Time, Space, and Position Information for Geosynchronous Satellites

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Abstract

A brief survey of characterizing the three dimensional radar cross section of satellites. The process of finding the optimal Fourier expression for each band is explored and different success measures are presented.

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†Contributed sections 1 and 2, classified as "4-o with canvas."

1 ChatGPT*

1.1 Two-Line Element Sets (TLE Data)

TLEs are a standard format for satellite position data, widely used for tracking satellites, including geosynchronous ones.

Where to Find:

- **CelesTrak:** https://celestrak.com/
  Provides up-to-date TLEs for geosynchronous satellites in various categories like communications, navigation, and weather.
- **NORAD (via Space-Track.org):** https://www.space-track.org/
  Requires registration but provides authoritative TLE data directly from the US government.

Use Cases: Input TLEs into satellite tracking software to determine positions in real time. Tools like STK, Orbitron, or Heavens-Above can visualize this data.

1.2 Satellite Databases

Comprehensive databases provide details on satellites' orbital parameters and operational details.

Key Resources:

- **Gunter's Space Page:** https://space.skyrocket.de/
  Contains detailed information about satellite launches, missions, and operators, including geostationary orbits.
- **SatNOGS Network:** https://db.satnogs.org/
  Open-source satellite database with tracking capabilities.

1.3 Real-Time Tracking Tools

Online tools provide real-time positional data for satellites.

Recommended Tools:

- **N2YO:** https://www.n2yo.com/
  Tracks geosynchronous satellites, providing real-time location, coverage maps, and pass details.
- **Heavens-Above:** https://heavens-above.com/
  Offers visualizations of satellite positions in the sky, including geostationary satellites.

1.4 Satellite Operators and Agencies

Many geosynchronous satellites are operated by private companies or government agencies that provide detailed orbital data.

Examples:

- **Intelsat and SES:** https://www.intelsat.com/, https://www.ses.com/
  Large operators of geosynchronous satellites often provide orbital and coverage information.
- **NOAA (National Oceanic and Atmospheric Administration):** https://www.noaa.gov/
  Provides data for weather satellites like GOES (Geostationary Operational Environmental Satellites).

1.5 Ephemeris Data Sources

Ephemeris data provides precise information about satellite positions and velocities.

Sources:

- **JPL Horizons System:** https://ssd.jpl.nasa.gov/horizons
  Offers high-precision ephemeris for various objects, including satellites.
- **SP3 Format Data:** Used in high-accuracy positioning and geodesy, available from providers like the International GNSS Service (IGS).

1.6 Software for Satellite Tracking and Analysis

Specialized software allows you to process satellite position data and visualize their orbits.

Popular Software:

- **STK (Systems Tool Kit):** https://www.agi.com/products/stk
  Advanced software for satellite orbit modeling and analysis.
- **GPredict:** https://gpredict.oz9aec.net/
  Free and open-source software for tracking satellites.

1.7 Research Papers and Publications

For precise and in-depth geostationary satellite data, scientific research often provides detailed information.

Sources:

- **NASA Technical Reports Server (NTRS):** https://ntrs.nasa.gov/
- **IEEE Xplore:** https://ieeexplore.ieee.org/

1.8 GNSS Augmentation Systems

For geosynchronous satellites involved in GNSS augmentation:

- **WAAS (Wide Area Augmentation System):** Covers the US; managed by the FAA.
- **EGNOS (European Geostationary Navigation Overlay Service):** Provides orbital data for geosynchronous satellites enhancing GPS accuracy.

Key Parameters to Consider:

- **Orbital Slot:** Longitude where the satellite is stationed (e.g., 119.5°W for a GOES satellite).
- **Inclination:** Near 0° for geostationary satellites.
- **Altitude:** 35,786 km for geostationary orbits.
- **Epoch Time:** Timestamp of the most recent TLE data.
- **RAAN (Right Ascension of the Ascending Node):** Orbital orientation relative to Earth's equator.

2 Using satnogs.org to Identify GEO Satellites*

Geostationary (GEO) satellites can be identified on the SatNOGS Database by utilizing their unique orbital characteristics and the filtering tools available on the platform. Below are the steps to locate and identify GEO satellites effectively.

2.1 Understanding GEO Characteristics

Geostationary satellites have the following orbital properties:

- **Altitude:** Approximately 35,786 km above the Earth's surface.
- **Inclination:** Near 0° to remain stationary over the equator.
- **Eccentricity:** Close to 0, indicating a circular orbit.
- **Orbital Slot:** Fixed at a specific longitude (e.g., 119.5°W for GOES satellites).

These properties can help filter and identify GEO satellites in the SatNOGS database.

2.2 Using the SatNOGS Search and Filters

1. Navigate to SatNOGS Database.
2. Use the search bar to look for:
   - Keywords such as `GEO` or `Geostationary`.
   - Known GEO satellite names or operators (e.g., GOES, Intelsat, SES).
3. Click on a satellite's entry to view its details and orbital parameters.
4. Look for the following key parameters:
   - **Inclination:** Near 0°.
   - **Altitude:** Approximately 35,786 km.
   - **Eccentricity:** Close to 0.
5. Use category tags (e.g., communication, weather, navigation) to narrow down the results.

2.3 Cross-Verification Using External Tools

If GEO satellites are not explicitly labeled in SatNOGS, the following tools can provide additional verification:

- **CelesTrak GEO Catalog:**
  Access the TLE catalog for GEO satellites at https://celestrak.org/NORAD/elements/geo.txt and cross-reference satellite names or NORAD IDs with SatNOGS entries.
- **Heavens-Above:**
  Use https://www.heavens-above.com/ to visualize GEO satellite positions and compare their orbital parameters.

2.4 Examples of GEO Satellites

Examples of well-known GEO satellites to search for:

- **Weather Satellites:** GOES (NOAA), Meteosat (EUMETSAT).
- **Communications Satellites:** Intelsat, SES satellites.
- **Navigation Satellites:** WAAS (USA), EGNOS (Europe).

2.5 Automating Identification (Optional)

For advanced users, you can programmatically compare TLE data from CelesTrak GEO Catalog with SatNOGS records using tools like Python (e.g., with the `PyEphem` library).

3 Conclusion

Using SatNOGS, along with external tools like CelesTrak and Heavens-Above, enables efficient identification and tracking of geostationary satellites.

4 Geo TLE

Sample file https://celestrak.org/NORAD/elements/geo.txt

```
TDRS 3
1 19548U 88091B   24325.92885469 -.00000302  00000+0  00000+0 0  9994
2 19548  13.0423 344.8375 0040075 335.1643  25.8602  1.00266141119620
FLTSATCOM 8 (USA 46)
1 20253U 89077A   24325.77379124 -.00000369  00000+0  00000+0 0  9996
2 20253  12.5869 354.5997 0006168 257.7869 212.2336  1.00276169254813
SKYNET 4C
1 20776U 90079A   24325.76378818  .00000123  00000+0  00000+0 0  9995
2 20776  13.5248 353.7193 0003851 254.3871 120.4274  1.00272744125145
```

5 Alphabetical Listing of 565 Open Source Geo Satellites

1. ABS
   - 1.1 ABS-2
   - 1.2 ABS-2A (MONGOLSAT-1)
   - 1.3 ABS-3A
   - 1.4 ABS-4 (MOBISAT-1)
   - 1.5 ABS-6
2. AEHF
   - 2.1 AEHF-1 (USA 214)
   - 2.2 AEHF-2 (USA 235)
   - 2.3 AEHF-3 (USA 246)
   - 2.4 AEHF-4 (USA 288)
   - 2.5 AEHF-5 (USA 292)
   - 2.6 AEHF-6 (USA 298)
3. AL YAH
   - 3.1 AL YAH 3
4. ALCOMSAT
   - 4.1 ALCOMSAT 1
5. ALPHASAT
   - 5.1 ALPHASAT
6. AMAZONAS
   - 6.1 AMAZONAS 2
   - 6.2 AMAZONAS 3
   - 6.3 AMAZONAS 4A
   - 6.4 AMAZONAS 5
7. AMAZONAS NEXUS
   - 7.1 AMAZONAS NEXUS
8. AMC
   - 8.1 AMC-11
   - 8.2 AMC-14
   - 8.3 AMC-15
   - 8.4 AMC-21
   - 8.5 AMC-3
   - 8.6 AMC-6
9. AMOS
   - 9.1 AMOS-17
   - 9.2 AMOS-3
   - 9.3 AMOS-4
10. ANGOSAT
    - 10.1 ANGOSAT 2
11. ANIK F
    - 11.1 ANIK F1
    - 11.2 ANIK F1R
    - 11.3 ANIK F2
    - 11.4 ANIK F3
12. ANIK G
    - 12.1 ANIK G1
13. APSTAR
    - 13.1 APSTAR-6C
    - 13.2 APSTAR-6D
    - 13.3 APSTAR-6E
    - 13.4 APSTAR-7
    - 13.5 APSTAR-9
14. ARABSAT
    - 14.1 ARABSAT-5A
    - 14.2 ARABSAT-5C
    - 14.3 ARABSAT-6A
    - 14.4 ARABSAT-7B (BADR-8)
15. ARCTURUS
    - 15.1 ARCTURUS
16. ARSAT
    - 16.1 ARSAT 1
    - 16.2 ARSAT 2
17. ASIASAT
    - 17.1 ASIASAT 4

- 17.2 ASIASAT 5
- 17.3 ASIASAT 6
- 17.4 ASIASAT 7
- 17.5 ASIASAT 8 (AMOS-7)
- 17.6 ASIASAT 9

18. ASIASTAR
    - 18.1 ASIASTAR
19. ASTRA
    - 19.1 ASTRA 1KR
    - 19.2 ASTRA 1L
    - 19.3 ASTRA 1M
    - 19.4 ASTRA 1N
    - 19.5 ASTRA 2A
    - 19.6 ASTRA 2E
    - 19.7 ASTRA 2F
    - 19.8 ASTRA 2G
    - 19.9 ASTRA 3B
    - 19.10 ASTRA 4A
    - 19.11 ASTRA 5B
20. AT
    - 20.1 AT&T T-16
21. ATHENA
    - 21.1 ATHENA-FIDUS
22. AZERSPACE
    - 22.1 AZERSPACE 1
    - 22.2 AZERSPACE 2 (IS-38)
23. BADR
    - 23.1 BADR-4
    - 23.2 BADR-5
    - 23.3 BADR-6
    - 23.4 BADR-7 (ARABSAT-6B)
24. BANGABANDHUSAT
    - 24.1 BANGABANDHUSAT-1
25. BEIDOU
    - 25.1 BEIDOU-2 G1
    - 25.2 BEIDOU-2 G3
    - 25.3 BEIDOU-2 G4
    - 25.4 BEIDOU-2 G5
    - 25.5 BEIDOU-2 G6
    - 25.6 BEIDOU-2 G7
    - 25.7 BEIDOU-2 G8
    - 25.8 BEIDOU-2 IGSO-1
    - 25.9 BEIDOU-2 IGSO-2
    - 25.10 BEIDOU-2 IGSO-3
    - 25.11 BEIDOU-2 IGSO-4
    - 25.12 BEIDOU-2 IGSO-5
    - 25.13 BEIDOU-2 IGSO-6
    - 25.14 BEIDOU-2 IGSO-7
    - 25.15 BEIDOU-3 G1
    - 25.16 BEIDOU-3 G2
    - 25.17 BEIDOU-3 G3
    - 25.18 BEIDOU-3 G4
    - 25.19 BEIDOU-3 IGSO-1
    - 25.20 BEIDOU-3 IGSO-2
    - 25.21 BEIDOU-3 IGSO-3
    - 25.22 BEIDOU-3S IGSO-1S
    - 25.23 BEIDOU-3S IGSO-2S
26. BELINTERSAT
    - 26.1 BELINTERSAT-1
27. BRISAT
    - 27.1 BRISAT
28. BSAT
    - 28.1 BSAT-3A
    - 28.2 BSAT-3B
    - 28.3 BSAT-3C (JCSAT-110R)
    - 28.4 BSAT-4A
    - 28.5 BSAT-4B
29. BULGARIASAT
    - 29.1 BULGARIASAT-1
30. CHINASAT
    - 30.1 CHINASAT 16 (SJ-13)
    - 30.2 CHINASAT 9B
31. CMS
    - 31.1 CMS-01
    - 31.2 CMS-02 (GSAT 24)
32. COMS
    - 32.1 COMS 1
33. COMSATBW
    - 33.1 COMSATBW-1
    - 33.2 COMSATBW-2
34. COSMOS
    - 34.1 COSMOS 2513
    - 34.2 COSMOS 2520
    - 34.3 COSMOS 2526
    - 34.4 COSMOS 2533
    - 34.5 COSMOS 2539
35. DIRECTV
    - 35.1 DIRECTV 10
    - 35.2 DIRECTV 11
    - 35.3 DIRECTV 12
    - 35.4 DIRECTV 14
    - 35.5 DIRECTV 15
    - 35.6 DIRECTV 5 (TEMPO 1)
    - 35.7 DIRECTV 8
    - 35.8 DIRECTV 9S
36. ECHOSTAR
    - 36.1 ECHOSTAR 10
    - 36.2 ECHOSTAR 11
    - 36.3 ECHOSTAR 14
    - 36.4 ECHOSTAR 15

36.5 ECHOSTAR 16
36.6 ECHOSTAR 17
36.7 ECHOSTAR 18
36.8 ECHOSTAR 19
36.9 ECHOSTAR 21
36.10 ECHOSTAR 23
37. EDRS
37.1 EDRS-C
38. ELEKTRO
38.1 ELEKTRO-L 2
38.2 ELEKTRO-L 3
38.3 ELEKTRO-L 4
39. ES
39.1 ES'HAIL 1
39.2 ES'HAIL 2
40. EUTELSAT
40.1 EUTELSAT 10B
40.2 EUTELSAT 115 WEST B
40.3 EUTELSAT 117 WEST A
40.4 EUTELSAT 117 WEST B
40.5 EUTELSAT 16A
40.6 EUTELSAT 172B
40.7 EUTELSAT 174A
40.8 EUTELSAT 21B
40.9 EUTELSAT 33E
40.10 EUTELSAT 36B
40.11 EUTELSAT 36D
40.12 EUTELSAT 3B
40.13 EUTELSAT 5 WEST B
40.14 EUTELSAT 65 WEST A
40.15 EUTELSAT 7 WEST A
40.16 EUTELSAT 70B
40.17 EUTELSAT 7A
40.18 EUTELSAT 7B
40.19 EUTELSAT 7C
40.20 EUTELSAT 8 WEST B
40.21 EUTELSAT 9B
41. EUTELSAT HOTBIRD
41.1 EUTELSAT HOTBIRD 13B
41.2 EUTELSAT HOTBIRD 13C
41.3 EUTELSAT HOTBIRD 13E
41.4 EUTELSAT HOTBIRD 13F
41.5 EUTELSAT HOTBIRD 13G
42. EUTELSAT KA
42.1 EUTELSAT KA-SAT 9A
43. EUTELSAT KONNECT
43.1 EUTELSAT KONNECT
44. EUTELSAT KONNECT VHTS
44.1 EUTELSAT KONNECT VHTS
45. EUTELSAT QUANTUM
45.1 EUTELSAT QUANTUM
46. EWS
46.1 EWS-G1 (GOES 13)
46.2 EWS-G2 (GOES 15)
47. EXPRESS
47.1 EXPRESS 103
47.2 EXPRESS 80
47.3 EXPRESS-AM44
47.4 EXPRESS-AM5
47.5 EXPRESS-AM6
47.6 EXPRESS-AM7
47.7 EXPRESS-AM8
47.8 EXPRESS-AMU1
47.9 EXPRESS-AT1
47.10 EXPRESS-AT2
48. EXPRESS AMU
48.1 EXPRESS AMU-3
48.2 EXPRESS AMU-7
49. FENGYUN
49.1 FENGYUN 2F
49.2 FENGYUN 2G
49.3 FENGYUN 2H
49.4 FENGYUN 4A
49.5 FENGYUN 4B
50. FLTSATCOM
50.1 FLTSATCOM 8 (USA 46)
51. FM
51.1 FM-5
51.2 FM-6
52. GALAXY
52.1 GALAXY 11 (G-11)
52.2 GALAXY 13 (HORIZONS-1)
52.3 GALAXY 14 (G-14)
52.4 GALAXY 16 (G-16)
52.5 GALAXY 17 (G-17)
52.6 GALAXY 18 (G-18)
52.7 GALAXY 19 (G-19)
52.8 GALAXY 23 (G-23)
52.9 GALAXY 25 (G-25)
52.10 GALAXY 28 (G-28)
52.11 GALAXY 30 (G-30)
52.12 GALAXY 31 (G-31)
52.13 GALAXY 32 (G-32)
52.14 GALAXY 33 (G-33)
52.15 GALAXY 34 (G-34)
52.16 GALAXY 35 (G-35)
52.17 GALAXY 36 (G-36)
52.18 GALAXY 37 (G-37)
52.19 GALAXY 3C (G-3C)
53. GAOFEN

53.1 GAOFEN-13 01
53.2 GAOFEN-13 02
53.3 GAOFEN-4
54. GEO
54.1 GEO-KOMPSAT-2A
54.2 GEO-KOMPSAT-2B
55. GOES
55.1 GOES 14
55.2 GOES 16
55.3 GOES 17
55.4 GOES 18
55.5 GOES 19
56. GS
56.1 GS-1
57. GSAT
57.1 GSAT-10
57.2 GSAT-11
57.3 GSAT-14
57.4 GSAT-15
57.5 GSAT-16
57.6 GSAT-17
57.7 GSAT-18
57.8 GSAT-19
57.9 GSAT-29
57.10 GSAT-30
57.11 GSAT-31
57.12 GSAT-6
57.13 GSAT-7
57.14 GSAT-7A
57.15 GSAT-8
57.16 GSAT-9
58. H
58.1 H2SAT (HEINRICH HERTZ)
59. HELLAS
59.1 HELLAS-SAT 2
59.2 HELLAS-SAT 3
59.3 HELLAS-SAT 4 & SGS-1
60. HIMAWARI
60.1 HIMAWARI-8
60.2 HIMAWARI-9
61. HISPASAT
61.1 HISPASAT 30W-5
61.2 HISPASAT 30W-6
61.3 HISPASAT 36W-1
62. HORIZONS
62.1 HORIZONS-2
62.2 HORIZONS-3E
63. HULIANWAN GAOGUI
63.1 HULIANWAN GAOGUI-01 (H*)
63.2 HULIANWAN GAOGUI-02 (H*)
64. HYLAS
64.1 HYLAS 1
64.2 HYLAS 2
64.3 HYLAS 4
65. ICO G
65.1 ICO G1
66. INMARSAT
66.1 INMARSAT 3-F1
66.2 INMARSAT 3-F2
66.3 INMARSAT 3-F3
66.4 INMARSAT 3-F5
66.5 INMARSAT 4-F1
66.6 INMARSAT 4-F2
66.7 INMARSAT 4-F3
66.8 INMARSAT 5-F1
66.9 INMARSAT 5-F2
66.10 INMARSAT 5-F3
66.11 INMARSAT 5-F4
66.12 INMARSAT 6-F1
67. INMARSAT GX
67.1 INMARSAT GX5
68. INSAT
68.1 INSAT-3D
68.2 INSAT-3DR
68.3 INSAT-3DS
69. INTELSAT
69.1 INTELSAT 10 (IS-10)
69.2 INTELSAT 10-02
69.3 INTELSAT 11 (IS-11)
69.4 INTELSAT 14 (IS-14)
69.5 INTELSAT 15 (IS-15)
69.6 INTELSAT 16 (IS-16)
69.7 INTELSAT 17 (IS-17)
69.8 INTELSAT 18 (IS-18)
69.9 INTELSAT 19 (IS-19)
69.10 INTELSAT 1R (IS-1R)
69.11 INTELSAT 20 (IS-20)
69.12 INTELSAT 21 (IS-21)
69.13 INTELSAT 22 (IS-22)
69.14 INTELSAT 23 (IS-23)
69.15 INTELSAT 25 (IS-25)
69.16 INTELSAT 28 (IS-28)
69.17 INTELSAT 30 (IS-30)
69.18 INTELSAT 31 (IS-31)
69.19 INTELSAT 32E (IS-32E)
69.20 INTELSAT 34 (IS-34)
69.21 INTELSAT 35E (IS-35E)
69.22 INTELSAT 36 (IS-36)
69.23 INTELSAT 37E (IS-37E)
69.24 INTELSAT 39 (IS-39)

69.25 INTELSAT 40E (IS-40E)
69.26 INTELSAT 9 (IS-9)
69.27 INTELSAT 901 (IS-901)
69.28 INTELSAT 902 (IS-902)
69.29 INTELSAT 904 (IS-904)
69.30 INTELSAT 905 (IS-905)
69.31 INTELSAT 906 (IS-906)
70. IRNSS
70.1 IRNSS-1A
70.2 IRNSS-1B
70.3 IRNSS-1C
70.4 IRNSS-1D
70.5 IRNSS-1E
70.6 IRNSS-1F
70.7 IRNSS-1G
70.8 IRNSS-1I
70.9 IRNSS-1J (NVS-01)
71. JCSAT
71.1 JCSAT-110A (JCSAT-15)
71.2 JCSAT-12 (JCSAT-RA)
71.3 JCSAT-13
71.4 JCSAT-16
71.5 JCSAT-17
71.6 JCSAT-18 (KACIFIC 1)
71.7 JCSAT-2B
71.8 JCSAT-3A
71.9 JCSAT-5A
72. JUPITER
72.1 JUPITER 3 (ECHOSTAR 24)
73. KAZSAT
73.1 KAZSAT-2
73.2 KAZSAT-3
74. KOREASAT
74.1 KOREASAT 116
74.2 KOREASAT 5 (MUGUNGWHA 5)
74.3 KOREASAT 5A
74.4 KOREASAT 6
74.5 KOREASAT 7
75. LAOSAT
75.1 LAOSAT 1
76. LDPE
76.1 LDPE-1
76.2 LDPE-2
76.3 LDPE-3A
77. LUCAS
77.1 LUCAS (JDRS-1)
78. LUCH
78.1 LUCH (OLYMP-K 1)
78.2 LUCH-5A
78.3 LUCH-5B
78.4 LUCH-5V
78.5 LUCH-5X (OLYMP-K 2)
79. LUDI TANCE
79.1 LUDI TANCE-4 01A
80. MEASAT
80.1 MEASAT 3D
80.2 MEASAT-3A
80.3 MEASAT-3B
81. MERAH PUTIH
81.1 MERAH PUTIH 2
82. METEOSAT
82.1 METEOSAT-10 (MSG-3)
82.2 METEOSAT-11 (MSG-4)
82.3 METEOSAT-12 (MTG-I1)
82.4 METEOSAT-9 (MSG-2)
83. MEV
83.1 MEV-1
83.2 MEV-2
84. MEXSAT
84.1 MEXSAT 3
85. MORELOS
85.1 MORELOS 3
86. MUOS
86.1 MUOS-1
86.2 MUOS-2
86.3 MUOS-3
86.4 MUOS-4
86.5 MUOS-5
87. NIGCOMSAT
87.1 NIGCOMSAT 1R
88. NILESAT
88.1 NILESAT 201
88.2 NILESAT 301
89. NIMIQ
89.1 NIMIQ 2
89.2 NIMIQ 4
89.3 NIMIQ 5
89.4 NIMIQ 6
90. NSS
90.1 NSS-10
90.2 NSS-11
90.3 NSS-12
90.4 NSS-9
91. NUSANTARA SATU
91.1 NUSANTARA SATU
92. NUSANTARA TIGA
92.1 NUSANTARA TIGA (SATRIA)
93. OPTUS
93.1 OPTUS 10
94. OPTUS C

94.1 OPTUS C1
95. OPTUS D
95.1 OPTUS D1
95.2 OPTUS D2
95.3 OPTUS D3
96. OVZON
96.1 OVZON-3
97. PAKSAT
97.1 PAKSAT-1R
97.2 PAKSAT-MM1
98. QUETZSAT
98.1 QUETZSAT 1
99. QZS
99.1 QZS-1R
99.2 QZS-2 (MICHIBIKI-2)
99.3 QZS-3 (MICHIBIKI-3)
99.4 QZS-4 (MICHIBIKI-4)
100. RADUGA
100.1 RADUGA-1M 2
100.2 RADUGA-1M 3
101. RASCOM
101.1 RASCOM-QAF 1R
102. SBIRS GEO
102.1 SBIRS GEO-1 (USA 230)
102.2 SBIRS GEO-2 (USA 241)
102.3 SBIRS GEO-3 (USA 282)
102.4 SBIRS GEO-4 (USA 273)
102.5 SBIRS GEO-5 (USA 315)
102.6 SBIRS GEO-6 (USA 336)
103. SDO
103.1 SDO
104. SES
104.1 SES-1
104.2 SES-10
104.3 SES-11 (ECHOSTAR 105)
104.4 SES-12
104.5 SES-14
104.6 SES-15
104.7 SES-17
104.8 SES-18
104.9 SES-19
104.10 SES-2
104.11 SES-20
104.12 SES-21
104.13 SES-22
104.14 SES-3
104.15 SES-4
104.16 SES-5
104.17 SES-6
104.18 SES-7 (PROTOSTAR 2)
104.19 SES-8
104.20 SES-9
105. SGDC
105.1 SGDC
106. SHIJIAN
106.1 SHIJIAN-17 (SJ-17)
106.2 SHIJIAN-20 (SJ-20)
106.3 SHIJIAN-21 (SJ-21)
106.4 SHIJIAN-23 (SJ-23)
107. SHIYAN
107.1 SHIYAN 12 01 (SY-12 01)
107.2 SHIYAN 12 02 (SY-12 02)
108. SKY MEXICO
108.1 SKY MEXICO-1
109. SKY MUSTER
109.1 SKY MUSTER 1 (NBN1A)
109.2 SKY MUSTER 2 (NBN1B)
110. SKYNET
110.1 SKYNET 4C
110.2 SKYNET 4E
110.3 SKYNET 5A
110.4 SKYNET 5B
110.5 SKYNET 5C
110.6 SKYNET 5D
111. SKYTERRA
111.1 SKYTERRA 1
112. SPACEWAY
112.1 SPACEWAY 2
113. SPAINSAT
113.1 SPAINSAT
114. ST
114.1 ST-2
115. STAR ONE C
115.1 STAR ONE C2
115.2 STAR ONE C3
115.3 STAR ONE C4
116. STAR ONE D
116.1 STAR ONE D1
116.2 STAR ONE D2
117. STPSAT
117.1 STPSAT-6
118. SUPERBIRD
118.1 SUPERBIRD-B3
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119. SXM
119.1 SXM-7
119.2 SXM-8
120. SYRACUSE
120.1 SYRACUSE 3A
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120.3 SYRACUSE 4A
120.4 SYRACUSE 4B
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123. TELSTAR
123.1 TELSTAR 11N
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124.1 TERRESTAR-1
125. THAICOM
125.1 THAICOM 4
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126. THOR
126.1 THOR 5
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127. THURAYA
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128.1 TIANLIAN 1-04
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128.3 TIANLIAN 2-01
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129. TIANTONG
129.1 TIANTONG-1 1
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130. TIBA
130.1 TIBA-1
131. TJS
131.1 TJS-1
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131.3 TJS-11
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131.5 TJS-3
131.6 TJS-4
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131.9 TJS-7
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132. TKSAT
132.1 TKSAT-1 (TUPAC KATARI)
133. TURKMENALEM
133.1 TURKMENALEM52E/MONACOSAT
134. TURKSAT
134.1 TURKSAT 3A
134.2 TURKSAT 4A
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135.1 UFO 10 (USA 146)
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136. USA
136.1 USA 115 (MILSTAR-1 2)
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138. VINASAT
138.1 VINASAT-1
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139. WFOV

139.1 WFOV (USA 332)
140. WGS
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141. WGS F
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142.1 WILDBLUE-1
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143.1 XM-3 (RHYTHM)
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148.17 ZHONGXING-9

6 More on Geosynchronous Orbits

The Geosynchronous Platform Definition Study, consisting of several volumes [2, 7, 8, 4, 6, 5]

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