COMMON FORMULAS AND RF POWER REQUIREMENTS FOR RADIATED IMMUNITY TESTING

Important Factors

- Antenna Gain
- Antenna VSWR
- Cable Losses
- Linearity of the power amplifier
- Anechoic room field gradients (6dB maximum)
- Antenna gain vs. Frequency
- Transmit distance
- Amplitude modulation
- Amplifier harmonic levels at rated power

Useful Formulas

Field Strength (far field)	$Eo = (30PiGa)^{1/2}/d$
Transmit power	$Pi = [(Eo^2)(d^2)]/30Ga$
Peak Voltage on AM carrier	$E_p = (E_{um})(1+AM/100)$
Peak envelope power (PEP) for 80% AM	$= 3.24P_{(um)}$ and is obtained from $(1+AM/100)^2$ with 20 log $(1+AM/100)^2$ = 5.1dB

$Ep/E_{(um)}$ = 20 log (1+AM/100) = 5.1dB for 80% AM *(This is the power increase required to accommodate an 80% depth of amplitude modulation.)*

Where	Eo	=	field strength in volts/meter
	Pi	=	incident power at the antenna in watts
	Ga	=	numeric antenna gain $(10^{(dbi/10)})$
	d	=	transmission distance in meters
	Ep	=	peak voltage of the modulated carrier
	E_{um}	=	unmodulated rf voltage
	P_{um}	=	unmodulated carrier power
	AM	=	depth of modulation (%)
	dBi	=	antenna gain referenced to an isotropic radiator (a theoretical point source radiator with uniform spherical coverage and no losses)

VSWR and Transmission Loss

Ratio of transmitted to incident power = $P_t/P_i - 1 - \Gamma^2$

Transmission loss of dB = $10 \log(1 - \Gamma^2)$

Where Γ = reflection coefficient = $(s-1)/(s+1) = 4s/(s+1)^2$

s = VSWR = $(\Gamma + 1)/(\Gamma - 1)$

P_i = incident power

P_t = transmit power

Return Loss in dB is often a more useful expression than VSWR or reflected coefficient

Return Loss (RL) = $20 \log \Gamma$

Convert Antenna Factor to Antenna Gain in dBi

$G = 20 \log(f) = AF - 29.79$ dB

Where G = antenna gain in dBi

AF = antenna factor in dB

f = frequency in MHz

Frequency and Wavelength

$\lambda = 300/f$

Where λ = wavelength in meters

f = frequency in MHz