

Link Budget

Electrical Engineering

Adding gains and subtracting losses in decibels to predict what a receiver will see.

Received power is transmitted power plus both antenna gains, minus path loss and every other loss.

$$P_r(\text{dBm}) = P_t + G_t + G_r - \text{FSPL} - L$$

2.4 GHz over 100 m

Free space.

FSPL $\approx$ 80 dB

Twice the distance

Inverse square.

6 dB more loss

Twice the frequency

Fixed aperture.

6 dB more loss

THE COMMON MISTAKE

✗ **Reading free-space loss as absorption**

✓ **It is a fixed power spreading over area**

Nothing absorbs the energy in free space. The same power simply covers a larger sphere, so less lands in the receiving aperture.

FSPL(dB) = 32.44 + 20 log f(MHz) + 20 log d(km). A fade margin on top covers rain, multipath and obstruction.