# Capacitor Basics

| Symbols | | | | | |
|---|---|---|---|---|---|
| K | Dielectric Constant | f | Frequency | $L_t$ | Test Life |
| A | Area | L | Inductance | $V_t$ | Test Voltage |
| $T_D$ | Dielectric Thickness | ∂ | Loss Angle | $V_o$ | Operating Voltage |
| V | Voltage | Φ | Phase Angle | $T_t$ | Test Temperature |
| T | Time | $L_o$ | Operating Life | $T_o$ | Operating Temperature |
| $R_s$ | Series Resistance | X&Y | Exponent effect of voltage and temperature | | |

| Value Codes - Farads | | | |
|---|---|---|---|
| | Pico | Nano | Micro |
| 101 | 100pF | | |
| 102 | 1000pF | 1nF | 0.001uF |
| 103 | 10000pF | 10nF | 0.01uF |
| 104 | 100,000pF | 100nF | 0.1uF |
| 105 | | 1000nF | 1uF |
| 106 | | | 10uF |

| 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 $10^{+12}$ |

| | |
|---|---|
| Capacitance (farads) | English: $C = \frac{.224\,KA}{T_D}$ Metric: $C = \frac{.0884\,KA}{T_D}$ |
| Energy Stored in Capacitors (Joules, watt-sec) | $E = \frac{1}{2}CV^2$ |
| Current Charge of a Capacitor (amperes) | $I = C\frac{dV}{dt}$ |
| Total Impedance of a Capacitor (ohms) | $Z_C = \frac{1}{j\omega C}, \quad \omega = 2\pi f$ |
| Capacitive Reactance (ohms) | $X_c = \frac{1}{2\pi\,fC}$ |
| Inductive Reactance (ohms) | $X_L = 2\pi fL$ |
| Dissipation Factor | D.F. = $\tan\partial(loss\ angle) = \frac{E.S.R.}{X_C} = (2\pi fC)(E.S.R.)$ |
| Power Factor (%) | P.F. = Sine ∂(loss angle) = Cos Φ (phase angle)<br>P.F. = (when less than 10%) = D.F. |
| Quality Factor (dimensionless) | Q = Cotan ∂ $(loss\ angle) = \frac{1}{D.F.}$ |
| Equivalent Series Resistance (ohms) | E.S.R. = (D.F.) ($X_C$) = (D.F.)/ (2πfC) |
| Power Loss (watts) | Power Loss = $(2\,\pi\,fCV^2)$(D.F.) |
| KVA (Kilowatts) | KVA = $2\,\pi\,fCV^2 \times 10^{-3}$ |
| Temperature Characteristic (ppm/°C) | T.C. = $\frac{C_t - C_{25}}{C_{25}(T_t - 25)} \times 10^6$ |
| Cap Drift (%) | C.D. = $\frac{C_1 - C_2}{C_1} \times 100$ |
| Reliability of Ceramic Capacitors | $\frac{Lo}{Lt} = \left(\frac{V_t}{V_o}\right)X\ \left(\frac{T_t}{T_o}\right)Y$ |
| Capacitors in Series (Current the same) | Any number: $\frac{1}{C_T} = \frac{1}{c_1} + \frac{1}{c_2} \ldots \frac{1}{C_N}$ Two: CT= $\frac{c_1 c_2}{c_1 + c_2}$ |
| Capacitors in Parallel (voltage the same) | CT = $c_1 + c_2 \ldots C_N$ |
| Aging Rate | A.R. = $\%\Delta C/decade\ of\ time$ |
| Decibels | dB = 20 log |