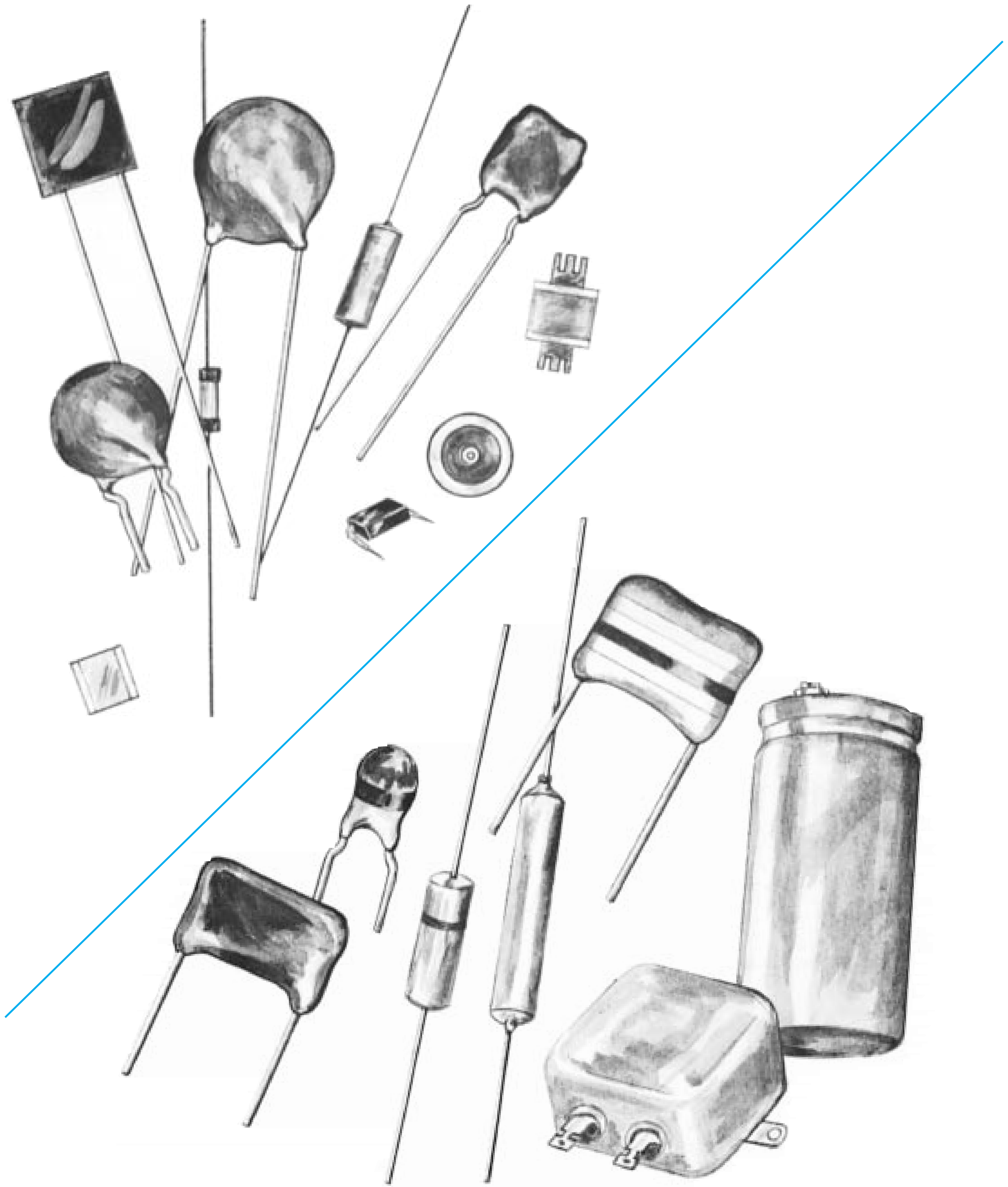
Dielectric Comparison Chart



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Basic Capacitor Formulas

I. Capacitance (farads)

English: $C = \dfrac{.224\ K\ A}{T_D}$

Metric: $C = \dfrac{.0884\ K\ A}{T_D}$

II. Energy stored in capacitors (Joules, watt - sec)

$E = \frac{1}{2}CV^2$

III. Linear charge of a capacitor (Amperes)

$I = C\ \dfrac{dV}{dt}$

IV. Total Impedance of a capacitor (ohms)

$Z = \sqrt{R_S^2 + (X_C - X_L)^2}$

V. Capacitive Reactance (ohms)

$x_C = \dfrac{1}{2\ \pi\ fC}$

VI. Inductive Reactance (ohms)

$x_L = 2\ \pi\ fL$

VII. Phase Angles:

Ideal Capacitors: Current leads voltage 90°
Ideal Inductors: Current lags voltage 90°
Ideal Resistors: Current in phase with voltage

VIII. Dissipation Factor (%)

D.F.= tan δ (loss angle) = $\dfrac{E.S.R.}{X_C}$ = $(2\ \pi fC)$ (E.S.R.)

IX. Power Factor (%)

P.F. = Sine δ (loss angle) = Cos ϕ (phase angle)
P.F. = (when less than 10%) = DF

X. Quality Factor (dimensionless)

Q = Cotan δ (loss angle) = $\dfrac{1}{D.F.}$

XI. Equivalent Series Resistance (ohms)

E.S.R. = (D.F.) (Xc) = (D.F.) / $(2\ \pi\ fC)$

XII. Power Loss (watts)

Power Loss = $(2\ \pi\ fCV^2)$ (D.F.)

XIII. KVA (Kilowatts)

KVA = $2\ \pi\ fCV^2 \times 10^{-3}$

XIV. Temperature Characteristic (ppm/°C)

$T.C. = \dfrac{Ct - C_{25}}{C_{25}\ (T_t - 25)} \times 10^6$

XV. Cap Drift (%)

$C.D. = \dfrac{C_1 - C_2}{C_1} \times 100$

XVI. Reliability of Ceramic Capacitors

$\dfrac{L_o}{L_t} = \left(\dfrac{V_t}{V_o}\right)^X \left(\dfrac{T_t}{T_o}\right)^Y$

XVII. Capacitors in Series (current the same)

Any Number: $\dfrac{1}{C_T} = \dfrac{1}{C_1} + \dfrac{1}{C_2} --- \dfrac{1}{C_N}$

Two: $C_T = \dfrac{C_1\ C_2}{C_1 + C_2}$

XVIII. Capacitors in Parallel (voltage the same)

$C_T = C_1 + C_2 --- + C_N$

XIX. Aging Rate

A.R. = % Δ C/decade of time

XX. Decibels

db = 20 log $\dfrac{V_1}{V_2}$

METRIC PREFIXES

Pico	X 10^{-12}
Nano	X 10^{-9}
Micro	X 10^{-6}
Milli	X 10^{-3}
Deci	X 10^{-1}
Deca	X 10^{+1}
Kilo	X 10^{+3}
Mega	X 10^{+6}
Giga	X 10^{+9}
Tera	X 10^{+12}

SYMBOLS

K	= Dielectric Constant	f	= frequency	L_t	= Test life
A	= Area	L	= Inductance	V_t	= Test voltage
T_D	= Dielectric thickness	δ	= Loss angle	V_o	= Operating voltage
V	= Voltage	ϕ	= Phase angle	T_t	= Test temperature
t	= time	X & Y	= exponent effect of voltage and temp.	T_o	= Operating temperature
R_S	= Series Resistance	L_o	= Operating life		

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S-DEC5M795-R

Capacitor Dielectric Comparison Chart

Characteristics		Multi-Layer Ceramics							Multi-Layer Glass-K									
		NPO	Stable	HiK	Ceramic Discs	Internal Barrier Layer	Reduced Titanates	Multi-Layer Glass	"T" Characteristic	"U" Characteristic	"V" Characteristic	Mica	Polyester	Poly-carbonate	Poly-propylene	Poly-styrene	Solid Tantalums	Aluminum Electrolytics
Capacitance	Range, mfd	1pF – .01µF	1pF – 2.2µF	.001 – 10µF	1pF 0.1µF	.01 – .22µF	.01 – 1.0µF	0.5pF – .01µF	270pF – .020µF	.012 – .039µF	.022 – .1µF	1pF – .09µF	.001 – 10µF	.001 – 10µF	47 – .047µF	100pF – .027µF	.01 – 1000µF	0.5 – 10^6µF
	Min. Tol. Avail. %	±0.5%	±5%	±20%	Same as Multi-layers	±20%	±20%	±0.5%	±5%	±10%	±10%	±0.5%	±5%	±1%	±0.5%	±0.5%	±5%	±20%
	Std. Tol. %	±5%, ±10%	±10%	+80%, -20%	Same as Multi-layers	+80%, -20%	+80%, -20%	±1%, ±5%	±5%, ±10%	±5%, ±10%	±5%, ±10%	±5%	±10%	±10%	±5%	±5%	±20%	+100%, -10%
Voltage Range	Typical, VDC	50 – 200	50 – 200	25 – 100	50 – 10,000	50	3 – 50	50 – 2000	25 – 50	25 – 50	25 – 50	50 – 500	100 – 600	100 – 600	100 – 600	30 – 600	6 – 125	3 – 500
Temperature	Range, °C	-55°C, +125°C	-55°C, +125°C	+10°C, +85°C and -55°C, +85°C	-55°C, +85°C	-55°C, +85°C	-55°C, +85°C	-75°C, +200°C	-75°C, +200°C	-75°C, +200°C	-75°C, +200°C	-55°C, +125°C	-55°C, +125°C	-55°C, +125°C	-55°C, +85°C	-55°C, +70°C	-55°C, +125°C	-40°C, +85°C
	T.C. %ΔC	±0.3%	±15%	+22%, –56% and –22%, –80%	Same as Multi-layers	±30%	±10%, ±30%	±1.65%	+2%, –10%	–2%, –15%	+20%, –45%	-.4%, +1.8%	±12%	±2%	±2.5%	±1%	±8%	±10%
I.R.	<1.0 mfd	10^5 MΩ	10^5 MΩ	10^4 MΩ	Same as Multi-layers	10^4 MΩ	10 MΩ	10^5 MΩ	10^4 MΩ	10^4 MΩ	10^4 MΩ	10^2 MΩ	10^4 MΩ	10^5 MΩ	10^5 MΩ	10^6 MΩ	10^2 MΩ	N.A.
	>1.0 mfd MΩ –mfd	N.A.	2,500	1,000	N.A.	N.A.	0.1	N.A.	N.A.	N.A.	N.A.	N.A.	10^3	10^4	N.A.	N.A.	10	100
Dissipation Factor	Percent At 1KHz, %	0.1%	2.5%	3.0%	0.1% to 4.0%	5.0%	5% to 10%	0.2%	1.0%	1.5%	3.0%	0.1%	2%	1.0%	0.35%	.1%	8% to 24%	8% (at 120 Hz)
Dielectric Absorption	Percent Typical, %	0.6%	2.5%	N.A.	Same as Multi-layers	N.A.	N.A.	.05%	0.1%	0.1%	1.3%	0.3% – 0.7%	0.5%	0.35%	.05%	.05%	N.A.	N.A.
Frequency Response	Freq. Response 10 = Best, 1 = Poorest	9	8	8	8	3	2	9	8	8	8	7	6	6	6	6	5	2
	Max. Freq. (MHz) For ΔC = ±10%	100	10	10	Same as Multi-layers	10	1	100	100	75	10	100	N.A.	N.A.	N.A.	N.A.	.002	N.A.
Stability (1000 Hrs.)	Typical Life Test, %ΔC	0.1%	10%	20%	Same as Multi-layers	20%	20%	0.5%	5%	10%	20%	0.1%	10%	5%	3%	2%	10%	10%
Polarity	Single Cap	N.P.	N.P.	N.P.	N.P.	N.P.	N.P.	N.P.	N.P.	N.P.	N.P.	N.P.	N.P.	N.P.	N.P.	N.P.	P	P

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