

Exhibit 4: GPS Link Budget Calculations

FCC File Number: 0157-EX-CM-2017

Satellite to Ground Link Budget

GPS Satellite Link Budget (Down Link)

GPS Satellite Downlink Power

Frequency L1	1575.42	MHz
Satellite Transmitter power	25	Watts
	13.98	dBW
RF Losses in transmitter path	1.25	dB
Antenna Gain (Isotropic)	13.5	dBi
Satellite Effective Radiated Power	26.23	dBW

Propagation Losses

Frequency L1	1575.42	MHz
	1.58E+09	Hz
Distance from Satellite to Earth	2.52E+07	Meters
	2.52E+04	Kilometers
Atmospheric and polarization loss	0.05	dB
Speed of Light	3.00E+08	M/Sec
Wavelength (C/F)	1.90E-01	Meters
Free Space Pathloss	184.43	dB
Received Power on Earth	-158.25	dBW
	-128.25	dBm

Power At Receive Antenna on Earth

Received Power on Earth	-158.25	dBW
	-128.25	dBm

Indoor Link Budget Receive antenna to Re-radiating Antenna

Indoor Link Budget (Receive antenna to Re-radiating Antenna)

Location: Chantilly Room 11

Frequency L1	1575.42	MHz
ANT-1 Antenna Receive Gain	38	dBic
RF Cable Loss (from Receive Antenna to Amplifier Input)	3.3	dB
LA-1 Line Amplifier Gain (Variable 0 - 30 dBm)	16	dB
RF Cable Loss (from Amplifier to Amplified Splitter Input)	0.1	dB
AS-1 Amplified Splitter Port 1 Gain	3	dB
RF Cable Loss (from Amplifier to Passive Antenna)	5.1	dB
Additional Attenuation	0	dB
RF Power at input to Re-radiating antenna	-79.75	dBm
ANT-2 Passive Re-Radiating Antenna Gain	4	dB
Re-radiated ERP Indoors	-75.75	dBm
Pathloss Target Distance	100	ft
	30.480	meters
Pathloss at 100 ft	66.08	dB
RF Power Level at 100 ft from antenna	-141.82	dBm
Required RF Power Level at 100 ft	-140	dBm/24 MHz

Indoor Link Budget (Receive antenna to Re-radiating Antenna)

Location: Chantilly Room 13

Frequency L1	1575.42	MHz
ANT-1 Antenna Receive Gain	38	dBic
RF Cable Loss (from Receive Antenna to Amplifier Input)	3.3	dB
LA-1 Line Amplifier Gain	16	dB
RF Cable Loss (from Amplifier to Amplified Splitter Input)	0.1	dB
AS-1 Amplified Splitter Port 2 Gain	3	dB
RF Cable Loss (from Amplifier to Passive Antenna)	5.9	dB
Additional Attenuation	0	dB
RF Power at input to Re-radiating antenna	-92.30	dBm
ANT-3 Passive Re-Radiating Antenna Gain	4	dB
Re-radiated ERP Indoors	-88.30	dBm
Pathloss Target Distance	100	ft
	30.480	meters
Pathloss at 100 ft	66.08	dB
RF Power Level at 100 ft from antenna	-154.38	dBm
Required RF Power Level at 100 ft	-140	dBm/24 MHz

Indoor Link Budget (Receive antenna to Re-radiating Antenna)**Location: Chantilly Room 69**

Frequency L1	1575.42	MHz
ANT-1 Antenna Receive Gain	38	dBic
RF Cable Loss (from Receive Antenna to Amplifier Input)	3.3	dB
LA-1 Line Amplifier Gain	16	dB
RF Cable Loss (from Amplifier to Amplified Splitter Input)	0.1	dB
AS-1 Amplified Splitter Port 3 Gain	3	dB
RF Cable Loss (from Amplifier to Passive Antenna)	11.8	dB
Additional Attenuation	0	dB
RF Power at input to Re-radiating antenna	-98.20	dBm
ANT-4 Passive Re-Radiating Antenna Gain	4	dB
Re-radiated ERP Indoors	-94.20	dBm
Pathloss Target Distance	100	ft
	30.480	meters
Pathloss at 100 ft	66.08	dB
RF Power Level at 100 ft from antenna	-160.28	dBm
Required RF Power Level at 100 ft	-140	dBm/24 MHz