

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. -n /Users/dantopa /GitHub/sharing/bibliographies/

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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 (<https://db.satnogs.org/>) 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 | 8.6 AMC-6 |
| 1.1 ABS-2 | 9. AMOS |
| 1.2 ABS-2A (MONGOLSAT-1) | 9.1 AMOS-17 |
| 1.3 ABS-3A | 9.2 AMOS-3 |
| 1.4 ABS-4 (MOBISAT-1) | 9.3 AMOS-4 |
| 1.5 ABS-6 | 10. ANGOSAT |
| 2. AEHF | 10.1 ANGOSAT 2 |
| 2.1 AEHF-1 (USA 214) | 11. ANIK F |
| 2.2 AEHF-2 (USA 235) | 11.1 ANIK F1 |
| 2.3 AEHF-3 (USA 246) | 11.2 ANIK F1R |
| 2.4 AEHF-4 (USA 288) | 11.3 ANIK F2 |
| 2.5 AEHF-5 (USA 292) | 11.4 ANIK F3 |
| 2.6 AEHF-6 (USA 298) | 12. ANIK G |
| 3. AL YAH | 12.1 ANIK G1 |
| 3.1 AL YAH 3 | 13. APSTAR |
| 4. ALCOMSAT | 13.1 APSTAR-6C |
| 4.1 ALCOMSAT 1 | 13.2 APSTAR-6D |
| 5. ALPHASAT | 13.3 APSTAR-6E |
| 5.1 ALPHASAT | 13.4 APSTAR-7 |
| 6. AMAZONAS | 13.5 APSTAR-9 |
| 6.1 AMAZONAS 2 | 14. ARABSAT |
| 6.2 AMAZONAS 3 | 14.1 ARABSAT-5A |
| 6.3 AMAZONAS 4A | 14.2 ARABSAT-5C |
| 6.4 AMAZONAS 5 | 14.3 ARABSAT-6A |
| 7. AMAZONAS NEXUS | 14.4 ARABSAT-7B (BADR-8) |
| 7.1 AMAZONAS NEXUS | 15. ARCTURUS |
| 8. AMC | 15.1 ARCTURUS |
| 8.1 AMC-11 | 16. ARSAT |
| 8.2 AMC-14 | 16.1 ARSAT 1 |
| 8.3 AMC-15 | 16.2 ARSAT 2 |
| 8.4 AMC-21 | 17. ASIASAT |
| 8.5 AMC-3 | 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. EHOSTAR
 - 36.1 EHOSTAR 10
 - 36.2 EHOSTAR 11
 - 36.3 EHOSTAR 14
 - 36.4 EHOSTAR 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
 - 118.2 SUPERBIRD-C2
- 119. SXM
 - 119.1 SXM-7
 - 119.2 SXM-8
- 120. SYRACUSE
 - 120.1 SYRACUSE 3A
 - 120.2 SYRACUSE 3B

- 120.3 SYRACUSE 4A
- 120.4 SYRACUSE 4B
- 121. TDRS
 - 121.1 TDRS 10
 - 121.2 TDRS 11
 - 121.3 TDRS 12
 - 121.4 TDRS 13
 - 121.5 TDRS 3
 - 121.6 TDRS 5
 - 121.7 TDRS 6
 - 121.8 TDRS 7
 - 121.9 TDRS 8
- 122. TELKOM
 - 122.1 TELKOM 3S
 - 122.2 TELKOM 4 (MERAH PUTIH)
- 123. TELSTAR
 - 123.1 TELSTAR 11N
 - 123.2 TELSTAR 12V
 - 123.3 TELSTAR 14R
 - 123.4 TELSTAR 18V
 - 123.5 TELSTAR 19V
- 124. TERRESTAR
 - 124.1 TERRESTAR-1
- 125. THAICOM
 - 125.1 THAICOM 4
 - 125.2 THAICOM 6
 - 125.3 THAICOM 8
- 126. THOR
 - 126.1 THOR 5
 - 126.2 THOR 6
 - 126.3 THOR 7
- 127. THURAYA
 - 127.1 THURAYA-2
 - 127.2 THURAYA-3
- 128. TIANLIAN
 - 128.1 TIANLIAN 1-04
 - 128.2 TIANLIAN 1-05
 - 128.3 TIANLIAN 2-01
 - 128.4 TIANLIAN 2-02
 - 128.5 TIANLIAN 2-03
- 129. Tiantong
 - 129.1 Tiantong-1 1
 - 129.2 Tiantong-1 2
 - 129.3 Tiantong-1 3
- 130. TIBA
 - 130.1 TIBA-1
- 131. TJS
 - 131.1 TJS-1
 - 131.2 TJS-10
 - 131.3 TJS-11
- 131.4 TJS-2
- 131.5 TJS-3
- 131.6 TJS-4
- 131.7 TJS-5
- 131.8 TJS-6
- 131.9 TJS-7
- 131.10 TJS-9
- 132. TKSAT
 - 132.1 TKSAT-1 (TUPAC KATARI)
- 133. TURKMENALEM
 - 133.1 TURKMENALEM52E/MONACOSAT
- 134. TURKSAT
 - 134.1 TURKSAT 3A
 - 134.2 TURKSAT 4A
 - 134.3 TURKSAT 4B
 - 134.4 TURKSAT 5A
 - 134.5 TURKSAT 5B
 - 134.6 TURKSAT 6A
- 135. UFO
 - 135.1 UFO 10 (USA 146)
 - 135.2 UFO 11 (USA 174)
 - 135.3 UFO 2 (USA 95)
 - 135.4 UFO 4 (USA 108)
- 136. USA
 - 136.1 USA 115 (MILSTAR-1 2)
 - 136.2 USA 134
 - 136.3 USA 148
 - 136.4 USA 149 (DSP 20)
 - 136.5 USA 153
 - 136.6 USA 157 (MILSTAR-2 2)
 - 136.7 USA 159 (DSP 21)
 - 136.8 USA 164 (MILSTAR-2 3)
 - 136.9 USA 167
 - 136.10 USA 169 (MILSTAR-2 4)
 - 136.11 USA 170
 - 136.12 USA 176 (DSP 22)
 - 136.13 USA 270
 - 136.14 USA 271
 - 136.15 USA 283
 - 136.16 USA 340
 - 136.17 USA 342
 - 136.18 USA 99 (MILSTAR-1 1)
- 137. VIASAT
 - 137.1 VIASAT-1
 - 137.2 VIASAT-2
 - 137.3 VIASAT-3
- 138. VINASAT
 - 138.1 VINASAT-1
 - 138.2 VINASAT-2
- 139. WFOV

- 139.1 WFOV (USA 332)
- 140. WGS
 - 140.1 WGS 10 (USA 291)
- 141. WGS F
 - 141.1 WGS F1 (USA 195)
 - 141.2 WGS F2 (USA 204)
 - 141.3 WGS F3 (USA 211)
 - 141.4 WGS F4 (USA 233)
 - 141.5 WGS F5 (USA 243)
 - 141.6 WGS F6 (USA 244)
 - 141.7 WGS F7 (USA 263)
 - 141.8 WGS F8 (USA 272)
 - 141.9 WGS F9 (USA 275)
- 142. WILDBLUE
 - 142.1 WILDBLUE-1
- 143. XM
 - 143.1 XM-3 (RHYTHM)
 - 143.2 XM-5
- 144. XTAR
 - 144.1 XTAR-EUR
- 145. YAHSAT
 - 145.1 YAHSAT 1A
 - 145.2 YAHSAT 1B
- 146. YAMAL
 - 146.1 YAMAL 202
 - 146.2 YAMAL 300K
 - 146.3 YAMAL 401
 - 146.4 YAMAL 402
 - 146.5 YAMAL 601
- 147. YAOGAN
 - 147.1 YAOGAN-41
- 148. ZHONGXING
 - 148.1 ZHONGXING-10
 - 148.2 ZHONGXING-11
 - 148.3 ZHONGXING-12
 - 148.4 ZHONGXING-19
 - 148.5 ZHONGXING-1D
 - 148.6 ZHONGXING-1E
 - 148.7 ZHONGXING-26
 - 148.8 ZHONGXING-2A
 - 148.9 ZHONGXING-2C
 - 148.10 ZHONGXING-2D
 - 148.11 ZHONGXING-2E
 - 148.12 ZHONGXING-3A
 - 148.13 ZHONGXING-6B
 - 148.14 ZHONGXING-6C
 - 148.15 ZHONGXING-6D
 - 148.16 ZHONGXING-6E
 - 148.17 ZHONGXING-9

6 More on Geosynchronous Orbits

The Geosynchronous Platform Definition Study, consisting of several volumes [**Myers1973'ExecSummary**, **Myers1973'StudySummary**, **Myers1973**, **Myers1973'TrafficBaseline**, **Myers1973'PlatformSynthesis**, **Myers1973'TransportationRequirements**, **Myers1973'ProgramEval**, **Myers1973'TransportationRequirements**] provides comprehensive insights into geosynchronous mission characteristics, traffic analysis, and platform synthesis.