Decibels

We have all heard the term “dB”. This is an abbreviation for decibel.   We should note the correct spelling for “db” is the little letter “d” followed by the capitol letter “D”. A decibel is a measure of power and is usually related to electrical power rather than for example vehicle power or the power of a light source.

The Decibel is actually a subunit of a larger unit called the bel. As originally used, the bel represented the power ratio of 10 to 1 between the strength or intensity i.e., power, of two sounds, and was named after Alexander Graham Bell. Thus a power ratio of 10:1 = 1 bel, 100:1 = 2 bels, and 1000:1 = 3 bels. Since the bel is a rather large unit, its use may be inconvenient. Usually a smaller unit, the Decibel or dB, is used. 10 decibels make one bel. A 10:1 power ratio, 1 bel, is 10 dB; a 100:1 ratio, 2 bels, is 20 dB.

We sometimes hear that a dB defined as the least change in volume or electrical power that the human ear can ascertain. This is true, but this is not the reason one dB is the level that it is. No one including Alexander Graham Bell said lets change the level until we can hear the difference and call it one dB. Mathematics or more correctly logarithms determines one dB and it just so happens that one dB is the smallest discernible level change.

Without in depth math and logarithms to prove it is understood that three dB is twice the power of zero dB and minus three dB is one half the power of zero dB. Ten times the power is equal to 10 dB and one tenth of the power is a minus 10 dB. The relationship between power and dB is not linear. The relationship is logarithmic. When we change power or a decibel by one the other does not change by one. Logarithmic formulas are used to determine the amount of change. We will not discuss logarithmic formulas today, but will only state simple relationships.

Tables are available in text books and the internet that give the relationship between dB and power. They should be used for all but the simplest of relationships such as three dB equaling twice the power and 10 dB equaling ten times the power. Do not try to mentally extrapolate other relationships between dB and power. Remember the relationship is not linear.

dB	Pwr Ratio
0	1.00
0.5	1.12
1.0	1.26
1.5	1.41
2.0	1.58
3.0	2.00
4.0	2.51

5.0	**3.16**
6.0	**3.98**
7.0	**5.01**
8.0	**6.31**
9.0	**7.94**
10.0	**10.0**

Power and hence dB can be expressed in absolute units by using 1 Watt (or 1 milliwatt) as the reference power. We then call it dBW or dBm. Note the correct spelling. Also note that dBW is based on one watt and that dBm is based on one milliwatt.

Zero dBm is one milliwatt of power. Using the general relationship we learned earlier we can say that three dBm is 2 milliwatts. And, ten dBm equals 10 milliwatts. And the same is true for negative dBm's. Again as we mentioned a few moments ago do not try to extrapolate other relationships between dBm's and power expressed in watts or milliwatts. Use a reference book or the internet.

Just as a side note in the world of audio processing zero dBm is considered to be one milliwatt of power developed across a 600 ohm load. Typically commercial audio systems are based on 600 ohm impedance's similar to coax cable in amateur radio is usually 50 ohm impedance.

Why are we concerned about dBm? In broadcasting, audio processing and in many other related fields the audio power that is processed, broadcast or recorded is measured by dBm's as it is referenced to one milliwatt. The manufacturer of your radio rig used this to determine and provide the proper relationship between you microphone and the rigs audio input. There are several different levels of input needed among all the amateur equipment on the market today. By having the specifications for microphones and the audio input of your rig you can better understand and that assure you will have a match that is correct.

The term dBi is used in measuring antenna gain and is the gain of an antenna referenced to an isotropic radiator. An isotropic radiator is an antenna that produces useful electromagnetic field output in all directions with equal intensity, and at 100-percent efficiency, in three-dimensional space. In other words this is the absolute ideal antenna with RF radiation equal in all directions. The gain numbers you see associated with various antennas is measured in dBi. The relation between dBi and RF power is the same as we have discussed for dB's in general.

The expression dBd uses a dipole radiator as a reference. A dipole radiator is 2.15 dB greater than an isotropic radiator. The relationship between dBd and RF power is the same as we previously discussed for dB's. When reviewing antenna specifications always determine whether the gain specifications for an antenna are in dBi or dBd. Add 2.15 dB to the dBi gain figures to obtain the dBd gain. Subtract

2.15 dB from dBd gain figures to obtain dBi gain. Antenna gain expressed in dBd will always be 2.15 dB more than dBi.

There are several other forms of decibels depending on what they are referenced to. If you see a dB expression that you are not familiar with check a good reference book or search the internet.

We hope this discussion has added to your knowledge of dB's. Remember it is better to look up complicated db relationships that try to extrapolate them mentally as the relationship is not linear.