

Link Budget (5G-NTN)

Example 1: Link budget for UE at Nadir Point; No interference.

Simulation Parameters	LEO 600km	LEO 1200km
Satellite coordinates (x, y, z) (User Input)	0, 0, 600	0, 0, 1200
UE coordinates (x, y, z) (User Input)	0, 0, 0	0, 0, 0
Frequency (User Input)	S-Band, n256	S-Band, n256
Terrestrial environment (User Input. Default based on sec 6.1.1.3 of 38.821)	Rural	Rural
LOS probability (User Input. Per LOS probability in 3GPP TR 38.811 sec 6.6.1)	1	1
Antenna Aperture Radius(m) (User Input. Default based on Table 6.1.1.1-2 of 38.821)	1	1
EIRP density (dBW/MHz) (User Input. Default based on Table 6.1.1.1-1 of 38.821)	34	40
Bandwidth B (User Input. Default based on Table 6.1.3.2-1 of 38.821)	30	30
EIRP (dBW) $= EIRP[dBW/MHz] + 10 \log_{10} B[MHz]$. Per TR 38.821 section 6.1.3.1-5	48.77	54.77
Elevation angle (Calculated in NetSim Per Elevation angle formulas provided in 3GPP TR 38.811 sec 6.6.2)	90	90
Slant range d (Km) (Calculated in NetSim. Per slant height formulas provided in 3GPP T1 38.811 sec 6.6.2)	600	1200
Free space pathloss (dB), PL_{FS} (Calculated in NetSim. Per Free space pathloss formulas provided in 3GPP TR 38.811 sec 6.6.2)	154.8	160.82
Shadow loss (dB), PL_{SM} (Calculated in NetSim Per Shadow loss formulas provided in 3GPP TR 38.811 sec 6.6.2)	0.39	0.39
Additional Loss(dB), PL_{AD} (User Input. Default based on Table 6.1.3.2-1 of 38.821)	2	2
Total Pathloss, L (dB) $L = PL_{FS} + PL_{SM} + PL_{AD}$	155.19	161.21
Rx Antenna Gain (User Input. Default based on Table 6.1.1.1-3 of 38.821)	0	0
Noise figure N_f (User Input. Default based on Table 6.1.1.1-3 of 38.821)	7	7
Rx Antenna Temp T_a (K) (User Input. Default based on Table 6.1.1.1-3 of 38.821)	290	290
RX equivalent antenna Temp, T [dBK] (Calculated in NetSim. Per TR 38.821 section 6.1.3.1)	31.62	31.62
Receiver G/T (dB/K) (Calculated in NetSim. Per RX G/T formulas provided in 3GPP TR 38.821 sec 6.1.3.1)	-31.62	-31.62
Boltzmann constant k [dBW/K/Hz]	-228.6	-228.6
Carrier to Noise Ratio, CNR (dB) (Calculated in NetSim Per CNR formulas provided in 3GPP TR 38.821 sec 6.1.3.1)	15.78	15.76

Example 2: Link budget for UE at Off Nadir Point; No interference.

Simulation Parameters	LEO 600km	LEO 1200km
Satellite coordinates (x, y, z) (User Input)	0, 0, 600	0, 0, 1200
UE coordinates (x, y, z) (User Input)	17,18, 0	64,34, 0
Frequency (User Input)	S-Band, n256	S-Band, n256
Terrestrial environment (User Input. Default based on sec 6.1.1.3 of 38.821)	Rural	Rural
LOS probability (User Input. Per LOS probability in 3GPP TR 38.811 sec 6.6.1)	1	1
Antenna Aperture Radius(m) (User Input. Default based on Table 6.1.1.1-2 of 38.821)	1	1
EIRP density (dBW/MHz) (User Input. Default based on Table 6.1.1.1-1 of 38.821)	34	40
Bandwidth B (User Input. Default based on Table 6.1.3.2-1 of 38.821)	30	30
EIRP (dBW) $= EIRP[dBW/MHz] + 10 \log_{10} B[MHz]$ per TR 38.821 section 6.1.3.1-5	48.77	54.77
Elevation angle (Calculated in NetSim Per Elevation angle formulas provided in 3GPP TR 38.811 sec 6.6.2)	87.57	86.51
Angular Antenna Gain $G(\theta)$, (dB) (Calculated in NetSim. Per Bessel function formulas provided in 3GPP TR 38.811 sec 6.4.1)	-4.48	-10.52
Slant range d (Km) (Calculated in NetSim. Per slant height formulas provided in 3GPP T1 38.811 sec 6.6.2)	600.49	1201.87
Free space pathloss (dB), PL_{FS} (Calculated in NetSim. Per Free space pathloss formulas provided in 3GPP TR 38.811 sec 6.6.2)	154.81	160.84
Shadow loss (dB), PL_{SM} (Calculated in NetSim Per shadow loss formulas provided in 3GPP TR 38.811 sec 6.6.2)	0.39	0.39
Additional Loss(dB), PL_{AD} (User Input. Default based on Table 6.1.3.2-1 of 38.821)	0	0
Total Pathloss, L (dB) $L = PL_{FS} + PL_{SM} + PL_{AD}$	155.2	161.23
Rx Antenna Gain (User Input. Default based on Table 6.1.1.1-3 of 38.821)	0	0
Noise figure N_f (User Input. Default based on Table 6.1.1.1-3 of 38.821)	7	7
Rx Antenna Temp T_a (K) (User Input. Default based on Table 6.1.1.1-3 of 38.821)	290	290
RX equivalent antenna Temp, T [dBK] (Calculated in NetSim. Per TR 38.821 section 6.1.3.1)	31.62	31.62
Receiver G/T (dB/K) (Calculated in NetSim. Per RX G/T formulas provided in 3GPP TR 38.821 sec 6.1.3.1)	-31.62	-31.62
Boltzmann constant k [dBW/K/Hz]	-228.6	-228.6
Carrier to Noise Ratio, CNR (dB) (Calculated in NetSim Per CNR formulas provided in 3GPP TR 38.821 sec 6.1.3.1)	11.29	5.23

Example 3: Link budget with UE at Off Nadir Point with Interference

The calculations proceed exactly per Example 2 up to CNR. Once CNR is computed, interference is added and to obtain CNIR.

Simulation Parameters	LEO 600km	LEO 1200km
Satellite coordinates (x, y, z) (User Input)	0, 0, 600	0, 0, 1200
UE coordinates (x, y, z) (User Input)	17,18, 0	64,34, 0
Frequency (User Input)	S-Band, n256	S-Band, n256
Terrestrial environment (User Input. Default based on sec 6.1.1.3 of 38.821)	Rural	Rural
LOS probability (User Input. Per LOS probability provided in 3GPP TR 38.811 sec 6.6.1)	1	1
Antenna Aperture Radius(m) (User Input. Default based on Table 6.1.1.1-2 of 38.821)	1	1
EIRP density (dBW/MHz) (User Input. Default based on Table 6.1.1.1-1 of 38.821)	34	40
Bandwidth B (User Input. Default based on Table 6.1.3.2-1 of 38.821)	30	30
EIRP (dBW) $= EIRP[dBW/MHz] + 10 \log_{10} B[MHz]$ per TR 38.821 section 6.1.3.1-5	48.77	54.77
Elevation angle (Calculated in NetSim Per Elevation angle formulas provided in 3GPP TR 38.811 sec 6.6.2)	87.57	86.51
Angular Antenna Gain $G(\theta)$, (dB) (Calculated in NetSim. Per Bessel function formulas provided in 3GPP TR 38.811 sec 6.4.1)	-4.48	-10.52
Slant range d (Km) (Calculated in NetSim. Per slant height formulas provided in 3GPP T1 38.811 sec 6.6.2)	600.49	1201.87
Free space pathloss (dB), PL_{FS} (Calculated in NetSim. Per Free space pathloss formulas provided in 3GPP TR 38.811 sec 6.6.2)	154.81	160.84
Shadow loss (dB), PL_{SM} (Calculated in NetSim Per shadow loss formulas provided in 3GPP TR 38.811 sec 6.6.2)	0.39	0.39
Additional Loss(dB), PL_{AD} (User Input. Default based on Table 6.1.3.2-1 of 38.821)	0	0
Total Pathloss, L (dB) $L = PL_{FS} + PL_{SM} + PL_{AD}$	155.2	161.23
Rx Antenna Gain (User Input. Default based on Table 6.1.1.1-3 of 38.821)	0	0
Noise figure N_f (User Input. Default based on Table 6.1.1.1-3 of 38.821)	7	7
Rx Antenna Temp T_a (K) (User Input. Default based on Table 6.1.1.1-3 of 38.821)	290	290
RX equivalent antenna Temp, T [dBK] (Calculated in NetSim. Per TR 38.821 section 6.1.3.1)	31.62	31.62
Receiver G/T (dB/K) (Calculated in NetSim. Per RX G/T formulas provided in 3GPP TR 38.821 sec 6.1.3.1)	-31.62	-31.62
Boltzmann constant k [dBW/K/Hz]	-228.6	-228.6

Carrier to Noise Ratio, CNR (dB) (Calculated in NetSim Per CNR formulas provided in 3GPP TR 38.821 sec 6.1.3.1)	11.29	5.23
Carrier to Interference Ratio, CIR (dB) (User Input. Per TR 38.821 section 6.1.3.1)	5	5
Carrier to Noise plus Interference Ratio, CNIR (dB) (Calculated in NetSim Per CNIR formulas provided in 3GPP TR 38.821 sec 6.1.3.1)	4.08	2.1

Notes:

1. Link budget is calculated for the satellite-to-Earth service link; feeder link is assumed ideal.
2. Scintillation, polarization, and atmospheric losses are not included. These are under development and can currently be specified through the Additional loss parameter