This spreadsheet calculates the field strength of an array of 256 slot dipoles

with uniform illumination.

The slot dipoles are oriented vertically (Horizontal polarization) and

are uniformly illuminated.

It is intended to predict power density levels close to the antenna.

Marcus da Silva

Power(W)	0.0174
Freqyency (MHz)	2437
C (m/Sec)	3.00E+08
Lambda (m)	1.23E-01
Beta	5.10E+01
Element Spacing	6.16E-02
NU	1.00E+00
Element Gain	2.00E+00
Array Gain	6.31E+02

Test point locations

Xt	Yt	Zt
0	1	0.0000

Array element locations, X horizontally, Z vertically

2

Mag Ex	20.63472553
Mag Ey	0

Actual Power Dens	0.000586458	mw/cm2
Power Dens (isotro	0.000138465	mw/cm2
Power Dens (Gain)	8.74E-02	mw/cm2
Effective gain	4.23543	
Effective gain (dB)	6.26898	

Equations for slot element derived from Ramo, Whinnery and Van Duzer, page 620

$$E_{x=}E_s e^{-j\beta\sqrt{(x-x_n)^2+(y-y_n)^2+(z-z_n)^2}}\frac{\cos\left(\frac{\pi}{2}\frac{z-z_n}{\sqrt{(x-x_n)^2+(y-y_n)^2+(z-z_n)^2}}\right)}{(x-x_n)^2+(y-y_n)^2}(y_n-y)$$

$$E_{y=}E_s e^{-j\beta\sqrt{(x-x_n)^2+(y-y_n)^2+(z-z_n)^2}}\frac{\cos\left(\frac{\pi}{2}\frac{z-z_n}{\sqrt{(x-x_n)^2+(y-y_n)^2+(z-z_n)^2}}\right)}{(x-x_n)^2+(y-y_n)^2}(x-x_n)$$

$$E_z=0$$

REAL X COMPONENT

M		-8	-7	-6	-5	-4	-3	-2	-1	1	2	3	4	5	6	7	8
		-0.4616	-0.4001	-0.3385	-0.2770	-0.2154	-0.1539	-0.0923	-0.0308	0.0308	0.0923	0.1539	0.2154	0.2770	0.3385	0.4001	0.4616
-8	-0.4616	0.2043	0.6971	0.4631	-0.1134	-0.5670	-0.7588	-0.7785	-0.7527	-0.7527	-0.7785	-0.7588	-0.5670	-0.1134	0.4631	0.6971	0.2043
-7	-0.4001	0.7035	0.3687	-0.3613	-0.7665	-0.7104	-0.4306	-0.1626	-0.0153	-0.0153	-0.1626	-0.4306	-0.7104	-0.7665	-0.3613	0.3687	0.7035
-6	-0.3385	0.4712	-0.3644	-0.7953	-0.5482	-0.0154	0.4284	0.6736	0.7673	0.7673	0.6736	0.4284	-0.0154	-0.5482	-0.7953	-0.3644	0.4712
-5	-0.2770	-0.1163	-0.7788	-0.5523	0.1372	0.6789	0.8860	0.8813	0.8326	0.8326	0.8813	0.8860	0.6789	0.1372	-0.5523	-0.7788	-0.1163
-4	-0.2154	-0.5850	-0.7263	-0.0156	0.6832	0.9049	0.7591	0.5199	0.3668	0.3668	0.5199	0.7591	0.9049	0.6832	-0.0156	-0.7263	-0.5850
-3	-0.1539	-0.7866	-0.4424	0.4365	0.8961	0.7629	0.3687	0.0187	-0.1654	-0.1654	0.0187	0.3687	0.7629	0.8961	0.4365	-0.4424	-0.7866
-2	-0.0923	-0.8098	-0.1676	0.6886	0.8943	0.5243	0.0188	-0.3481	-0.5207	-0.5207	-0.3481	0.0188	0.5243	0.8943	0.6886	-0.1676	-0.8098
-1	-0.0308	-0.7842	-0.0158	0.7858	0.8465	0.3706	-0.1663	-0.5217	-0.6784	-0.6784	-0.5217	-0.1663	0.3706	0.8465	0.7858	-0.0158	-0.7842
1	0.0308	-0.7842	-0.0158	0.7858	0.8465	0.3706	-0.1663	-0.5217	-0.6784	-0.6784	-0.5217	-0.1663	0.3706	0.8465	0.7858	-0.0158	-0.7842
2	0.0923	-0.8098	-0.1676	0.6886	0.8943	0.5243	0.0188	-0.3481	-0.5207	-0.5207	-0.3481	0.0188	0.5243	0.8943	0.6886	-0.1676	-0.8098
3	0.1539	-0.7866	-0.4424	0.4365	0.8961	0.7629	0.3687	0.0187	-0.1654	-0.1654	0.0187	0.3687	0.7629	0.8961	0.4365	-0.4424	-0.7866
4	0.2154	-0.5850	-0.7263	-0.0156	0.6832	0.9049	0.7591	0.5199	0.3668	0.3668	0.5199	0.7591	0.9049	0.6832	-0.0156	-0.7263	-0.5850
5	0.2770	-0.1163	-0.7788	-0.5523	0.1372	0.6789	0.8860	0.8813	0.8326	0.8326	0.8813	0.8860	0.6789	0.1372	-0.5523	-0.7788	-0.1163
6	0.3385	0.4712	-0.3644	-0.7953	-0.5482	-0.0154	0.4284	0.6736	0.7673	0.7673	0.6736	0.4284	-0.0154	-0.5482	-0.7953	-0.3644	0.4712
7	0.4001	0.7035	0.3687	-0.3613	-0.7665	-0.7104	-0.4306	-0.1626	-0.0153	-0.0153	-0.1626	-0.4306	-0.7104	-0.7665	-0.3613	0.3687	0.7035
8	0.4616	0.2043	0.6971	0.4631	-0.1134	-0.5670	-0.7588	-0.7785	-0.7527	-0.7527	-0.7785	-0.7588	-0.5670	-0.1134	0.4631	0.6971	0.2043

10.867910

IMAG X COMPONENT

M		-8	-7	-6	-5	-4	-3	-2	-1	1	2	3	4	5	6	7	8
		-0.4616	-0.4001	-0.3385	-0.2770	-0.2154	-0.1539	-0.0923	-0.0308	0.0308	0.0923	0.1539	0.2154	0.2770	0.3385	0.4001	0.4616
-8	-0.4616	0.6454	0.0841	-0.5582	-0.7371	-0.5105	-0.1647	0.1058	0.2413	0.2413	0.1058	-0.1647	-0.5105	-0.7371	-0.5582	0.0841	0.6454
-7	-0.4001	0.0849	-0.6373	-0.6706	-0.1664	0.3753	0.6959	0.8126	0.8338	0.8338	0.8126	0.6959	0.3753	-0.1664	-0.6706	-0.6373	0.0849
-6	-0.3385	-0.5681	-0.6762	-0.0315	0.6107	0.8415	0.7434	0.5496	0.4208	0.4208	0.5496	0.7434	0.8415	0.6107	-0.0315	-0.6762	-0.5681
-5	-0.2770	-0.7557	-0.1691	0.6153	0.8425	0.5540	0.1196	-0.2117	-0.3735	-0.3735	-0.2117	0.1196	0.5540	0.8425	0.6153	-0.1691	-0.7557
-4	-0.2154	-0.5267	0.3837	0.8532	0.5575	-0.0457	-0.5286	-0.7810	-0.8708	-0.8708	-0.7810	-0.5286	-0.0457	0.5575	0.8532	0.3837	-0.5267
-3	-0.1539	-0.1708	0.7150	0.7575	0.1210	-0.5313	-0.8753	-0.9634	-0.9565	-0.9565	-0.9634	-0.8753	-0.5313	0.1210	0.7575	0.7150	-0.1708
-2	-0.0923	0.1100	0.8377	0.5619	-0.2148	-0.7876	-0.9668	-0.9175	-0.8404	-0.8404	-0.9175	-0.9668	-0.7876	-0.2148	0.5619	0.8377	0.1100
-1	-0.0308	0.2514	0.8610	0.4309	-0.3797	-0.8797	-0.9615	-0.8419	-0.7318	-0.7318	-0.8419	-0.9615	-0.8797	-0.3797	0.4309	0.8610	0.2514
1	0.0308	0.2514	0.8610	0.4309	-0.3797	-0.8797	-0.9615	-0.8419	-0.7318	-0.7318	-0.8419	-0.9615	-0.8797	-0.3797	0.4309	0.8610	0.2514
2	0.0923	0.1100	0.8377	0.5619	-0.2148	-0.7876	-0.9668	-0.9175	-0.8404	-0.8404	-0.9175	-0.9668	-0.7876	-0.2148	0.5619	0.8377	0.1100
3	0.1539	-0.1708	0.7150	0.7575	0.1210	-0.5313	-0.8753	-0.9634	-0.9565	-0.9565	-0.9634	-0.8753	-0.5313	0.1210	0.7575	0.7150	-0.1708
4	0.2154	-0.5267	0.3837	0.8532	0.5575	-0.0457	-0.5286	-0.7810	-0.8708	-0.8708	-0.7810	-0.5286	-0.0457	0.5575	0.8532	0.3837	-0.5267
5	0.2770	-0.7557	-0.1691	0.6153	0.8425	0.5540	0.1196	-0.2117	-0.3735	-0.3735	-0.2117	0.1196	0.5540	0.8425	0.6153	-0.1691	-0.7557
6	0.3385	-0.5681	-0.6762	-0.0315	0.6107	0.8415	0.7434	0.5496	0.4208	0.4208	0.5496	0.7434	0.8415	0.6107	-0.0315	-0.6762	-0.5681
7	0.4001	0.0849	-0.6373	-0.6706	-0.1664	0.3753	0.6959	0.8126	0.8338	0.8338	0.8126	0.6959	0.3753	-0.1664	-0.6706	-0.6373	0.0849
8	0.4616	0.6454	0.0841	-0.5582	-0.7371	-0.5105	-0.1647	0.1058	0.2413	0.2413	0.1058	-0.1647	-0.5105	-0.7371	-0.5582	0.0841	0.6454

-17.54082165

REAL Y COMPONENT

M		-8	-7	-6	-5	-4	-3	-2	-1	1	2	3	4	5	6	7	8
		-0.4616	-0.4001	-0.3385	-0.2770	-0.2154	-0.1539	-0.0923	-0.0308	0.0308	0.0923	0.1539	0.2154	0.2770	0.3385	0.4001	0.4616
-8	-0.4616	-0.0943	-0.2789	-0.1568	0.0314	0.1222	0.1168	0.0719	0.0232	-0.0232	-0.0719	-0.1168	-0.1222	-0.0314	0.1568	0.2789	0.0943
-7	-0.4001	-0.3248	-0.1475	0.1223	0.2123	0.1530	0.0663	0.0150	0.0005	-0.0005	-0.0150	-0.0663	-0.1530	-0.2123	-0.1223	0.1475	0.3248
-6	-0.3385	-0.2175	0.1458	0.2692	0.1518	0.0033	-0.0659	-0.0622	-0.0236	0.0236	0.0622	0.0659	-0.0033	-0.1518	-0.2692	-0.1458	0.2175
-5	-0.2770	0.0537	0.3116	0.1870	-0.0380	-0.1463	-0.1363	-0.0814	-0.0256	0.0256	0.0814	0.1363	0.1463	0.0380	-0.1870	-0.3116	-0.0537
-4	-0.2154	0.2700	0.2906	0.0053	-0.1892	-0.1949	-0.1168	-0.0480	-0.0113	0.0113	0.0480	0.1168	0.1949	0.1892	-0.0053	-0.2906	-0.2700
-3	-0.1539	0.3631	0.1770	-0.1478	-0.2482	-0.1644	-0.0567	-0.0017	0.0051	-0.0051	0.0017	0.0567	0.1644	0.2482	0.1478	-0.1770	-0.3631
-2	-0.0923	0.3738	0.0671	-0.2331	-0.2477	-0.1129	-0.0029	0.0321	0.0160	-0.0160	-0.0321	0.0029	0.1129	0.2477	0.2331	-0.0671	-0.3738
-1	-0.0308	0.3620	0.0063	-0.2660	-0.2345	-0.0798	0.0256	0.0482	0.0209	-0.0209	-0.0482	-0.0256	0.0798	0.2345	0.2660	-0.0063	-0.3620
1	0.0308	0.3620	0.0063	-0.2660	-0.2345	-0.0798	0.0256	0.0482	0.0209	-0.0209	-0.0482	-0.0256	0.0798	0.2345	0.2660	-0.0063	-0.3620
2	0.0923	0.3738	0.0671	-0.2331	-0.2477	-0.1129	-0.0029	0.0321	0.0160	-0.0160	-0.0321	0.0029	0.1129	0.2477	0.2331	-0.0671	-0.3738
3	0.1539	0.3631	0.1770	-0.1478	-0.2482	-0.1644	-0.0567	-0.0017	0.0051	-0.0051	0.0017	0.0567	0.1644	0.2482	0.1478	-0.1770	-0.3631
4	0.2154	0.2700	0.2906	0.0053	-0.1892	-0.1949	-0.1168	-0.0480	-0.0113	0.0113	0.0480	0.1168	0.1949	0.1892	-0.0053	-0.2906	-0.2700
5	0.2770	0.0537	0.3116	0.1870	-0.0380	-0.1463	-0.1363	-0.0814	-0.0256	0.0256	0.0814	0.1363	0.1463	0.0380	-0.1870	-0.3116	-0.0537
6	0.3385	-0.2175	0.1458	0.2692	0.1518	0.0033	-0.0659	-0.0622	-0.0236	0.0236	0.0622	0.0659	-0.0033	-0.1518	-0.2692	-0.1458	0.2175
7	0.4001	-0.3248	-0.1475	0.1223	0.2123	0.1530	0.0663	0.0150	0.0005	-0.0005	-0.0150	-0.0663	-0.1530	-0.2123	-0.1223	0.1475	0.3248
8	0.4616	-0.0943	-0.2789	-0.1568	0.0314	0.1222	0.1168	0.0719	0.0232	-0.0232	-0.0719	-0.1168	-0.1222	-0.0314	0.1568	0.2789	0.0943

0.0000

IMAG Y COMPONENT

M		-8	-7	-6	-5	-4	-3	-2	-1	1	2	3	4	5	6	7	8
		-0.4616	-0.4001	-0.3385	-0.2770	-0.2154	-0.1539	-0.0923	-0.0308	0.0308	0.0923	0.1539	0.2154	0.2770	0.3385	0.4001	0.4616
-8	-0.4616	-0.2980	-0.0337	0.1890	0.2042	0.1100	0.0253	-0.0098	-0.0074	0.0074	0.0098	-0.0253	-0.1100	-0.2042	-0.1890	0.0337	0.2980
-7	-0.4001	-0.0392	0.2550	0.2270	0.0461	-0.0809	-0.1071	-0.0750	-0.0257	0.0257	0.0750	0.1071	0.0809	-0.0461	-0.2270	-0.2550	0.0392
-6	-0.3385	0.2622	0.2706	0.0107	-0.1692	-0.1813	-0.1144	-0.0507	-0.0129	0.0129	0.0507	0.1144	0.1813	0.1692	-0.0107	-0.2706	-0.2622
-5	-0.2770	0.3488	0.0676	-0.2083	-0.2333	-0.1193	-0.0184	0.0195	0.0115	-0.0115	-0.0195	0.0184	0.1193	0.2333	0.2083	-0.0676	-0.3488
-4	-0.2154	0.2431	-0.1535	-0.2888	-0.1544	0.0098	0.0813	0.0721	0.0268	-0.0268	-0.0721	-0.0813	-0.0098	0.1544	0.2888	0.1535	-0.2431
-3	-0.1539	0.0788	-0.2861	-0.2564	-0.0335	0.1145	0.1347	0.0890	0.0294	-0.0294	-0.0890	-0.1347	-0.1145	0.0335	0.2564	0.2861	-0.0788
-2	-0.0923	-0.0508	-0.3351	-0.1902	0.0595	0.1697	0.1488	0.0847	0.0259	-0.0259	-0.0847	-0.1488	-0.1697	-0.0595	0.1902	0.3351	0.0508
-1	-0.0308	-0.1161	-0.3445	-0.1459	0.1052	0.1895	0.1480	0.0777	0.0225	-0.0225	-0.0777	-0.1480	-0.1895	-0.1052	0.1459	0.3445	0.1161
1	0.0308	-0.1161	-0.3445	-0.1459	0.1052	0.1895	0.1480	0.0777	0.0225	-0.0225	-0.0777	-0.1480	-0.1895	-0.1052	0.1459	0.3445	0.1161
2	0.0923	-0.0508	-0.3351	-0.1902	0.0595	0.1697	0.1488	0.0847	0.0259	-0.0259	-0.0847	-0.1488	-0.1697	-0.0595	0.1902	0.3351	0.0508
3	0.1539	0.0788	-0.2861	-0.2564	-0.0335	0.1145	0.1347	0.0890	0.0294	-0.0294	-0.0890	-0.1347	-0.1145	0.0335	0.2564	0.2861	-0.0788
4	0.2154	0.2431	-0.1535	-0.2888	-0.1544	0.0098	0.0813	0.0721	0.0268	-0.0268	-0.0721	-0.0813	-0.0098	0.1544	0.2888	0.1535	-0.2431
5	0.2770	0.3488	0.0676	-0.2083	-0.2333	-0.1193	-0.0184	0.0195	0.0115	-0.0115	-0.0195	0.0184	0.1193	0.2333	0.2083	-0.0676	-0.3488
6	0.3385	0.2622	0.2706	0.0107	-0.1692	-0.1813	-0.1144	-0.0507	-0.0129	0.0129	0.0507	0.1144	0.1813	0.1692	-0.0107	-0.2706	-0.2622
7	0.4001	-0.0392	0.2550	0.2270	0.0461	-0.0809	-0.1071	-0.0750	-0.0257	0.0257	0.0750	0.1071	0.0809	-0.0461	-0.2270	-0.2550	0.0392
8	0.4616	-0.2980	-0.0337	0.1890	0.2042	0.1100	0.0253	-0.0098	-0.0074	0.0074	0.0098	-0.0253	-0.1100	-0.2042	-0.1890	0.0337	0.2980

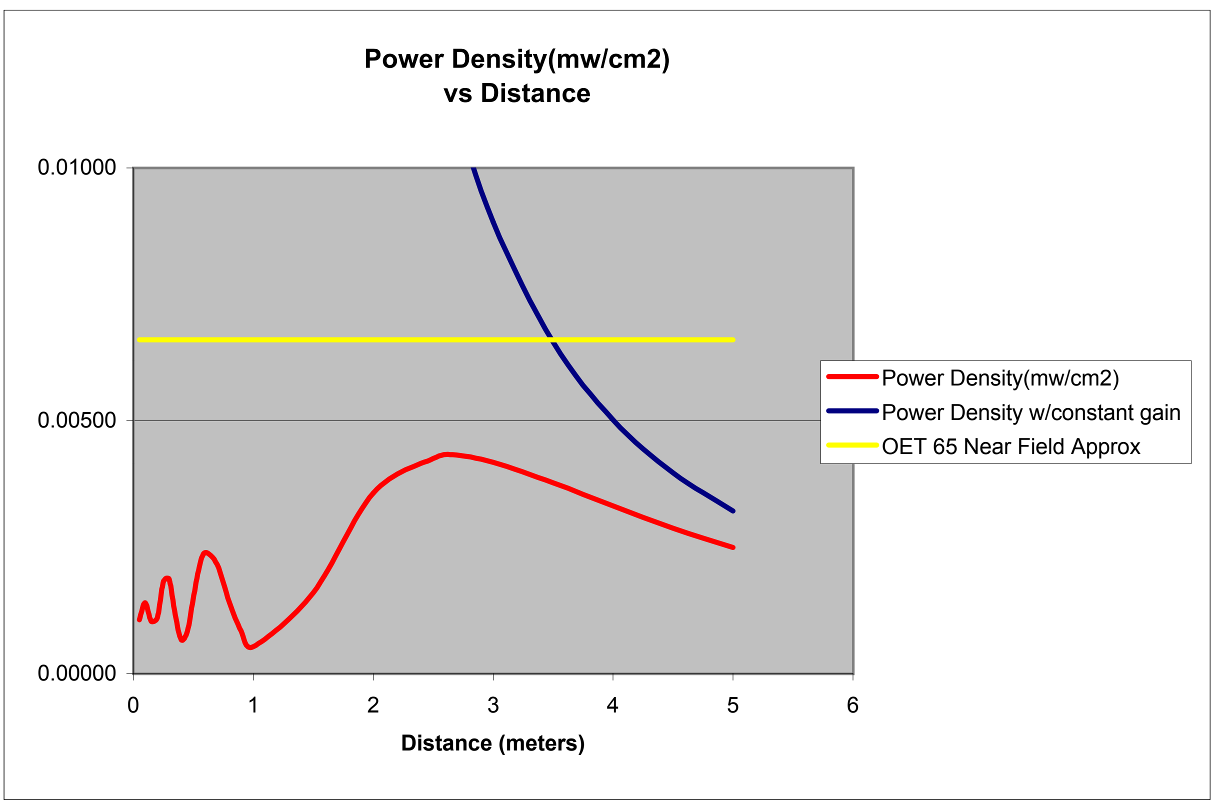
0.0000

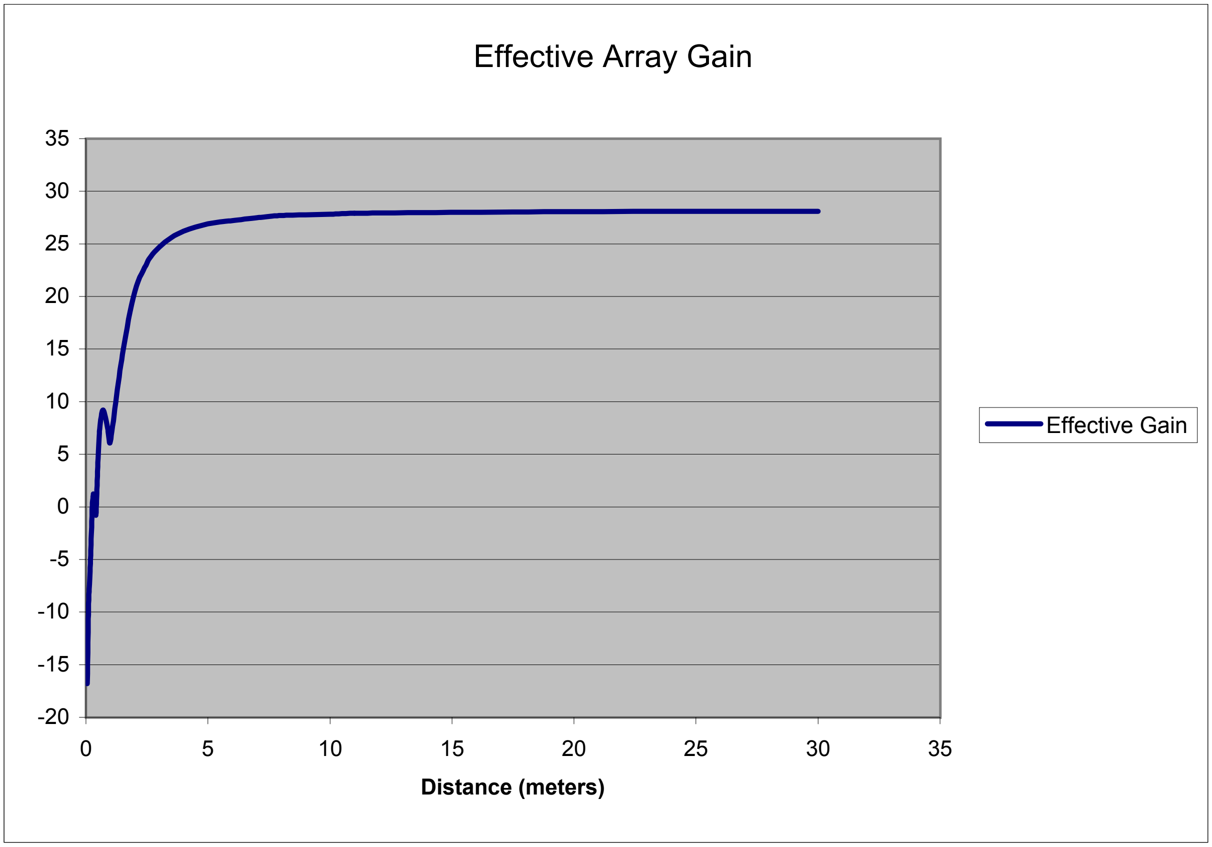
16 X 16 array. 16 driven vertical arrays.

INPUTS	
Input power per element (dBm)	0
Total Input power (W)	0.016
EIRP(dBm) far field	40.1752
FCC max EIRP (dBm)	50.756
Antenna area	0.969865
Antennaefficiency	1

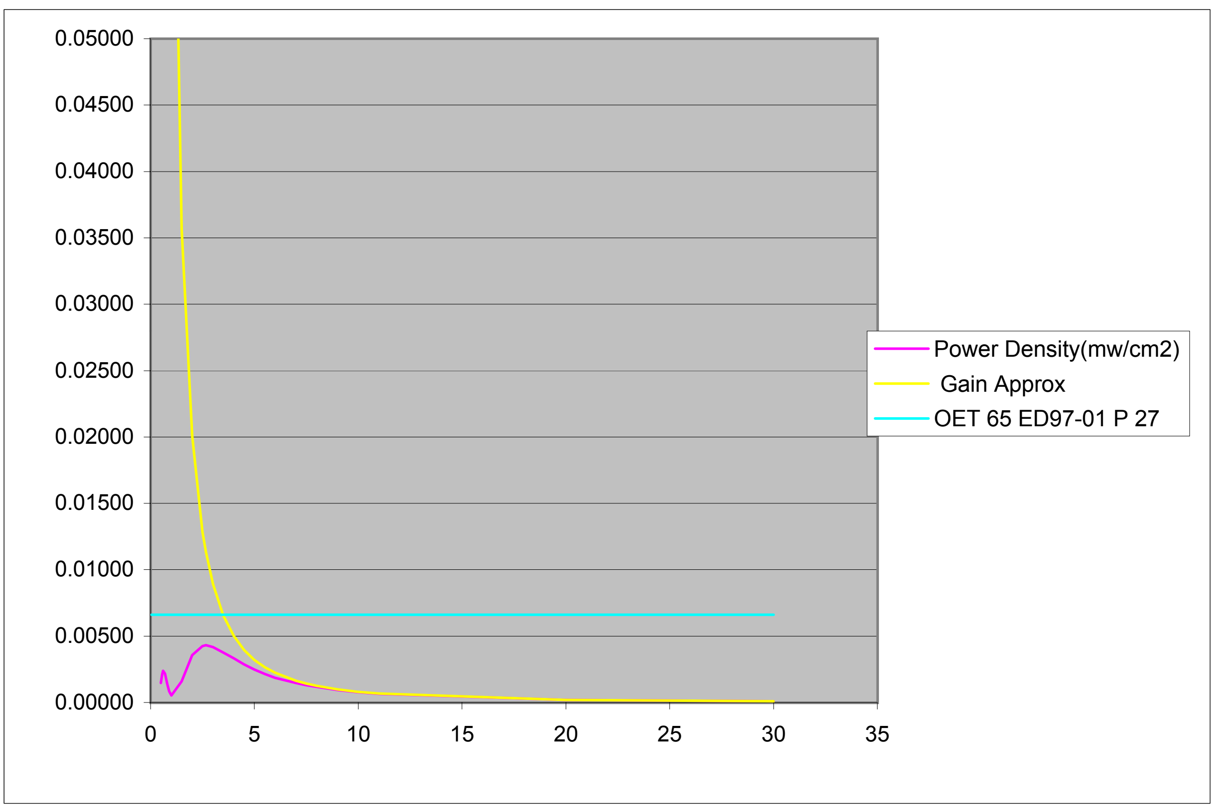
Distance	Effective G	Power Density(r	Gain Approx	OET 65 ED97-01 P 27
0.05	-16.8	0.00106	32.13439	0.006598854
0.1	-9.6	0.00140	8.03360	0.006598854
0.15	-7.4	0.00103	3.57049	0.006598854
0.2	-4.6	0.00110	2.00840	0.006598854
0.25	-0.5	0.00182	1.28538	0.006598854
0.3	1.2	0.00186	0.89262	0.006598854
0.35	0.5	0.00117	0.65580	0.006598854
0.4	-0.8	0.00066	0.50210	0.006598854
0.45	1.25	0.00084	0.39672	0.006598854
0.5	4.6	0.00147	0.32134	0.006598854
0.55	6.98	0.00210	0.26557	0.006598854
0.6	8.3	0.00239	0.22316	0.006598854
0.7	9.2	0.00216	0.16395	0.006598854
0.8	8.5	0.00141	0.12552	0.006598854
0.9	7.3	0.00084	0.09918	0.006598854
1	6.2	0.00053	0.08034	0.006598854
1.5	14.5	0.00159	0.03570	0.006598854
2	20.5	0.00357	0.02008	0.006598854
2.5	23.2	0.00426	0.01285	0.006598854
2.663	23.82	0.00433	0.01133	0.006598854
3	24.7	0.00418	0.00893	0.006598854
3.5	25.6	0.00377	0.00656	0.006598854
4	26.2	0.00332	0.00502	0.006598854
4.5	26.6	0.00287	0.00397	0.006598854
5	26.9	0.00249	0.00321	0.006598854
5.5	27.1	0.00216	0.00266	0.006598854
6	27.2	0.00186	0.00223	0.006598854
7	27.5	0.00146	0.00164	0.006598854
7.5	27.6	0.00130	0.00143	0.006598854
8	27.7	0.00117	0.00126	0.006598854
9	27.75	0.00094	0.00099	0.006598854
10	27.83	0.00077	0.00080	0.006598854
11	27.9	0.00065	0.00066	0.006598854
20	28.07	0.00020	0.00020	0.006598854
30	28.1	0.00009	0.00009	0.006598854
100	28.134	0.00001	0.00001	0.006598854


Effective Array Gain
30
25
20
15
10
5
0
-5
-10
-15
-20
0
0.5
1
1.5
2
2.5
3
3.5
Distance (meters)
Effective Gain


Power Density(mw/cm2)
vs Distance
0.01000
0.00500
0.00000
0
1
2
3
4
5
6
Distance (meters)
Power Density(mw/cm2)
Power Density w/constant gain
OET 65 Near Field Approx



Effective Array Gain
35
30
25
20
15
10
5
0
-5
-10
-15
-20
0
5
10
15
20
25
30
35
Distance (meters)
Effective Gain



0.05000
0.04500
0.04000
0.03500
0.03000
0.02500
0.02000
0.01500
0.01000
0.00500
0.00000
0
5
10
15
20
25
30
35
Power Density(mw/cm2)
Gain Approx
OET 65 ED97-01 P 27

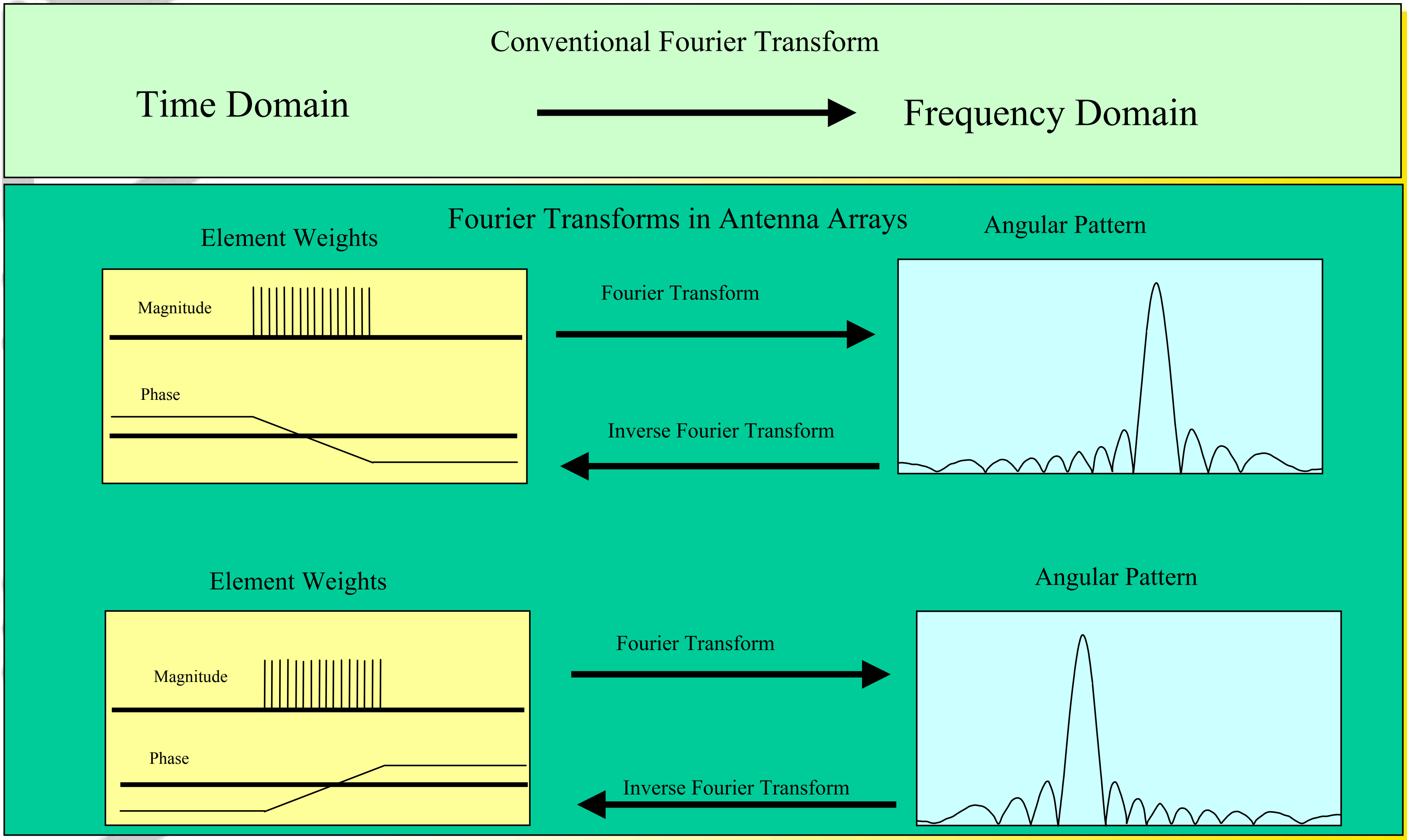
W i - F i E V E R Y W H E R E

Mabuhay Networks
Phased Array Antenna Tutorial

Marcus da Silva

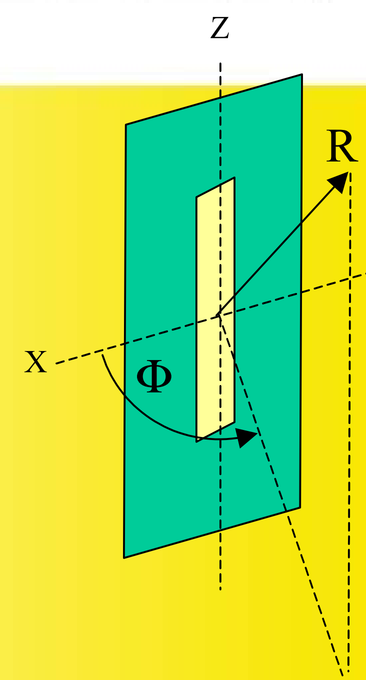
VP Engineering

The Fourier Transform relates the antenna element weights to the angular pattern they generate



Consider a Vertical Slot Antenna

- From Ramo, Whinnery and Van Duzer, P 620



$$\overline{E} = \frac{E_0}{R} e^{j(\omega t - \beta R)} \frac{\cos\left(\frac{\pi}{2}\cos\theta\right)}{\sin\theta} \overline{a_\Phi}$$

$$\overline{E} = \frac{E_s}{R} e^{-j\beta R} \frac{\cos\left(\frac{\pi}{2}\cos\theta\right)}{\sin\theta} \overline{a_\Phi}$$

$$\overline{a_\Phi} = -\sin\phi\,\overline{a_x} + \cos\phi\,\overline{a_y} = \frac{-y}{\sqrt{x^2+y^2}}\overline{a_x} + \frac{x}{\sqrt{x^2+y^2}}\overline{a_y}$$

$$R = \sqrt{x^2+y^2+z^2}$$

$$\cos\theta = \frac{z}{\sqrt{x^2+y^2+z^2}}$$

$$\sin\theta = \frac{\sqrt{x^2+y^2}}{\sqrt{x^2+y^2+z^2}}$$

Where:

$\overline{E}$=Electric field strength vector

R=radial distance from antenna

ω=radian frequency

β=Propagation constant

E_ϕ= Electric field component

W i - F i   E V E R Y W H E R E

Expressing in Rectangular Coordinates

$$\overline{E} = \frac{E_s}{\sqrt{x^2+y^2+z^2}} e^{-j\beta\sqrt{x^2+y^2+z^2}} \frac{\cos\left(\frac{\pi}{2}\frac{z}{\sqrt{x^2+y^2+z^2}}\right)}{\frac{\sqrt{x^2+y^2}}{\sqrt{x^2+y^2+z^2}}} \left(\frac{-y}{\sqrt{x^2+y^2}}\overline{a_x} + \frac{x}{\sqrt{x^2+y^2}}\overline{a_y} \right)$$

$$E_{x=}E_s e^{-j\beta\sqrt{x^2+y^2+z^2}} \frac{\cos\left(\frac{\pi}{2}\frac{z}{\sqrt{x^2+y^2+z^2}}\right)}{x^2+y^2}(-y)$$

$$E_{y=}E_s e^{-j\beta\sqrt{x^2+y^2+z^2}} \frac{\cos\left(\frac{\pi}{2}\frac{z}{\sqrt{x^2+y^2+z^2}}\right)}{x^2+y^2}(x)$$

$$E_z = 0$$

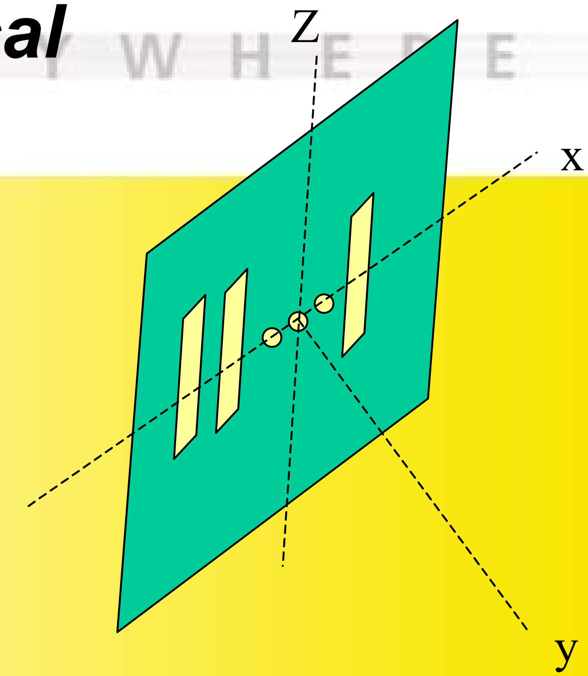
Consider an arbitrarily locaytion (x_n,y_n,z_n)

$$E_{x=}E_s e^{-j\beta\sqrt{(x-x_n)^2+(y-y_n)^2+(z-z_n)^2}}\frac{\cos(\frac{\pi}{2}\frac{z-z_n}{\sqrt{(x-x_n)^2+(y-y_n)^2+(z-z_n)^2}})}{(x-x_n)^2+(y-y_n)^2}(y_n-y)$$

$$E_{y=}E_s e^{-j\beta\sqrt{(x-x_n)^2+(y-y_n)^2+(z-z_n)^2}}\frac{\cos(\frac{\pi}{2}\frac{z-z_n}{\sqrt{(x-x_n)^2+(y-y_n)^2+(z-z_n)^2}})}{(x-x_n)^2+(y-y_n)^2}(x-x_n)$$

$$E_z=0$$

An Array of Vertical Slot Antennas



Consider an array of vertical slot antennae located in positions (X_n,0, Z_n)

$$E_x = \sum_n E_n e^{-j\beta\sqrt{(x-x_n)^2+(y)^2+(z-z_n)^2}} \frac{\cos\left(\frac{\pi}{2}\frac{z-z_n}{\sqrt{(x-x_n)^2+(y)^2+(z-z_n)^2}}\right)}{(x-x_n)^2+(y)^2}(-y)$$

$$E_y = \sum_n E_n e^{-j\beta\sqrt{(x-x_n)^2+(y)^2+(z-z_n)^2}} \frac{\cos\left(\frac{\pi}{2}\frac{z-z_n}{\sqrt{(x-x_n)^2+(y)^2+(z-z_n)^2}}\right)}{(x-x_n)^2+(y)^2}(x-x_n)$$

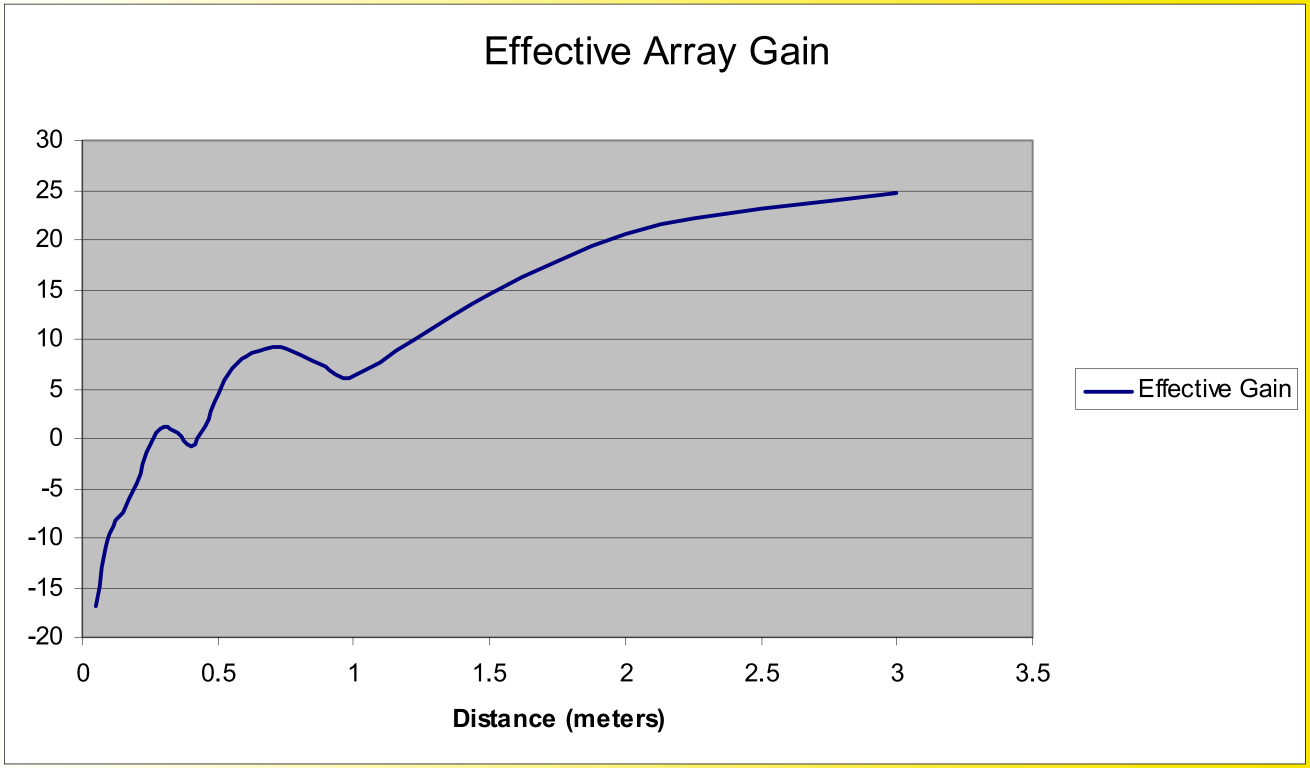
$$E_z = 0$$

W i - F i   E V E R Y W H E R E

Effective Gain

- The array produces a pattern that is not completely focused until about 20 meter from the antenna face.
- This leads us to the concept of an effective array gain.
- The effective array gain varies with direction and wit distance. For a uniformly distributed array with driven with equal phase to all elements, the maximum gain is along the perpendicular center line (bore sight).

Effective gain of a 16 X 16 element antenna array with 28.1 dBi gain in the far field



OET 65 Approximation for

- OET 65 ED 97-01, Page 27-28
  - Approximation for near field of antenna arrays
  - Max power density in the near field is 4 times the power divided by the antenna area

$$P_D = \frac{4P_T}{A}$$

W i - F i   E V E R Y W H E R E

Power Density as a function of distance. 50 dBm EIRP 28 dBi gain