The Decibel Measurement System

Because the actual calculation of decibel measurements is seldom required in practical applications, the explanation is somewhat simplified. Most modern test equipment is designed to measure and indicate decibels directly which eliminates the need for complicated mathematical calculations. Nevertheless, a basic explanation of the decibel measurement system is necessary for you to understand the significance of dB readings and equipment gain ratings which are expressed in decibels.

The bel is a unit that expresses the logarithmic ratio between the input and output of any given component, circuit, or system and may be expressed in terms of voltage, current, or power. Most often it is used to show the ratio between input and output power. The equation is as follows:

$V = 10 \log \frac{Pout}{Pin}$ $\frac{Pout}{Pin} = 10^{(V[dB])/10}$ (1)

When you speak of the dB level of a signal, you are really speaking of a logarithmic comparison between the input and output signals. The input signal is normally used as the reference level. However, the application sometimes requires the use of a standard reference signal. The most widely used reference level is a 1-milliwatt signal. The standard decibel abbreviation of dB is changed to dBm to indicate the use of the 1-milliwatt standard reference. Thus, a signal level of +3 dBm is 3 dB above 1 milliwatt, and a signal level of -3 dBm is 3 dB below 1 milliwatt. Whether using dB or dBm, a plus (+) sign (or no sign at all) indicates the output signal is larger than the reference; a minus (-) sign indicates the output signal is less than the reference.

$V = 10 \log \frac{Pout}{1\ mW}$ $Pout = 1\ mW \cdot 10^{(V[dB])/10}$ (2)

The reason for using the decibel system when expressing signal strength may be seen in the power ratios in the following table. For example, to say that a reference signal has increased 50 dB is much easier than to say the output has increased 100,000 times. The amount of increase or decrease from a chosen reference level is the basis of the decibel measurement system, not the reference level itself. Whether the input power is increased from 1 watt to 100 watts or from 1,000 watts to 100,000 watts, the amount of increase is still 20 decibels.

30 dB = 1000 - times,

3 dB = 2 - times ,

-3 dB = 0.5 - times

36 dB you calculate as (30+3+3) dB = 1000 · 2 · 2 = 4000 - times,

27 dB = (30 - 3) dB = 1000 / 2 = 500 - times.

You can calculate with the reference level by the same way:

30 dBm = 1000 · 1mW = 1W

60 dBm = 1000 W

99 dBm = 8,000,000 W,

The following table ist useful certainly:

level (dB)		factor	level (dB)		factor
1	=	1.3	10	=	10 = 101
3	=	2.0	20	=	100 = 102
5	=	3.2	30	=	1000 = 103
6	=	4.0	40	=	10.000 = 104
7	=	5.0		...	
9	=	6.0	140	=	1014

Source: http://www.radartutorial.eu/18.explanations/ex15.en.html