CERAMIC CAPACITORS

High Voltage

High Current

High Frequency

HIGH ENERGY CORP.

Sales@HighEnergyCorp.com (610) 593-2800 FAX (610) 593-2985

Parkesburg Pennsylvania – a very special place where 21st Century technology converges with Old World ethics.

High Energy Corporation is housed in a modern factory at the edge of time. Historic Parkesburg stands at the eastern gateway to Pennsylvania's Lancaster County, a place where time sometimes seems to stand still. Our neighbors farm in centuries-old fashion. Come to visit us and your car may share the road with an Amish buggy or a horse-drawn farm wagon. Our people reflect the values of their surroundings; they are hard working, honest to a fault and loyal to their employer and to their customers. Parkesburg residents have been this way for over 200 years and will not change. While our technology advances at the pace of modern-world commerce, our values remain true to an older time and stricter code. We may be an anachronism, but we like it this way. Our customers have come to appreciate doing business in an old fashioned manner within the modern world.

Partner with us and enjoy the benefits of buying first-rate modern technology components from people who exalt old-world craftsmanship and view their word as a bond. Step back in time and forward in technology by choosing High Energy Corporation capacitors for your products.

http://www.highenergycorp.com

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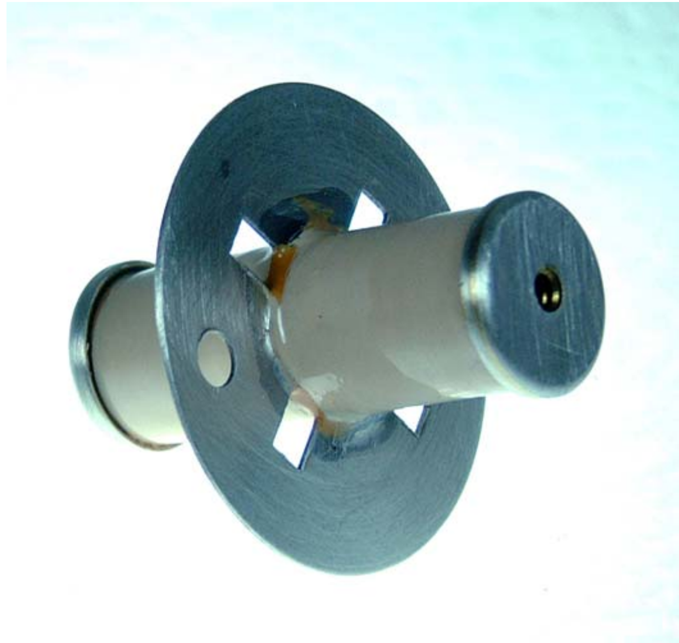
Contents

All High Energy Corporation ceramic capacitors are built in conformity to RoHS Directive. Specifically, in conformity with EU Directive 2002/95/EC, lead, cadmium, mercury, hexavalent chromium and specific bromine-based flame-retardants, PBB and PBDE, have not been used, except for exempted applications.

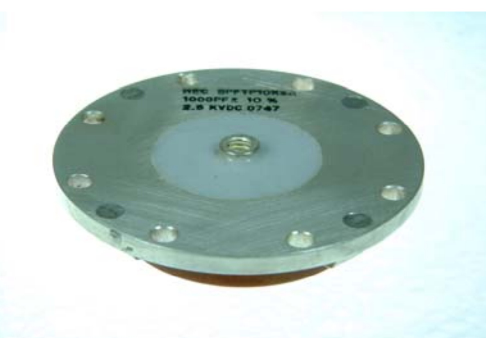
Note: all specifications are subject to change without notice.

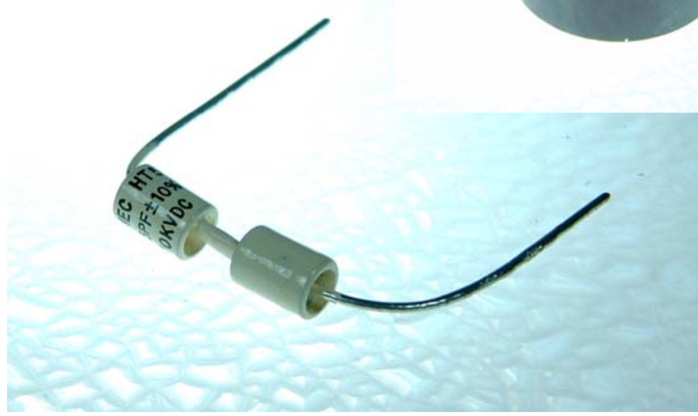
In today's 'modern' business climate, companies tend to provide products that fit the general needs of the industry they serve and to avoid deviating from these popular offerings. However, such 'blister-pack' solutions don't always serve the customer well. **High Energy Corporation** takes a different stance; we welcome the challenge of providing custom parts of the highest quality, rapidly and at a fair price.



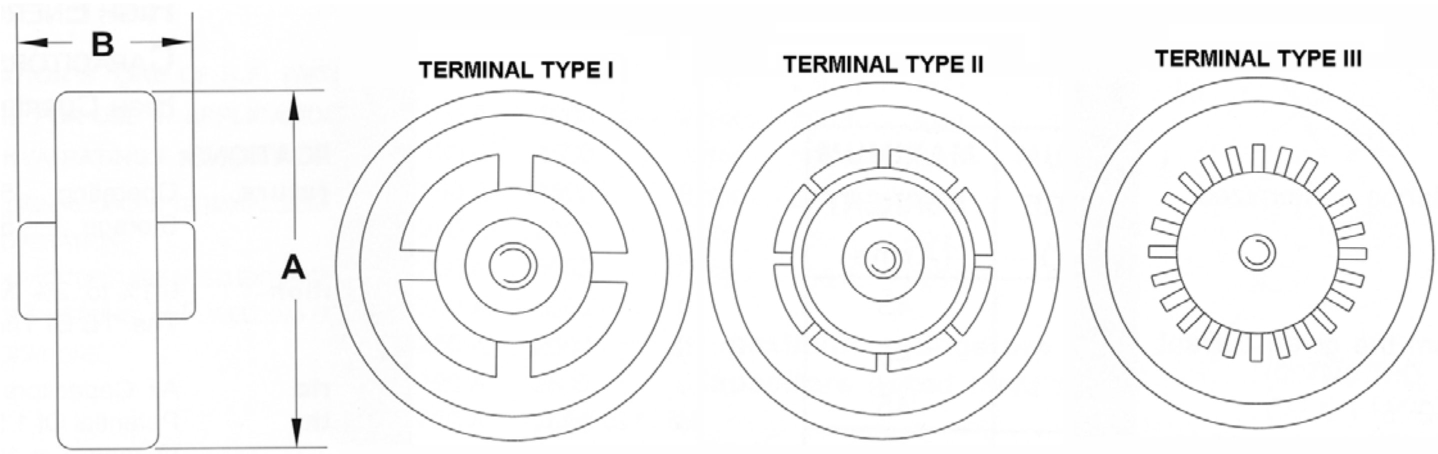
We are an Engineering managed and driven enterprise and we welcome the chance to partner with our customers and to bring our unique capabilities to bear upon the development, refinement and evolution of state-of-the-art ceramic components. Whether your needs are for a simple custom value in one of our standard products, or for an entirely new packaging concept, we are ready to work with you in refining your high voltage, current, power or frequency application.

This catalog illustrates many standard **High Energy Corporation** products. Think of these as a launch point for your product planning and design thoughts. We will be delighted to produce *exactly* the 'right' ceramic component for your new design or for your mature product and you will be delighted with the result! Peruse some unique custom parts designed for others here.





Some custom and special parts become popular enough to become "catalog items". For example, consider the following collection of (previously special) Power Disk capacitors now offered as standard parts:



pF	Class I Dielectric	PERFORMANCE RATINGS V_{MAX} (kV_{DC})	S_{MAX} (kVA)	I_{MAX} (A_{RMS})	PHYSICAL A (In)	B (In)	Terminal Type	PART NUMBER
33	NP0	7.5	6	10	1.85	0.78	I	SPHTV330KA
39		7.5	6	10	1.85	0.78	I	SPHTV390KA
47		7.5	6	10	1.85	0.78	I	SPHTV479KA
56		7.5	6	10	1.85	0.78	I	SPHTV560KA
200	N470	5	10	15	1.875	0.688	I	SPHTT201JD
2000		10	60	150	5.188	1.44	Special	SPHT1202MC
900	N800	12	90	60	5.665	2.152	II	SPHT1901KA
1000		15	70	40	4.75	2.00	II	SPHT2102MB
1000	N2200	30	70	30	4.3	3.35	III	SPHT5102MA
500	N3300	5	7.5	10	1.343	0.828	I	SPHTT501KB
1000		40	70	30	4.5	4.625	Special	SPHT7102MA

pF	Class II Dielectric	PERFORMANCE RATINGS V_{MAX} (kV_{DC})	S_{MAX} (kVA)	I_{MAX} (A_{RMS})	PHYSICAL A (In)	B (In)	Terminal Type	PART NUMBER
1000	X5T	2.5	.25	10	0.875	0.75	I	SPHHR102TK
6800		3.5	1	30	1.915	0.875	I	SPHHR682TN
1500	X5V	3.5	.25	10	1	0.875	Special	SPHHR152TA
3300		2.5	.5	20	1.281	0.719	I	SPHHR332TK
10,000		3.5	.25	10	2.35	1	I	SPHHR103TA

HT Series Ceramic Capacitors are small, RF-capable, Class 1 parts featuring high Voltage, Current and Power ratings. They exhibit a low dissipation factor and minimum self-inductance. These extremely rugged capacitors are carefully designed to live in the demanding world of broadcast and high-voltage industrial application. Their structure is both simple and robust, assuring a long trouble free life. HT Series parts feature a nonconductive, humidity-resistant, coating and a long flashover path. They are built upon a choice of six Class I dielectrics, providing a broad range of capacitance and temperature coefficients. Typical applications include **transmitters**, **antennas**, **induction heating**, **X-ray**, **diathermy** and **welding**.

CLASS 1 Capacitor Dielectric Characteristics

Dielectric Material	Temperature Coefficient (ppm/°C)	TC Tolerance (ppm/°C)	Max Dissipation Factor (δ measured at 1 MHz)
NPO	0	± 60 *	0.1 %
N-750	-750	± 120	0.1 %
N-2200	-2200	± 500	0.1 %
N-3300	-3300	± 500	0.2 %
N-5250	-5250	± 1000	0.3 %
N-5500	-5500	± 1000	0.5 %

* Wire-leaded HT53, 54 & 55 parts available in more stringent tolerances.

GENERAL SPECIFICATIONS

Temperature Range	Operating: -55° C to +85 ° C Storage: -55° C to +125 ° C
Capacitance Tolerance	From ± 2.5% to ± 20% and from ±2.5 pF to ±1 pF
Dissipation Factor	0.1% to 0.5% Maximum (see Dielectric chart above)
Dielectric Strength	Will withstand an AC potential of 1.5 times Rated Working Voltage for 10 Seconds at 25° C.
Insulation Resistance	10,000 Megohms (MΩ) Minimum
Terminals	Silver Plated
Terminal Strength	Maximum applied torque to be 20 inch-pounds or less (HT57 & HT59 series) “” “” “” 6 inch-pounds or less (HT50 & HT58 series with standard terminal) “” “” “” 17 inch-pounds or less (HT 50 & HT58 series with solid terminal)
Humidity Protection	Nonconductive Coating
Standard Markings	“HEC”, Capacitance, Tolerance, Rated Working Voltage (V_{DC}), TC and Date Code

Summary of Available HT Series Ceramic Capacitors

Series	V_{Max} (kV_{DC})	S_{Max} (kVA)	I_{Max} (A_{RMS})	Capacitance (pF)	Diameter (Inch)	Length (Inch)
HT59	25	50	16.8 - 35.5	50 – 1500	2.25	3.00 max
HT57	15	35	6.9 - 15	10 – 500	1.187	1.890 max
HT50	7.5	10	6.9 - 10.4	10 – 700	.820	.890 max
HT58	7.5	10	8.9 – 9.7	40 – 65	.820	.890 max
HT53	5	7	4.0 – 5.3	7 – 45	.563*	.484*
HT54	5	5	2.0 – 5.6	3 – 40	.438*	.422*
HT55	5	3	1.2 – 3.0	1 – 15	.313*	.391*

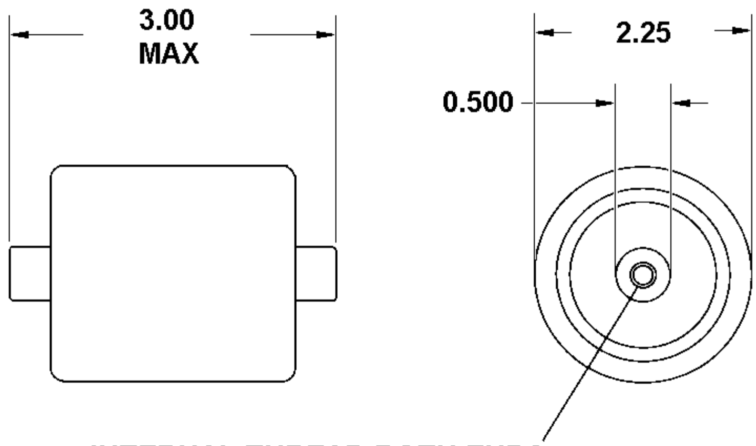
* With threaded terminals, smaller with wire leads.

Part Number System for HT Series Ceramic Capacitors:

HT55 T 259 K B-30

SERIES	VOLTAGE RATING	CAPACITANCE VALUE (pF)	CAPACITANCE TOLERANCE	DETAIL CODE
HT50	T = 5 kV_{DC}	(two digits &	C = ± 0.25 pF	A = UNF Threaded Terminals
HT53	V = 7.5 kV_{DC}	power-of-10	D = ± 0.5 pF	A-M = Metric Threaded Terminals
HT54	X = 10 kV_{DC}	multiplier*)	F = ± 1 pF	A-SM = Solid Metric Terminal for HT50
HT55	Y = 15 kV_{DC}	250 = 25 pF	G = ± 2.5 %	B = Wire Ends for HT 53, 54 & 55 (± 60 ppm/°C)
HT57	Z = 20 kV_{DC}	251 = 250 pF	J = ± 5 %	B-10 = " " " with ± 10 ppm/°C TC Tolerance
HT58	4 = 25 kV_{DC}	252 = 2500 pF	K = ± 10 %	B-20 = " " " with ± 20 ppm/°C TC Tolerance
HT59		259* = 2.5 pF	M = ± 20 %	B-30 = " " " with ± 30 ppm/°C TC Tolerance
		* multiplier 9 = 1/10	Z = +80%, - 20 %	

- **25 kV_{DC} Working Voltage**
- **50 kVA Max Power**
- **50 to 1,500 pF Capacitance**
- **2.25" Diameter x 3" Maximum**
- **Choice of four Class I TC's**



INTERNAL THREAD BOTH ENDS
10-32 UNF-2B, 1/4 DEEP (A)
OR M5, 6mm DEEP (A-M)

CAPACITANCE		PERFORMANCE RATINGS					PART NUMBER
pF	Dielectric (TC)	V_{MAX} (kV_{DC})	f_L (MHz)	S_{MAX} (kVA)	f_H (MHz)	I_{MAX} (A_{RMS})	
50	**NP0**	**25**	.509	**50**	18.0	**16.8**	HT594500MA
75		**25**	.339	**50**	13.6	**17.9**	HT594750MA
100		**25**	.254	**50**	13.0	**20.2**	HT594101MA
130		**25**	.196	**50**	14.2	**24.1**	HT594131MA
150	**N750**	**25**	.170	**50**	13.9	**25.6**	HT594151MA
200		**25**	.127	**50**	14.3	**30.0**	HT594201MA
250		**25**	.102	**50**	16.0	**35.5**	HT594251MA
300	**N3300**	**25**	.0848	**50**	5.18	**22.1**	HT594301MA
500		**25**	.0509	**50**	3.36	**23.0**	HT594501MA
700		**25**	.0363	**50**	2.73	**24.5**	HT594701MA
800	**N5250**	**25**	.0318	**50**	2.10	**23.0**	HT594801MA
1000		**25**	.0254	**50**	1.99	**25.0**	HT594102MA
1500		**25**	.0170	**50**	1.67	**28.1**	HT594152MA

The table above shows a selected subset from the many HT59 Series parts available. A continuous range of capacitance values between those listed here is available. You can 'build' a part number for any desired HT59 capacitor using the "construction rules" shown at right.

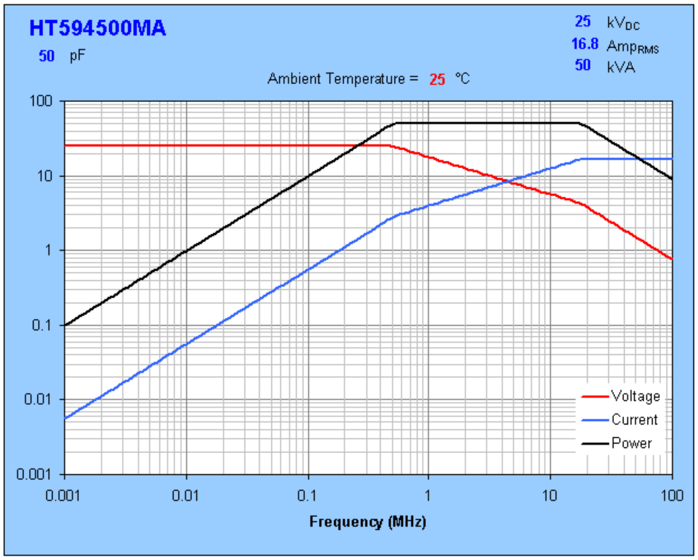
HT59 Series Ceramic Capacitor Part Numbers:

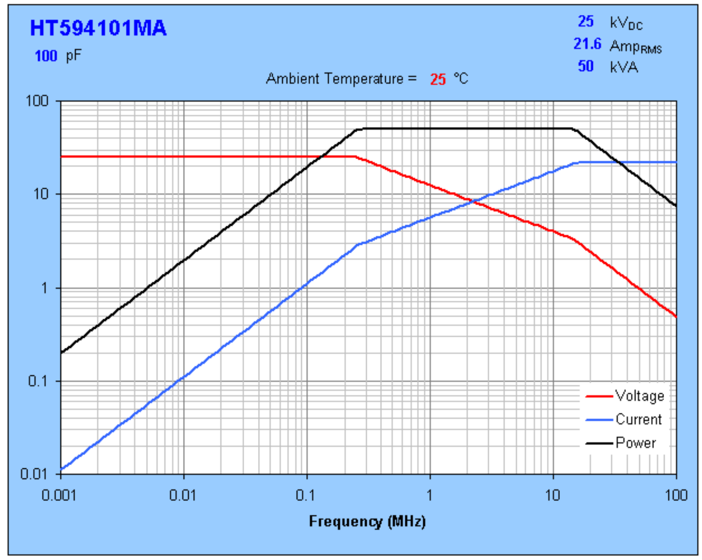
HT594	**500** (50 pF)	**M** (± 20%)	**A** (10-32 Terminals)
	to	or	or
	152 (1500 pF)	**K** (± 10%)	**A-M** (M5 Terminals)

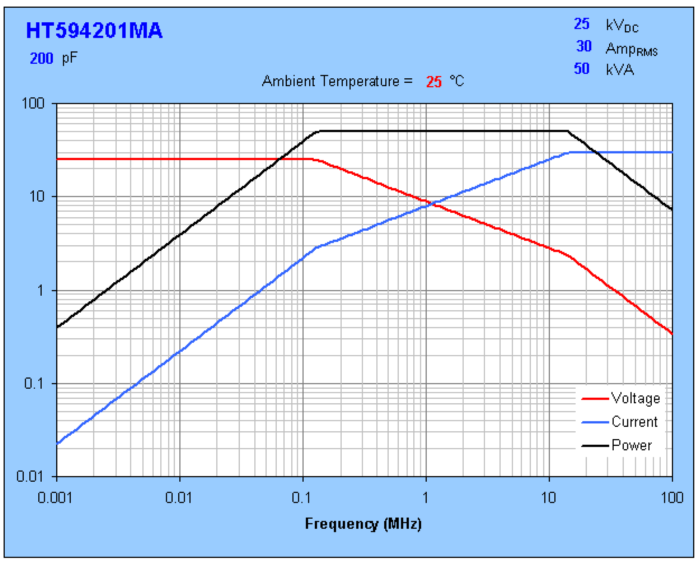
Also available with 15 kV and 20 kV rating as:

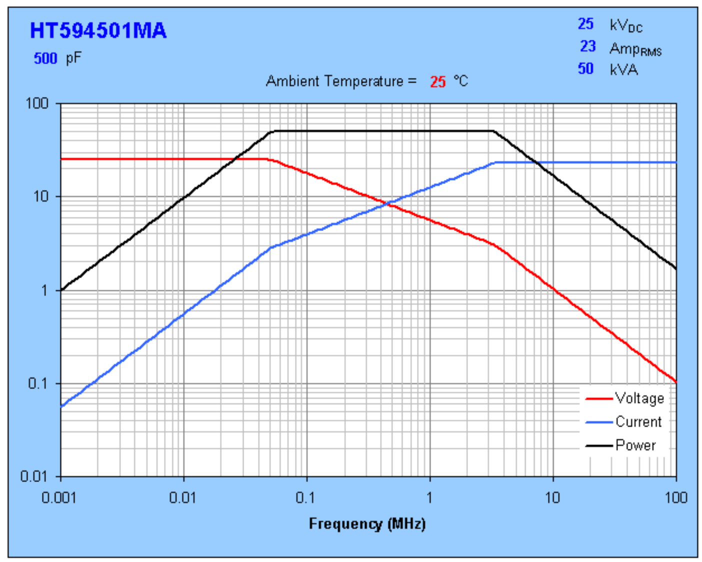
HT59Y (15 kV_{DC}) and **HT59Z** (20 kV_{DC})

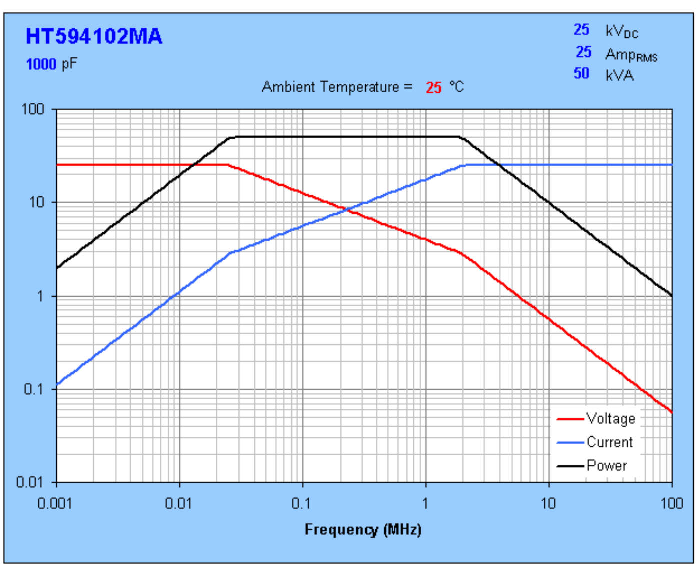
Typical Maximum Rating Curves for HT59 Series Capacitors

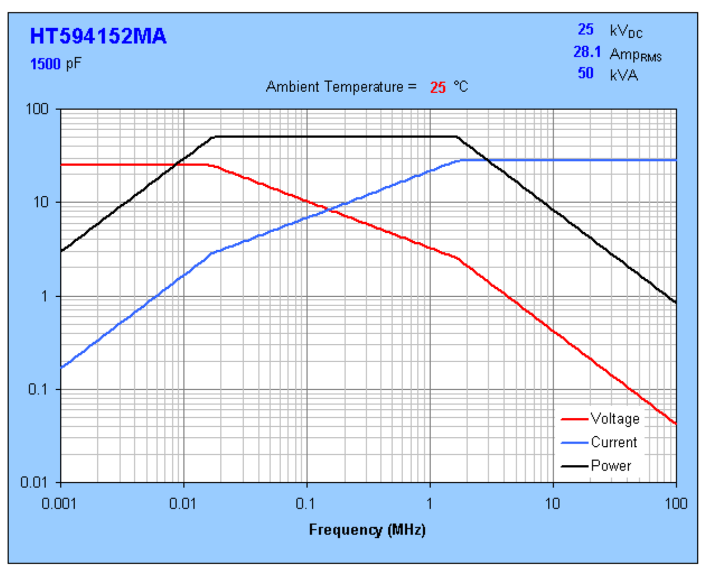




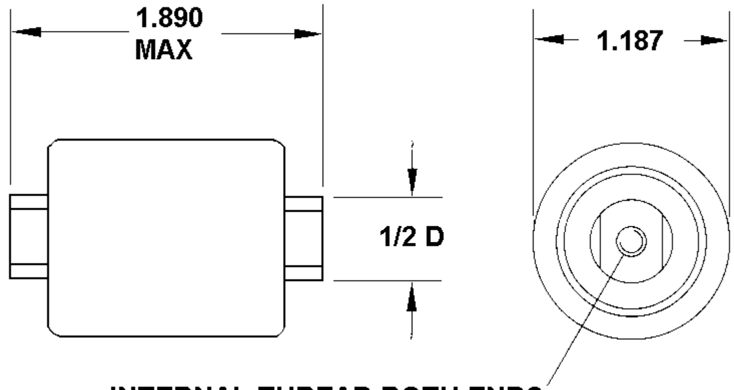








- 15 kV_{DC} Working Voltage
- 35 kVA Max Power
- 10 to 500 pF Capacitance
- 1.187" Diameter x 1.890" Maximum
- Choice of four Class I TC's



INTERNAL THREAD BOTH ENDS
10-32 UNF-2B, 1/4 DEEP (A)
OR M5, 6mm DEEP (A-M)

CAPACITANCE		PERFORMANCE RATINGS					PART NUMBER
pF	Dielectric (TC)	V_{MAX} (kV_{DC})	f_L (MHz)	S_{MAX} (kVA)	f_H (MHz)	I_{MAX} (A_{RMS})	
10	NP0	15	4.95	35	58.0	11.3	HT57Y100KA
25		15	1.98	35	28.4	12.5	HT57Y250KA
50		15	.990	35	15.4	13.0	HT57Y500KA
60		15	.825	35	12.8	13.0	HT57Y600KA
75	N750	15	.660	35	10.4	13.1	HT57Y750KA
100		15	.495	35	8.53	13.7	HT57Y101KA
150		15	.330	35	6.37	14.5	HT57Y151KA
200		15	.247	35	5.11	15.0	HT57Y201KA
250	N3300	15	.198	35	.890	7.00	HT57Y251KA
300		15	.165	35	.742	7.00	HT57Y301KA
400		15	.124	35	.639	7.50	HT57Y401KA
500	N5250	15	.0989	35	.433	6.90	HT57Y501KA

The table above shows a selected subset from the many HT57 Series parts available. A continuous range of capacitance values between those listed here is available. You can 'build' a part number for any desired HT57 capacitor using the "construction rules" shown at right.

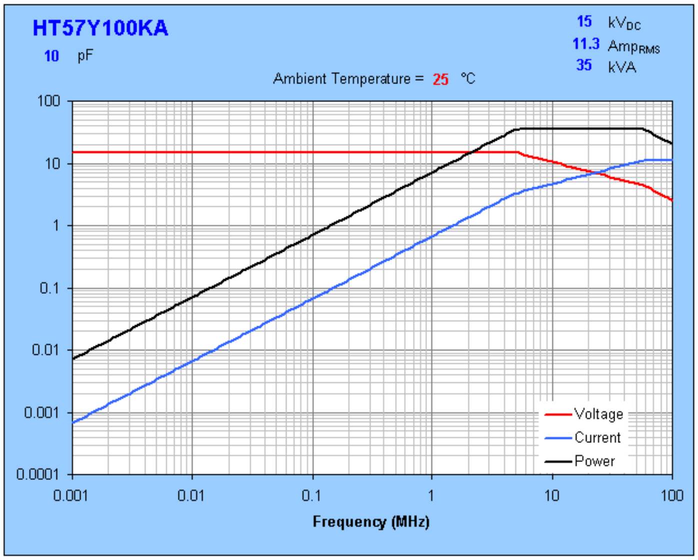
HT57 Series Ceramic Capacitor Part Numbers:

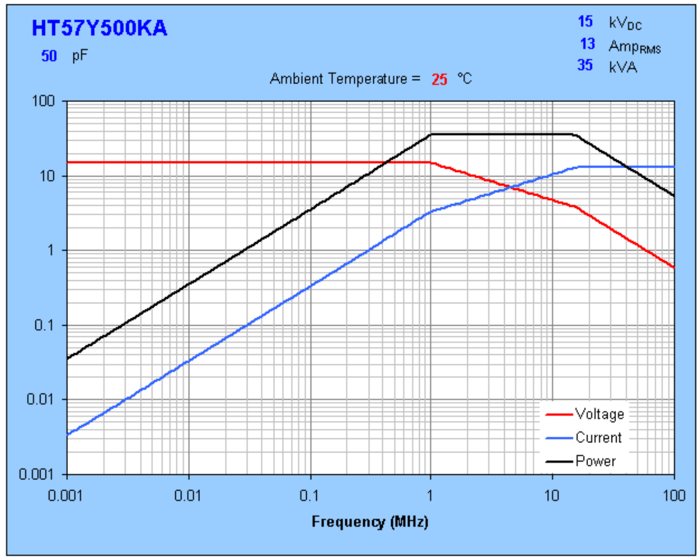
HT57Y	100 (10 pF) to 501 (500 pF)	M (± 20%) or K (± 10%) or J (± 5%) or G (± 2.5%)	A (10-32 Terminals) or A-M (M5 Terminals)

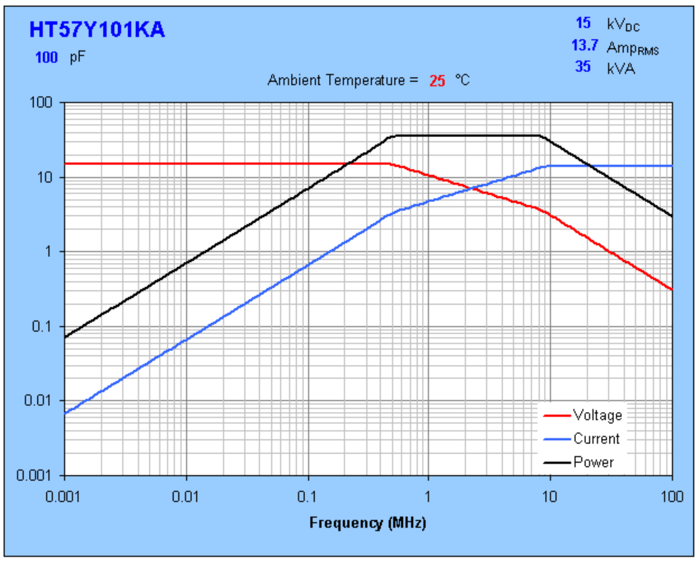
Also available with 7.5 kV and 10 kV rating as:

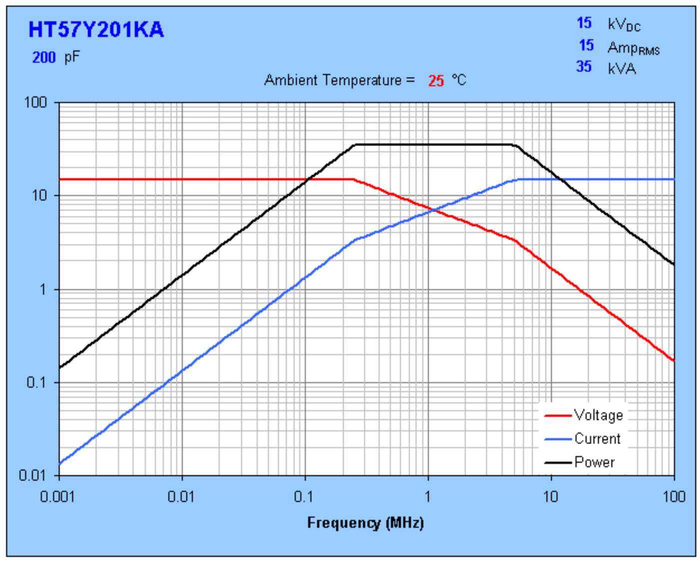
HT57V (7.5 kV_{DC}) and HT57X (10 kV_{DC})

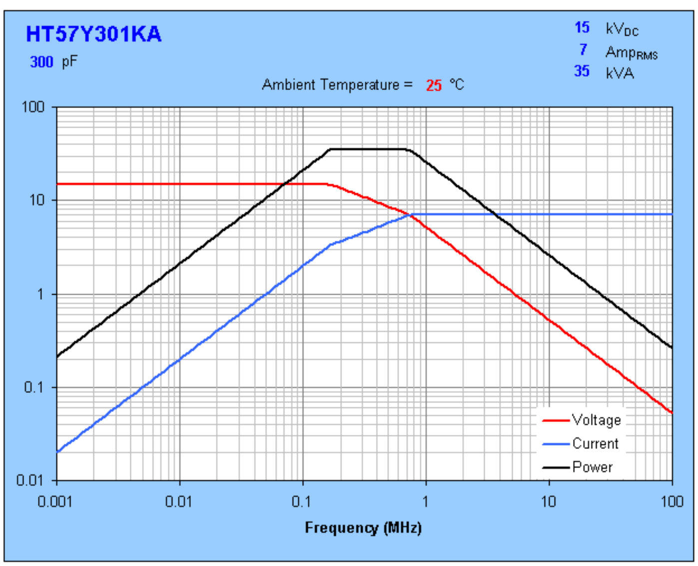
Typical Maximum Rating Curves for HT57 Series Capacitors

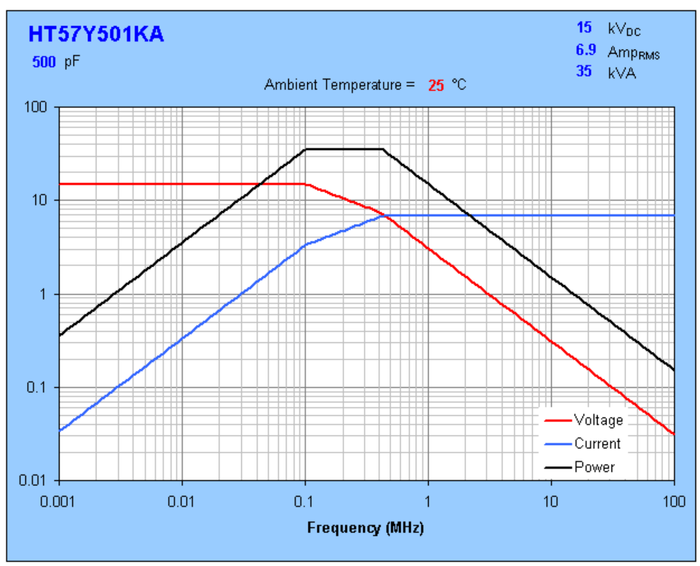




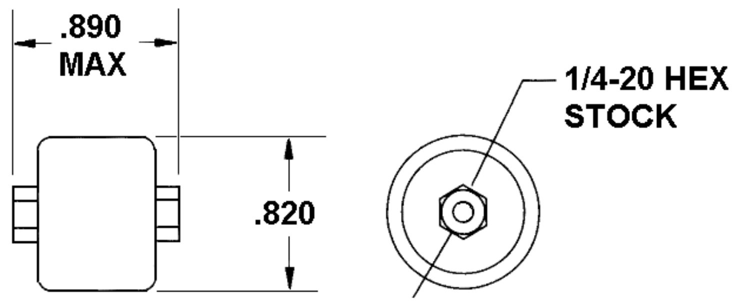








- **7.5 kV_{DC} Working Voltage**
- **10 kVA Max Power**
- **10 to 700 pF Capacitance**
- **.820" Diameter x .890" Maximum**
- **Choice of four Class I TC's**



INTERNAL THREAD BOTH ENDS
6-32 UNC-2B, 5/32 MIN DEEP (A)
OR M4, 4 mm MIN DEEP (A-M)
OR M4, 4 mm MIN DEEP (A-SM)

CAPACITANCE		PERFORMANCE RATINGS					PART NUMBER
pF	Dielectric (TC)	V_{MAX} (kV_{DC})	f_L (MHz)	S_{MAX} (kVA)	f_H (MHz)	I_{MAX} (A_{RMS})	
10	**HT50 SERIES**	**7.5**	5.65	**10**	84.7	**7.3**	HT50V100KA
15	**NP0**	**7.5**	3.77	**10**	56.5	**7.3**	HT50V150KA
25		**7.5**	2.26	**10**	39.7	**7.9**	HT50V250KA
30		**7.5**	1.88	**10**	33.9	**8.0**	HT50V300KA
35		**7.5**	1.62	**10**	31.3	**8.3**	HT50V350KA
40		**7.5**	1.4	**10**	27.4	**8.3**	HT50V400KA
45		**7.5**	1.26	**10**	24.9	**8.4**	HT50V450KA
50		**7.5**	1.13	**10**	23.0	**8.5**	HT50V500KA
55		**7.5**	1.03	**10**	21.4	**8.6**	HT50V550KA
60		**7.5**	.942	**10**	20.1	**8.7**	HT50V600KA
65		**7.5**	.870	**10**	19.4	**8.9**	HT50V650KA
75	**N750**	**7.5**	.754	**10**	19.9	**9.7**	HT50V750KA
100		**7.5**	.565	**10**	15.0	**9.7**	HT50V101KA
150		**7.5**	.377	**10**	11.0	**10.2**	HT50V151KA
170		**7.5**	.333	**10**	10.1	**10.4**	HT50V171KA
200	**N3300**	**7.5**	.283	**10**	3.78	**6.9**	HT50V201KA
300		**7.5**	.188	**10**	2.90	**7.4**	HT50V301KA
400		**7.5**	.141	**10**	2.36	**7.7**	HT50V401KA
500	**N5250**	**7.5**	.113	**10**	1.69	**7.3**	HT50V501KA
600		**7.5**	.0942	**10**	1.49	**7.5**	HT50V601KA
700		**7.5**	.0808	**10**	1.42	**7.9**	HT50V701KA

40	**HT58 SERIES**	**7.5**	1.41	**10**	31.5	**8.9**	HT58V400KA
50	**N750**	**7.5**	1.13	**10**	28.1	**9.4**	HT58V500KA
60		**7.5**	.942	**10**	24.9	**9.7**	HT58V600KA
65		**7.5**	.870	**10**	23.0	**9.7**	HT58V650KA

The preceding table shows a selected subset from the many HT50 or HT58 Series parts available. A continuous range of capacitance values between those listed here is available. You can ‘build’ a part number for any desired HT50 or HT58 capacitor using the “construction rules” shown at right.

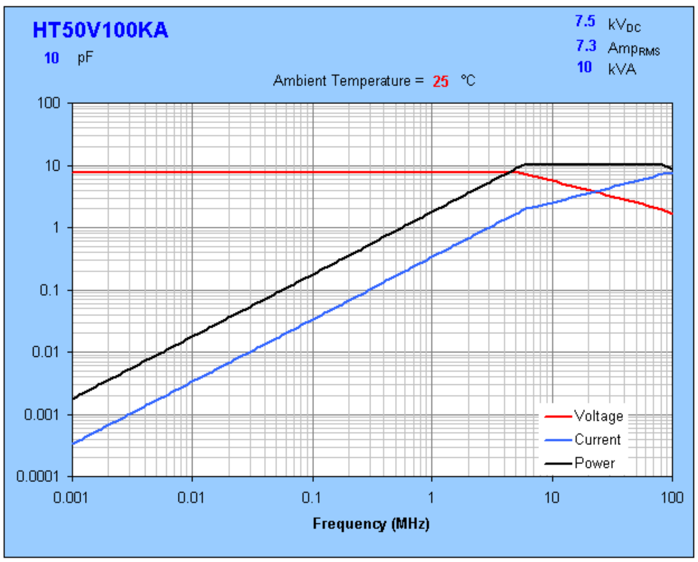
HT50 Series Ceramic Capacitor Part Numbers:

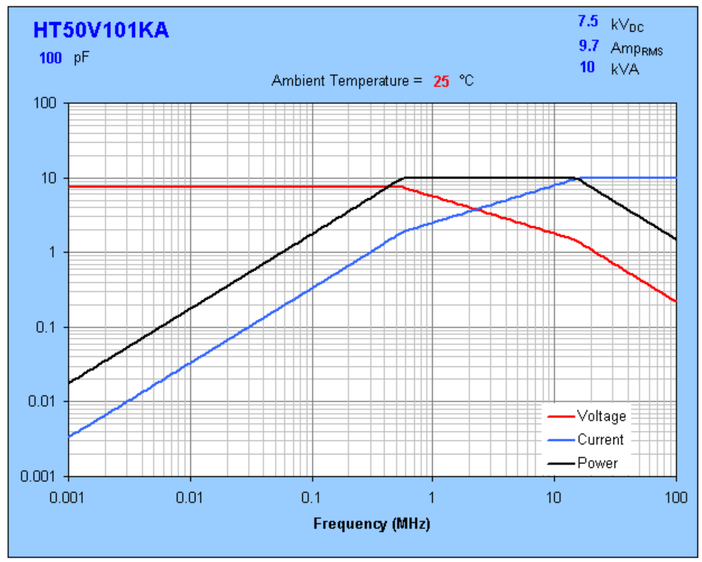
HT50V	**100** (10 pF)	**M** (± 20%)	**A** (6-32 Terminals)
or	to	or	or
HT58V	**701** (700 pF)	**K** (± 10%)	**A-M** (M4 Terminals)
		or	or
		J (± 5%)	**A-SM** (Solid Metric)
		or	
		G (± 2.5%)	

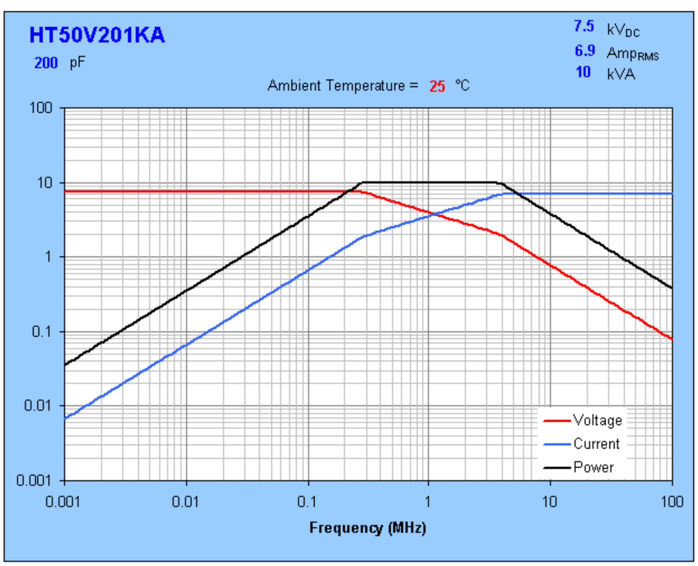
Also available with 5 kV rating as:

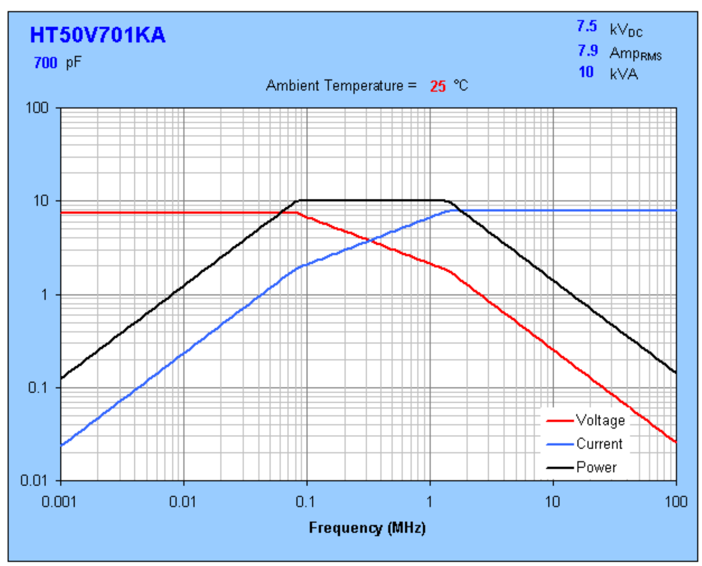
HT50T (5 kV_{DC})

Typical Maximum Rating Curves for HT50 Series Capacitors





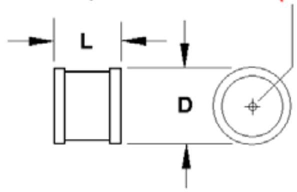


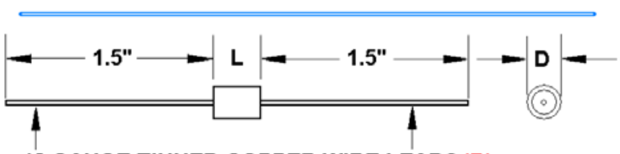


- **5 kV$_{DC}$ Working Voltage**
- **Choice of 3, 5 or 7 kVA Max Power**
- **1 to 40 pF Capacitance**
- **Threaded Terminals or Wire Leads**
- **Class I NPO or N750 TC's**

SERIES	L	D
HT53 ... A or A-M	31/64"	9/16"
HT54 ... A or A-M	27/64"	7/16"
HT55 ... A or A-M	25/64"	5/16"

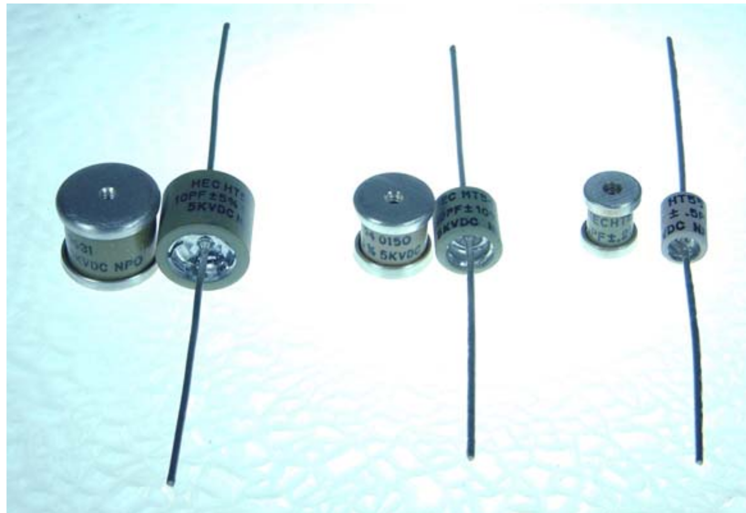
INTERNAL THREADS BOTH ENDS
2-56 UNC-2B, 1/8" MIN DEEP (A)
OR M2, 3 mm MIN DEEP (A-M)





18 GAUGE TINNED COPPER WIRE LEADS (B)

SERIES	L	D
HT53 ... B	7/16"	1/2"
HT54 ... B	3/8"	3/8"
HT55 ... B	11/32"	9/32"



CAPACITANCE		PERFORMANCE RATINGS					PART NUMBER
pF	Dielectric (TC)	V_{MAX} (kV_{DC})	f_L (MHz)	S_{MAX} (kVA)	f_H (MHz)	I_{MAX} (A_{RMS})	
7	**NPO**	5	12.7	7	46.8	3.8	HT53T709DB
10		5	8.91	7	36.3	4.0	HT53T100KB
20		5	4.45	7	23.0	4.5	HT53T200KB
25		5	3.56	7	20.9	4.8	HT53T250KB
30	**N750**	5	2.97	7	18.9	5.0	HT53T300KB
35		5	2.54	7	16.9	5.1	HT53T350KB
40		5	2.23	7	15.4	5.2	HT53T400KB
45		5	1.98	7	14.2	5.3	HT53T450KB

The preceding tables show only a selected subset from the many HT53 Series parts available. A continuous range of capacitance values between those listed here is available. You can 'build' a part number for any desired HT53 capacitor using the "construction rules" shown at right.

HT53 Series Ceramic Capacitor Part Numbers:

HT53T	**709** (7 pF)	**K** (± 10%)	**A** (2-56 Terminals)
	to	or	or
	450 (45 pF)	**J** (± 5%)	**A-M** (M4 Terminals)
		or	or
		C (± .25 pF)	**B** (#18 Wire Leads)
		or	
		D (± .5 pF)	

HT54 SERIES

CAPACITANCE pF	Dielectric (TC)	PERFORMANCE RATINGS V_{MAX} (kV_{DC})	f_L (MHz)	S_{MAX} (kVA)	f_H (MHz)	I_{MAX} (A_{RMS})	PART NUMBER
3	NPO	5	21.2	5	42.4	2.0	HT54T309DB
5		5	12.7	5	30.8	2.2	HT54T509DB
10		5	6.36	5	24.9	2.8	HT54T100KB
12		5	5.30	5	22.3	2.9	HT54T120KB
14		5	4.54	5	23.3	3.2	HT54T140KB
15	N750	5	4.24	5	35.6	4.1	HT54T150KB
20		5	3.18	5	44.7	5.3	HT54T200KB
25		5	2.54	5	37.1	5.4	HT54T250KB
30		5	2.12	5	32.1	5.5	HT54T300KB
35		5	1.82	5	28.5	5.6	HT54T350KB
40		5	1.59	5	24.9	5.6	HT54T400KB

The preceding tables show only a selected subset from the many HT54 Series parts available. A continuous range of capacitance values between those listed here is available. You can 'build' a part number for any desired HT54 capacitor using the "construction rules" shown at right.

HT54 Series Ceramic Capacitor Part Numbers:

HT54T	309 (3 pF) to 400 (40 pF)	K (± 10%) or J (± 5%) or C (± .25 pF) or D (± .5 pF)	A (2-56 Terminals) or A-M (M4 Terminals) or B (#18 Wire Leads)

HT55 SERIES

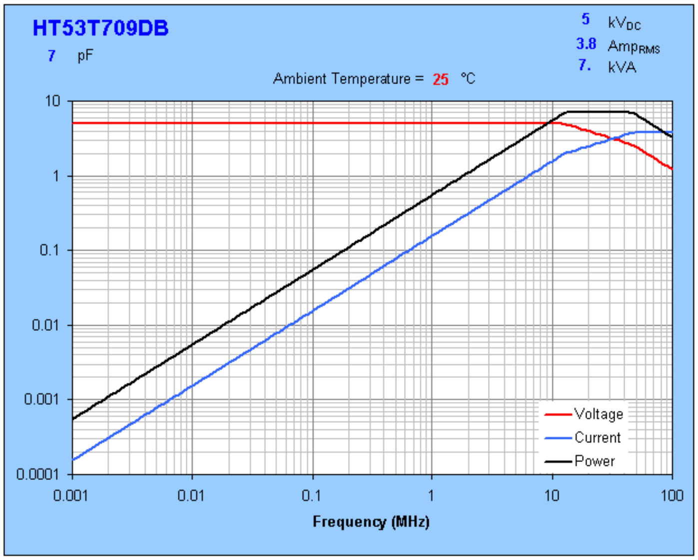
CAPACITANCE pF	Dielectric (TC)	PERFORMANCE RATINGS V_{MAX} (kV_{DC})	f_L (MHz)	S_{MAX} (kVA)	f_H (MHz)	I_{MAX} (A_{RMS})	PART NUMBER
1	NPO	5	5.65	3	84.7	1.2	HT55T109DB
2		5	3.77	3	56.5	1.3	HT55T209DB
3		5	2.26	3	39.7	1.4	HT55T309DB
5		5	2.26	3	39.7	1.7	HT55T509DB
7		5	.870	3	19.4	2.2	HT55T709DB
8	N750	5	.754	3	19.9	2.4	HT55T809DB
10		5	.565	3	15.0	2.8	HT55T100KB
12		5	.377	3	11.0	3.0	HT55T120KB
15		5	.377	3	11.0	3.0	HT55T150KB

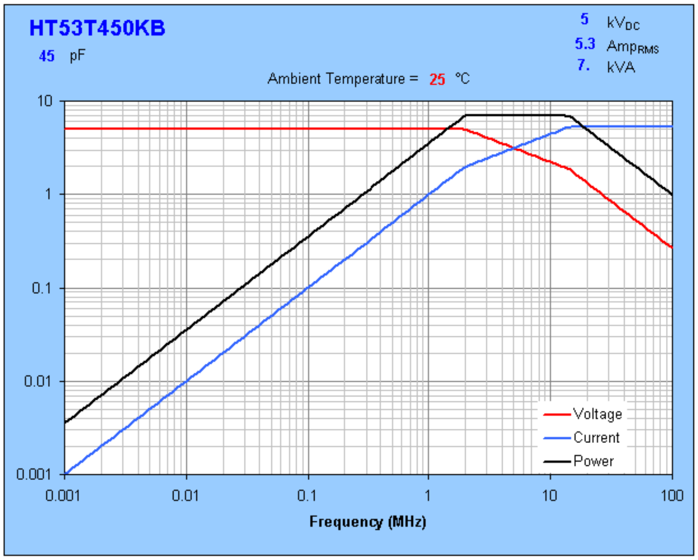
The preceding tables show only a selected subset from the many HT55 Series parts available. A continuous range of capacitance values between those listed here is available. You can 'build' a part number for any desired HT55 capacitor using the "construction rules" shown at right.

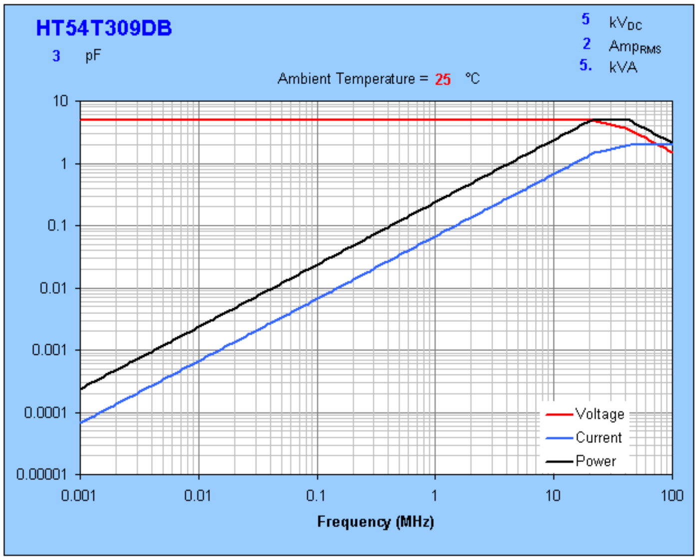
HT55 Series Ceramic Capacitor Part Numbers:

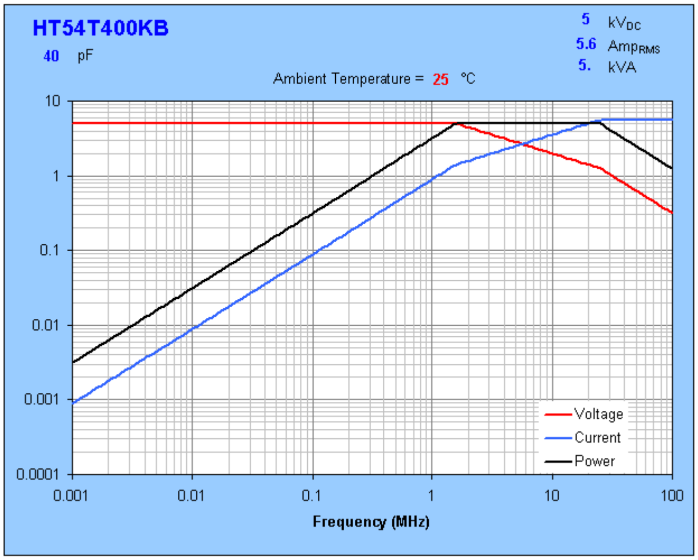
HT55T	109 (1 pF) to 150 (15 pF)	K (± 10%) or J (± 5%) or C (± .25 pF) or D (± .5 pF)	A (2-56 Terminals) or A-M (M4 Terminals) or B (#18 Wire Leads)

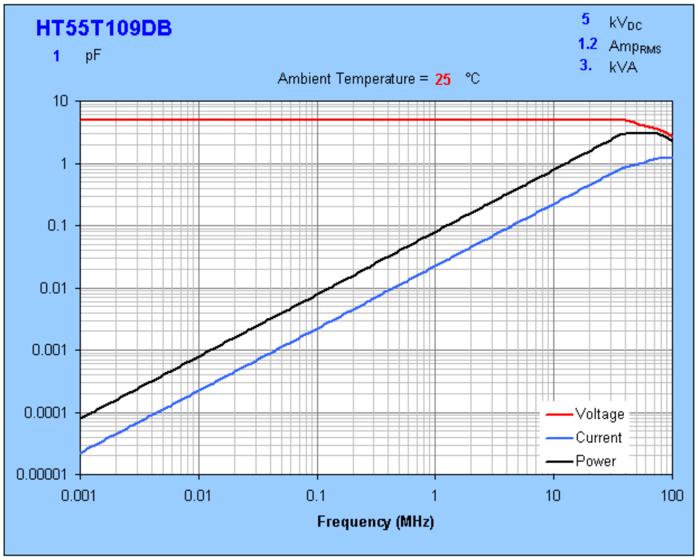
Typical Maximum Rating Curves for HT53, HT54 & HT55 Capacitors

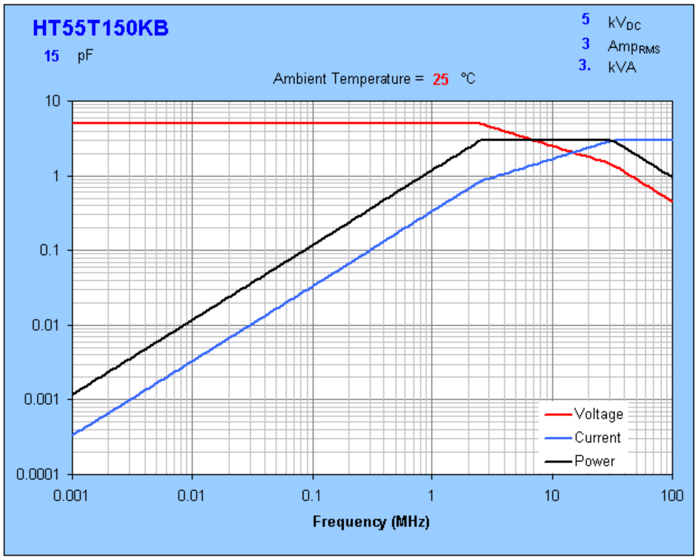












SPHT Series Ceramic Capacitors are Class 1 parts featuring high Voltage, Current and Power ratings and low self-inductance. A broad variety of these 'Power-Disk' capacitors are offered including the innovative and cost effective 'Ferris-Wheel' configuration. All SPHT capacitors have low dissipation factors. Their structure is both simple and robust, assuring a long trouble free life. SPHT Series feature a phenolic resin coating and a long flashover path. They are built upon a choice of eight Class I dielectrics, providing a broad range of capacitance and temperature coefficients. Uses include **RF transmitter circuits**, **antenna couplings**, and other high-power RF bandwidth applications.

CLASS 1 Capacitor Dielectric Characteristics

Dielectric Material	Temperature Coefficient (ppm/°C)	TC Tolerance (ppm/°C)	Max Dissipation Factor (δ measured at 1 MHz)
NPO	0	± 60	0.1 %
N-470	-470	±75	0.1%
N-750	-750	± 120	0.1 %
N-800	-800	± 90	0.1%
N-2200	-2200	± 500	0.1 %
N-3300	-3300	± 500	0.2 %
N-5250	-5250	± 1000	0.3 %
N-5500	-5500	± 1000	0.5 %

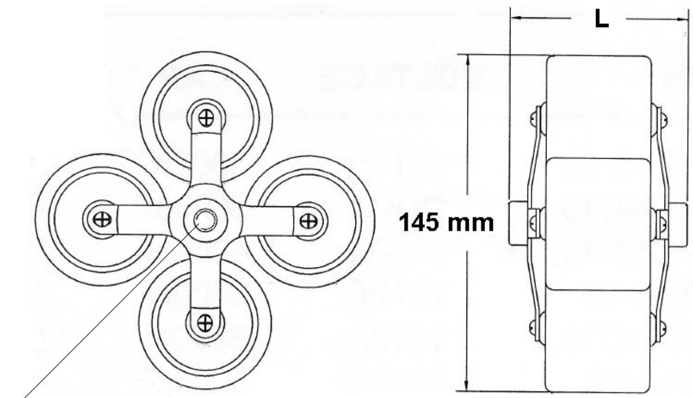
GENERAL SPECIFICATIONS

Temperature Range	Operating: -55° C to +85 ° C Storage: -55° C to +125 ° C
Capacitance Tolerance	From ± 2.5% to ± 20% and from ±2.5 pF to ±1 pF
Dissipation Factor	0.1% to 0.5% Maximum (see Dielectric chart above)
Dielectric Strength	Will withstand a DC potential of 1.5 times Rated Working Voltage for 10 Seconds at 25° C.
Insulation Resistance	10,000 Megohms (MΩ) Minimum
Terminals	Silver Plated
Terminal Strength	Maximum applied torque to be 20 inch-pounds or less
Humidity Protection	Nonconductive Coating
Standard Markings	"HEC", Capacitance, Tolerance, Rated Working Voltage (V_{DC}), TC and Date Code

Summary of Available SPHT Series Ceramic Capacitors

Series	V_{Max} (kV_{DC})	S_{Max} (kVA)	I_{Max} (A_{RMS})	Capacitance (pF)	Form/Size
SPHTM	13	100 - 150	38.5 - 57.7	50 – 10,000	145 x 65 mm Ferris Wheel
SPHTN	14	100 - 150	38.5 – 57.7	50 – 10,000	145 x 65 mm Ferris Wheel
SPHTZ	20	100 - 150	25 – 37.5	50 – 10,000	145 x 80 mm Ferris Wheel
SPHT5	30	75 - 90	12.5 – 15	500 – 7,000	155 mm Diameter Power Disk
SPHT9 (C)	11 - 14	90	45	300 – 3,000	140 mm Diameter Power Disk
SPHT9 (B)	11 - 14	40	35	100 – 1,600	100 mm Diameter Power Disk
SPHT9 (A)	11 - 14	20	16	50 – 1,000	70 mm Diameter Power Disk

- 20 kV_{DC} Max Working Voltage
- 150 kVA Max Power
- 50 to 10,000 pF Capacitance
- 145 mm x 145 mm x 80 mm
- Choice of five Class I TC's



L = 65 mm (SPHTM & SPHTN)

CAPACITANCE		PERFORMANCE RATINGS					PART NUMBER
pF	Dielectric (TC)	V_{MAX} (kV_{DC})	f_L (MHz)	S_{MAX} (kVA)	f_H (MHz)	I_{MAX} (A_{RMS})	
50	**NP0**	13	3.76	100	47.1	38.5	SPHTM500MA-A10
100	(A)	13	2.07	110	25.9	42.3	SPHTM101MA-A10
250		13	.828	110	10.3	42.3	SPHTM251MA-A10
500		13	.565	150	7.06	57.7	SPHTM501MA-A10
750		13	.376	150	4.70	57.7	SPHTM751MA-A10
1000		13	.282	150	3.53	57.7	SPHTM102MA-A10
500	**N470**	13	.565	150	7.06	57.7	SPHTM501MA-B10
750	(B)	13	.376	150	4.70	57.7	SPHTM751MA-B10
1000		13	.282	150	3.53	57.7	SPHTM102MA-B10
1500		13	.188	150	2.35	57.7	SPHTM152MA-B10
2000		13	.141	150	1.76	57.7	SPHTM202MA-B10
800	**N800**	13	.353	150	4.41	57.7	SPHTM801MA-C10
1000	(C)	13	.282	150	3.53	57.7	SPHTM102MA-C10
1500		13	.188	150	2.35	57.7	SPHTM152MA-C10
2000		13	.141	150	1.76	57.7	SPHTM202MA-C10
2500		13	.113	150	1.41	57.7	SPHTM252MA-C10
3000		13	.0941	150	1.18	57.7	SPHTM302MA-C10
5000	**N3300**	13	.0565	150	0.706	57.7	SPHTM502MA-D10
6000	(D)	13	.0470	150	0.588	57.7	SPHTM602MA-D10
8000		13	.0353	150	0.441	57.7	SPHTM802MA-D10
10000		13	.0282	150	0.353	57.7	SPHTM103MA-D10

L = 80 mm (SPHTZ)

CAPACITANCE pF	Dielectric (TC)	PERFORMANCE RATINGS V_{MAX} (kV_{DC})	f_L (MHz)	S_{MAX} (kVA)	f_H (MHz)	I_{MAX} (A_{RMS})	PART NUMBER
50	NP0	20	1.59	100	19.9	25.0	SPHTZ500MA-A10
100	(A)	20	.875	110	10.9	27.5	SPHTZ101MA-A10
250		20	.350	110	4.37	27.5	SPHTZ251MA-A10
500		20	.239	150	2.98	37.5	SPHTZ501MA-A10
800		20	.149	150	1.86	37.5	SPHTZ801MA-A10
500	N470	20	.239	150	2.98	37.5	SPHTZ501MA-B10
750	(B)	20	.159	150	1.99	37.5	SPHTZ751MA-B10
1000		20	.119	150	1.49	37.5	SPHTZ102MA-B10
1500		20	.0795	150	0.994	37.5	SPHTZ152MA-B10
800	N800	20	.149	150	1.86	37.5	SPHTZ801MA-C10
1000	(C)	20	.119	150	1.49	37.5	SPHTZ102MA-C10
1500		20	.0795	150	.994	37.5	SPHTZ152MA-C10
2000		20	.0596	150	.745	37.5	SPHTZ202MA-C10
2500	N3300	20	.0477	150	.596	37.5	SPHTZ252MA-D10
3000	(D)	20	.0398	150	.497	37.5	SPHTZ302MA-D10
5000		20	.0239	150	.298	37.5	SPHTZ502MA-D10
6000		20	.0199	150	.248	37.5	SPHTZ602MA-D10
4000	N5250	20	.0298	150	.373	37.5	SPHTZ402MA-E10
6000	(E)	20	.0199	150	.248	37.5	SPHTZ602MA-E10
8000		20	.0149	150	.186	37.5	SPHTZ802MA-E10
10000		20	.0119	150	.149	37.5	SPHTZ103MA-E10

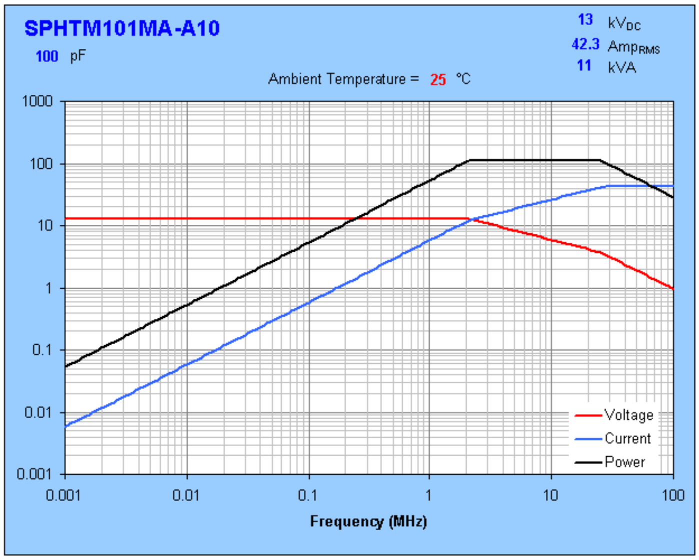
The preceding tables show a selected subset from the many SPHT Ferris Wheel parts available. A continuous range of capacitance values between those listed here is available. You can 'build' a part number for any desired Ferris Wheel capacitor using the "construction rules" shown below.

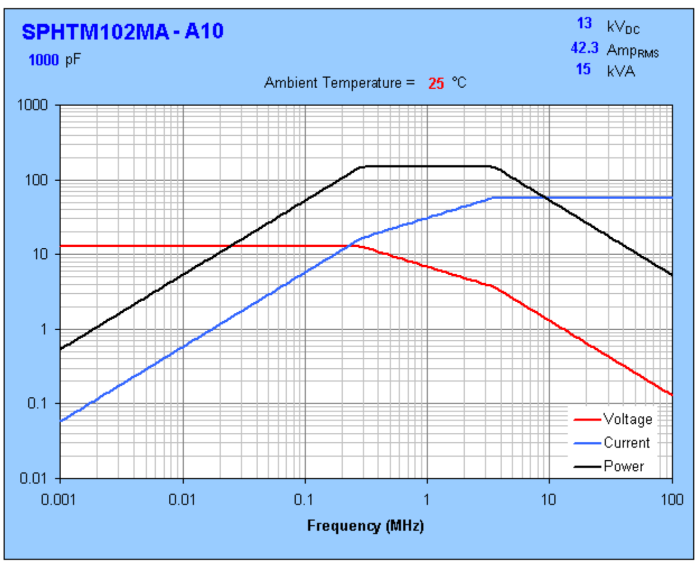
SPHT Ferris Wheel Ceramic Capacitor Part Numbers:

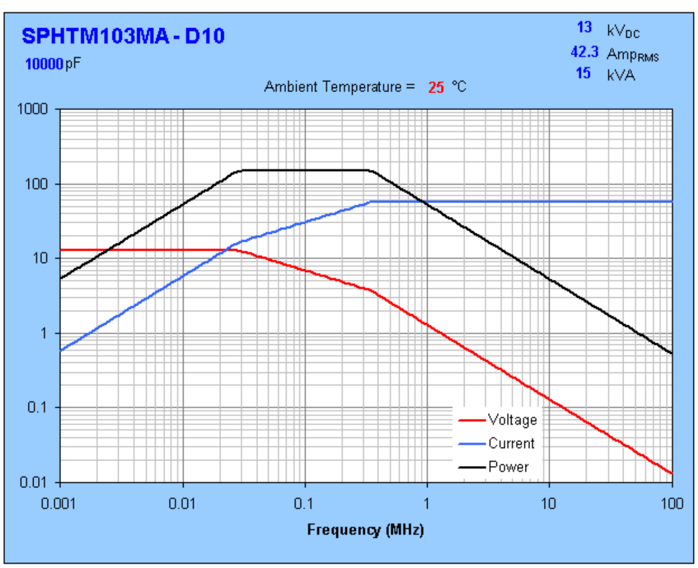
SPHT	**M** (12 kV_{DC}) or **N** (13 kV_{DC}) or **Z** (20 kV_{DC})	**500** (50 pF) to **103** (10,000 pF)	**M** (± 20%) or **K** (± 10%) or **J** (± 5%)	**-A** (NPO Dielectric) or **-B** (N470) or **-C** (N800) or **-D** (N3300) or **-E** (N5250)	**No Suffix** (5/16-18 UNC Thread) or **08** (M8 Metric Thread) or **10** (M10 Metric Thread)

Typical Maximum Rating Curves

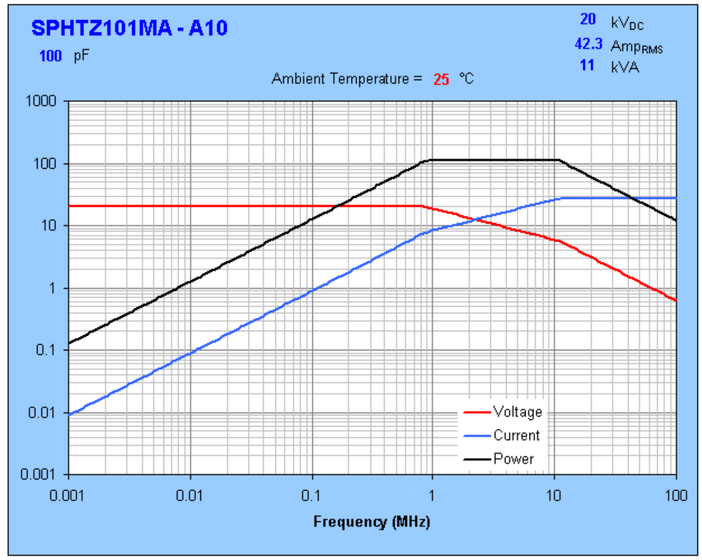
13 kV$_{DC}$ SPHTM Series

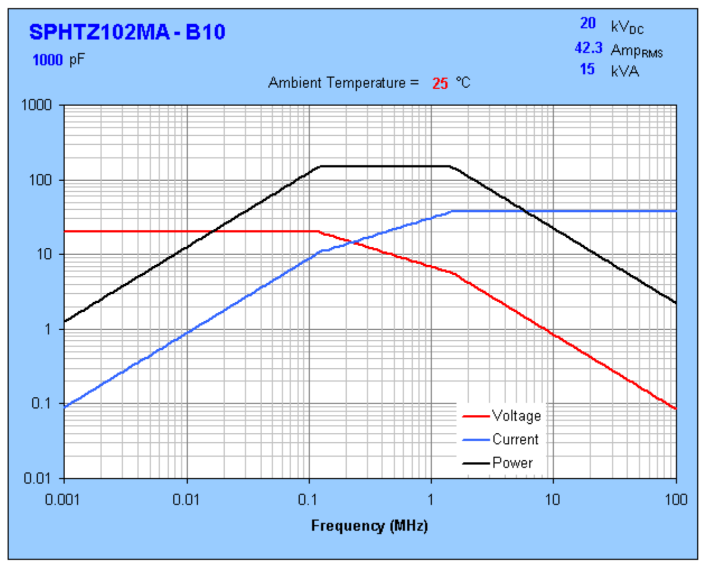


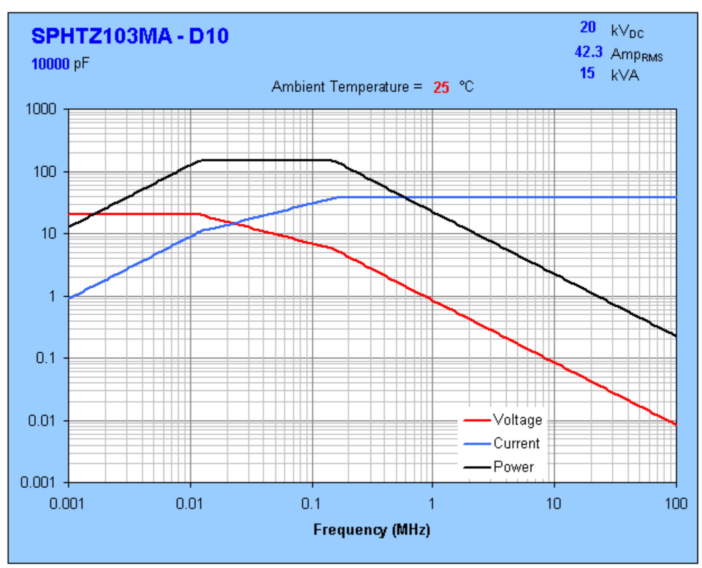




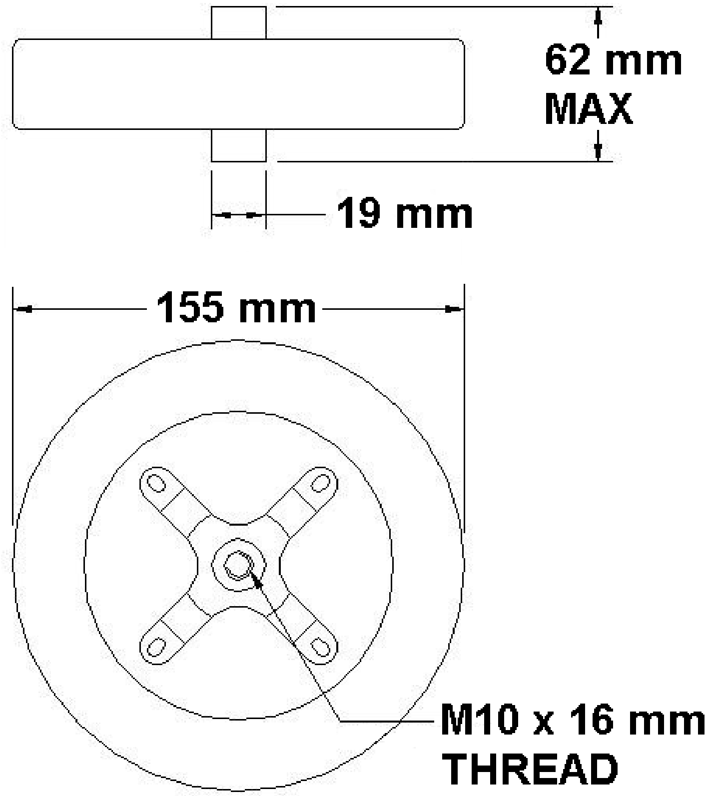
20 kV$_{DC}$ SPHTZ Series







- Up to 30 kV_{DC} Working Voltage
- Up to 90 kVA Power Rating
- 50 to 7,000 pF Capacitance
- 70, 100, 140 & 165 mm Diameters
- Choice of four Class I TC's



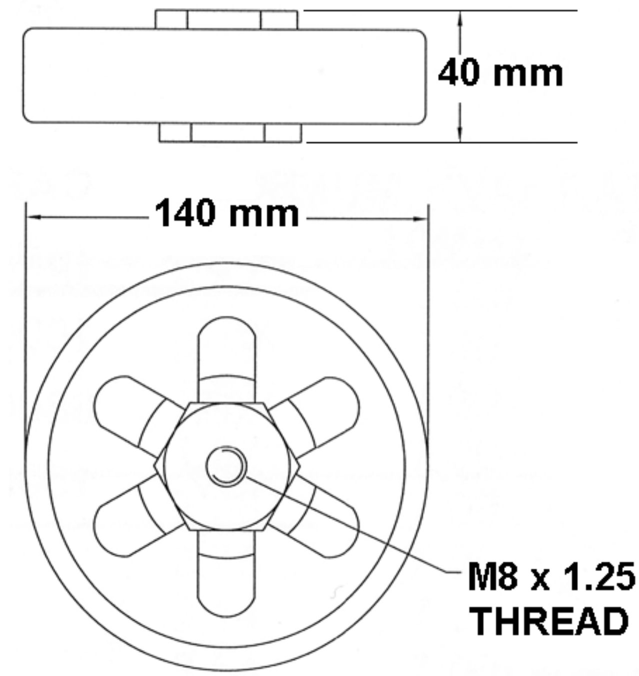
155 mm DIAMETER POWER DISK

CAPACITANCE		PERFORMANCE RATINGS					PART NUMBER
pF	Dielectric (TC)	V_{MAX} (kV_{DC})	f_L (MHz)	S_{MAX} (kVA)	f_H (MHz)	I_{MAX} (A_{RMS})	
500	**NP0**	**30**	.0530	**75**	.662	**12.5**	SPHT5501MA-10
750		**30**	.0353	**75**	.442	**12.5**	SPHT5751MA-10
1000		**30**	.0318	**90**	.397	**15**	SPHT5102MA-10
1500	**N800**	**30**	.0212	**90**	.265	**15**	SPHT5152MA-10
2000		**30**	.0159	**90**	.199	**15**	SPHT5202MA-10
2500		**30**	.0127	**90**	.159	**15**	SPHT5252MA-10
3000		**30**	.0106	**90**	.132	**15**	SPHT5302MA-10
4000	**N3300**	**30**	.00795	**90**	.0994	**15**	SPHT5402MA-10
5000		**30**	.00636	**90**	.0795	**15**	SPHT5502MA-10
6000		**30**	.00530	**90**	.0662	**15**	SPHT5602MA-10
7000		**30**	.00454	**90**	.0568	**15**	SPHT5702MA-10

The table above shows a selected subset from the many 155 mm diameter SPHT5 Series parts available. A continuous range of capacitance values between those listed here is available. You can 'build' a part number for any desired SPHT5 capacitor using the "construction rules" shown at right.

155 mm SPHT5 Series Ceramic Capacitor Part Numbers:

SPHT5	**501** (500 pF)	**M** (± 20%)	**A** (5/16-18 UNC Thread)
	to	or	or
	702 (7000 pF)	**K** (± 10%)	**A-10** (M10 Metric Thread)
		or	or
		J (± 5%)	**A-08** (M8 Metric Thread)



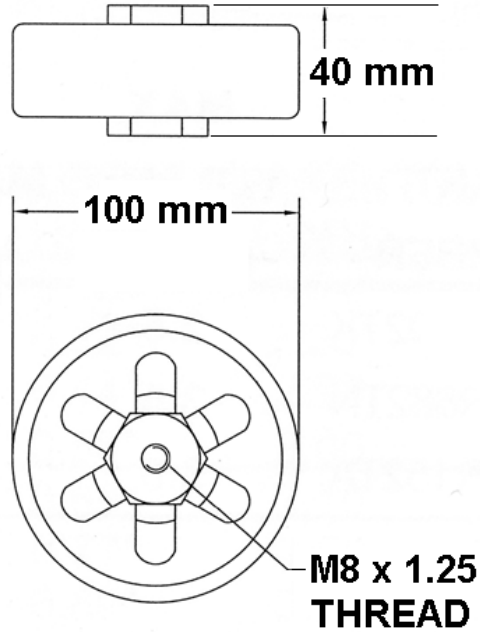
140 mm DIAMETER POWER DISK

CAPACITANCE		PERFORMANCE RATINGS					PART NUMBER
pF	Dielectric (TC)	V_{MAX} (kV_{DC})	f_L (MHz)	S_{MAX} (kVA)	f_H (MHz)	I_{MAX} (A_{RMS})	
300	**NP0**	**14**	.487	**90**	11.9	**45**	SPHT9301MC
500		**14**	.292	**90**	7.15	**45**	SPHT9501MC
1000		**13**	.169	**90**	3.58	**45**	SPHT9102MC
1200	**N750**	**14**	.122	**90**	2.98	**45**	SPHT9122MC
2000		**13**	.0847	**90**	1.79	**45**	SPHT9202MC
3000		**11**	.0789	**90**	1.19	**45**	SPHT9302MC

The table above shows a selected subset from the many 140 mm diameter SPHT9 Series parts available. A continuous range of capacitance values between those listed here is available. You can 'build' a part number for any desired 140 mm SPHT9 capacitor using the "construction rules" shown at right.

140 mm SPHT9 Series Ceramic Capacitor Part Numbers:

SPHT9	**301** (300 pF) to **302** (3000 pF)	**M** (± 20%) or **K** (± 10%) or **J** (± 5%)	**C** (140 mm / 90 KVA)



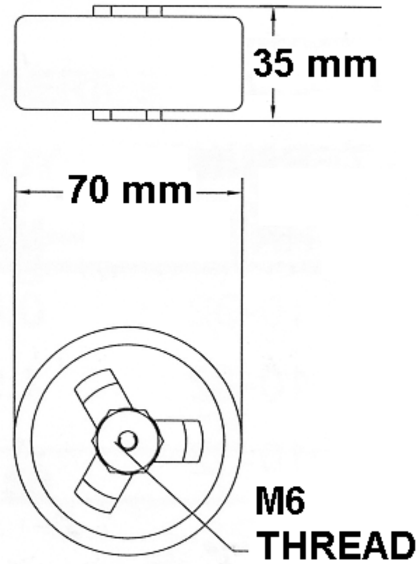
100 mm DIAMETER POWER DISK

CAPACITANCE		PERFORMANCE RATINGS					PART NUMBER
pF	Dielectric (TC)	V_{MAX} (kV_{DC})	f_L (MHz)	S_{MAX} (kVA)	f_H (MHz)	I_{MAX} (A_{RMS})	
100	**NP0**	**14**	.649	**40**	48.7	**35**	SPHT9101MB
200		**13**	.376	**40**	24.3	**35**	SPHT9201MB
400		**12**	.221	**40**	12.2	**35**	SPHT9401MB
500	**N750**	**14**	.130	**40**	9.74	**35**	SPHT9501MB
1000		**13**	.0753	**40**	4.87	**35**	SPHT9102MB
1600		**11**	.0657	**40**	3.04	**35**	SPHT9162MB

The table above shows a selected subset from the many 100 mm diameter SPHT9 Series parts available. A continuous range of capacitance values between those listed here is available. You can 'build' a part number for any desired 100mm SPHT9 capacitor using the "construction rules" shown at right.

100 mm SPHT9 Series Ceramic Capacitor Part Numbers:

SPHT9	**101** (100 pF) to **162** (1600 pF)	**M** (± 20%) or **K** (± 10%) or **J** (± 5%)	**B** (100 mm / 40 kVA)



70 mm DIAMETER POWER DISK

CAPACITANCE		PERFORMANCE RATINGS					PART NUMBER
pF	Dielectric (TC)	V_{MAX} (kV_{DC})	f_L (MHz)	S_{MAX} (kVA)	f_H (MHz)	I_{MAX} (A_{RMS})	
50	**NP0**	**14**	.649	**20**	40.7	**16**	SPHT9500MA
100		**14**	.325	**20**	20.4	**16**	SPHT9101MA
160		**13**	.235	**20**	12.7	**16**	SPHT9161MA
200	**N750**	**14**	.162	**20**	10.2	**16**	SPHT9201MA
500		**13**	.0753	**20**	4.07	**16**	SPHT9501MA
1000		**11**	.0526	**20**	2.03	**16**	SPHT9102MA

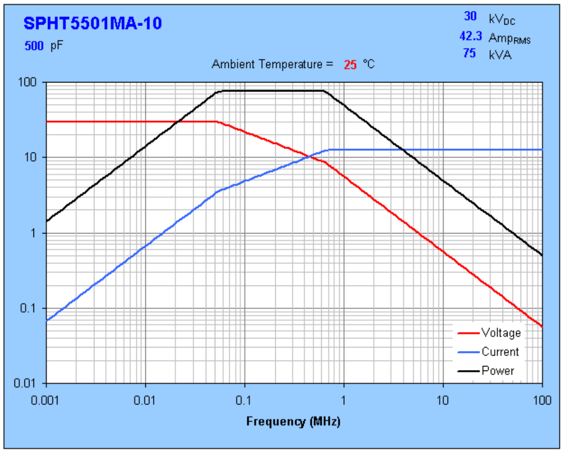
The table above shows a selected subset from the many 70 mm diameter SPHT9 Series parts available. A continuous range of capacitance values between those listed here is available. You can 'build' a part number for any desired 70 mm SPHT9 capacitor using the "construction rules" shown at right.

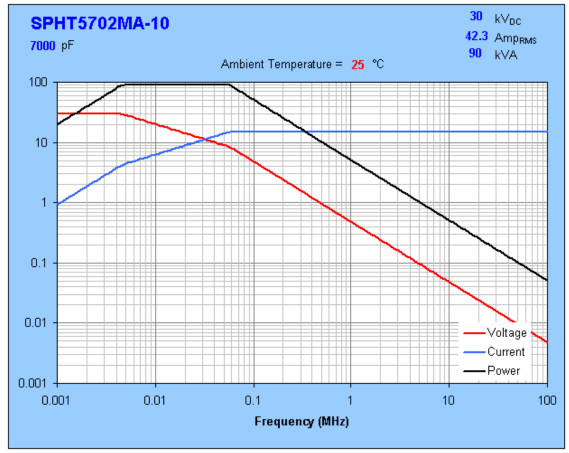
70 mm SPHT9 Series Ceramic Capacitor Part Numbers:

SPHT9	**500** (50 pF) to **102** (1000 pF)	**M** (± 20%) or **K** (± 10%) or **J** (± 5%)	**A** (70 mm / 20 kVA)

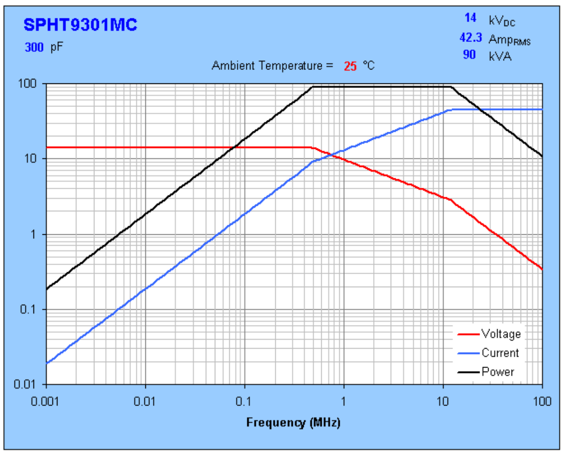
Typical Maximum Rating Curves for SPHT Power Disks

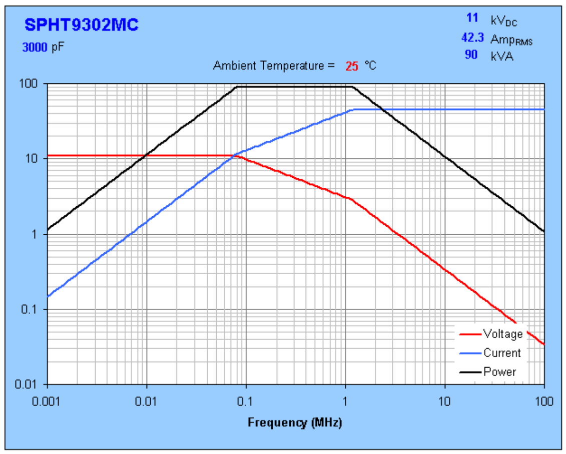
155 mm Diameter Power Disks



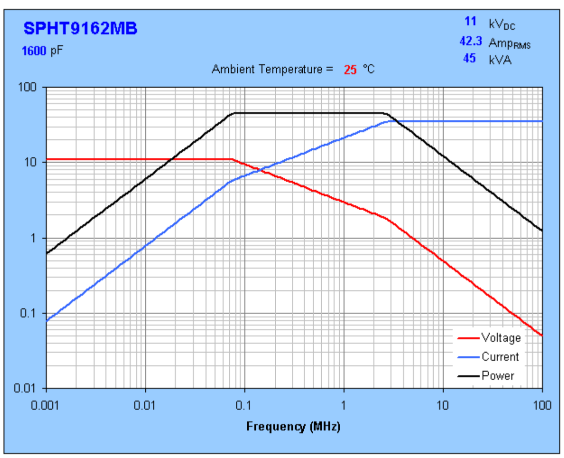


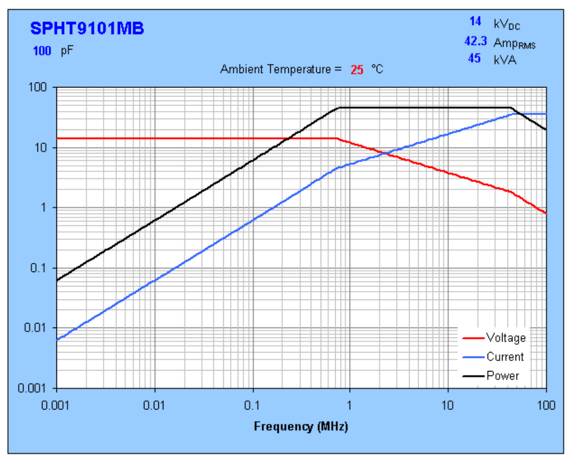
140 mm Diameter Power Disks



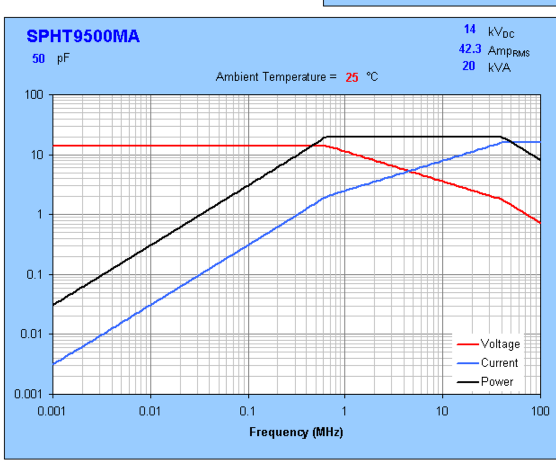


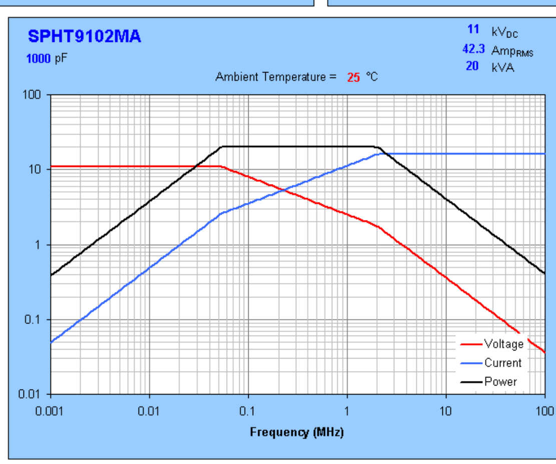
100 mm Diameter Power Disks



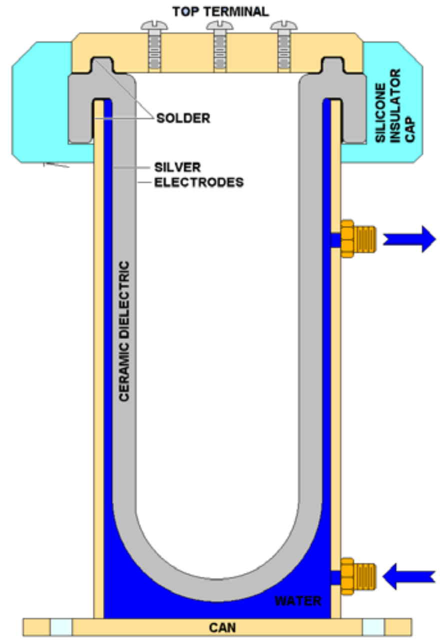


70 mm Diameter Power Disks





PWC Series Ceramic Capacitors are large water-cooled 'pot' style components providing current capacity to 300 Amperes and maximum reactive power ratings up to 4000 kVA. These parts feature a low dissipation factor Class I dielectric combined with superior structural strength coupled with the high thermodynamic efficiency of water-cooling to allow operation at extremely high power levels and high frequency. They are ideal for operation in the tank circuit of high power RF equipment. Popular applications include induction heating, dielectric heating and high-frequency welding equipment.



GENERAL SPECIFICATIONS

Temperature Range — Operating: -55° C to +85 ° C
Storage: -55° C to +125 ° C

Capacitance Tolerance — Standard ± 20%
Optional ± 10%

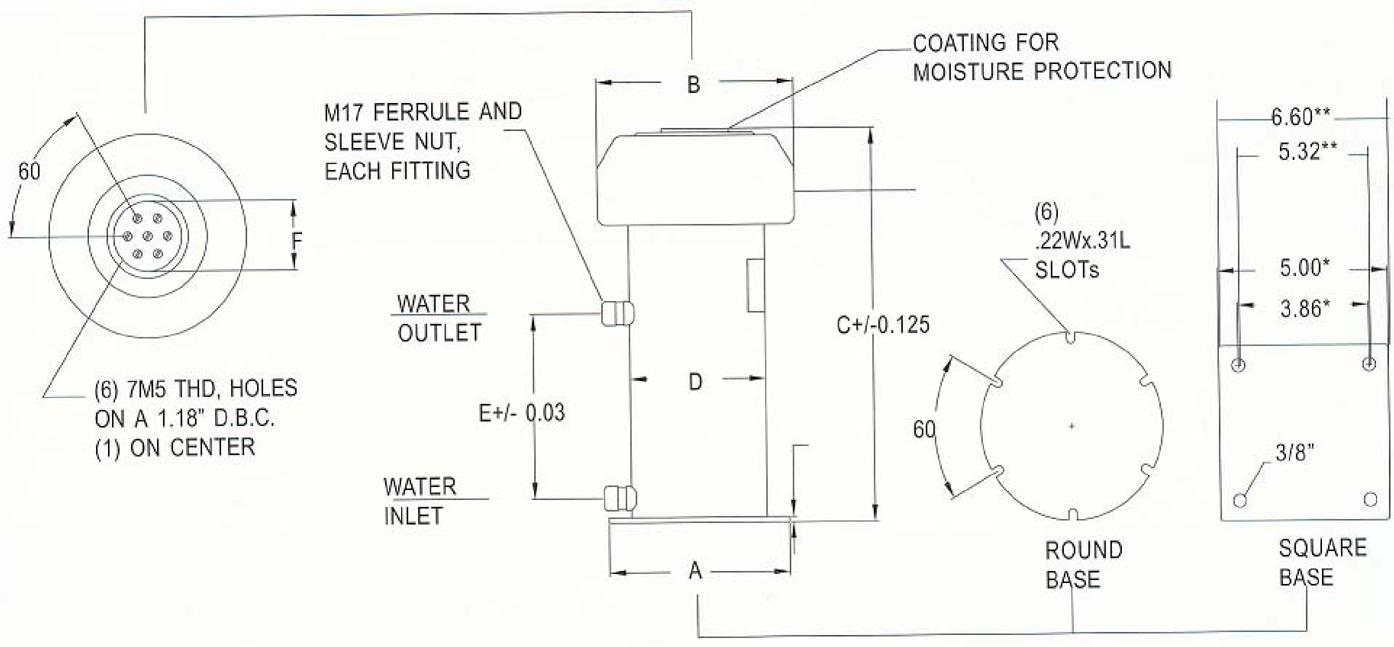
Dissipation Factor — 0.05% Maximum

Dielectric Strength — Will withstand an AC potential of 1.4 times Rated Working Voltage for 10 Seconds at 25° C.

Insulation Resistance — 10,000 Megohms (MΩ) Minimum

Standard Markings — "HEC", Capacitance, Tolerance, Rated Working Voltage (V_{DC}), Maximum Frequency, Maximum Reactive Power, Maximum Current and Date Code

CAPACITANCE	PERFORMANCE RATINGS					PART NUMBER
pF	V_{MAX} (kV_{DC})	f_L (MHz)	S_{MAX} (kVA)	f_H (MHz)	I_{MAX} (A_{RMS})	
10,000	10	.636	2000	.623	280	PWC10103MA
5000	12	.563	1275	.561	150	PWC12502MA
400	14	6.09	1500	5.96	150	PWC14401MA
1000	14	2.43	1500	2.38	150	PWC14102MA
1500	14	1.08	1000	2.38	150	PWC14152MA
2000	14	1.22	1500	1.19	150	PWC14202MA
2500	14	.974	1500	.954	150	PWC14252MA
5000	14	.649	2000	.636	200	PWC14502MA
7500	14	.649	3000	.442	250	PWC14752MR
7500	14	.649	3000	.636	300	PWC14752MA
7600	14	.534	2500	.523	250	PWC14762MA
10,000	14	.454	2800	.477	290	PWC14103MA
4000	16	.776	2500	.994	250	PWC16402MA
5000	16	.703	2830	.702	250	PWC16502MA
6000	16	.586	2830	.585	250	PWC16602MA
7600	16	.409	2500	.523	250	PWC16762MA
10,000	16	.422	3395	.421	300	PWC16103MA
7600	18	.323	2500	.523	250	PWC18762MA
10,000	18	.245	2500	.397	250	PWC18103MA
3000	20	.530	2000	1.06	200	PWC20302MA
5000	20	.477	3000	.662	250	PWC20602MA
6000	20	.398	3000	.644	270	PWC20602MA
7500	22	.350	4000	.649	350	PWC22752MA
5000	25	.326	3200	.621	250	PWC25502MA



PART NUMBER	DIMENSIONS						COOLING FLOW
	A (in)	B (in)	C (in)	D (in)	E (in)	F (in)	(gallon/minute)
PWC10103MA	*	5.83	11.93	4.00	7.09	2.00	0.38
PWC12502MA	3.74	4.18	8.66	2.75	4.53	1.50	0.27
PWC14401MA	3.74	4.18	6.38	2.75	2.17	1.50	0.27
PWC14102MA	3.74	4.18	7.36	2.75	3.15	1.50	0.27
PWC14152MA	3.74	4.18	6.38	2.75	2.17	1.50	0.27
PWC14202MA	3.74	4.18	6.38	2.75	2.17	1.50	0.27
PWC14252MA	3.74	4.18	6.38	2.75	2.17	1.50	0.27
PWC14502MA	5.32	5.83	6.38	2.75	5.28	2.00	0.27
PWC14752MR	5.32	5.53	11.38	4.00	5.28	2.00	0.40
PWC14752MA	6.60	6.69	10.63	5.00	5.28	2.95	0.57
PWC14652MA	*	5.83	11.93	4.00	5.28	2.00	0.54
PWC14103MA	*	5.83	15.95	4.00	11.02	2.00	0.54
PWC16402MA	5.32	5.83	8.53	4.00	4.25	2.00	0.49
PWC16502MA	5.32	5.83	9.80	4.00	5.28	2.00	0.40
PWC16602MA	5.32	5.83	10.70	4.00	5.28	2.00	0.40
PWC16762MA	**	6.69	10.63	5.00	5.51	2.95	0.54
PWC16103MA	**	6.69	13.89	5.00	8.19	2.95	0.70
PWC18762MA	*	5.83	16.54	4.00	11.02	2.00	0.54
PWC18103MA	**	6.69	16.54	5.00	11.02	2.95	0.54
PWC20302MA	5.32	5.83	9.53	4.00	4.24	2.00	0.38
PWC20502MA	5.32	5.83	11.25	4.00	5.28	2.00	0.40
PWC20602MA	**	6.69	10.95	5.00	5.35	2.95	0.57
PWC22752MA	**	5.69	13.23	5.00	7.64	2.95	0.80
PWC25502MA	5.32	5.83	14.69	4.00	8.50	2.00	0.62

* and ** denote 5.0” and 6.50” square bases with dimensions as shown in the drawing above; all others round

The preceding tables show a selected subset from the many PWC Series parts available. A continuous range of capacitance values between those listed here is available. You can 'build' a part number for any desired PWC capacitor using the "construction rules" shown at right.

PWC Series Ceramic Capacitor Part Numbers:

PWC 1 (10 kV_{DC}) or **12, 14, 16, 18, 20** **22 or 25** (25 kV_{DC})	**401** (400 pF) to **103** (10,000 pF)	**M** (± 20%) or **K** (± 10%)	**A**

COOLING WATER REQUIREMENTS

Maximum Capacitor Temperature The maximum allowable temperature of the **Inner Terminal** is **100° C**.

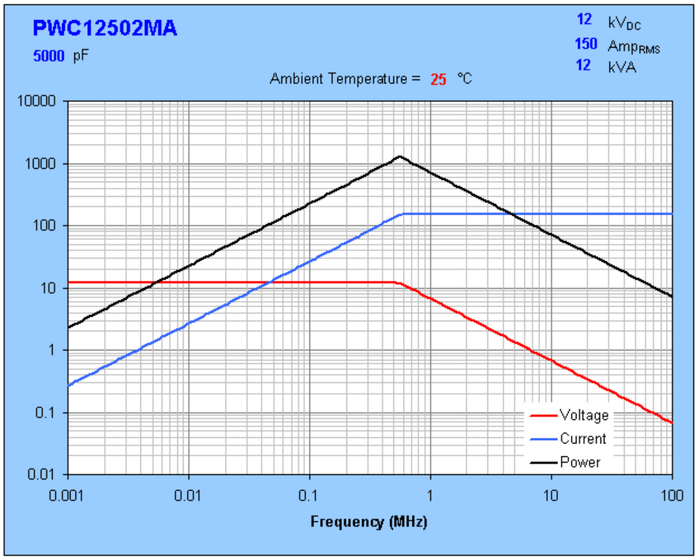
Maximum Temperature Rise The maximum allowable temperature rise is **10° C** with an inlet temperature of 25° C.

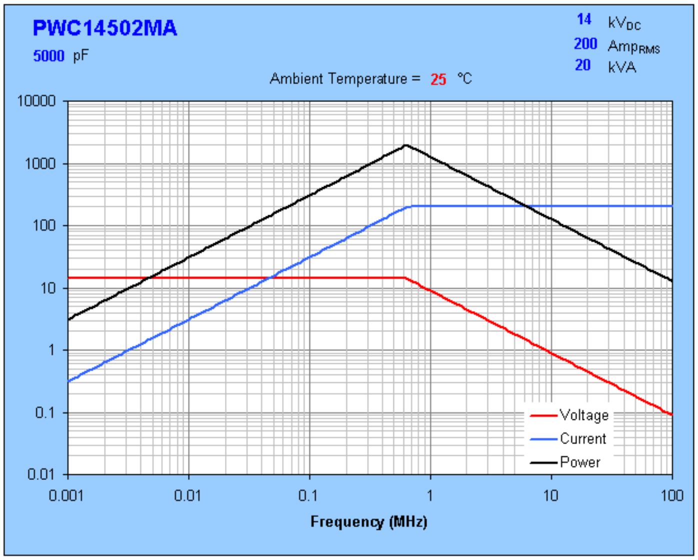
Inlet Water Temperature **30° C** or less recommended; not to exceed **50° C** when capacitor cooling is chained

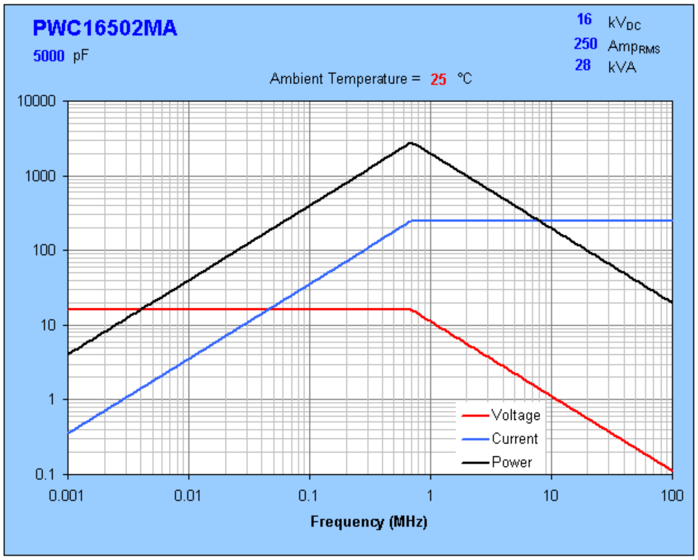
Cooling Water Pressure Not to exceed **60 PSIA** (132 feet of H_2O)

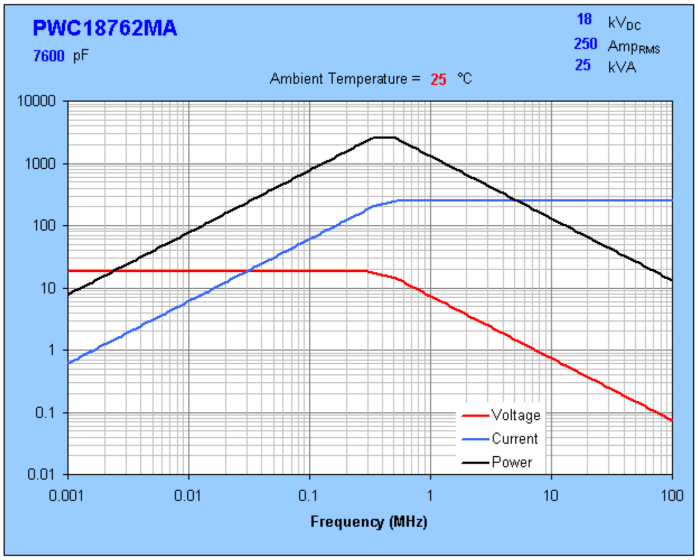
Closed System Derating Increase **Cooling Flow** by **20%** when antifreeze is used

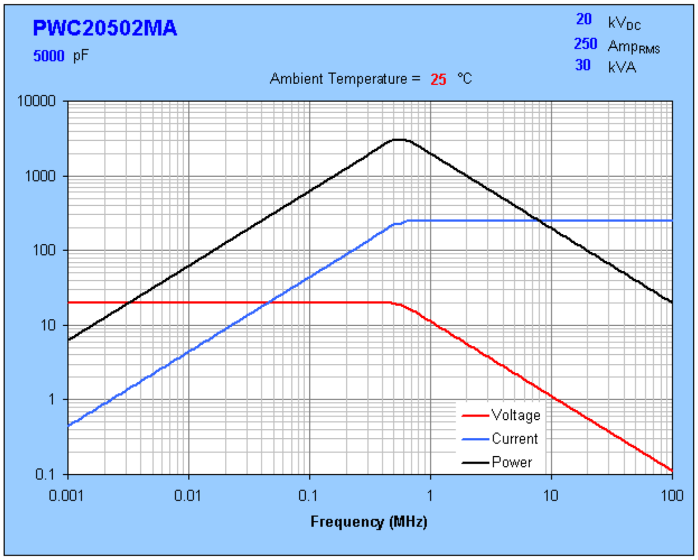
Typical Maximum Rating Curves for PWC Series Capacitors

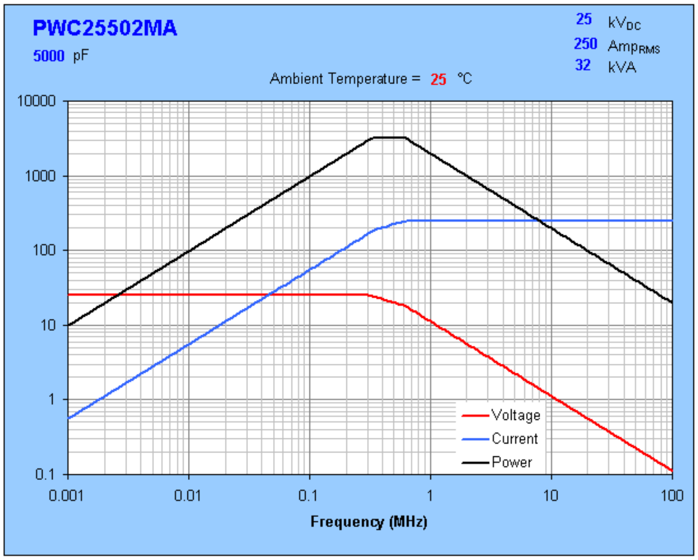






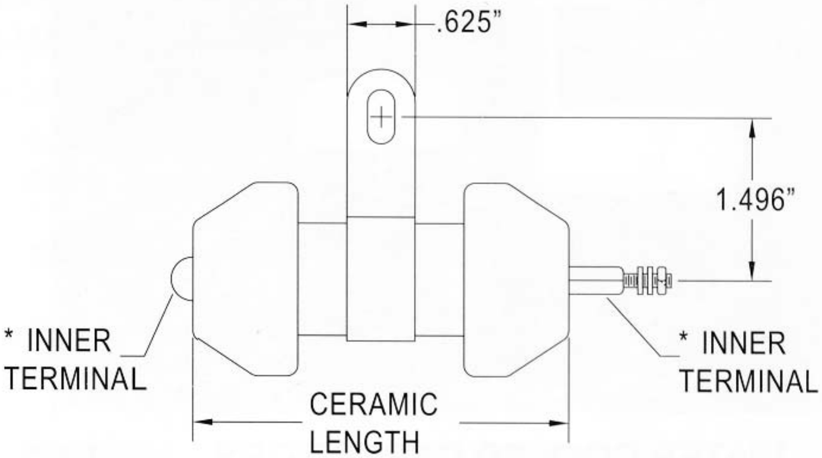




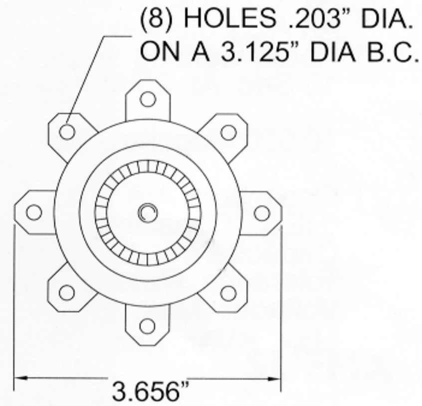


High Energy Corporation SPFT Series Feed-Thru capacitors are carefully designed, hollow ceramic tubes used to communicate power and low frequency signals between high-power RF chassis and other RF-radiating elements. These capacitors provide an elegantly simple means of bypassing massive amounts of RF energy to ground to maintain system signal integrity. They are built upon high quality Class I dielectrics, assuring a low dissipation factor and high bandwidth. SPFT feed-thru capacitors find application in RF heating, power transmitters and high voltage filters.

CAPACITANCE	PERFORMANCE RATINGS		PHYSICAL		PART NUMBER
pF (Tolerance)	Dielectric (TC)	V_{MAX} (kV_{DC})	Length (In)	Type	
1200 ± 5%	N330	**8.5**	4.565	II	SPFTW122KA
2000 ± 5%	N470	**8.5**	5.156	II	SPFTW202JK
150 ± 20%	NPO	**10**	3.465	V	SPFT1151ME
330 ± 20%	NPO	**10**	3.465	I	SPFT1331MD
430 ± 20%	NPO	**10**	3.465	V	SPFT1431ME
500 ± 20%	NPO	**10**	3.465	I	SPFT1501MD
1000 ± 20%	N5250	**10**	3.465	IV	SPFT1102MC
1250 ± 20%	N800	**10**	3.465	I	SPFT112AMD
2000 ± 20%	N2200	**10**	3.465	V	SPFT1202ME
2000 ± 20%	N5250	**10**	3.860	IV	SPFT1202MH
10,000 +80, -20%	N5250	**10**	5.220	II	SPFT1103PA
4000 ± 20%	N2200	**12**	6.105	Not Shown	SPFT2402MB
1500 GMV	N3300	**15**	4.200	III	SPFT2152PC
2000 ± 20%	N5250	**15**	3.860	IV	SPFT2202MF
2000 ± 20%	N3300	**20**	4.875	Modified VI	SPFT3202MA
500 ± 20%	N3300	**25**	5.625	VI	SPFT4501MA
2000 ± 20%	N3300	**25**	5.625	VI	SPFT4202MA
2000 ± 2%	N3300	**40**	7.500	VI	SPFT7202MA



TYPE I



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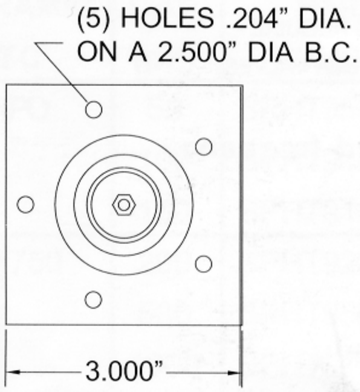

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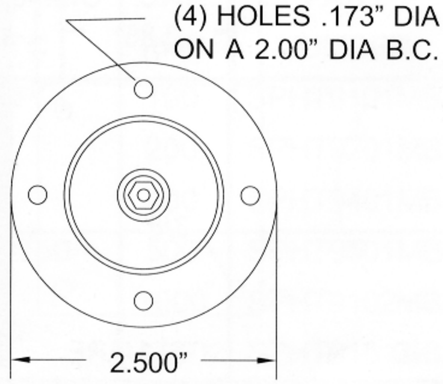

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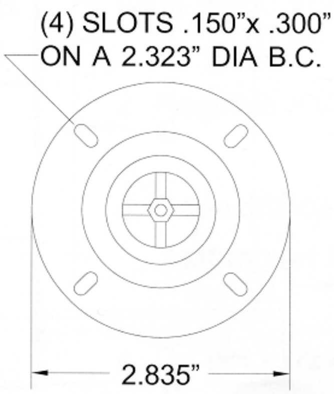
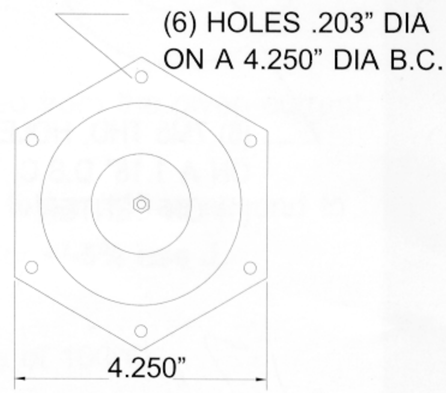
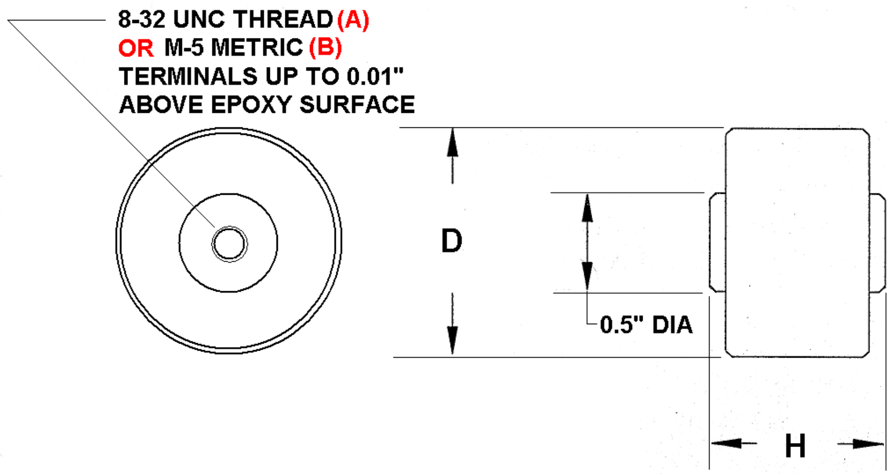


TYPE V



TYPE VI

- **High Amplitude, Short Pulse Rated**
- **Up to 50 kV_{DC} Max Working Voltage**
- **Compact & Epoxy Encapsulated**
- **Low (0.5%) Dissipation Factor**
- **Stable Class I Dielectric**



The EPSP Series of pulse power ceramic capacitors are optimized for sourcing and sinking short-duration high-current pulses. They are ideal components for use in pulsed gas laser systems, HVDC power supplies, lightning arrestor systems, electrostatic copying machines and electron microscopes. They utilize an N5500 temperature characteristic Class 1 dielectric to achieve a very low dissipation factor coupled with a very high capacitance-per-volume and an absence of detectable piezoelectric or electrorestrictive effects. Epoxy encapsulation provides excellent insulation resistance and a physically robust package.

CAPACITANCE	PERFORMANCE RATINGS		PHYSICAL		PART NUMBER
pF	V_{MAX} (kV_{DC})	V_{TEST} (kV_{DC})	D mm (In)	H mm (In)	
1400	20	30	38 (1.50)	23 (0.906)	EPSP3142MA
2500	20	30	48 (1.89)	23 (0.906)	EPSP3252MA
4000	20	30	60 (2.26)	23 (0.906)	EPSP3402MA
940	30	45	38 (1.50)	26 (1.02)	EPSP5941MA
1700	30	45	48 (1.89)	26 (1.02)	EPSP5172MA
2700	30	45	60 (2.26)	26 (1.02)	EPSP5272MA
700	40	55	38 (1.50)	32 (1.26)	EPSP7701MA
1300	40	55	48 (1.89)	32 (1.26)	EPSP7132MA
2000	40	55	60 (2.26)	32 (1.26)	EPSP7202MA
500	50	65	38 (1.50)	35 (1.38)	EPSP9501MA
900	50	65	48 (1.89)	35 (1.38)	EPSP9901MA
2000	52	65	70 (2.75)	35 (1.38)	EPSP9202MA

GENERAL SPECIFICATIONS

Temperature Range Operating: -30° C to +50 ° C
Storage: -30° C to +50 ° C

Capacitance Tolerance ± 20% standard; other tolerances available

Dissipation Factor 0.5% Maximum when measured at a frequency of 1 kHz

Dielectric Characteristic Class I N5500 (± 1000 ppm/ °C) over the Operating Temperature range

Dielectric Strength Will withstand a DC potential of V_{TEST} (listed above) for 10 Seconds at 25° C

Insulation Resistance 20,000 Megohms (MΩ) Minimum at 100 V_{DC}

Terminal Strength Maximum applied torque to be 20 inch-pounds or less

Humidity Protection Epoxy encapsulated

Standard Markings "HEC", Capacitance, Tolerance, Rated Working Voltage (V_{DC}), TC and Date Code

EPSP Series High-Voltage Pulse Ceramic Capacitor Part Numbers:

EPSP	3 (20kV_{DC}) or 5 (30 kV_{DC}) or 7 (40 kV_{DC}) or 9 (50 kV_{DC})	501 (500 pF) to 402 (4000 pF)	M (± 20%) or K (± 10%)	A (8-32 UNC Thread) or B (M5 Metric Thread)

- **Designed For High Voltage DC-Blocking**
- **High Capacitance Values in Small Size**
- **Rugged & Epoxy Encapsulated**
- **High-Torque Terminals Available**
- **Class II X5U Dielectric**

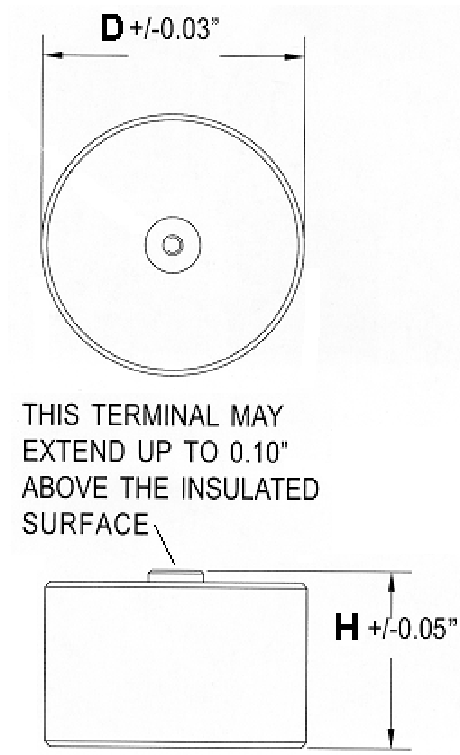
GENERAL SPECIFICATIONS

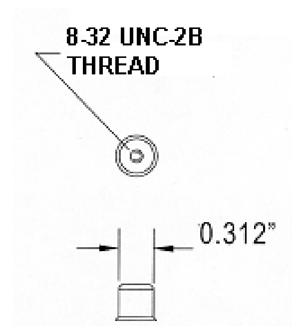
Temperature Range	Operating: -55° C to +85° C Storage: -55° C to +125° C
Capacitance Tolerance	+80%, -20% standard
Dissipation Factor	1.5% Maximum when measured at a frequency of 1 kHz and 25° C
Dielectric Characteristic	Class II X5U (+22%, -56% capacitance change with temperature over -55° C to +85° C)
Dielectric Strength	Will withstand a DC potential of 1.5 times V_{MAX} rating for 10 Seconds at 25° C
Insulation Resistance	20,000 Megohms (MΩ) Minimum at 100 V_{DC}
Terminal Strength	Maximum applied torque to be 12 inch-pounds or less (standard **S** terminal) Maximum applied torque to be 25 inch-pounds or less (high-strength **H** terminal)
Humidity Protection	Epoxy encapsulated
Standard Markings	"HEC", Capacitance, Tolerance, Rated Working Voltage (V_{DC}) and Date Code

EPSL Series Epoxy Encapsulated Ceramic Capacitor Part Numbers:

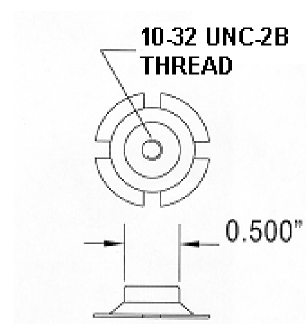
EPSL	**U** (6kV$_{DC}$) or **1** (10 kV$_{DC}$) or **2** (15 kV$_{DC}$) or **3** (20 kV$_{DC}$) or **5** (30 kV$_{DC}$) or **7** (40 kV$_{DC}$)	**181** (180 pF) to **163** (16,000 pF)	**Z** (+80%, -20%)	**S** (8-32 UNC Thread) or **H** (10-32 UNC Thread)

RATINGS		PHYSICAL		PART NUMBER	
pF	V_{MAX} (kV_{DC})	D (In)	H (In)		Terminal H Available √
1100	6	0.83	0.69	EPSLU112ZS	
2000	6	1.00	0.69	EPSLU202ZS	
3400	6	1.25	0.69	EPSLU342ZS	
5400	6	1.50	0.69	EPSLU542ZS	
8000	6	1.75	0.69	EPSLU802ZH	√
11,000	6	2.08	.069	EPSLU113ZS	√
14,000	6	2.25	0.69	EPSLU143ZH	√
16,000	6	2.37	0.69	EPSLU163ZS	√
800	10	0.83	0.81	EPSL1681ZS	
1200	10	1.00	0.81	EPSL1122ZS	
2000	10	1.25	0.81	EPSL1202ZS	
3200	10	1.50	0.81	EPSL1322ZS	
4700	10	1.75	0.81	EPSL1472ZS	√
6500	10	2.08	0.81	EPSL1652ZS	√
8300	10	2.25	0.81	EPSL1832ZS	√
9300	10	2.37	0.81	EPSL1932ZS	√
470	15	0.83	0.95	EPSL2471ZS	
800	15	1.00	0.95	EPSL2801ZS	
1300	15	1.25	0.95	ESPL2132ZS	
2200	15	1.50	0.95	ESPL2222ZS	
3200	15	1.75	0.95	EPSL2322ZS	√
4600	15	2.08	0.95	EPSL2462ZS	√
5800	15	2.25	0.95	EPSL2582ZS	√
6500	15	2.37	0.95	EPSL2652ZS	√
350	20	0.83	1.13	ESPL3351ZS	
500	20	1.00	1.13	ESPL3501ZS	
600	20	1.25	1.13	ESPL3601ZS	
1000	20	1.50	1.13	ESPL3102ZS	
1600	20	1.75	1.13	ESPL3162ZS	√
2400	20	2.08	1.13	ESPL3242ZS	√
3300	20	2.25	1.13	EPSL3332ZS	√
4300	20	2.25	1.13	ESPL3432ZS	√
4800	20	2.37	1.13	ESPL3482ZS	√
260	30	0.83	1.31	ESPL5261ZS	
460	30	1.00	1.31	ESPL5461ZS	
780	30	1.25	1.31	ESPL5781ZS	
1200	30	1.50	1.31	ESPL5122ZS	
1800	30	1.75	1.31	ESPL5182ZS	√
2500	30	1.75	1.31	ESPL5252ZS	√
3300	30	2.25	1.31	ESPL5332ZS	√
3600	30	2.37	1.31	EPSL5362ZS	√
180	40	0.83	1.61	EPSL7181ZS	
340	40	1.00	1.61	EPSL7341ZS	
570	40	1.25	1.61	EPSL7571ZS	
920	40	1.50	1.61	EPSL7921ZS	
1300	40	1.75	1.61	EPSL7132ZS	√
1900	40	2.08	1.61	EPSL7192ZS	√
2400	40	2.25	1.61	EPSL7242ZS	√
2700	40	2.37	1.61	EPSL7272ZS	√



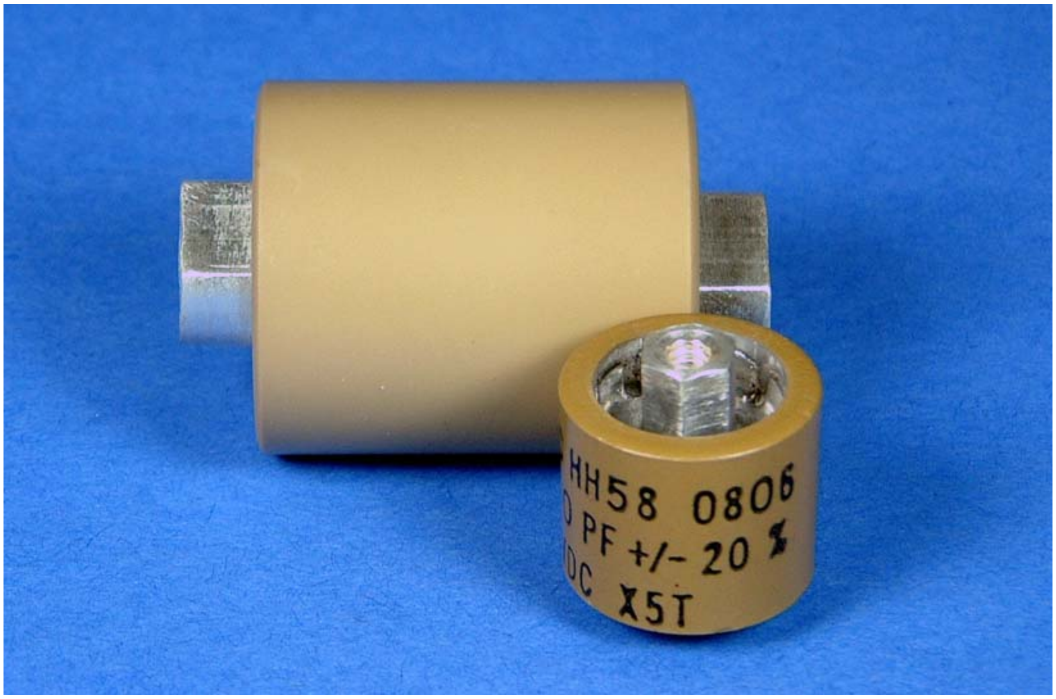


STANDARD
TERMINAL (S)



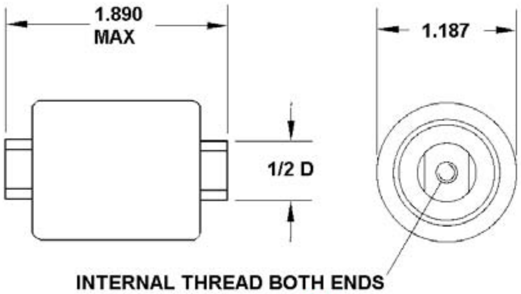
HIGH STRENGTH
TERMINAL (H)

- **Compact High Capacitance Parts**
- **7.5 and 15 kV_{DC} Power Ratings**
- **Broadcast Barrel Package**
- **Metric or English Terminals**
- **Three Class II Dielectrics**



GENERAL SPECIFICATIONS

Temperature Range	Operating: -55° C to +85 ° C Storage: -55° C to +125 ° C
Capacitance Tolerance	± 10% or ± 20% standard
Dissipation Factor	1.5% Maximum when measured at a frequency of 1 kHz and 25° C
Dielectric Characteristic	Class II **X5T** (+22%, -33% capacitance change with temperature over -55° C to +85° C) or **X5U** (+22%, -56% capacitance change with temperature over -55° C to +85° C) or **X5V** (+22%, -82% capacitance change with temperature over -55° C to +85° C)
Dielectric Strength	Will withstand an AC potential of 1.5 times Rated Working Voltage for 10 Seconds at 25° C.
Insulation Resistance	10,000 Megohms (MΩ) Minimum at 100 V_{DC}
Terminals	Silver Plated
Terminal Strength	Maximum applied torque to be 20 inch-pounds or less (HH57 series) "" "" "" 6 inch-pounds or less (HH58 series with standard terminal) "" "" "" 17 inch-pounds or less (HH58 series with solid terminal)
Humidity Protection	Nonconductive Coating
Standard Markings	"HEC", Capacitance, Tolerance, Rated Working Voltage (V_{DC}) and Date Code



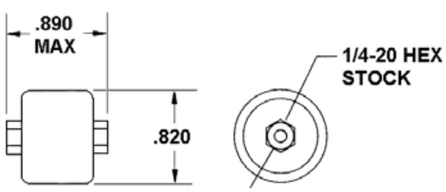
HH57 Series Ceramic Capacitor Part Numbers:

HH57Y	**751** (750 pF) to **152** (1500 pF)	**M** (± 20%) or **K** (± 10%)	**A** (10-32 Terminals) or **A-M** (M5 Terminals)

Also available with 7.5 kV and 10 kV rating as:

HH57V (7.5 kV_{DC}) and **HH57X** (10 kV_{DC})

CAPACITANCE		PERFORMANCE RATINGS					PART NUMBER
pF	Dielectric (TC)	V_{MAX} (kV_{DC})	f_L (MHz)	S_{MAX} (kVA)	f_H (MHz)	I_{MAX} (A_{RMS})	
750	**X5T**	**15**	0.0660	**35**	0.288	**6.90**	HH57Y751KA
1000		**15**	0.0495	**35**	0.118	**5.10**	HH57Y102KA
1200		**15**	0.0412	**35**	0.0985	**5.10**	HH57Y122KA
1500		**15**	0.0330	**35**	0.0851	**5.30**	HH57Y152KA



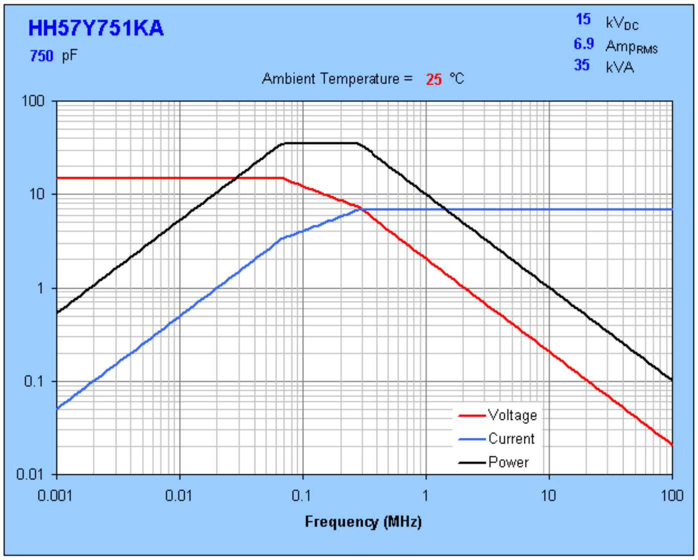
HH58 Series Ceramic Capacitor Part Numbers:

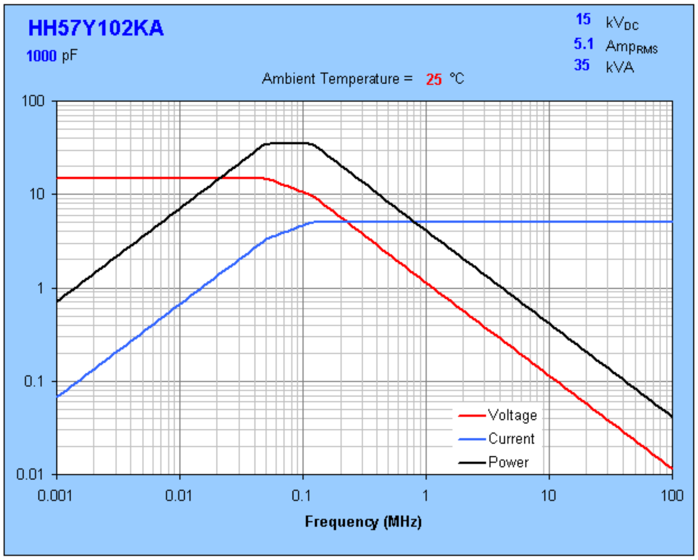
HH58V	**100** (500 pF) to **701** (2500 pF)	**M** (± 20%) or **K** (± 10%)	**A** (6-32 Terminals) or **A-M** (M4 Terminals) or **A-SM** (Solid Metric)

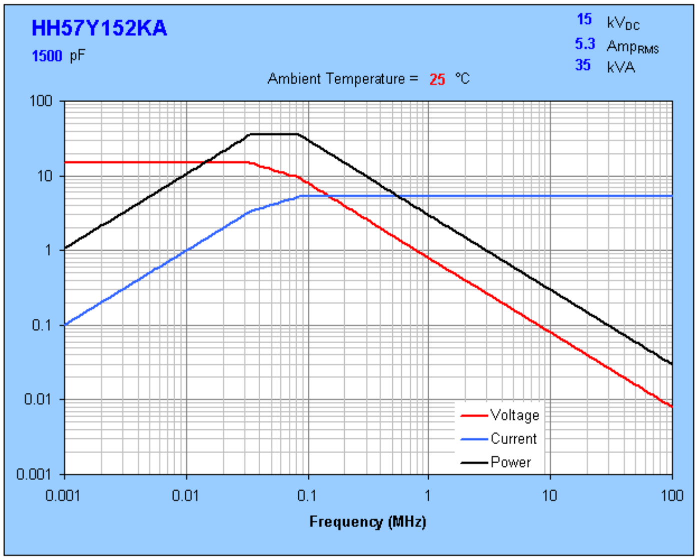
CAPACITANCE		PERFORMANCE RATINGS					PART NUMBER
pF	Dielectric (TC)	V_{MAX} (kV_{DC})	f_L (MHz)	S_{MAX} (kVA)	f_H (MHz)	I_{MAX} (A_{RMS})	
500	**X5T**	**7.5**	0.00679	**0.6**	12.7	**4.90**	HH58V501KA
700		**7.5**	0.00485	**0.6**	9.85	**5.10**	HH58V701KA
900		**7.5**	0.00377	**0.6**	8.27	**5.30**	HH58V901KA
1000	**X5V**	**7.5**	0.00339	**0.6**	8.31	**5.60**	HH58V102KA
2000		**7.5**	0.00170	**0.6**	5.26	**6.30**	HH58V202KA
2500	**X5U**	**7.5**	0.00136	**0.6**	4.62	**6.60**	HH58V252KA

Typical Maximum Rating Curves

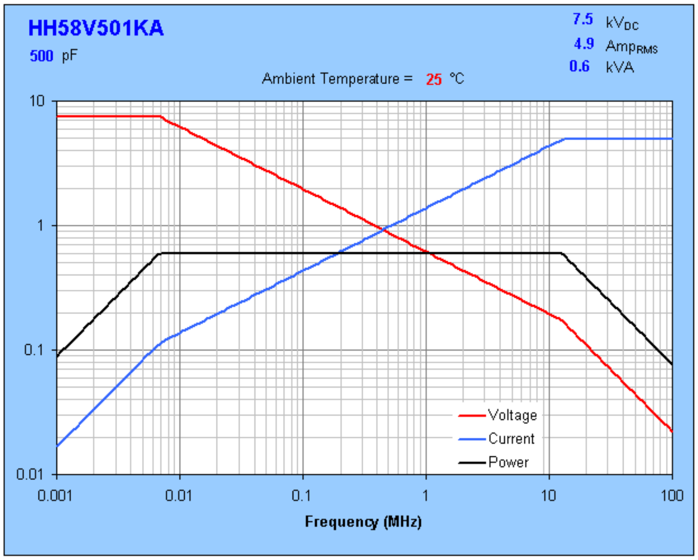
15 kV_{DC} HH57Y Series

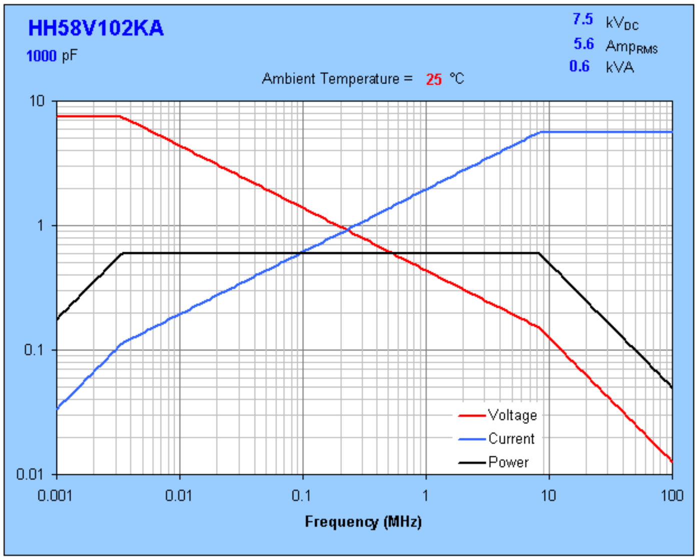


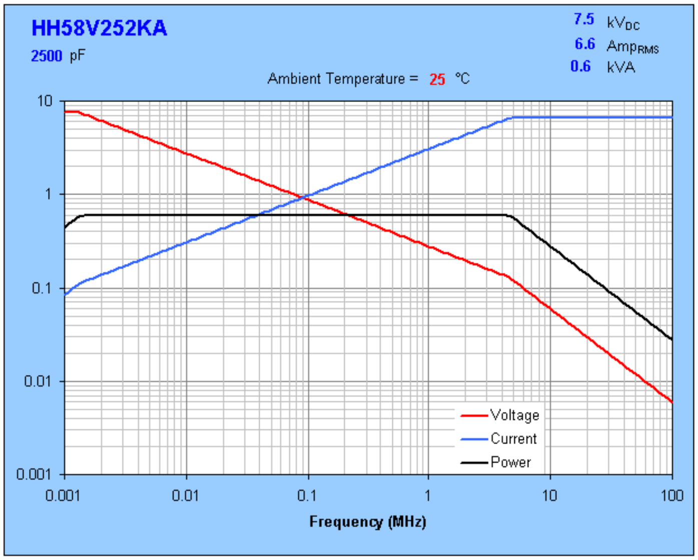




7.5 kV_{DC} HH58V Series



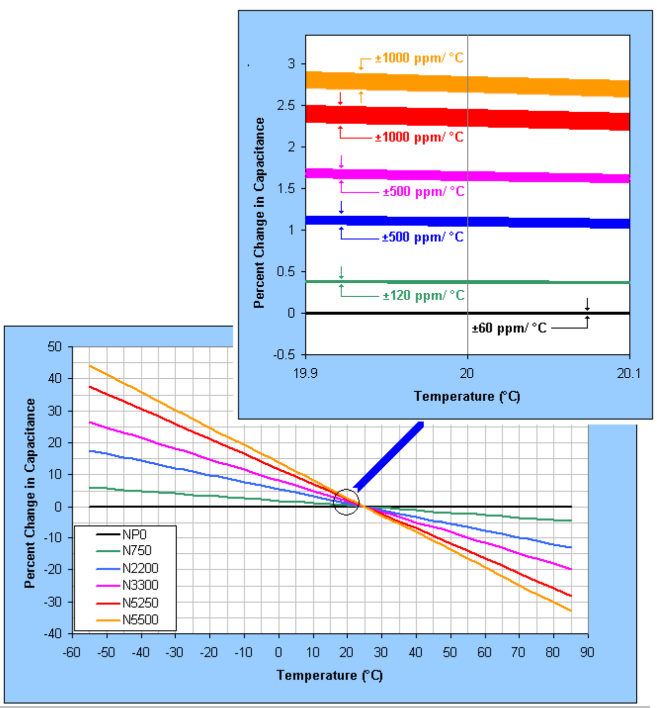




Dielectric Characteristics

High Energy Corporation designs and manufactures ceramic capacitors spanning a very broad range of applications. For this reason, it blends, mills and fires a broad range of dielectric materials, each optimized for a specific use. The properties of a few representative dielectrics are discussed herein. Broadly, all of our dielectrics fall into one of two categories, either Class I or Class II.

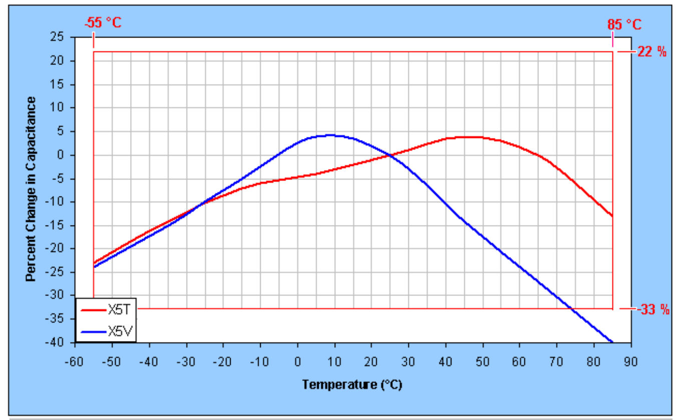
Class I capacitors are intended for use in high-Q circuits where a *low dissipation factor* and *stability of capacitance value* are of paramount importance. Dielectrics providing these characteristics are made from high-purity calcium titanate ($CaTiO_3$) blended with proprietary mixes of other titanate materials. Basic Class I dielectrics exhibit a low (below 150) relative dielectric constant, **K.** Various additives can increase this into the high-hundreds, providing *extended temperature compensating* Class I capacitors.



Temperature characteristics of some Class I dielectrics.

Class I capacitors have a (near) *linear* change in capacitance with temperature, as shown above. The identifying *Industry Type* is a simple code for the slope of this characteristic. An **N** says the slope is *negative*, while a **P** denotes a *positive* slope. The number following the letter gives the slope in parts-per-million per degree Centigrade (ppm/°C). All High Energy Class I designs use 'N' dielectrics.

Class I *Industry Type* **NP0** is a special case. This abbreviation stands for "negative-positive-zero", denoting a capacitor of (essentially) constant value with temperature. High Energy **NP0** capacitors exhibit the *same* capacitance from –55 to 85 °C within a temperature tolerance of ±60 ppm/ °C, as shown by the expanded inset at left below. Note that the *absolute* capacitance tolerance (i.e. ± 5%) is specified separately.



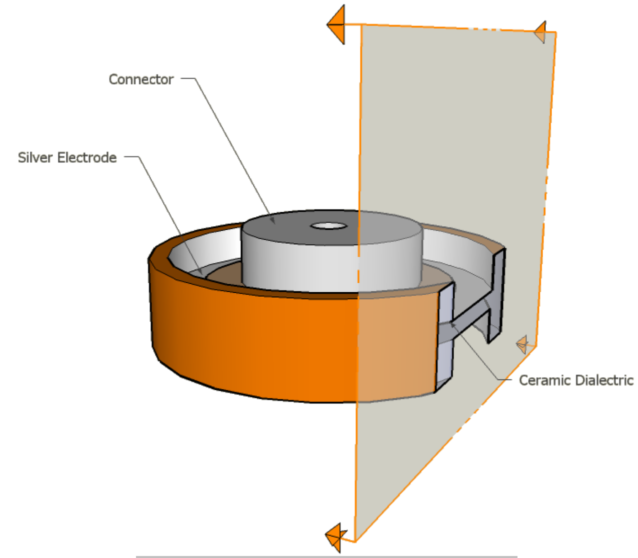
Temperature characteristics of some Class II dialectrics.

Class II capacitors are used in circuits where Q and component stability is less critical. This includes bypass decoupling, filters and other frequency discriminating circuits. These capacitors use a 'high-**K**' dielectric (**K** up to 10,000) to achieve a high capacitance/volume ratio. The dielectric is compounded upon a barium titanate (Ba_2TiO_3) base.

Class II parts are much smaller than Class I for similar capacitance. However, Class II parts provide much less tightly controlled capacitance variation with temperature as shown above.

The letter-number-letter dielectric identifier specifies a "performance rectangle". The first letter defines the *lowest* operating temperature. For example, **X** means –55 °C. The number defines the *maximum* operating temperature. For example, **5** means +85°C. The last letter defines the allowable plus and minus *percentage change in capacitance*. For instance, **T** stands for +22 % to –33 %, while **V** indicates a range of +22 % to –82 %.

Class II capacitors can also exhibit capacitance change *with time* and *with operating voltage*. They can also demonstrate *microphonic* behavior, owing to the piezoelectric character of Ba_2TiO_3.



Anatomy of a ceramic capacitor.

A ceramic capacitor is produced by forming and firing a ceramic cup (or back-to-back "double cup") of an insulating *dielectric* material and depositing a silver (or other noble metal) *electrode* on both sides of the 'web' or cup bottom. Copper or brass *terminals* are then soldered to each electrode and the entire structure is often encapsulated or otherwise insulated.

The capacitance is determined by the *surface area* of the electrodes, **A**, the *thickness*, **t**, of the web and the *relative dielectric constant*, **K**, of the ceramic material. In specific:

$$C = \frac{KA\varepsilon_0}{t} \qquad (1)$$

C = Capacitance in *Farads* (F)
K = Relative Dielectric Constant (dimensionless)
A = Surface area of each electrode (m^2)
ε_0 = Permitivity of vacuum = 8.854 x 10^{-12} (F/m)
t = Thickness of web between electrodes (m)

High Energy Corporation uses a broad range of dielectric materials for its products. Table 1 summarizes some properties, including **K**, of the most frequently selected dielectric formulas.

Table 1:Important Properties of Ceramic Dielectrics

Type	Similar EIA	Class	typical K	max δ @ freq.
NPO	COG	1	45	0.1% @ 1MHz
N750	U2J	1	120	0.1% @ 1MHz
N3300	S3L	1	400	0.2% @ 1MHz
N5250	T3M	1	700	0.3% @ 1MHz
N5500		1	2200	0.5% @ 1kHz
	X5T	2	1300	1.5% @ 1kHz
	X5V	2	8000	2.5% @ 1kHz

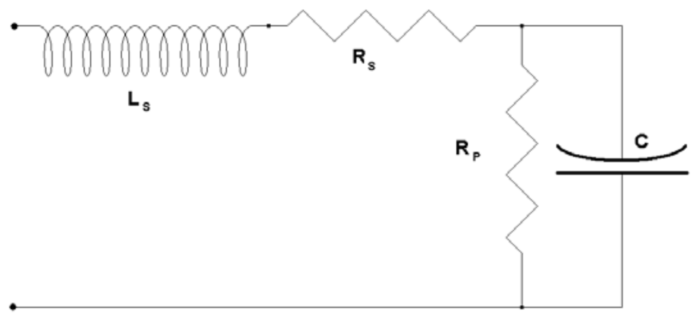
Basic Electronic Considerations

The *impedance* of an ideal capacitor is the complex spectrum given by:

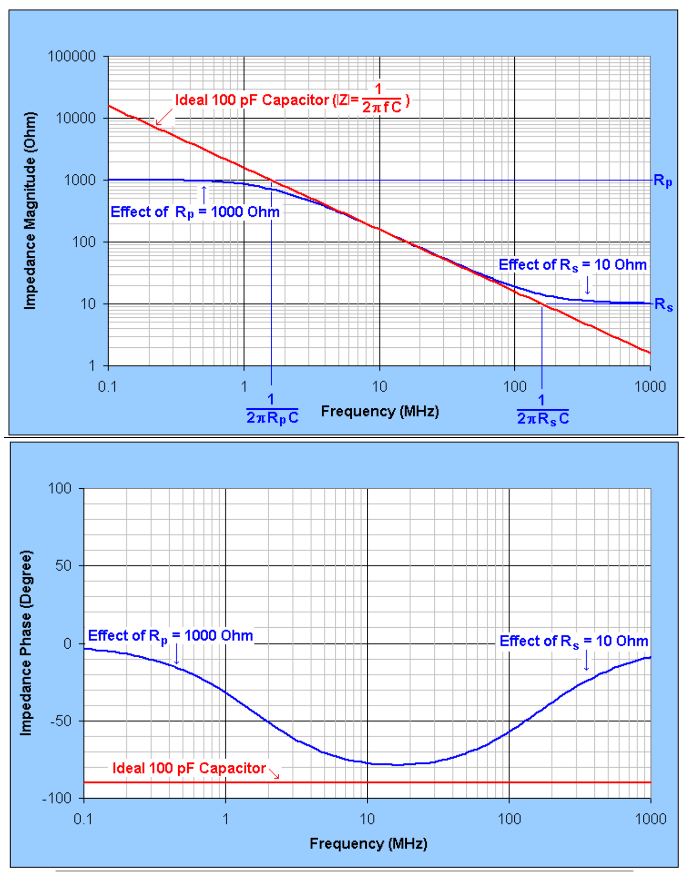
$$Z(f) = \frac{V(f)}{i(f)} = \frac{1}{2\pi fC}\left\langle -90^\circ \right. \qquad (2)$$

Z = Impedance in Ohms (Ω)
f = Frequency in Hertz (Hz)
V = Electromotive Force (Volt)
I = Current (Ampere)
π = 3.14159 ....

However, as illustrated below, a real capacitor will have imperfections that can be modeled by series and parallel resistors and a series inductor. A more complicated impedance results.



Equivalent circuit model for a ceramic capacitor.

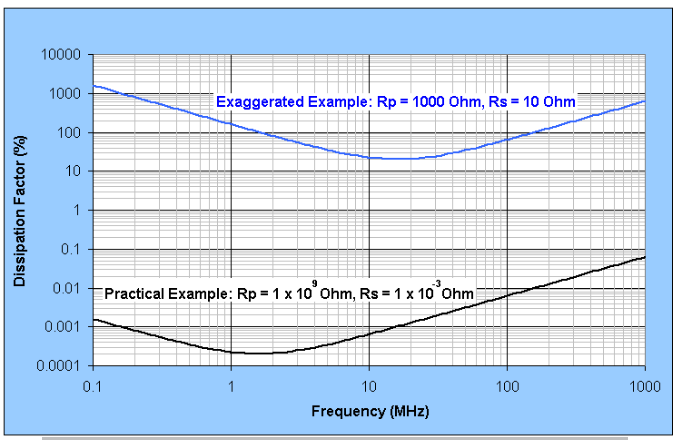


Effect of (exaggerated) R_p and R_s on impedance.

As shown (by the red traces) in the directly preceding figure, the *magnitude* of a (100 pF) capacitor's impedance decreases in proportion to frequency while its *phase angle* is a constant -90°. The blue traces illustrate the (exaggerated) effects of parallel and series resistors, $\mathbf{R_p}$ and $\mathbf{R_s}$.

A low value of parallel or 'leakage' resistor, $\mathbf{R_p}$, causes a *reduction* of the capacitor's impedance at frequencies less than $\mathbf{1/2\pi R_p C}$ Hz. It also causes the *phase* to deviate from -90° towards 0°. A high value of series resistor, $\mathbf{R_s}$, causes an *increase* in capacitor impedance for frequencies above $\mathbf{1/2\pi R_s C}$ with a phase shift towards 0°.

However, the resistor values ($\mathbf{R_p}$ = 1000 Ω and $\mathbf{R_s}$ = 10 Ω) of the previous figures are unrealistic. More typical values might be $\mathbf{R_p}$ = 1 GΩ (10^9 Ω) and $\mathbf{R_s}$ = 1 mΩ (10^{-3} Ω), shown in black below. These are compared with the (blue trace) previous "million-fold" exaggerations in *Dissipation Factor* spectra.



Dissipation Factors comparing effect of $\mathbf{R_p}$ and $\mathbf{R_s}$.

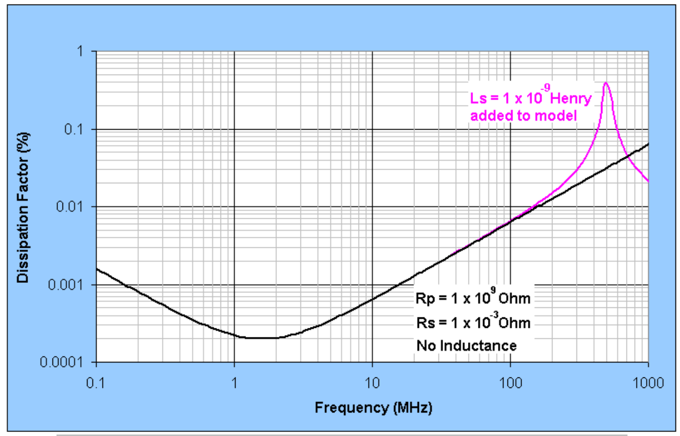
The *Dissipation Factor* (DF), δ, is a real-valued spectrum corresponding to the *tangent* of the *impedance phase*. As such, it is the ratio of *real* or phase-coincident response to the *imaginary* or quadrature-phase response.

The Dissipation Factor is thus also equal to the ratio of (heat producing) *real power* dissipated within the capacitor to the *reactive power* oscillating through it. Note that for an 'ideal' capacitor (prior red traces) the Dissipation Factor is zero-valued at all frequencies and cannot be plotted in the above log-log format.

Now consider the influence of a "series inductance", $\mathbf{L_s}$:

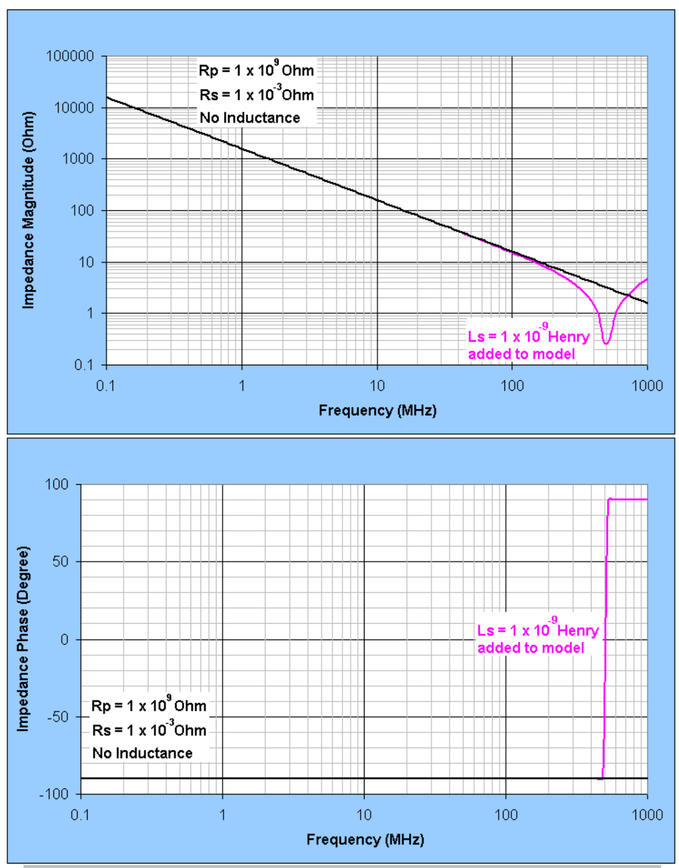
The following violet trace shows that the addition of a small series inductance (1 nanoHenry in this case) creates a peak in the Dissipation Factor at the *self-resonance frequency*, $\mathbf{f_n}$, defined by:

$$f_n = \frac{1}{2\pi}\sqrt{\frac{1}{LC}} \text{ (Hz)} \qquad (3)$$



Dissipation Factor for realistic parameter values.

The addition of this component to the ceramic capacitor model produces a noticeable 'notch' in the impedance *magnitude* at the same frequency. The most pronounced effect is a 180° 'jump' in the impedance phase spectrum at $\mathbf{f_n}$, as shown below.

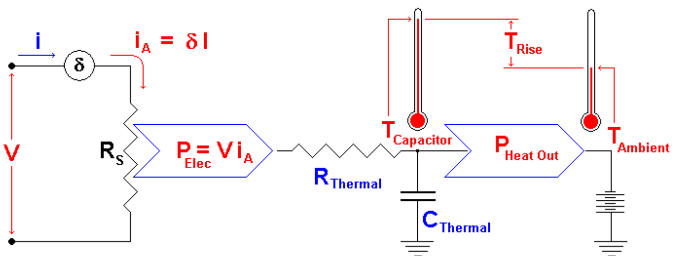


Impedance *Magnitude* and *Phase* with and without $\mathbf{L_s}$.

Performance Limits & Thermodynamics

The *Leakage Resistance*, $\mathbf{R_p}$, is fundamentally determined by the *resistivity* of the dielectric and the terminal-to-terminal insulation of the capacitor. The *Equivalent Series Resistance* (ESR), $\mathbf{R_s}$, is dominated by the quality of the soldered joints between the *connectors* and the *electrodes*. The *Equivalent Series Inductance* (ESI), $\mathbf{L_s}$, is basically determined by the length of the terminal assemblies as well as physical properties of the dielectric.

Other considerations limit the performance of a capacitor. The *maximum voltage* is fundamentally determined by the *thickness of the web*, **t**, between the electrodes and the resistivity and the break-down potential of the dielectric. The *maximum current* is limited by the *surface area of the electrodes*, **A** and the allowable current density of the electrode material.



Thermal model of a capacitor in its environment.

Electrical parameters are further limited by thermodynamic considerations. An alternating current passing through a theoretically perfect capacitor generates no heat, as the voltage across the capacitor is 90° out-of-phase with the current. Multiplying (and averaging) the instantaneous voltage and this *reactive* current produces only imaginary *reactive power*, **Q**.

In a real ceramic capacitor, the voltage, **V**, and current, **I**, are <u>not</u> in perfect phase-quadrature. The total current contains a small (-60 dB, typical) *active* component, $\mathbf{I_A}$, in phase-coincidence with the voltage. The product (of RMS values), $\mathbf{V \cdot I_A = P}$, defines the *active* electrical power (Watts) dissipated within the capacitor as heat. $\mathbf{I_A}$ is well approximated by $\mathbf{I \cdot \delta}$, where δ is the previously defined dissipation factor.

The product of RMS values, $\mathbf{V \cdot I = S}$, is always a larger number, termed the *apparent power*. **S** reflects both the active and reactive power components in accordance with:

$$S = \sqrt{P^2 + Q^2} \quad \text{(VA)} \tag{4}$$

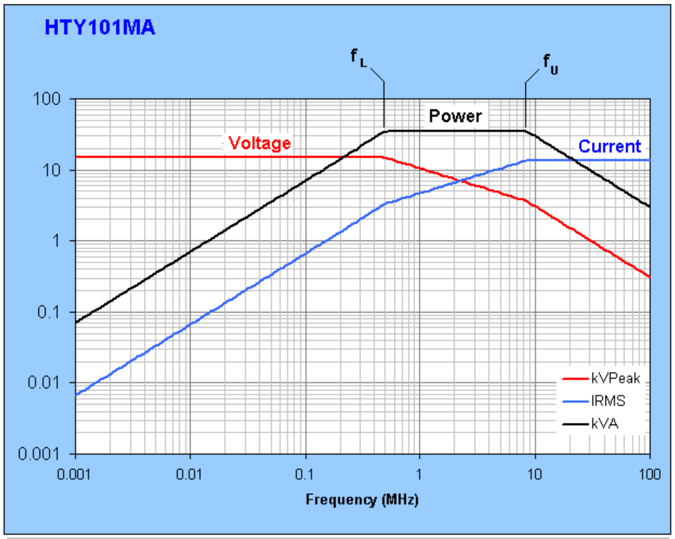
When the capacitor is at the *same* temperature ($\mathbf{T_{Ambient}}$) as it surroundings, it cannot expel any heat. As its temperature increases (by $\mathbf{T_{Rise}}$) above the surrounding $\mathbf{T_{Ambient}}$, it is able to pass thermal power, $\mathbf{P_{Heat\ Out}}$, to the environment.

The amount of heat expelled, $\mathbf{P_{Heat\ Out}}$, is a function of $\mathbf{T_{Rise}}$. (This relationship is well modeled by a fourth-order polynomial.) When $\mathbf{P_{Heat\ Out} = P_{Elect}}$, the capacitor's temperature stabilizes at $\mathbf{T_{Rise}}$ above $\mathbf{T_{Ambient}}$.

Thus, the ceramic capacitor has three very fundamental limiting specifications. These are:

1. Maximum rated operating *Voltage*, $\mathbf{V_{Max}}$
2. Maximum rated operating *Current*, $\mathbf{I_{Max}}$
3. Maximum rated operating *Apparent Power*, $\mathbf{S_{Max}}$

The following figure illustrates typical **Maximum Rated** power parameters as a function of frequency.



Typical Maximum Rating curves for a ceramic capacitor.

Within that frequency band bounded by lower frequency, $\mathbf{f_L}$, and upper frequency, $\mathbf{f_U}$, the *limiting specification* is the maximum rated apparent power. $\mathbf{S_{max}}$ is that experimentally-determined total power that will cause the capacitor's temperature to rise 30° C above the ambient. Within this frequency band, both the <u>voltage and current must be less than their respective maximum ratings</u>.

Below f_L, the limiting specification is the maximum rated voltage, V_{Max}. In this region, both the current and power must be less than their maximum rated values. Above f_U, the limiting specification is the maximum rated current, I_{Max}. In this frequency span, both the voltage and power must be less than their maximum rated values.

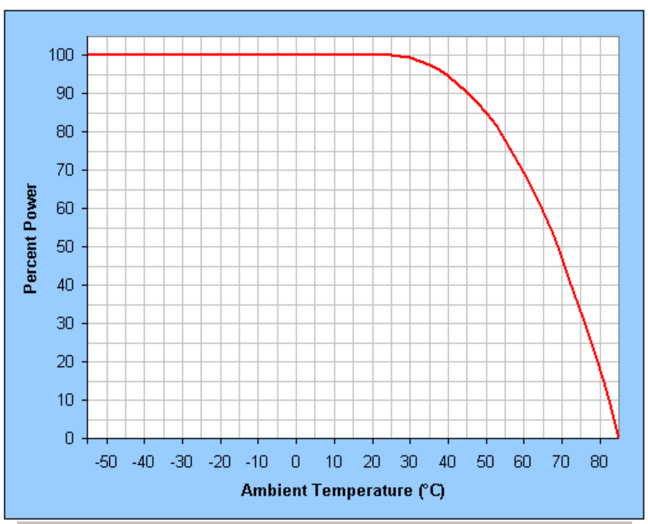
Published specifications for High Energy capacitors reflect design calculations and experimental verification. Each rating incorporates an appropriate *Safety Factor*, assuring a long-lived component if operated within the ratings.

The maximum rated voltage, V_{Max}, is a peak value (not an RMS measurement). It is equal to the sum of the peak AC value and the absolute value of any DC bias it rides upon.

The maximum rated current, I_{Max}, is the root-mean-square (RMS) value of the total or *apparent current* flowing through the capacitor.

The maximum rated apparent power, S_{Max}, is the product of the RMS voltage applied to the capacitor and the RMS current flowing through it (without regard to phase). This measurement reflects both the dominant *reactive power* and the far smaller heat-producing *active power*.

Note that the maximum rated power, S_{Max}, must be derated in accordance with the following figure if the ambient temperature, T_C, exceeds **25° C**.

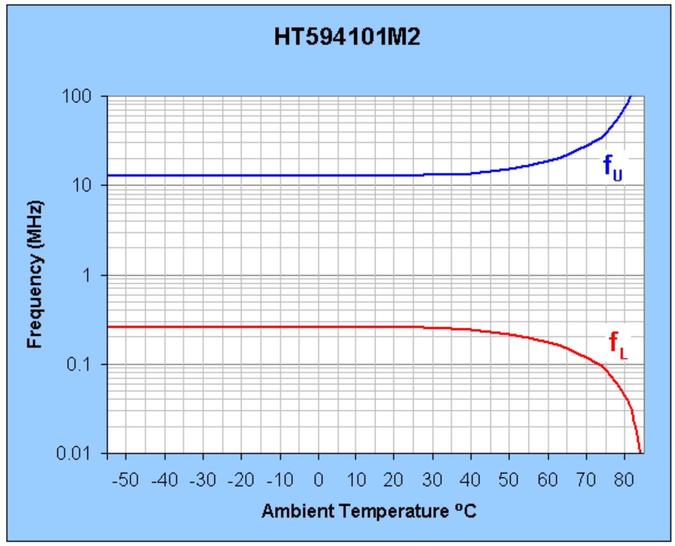


Derating curve for High Energy Ceramic Capacitors.

The equation for this derating is given by:

$$\frac{S_{Derate}}{S_{Max}} = .891 + .811\left(\frac{T_C}{100}\right) - 1.21\left(\frac{T_C}{100}\right)^2 - 1.15\left(\frac{T_C}{100}\right)^3 \quad (5)$$

When the value of S_{Max} is reduced for temperature derating, it causes f_U to *increase* and f_L to *decrease*, as shown below. That is, derating for temperature increases the frequency span over which the reduced S_{Max} is the limiting performance parameter.



Effect of derating on power breakpoint frequencies.

The apparent power, **S**, at any frequency, **f**, is related to the root-mean-square current, I_{RMS} by:

$$S = I_{RMS}^2 \cdot |Z| = \frac{I_{RMS}^2}{2 \cdot \pi \cdot f \cdot C} \leq S_{Derate} \quad (6)$$

When the frequency, **f**, exactly equals the upper bounding frequency, f_U, the current, I_{RMS}, must equal I_{Max} and (6) can be solved for f_U.

$$f_U = \frac{I_{Max}^2}{2 \cdot \pi \cdot C \cdot S_{Derate}} \cong \frac{0.159 \cdot I_{Max}^2}{C \cdot S_{Derate}} \quad (7)$$

The apparent power, **S**, may also be expressed in terms of the peak voltage, V_{peak}.

$$S = \frac{V_{Peak}^2}{2 \cdot |Z|} = \pi \cdot f \cdot C \cdot V_{Peak}^2 \leq S_{Derate} \quad (8)$$

Equation (8) can be solved for lower bounding frequency, f_L, where the peak voltage, V_{Peak} must equal V_{max}.

$$f_L = \frac{S_{Derate}}{\pi \cdot C \cdot V_{Max}^2} \cong \frac{0.318 \cdot S_{Derate}}{C \cdot V_{Max}^2} \quad (9)$$

Thus the maximum rated peak operating voltage may be stated:

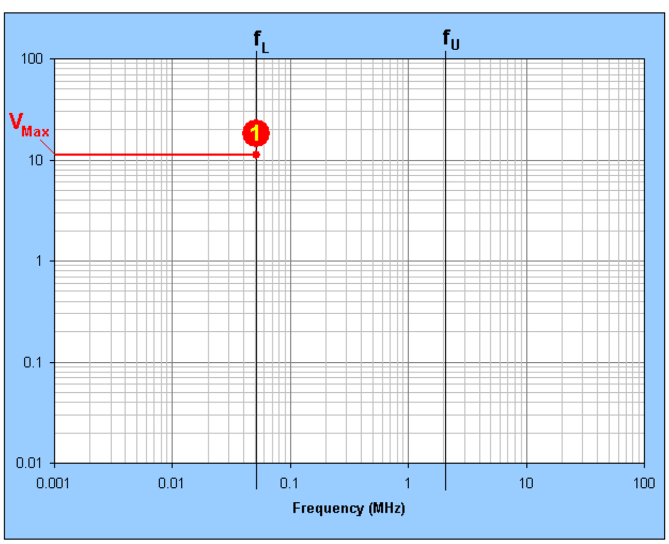
$$
\begin{aligned}
V_{\substack{Peak \\ f<f_l}} &= V_{Max} \\
V_{\substack{Peak \\ f_L \le f \le f_U}} &= \sqrt{\frac{S_{Max}}{\pi \cdot f \cdot C}} \qquad (10) \\
V_{\substack{Peak \\ f>f_U}} &= \frac{\sqrt{2}}{2} \cdot \frac{I_{Max}}{\pi \cdot C \cdot f}
\end{aligned}
$$

In like manner, the maximum rated RMS operating current is described by:

$$
\begin{aligned}
I_{\substack{RMS \\ f<f_L}} &= \sqrt{2} \cdot \pi \cdot f \cdot C \cdot V_{Max} \\
I_{\substack{RMS \\ f_L \le f \le f_U}} &= \sqrt{2 \cdot \pi \cdot f \cdot C \cdot S_{Max}} \qquad (11) \\
I_{\substack{RMS \\ f>f_U}} &= I_{Max}
\end{aligned}
$$

Plotting Rating Curves for HEC Parts

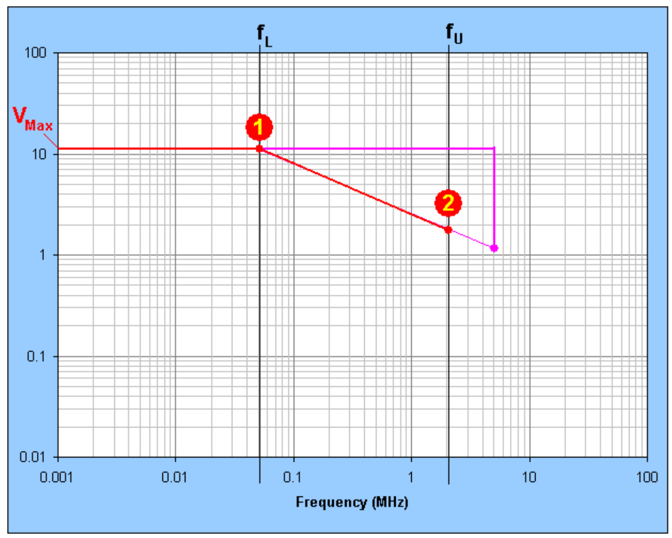
Most Class I example HEC Ceramic Capacitors listed in this catalog are presented with five power parameters: V_{Max}, f_L S_{Max}, F_U and I_{Max}. These are sufficient information to allow construction of the three *maximum rating* curves without using equations (7) and (9). To do so, start by copying the log-log plot template at the end of this section or by obtaining a suitable sheet of 4-by-5 cycle log-log graph paper.



Drawing the vertical and horizontal lines of a V_{Max} plot.

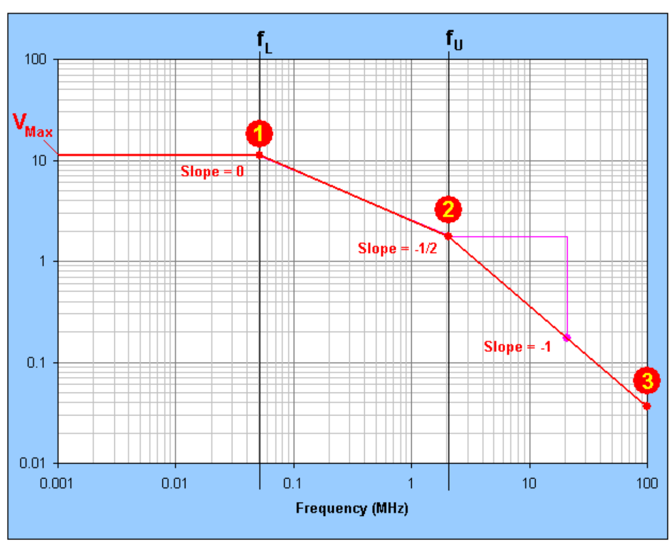
Begin by striking vertical reference lines at the $\mathbf{f_L}$ and $\mathbf{f_U}$ frequency locations as shown above. Then, to plot a *Maximum Voltage* spectrum, draw a horizontal line at the $\mathbf{V_{Max}}$ level from the graph's minimum frequency to f_L. Stop at this location, labeled **Point 1**.

Draw a construction point two decades to the right and one decade below **Point 1**, as shown below. Draw a line from **Point 1** toward this temporary construction point. Stop the line at **Point 2**, the intersection with $\mathbf{f_U}$.

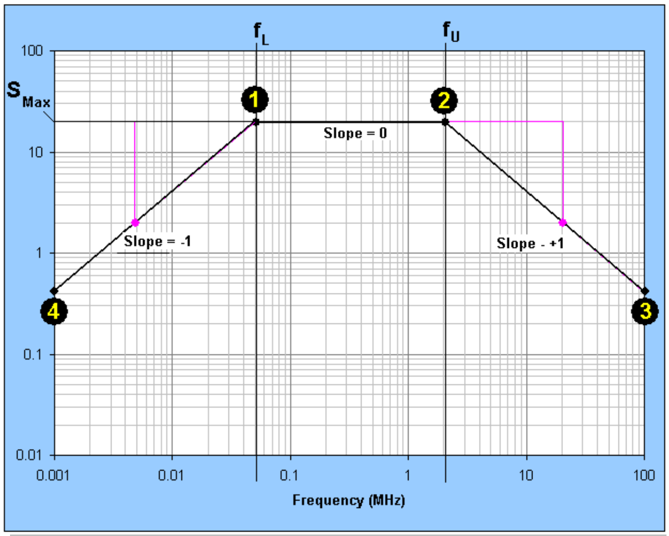


Adding a segment with a slope equal to **–1/2** to the plot.

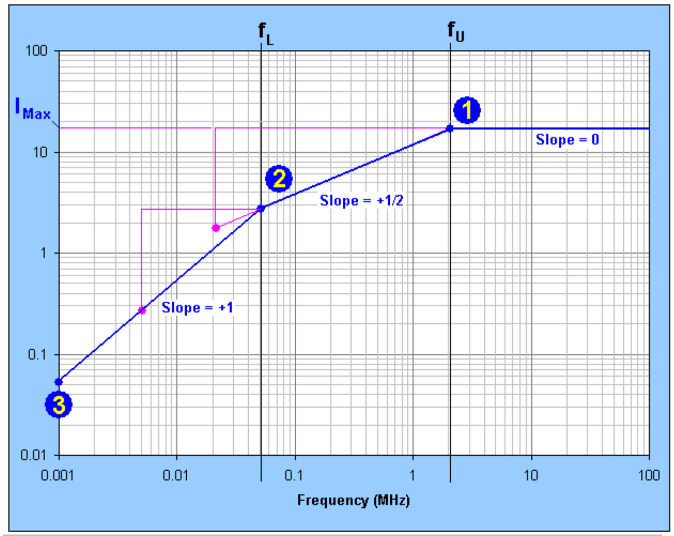
From **Point 2** construct a temporary point one decade to the right and one decade below **Point 2**, as shown below. Draw a line from **Point 2** through this temporary construction point to the graph's maximum frequency.



Completing the V_{Max} plot with a segment with a **–1** slope.



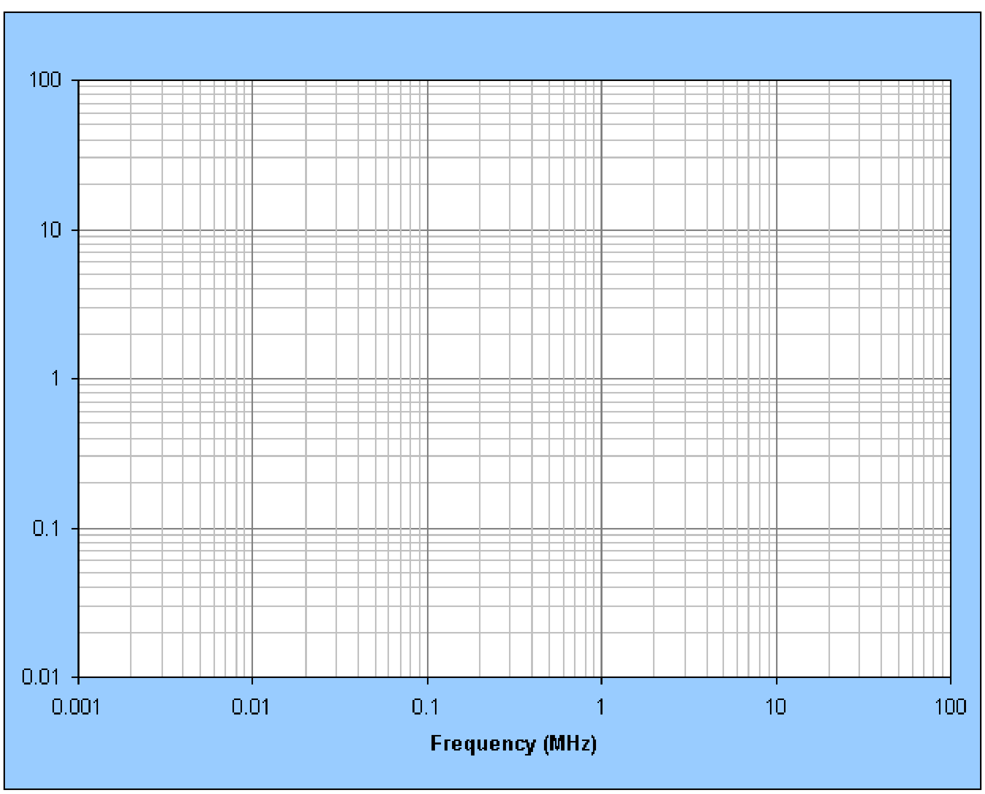
An S_{Max} power plot is drawn with slopes of **–1**, **0** and **+1**.



An I_{Max} plot is constructed with slopes of **+1**, **0** and **+1/2**.

To construct a *Maximum Power* diagram, draw a horizontal line at $\mathbf{S_{Max}}$ amplitude between the f_L and f_U endpoints. Construct temporary points one decade below and one decade to the side of **Points 1** and **2**. Draw lines through these temporary points from **Point** 1 and **Point 2** to the upper (**Point 3**) and lower (**Point 4**) frequency extremes of the plot as shown above.

Finally, draw a *Maximum Current* spectrum by drawing a horizontal line at amplitude $\mathbf{I_{max}}$ from the graph's maximum frequency to **Point 1** at $\mathbf{f_U}$. Then raw a construction point two decades to the left and one decade below **Point 1**, as shown above. Draw a line from **Point 1** toward this temporary point. Stop the line at **Point 2**, the intersection with $\mathbf{f_L}$. From **Point 2** construct a temporary point one decade to the left and one decade below **Point 2**. Draw a line from **Point 2** through this temporary construction point to the graph's minimum frequency at **Point 3**.



WARRANTY

All products purchased from High Energy Corporation are guaranteed to be free from defects of workmanship and material under normal use for a period of one year from the date of shipment.

LIMITATIONS

There are no other warranties, expressed or implied. Specifically excluded, but not by way of limitation, are the implied warranties of fitness for a particular purpose and merchantability.

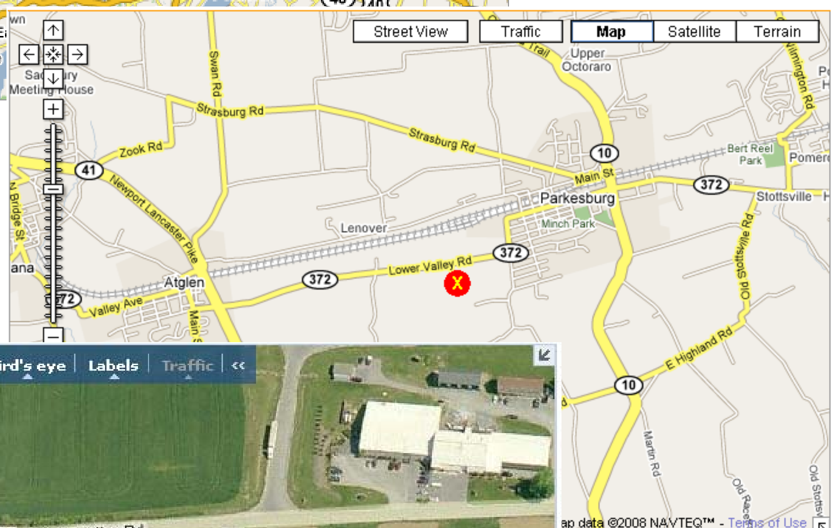
It is understood and agreed that the sellers liability, whether in contract, in tort, under any warrantee, in negligence or otherwise, shall not exceed the price paid by the purchaser, and under no circumstance shall the seller be liable for special, indirect or consequential damages. The price stated for the equipment is a consideration in limiting the seller's liability. No action, regardless of form, arising out of the transaction of this agreement may be brought by purchaser more than one year after the course of action has accrued.

Seller's maximum liability shall not exceed and buyer's remedy is limited to either (i) repair or replacement of the defective product, or at the seller's option (ii) return of the product and refund of the purchase price, and such remedy shall be the entire and exclusive remedy.

All High Energy Corporation ceramic capacitors are built in conformity to RoHS Directive. Specifically, in conformity with EU Directive 2002/95/EC, lead, cadmium, mercury, hexavalent chromium and specific bromine-based flame-retardants, PBB and PBDE, have not been used, except for exempted applications.

All specifications are subject to change without notice.

We're easy to find!



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