

GPS L1 Link Budget

Satellite Transmitter

Transmitter Power (25 Watts)	14.25 dBW	
RF Losses in transmitter path	-1.25 dB	
Antenna Gain (with respect to an isotrope)	13.5 dBi	
Satellite EIRP (wrt isotropic radiator)	26.50 dBW	446.68 Watts

Propagation

Atmospheric and Polarization Losses	-0.5 dB
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$$Free\ Space\ Path\ Loss = -10 \times \log_{10} \left[\left(\frac{4\pi d}{\lambda} \right)^2 \right]$$

where d = distance from antenna = 2.52E+07 meters
 c = speed of light = 3.00E+08 m/sec
 f = frequency = 1.58E+09 Hz
 lambda = wavelength = c/f = 1.90E-01 meters

$$= -10 \log_{10} \left[3.17E+08 / 1.90E-01 \right]^2$$

$$= -10 \log_{10} \left[1.67E+09 \right]^2$$

Free Space Path Loss over Distance -184.43 dB

Received Power on Earth	-158.43 dBW	
	-128.43 dBm	1.44E-04 pW

Gain of Receive Antenna	38 dBic
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RF losses in 300 feet of LMR400UF cabling and connectors from Receive Antenna to Line Amplifier	-6.7 dB
Gain of Line Amplifier	20 dB

RF Power at Input to Re-Radiating Antenna	-77.13 dBm	19.36 pW
Gain of Passive Re-Radiating Antenna	3 dBic	

Re-Radiated EIRP (wrt isotropic radiator)	-74.13 dBm	38.64 pW
Re-Radiated ERP (wrt dipole radiator)	-76.28 dBm	23.55 pW

$$\textit{Free Space Path Loss} = -10 \times \log_{10} \left[\left(\frac{4\pi d}{\lambda} \right)^2 \right]$$

where d = distance from antenna = 100 feet

$$= -10 \log_{10} \left[\frac{383.023}{1.90E-01} \right]^2$$

$$= -10 \log_{10} \left[2.01E+03 \right]^2$$

Free Space Path Loss over Distance -66.07 dB

RF power level at 100 ft distance = -140.20 dBm wrt isotropic antenna

-142.35 dBm wrt dipole antenna

GPS L2 Link Budget

Satellite Transmitter

Transmitter Power (4.32 Watts)	6.35 dBW	
RF Losses in trasmitter path	-1.25 dB	
Antenna Gain (with respect to an isotrope)	11.5 dBi	
Satellite EIRP (wrt isotropic radiator)	16.60 dBW	45.71 Watts

Propagation

Atmospheric and Polarization Losses	-0.5 dB
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$$Free\ Space\ Path\ Loss = -10 \times \log_{10} \left[\left(\frac{4\pi d}{\lambda} \right)^2 \right]$$

where d = distance from antenna = 2.52E+07 meters
 c = speed of light = 3.00E+08 m/sec
 f = frequency = 1.23E+09 Hz
 lambda = wavelength = c/f = 2.44E-01 meters

$$= -10 \log_{10} \left[\frac{3.17E+08}{2.44E-01} \right]^2$$

$$= -10 \log_{10} \left[1.30E+09 \right]^2$$

Free Space Path Loss over Distance -182.26 dB

Received Power on Earth	-166.16 dBW	
	-136.16 dBm	2.42E-05 pW

Gain of Receive Antenna	38 dBic
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RF losses in 300 feet of LMR400UF cabling and connectors from Receive Antenna to Line Amplifier	-6.7 dB
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Gain of Line Amplifier	20 dB
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RF Power at Input to Re-Radiating Antenna	-84.86 dBm	3.26 pW
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Gain of Passive Re-Radiating Antenna	3 dBic
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Re-Radiated EIRP (wrt isotropic radiator)	-81.86 dBm	6.51 pW
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Re-Radiated ERP (wrt dipole radiator)	-84.01 dBm	3.97 pW
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$$\textit{Free Space Path Loss} = -10 \times \log_{10} \left[\left(\frac{4\pi d}{\lambda} \right)^2 \right]$$

where d = distance from antenna = 100 feet

$$= -10 \log_{10} \left[\frac{383.02298}{2.44\text{E-}01} \right]^2$$

$$= -10 \log_{10} \left[1.57\text{E+}03 \right]^2$$

Free Space Path Loss over Distance -63.90 dB

RF power level at 100 ft distance = -145.77 dBm wrt isotropic antenna
-147.92 dBm wrt dipole antenna