



Eurobot^{Open} Junior 2024 Rules

31th edition of the robotic contest - Eurobot
OFFICIAL 1.1 version



NOTE: all images in this document are provided as a guide to illustrate the various paragraphs. In no case they can serve as a reference. Only the dimensions, colors and materials indicated in the appendix shall be taken into consideration.

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A. NOTICE

WARNING!

General remarks are annotated in the document. Please, pay special attention to these points.

The rules have been split up in several documents. Most parts remain the same for the Eurobot^{Open} and Eurobot^{Open} Junior contests, but to avoid confusion, each contest has its own rules as a single document.

Thus the particular cases specific to one of the competitions appears only in the document concerning it.

You will find the Eurobot^{Open} and the Eurobot^{Open} Junior rules and other information on the Eurobot^{Open} website (www.eurobot.org/)

Please note that the version of this release is noted down at the end of this page. For any inquiry, only an OFFICIAL version should be considered.

Changes or clarifications of the rules may be made during the year. We therefore strongly encourage all participants to check our website regularly (www.eurobot.org/) as well as your NOC's own website for news. You can also follow discussions, ask questions or get further assistance on our faq (www.eurobot.org/faq/).

Possible changes of the technical specifications will be announced on the Eurobot website, (www.eurobot.org/) or on the website of the National Organization Committee (NOC) in your country.

The FAQ responses from a referee are official responses taken into account for match refereeing and homologation stages.

In case of doubt regarding any point of the rules or the approval of robots, the referee committee may also be contacted at referee@planete-sciences.org.

Have a good reading!

Common parameters of the rules can change from one year to another. Accordingly, please read the rules carefully even if the chapters may seem familiar to you.

B. CONTEST PRESENTATION

Eurobot^{Open} and Eurobot^{Open} Junior are two events addressed to young people interested in robotics. Teams are usually composed of students involved in an Eurobot^{Open} school project, a group of friends, or independent robotics clubs. They share the same goal: to offer young people an active learning process, to put into practice their knowledge and soft skills during a fun and friendly event. The technical challenge is to build a remote controlled robot .

Eurobot^{Open} and Eurobot^{Open} Junior have for only ambitions those described above. As an actor of the popular education movement and as a youth movement, inclusiveness is a strong value of Planète Sciences and its European partners. The organizers do not (and will never) impose a team model; whether you participate to discover robotics, to practice your skills, as part of teaching or for competition, you are (and always will be) welcome.

The Eurobot^{Open} and Eurobot^{Open} Junior meetings are prepared with passion throughout the year by volunteers of all nationalities who believe in the educational values of this experience and are themselves, often, former participants.

The rules for both events (Eurobot^{Open} and Eurobot^{Open} Junior) are based on the same concept. As organisers, we intend to provide a common platform for the Eurobot^{Open} event. This platform is dedicated to autonomous robots for Eurobot^{Open} while for Eurobot^{Open} Junior, the robots are remote controlled. In this way, a Eurobot^{Open} organiser can easily set up a Eurobot^{Open} Junior contest and vice versa.

You're currently reading version
Eurobot^{Open} Junior OFFICIAL 1.1 of 2024rules.
(this version concerns only the manually-guided robots)

C. Main registration requirements

The rules below defines the general running of the competition, the gameplay and the running of matches. For any participation, the following registration requirements are added. In addition, the organizers of a Eurobot^{Open} event can add additional registration requirements in a separate document.

C.1. Age limitation of the participants

Participants in the Eurobot^{Open} Junior finals must be aged up to 18 years. Each team must have a supervisor to whom the age limit does not apply.

Be careful, depending on your country's educational system, this age limit may be slightly different. Check the registration requirements stated by your National Organizing Committee.

C.2. Teams members

A team is a group of at least 2 young participants who have built one robot for the event, as well as auxillary systems. A person can be part of only one team. However, we encourage teams to share their expertise and knowledge.

C.3. Teams registration and nationality

An organization (club, school, etc.) can supervise and register several teams, if allowed by the registration requirements set by your National Organizing Committee. The acceptance of these requirements is compulsory to validate your registration and your entry.

The nationality of a team is defined by the address of the organization which supports the team (club, school, etc.). A team can be composed of members of different nationalities.

C.4. Supervision and commercial components for the robots

The project can be supervised by an individual above the age limit (teacher, parent, group leader, etc.), but all elements of the robot(s) must be designed by the participants.

The teams must get involved in a scientific and technical project of their own and which consists of the design of a robot. They can use commercial components as long as they properly integrated into their project.

In this case, the off-the-shelf chassis or robot bases can be used for the robots as long as they were clearly modified by the participant to comply with the Eurobot rules and are integrated into their own scientific and technical project.

The organization reserves the right to deny the participation of a robot if it was obviously imagined, designed or assembled by the supervisor and not the students. During the event, the supervisor does not have the right to modify the robot directly. However, he can advise the students on the modifications to be done.

C.5. Meetings and participating countries

Eurobot^{Open} and Eurobot^{Open} Junior European finals gather teams selected after national qualifications if they were organized. European finals take place in Europe, but all countries can participate. Countries with more

than three registered teams, are required to organize a national qualification to select which teams will compete the European finals.

C.6. Decency and safety

Robotics contests are public and family-friendly events. Therefore, we kindly ask the teams to respect the rules of decency and safety (electrical, sound level, manners, etc.). These rules apply to the participants, as well as their supporters and their equipment.

D. THEME PRESENTATION

Space, the frontier of infinity towards which our spaceship travels, our first stage is: Mars. But if we arrive at lunchtime, how are we going to sustain ourselves ? All the cakes of Grandma Monique were eaten last year, after all!

This is why our robots have a very important mission for the success of our trip: prepare the ground and stock up some food! Or more precisely, to ensure that the autonomous greenhouse already in place survives long enough for our astronauts to be able to harvest fruits and vegetables, and then survive!

The missions will be:

- **Repot the plants and put them in cultivation,**
- **Orient the solar panels so that the greenhouse does not lose energy,**
- **Ensure the pollination of plants,**
- **Return to recharge the batteries,** at the end of the working day,
- **Anticipate future crop yield.**

Please note: All actions are independent from one another and no specific sequence is imposed whatsoever. No single action is mandatory. Give careful thoughts to your strategy. It is strongly recommended to design simple and reliable systems with a limited number of actions.

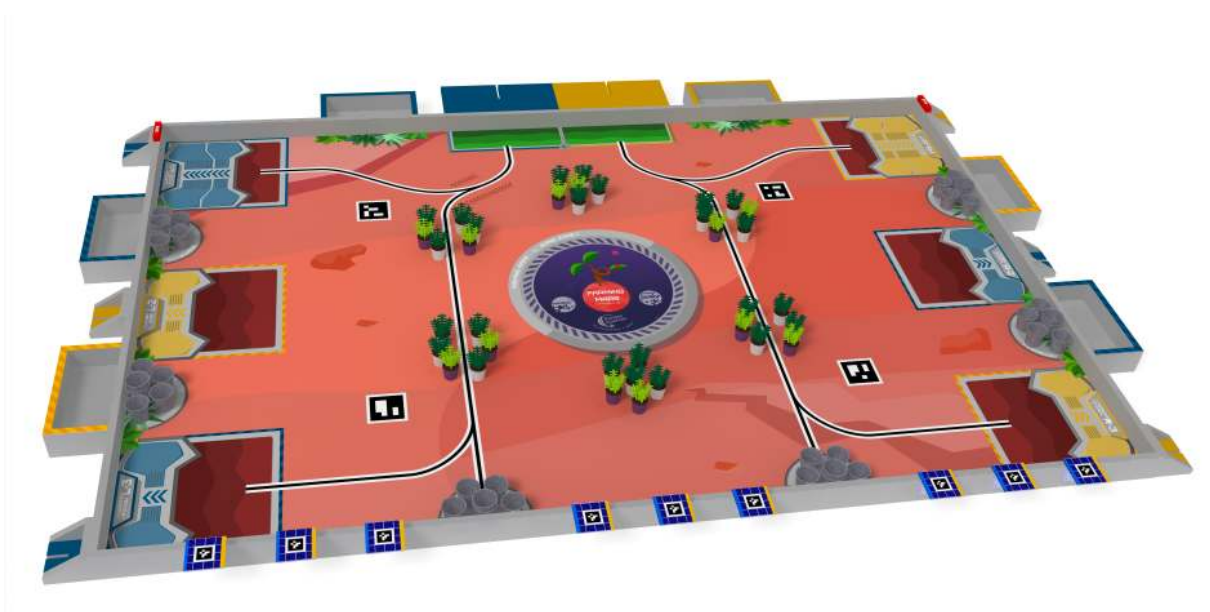


Figure 1: Overview of the playing area

E. PLAYING AREA AND ACTIONS

E.1. IMPORTANT INFORMATION

The organizers are committed to build the playing area with as much accuracy as possible. Nevertheless, minor tolerances may be observed depending on manufacturing constraints.

No complaints regarding dimensional deviations will be taken into account.

Teams are warned that the surface condition may differ from one playing area to another and may also degrade over time.

Graphics displayed in this document represent the Eurobot^{Open} playing area and not the Eurobot^{Open} Junior one. Thus figures show elements not useful in this version of the rules such as fixed beacon supports and remote calculation device.

E.2. PLAYING AREA

The playing area is a horizontal rectangular plan of 3000 mm by 2000 mm with borders of 70 mm height and 22mm thick on each outer side. Depending on the building process, it may consist of one or more pieces (eg 3 pieces of 1000 mm per 2000 mm).

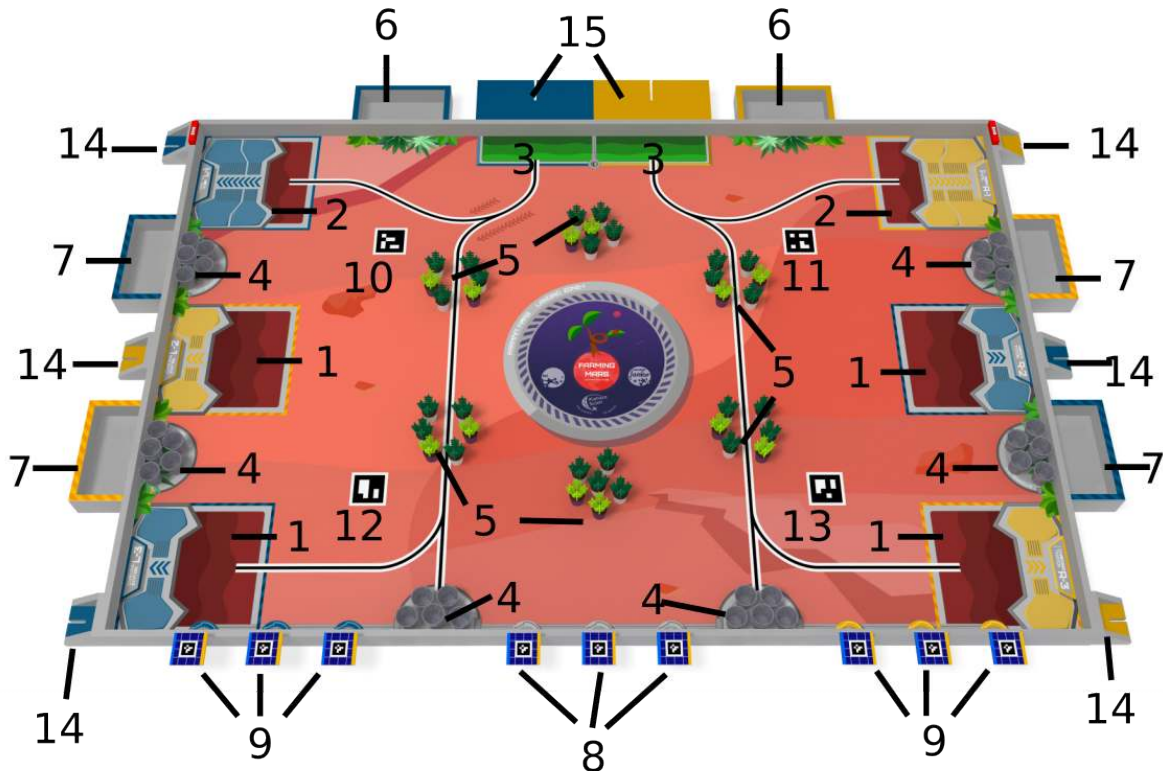


Figure 2: Detailed view of the playing area

- | | |
|--|-------------------------------------|
| 1. Departure/arrival and drop-off areas | 9. Reserved solar panels |
| 2. Departure/arrival and reserved drop-off areas | 10. ArUco marker number 20 |
| 3. Departure areas SIMA (ladybug hive) | 11. ArUco marker number 21 |
| 4. Pot supply | 12. ArUco marker number 22 |
| 5. Plant supply | 13. ArUco marker number 23 |
| 6. Reserved planters | 14. Fixed beacon supports (Eurobot) |
| 7. Planters | 15. Remote computing area (Eurobot) |
| 8. Solar panels | |

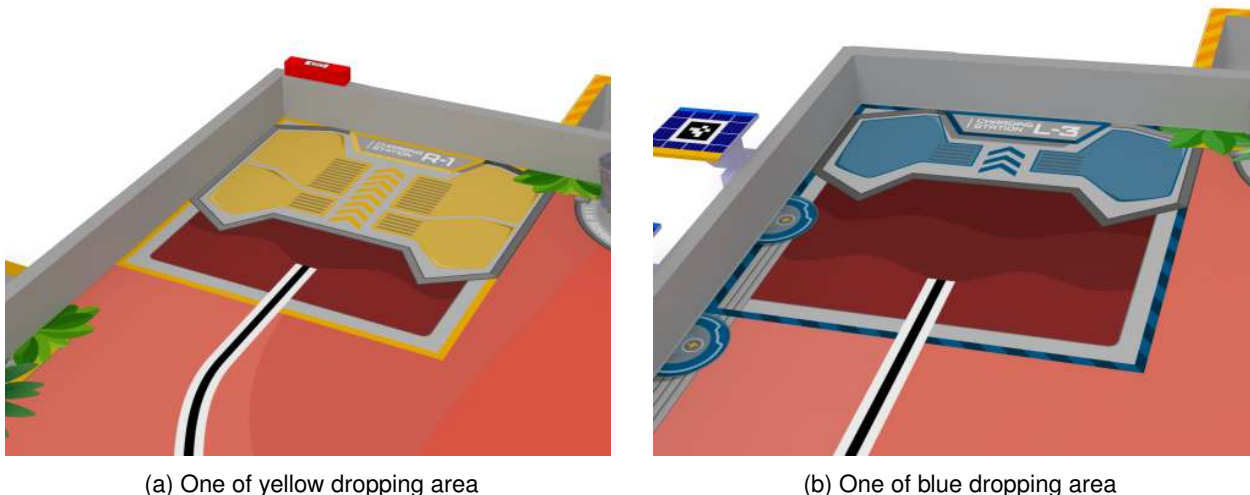
Full specifications of the playing area and game elements (dimensions, positions at the beginning of the match, colors and other references) are listed in the appendix.

In the remainder of this document, horizontal and vertical directions are stated relative to the playing area. Notions of “left”, “right”, “front” and “back” are stated with respect to the spectator’s point of view.

E.3. STARTING AREAS

E.3.a. DESCRIPTION

Each team has 3 starting areas, these are square surfaces of 45 cm sides delimited by a line on the table, which is itself included in this zone and of the color of the team. These areas are the starting zones for the robot, plant drop area, and also the arrival area for the robot. (See the distribution of drop-off areas in the description of the playing area)



(a) One of yellow dropping area

(b) One of blue dropping area

Figure 3: Detailed view of the blue and yellow team drop-off areas

E.3.b. CONSTRAINTS

At the end of the setup time, the vertical projection of the robots must not exceed the limits of their starting area.

Make sure your robots can fully enter their starting area. The colored lines and the edge of the table stuck to the area are also included in the starting areas.

During the 3 minutes of preparation time, a robot can change its starting zone among all the zones of the team. After the 3 minutes, the robot has to start from the zone in where it is.

E.4. DESCRIPTION AND LAYOUT OF THE PLAYING ELEMENTS

Plants: The plants are plastic plants, with a diameter of 5 cm, 12 cm high with a maximum mass of 25 g. There are 36 plants on the table, 12 plants of types resistant and 24 plants of type delicate, and are initially located on plant stocks according to the markings on the playing area by 2 sets of 3.

For the 4 side plant stocks, these zones are separated in two semi-circle delimited by the black and white tracking line, and each half-zone contains 2 fragile type plants and 1 resistant type plants in random position. The central plant stocks at the front and back of the table have a single area containing the 6 plants in random positions.



Figure 4: The 2 types of plant and the steel pot

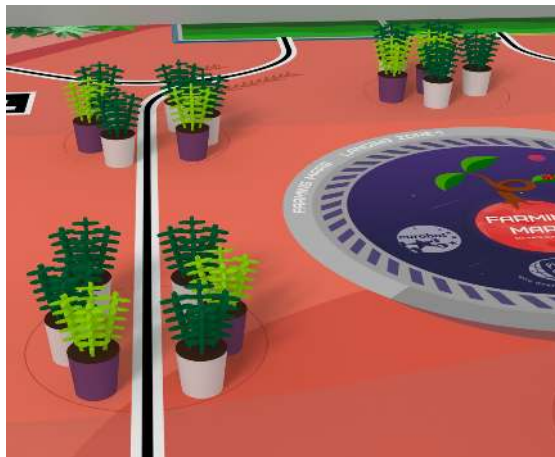


Figure 5: Plante distribution

There are 2 types of plants, each has a color around its base and an RFID tag on its underside :

- Delicate plants : dark green foliage, white base, RFID tag "1" and aruco tag 36
- Resistant plants : light green foliage, purple base, RFID tag "2" and aruco tag 13



(a) Two delicate plants



(b) One resistant plant

Figure 6: The different types of plants : resistant and delicate

Steel pots: The pots are 0.1L galvanized steel pot covers, diameter 7cm, height 6.5cm with a maximum mass of 50 g. They are 36 on the table, and are initially located on pot stocks according to the markings on the playing area: sets of 6 in a fixed position in each zone.



(a) Arrangement of steel pots



(b) A plant in the pot.

Figure 7: Steel pot distribution on the table and a steel pot with a plant

The planters: These are the drop-off supports for each team placed outside the borders of the playing area.

Please note: certain deposit supports are for the exclusive use of each team, while the others are not protected from theft. (See the distribution of drop-off areas in the description of the playing area)

The ladybugs: Made by the team, the ladybug is a small independent mobile actuator that can be released at the end of match to "pollinate plants".

The solar panels: The solar panels are 3D printed elements, placed on the front of the table, oriented towards the outside of the table, and the teams have to orient them towards their own side.

E.5. REPOT THE PLANTS AND PUT THEM IN CULTIVATION

The robots will have to collect the plants freshly arrived from the Earth, repot them and put them in cultivation so that they survive. But will there be enough for the mission to succeed?

E.5.a. DESCRIPTION AND LAYOUT OF THE PLAYING ELEMENTS

For this action, plants and pots are used alongside the drop-off areas and the planters.

E.5.b. ACTIONS AND CONSTRAINTS

Actions:

- Robots must collect plants and put them in pots to increase their chances of survival. Once the plants have been repotted, they will have to deposit them in the deposit areas adapted to each plant in order to improve their productivity.

Constraints:

- If a plant is knocked over, it will not grow, and is worth no points. To be considered valid, a plant must be upright, that's mean have the entire lower side of its base, or that of its pot, in contact with the ground or the bottom of a planter; or if it is leaning against an obstacle, return to full contact with the ground once the obstacle has been cleared.
- If a plant is in a pot, then it is more valuable, and earns more points. To be considered in a pot, the pot must be between the plant and the ground, and the base of the plant must be entirely contained in the pot. This is still valid when several pot are stacked under the pot containing the plant.
- When several pots are stacked under the pot containing the plant, these pots are considered as obstacles and the validation of the plant will be determined once the excess pots removed.
- To be considered valid for a team, a plant must have all or part of the contact surface of its base, or that of its pot, with the ground of a drop-off area or the bottom of a planter of this same team. If the plant is leaning against an obstacle, the measurement will be made once the obstacle has been removed.
- Each types of plants can be planted in one or more environments.
 - Resistant plants: can be planted in all environments.
 - Delicate plants: can only be planted in planters.Respect for plants and their environments awards points. A potted plant becomes valid in all environments.
- A deposit area or a planter cannot accommodate more than 6 plants, any additional plants will not be counted. In this case, the counting of points will be done to the advantage of the team.
- Only plants dropped off in reserved drop off areas will be for the exclusive use of the team (See the distribution of drop-off areas in the description of the playing area). Any item removed from these protected areas by the opposing team will result in a forfeit.
- A plant still under control by a robot at the end of the match will not be counted.

E.5.c. POINTS

- **3 points** per validated plant in a suitable area
- **1 extra points** if the validated plant is in a pot
- **1 extra points** if the validated plant is in a planter

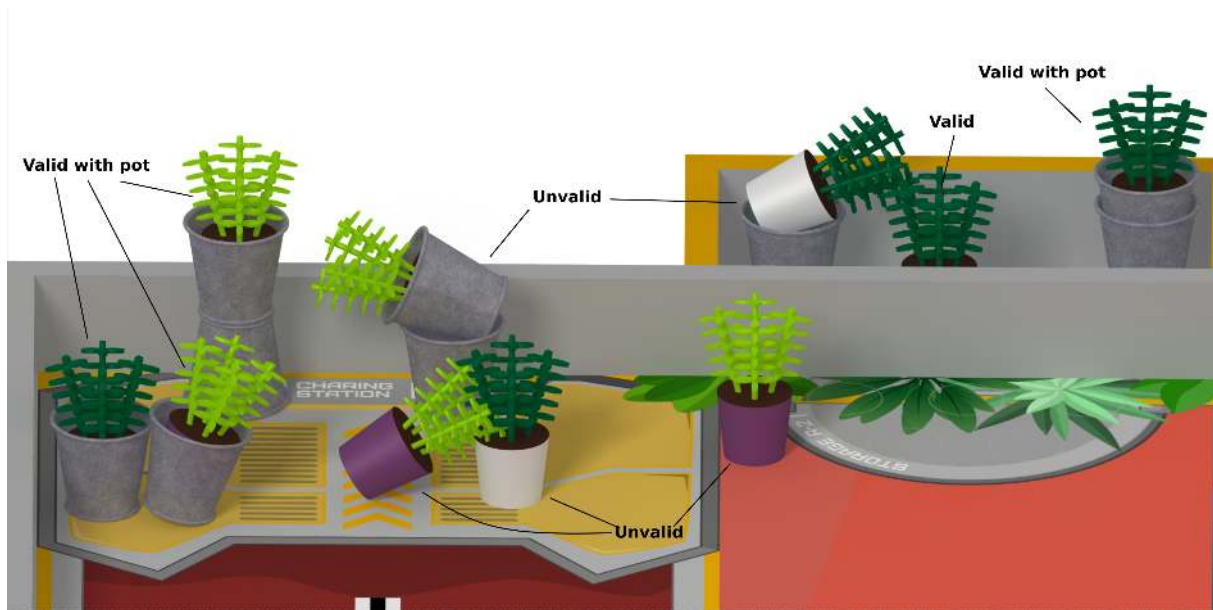


Figure 8: Different positions of valid and invalid plant.

E.6. ORIENT THE SOLAR PANELS

A robotic greenhouse consumes energy, a lot of energy, and to continue to function correctly, the solar panels must be oriented facing the sun and thus fill up with electrons.

E.6.a. DESCRIPTION AND LAYOUT OF THE PLAYING ELEMENTS

The solar panels are used for this action.

E.6.b. ACTIONS AND CONSTRAINTS

Actions:

- Orient the panels so that their faces point to the side of the table associated with the team.

Constraints:

- At the start of the match, the solar panels are oriented towards the outside of the table, no colored bands are inside the table.
- For a panel to be considered valid for a team, it must have all or part of the vertical projection of the edge with the team color included inside the table. If both color edges are inside the table, the panel is valid for both teams.
- The first 2 panels on the side reserved to a team are for the exclusive use of this team, the opposite team can not touch it.
- Solar panels are for the exclusive use of robots, SIMA are not allowed to touch them.

E.6.c. POINTS

- **5 points** for each panel valid for the team;

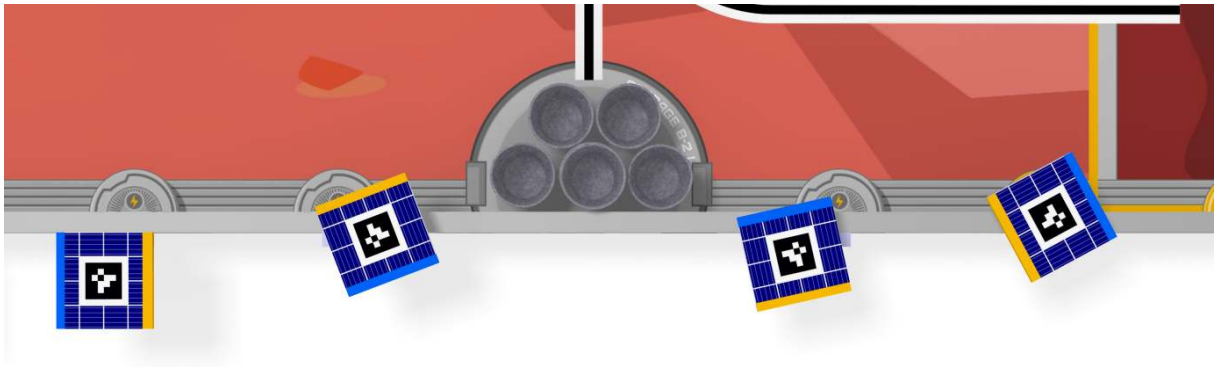


Figure 9: Panel on initial position, validated for side yellow , blue , for both.

E.7. ENSURE THE POLLINATION OF PLANTS

Making plants survive is good, but to feed our astronauts, these plants will have to produce fruits and vegetables. That is why an important mission is to pollinate plants.

E.7.a. DESCRIPTION AND LAYOUT OF THE PLAYING ELEMENTS

This action involves the plants in the drop zone and ladybugs (SIMA).

E.7.b. ACTIONS AND CONSTRAINTS

Actions:

- The team must release one or more ladybugs, and make sure they reach plants or pots.
- The ladybug(s) are small independent mobile actuator (SIMA) designed by the team. For reasons of easy identification, a harmonization of design and colors between ladybugs and robots is desired.

Constraints:

- During the preparation, the ladybugs will be deposited in the starting zone of the SIMA (ladybug hive), and must be contained within the limits of the zone. The colored lines and the edge of the table (on this 22mm thick) stuck to the area are also included in the starting areas.
- A team can have as many ladybugs as they want, all the ladybugs have to fit within the SIMA starting zone and are not stackable. They must be released after the 90th seconds of the match (invalidation of the ladybug in other case), the ladybugs will then have until the 100th seconds to achieve their objectives.
- The ladybug is validated as being in the zone if all or part of its vertical projection is in a drop zone on the ground or on a planter at the end of the match.
- The ladybug is validated as being in contact if it remains in contact with a plant (validated or not validated), or a pot containing a plant, in a drop area.
- The ladybug does not have the right to take a plant out of an area, or to bring a plant into an area (invalidation of the action of the ladybug in this case, reestablishment of the plant concerned).
- The ladybug has the following dimensional constraints:
 - All ladybugs must enter inside the SIMA starting area (15 cm by 45 cm).
 - Ladybugs have a height limit of 15 cm.
 - A ladybug must be larger than a 60mm cube.
- The weight of each ladybug must not exceed 1.5 kg.

- The ladybug cannot be activated by an external element outside of the table (team crew, remote control, ...).

E.7.c. POINTS

- **5 points** per team drop zone occupied by at least one Ladybug at the end of the match
- **5 extra points** per team drop zone in which at least one ladybug is in contact with a plant or a pot containing a plant at the end of the match
- **Attention** : if a ladybug performs its actions in an opposing zone, then the points thus made go to the opposing team.

E.8. RETURN TO RECHARGE THE BATTERIES

Once their work is done, the robots must go to recharge their batteries at their charging stations. But attention! The robots have already emptied the power source of their starting zone, they need to find power somewhere else!

E.8.a. DESCRIPTION AND LAYOUT OF THE PLAYING ELEMENTS

This action involves robots, the starting tag and charging areas (SIMA are excluded from this action).

E.8.b. ACTIONS AND CONSTRAINTS

Actions:

- At the end of the match, the robot must be stopped in their own dropping area.

Constraints:

- At the end of the preparation time, the referees will place the starting zone marker on the edges of the zones occupied by the robots. This marker is a square stick of 22mm side and 100mm long, placed on the edge of the table. This starting tag will be positioned in front of the external marker supports
- To be considered valid in zone, the main robot vertical projection must be at least partially inside the limits of the dropping area of the team. This action does not concern the second robot.
- To be considered in a valid zone, a robot must be a different area than the starting are, i.e. in area without starting tag.

E.8.c. POINTS

- **10 points** if the main robot of the team is in its valid reloading area.

E.9. ANTICIPATE FUTURE CROP YIELD

E.9.a. DESCRIPTION AND LAYOUT OF THE PLAYING ELEMENTS

The device for displaying the score estimation during the match must be made by the team.

E.9.b. ACTIONS AND CONSTRAINTS

- The team must evaluate the number of points scored in the match by its robot. For this, there are two exclusive options:
 - Pre-match evaluation on a static display: the team writes the score it intends to make during the match.
 - Evaluation during a match on a dynamic display device, which must continue to show the estimated score after the end of the match.
- The display must be on the robot.
- The display area and its reading orientation must be easily visible and identifiable by the referees. And if possible visible by the supporters.
- The estimated score is an integer and must be expressed in decimal system.
- Under no circumstances should the score change once the match has ended, otherwise the bonus will be lost!
- In case of a dynamic display, the pilot control box can be used to update the display, but not to directly show the score.
- The copilot is not allowed to update the score estimation, nevertheless the copilot can compute and transmit the score estimation to the pilot, the usage of electric/electronic tool is allowed if its offline.

E.9.c. POINTS

The estimation is based on all the following actions.

- REPOT PLANTS AND PUT THEM INTO CULTURE.
- ORIENT THE SOLAR PANELS.
- GO BACK TO RECHARGE YOUR BATTERIES.

The estimation bonus is calculated as follows: **Bonus = min(20 points - Delta/2, score done)**

- The score is the one scored by the team during the match on actions listed above.
- The delta is the difference between the score made by the team during the match and the score estimated by the team. This one is always positive (Absolute value).
- The bonus cannot be higher than the score made by the team during the match.
- The bonus is added to the points of the team.
- A bonus is rounded up to the next integer.
- A negative bonus is reduced to 0.
- The penalties are not included in the performance estimation.

F. PROJECT PRESENTATION

Both Eurobot^{Open} and Eurobot^{Open} Junior encourage participants to practice science in a funny and original way. Our main objective is to assist and value your projects conceived during the year. To achieve this, the teams must create a poster, and organizers may ask the teams to create a technical documentation of their robots.

We expect to see attractive, innovative robots that respect this edition's technical constraints and rules. Being creative and original will add value to your work as much as the performance of your robot(s) during the matches. By doing this presentation, you will increase the communication value of your project and the visual effect of your robots, for both the public coming to the events as well as for your own satisfaction. Having created something aesthetically and functionally complete, will strengthen your work attitude during and after the competition.

As in previous years, the presentation of your team's project (through project management on the long-term, task distribution ...) as well of your robots (technical systems implemented, chosen strategies ...) is an integral part of the event. Teams should present their projects in a way that is easily understandable and visible to the general public and the rest of the participants.

F.1. CONSTRAINTS

This presentation must be made on a panel size A1 (594 x 841 mm) at least. If you want to use other visual media than paper, it is quite possible. Let your imagination be free!

F.2. EVALUATION

The project must be exposed to the referees and / or guardian angels during the homologation of the robot to allow the teams to show all their work. This presentation will be taken into account in the homologation sheet.

During the meetings, a jury will pass through each panel and discuss with the teams to award a special prize for the best presentation. Team members must be able to present their project in English and/or in French, in order to compete for these prizes.

G. THE ROBOTS

G.1. FOREWORDS

Each team is allowed to register one robot and as many SIMA(s) as they choose (Small Independent Mobile Actuator). Each robot and SIMA have specific dimensional constraints, but it must be possible to distinguish them from each team's robot and SIMA from the public.

For Eurobot^{Open} Junior, the principal robot is wire-guided or remote controlled and the SIMAs are autonomous.

The construction of SIMAs is optional. The aim is to allow teams with many members to work on a second project. It is recommended for beginning teams to concentrate on building a single functional machine. Having one robot that works well is better than having two that do not move.

A SIMA can compete only with the main robot for which it was designed and approved. It cannot be re-approved with another main robot.

The main robot and SIMAs must be made up of elements that are fixed to each other (so robots cannot leave parts or elements on the playing area), with the exception of the playing elements.

Deliberately vibrating the table, attach themselves to it or any other irregular action exposes the team to a refusal of approval.

Each team must design a unique and original set of robots, specific to their team.

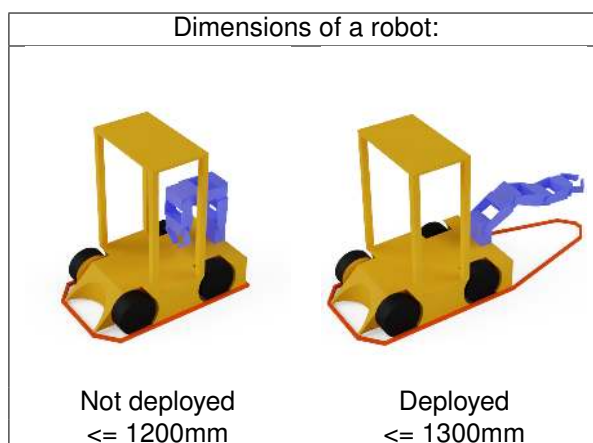
Be imaginative! For example, as an innovation but also to offer the public and the media an attractive show, your robot can use sounds, display expressions, etc.!

G.2. DIMENSIONS

Information: the dimensions of Eurobot^{Open} robots are identical to those of Eurobot^{Open} Junior. Eurobot^{Open} Junior participants can more easily access the Eurobot^{Open} meetings. The Eurobot^{Open} Junior robot will only need modifications to make it autonomous.

Dimensions of the robots :

The perimeter of a robot is the perimeter of the convex shell of its vertical projection on the ground. It is measured by surrounding it as shown in the illustrations below:



The perimeter of a robot must not exceed 1200 mm at the departure time. The perimeter of the fully deployed

robot shall not exceed 1300 mm during the match. It is allowed to change the convex hull shape during the game, as long as the perimeter of this one always respects the maximum perimeter constraint.

At any time during the match the height of each robot and manipulated object must not exceed 350 mm. However, it can be tolerated that the emergency stop button exceeds this height limit to reach 375 mm.

G.3. SECURITY CONSTRAINTS

G.3.a. GENERAL ASPECTS

All systems (robots and accessories) must comply with all applicable regulations in Europe and in the countries hosting the events.

This is mandatory for the countries that are organizing national meetings or send independent teams for the European Finals. Among other things, these security standards must respect safety rules and must in no way endanger participants, organizers or the public, whether during matches, backstage or in the stands. They must have no protruding or pointed parts likely to be dangerous or cause damage

The use of liquid, corrosive, fuel, pyrotechnic, radioactive, living beings or zombies is prohibited.

In general, any system deemed as dangerous by the referees' committee will not be approved, and must be removed, in order to be accepted in the competition.

G.3.b. ENERGY SOURCES

The only sources of stored energy authorized in robots and auxiliary systems are chemical batteries, CE-certified commercial batteries, springs and elastics, compressed air, gravitational energy. All other energy sources are prohibited.

If you have any doubt about unconventional energy sources, ask the referees' committee as soon as possible, providing the corresponding datasheets.

All robots must comply with standard "low voltage" regulations. As a result, **the on-board voltages must not exceed 48 V DC and 48 V peak to peak AC**.

Potential differences greater than 48 V may exist, but only within closed commercial devices (eg lasers, LCD backlights, etc.) and only if these devices have not been modified and comply with national and European regulations.

Batteries:

If the team chooses a battery power supply, we remind that only unmodified batteries can be used.

Teams must be able to play three games in a row. Note that this includes the time required to set up, during which the robot will be powered and awaiting the start.

Therefore, we strongly recommend that teams bring several sets of batteries and provide easy access to them in the robot for their replacement. Teams are reminded that it is essential to have a set of spare batteries, fully charged and available at all times.

Note on the use of Lithium-based batteries:

Lithium batteries are known for their lack of stability and can easily ignite when certain precautions are not taken.

This type of battery is therefore authorized under the following conditions:

- Suitable battery charger, which must be submitted for approval.

- Batteries kept in certified and unmodified fireproof bags.
- A system for detecting under voltage is highly recommended.
- Exception in the case of the following batteries, authorized without the conditions listed above:
 - Lithium-based batteries including a BMS (Battery Management System) integrated by the manufacturer and solid case (LEGO Mindstorm / laptop / mobile phone / power tools / USB charging battery), not dismantled and used for the intended purpose of the manufacturer.
 - Lithium-Iron batteries (LiFePo4)

In the case where a team is in possession of an unstable Lithium battery, the team is fully responsible of all potential damage caused by the defective battery. Thus, the team must :

1. Secure it immediately.
2. Inform the organization of the meeting without delay.
3. Recycle it, by your own means, before the end of the meeting.

Warning! The supply systems must be easily transportable. Teams may have to go up and down the stairs on their way to the stage where the matches take place.

The power source transmitted to the robot can only be electric. The maximum permissible voltage is 13.8 V (measured between any two wires of the cable and the robot). This voltage source is not provided on the day of the meeting. On the other hand, the teams have one access to the standard (one power socket at 230 V 50 Hz standard) and can use batteries.

The terminals of the cables must be insulated.

Emergency stop button :

All robots have to be equipped with a red emergency stop button of at least 20 mm in diameter, as well as other systems including moving parts (motor, actuator, ...) or potentially dangerous components (laser, powerful light, ...). It must be placed on the top of the robot and on an easily accessible side for the other systems, in a visible position on a free surface and in a non-hazardous area to be immediately accessible by the referees at any time during the match.

The button may exceed the system's height by 25 mm. The emergency stop button must be operated by a simple and quick movement (for example, by hitting it with the fist).

Only exceptions to this rule, the beacons embedded on the beacon mast of the opposing robots are exempt from the emergency stop button, as well as commercial and not modified devices.

Pressing this button must stop all systems immediately. For robots, it is tolerated to leave the control and avoidance systems switched on.

In order to avoid any risk of fire, attention should be paid to the diameters of the wires, depending on the intensity of the currents flowing through them. It is also strongly advised to protect the electrical installation with a fuse, wired close to the batteries.

G.3.c. LASERS

Only laser systems and classes defined according to the IEC60825 international standards are accepted. Teams using lasers must provide the manufacturer's document mentioning **the class of the device** (this information is normally always available on the system itself).

On the basis of this classification, class lasers:

- 1 and 1M are accepted without restriction
- 2 are tolerated only in case the laser beam do not exceed the play area, and if it is off when the robot does not touch the play area.

- 2M, 3R, 3B and 4 are strictly forbidden.

WARNING: Disassembling or modifying devices using laser sources often results in a change of class. Laser devices must not be altered and only be used in the state of their commercialization (laser device = source + optics + electronics).

G.3.d. HIGH POWER LIGHT SOURCES

When using a high intensity light source, the light intensity must not be dangerous to the human eye in case of direct contact. Note that some types of LEDs have warnings. Be responsible, as your machines are evolving in front of a general audience!

In the case of slightest doubt, the organization reserves the right to request the manufacturer's specifications to verify the non-dangerous nature of the lighting system used. If it turns out that the system is potentially dangerous, it may result in revocation of lasers of class 2M and more.

G.3.e. COMPRESSED AIR SYSTEMS

Compressed air systems must not exceed 4 bars, except in pre-assembled commercial products, and only if:

1. these devices have not been modified.
2. They are compliant with european safety regulations.
3. they are safe.

The use of pressurised gas cartridges such as CO2 cartridges is prohibited

G.4. COMMUNICATION SIGNALS

To avoid interference between teams, it is recommended to encode the communication signals. We strongly recommend teams using infrared devices, to take into account the strong ambient light used during the encounters. In addition, this luminosity may vary in time and according to the emplacement of the playground in the hall.

We also remind teams that the organizing staff uses high-frequency radio devices and under no circumstances can they be held responsible for the malfunctions encountered by the robots.

CAUTION: Beyond the edges of the playing area, there may be elements that may interfere with color detection or communications signals such as:

- decor, lights and objects of the playing area
- people (referees, teams, etc.)
- electronic systems (microphones, cameras, etc.)

It is strictly forbidden to ask people to go away or move away objects/decors around the playing area.

Wifi networks:

At multiple contest locations, the number of active Wifi devices can disturb the robots implementing this technology for communication. To answer this issue, it's recommended (but not mandatory) to use the 5 GHz frequency rather than the 2.4 GHz one.

Control system For the main robot, each team must have a control console operated by a single driver.

It is authorized to pilot your main robot by a wireless remote control. Both solutions, wired and wireless, are allowed this year. Please, read the next paragraphs to know the conditions.

G.4.a. THE WIRE CONTROL SYSTEM

The control system It's the housing used for controlling the electrical devices of the robot. It is connected to the robot only by an electric cable. Any other communication type system between the robot and the outside, is strictly forbidden.

G.4.b. THE WIRELESS CONTROL SYSTEM

It is a housing for controlling the controlled robot's electrical devices. It communicates with the robot using wireless equipment. It can be connected to the robot by an electric cable to power it. The wireless control system should only be used for communication between the pilot and the robot. Under no circumstances should it be used to communicate with the outside world during matches.

To avoid interference problems with another team, the public or the equipment used by the organizer, it is strongly recommended that a team choosing a wireless control system be able to quickly change the frequency and/or communication channel. Under no circumstances may the team contest the inconvenience caused by possible interference.

G.4.c. THE CABLE

The electrical cable connecting the robot to its control system is not provided: it must be designed and implemented by each team, according to its needs.

The robot executes a lot of movements on the playing area, therefore the cable must have a minimum length of: two meters between the power outlet and the power supply and five meters between the robot and the control box.

The cable must come out from the top of the robot, so that it does not touch the playing area.

It is held in the air by the co-pilot using a pole provided by the organizers.

During the match, the co-driver must not interfere in the control or in the settings of the robot (supply voltage for example). Consequently, the departure of the SIMA can only be triggered by the pilot.

The cable must not be used to guide the robot, or direct it in case of reversal. Penalties can be give to co-pilots that use the cable to guide their robot !

G.5. OTHER DESIGN CONSTRAINTS

Visibility : A rectangular, entire and non-deformable space of 100 x 70 mm per robot must be left free on one of the side faces. The teams will receive stickers printed by the organization (team number, sponsors etc), which they have to place on these open spaces.

Starting cord of autonomous robots: One or more present elements of the team on the table need to be equipped with a starting device easily accessible. This device has to be triggered by pulling the end of a cord at least 500 mm long. This cord must not stay attached to the element after departure. After the device was triggered, the autonomous robots can start.

No other starting system (remote control, manual rocker switch, etc.) will be approved.

List of elements that can be had with the starting device :

1. The robot
2. The SIMAs

Avoidance system : Robots and SIMA avoidance systems are optional for Eurobot^{Open} Junior participants.

G.6. SMALL INDEPENDENT MOBILE ACTUATOR

The small independent mobile actuator (or SIMA) must respect the same building and safety constraints as robots (Emergency stop, avoidance, laser, bag for lipo battery,...). Like robots, a SIMA must be able to play a match whatever of the color of its team.

Teams can use any kind of control system for the SIMA (analog, microprocessor-based, microcontroller, embedded computer, programmable logic, etc.).

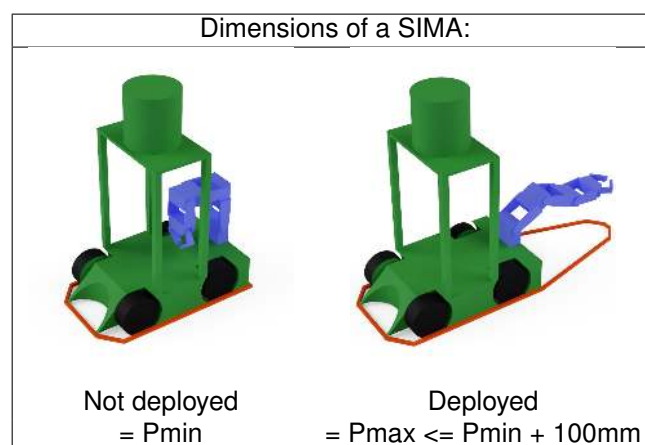
These systems must be fully integrated into the secondary SIMA.

The control system must allow the SIMA(s) to play a match with either one of the colors provided to teams. Ideally, it should be configured shortly before the match with any of the two colours.

They can be launched at the start of the match by a starter cord, or during the match by the robots themselves. A robot has the right to touch or communicate with a SIMA of its team throughout the duration of the match, but the SIMA have to move by itself.

SIMA must respect the following dimensional constraints:

- All SIMA must enter the SIMA starting area (150 mm by 450 mm).
- The SIMA has a height limit of 150 mm.
- A SIMA must be larger than a 60mm side cube.
- A SIMA can be deployed within the limit of an increase of 100 mm in its perimeter.
- A SIMA can be deployed and move within the limit at a height of 350 mm.
- A SIMA must have a area of 30 x 30mm for the stand number tag.
- The weight of each SIMA must not exceed 1.5 kg.



As SIMAs have a height restriction, they dont have:

- The beacon mast.
- Beacon support (and therefore do not carry an ArUco marker).

H. TAG RECOGNITION SYSTEM

H.1. ROBOT IDENTIFICATION

Embedded/ on-board tag support system : To ease the identification of team robots by players, referees and the public, the robots will include tag support on their tops on which will be placed tags of the color of the team. This support must respect the following points:

- have its upper surface flat, horizontal and positioned at a height of 430 mm above the playing area to allow the beacon of the opposing team to be placed in good conditions;
- the top of surface of the platform will be fully covered of VelcroTM (hook side);
- the on-board beacon support must be stable, motionless regarding the robot structure.
- Pay attention to the height of the tag support, if it is too high from the top of the robot, it can snag the robots' control wires.

H.2. ROBOT IDENTIFICATION

During each match, the robots will be assigned a marker (provided by the organizer) placed at the top of the beacon holder, or at the top of the on-board beacon (if present)(Figure 10b). This marker has two purposes:

- allow the public to identify the team to which a robot belongs;
- allow a vision system on the central mast to identify and locate each robot.

The marker is a square 10cm wide, 2cm thick (± 2 mm) and with a mass less than or equal to 100g. Its upper side is covered with a vinyl with a 7cm ArUco tag (Not used for juniors and can be changed at will). A 1cm wide white outline is drawn around the ArUco tag to facilitate its detection. A 0.5cm wide contour in the same colour as the team is drawn at the edge of the upper surface. The team's color also occupies the edge of the marker.(Figure 10a)

(a) Robot identification marker (Tag n°1).

(b) Marker on the on-board beacon support.

I. MATCHES

Only two persons per team are permitted to go backstage and on stage to play the matches.

To ensure that the contest runs smoothly, at least one member of the teams must be present on their booth with the robot(s) and ready to go 30 minutes before the start of each series and until that the game is played.

In case of a problem, it is tolerated by the organization to ask for a delay to go to the match but this delay can never exceed the end of the current series.

I.1. PREPARATION TIME

At the start of a match, the elements of the playing area and the playing area itself are installed as indicated in the diagrams in the appendix.

Upon arrival on the playing area, each team has a maximum of three minutes to proceed with the placement of the robots and other equipment. At the end of the preparation time, the robot are not allowed to move until the start of the match.

A robot which is not ready at the end of this period exposes the team to a forfeit for the match.

Besides, the other team's robots will still play their own game on the playing area. The team will have to score points to be declared the winner.

When both teams have finished setting up, or when the preparation time is over, the referee asks the participants if they are ready, and they place the starting area tag. From this moment, teams are no longer allowed to touch their robots. It will be tolerated that the emergency stop button is pressed by the teams after the preparation time in order to preserve the batteries and actuators while waiting for the beginning of the match. No dispute can be made on the disposition of the elements of play after the beginning of the match.

I.2. THE MATCH

At the signal of the referee, each robot is switched on and it has 100 seconds to do these actions.

No one except the referee can touch the robots and the playing elements unless expressly indicated by the referees.

No elements taken out of the playing area can be put back on the table before the end of the match and the validation of the scores.

I.3. END OF MATCH

At the end of the 100 seconds, the robots must stop and turn off all their actuators. It is allowed to keep on any dynamic displays.

No one except the referee can touch the robots and the playing elements unless expressly indicated by the referees. The referees count the points; they give the result of the match, including the points to the teams. If they both agree, they validate the match sheet, can take back their robot(s) and join their booth. If the teams do not agree, they refer calmly to the referees. The robots remain in place until the dispute is resolved. **Refereeing decisions are final.**

In the event of a situation that is difficult to judge, the referees reserve the right to decide whether or not to replay the match.

The referees are allowed to pronounce the end of a game in advance, before the end of the regular time if both teams agree (if the robots are blocked for example).

I.4. COUNTING POINTS

Points summary

I.4.a. REPOT THE PLANTS AND PUT THEM IN CULTIVATION

- **3 points** per validated plant in a suitable area
- **1 extra points** if the validated plant is in a pot
- **1 extra points** if the validated plant is in a planter

I.4.b. ORIENT THE SOLAR PANELS

- **5 points** for each panel valid for the team;

I.4.c. ENSURE THE POLLINATION OF PLANTS

- **5 points** per team drop zone occupied by at least one Ladybug at the end of the match
- **5 extra points** per team drop zone in which at least one ladybug is in contact with a plant or a pot containing a plant at the end of the match
- **Attention** : if a ladybug performs its actions in an opposing zone, then the points thus made go to the opposing team.

I.4.d. RETURN TO RECHARGE THE BATTERIES

- **10 points** if the main robot of the team is in its valid reloading area.

I.4.e. ANTICIPATE FUTURE CROP YIELD

The estimation is based on all the following actions.

- REPOT PLANTS AND PUT THEM INTO CULTURE.
- ORIENT THE SOLAR PANELS.
- GO BACK TO RECHARGE YOUR BATTERIES.

The estimation bonus is calculated as follows: **Bonus = min(20 points - Delta/2, score done)**

- The score is the one scored by the team during the match on actions listed above.
- The delta is the difference between the score made by the team during the match and the score estimated by the team. This one is always positive (Absolute value).
- The bonus cannot be higher than the score made by the team during the match.
- The bonus is added to the points of the team.
- A bonus is rounded up to the next integer.
- A negative bonus is reduced to 0.
- The penalties are not included in the performance estimation.

Warning! An element controlled by a robot, does not yield points. An element is considered to be controlled by a robot, if by moving the robot along its natural axis of movement the element is moved.

I.4.f. THE PENALTIES

Several actions during the match may result in penalties.

The following actions will result in a **warning** or a **point loss** on the final score if a warning has already been issued for the team (the warning rule is only valid during the series):

- loss of part or element of a robot on the playground: **loss of 20 points**.
- degradation of the table or a game element: **loss of 30 points**.
- pull on the cable to move the robot: **loss of 30 points**.
- false start: **loss of 50 points**.
- robot keeps moving when time runs out: **loss of 50 points**.
- excessive preparation time: **loss of 50 points**.
- robot change its start zone after 3 minute of preparation : **loss of 50 points**.
- unfair or unsportsmanlike conduct: **loss of 50 to 100 points**.
- on arbitration decisions: **loss of 50 to 100 points**.
- on decisions of the organization: **loss of 50 to 100 points**.

The following actions will result in a **team forfeit**:

- no robot exit from its starting area.
- removal of point from an opposing element or protected area.
- repeated excessive preparation time.
- dimensional limitations not respected.
- repeated false start.
- intentionally shoot at people in the vicinity.
- voluntary fixate, vibrate the table.
- intervention of a team member on the table, game elements or robots, after the preparation time (with the exception of the emergency stop button).
- intervention of a team member on the table, the game elements or the robots, during the match.
- the team is unable to play the game before the end of the series.
- following arbitration decisions.
- following decisions of the organization committee.

The following actions will result in **disqualification of the team from the competition**:

- voluntary deactivation of robot avoidance systems.
- design robots that are noticeably similar to robots from other teams (for example: rolling bases or identical actuators). If during the year you see a team building a robot similar to yours, report it to the organization as soon as possible.
- intentional degradation of robot belonging to other teams.
- following decisions of the organization committee.

During a same match, several penalties can be applied.

The so-called "additional" points are only counted if the previous points of the action are validated.

The score of a forfeited team or a negative score will be reduced to 0.

Only the referees are authorized to intervene on the table or the robots after the preparation time and during the match. In case of concern, ask the referee to intervene to avoid the forfeit.

Video refereeing is prohibited.

A general definition of anti-game: "If the goal is to harm without building, then it's anti-game".

The appreciation of the penalties and the anti-game remains at the referee's judgement. They cannot be disputed after the match.

RECALL:

The penalties are intended to compensate for damage caused by a possible incident during the course of the game. A penalty situation is considered as non-respect of the rules of the game, this type of situation must remain exceptional! In some rare situation, a penalty may result in the team's forfeit. The referees' committee will also be attentive to the penalties distributed between several levels of meeting (regional/national/European).

I.4.g. BONUS POINTS

1 bonus point is awarded to all teams that are not "forfeit". This bonus point is not included in the performance estimation.

J. THE CONTESTS

J.1. GENERAL INFORMATION

The Eurobot^{Open} Junior meetings can be organized on three levels:

- regional: when they exist (e.g. in France, Eurobot^{Open} Junior), qualify a number of teams for the national meeting,
- national: it allows to qualify the teams for the European meeting,
- European: this last stage brings together, in the same friendly spirit, teams from different countries in Europe and elsewhere.

Each meeting has several successive steps:

- The static and dynamic approvals of all the robots;
- A qualification phase, with at least 3 series;
- An optional play-off phase;
- A final phase.

The organizers of each meeting can distribute awards, if they want, to the teams in order to reward an aspect of the participation of the team or its robot.

J.2. APPROVAL

J.2.a. STATIC APPROVAL

Before the start of the matches, robots are subject to the supervision of a referee who checks their compliance with the rules. Robots must be able to easily show all their mechanisms.

The ancillary systems (accessories, control panel, etc.) will also be subject to static control (size, mass, presence of mandatory elements, etc.).

J.2.b. DYNAMIC APPROVAL

The robots must, within 100 seconds, validate at least one action. The robots are put in a game situation but without the presence of an opposing team. Certain specific features provided for in the regulation will also be checked (timer, avoidance of opponents, etc.).

If the assembly consisting of the main robot and the optional SIMA fulfills these conditions, it is declared approved.

J.2.c. SIGNIFICANT TECHNICAL MODIFICATIONS AFTER THE APPROVAL

It is essential to inform the referees of any significant modifications (functional, structural, dimensional ...) brought to the robot(s) or any other element after approval. The referees will then check the modifications made and re-approve the robot if they deem it necessary. In the event of a breach, the team may be declared disqualified from the contest.

J.3. QUALIFICATION PHASE

During the qualification phase, the registered teams will have the possibility to play at least three games (often more, depending on the local organizers).

A ranking is established according to the accumulated points in order to select the qualified teams for the next phase.

The tied teams are tied by comparing their scores without taking into account their bonus points. Organizers may also use additional matches.

At the end of the qualifying phase, the first teams (according to the matches) are qualified for the next phase.

Number of participating teams	Minimum team selected
$N \leq 16$	4
$16 < N \leq 50$	8
$50 < N$	16

J.4. THE PLAY-OFF PHASE

An additional play-off phase may set up in the event that a meeting hosts two contests, the first of which qualifies for the second. For example:

- a regional meeting (A) and its national meeting (B)
- or a national meeting (A) and the European meeting (B)

The organizer may carry out the qualifying phase of both matches (A) and (B) either in parallel fashion or in a mixed fashion. In this case, a play-off phase may be organised in order to allow teams from the match (A) to qualify for the match (B), exempting them from having to catch up on all the matches from the qualifying phase of (B) in favour of this play-off phase.

The teams participating in this play-off phase are:

- the teams of the match (A), in a number corresponding to its qualification quota, and chosen in the order of ranking at the end of the final phase of (A) or through an award during the regional meeting.
- the teams of the match (B), in a number equivalent to the participants in this phase from (A), chosen from among the last teams normally qualified for the final phase of the match (B).

Example for a national meeting qualifying three teams for its European final whose European final phase has 16 teams. The teams participating in the play-off phase are:

- **the first three teams of the national meeting at the end of the final phase of the national meeting;**
- **and the teams ranked 16th, 15th and 14th in the qualifying phase of the European meeting.**

In this play-off phase, one match will be played for each participating team. The participating teams from the match (A) qualified through the ranking will play, in order of their ranking, with the teams from the match (B) with the lowest ranking. And the team(s) of (A) qualified for this play-off phase through an award will play against the top-ranked teams of (B) in a random order.

Each team that wins its play-off match will be included in the main draw of the final phase of the match (B). At the end of the play-off phase, the tree of the final phase of the match (B) presented in Figure 11 may be revised to more accurately represent the level of each team.

J.5. THE FINAL PHASE

At the end of the previous phase, the qualified teams form the table of the matches of the final phase.

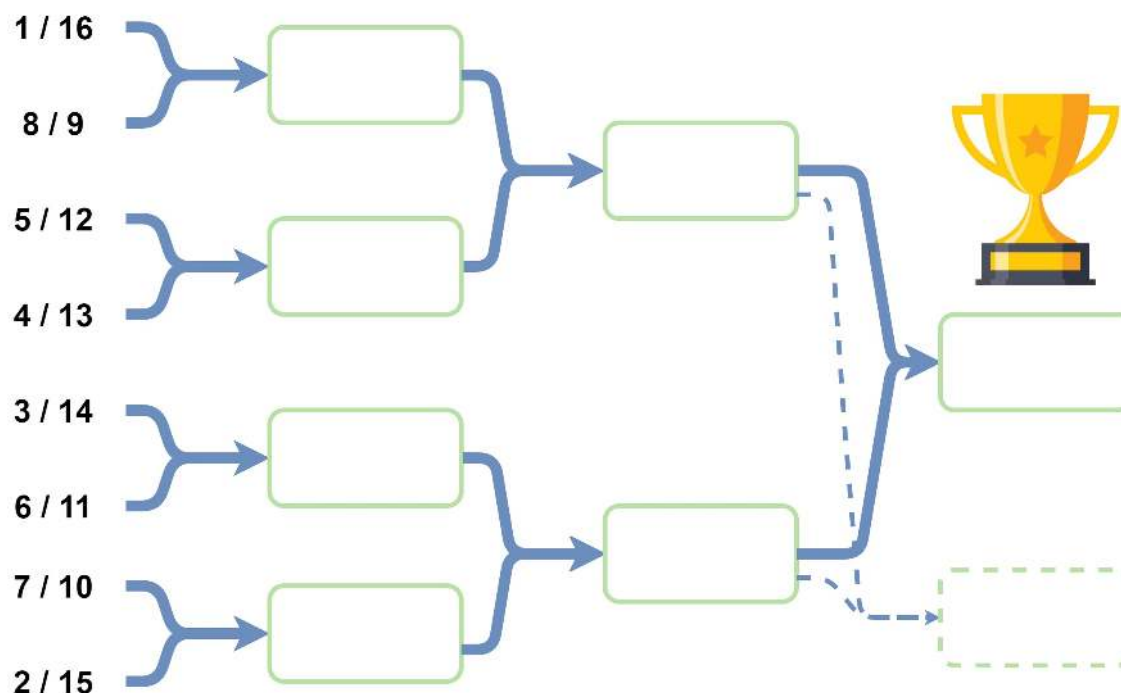


Figure 11: Tree of the final phase

The matches of the final phase are with knockout, unless otherwise organized on some meetings. In the event of double forfeit, double defeat or tie, the match is replayed immediately; if this second match is still a case of double forfeit, double defeat or equality, the winner is determined according to the points acquired at the end of the qualifying phase.

The final is played in two winning games. Be careful to provide batteries accordingly for autonomous robots.

J.6. QUALIFICATION FOR THE NATIONAL MEETING

When there are regional meetings, the number of teams qualified per regional meeting is proportional to the total number of teams registered at the national level.

The best teams in the ranking established at the end of the qualifying phase of each regional meeting, as well as at least one team chosen by the organizers from the special prizes (e.g. creativity, fair play, presentation, etc.).

J.7. QUALIFICATION FOR THE EUROPEAN MEETING

Each country participating in Eurobot^{Open} Junior organizes a national meeting to determine the qualified teams for the international meeting.

The number of qualified teams per country is proportional to the total of international registered teams. The top teams in the final rounds (and not the qualification rounds) will qualify for the European meeting. In the event of a tie, the teams are selected by their ranking at the end of the qualification rounds.

News and more information about Eurobot^{Open} and Eurobot^{Open} Junior are available on our website

www.eurobot.org

(It also contains links to your local organization)

The whole organization team of Eurobot^{Open} and Eurobot^{Open} Junior wishes you a lot of fun and success in the coming months, and looks forward to seeing you soon around our playing areas!

Robotic Regards,

The Eurobot^{Open} Eurobot^{Open} Junior organization committee.

K. APPENDIX

K.1. GENERAL DRAWINGS

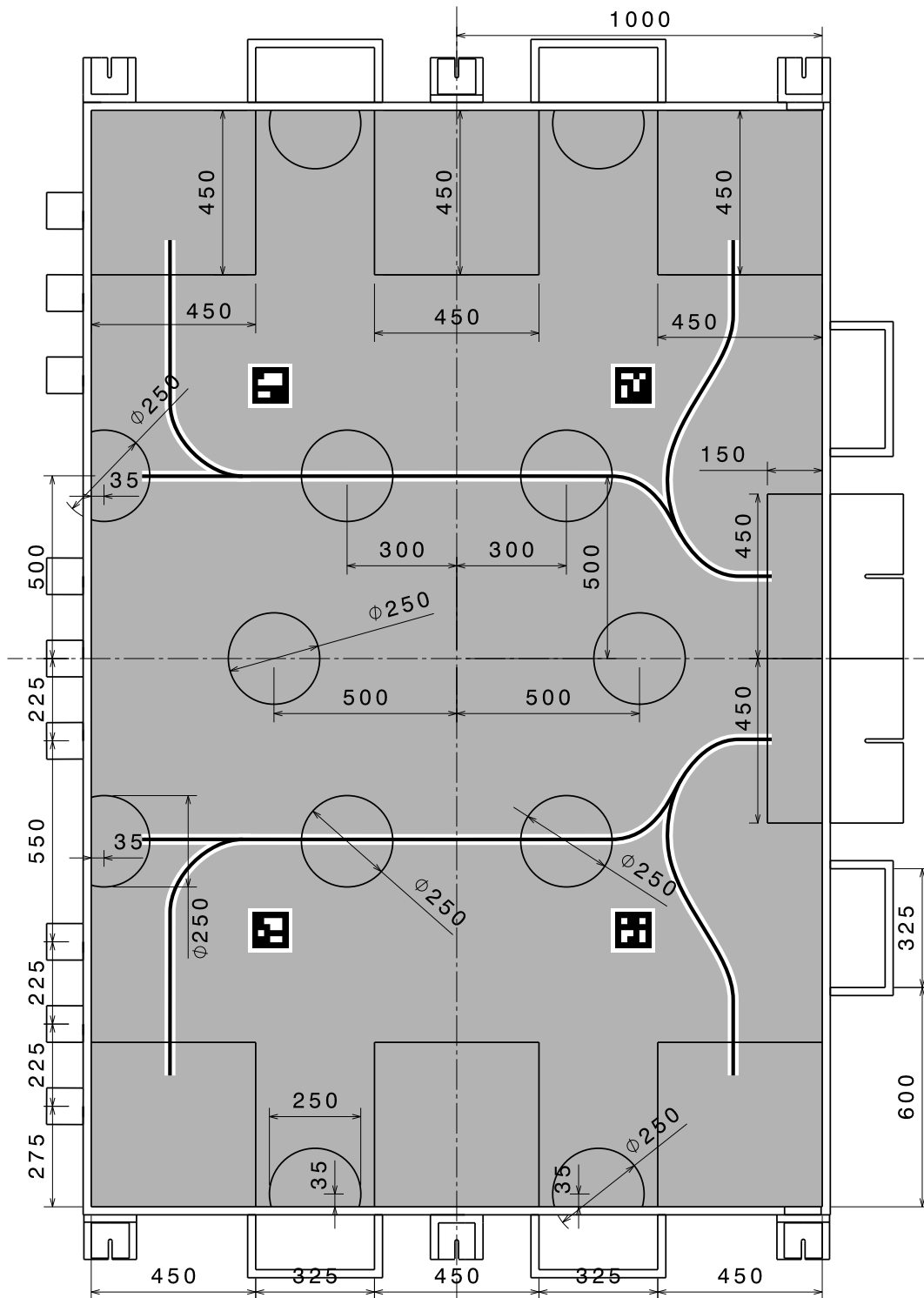


Figure 12: Top view of the playing area.

K.1.a. SOLAR PANEL

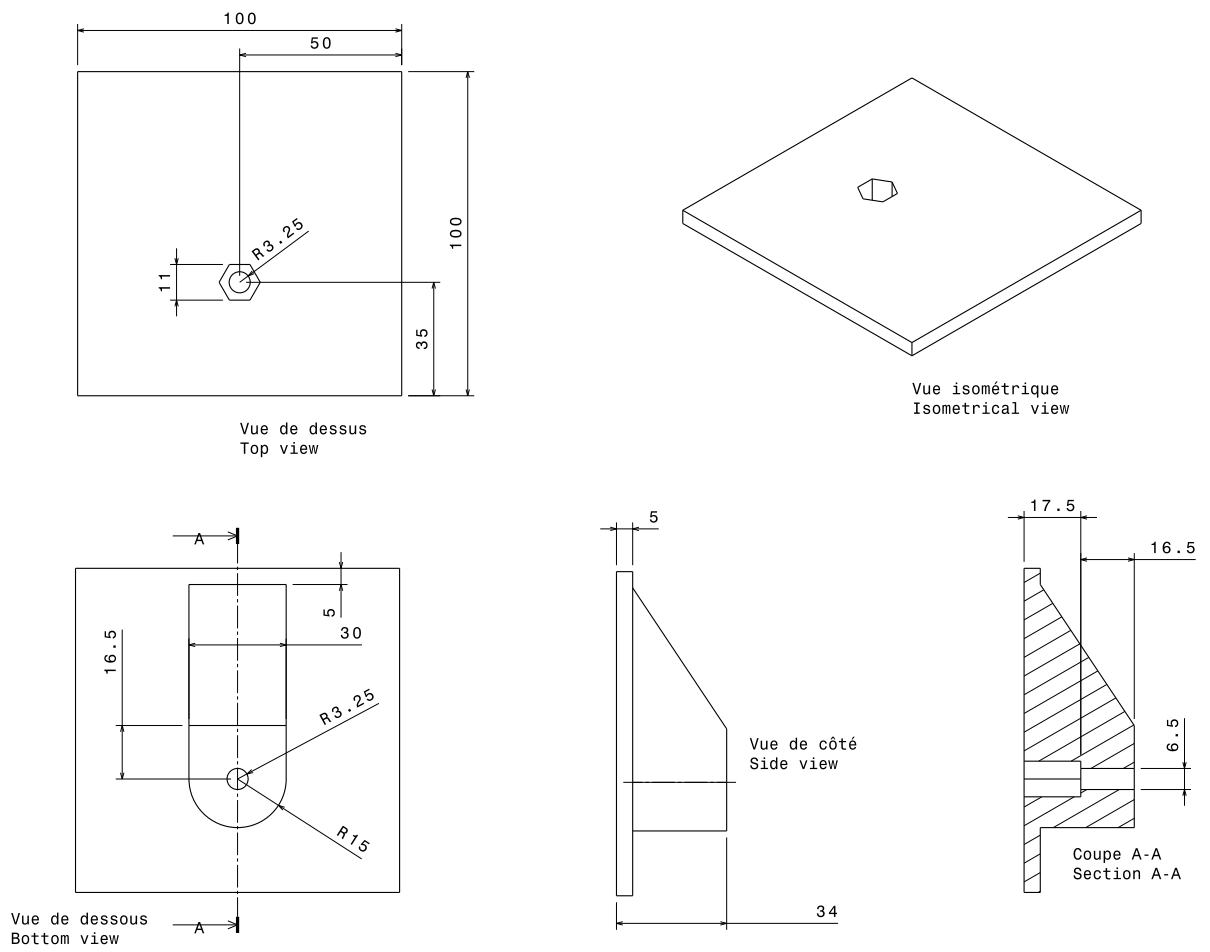
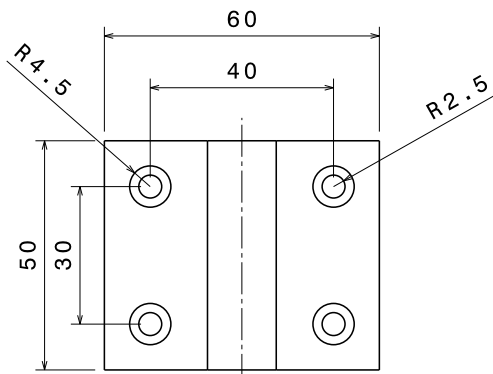
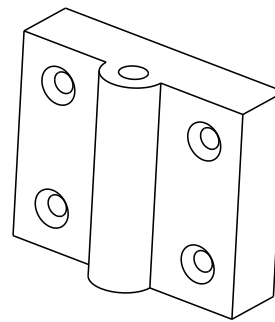


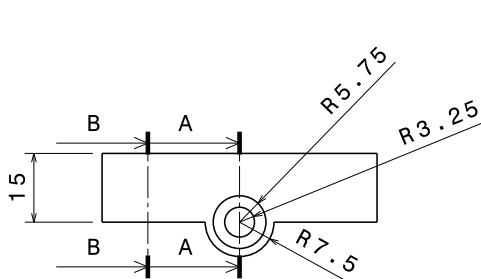
Figure 13: Solar panel



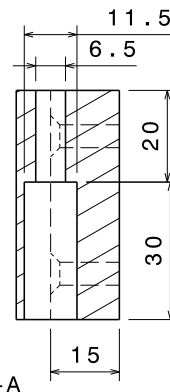
Vue de face
Face view



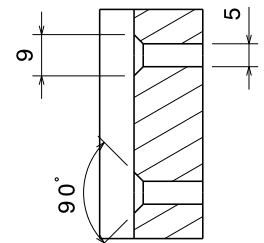
Vue isométrique
Isometrical view



Vue de dessous
Bottom view



Coupe A-A
Section A-A



Coupe B-B
Section B-B

Figure 14: Solar panel support

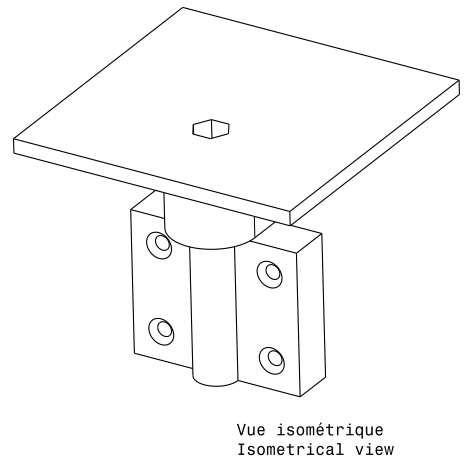
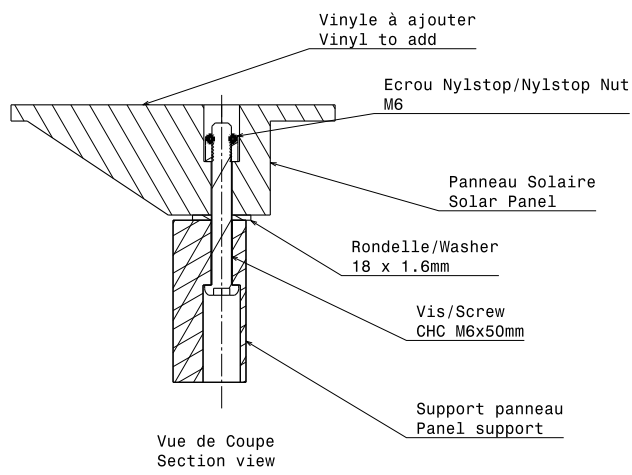


Figure 15: Solar panel assembly

K.1.b. PLANTER

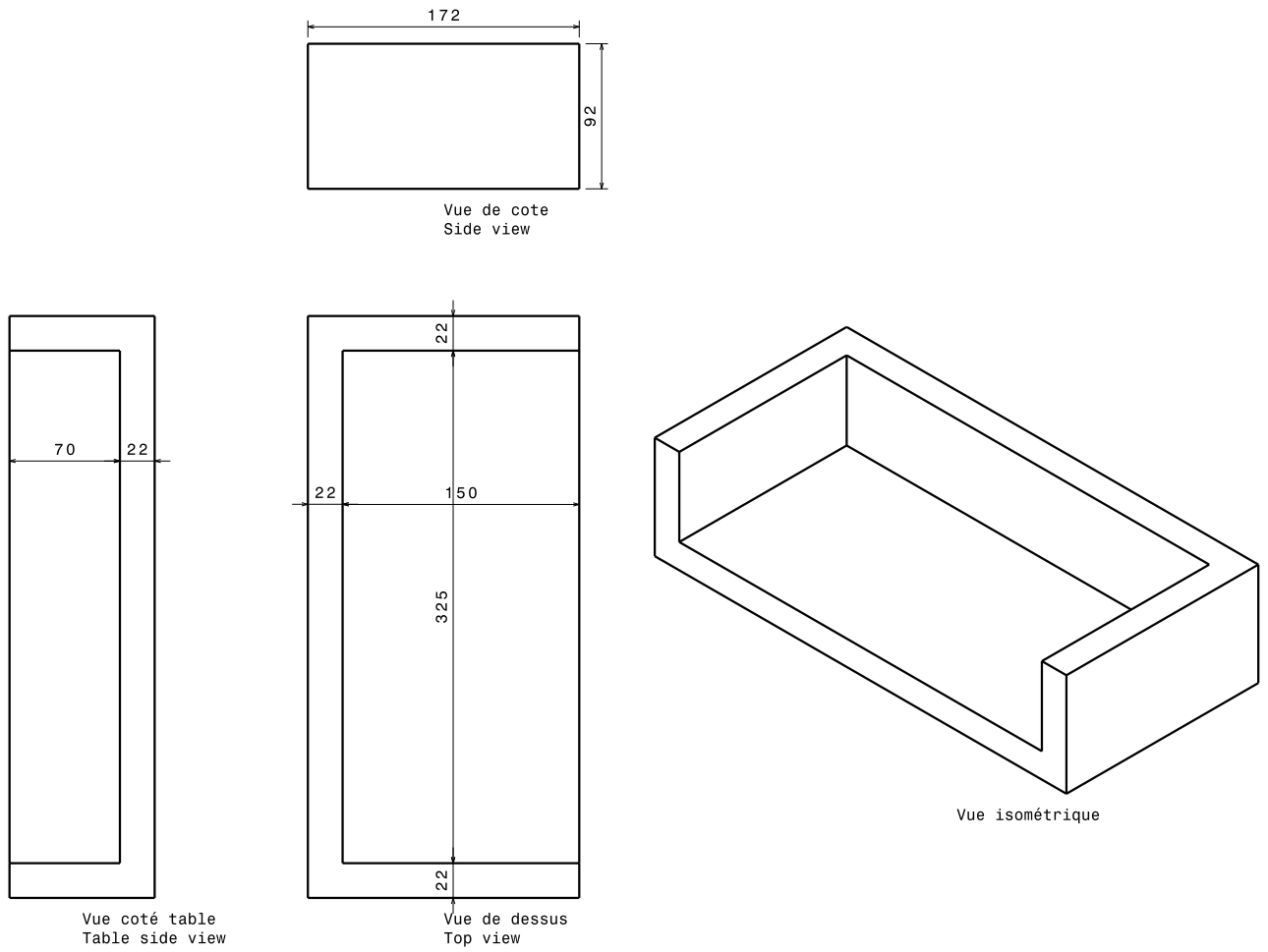


Figure 16: Planter

K.1.c. START TAG

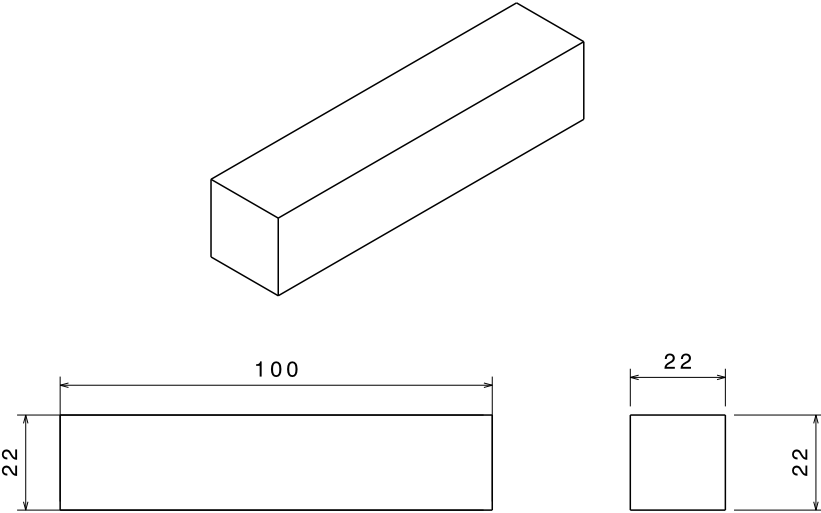


Figure 17: Start tag

K.1.d. POSITIONING

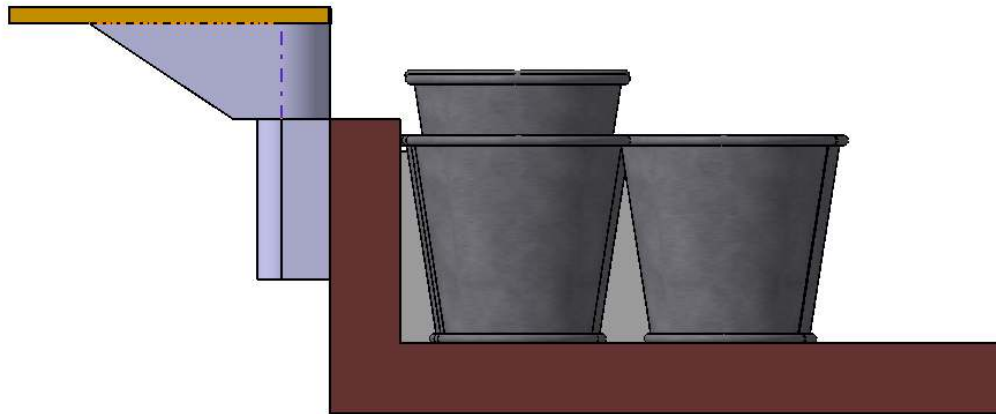


Figure 18: Position of a solar panel

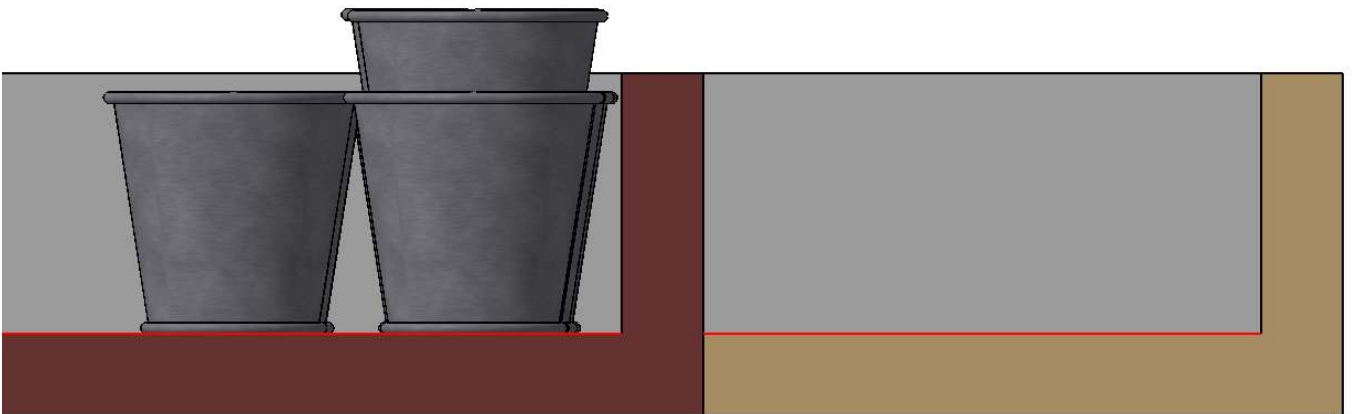


Figure 19: Position of a Planter

K.2. MATERIAL REFERENCES

Elements	Material or reference	Comments
Delicate plants	IKEA Plant, model FEJKA with a 5 cm diameter, sold in packs of 3, covered by printed monomeric gripping vinyl or Plant consisting of a 3D printed PLA pot covered with printed monomeric gripping vinyl and an artificial plant branch.	Ref : 405.084.07 See STL files, print settings and tutorial on www.eurobot.org
Resistant plants	IKEA Plant, model FEJKA with a 5 cm diameter, sold in packs of 3, covered by printed monomeric gripping vinyl or Plant consisting of a 3D printed PLA pot covered with printed monomeric gripping vinyl and an artificial plant branch	Ref : 405.084.07 See STL files, print settings and tutorial on www.eurobot.org
RFID Tags	Tag RFID "NFC Forum Type 2 Tag" compliant	Ref : NTAG213 or NTAG215
Steel pot	IKEA flowerpot cover, model ÅKER-BÄR of 6cm diameter in Galvanized steel of 0.1 Liter. 36 per table. or 3D printed PLA pot	Ref : 905.371.53 See STL files, print settings and tutorial on www.eurobot.org
Solar panel	3D printed in 40% filled PLA cover by printed monomeric gripping vinyl	See STL files, print settings and tutorial on www.eurobot.org
Solar panel support	3D printed in 40% filled PLA.	See STL files, print settings and tutorial on www.eurobot.org
Game floor	Printed monomeric gripping vinyl	Ordering information will be provided by Planète Sciences
Planter	Wood cover by printed monomeric gripping vinyl	
Start Tag	Wood cover by printed monomeric gripping vinyl	

In the case of game elements with two versions, the organization undertakes as much as possible to provide the purchased version of the game element. The second 3D printed version is present in case supply is no longer available during official meetings. For private meetings, the choice is left to the organizer.

K.3. MANUFACTURING TOLERANCES

All dimensions are in millimeters (or mm). Manufacturing tolerances shall comply with the following rules, unless otherwise specified directly on the drawings.

Dimensions	General Tolerances
≤ 20	±1.50
> 20 and ≤ 70	±2.50
> 70 and ≤ 150	±4.00
> 150	±5.00

No objections regarding differences in dimensions will be taken into account.

The material's density can change from one country to another. It is highly recommended that the teams try different types of materials since the weight may differ significantly.

K.4. COLOUR REFERENCES

	Colors	References	CMYK
Team blue	Traffic Blue	RAL 5017 Mat	100% , 60% , 0% , 10%
Team yellow	Traffic yellow	RAL 1023 Mat	0% , 25% , 100% , 0%
Resistant flower Pot	Signal Violet	RAL 4008 Mat	0% , 42% , 2% , 48%
Borders and non-colored elements	Pebble grey	RAL 7032 Mat	15% , 10% , 25% , 20%

RAL hues can vary from a printed soil mat to another.