LIST OF SYMBOLS

Upper Case

A = Acceleration factor
= Area
= Constant
A_c = Area, contact
A_v = Area, voids
= Area, vias
$\boldsymbol{A}$ = Acceleration factor
= Amplitude transmission coefficient
B = Bandwidth
= Constant
C = Capability
= Capacitance
= Coefficient, damping
= Degrees, Celsius
C_c = Critical damping coeff.
C_v = Coefficient of variation
C' = Capacitance/unit length
[C] = Damping matrix
D = Diameter
= Diameter, hydraulic
= Ductility
= Flexural rigidity
D_s = Substrate density
{D} = Displacement vector
DNP = Distance neutral point
E = Electric field
= Emission energy
= Energy, radiation
= Modulus of elasticity
E_a = Energy, activation
E_λ^b = Energy radiated
$\boldsymbol{E}_k$ = Energy, kinetic
$\boldsymbol{E}_p$ = Energy, potential
$\boldsymbol{E}_s$ = Energy, stored
F = Correlation factor
= Force
= Unreliability
F_e = Etch Factor
= Force, extraction
F_i = Force, insertion
= Force, preload
F_w = Force, wiping
F_L = Loss factor
F^s = Unreliability, system
FIT = Failure in time
$\boldsymbol{F}$ = Force transmission coeff.
= Shape factor
G = acceleration, dimensionless
= Gain
= Material constant
= Shear modulus
= Velocity, mass
= Volume flow rate, GPM
G' = 1/R'
GR = Grashof number
H = Hardness
= Height
= Irradiation
$\boldsymbol{H}$ = Hazard funct, cumulative
HR = Hazard rate
I = Current
= Moment of inertia
$\boldsymbol{I}$ = Amplitude ratio, isolated
J = Current density
= Polar moment of inertia
= Radiosity
K = Conduction, thermal
= Constant
= stress concentration factor
[K] = Stiffness matrix
L = Length
= Inductance
L' = Inductance/unit length
$\boldsymbol{L}$ = Length
M = Material constant
= Moment
[M] = Mass matrix
MR = Median rank
MTTF = Mean time to failure
N = Number
N_f = Cyclic life
= Number of failures
N_s = Number of successes
Nu = Nusselt's number
P = Force
= Power
= Probability
P_{cr} = Load, critical
Pr = Prandtl's number
PRN = Priority ranking number
Q = Shear force
= Volume flow rate
R = Radius
= Resistance, electrical
= Reliability
R_T = Resistance, thermal
R^s = Reliability, system
R' = Resistance/unit length
$\boldsymbol{R}$ = Range
RA = Reduction in area
Ra = Rayleigh's number
Re = Reynold's number
{R} = Force vector
S = Shape factor
S_x = Standard deviation of x
$S_{\bar{x}}$ = Standard deviation of $\bar{x}$
S_e = Strength, endurance
S_f = Strength, fatigue
S_a = Strength, fatigue modified
S_p = Strength, proof
S_u = Strength, tensile
S_y = Strength, yield
S_{ys} = Strength, yield in shear
$\boldsymbol{S}$ = Safety factor
SF = Safety factor
T = Temperature
T_a = Temperature, absolute
= Temperature, ambient
T_j = Temperature, junction
T_0 = Temperature, reference
T = Torque
U = Energy, distortion
= Velocity, free stream
V = Force, shear
= Voltage
V_{CB} = Voltage, collector-base
$\boldsymbol{V}$ = Volume
W = Channel width
= Strain energy density
= Weight
WD = Wiring demand
Z = Impedance
Z_0 = Characteristic Impedance

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$\boldsymbol{V}$ = Volume
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= Weight
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Z_0 = Characteristic Impedance

Lower case

a = Acceleration
= Dimension, plate
= Radius
b = Dimension, plate
= Pad width, beam width
= Radius
c = ½ wire diameter
= Specific heat
= Wave velocity
d = Diameter
= Differential expansion
= Distance
d_x = Deviation in x
e = Electron charge
= Exponential number (2.718)
f = Failure density function
= Function, relative frequency
f_n = Frequency, natural
$\boldsymbol{f}$ = Friction factor
g = Gravitational constant
h = Coefficient, convection
= Head, hydraulic
= Height, beam
= Thickness
h_c = Coefficient, contact
h_r = Coefficient, radiation
j = Imaginary number (−1)
k = Boltzmann's constant
= Coeff. thermal conductivity
= Exponent
= Number
= Spring rate
m = Mass
= Slope
$\dot{m}$ = Mass flow rate
n = Index number
p = Perimeter
= Pressure
= Pressure, contact
q = Charge
= Exponent
= Load per unit length
= Rate, heat transfer
q_g = Rate, heat generated
r = Radial coordinate
= Radius
s = Manhattan distance
= Spacing
t = Thickness
= Time
t_f = Time to failure
t_0 = Location parameter
t_w = Time, warm-up
u = Dimension — under size
= Velocity, convection
v = Velocity
w = Width
= Displacement, out-of-plane
$\ddot{w}$ = Acceleration, out-of-plane
x, y, z Rectangular coordinates
x = Arbitrary quantity
$\bar{x}$ = Mean of some quantity
y = Displacement
= Distance, vertical
$\dot{y}$ = Velocity
z = Height
= Material constant

Greek Symbols

α = Absorbed, radiation ratio
= Coefficient
= Diffusivity, thermal
= Exponent
= Scale parameter
= Temp. coeff. expansion
β = Coeff. thermal expansion
= Coefficient
= Shape factor
γ = Constant
= Coefficient
= Material constant
= Shear strain
δ = Boundary layer thickness
= Deflection, elongation
= Loss angle
ε = Emissivity
= Permittivity
= Strain
ε_p = Strain, plastic
ε_r = Dielectric constant
ζ = Dummy variable
η = Carrier mobility
ξ = Damping ratio
θ = Angle
θj-a = Resistance, thermal
κ = Curvature
= Parameter
λ = failure rate
= Real or complex number
= Wave length
μ = Friction coefficient
= Permeability
= Viscosity
ν = Frequency
= Poisson's ratio
= Viscosity, kinematic
π = Number Pi (3.1416)
ρ = Density, mass
= Density, mass/unit volume
= Radius coordinate
= Radius of curvature
= Reflected, radiation ratio
= Resistivity
σ = RMS surface roughness
= Stefan-Boltzmann's const.
= Stress
$\sigma_1, \sigma_2, \sigma_3$ = Stress, principal
σ_a = Stress, alternating
σ_m = Stress, mean
τ = Stress, shear
= Time constant
= Transmitted, radiation ratio
τ_w = Shear stress, wall
ϕ = Angle, phase
= Angle, twist
ψ = Fin factor
ω = Angular frequency
= Density
= Velocity, angular
ω_n = Natural frequency

Δ = Boundary layer thickness
∇^2 = Laplace's operator