# Decibels in the context of ADSL

19 Jonathan Tue, Jul 25, 2017 Broadband / IC-Air 3851

## The decibel

The decibel is a logarithmic unit which specifies the ratio of two powers. It was devised originally for use in telephone transmission systems. The original unit was the Bel, and it is defined as:

```
Number of Bels = logarithm (base 10) of the ratio OutputPower / InputPower
```

For use in telephone systems, the Bel is rather too large a unit for many purposes, so the decibel (dB) is usually used instead. There are 10 decibels in a Bel.

Although the decibel is rather unfamiliar to most people, it is actually quite a convenient way of specifying a power gain or loss, and it has some advantages. For example, some way of specifying a power ratio is needed because:

1. Because of the way that logarithms work, the overall gain of several cascaded stages can be calculated by adding the power ratios of the gains of each stage. This is a lot easier than multiplying and dividing the power ratios.
2. The log of a number less than 1 is negative, so all power gains have positive dB values. If the input and output powers are equal, then the gain is 0 dB. Losses have negative dB values.

**Some example values**

| Decibel value | Arithmetic equivalent |
|---|---|
| -6 dB | 0.25 |
| -3 dB | 0.5 |
| 0 dB | 1 |
| 3 dB | 2 |
| 6 dB | 4 |
| 10 dB | 10 |
| 20 dB | 100 |
| 30 dB | 1000 |

## Attenuation

Ordinary twisted pair telephone lines were not designed for the high frequencies used for ADSL, and the user will find that the strength of the signal decreases with the length of the line. The extent to which a signal is weakened is called the attenuation, and it is usually measured in decibels. The greater the attenuation, the weaker the signal that reaches the exchange and the user. What may surprise you is just how much gets lost...

On 6 September 2006, the limiting attenuation figure for all UK ADSL installations was increased from 85 dB to 100 dB. This change was made because the higher figure was considered adequate for virtually all circumstances, and it would allow a few more customers to receive an ADSL service. 100 dB represents a power ratio of about 32 million. Lower levels of attenuation are obviously preferable.

## Signal-to-noise ratio

Just as much information can be lost in the telephone network as a result of noise as a result of attenuation. Noise is added to the signal in the telephone exchange, in the customer's equipment, and in the line itself. The ratio between the power of the received signal and the power of the noise is called the signal-to-noise ratio, or SNR. The greater this ratio is, the better the received signal is likely to be.

The limiting value of SNR is usually taken to be 6 dB (or 6 Bels). This corresponds to a power ratio of 4. Lower values of SNR will make it very difficult to separate out a clean ADSL signal.

It should be noted that ADSL modems and routers usually provide a noise margin (or SNR margin) which is the measured SNR minus the minimum SNR. For example, if the minimum SNR is 6 dB and the measured SNR was 10 dB, then the modem/router would report a noise margin of 4 dB.

## Decibels used as power measurement

As described above, decibels specify a ratio between two numbers. For example, if a signal is attenuated by 3 dB, then the power ratio is 2. If it is attenuated by 6 dB, then the power ratio is 4. If it is attenuated by 10 dB, then the power ratio is 10.

Sometimes, however, decibels are used to specify the power of a signal. This is done by specifying a reference power level, and then the power is specified as that number of dB above or below the reference level. For example, if the reference level is 1 mW, then a power of 2 mW is 3 dB above the reference level, and a power of 10 mW is 10 dB above the reference level. The power is converted to dB, and then the power is specified as that number of dBm. For example:

| Power | dBm equivalent |
|---|---|
| 1 mW | 0 dBm |
| 2 mW | 3 dBm |
| 10 mW | 10 dBm |

| | |
|---|---|
| 100 mW | 20 dBm |
| 1 W (1000 mW) | 30 dBm |
| 100 W (100,000 mW) | 50 dBm |

Most modern routers report the upstream and downstream power levels in dBm from the exchange. In (or remote) power is the power transmitted by the DSLAM or MSAN in the

Online URL: https://kb2.ic.uk/article.php?id=19