RF System (Link Budget) Calculations

System Variables	Variable	Units	Equation	S-E Value	E-S Value	E-S Value
Frequency	f_0	MHz		400.5	402.5	450.125
Speed of Light	c	m/s		*299792458*	*299792458*	*299792458*
Wavelength	λ	m	$\lambda = c/f_0$	0.748545	0.744826	0.666020
Orbit Heigh	d	Km		500	500	500

Block	Variable	Units	Equation	Value	Value	Value
PA Power	P_{PA}	W		2	9	9
PA Power	P_{PA}	dBW		3.0103	9.5424	9.5424
PA Power	P_{PA}	dBm		33.0103	39.5424	39.5424
PA TX power	P_{TX}	dBm		33.0103	39.5424	39.5424
TX cable and connectors related losses	L_{cabTX}	dB		-1	-1	-1
TX power	P_T	dBm	$P_T = P_{TX}L_{cabTX}$	32.0103	38.5424	38.5424
TX antenna gain	G_T	dBi		3	3	3
Effective (Isotropic) Radiated Power	EIRP	dBm	$EIRP = P_T + G_T$	35.0103	41.5424	41.5424
Effective (Isotropic) Radiated Power	EIRP	dBW	$EIRP = P_T + G_T$	5.0103	11.5424	11.5424
Distance	d	m		500,000	500,000	500,000
Free Space Loss	L_{FS}	dB	$L_{FS} = 20 \text{ Log } (4\pi d/\lambda)$	-138.4792	-138.5225	-139.4938
Power at RX Antenna, Free Space Path	P_{FS}	dBm	$P_{FS} = L_{FS}$ EIRP	-103.4689	-96.9801	-97.9514
Power at RX Antenna, Free Space Path	P_{FS}	dBW	$P_{FS} = L_{FS}$ EIRP	-133.4689	-126.9801	-127.9514
RX antenna gain	G_R	dBi		3	3	3
RX cable and connectors related losses	L_{cabRx}	dB		-1	-1	-1
Miscellaneous Losses	Lv	dB	Lv (rain, atmospheric, etc)	-3	-3	-3
RX power, Free Space Path	P_{RFS}	dBm	$P_{RFS} = P_{FS}\,G_R L_{cabRx} Lv$	-104.4689	-97.9801	-98.9514
RX power, Free Space Path	P_{RFS}	dBW	$P_{RFS} = P_{FS}\,G_R L_{cabRx} Lv$	-134.4689	-127.9801	-128.9514

Budget Link	Variable	Units	Equation	Value	Value	Value
RX Noise Figure	NF	dB		12	12	12
Operating Temperature	T_0	K		290	290	290
Effective Noise Temperature	T_e	K	$T_e = T_0(NF - 1)$	4306.1903	4306.1903	4306.1903
Boltzmann's constant	*k*	J/K		*1.38E-23*	*1.38E-23*	*1.38E-23*
Boltzmann's constant	*k*	J/K		-228.6	-228.6	-228.6
Bandwidth	BW	MHz		0.2	0.2	0.05
Antenna Temperature	T_{Ant}	K		300	300	300
Noise Power (at RX)	P_n	dBm	$P_n = k\,(T_{Ant} + T_e)BW$	-108.9574905	-108.9574905	-114.9780904
G/T_{Rx}	G/T_{Rx}	dB/K	$G/T_{Rx} = G_R - T_e$	-33.3409	-33.3409	-33.3409
C/N	C/N	dBm	$C/N = EIRP + G/T - L_{FS} - Lv - k - BW$	35.7798	42.2687	47.3179
C/N	C/N	dBW	$C/N = EIRP + G/T - L_{FS} - Lv - k - BW$	5.7798	12.2687	17.3179
Required Eb/No	Eb/No	dB		12	12	8
Max PA Power	P_{PA}	W	Maximum Power	2.9	10	10
Max PA Power	P_{PA}	dBW	Maximum Power	4.6240	10.0000	10.0000
Effective (Isotropic) Radiated Power	EIRP	dBW	$EIRP = P_T + G_T$	7.6240	13.0000	13.0000
Min Power Density	PD_{Min}	W/Hz	$PD_{Min} = P_{Total}/BW$	-48	-41.46787486	-35.44727495
Max Power Density	PD_{Max}	W/Hz	$PD_{Max} = P_{Total}/BW$	-45.38631998	-40.01029996	-33.98970004
Power Density	PD_{Min}	W/Hz	$PD = P_{Total}/4KHz$	-31.0103	-24.4782	-24.4782