WHEN TO USE THE POWER AMPLIFIER

Power amplifier (PA) is useful when there is a requirement to boost the signal in an RF link. In general, usage of power amplifier must be considered after other possibilities of increasing the total system gain have been explored.

The received signal in an RF link under Line of Sight conditions is given by Friis transmission formula:

$$P_r = P_t + G_1 + G_2 - P_L - L$$

where P_r is the received power, G_1 and G_2 are the antenna gains, P_L is the path-loss and L is the sum of other losses such as cable and connector losses. The transmitter that sends the modulated signal has an output power level of P_t. The receiver which receives the modulated signal has a **receive threshold** denoted by T. The receive threshold is the minimum signal which can be detected by the receiver so as to be able to retrieve (down convert and demodulate) the base band data. In other words, if the signal received is lower than the receive threshold, the base band data cannot be retrieved properly. The receive threshold is also referred to as **receiver sensitivity**. For proper operation of a radio link, the signal received should considerably be above the receive threshold of the receiver. The difference between the actual signal level received and the receive threshold is defined as the **fade margin.** Thus in an RF link the parameters that can be varied to increase P_r are the antenna gains, cable losses and the transmit power P_t. Cable losses can be reduced by selecting suitable low loss cables. Usually thicker cables will have lower losses. However, thicker cables are more expensive and are less flexible than thinner cables. The thicker cables are also difficult to route due to their non-flexibility. However, usage of outdoor radio units eliminates RF cable losses and routing problems and hence are highly recommended for use whenever possible. Other key parameters that can be varied are the gains of transmit and receive antennas. In general larger antennas will have larger gains. However, larger antennas are more expensive and cause wind loading. The towers on which the antennas are mounted must be able to withstand the wind loading due to the antennas. Again larger and stronger towers are more expensive and demand larger and stronger foundations that have direct cost and space implications.

Therefore, use of PA may be considered* under following conditions:

1. The radio network involves omni directional or sectoral antennas. In this case, the antenna gain cannot be increased beyond a point.

2. A link is already installed and there is insufficient fade margin due to improper prior planning.

3. The distance between the sites is so large that the link requires very large antennas and/or tall towers.

4. The receive sensitivity and/or the transmit power are inadequate to ensure a healthy fade margin.

5. There is RF interference after installation that needs to be tackled.

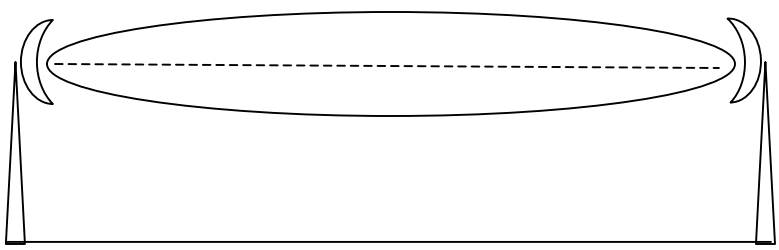
6. The towers heights are large even for 60% Fresnel zone clearance (see the note below on Fresnel zone clearance) and further increase in height turns out to be prohibitive due to cost, size, space and weight constraints.

7. There is constraint on mounting height of the antenna, and so on.

* Note: Local regulations regarding maximum transmitted power and effective radiated power (ERP) need to be adhered to when designing RF links.

Fresnel Zone Clearance

Fresnel zone is an ellipsoid of revolution whose axis is the straight line connecting the transmit and receive antennas. (See Fig. below). For clear propagation, no obstacle (including the ground) should encroach into the Fresnel ellipsoid.



The cross sectional radius R_F of Fresnel ellipsoid is given by

$$R_F = 31.6\sqrt{\frac{d_1 d_2}{d_1 + d_2}\lambda}$$

where, R_F is in meters, d_1 and d_2 are distances in kilometers of a point between transmitter location T and receiver location R, respectively, and λ is the wavelength in meters. For minimum diffraction Loss, a clearance of at least $0.6R_F$ is required.