Flight 160

Launching satellites for two loyal customers

Arianespace's second launch of the year will boost two communications satellites into geostationary transfer orbit: Insat 3A for ISRO, the Indian space agency, and Galaxy XII for PanAmSat, the world's leading private telecom operator.

Insat 3A will be the tenth Indian satellite orbited by an Ariane launcher. Arianespace has teamed up with ISRO (Indian Space Research Organization) for 22 years, starting with the launch of the organization's first satellite, Apple, in June 1981.

Insat 3A was designed, produced and integrated by ISRO in Bangalore, southern India. Positioned at 93.5 degrees East, it will be fitted with 18 C-band and extended C-band transponders and 6 Ku-band transponders.

The satellite will provide telecommunications and TV transmission services for the Indian sub-continent, while also carrying out a meteorological observation mission (VHRR) and a search and rescue payload.

Galaxy XII will be the 18th satellite launched by Arianespace for PanAmSat, one of its longest-standing customers. The relations of mutual confidence between Arianespace and the world's leading private telecom operator reach back to the maiden Ariane 4 launch, in June 1988.

Galaxy XII was built by Orbital Sciences Corporation at its Dulles, Virginia manufacturing facility. It is based on Orbital's Star-2 platform and will weigh 1,760 kg at launch. Galaxy XII will be positioned at 74 degrees West and has a design life of 15 years. It will provide C–band links between the United States, Alaska and Hawaii. The Galaxy XI and Galaxy IVR satellites were orbited on Arianespace Flights 125 and 129, respectively.

Arianespace Flight 160 will use a standard Ariane 5 launch vehicle.

Follow the launch live on the Internet
at www.arianespace.com
(starting 20 minutes before lift-off)

1. Arianespace Flight 160 mission

The 159th Ariane launch (Flight 160/Ariane 514) will use an Ariane 5 to place 2 telecommunications satellites into geostationary transfer orbit: the INSAT 3A satellite for Indian space agency, ISRO and GALAXY XII for PanAmSat.
For Arianespace, this marks the twelfth commercial mission of the Ariane 5 launcher.
The Ariane 514 launcher will carry a dual payload of 5,244 kg (11,536 lb), including 4,750 kg (10,450 lb) for the satellites.
The launch will be carried out from the ELA 3 launch complex in Kourou, French Guiana.

Injection orbit

Perigee altitude	***860 km***
Apogee altitude	***35,936 km at injection***
Inclination	***2° degrees***

The lift-off is scheduled on the night of April 8 to 9, 2003 as soon as possible within the following launch window :

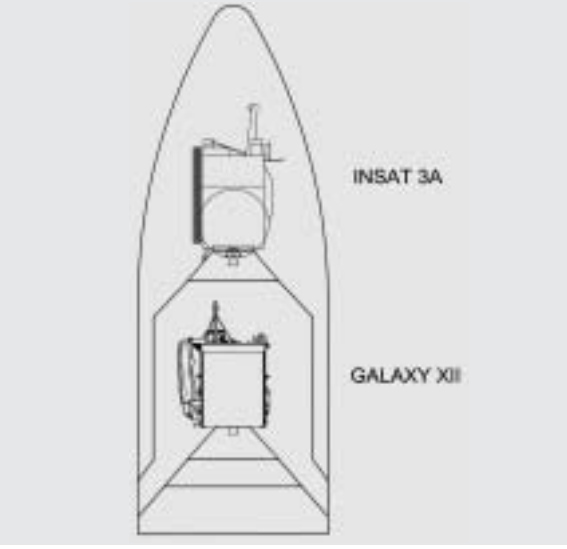
Launch opportunity

	Universal time (GMT)	*Paris time*	*Washington time*	*Kourou time*
Between	*10:49 pm*	*00:49 am*	*06:49 pm*	*07:49 pm*
and	*11:30 pm*	*01:30 am*	*07:30 pm*	*08:30 pm*
on	*April 8, 2003*	*April 9, 2003*	*April 8, 2003*	*April 8, 2003*

Ariane V160 payload configuration

The INSAT 3A satellite was designed and built by ISRO in Bangolore (India).
Orbital position: 93.5° East, over the Indian Ocean.

The GALAXY XII satellite was built by Orbital Sciences Corporation in Dulles (Virginia) for PanAmSat.
Orbital position: 74° West, above Columbia.



2. Range operations campaign : ARIANE 5 – INSAT 3A - GALAXY XII

The actual work for satellite range operations lasts 36 working days for INSAT 3A from its arrival in Kourou (before beginning combined operations).
The actual work for satellite range operations lasts 15 working days for GALAXY XII from its arrival in Kourou (before beginning combined operations).
A hold in the campaign occured from february 13 to march 18.

Satellites and launch vehicle campaign calendar

Ariane activities	*Dates*	*Satellites activities*
	January 14, 2003	*Arrival in Kourou and beginning of INSAT 3A preparation campaign in S5C-North building*
Campaign start review	*January 20, 2003*	
EPC Erection	*January 20, 2003*	
EAP transfer and positionning	*January 22, 2003*	
Integration EPC/EAP	*January 22, 2003*	
EPS Erection	*January 24, 2003*	
Integration equipement bay	*January 24, 2003*	
	February 4, 2003	*Arrival in Kourou and beginning of GALAXY XII preparation campaign in S5C-South building*
	February 14, 2003	*Transfer of GALAXY XII into the S5B building*
	February 17, 2003	*GALAXY XII filling operations in S5B building*
	February 24, 2003	*Transfer of INSAT 3A into the S5A building*
	March 1, 2003	*INSAT 3A filling operations in S5A building*
Roll-out from BIL to BAF	*March 25, 2003*	

Satellite and launch vehicle campaign final calendar

J-9	*Wednesday, March 26*	*INSAT 3A integration on ACU*
J-8	*Thursday, March 27*	*INSAT 3A integration on Sylda*
J-7	*Friday, March 28*	*GALAXY XII integration on ACU*
J-6	*Monday, March 31*	*GALAXY XII integration on launcher*
J-5	*Tuesday, April 1*	*INSAT 3A integration on launcher*
J-4	*Wednesday, April 2*	*Filling of SCA with N_2H_4*
J-3	*Thursday, April 3*	*Filling of EPS with N_2O_4 and arming of launch vehicle*
J-2	*Friday, April 4*	*Launch rehearsal and launcher final preparation*
	Saturday, April 5	*Launch rediness review (RAL)*
J-1	*Monday, April 7*	*Roll-out from BAF to Launch Area (ZL), launch vehicle connections and filling of the EPC Helium sphere*
J-0	*Tuesday, April 8*	*Launch countdown including EPC filling with liquid oxygen and liquid hydrogen*

3 - Launch countdown and flight events

The countdown comprises all final preparation steps for the launcher, the satellites and the launch site. If it proceeds as planned, the countdown leads to the ignition of the main stage engine, then the two solid boosters, for a liftoff at the targeted time, as early as possible in the satellites launch window.
The countdown culminates in a synchronized sequence (see appendix 3), which is managed by the control station and onboard computers starting at T-7 minutes.
If an interruption in the countdown means that T-0 falls outside the launch window, then the launch will be delayed by one, two or more days, depending on the problem involved, and the solution developed.

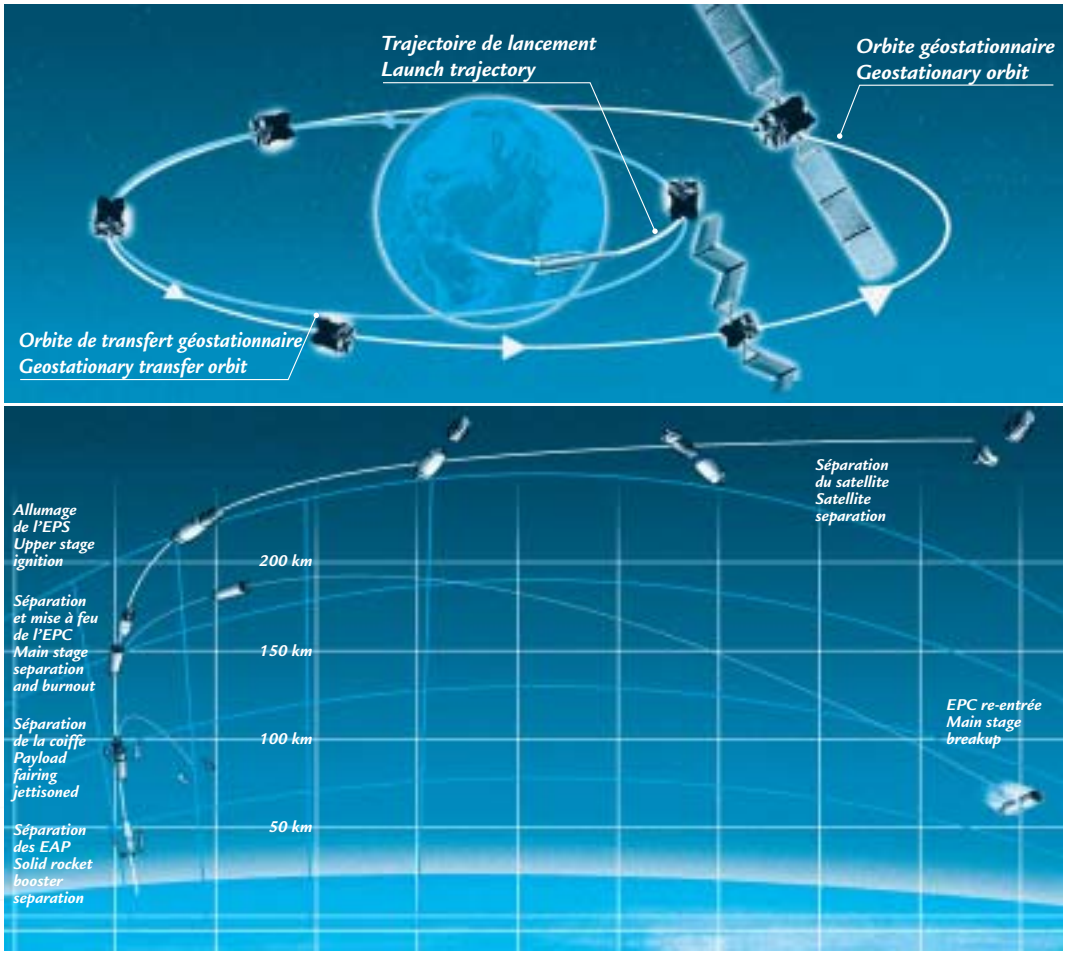
Time	Events
– 11h 30 mn	Start of final countdown
– 7 h 30 mn	Check of electrical systems
– 4 h 50 mn	Start of filling of main cryogenic stage with liquid oxygen and hydrogen
– 3 h 20 mn	Chilldown of Vulcain main stage engine
– 1 h 10 mn	Check of connections between launcher and telemetry, tracking and command systems
– 7 mn 00 s	"All systems go" report, allowing start of synchronized sequence
– 4 mn 00 s	Tanks pressurized for flight
– 1 mn 00 s	Switch to onboard power mode
– 04 s	Onboard systems take over
– 03 s	Unlocking of guidance systems to flight mode

HO	Ignition of the cryogenic main stage engine (EPC)	ALT (km)	V. rel. (m/s)
+ 7.0 s	Ignition of solid boosters	0	0
+ 7.3 s	Liftoff	0	0
+ 13 s	End of vertical climb and beginning of pitch rotation (10 seconds duration)	0.086	34.8
+ 17 s	Beginning of roll maneuver	0.296	67.0
+ 2 mn 21 s	Jettisoning of solid boosters	68.4	2062.5
+ 3 mn 10 s	Jettisoning of fairing	107.4	2240.7
+ 7 mn 29 s	Acquisition by Natal tracking station	172.6	4545.7
+ 9 mn 56 s	Extinction of main cryogenic stage	262.3	7584.6
+ 10 mn 02 s	Separation of main cryogenic stage	206.2	7602.0
+ 10 mn 09 s	Ignition of the storable propellant stage (EPS)	210.8	7597.0
+ 12 mn 04 s	Acquisition by Ascension tracking station	296.2	7692.0
+ 21 mn 45 s	Acquisition by Malindi tracking station	1045.3	8112.9
+ 27 mn 12 s	Extinction of EPS	1884.2	8400.4
+ 27 mn 22 s	Separation of INSAT 3A satellite	2297.2	8139.9
+ 32 mn 48 s	Separation of Sylda 5	2942.6	7705.6
+ 38 mn 43 s	Separation of GALAXY XII satellite	4322.9	6987.3
+ 55 mn 02 s	End of ARIANESPACE Flight 160 mission	8032.7	5474.4

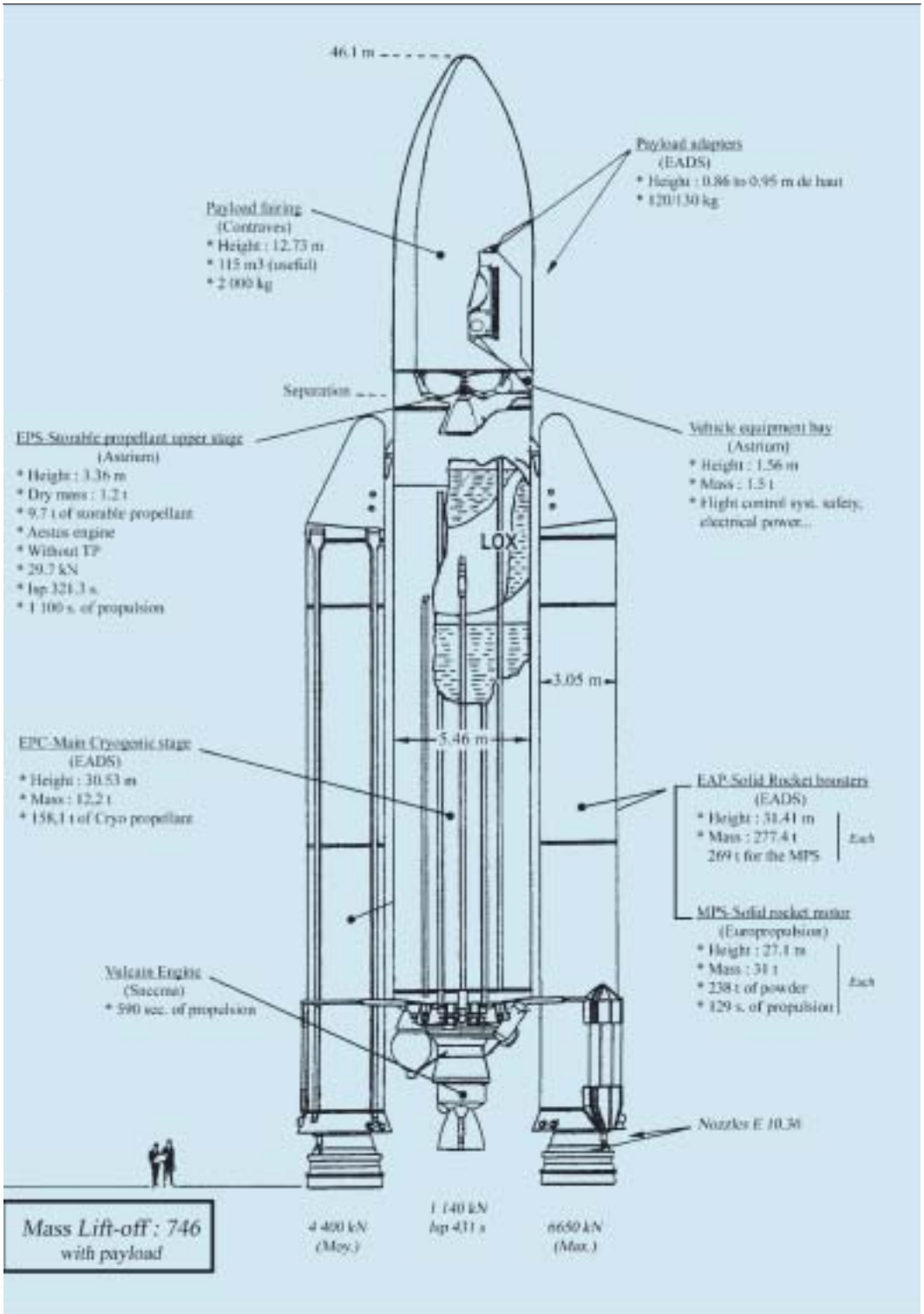
4 - Flight 160 trajectory

The launcher's attitude and trajectory are totally controlled by the two onboard computers, located in the Ariane 5 vehicle equipment bay (VEB).
7.0 seconds after ignition of the main stage cryogenic engine at T-0, the two solid-propellant boosters are ignited, enabling liftoff. The launcher first climbs vertically for 6 seconds, then rotates towards the East. It maintains an attitude that ensures the axis of the launcher remains parallel to its velocity vector, in order to minimize aerodynamic loads throughout the entire atmospheric phase, until the solid boosters are jettisoned.
Once this first part of the flight is completed, the onboard computer optimizes the trajectory in real time, minimizing propellant consumption to bring the launcher first to the intermediate orbit targeted at the end of the main stage propulsion phase, and then the final orbit at the end of the flight of the upper cryogenic stage.
The main stage falls back off the coast of South America in the middle of the Pacific Ocean.
On orbital injection, the launcher will have attained a velocity of approximately 8,400 meters/second, and will be at an altitude of about 1884 kilometers.
The fairing protecting the INSAT 3A/GALAXY XII spacecrafts is jettisoned shortly after the boosters are jettisoned at about T+190 seconds.

Standard Ariane 5 trajectory for geostationary transfer orbit



5 - ARIANE 5G LAUNCHER (Industrial architect: EADS Launch Vehicles)



6 - The INSAT 3A satellite

Customer	***Indian Space Research Organisation (ISRO)***	
Prime contractor	*ISRO/ISAC*	
Mission	*Communications*	
Mass	*Total mass at lift-off*	*2,950 kg*
	Dry mass	*1,350 kg*
Stabilization	*3 axis stabilized*	
Dimensions		*2.8 x 1.7 x 2.0 m*
	Span in orbit	*24.4 m*
Payload	*6 Ku band transponders,18 C band transponders,* *1 VHRR, 1 CDD camera, 1 search and rescue payload*	
On-board power	*3,230 W (at end of life)*	
Life time	*15 years*	
Orbital position	*93,5° East (above the Bengal Gulf)*	
Coverage area	*India*	

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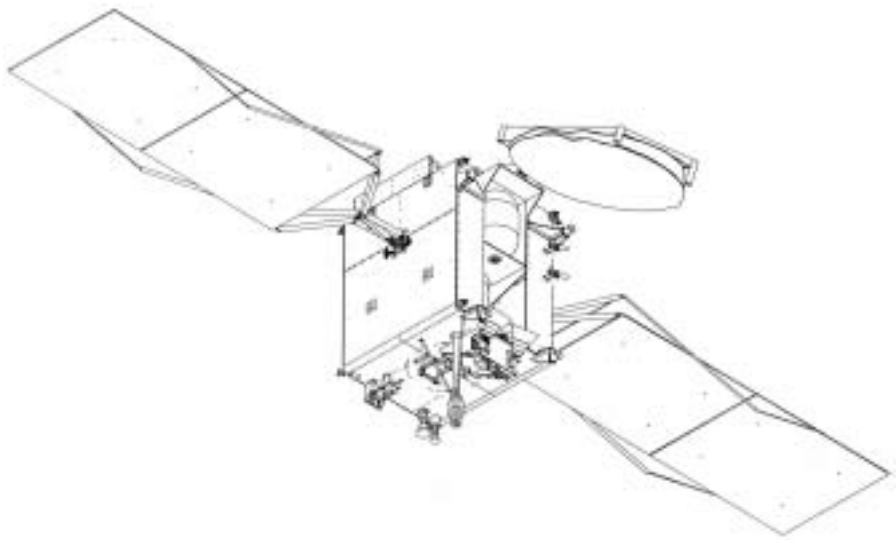
7 - The GALAXY XII satellite



Customer	***PanAmSat***	
Prime contractor	*Orbital Sciences Corporation*	
Mission	*Communications*	
Mass	*Total mass at lift-off*	*1,760 kg*
	Dry mass	*800 kg*
Stabilization	*3 axis stabilized*	
Dimensions		*3.3 x 1.9 x 1.5 m*
	Span in orbit	*12.6 m*
Platform	*Orbital's Star-2*	
Payload	*24 C band transponders*	
On-board power	*2,640 W (at end of life)*	
Life time	*15 years*	
Orbital position	*74° West (above Columbia)*	
Coverage area	*Continental United States, Alaska and Hawaii*	

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Annex 1 - Arianespace Flight 160 key personnel

In charge of the launch compaign			
Mission Director	*(CM)*	*Rémy KOCHER*	*ARIANESPACE*
In charge of the launch service contracts			
ARIANE Payload Manager	*(RCUA)*	*Christophe BARDOU*	*ARIANESPACE*
ARIANE Deputy Mission Manager	*(RCUA/A)*	*Jean-François LAUMONIER*	*ARIANESPACE*
In charge of INSAT 3A satellite			
Satellite Mission Director	*(DMS)*	*RAJANGAM R.K.*	*ISRO*
Satellite Project Director	*(CPS)*	*KATTI V.R.*	*ISRO*
Satellite Preparation Manager	*(RPS)*	*NAGARAJ C.S.*	*ISRO*
In charge of GALAXY XII satellite			
Satellite Mission Director	*(DMS)*	*Rick LAURIE*	*PANAMSAT*
Satellite Project Director	*(CPS)*	*Timothy HEMKE*	*OSC*
Satellite Project Director	*(RPS)*	*Eric STUCKEY*	*OSC*
In charge of the launch vehicle			
Launch Site Operations Manager	*(COEL)*	*André SICARD*	*ARIANESPACE*
ARIANE Production Project Manager	*(CPAP)*	*Jean-Marie CHOMMELOUX*	*ARIANESPACE*
In charge of the Guiana Space Center (CSG)			
Range Operations Manager	*(DDO)*	*Pierre RIBARDIERE*	*CNES/CSG*
Flight Safety Officer	*(RSV)*	*Hervé POUSSIN*	*CNES/CSG*

Annex 2 - Launch environment conditions

Acceptable wind speed limits at liftoff range from between 7.5 m/s. to 9.5 m/s. according to the wind direction. The most critical is a northerly wind. For safety reasons, the wind's speed on the ground (Kourou) and at a high altitude (between 10.000 and 2.000 m) is also into account.

Annex 3 - The synchronized sequence

The synchronized sequence starts 7 mn before ignition (T-0). It is primarily designed to perform the final operations on the launcher prior to launch, along with the ultimate checks needed following switchover to flight configuration. As its name indicates, it is fully automatic, and is performed concurrently by the onboard computer and by two redundant computers at the ELA 3 launch complex until T-4 seconds.
The computers command the final electrical operations (startup of the flight program, servocontrols, switching from ground power supply to onboard batteries, etc.) and associated checks. They also place the propellant and fluid systems in flight configuration ans perform associated checks. In additionn, it handles the final ground system configurations, namely :

- startup of water injection in the flame trenches and jet guide (T-30 sec);
- hydrogen aspiration for chilldown of Vulcain engine in the jet guite (T-18 sec);
- burnoff of hydrogen used for chilldown (T-5.5 sec);

At T-4 seconds, the onboard computer takes over control of final engine startup ans liftoff operations :

- It starts the ignition sequence for the Vulcain main stage engine (T-0);
- It checks engine operation (from T+4.5 to T+7.3 sec);
- It commands ignition of the solid boosters for immediate liftoff at T+7.3 seconds.

Any shutdown of the synchronized sequence after T - 7 mn automatically places the launcher back in its T-7 min configuration.

Annex 4 - ARIANESPACE, its relations with ESA and CNES

FROM A PRODUTION BASE IN EUROPE, ARIANESPACE, A PRIVATE COMPANY, SERVES CUSTOMERS ALL OVER THE WORLD.
Arianespace is the world's first commercial space transportation company, created in 1980 by 36 leading European aerospace and electronics corporations, 13 major banks and the French space agency CNES (Centre National d'Etudes Spatiales).
The shareholder partners in Arianespace represent the scientific, technical, financial and political capabilities of 12 countries : Belgium, Denmark, Germany, France, Great Britain, Ireland, Italy, Netherlands, Norway, Spain, Switzerland and Sweden.
In order to meet the market needs, Arianespace is present throughout the world : in Europe, with its head office located near Paris, France at Evry, in North America with its subsidiary in Washington D.C. and in the Pacific Region, with its representative offices in Tokyo, Japan, and in Singapore.
Arianespace employs a staff of 350. Share capital totals 317,362,320 €.
Arianespace is in charge of these main areas :
❍ markets launch services to customers throughout the world ;
❍ finances and supervises the construction of Ariane expendable launch vehicles ;
❍ conducts launches from Europe's Spaceport of Kourou in French Guiana ;
❍ insures customers for launch risks.
Personalized reliable service forms an integral part of Arianespace launch package. It includes the assignment of a permanent team of experts to each mission for the full launch campaign.

The world's commercial satellite operators habe contracted to launch with Arianespace. This record is the result of our company's realistic cost-effective approach to getting satllites into orbit.

RELATIONS BETWEEN ESA, CNES AND ARIANESPACE
Development of the Ariane launcher was undertaken by the European Space Agency in 1973. ESA assumed overall direction of the ARIANE 1 development program, delegating the technical direction and financial management to CNES. The ARIANE 1 launcher was declared qualified and operational in January 1982. At the end of the development phase which included four launchers, ESA started the production of five further ARIANE 1 launchers. This program, known as the "promotion series", was carried out with a management arrangement similar to that for the ARIANE 1 development program.
In January 1980 ESA decided to entrust the commercialization, production and launching of operational launchers to a private-law industrial structure, in the form of ARIANESPACE company, placing at its disposal the facilities, equipment and tooling needed of producing and launching the ARIANE launchers.
Ariane follow-on development programs have been undertaken by ESA since 1980. They include a program for developing uprated versions of the launcher : Ariane 2 and Ariane 3 (qualified in August 1984) ; the program for building a second ARIANE launch site (ELA 2) (validated in August 1985) ; the Ariane 4 launcher development program (qualified on June 15th, 1988) ; and the preparatory and development program of the Ariane 5 launcher and its new launch facilities : ELA 3 (qualified on November, 1997). All these programs are run under the overall direction of ESA, which has appointed CNES as prime contractor.
In general, as soon as an uprated version of the launcher has been qualified 5 Oct, 1998, ESA makes the results of the development program together with the corresponding production and launch facilities available to ARIANESPACE.
ESA is responsible (as design authority) for development work on the Ariane launchers. The Agency owns all the assets produced under these development programs. It entrusts technical direction and financial management of the development work to CNES, which writes the program specifications and places the industrial contracts on its behalf. The Agency retains the role of monitoring the work and reporting to the participating States.
Since Flight 9 Arianespace has been responsible for building and launching the operational Ariane launchers (as production authority), and for industrial production management, for placing the launcher manufacturing contracts, initiating procurements, marketing and providing Ariane launch services, and directing launch operations.