Space Launch Report: Delta II Data Sheet

Delta II

Vehicle Configurations

Vehicle Components

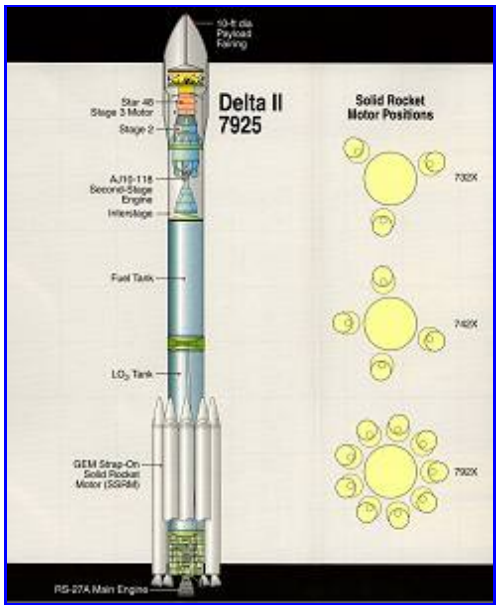
Delta Launch History

Delta 226, a Standard 7925-9.5 with a GPS Payload

Boeing's Delta II, one of the world's most most successful expendable space launch vehicles, was an updated version of the Thor-Delta series that first flew for NASA in 1960. In the early 1980s, NASA halted procurement at Delta 183 after shifting all payloads to the Space Transportation System.

To create Delta II for the U.S. Air Force Medium Launch Vehicle (MLV) program after the 1986 Challenger accident, McDonnell Douglas had to restart Delta production. The new rocket's first stage was stretched 3.66 meters and it's payload fairing was widened. The ultimate Delta II version, which did not appear until 1990, was boosted by more powerful solid rocket motors and a more powerful first stage motor. Delta 184, the first Delta II, launched GPS 14 on Valentine's Day, 1989.

Boeing used a four-digit numbering system to identify specific Delta models. The first digit indicated the first stage and solid rocket motor (SRM) type. The first Delta II models, 16 altogether, were 6000-series birds with Extra Long Extended Tank (XLET) Thor first stages, with a Rocketdyne RS-27A main engine, and with Thiokol Castor 4A SRMs. Subsequent 7000-series Delta II vehicles used more powerful Alliant Graphite Epoxy SRMs (GEMs).



Delta 2 7925-10C (Composite 10 ft. Payload Fairing) Diagram

The second digit told how many SRMs were used, usually 3, 4 or 9. When nine SRMs were used, six ignite on the pad. The remaining three ignited in the air after the first six burn out.

The third digit indicated the type of second stage. After 1982, Delta used a Type 2 second stage powered by an Aerojet AJ10-118K pressure-fed, restartable hypergolic engine.

The fourth digit identified the optional third stage type. Delta II could be configured with no third stage (Type 0), with a Star 48B (Type 5), or with a Star 37 (Type 6). These solid motors were spun up on a second-stage-mounted spin table to add stability prior to release. Delta II did not use a third stage for low earth orbit missions.

In 2003, a new Delta II type, the 7XXX-H series (H for "Heavy") debuted. Delta II Heavy used nine of the larger, more powerful GEM-46 LDXL SRMs that were originally developed for Boeing's Delta III.

Delta 261, a 7326 "Med-Lite", Launches Deep Space One in 1998

Three Delta II payload fairings were available. The standard 2.9 meter diameter aluminum hammerhead payload fairing was designed to handle GPS-class payloads. A 3 meter tapered composite fairing later became the standard, replacing the aluminum fairing.

Versatile Delta II flew a wide variety of missions from fixed pads at both Cape Canaveral (SLC 17A and 17B) and Vandenberg (SLC 2W). Payload capacity to low earth orbit (LEO) from the Cape ranged from 2.8 to 6.1 metric tons. Polar orbit LEO payload capacity from Vandenberg was 2.1 to 3.8 tons (more mass could be boosted if SLC 2W were modified to handle the GEM-46 SRMs). Delta II could launch 1.1 to 2.2 tons to a 28.5 degree inclination geosynchronous transfer orbit (GTO) from Canaveral, and could propel nearly as much mass to solar orbit using a third stage.

Its GTO mission business dwindled after the 1990s, but Delta II continued to launch LEO satellites, NASA deep space missions, and GPS satellites for the U.S. Air Force. The GPS launches finally ended on August 17, 2009 with a final launch from SLC 17A. Seven subsequent non GPS launches from SLC 17B and from Vandenberg AFB SLC 2W closed out the planned manifest during 2009-2011. The final Cape launch, by Delta 356 (a 7920H) on September 9, 2011, sent NASA's GRAIL A and B spacecraft toward the Moon. Delta 357 (a 7920), closed out the manifest, and possibly the program, with an October 28, 2011 launch from Vandenberg carrying NPP and several additional satellites into sun synchronous orbit. It was the 151st Delta II and the 96th consecutive success. It was also the 340th Thor-Delta, the 606th orbital Thor, and the 719th Thor launch of any type.

After D357, United Launch Alliance still had parts on hand, in inventory at suppliers, or with parts able to be manufactured, to assemble five more Delta II rockets. None had payloads assigned, but ULA was actively offering the vehicles to NASA.

NASA Revives Delta 2

Delta 314, a 7420-10C, Stands on Vandenberg AFB SLC 2W in 2006

On July 16, 2012, NASA announced that it had awarded launch services contracts for three United Launch Alliance Delta 2 rockets, all to launch from California's Vandenberg Air Force Base. The announcement marked a reprieve for Delta 2, which had no manifested flights prior to the announcement.

Delta 2 will launch the Soil Moisture Active Passive (SMAP) satellite during October 2014, the Orbiting Carbon Observatory-2 (OCO-2) during July 2014, and the Joint Polar Satellite System-1 (JPSS-1)

spacecraft during November 2016. The total cost for the three launches, including payload processing and other mission-unique ground support, is about $412 million.

The three rockets, which will fly from Space Launch Complex 2 West toward sun synchronous low earth orbits, will largely be assembled from already-manufactured stockpiled components, such as engines, tank panels, and avionics. ATK will manufacture new solid rocket motor sets for the 7x20-series rockets. Parts for two additional unassigned Delta 2 rockets remained.

On February 22, 2013, NASA announced that it had assigned a fourth Delta 2 to launch the Ice, Cloud and Land Elevation Satellite (ICESat)-2 into near polar obit from Vandenberg AFB, a launch then scheduled for July 2016. A firm fixed-price launch service task order was awarded for the Delta 7320-10C launch under the indefinite-delivery, indefinite-quantity NASA Launch Services (NLS) II contract. NASA's total cost to launch ICESat-2 would be $96.6 million, including payload processing, integrated services, telemetry, reimbursables and other launch support requirements. The assignment gave Delta 2 a chance to record 100 consecutive success, should all four missions succeed.

Delta, and Thor, Finale

The final Delta 2, a 7420-10 variant flying the Delta 181 mission, successfully orbited NASA's Ice, Cloud and land Elevation Satellite-2 (ICESat-2) from Vandenberg AFB Space Launch Complex 2 West on September 15, 2018. Liftoff took place at 13:02 UTC, beginning a roughly 52 minute mission that placed 1,515 kg ICESat-2 into a 463 km sun synchronous low earth orbit.

It was the 155th Delta 2 and the 100th consecutive success, ending a program that first took flight on February 14, 1989. Delta 2 itself was an ancestor of the Thor IRBM, which first attempted to fly on January 25, 1957 and first succeeded on September 29, 1957, 61 years ago. Thor eventually saw extensive service as an orbital booster, topped by Agena, Delta, liquid hydrogen fueled, and solid motor stages. It even flew as a booster for Japan's N-1, N-2, and H-1 launch vehicles during the 1970s, 80s, and 90s. A total of 723 Thor/Delta launches took place, not including two Thors that were destroyed in pre-launch pad accidents. Thor remains the most oft-flown U.S. launch vehicle, and will for years to come.

Northrop Grumman-built ICESat-2 will use its Advanced Topographic Laser Altimeter System (ATLAS) to measure changes in glaciers, sea ice, forests, and terrain. Four CubeSats were also deployed from the Delta II pressure-fed hypergolic second stage. Built by UCLA, the University of Central Florida, and Cal Poly, the CubeSats carry a variety of space experiments.

Delta 381 consisted of an RP/LOX booster powered by the final Rocketdyne RS-27A engine producing 200,000 lbs of sea-level thrust, augmented by four Graphite Epoxy Motors (GEMs), topped by an Aerojet AJ10-118K powered second stage, which burned Aerozine 50 and Nitrogen Tetroxide to produce 9,850 lb

thrust. The second stage hosted the rocket's guidance system. A 10 foot diameter two-piece payload fairing topped the rocket. Delta 2 stood 132 feet and its core was 8 feet in diameter.

The GEMs jettisonned at T+ 1:22.5 min, MECO took place at 4:24.7 min, The second stage burned from T+4:39.0 min to T+10:57.4 min, then reignited for a second burn at T+47:36.5 min that lasted about six seconds. ICESat-2 separated at T+52:43.5 min. The second stage was expected to perform two subsequent burns to deorbit itself, with reentry over the Pacific Ocean expected about two hours after liftoff.

It was the final flight for several long-running propulsion systems. These included the LOX/RP-1 Rocketdyne (now Aerojet Rocketdyne) RS-27A main engine and LR-101 verniers whose ancestors date back to the 1955 Atlas ICBM program and the earlier Navaho missile program. It was also the last flight of the Aerojet (now Aerojet Rocketdyne) AJ10-118K pressure fed hypergolic second stage engine and of the ATK (now Northrop Grumman) GEM-40 strap on motors.

It was also the final launch from SLC 2W, a pad that hosted its first Thor IRBM launch on September 17, 1959. It subsequently hosted Thor and Thrust Augmented Thor Agena D, Thor Able Star, Thrust Augumented Improved Delta, Long Tank Thor Delta, Extended Long Tank Delta, and Delta 2. It handled a total of 99 launches, including 71 Deltas, 45 of which were the Delta 2 type. The site was named Launch Complex 75-1 Pad 2 (75-1-2) until 1966. NASA took over the site from the U.S. Air Force in 1969. The final 166 foot tall Mobile Service Tower was built during 1978-81 and upgraded for Delta 2 during 1994-95.

ULA and NASA decided to apply one final set of Delta logos plastered with success stars. Each star represented a success in the longest consecutive Thor-Delta success string, which in this case actually ended with Delta 181 at 100. Traditionally there would only have been 99 stars, since the streak was 99 prior to the Delta 381 launch, but the team optimistically applied 100 this time. This tradition dated back to Delta 50, launched in 1967, which sported 17 stars. The tradition was shelved in 2007 after ULA took over the Delta 2 program. Delta 322, the last previous flight with the emblems, carried 71 stars when it flew from SLC 2W during December 2006.

Vehicle Configurations

	LEO Payload (metric tons) 185 km x (1) 28.5 deg (2) 90 deg	GTO Payload 1800 m/s from GEO* (metric tons) 185x35786km x28.7deg	Earth Escape Payload C3=0.4 km^2/s^2 i=28.7 deg (metric tons)	Configuration	LIftoff Height (meters)	Liftoff Mass (metric tons)
Delta 7320	2.80 t (1) 2.07 t (2)			XLET + 3xGEM + Stg2 + SPF	38.9 m	152 t
Delta 7420	3.20 t (1) 2.46 t (2)			XLET + 4xGEM + Stg2 + SPF	38.9 m	162 t
Delta 7425		1.14 t	0.806 t	XLET + 4xGEM + Stg2 + Star48B + SPF	38.9 m	165 t
Delta 7920	5.10 t (1) 3.83 t (2)			XLET + 9xGEM + Stg2 + SPF	38.9 m	228 t
Delta 7925		1.84 t	1.284 t	XLET + 9xGEM + Stg2 + Star48B + SPF	38.9 m	232 t
Delta 7920H	6.14 t (1)			XLET + 9xGEM-46 + Stg2 + SPF	38.9 m	283 t
Delta 7925H		2.19 t	1.519 t	XLET + 9xGEM-46 + Stg2 + Star48B + SPF	38.9 m	286 t

*GEO: Geosynchronous Earth Orbit

Vehicle Components

	GEM SRMs (each)	GEM-46 LDXL SRMs (each)	Extra Long Extended Tank (XLET) Thor First Stage	Second Stage	Star 48B Third Stage
Diameter (m)	1 m	1.17 m	2.4 m	2.4 m	1.2 m
Length (m)	13.0 m	14.7 m	26.1 m	6.0 m	2.0 m
Propellant Mass (tons)	11.77 t	16.86 t	96.12 t	6.00 t	2.01 t
Total Mass (tons)	13.08 t (GL) 13.2 t (AL)	19.07 t	101.80 t	6.95 t	2.27 t
Engine	GEM	GEM-46	RS-27A	AJ10-118K	Star 48B
Engine Mfgr	Alliant	Alliant	Rocketdyne	Aerojet	Thiokol
Fuel	HTPB	HTPB	RP-1	A-50	HTPB
Oxidizer			LOX	N2O4	
Thrust (SL tons)	45.48 t	72.58 t (liftoff)	90.72 t		
Thrust (Vac tons)	50.9 t (GL) 52.64 t (AL)	62.28 t (avg)	110.72 t	4.45 t	6.77 t
ISP (SL sec)	245.4 s	273 s	254.2 s		

ISP (Vac sec)	274 s (GL) 283.4 s (AL)	278 s	301.7 s	319.2 s	292.2 s
Burn Time (sec)	63.3 s	75 s	260.5 s	431.6 s	87.1 s
No. Engines	1	1	1	1	1

Vehicle Components, Cont'd

	Standard 2.9 m Fairing	3 m Composite Fairing	3 m Composite Long Fairing
Diameter (meters)	2.9 m	3 m	3 m
Length (meters)	8.49 m	8.88 m	9.25 m
Mass (tons)	0.88 t		

Delta 2 Launch History

DELTA 2 ORBITAL SPACE LAUNCH LOG

DATE	VEHICLE	ID	PAYLOAD	MASS(t)	SITE*	ORBIT*
02/14/89	Delta 2-6925	D184	GPS-2 1 (USA 35)	1.66	CC 17A	MTO [1]
06/10/89	Delta 2-6925	D185	GPS-2 2 (USA 38)	1.66	CC 17A	MTO
08/18/89	Delta 2-6925	D186	GPS-2 3 (USA 42)	1.66	CC 17A	MTO
10/21/89	Delta 2-6925	D188	GPS-2 4 (USA 47)	1.66	CC 17A	MTO
12/11/89	Delta 2-6925	D190	GPS-2 5 (USA 49)	1.66	CC 17B	MTO
01/24/90	Delta 2-6925	D191	GPS-2 6 (USA 50)	1.66	CC 17A	MTO
02/14/90	Delta 2-6920-8	D192	LACE / RME	2.47	CC 17B	LEO [2]
03/26/90	Delta 2-6925	D193	GPS-2 7 (USA 54)	1.66	CC 17A	MTO
04/13/90	Delta 2-6925-8	D194	Palapa B2R	1.2	CC 17B	GTO
06/01/90	Delta 2-6920-10	D195	ROSAT	2.426	CC 17A	LEO
08/02/90	Delta 2-6925	D197	GPS-2 8 (USA 63)	1.66	CC 17A	MTO
08/18/90	Delta 2-6925	D198	Marco Polo 2	1.25	CC 17B	GTO
10/01/90	Delta 2-6925	D199	GPS-2 9 (USA 64)	1.66	CC 17A	MTO
10/30/90	Delta 2-6925	D200	Inmarsat-2 F1	1.31	CC 17B	GTO
11/26/90	Delta 2-7925	D201	GPS-2A 1 (USA 66)	1.816	CC 17A	MTO
01/08/91	Delta 2-7925	D202	NATO 4A	1.434	CC 17B	GTO
03/08/91	Delta 2-6925	D203	Inmarsat-2 F2	1.31	CC 17B	GTO
04/13/91	Delta 2-7925	D204	ASC 2	1.35	CC 17B	GTO
05/29/91	Delta 2-7925	D205	Satcom C5 (Aurora 2)	1.169	CC 17B	GTO
07/04/91	Delta 2-7925	D206	GPS-2A 2 / Losat X	1.816	CC 17A	MTO
02/23/92	Delta 2-7925	D207	GPS-2A 3 (USA 79)	1.816	CC 17B	MTO
04/10/92	Delta 2-7925	D208	GPS-2A 4 (USA 80)	1.816	CC 17B	MTO
05/14/92	Delta 2-7925-8	D209	Palapa B4	1.2	CC 17B	GTO
06/07/92	Delta 2-6920-10	D210	EUVE	3.275	CC 17A	LEO
07/07/92	Delta 2-7925	D211	GPS-2A 5 (USA 83)	1.816	CC 17B	MTO
07/24/92	Delta 2-6925	D212	Geotail / DUVE	1.009	CC 17A	EEO [3]
08/31/92	Delta 2-7925	D213	Satcom C4	1.169	CC 17B	GTO
09/09/92	Delta 2-7925	D214	GPS-2A 6 (USA 84)	1.816	CC 17A	MTO
10/12/92	Delta 2-7925	D215	DFS-Kopernikus 3	1.415	CC 17B	GTO
11/22/92	Delta 2-7925	D216	GPS-2A 7 (USA 85)	1.816	CC 17A	MTO
12/18/92	Delta 2-7925	D217	GPS-2A 8 (USA 87)	1.816	CC 17B	MTO
02/03/93	Delta 2-7925	D218	GPS-2A 9 (USA 88)	1.816	CC 17A	MTO
03/30/93	Delta 2-7925	D219	GPS-2A 10 / SEDS 1	1.816	CC 17A	MTO
05/13/93	Delta 2-7925	D220	GPS-2A 11 (USA 91)	1.816	CC 17A	MTO

06/26/93	Delta 2-7925	D221	GPS-2A 12 (USA 92)/PMG	1.816	CC 17A	MTO
08/30/93	Delta 2-7925	D222	GPS-2A 13 (USA 94)	1.816	CC 17B	MTO
10/26/93	Delta 2-7925	D223	GPS-2A 14 (USA 96)	1.816	CC 17B	MTO
12/08/93	Delta 2-7925	D224	NATO 4B (USA 98)	1.434	CC 17A	GTO
02/19/94	Delta 2-7925-8	D225	Galaxy 1R2	1.397	CC 17B	GTO
03/10/94	Delta 2-7925	D226	GPS-2A 15 / SEDS 2	1.816	CC 17A	MTO
11/01/94	Delta 2-7925-10	D227	Wind	1.2	CC 17B	EEO
08/05/95	Delta 2-7925	D228	Koreasat 1 (Mugunghwa 1)	1.464	CC 17B	[EEO][4]
11/04/95	Delta 2-7920-10	D229	Radarsat 1 / Surfsat 1	2.805	Va 2W	LEO/S
12/30/95	Delta 2-7920-10	D230	XTE (RXTE)	3.035	CC 17A	LEO
01/14/96	Delta 2-7925	D231	Koreasat 2 (Mugunghwa 2)	1.464	CC 17B	GTO
02/17/96	Delta 2-7925-8	D232	NEAR (Discovery 2)	0.818	CC 17B	HCO
02/24/96	Delta 2-7925-10	D233	Polar	1.25	Va 2W	EEO/P
03/27/96	Delta 2-7925	D234	GPS-2A 16 (USA 117)	1.816	CC 17B	MTO
04/24/96	Delta 2-7920-10	D235	MSX	2.7	Va 2W	LEO/P
05/23/96	Delta 2-7925	D236	Galaxy 9	1.397	CC 17B	GTO
07/16/96	Delta 2-7925	D237	GPS-2A 17 (USA 126)	1.816	CC 17A	MTO
09/12/96	Delta 2-7925	D238	GPS-2A 18 (USA 128)	1.816	CC 17A	MTO
11/07/96	Delta 2-7925	D239	Mars Global Surveyor	1.03	CC 17A	HCO
12/04/96	Delta 2-7925	D240	Mars Pathfinder	0.89	CC 17B	HCO
01/16/97	Delta 2-7925	D241	GPS-2R 1	2.032	CC 17A	[FTO][5]
05/05/97	Delta 2-7920-10C	D242	Iridium 04-08	3.445	VA 2W	LEO/P
05/24/97	Delta 2-7925	D243	Thor 2	1.467	CC 17A	GTO
07/09/97	Delta 2-7920-10C	D244	Iridium 15,17,18,20,21	3.445	VA 2W	LEO/P
07/23/97	Delta 2-7925	D245	GPS-2R 2 (USA 132)	2.032	CC 17A	MTO
08/21/97	Delta 2-7920-10C	D246	Iridium 22-26	3.445	VA 2W	LEO/P
08/25/97	Delta 2-7920-8	D247	ACE	0.785	CC 17A	HCO
09/25/97	Delta 2-7920-10C	D248	Iridium 19, 34-37	3.445	VA 2W	LEO/P
11/06/97	Delta 2-7925	D249	GPS-2A 19 (USA 135)	1.816	CC 17A	MTO
11/09/97	Delta 2-7920-10C	D250	Iridium 38-41, 43	3.445	VA 2W	LEO/P
12/20/97	Delta 2-7920-10C	D251	Iridium 45-49	3.445	VA 2W	LEO/P
01/10/98	Delta 2-7925	D252	Skynet 4D	1.500	CC 17B	GTO
02/14/98	Delta 2-7420-10C	D253	Globalstar 1-4	1.800	CC 17A	LEO
02/18/98	Delta 2-7920-10C	D254	Iridium MS-7 (50,52-4,56)	3.445	VA 2W	LEO
03/30/98	Delta 2-7920-10C	D255	Iridium MS-8 (55,57-60)	3.445	VA 2W	LEO
04/24/98	Delta 2-7420-10C	D256	Globalstar 6,8,14,15	1.500	CC 17A	LEO
05/17/98	Delta 2-7920-10C	D257	Iridium MS-9 (70,72-75)	3.445	VA 2W	LEO
06/10/98	Delta 2-7925	D258	Thor 3	1.451	CC 17A	GTO
09/08/98	Delta 2-7925-10C	D260	Iridium MS-10 (77,79-82)	3.445	VA 2W	LEO
10/24/98	Delta 2-7326	D261	Deep Space 1	0.486	CC 17A	HCO [6]
11/06/98	Delta 2-7920-10C	D262	Iridium MS-11 (2,83-86)	3.445	VA 2W	LEO
11/22/98	Delta 2-7925	D263	Bonum 1	1.406	CC 17B	GTO
12/11/98	Delta 2-7425	D264	Mars Climate Orbiter	0.633	CC 17A	HCO
01/03/99	Delta 2-7425	D265	Mars Polar Lander/DS 2	0.574	CC 17B	HCO
02/07/99	Delta 2-7426	D266	Stardust (NASA)	0.385	CC 17A	HCO [7]
02/23/99	Delta 2-7920-10	D267	ARGOS/Orsted/Sunsat	2.845	VA 2W	LEO/S
04/15/99	Delta 2-7920-10C	D268	Landsat 7 (NASA)	1.970	VA 2W	LEO/S
06/10/99	Delta 2-7420-10C	D270	Globalstar 25,47,49,52	1.500	CC 17B	LEO
06/24/99	Delta 2-7320-10C	D271	FUSE	1.335	CC 17A	LEO
07/10/99	Delta 2-7420-10C	D272	Globalstar 30,32,35,51	1.500	CC 17B	LEO
07/25/99	Delta 2-7420-10C	D273	Globalstar 26,28,43,48	1.500	CC 17A	LEO
08/17/99	Delta 2-7420-10C	D274	Globalstar 24,27,53,54	1.500	CC 17B	LEO
10/07/99	Delta 2-7925	D275	GPS 2R-3	2.032	CC 17A	MTO
02/08/00	Delta 2-7420-10C	D276	Globalstar 60,62-64	1.500	CC 17B	LEO
03/25/00	Delta 2-7326	D277	IMAGE	0.494	VA 2W	EEO/P
05/11/00	Delta 2-7925	D278	GPS 2R-4	2.032	CC 17A	MTO
07/16/00	Delta 2-7925	D279	GPS 2R-5	2.032	CC 17A	MTO
11/10/00	Delta 2-7925	D281	GPS 2R-6	2.032	CC 17A	MTO

11/21/00	Delta 2-7320-10C	D282	EO-1/SAC-C/Munin	0.889	VA 2W	LEO/S
01/30/01	Delta 2-7925	D283	GPS 2R-7	2.032	CC 17A	MTO
04/07/01	Delta 2-7925	D284	Mars Odyssey	0.725	CC 17A	HCO
05/18/01	Delta 2-7925	D285	GeoLITE	1.800	CC 17B	GTO
06/30/01	Delta 2-7425-10C	D286	MAP	0.800	CC 17B	EEO [8]
08/08/01	Delta 2-7326	D287	Genesis	0.636	CC 17A	HCO [9]
10/18/01	Delta 2-7320-10C	D288	QuickBird 2	1.028	VA 2W	LEO/S
12/07/01	Delta 2-7920-10C	D289	JASON/TIMED	1.048	VA 2W	LEO
02/11/02	Delta 2-7910-10C	D290	Iridium (5) IS-1	3.445	VA 2W	LEO/S
05/04/02	Delta 2-7920-10L	D291	Aqua (NASA)	2.934	VA 2W	LEO/S
07/03/02	Delta 2-7425	D292	CONTOUR	1.005	CC 17A	EEO [10]
01/13/03	Delta 2-7320-10C	D294	ICESat/CHIPSat	1.085	VA 2W	LEO/S
01/30/03	Delta 2-7925	D295	GPS 2R-8	2.032	CC 17B	MTO
03/31/03	Delta 2-7925	D297	GPS 2R-9	2.032	CC 17A	MTO
06/10/03	Delta 2-7925	D298	MER-A (Spirit)	1.063	CC 17A	HCO [11]
07/08/03	Delta 2-7925H	D299	MER-B (Opportunity)	1.063	CC 17B	HCO [11]
08/25/03	Delta 2-7920H	D300	SIRTF	0.923	CC 17B	HCO [12]
12/21/03	Delta 2-7935	D302	GPS 2R-10	2.032	CC 17A	MTO
03/20/04	Delta 2-7925	D303	GPS 2R-11	2.03	CC 17B	MTO
04/20/04	Delta 2-7920-10C	D304	Gravity Probe B	3.3	VA 2W	LEO/P
06/23/04	Delta 2-7925	D305	GPS 2R-12	2.0	CC 17B	MTO
07/15/04	Delta 2-7920-10L	D306	Aura (NASA)	3.1	VA 2W	LEO/S
08/03/04	Delta 2-7925H	D307	MESSENGER (NASA)	1.1	CC 17B	HCO [13]
11/06/04	Delta 2-7925	D308	GPS 2R-13	2.0	CC 17B	MTO
11/20/04	Delta 2-7320-10C	D309	SWIFT (NASA)	1.3	CC 17A	LEO
01/12/05	Delta 2-7925	D311	Deep Impact	1.4	CC 17B	HCO [14]
05/20/05	Delta 2-7320-10C	D312	NOAA-N (18)	2.2	VA 2W	LEO/S
09/26/05	Delta 2-7925	D313	GPS 2R-14(M1)	2.1	CC 17A	MTO
04/28/06	Delta 2-7420-10C	D314	CALIPSO/Cloudsat	1.7	VA 2W	LEO/S
06/21/06	Delta 2-7925	D316	MITEX A/B	1.1	CC 17A	GTO [15]
09/25/06	Delta 2-7925	D318	GPS 2R-15(M)	2.06	CC 17A	MTO
10/26/06	Delta 2-7925-10L	D319	STEREO (two sats)	1.24	CC 17B	EEO
11/17/06	Delta 2-7925	D321	GPS 2R-16(M3)	2.06	CC 17A	MTO
12/14/06	Delta 2-7920-10C	D322	NRO L-21		VA 2W	LEO
02/17/07	Delta 2-7925-10C	D323	THEMIS	0.5	CC 17B	EEO
06/08/07	Delta 2-7420-10C	D324	COSMO/SkyMed 1	1.91	VA 2W	LEO/S
08/04/07	Delta 2-7925	D325	Phoenix Mars Lander	0.67	CC 17A	HCO
09/18/07	Delta 2-7920-10C	D326	WorldView 1	2.5	VA 2W	LEO/S
09/27/07	Delta 2-7925H	D327	Dawn	1.218	CC 17B	HCO [16]
10/17/07	Delta 2-7925	D328	GPS 2R-17	2.059	CC 17A	MTO
12/09/07	Delta 2-7420-10C	D330	COSMO-Skymed 2	1.90	VA 2W	LEO/S
12/20/07	Delta 2-7925	D331	GPS 2R-18	2.06	CC 17A	MTO
03/15/08	Delta 2-7925	D332	GPS 2R19	2.06	CC 17A	MTO
06/11/08	Delta 2-7920H-10C	D333	GLAST	3.37	CC 17B	LEO
06/20/08	Delta 2-7320-10C	D334	Jason 2	0.506	VA 2W	LEO
09/06/08	Delta 2-7420-10C	D335	GeoEye 1	1.923	VA 2W	LEO/S
10/25/08	Delta 2-7420-10C	D336	Cosmo/Skymed 3	1.90	VA 2W	LEO/S
02/06/09	Delta 2-7320-10C	D338	NOAA-N Prime	1.44	VA 2W	LEO/S
03/07/09	Delta 2-7925-10L	D339	Kepler	1.05	CC 17B	HCO [17]
03/24/09	Delta 2-7925	D340	GPS 2R-20(M)	2.059	CC 17A	MTO
05/05/09	Delta 2-7920-10C	D341	STSS-ATRR		VA 2W	LEO/P
08/17/09	Delta 2-7925	D343	GPS 2R-21(M)	2.059	CC 17A	MTO
09/25/09	Delta 2-7920-10C	D344	STSS Demo	2.244	CC 17B	LEO
10/08/09	Delta 2-7920-10C	D345	Worldview 2	2.615	VA 2W	LEO/S
12/14/09	Delta 2-7320-10C	D347	WISE	0.674	VA 2W	LEO/S
11/06/10	Delta 2-7420-10C	D350	COSMO-SkyMed 4	1.9	VA 2W	LEO/S
06/10/11	Delta 2-7320-10C	D354	SAC-D/Aquarius	1.35	VA 2W	LEO/S
09/10/11	Delta 2-7920H-10C	D356	GRAIL A/B	0.614	CC 17B	EEO [18]

10/28/11	Delta 2-7920-10C	D357	NPP	1.97	VA 2W	LEO/S
07/02/14	Delta 2-7320-10C	D367	OCO 2	0.453	VA 2W	LEO/S
01/31/15	Delta 2-7320-10C	D370	SMAP	0.944	VA 2W	LEO/S
11/18/17	Delta 2-7920-10C	D378	JPSS 1	2.54	VA 2W	LEO/S
09/15/18	Delta 2-7420-10C	D381	ICESat 2	1.515	VA 2W	LEO/S

[1] Standard GPS mission used 3.5 stage Delta 2 to put satellite into a 187 x 20,368 km transfer orbit. A Star 37 apogee kick motor (part of the satellite payload) would fire at first apogee to circularize the orbit.

[2] LEO missions typically used 2.5 stage Delta 2.

[3] Final Delta with Castor 4A strap on motors, launched Japan's ISAS Geotail into into a highly elliptical orbit, which was subsequently modified by two lunar swingbys into a 57,000 km × 200,000 km x 29 deg orbit.

[4] One SRM failed to separate, leaving Koreasat in much lower than planned orbit.

[5] Solid Rocket Motor exploded at T+7 seconds, destroying vehicle.

[6] Deep Space 1 tested xenon-ion engine. Flew by Asteroid 9962 Braille on 7/29/99 and comet 19P/Borrelly on 09/22/01.

[7] Stardust flew by asteriod 5535 Annefrank on 11/02/02 and collected dust samples during flyby of Comet 81P/Wild 2 during January 2004. Returned samples in capsule that parachuted to landing in Utah on 01/15/06. Spacecraft continued an extended mission that flew by comet 9P/Tempel 1 on 02/14/11.

[8] Lunar swingby to L2

[9] Genesis orbited the Earth-Sun L-1 point to collect solar wind samples for 30 months. Sample return capsule reentered on 09/09/04, but parachute failed to deploy and capsule crash landed in Utah desert. Cause was improper orientation of gravity switches. Some samples extrated from wrecked capsule.

[10] Contour lost on 8/15/02 with Star 30 motor embedded in and part of spacecraft ignited to accelerate Contour from highly elliptic phasing orbit to solar orbit. Motor exhaust plume heating destroyed spacecraft due to improper design.

[11] Mars Exploration Rovers.

[12] SIRTF (Space Infrared Telescope Facility) was a 1 meter cryo-cooled infrared space telescope placed in solar orbit. Renamed Spitzer Space Telescope once in orbit.

[13] MESSENGER entered orbit of Mercury on 03/18/11 after performing an Earth flyby, two Venus flybys, and three Mercury flybys.

[14] Deep Impact released impactor that hit comet P/Tempel 1 on 07/04/05. Spacecraft imaged effects of impact during flyby.

[15] Payload included new USN liquid fourth stage

[16] Dawn, powered by ion engines, orbited asteriod Vesta between July 2011 and September 2012 at altitudes as close as 200 km. Dawn then departed and headed for a planned 2015 encounter with asteriod Ceres.

[17] Kepler discovered thousands of exoplanets candidates during landmark mission.

[18] Entered polar lunar orbit via. L1 point during a 3.5 month "cruise". Mapped lunar gravity details.

*Site Code:

CC = Cape Canaveral, FL, USA
VA = Vandenberg AFB, CA, USA

*Orbit Code:

[FTO] = Failed to Orbit
[EEO] = Unplanned EEO
EEO = Elliptical Earth Orbit
EEO/P = EEO Polar Inclination
GTO = Geosynchronous Transfer Orbit
GTO+ = Supersynchronous Transfer Orbit
GTO- = Subsynchronous Transfer Orbit
GEO = Geosynchronous Orbit
HCO = Heliocentric (solar) Orbit
HTO = High Earth Transfer Orbit
LEO = Low Earth Orbit
LEO/S = Sun Synchronous Low Earth Orbit
LEO/P = Polar Low Earth Orbit
MEO = Medium Earth Orbit
MTO = Medium Earth Transfer Orbit

References

Delta II Payload Planners Guide, October 2000
ATK Space Propulsion Products Catalog, 2008

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