TECHNICAL SPECIFICATIONS DOCUMENT FOR SERVICE CONTRACT FOR THE DESIGN AND PROVISION OF THE PHOTSAT SATELLITE PLATFORM AND THE SERVICES FOR THE PHOTSAT SATELLITE LAUNCH, COMMISSIONING AND OPERATIONS

Table of Contents

List of figures

1. Purpose of the contract

The present contract's purpose is the provision of satellite components and services according to the needs identified by the Institut d'Estudis Espacials de Catalunya (IEEC) to carry out the PhotSat mission, an astrophysics satellite dedicated to the observation and study of the space that will integrate an astronomy payload designed and developed by the IEEC.

The provisions and services to be supplied are as follows:

- Design, implementation, testing and validation of the PhotSat satellite platform in line with the requirements described in this document and its applicable ones.
- Service for the integration, test and validation of an astronomy payload: provision of the service for the integration of the IEEC scientific payload of the PhotSat satellite into the platform.
- Advisory services for the IEEC for the registration of the PhotSat satellite with the competent authorities.
- ITU frequency filing and procurement of the necessary licenses for the satellite launch and operations.
- Launch and commissioning of the PhotSat satellite.
- Nominal operations, preventive and corrective maintenance operations, and contingency operations on the satellite. Management of the end of the satellite's life cycle during the operational period specified in the contract.

The design, integration and validation of the PhotSat platform and the integration of the astronomy payload include all the following activities:

- Complete the design of the PhotSat platform following the requirements described by the IEEC in this document through an iterative design process; phases 0 to C according to [AD-07].
- Management of purchases, stock, and availability of the necessary test infrastructure.
- Provision of the service for integrating the astronomy payload designed and implemented by the IEEC into the platform.
- Integration, verification, and qualification of the complete satellite; phase D according to [AD-07].

The ITU frequency filing, launch and commissioning of the PhotSat satellite and the operations phase include the following activities:

- Necessary coordination for the use of radio spectrum for each band used by the satellite (ITU frequency filling for the nominal bands used in operations, that is S band and X band). Secondary band (e.g., Iridium ISL) will be evaluated within the framework of the tender (but is not mandatory).

- Advisory services for the IEEC for the registration of the PhotSat satellite with the competent authorities and procurement of the necessary licenses for the satellite launch and operations.
- Contract a launch provider, which must be expressly accepted by the IEEC through a favorable report from the contract manager on behalf of the IEEC and a resolution from the contracting authority. Also, contract an appropriate deployment method in orbit to release the PhotSat satellite into a sun-synchronous Low Earth Orbit.
- Commissioning service of the platform and the astronomy payload in orbit to validate the functionalities and performance of the PhotSat satellite.
- Nominal operations, preventive and corrective maintenance operations, and contingency operations on the PhotSat satellite; phase E according to [AD-07].
- Management of the end of the satellite's life cycle during the operational period specified in the contract, phase F according [AD-07].

This contract is part of the PhotSat mission, a project co-financed by the Recovery, Transformation and Resilience Mechanism - NextGeneration of the European Union and by the Generalitat de Catalunya. This mission is led and managed by the IEEC with the collaboration of various academic groups and research centers such as the UB (University of Barcelona), the UPC (Polytechnic University of Catalonia), the UAB (Autonomous University of Barcelona), and the ICE-CSIC (Institute of Space Sciences).

2. Technical Specifications and Statement of Work

The services to be performed are defined based on the set of applicable technical specifications for the mission detailed in clause 6 of this document ("Technical Requirements and Specifications") and the overall work expected to be performed by the successful bidder described in clause 7 ("Deadlines, phases, and monitoring of the provision of services").

3. Applicable Documents

Applicable documents are considered to be part of this document, to the extent specified in this document.

AD	Title/Author	Document Reference	Version	Date
AD-01	PhotSat Platform Requirements	PHOTSAT-IEEC-RDD-PFM-004	1.2	2024/02/05
AD-02	Quality assurance	ECSS-Q-ST-20C		
AD-03	Verification	ECSS-E-ST-10-02C		
AD-04	Testing	ECSS-E-ST-10-03C		
AD-05	Ground systems and operations	ECSS-E-ST-70C		
AD-06	Cubesat Design Specification	CDS	13	
AD-07	Project Planning and Implementation	ECSS-M-ST-10C		
AD-08	Space Management	ECSS-S-ST-10-01C		
AD-09	Risk Management	ECSS-M-ST-80C		
AD-10	Dependability	ECSS-Q-ST-30C		
AD-11	Cubesat Design Specification 14	CP-CDS-R14.1		
AD-12	Interface Management	ECSS-E-ST-10-24C		
AD-13	PhotSat Ground Segment Requirements	PHOTSAT-IEEC-RDD-GS-005		

4. Acronyms

ADCS	Attitude Determination and Control System
AIV	Assembly, Integration and Verification
AR	Acceptance Review
CDS	Cubesat Design Specification
CDR	Critical Design Review
CONOPS	Concept of Operations
CRR	Commissioning Result Review
ECSS	European Coordination for Space Standarization
EEE	Electrical and Electronic Equipment
EMI	Electromagnetic Interference
EPS	Electronic Power System
ESA	European Space Agency
FDIR	Fault Detection, Isolation, and Recovery
FM	Flight Model
FRR	Flight Readiness Review
FW	Firmware
HW	Hardware
ICD	Interface Control Document
ICRF	International Celestial Reference Frame
ICU	Instrument Control Unit
IEEC	Institut d'Estudis Espacials de Catalunya
IOSDC	Instrument Operations and Science Data Centre

KO	Kick-Off
LEO	Low Earth Orbit
LEOP	Launch and Early Operation Phase
MCC	Mission Control Center
MDR	Mission Design Review
OBC	On Board Computer
PDR	Preliminary Design Review
PM	Project Manager
QM	Qualification Model
RID	Review Item Discrepancy
RML	Recovered Mass Loss
SEE	Single Event Effects
SoW	Statement of Work
SW	Software
SPF	Single Point Failures
SWIR	Short Wave Infrared
TRL	Technological Readiness Level
TRP	Temperature Reference Point
TRR	Test Readiness Review
TT&C	Telemetry Tracking and Command

5. Introduction

This document defines the services to be executed to comply with the needs of IEEC in relation to the PhotSat mission regarding the procurement of the PhotSat platform, integration of the satellite, its launch, commissioning and operations.

5.1. Background

The PhotSat mission consists of the first space mission entirely led by the IEEC, dedicated to the field of astrophysics through the development of a satellite capable of performing photometry of the brightest stars.

PhotSat mission is a IEEC's space project with the objective to develop a small satellite with two space telescopes, to give response to the IEEC scientific interest in having their own system to observe astronomical phenomena that cannot be properly characterized from Earth. Another purpose of this project consists of developing the academic and industrial infrastructure of the space sector in order to be capable to carry out future end-to-end missions and projects using smallsat technology in-house in short development time (<3 years).

Performing astronomy from ground-based observatories on Earth is limited by the filtering and distortion of electromagnetic radiation (scintillation or twinkling) due to the atmosphere and by the day-night cycle that limits the amount of time that can be devoted to each object. By avoiding the Earth's atmosphere, space observatories open the possibility of reaching much higher precision in photometry or observing in wavelength regions blocked by the atmosphere.

The PhotSat will be a multi-purpose space observatory capable of performing high precision photometry in the Visible and Ultraviolet bands. The observatory will be used for a variety of science cases and to provide supporting data to numerous on-going international programmes including: photometric characterization of sources observed by the JWST, cover the bright end of the LSST survey, combine space-based high quality multiband photometry with ground based observations, among others. More specifically, these kinds of observations will be relevant to the field of: exoplanets, stellar physics, bright transient events (supernova, kilonova and more), variability of energetic events, solar system objects. Given the development of the NewSpace sector, we also aim at developing a pipeline of expertise to be able to develop scientific experiments with these new platforms.

The satellite of the PhotSat mission will consist of a 12U CubeSat satellite (being 1U, a unit defined according to the CubeSat standard) with an astronomy payload developed at IEEC that will orbit in a sun-synchronous Low Earth Orbit at a minimum of 500 km. The main technical objective of the mission is to scan and perform photometric monitoring of the entire available sky, in various photometric bands, with a cadence of 2 days and with a photometric precision of 1% at the visual magnitude (VIS band) of 12 or brighter. This satellite will be the first one of the IEEC and it is expected to be fully operational by the year 2026 and for at least during 2 years.

Once the astronomy payload is ready, it is necessary to integrate it in a platform to form the satellite PhotSat. This platform is responsible for providing the electric power to the payload, a communication link with the Ground Segment and the capability of controlling its orientation for pointing to specific targets. The satellite shall be placed in a sun synchronous dawn-dusk low Earth orbit (LEO) for its operation. Through this contract,

the successful bidder will have to provide both the launch service and the commissioning of the PhotSat satellite, as well as the nominal operations, preventive and corrective maintenance operations, and contingency operations of the satellite, complying with the technical specifications defined in clause 6 and following the work statement defined in clause 7 of the present document.

5.2. Scope

This document is part of the documentation package delivered for the tender of the PhotSat platform, launch, commissioning and operations of the satellite. It contains the technical specifications and the statement of work applicable for the contracting of the mentioned services. This includes the design and manufacture of a 12U CubeSat structure, the design and integration of the platform systems and subsystems, the integration of the IEEC's astronomy payload within the platform, the verification of the complete satellite functionality and performance before launch, its delivery to the launch site and preparation for the launch, the accomplishment of the commissioning activities required before the start of routine operations and the satellite nominal operations.

The clause 6 of this document contains the technical requirement specifications for the supply of the PhotSat satellite platform, the integration of the astronomy payload and the conditions for launch, commissioning and nominal operations. These specifications will be used by the bidders during the tendering phase to define a proposal to design, develop and manufacture the platform and the whole satellite and to present proposals for the launch, commissioning and operations of the PhotSat mission and which will submitted to the IEEC.

The clause 7 and 8 contains the statement of work and conditions for the performance of the service proposed for the delivery of the PhotSat platform and the integration of the whole satellite, launch, commissioning and operations. It includes a definition of the phases associated with the project development, the main milestones foreseen within these phases, the deliverables required at each milestone and the proposed reviews to monitor and control the evolution of the project.

The successful bidder shall support the IEEC PhotSat engineering team of the full spacecraft configuration and development, including the definition and management of interfaces with the astronomy payload. As stated before, the astronomy payload will be an internal IEEC development, and it is out of the scope of the statement of work but both developments (platform and astronomy payload) shall converge in schedule and performances.

5.2.1. Design, integration and satellite mission management service

The design, integration and management service of a satellite mission include all those engineering activities related to the achievement of the services entrusted to the successful bidder. Through this service, the successful bidder shall guarantee that all other services may run satisfactorily and in line with the IEEC's needs. This service includes the following tasks:

- Design of PhotSat mission following the requirements described by the IEEC through an iterative design process; phases 0 to C according to [AD-07].
- Management of purchases, stock and availability of necessary test infrastructure.

- Verification, integration and qualification; phase D according to [AD-07].
- Advisory services for the IEEC for the registration of the PhotSat satellite with the competent authorities and procurement of the necessary licenses for the satellite launch and operations as well as the coordination necessary for the use of the radio-electric spectrum for each of the bands used by the satellite.
- Launch and commissioning.
- Nominal operations, preventive and corrective maintenance operations, and contingency operations on the satellite and its payload; phase E according to [AD-07].
- Management of the end of the satellite's life cycle during the operational period specified in the contract; phase F according to [AD-07].
- Supplementary activities necessary to complete the entrusted tasks derived from the requirements described by the IEEC, such as maintenance of ground control software, integration of communication antennas, execution of compatibility tests. In this sense, the contractor shall be obliged to carry out all the supplementary tasks required by the IEEC through the contract manager for its correct execution.

5.2.2. Integration of an astronomy payload service

The service for the integration of an astronomy payload designed and developed by IEEC on board PhotSat satellite include the following activities:

- Analysis of requirements and needs of the astronomy payload for its integration, verification and testing.
- Production of associated documentation, specifically the Interface Control Document (ICD) with the satellite platform and the Mission Control System (MCS) used by the successful bidder.
- Supply of a simulator of the On-Board Computer (OBC) and an engineering model of the OBC, EPS and the structure representing the platform's hardware, software and mechanical interfaces, alongside a user manual.
- Mechanical and electrical integration, and support to the functional validation of the astronomy payload into the satellite platform.
- Coordination and execution of commissioning activities.
- Operation and maintenance of interfaces during the astronomy payload's operational phase.
- Coordination with IEEC during all phases of the mission.

6. Technical requirement specifications

The requirements and technical specifications that the platform must comply, as well as the conditions for launch, commissioning, and operations, are described in Annex I of this document.

7. Deadlines, phases and monitoring of the provision of services

7.1. Maximum deadline for performance and partial deadlines

The development of the services must follow the approach defined by the ECSS standard in [AD-17] and in accordance with the technical requirements described in clause 6 of this document. Design phases are defined through a V-shaped project management model, adapting the [AD-07] standard. ***Figure 1*** shows, without a time scale, the relationship between the Milestones and Phases applicable to the performance of the contract.

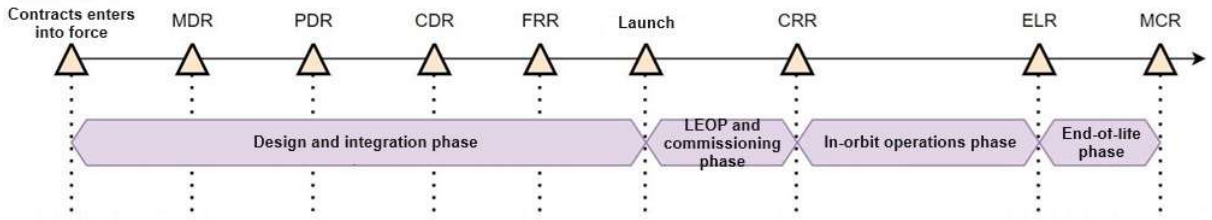

Figure 1 *Relationship between Milestones and Phases (with no time scale)*

Table 1 sets out the partial deadlines related to the milestones defined below according to the following timeline, T0 being the date on which the contract is signed:

Milestone	Name	Deadline
1	Mission Design Review (MDR)	T0 + 2 months
2	Preliminary Design Review (PDR)	T0 + 4 months
3	Critical Design Review (CDR)	T0 + 6 months
4	Flight Readiness Review (FRR)	T0 + 13 months
5	Launch	Fita 4 + 3 months
6	Commissioning Results Review (CRR) and start of the nominal operations phase	Fita 5 + 3 months
7	Operations Review 1	Fita 6 + 3 months
8	End of Life Review (ELR)	At the end of the contract

Table 1 *List of contractual Milestones and contract deadlines.*

7.1.1. Extension

It is anticipated that the contract may be extended regarding the operations phase for periods of 6 months, up to a maximum of 2 additional years, expected end date of the PhotSat satellite's useful life.

The extension will be agreed upon by the contracting authority and will be mandatory for the successful bidder provided that notice is given at least two months before the end of the contract term in accordance with Article 29 of the LCSP.

7.2. Phases and monitoring of the provision of services

The contract will be monitored through milestones and follow-up meetings at different intervals according to the applicable phase attended by the person responsible for the contract on the part of the awarded company and the specialized staff of the IEEC, either the person responsible for the contract or the person designated by them. The milestones will be held according to the ECSS standard in [AD-08] and will be considered achieved when the successful bidder delivers the associated deliverables and the corresponding reference and applicable documentation, the two parties accept the minutes of the meeting and agree that there are no open review item discrepancies (RID, according to the applicable standard). In the event that a RID remains open for review at a subsequent milestone, this must be reflected in the minutes of the milestone and may be subject to evaluation for possible contractual penalties.

Both the IEEC and the successful bidder may request the convening of any additional technical meetings that may be necessary for the correct performance of the contract.

In each of the meetings, the successful bidder will deliver the minutes of the meeting and the additional applicable documentation:

- Milestones: deliverables and associated reference documentation.
- Follow-up meetings: progress report.

The successful bidder will monitor the actions that may arise from the meetings throughout the duration of the contract.

The successful bidder must send the deliverables for each milestone to the IEEC at least one week before the meeting for review.

7.2.1. KO phase

The project begins with a kick-off meeting (KO). The kick-off meeting will:

- Confirm and formalize the start of the project and initiate the next phase.
- Ensure that both parties have a clear understanding of the contract terms and conditions related to project execution.
- Discuss and resolve any issues or concerns that have arisen since the bidding phase.

- Set specific deadlines to resolve any pending issues related to project documentation.
- Ensure agreement on the content and format of the deliverables.

Within fifteen days of contract signing, the provider must conduct an additional analysis of the requirements defined in clause 6 of this document in collaboration with the IEEC. This analysis aims to deepen the understanding of the project requirements and ensure alignment between the provider and the contracting entity (IEEC).

7.2.2. Design and Integration Phase

The design and integration phase starts automatically with the start of the contract and ends with the launch of the PhotSat satellite.

During this phase, the successful bidder, based on the proposed technical requirements defined in clause 6, is responsible for the design, development, assembly, integration, validation, testing, qualification and processing of the necessary permits and registrations of the satellite (phases A, B, C and D defined according to the ECSS standard in [AD-07]) as well as the management of the launch and the implementation of the Ground Segment. Given that the astronomy payload is designed and implemented by the IEEC, this phase requires close coordination between the technical teams of the successful bidder and the IEEC.

A team of engineers from the IEEC will collaborate with the successful bidder regarding the design of the platform's ADCS system during this phase and subsequent phases if necessary. At the beginning of the phase, a management plan and a schedule will be defined to establish the working framework for the two teams and to describe the tasks to be performed and the assignment of responsibilities.

During this phase, the carrying out of tests relating to the integration of the astronomy payload with the platform must follow the procedures and organization established in the ECSS standard in [AD-02]. These tests must be organized by the successful bidder with specialized IEEC staff in attendance, either the person responsible for the contract or a person designated by them.

7.2.2.1. IEEC Astronomy payload integration process

Between Milestone 1 (MDR) and 3 (CDR), the successful bidder will coordinate the activities relating to:

- Construction of the Interface Control Document (ICD) according to the ECSS standard in [AD-12].
- Communication of the integration timeline of the astronomy payload with the platform.
- Preparation of the plan and procedures of the AIV/AIT (Assembly, Integration, Verification and Testing) of the astronomy payload with the satellite platform.
- Development of the other documents and organization of the relevant activities for a correct implementation of the commissioned services.

- Find and reserve a shared space on a launcher that meets the mission requirements.

The deadlines for the delivery of documentation, information and integration requirements must ensure that they are compatible with the astronomy payload design and integration timeline with the PhotSat platform.

Once the flight model of the IEEC's astronomy payload is completed, the successful bidder must arrange its collection from the IEEC facilities, covering any expenses related to the delivery.

The successful bidder must temporarily provide IEEC, between milestones 2 (PDR) and 3 (CDR), with a simulator of the On-Board Computer (OBC) selected for the platform, representative of the OBC FM (Flight Model) at the level of the Hardware and Software interfaces, so that IEEC can verify, at its own test site, regardless of the availability of the platform provider (the successful bidder), the proper functioning of the astronomy payload in its interfaces with the OBC. The OBC must be accompanied by any additional elements, subsystems and documentation of use that are necessary for its operation by IEEC in such a way that IEEC can use it independently.

After Milestone 3 (CDR), the successful bidder will coordinate and execute the tasks of mechanical and electrical integration, and assembly of the astronomy payload with the satellite platform through the AIV/AIT Plan and Procedures, ensuring compatibility with the ICD.

To facilitate the integration of the IEEC's astronomy payload, the successful bidder must work jointly with the IEEC's PhotSat team in defining the ICD in aspects related to the integration of the IEEC's payload.

A team of IEEC engineers shall assist and provide support, to the extent possible, during this phase, especially during the verification activities related to the payload.

The successful bidder must be fully responsible for defining the integration and test plan for the IEEC's payload with the platform.

7.2.2.2. Qualification tests

The successful bidder must pass at least the following qualification tests (QT):

- Physical Properties Test
- Electrical Interface Test
- Functional Test
- Electromagnetic Compatibility Test (EMC)
- Vibration test
- Thermal Test (test in the Thermal Vacuum Chamber, TVAC)

The successful bidder must demonstrate the execution of operational readiness tests (QO) in order to verify the compatibility of the chain within the framework of the FRR milestone.

7.2.2.3. Launch vehicle

During the tender phase, the bidder must explain in the proposal's technical report the options foreseen for the launch vehicle and/or deployer or orbit transfer service taking into account the mission requirements and based on the conditions and criteria for launcher selection defined in the clause 6.

In this phase, and for the FRR milestone, the contract or commitment with the satellite launch company must be delivered.

7.2.2.4. Ground Segment

During the tender phase, the bidder must explain the planned options for the implementation of the Ground Segment in the technical proposal, considering the mission requirements.

During this phase, all necessary tasks for the implementation of the Ground Segment must be carried out in accordance with the conditions and requirements defined in clause 6 of this document.

7.2.2.5. Monitoring

Monitoring during this phase will be done as follows:

- Follow-up meetings, where the successful bidder will deliver a Progress Report according to the method described in the clause 8 of this document, with the following minimum frequency:
  - Between the start of the contract and the MDR milestone they will be monthly.
  - Between the MDR and FRR milestones they will be weekly.

The IEEC reserves the right to call additional follow-up or technical meetings as well as to include experts from collaborating entities, who will ascribe the necessary confidentiality. The bidder may propose additional meetings of a technical nature.

- Holding of the following milestones:
  - MDR: Mission Design Review
  - PDR: Preliminary Design Review
  - CDR: Critical Design Review
  - FRR: Flight Readiness Review

The technical documentation required and method of holding each milestone is detailed in clause 8 of this document.

The successful passing of the FRR milestone will imply the acceptance of the status of all the systems involved for all segments of the mission towards the launch.

After the acceptance of the FRR milestone, the successful bidder will coordinate the tasks associated with the transport of the satellite to the launch site and its subsequent integration into the launch vehicle for sending it into orbit.

7.2.3. Launch and Early Operation Phase (LEOP)

The Launch phase begins after the successful completion of the FRR milestone and ends when the satellite reaches its nominal orbit and makes first contact.

This phase must follow the procedures and organization established in the ECSS standard in [AD-02] and its main objectives will be as follows:

- Store and maintain the satellite until launch.
- Transport and integrate the satellite into the launcher.
- Monitor the launch and establish first contact with the satellite.

The successful completion of the milestone implies the acceptance of the status of all systems involved in this phase for all mission segments regarding the commissioning of the satellite's platform and astronomy payload.

7.2.3.1. Monitoring

The follow-up meetings and the delivery of the Progress Report will be on a weekly basis from this phase until the contract's termination.

7.2.4. Commissioning in orbit phase

The Commissioning phase begins after the successful orbit insertion of the satellite and ends after the successful completion of the CRR milestone.

From the first contact with the satellite, the successful bidder will coordinate the tasks associated with the validation of the platform's subsystems to assess the satellite's status and its capacity to meet the mission requirements assigned to the platform, such as power generation, pointing stability, communication capabilities with the ground segment, processing capabilities, etc. These tasks will be carried out by the MCC of the successful bidder, which will generate a report to be evaluated by the IOSDC of the IEEC.

Once the platform's capabilities have been quantified, the successful bidder, with direct support from the IOSDC engineers and scientists of the IEEC, will coordinate the tasks associated with the validation of the astronomy payload subsystems to assess the status of the instruments and their capacity to meet the mission requirements, such as pointing accuracy, optical quality, onboard processing, etc.

Once the platform's capabilities and the astronomy payload have been quantified, the successful bidder, with direct support from the IEEC's IOSDC engineers and scientists, will coordinate the tasks associated with the photometric calibration of the instruments and the validation of all aspects related to the acquisition and processing of a complete sky scan, from image capture to ground processing into various scientific products.

This phase must follow the procedures and organization established in the ECSS standard in [AD-02] and its main objectives will be as follows:

- Commissioning of the satellite platform subsystems.
- Stabilize and configure satellite subsystems.
- Demonstration of compliance with the minimum service requirements for the astronomy payload.
- Commissioning of the astronomy payload according to the instructions of IEEC.
- Characterize and guarantee the behavior of instruments in orbit with the support of IEEC.
- Execution of *n* sky scanning cycles to validate the CONOPS (Concept of Operations) and the entire data pipeline from image capture to ground processing of various scientific products.

7.2.4.1. Monitoring

The follow-up meetings and the delivery of the Progress Report in this phase will be weekly until the termination of the contract.

7.2.5. Nominal Operations

The Nominal Operations phase will have a duration of 3 months from its start date (Milestone 6).

The technical support from the successful bidder during the operational phase must include at least:

- Maintenance of the platform software (SW and FW).
- Preventive, corrective, and contingency actions in case any problems are discovered during operations.
- Analysis of platform issues detected during the operational phase.
- Analysis of contingency situations.
- Definition of actions and procedures necessary for restarting operations.

The successful bidder will organize in-orbit calibration campaigns for the payload according to IEEC specifications. These calibration campaigns must be organized in a way that minimizes the impact on data acquisition services.

7.2.5.1. Monitoring

During this phase, follow-up meetings will be weekly with annual contractual milestones if applicable.

7.2.6. End of the mission

The activities carried out in the end-of-mission phase must ensure that the mission complies with the applicable European Space Agency (ESA) space debris mitigation measures.

8. Conditions for the performance of the service

8.1. Deliverables

The successful bidder, in the periodic follow-up meetings, will deliver a Progress Report. The report will detail the content shown in ***Table 2*** once a month, throughout the duration of the contract.

Document	Content	Frequency
Progress Report	- Activities carried out since the last progress report. - Incidents, anomalies and actions. - Planned activities until the next follow-up meeting. - Follow-up of open actions.	Variable, according to the frequency indicated in the description of each phase
	- Activities carried out since the last progress report. - Incidents, anomalies and actions. - Planned activities until the next follow-up meeting. - Calculation of Service Level Agreements. - Forecast of achievement of future Milestones. - Update of the risk management table. - Follow-up of open actions.	Monthly

Table 2 *Content of the Progress Report*

Table 3 shows the deliverables associated with each of the contractual milestones. In the event that a previously delivered document is subject to review or amendment, it must be delivered at the current contractual milestone.

Document	ECSS Reference	MDR	PDR	CDR	FRR	Launch	CRR	AOR	ELR
Project Organization Plan	ECSS-M-ST-10C	X	X	X					
Description of the Mission	ECSS-M-ST-10C	X	X	X					
Mission Requirements	ECSS-E-ST-10-06C	X	X						
Design Iterations (*Trade-off*)	ECSS-E-ST-10C	X	X	X					
System Concept	ECSS-E-ST-10C	X	X	X					
System Engineering Plan	ECSS-E-ST-10C	X	X	X	X				
Mission Requirements Compliance Matrix			X	X	X		X		
Mission Concept of Operations	ECSS-E-ST-10C		X	X	X				
Definition of System Architecture		X	X	X	X				
System Requirements	ECSS-E-ST-10-06C	X	X						
Subsystems Requirements	ECSS-E-ST-10-06C		X	X					
Technical Specifications of the Ground Segment	ECSS-E-ST-70C		X	X					
Technical Budgets Analysis (Mass Budget, Power Budget, Link Budget, Memory and Data Budget, Pointing Budget)	ECSS-E-ST-10C		X	X					

AIV/AIT Plan and Procedures of the astronomy payload with the Satellite Platform and with the Mission Control System (MCS)	ECSS-E-ST-10-02C (AIV) ECSS-E-ST-10-03C (AIT)		X	X	X				
ICD of the Satellite Platform with the astronomy payload	ECSS-E-ST-10-24C		X	X					
Test Report (AIT/AIV)	ECSS-E-ST-10-03C			X	X		X		
Verification Control Reports	ECSS-E-ST-10-02C		X	X	X				
Contingency plan	ECSS-Q-ST-30C			X	X		X		
Contract or commitment with the satellite launch company					X				
Space Debris Mitigation Report			X	X	X				X
Post-Launch Evaluation Report						X	X		
Annual Operations Report								X	X

Table 3 *List of deliverables for each of the contractual Milestones*

8.2. Communication and disclosure

Any communications associated with the publication of results or technical achievements derived from the fulfilment of the various milestones stipulated in the contract must be coordinated and approved by IEEC.

Once the contract has been awarded, IEEC and the successful bidder will agree on a communication plan for each phase.

The successful bidder will not be able to make public any audiovisual material (image, video, etc.) generated in relation to the PhotSat mission until it is explicitly authorized to do so by the IEEC. In the case of material owned by IEEC, the IEEC will establish the conditions for dissemination by the successful bidder and third parties, where applicable.

With the aim of disseminating the results of the mission, the successful bidder must deliver to the IEEC:

- A CAD file in STEP format according to ISO10303 of the satellite in high resolution, which does not include parts that are the exclusive intellectual property of the successful bidder or its suppliers (in this case, the component or components will have to be simulated). Delivery deadline: within the framework of the CDR milestone.

The IEEC may use this deliverable for non-profit promotional purposes.

The successful bidder must also provide the IEEC with images and videos of the launch of the satellite of the PhotSat mission, which the IEEC will be able to broadcast on its own communication channels. Likewise, if the launcher provides them, the successful bidder must provide images and videos of the insertion into orbit of the satellite, which the IEEC may also broadcast.

9. Project Management and Product Assurance

To ensure the on-time delivery of the PhotSat satellite in compliance with all requirements established in clause 6, the successful bidder must follow:

- The ECSS standards in [AD-17] for project planning and implementation.
- The ECSS standards in [AD-18] for product assurance of space projects.

The following clauses detail some of the requirements established in these two standards that are considered critical for the success of the project.

9.1. Project Management

The following project management tasks are considered critical to ensure smooth communication with IEEC and the timely delivery of the satellite according to the proposed schedule:

- Definition of the project organization and management to allocate necessary resources to ensure contract completion within the required period.
- Appointment of a Project Manager (PM) and definition of a project team.
- Conducting meetings in a timely manner according to established milestones, with agreed minutes and actions signed by all participants after the meeting.
- Definition and maintenance of a schedule that considers activities to be carried out, resources to be allocated, key project milestones, and the critical path.

9.2. Product Assurance and Quality Control

The following product assurance tasks are considered critical to ensure the development and launch of the PhotSat satellite in accordance with the requirements:

- Appointment of a product assurance manager who reports to the project manager.
- Preparation, maintenance, and implementation of a Product Assurance Plan.
- Identification of critical elements.
- Definition and implementation of a critical elements control program.
- Definition and implementation of a non-conformity control system.

The successful bidder will be responsible for the Product Assurance and Quality Control process in accordance with the following requirements.

9.2.1. Risk Management

The successful bidder will be responsible for continuously assessing the risks during the course of all phases of the project, recording them in the form of a Risk Register, along with the assessment and the corresponding mitigation actions that it must communicate to the IEEC standard in [AD-09] guidelines. This communication will be made at each of the milestones as well as at the time any risks categorized as severe (high or very high according to the applicable standard) are identified. The successful bidder is responsible for properly addressing these risks and planning specific actions to mitigate them.

9.2.2. Quality Assurance and Management

The successful bidder must implement a quality management system in order to:

- Carry out the configuration control of the documentation, hardware and software related to the project.
- Carry out quality control in the different phases of the project and demonstrate fulfilment of the required quality.
- Report non-conformities and anomalies in a systematic and orderly manner and according to the defined Service Level Agreement (§10). Non-conformities and anomalies must be classified as critical, non-critical or minor based on the following criteria:
    - Critical: Those that may affect security, the mission objectives, basic system functions or the provision of any of the services.
    - Non-critical: Those that affect a small group without immediately affecting vital processes of the system or the provision of the service, doing so at a non-critical time, but which may have an impact on the following defined requirements:
        - Operational, functional or contractual requirements
        - Reliability
        - Duration of useful life
    - Minor: Those that by definition cannot be classified as critical or non-critical.

      The successful bidder will report minor non-conformities during the next review period established according to the contract, milestone or follow-up meeting.

The successful bidder is obliged to enable a software tool available for the IEEC to register and monitor the activities, incidents and anomalies related to the mission, identified/numbered for their subsequent traceability, in order to:

- Monitor those incidents or anomalies/non-conformities that may have an impact on the provision of the different services.
- Extract the necessary information for the calculation and justification of Service Level Agreements (SLA).

9.2.3. Contingency measures

The successful bidder must provide, within the framework of Milestone 3 (CDR), a contingency management plan in case of critical failures in the various actors involved, in order to guarantee the success of the project, following the guidelines of the ECSS standard in [AD-10].

10. Service Level Agreements. Infringements and Penalties

The following service level agreements (SLAs) are established, to which the successful bidder will be bound in order to ensure a high-quality service based on an objective assessment regarding any possible incidents that may occur in the performance of the contract and therefore including the operations phase.

The successful bidder must propose a monitoring tool that allows the IEEC to extract the information necessary to verify compliance with the SLAs. The successful bidder will be responsible for justifying the achievement of the SLAs during the monthly deliveries of the progress reports.

When imposing the penalties contemplated in this clause, the IEEC will take into consideration whether the failure to achieve the required quality level in each case is the result of PhotSat anomalies that cannot be attributed to the successful bidder due to force majeure or whether they are due to the latter's fault or negligence. In cases of force majeure, the contractor will be exempt from liability.

In each case, the successful bidder must duly justify the reason why the required service level indicator has not been met.

The penalties accumulated and imposed by the IEEC on the successful bidder will in no case exceed the ceiling of 20% of the value of the next milestone for the milestone 7, 15% for milestone 8 and 10% for the additional milestones in case of contract extensions. If this ceiling is reached, the IEEC will have the option of imposing the penalty or terminating the contract.

Data delivery:

Code	Name	Description	Frequency of calculation	Penalty applicable
SLA-PHOTSAT-01	Data delivery	The average delivery time for the RAW data and the corresponding auxiliary files (metadata) of the telemetry and scientific data produced in one day to their receipt at the IEEC's IOSDC must be less than 24 hours after the data is produced in 95% of cases.	Monthly	Penalty of 0.5% of the amount to be paid in the next contractual milestone for every 2% deviation from the target. *For example: in the first year of operations, the calculation of this agreed indicator exceeds 95% in all but two months.* *In the first month of non compliance, the figure of 94% is achieved and in the second, 89%. Therefore, a penalty of 2% will be applied on the amount to be paid by the IEEC in Milestone 7.*

Reporting of incidents, non-conformities and anomalies:

Code	Name	Description	Frequency of calculation	Penalty applicable
SLA-PHOTSAT-02	Reporting of incidents, non-conformities and anomalies	The time between the identification and reporting of incidents, non-conformities and anomalies to the IEEC must not exceed: - 1 working day, for those classified as critical - 1 calendar week, for those classified as non-critical for 98% of incidents, non-conformities and anomalies.	Monthly	Penalty of 0.5% of the amount to be paid in the next contractual milestone for every 2% deviation from the target. *For example: in the first year of operations, the calculation of this agreed indicator exceeds 95% in all but two months.* *In the first month of non compliance, the figure of 94% is achieved and in the second, 89%. Therefore, a penalty of 2% will be applied on the amount to be paid by the IEEC in Milestone 7.*

11. ANNEX I

11.1. Technical requirement specifications

The technical requirements and specifications described in this clause are extracted from the requirement definition documents [AD-01] and [AD-13].

11.1.1. Purpose and scope

The purpose of this clause is to define the technical requirements and objectives for the development, testing, and operations of the PhotSat platform, the satellite launch, commissioning, and nominal operations.

11.1.2. Requirements Format Definition

Each Requirement and goal will be defined in a table containing all the relevant information to identify, track, understand and verify a given requirement/goal. The following section defines the format of this table and its parameters.

ID	R-SUBS-TYPE-PRI-VER-XXY
Title	
Description	
Priority	
Verification	
Parents	
Assignee	
Justification	

11.1.2.1. ID (Identification code)

The requirement/goal identification code. With its cell painted in gray if it is a Requirement and painted in blue if it is a Goal. It follows a *R-SUBS-TYPE-PRI-VER-XXY* format:

SUBS refers to the subsystem which shall comply with the requirement. In this case, the Platform subsystem (PFM)

TYPE refers to the type of requirement, and shall be one of the following options:

code	Definition
SCI	Scientific requirement
FUN	Functional Requirement
PER	Performance Requirement
ENV	Environmental Requirement
IF	Interface Requirement
QA	Quality Assurance Requirement
LG	Logistics Requirement
DEV	Development Requirements

PRI refers to the priority of the requirement, and shall be one of the following options:

code	Definition
L	Low priority
M	Medium priority
H	High priority

VER refers to the verification method used to validate the compliance of the requirement, and shall be one or a combination of the following options:

code	Definition
R	Verification by Review of Design
I	Verification by Visual Inspection
A	Verification by Analysis
T	Verification by Test

XXY is the number of the requirement/goal of a given *TYPE:*

code	Definition
XX	2-digit number starting with 01
Y	0 if it is a requirement. 5 if it is a goal.

Example: R-PFM-SCI-H-R-010

11.1.2.2. Title

A human readable name for the requirement/goal.

11.1.2.3. Description

Detailed description of the requirement/goal.

11.1.2.4. Priority

Priority of the requirement/goal. It shall be one of the following options and match the ID of the requirement/goal:

Priority	ID *PRI* code	Meaning
Low Priority	L	Modifying the nature of the requirement does not directly impact Scientific mission nor other requirements
Medium Priority	M	Modifying the nature of the requirement implies a trade off with other requirements
High Priority	H	Modifying the nature of the requirement is not possible as it directly impacts the Scientific mission or other critical requirements

11.1.2.5. Verification Method

Verification method to validate the correct implementation of the requirement/goal. It shall be one or a combination of the following options and match the ID code of the requirement/goal:

Verification Method	ID *PRI* code
Review of the design	R
Inspection	I
Analysis	A
Test	T

11.1.2.6. Parents

Parent requirements ID codes of the requirement/goal, separated with commas.

Example: R-TOP-SCI-H-R-010, R-TOP-SCI-H-R-020, …

11.1.2.7. Justification (optional)

Optional field. Description of the reasons and the context that justifies the requirement's existence.

11.1.2.8. Examples

ID	R-PFM-QA-H-R-30
Title	Platform TRL
Description	The TRL of the Platform components and subsystems shall be 7 or higher
Priority	High
Verification	Review of the Design
Parents	R-TOP-QA-H-R-30
Justification	

ID	R-PFM-QA-H-R-35
Title	Platform TRL Goal
Description	The TRL of the Platform components and subsystems should be 9 and have flight heritage
Priority	High
Verification	Review of the Design
Parents	R-TOP-QA-H-R-35
Justification	

11.1.3. Satellite system overview

This section explains the general view of the mission, with special attention to the separation between the astronomy payload and the platform elements of the PhotSat satellite.

PhotSat is a 12 units CubeSat (12U according to the CubeSat standard - cubesat.org), shown in ***Figure 2***, that will scan the sky and extract photometry of the brightest stars. It will orbit the Earth at an altitude of approximately and no less than 500 km in a sun synchronous Dawn-Dusk orbit. With two small cameras and with a rotating mechanism (***Figure 3***), the satellite will be able to observe stars within the range of VIS and UV wavelength, while detecting and warning of possible supernovae. With agile development, the satellite is expected to be launched by the end of 2025.

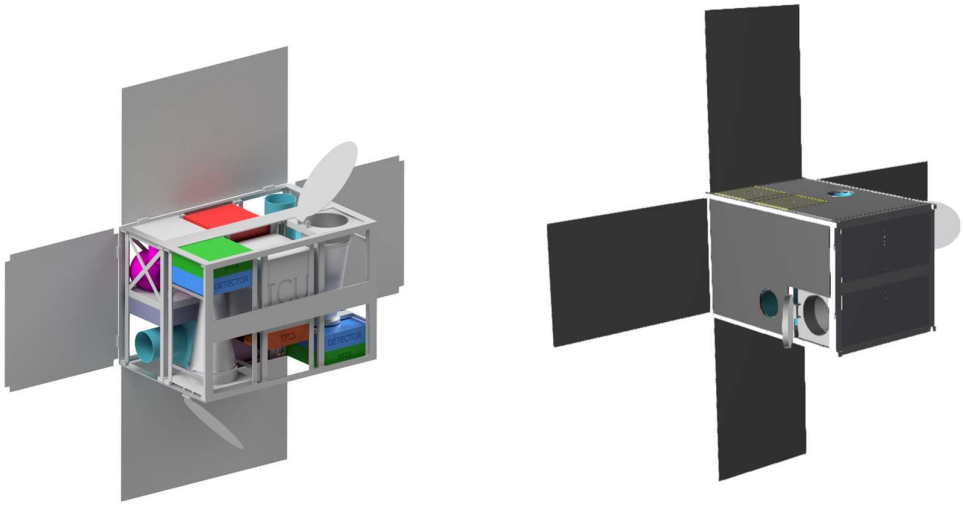

Figure 2 *Overall view of the satellite (possible configurations)*

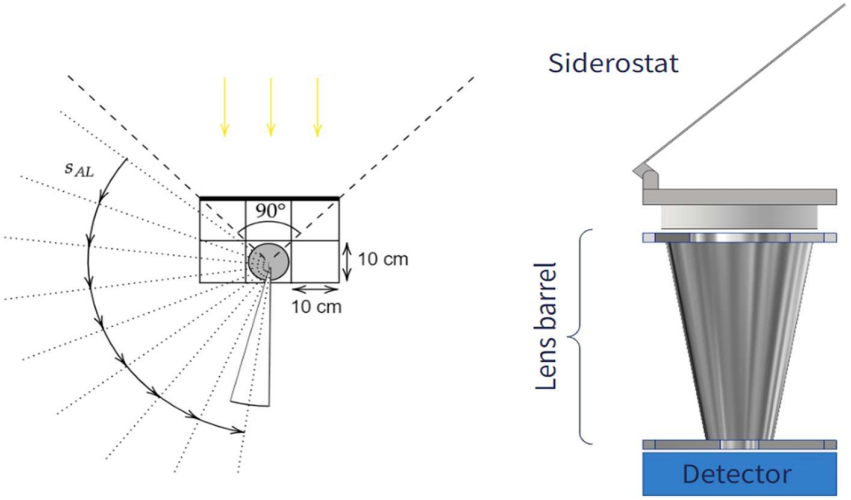

Figure 3 *Rotation diagram of the siderostat (left) and the concept of the optical systems (right)*

A block diagram of the PhotSat satellite can be seen in ***Figure 4***, with a clear distinction between astronomy payload and platform subsystems. While the payload will be in charge of moving the siderostats and extracting scientific data from the optical system, the platform will be in charge of powering the satellite, controlling its orientation, establishing communications with the ground segment and managing all data between subsystems, including the astronomy payload.

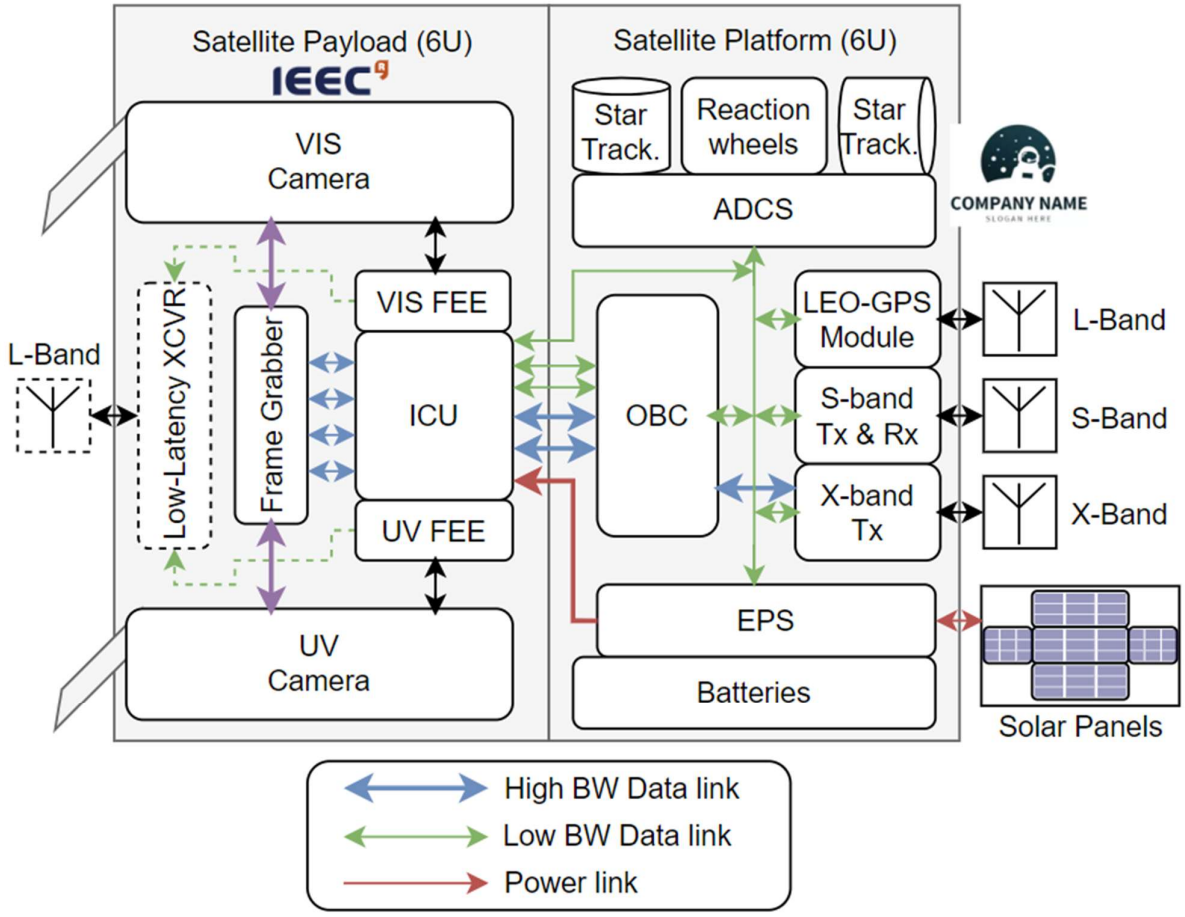

Figure 4 *PhotSat astronomy payload and platform main subsystems concept*

11.1.4. Platform Level Requirements

11.1.4.1. Functional Requirements

Specify what the Platform must do, and how it shall interact with the Payload and the Ground Segment.

ID	R-PFM-FUN-H-R-010
Title	Platform Operative location
Description	The PhotSat Platform shall operate, together with the PhotSat Payload, in a Heliosynchronous Dawn-Dusk LEO orbit with an eccentricity lower than 0.0025, no lower than 500 km altitude and the inclination required for the orbital plane to precede (e.g. 97.7º)
Priority	High
Verification	Review of the Design
Parents	R-TOP-SCI-H-A-010, R-TOP-SCI-H-A-015, R-TOP-SCI-H-RA-020, R-TOP-SCI-H-RA-025, R-TOP-FUN-H-R-010
Justification	Heliosynchronous orbit to scan all sky along a year. Dawn-Dusk to improve power and thermal stability.

ID	R-PFM-FUN-H-R-020
Title	Platform On-Board Computer
Description	The PhotSat Platform shall include a digital computer, able to receive and decode telecomands from the ground segment, control Platform subsystems and communicate with Payload.
Priority	High
Verification	Review of the Design
Parents	R-TOP-FUN-H-R-040, R-TOP-FUN-H-R-110
Justification	

ID	R-PFM-FUN-H-RT-030
Title	Platform Modes of operation
Description	PhotSat Platform modes of operations shall be compatible and work in parallel with Payload modes of operation (e.g. Scan mode, Stare mode, Alert response mode, HK mode, Idle mode, etc) to fulfill the scientific mission. Precise number and functionalities of each mode will be co-designed by IEEC and the Platform provider engineers previous to the CDR.
Priority	High
Verification	Review of the Design, Test
Parents	R-TOP-FUN-H-R-030
Justification	

ID	R-PFM-FUN-H-RA-040
Title	In-orbit Power Generation and Storage
Description	The PhotSat Platform shall produce electric power from solar cells and store it in chemical batteries in-orbit, for the duration of the mission.
Priority	High
Verification	Review of the Design, Analysis
Parents	R-TOP-FUN-H-R-050
Justification	

ID	R-PFM-FUN-H-RT-050
Title	In-orbit Power Distribution
Description	The PhotSat Platform shall use an EPS to regulate, control, manage, protect and distribute the electric power generated in-orbit to its subsystems and to the Payload, while protecting them from overcurrent events, for the duration of the mission.
Priority	High
Verification	Review of the Design, Test
Parents	R-TOP-FUN-H-R-050
Justification	

ID	R-PFM-FUN-H-RA-060
Title	In-orbit Thermal Control Systems
Description	The PhotSat Platform shall use passive or active Thermal Control Systems (TCS) to guarantee that the absolute temperature and stability of the Temperature Reference Point (TRP) of its subsystems, as well as Payload subsystems, are kept in their operative temperature range for the duration of the mission. Heat generation shall be performed with electrical heaters, while heat extraction shall use passive elements such as structural anchoring points, CubeSat structure (as heat pipes) and the radiative properties of the external surfaces of the satellite (as heat sink).
Priority	High
Verification	Review of the Design, Analysis
Parents	R-TOP-FUN-H-R-060, R-TOP-FUN-H-R-065
Justification	

ID	R-PFM-FUN-H-RT-070
Title	In-orbit Attitude Determination
Description	The PhotSat Platform shall be able to know the orientation of the PhotSat satellite in-orbit (w.r.t to the Sun vector and ICRF), and send the information to Payload ICU, for the duration of the mission.
Priority	High
Verification	Review of the Design, Test
Parents	R-TOP-FUN-H-R-070
Justification	

ID	R-PFM-FUN-H-RT-080
Title	In-orbit Attitude Control
Description	The PhotSat Platform shall be able modify the orientation of the satellite (w.r.t to the Sun vector and ICRF) in all 3 Euler angles (pitch, roll, yaw) in orbit, to perform scientific operations and data download operations, for the duration of the mission.
Priority	High
Verification	Review of the Design, Test
Parents	R-TOP-FUN-H-R-080
Justification	The satellite shall have an Attitude Determination and Control system to function.

ID	R-PFM-FUN-H-RA-090
Title	In-orbit Positioning
Description	The PhotSat satellite shall be able to know its precise position in-orbit and send the information to Payload ICU, for the duration of the mission.
Priority	High
Verification	Review of the Design, Analysis
Parents	R-TOP-FUN-H-R-090
Justification	

ID	R-PFM-FUN-H-RT-100
Title	Platform communications to Ground Segment
Description	PhotSat Platform shall be able to establish communication with the Ground Segment, receive commands to control the in-orbit instruments and download Scientific and House Keeping data to ground for the duration of the mission.
Priority	High
Verification	Review of the Design, Test
Parents	R-TOP-FUN-H-R-100
Justification	

ID	R-PFM-FUN-H-RT-110
Title	Platform communications to Payload
Description	PhotSat Platform shall be able to establish communication with the Payload ICU, send commands to control the in-orbit instruments and receive Scientific and HK data from them.
Priority	High
Verification	Review of the Design, Test
Parents	R-TOP-FUN-H-R-040, R-TOP-FUN-H-R-110
Justification	

ID	R-PFM-FUN-H-RIT-120
Title	In-orbit Platform Software
Description	The PhotSat Platform shall include an embedded software that is able to decode commands from ground, control subsystems as well as manage, process, store and compress data from Payload and Platform in-orbit, for the duration of the mission.
Priority	High
Verification	Review of the Design, Inspection, Test
Parents	R-TOP-FUN-H-R-110
Justification	The satellite shall have a digital processing system to function.

ID	R-PFM-FUN-H-RIT-130
Title	Platform Mass Memory
Description	The PhotSat Platform shall include a mass memory with sufficient capacity and data retention to safely store all the relevant data generated by the Payload and the Platform until it is downloaded to Ground Segment.
Priority	High
Verification	Review of the Design, Analysis, Test
Parents	R-TOP-FUN-H-R-110
Justification	The satellite shall have a mass memory system as a buffer to store all information prior to its download. Payload data will be stored compressed.

ID	R-PFM-FUN-H-RT-140
Title	Reprogrammability
Description	The PhotSat Platform Subsystems (OBC, EPS, ADCS, Radios, etc) and Payload ICU shall be able to receive and implement SW and FW updates in-orbit with the help of the platform OBC, for the duration of the mission.
Priority	High
Verification	Review of the Design, Test
Parents	R-TOP-FUN-H-R-120
Justification	Current technologies allow the implementation of this feature with high reliability and it is very desirable to have.

ID	R-PFM-FUN-M-RT-150
Title	Remote Payload Console Access
Description	The PhotSat Platform shall provide remote access (from ground) to the debug console of Payload's ICU, for the duration of the mission.
Priority	Medium
Verification	Review of the Design, Test
Parents	R-TOP-FUN-H-R-040, R-TOP-FUN-H-R-110
Justification	

ID	R-PFM-FUN-M-RA-160
Title	SEU Platform Protections
Description	The PhotSat Platform shall include protection features against SEU in its EEE digital and memory systems.
Priority	Medium
Verification	Review of the Design, Analysis
Parents	R-TOP-FUN-H-R-010, R-TOP-PER-H-R-040
Justification	

ID	R-PFM-FUN-H-R-170
Title	Time synchronization
Description	The PhotSat Subsystems shall be able to sync its clocks with the platform's OBC, for the duration of the mission.
Priority	High
Verification	Review of the Design, Analysis
Parents	R-TOP-FUN-H-RA-130
Justification	Current technologies allow the implementation of this feature with high reliability and it is very desirable to have.

ID	R-PFM-FUN-H-RI-180
Title	Primary Mirror Shading
Description	PhotSat Platform shall guarantee that no sunlight reaches the deployed primary mirrors of the Payload (e.g. using the solar panels as shaders) in a +-5º deviation from the sun vector, during nominal operations, for the duration of the mission.
Priority	High
Verification	Review of the Design, Inspection
Parents	R-TOP-SCI-H-A-010, R-TOP-SCI-H-A-015, R-TOP-SCI-H-R-030
Justification	Siderostat can not receive direct sunlight as it can damage the pixels of the detector.

11.1.4.2. Performance Requirements

Specify how well a subsystem must perform in order to meet the mission objectives.

ID	R-PFM-PER-H-RA-010
Title	Contact Cadence
Description	PhotSat Platform shall establish communications with the Ground Segment at least twice every day for TT&C and at least twice every day for Scientific Data download.
Priority	High
Verification	Review of the Design, Analysis
Parents	R-TOP-PER-H-R-020
Justification	

ID	R-PFM-PER-H-RA-015
Title	Contact Cadence Goal
Description	PhotSat Platform should establish communications with the Ground Segment every orbit for TT&C and more than 4 times every day for Scientific Data download.
Priority	High
Verification	Review of the Design, Analysis
Parents	R-TOP-PER-H-R-025
Justification	

ID	R-PFM-PER-H-RAT-020
Title	Nominal Subsystem Temperatures
Description	The PhotSat Platform shall maintain during nominal operations, passively or actively, the absolute temperature and stability of the Platform subsystems while ensuring that the Payload subsystems TRP stay in their operative thermal ranges: • Siderostat [-20, +35] ± 5ºC • Optics [+5, +35] ± 5ºC • Detector [-10, +35] ± 5ºC • ICU [-10, +60] ± 5ºC
Priority	High
Verification	Review of the Design, Analysis, Test
Parents	R-TOP-FUN-H-R-060, R-TOP-FUN-H-R-065
Justification	

ID	R-PFM-PER-H-RAT-030
Title	Survival Subsystem Temperatures
Description	The PhotSat Platform shall guarantee, passively or actively (e.g. with survival heaters) that the Platform and Payload subsystems survival temperature does not reach their cold and the hot survival limits: • Siderostat [-45, +80] ± 5ºC • Optics [-30, +70] ± 5ºC • Detector [-45, +80] ± 5ºC • ICU [-45, +95] ± 5ºC
Priority	High
Verification	Review of the Design, Analysis, Test
Parents	R-TOP-FUN-H-R-060, R-TOP-FUN-H-R-065
Justification	Initial simulations suggest the need to use survival heaters in some subsystems.

ID	R-PFM-PER-M-R-040
Title	Operative Lifetime
Description	The PhotSat Platform shall nominally operate in-orbit for a minimum of 2 years.
Priority	Medium
Verification	Review of the Design
Parents	R-TOP-PER-H-R-040
Justification	

ID	R-PFM-PER-M-R-045
Title	Operative Lifetime Goal
Description	The PhotSat Platform should nominally operate in-orbit for a minimum of 3 years.
Priority	Medium
Verification	Review of the Design
Parents	R-TOP-PER-H-R-045
Justification	

ID	R-PFM-PER-H-RAT-050
Title	Pointing Determination Precision
Description	The PhotSat Platform shall be able to know the orientation of the PhotSat satellite body reference frame (BRF) at 1 Hz with an absolute precision better than 5 arcsec.
Priority	High
Verification	Review of the Design, Analysis, Test
Parents	R-TOP-PER-H-AT-080
Justification	

ID	R-PFM-PER-M-RAT-055
Title	Pointing Determination Precision Goal
Description	The PhotSat Platform shall be able to know the orientation of the PhotSat satellite body reference frame (BRF) at 5 Hz with an absolute precision better than 2.5 arcsec.
Priority	Medium
Verification	Review of the Design, Analysis, Test
Parents	R-TOP-PER-M-AT-085
Justification	

ID	R-PFM-PER-H-RAT-060
Title	Platform Pointing Drift (≤1Hz)
Description	PhotSat Platform shall guarantee a pointing stability drift (≤1Hz) of <5 arcsec between two frame acquisitions (~1 second) while in nominal operations, for the duration of the mission.
Priority	High
Verification	Review of the Design, Analysis, Test
Parents	R-TOP-PER-H-RAT-090
Justification	

ID	R-PFM-PER-M-RAT-065
Title	Platform Pointing Drift (≤1Hz) Goal
Description	PhotSat Platform should guarantee a pointing stability drift (≤1Hz) of <2.5 arcsec during a full image acquisition (~50 seconds) while in nominal operations, for the duration of the mission.
Priority	Medium
Verification	Review of the Design, Analysis, Test
Parents	R-TOP-PER-H-RAT-095
Justification	

ID	R-PFM-PER-H-RAT-070
Title	Platform Pointing Jitter (>1Hz)
Description	PhotSat Platform shall guarantee a pointing stability jitter (>1Hz) of <5 arcsec (total RMS of the pointing jitter) between two frame acquisitions (~1 second), while in nominal operations, for the duration of the mission.
Priority	High
Verification	Review of the Design, Analysis, Test
Parents	R-TOP-PER-H-RAT-090
Justification	

ID	R-PFM-PER-M-RAT-075
Title	Platform Pointing Jitter (>1Hz) Goal
Description	PhotSat Platform should guarantee a pointing stability jitter (>1Hz) of <2.5 arcsec (total RMS of the pointing jitter) during a full image acquisition (~50 seconds) while in nominal operations, for the duration of the mission.
Priority	Medium
Verification	Review of the Design, Analysis, Test
Parents	R-TOP-PER-H-RAT-095
Justification	

ID	R-PFM-PER-M-RT-080
Title	Platform Nominal Slew Rate
Description	PhotSat Platform should be able to modify the orientation of the satellite with a slew rate of 2 º/s in any axis during scientific operations, for the duration of the mission.
Priority	Medium
Verification	Review of the Design, Test
Parents	R-TOP-PER-H-R-010, R-TOP-PER-H-R-015
Justification	

ID	R-PFM-PER-M-RT-090
Title	Platform Data Download Slew Rate
Description	PhotSat Platform should be able to modify the orientation of the satellite with a slew rate of 3º/s in any axis during Data Download operations, for the duration of the mission.
Priority	Medium
Verification	Review of the Design, Test
Parents	R-TOP-PER-H-R-020, R-TOP-PER-H-R-025
Justification	

ID	R-PFM-PER-H-RA-100
Title	Platform Nominal stabilization settling time
Description	PhotSat Platform shall be able stabilize the orientation of the satellite after it rotates to a fixed position in less than 10 seconds during scientific operations, for the duration of the mission.
Priority	High
Verification	Review of the Design, Analysis
Parents	R-TOP-SCI-H-A-010, R-TOP-PER-H-R-010
Justification	

ID	R-PFM-PER-M-RA-105
Title	Platform Nominal stabilization settling time goal
Description	PhotSat Platform should be able stabilize the orientation of the satellite after it rotates to a fixed position in less than 5 seconds during scientific operations, for the duration of the mission.
Priority	Medium
Verification	Review of the Design, Analysis
Parents	R-TOP-SCI-H-A-015, R-TOP-PER-H-R-015
Justification	

ID	R-PFM-PER-H-RT-110
Title	Payload Power Rails
Description	PhotSat Platform EPS shall be able to provide to Payload ICU the following set of independent DC power rails: • safe3 +3.3V 1% Vripple 4 A maximum • main3v3 +3.3V 1% Vripple 4 A maximum • main5v +5V 1% Vripple 4 A maximum • main12v +12V 5% Vripple 2 A maximum
Priority	High
Verification	Review of the Design, Test
Parents	R-TOP-FUN-H-R-050
Justification	

ID	R-PFM-PER-H-RT-115
Title	Payload Power Rails Goal
Description	PhotSat Platform EPS shall be able to provide to Payload ICU the following set of independent DC power rails: • safe3 +3.3V 1% Vripple 4 A maximum • main3v3 +3.3V 1% Vripple 4 A maximum • main5v +5V 1% Vripple 4 A maximum • analog5v +5V 5% Vripple 4 A maximum • main12v +12V 5% Vripple 2 A maximum • analog12v +12V 10% Vripple 2 A maximum • analog-12v -12V 10% Vripple -2 A maximum
Priority	High
Verification	Review of the Design, Test
Parents	R-TOP-FUN-H-R-050
Justification	

ID	R-PFM-PER-H-RT-120
Title	Payload Power Rails Protections
Description	PhotSat Platform EPS shall include overcurrent protections to the power rails of the Payload with the current thresholds of each rail adjustable during operations from ground.
Priority	High
Verification	Review of the Design, Test
Parents	R-TOP-FUN-H-R-050
Justification	

ID	R-PFM-PER-H-RA-130
Title	Platform Mass Memory Capacity
Description	PhotSat Platform Mass Memory shall have a storage capacity dedicated to the payload of ≥128 GB at EOL with enough retention rate and ECC to ensure a safe recovery of its stored data even above SAA (South Atlantic Anomalies).
Priority	High
Verification	Review of the Design, Analysis
Parents	R-TOP-FUN-H-R-110
Justification	

ID	R-PFM-PER-H-RAT-150
Title	Downlink Capacity
Description	PhotSat Platform shall be able to lossless transmit to the Ground Segment all stored data in one day of operations with one or more contacts.
Priority	High
Verification	Review of the Design, Analysis, Test
Parents	R-TOP-PER-H-R-030, R-TOP-PER-H-R-035
Justification	

11.1.4.3. Environmental Requirements

Specify the environmental conditions that a subsystem must be able to withstand, on ground, during launch and in space.

ID	R-PFM-ENV-H-RI-010
Title	Satellite Standards
Description	PhotSat Platform shall follow the CubeSat standard (RD-18) and the tailored ECCS standards for cubesats (RD-19) and be able to complete its mission with a standard commercial 12U CubeSat.
Priority	High
Verification	Review of the Design, Inspection
Parents	R-TOP-ENV-H-R-010
Justification	CubeSat standards are suitable for a fast mission like PhotSat and reduce design, development and manufacturing of the satellite as well as its launch costs.

ID	R-PFM-ENV-H-RI-020
Title	Platform Volume allocation
Description	The Platform subsystems total volume (excluding mechanical structure) shall be less than 6U (10x20x30 cm approx).
Priority	High
Verification	Review of the Design, Inspection
Parents	R-TOP-ENV-H-R-020
Justification	Initial studies suggest a feasible platform with 5U - 6U volume.

ID	R-PFM-ENV-H-RT-030
Title	Platform Mass allocation
Description	The Platform total dry mass shall be less than 8 kg.
Priority	High
Verification	Review of the Design, Test
Parents	R-TOP-ENV-H-RT-030
Justification	1U max mass = 1,333 kg // 1U * 12 = 15,999 kg (margins not taken into account)

ID	R-PFM-ENV-H-AT-040
Title	Platform Nominal Thermal environment
Description	The PhotSat Platform shall be able to nominally operate under the thermal conditions present in a Sun-Synchronous Dawn-Dusk LEO, taking into consideration the internal heat, solar radiation profile along the year, the nominal orientation of the satellite w.r.t. the Sun, the albedo and IR radiation of Earth and the Moon as well as the optical properties of the external surfaces of the satellite.
Priority	High
Verification	Analysis, Test
Parents	R-TOP-ENV-H-AT-040
Justification	

ID	R-PFM-ENV-H-AT-050
Title	Platform Survival Thermal environment
Description	The PhotSat Platform shall be able to survive under the thermal conditions present in a Sun-Synchronous Dawn-Dusk LEO when there are short Earth eclipses, in case the satellite enters in survival or safe mode (Payload off and minimum Platform subsystems on), while preventing the Payload internal subsystems to fall out of their survival thermal range.
Priority	High
Verification	Analysis, Test
Parents	R-TOP-ENV-H-AT-050
Justification	The satellite must survive extreme conditions, especially when there is no internal heat generation and it is cold outside due to the eclipses the dawn-dusk orbit experiences during some parts of the year. Survival or safe mode assumes only essential subsystems are ON (OBC, EPS and TT&C radio) and thus is the coldest state the satellite shall withstand.

ID	R-PFM-ENV-H-AT-060
Title	Launch environment
Description	The PhotSat Platform, its structures and subsystems shall be able to withstand the vibrational, acoustic and shock environment of the launch.
Priority	High
Verification	Analysis, Test
Parents	R-TOP-ENV-H-AT-060
Justification	

ID	R-PFM-ENV-H-A-070
Title	Radiation environment
Description	The PhotSat Platform shall survive and operate in the radiation environment present in a polar LEO orbit, including the SAA, for the duration of the mission.
Priority	High
Verification	Analysis
Parents	R-TOP-ENV-H-A-070
Justification	

ID	R-PFM-ENV-L-A-080
Title	Atomic O environment
Description	Platform elements exposed to the exterior of the satellite shall incorporate in their design mitigation techniques to reduce the impact of the atomic oxygen erosion in LEO orbit and ensure its optimal operations for the duration of the mission.
Priority	Low
Verification	Analysis
Parents	R-TOP-ENV-L-A-080
Justification	Atomic Oxygen will "rain" from every direction (as the satellite rotates to scan all the maximum circles) and affect the external surfaces of the satellite, except from the sun and antisun faces, which are almost orthogonal to trajectory. Seems like glass is not that affected (https://www.nasa.gov/topics/technology/features/atomic_oxygen.html), so the main mirror should be OK, but the coatings in some parts might not.

ID	R-PFM-ENV-H-IAT-090
Title	Straylight environment
Description	Platform elements that are in contact with, or close to, the optical path of the optical system of the payload shall be treated with a high absorbance coating to reduce straylight that shall last for the duration of the mission.
Priority	High
Verification	Inspection, Analysis, Test
Parents	R-TOP-ENV-H-AT-090
Justification	The Earth and the Moon will be around the satellite pouring albedo light.

ID	R-PFM-ENV-H-RA-100
Title	Outgassing environment
Description	Platform elements that are in contact with, or close to, the optical path shall have a TML < 1% with a CVCM of <0.1% and a WVR < 1%.
Priority	High
Verification	Review of the design, Analysis
Parents	R-TOP-ENV-H-RA-100
Justification	To avoid polluting the lenses and the main mirror.

ID	R-PFM-ENV-H-RT-110
Title	Vacuum environment
Description	All Payload elements shall be able to withstand a pressure of 10-8mbar for the duration of the mission and provide purge holes to evacuate trapped air inside complicated geometries and assemblies.
Priority	High
Verification	Review of the design, Test
Parents	R-TOP-ENV-H-RA-110
Justification	

ID	R-PFM-ENV-H-RT-120
Title	Charging environment
Description	All Platform elements shall be electrically connected to the satellite structure and share a "chassis" connection with the EPS
Priority	High
Verification	Review of the design, Test
Parents	R-TOP-ENV-H-RT-120
Justification	

ID	R-PFM-ENV-H-RT-130
Title	EMI environment
Description	All Platform elements and subsystems shall not emit EMI as per ECSS, especially in the bands reserved for communications to ground (e.g. S-band, X-band, etc).
Priority	High
Verification	Review of the design, Test
Parents	R-TOP-ENV-H-RT-130
Justification	

11.1.4.4. Interface Requirements

Specify how a subsystem must interact with other subsystems, both electrically and physically.

ID	R-PFM-IF-H-RAT-010
Title	Platform to Ground Communication Interfaces
Description	Platform OBC shall be able to communicate with the ground segment using: • Low bandwidth radio (e.g. S-Band radio) for TT&C • High bandwidth radio, (e.g. X-band radio) for Scientific Data download
Priority	High
Verification	Review of the Design, Analysis, Test
Parents	R-TOP-IF-H-AR-010
Justification	

ID	R-PFM-IF-H-RIT-020
Title	Platform to Payload Communication Interfaces
Description	Platform OBC shall be able to establish communication with the Payload ICU using standard digital communication buses: • x2 Ethernet connections (nominal and redundant) • x2 CAN connections (1 dedicated to Payload, 1 to common platform CAN) • x2 UART connection (nominal and redundant)
Priority	High
Verification	Review of the Design, Inspection, Test
Parents	R-TOP-IF-H-RT-020
Justification	

ID	R-PFM-IF-H-RIT-030
Title	Platform to Payload Electrical Power interfaces
Description	Platform EPS shall be able to provide power to the Payload ICU through a dedicated harness with the power rails specified in section 5.3. Each power rail shall be connected to ICU with a twisted pair harness with 2 wires minimum (one for the power rail and one for the return to EPS ground) as well as a harness shield that shall be connected to the chassis.
Priority	High
Verification	Review of the Design, Inspection, Test
Parents	R-TOP-IF-H-RIT-030
Justification	

ID	R-PFM-IF-H-RIT-040
Title	Platform to Payload Harnesses and connectors
Description	All harnesses between Payload and Platform shall include EMI shielding and provide electrical connection to it at the connectors of both ends. The connectors and wire's characteristics of each harness shall be tailored for each application during the ICD discussions with payload and platform development teams.
Priority	High
Verification	Review of the Design, Inspection, Test
Parents	R-TOP-ENV-H-RT-130, R-TOP-IF-H-RIT-040
Justification	

ID	R-PFM-IF-H-RI-050
Title	Platform Mechanical Structures and Interfaces
Description	PhotSat Platform shall provide a 12U Mechanical Structure that follows the CubeSat Standard and is composed of lateral rails with equidistant holes in which to anchor Payload and Platform Subsystems via M2.5 screws (similar to a server rack structure).
Priority	High
Verification	Review of the Design, Inspection
Parents	R-TOP-ENV-H-R-010, R-TOP-IF-H-RI-050
Justification	

ID	R-PFM-IF-H-RAT-060
Title	Platform Thermal Interfaces
Description	PhotSat Platform shall provide to the Payload and Platform subsystems tailored thermal interfaces (via mechanical structure or Thermal Control Systems) in order to exploit the thermal conduction mechanism to extract their heat and move it towards external surfaces and/or radiators in the anti-sun face of the satellite so they radiate extra heat and ensure that the subsystems TRP stays in nominal thermal conditions when in operations and in survival thermal conditions when in survival or safe mode (minimum subsystems ON).
Priority	High
Verification	Review of the Design, Analysis, Test
Parents	R-TOP-IF-H-RAT-060
Justification	

ID	R-PFM-IF-L-RI-070
Title	External Satellite Payload Radiators
Description	PhotSat Platform shall provide two separated external surfaces, at the anti-sun face of the satellite, of at least 100x100 mm (2x 10x10 cm), where two radiators can be attached and connected to payload thermal straps.
Priority	Medium
Verification	Review of the Design, Inspection
Parents	R-TOP-IF-H-RAT-060
Justification	

ID	R-PFM-IF-L-RI-085
Title	External Satellite Payload Antennas
Description	PhotSat Platform should provide an external surface of at least 100x100 mm, where a patch antenna shall be attached and connected to payload Alerts communication system.
Priority	Low
Verification	Review of the Design, Inspection
Parents	R-TOP-FUN-M-R-025, R-TOP-PER-M-RA-105, R-TOP-IF-M-RAT-015
Justification	

ID	R-PFM-IF-L-RI-090
Title	External Satellite Labels and Logos surface
Description	PhotSat Platform shall provide an external surface of at least 50x100 mm, visible even when the solar panels are stowed, where a label and a logo could be added without interfering with PhotSat nominal operations.
Priority	Low
Verification	Review of the Design, Inspection
Parents	R-TOP-IF-L-RI-070
Justification	

ID	R-PFM-IF-L-RI-095
Title	External Satellite Labels and Logos surface goal
Description	PhotSat Platform should provide an external surface of at least 100x100 mm (or two of 50x100mm in different places), visible even when the solar panels are stowed, where a label and a logo could be added without interfering with PhotSat nominal operations.
Priority	Low
Verification	Review of the Design, Inspection
Parents	R-TOP-IF-L-RI-075
Justification	

ID	R-PFM-IF-H-RI-100
Title	Release Mechanism Mechanical Interface
Description	PhotSat Platform shall provide an internal mechanical interface capable of holding the Payload's main mirror release mechanism to its structure.
Priority	High
Verification	Review of the Design, Inspection
Parents	R-TOP-IF-H-RI-050
Justification	As the center of the payload will be occupied by the ICU and a set of reaction wheels, the release mechanism of the main mirror shall be located in Platforms' allocated volume.

ID	R-PFM-IF-H-RI-110
Title	Flat Field Calibration Image Interface
Description	PhotSat Platform shall provide 2 external surfaces behind top and bottom solar panels of at least 100x100 mm, where a calibration image can be anchored without interfering with PhotSat nominal operations.
Priority	High
Verification	Review of the Design, Inspection
Parents	R-TOP-PER-H-RA-070, R-TOP-PER-H-RA-075
Justification	

11.1.4.5. QA and Reliability Requirements

Specify the Quality Assurance and Reliability considerations that must be taken into account when designing and operating the astronomy payload.

ID	R-PFM-QA-H-R-010
Title	ECSS Standards
Description	Platform development shall conform with the ECSS standards that are applicable to CubeSats, if there are no budget or time constraints (in which case a justification report shall be issued)
Priority	High
Verification	Review of the Design
Parents	R-TOP-QA-H-R-010
Justification	By default, ECSS standards shall be applied, but there might be some cases in which other standards (automotive, medical, etc) can be used. Ref: https://copernicus-masters.com/wp-content/uploads/2017/03/IOD_CubeSat_ECSS_Eng_Tailoring_Iss1_Rev3.pdf

ID	R-PFM-QA-M-RA-020
Title	Radiation Tolerant Components
Description	Platform electronics shall be composed of radiation tolerant components and/or COTS with radiation mitigation techniques with enough overall reliability to survive the complete duration of the PhotSat mission.
Priority	Medium
Verification	Review of the Design, Analysis
Parents	R-TOP-QA-H-AR-020
Justification	

ID	R-PFM-QA-H-R-30
Title	Platform TRL
Description	The TRL of the Platform components and subsystems shall be 7 or higher.
Priority	High
Verification	Review of the Design
Parents	R-TOP-QA-H-R-30
Justification	

ID	R-PFM-QA-H-R-35
Title	Platform TRL Goal
Description	The TRL of the Platform components and subsystems should be 9 and have flight heritage.
Priority	High
Verification	Review of the Design
Parents	R-TOP-QA-H-R-35
Justification	

ID	R-PFM-QA-M-RA-045
Title	Platform Single Point Failures Goal
Description	Single Point Failures (SPF) should be avoided wherever possible
Priority	Medium
Verification	Review of the Design, Analysis
Parents	R-TOP-QA-M-RA-045
Justification	

ID	R-PFM-QA-M-R-050
Title	Margin Philosophy
Description	Platform development shall take into account a 20% margin for the engineering budgets (volume, mass, power, pointing, timings, etc) during early phases and until CDR. From CDR until FDR, 10% margins.
Priority	Medium
Verification	Review of the Design
Parents	R-TOP-QA-H-R-050
Justification	

ID	R-PFM-QA-M-R-065
Title	Testing Philosophy goal
Description	Photsat development plans should prioritize subsystem level testing (e.g. completed PCBs, mechanisms, thermal control loops, etc) over component level testing (e.g. standalone ICs, heaters, motors, etc), to increase development speed but maintaining QA methods and procedures.
Priority	Medium
Verification	Review of the Design
Parents	R-TOP-QA-M-R-065
Justification	

ID	R-PFM-QA-H-RT-070
Title	Platform FDIR Capabilities
Description	The Platform SW shall include FDIR functionalities that allows the satellite to fall to a safe or survival mode (with minimum power consumption) whenever a faulty situation occurs and still capture and transmit the issue data to Ground Segment.
Priority	High
Verification	Review of the Design, Test
Parents	R-TOP-QA-H-RT-070
Justification	

ID	R-PFM-QA-H-RT-075
Title	Platform FDIR Capabilities Goal
Description	The Platform SW shall include FDIR functionalities that allows the satellite to fall to a safe or survival mode (with minimum power consumption) whenever a faulty situation occurs and still capture and transmit the issue data to Ground Segment using Payload's Low Latency radio.
Priority	High
Verification	Review of the Design, Test
Parents	R-TOP-QA-H-RT-075
Justification	

ID	R-PFM-QA-H-RI-080
Title	Platform Operational Manual
Description	The Platform supplier shall provide an operational manual of the PhotSat platform with nominal and contingency procedures in enough detail to allow the transfer of operations to a third party.
Priority	High
Verification	Review of the Design, Inspection
Parents	R-TOP-QA-H-RI-080
Justification	

ID	R-PFM-QA-H-RI-090
Title	Platform Manufacturing and Verification Plan
Description	The Platform supplier shall provide and document the planning of the manufacturing, assembly and integration stages in the manufacturing plan or flow chart for the PhotSat satellite, including the sequence of operations, inspections, tests and verifications, with the reference to the procedures by which the various activities are performed and the required cleanliness levels and temperature and humidity requirements of the facilities.
Priority	High
Verification	Review of the Design, Inspection
Parents	R-TOP-QA-H-RI-090
Justification	

ID	R-PFM-QA-H-RI-100
Title	Platform Commissioning Plan
Description	The Platform supplier shall provide and document the planning of the commissioning stage, in the commissioning plan or flow chart for the PhotSat satellite, including the sequence of operations, tests and verifications, with the reference to the procedures by which the various activities are performed.
Priority	High
Verification	Review of the Design, Inspection
Parents	R-TOP-QA-H-RI-090
Justification	

ID	R-PFM-QA-H-R-110
Title	Platform Plans Reviewing Methods
Description	The manufacturing, verification and commissioning plans shall be reviewed and discussed with Payload engineers during the development phase to simplify and accelerate the tests and verifications of the Payload.
Priority	High
Verification	Review of the Design
Parents	R-TOP-QA-H-RI-100
Justification	

ID	R-PFM-QA-H-R-120
Title	Platform Development Reviewing Methods
Description	Periodic meetings to report the development status of the Platform and its subsystems shall be established between Platform Provider and a formal review board of IEEC experts.
Priority	High
Verification	Review of the Design
Parents	R-TOP-QA-H-RI-100
Justification	

ID	R-PFM-QA-H-RI-130
Title	Non-Conformance Procedure
Description	The Platform supplier should implement a non-conformance control procedure
Priority	High
Verification	Review of the Design, Inspection
Parents	R-TOP-QA-H-RI-100
Justification	

11.1.4.6. Logistics Requirements

Specify the logistics considerations that must be taken into account when manufacturing, assembling, testing and operating the platform.

ID	R-PFM-LG-H-RI-010
Title	PhotSat Development Shippings
Description	The Platform supplier shall be responsible, in cost and risk, for the transport of the complete PhotSat Satellite and its different subsystems (including Payload ones) during the development phase.
Priority	High
Verification	Review of the Design, Inspection
Parents	R-TOP-LG-H-RI-010
Justification	

ID	R-PFM-LG-H-RI-020
Title	PhotSat Satellite Package
Description	PhotSat satellite shall be properly packaged by the Platform provider after the AIV/AIT campaign at the end of the development phase with a container that ensures a safe transportation and a clean storage environment for the satellite.
Priority	High
Verification	Review of the Design, Inspection
Parents	R-TOP-LG-H-RI-010
Justification	

ID	R-PFM-LG-H-RI-030
Title	PhotSat Satellite Storage
Description	PhotSat Platform provider shall store the complete PhotSat satellite until its delivery to the launcher as well as document the requirements of the facility in which to store it and the procedures to maintain its functionality and performance (e.g. battery charge, periodic cleaning, etc)
Priority	High
Verification	Review of the Design, Inspection
Parents	R-TOP-LG-H-RI-010
Justification	

ID	R-PFM-LG-H-R-040
Title	Frequency Fillings
Description	The Platform supplier shall be responsible for the frequency fillings of the S-band and X-ban radios for the commissioning phase of the mission.
Priority	High
Verification	Review of the Design
Parents	R-TOP-LG-H-R-020
Justification	

ID	R-PFM-LG-H-R-045
Title	Frequency Fillings Goal
Description	The Platform supplier shall be responsible for the frequency fillings of the S-band, X-ban and the Payload's Low Latency radios for the duration of the mission.
Priority	High
Verification	Review of the Design
Parents	R-TOP-LG-H-R-020
Justification	

ID	R-PFM-LG-H-R-050
Title	Platform SW & FW maintenance
Description	The Platform supplier shall be responsible for the delivery of Patform's SW and FW updates during PhotSat lifetime, in a format that a third party of operators could implement during operations, for maintenance and faulty conditions recovery or mitigation, in order to guarantee that PhotSat meets its operative lifetime.
Priority	High
Verification	Review of the Design
Parents	R-TOP-LG-H-R-030
Justification	

11.1.4.7. Development and Verification Requirements

Specify the considerations that must be taken into account when developing and verifying PhotSat's Platform and Payload.

ID	R-PFM-DEV-H-RI-010
Title	Satellite AIV/AIT Activities
Description	The Platform supplier shall be responsible for performing the verification of the complete satellite regarding functionality, performance and environmental testing, with the support and direct involvement of the IEEC Engineering team for the activities related with PhotSat Payload.
Priority	High
Verification	Review of the Design, Inspection
Parents	R-TOP-DEV-H-RI-010
Justification	

ID	R-PFM-DEV-H-RI-020
Title	Platform Mechanical EM
Description	The Platform supplier shall provide an Engineering Model (EM) of the Platform mechanical structure, representative of the Flight Model, no later than Q3 of 2024, to ease the mechanical integration between the platform and the payload and to be used in the TVAC, Shaking and radiation tests of the payload.
Priority	High
Verification	Review of the Design, Inspection
Parents	R-TOP-DEV-H-RI-020
Justification	

ID	R-PFM-DEV-H-RT-030
Title	Platform EPS EM
Description	The Platform supplier shall provide an Engineering Model of the Platform EPS, with the required harnesses, representative of the Flight Model, no later than Q3 of 2024, to support the development of the power interfaces of the Payload subsystems and ease the electrical integration between the Platform and the Payload during AIV/AIT activities.
Priority	High
Verification	Review of the Design, Test
Parents	R-TOP-DEV-H-RI-020
Justification	

ID	R-PFM-DEV-H-R-040
Title	Platform OBC EM
Description	The Platform supplier shall provide an Engineering Model of the Platform OBC, with the required harnesses and SW, representative of the Flight Model, no later than Q3 of 2024, to support the development of the scientific and HK data pipeline and communication interfaces of the Payload ICU and ease the electrical and SW integration between the Platform and the Payload during AIV/AIT activities.
Priority	High
Verification	Review of the Design
Parents	R-TOP-DEV-H-RI-020
Justification	

ID	R-PFM-DEV-H-R-050
Title	Platform Simulator
Description	The Platform supplier shall provide a Platform Simulator that emulates the PhotSat Platform functional behavior at subsystem level, representative of the of the Flight Model and updated according to PhotSat SW/FW updates during its operative lifetime, no later than Q4 of 2024 and maintained during PhotSat operative lifetime, to support the development of the scientific and HK data pipeline and communication interfaces of the Payload ICU and simplify the debugging of possible issues during PhotSat operations
Priority	High
Verification	Review of the Design
Parents	R-TOP-DEV-H-RI-030
Justification	

11.1.5. Launch vehicle requirements

During the tender phase, the bidder must explain in the proposal's technical report the options foreseen for the launch vehicle and/or deployer or orbit transfer service taking into account the mission requirements. It is established as a condition for achieving the FRR milestone that the successful bidder must provide the contract or commitment with the satellite launch company.

The launch vehicle must meet the following minimum requirements: the launch vehicle used to put the satellite into orbit must have a solid record of success in similar launch-into-orbit operations during the past 3 years. The vehicle shall be understood to have a solid record of success when 90% of the satellites it launched in the past three years reached orbit.

In order to prove this requirement, the successful bidder must attach to the contract or to the commitment with the launching company a list of the latter's solid record over the last three years, indicating missions and their result.

Should the bidder choose to contract a deployer or orbit transfer service after the launch, the chosen provider is required to have a solid record of success for satellites of similar characteristics in the past two years. A solid record of success shall be understood to have been attained when 90% of the satellites launched in the past 2 years reached orbit.

In the case of a deployer, in order to prove this requirement, within the FRR milestone framework, the successful bidder must attach to the contract or to the commitment with the launching company, a list of the latter's solid record over the last 2 years, indicating missions and their result.

11.1.6. Ground Segment requirements

During the tender phase, the bidder must explain in the proposal's technical report the options foreseen for the implementation of the Ground Segment taking into account the mission requirements. It is established as a condition for achieving the FRR milestone that the successful bidder must provide the contract(s) with the supplier(s) of communication antennas or satellite data services, as well as the interfaces, protocols, and procedures with the respective entities to ensure satellite control by the MCC and the IOSDC (see ***Figure 5***).

During the design phase, the interfaces and protocols between the successful bidder's MCC and the IEEC's IOSDC will be defined with the assistance and support of IEEC engineers and scientists.

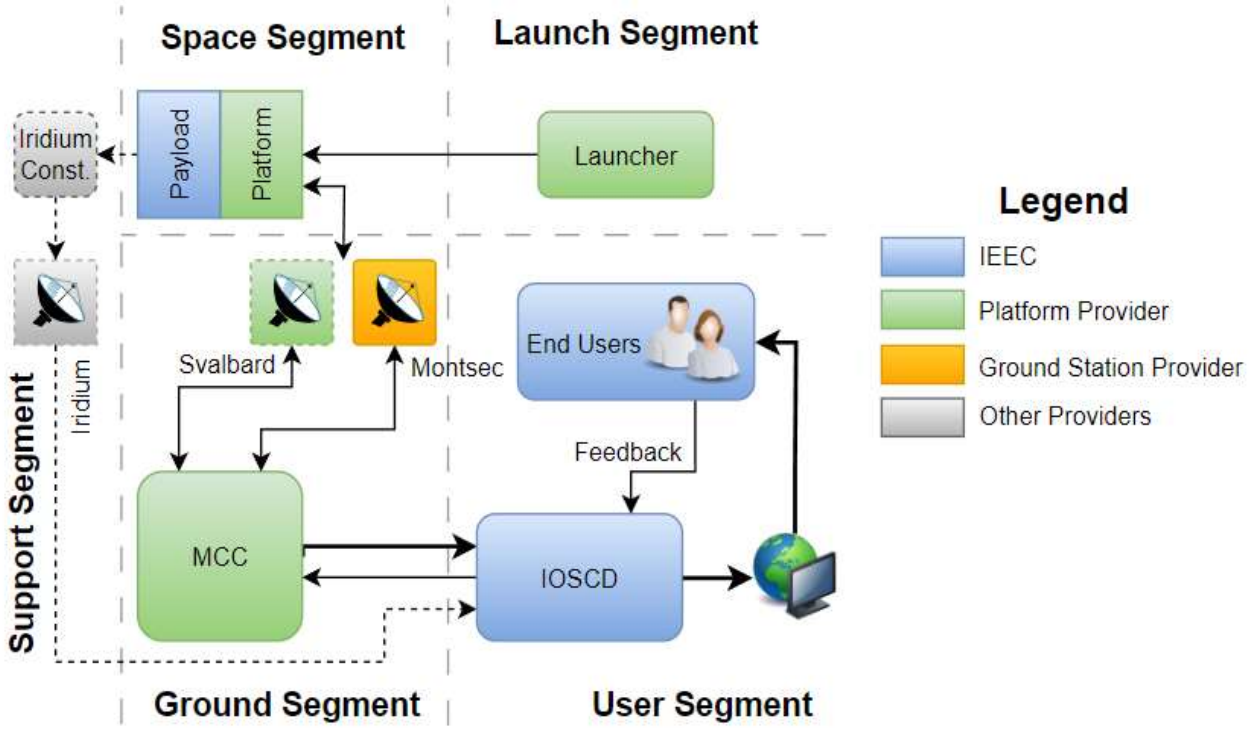

Figure 5 *Diagram of the key players during the satellite commissioning and nominal operations*

- ***Mission Control Centre*** **(MCC) (successful bidder)**: It is the center responsible for carrying out the mission operations, monitoring and controlling the PhotSat satellite platform, as well as the astronomy payload during all phases of the mission. Therefore, the MCC also conducts testing and validation activities and trains the teams involved in carrying out the PhotSat mission operations. The responsibilities of the MCC are as follows:
    - Preparation of mission flight operations and procedures.
    - Monitoring and control of the satellite platform and the astronomy payload.
    - Health check and safety maintenance of both the satellite platform and the astronomy payload.
    - Identifying, correcting, tracking, and documenting anomalies in Non-Conformance Reports (NCRs).
    - Operations planning, generation and uploading of telecommands (TC) to the satellite platform and instruments (the Science Operations commands are provided by the Instrument Operations and Science Data Centre, IOSDC) and task automation.
    - Satellite maintenance and engineering support (e.g., onboard software maintenance).
    - Support in flight dynamics, including the determination and control of the satellite's orbit and attitude.
    - Planning, scheduling, and execution of contacts or passes with Ground Stations.

- Reception and management of Telemetry (TM) data and astronomical observation payload data (Science data).
- Distribution of all relevant mission data to the Instrument Operations and Science Data Centre (IOSDC). The delivery time between the MCC and the reception of the data at the IOSDC for the RAW data and the corresponding auxiliary files (metadata) of the telemetry and scientific data produced in one day between must be as immediate as possible.
- Control and monitoring of space traffic and space debris through the SSA (Space Situational Awareness) provider.
- Control and monitoring of space weather, including events such as geomagnetic storms or solar radiation, to predict and mitigate potential disruptions in flight operations and the astronomy payload operations.

- ***Ground Stations Network***: A set of ground telecommunications antennas used so that the MCC can communicate with the satellite. Below, the ground stations for the PhotSat mission are defined, as well as the necessary interfaces to connect the MCC with each ground station:
  - Estació de Montsec: Primary ground station for communications via S band (transmitter/receiver) and X band (receiver) located at the Montsec Observatory (location: Longitude: 00° 43' 46" E; Latitude: 42° 03' 05" N; Altitude: 1570 m a.s.l.), a scientific and technological infrastructure located in Sant Esteve de la Sarga (Lleida, Spain) managed by the IEEC. This primary station will be used for the following:
    - TT&C (Telemetry, Tracking & Control) operations for sending Telecommands (TC) and downloading Telemetry (TM) for the maintenance of subsystems and logs.
    - Payload data downlink operations.
  - Additional ground stations (optional): Ground communication stations via S band (transmitter/receiver) and X band (receiver) to provide redundancy in the ground system in case of failure or downtime of the Montsec Station to meet the previously defined requirements. The additional stations will be used for:
    - TT&C (Telemetry, Tracking & Control) operations for sending Telecommands (TC) and downloading Telemetry (TM) for the maintenance of subsystems and logs.
    - Payload data downlink operations.
  - APIs (Application Programming Interface): Required software interfaces to allow the MCC to connect to the primary ground station and the additional ground stations. There may be several APIs depending on whether it is the same Ground Station Provider or different providers.

In order to better define the MCC, the functioning of IEEC's IOSDC must be taken into account:

- ***Instrument Operations and Science Data Centre (IOSDC) (IEEC)***: This is the centre responsible for controlling the PhotSat astronomy payload (through the MCC) and validating the correct functioning of the instruments, as well as processing and managing the scientific data. The responsibilities of the IOSDC are:

    - IOSDC-A:
        - Generation and provision of Science Operations telecommands to the MCC to control the operational modes of the astronomy payload:
            - Repeat the past scan (in case of error in TM).
            - Upload new software to the ICU (to correct possible bugs or improve performance).
            - Execute the in-orbit calibration procedure.
            - Execute scans or additional procedures to follow up on interesting astronomical events for the scientific community.
            - Execute the next scan (if all previously received data is OK).
            - Reception of science data, housekeeping (HK), metadata, and auxiliary data (GNSS data, ADCS TM, Alerts) from the satellite, received via MCC.
            - Implementation of telemetry data analysis tools for the astronomy payload telemetry and health monitoring of the instruments.
            - Analysis and distribution of Housekeeping data products from the MCC to the IOSDC-B and other users.
            - Operational support in satellite operations involving the astronomy payload.
            - Execution of the commissioning plan for the astronomy payload.
            - Mission planning and scheduling of astronomical observations during the nominal operations phase.

- IOSDC-B:
  - Implementation of the Science Operations schedule generation tool to control the operational modes of the astronomy payload.
  - Definition of the operational modes and observation modes of the astronomy payload.
  - Definition of the calibration plan and procedures for the payload instruments.
  - Execution, in collaboration with the MCC, of the payload instruments calibration procedures.
  - Implementation of data processing software up to Ln products (*TBD*) and execution of the automatic processing chain of data and metadata from the astronomy payload.
  - Production, quality control, maintenance, and delivery of the different data products (HK, calibration, scientific, etc.) to end users.
  - Mission planning and scheduling of astronomical observations during the nominal operations phase, according to scientific objectives and feedback from the scientific community.
  - Reception, storage, and management of data and metadata delivered by the MCC.
  - Reception and processing of Alerts received via the Iridium service (*TBC*) to be taken into account when planning various scientific operations (Science Operations) to be performed by the astronomical observation payload.
  - User-made plans, as well as special commands (calibrations, responses to Iridium alerts, etc.), are sent to the MCC through IOSDC-A.

11.1.6.1. Integration of the future S-band and X-band telecommunications station (Montsec Ground Station) in the mission Ground Segment requirements

The IEEC manages the Montsec Observatory (OdM), a scientific facility located in Sant Esteve de la Sarga (Lleida), where space-related activities are carried out: astronomical observatory, environmental and meteorological measurement station, base for different telecommunications services, among others.

At present, the corresponding administrative procedures have been initiated so that these activities may also include those associated with a satellite communication and calibration station. This new service offered by the OdM will include, in a first phase, the construction of an S-band and X-band telecommunications antenna for satellites.

Once the Montsec Ground Station is operational, the successful bidder must integrate it into the ground segment used for the operations of the PhotSat mission by signing the corresponding agreement with the station manager.

The costs derived from the use will not be the subject of this contract and therefore do not take part of the tender budget and will be borne by the successful bidder, who will be responsible for agreeing them directly with the owner of the Montsec Ground Station.

The successful bidder shall include the use of the Montsec Ground Station within the Mission Concept of Operations document, with the aim of maximizing the use of the Montsec Ground Station.

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