DBW, dBm, Watts, Noise and bandwidth

1. Units and conversions commonly employed

2. EMF and PD

3. Relationship between noise power and bandwidth:

Units and conversions commonly employed

In a 50Ω system the most convenient and widely used reference level is in power and decibels relative to a thousandth of a Watt or one milliwatt =1mW or zero decibels relative to 1mW fed to 50Ω load = 0dBm. (In satellite communications design it is more usual to use dBW in calculations but otherwise dBm are more convenient.

1W (into 50Ω) = 10 $\log_{10}(1)$ = 0 dBW

1W = 1000mW = 10 $\log_{10}$ (1000) = +30dBm

10^{-3}Watts = 1mW = 0dBm = $10\log10^{-3}$ = - 30dBW.

Conversion from dBW or dBm to power in Watts is as follows:

$$P(\text{Watts}) = 10^{(dBW/10)}$$

so for example -137dBW or -107dBm $P = 10^{(-137/10)} = 2 \times 10^{-14}$ Watts

The impedance and the level in dBm are interrelated as indicated in the chart below. { NB: 0dBμV = -107dBm = -137dBW in 50Ω}.

dBuV and dBm vs. CABLE IMPEDANCE TABLE

dBμV	Power in dBm for Indicated Impedance							
	50	75	93	100	150	300	600	10 k
−60	−167	−169	−170	−170	−172	−175	−178	−180
−50	−157	−159	−160	−160	−162	−165	−168	−170
−40	−147	−149	−150	−150	−152	−155	−158	−160
−30	−137	−139	−140	−140	−142	−145	−148	−150
−20	−127	−129	−130	−130	−132	−135	−138	−140
−10	−117	−119	−120	−120	−122	−125	−128	−130
0	−107	−109	−110	−110	−112	−115	−118	−120
7	−100	−102	−103	−103	−105	−108	−111	−113
17	−90	−92	−93	−93	−95	−98	−101	−103
27	−80	−82	−83	−83	−85	−88	−91	−93
37	−70	−72	−73	−73	−75	−78	−81	−83
47	−60	−62	−63	−63	−65	−68	−71	−73
57	−50	−52	−53	−53	−55	−58	−61	−63
67	−40	−42	−43	−43	−45	−48	−51	−53
77	−30	−32	−33	−33	−35	−38	−41	−43
87	−20	−22	−23	−23	−25	−28	−31	−33
97	−10	−12	−13	−13	−15	−18	−21	−23
100	−7	−9	−10	−10	−12	−15	−18	−20
107	0	−2	−3	−3	−5	−8	−11	−13
117	10	8	7	7	5	2	−1	−3
127	20	18	17	17	15	12	9	7
137	30	28	27	27	25	22	19	17
167	60	58	57	57	55	52	49	47

EMF and PD

RF signal generators are often calibrated in electromotive force EMF or potential difference PD. If a generator is loaded with an impedance equal to its designed output impedance then the open circuit output voltage (EMF) will be halved. This correctly loaded output voltage is known as the PD.

The advantage of using EMF is that the match is not assumed.

In antenna work the antenna can be represented as and EMF source in series with an impedance which closely matches the actual practical case.

Receivers sensitivity is quoted in microvolts assuming some input impedance:

e.g. 1μV into 50Ω, $P=V^2/R$ so $P(Watts) = (10^{-6})^2/50 = 2 \times 10^{-14}$ W

1μV into 50Ω expressed in decibels with respect to a Watt (0dBW):

$10\log_{10}(2 \times 10^{-14}) = -137$dBW or since dBm = [dBW + 30]

1μV = -107dBm

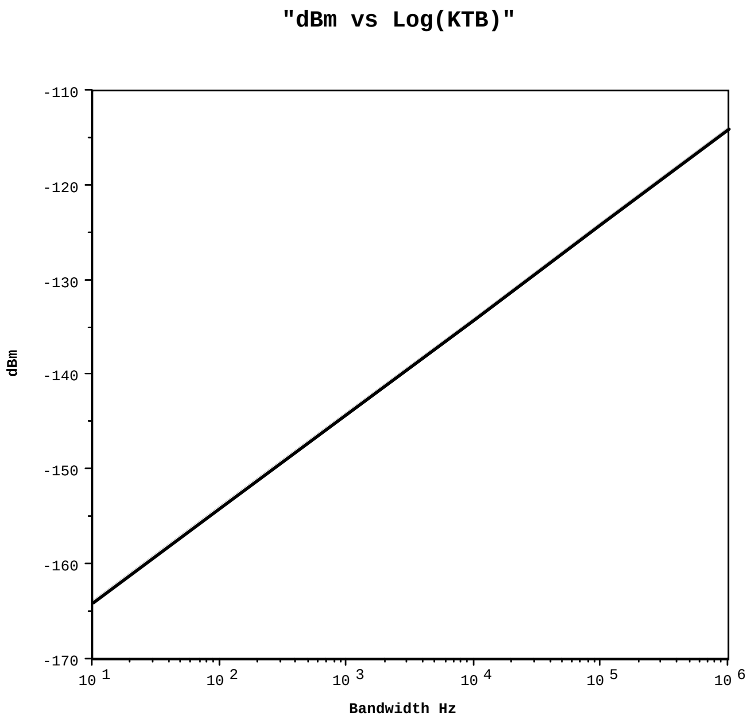
0.1μV is equivalent to -127dBm

0.01μV is equivalent to -147dBm

Also $dBW = 10\log_{10}\{(\mu V \times 10^{-6})^2/50\}$ or $\mu V \times 10^{-6} = \{(10^{dBW/10}) \times 50\}^{0.5}$

Relationship between noise power and bandwidth:

$P_n = kTB$


"dBm vs Log(KTB)"
-110
-120
-130
-140
-150
-160
-170
dBm
10 1
10 2
10 3
10 4
10 5
10 6
Bandwidth Hz