**Decibels.**Decibels are in common use in radio electronics and telecommunications to express the ratio between two measurements of electrical power. It must be understood that the dB doesn't have to relate to any fixed level of signal and can be used purely to describe the ratio of two signal levels.

Decibels are expressed in a logarithmic manner which just happens to be the way the human ear and brain perceives sound levels.

The decibel is used rather than arithmetic ratios or percentages because when certain types of circuits, such as amplifiers, attenuators, feed-lines and antennas are connected in series, expressions of power level in decibels may be arithmetically added and subtracted to easily obtain an overall figure for power gain or power loss.

A very large range of ratios can be expressed with decibel values of moderate size, allowing one to clearly visualise huge changes of some quantity, such as power level.



*The formula for calculating power gain in decibels*

|  |  |
| --- | --- |
| **Power Ratio** | **dB level**  |
| x 0.001 | -30dB  |
| x 0.01 | -20dB  |
| x 0.1 | -10dB  |
| x 0.5 | -3dB  |
|  x 2 | +3dB  |
| x 4 | +6dB  |
| x 8 | +9dB  |
| x 10 | +10dB  |
| x 100 | +20dB  |
| x 1000 | +30dB  |

Common power ratios and their corresponding dB value

It can be seen how a large power ratio such as 1000 times can be expressed as -30dB for a power loss or +30dB for a power gain.

Note also that a doubling of power level from x4 to x8 involves nothing more than adding 3dB to the existing dB level of 6dB to give 9dB total gain.

**Link Budget:**

Decibels are used to account for the gains and losses of a signal from a transmitter to a receiver through some medium (free space, coax cable etc.) using a Link Budget. This is the method for accounting for all of the gains and losses in a system by adding and subtracting the relative decibel values of gain/loss for each element in the system.

**Example:**

Suppose a 10W VHF transmitter is connected to a 100W amplifier and then through a coaxial feed-line which reduces the signal level by half. The feed-line connects to a Yagi antenna with a gain of 4.

It would be tedious to make the calculation once but imagine making the calculation over and over after trying different feed-line characteristics or antenna gain values.

Using the link budget method it is a simple matter of adding up the decibel values of the gains / losses e.g.

|  |  |  |  |
| --- | --- | --- | --- |
| **Amplifier**  | **Feed-line**  | **Antenna**  | **Total**  |
| **10dB**  | **- 3dB**  | **+ 6dB**  | **=  + 13dB(or 200W ERP)** |

Any improvements made to the system such as using a shorter run of better coax, or raising the power, mean that you can simply add the extra dB improvement figure directly to the existing total.

**An easy to remember guide is:**

3dB is a doubling of power, 6dB is a doubling twice of the power, for example, if you had 5 watts output to an antenna with a 3dB gain, the effective radiated power (erp) would be 10 watts, the same 5 watts into a 6dB gain would be 5 watts doubled = 10 watts, doubled again = 20 watts erp. 9 dB gain would give 40 watts erp.

A 10dB gain is 10 times, with 20dB being 10 times again, using the 5 watt example would give 50 watts (10dB) and 500 Watts (20dB).

Losses work the same way, 3dB loss is half the original power and 6dB loss would be half of the 3dB figure. 10dB loss is the power level divided by 10 and 20dB is the 10dB figure divided by 10.
5 watts with 20dB loss becomes 0.05 watts!

**History of Decibels**

The **bel** (symbol **B**) is mostly used in telecommunication, electronics, and acoustics. Invented by engineers of the Bell Telephone Laboratory, it was originally called the *transmission unit* or *TU*, but was renamed in 1923 or 1924 in honour of the laboratory's founder and telecommunications pioneer Alexander Graham Bell. The bel was too large for everyday use, so the decibel (dB), equal to one tenth of a bel (B), was adopted.

**History of Logarithms**

Logarithms were introduced in the year 1614 by the mathematician John Napier. Prior to the invention of calculators and computers logarithms (or logs) were the only practical method of performing complicated multiplication and division. They were used extensively in all aspects of science, navigation, surveying and other branches of practical mathematics. The most commonly used logs, and those used in decibel calculations, are logs to the base of 10. These are shown as log10