## ONE-WAY RADAR EQUATION

Peak Power at Receiver Input, $P_r \text{ (or } S) = P_D A_e = \frac{P_t G_t A_e}{4\pi R^2}$ 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 :

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

* keep $\lambda$, c, and R in the same units

On reducing to log form this becomes:
$10\log P_r = 10\log P_t + 10\log G_t + 10\log G_r - 20\log fR + 20\log (c/4\pi)$

or in simplified terms:
$10\log P_r = 10\log P_t + 10\log G_t + 10\log G_r - \alpha_1$ (in dB)

Where: $\alpha_1$ = one-way free space loss = $20\log (f_1R) + K_1$ (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 (units) | $f_1$ in MHz $K_1$ = | $f_1$ in GHz $K_1$ = |
|---|---|---|
| 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.

| dB<br>Receive Ant Gain | dB<br>Ant Cable Insertion Loss | dB<br>Repeater Amp Gain | dB<br>Repeater Ant Gain Best Case | dB<br>Total System Gain | Avg Receive Power L1 dBm North America |
|---|---|---|---|---|---|
| 35 | -10 | 28 | 3 | 56 | -130 |

Radiated Power dBm
-74

Effective Radiated Power (dBW)
-104

Transmitted Power (W)
20.0E-12

| Range in Miles | Range in Feet | GPS Carrier Frequency MHz | Free Space loss with Isotropic Antennas (K1 + 20LogFR) K1 = 36.6 units: mi |
|---|---|---|---|
| 0.02 | 100 | 1575 | -66.09 |

Effective Radiated Power (W)
39.8E-12

| Range in Kilometers | Range in Meters |
|---|---|
| 0.10 | 31.17 |

Repeated Signal Power @ Range In dBm
-140.09

R = Range in miles and F = Frequency in MHz
Add +2.15dB for dipole receive Antenna

Total Signal Power @ Range in Watts
9.8E-18