W2AEW

WHAT IS dBm, dBmV, dBuV, dBc ...?

... AND WHY DO WE USE THESE UNITS ON A SPECTRUM ANALYZER?

WHAT IS A dB?

A LOGARITHMIC EXPRESSION OF THE RATIO OF TWO POWER LEVELS

$$10 \times LOG_{10}\left(\frac{P1}{P2}\right) \quad \text{(not LN)}$$

P1	P2	$\frac{P1}{P2}$	dB
1	1	1	0
2	1	2	3
10	1	10	10
0.5	1	0.5	-3
7.2	1.6	4.5	6.5
100	1	100	20
1000	1	1000	30

LOGARITHMS TURN $\times$ & $\div$ INTO $+$ & $-$

LARGE VARIATIONS IN RATIOS CAN BE EXPRESSED ON A REASONABLE SCALE

SINCE A dB IS A RATIO, IT IS NOT AN ABSOLUTE QUANTITY, LIKE A WATT, ETC.

WE CAN SAY...

... THIS SIGNAL IS 3dB GREATER THAN THAT ONE.

WE CANNOT SAY...

... THIS SIGNAL LEVEL IS 3dB.

TO MAKE IT AN ABSOLUTE QUANTITY, WE MUST SPECIFY OR IMPLY A REFERENCE!

KNOWING THE REFERENCE THE RATIO BECOMES AN ABSOLUTE VALUE!

EXAMPLES...

... THIS SIGNAL IS TWICE AS BIG AS XXX
... THIS SIGNAL IS HALF THE VALUE OF YYY

THE SUFFIX AFTER dB_ IMPLIES THE REFERENCE!

dBm → REFERENCE IS MILLIWATT (mW)

dBμ → REFERENCE IS MICROWATT (μW)

dBmV → REFERENCE IS MILLIVOLT (mV)

THE SUFFIX CAN TURN dB INTO AN ABSOLUTE QUANTITY dBm

EXAMPLE

10 MHz SINEWAVE AT 950 mVpp INTO 50Ω

$$V_{pp} = 950\,mV$$

$$V_{RMS} = V_{pp} / 2\cdot\sqrt{2} = \frac{950mV}{2\cdot\sqrt{2}} = 336\,mV_{RMS}$$

THEREFORE, THE POWER IN THE 50Ω LOAD IS:

$$P = \frac{(V_{RMS})^2}{R} = \frac{0.336^2}{50} = 2.256\,mW$$

TO EXPRESS THIS IN dBm, THE REFERENCE IS 1 mW

$$dBm = 10\cdot LOG_{10}\left(\frac{2.256\,mW}{1\,mW}\right) = \underline{3.53\,dBm}$$

IN dB_N, REFERENCE IS 1 nW

$$dB_N = 10\cdot LOG\left(\frac{2.256\times10^{-3}}{1\times10^{-6}}\right) = 33.53\,dBm$$

WHAT ABOUT COMPARING VOLTAGE RATIOS?

THE dB RELATES TO POWER ...

... SO WE HAVE TO CALCULATE POWER

$$10 \cdot \log\left[\frac{\frac{V_1^2}{R}}{\frac{V_2^2}{R}}\right]$$

$$10 \cdot \log\left[\frac{V_1^2}{R} \cdot \frac{R}{V_2^2}\right]$$

$$10 \cdot \log\left[\frac{V_1^2}{V_2^2}\right]$$

$$10 \cdot \log\left[\left(\frac{V_1}{V_2}\right)^2\right]$$

$$2 \cdot 10 \cdot \log\left[\frac{V_1}{V_2}\right]$$

ASSUMING EQUAL IMPEDANCE

$$20 \cdot \log\left[\frac{V_1}{V_2}\right]$$

THUS, OUR 950mVpp CAN BE EXPRESSED IN dBmV

$$dBmV = 20 \cdot \log\left(\frac{336mV}{1mV}\right) = 50.5 dBmV$$

WHAT ABOUT dBc?

- dBc MEANS IT IS dB RELATIVE TO SOME "CARRIER" POWER LEVEL

- VERY COMMON IN RF APPLICATIONS