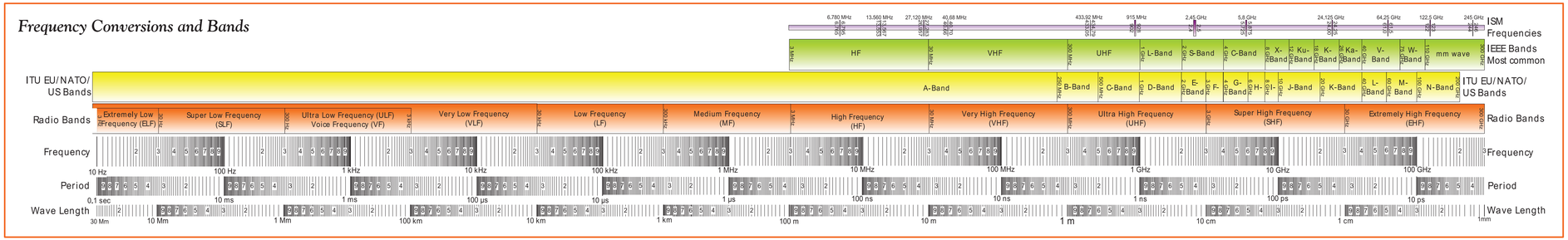
Electronics / EMC Equations & Conversion Charts

Frequency Conversions and Bands



Term Conversions in 50Ω Environments

Log

dBµV to dBm	$dBm = dB\mu V - 107$
dBµA to dBm	$dBm = dB\mu A - 73$
dBm to dBµV	$dB\mu V = dBm + 107$
dBµA to dBµV	$dB\mu V = dB\mu A + 34$
dBm to dBµA	$dB\mu A = dBm + 73$
dBµV to dBµA	$dB\mu A = dB\mu V - 34$

Linear → Log

Volts to dBm	$dBm = 20 * Log(Volts) + 13$
Amps to dBm	$dBm = 20 * Log(Amps) + 47$
Watts to dBµV	$dB\mu V = 10 * Log(Watts) + 137$
Amps to dBµV	$dB\mu V = 20 * Log(Amps) + 154$
Watts to dBµA	$dB\mu A = 10 * Log(Watts) + 103$
Volts to dBµA	$dB\mu A = 20 * Log(Volts) + 86$

Log → Linear

dBµV to Watts	$Watts = 10^{\left(\frac{dB\mu V - 137}{10}\right)}$
dBµA to Watts	$Watts = 10^{\left(\frac{dB\mu A - 103}{10}\right)}$
dBm to Volts	$Volts = 10^{\left(\frac{dBm - 13}{20}\right)}$
dBµA to Volts	$Volts = 10^{\left(\frac{dB\mu A - 86}{20}\right)}$
dBm to Amps	$Amps = 10^{\left(\frac{dBm - 47}{20}\right)}$
dBµV to Amps	$Amps = 10^{\left(\frac{dB\mu V - 154}{20}\right)}$

Unit Conversions

Linear → Log

Watts to dBm	$dBm = 10 * Log(Watts) + 30$
Volts to dBµV	$dBm = 20 * Log(Volts) + 120$
Amps to dBµA	$dB\mu A = 20 * Log(Amps) + 120$
Ω to dB Ω	$dB\Omega = 20 * Log(\Omega)$

Used for conversion of voltage and current

Log → Linear

dBm to Watts	$Watts = 10^{\left(\frac{dBm - 30}{10}\right)}$
dBµV to Volts	$Volts = 10^{\left(\frac{dB\mu V - 120}{20}\right)}$
dBµA to Amps	$Amps = 10^{\left(\frac{dB\mu A - 120}{20}\right)}$
dB Ω to Ω	$\Omega = 10^{\left(\frac{dB\Omega}{20}\right)}$

Used for conversion of voltage and current

Term Conversion / Ohms Law

Linear Calculations

Find Watts	$Watts = Amps^2 * \Omega,\ \frac{Volts^2}{\Omega}$
Find Volts	$Volts = Amps * \Omega,\ \sqrt{Watts * \Omega}$
Find Amps	$Amps = \sqrt{\frac{Watts}{\Omega}},\ \frac{Volts}{\Omega}$

dB Calculations

dB Δ Watts	$dB = 10Log\left(\frac{Watts_1}{Watts_2}\right)$
dB Δ Volts	$dB = 20Log\left(\frac{Volts_1}{Volts_2}\right)$
dB Δ Amps	$dB = 20Log\left(\frac{Amps_1}{Amps_2}\right)$
New Watts w/dB Δ	$Watts_{New} = 10^{\left(\frac{dB\Delta + 10 * Log(Watts_{Start})}{10}\right)}$
New Volts w/dB Δ	$Volts_{New} = 10^{\left(\frac{dB\Delta + 20 * Log(Volts_{Start})}{20}\right)}$
New Amps w/dB Δ	$Amps_{New} = 10^{\left(\frac{dB\Delta + 20 * Log(Amps_{Start})}{20}\right)}$

dB Correction for distance change (antenna far field)

$$dB = 20 * Log\left(\frac{distance_2}{distance_1}\right)$$

Sine Wave

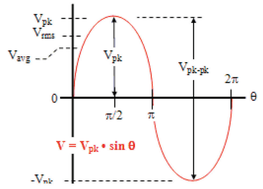
Voltage levels for a sine wave

$$Volts_{peak} = \sqrt{2} * Volts_{rms} = \frac{\pi}{2} * Volts_{Avg}$$

$$Volts_{rms} = \frac{Volts_{peak}}{\sqrt{2}} = \frac{\pi}{2*\sqrt{2}} * Volts_{Avg}$$

$$Volts_{Avg} = \frac{2}{\pi} * Volts_{peak} = \frac{2 * \sqrt{2}}{\pi} * Volts_{rms}$$

$$Volts_{peak-peak} = 2 * Volts_{peak}$$



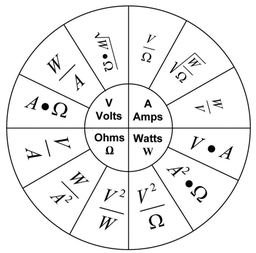
Radiated Field

dBµ V/m to V/m	$V/m = 10^{\left(\frac{dB\mu V/m - 120}{20}\right)}$
V/m to dBµ V/m	$dB\mu\ V/m = 20 * Log(V/m) + 120$
New V/m with dBΔ	$V/m_{new} = 10^{\left(\frac{dB\Delta + 20 * Log(V/m_{start})}{20}\right)}$

Field Strength

$$V/m = \sqrt{\frac{30 * Watts * Gain_{numeric}}{Meters}} \qquad V/m = \sqrt{\frac{30 * Watts * 10^{\left(\frac{Gain_{dBi}}{10}\right)}}{Meters}}$$

$$Watts = \frac{(V/m * meters)^2}{30 * Gain_{numeric}} \qquad Watts = \frac{(V/m * meters)^2}{30 * 10^{\left(\frac{Gain_{dBi}}{10}\right)}}$$



Power required if gain remains constant (in far field using the same antenna and changing the field level or test distance

For Field Change $Watts_{New} = Watts_{Old} \frac{(V/m_{new})^2}{(V/m_{old})^2}$

For Distance Change $Watts_{New} = Watts_{Old} \frac{(Meters_{New})^2}{(Meters_{Old})^2}$

Conducted Current Measurement Using a Current Probe
where reading is in dBµV and probe factor is dBΩ or Ω

$$dB\mu A = dB\mu V - dB\Omega$$

$$dB\mu A = dB\mu V - 20 * Log(\Omega)$$

Power Required for TEM Cell
Height of the TEM Cell

$$Watts = \frac{(V/m * Height * 0.5)^2}{Z_{(50\Omega)}}$$

Power Required for GTEM Cell
Height in meters

$$Watts = \frac{(V/m * SeptumHeight)^2}{Z_{(50\Omega)}} * 1.08$$

Wavelength (λ)

$$\lambda[meters] = \frac{300}{MHz} \qquad \frac{1}{\lambda}\lambda[meters] = \frac{75}{MHz}$$

Period

$$Time(s) = \frac{1}{Hz} \qquad Hz = \frac{1}{Time(s)}$$

VSWR

VSWR given Fwd/Rev Power

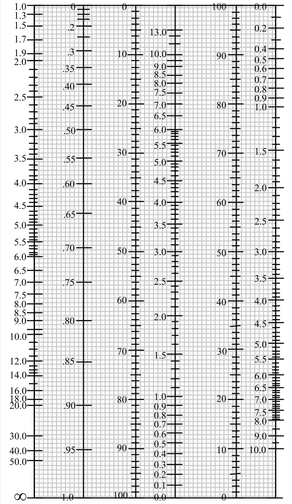
$$VSWR = \frac{1 + \sqrt{\frac{Watts_{rev}}{Watts_{fwd}}}}{1 - \sqrt{\frac{Watts_{rev}}{Watts_{fwd}}}}$$

VSWR Given Impedance (Z)

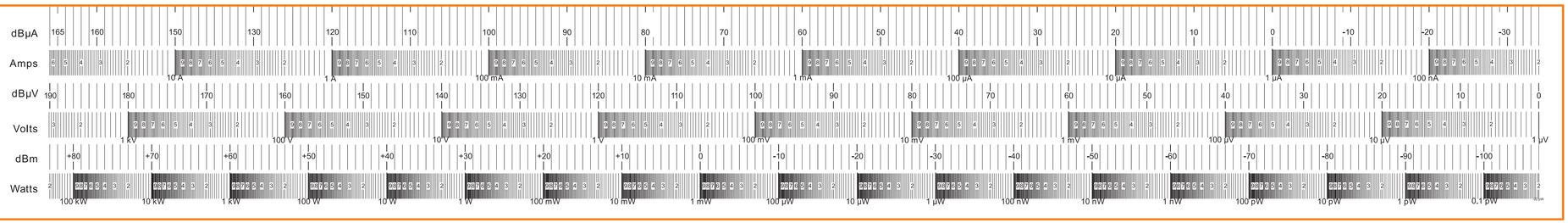
$$Z_O > Z_L \qquad VSWR = \frac{Z_O}{Z_L}$$

$$Z_L > Z_O \qquad VSWR = \frac{Z_L}{Z_O}$$

VSWR Conversion Chart

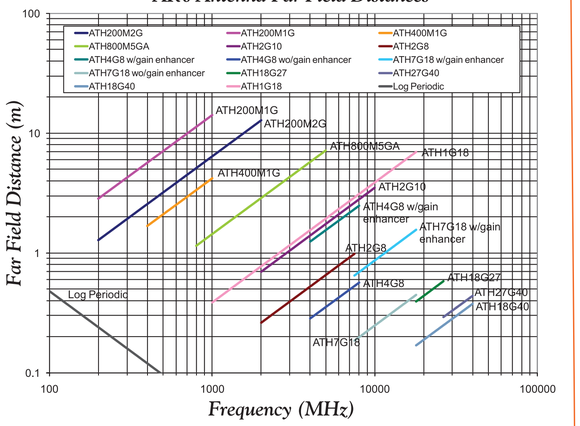


Conversions for 50Ω Environment

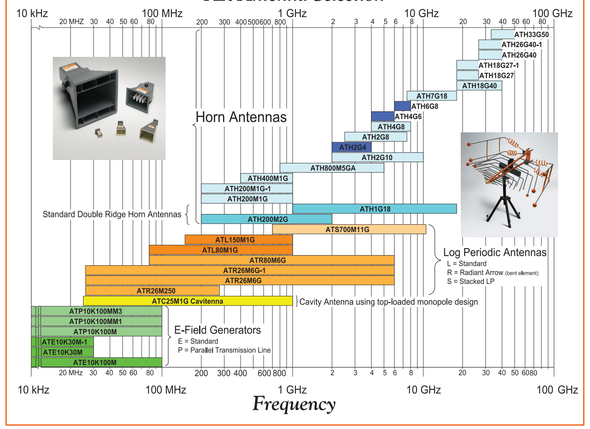


Antenna Equations and Selection Guide

AR's Antenna Far Field Distances



AR Antenna Selection



Antenna Equations

Far Field Distance Estimation

Dipole & Log-periodic antennas $FarField = \frac{\lambda}{2*\pi}$

Horn Antennas $FarField = \frac{2*aperture^2}{\lambda}$

Far Field Equations

Gain Over Isotropic $Gain_{Numeric} = 10^{\left(\frac{Gain_{dBi}}{10}\right)}$

$$Gain_{dBi} = 10 * Log(Gain_{Numeric})$$

$$Gain_{Numeric} = \frac{(Meters * V/m)^2}{30 * Watts}$$

$$Gain_{dBi} = 10 * Log\left(\frac{(Meters * V/m)^{20}}{30 * Watts}\right)$$

$$Gain_{dBi} = 20 * Log(MHz) - AF - 29.79$$

Antenna Factor (AF)

$$AF = 20 * Log(MHz) - Gain_{dBi} - 29.79$$

$$AF = 20 * Log(MHz) - 10 * Log(Gain_{numeric}) - 29.79$$

Find Antenna Spot Size, Beam Width and Distance

$$Spot_{meters} = 2 * Distance_{meters} \tan\left[\frac{Angle_{3dB}}{2}\right]$$

$$Distance_{meters} = \frac{Spot_{meters}}{2 * \tan\left(\frac{Angle_{3dB}}{2}\right)}$$

$$Angle_{3dB} = 2 * tan^{-1}\left[\frac{Spot_{meters}}{2 * distance}\right]$$