Atmospheric and Ionospheric Losses: Alpha CubeSat 2016 February 05

Loss due to Atmospheric Gases:		
Uplink and Downlink:		
Elevation Angle:	*Loss:*	*Unit:*
0 °	10.2	dB
2.5 °	4.6	dB
5 °	2.1	dB
10 °	1.1	dB
30 °	0.4	dB
45 °	0.3	dB
90 °	0.0	dB
Min. Elev. Angle:	5	deg.
Loss Determined:	2.1	dB

NOTE:

Link Losses Resulting from Signals Passing Through Atmospheric Gases:

Losses due to atmospheric gases (Nitrogen, Oxygen, Carbon Dioxide, Hydrogen, etc.) are nearly independent of atmospheric temperature, mean density and relative humidity at frequencies below 2 GHz. Atmospheric absorption depends strongly upon the total number of molecules distributed along the path between the spacecraft and the ground station. This, in turn, means that the losses from or to the satellite are elevation angle dependent.

The table to the left is a look-up table. The minimum elevation angle selected in the "Orbit" worksheet is matched against the closest fit from the table and the result is given at Cell [D23] and is automatically inserted into the uplink and downlink budgets.

The data used here is taken from "*Radiowave Propagation in Satellite Communications*" by Louis J. Ippolito, Jr., Van Nostrand-Reinhold, 1986, pp. 33-34, Tables 3-3a-c.

One additional interpolated value is added at 2.5° elevation angle. This was not taken from Ippolito's text.

If you are using uplink or downlink frequencies above 2 GHz, refer to the referenced text given above to determine the appropriate atmosperic losses. At millimeter wave frequencies the losses can be much higher.

Loss due to Ionosphere:			
Uplink:	Loss Determined:		0.0 dB
Frequency:	*Unit:*	*Loss:*	*Unit:*
146	MHz	0.7	dB
438	MHz	0.4	dB
2410	MHz	0.1	dB
7145	MHz	0.04	dB

Link Model Operator Estimate Inserted Here.

Loss due to Ionosphere:			
Downlink:	Loss Determined:		0.0 dB
Frequency:	*Unit:*	*Loss:*	*Unit:*
146	MHz	0.7	dB
438	MHz	0.4	dB
2410	MHz	0.1	dB
32000	MHz	0.008	dB

Link Model Operator Estimate Inserted Here.
If the "Link Model Operator" has selected a user option for the frequency, then an estimate of the ionospheric losses must be provided by the operator.

Link Losses Resulting from Signals Passing Through the Ionosphere:

Radio waves passing through the ionosphere at VHF, UHF and Microwave frequencies are influenced far less by this layer of ionized particles than at frequencies in the HF, MF and LF portions of the radio spectrum. While there is certainly some correlation between the elevation angle to a satellite and the signal absorption or scintillation experienced, this dependency is nearly masked out by the time variability of effects.

There is, however, a frequency depencency that can be quantified, on average. As transmitter frequencies go below 100 MHz there are times when the attenuation can increase to as much as tens of dB, especially at low elevation angles. The ionosphere certainly limits the lowest frequency at which satellite communications is feasible. Below 20 MHz, during solar maximum space signals are usually fully absorbed or reflected by the layers of the ionosphere (D, E, F_1 and F_2).

The values provided in this table are approximate mean values for low earth station elevation angles. It is proposed that these values can be conservatively used in satellite link analyses. The higher order statistics of these loss parameters would be interesting to review, however, this effort is more than is necessary for the development of an effective link budget.

The losses determined here for the uplink and downlink are based on the operator-selected frequency choice made in the "Orbit" worksheet. If the "User Defined" option is selected by the link model operator, then the operator must estimate the appropriate ionospheric loss value and manually insert it in either Cell [D34] or Cell [D47] accordingly.

Proceed to the "Modulation-Demodulation Method" W/S.