

LINK BUDGET CALCULATIONS FOR HIGH ALTITUDE WEATHER BALLOON

LINK DISTANCE: 500Km (LOS)

Free space loss:

$$D = 500\text{Km}$$

$$F = 433\text{MHz}$$

$$L_{FS} = 32.45 + 20\log(500) + 20\log(433) = (32.45 + 53.97 + 52.73) \text{ dB} = \mathbf{139.15 \text{ dB}}$$

On board antenna:

Half wave dipole:

$$G_{\text{dipole}} = \mathbf{5 \text{ dBi}}$$

GCS antenna:

3 director 1 reflector Yagi Uda antenna driven by half wave folded dipole:

$$G_{\text{yagi}} = \mathbf{12 \text{ dBi}}$$

FOR BALLOON TO GCS COMMUNICATION:

PA LNA on balloon as well as GCS.

$$P_{\text{balloonTX}} = \mathbf{27 \text{ dBm}}$$

$$L_{\text{TX}} = \mathbf{2 \text{ dB}}$$

$$L_{\text{RX}} = \mathbf{2 \text{ dB}}$$

$$L_{\text{misc}} = \mathbf{1 \text{ Db}}$$

$$G_{\text{RX_LNA}} = \mathbf{14 \text{ dB}}$$

LINK BUDGET:

$$P_{\text{RX}} = P_{\text{TX}} + G_{\text{RX_LNA}} + G_{\text{TX}} + G_{\text{RX}} - L_{\text{TX}} - L_{\text{FS}} - L_{\text{misc}} - L_{\text{RX}}$$

$$P_{\text{RX}} = \mathbf{27 + 14 + 5 + 12 - 2 - 139.15 - 1 - 2 = \underline{\underline{-86.15 \text{ dBm}}}}$$

$$\text{RX sensitivity (50 kbps)} = \mathbf{-109 \text{ dBm}}$$

$$\text{Margin} = \mathbf{109 - 86.15 = \underline{\underline{22.85 \text{ dBm}}}}$$

FOR GCS TO BALLOON COMMUNICATION:

PA LNA on balloon as well as GCS.

$$P_{\text{GCS_TX}} = 30 \text{ dBm}$$

$$L_{\text{TX}} = 2 \text{ dB}$$

$$L_{\text{RX}} = 2 \text{ dB}$$

$$L_{\text{misc}} = 1 \text{ Db}$$

$$G_{\text{RX_LNA}} = 14 \text{ dB}$$

LINK BUDGET:

$$P_{\text{RX}} = P_{\text{TX}} + G_{\text{RX_LNA}} + G_{\text{TX}} + G_{\text{RX}} - L_{\text{TX}} - L_{\text{FS}} - L_{\text{misc}} - L_{\text{RX}}$$

$$P_{\text{RX}} = 30 + 14 + 12 + 5 - 2 - 139.15 - 1 - 2 = \underline{\underline{-83.15 \text{ dBm}}}$$

$$\text{RX sensitivity (50 kbps)} = \underline{\underline{-109 \text{ dBm}}}$$

$$\text{Margin} = 109 - 83.15 = \underline{\underline{25.85 \text{ dBm}}}$$