THE ALMANAC

Orbit Data and Resources on Active GNSS Satellites

GPS Constellation

SVN	PRN	CLOCK	LAUNCHED	USABLE	PLANE/SLOT	NOTES
TYPE: Block IIA						
23	32	Rb	11-26-90	2-26-08	E5	
26	26	Rb	7-7-92	7-23-92	F2-F	
39	09		6-26-93			A
34	04	Rb	10-26-93	11-22-93	D4	
33	03		3-28-96			B
40	10	Cs	7-16-96	8-15-96	E6	
38	08		11-6-97			C
TYPE: Block IIR						
43	13	Rb	7-23-97	1-31-98	F3	
46	11	Rb	10-7-99	1-3-00	D2-F	
51	20	Rb	5-11-00	6-1-00	E1	
44	28	Rb	7-16-00	8-17-00	B3	
41	14	Rb	11-10-00	12-10-00	F1	
54	18	Rb	1-30-01	2-15-01	E4	
56	16	Rb	1-29-03	2-18-03	B1-A	
45	21	Rb	3-31-03	4-12-03	D3	
47	22	Rb	12-21-03	1-12-04	E2	D
59	19	Rb	3-20-04	4-5-04	C3	
60	23	Rb	6-23-04	7-9-04	F4	
61	02	Rb	11-6-04	11-22-04	D1	
TYPE: Block IIR-M						
53	17	Rb	9-26-05	12-16-05	C4	
52	31	Rb	9-25-06	10-12-06	A2	
58	12	Rb	11-17-06	12-13-06	B4	
55	15	Rb	10-17-07	10-31-07	F2-A	
57	29	Rb	12-20-07	1-2-08	C1	
48	07	Rb	3-15-08	3-24-08	A4	
50	05	Rb	8-17-09	8-27-09	E3	
TYPE: Block IIF						
62	25	Rb	5-28-10	8-27-10	B2	
63	01	Rb	7-16-11	10-14-11	D2-A	
65	24	Cs	10-4-12	11-14-12	A1	
66	27	Rb	5-15-13	6-21-13	C2	
64	30	Rb	2-21-14	5-30-14	A6	
67	06	Rb	5-17-14	6-10-14	D6	
68	09	Rb	8-2-14	9-17-14	F6	
69	03	Rb	10-29-14	12-12-14	E1	

General Notes:

1. "SV Number" refers to space vehicle number. "PRN Number" refers to the satellite's unique pseudorandom noise code.
2. Clock: Rb = rubidium; Cs = cesium.
3. "Launched" and "Usable" dates are based on Universal Time.
4. The current active GPS constellation consists of 4 Block IIA satellites, 12 Block IIRs, 7 Block IIR-Ms, and 8 Block IIFs for a total of 31 satellites and is under FOC (Full Operational Capability). The constellation is in the 24+3 (or "Expandable 24") configuration with satellites occupying the fore and aft bifuracted slots in the B, D, and F planes. There are currently 7 reserve satellites, SVNs 27, 32, 33, 35, 36, 37, and 38, and one test satellite, 49, near slots A1, F2-F, C4, B1-F, C2, C1, A3, and B1-F, respectively. SVN35 transmitted signals as PRN03 between September 5 and October 20, 2014. The satellite was set unhealthy and not included in broadcast almanacs.
5. The Block IIF-1 through IIF-8 satellites have nicknames Polaris, Sirius, Arcturus, Vega, Canopus, Rigel, Capella, and Spica, respectively.
6. SVN35 and 36 carry onboard corner-cube reflectors for satellite laser ranging (SLR). SLR tracking of the satellites permitted analysts to differentiate between onboard clock errors and satellite ephemeris errors in GPS tracking.
7. Selective availability (SA) was set to zero on all satellites by presidential order on May 2, 2000 at approximately 4:00 UT. Previous Almanacs provide a history of SA status.
8. Antispoofing (AS) was activated on January 31, 1994, on all Block IIs. AS is occasionally off for testing and other purposes. Previous Almanacs provide a history of AS status.
9. The design life and mean-mission duration goals of the Block IIA, IIR, and IIF satellites are 7.5 and 6 years, 10 and 7.5 years, and 12 and 9.9 years, respectively.
10. *GPS World* believes this information to be correct as of press time. However, because of the satellite constellation's evolving nature, readers should contact GPS information services listed on these pages for more current data.
11. Dr. Richard Langley of the University of New Brunswick provided the GPS satellite status information and compiled the notes.

Performance Notes:

A. SVN39/PRN09 was set unusable and removed from the GPS constellation on May 19, 2014. It continued to transmit L-band signals until May 27, 2014. It was then reactivated, but still set unusable, on June 13, 2014, for a rubidium clock checkout. It transmitted L-band signals until July 21, 2014.

B. SVN33/PRN03 was set unusable and removed from the GPS constellation on August 2, 2014. It is now a reserve satellite, currently located near slot C4.

C. SVN38/PRN08 was set unusable and removed from the GPS constellation on October 30, 2014. It continues to transmit signals for test purposes. Subsequently, it will become a reserve satellite, initially located near slot A3.

D. The usable date for SVN47/PRN22 has been corrected to 1-12-04.

GPS Satellite & System Information

GPS.gov

The U.S. government provides the GPS.gov website to educate the public about the Global Positioning System and related topics. Information includes sections for the general public, for Congress, for international citizens, for professionals, and for students. The site is maintained by the National Coordination Office for Space-Based Positioning, Navigation, and Timing in coordination with multiple federal agencies.

National Executive Committee for Space-Based Positioning, Navigation & Timing

www.gps.gov/governance/excom/

The EXCOM advises senior national government leadership and coordinates with federal agencies about policy matters concerning GPS, its augmentations, and related systems. The National Space-Based PNT Advisory Board operates in an independent advisory capacity for the EXCOM as directed by the National PNT Policy and in accordance with the Federal Advisory Committee Act.

DoD GPS Operations Center and 2SOPS Constellation Status

https://gps.afspc.af.mil/gpsoc/; https://gps.afspc.af.mil/gps/

The U.S. Department of Defense (DoD) GPS Operations Center and the 2nd Space Operations Squadron (2SOPS), U.S. Air Force, maintain Internet sites for military and DoD users. The GPS Operations Center provides DOP predictions, performance assessments, anomaly impact analysis, FAQs, and other services for GPS users in the field. 2SOPS operates a GPS Constellation Status site with scheduled outages, user advisories, almanac data, electronic mail, and downloadable files.

U.S. Coast Guard Navigation Center Navigation Information Service (NIS)

www.navcen.uscg.gov

This site offers GPS constellation status, scheduled outage updates, user advisories, and almanac data as well as Differential GPS and Coast Guard Local Notice to Mariners information.

GLONASS Constellation

GLONASS NUMBER	KOSMOS NUMBER	LAUNCHED	USABLE	ALMANAC/ SLOT	CHANNEL	ORBIT PLANE	NOTES
95 (712)	2413	12-26-04		(8)		1	A
100 (714)	2419	12-25-05		(17)		3	B
101 (715)	2424	12-25-06	4-3-07	14	-7	2	
102 (716)	2425	12-25-06	10-12-07	15	0	2	
103 (717)	2426	12-25-06	4-3-07	10	-7	2	
105 (719)	2432	10-26-07	11-27-07	20	2	3	
106 (720)	2433	10-26-07	11-25-07	19	3	3	
107 (721)	2434	12-25-07	2-8-08	13	-2	2	
109 (723)	2436	12-25-07	1-22-08	11	0	2	
110 (724)	2442	9-25-08	10-26-08	(18)		3	C
111 (725)	2443	9-25-08	11-5-08	21	4	3	
116(730)	2456	12-14-09	1-30-10	1	1	1	
117(733)	2457	12-14-09	1-24-10	6	-4	1	
118(734)	2458	12-14-09	1-10-10	5	1	1	
119(731)	2459	3-1-10	3-28-10	22	-3	3	
120(732)	2460	3-1-10	3-28-10	23	3	3	
121(735)	2461	3-1-10	3-28-10	24	2	3	
122(736)	2464	9-2-10	10-4-10	9	-2	2	
123(737)	2465	9-2-10	10-12-10	12	-1	2	
124(738)	2466	9-2-10	10-11-10	16	-1	2	
125(701)	2471	2-26-11		(20)	-5	3	D
126 (742)	2474	10-2-11	10-25-11	4	6	1	
127 (743)	2475	11-4-11	3-5-13	8	6	1	
128 (744)	2476	11-4-11	12-8-11	3	5	1	
129 (745)	2477	11-4-11	12-23-11	7	5	1	
130 (746)	2478	11-28-11	12-23-11	17	4	3	
131 (747)	2485	4-26-13	7-4-13	2	-4	1	
132 (754)	2491	3-24-14	4-13-14	18	-3	3	E
133 (755)	2500	6-14-14	8-3-14	21	4	3	
134(702)	2501	11-30-14		(9)		2	F

◀ **THE SECOND GLONASS-K1** satellite was launched from the snowy Plesetsk Cosmodrome on November 30, 2014.

General Notes:

1. The first GLONASS satellite was launched October 12, 1982.
2. The GLONASS numbering scheme used in this table includes the eight "dummy" satellites orbited as ballast along with "real" satellites on the first seven GLONASS launches. The second number (in parentheses) in the "GLONASS Number" column is that assigned by the Russian Space Forces.
3. The Russian Federation designated the "Kosmos Number."
4. GLONASS numbers 1–94 have been withdrawn from service.
5. All operational satellites are GLONASS-M satellites, except GLONASS 125 and 134, which are GLONASS-K1 satellites. GLONASS 132 includes an L3 transmitter.
6. All launch and usable dates are based on Moscow Time (Universal Time + 3 hours).
7. Almanac/slot numbers in parentheses indicate the physical orbital slot of reserve/ test satellites or those in maintenance and not in the almanac.
8. Channel number "k" indicates L1 and L2 carrier frequencies: L1 = 1,602 + 0.5625 k (MHz); L2 = 1,246 + 0.4375 k (MHz).
9. All GLONASS satellites use cesium atomic clocks.
10. Twenty-four GLONASS satellites are currently set healthy.
11. The latest GLONASS launch was for GLONASS 134, which was launched from the Plesetsk Cosmodrome on November 30, 2014. It is currently drifting to its assigned orbital slot and is still undergoing checkout and is not yet operational. A GLONASS-M single-satellite launch from Plesetsk is expected in the first quarter of 2015. A GLONASS-M triple-satellite launch from Baikonur is expected in the April/May 2015 timeframe.
12. New GLONASS channel allocations were introduced September 1993 to reduce interference to radio astronomy. Note the use of the same channel on pairs of antipodal satellites.
13. *GPS World* believes this information to be correct as of press time. However, because of the satellite constellation's evolving nature, we encourage readers to contact the GLONASS sources listed on these pages for more current information.
14. Information compiled by Richard Langley.

Performance Notes:

A. GLONASS 95 is a reserve satellite.
B. GLONASS 100 was operational and set healthy between February 24 and April 11, 2014, using frequency channel -6. It subsequently resumed its status as a reserve satellite.
C. Maintenance tests of GLONASS 110 were concluded on July 23, 2014, and the satellite has been removed from the constellation.
D. GLONASS 125 is currently in flight test mode and is near physical orbital slot 20. When not in the active constellation, the satellite typically identifies itself as satellite 26 in its broadcast ephemeris.
E. GLONASS 132 has a Kosmos number of 2491 assigned by the Russian Federation but NORAD is using a designation of 2492.
F. GLONASS 134 is undergoing commissioning and is not yet operational.

GLONASS Satellite & System Information

Information–Analytical Center (IAC), Russian Space Agency
www.glonass-ianc.rsa.ru/

The IAC publishes official information about GLONASS status and plans as well as consultation, information, and scientific-method services to increase GLONASS applications efficiency. It provides current constellations, Earth maps of the current and daily navigation availabilities, results of GNSS navigation field monitoring in the Moscow area in a real-time mode, and other data. **For more information:** IAC, Mission Control Center, email: glonass-ianc@mcc.rsa.ru.

Satellite-Based Augmentation Systems

SBAS	SATELLITE	ORBIT LONGITUDE	PRN	SIGNALS	NOTES
EGNOS	Inmarsat-3-F2/AOR-E	15.5° W	120	L1	A
	Astra 5B	31.5° E	123	L1/L5	B
	Artemis	21.5° E	124	L1	C
	Inmarsat-4-F2	25° E	126	L1	D
	SES-5	5° E	136	L1/L5	E
GAGAN	GSAT-8	55° E	127	L1/L5	F, H
	GSAT-10	83° E	128	L1/L5	G, H
MSAS	MTSAT-1R	140° E	129	L1	I
	MTSAT-2	145° E	137	L1	I
QZSS	QZS-1	135° E	183	L1	J
SDCM	Luch-5A	167° E	140	L1	K
	Luch-5B	16° W	125	L1	L
	Luch-5V	95° E	141	L1	M
WAAS	Intelsat Galaxy 15 (CRW)	133° W	135	L1/L5	N, P
	TeleSat Anik F1R (CRE)	107.3° W	138	L1/L5	O, P
	Inmarsat-4-F3 (AMR)	98° W	133	L1/L5	Q

Notes:

A. Inmarsat 3-F2 began Safety-of-Life Service on March 2, 2011, and is transmitting message type 2.
B. Astra 5B was launched on March 22, 2014, and started transmitting L1 test signals on December 11, 2014.
C. Decomissioned for EGNOS use. Satellite sold to Britain's Avanti Communications.
D. Inmarsat-4-F2 began Safety-of-Life Service on March 22, 2012, and is transmitting message type 2.
E. SES-5 (also known as Sirius 5 and Astra 4B) was launched on July 9, 2012. Satellite occasionally transmits test signals.
F. GSAT-8 was launched on May 20, 2011. Not currently transmitting signals.
G. GSAT-10 was launched on September 28, 2012.
H. GAGAN was certified for enroute navigation and non-precision approaches on December 30, 2013.
I. MSAS commissioned for aviation use on September 27, 2007. Either satellite can transmit both PRN signals if necessary.
J. QZS-1 (nicknamed Michibiki) transmits an L1 augmentation signal using PRN code 183. That signal is in test mode. Central longitude can vary by ± 5° or more from nomimal value.
K. Luch-5A was launched on December 11, 2011. Initially positioned at 58.5° E, it was shifted to 95° E between about May 30 and June 28, 2012, then shifted to 167° E between about November 30 and December 22, 2012. Transmissions as PRN 140 began on July 12, 2012. Transmitted occasional, non-coherent code/carrier test signals.
L. Luch-5B was launched on November 2, 2012, and started transmitting test signals on January 17, 2013.
M. Luch-5V was launched on April 28, 2014. Testing may have started using PRN 140, not 141.
N. Galaxy 15 ranging supports enroute through precision approach modes. Switched to backup satellite oscillator on January 6, 2012.
O. Anik F1R ranging supports enroute through precision approach modes.
P. The Galaxy 15 and and Anik F1R payloads, operated by Lockhhed Martin for the FAA, are known as LMPRS-1 and LMPRS-2, respectively.
Q. Inmarsat-4-F3 supports non-precision approach ranging service.

BeiDou (formerly Compass) Constellation

SATELLITE	NORAD ID	PRN	LAUNCHED	ORBIT	NOTES
BeiDou M1	31115	C30	4-13-07	MEO period 12.89 hours	A
BeiDou G2	34779	N/A	4-14-09	GEO drifting	B
BeiDou G1	36287	C01	1-16-10	GEO 140° E	C
BeiDou G3	36590	C03	6-2-10	GEO 110.5° E	D
BeiDou IGSO1	36828	C06	7-31-10	IGSO 118° E, 55.0° incl.	
BeiDou G4	37210	C04	10-31-10	GEO 160.0° E	
BeiDou IGSO2	37256	C07	12-17-10	IGSO 118° E, 55.0° incl.	
BeiDou IGSO3	37384	C08	4-9-11	IGSO 118° E, 55.0° incl.	
BeiDou IGSO4	37763	C09	7-26-11	IGSO 95° E, 55.0° incl.	
BeiDou IGSO5	37948	C10	12-1-11	IGSO 95° E, 55.0° incl.	
BeiDou G5	38091	C05	2-24-12	GEO 58.75° E	
BeiDou M3	38250	C11	4-29-12	MEO period 12.89 hours	E
BeiDou M4	38251	C12	4-29-12	MEO period 12.89 hours	E
BeiDou M5	38774	C13	9-18-12	MEO period 12.89 hours	E, F
BeiDou M6	38775	C14	9-18-12	MEO period 12.89 hours	E
BeiDou G6	38953	C02	10-25-12	GEO 80° E	

Notes:

IGSO node longitudes are nominal values. Nodes are allowed to drift ±3 degrees or so.

A. Inactive.
B. Initially achieved geostationary orbit at a longitude of about 84.5° E, but appears to have become uncontrollable shortly thereafter. Librating about the 75° E libration point.
C. GEO, formerly at 144.5° E, shifted to 140° E between about June 30 and July 9, 2011.
D. GEO, formerly at 84° E, shifted to 110.5° E between about November 7 and November 23, 2012.
E. The MEO satellites are in a 24-satellite three-orbit-plane Walker constellation with orbit planes spaced by 120°. The first four MEO satellites occupy slots 7and 8 in plane 1 and slots 3 and 4 in plane 2.
F. Satellite is not currently transmitting standard signals.

BeiDou System Information

China fielded a demonstration regional satellite-based navigation system known as BeiDou (Chinese for the "Big Dipper" asterism and pronounced "bay- dough") following a program of research and development that began in 1980. The initial constellation of three geostationary Earth orbit (GEO) satellites was completed in 2003. A fourth GEO satellite was launched in 2007. The initial regional BeiDou system (BeiDou-1) has been replaced by a global system known as BeiDou-2 (or simply BeiDou and, formerly, Compass). It will eventually include five GEO satellites, 27 medium Earth orbit (MEO) satellites, and five inclined geosynchronous orbit (IGSO) satellites. BeiDou-2 was declared operational for use in China and surrounding areas on December 27, 2011. FOC for this area was declared on December 27, 2012. The system will provide global coverage by 2020, or even as early as 2017, according to some reports.

For more information: Official BeiDou website (English-language version): *http://en.beidou.gov.cn/*

IRNSS Constellation

▲ **IRNSS-1C** being assembled with the launch vehicle.

According to the Indian Space Research Organisation, the Indian Regional Navigation Satellite System (IRNSS) will consist of three GEO satellites located at 34°E, 83°E, and 131.5°E as well as two pairs of IGSO satellites with their nodes at longitudes of 55°E and 111.5°E with an orbital inclination of 29°. The satellites will transmit signals at 1176.45 and 2492.028 MHz.

The first satellite in the planned constellation, IRNSS-1A, was launched from the Satish Dhawan Space Centre on July 1, 2013, at 18:11 UTC. The satellite, with international designation 2013-034A and NORAD/JSpOC identification number 39199, achieved its assigned IGSO on July 18, 2013, with a nominal nodal longitude of 55°E and an orbital inclination of 27°. Test transmissions started shortly thereafter. The second IGSO satellite, IRNSS-1B, was launched on April 4, 2014, at 11:44 UTC. Designated as 2014-017A and 39635, it was placed in an orbit with a nominal nodal longitude of 55° E and an inclination of 31°. The first GEO satellite, IRNSS-1C, was launched on October 15, 2014, at 20:02 UTC. Designated as 2014–061A and 40269, it is in a nominally geostationary orbit with a longitude of 83° E.

For more information:
ISRO website:
http://www.isro.org/satellites/navigationsatellites.aspx

Galileo Constellation

SATELLITE	NORAD ID	LAUNCHED	OPERATIONAL	SLOT	PRN	CLOCK	NOTES
GIOVE-A	28922	12-28-05					A
GIOVE-B	32781	4-27-08					B
PFM (GSAT0101)	37846	10-21-11	12-10-11	B5	E11	H	C, I
FM2 (GSAT0102)	37847	10-21-11	1-16-12	B6	E12	H	D, I
FM3 (GSAT0103)	38857	10-12-12	12-1-12	C4	E19	H	E, I
FM4 (GSAT0104)	38858	10-12-12	12-12-12	C5	E20	Rb	F, I
FOC-FM1 (0201)	40128	08-22-14			E18	Rb	G, J
FOC-FM2 (0202)	40129	08-22-14					H, J

Notes:

A. Navigation signals from GIOVE-A were switched off on June 30, 2012, and the satellite decommissioned for ESA use.
B. Navigation signals from GIOVE-B were switched off on July 23, 2012, and the satellite decommissioned for ESA use.
C. Nicknamed Thijs.
D. Nicknamed Natalia.
E. Nicknamed David.
F. Nicknamed Sif. Payload power problem beginning May 27, 2014. Now only transmits an E1 signal.
G. Nicknamed Doresa. Orbit perigree raised by about 3500 kilometers in November 2014. Began transmitting L-band navigation signals on November 29, 2014.
H. Nicknamed Milena.
I. System is undergoing in-orbit validation campaign. Occasional planned outages of satellite signals. Satellites are currently transmitting valid navigation messages.
J. Satellites launched into wrong orbits.

Galileo System Information

Galileo is a joint initiative of the European Commission (EC, *ec.europa.eu*) and the European Space Agency (ESA, *www.esa.int*). Initially, they formed the Galileo Joint Undertaking (GJU) to manage Galileo's development phase. The European GNSS Supervisory Authority (GSA, *www.gsa.europa.eu*), initially headquartered in Brussels, Belgium, took over Galileo responsibility from GJU on January 1, 2007. The headquarters were moved to Prague in the Czech Republic on September 1, 2012. The GSA's tasks include management of the first series of satellites to ensure the large-scale demonstration of the capabilities and reliability of the Galileo system. The first two Galileo satellites secured the system's frequency allocation and validate key technologies for the full Galileo constellation. Surrey Satellite Technology Ltd. (SSTL, *www.sstl.co.uk*) in Guildford, United Kingdom, constructed the first test satellite. Formerly known as the Galileo System Test Bed (GSTB) V2/A satellite, it has been christened Galileo In-Orbit Validation Element-A (GIOVE-A) and was launched on December 28, 2005. The second test satellite, GSTB V2/B or GIOVE-B, constructed by a team led by Astrium GmbH (now Airbus Defence and Space, *www.space-airbusds.com*) in Ottobrunn near Munich, Germany, was launched on April 26, 2008. The first two in-orbit validation (IOV) satellites were launched on October 21, 2011, and the third and fourth IOV satellites were launched on October 12, 2012 — all provided by Astrium. The IOV satellites are currently transmitting test signals. The satellites were provided by Astrium. Transmission of valid navigation messages began on January 17, 2013. The first two full-operational-capability satellites, manufactured by OHB Systems GmbH (Bremen, Germany) and SSTL, were launched on August 22, 2014, into wrong orbits due to an upper rocket stage anomaly.

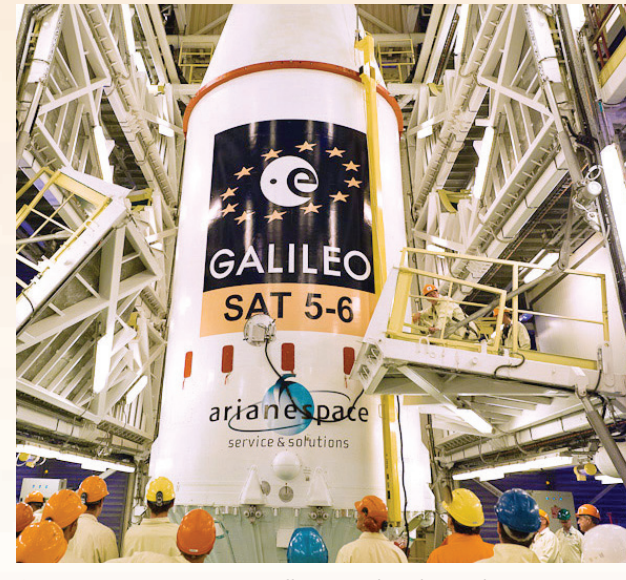

Photo: ESA

▲ **EUROPE'S FIFTH AND SIXTH** satellites are placed atop their Soyuz launcher August 19 in preparation for the August 22 launch.

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