

ONE-WAY RADAR EQUATION

Peak Power at Receiver Input, P_r (or S) = $P_t A_r = \frac{P_t G_t A_r}{4\pi R^2}$ and Antenna Gain, $G = \frac{4\pi A_e}{\lambda^2}$ or: Equivalent Area, $A_e = \frac{G\lambda^2}{4\pi}$

So the one-way radar equation is :

$$S \text{ (or } P_r) = \frac{P_t G_t G_r \lambda^2}{(4\pi R)^2} = P_t G_t G_r \left[\frac{c^2}{(4\pi f R)^2} \right] \quad (\text{Note: } \lambda = \frac{c}{f})$$

* Keep λ , c , and R in the same units

On reducing to log form this becomes:

$$10\log P_r = 10\log P_t + 10\log G_t + 10\log G_r - 20\log f - 20\log R + 20\log (c/4\pi)$$

or in simplified terms:

$$10\log P_r = 10\log P_t + 10\log G_t + 10\log G_r - \alpha_1 \quad (\text{in dB})$$

Where: α_1 = one-way free space loss = $20\log (f/R) + K_1$ (in dB)

and: $K_1 = 20\log [(4\pi/c)]$ (Conversion factors if units if not in m/sec, m, and Hz)

Note: To avoid having to include additional terms for these calculations, always combine any transmission line loss with antenna gain

Values of K_1 (in dB)		
Range	f_1 in MHz	f_1 in GHz
(units)	$K_1 =$	$K_1 =$
NM	37.8	97.8
km	32.45	92.45
m	-27.55	32.45
yd	-28.33	31.67
ft	-37.87	22.13

Note: Losses due to antenna polarization and atmospheric absorption are not included in any of these equations.

Calculations for the following location:

65 Kenworth Drive Chillicothe, OH
39-23-53 N Latitude, 82-57-32 W Longitude
Antenna #1

Note: Other antenna calculations located on separate worksheets within this spreadsheet

	dB	dB	dB	dB	dB		
	Receive Ant Gain	Ant Cable Insertion Loss (incl connections)	Repeater Amp Gain	Repeater Ant Gain Best Case	Total System Gain	Avg Receive Power L1 dBm North America	
	35	-11.4	30	3	56.6	-130	
Relevant Part	L1ACE Active Antenna	(2) 100' WBC 400 Cables @ -5.7dB per cable	A11-M-P110/5-NF-SM	L1A-PM Antenna			
	Change the values in the green boxes to calculate required readings					Radiated Power dBm	Effective Radiated Power (dBW)
						-73.4	-103.4
						Free Space loss with Isotropic Antennas ($K_1 + 20\log FR$) $K_1 = 36.6$ units: mi	Transmitted Power (W)
	Range in Miles	Distance in feet of antenna to perimeter of building	Range in Feet (distance of antenna to building perimeter plus 100 feet.	GPS Carrier Frequency MHz		-69.90	22.9E-12
	0.03	55	155	1575			Effective Radiated Power (W)
		Range in Kilometers	Range in Meters				45.7E-12
		0.16	48.31				
	Repeated Signal Power @ Range In dBm					-143.30	R = Range in miles and F = Frequency in MHz Add +2.15dB for dipole receive Antenna
	Total Signal Power @ Range in Watts					4.7E-18	