.575         50         56         1600         1700		D100	1.000	0.500	0.475	30	40	950	1200
D140         1.400         0.625         0.475         60         77         1900         2300           D50         0.500         0.375         0.575         4.6         6.8         140         210           D60         0.600         0.375         0.575         6.2         8.9         190         270           D70         0.700         0.500         0.575         10         14         310         430           D80         0.800         0.500         0.575         15         17         470         520           D90         0.900         0.500         0.575         18         23         560         720           D100         1.000         0.500         0.575         32         45         1000         1400           D120         1.200         0.500         0.575         50         56         1600         1700		D120	1.200	0.500	0.475	40	60	1300	1900
D50         0.500         0.375         0.575         4.6         6.8         140         210           D60         0.600         0.375         0.575         6.2         8.9         190         270           D70         0.700         0.500         0.575         10         14         310         430           D80         0.800         0.500         0.575         15         17         470         520           D90         0.900         0.500         0.575         18         23         560         720           D100         1.000         0.500         0.575         32         45         1000         1400           D120         1.200         0.500         0.575         50         56         1600         1700		D140	1.400	0.625	0.475	60	77	1900	2300
D60         0.600         0.375         0.575         6.2         8.9         190         270           D70         0.700         0.500         0.575         10         14         310         430           D80         0.800         0.500         0.575         15         17         470         520           D90         0.900         0.500         0.575         18         23         560         720           D100         1.000         0.500         0.575         24         30         760         900           D120         1.200         0.500         0.575         32         45         1000         1400           D140         1.400         0.625         0.575         50         56         1600         1700		D50	0.500	0.375	0.575	4.6	6.8	140	210
D/0         0.700         0.500         0.575         10         14         310         430           D80         0.800         0.500         0.575         15         17         470         520           D90         0.900         0.500         0.575         18         23         560         720           D100         1.000         0.500         0.575         32         45         1000         1400           D140         1.400         0.625         0.575         50         56         1600         1700	Ö	D60	0.600	0.375	0.575	6.2	8.9	190	270
D80         0.000         0.300         0.375         15         17         470         520           D90         0.900         0.500         0.575         18         23         560         720           D100         1.000         0.500         0.575         24         30         760         900           D120         1.200         0.500         0.575         32         45         1000         1400           D140         1.400         0.625         0.575         50         56         1600         1700	ă	D70	0.700	0.500	0.5/5	10	14	310	430
D90         0.900         0.900         0.900         0.900         0.900         0.75         18         23         560         720           D100         1.000         0.500         0.575         24         30         760         900           D120         1.200         0.500         0.575         32         45         1000         1400           D140         1.400         0.625         0.575         50         56         1600         1700	2 2	080	0.800	0.500	0.5/5	15	17	4/0	520
D100         1.000         0.500         0.575         24         30         760         900           D120         1.200         0.500         0.575         32         45         1000         1400           D140         1.400         0.625         0.575         50         56         1600         1700	۲ ۲	D90	1.000	0.000	0.3/3	18	23	200	/ 20
D120 1.400 0.625 0.575 50 56 1600 1700	2(	D100	1 200	0.500	0.575	24 32	30	1000	900 1400
		D120	1.400	0.625	0.575	50	56	1600	1700

# **High Voltage Radial Leaded Disc Capacitors** High Temperature +200°C Rated - 3 kVDC to 20 kVDC

### D30 D50 HT Series Dielectric HT = High Temp Voltage Style N = HTNPO D30 = 3 kVDC +200 °C D100 = 10 kVDC D50 X = HTX7RD150 = 15 kVDC - Reference table

Performance Charts (Typical)



# HTX7R Temperature Coefficient



**Capacitance Vs Frequency** 

CRT-0018 Rev 1410 **Part Number / Ordering Information** 





**HTNPO** Temperature Coefficient



**Dissipation Factor Vs Frequency** 

CRT-0018 Rev 1410

# **High Temperature - High Voltage Leaded Capacitors**

200°C Rated NPO / HTX7R - 50 Vdc to 10 KVdc



Lead Type: #22 AWG, silver plated, CCFE or solid nickel

Performance Characteristics

CalRamic Technologies LLC manufactures a series of highly reliable, encapsulated radial / axial leaded ceramic capacitors that are designed specifically for those severe conditions where the capacitor may be exposed to elevated levels of mechanical stress and high temperature conditions. These assemblies are packaged in a high resistance, high temperature rated case and backfilled with a high temperature epoxy that provides enhanced electrical isolation and added environmental protection.

Intended for continuous operation at full rated voltage and across the entire operating temperature range of -55 to +200°C, these capacitors utilize a special internal design specifically intended to reduce electric field stresses, thereby providing a device that exhibits very low ESR characteristics and no reduction in insulation resistance with life.

Available with ultra stable Class I, NPO and stable Class II, X7R dielectric materials, these capacitors are ideally suited for a variety of extreme applications associated with the high temperature aerospace, down-hole mining and automotive industries.

Specification		Dielectric Type (EIA Designation)	
Specification	NPO (COG)	HTX7R	HTX7R [Extended Range]
Material Classification	Type I, Ultra Stable, K90	Type II, Stable, K2100	Type II, Stable, K2500
Coefficient of Thermal Expansion	9 x 10 <sup>-6</sup> / °C	11 x 1	0° / °C
Density		72 g / in <sup>3</sup>	
Operating Temperature Range		-55 to +200°C	
Aging Rate	0	-2% Max per	decade hour
Temperature Coefficient	±60 PPM / °C	+15 / -40%	+15 / -60%
Voltage Coefficient	Negligible	-20% Max @ WVDC	-35% Max @ WVDC
Maximum Capacitance	0.10 μF HTR / 0.010 μF HTA	1.8 μF HTR / 0.68 μF HTA	2.7 μF HTR / 1.0 μF HTA
Voltage Range		50 VDC to 10 kVDC	
Insulation Resistance @ +25°C		100,000 M $\Omega$ or 1000 M $\Omega$ - $\mu F,$ W/E is less	i
Insulation Resistance @ 200°C		100 MΩ or 1 MΩ - $\mu$ F, W/E is less	
Dissipation Factor	0.1% Max	2.0%	Max
DWV	2 x WVDC @ WVDC < 200 VDC / 1	.5 x WVDC @ 200 VDC WVDC < 1 kVD	C / 1.2 x WVDC @ WVDC 1 kVDC

# **Mechanical Dimensions**

Dimensions		Product Style													
inches [mm]	HTR01	HTR02	HTR03	HTR04	HTR05	HTR06	HTR07	HTA10	HTA11	HTA12	HTA13	HTA14			
Width - Max	0.200 [5.08]	0.200 [5.08]	0.200 [5.08]	0.300 [7.60]	0.500 [12.70]	0.700 [17.80]	1.500 [38.10]	•	•	•	•	•			
Height - Max	0.200 [5.08]	0.200 [5.08]	0.200 [5.08]	0.300 [7.60]	0.500 [12.70]	0.400 [10.16]	0.750 [19.05]	0.170 [4.32]	0.270 [6.86]	0.400 [10.16]	0.500 [12.70]	0.750 [19.10]			
Thickness - Max	0.100 [2.54]	0.100 [2.54]	0.150 [3.81]	0.150 [3.81]	0.250 [6.35]	0.250 [6.35]	0.300 [7.62]	•	•	•	•	•			
Diameter - Max	•	•	•	•	•	•	•	0.100 [2.54]	0.135 [3.43]	0.155 [3.94]	0.200 [5.08]	0.375 [9.53]			
Lead Spacing ±0.030 [0.762]	0.100 [2.54]	0.200 [5.08]	0.100 [2.54]	0.200 [5.08]	0.400 [10.16]	0.500 [12.70]	1.375 [34.93]	•	•	•	•	•			

# **High Temperature - High Voltage Leaded Capacitors** 200°C Rated NPO / HTX7R - 50 Vdc to 10 KVdc

### Electrical Characteristics

	HT NPO Capacitance Range [Max]														
Style		HTR01	HTR02 HTR0		HTR04	HTR05	HTR06	HTR07	HTA10	HTA11	HTA12	HTA13	HTA14		
WVDC	50	562	562	562	253	683	104	•	142	332	103	•	•		
	100	472	472	472	223	563	823	• 12		272	272 822		•		
	200	392	392	392	183	473	683	•	102 252		682	•	•		
	500	182	182	272	103	333	473	• 681		182	472	•	•		
	1000	561 561		102	332	183	163	104	181	471	222	•	•		
	2000	0 • •		•	561	392	562	223	•	٠	221	٠	•		
	3000	• •		٠	٠	272	392	153	•	•	221	٠	•		
	4000	٠	• •		٠	681	222	472	•	٠	•	٠	•		
	5000	•	•	•	•	•	102	372	•	•	•	•	•		
	10000	•	•	•	•	•	•	122	•	•	•	•	•		

HTX7R Capacitance Range																									
Style		HTR01		HTR02		HTR03		HTR04		HTR05		HTR06		HTR07		HTA10		HTA11		HTA12		HTA13		HTA14	
Cap Range		STD	EXT																						
WVDC	50	823	124	823	124	823	124	474	824	125	185	185	275	٠	٠	273	393	683	104	184	274	274	394	684	105
	100	683	104	683	104	683	104	394	684	105	155	155	225	•	٠	223	333	563	823	154	224	224	334	564	824
	200	273	393	273	393	393	563	154	224	564	824	824	125	•	•	822	123	333	473	823	124	124	184	334	474
	500	392	562	392	562	682	103	223	333	224	334	334	474	•	•	102	152	332	47	153	223	273	393	124	184
	1000	102	152	102	152	182	272	562	822	563	823	823	124	394	564	271	391	681	102	272	392	562	822	333	473
	2000	٠	•	•	•	•	•	102	152	153	223	183	273	863	124	•	•	•	•	561	102	152	222	682	103
	3000	•	•	•	•	•	•	•	•	562	822	822	103	333	473	•	•	٠	•	391	561	102	122	332	472
	4000	٠	•	•	•	•	•	•	•	252	392	392	562	153	183	•	•	٠	•	•	•	271	391	122	182
	5000	•	•	•	•	•	•	•	•	•	•	222	332	103	123	•	•	•	•	•	•	•	•	821	122
	10000	٠	•	٠	٠	•	•	٠	٠	٠	•	٠	•	222	332	•	•	٠	•	•	•	•	•	•	•

### Notes

- product rated at  $\leq$  200 VDC].
- for more information.
- 3. Custom voltages, package sizes and capacitance values available. Contact factory
- 4. X7R dielectrics are not intended for AC line filtering applications.
- mechanical shock. Refer to Technical Bulletin AN103 for handling and installation recommendations.

# **Part Number / Ordering Information**



1. Group A screening available to MIL-PRF-49467 at +200°C. [Voltage conditioning performed at 1.5 x WVDC for

2. Special testing including Partial Discharge (Corona) is available for product rated at ≥500 VDC. Contact factory

5. Large ceramic capacitors, even leaded devices are susceptible to damage when exposed to thermal and / or



# **High Temperature - High Voltage Leaded Capacitors**

 $200^{o}\,C$  Rated NPO / HTX7R – 50 Vdc to 10 KVdc



Notes CALRAMIC (775) 851-3580 / calramic.com / 5462 Louie Lane / Reno, NV 89511 USA TECHNOLOGIES LLC

# Notes







(775) 851-3580 / calramic.com / 5462 Louie Lane / Reno, NV 89511 USA

**CalRamic Technologies LLC** is an ISO9001-2008 Certified facility. Our commitment to Quality is our primary objective and we pride ourselves on our satisfaction to our client base. Our Goal is to provide the upmost Quality from the initial contact in introducing our company, to quoting the same day if possible, followed by offering short deliveries coupled with "on time deliveries" of our products. And of course, what we consider the most important element, the reliability of the components in the application once delivered. In addition, we remain dynamic and open to our customer's inputs so we may continue to improve in all aspects related to our chosen field. We continue to grow at a substantial rate and believe that is in direct response to maintaining the Quality Objectives stated above.





### MORE ABOUT US

**CalRamic Technologies LLC** is a US based manufacturing plant in Reno, Nevada. It was started in 2001 by Jeff Day who is the current President and CEO.

Jeff obtained his degree in Materials Science Engineering in 1984 from the University of Washington and has focused his entire career in the field of High Voltage Ceramic Capacitors. Over the years of service, he has acquired standard design and manufacturing practices to insure the upmost quality of the components.

**CalRamic Technologies LLC** focuses primarily on the High Voltage Ceramic Capacitor market that has the range of 500 volts to 20,000 volts. We pride ourselves on Lean Manufacturing practices which correspond with short deliveries, low cost, high quality components, combined with low overhead to compete on a World-Wide basis.

**CalRamic Technologies LLC** is privately owned with Jeff Day as the majority shareholder. CalRamic's partner company and shareholder is Voltage Multipliers Inc.,Visalia, CA. Voltage Multipliers manufactures diodes and power supplies.

Whatever your Market or application that may require a catalog part, or a part that needs to be custom made, CalRamic can assist you in your design.

Jeff Day







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www.voltagemultipliers.com ~ HV Diodes and Power Supplies Partner company of CalRamic Technologies LLC