What is **dBi** ?

When we do calculations using antenna gain, we have a technique for converting to dB units. Let's first review the meaning of antenna gain. When we talk of antenna gain, we refer to a focusing of the radar beam by the antenna to increase power in certain directions.

The antenna is compared to a mathematical ideal, the isotropic antenna. (*Isotropic - equal in all directions*). For an ideal isotropic antenna, radiation is distributed uniformly on the surface of a sphere of radius R surrounding the antenna. The surface area of such a sphere is A = $4\pi R^2$. The power density at the surface is just the power P divided by the surface area A.

$$\text{Power density} = P / A = P / 4\pi R^2$$

When we talk about antenna gain G, we use it as a multiplier compared to a mathematically ideal isotropic antenna. Where are we getting the extra power to get antenna gain? We can't change the total power of the antenna, we are just redistributing it. We reduce the power in directions we do not want an antenna beam, and increase it greatly in areas in which we do want high antenna power. The power density, *in the mainbeam only*, is described as

$$\text{Power density} = P \cdot G / 4\pi R^2$$

G is said to be the gain of the antenna. Note that a gain of 1 gives the same power density as an isotropic antenna. We say that the gain is referenced to an isotropic antenna. If we compare power density, for the same transmit power and the same range, we can use the dB formula to get

$$dB = 10 \cdot \log_{10}(P_{antenna}/P_{isotropic})$$

$$= 10 \cdot \log_{10}[(P \cdot G / 4\pi R^2)/(P / 4\pi R^2)]$$

$$= 10 \cdot \log_{10}(G)$$

Why did we go through a long-winded derivation to get a simple result such as the one above? The key reason for doing this is so that we know that we always go back to the definition of a power ratio when dealing with dB.

When we want to compare antenna gain to an absolute level, we use

$$dBi = 10 \cdot \log_{10}(G)$$

The correct pronunciation of this is *dBi*, or *decibels relative to isotropic*.

Antenna gain is also referred to in comparison to other power levels besides an isotropic radiator. When this is done, the antenna gain is referred to as dB.

dbi   db

For example, a particular sidelobe of an antenna may be said to be some negative number, say -20 dB. This is taken to mean that the gain of that sidelobe (for that particular look angle and antenna) are down 20 dB compared to the mainlobe. One must be careful to distinguish between gain relative to an isotropic antenna (dBi) and gain relative to something else (dB), usually the antenna mainbeam.

To prevent errors, always think of what powers are being compared when using antenna gain. The choices for reference power are isotropic antenna (dBi), antenna mainbeam (dB), or some other antenna (dB).

   dBi is usually a positive number,

   antenna mainbeam dB are almost always negative,

   other antenna comparisons may be positive or negative.

The decibel calculator can be useful for these problems. All these questions relate to the antenna pattern shown below.

1. 37dbi

2. 13db isotropic

1. An antenna gain is said to be 37 dBi. What is the power ratio this corresponds to?
2. The same antenna has a first sidelobe down 13 dB. How many dBi does this represent? What is the power ratio of this sidelobe compared to isotropic?
3. A far antenna sidelobe is -2 dBi. How many dB down from the peak is this?
4. A different antenna has 4 dB more gain than this antenna. What is the power ratio between the two antennas for the same input signal strength?
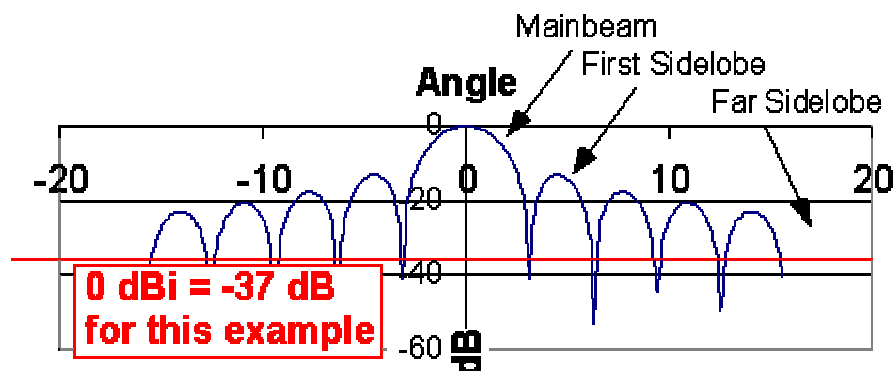
What   is   **dBi ?**   **Hint 1 !**

The decibel calculator can be useful for these problems. All these questions relate to the antenna pattern shown below.

   1.

$$37 \text{ dBi} = 10 \cdot \log_{10}(G)$$

2. The first sidelobe is down 13 dB. Down 13 dB from what? Note the power ratio aspect of this problem is similar to the previous one.
3. You are now given a -2 dBi sidelobe. To find out how far down it is from the peak, you will have to use the peak gain.
4. This problem, with 4 dB greater gain, is similar to the other dB problems you have done. The solution is similar as well.

What   is   **dBi ?**   **Hint 2 !!**

The decibel calculator can be useful for these problems. All these questions relate to the antenna pattern shown below.

   1.

$$G = 10^{(37/10)}$$

2. The first sidelobe is down 13 dB from the peak gain of 37 dBi. Once you determine the fist sidelobe gain in dBi, use the formula from the previous problem to solve for the gain G of the first sidelobe, using the number of dBi you just calculated.

3. You are now given a -2 dBi sidelobe. The peak gain is 37 dBi. How many dB down is this?

4.

$$4 \text{ dB} = 10 \cdot \log_{10}(\text{Power ratio})$$

What is the power ratio?

What is **dBi ?**   **Solution**

The decibel calculator can be useful for these problems. All these questions relate to the antenna pattern shown below.

1.

$$G = 10^{(37/10)}$$
$$= 10^{(3.7)}$$
$$\approx 5000$$

2. The first sidelobe gain in dBi = 37 dBi - 13 dB = 24 dBi.

$$G = 10^{(24/10)}$$
$$= 10^{(2.4)}$$
$$\approx 250$$

3. 37 dBi - (-2 dBi) = 39 dB down from the peak.
   In this problem, you have seen a negative value in dBi. This occurs occasionally; the negative dBi values you will see will typically be very small.

4.

$$\text{Power ratio} = 10^{(4/10)}$$
$$= 10^{(0.4)}$$
$$\approx 2.5$$

∗ http://www.radarproblems.com/ 에서 발췌함.