

Applicant: The Boeing Company

File Number: 1752-EX-CN-2023

Correspondence Reference Number: 82355

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- (1) Please provide the size (meter), antenna gain (dBi), input power at antenna flange (watts), and EIRP (dBW) of the proposed Datapath CTT-120 experimental antenna that will be used to communicate with the Eutelsat E172b, S3021, satellite located at 172E GSO satellite.
- (2) The ERP should be 57.37 dBW which equals 545758 W (ERP). See link budget below.

Link Budget

Produced using Satmaster Pro

Wednesday 14 June 2023

Service Name	CONUS 129W
Coverage	CONUS
Uplink earth station	CCT120 50W - Hawaii
Downlink earth station	BRW129
Satellite name	E172b
Modcod	DVBS2,normal frame,4-PSK (2/3),no pilots

Link Input Parameters

	Up	Down	Units
Site latitude	21.42N	48.1N	degrees
Site longitude	157.59W	119W	degrees
Site altitude	0.120	0.540	km
Frequency	14.2	12	GHz
Polarization	Horizontal	Vertical	
Rain model	ITU-R	ITU-R	
R0.01%	65.821	16.761	mm/h
Overall availability (average year)	99.5000	AUTO	%
Antenna aperture	1.2	4.8	metres
Antenna efficiency or gain (+ or - prefix)	+41.9	+52.7	% or dB
Coupling loss	0.5	1	dB
Antenna mispoint loss	0	0.5	dB
Other path losses (site diversity gain -ve)	0	0	dB
LNB noise figure or temp (+ prefix)		+0.8	dB or K
Antenna noise		45.00	K
Csat/AClo	140		dB-Hz
Csat/ASlo	100.00		dB-Hz
Csat/XPlo	103		dB-Hz
HPA C/IMo	140		dB-Hz
Csat/AClo		140	dB-Hz
Csat/ASlo		107.00	dB-Hz
Csat/XPlo		107	dB-Hz
Uplink station HPA output back-off	1		dB
Uplink power control available	0		dB
Number of carriers / HPA	1		
Required HPA power	MIN		W

Satellite Input Parameters

	Value	Units
Satellite longitude	172E	degrees
Transponder type	TWTA	
G/T Reference	1	dB/K
SFD Reference	-88	dBW/m2
Receive G/T	1	dB/K
Flux control attenuator (FCA)	0	dB
Effective SFD	-88.00	dBW/m2
Satellite ALC	0	dB
EIRP (saturation)	44.5	dBW
EIRP (beam peak)	44.5	dBW
Transponder bandwidth	54	MHz
Input back off total	4	dB
Output back off total	3	dB
C/IM	13.37	dB
Carriers per transponder	AUTO	

Carrier/Link Input Parameters

	Value	Units
Modulation	4-PSK	
Required Es/No	3.10	dB
Information rate	10	Mbps
Information rate overhead	0	%
FEC code rate	0.6611	
Spreading gain	0	dB
(1 + Roll off factor)	1.05	
Carrier spacing factor	1.05	
Bandwidth allocation step size	0.01	MHz
Implementation loss	0	dB
System margin	0	dB

Calculations at Saturation

	Value	Units
Gain 1m^2	44.50	dB/m2
Uplink C/No	97.10	dB-Hz
Downlink C/No	97.46	dB-Hz
Total C/No	94.27	dB-Hz
Uplink EIRP for saturation	74.54	dBW

General Calculations

	Up	Down	Units
Elevation	47.76	5.35	degrees
True azimuth	237.41	254.05	degrees
Compass bearing	227.90	239.39	degrees
Path distance to satellite	37224.89	41107.24	km
XPD during rain	26.71	22.95	dB
Propagation time delay	0.124169	0.137119	seconds
Antenna efficiency	48.57	51.11	%
Antenna gain	41.90	52.70	dBi
Availability (average year)	99.7052	99.7941	%
Link downtime (average year)	25.834	18.048	hours
Availability (worst month)	99.0153	99.2792	%
Link downtime (worst month)	7.192	5.264	hours

Uplink Calculation

	Clear	Rain Up	Rain Dn	Units
Transmit EIRP	57.37	57.37	57.37	dBW
Uplink power control used	0.00	0.00	0.00	dB
Transponder input back-off (total)	4.00	4.00	4.00	dB
Input back-off per carrier	17.17	20.75	17.17	dB
Antenna mispoint	0.00	0.00	0.00	dB
Free space loss	206.91	206.91	206.91	dB
Atmospheric absorption (Ag(1%) cap)	0.13	0.19	0.13	dB
Tropospheric scintillation	0.00	0.36	0.00	dB
Cloud attenuation (Ac(1%) cap)	0.00	0.30	0.00	dB
Rain attenuation	0.00	3.20	0.00	dB
Total attenuation (gas-rain-cloud-scintillation)	0.13	3.71	0.13	dB
Other path losses	0.00	0.00	0.00	dB
C/No (thermal)	79.93	76.35	79.93	dB-Hz
C/N (thermal)	11.14	7.56	11.14	dB
C/ACI	54.04	50.46	54.04	dB
C/ASI	14.04	10.46	14.04	dB
C/XPI	17.04	16.60	17.04	dB
C/IM	70.21	70.21	70.21	dB
C/I (total)	12.28	9.52	12.28	dB
C/(N+I) [Es/(No+Io)]	8.66	5.42	8.66	dB
Eb/(No+Io)	7.45	4.21	7.45	dB

Downlink Calculation

	Clear	Rain Up	Rain Dn	Units
Satellite EIRP total	44.50	44.50	44.50	dBW
Transponder output back-off (total)	3.00	3.00	3.00	dB
Output back-off per carrier	16.17	19.75	16.17	dB
Satellite EIRP per carrier	28.33	24.75	28.33	dBW
Antenna mispoint	0.50	0.50	0.50	dB
Free space loss	206.31	206.31	206.31	dB
Atmospheric absorption (Ag(1%) cap)	0.60	0.60	0.79	dB
Tropospheric scintillation	0.00	0.00	2.05	dB
Cloud attenuation (Ac(1%) cap)	0.00	0.00	1.01	dB
Rain attenuation	0.00	0.00	2.05	dB
Total attenuation (gas-rain-cloud-scintillation)	0.60	0.60	4.47	dB
Other path losses	0.00	0.00	0.00	dB
Noise increase due to precipitation	0.00	0.00	3.26	dB
Downlink degradation (DND)	0.00	0.00	7.13	dB
Total system noise	98.33	98.33	208.09	K
Figure of merit (G/T)	31.77	31.77	28.52	dB/K
C/No (thermal)	81.29	77.71	74.16	dB-Hz
C/N (thermal)	12.50	8.92	5.38	dB
C/ACI	55.04	51.46	55.04	dB
C/ASI	22.04	18.46	22.04	dB
C/XPI	22.04	18.46	19.46	dB
C/IM	13.37	13.37	13.37	dB

C/I (total)	12.33	11.28	11.97	dB
C/(N+I) [Es/(No+Io)]	9.40	6.93	4.52	dB
Eb/(No+Io)	8.19	5.72	3.30	dB

Totals per Carrier (End-to-End)

	Clear	Rain Up	Rain Dn	Units
C/No (thermal)	77.54	73.97	73.14	dB-Hz
C/N (thermal)	8.76	5.18	4.35	dB
C/ACI	51.50	47.92	51.50	dB
C/ASI	13.40	9.82	13.40	dB
C/XPI	15.85	14.42	15.07	dB
C/IM	13.37	13.37	13.37	dB
C/I (total)	9.29	7.30	9.11	dB
C/(No+Io)	74.79	71.89	71.89	dB-Hz
C/(N+I) [Es/(No+Io)]	6.01	3.10	3.10	dB
Eb/(No+Io)	4.79	1.89	1.89	dB
Implementation loss	0.00	0.00	0.00	dB
System margin	0.00	0.00	0.00	dB
Net Es/(No+Io)	6.01	3.10	3.10	dB
Required Es/(No+Io)	3.10	3.10	3.10	dB
Excess margin	2.91	0.00	0.00	dB

Carrier EIRP Density Calculations

	Clear	Rain Up	Rain Dn	Units
Flange transmit (up)	-53.32	-53.32	-53.32	dBW/Hz
Satellite (down)	-40.46	-44.04	-40.46	dBW/Hz
Satellite beam peak (down)	-40.46	-40.46	-40.46	dBW/Hz
Flange receive (down)	-195.17	-198.75	-202.30	dBW/Hz

Earth Station Power Requirements

	Value	Units
EIRP per carrier	57.37	dBW
Available uplink power control	0.00	dB
Total EIRP required	57.37	dBW
Antenna gain	41.90	dB
Antenna feed flange power per carrier	15.47	dBW
HPA output back off	1.00	dB
Waveguide loss	0.5	dB
Number of HPA carriers	1	
Total HPA power required	16.9660	dBW
Required HPA power	49.7278	W

Space Segment Utilization

	Value	Units
Overall target availability	99.5000	%
Information rate	10.0000	Mbps
Information rate (inc overhead)	10.0000	Mbps
Transmit rate	15.1263	Mbps
Symbol rate	7.5632	Mbaud
Noise Bandwidth	68.79	dB-Hz
Occupied bandwidth	7.9413	MHz
Minimum allocated bandwidth required	7.9413	MHz
Allocated transponder bandwidth	7.9500	MHz
Overall Link efficiency	1.258	bps/Hz
Percentage transponder bandwidth used	14.72	%
Used transponder power	28.33	dBW
Percentage transponder power used	4.82	%
Max carriers / transponder	6.79	
Limited by:	Bandwidth	
Power equivalent bandwidth usage	2.6014	MHz