XPS Plasma Propulsion System on AlphaBus

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Abstract: Thales Alenia Space experience on electric propulsion has been developed in the frame of Stentor, Astra 1K and GEi programs with plasma propulsion systems using SPT100 thrusters manufactured by Fakel and commercialized by Snecma . The PPS (Plasma propulsion system) use in house equipments such as Power Processing Unit (PPU) manufactured by Thales Alenia Space-ETCA in Charleroi Belgium and the Thruster Orientation Mechanism manufactured by Thales Alenia Space-France in Cannes . The PPS subsystem is used on telecoms satellite family to perform North-South station keeping in geostationary orbit.

The activity on the XPS (Xenon Propulsion System) is dedicated to the European platform Alphabus currently jointly developed by Thales Alenia Space and Astrium with CNES and ESA support. The XPS uses the same PPU and Thruster Orientation Mechanism mentioned above, the thruster is the PPS1350 Thruster manufactured by Snecma and the Xe tank is developed by Thales Alenia Space-Italy ; the XPS uses also European equipments under development or off the shelf (regulator, latch valve, xenon filter, pyro valve, pressure transducer fill and drain valve).

The general status of the implementation of the propulsion system on Alphasat, first application of the generic Alphabus platform, is given .

I. Introduction

THIS document describes the general status of the AlphaBus and AlphaSat programs on plasma Hall effect thrusters propulsion subsystems .

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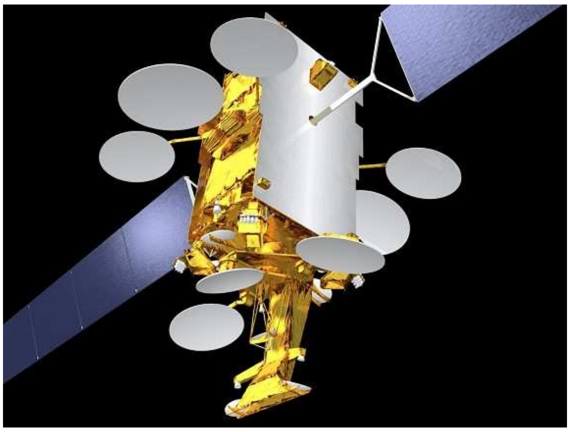
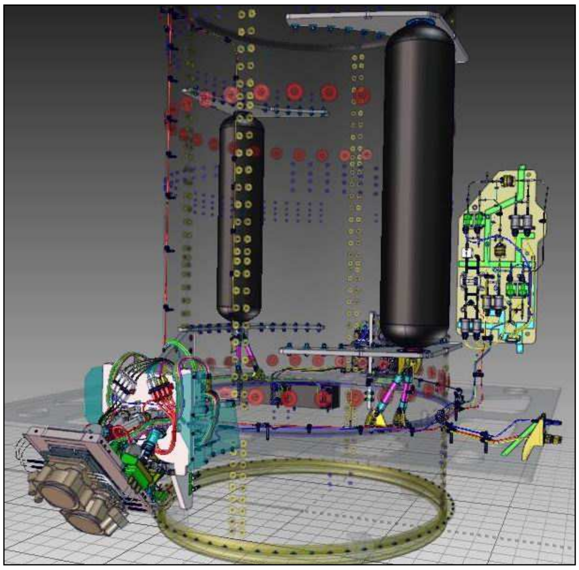
II. ALPHABUS program

Since several years, a joint team of the two leading European satellite companies is working with the support of ESA (European Space Agency) and CNES (Centre National d'Etudes Spatiales of France) to define a product line able to efficiently address the upper segment of communications satellites. AlphaBus is then the vector for Europe to develop new reliable solutions for large satellites and offer them on the world market.



The AlphaBus platform is designed for communications satellites with payload power in the range 12-18 kW. This support the renewal of the fleet for large operators, offering a lower cost per transponder and the ability to accommodate reconfigurable missions, as well as the development of applications such new generation mobile and broadband services, digital audio broadcast and HDTV. Satellites based on AlphaBus can have a launch mass within the range 6 to 8 tons, and take full benefit of the capabilities of the new generation of 5 meter fairing commercial launchers. In order to cover the mission range in an optimized way, the platform product line includes several options such as electric propulsion [3], and features scalable resources (solar array, radiators for thermal dissipation, etc.). The platform [5] is able to accommodate up to 190 high power transponders and large antenna farms, and has a significant growth potential.
Astrium and Thales Alenia Space have jointly developed AlphaBus and is marketing it for commercial communications satellites on the worldwide market.



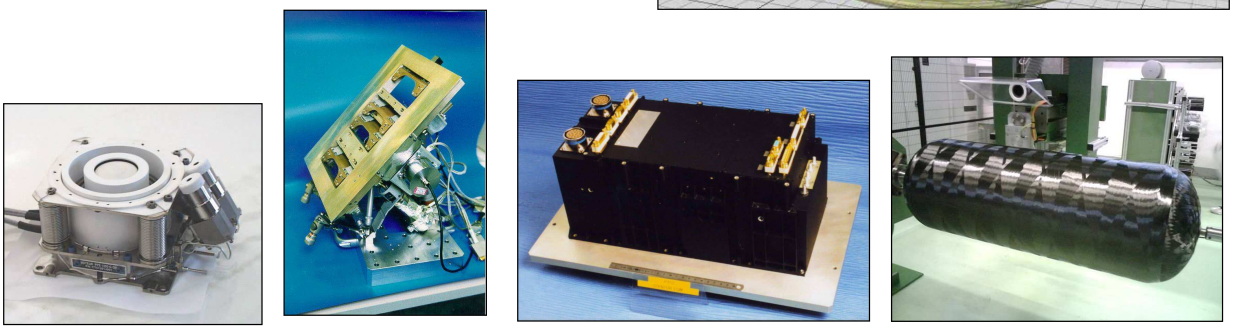
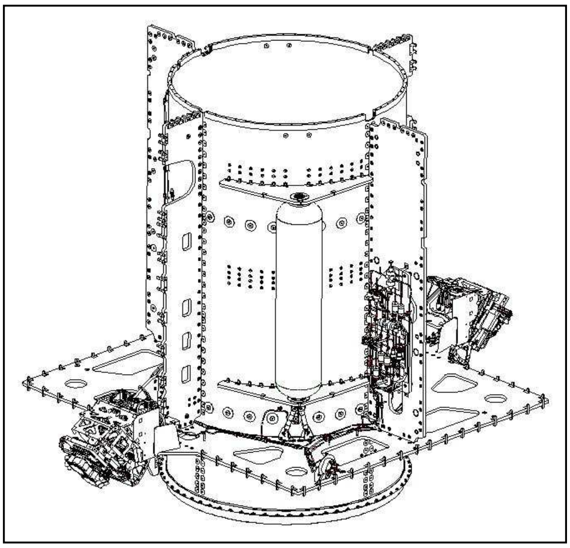


Figure 1 : PPS1350 thruster Snecma ; TOM Thales Alenia Space Cannes ; PPU Thales Alenia Space ETCA, Xe Tank Thales Alenia Space Turin

III. Xenon Propulsion System

1. XPS system activities



The PDR has been held in September 2006 .

The general design of the Xenon Propulsion System scheme proposed take benefit from previous programs and allow to achieve a strong level of reliability owing to the high level of optimization of the fluidic and electrical scheme and of the maturity of the main equipments used such as TOM, PPU, FU, Thruster and fluidic components : pyro valve, xenon filter, fill and drain valves, pressure transducers.

The detailed design of the plasma propulsion system has been performed and is now completed for the AlphaBus product line

The CDR has been held in 2008

2. General

The function of the Xenon Propulsion System is to provide inclination and eccentricity control for North/South station keeping and in addition it allows unloading of reaction wheels. In option, XPS can be used for top-up.

The XPS is an Electric Propulsion System using Xenon as propellant. It includes all devices to store and supply Xenon to the electrical thrusters, four Plasma Thrusters (PPS 1350) which are accommodated by pairs on two orientation mechanisms, electronic units required to manage and provide power to the thrusters and the orientation mechanisms. As shown in the following figures, the XPS can be divided in three main parts :

- the Gas Module (GM)
- the Power Supply Unit (PPU), which includes one Thruster Selection Unit (TSU), two Power Supplies are provided.
- the Thruster Module (TM), with two Thrusters and associated Xenon Flow Controller (XFC), an orientation mechanism bearing and canting the Thrusters. Two thruster modules are provided, one for the North maneuvers and one for the South maneuvers, each one including a nominal and a redundant thruster.

The North (resp. South) module is implemented on the anti-earth face on the north (resp. south) face of the satellite and is used for South (resp. North) Station keeping maneuvers.

3. Gas module description

The Gas Module is required to store Xenon and isolate the Xenon storage from the Electric thrusters during pre-launch, launch and orbit raising phases in safe conditions. During on-orbit phase, it will then supply Xenon to the Thruster Modules at the required regulated pressure and cleanliness level.

It includes the following equipments :

- two Xenon tank to store Xenon up to 150 bar,
- a high pressure fill and drain valve to pressurize the tanks,
- two normally closed pyro valve, in parallel, isolating the storage volume during ground integration activities and launch,
- a filter in order to protect all the downstream components of any abnormal particulate cleanliness,
- two standard accuracy pressure transducers for Xenon gauging,
- two associated titanium feed lines (1/4” diameter), one nominal branch and one redundant.
- two additional fill and drain valves located upstream and downstream the pressure regulator. These valves are used for ground tests,

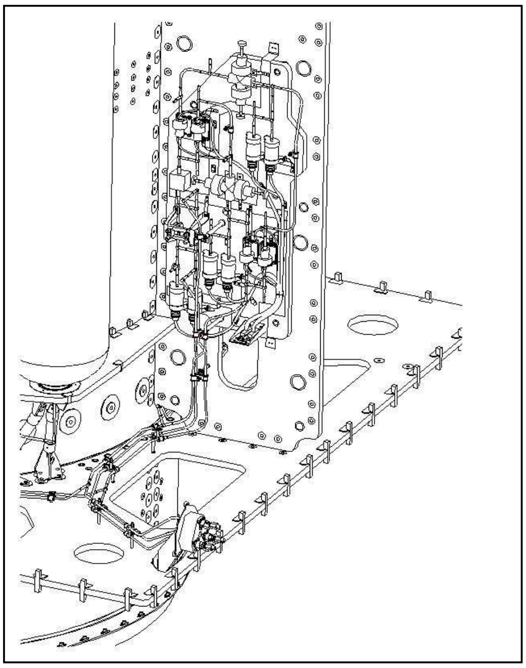
· four latch valves (two in each branch) located upstream and downstream of each regulator to control which branch works during mission

· two mechanical pressure regulator which are fully series redundant (two stage regulators). Each stage is capable of delivering Xenon at a regulated pressure to the thruster module over the complete range of temperature, inlet pressure and flow rate during thruster operation and it provides leak tightness between two thruster operations.

-· four low pressure transducers used to tightly monitor the level of the regulated pressure at the outlet of the pressure regulator.

· titanium feed lines up to the thruster modules and screwed titanium-stainless steel connection.

Furthermore thermistors and heaters, parts of the thermal control subsystem will control the equipment temperatures and then the Xenon state in the tank and the lines.



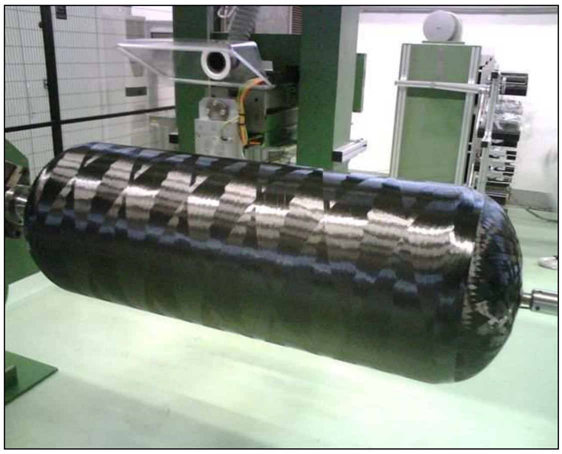
4. PPS1350 Thruster status

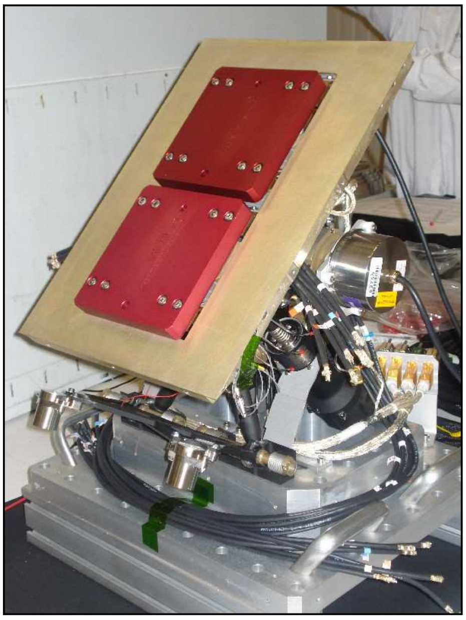
The Snecma PPS1350 has achieved more than 10500 hours of operation and the qualification review has been held [7]

5. Xenon tank Development status

The xenon tank is developed by Thales Alenia Space-Italy in Turin, Italy .

This over wrapped tank has achieved its BDR, PDR and the detailed design has been carried out; first assessment performed on a EM model with a full characterization testing including pressure and thermal cycles, vibration and proof tests .





6. Thruster Orientation Mechanism Status

This equipment is manufactured by Thales Alenia Space-France in Cannes and is already qualified and flown on different spacecrafts : Intelsat 10-02, Inmarsat 4F1&2&3, etc .

The adaptation of the Mechanism to the PPS1350 has been performed and validated through a Delta Design Review, which has been held and closed.

A qualification model DQM has been built in order to perform a delta qualification test sequence which is completed .

7. Power Processing unit (PPU)

This equipment is manufactured by Thales Alenia Space- ETCA in Charleroi (B) and is already qualified and flown on different spacecrafts : Intelsat 10-02, Inmarsat 4F1&2&3, Smart1 etc .

The adaptation of the PPU to the PPS1350 has been performed and validated through a Delta Design Review, in December 2007 .

*PPU Modes Description :*Each PPU (Power Processing Unit) is exchanging data with the On-board computer. According to the received orders the PPU enters into one of its six possible modes:

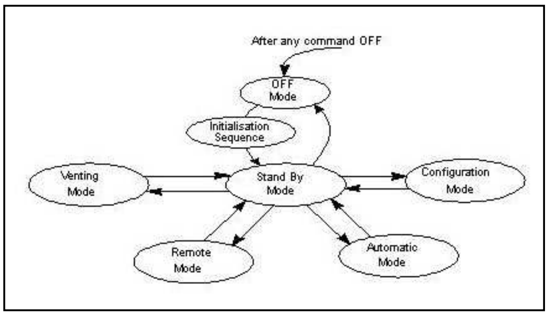
· **Off mode** : In this mode, the only accepted command by the PPU is the ON command which puts the micro-controller into Stand-by mode after the execution of the Initialization sequence.

· **Stand-by mode** : In this mode, the PPU is in a stable state. Only low level electronic (DC/DC, sequencer and serial I/F) is active. The PPU then accepts any transition to another mode but the transition between two other modes (except OFF mode) requires to enter in the stand-by mode. In this mode only DC/DC, sequencer and serial I/F are active. The PPS1350 (Anode, Ignitor, Heater), XFC (Thermothrottle) supplies, Input switch and LLSI are OFF.

· **Configuration mode** : In this mode, the PPU accepts orders to modify the selection of PPS1350 and XFC units by actuating the TSU (Thruster Selection Unit) relays. It is also possible to modify the setting of firing parameters (cathode heater current, discharge current). In the absence of any order the PPU will use the default values of these parameters loaded in a PROM. The setting of firing parameters allows to use the PPS 1350 in a wide range of performances. In this mode only DC/DC, sequencer and serial I/F are active. The PPS1350 (Anode, Magnet, Ignitor, Heater), XFC (Thermothrottle) supplies, Input switch and LLSI are OFF.

· **Venting mode** : The "VENTING" is only used at the mission beginning to allow venting of the Xenon lines before the first PPS1350 firing. In this mode the PPU open all the XFCs valves when receiving the command VENTING EXE. It will stop the opening of the valves if a TC to return to stand-by mode is sent or it will automatically stop if new command is not sent after a delay ($T_{venting}$ delay).

· **Remote. mode** : In the "REMOTE mode" the PPU micro-controller could be overridden by dedicated commands. The onboard computer allows to manage "step-by-step" the thrusters in order to provide flexibility to the ground operators if necessary. The DC/DC, sequencer, serial I/F and LLSI are active. Each PPS1350 or XFC supplies may be activated. Input switch remains OFF, it is turned ON only during the activation of an PPS1350 supply.



· **Automatic mode** : The "AUTOMATIC mode" is the nominal mode of the PPU when the PPU drives the firing PPS1350 in closed-loop. The power supplies of the PPU are active. The firing is driven with the set of parameters defined in the configuration mode. The logic of the "automatic thrust" mode is based on a starting phase and a stabilized thrust phase. The DC/DC, sequencer and serial I/F are active. Input switch and LLSI are switch ON only when command "Automatic EXEC" is sent. In the starting phase the PPU is step by step:

- heating the selected cathode and thermothrottle up to the real stabilized thrust of the PPS1350 (discharge current above 1.5 A)
- opening the XFC valves 150s after the preheating has been started
- supplying the cathode with ignition pulses at 10 Hz 160s after the preheating has been started.

The PPS1350 shall start within 220s . In case of failure PPU goes into "Stand-by" mode and sends a failed status signal. After PPS1350 start, the ignition electrode is no longer supplied and the closed control loop becomes operational. In stabilized mode the discharge current control is made by adjusting the Xenon flow rate through a thermothrottle . In case of Discharge fault or Ignition fault the sequencer stays in the automatic mode without performing any action, and a command shall be sent to return to Stand-by mode.

The different mode transition are shown in Figure

A dedicated paper from ETCA is presented during this conference

8. Other equipments

They take benefit from previous programs where they have been already qualified : regulator, xenon filter, fill and drain valve, pyro valve, pressure transducers, electrical filter unit, etc ..

IV. ALPHABUS extension

Besides the so-called AlphaBus generic product line (ie: nominal range is defined between 12 and 18 kW of payload power), the AlphaBus extension program has been prepared ; the goal is to allow to increase in the top range the spacecraft capacity.

For the XPS propulsion system dedicated activities have been identified to increase the capacity of the plate-form AlphaBus :

- PPU-Mk2 product, improved performances and cost and versatility in terms of thrusters driven
- European xenon latch valve
- European xenon regulator
- Xenon tank with increased capacity
- PPS1350 cathode

1. PPU Mk2

In order to propose more competitive product for AlphaBus, Eurostar 3000, SpaceBus 4000 and SmallGEO platforms, TAS-ETCA has started, in March 2009, the design, development and qualification of the new generation of PPU, called PPU-Mk2, to be qualified in 2011.

This activity is funded under Artes 8 program from ESA .

2. Xenon Latch valve status

The xenon latch from Ampac Ireland take benefit from previous development and the detailed design is now continuing .

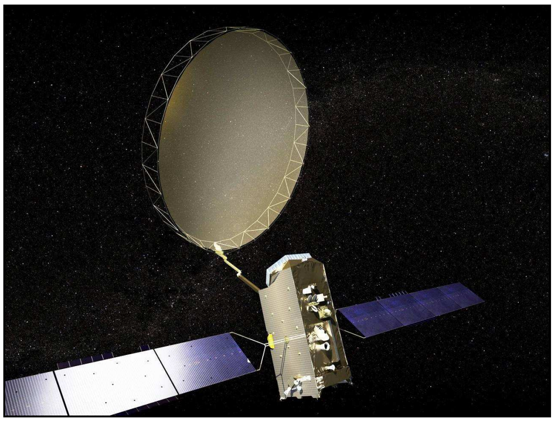
3. Xenon Regulator

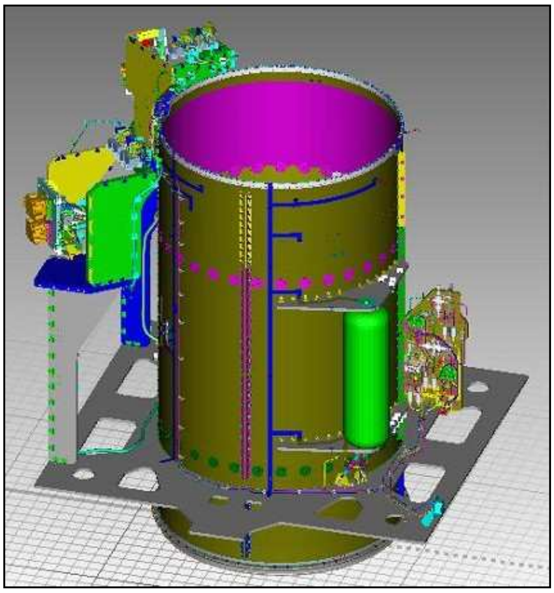
The xenon regulator from Ampac Ireland has been studied and a preliminary design has been proposed in 2007 ; this activity should be continued with an optimization phase of the design in order to cope with the AlphaBus requirements

4. PPS1350 cathode consolidation

A program of industrial consolidation of some particular process used inside the cathode has been started and will be followed by a qualification at cathode level

V. ALPHASAT application





The XPS for AlphaSat is derived from the AlphaBus generic product line XPS . It is an Electric Propulsion System using Xenon as propellant. It includes all devices to store and supply Xenon to the electrical thrusters, four Plasma Thrusters (PPS 1350) which are accommodated by pairs on two orientation mechanisms, electronic units required to manage and provide power to the thrusters and the orientation mechanisms. As shown in the following figures,

the XPS can be divided in three main parts :

· the Gas Module (GM)

· the Power Processing Unit (PPU), which includes one Thruster Selection Unit (TSU), (two PPU are provided per spacecraft).

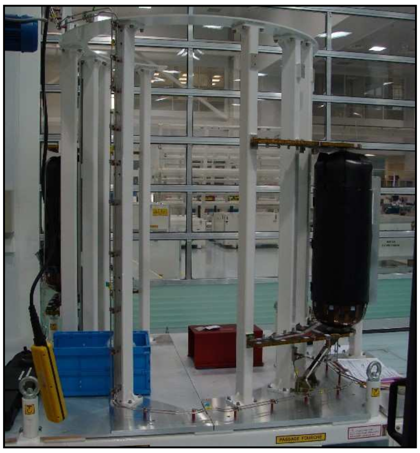
· the Thruster Module (TM), with two Thrusters and associated Xenon Flow Controller (XFC), an orientation mechanism bearing and canting the Thrusters. Two thruster modules are provided, each one including a nominal and a redundant thruster.

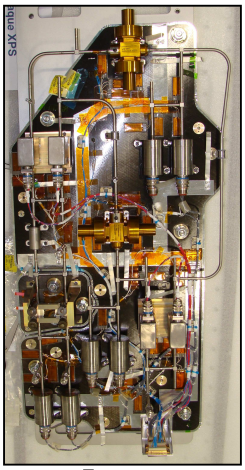
The main difference between AlphaBus and AlphaSat is the Thruster Module location in the satellite: for AlphaSat, the thruster module is located inside the RM.

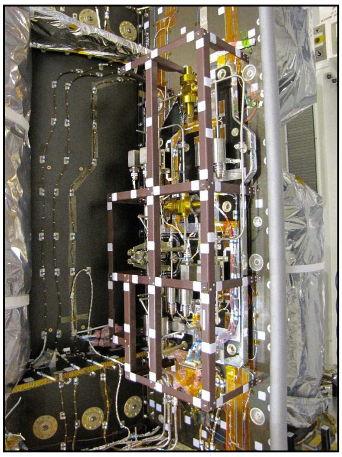
1. Gas Module Description

The Gas Module is required to store Xenon and isolate the Xenon storage from the Electric thrusters during pre-launch, launch and orbit raising phases in safe conditions. During on-orbit phase, it will then supply Xenon to the Thruster Modules (tubing "Module 2") at the required regulated pressure and cleanliness level. On AlphaSat, the module is different because of the new thruster module position.

The configuration selected for AlphaSat is the use of two GDATP 68L Xenon tank.







2. Power Supplies

The Power Supplies (PPU) manage and deliver to the PPS 1350 thrusters the required power for operation. Each supply is connected to two thrusters but operates only one thruster at one time. As on AlphaBus platform, each PPU is connected to 1 nominal thruster and 1 redundant thruster .

Power supply controls the selected thruster and its associated XFC on the basis of programmed procedures and commands received from the on-board computer. In particular the PPU manages an automatic sequence for the thruster start-up.

Power supply also includes a remote control mode in order to provide tools for step by step control / diagnostics purposes.

Power Supply is connected to the RS 485 Bus and to the 100 Volts power bus.

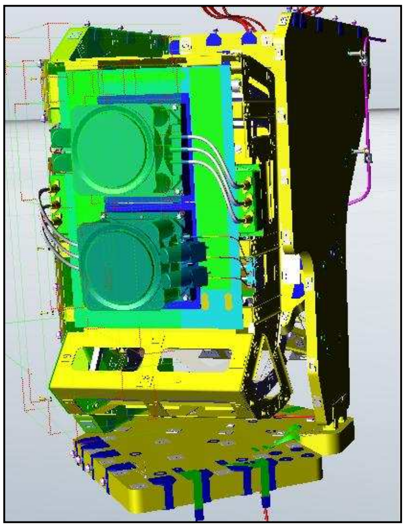
The harness between Power Supply and thruster modules is part of the Harness Subsystem. Due to the different location of the thruster modules with respect to AlphaBus, AlphaSat harness length (between PPUs and FUs) will be longer than the AlphaBus's one.
The XPS is accommodated with 2 PPUs.

3. Thruster module

Two electrical thruster Modules composed of a Thruster Orientation Mechanism (TOM) bearing and canting the AlphaBus selected electrical thrusters mounting plane. Two electrical thrusters (PPS1350-G) are mounted on each mounting plane. Each TOM provides a 2 axis orientation capability of the thruster' mounting plane.

The thrusters are mounted on aiming shim (to aim spacecraft CoG) which are attached on the mobile part of the orientation mechanism which includes also radiative elements. The XFCs are accommodated on the rear part of the fixed part. Interface connectors are located on a lateral face of the fixed part of the assembly.

The Thruster Module is located inside the payload (Repeater Module RM). This location is quite different from AlphaBus generic product line one. Consequently, the TOM secondary structure has been fully re-designed



3.1. Architecture

3.1.1. Procured equipment

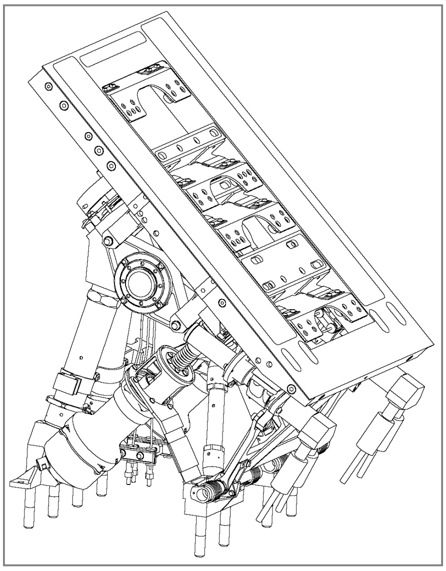
- 2 PPS 1350 (one nominal, one redundant) Each thruster are manufactured and acceptance tested by SNECMA
- 4 Xenon Flow Controllers (XFC), 2 XFCs are associated to each thruster. The XFC includes a thermothrottle which allows to control the Xenon mass flow.
- 2 Filter Unit (FU) located upstream each plasma thruster in order to limit electromagnetic conduction from the thruster towards the Power Supply (TAS-F ETCA)
- 2 Hot Interconnection Box located on the TOM mobile plate (TAS-F ETCA)

3.1.2. TAS-F Equipment

- Thruster Orientation Mechanism
- A honey comb baseplate, designed to guarantee structural integrity
- One set of Xenon feeding pipes and electrical harness to thrusters and XFCs, including a flexible part accommodated through TOM gimbals assembly.
- One set of thermal control devices (thermistors, heaters, OSR and MLI).
- Individual shim under each thrusters, determined for each missions

3.2. Thruster Orientation Mechanism description

3.2.1. Global Architecture



The Thruster Orientation Mechanism provided by TAS has a standard architecture of Electric Propulsion Pointing Mechanism (EPPM), composed of the following elements :

- a mobile plate or radiative plate
- a gimbal assembly
- a structure made of five feet
- 2 linear actuators
- 2 switches giving the zero-reference position
- a hold-down and release mechanism

Some module equipment are integrated at mechanism level, mainly located at the mobile plate level :

- Optical Solar Array and active thermal control
- Flexible harnesses to supply thrusters
- Tubing

The TOM assembled is therefore an “equipped” mechanism,

3.2.2. Main performances

- Angular range : ±12° around each axis
- Resolution step better than 0.005° (0.0027° on each gimbals’ axis and 0.0019° on combined axis)
- TOM mass : 14.5 kg
- In Orbit Lifetime : 15 years

3.3. Thruster Module Development

3.3.1. Heritage

The Plasma Propulsion System (PPS) has been developed and qualified through STENTOR, ASTRA-1K and GEi programs (AMC satellites). The SpaceBus 4000C PPS is based on the Plasma Propulsion System from ASTRA-1K and Stentor but with SPT 100 thrusters and new avionics interfaces (100V and “Rubi” TM/TC interfaces).
The SpaceBus 4000C PPS reference configuration is extended to cope with PPS1350-G instead of SPT 100 ones:

- PPS 1350-G has completed its qualification (environmental tests, life test) to reach 8500h (with one cathode and 10532 h (It=3,38 MNs) with two cathodes
- TOM mechanism adaptation for the PPS 1350-G thruster (4.4 kg each instead of 3.5 kg for SPT 100)

3.3.2. Alphabus baseline

Alphabus XPS for nominal range is derived from existing SpaceBus version PPS based on the PPS1350-G thrusters configuration. Dedicated tasks are set up for subsystem design adaptation:

- implementation to cope with Alphabus constraints and requirements
- Alphabus TOM Delta qualification
- Secondary structure optimization
- X axis shift of thrusters on TOM mobile plate up to 50 mm (not applicable for Alphasat)
- Top-up/ On Station mission : Thruster Module adaptation on thermal aspect (radiator extended on rear part)

Except the above mentioned activities, development and qualification efforts, all the other equipment needed for the AlphaBus have been developed and qualified in the frame of SpaceBus.

3.4. Delta qualification performed at equipped mechanism level

3.4.1. Delta qualification logic at mechanism

3.4.1.1. Heritage

The Thruster Orientation Mechanism was developed and qualified in the frame of the project STENTOR initiated by CNES 10 years ago. Since that time, TOM has acquired a successful and valuable flight heritage : since June 2004 (Eutelsat 10). 12 units are in orbit (Intelsat 10, Inmarsat 4F1-F2-F3, KaSat, Yahsat 1A), and 13 units have been delivered.

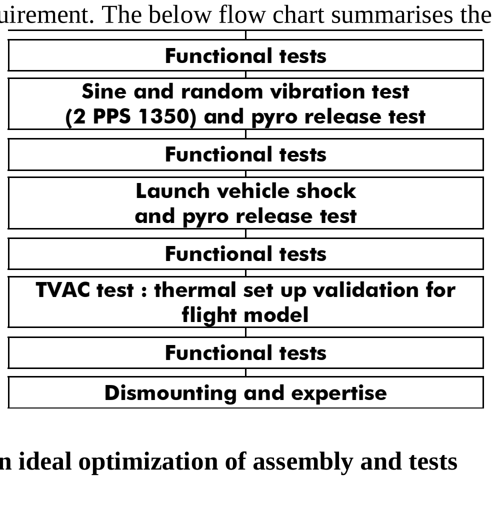
3.4.1.2. Delta qualification : origin and driver

Due to performance evolution (the baseline at Thruster Module level is the use of two PPS1350-G) and Alphabus mechanical environment (higher than the qualification status), a delta design of the TOM has been performed.
The main challenging delta design driver was to strengthen the mechanism structure while keeping :

- thermal qualification status.
- lifetime qualification status

3.4.2. Test sequence of the DQM model

Delta qualification test plan includes all the mechanical environment test to demonstrate that the reinforcement performed fulfill the Alphabus requirement. The below flow chart summarises the qualification test sequence.



3.5. Benefits for the customer : an ideal optimization of assembly and tests

All integration and test are performed in house TAS-F.
The main benefit is the strong cost saving through the use of a fully optimized sequence for assembly and test.

3.5.1. Assembly sequence

Some module part are integrated at mechanism level. These elements are mainly located on the mobile plate :

- Optical Solar Array and active thermal control
- Flexible harnesses to supply thrusters
- Tubing

The TOM obtained is an “equipped” mechanism.

3.5.2. Acceptance test sequence

The optimized assembly sequence avoids a phase of dismounting at Thruster Module level.
The consequence is that vibration and TVAC test are requested only at mechanism level acceptance.
At Thruster Module level, the acceptance sequence is therefore limited to assembly verification and functional test within TM configuration:

1 Visual and dimensional inspection
2 Electrical controls Check of the electrical continuities, resistances and isolations, valve opening
3 Locking and release tests with alignment controls (without pyrotechnically actuation)
4 Internal leakage at MEOP on XFC valves.
5 TOM performances control tests (Angular range, slew rate, resolution, accuracy, reproducibility)

3.6. Mechanical sizing : an optimisation of dynamic mechanical behaviour

3.6.1. Global sizing logic

One of the mechanical sizing driver is to take into account the modal signature of :

- the mechanism
- the mechanism support structure
- the spacecraft
- the plasma thrusters

The goal of the mechanical design is to suppress any unwanted mechanical coupling.

3.6.2. Analyses performed

The mechanical analyses permit to determine the principal modes frequencies of the propulsion module mounted on the satellite, then to compare these frequencies to the spacecraft main frequencies. The sine response analyses permits to determine the amplifications and I/F loads, and to evaluate the impact and acceptability on input level of thrusters module notching criteria.
The supporting structure is adjustable (compared with spacecraft and mechanisms) at the different stage of the project : the knowledge of its design parameters permits to find the best global mechanical behaviour compromise.

3.6.3. Conclusion

The synergy between mechanical engineering at mechanism and system levels allows to optimize in a very efficient way the overall dynamic mechanical behaviour.

3.7. Thermal sizing : an optimisation of thermal behaviour

3.7.1. Global sizing logic

The aim of the thermal analysis is to demonstrate the adequacy between :

- Thruster Module thermal control
- System thermal constraints linked to Thruster module location in the Spacecraft and corresponding thermal environment (temperatures for external spacecraft surfaces, interfacing structures, reflectors, fluxes form solar arrays, …);
- System firing strategy : firing duration (several hours) over a day and lifetime, firing schedule wrt season over one year.
- Mechanism components thermal qualification status

The goal of thermal sizing is to optimize in term of mass, heater lines power consumption and the active and passive thermal control. A global thruster Module thermal model is built including all equipments and adding all thermal control components as :
- O.S.R. (Optical semi reflector) and supporting radiators
- M.L.I. (Multi Layer Insulation) and supports
- Heaters lines (heaters and thermistors).

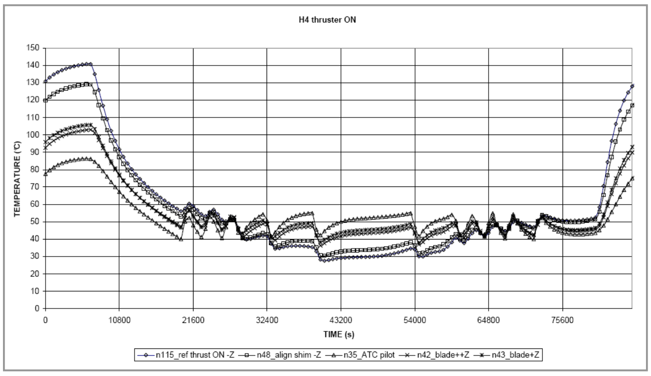
The mechanical structure interfacing thruster module base plate and Spacecraft panels is also modelized.

3.7.2 . Analyses performed

A nodal method is used to build thermal models and performed corresponding sizing analysis.

3.7.3. Thermal results

Thermal analysis allows to demonstrate that active and passive thermal control implemented keep all units within their design temperature ranges over spacecraft lifetime (transfer orbit, geostationary orbit during 15 years) and justify heater lines design (heater line sizing ; location of thermistors).
Figure: typical results of firing thruster and its environment for hottest conditions (solstice, end of life)



3.7.4. Conclusion

The thermal behaviour of the thruster module depends on firing sequence (defined at system level in accordance with mission needs). The thermal mapping and thermo-elastic analyses are optimized with a thruster module fully modelised in the satellite global model.

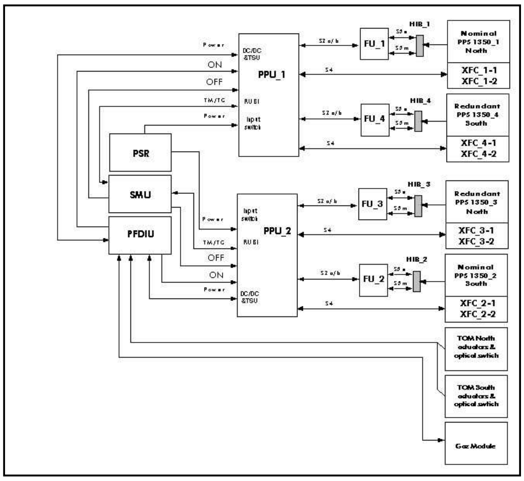
3.8. Conclusion : COST SAVING

The integration of the main elements (tubing, harness, thermal control) at TOM level for TOM acceptance tests allows to minimize acceptance test sequence at thrusters Module level:

- No mechanical acceptance at thruster module level needed (each TM equipment already mechanically acceptance tested)
- No firing test during acceptance at thruster module level needed (Thrusters already performed acceptance firings)
- No thermal balance test during acceptance at thruster module level needed (each TM equipment already thermally acceptance tested)

4. XPS Electrical block diagram

The XPS has electrical interfaces with on board computer SMU, power PSR and interface unit PFDIU .



5. Integration of the hardware on AlphaSat

After assembly on a JIG, the Gas Module with its two Xe tank has been transferred from the manufacturing JIG on the integration JIG .

Then with the help of this integration JIG the Gas Module has been installed onto the Service Module of the Spacecraft AlphaSat end of 2009.

6. AIT Phase

The spacecraft has entered the AIT sequence since early 2010 after mating of the Service Module with the Communication Module

The XPS system has been carefully checked through a detailed dedicated test plan including cross checks (PPU, Thrusters, TOMs), electrical checks, fluidics checks (proof and leak tests, functional tests of xe regulators, latch valves, PPUs) .

The spacecraft has been mechanically tested mid-2011

The AIT sequence is continuing up to the delivery to the customer in 2012

VI. Conclusion

During STENTOR and ASTRA1K programs system environment tests, THALES ALENIA SPACE successfully performed performances and end-to-end tests of the Plasma Propulsion Subsystem integrated in the spacecraft. Results of all the effort of development has been profitable to the European industry and is now used in flight with THALES ALENIA SPACE major equipments such as TOM and PPU .

THALES ALENIA SPACE has acquired a valuable experience, and can offer a qualified Plasma Propulsion Subsystem onto its SPACEBUS family when needed, to increase propellant lifetime or to decrease significantly the launch mass.

THALES ALENIA SPACE has prepared the XPS propulsion system for ALPHABUS and ALPHASAT .

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