



# APRS Mission Payload Design Competition



Handbook



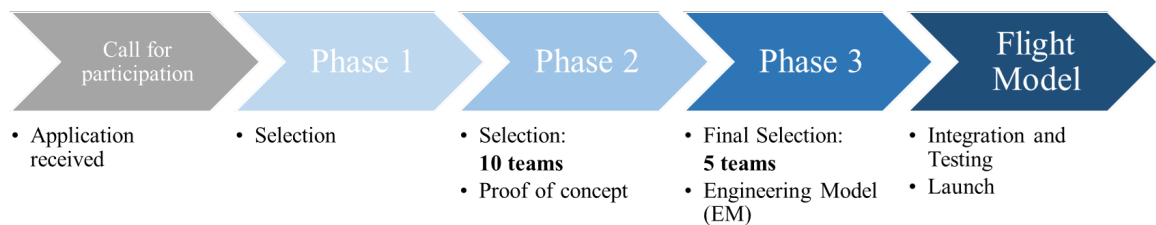
## Revision History

| <b>Version</b> | <b>Description</b>        | <b>Date</b> |
|----------------|---------------------------|-------------|
| v1.0           | Initial document creation | 29/12/2022  |



## 1. Introduction

BIRDS-X Automatic Packet Reporting System (APRS) Payload Design Competition will provide an opportunity for students, engineers, space enthusiasts and amateur radio operators to launch their designed payload in a 2U CubeSat based on BIRDS Open-Source Bus design (<https://birds-project.com/open-source>). The competition is open to everyone. Five final APRS payloads will be selected through a series of competition phases. The payload designs if selected will be launched to space and will be able to provide services to the amateur radio community through APRS digipeating and Store and Forward (S&F) mission of the satellite.



## 2. Objectives

Increase the users of amateur radio community by using one APRS payload space of a 2U CubeSat, as well as helping people to get involved in the design, development, testing and on-orbit operation of that payload, resulting in the improvement of technical skills and democratization of space.

## 3. Revision

The Master Schedule Document will be updated as needed throughout the period leading up to the selection of five payload boards. The up-to-date version will be maintained in the BIRDS-X Project Website. All participants are responsible for working with the correct version by checking the revision date.



## 4. Documentation

The following documents includes the interface control document, guidelines, application forms for Phase 1 and Phase 2 and the scoring criteria.

| Document                         | File Location   |
|----------------------------------|---|
| Application form for Phase 1     | <a href="https://birds-x.birds-project.com/2022/12/29/application-form-for-phase-1/">https://birds-x.birds-project.com/2022/12/29/application-form-for-phase-1/</a> |
| Application form for Phase 2     |   |
| Guidelines                       |   |
| Interface Control Document (ICD) |   |

## 5. Deliverables and Deadlines

The following table details the schedule on which the teams for *BIRDS-X APRS Payload Design Competition* must submit the required deliverables to be considered for selection.

| Date                           | Action  |
|--------------------------------|---|
| 28 December 2022               | Call for Participation                        |
| 22:00 JST 14 January 2023      | Webinar for Q&A regarding the competition     |
| 28 February 2023               | Application Deadline for Phase 1              |
| 10 March 2023                  | Announcement of selected teams for Phase 1    |
| 5 May 2023                     | Application Deadline for Phase 2              |
| 31 May 2023                    | Announcement of 10 selected teams for Phase 2 |
| 31 August 2023                 | Submission of Engineering Model boards        |
| 31 October 2023                | Announcement of final 5 (6) selected teams    |
| 31 <sup>st</sup> December 2023 | Submission of Flight Model Boards             |



## 6. Detailed Schedule until Selection of Flight Models

This section will describe the flow of competition of each phase and the scoring criteria for evaluation.

### 6.1 Phase 1

Phase 1 will determine the motivation, objectives and expected outcomes of all teams for participating in the *BIRDS-X APRS Payload Design Competition*. Selection of teams will be made based on the submitted application form and video explaining the motivation, objective, and concept of operations. The application form is available at <https://birds-x.birds-project.com/2022/12/29/application-form-for-phase-1/>.

#### **The deliverables for Phase 1 are:**

1. Application form, limit 10 pages (link)
2. Video for extra points (Info, motivation, objective, concept of operation)
3. Consent for open sourcing of all the documents of the participating team

The application form, link to the video and consent form **MUST** be submitted through the BIRDS-X website (link).

#### **The general terms of participation for Phase 1 are:**

1. Only ONE entry can be submitted per team/participant (no limit for number of team members)
2. Each team/participant **MUST** have an affiliation(s)
3. The teams that will progress to the next phase will be those with the highest number of points
4. All teams **MUST** mention point of contact in the application form so that the person can be reached immediately through the entire period of competition



5. All teams **MUST** provide the required documents
6. All teams **MUST** consent to Open Sourcing of the payload design if selected after the competition ends.
7. Any violation of the rules may result in disqualification

**Scoring will be performed based on the following table:**

|  |                     |
|--|---------------------|
| Extra points for developing country                                | <b>5 points</b>     |
| Team composition   | <b>Max 5 points</b> |
| All students up to MS  | <b>5 points</b>     |
| Mix  | <b>3 points</b>     |
| All professionals and PhD students                                 | <b>2 points</b>     |
| Motivation, objectives and expected outcome,<br>Mission definition | <b>30 points</b>    |
| Block diagram for the payload                                      | <b>10 points</b>    |
| Concept of operations  | <b>10 points</b>    |
| Preliminary budget plan  | <b>10 points</b>    |
| Schedule   | <b>10 points</b>    |
| Plan for outreach  | <b>10 points</b>    |
| Quality of application and Video Explanation                       | <b>10 points</b>    |

### Schedule for Phase 1

| TASK                           | 2022   |        |        |        |        | 2023    |   |   |   |   |          |   |   |   |        |        |        |        |
|--------------------------------|--------|--------|--------|--------|--------|---------|---|---|---|---|----------|---|---|---|--------|--------|--------|--------|
|                                | DEC    |        |        |        |        | JANUARY |   |   |   |   | FEBRUARY |   |   |   | MARCH  |        |        |        |
|                                | 4<br>8 | 4<br>9 | 5<br>0 | 5<br>1 | 5<br>2 | 1       | 2 | 3 | 4 | 5 | 6        | 7 | 8 | 9 | 1<br>0 | 1<br>1 | 1<br>2 | 1<br>3 |
| Preliminary announcement       |        |        |        |        |        |         |   |   |   |   |          |   |   |   |        |        |        |        |
| <b>1st Phase</b>               |        |        |        |        |        |         |   |   |   |   |          |   |   |   |        |        |        |        |
| Call for Participation         |        |        |        |        |        |         |   |   |   |   |          |   |   |   |        |        |        |        |
| Application Deadline           |        |        |        |        |        |         |   |   |   |   |          |   |   |   |        |        |        |        |
| Evaluation period              |        |        |        |        |        |         |   |   |   |   |          |   |   |   |        |        |        |        |
| Announcement of selected teams |        |        |        |        |        |         |   |   |   |   |          |   |   |   |        |        |        |        |

## 6.2 Phase 2



The objective of Phase 2 is to determine the commitment and progress of all teams for the development of *BIRDS-X APRS Payload* and select the 10 best teams to proceed to Phase 3. Each team should have a bread board model developed, *Proof of Concept* of operation verified and have preliminary test results. Selection of teams will be based on the deliverables summarized in the Progress Report form available at <http://birds-x.birds-project.com/>. More detailed interface control document (ICD) and webinars will be provided for any additional information.

**The deliverables for Phase 2 are:**

1. Progress Report form with all the required information

**The general terms of participation for Phase 2 are same as those in Phase 1 and the following additional points:**

1. At least one of the team members **MUST** have Amateur Radio license for the Phase 2
2. Each team/participant **MUST** provide a datasheet for every component and materials used in the design

**Scoring will be performed based on the following table:**

|  |                  |
|--|------------------|
| System Block Diagram   | <b>20 points</b> |
| Bill of material (BOM)   | <b>5 points</b>  |
| Feasibility study and function test:                                 |                  |
| • Power budget   | <b>10 points</b> |
| • Mass & volume for each component and the total mass of the payload | <b>10 points</b> |
| • Concept of operation   | <b>10 points</b> |
| • Preliminary link budget  | <b>10 points</b> |
| Safety compliance  | <b>10 points</b> |
| • Measures to avoid interference to the other subsystems             |                  |
| • Measures isolate the payload from the satellite during emergency   |                  |
| Quality of submission  | <b>5 points</b>  |



|          |                  |
|----------|------------------|
| Schedule | <b>10 points</b> |
| Outreach | <b>10 points</b> |

### Schedule for Phase 2

| TASK                                   | 2023  |    |    |    |       |    |    |    |     |    |    |    |    |
|--|-------|----|----|----|-------|----|----|----|-----|----|----|----|----|
|  | MARCH |    |    |    | APRIL |    |    |    | MAY |    |    |    |    |
|  | 10    | 11 | 12 | 13 | 14    | 15 | 16 | 17 | 18  | 19 | 20 | 21 | 22 |
| <b>2nd Phase</b>                       |       |    |    |    |       |    |    |    |     |    |    |    |    |
| Development period                     |       |    |    |    |       |    |    |    |     |    |    |    |    |
| Application deadline                   |       |    |    |    |       |    |    |    |     |    |    |    |    |
| Evaluation period                      |       |    |    |    |       |    |    |    |     |    |    |    |    |
| Announcement of selected 10 (11) teams |       |    |    |    |       |    |    |    |     |    |    |    |    |

### 6.3 Phase 3

The objective of Phase 3 is to select the final 5 payload designs that will be launched in the BIRD-X satellite. Selection of the final teams will be performed based on the technical compatibility of the submitted Engineering Models with the satellite bus. The payloads will be integrated with the satellite bus and series of tests will be performed.

The detailed information regarding the payload design will be provided by the BIRDS-X team for developing the EM (Engineering Model) board and all teams **MUST** comply with the following requirements:

1. Physical dimensions (mass, position of holes, size, thickness)
2. Software and commands ICD
3. PIN assignment
4. Power consumption and operating voltage
5. Programming platform and communication protocols
6. Antenna connector type
7. Testing and integration procedures
8. Manufacturing numbers





### **The deliverables for Phase 3 are:**

1. Engineering Model complying with:
  - Sensitivity (RF output, link budget)
  - Size and mass requirements
  - Ability to survive in space environment
  - Power budget
  - Ability to communicate with the satellite
  - Safety (not harming the satellite, noise, isolation capability of the payload...)
2. Documents
  - Functional test report for the board
  - Operation manual
  - Link budget
  - Test environment report
  - Sensitivity (RF output, link budget)
3. Operation software
4. Schematic, PCB design
5. CAD model

The selection for Phase 3 will be performed according to the integration tests and results of the submitted payload with the satellite.

### **Schedule for Phase 3**



| TASK                                 | 2023 |    |      |    |    |      |    |    |    |        |    |    |    |    |           |    |    |    |         |    |    |    |          |    |    |    |    |          |    |    |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|--------------------------------------|------|----|------|----|----|------|----|----|----|--------|----|----|----|----|-----------|----|----|----|---------|----|----|----|----------|----|----|----|----|----------|----|----|----|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|
|                                      | MAY  |    | JUNE |    |    | JULY |    |    |    | AUGUST |    |    |    |    | SEPTEMBER |    |    |    | OCTOBER |    |    |    | NOVEMBER |    |    |    |    | DECEMBER |    |    |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                      | 22   | 23 | 24   | 25 | 26 | 27   | 28 | 29 | 30 | 31     | 32 | 33 | 34 | 35 | 36        | 37 | 38 | 39 | 40      | 41 | 42 | 43 | 44       | 45 | 46 | 47 | 48 | 49       | 50 | 51 | 52 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| <b>3rd Phase</b>                     |      |    |      |    |    |      |    |    |    |        |    |    |    |    |           |    |    |    |         |    |    |    |          |    |    |    |    |          |    |    |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Development period                   |      |    |      |    |    |      |    |    |    |        |    |    |    |    |           |    |    |    |         |    |    |    |          |    |    |    |    |          |    |    |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Submission of EM Board               |      |    |      |    |    |      |    |    |    |        |    |    |    |    |           |    |    |    |         |    |    |    |          |    |    |    |    |          |    |    |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Evaluation period                    |      |    |      |    |    |      |    |    |    |        |    |    |    |    |           |    |    |    |         |    |    |    |          |    |    |    |    |          |    |    |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Announcement of selected 5 (6) teams |      |    |      |    |    |      |    |    |    |        |    |    |    |    |           |    |    |    |         |    |    |    |          |    |    |    |    |          |    |    |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Flight model development             |      |    |      |    |    |      |    |    |    |        |    |    |    |    |           |    |    |    |         |    |    |    |          |    |    |    |    |          |    |    |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Flight model Arrival                 |      |    |      |    |    |      |    |    |    |        |    |    |    |    |           |    |    |    |         |    |    |    |          |    |    |    |    |          |    |    |    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

## 7. Schedule after Competition

The schedule after the selection of the flight model although depends on the launch schedule is detailed below:

| Date           | Action                         |
|----------------|--------------------------------|
| 31 March 2024  | Flight Readiness Review        |
| 30 April 2024  | Hand over of satellite to JAXA |
| September 2024 | Release of satellite from ISS  |
| October 2024 ~ | Operation of the missions      |