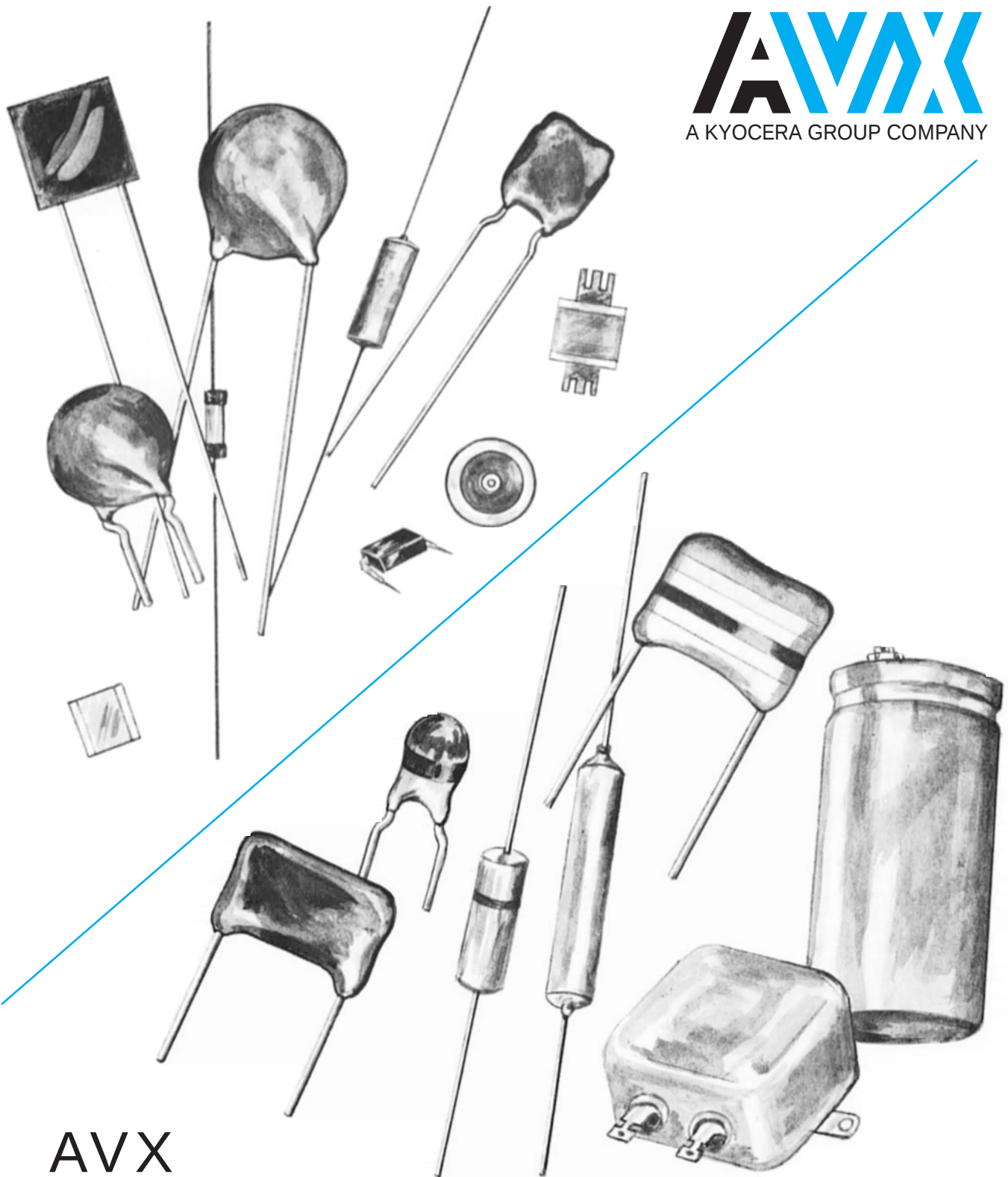




AVX Dielectric Comparison Chart

Capacitor Dielectric Comparison Chart



Characteristics		Multi-Layer Ceramics							Multi-Layer Glass-K									
		NP0	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 – .02μF	.012 – .039μF	.022 – .1μF	1pF – .09μF	.001 – 10μF	.001 – 10μF	47 – .047μF	100pF – .027μF	.01 – 1000μF	0.5 – 10 ⁶ μF
	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%	±1%, ±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. % Δ C	±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 Δ C = ±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, % Δ C	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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Basic Capacitor Formulas



I. Capacitance (farads)

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

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

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

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

III. Linear charge of a capacitor (Amperes)

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

IV. Total Impedance of a capacitor (ohms)

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

V. Capacitive Reactance (ohms)

$X_C = \frac{1}{2 \pi fC}$

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 (%)

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

IX. Power Factor (%)

P.F. = Sine δ (loss angle) = Cos ϕ (phase angle)

P.F. = (when less than 10%) = DF

X. Quality Factor (dimensionless)

$Q = \cotan \delta \text{ (loss angle)} = \frac{1}{D.F.}$

XI. Equivalent Series Resistance (ohms)

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

XII. Power Loss (watts)

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

XIII. KVA (Kilowatts)

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

XIV. Temperature Characteristic (ppm/°C)

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

XV. Cap Drift (%)

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

XVI. Reliability of Ceramic Capacitors

$\frac{L_0}{L_t} = \left(\frac{V_t}{V_0} \right)^X \left(\frac{T_t}{T_0} \right)^Y$

XVII. Capacitors in Series (current the same)

Any Number: $\frac{1}{C_T} = \frac{1}{C_1} + \frac{1}{C_2} \dots \frac{1}{C_N}$

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

XVIII. Capacitors in Parallel (voltage the same)

$C_T = C_1 + C_2 \dots + C_N$

XIX. Aging Rate

$A.R. = \% \Delta C / \text{decade of time}$

XX. Decibels

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

METRIC PREFIXES

Pico	X 10 ⁻¹²	Deca	X 10 ⁻¹
Nano	X 10 ⁻⁹	Kilo	X 10 ⁻³
Micro	X 10 ⁻⁶	Mega	X 10 ⁻⁶
Milli	X 10 ⁻³	Giga	X 10 ⁻⁹
Deci	X 10 ⁻¹	Tera	X 10 ⁻¹²

SYMBOLS

K	= Dielectric Constant
A	= Area
T _D	= Dielectric thickness
V	= Voltage
t	= time
L ₀	= Operating life

f	= frequency
L	= Inductance
δ	= Loss angle
ϕ	= Phase angle
X & Y	= exponent effect of voltage and temp.

L _t	= Test life
V _t	= Test voltage
V ₀	= Operating voltage
T _t	= Test temperature
T ₀	= Operating temperature
R _S	= Series Resistance

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