Voltage to Power Conversion in a 50 Ω System
(with no DC component)

A lot of people have a hard time converting between power and voltage in 50 Ω systems. The full derivation requires a little extra work because of the use of the root-mean-square value of a sinewave, based on its peak voltage value. Here's how it's done.

The Table of Equivalent Voltages & Powers was generated using an Excel spreadsheet. Equations for the cells are shown at the bottom of the table.

Voltage to Power (for a sinewave with no DC component) in a 50 Ω System

$$P_{mW(50\Omega)} = \frac{\left(\frac{V_{pk(V)}}{\sqrt{2}}\right)^2}{R} * 1000 = \frac{V_{pk(V)}^2}{2 * 50} * 1000 = 10 * V_{pk(V)}^2 \ [mW]$$

$$P_{dBm(50\Omega)} = 10 * log_{10}\left(P_{mW(50\Omega)}\right) = 10 * log_{10}\left(10 * V_{pk(V)}^2\right) = 10 + 20 * log_{10}\left(V_{pk}\right) \ [dBm]$$

where V_{pk} is the peak (not pk-pk) voltage in units of volts

Power to Voltage (for a sinewave with no DC component) in a 50 Ω System

$$V_{pk(50\Omega)} = 10^{\frac{P_{dBm\,(50\Omega)} - 10}{20}} \ [V]$$

Table of Equivalent Voltages & Powers in a 50 Ω System

V_{peak}(V)	V_{rms}(V)	V_{avg}(V)	P(W)	P(mW)	P(dBm)
10	7.07107	6.36620	1.00000	1000.00000	30.00000
9	6.36396	5.72958	0.81000	810.00000	29.08485
8	5.65685	5.09296	0.64000	640.00000	28.06180
7	4.94975	4.45634	0.49000	490.00000	26.90196
6	4.24264	3.81972	0.36000	360.00000	25.56303
5	3.53553	3.18310	0.25000	250.00000	23.97940
4	2.82843	2.54648	0.16000	160.00000	22.04120
3.162278	2.23607	2.01317	0.10000	100.00000	20.00000
3	2.12132	1.90986	0.09000	90.00000	19.54243
2	1.41421	1.27324	0.04000	40.00000	16.02060
1	0.70711	0.63662	0.01000	10.00000	10.00000
0.9	0.63640	0.57296	0.00810	8.10000	9.08485
0.8	0.56569	0.50930	0.00640	6.40000	8.06180
0.7	0.49497	0.44563	0.00490	4.90000	6.90196
0.6	0.42426	0.38197	0.00360	3.60000	5.56303
0.5	0.35355	0.31831	0.00250	2.50000	3.97940
0.4	0.28284	0.25465	0.00160	1.60000	2.04120
0.316228	0.22361	0.20132	0.00100	1.00000	0.00000
0.3	0.21213	0.19099	0.00090	0.90000	-0.45757
0.2	0.14142	0.12732	0.00040	0.40000	-3.97940
0.1	0.07071	0.06366	0.00010	0.10000	-10.00000
0.09	0.06364	0.05730	0.00008	0.08100	-10.91515
0.08	0.05657	0.05093	0.00006	0.06400	-11.93820
0.07	0.04950	0.04456	0.00005	0.04900	-13.09804
0.06	0.04243	0.03820	0.00004	0.03600	-14.43697
0.05	0.03536	0.03183	0.00003	0.02500	-16.02060
0.04	0.02828	0.02546	0.00002	0.01600	-17.95880
0.031623	0.02236	0.02013	0.00001	0.01000	-20.00000
0.03	0.02121	0.01910		0.00900	-20.45757
0.02	0.01414	0.01273		0.00400	-23.97940
0.01	0.00707	0.00637		0.00100	-30.00000
0.009	0.00636	0.00573		0.00081	-30.91515
0.008	0.00566	0.00509		0.00064	-31.93820
0.007	0.00495	0.00446		0.00049	-33.09804
0.006	0.00424	0.00382		0.00036	-34.43697
0.005	0.00354	0.00318		0.00025	-36.02060
0.004	0.00283	0.00255		0.00016	-37.95880
0.003162	0.00224	0.00201		0.00010	-40.00000
0.003	0.00212	0.00191		0.00009	-40.45757
0.002	0.00141	0.00127		0.00004	-43.97940
0.001	0.00071	0.00064		0.00001	-50.00000
Formulas	V_{pk}/SQRT(2)	V_{pk}*2/PI()	V^2_{pk}/(2*50)	P_W*1000	10*log(P_{mW})

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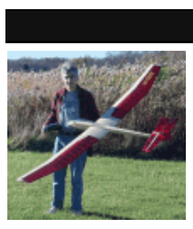

RF Cafe began life in 1996 as "RF Tools" in an AOL screen name web space totaling 2 MB. Its primary purpose was to provide me with ready access to commonly needed formulas and reference material while performing my work as an RF system and circuit design engineer. The Internet was still largely an unknown entity at the time and not much was available in the form of WYSIWYG ...

My Hobby Website: AirplanesAndRockets.com