MODEL SATELLITE COMPETITION 2024 Guide

Mission: Mechanical Filtering Module

Bonus Mission: IoT Data Transfer

Version 2.1

Table of Contents

VERSION	DATE	CHANGES
1.0	15.02.2018	First Version -
1.1	15.01.2019	Telecommand Package 3 Axis Gyro Entegration & Simulation Dimension, Disqualification Guidelines Weather Conditions (Flight Plan B)
1.2	17.01.2020	Size and weight Descent Control System, Video Transfer Disqualification Guidelines Weather Conditions (Plan B)
1.3	10.03.2020	Size Timeline
1.4	21.07.2020	Video Transfer (1MB) FRR
1.5	15.12.2020	Bonus Mission: Altitude Stabilization Size Weight Rocket Capsule (Colored Smoke) Competition Prizes
1.6	13.12.2021	Intersystem Communication Network (Technical Requirements Page 39) Bonus Task: Asynchronous Video Transfer (Technical Requirements Page 24) Original Mission (Technical Requirements Page 37-38) Size, Weight Telemetry Format
2.0	21.09.2022	Passive Landing System , Point Weights Delivered Documents (Stage Revisions) Parachute Colors (Technical Requirements Page 34) Interface Alarm System (Technical Requirements Page 36) Telemetry Format Bonus Mission
2.1	10.11.2023	Mechanical Filtering Module (Technical Requirements Page 35) Bonus Mission: IoT Data Transfer (Technical Requirements Page 36) Point Weights Table Delivered Documents (Stage Revisions) Telemetry Format

1. INTRODUCTION

1.1 General Information

TURKSAT Model Satellite Competition is a design-build-flight competition. The T-MUY provides teams with an opportunity to experience process from design to beginning of active mission of an aerospace system. The T-MUY competition is planned to reflect an aerospace project on a small scale and includes all aspects of an aerospace project, from design to production and post-mission review. The competition is designed to reflect various aspects of real missions such as addressing telemetry and communication requirements, provide autonomous structure and developing an interdisciplinary working system.

T-MUY aims to provide undergraduate and graduate students with the opportunity to transfer knowledge from theory to practice and to acquiring the ability to work interdisciplinary. Additionally, It is aimed that the students will have the opportunity to share their experiences with other university teams and to communicate with the institution, companies, experts and engineers operating in the sector.

1.2 General Provision

The announcements related to the competition are made via the websites https://modeluydu.turksat.com.tr/ and https://www.teknofest.org/. No another announcement will be made for each team and the announcements published on the website will be a notification. Participation in the competition as a team is mandatory. Individual applications will not be considered. During the competition, any communication activity will be implemented by using alternative channels via TURKSAT.

The teams that their applications are accepted and announced can make sponsorship negotiation for their needs and they can receive financial assistance for this purpose. Teams continuing the competitions process should take care to participate in all organizations determined by TURKSAT. TURKSAT reserves the right to change the prizes, rules or to cancel the competition with giving reason. The number of teams that will participate in the flight is determined by TURKSAT in order to conduct flight day activities effeciently.

1.3 Mission Overview

In the TURKSAT Model Satellite Competition, Model Satellite represents the Science Payload that can land in a planet's atmosphere, collect data from its sensors, reflect the collected data on an interface, record image and make instant data exchanges.

Model Satellite shall be designed and produced in a way that consists of two parts, Science Payload and the Container. The Container is to protect Science Payload that performs desired tasks.

The Model Satellite (Container + Science Payload) will be raised above 500-700 meters with a rocket provided by TURKSAT or a drone if the safety of the competition is considered risky and will be released from a altitude of approximately 500-700 meters. The Model Satellite will descend to 400 meters at a rate of 12-14 m/s with the passive landing system. At a height of 400 meters the Container and the Science Payload will be released. After release, the Science Payload will continue to descend by parachute with the passive landing system. After the Science Payload release the Container, it will continue to descend at a rate of 6 – 8 m/s. The determined altitude may vary with the effect of adverse weather conditions on the flight day.

The Science Payload will send the video image and telemetry package every second (1 Hz) during the entire flight (form the moment run to landed) to the competitor's own ground station. The data will also be recorded on the SD card on the Science Payload. In addition, a video package provided by TURKSAT will be sent from the ground station during the flight and recorded on the SD Card on the Science Payload. The time dependent graphs of telemetry data will simultaneously be plotted on the ground station. Video image will be watched on the ground station. Telemetry data and video image will also be recorded to the ground station. When the mission is completed, whole data recorded in the ground station software will be delivered to competition officer.

After the Science Payload has landed, it will continue to the data transfer for 30 seconds and at the end of 30 seconds, the data transmission will be terminated automatically and give an audible signal with buzzer for recovery and the landing point will be marked on the ground station interface.

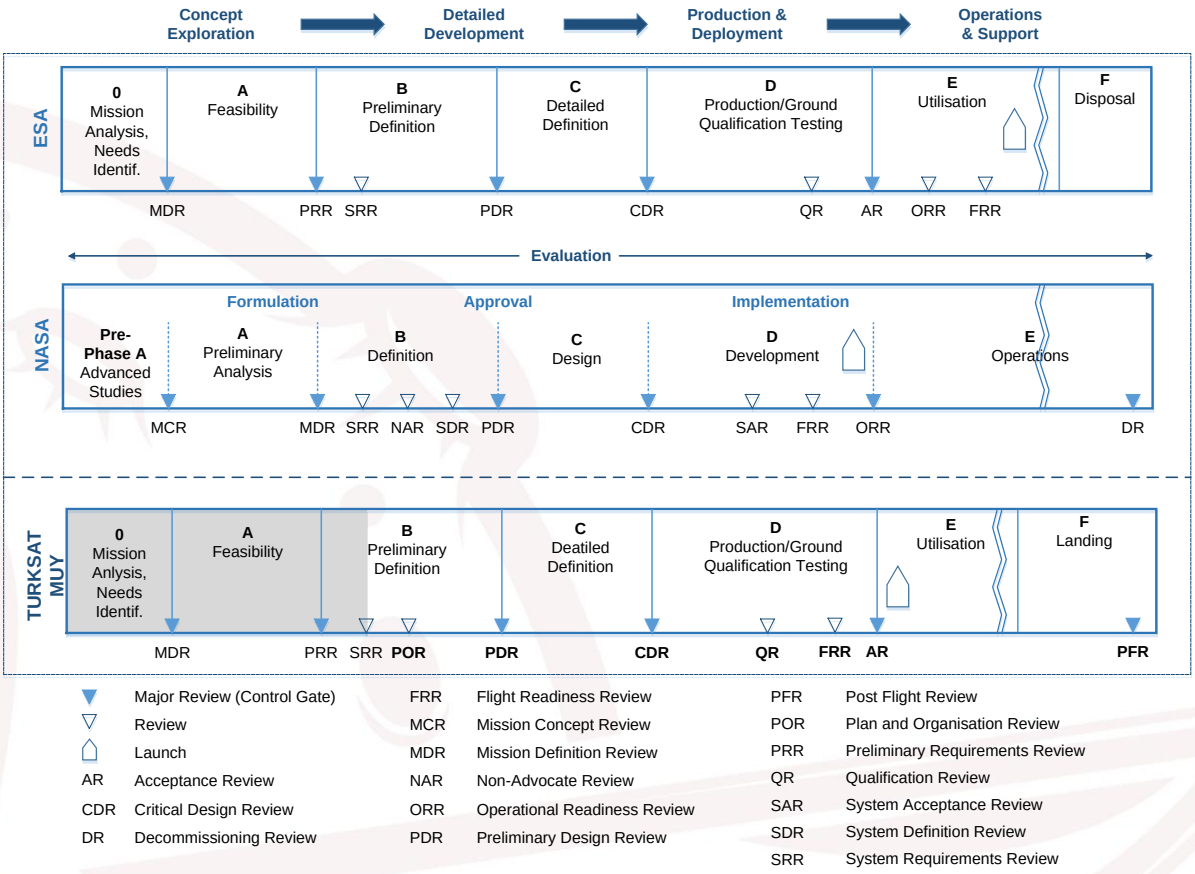
1.4 Competition Description

The competition is in six phases.

First phase is the application and acceptance phase. Applications will be made within the specified date range via the https://www.t3kys.com/tr website with the team created as stated in the team structure section. The teams applications are accepted will be announced on the website.

Application details are specified in the competition application section.

Table 1 T-MUY Phases



▼	Major Review (Control Gate)	FRR	Flight Readiness Review	PFR	Post Flight Review
▽	Review	MCR	Mission Concept Review	POR	Plan and Organisation Review
⌂	Launch	MDR	Mission Definition Review	PRR	Preliminary Requirements Review
AR	Acceptance Review	NAR	Non-Advocate Review	QR	Qualification Review
CDR	Critical Design Review	ORR	Operational Readiness Review	SAR	System Acceptance Review
DR	Decommissioning Review	PDR	Preliminary Design Review	SDR	System Definition Review
				SRR	System Requirements Review

Table 1 shows the phases of TURKSAT Model Satellite Contest. For comparison, the phases that ESA and NASA follow for a standard satellite project are also included in the table.

The part indicated in gray is the preparation phases of TURKSAT Inc. until the announcement of the competition. Then, the following steps are;

I. POR: The project plan was formed and the team organization was determined,
II. PDR: The pre-design are made, the plans and procedures of the tests to be carried out at the equipment, subsystem and system level are reported,
III. CDR: Containing the details of the design to be produced; The stage where equipment and subsystems are tested and reported,
IV. QR: The system level tests are performed and reported for the installation of the system,
V. FRR: The Model Satellite is physically controlled to be sure that is ready to flight,
VI. AR + Launch: Delivery of the model satellite to the competition commission and its flight,
VII. PFR: The phase after the flight is examined and the experiences obtained are presented.

Second Phase; is the reporting phase of the project plan and organization chart (POR–Plan and Organization Review). Teams will complete the project plans and the task distribution of the team members in detail by the form of Gantt chart at this stage. This report shall be submitted in the format as detailed in the description.

Third Phase; is to prepare Preliminary Design Review (PDR) report. Teams shall develop their designs, prototypes, test concepts (plans and procedures for tests to be

carried out on each equipment, subsystem and Model Satellite integrated and assembled) and report them using the preliminary design review report (PDR) template provided to them. This report must be submitted in the format described in the detailed description and in the appropriate format. After the review of the prepared PDR report by the competition judge, teams will present report via teleconference. A schedule will be made available on when to present teleconference. **Submit the documents early to be safe.**

Fourth Phase; is to prepare Critical Design Review (CDR) report and presentation. The teams will complete their design and start to order their components, manufacturing parts. The test results (with the implementation of the specified plans and procedures in the PDR) of equipment and subsystems will be included in this report. This report and presentation shall be submitted in the format described in the detailed description and in the appropriate format. **Submit the documents early to be safe.**

Fifth Phase; is that system level tests of the completed system, that is, Model Satellite which is assembled and integrated are performed and presented (QR–Qualification Review). In this phase, the teams shall merge the subsystems of the model satellites to system level and perform system comminication tests.

Sixth Phase; is the time of the competition. One day before the competition; the teams will present the completed model satellites for the flight preparation examination to the review commission. This is the stage in which the competence to flight is controlled, the FRR - Flight Readiness Review stage. The model satellite shall be fully assembled and activated. In order to participate in the flight, model satellites must pass the flight preparation assessment.

The plan of the competition day is indicated in the related section.

Seventh Phase; is the Post Flight Review report (PFR). The technical results obtained from the competition, the problems they experienced in the flight, the reasons for these problems, solutions to these problems and what they learned during the project in the critical term will be reported using the PFR template given to them. Details of the PFR phase are given in the relevant section.

Team members are required to attend all stages of the competition and to participate in the competition area to receive a participation certificate and award.

The competition is performed by voluntary TURKSAT employees who aims to share their experience with students, to learn more about the space/spacecraft projects and to provide students with the experience of communicating the process management of an organization.

Model Satellite Competition is carried out by volunteers to provide a practical training experience for teams. Volunteers devote their time to this organization to support the competition. **For this reason, please submit your reports before the deadline in accordance with the document templates and the document name; please pay attention to the style required in communication processes with the members of the organization board, mentors and referees.**

1.5 Timeline

The general outline of the competition plan is as follows. **The dates to be considered for teams are highlighted in bold.**

DEADLINE*	PHASE
February 29, 2024- 23:59	Application Date
March 18, 2024 – 22:00	POR Report Submission
May 3, 2024 – 17:00	PDR Report Submission
May 6-10, 2024	PDR Presentation (Online)
June 7, 2024 17:00	CDR Report Submission
****	Participation Documents Submission
July 1-5, 2024	QR Presentations (Online)
August, 2024**	Flight Readiness Review (FRR)
	Flights
	Post-Flight Presentations of PFR
	Announcement of Competition Results and Award Ceremony

***TURKSAT reserves the right to make changes.

****Dates will be announced on the https://modeluydu.turksat.com.tr/ and https://www.teknofest.org/tr/ websites.

*****The flight date will be announced to the teams after the QR phase.**

1.6 Team Composition

Teams consisting of the same university students (undergraduate, graduate students) studying in Turkiye and abroad can participate in the competition. Teams consist of at least 3 and at most 6 people.

Each team must have only one advisory faculty member (assistant professor, professor). Teams that have difficulty in determining a consultant during the aplication may choose their advisor as an instructor (Research Assistant and Instructor). However, the teams have to be uptaded as a consultant faculty member (assistant professor, professor) until the DR report submission date.

The role of advisor is;

- Providing laboratory resources for the team, working class/room/environment and the environment for teleconferencing,
- Leading the team leader and the team,
- Taking part in official correspondence with the TURKSAT competition commission.

The advisor should not do the followings;

- Design or suggest a design directly,
- Advise more than one team for this competition,
- Manage the operation on the day of the competition,

Each team must have a Team Leader selected from members. Missions;

- Provide coordination and knowledge transfer between the team and the advisor,
- Provide coordination with competition officials,
- Conducting the project and ensuring coordination within the team.

Each team will be given a team number through the KYS system.

Teams can contact via e-mail (competition mail group) for any information about the competition rules and the organization.

1.7 Application

Applications will be made on the https://www.t3kys.com/tr website and the teams whose applications will be accepted will be announced on the website.

1.8 Competition Prizes

In the Teknofest organization, awards are presented to the top 3 teams in the overall ranking, who successfully complete the main tasks at the end of all processes in the competition. Teams that cannot communicate between the Science Payload and the ground station and cannot separate the Science Payload from the Container will only be given honorable mention if they are in the top three in the ranking.

2. TECHNICAL REQUIREMENTS

2.1 Base Requirements

NO	REQUIREMENT
1	The Model Satellite shall consist of two parts: Science Payload and Container.
2	Total mass of the Model Satellite (Science Payload and Container) shall be 730 grams +/- 20 grams.
3	Model Satellite shall design as a cylindrical structure of 300 mm length x 113 mm diameter.
4	The Container shall be designed in such a way that it will not get stuck to any place and shall be constructed confident to protect the Science Payload. (The team number and name should be on the Container.)
5	With a passive landing system, the Model Satellite (Container + Science Payload) should descend at a rate of 12-14 m / s up to a height of 400 meters (up to 400 meters altitude). (The determined altitude may vary with the effect of bad weather conditions on the flight day.)
6	At a height of 400 (+/- 10) meters, the Container and the Science Payload shall be autonomously separated by a mechanism.
7	Release mechanisms shall not use pyrotechnics or chemicals.
8	After the release, the Science Payload shall descend at the rate of 6 - 8 m / s with **a passive landing system.** (The team number and name should be on the Science Payload.)
9	All descent control device attachment components shall survive at least 8 G of shock.
10	All electronic equipment and mechanical components to be assembled shall be assembled and fastened using suitable equipment such as connectors, screws and high-performance adhesives.
11	Model Satellite shall be ensured to be landed non-damaged.
12	The Science Payload shall acquire outside temperature, air pressure, altitude, descent rate, position, battery voltage and axes data during the fligth. (It is recommended that the teams that will participate in the flight day work with redundant equipment.)
13	The satellite should send the measured data continuously to the ground station every second (1 Hz) in the form of packages suitable for the given telemetry format.
14	The telemetry package shall include the task time. During the task, the time data shall be preserved even if the processor restarts.

NO	REQUIREMENT
15	The flight software shall maintain the number of packets sent and increase the number in each packet transmission starting from 1. If the processor restarts, the number of packets shall resume.
16	Telemetry data shall also be printed on an SD card in the satellite at the same time.
17	On the Science Payload, there should be a ground-facing camera. Camera images shall be recorded as video on an SD card during the entire flight period.
18	The model satellite facing the earth shall send the video image to the ground station during the mission (from the moment the system starts working).
19	Alkaline, Ni-MH, Lithium Ion and Lithium Polymer batteries can be used.
20	The battery to be selected shall be sufficient to operate the system for 1 hour.
21	In the case of non-separation of the Science Payload, the command sent from the ground station shall be separated from the Container.
22	The Science Payload shall have an on / off button. This button shall be designed to be accessible even when the Science Payload is inside the Container
23	Installation of the electronic equipment shall be done by fixing the mechanical fixture. Connectors in the electronic circuit shall not be used to cause dislodgement or disconnection.
24	The Model Satellite shall continue telemetry and video broadcasting for at least 10 seconds after it has been undamaged landed. The location of the satellite can be determined with the telemetry package which has location data.
25	The Model Satellite shall give an audible warning when it starts to run.
26	Each team shall develop their own ground station. The interface of the ground station must be a single page.
27	Wireless communication modules should be used to send telemetry data and image to ground station.
28	In the ground station software, telemetry data from the Science Payload must be recorded, displayed in real time, telemetry flow line should be shown and time-dependent graphs shall be drawn in real time with the correct engineering units.
29	The live video shall be monitored in real time on the ground station and recorded in the ground station.
30	The computer where the ground station software is to be operated shall have at least two hours of battery full.

NO	REQUIREMENT
31	The gyro sensor on the Science Payload shall simulate the position information of the model satellite in the ground station interface on at least 1 plane(x-y) and 2 dimension. Axis Position Information is given in the appendix 5.2.
32	The parachute color of the descending Science Payload with the passive landing system should be orange and the parachute color of the Container should be black.
33	**INTERSYSTEM COMMUNICATION NETWORK(ICN) :** A module that transmits one-way data should be integrated on the Container. This module should only transmit pressure to the Science Payload. This module should transmit the data to the Science Payload after the Science Payload separates from the Container. The Science Payload must transfer the package received from the Container to the ground station by adding it to the existing telemetry file. This data should also be saved on the SD card on the Science Payload. During the mission, the altitude change between the Container and the Science Payload should be displayed numerically on the ground station interface.
34	**IAS (Interface Alarm System) :** Container-Science Payload rates, container pressure information, science payload position information and separation status should be checked by the algorithm and specified mission states should be reflected on the ground station interface. In addition, the error codes of the missions should be recorded in the ground station interface and the Science Payload SD card telemetry file. **(See:Title 2.2)**
35	**Mechanical Filtering Module:**After the model satellite leaves the container, the disk-shaped mechanical filter in front of the camera must be activated with a 4-digit (Number-Letter-Number-Letter) command sent from the interface. **(See: Title 2.3)**
36	**BONUS TASK:** "IoT Data Transfer" is the task of transferring the temperature or humidity data packets received from a point close to the ground station computer during the flight to the satellite at 1Hz, writing them to the satellite SD card via the satellite and downloading them back to the same ground station. Data transmission from the IoT sensor to the ground station must be carried out via cable. Additionally, IoT data coming from the satellite to the ground station should be graphed in the interface.

*** :** Teams that perform the bonus mission gain final flight points by adding a maximum of 5% of the total flight points they receive outside of the bonus mission, according to the success rate in the bonus mission.

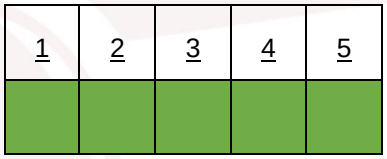
2.2 IAS (Interface Alarm System)

In real satellite control operations and during the inspection of all satellite subsystems in the control interface, if there is a problem in the subsystems or a deviation in the telemetry value, this situation turns into an audible and visual alarm for the engineers performing the operation to response in the system.

In the model satellite competition, the purpose of the Interface Alarm System is to control the subsystem data; detecting the values that do not work or deviating from the required range, converting to a visual alert in the ground station interface, recording the alarm code to the ground station and the Science Payload SD card. Visual alert generation and error code according to the following points;

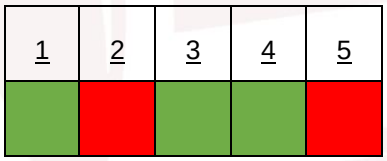
1. At values other than 12-14 m/s of the Container landing rate
2. At values other than 6-8 m/s of the Science Payload landing rate
3. In case of the Container pressure data failure
4. In case of the Science Payload position data failure
5. In case of the release failure,

Alert visuals are created in the ground station interface and an error code should be created in the telemetry format. Example interface error visual and error codes to be written to telemetry;



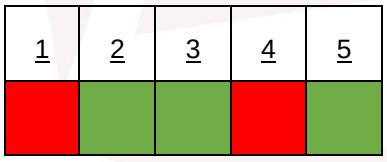
ERROR CODE: <00000>

(Errorless Flight Status)



ERROR CODE: <01001>

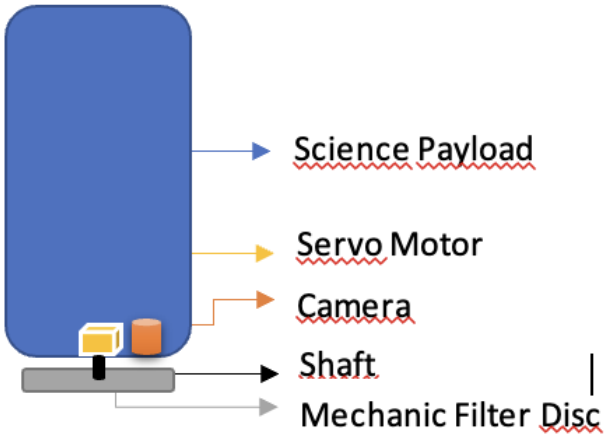
(Science Payload descent rate deviation and release failure)

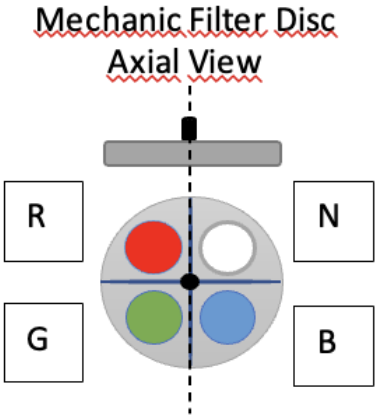


ERROR CODE: <10010>

(Container descent rate deviation and Science Payload position data failure)

2.3 Mechanical Filtering Module





Model After the satellite leaves the carrier, the disk-shaped mechanical filter in front of the camera is activated with a 4-digit command (DIGITAL-LETTER-NUMBER-LETTER) sent from the interface.

Time	Filter	Time	Filter	The Expected Image at the Time of Flight
6	G	4	R	
4	B	6	G	
3	R	7	B	
5	R	5	G	
.?.	.?.	….	…	..?..

TABLE: Sample Commend and Expected Image Afterward

The numbers in the command (1-9) indicate the duration of filtering; Letters (R-G-B) indicate the filtering to be performed during this period. The filter in front of the activated camera will transmit a spectral image for the specified period of time. Thus;

• The subsystem is activated with a command from the ground station to the satellite,

• Duration, direction and degree of change in the subsystem are managed,

• The change of the activated subsystem is monitored real time from the interface,

• Whether the upstream connection has occurred or not is verified through a different channel.

Before the command, the image must be in standard (N) state without filter. After the command task is completed, it should return to the standard (N) state. The delay in filter transitions should not exceed 2 seconds. The total duration of 2 different filterings will be 10 seconds. Filter type and duration are team specific. The team will be notified by the ground station referees at the time of the flight.

Image: Sample Materials

Transparent circular colored foils can be adhered to the single piece of acrylic plexiglass shown in the example picture above. The disc can be 3D printed and the cells can be applied separately with transparent colored material. Filter cells should be designed with an appropriate diameter according to the camera field of view and placed at an appropriate distance from the camera in order to fully present the spectral image. Filter diameter, disc diameter and thickness should be designed considering the design criteria. The servo motor should be set clockwise and the step range should be 90°.

2.4 Telemetry Format

<PACKET NUMBER>, <SATELLITE STATUS>, <ERROR CODE>, <MISSION TIME>, <PRESSURE1>, <PRESSURE2>, <ALTITUDE1>, <ALTITUDE2>, <ALTITUDE DIFFERENCE>, <DESCENT RATE>, <TEMP>, <BATTERY VOLTAGE>, <GPS1 LATITUDE>, <GPS1 LONGITUDE>, <GPS1 ALTITUDE>, <PITCH>, <ROLL>, <YAW>, <LNLN>,<IoT DATA>, <TEAM NUMBER >,

Telemetry Format Descriptions:

<PACKET NUMBER>: It is the sequential number assigned to each telemetry packet generated at the time of the competition and sent to the ground station. The first package begins with 1 and continues sequentially. In the case of a restart of the processor, the packets must continue at the last remaining number.

<SATELLITE STATUS>: It is meaningful and numerically information that shows the status of the satellite during the mission period. The following statuses should be formed numerically.

0 : Ready to Flight (Before the Rocket Launching)

1 : Ascent

2: Model Satellite Descent

3: Release

4: Science Payload Descent

5: Recovery (Payload Ground Contact)

<ERROR CODE>: It is a 5-digit telemtry data consisting of 0 or 1 to be created according to the error conditions specified in Chapter 2.2.

<MISSION TIME>: It is the real time with the format Day/Month/Year, Hour/Minute/Second.

<PRESSURE1>: It is the atmospheric pressure value measured by the sensor on the Science Payload. The unit is pascal.

<PRESSURE2>: It is the atmospheric pressure value measured by the sensor on the Container. The unit is pascal.

<ALTITUDE1>: It is the altitude of the Science Payload from the point where the flight begins. The altitude configuration shall be adjusted to be 0 meters from the beginning of the flight. The unit is meters.

<ALTITUDE2>: It is the altitude of the Container from the point where the flight begins. The altitude configuration shall be adjusted to be 0 meters from the beginning of the flight. The unit is meters.

<ALTITUDE DIFFERENCE>: The absolute difference between ALTITUDE1 and ALTITUDE2 is the value. The unit is meters.

<DESCENT RATE>: It is the descent rate data. The unit is m/s.

<TEMP>: It is the sensed temperature in degrees C.

<VOLTAGE LEVEL>: It displays the battery voltage of the Science Payload in Volt.

<GPS1 LATITUDE>: It is the latitudinal position of the Science Payload.

<GPS1 LONGITUDE>: It is the longitudinal position of the Science Payload.

<GPS1 ALTITUDE>: It is the altitude data of the Science Payload generated by the GPS.

<PITCH>: It is the tilt angle in the pitch axis in degrees.

<ROLL>: It is the tilt angle in the roll axis in degrees.

<YAW>: is the tilt angle in the yaw axis in degrees.

<LNLN>: This is the 4-digit (Number Letter, Digit Letter) code to be sent from the interface to the model satellite.

<IoT DATA>: Temperature or humidity data. The unit of temperature is degrees C and humidity is %.

<TEAM ID>: After the application process is completed, the team numbers are given. It is a 5 digit number. The team number of each team is different from the number of the other teams.

NOTE: A 2% flight score deduction will be made from teams that do not present post-competition mission load and ground station telemetry records in the specified order, table variables separately, variable titles and variable units in the order specified just below the title.

3. DELIVERABLE ITEMS

3.1 Official Documents

The documents required for the teams with positive application are listed below. Documents should be uploaded to the KYS System after QR.

a) 1 photo (each team member, with the name behind)
b) Student certificate (each team member)
c) Official letter (including date and number) with letterhead containing the current status of the team member and the advisor (student or staff) and indicating that the team is authorized to represent the university / unit in the competition
d) Statement of participation and recognizance completed and signed by the members of the participating team and their advisor

3.2 Plan and Organization Review (POR) Report

POR is the first report of the model satellite project. During the preparation of this report; how to manage the team and how to conduct the work will be determined and a systematic structure will be established. The team structure will also be created at this stage and displayed in an organizational chart. Considerations when preparing the POR report for TURKSAT Model Satellite Competition:

- **POR Report template shared with teams must be used.**
- It shall consist of 3 parts;
  - First part of the report is cover page,
  - Second part is the organization chart,
  - Third part is the project plan calendar in Gantt Chart form.
- The report footer shall be updated with the team information.

3.3 Preliminary Design Review (PDR) Report

In PDR phase, preliminary system designs are made. Meet the performance requirements of the pre-systems designed in the Design Review Report within the scope of the cost (program budget), work plan (schedule), risk and other system constraints; is an "interdisciplinary" review report created to decide the final detailed design. At the end of this report, one of the designs is decided. Considerations when preparing the DR report for TURKSAT Model Satellite Competition:

- An understanding of the Model Satellite mission requirements,
- How to derive system and subsystem requirements and how to allocate according to the design criteria,
- How to verify system, subsystem, and equipment requirements (Test, Analyze, Design Review, Inspectability),
- Explanation the operation management of the Model Satellite and its subsystems (Consept of Operation / Operational Architecture),
- Overview of preliminary designs that meet specified requirements,
- Description of what to do for design (It is not necessary, although it is ideal to complete the procedures described before pre-preparation.),
- Step by step plan of testing for equipment, subsystems and system (If there are tests carried out, they should include prototypes, tests on prototypes and interpretations of the tests.)
- The installation plan of the equipments form the subsystems,
- The integration plan of subsystems that form the system (Model Satellite),
- Preliminary budget plan.

After reviewing the prepared PDR report by the jury, a presentation to the jury will be made by teleconference. After the presentation is completed, there will be allocated for questions and answers and the juries will make suggestions. The timetable for determining the teleconference date will be shared with the teams.

3.4 Critical Design Review (CDR) Report

In the CDR phase; the detailed design of the system decided in the Preliminary Design Review Report, the tests of the equipment are carried out as planned, and the integration plan of the subsystems is shown. Critical Design Review Report; production of subsystems, test results of subsystems and components, descriptions of system details; is a review report created to see if the interdisciplinary performance requirements specified within the cost (program budget), work plan (program schedule), risk and other system constraints are met.Considerations when preparing the CDR report for TURKSAT Model Satellite Competition:

- Overview of task operations,
- Explanation the operation management of the Model Satellite and its subsystems (Consept of Operation / Operational Architecture),
- Detailed design and analysis results for each subsystem,
- How to verify system, subsystem, and equipment requirements (Test, Analyze, Design Review, Inspectability),
- Plans of equipment, subsystem and system level tests required for verification of requirements,
- Results of tests for equipment,
- Installation plan of sub-systems (for each subsystem),
- If done, the results of the subsystem tests,
- The integration plan of subsystems that form the system (Model Satellite),
- Test results of requirement verification (Subsystem tests must be completed),
- Updated detailed work schedule chart (Completed jobs must be specified.),
- Updated budget plan (It will include the purchase status.; pending, on the cargo, delivery, refunded etc.).

With the CDR report, teams are required to submit their CDR Presentation. The CDR Presentation will not be conducted online. The Presentation Template will be shared with the teams.

Because the CDR Report is the final design report, no design major changes can be made after this stage. If any, teams will be notified of any minor changes to the competition committee.

3.5 Qualification Review (QR) Report

QR is the stage where the mechanical integrity, command control and communication tests performed at the system level of the model satellite, whose assembly and integration are completed, are performed live. During the QR phase, a teleconference will be realized with the referees. The consideration criteria template of this stage will be shared with the teams.

3.6 Post Flight Review (PFR) Report

Post Flight Review Report includes flight operations and flight results. In the presentation of the PFR Report, it is necessary to specify which of the tasks to be completed in the flight operation are successful and which ones are unsuccessful with its results and solution suggestions shall be made to prevent any further occurrence. This report should be prepared using the **PFR Post-Flight Review Report template** published on the competition site. Considerations when preparing the PFR report for TURKSAT Model Satellite Competition:

- An overview of the team's Model Satellite design and team’s objectives of the competition,
- Comparison of planned and implemented operations management,
- Raw and processed data received from flight operation,
- Analysis and evaluation of problems (for failed mission objectives),
- What they learn from the project.

The PFR Report will be completed by the teams after the flight takes place.

This report; one day after the flights, the referees will be presented within 15 minutes, with 10 minutes of presentation and 5 minutes of question and answer.

Teams should send their PFR presentations to modeluydu@turksat.com.tr and https://www.t3kys.com/tr mail address in **.pdf format** until the time specified by the competition officer on the day of the presentation.

3.7 Point Weights of Stages

STAGE	POINT WEIGHT (%)
Plan and Organization Review Report (POR)	Team Approval
Preliminary Design Review Report (PDR)	15
Critical Design Review Report (CDR)	12
Qualification Review (QR)	20
Flight Readiness Review (FRR)	Flight Approval
Flight	50
Post Flight Review Report (PFR)	3

3.8 Deliverable Submission and Scheduling

The first 2 documents specified in the table below; it should be uploaded to the KYS system taking into account the deadline. All documents except flight telemetry data, ground station video and flight software file will be in .pdf format. Documents must be sent in .pdf format.

Document	Required Format Format	Due Date
POR	TMUY2024_xxxx_POR_vYY.pdf	**March 18, 2024 – 22:00**
PDR	TMUY2024_xxxx_PDR_vYY.pdf	**May 3, 2024 – 17:00**
CDR	TMUY2024_xxxx_CDR_vYY.pdf	**June 7, 2024 – 17:00**
Flight Telemetry Data, Ground Station Video and Flight Software File	TMUY2024_xxxx_TLM.csv TMUY2024_xxxx_VIDEO TMUY2024_xxx_ FLIGHTSOFTWARE	During the competition
PFR	TMUY2024_xxxx_PFR_vYY.pdf	1 day later from competition

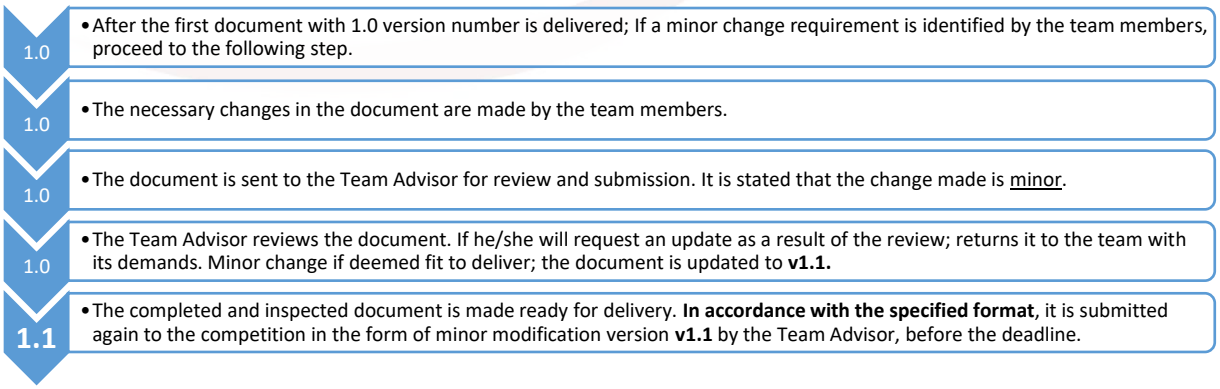
3.9 Version Numbering

Each team should use the version number starting from 1.0 **when naming the documents it submits.**

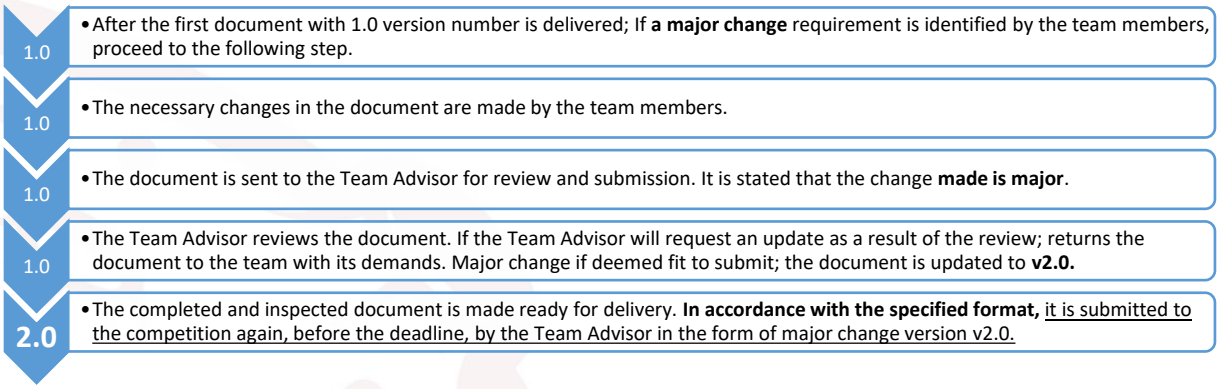
Example-1: For the DR document to be sent by the 4502 team; the 1.0 major version should be sent as **TMUY20XX_4502_DR_v1.0.pdf.**

If the document is updated after the first delivery of a delivered document as v1.0, **provided that the deadline is not exceeded**; can resend the updated version. For this, the following two situations should be considered;

In case of minor changes, it should be resubmitted with the version number as v1.1, v1.2, v1.3. **Minor change;** includes corrections of typos in the document, improvements to images, and minor changes to subsystems.



In case of major change, it should be resubmitted with the version number as v2.0, v3.0. **Major change;** encompasses fundamental changes in the project. That is, it indicates a change at the system level.



Example-2: If a minor change will be made and delivered after v2.0, it will be delivered as v2.1. After v2.1 is delivered, another minor change is made and it is specified as v2.2 when the document is delivered.

Example-3: If a minor change will be made and sent after v1.1, v1.2; If a major change will be made and sent after v1.2, it will be delivered as v2.0. One minor change after v2.0, v2.1; after v2.1, when a major change is made and delivered, the v3.0 nomenclature is used.

4. FLIGHT OPERATIONS

4.1 Program

The detailed program will be informed to the teams that are in progress after the QR phase.

4.2 Flight Readiness Review (FRR)

It is the phase which the teams are checked for flight convenience. Successful completion of this phase means that the Model Satellite is ready for flight. **FRR consists of 6 stages**;

The first phase, is the measurement of the size and weight. It is checked that the measured values should be at the values specified in the competition requirements.

The second phase, is the vibration test. Vibration test is performed to verify the assembly workmanship and the stability of the system after the vibration that the model satellite, whose integration has been completed before the flight, will be exposed to. 150-250 Hz vibration will be applied. During the testing process, the model satellite should be on and data transmission to the ground station should continue.

The third phase, is the drop test. The Model Satellite will be connected with a rope and the Model Satellite (Container + Science Payload) will be carried out by releasing it from a certain height. It is checked that the Science Payload does not leave the Container and that the system remains undamaged. During the testing process, the Model Satellite should be on and data transmission to the ground station should continue.

In the fourth phase, the communication test will be carried out. To pass this test; the telemetry data shall be transmitted to the ground station computer and plotted in real time on the ground station.

The fifth phase, the separation of the Science Payload from the Container will be tested. A release command will be sent to the Science Payload from the ground station, and the separation mechanism between the Container and the Science Payload will be checked for the necessity of separation, owing to the release command.

The sixth phase, is the visual (security) check phase of the Model Satellite is made after tests.

- **Rocket separation test:** This is the stage where the rocket separation process, which takes place at the time of flight to the FRR stages, is tested with the real system on the ground. Whether the test will be performed or not will be notified to the teams during the CDR process.

- **Shock test:** This is the stage in which the effect of the G force, which occurs due to gravity at the moment of rocket takeoff, on the satellite is realized with the test mechanism on the ground. Whether the test will be performed or not will be notified to the teams during the CDR process.

4.3 Team Member Flight Operations Crew Assignments

Team members must be assigned roles during the flight operation. For a successful operation, the teams must be coordinated with each other and with the competition coordinators.

Team members must be assigned to specific tasks and develop a checklist for a successful flight. Members in the team must be assigned for the following tasks:

Mission Control Officer: The Mission Control Officer consists of one person. The Mission Control Officer is responsible for placing the team's model satellite in the rocket capsule and managing the operation.

Ground Station Crew: This is one or more persons who is responsible for monitoring the ground station for telemetry and video reception and issuing commands(e.g. release command) to the Model Satellite. This team will deliver the “Flight Telemetry Data” and “Ground Station Video” to the Ground Station Referee.

Preparation Crew: This is one or more persons responsible for preparing the Model Satellite, delivering to Mission Control Officer, integrating it into the rocket, and verifying its status.

Recovery Crew: Recovery Crew can consist of more than one person. Recovery Crew is responsible for tracking the Model Satellite and locating it after landing. When this crew find the Container and the Science Payload, they should call the Field Referee.

Team members can take on multiple roles except for the Mission Control Officer. The Mission Control Officer should be coordinating all mission crew and interacting with the competiton coordinators as needed.

4.4 Flight Schedule

The model satellites of the teams that qualify for the competition will be integrated it into the rocket after configuring the Science Payload as 0 meters on the day of the flight.

An overview of the flight day operations include the following activities:

1. Arrive at flight site.
2. Installation of the ground station in the assigned tables.
3. In order for the flight referees to follow up on the ground station during the flight, the ground station computers of the teams should be HDMI input.
4. The height is set to 0 meters from ground station.
5. Preparing the Model Satellite for flight and final testing.
6. The model satellite shall be kept fully assembled and electronic circuit closed until the flight time of the relevant team.
7. Mission Control Officer and Preparation Crew will go to the control desk. Then they will place the Model Satellites on the flight platform with the Operation Referee.
8. The Mission Control Officer and the Flight Coordinator shall implement the initiation procedures.
9. Ground Station Crew; verifying that the Model Satellite and the ground station are communicating.
10. As for the flight time, the Ground Station Referee and the Ground Station Crew follow the ground station operation.
11. Ground Station Crew delivery of flight information to the Ground Station Referee.
12. The Ground Station Crew will carry out all necessary flight operations.
13. At the time of landing and after, the Rescue Crew shall follow the Science Payload and Container and go to the landing site. The teams shall determine the location of the Science Payload using the GPS data received from the Ground Station Crew.
14. The Rescue Crew members who find the Container and the Science Payload should call the Field Referee. Do not interfere with the Model Satellite until the Field Referee arrives.
15. The Field Referee and the Recovery Crew members will review the Science Payload.
16. Back to the competition area.

NOTE: If the flight alignment changes the alignment of the incoming team, 3% will be deducted from the total flight points**.**

4.5 Disqualification Guidelines

- The teams that copy content or design from other teams,
- The teams that deliver documents that is blank or have meaningless content,
- The teams that do not comply with safety precautions in Flight Day,
- The teams that sabotage the operation and flight process of other teams,
- The teams that do not submit any of their reports during the competition process,
- Teams that include people other than team members in their work before and during the flight,
- Teams that do not comply with the rules declared by the competition commission during the entire competition period,
- Teams that engage in deception of the competition commission on data obtained and submitted throughout the entire competition process,
- The teams that act verbally or in writing (including social media) who act in a manner that disrupts the peace of the competition or competition officials before, during and after the competition will be disqualified.

4.6 Weather Conditions

In order to control the physical workability of Model Satellite Designs, it is aimed to make Flight Rating which is the most important stage of the competition process. During a normal flight, the Flight Operation Scoring Table basically asks for the landing rate, release of the model satellite, the transfer of telemetry data and flight images to the ground station during flight, and visualization of these data on the ground station computer. In the event that the flight does not take place, the flight day can be changed or scoring is performed on the basis of most of the normal flight requirements specified in the Flight Operation Scoring Table. FLIGHT_PLAN_B is applied for the following weather conditions.

The Flight Platform (Drone, Rocket or helium balloon) on which Model Satellites will be located may vary depending on the security and technical requirements by the Competition Board. TURKSAT reserves the decision to change the platform.

Conditions that may prevent the flight are as follows:

- **WIND RATE** and **RAINY WEATHER** that will pose a risk to the flight platform or hinder its flight:

STABIL FLIGHT	SEMI STABILITY FLIGHT	RISKY FLIGHT	FLIGHT CANCELLATION
0-15 KNOT	15-24 KNOT	24-32 KNOT	32<..KNOT

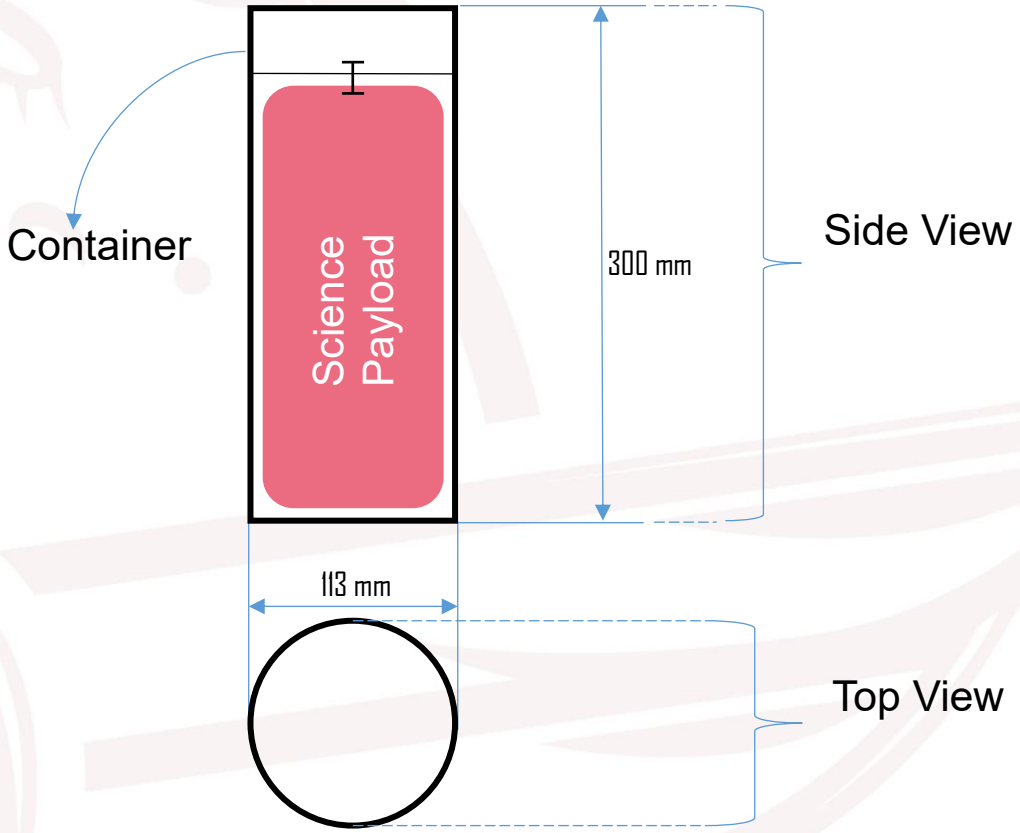
- For mandatory reasons that may occur before or after the flight,
- For weather conditions, safety reasons or technical reasons that may pose a risk or hinder for flight platform,

FLIGHT_PLAN_B is published if it needed.

5. APPENDIX

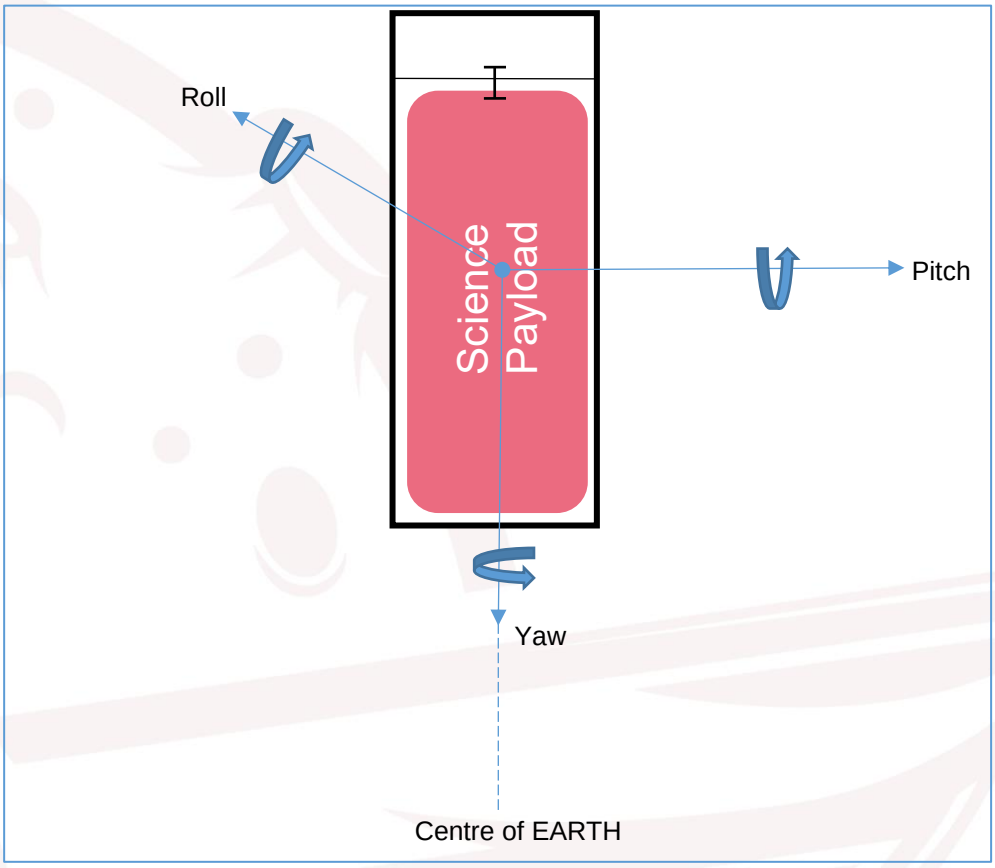
5.1 Model Satellite Mechanical Design Description

The draft structure of the Container and Science Payload parts of the Model Satellite to be designed as specified in the technical requirements is given below.



5.2 Axis Position Information

In accordance with #31 of the technical requirements; the example of axis position information and 2 dimensional simulation image is as follows:



5.3 Rocket Capsule

Model satellites should be evaluated considering that they will be exposed to high shock (maximum 8 G) and vibration (150 - 200 Hz) in the rocket.

The dimensions of the model satellites to be designed must be within the dimensions specified in the technical requirement in order to fit into the rocket capsule on the day of flight.

5.4 General And Ethical Rules

Click here to access the general and ethical rules document within the scope of the competition.

7TH YEAR

#MİLLİ TEKNOLOJİ HAMLESİ