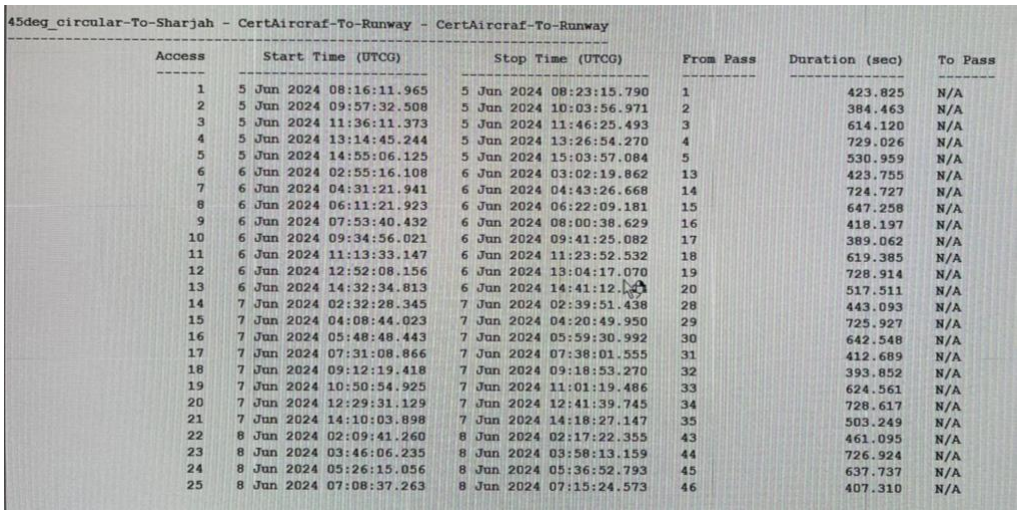
Number of Passes for Different Angles of Inclination

All orbits have altitude of 500kms.
Ground station is at Sharjah

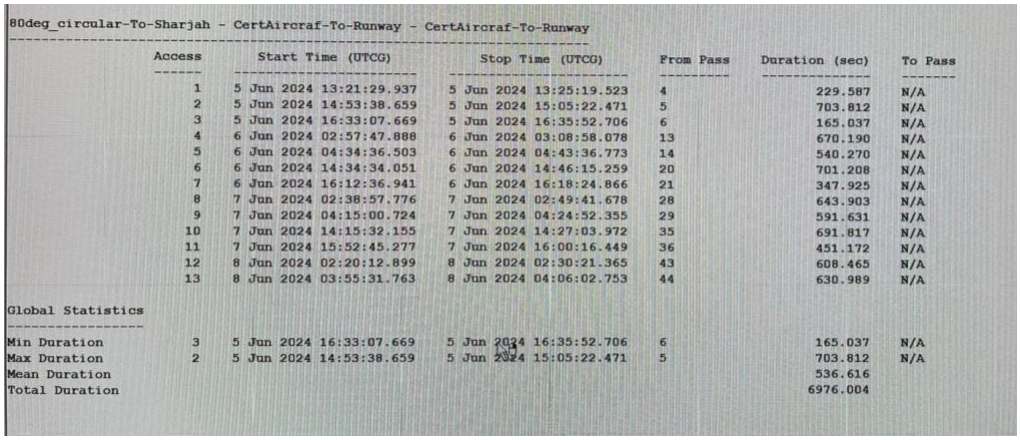
Circular orbit with 45 degrees inclination



45deg_circular-To-Sharjah - CertAircraf-To-Runway - CertAircraf-To-Runway

Access	Start Time (UTCG)	Stop Time (UTCG)	From Pass	Duration (sec)	To Pass
1	5 Jun 2024 08:16:11.965	5 Jun 2024 08:23:15.790	1	423.825	N/A
2	5 Jun 2024 09:57:32.508	5 Jun 2024 10:03:56.971	2	384.463	N/A
3	5 Jun 2024 11:36:11.373	5 Jun 2024 11:46:25.493	3	614.120	N/A
4	5 Jun 2024 13:14:45.244	5 Jun 2024 13:26:54.270	4	729.026	N/A
5	5 Jun 2024 14:55:06.125	5 Jun 2024 15:03:57.084	5	530.959	N/A
6	6 Jun 2024 02:55:16.108	6 Jun 2024 03:02:19.862	13	423.755	N/A
7	6 Jun 2024 04:31:21.941	6 Jun 2024 04:43:26.668	14	724.727	N/A
8	6 Jun 2024 06:11:21.923	6 Jun 2024 06:22:09.181	15	647.258	N/A
9	6 Jun 2024 07:53:40.432	6 Jun 2024 08:00:38.629	16	418.197	N/A
10	6 Jun 2024 09:34:56.021	6 Jun 2024 09:41:25.082	17	389.062	N/A
11	6 Jun 2024 11:13:33.147	6 Jun 2024 11:23:52.532	18	619.385	N/A
12	6 Jun 2024 12:52:08.156	6 Jun 2024 13:04:17.070	19	728.914	N/A
13	6 Jun 2024 14:32:34.813	6 Jun 2024 14:41:12.330	20	517.511	N/A
14	7 Jun 2024 02:32:28.345	7 Jun 2024 02:39:51.438	28	443.093	N/A
15	7 Jun 2024 04:08:44.023	7 Jun 2024 04:20:49.950	29	725.927	N/A
16	7 Jun 2024 05:48:48.443	7 Jun 2024 05:59:30.992	30	642.548	N/A
17	7 Jun 2024 07:31:08.866	7 Jun 2024 07:38:01.555	31	412.689	N/A
18	7 Jun 2024 09:12:19.418	7 Jun 2024 09:18:53.270	32	393.852	N/A
19	7 Jun 2024 10:50:54.925	7 Jun 2024 11:01:19.486	33	624.561	N/A
20	7 Jun 2024 12:29:31.129	7 Jun 2024 12:41:39.745	34	728.617	N/A
21	7 Jun 2024 14:10:03.898	7 Jun 2024 14:18:27.147	35	503.249	N/A
22	8 Jun 2024 02:09:41.260	8 Jun 2024 02:17:22.355	43	461.095	N/A
23	8 Jun 2024 03:46:06.235	8 Jun 2024 03:58:13.159	44	726.924	N/A
24	8 Jun 2024 05:26:15.056	8 Jun 2024 05:36:52.793	45	637.737	N/A
25	8 Jun 2024 07:08:37.263	8 Jun 2024 07:15:24.573	46	407.310	N/A

Circular orbit with 80 degrees inclination



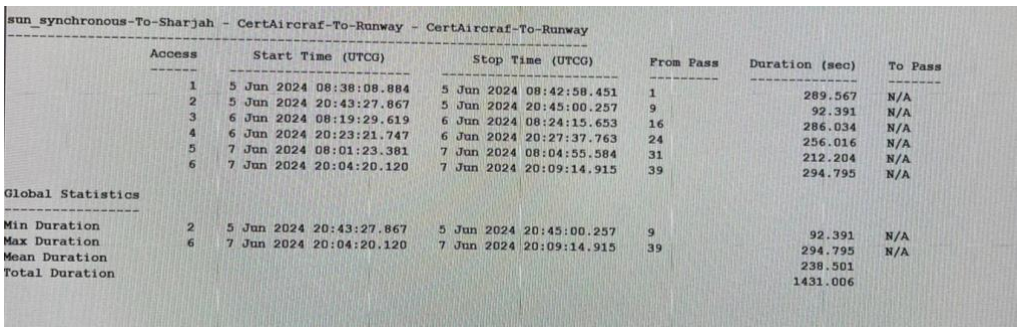
80deg_circular-To-Sharjah - CertAircraf-To-Runway - CertAircraf-To-Runway

Access	Start Time (UTCG)	Stop Time (UTCG)	From Pass	Duration (sec)	To Pass
1	5 Jun 2024 13:21:29.937	5 Jun 2024 13:25:19.523	4	229.587	N/A
2	5 Jun 2024 14:53:38.659	5 Jun 2024 15:05:22.471	5	703.812	N/A
3	5 Jun 2024 16:33:07.669	5 Jun 2024 16:35:52.706	6	165.037	N/A
4	6 Jun 2024 02:57:47.888	6 Jun 2024 03:08:58.078	13	670.190	N/A
5	6 Jun 2024 04:34:36.503	6 Jun 2024 04:43:36.773	14	540.270	N/A
6	6 Jun 2024 14:34:34.051	6 Jun 2024 14:46:15.259	20	701.208	N/A
7	6 Jun 2024 16:12:36.941	6 Jun 2024 16:18:24.866	21	347.925	N/A
8	7 Jun 2024 02:38:57.776	7 Jun 2024 02:49:41.678	28	643.903	N/A
9	7 Jun 2024 04:15:00.724	7 Jun 2024 04:24:52.355	29	591.631	N/A
10	7 Jun 2024 14:15:32.155	7 Jun 2024 14:27:03.972	35	691.817	N/A
11	7 Jun 2024 15:52:45.277	7 Jun 2024 16:00:16.449	36	451.172	N/A
12	8 Jun 2024 02:20:12.899	8 Jun 2024 02:30:21.365	43	608.465	N/A
13	8 Jun 2024 03:55:31.763	8 Jun 2024 04:06:02.753	44	630.989	N/A

Global Statistics

Min Duration	3	5 Jun 2024 16:33:07.669	5 Jun 2024 16:35:52.706	6	165.037	N/A
Max Duration	2	5 Jun 2024 14:53:38.659	5 Jun 2024 15:05:22.471	5	703.812	N/A
Mean Duration					536.616	
Total Duration					6976.004	

Sun-synchronous orbit



sun_synchronous-To-Sharjah - CertAircraf-To-Runway - CertAircraf-To-Runway

Access	Start Time (UTCG)	Stop Time (UTCG)	From Pass	Duration (sec)	To Pass
1	5 Jun 2024 08:38:08.884	5 Jun 2024 08:42:58.451	1	289.567	N/A
2	5 Jun 2024 20:43:27.867	5 Jun 2024 20:45:00.257	9	92.391	N/A
3	6 Jun 2024 08:19:29.619	6 Jun 2024 08:24:15.653	16	286.034	N/A
4	6 Jun 2024 20:23:21.747	6 Jun 2024 20:27:37.763	24	256.016	N/A
5	7 Jun 2024 08:01:23.381	7 Jun 2024 08:04:55.584	31	212.204	N/A
6	7 Jun 2024 20:04:20.120	7 Jun 2024 20:09:14.915	39	294.795	N/A

Global Statistics

Min Duration	2	5 Jun 2024 20:43:27.867	5 Jun 2024 20:45:00.257	9	92.391	N/A
Max Duration	6	7 Jun 2024 20:04:20.120	7 Jun 2024 20:09:14.915	39	294.795	N/A
Mean Duration					238.501	
Total Duration					1431.006	

Conclusions:

For ground station located at Sharjah, a smaller inclination will result in more number of passes. However, for CubeSats, since we do not have limited ability to choose the orbit, it is usually deployed in a sun synchronous orbit.

Power Generation Report for Different Attitudes

Settings:

Propagator: HPOP
Step size: 1s

Satellite model: CubeSat 1U
Orbit type: Sun-synchronous
Altitude: 500km

LTANs: 12:00 am, 6:00 am, 10:00 am

Analysis Time Period:

Start: 5 Jun 2024 08:00:00 UTCG
End: 6 Jun 2024 08:00:00 UTCG
Time step: 50s

Results:

LTAN	Spinning X:1, Y:1, Z:1, Spin rate: 1.2 revs/min	Nadir Pointing with ECI Constraint
00:00	1.777717 W	1.286743 W
06:00	2.792869 W	2.450913 W
10:00	1.792257 W	1.721111 W

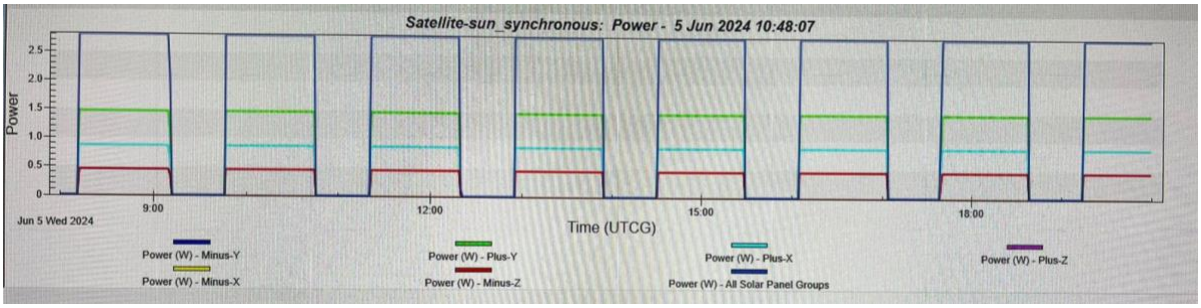


Figure 1: LTAN 00:00, Spinning

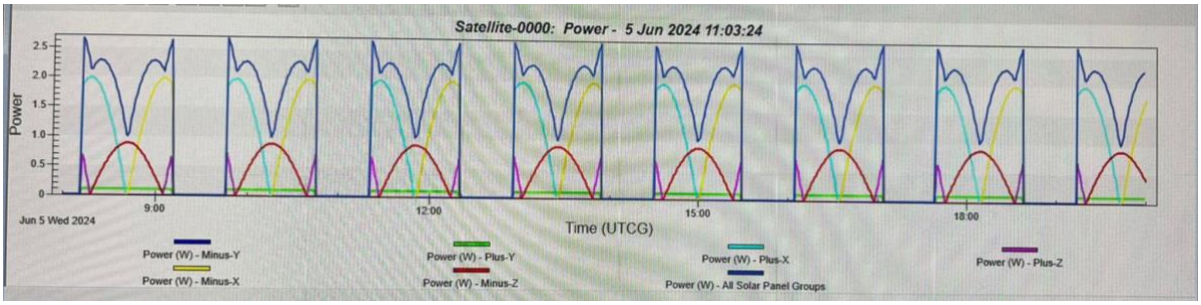


Figure 2: LTAN 00:00, Nadir Pointing

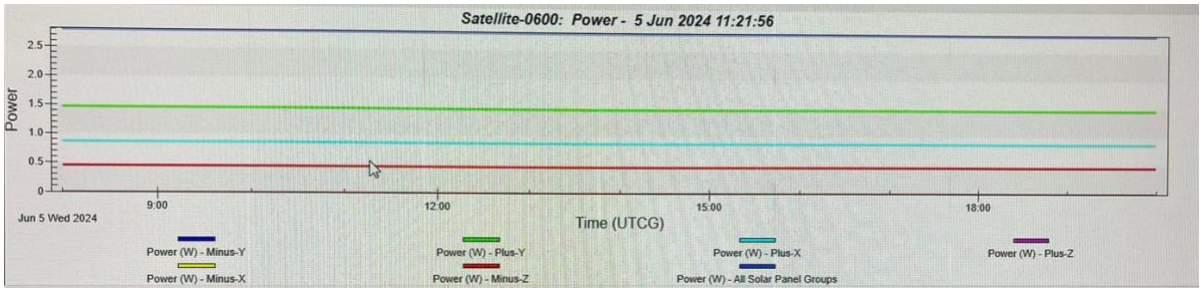


Figure 3: LTAN 06:00, Spinning

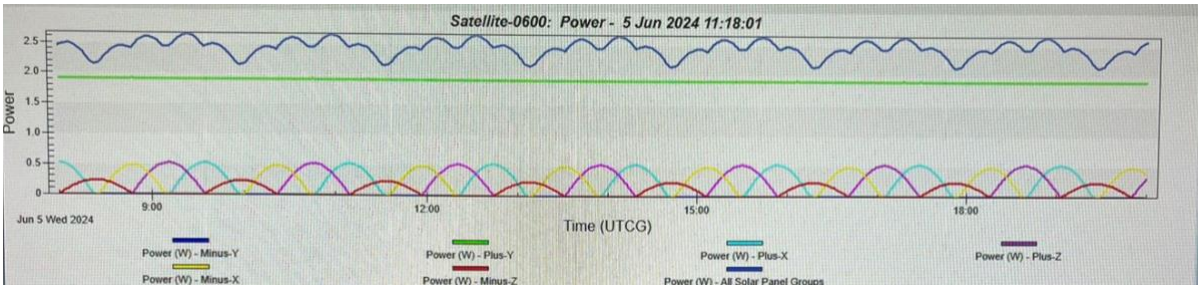


Figure 4: LTAN 06:00, Nadir Pointing

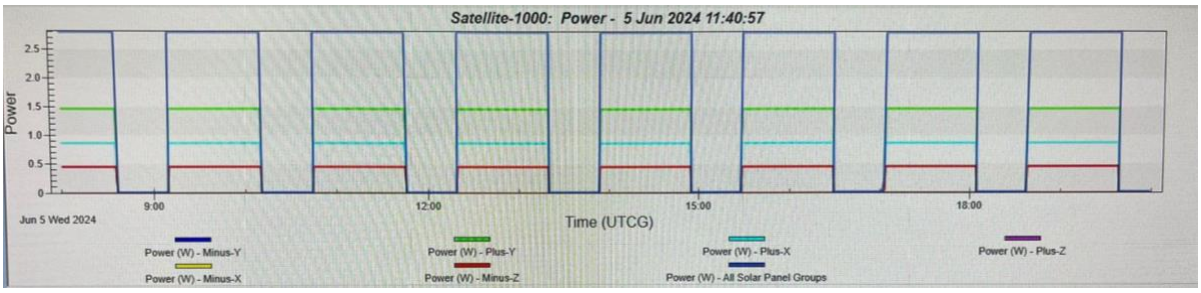


Figure 5: LTAN 10:00, Spinning

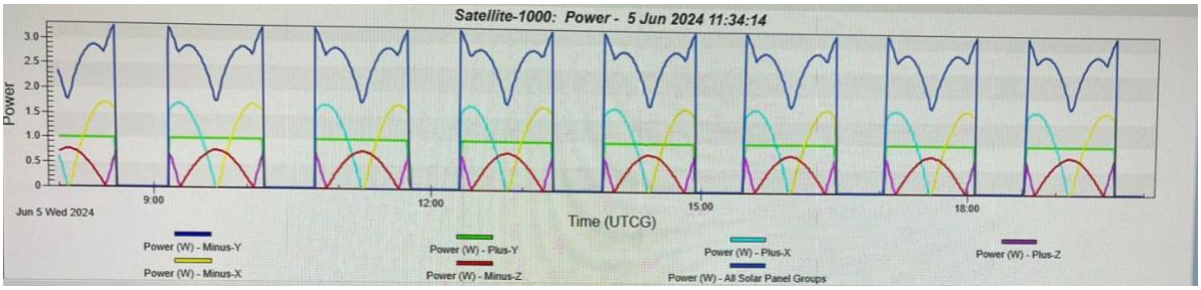


Figure 6: LTAN 10:00, Nadir Pointing

Conclusions:

The power generation is higher when the attitude is spinning for all three LTANs. The highest power generation is when the CubeSat has an LTAN of 6:00 am. This is because the satellite is always facing the sun with such an LTAN. As seen in figure 3 and 4, the total power generated is never zero because the solar panels are always illuminated. With Nadir pointing, there are more fluctuations in power because one part of the satellite (in this case, the camera) is always pointing towards the earth. With the spinning attitude, the power generation is almost constant. The drawback of using 6:00 am as the LTAN is that we need to have proper thermal management system functioning at all times.

Lifetime Estimation Report

Settings:

Propagator: HPOP
Step size: 1s

Satellite model: CubeSat 1U
Orbit type: Sun-synchronous
Altitude: 500km

Attitude: Nadir pointing/Spinning
Since we are using a 1U CubeSat, the drag area and area exposed to the sun with spinning will be approximately the same as the drag area and area exposed to sun with nadir pointing attitude.

Drag area: $0.01m^2$
Area exposed to sun: $0.01m^2$
Mass: 1 kg

Analysis Time Period:

Start: 5 Jun 2024 08:00:00 UTCG
End: 5 Jun 2039 08:00:00 UTCG
Time step: 100s

LTAN	Lifetime	No. of orbits
00:00	2.7 years	15275
06:00	3.2 years	17898
10:00	3.0 years	16898

Conclusions:

With all 3 LTANs the CubeSat is expected to have a lifetime of approximately 3 years. The CubeSat will have the longest lifetime of 3.2 years if the LTAN is 6:00 am.