

Ground Sphere Preliminary Link Budget Calculation Worksheet

Variable	Value
Altitude (in meters)	425000
Transmit power (in dB)	37
Transmit antenna gain	0
Preamplifier gain	19
Preamplifier noise figure	0.57
Receiver sensitivity	97.5
Bldg and line attenuation	-12

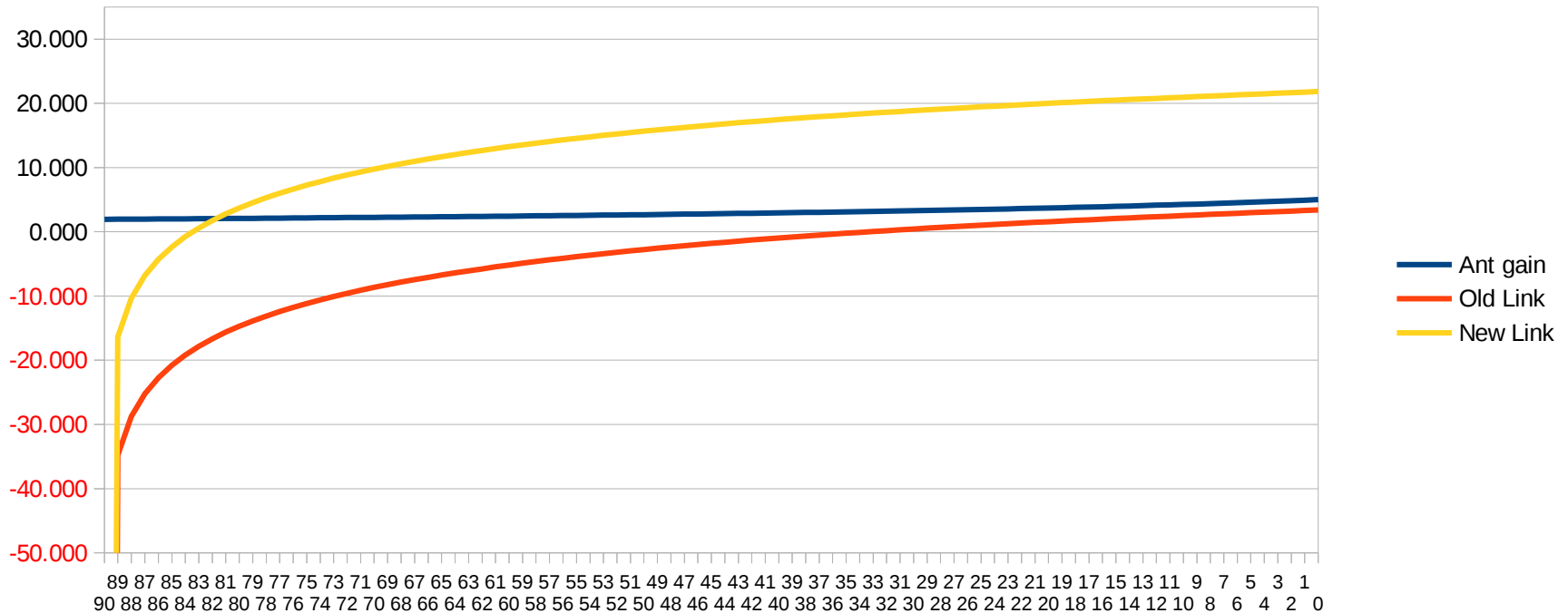
Notes:

Figures highlighted in yellow are approximate due to simplified distance measurement of $d = \text{Alt} / \cos(\theta)$

Antenna gain figures are based upon a simplified model based on observation of a UHF antenna of similar design, an "eggbeater" antenna. The 900MHz version should match gain and pattern

Known issues:

The distance to the satellite is based upon observation angle, not lat-long offset. This means that the distance, and therefore free space propagation loss (FSPL) is slightly exaggerated at low observation angles. In use, this means that we can reasonably expect the actual ground station hardware to have superior performance than this simplified model



Theta Angle	Theta Radians	Propagation Distance	Tx Perf	FSPL in dB	Rx signal at Ant	Ant gain (proj)	Result Sens.	Old Rx Gain	Old Link Budget	Result Sens.	New Rx Gain	New Link Budget
90	1.571	6.94E+21	37	-448.355	-411.355	1.945	85.500	87.445	-323.910	103.930	105.875	-307.425
89	1.553	2.44E+07	37	-159.257	-122.257	1.958	85.500	87.458	-34.799	103.930	105.888	-16.369
88	1.536	1.22E+07	37	-153.238	-116.238	1.972	85.500	87.472	-28.766	103.930	105.902	-10.336
87	1.518	8.12E+06	37	-149.718	-112.718	1.985	85.500	87.485	-25.233	103.930	105.915	-6.803
86	1.501	6.09E+06	37	-147.223	-110.223	1.999	85.500	87.499	-22.723	103.930	105.929	-4.293
85	1.484	4.88E+06	37	-145.288	-108.288	2.013	85.500	87.513	-20.775	103.930	105.943	-2.345
84	1.466	4.07E+06	37	-143.710	-106.710	2.028	85.500	87.528	-19.182	103.930	105.958	-0.752
83	1.449	3.49E+06	37	-142.377	-105.377	2.042	85.500	87.542	-17.835	103.930	105.972	0.595
82	1.431	3.05E+06	37	-141.223	-104.223	2.057	85.500	87.557	-16.667	103.930	105.987	1.763
81	1.414	2.72E+06	37	-140.208	-103.208	2.071	85.500	87.571	-15.636	103.930	106.001	2.794
80	1.396	2.45E+06	37	-139.301	-102.301	2.087	85.500	87.587	-14.714	103.930	106.017	3.716
79	1.379	2.23E+06	37	-138.482	-101.482	2.102	85.500	87.602	-13.881	103.930	106.032	4.549
78	1.361	2.04E+06	37	-137.737	-100.737	2.117	85.500	87.617	-13.119	103.930	106.047	5.311
77	1.344	1.89E+06	37	-137.053	-100.053	2.133	85.500	87.633	-12.419	103.930	106.063	6.011
76	1.326	1.76E+06	37	-136.421	-99.421	2.149	85.500	87.649	-11.772	103.930	106.079	6.658
75	1.309	1.64E+06	37	-135.834	-98.834	2.165	85.500	87.665	-11.169	103.930	106.095	7.261
74	1.292	1.54E+06	37	-135.288	-98.288	2.182	85.500	87.682	-10.606	103.930	106.112	7.824
73	1.274	1.45E+06	37	-134.776	-97.776	2.199	85.500	87.699	-10.077	103.930	106.129	8.353
72	1.257	1.38E+06	37	-134.295	-97.295	2.216	85.500	87.716	-9.579	103.930	106.146	8.851
71	1.239	1.31E+06	37	-133.842	-96.842	2.233	85.500	87.733	-9.109	103.930	106.163	9.321
70	1.222	1.24E+06	37	-133.413	-96.413	2.250	85.500	87.750	-8.663	103.930	106.180	9.767
69	1.204	1.19E+06	37	-133.008	-96.008	2.268	85.500	87.768	-8.240	103.930	106.198	10.190
68	1.187	1.13E+06	37	-132.623	-95.623	2.286	85.500	87.786	-7.836	103.930	106.216	10.594
67	1.169	1.09E+06	37	-132.257	-95.257	2.305	85.500	87.805	-7.452	103.930	106.235	10.978
66	1.152	1.04E+06	37	-131.908	-94.908	2.324	85.500	87.824	-7.085	103.930	106.254	11.345
65	1.134	1.01E+06	37	-131.575	-94.575	2.343	85.500	87.843	-6.733	103.930	106.273	11.697
64	1.117	9.69E+05	37	-131.258	-94.258	2.362	85.500	87.862	-6.396	103.930	106.292	12.034
63	1.100	9.36E+05	37	-130.953	-93.953	2.381	85.500	87.881	-6.072	103.930	106.311	12.358
62	1.082	9.05E+05	37	-130.662	-93.662	2.401	85.500	87.901	-5.761	103.930	106.331	12.669
61	1.065	8.77E+05	37	-130.383	-93.383	2.422	85.500	87.922	-5.461	103.930	106.352	12.969
60	1.047	8.50E+05	37	-130.115	-93.115	2.442	85.500	87.942	-5.173	103.930	106.372	13.257
59	1.030	8.25E+05	37	-129.858	-92.858	2.463	85.500	87.963	-4.894	103.930	106.393	13.536
58	1.012	8.02E+05	37	-129.610	-92.610	2.485	85.500	87.985	-4.625	103.930	106.415	13.805
57	0.995	7.80E+05	37	-129.372	-92.372	2.506	85.500	88.006	-4.366	103.930	106.436	14.064
56	0.977	7.60E+05	37	-129.143	-92.143	2.529	85.500	88.029	-4.115	103.930	106.459	14.315

55	0.960	7.41E+05	37	-128.923	-91.923	2.551	85.500	88.051	-3.871	103.930	106.481	14.559
54	0.942	7.23E+05	37	-128.710	-91.710	2.574	85.500	88.074	-3.636	103.930	106.504	14.794
53	0.925	7.06E+05	37	-128.505	-91.505	2.597	85.500	88.097	-3.408	103.930	106.527	15.022
52	0.908	6.90E+05	37	-128.308	-91.308	2.621	85.500	88.121	-3.186	103.930	106.551	15.244
51	0.890	6.75E+05	37	-128.117	-91.117	2.645	85.500	88.145	-2.972	103.930	106.575	15.458
50	0.873	6.61E+05	37	-127.933	-90.933	2.670	85.500	88.170	-2.763	103.930	106.600	15.667
49	0.855	6.48E+05	37	-127.756	-90.756	2.695	85.500	88.195	-2.560	103.930	106.625	15.870
48	0.838	6.35E+05	37	-127.584	-90.584	2.721	85.500	88.221	-2.363	103.930	106.651	16.067
47	0.820	6.23E+05	37	-127.419	-90.419	2.747	85.500	88.247	-2.172	103.930	106.677	16.258
46	0.803	6.12E+05	37	-127.259	-90.259	2.773	85.500	88.273	-1.986	103.930	106.703	16.444
45	0.785	6.01E+05	37	-127.105	-90.105	2.800	85.500	88.300	-1.804	103.930	106.730	16.626
44	0.768	5.91E+05	37	-126.956	-89.956	2.828	85.500	88.328	-1.628	103.930	106.758	16.802
43	0.750	5.81E+05	37	-126.812	-89.812	2.856	85.500	88.356	-1.456	103.930	106.786	16.974
42	0.733	5.72E+05	37	-126.673	-89.673	2.885	85.500	88.385	-1.288	103.930	106.815	17.142
41	0.716	5.63E+05	37	-126.539	-89.539	2.914	85.500	88.414	-1.124	103.930	106.844	17.306
40	0.698	5.55E+05	37	-126.409	-89.409	2.944	85.500	88.444	-0.965	103.930	106.874	17.465
39	0.681	5.47E+05	37	-126.284	-89.284	2.975	85.500	88.475	-0.809	103.930	106.905	17.621
38	0.663	5.39E+05	37	-126.164	-89.164	3.006	85.500	88.506	-0.658	103.930	106.936	17.772
37	0.646	5.32E+05	37	-126.047	-89.047	3.038	85.500	88.538	-0.509	103.930	106.968	17.921
36	0.628	5.25E+05	37	-125.935	-88.935	3.071	85.500	88.571	-0.365	103.930	107.001	18.065
35	0.611	5.19E+05	37	-125.827	-88.827	3.104	85.500	88.604	-0.223	103.930	107.034	18.207
34	0.593	5.13E+05	37	-125.723	-88.723	3.138	85.500	88.638	-0.085	103.930	107.068	18.345
33	0.576	5.07E+05	37	-125.623	-88.623	3.173	85.500	88.673	0.050	103.930	107.103	18.480
32	0.559	5.01E+05	37	-125.526	-88.526	3.208	85.500	88.708	0.182	103.930	107.138	18.612
31	0.541	4.96E+05	37	-125.433	-88.433	3.245	85.500	88.745	0.311	103.930	107.175	18.741
30	0.524	4.91E+05	37	-125.344	-88.344	3.282	85.500	88.782	0.438	103.930	107.212	18.868
29	0.506	4.86E+05	37	-125.258	-88.258	3.320	85.500	88.820	0.562	103.930	107.250	18.992
28	0.489	4.81E+05	37	-125.176	-88.176	3.359	85.500	88.859	0.683	103.930	107.289	19.113
27	0.471	4.77E+05	37	-125.097	-88.097	3.398	85.500	88.898	0.802	103.930	107.328	19.232
26	0.454	4.73E+05	37	-125.021	-88.021	3.439	85.500	88.939	0.918	103.930	107.369	19.348
25	0.436	4.69E+05	37	-124.949	-87.949	3.481	85.500	88.981	1.032	103.930	107.411	19.462
24	0.419	4.65E+05	37	-124.880	-87.880	3.524	85.500	89.024	1.144	103.930	107.454	19.574
23	0.401	4.62E+05	37	-124.814	-87.814	3.568	85.500	89.068	1.254	103.930	107.498	19.684
22	0.384	4.58E+05	37	-124.751	-87.751	3.613	85.500	89.113	1.362	103.930	107.543	19.792
21	0.367	4.55E+05	37	-124.691	-87.691	3.659	85.500	89.159	1.468	103.930	107.589	19.898
20	0.349	4.52E+05	37	-124.635	-87.635	3.706	85.500	89.206	1.572	103.930	107.636	20.002
19	0.332	4.49E+05	37	-124.581	-87.581	3.755	85.500	89.255	1.674	103.930	107.685	20.104
18	0.314	4.47E+05	37	-124.530	-87.530	3.805	85.500	89.305	1.774	103.930	107.735	20.204
17	0.297	4.44E+05	37	-124.482	-87.482	3.856	85.500	89.356	1.873	103.930	107.786	20.303

16	0.279	4.42E+05	37	-124.438	-87.438	3.909	85.500	89.409	1.971	103.930	107.839	20.401
15	0.262	4.40E+05	37	-124.396	-87.396	3.963	85.500	89.463	2.067	103.930	107.893	20.497
14	0.244	4.38E+05	37	-124.356	-87.356	4.018	85.500	89.518	2.162	103.930	107.948	20.592
13	0.227	4.36E+05	37	-124.320	-87.320	4.075	85.500	89.575	2.255	103.930	108.005	20.685
12	0.209	4.34E+05	37	-124.286	-87.286	4.134	85.500	89.634	2.348	103.930	108.064	20.778
11	0.192	4.33E+05	37	-124.255	-87.255	4.195	85.500	89.695	2.439	103.930	108.125	20.869
10	0.175	4.32E+05	37	-124.227	-87.227	4.257	85.500	89.757	2.530	103.930	108.187	20.960
9	0.157	4.30E+05	37	-124.202	-87.202	4.321	85.500	89.821	2.619	103.930	108.251	21.049
8	0.140	4.29E+05	37	-124.179	-87.179	4.387	85.500	89.887	2.708	103.930	108.317	21.138
7	0.122	4.28E+05	37	-124.159	-87.159	4.456	85.500	89.956	2.796	103.930	108.386	21.226
6	0.105	4.27E+05	37	-124.142	-87.142	4.526	85.500	90.026	2.884	103.930	108.456	21.314
5	0.087	4.27E+05	37	-124.128	-87.128	4.599	85.500	90.099	2.971	103.930	108.529	21.401
4	0.070	4.26E+05	37	-124.116	-87.116	4.674	85.500	90.174	3.058	103.930	108.604	21.488
3	0.052	4.26E+05	37	-124.106	-87.106	4.751	85.500	90.251	3.145	103.930	108.681	21.575
2	0.035	4.25E+05	37	-124.100	-87.100	4.831	85.500	90.331	3.232	103.930	108.761	21.662
1	0.017	4.25E+05	37	-124.096	-87.096	4.914	85.500	90.414	3.319	103.930	108.844	21.749
0	0.000	4.25E+05	37	-124.094	-87.094	5.000	85.500	90.500	3.406	103.930	108.930	21.836