SONA OPTICAL WIRELESS

Application Brief - Link Margin and Free Space Optics

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There are a lot of claims out there in the optical wireless industry, some of which may be a bit confusing, or even a bit hard to believe. A parameter as straightforward as "output power" may not be quite what you think. The fundamental concept of "link margin" is defined differently for different products. How can you be sure that what you hear is true? How can you distinguish the real market from a clever marketing slant?

All you need is a little straight-talk

The basic ideas that describe how an FSO link works are not too complicated. As usual, however, there is a difference between theory and practice. It is one thing to describe an FSO system on paper (or in a brochure), and quite another to have a robust and reliable system working in the field. Understanding some of the subtleties involved in achieving optimal performance will allow you to make intelligent decisions about FSO, and can help separate product from product hype.

Shedding Light on the Subject

The key to a reliable free space optics link is getting as much light as possible from one transceiver to the other. For a given distance between terminals and set of weather conditions, there are two simple yet fundamental questions to ask; how much light is being transmitted from one end, and how much light is being received at the other end? There is a difference between the two because the light gets attenuated to some degree in the atmosphere, as shown in figure 1. Just as one can see buildings several kilometers away on a clear day, so can an FSO transceiver. On a foggy day, however, when it is difficult to see the house in front of you, an FSO link will also have a harder time.

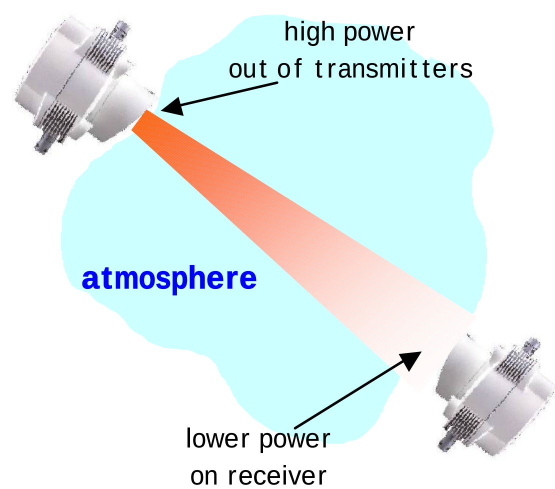

Figure 1 *Atmospheric Attenuation*

On the transmit side, the higher the output power of the laser the better. More power means you can penetrate further through the atmosphere to get longer link ranges. Or, conversely, for a given range, higher power increases the availability of the link because it can handle more difficult weather (e.g. thicker fog). Of course, transmitting a lot of power isn't much good unless it is received at the other end. For this, a larger receive diameter is better as it collects more of the incident light. The receiver itself should be designed to accept as low a signal level as possible.

What is Link Margin?

Probably the single most significant parameter in describing the performance of an FSO link is the link margin. Basically, this is the amount of light received by a terminal over and above what is required to keep the link active (hence the term "margin"). This is usually measured in dB (decibels), where… $dB = 10 \bullet \log(\frac{\text{power}}{\text{min. power}})$.

ratio of $\frac{\text{power}}{\text{min. power}}$	Link Margin (dB)
2	3
10	10
100	20

For example, suppose the receiver must see a minimum of 2 microWatts of power in order to keep the link active. If the transmitter puts out enough power so that the receiver actually sees 4 microWatts, then the link margin is 3dB (twice the power required to keep the link active). This means that up to half the power of the transmitted beam can be attenuated in the atmosphere before the link goes down.

As straightforward as this definition is, it can be manipulated to yield somewhat misleading results. Some vendors, for example, define link margin using the power coming directly out of the transmitter, rather than the power being received at the other end. This number will generally be larger (due to the atmospheric attenuation of the signal), yielding a more attractive-sounding link margin. Even more misleading is when the power referred to is that of the laser itself within the system. If the optical system is not efficient, the actual output power emanating from the terminal can be significantly less than that of the laser. Consequently, the real link margin (according to the above definition) could be much less than the value stated.

It is important to understand that the link margin of a particular FSO link is a direct function of the atmospheric conditions as well as the distance (i.e. range) between the terminals. The transmitters may be capable of outputting a certain maximum amount of power, regardless of weather or range, but the amount of light actually received by the receiver will vary. For example, a link in Tucson, AZ, where the worst-case atmospheric attenuation is generally low, may have a link margin of 30dB. That same link in foggy London, however, would have a considerably lower margin. Similarly, a 2-km link will have a lower link margin than a 1-km link, because of the greater atmospheric attenuation over the longer range. Therefore, it is not enough to simply state a link margin for a particular system. It is necessary to specify the range and the typical or worst-case weather conditions as well.

The fSONA Advantage

Now that we have a common and correct understanding of what makes an FSO link work, it is easy to see how fSONA's SONAbeam™ products stand out among the crowd…

- The SONAbeam™ has about **30 times more power** than its nearest competitors. Because it transmits at a wavelength of 1550nm – a spectrum band to which the human eye is insensitive – the lasers easily meet class 1M eye safety regulations.
- Multiple lasers are used to increase the total power and, more importantly, to provide a level of **redundancy** to ensure that this power is not lost.
- With all the relevant factors taken into account (power, receiver design, etc…), the link margin of the SONAbeam™ is **11 to 14 times greater** (10.4 to 11.5 dB) than its nearest competitors.

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