Application Note 808: Feb 27, 2002

CATV dBm, dBmV, and dBµV Conversions

Cable television systems are based on 75-ohm interfaces, while most RF test equipment is 50-ohm impedance. This paper presents the needed conversions between power and voltage levels in the two environments. Two tables are provided for easy look-up of the appropriate conversion factor.

Additional Information: Wireless Product Line Page
Quick View Data Sheet for the MAX3507
Quick View Data Sheet for the MAX3509
Quick View Data Sheet for the MAX3514/MAX3516/MAX3517
Applications Technical Support

Introduction

CATV circuits operate in a 75Ω environment. Most RF laboratories equipped with standard test instruments employ 50Ω as the standard interface impedance.

dBmV and dBµV

Most CATV measurements are referenced to voltage and measured in dBmV or dBµV. In the classic definition, dBmV is referenced to 1mVrms and output voltage (Vout) is measured in mVrms (EQN1). Since EQN1 is a ratio of voltage, it can also be measured in mVpp referenced to 1mVpp or any voltage unit as long as the same units are used.

$$dBmV = 20 \log\left(\frac{Vout}{1mV}\right); \text{(Vout in mV)} \qquad \text{EQN1}$$

Inspection of EQN1 shows dBmV to be independent of impedance.
In the classic definition, dBµV is referenced to 1µVrms and output voltage (Vout) is measured in µVrms (EQN2). Since EQN1 is a ratio of voltage, it can also be measured in µVpp referenced to 1µVpp or any voltage unit as long as the same units are used.

$$dB\mu V = 20 \log\left(\frac{Vout}{1\mu V}\right); \text{(Vout in } \mu V) \qquad \text{EQN2}$$

Inspection of EQN1shows dBµV to be independent of impedance.

Conversion of dBm to dBmV

dBm is defined in EQN3.

$$dBm = 10 \log\left(\frac{Pout}{1mW}\right) \qquad \text{EQN3}$$

Pout is measured in mW. The dBm is referenced to 1mW. EQN3 does depend on impedance of the load as shown in EQN4. Most RF equipment has a 50Ω load or input impedance. EQN3 is still valid for any load impedance including 75Ω.

Power depends on load impedance. EQN4 equates power to voltage and load impedance.

$$Pout = \frac{Vout^2}{R} \qquad \text{EQN4}$$

Rearranging terms,

$$Pout \bullet R = Vout^2 \qquad \text{EQN4.1}$$

Solving EQN3 for Pout,

$$Pout = (1 \bullet 10^{-3})10^{\frac{dBm}{10}} \qquad \text{EQN3.1}$$

Solving EQN1 for Vout,

$$Vout = (1 \bullet 10^{-3})10^{\frac{dBmV}{20}} \qquad \text{EQN1.1}$$

Substituting EQN3.1 and EQN1.1 into EQN4.1,

$$R(1 \bullet 10^{-3})10^{\left(\frac{dBm}{10}\right)} = \left((1 \bullet 10^{-3})10^{\left(\frac{dBmV}{20}\right)}\right)^2 \qquad \text{EQN5}$$

Solving for dBmV in terms of dBm,

$$dBmV = 10 \log\left(\frac{R}{1 \bullet 10^{-3}}\right) + dBm \qquad \text{EQN5.1}$$

Using R = 50Ω,

$$dBmV = 46.9897 + dBm_{50\Omega} \qquad \text{EQN5.2}$$

EQN5.2 is valid for 50Ω measurement equipment.

Solving EQN5.1 using R = 75Ω,

$$dBmV = 48.7506 + dBm_{75\Omega} \qquad \text{EQN5.3}$$

EQN5.3 is valid for 75Ω measurement equipment.
Using the same technique it can be shown that the relationship for dBµV to dBmV is

$$dB\mu V = 20 \log\left(\frac{1 \bullet 10^{-3}}{1 \bullet 10^{-6}}\right) + dBmV \qquad \text{EQN6}$$

$$dB\mu V = 60 + dBmV \qquad \text{EQN6.1}$$

Table 1 and Table 2 show conversions between dBmV, dBµV and dBm in a 50Ω and 75Ω environment.

Table 1. Conversions of Power 50 Ohms

DBmV	dBµV	DBm 50Ω	mVrms	mW 50Ω
8	68	-38.99	2.51	1.3E-04
9	69	-37.99	2.82	1.6E-04
10	70	-36.99	3.16	2.0E-04
11	71	-35.99	3.55	2.5E-04
12	72	-34.99	3.98	3.2E-04
13	73	-33.99	4.47	4.0E-04
14	74	-32.99	5.01	5.0E-04
15	75	-31.99	5.62	6.3E-04
16	76	-30.99	6.31	8.0E-04
17	77	-29.99	7.08	1.0E-03
18	78	-28.99	7.94	1.3E-03
19	79	-27.99	8.91	1.6E-03
20	80	-26.99	10.00	2.0E-03
21	81	-25.99	11.22	2.5E-03
22	82	-24.99	12.59	3.2E-03
23	83	-23.99	14.13	4.0E-03
24	84	-22.99	15.85	5.0E-03
25	85	-21.99	17.78	6.3E-03
26	86	-20.99	19.95	8.0E-03
27	87	-19.99	22.39	0.010
28	88	-18.99	25.12	0.013
29	89	-17.99	28.18	0.016
30	90	-16.99	31.62	0.020
31	91	-15.99	35.48	0.025
32	92	-14.99	39.81	0.032
33	93	-13.99	44.67	0.040
34	94	-12.99	50.12	0.050
35	95	-11.99	56.23	0.063
36	96	-10.99	63.10	0.080
37	97	-9.99	70.79	0.100
38	98	-8.99	79.43	0.126
39	99	-7.99	89.13	0.159
40	100	-6.99	100.00	0.200
41	101	-5.99	112.20	0.252
42	102	-4.99	125.89	0.317
43	103	-3.99	141.25	0.399
44	104	-2.99	158.49	0.502
45	105	-1.99	177.83	0.632
46	106	-0.99	199.53	0.796
47	107	0.01	223.87	1.002
48	108	1.01	251.19	1.262
49	109	2.01	281.84	1.589
50	110	3.01	316.23	2.000
51	111	4.01	354.81	2.518
52	112	5.01	398.11	3.170
53	113	6.01	446.68	3.991
54	114	7.01	501.19	5.024
55	115	8.01	562.34	6.325
56	116	9.01	630.96	7.962
57	117	10.01	707.95	10.024

58	118	11.01	794.33	12.619
59	119	12.01	891.25	15.887
60	120	13.01	1000.00	20.000
61	121	14.01	1122.02	25.179
62	122	15.01	1258.93	31.698
63	123	16.01	1412.54	39.905
64	124	17.01	1584.89	50.238
65	125	18.01	1778.28	63.246
66	126	19.01	1995.26	79.621
67	127	20.01	2238.72	100.237
68	128	21.01	2511.89	126.191

Table 2. Conversions of Power 75 Ohms

dBmV	dBµV	dBm 75Ω	mVrms	mW 75Ω
8	68	-40.75	2.51	8.4E-05
9	69	-39.75	2.82	1.1E-04
10	70	-38.75	3.16	1.3E-04
11	71	-37.75	3.55	1.7E-04
12	72	-36.75	3.98	2.1E-04
13	73	-35.75	4.47	2.7E-04
14	74	-34.75	5.01	3.3E-04
15	75	-33.75	5.62	4.2E-04
16	76	-32.75	6.31	5.3E-04
17	77	-31.75	7.08	6.7E-04
18	78	-30.75	7.94	8.4E-04
19	79	-29.75	8.91	1.1E-03
20	80	-28.75	10.00	1.3E-03
21	81	-27.75	11.22	1.7E-03
22	82	-26.75	12.59	2.1E-03
23	83	-25.75	14.13	2.7E-03
24	84	-24.75	15.85	3.3E-03
25	85	-23.75	17.78	4.2E-03
26	86	-22.75	19.95	5.3E-03
27	87	-21.75	22.39	6.7E-03
28	88	-20.75	25.12	8.4E-03
29	89	-19.75	28.18	0.011
30	90	-18.75	31.62	0.013
31	91	-17.75	35.48	0.017
32	92	-16.75	39.81	0.021
33	93	-15.75	44.67	0.027
34	94	-14.75	50.12	0.033
35	95	-13.75	56.23	0.042
36	96	-12.75	63.10	0.053
37	97	-11.75	70.79	0.067
38	98	-10.75	79.43	0.084
39	99	-9.75	89.13	0.106
40	100	-8.75	100.00	0.133
41	101	-7.75	112.20	0.168
42	102	-6.75	125.89	0.211
43	103	-5.75	141.25	0.266
44	104	-4.75	158.49	0.335
45	105	-3.75	177.83	0.422
46	106	-2.75	199.53	0.531
47	107	-1.75	223.87	0.668

48	108	-0.75	251.19	0.841
49	109	0.25	281.84	1.059
50	110	1.25	316.23	1.333
51	111	2.25	354.81	1.679
52	112	3.25	398.11	2.113
53	113	4.25	446.68	2.660
54	114	5.25	501.19	3.349
55	115	6.25	562.34	4.216
56	116	7.25	630.96	5.308
57	117	8.25	707.95	6.683
58	118	9.25	794.33	8.413
59	119	10.25	891.25	10.591
60	120	11.25	1000.00	13.333
61	121	12.25	1122.02	16.786
62	122	13.25	1258.93	21.132
63	123	14.25	1412.54	26.604
64	124	15.25	1584.89	33.492
65	125	16.25	1778.28	42.164
66	126	17.25	1995.26	53.081
67	127	18.25	2238.72	66.825
68	128	19.25	2511.89	84.128

September 2001

MORE INFORMATION

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MAX3509:	QuickView	-- Full (PDF) Data Sheet (232k)	-- Free Sample
MAX3510:	QuickView	-- Full (PDF) Data Sheet (152k)	-- Free Sample
MAX3514:	QuickView	-- Full (PDF) Data Sheet (544k)	-- Free Sample
MAX3516:	QuickView	-- Full (PDF) Data Sheet (544k)	-- Free Sample
MAX3517:	QuickView	-- Full (PDF) Data Sheet (544k)	-- Free Sample