

## RoboCupJunior Soccer Entry Rules 2023 (Draft)

### 1:1 Lightweight • Draft

#### Soccer League Committee 2022:

Michael Ambrose	USA
Javier E. Delgado Moreno	Mexico
Hikaru Sugiura	Japan
Marco Dankel	Germany (CHAIR)
James Riley	Australia
Adrián Matejov	Slovakia

#### Soccer Technical Committee 2020 and 2021:

Georgia Gallant	USA
Javier E. Delgado Moreno	Mexico
Hikaru Sugiura	Japan
Marco Dankel	Germany
Felipe Nascimento Martins	Netherlands
Marek Šuppa	Slovakia (CHAIR)

## Offizielles Regelwerk - Final Version - RoboCupJunior Austrian Open 2023



Regional and super-regional tournament organizers may use these rules, make changes specific to their regions or not run Entry leagues at all. Contact your regions or super-regions tournament organizers to find out which rules are going to be played at your tournament.



This is a draft version of these rules, subject to change. Suggest changes and tell us what you think of the rules in the public discussion and feedback thread on the RoboCup Junior Forum: <https://junior.forum.robocup.org/t/2023-entry-league-draft-rules-public-discussion-soccer-rules-entry-2023/2705>



This ruleset is not intended to be used at international level, except for super-regional tournaments.

These are the RoboCup Junior Soccer Entry rules for the **1:1 Lightweight League**, proposed for suggested use by regional and super-regional tournaments in the 2023 season. They are released by the RoboCup Junior League Committee. The English version of these rules has priority over any translations.

The aim of this document is to provide an entry-level ruleset for RoboCup Junior Soccer that is harmonized across regions and that may be used as-is or adapted to specific needs at regional and super-regional tournaments. Some regions already have their own, separate version of Soccer Entry rules. Teams are advised to check with the local tournament organizers and Regional Representative regarding updates and changes to this ruleset specific to their location. Each team is responsible for verifying the correct and latest version of the rules prior to competition.

**Figure 1** Two teams with one LWL robot each will compete using an IR ball on RCJ Soccer fields without the out-area. There is no need for using camera vision or line detection. Photo: Andreas Lander



## Preface

In the RoboCupJunior Soccer Entry challenge, teams of young engineers design, build, and program **one**<sup>1</sup> fully autonomous mobile robot to compete against another team in matches. The robots must detect a ball and score into a color-coded goal on a special field that resembles a human soccer field.

To be successful, participants must demonstrate skill in programming, robotics, electronics and mechanics. Teams are also expected to contribute to the advancement of the community as a whole by sharing their discoveries with other participants and by engaging in good sportsmanship, regardless of culture, age or result in the competition. **All are expected to compete, learn, have fun, and grow.**

RoboCupJunior Soccer Entry rules are supplied for one entry-level league modeled after LWL. Some regions run and will probably continue to run an additional league restricted to standard kit components.

These rules are based on the international rulesets. Their main differences compared to those are:

- **The Field** has no out of bounds areas and gameplay may touch the walls. This reduces the complexity of robot construction and gameplay. Use of many existing fields is permissible with no or minor modifications due to flexible dimensions.
- Each team starts **only one robot**
- **The Ball** The league uses the same special ball that emits an IR signal that Light Weight League uses. Please see Rule 6, **BALL** for balls specifications.

## Detailed list of changes compared to regular soccer rules

- Added "Team members can participate only twice"
- Added " Robots may enter the goals. "
- Added "The four corners of the field are flattened in order to make it easier for robots to retrieve the ball from a corner. The flat area is approx. 14cm in width."
- Added "There is no outer area."

<sup>1</sup> In previous version this said "two"

- Added "The goal may or may not have a cross-bar on top. The size of the cross-bar is 2 +/- 1 cm in height."
- Added "smoothly"
- Changed "two" to "one"
- Changed "two" to "one"
- Changed "out of bounds" to "inside the goal"
- Changed "Robots are expected to be capable of dealing with any colors above the walls (e.g. blue, yellow, green or orange shirts) either in hardware (e.g. limiting the field of view from looking up) or in software (e.g. masking the input image)." to "Any person close to playing fields with walls lower than 22cm is not allowed to wear any yellow or blue clothes that can be seen by the robots (to avoid interference). A referee can require a team member to change clothes or to be replaced by another team member if interference is suspected."
- Changed "at most two robots" to "only one robot"
- Changed "A robot must have markings in order to be distinguished by the referee. " to " Top markers (as mentioned in the international rulesets) are not required."
- Changed "158cm" to "between 110 cm and 160 cm"
- Changed "219cm" to "between 180 cm and 225 cm"
- Changed "wall is 22cm" to "wall is between 10cm and 25cm"
- Changed "60 cm" to "45 to 60 cm wide"
- Changed "25cm wide and 80cm long penalty area " to "penalty area (optional). It is decorative and serves no purpose in gameplay."

## 1 Competition Cap

- 1.0.1 **Team members can participate only twice** in leagues played according to this RoboCupJunior Soccer Entry ruleset. After their second participation, they need to move on to the international RCJ Soccer leagues instead.<sup>2</sup>
- 1.0.2 Team members that participated in the international RoboCupJunior Soccer leagues at any level (local, regional, super-regional, international) before may not participate in the Entry league(s) again.

### **Construction and Programming have to be performed exclusively by the students**

- 1.0.3 Robots must be constructed and programmed exclusively by student members of the team. Mentors, teachers, parents or companies should not be involved in the design, construction, assembly, programming or debugging of robots. To avoid possible disqualification, it is extremely important that teams abide by this league's regulations, especially Rule 8.5.D, **Construction** and Rule 8.5.E, **Programming**, and all other competitor's rules.
- 1.0.4 If in doubt, please consult with your Regional Representative before registering your team.

<sup>2</sup> Some regions will have other entry leagues that may be exempt from this rule. Please refer to your local tournament organizers in order to find out in which leagues you may compete.

## 2 GAMEPLAY

### 2.1 Game procedure and length of a game

- 2.1.1 RCJ Soccer games consist of two teams of **one**<sup>3</sup> robot each, playing soccer against each other. Each team has one autonomous robot. The game will consist of two halves. The duration of each half is 10-minutes. There will be a 5-minute break in between the halves.
- 2.1.2 The game clock will run for the duration of the halves without stopping (except when a referee wants to consult another official). The game clock will be run by a referee or a referee assistant (see Rule 8.1, **Referee and referee assistant** for more information on their roles).
- 2.1.3 Teams are expected to be at the field 5 minutes before their game starts. Being at the inspection table does not count in favor of this time limit. Teams that are late for the start of the game may be penalized one goal **per 30 seconds** at the referee's discretion.
- 2.1.4 The final game score will be trimmed so that there is at most 10-goal difference between the losing and the winning team.

### 2.2 Pre-match meeting

- 2.2.1 At the start of the first half of the game, a referee will toss a coin. The team mentioned first in the draw shall call the coin. The winner of the toss can choose either which end to kick towards, or to kick off first. The loser of the toss chooses the other option. After the first half, teams switch sides. The team not kicking off in the first half of the game will kick off to begin the second half of the game.
- 2.2.2 During the pre-match meeting the referee or their assistant may check whether the robots are capable of playing (i.e., whether they are at least able to follow and react to the ball). If none of the robots is capable of playing, the game will not be played and zero goals will be awarded to both teams.

### 2.3 Kick-off

- 2.3.1 Each half of the game begins with a kick-off. All robots must be located on their own side of the field. All robots must be halted. The ball is positioned by a referee in the center of the field.
- 2.3.2 The team kicking off places their robot on the field first.
- 2.3.3 The team not kicking off will now place their robot on the defensive end of the field. The robot on the team not kicking off must be at least 30 cm away from the ball (outside of the center circle).
- 2.3.4 Robots cannot be placed **inside the goal**<sup>4</sup>. Robots cannot be repositioned once they have been placed, except if the referee requests to adjust their placement to make sure that the robots are placed properly within the field positions.
- 2.3.5 On the referee's command (usually by whistle), all robots will be started immediately by each captain. Any robots that are started early will be removed by the referee from the field and deemed damaged.
- 2.3.6 Before a kick-off, **all damaged robots** are allowed to return to the playing field immediately if they are *ready and fully functional*.
- 2.3.7 If no robots are present at a kick-off (because they are damaged Rule 2.8, **Damaged robots**), the penalties are discarded and the match resumes with a Rule 2.3.A, **Neutral kick-off**.

---

<sup>3</sup> In previous version this said "two"

<sup>4</sup> In previous version this said "out of bounds"

### 2.3.A Neutral kick-off

- 2.3.A.1 A neutral kick-off is the same as the one described in Rule 2.3, **Kick-off** with a small change: all robots must be at least 30 cm away from the ball (outside of the center circle).

## 2.4 Human interference

- 2.4.1 Except for the kick-off, human interference from the teams (e.g. touching the robots) during the game is not allowed unless explicitly permitted by a referee. Violating team(s)/team member(s) may be disqualified from the game.
- 2.4.2 The referee or a referee assistant can help robots get unstuck if the ball is not being disputed near them and if the situation was created from normal interaction between robots (i.e. it was not a design or programming flaw of the robot alone). The referee or a referee assistant will pull back the robots just enough for them to be able to move freely again.

## 2.5 Ball movement

- 2.5.1 A robot cannot hold a ball. Holding a ball is defined as taking full control of the ball by removing all of degrees of freedom. Examples for ball holding include fixing a ball to the robot's body, surrounding a ball using the robot's body to prevent access by others, encircling the ball or somehow trapping the ball with any part of the robot's body. If a ball does not roll while a robot is moving, it is a good indication that the ball is trapped.
- 2.5.2 The only exception to holding is the use of a rotating drum (a "dribbler") that imparts dynamic back spin on the ball to keep the ball on its surface.
- 2.5.3 Other players must be able to access the ball.
- 2.5.4 The ball needs to stay within the bounds of the field, as defined by the walls. If a robot moves the ball outside of the field (that is, beyond the walls or above their height), it is deemed damaged. (Rule 2.8, **Damaged robots**)

## 2.6 Scoring

- 2.6.1 A goal is scored when the ball strikes or touches the back wall of the goal. Goals scored by any robot have the same end result: they give one goal to the team on the opposite side. After a goal, the game will be restarted with a kick-off from the team who was scored against.

## 2.7 Lack of progress

- 2.7.1 Lack of progress occurs if there is no progress in the gameplay for a reasonable period of time and the situation is not likely to change. Typical lack of progress situations are when the ball is stuck between robots, when there is no change in ball and robot's positions, or when the ball is beyond detection or reach capability of all robots on the field.
- 2.7.2 After a visible and loud count <sup>5</sup>, a referee will call **lack of progress** and will move the ball to the nearest unoccupied neutral spot. If this does not solve the lack of progress, the referee can move the ball to a different neutral spot.

---

<sup>5</sup> usually a count of three

## 2.8 Damaged robots

- 2.8.1 If a robot is damaged, it has to be taken off the field and must be fixed before it can play again. Even if repaired, the robot must remain off the field for at least one minute or until the next kick-off is due.
- 2.8.2 Some examples of a damaged robot include:
- it does not respond to the ball, or is unable to move (it lost pieces, power, etc.).
  - it turns over on its own accord.
- 2.8.3 Computers and repair equipment are not permitted in the playing area during gameplay. Usually, a team member will need to take the damaged robot to an “approved repair table” near the playing area. A referee may permit robot sensor calibration, computers and other tools in the playing area, only for the 5 minutes before the start of each half.
- 2.8.4 After a robot has been fixed, it will be placed on the unoccupied neutral spot furthest from the ball, facing its own goal. A robot can only be returned to the field if the damage has been repaired. If the referee notices that the robot was returned to the field with the same original problem, they may ask the robot to be removed and proceed with the game as if the robot had not been returned.
- 2.8.5 **Only the referee decides whether a robot is damaged.** A robot can only be taken off or returned with the referee’s permission.
- 2.8.6 Whenever a robot is removed from play, its motors must be turned off.

## 2.9 Interruption of Game

- 2.9.1 In principle, a game will not be stopped.
- 2.9.2 A referee can stop the game if there is a situation on or around the field which the referee wants to discuss with an official of the tournament or if the ball malfunctions and a replacement is not readily available.
- 2.9.3 When the referee has stopped the game, all robots must be stopped and remain on the field untouched. The referee may decide whether the game will be continued/resumed from the situation in which the game was stopped or by a kick-off.

# 3 TEAM

## 3.1 Regulations

- 3.1.1 A team must have more than one member to form a RoboCupJunior team to participate in the competition. A team member(s) and/or robot(s) cannot be shared between teams. The maximum number of team members is defined by each competition respectively, but is usually 4.
- 3.1.2 Each team member needs to carry a technical role.
- 3.1.3 Each team must have a **captain**. The captain is the person responsible for communication with referees. The team can replace its captain with another team member during the competition. Each team is allowed to have at most two members beside the field during gameplay: they will usually be the captain and an assistant team member.

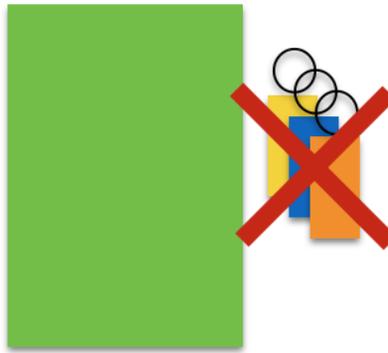
## 3.2 Violations

- 3.2.1 Teams that do not abide by the rules are not allowed to participate.
- 3.2.2 **Any person close to playing fields with walls lower than 22cm is not allowed to wear any yellow or blue clothes that can be seen by the robots (to avoid interference). A referee can require a team member to change clothes or to be replaced by another team member if interference is suspected.**<sup>6</sup>
- 3.2.3 The referee can interrupt a game in progress if any kind of interference from spectators is suspected (color clothing, IR emitters, camera flashes, mobile phones, radios, computers, etc.).
- 3.2.4 This needs to be confirmed by the tournament organizers if a claim is placed by the other team. A team claiming that their robot is affected by colors has to show the proof/evidence of the interference.

---

**Figure 2** Anyone close to the playing field is not allowed to wear orange, yellow or blue clothes

---



## 4 ROBOTS

### 4.1 Number of robots / substitutions

- 4.1.1 Each team is allowed to have **only one robot**<sup>7</sup> for the full tournament. The substitution of robots during the competition within the team or with other teams is forbidden.

### 4.2 Interference

- 4.2.1 Robots are not allowed to be colored yellow or blue in order to avoid interference. Yellow or blue colored parts used in the construction of the robot must either be occluded by other parts from the perception by another robot or be taped/painted with a neutral color.
- 4.2.2 Robots must not produce magnetic interference in another robot on the field.
- 4.2.3 Robots must not produce visible light that may prevent the opposing team from playing when placed on a flat surface. Any part of a robot that produces light that may interfere with the opposing robot's vision system must be covered.

---

<sup>6</sup> In previous version this said "Robots are expected to be capable of dealing with any colors above the walls (e.g. blue, yellow, green or orange shirts) either in hardware (e.g. limiting the field of view from looking up) or in software (e.g. masking the input image)."

<sup>7</sup> In previous version this said "at most two robots"

- 4.2.4 A team claiming that their robot is affected by the other team's robot in any way must show the proof/evidence of the interference. Any interference needs to be confirmed by the tournament organizers if a claim is placed by the other team.

### 4.3 Control

- 4.3.1 The use of remote control of any kind is not allowed during the match. Robots must be started and stopped manually by humans and be controlled autonomously.

### 4.4 Agility

- 4.4.1 Robots must be constructed and programmed in a way that their movement is not limited to only one dimension (defined as a single axis, such as only moving in a straight line). They must move in all directions, for example by turning.
- 4.4.2 Robots must respond to the ball in a direct forward movement towards it. For example, it is not enough to basically just move left and right in front of their own goal, it must also move directly towards the ball in a forward movement. A robot must be able to seek and approach the ball anywhere on the field.
- 4.4.3 A robot must touch the ball that is placed no further than 20 cm from any point on its convex hull within 10 seconds. If a robot does not do so within the time limit, it is deemed to be damaged. (See **Damaged Robots.**)
- 4.4.4 **\* Robots may enter the goals. \***

### 4.5 Handle

- 4.5.1 All robots must have a stable and easily noticeable handle to hold and to lift them. The handle must be easily accessible and allow the robot to be picked up from at least 5 cm above the highest structure of the robot.
- 4.5.2 The dimensions of the handle may exceed the robot height limitation, but the part of the handle that exceeds this limit cannot be used to mount components of the robot.

### 4.6 Top Markers

- 4.6.1 **\* Top markers (as mentioned in the international rulesets) are not required.\*<sup>8</sup>**

### 4.7 Violations

- 4.7.1 Robots that do not abide by these specifications/regulations are not allowed to play.
- 4.7.2 If violations are detected during a running game the team may be disqualified for that game.
- 4.7.3 If similar violations occur repeatedly, the team may be disqualified from the tournament.

---

<sup>8</sup> In previous version this said "A robot must have markings in order to be distinguished by the referee. "

## 5 FIELD

### 5.1 Dimensions of the field

- 5.1.1 The playing field is **between 110 cm and 160 cm**<sup>9</sup> in width.
- 5.1.2 The playing field is **between 180 cm and 225 cm**<sup>10</sup> in depth.
- 5.1.3 This allows for re-using existing equipment such as older RCJ soccer fields (122 cm by 183 cm, used to be called "Soccer A") which is recommended where available or FLL (236 cm, 221 cm with goals placed inside by 114 cm) and regular RCJ Soccer fields to be temporarily converted with some temporary wooden walls (219 cm x 158 cm with walls on lines). Teams should contact the organizers of their tournament about the exact dimensions used within the competition.

### 5.2 Walls

- 5.2.1 Walls are placed all around the field. The height of the **wall is between 10cm and 25cm**<sup>11</sup>. A height of at least 14 cm is recommended. The walls are painted matte black.
- 5.2.2 **The four corners of the field are flattened in order to make it easier for robots to retrieve the ball from a corner. The flat area is approx. 14cm in width.**
- 5.2.3 **There is no outer area.**

### 5.3 Goals

- 5.3.1 The field has two goals, centered on each of the shorter sides of the playing field. The goal inner space is **45 to 60 cm wide**<sup>12</sup> and 74 mm deep. It is outside the playing field (submerged into the walls). The height of the goal is equal to the height of the walls.
- 5.3.2 **The goal \*may or may not have a cross-bar on top. The size of the cross-bar is 2 +/- 1 cm in height.\***
- 5.3.3 The interior walls and the crossbar of each goal are colored matte, one goal in yellow, the other goal in blue.
- 5.3.4 It is recommended that the blue be of a brighter shade so that it is different enough from the black exterior.

### 5.4 Floor

- 5.4.1 The floor consists of green carpet ideally of darker shade on top of a hard level surface. Teams should be prepared to adjust to different levels of contrast between the green carpet and lines as some events may be restricted to using lighter shades of green. All lines on the field should be painted, marked with tape or installed as white carpet and be somewhat resistant to tearing or ripping. Lines should have a width of 20mm ( $\pm 10\%$ ).
- 5.4.2 It is impractical to set international constraints on carpet other than it being green. In the spirit of the competition, teams should design robots to be tolerant or adaptable to different fibers, textures, construction, density, shades and designs of carpet especially when competing amongst different regions. Teams

---

<sup>9</sup> In previous version this said "158cm"

<sup>10</sup> In previous version this said "219cm"

<sup>11</sup> In previous version this said "wall is 22cm"

<sup>12</sup> In previous version this said "60 cm"

are encouraged to visit regional resources or reach out to Local Organization Committee for suggestions if desiring to build their own practice field(s).

## 5.5 Neutral spots

- 5.5.1 There are five neutral spots defined in the field. One is in the center of the field. The other four are adjacent to each corner, located 45 cm along the long edge of the field, aligned with each goal post towards the middle of the field (from the goal post). The neutral spots can be drawn with a thin black marker. The neutral spots ought to be of circular shape measuring 1 cm in diameter.

## 5.6 Center circle

- 5.6.1 A center circle will be drawn on the field. It is 60 cm in diameter. It is a thin black marker line. It is there for Referees and Captains as guidance during kick-off.

## 5.7 Penalty areas

- 5.7.1 In front of each goal there is a **penalty area (optional). It is decorative and serves no purpose in gameplay.** <sup>13</sup>

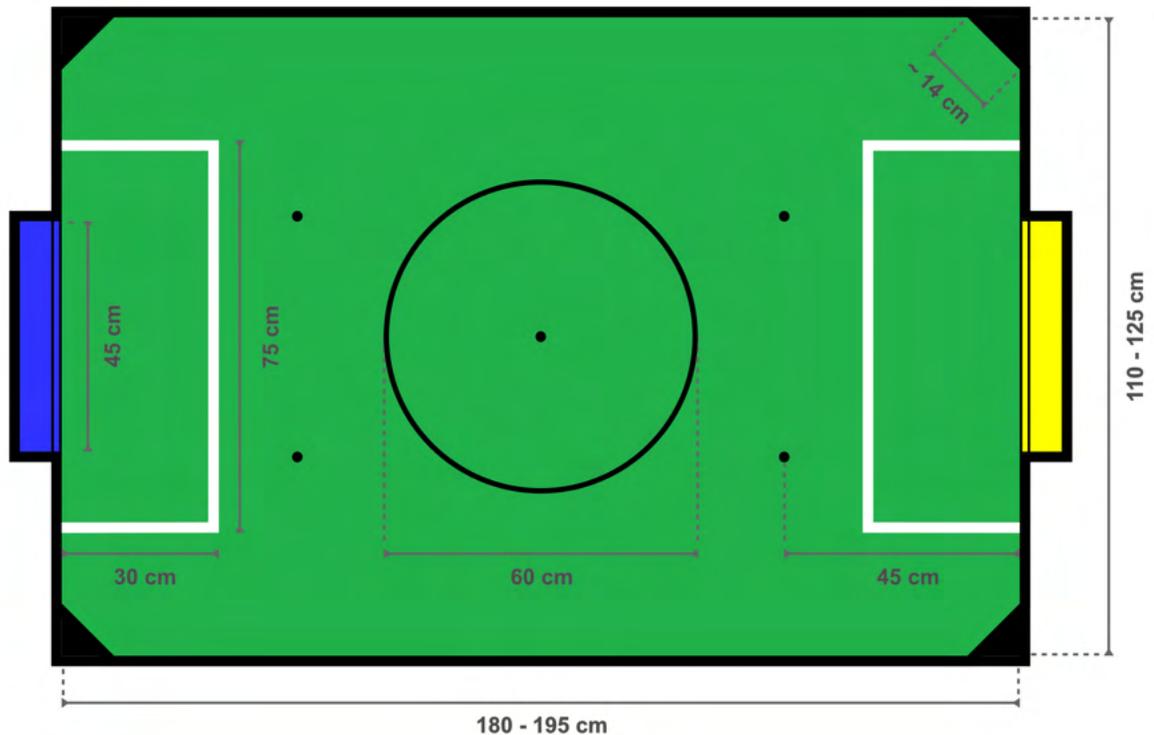
## 5.8 Lighting and Magnetic Conditions

- 5.8.1 The tournament organizers will do their best to limit the amount of external lightning and magnetic interference. However, the robots need to be constructed in a way which allows them to work in conditions that are not perfect (i.e. by not relying on compass sensors or specific lightning conditions).

---

<sup>13</sup> In previous version this said "25cm wide and 80cm long penalty area "

## FIELD DIAGRAMS



5.8.2

## 6 BALL

### 6.1 Specification for Soccer Entry Ball

6.1.1 See Appendix A, [Technical Specification for pulsed Soccer Ball](#).

### 6.2 Tournament balls

6.2.1 Balls for the tournament must be made available by the tournament organizers. Tournament organizers are not responsible for providing balls for practice.

## 7 CODE OF CONDUCT

### 7.1 Fair Play

7.1.1 It is expected that the aim of all teams is to play a fair and clean game of robot soccer. It is expected that all robots will be built with consideration to other participants.



- 7.1.2 Robots are not allowed to cause deliberate interference with or damage to other robots during normal gameplay.
- 7.1.3 Robots are not allowed to cause damage to the field or to the ball during normal gameplay.
- 7.1.4 A robot that causes damage may be disqualified from a specific match at the tournament organizer's discretion.
- 7.1.5 Humans are not allowed to cause deliberate interference with robots or damage to the field or the ball.

## 7.2 Behavior

- 7.2.1 All participants are expected to behave themselves. All movement and behavior is to be of a subdued nature within the tournament venue.

## 7.3 Help

- 7.3.1 Mentors (teachers, parents, chaperones, and other adult team-members including translators) are not allowed in the student work area unless it is explicitly but temporarily permitted by tournament organizers. Only participating students are allowed to be inside the work area.
- 7.3.2 **Mentors must not touch, build, repair, or program any robots.**

## 7.4 Sharing

- 7.4.1 The understanding that any technological and curricular developments should be shared among the RoboCup and RoboCupJunior participants after the tournament has been a part of world RoboCup competitions.

## 7.5 Spirit

- 7.5.1 It is expected that all participants, students, mentors, and parents will respect the RoboCupJunior mission.
- 7.5.2 ***It is not whether you win or lose, but how much you learn that counts!***

## 7.6 Violations / Disqualification

- 7.6.1 Teams that violate the code of conduct may be disqualified from the tournament. It is also possible to disqualify only single person or single robot from further participation in the tournament.
- 7.6.2 In less severe cases of violations of the code of conduct, a team will be given a warning. In severe or repeated cases of violations of the code of conduct a team may be disqualified immediately without a warning.

## 8 CONFLICT RESOLUTION

### 8.1 Referee and referee assistant

- 8.1.1 The referee is a person in charge of making decisions with regards to the game, according to these rules, and may be assisted by a referee assistant.
- 8.1.2 **During gameplay, the decisions made by the referee and/or the referee assistant are final.**
- 8.1.3 Any argument with the referee or the referee assistant can result in a warning. If the argument continues or another argument occurs, this may result in immediate disqualification from the game.
- 8.1.4 Only the captain has a mandate to freely speak to the referee and/or their assistant. Shouting at a referee and/or their assistant, as well as demanding a change in ruling may be penalized by a warning at the referee's discretion.
- 8.1.5 At the conclusion of the game, the result recorded in the scoresheet is final. The referee will ask the captains to add written comments to the scoresheet if they consider them necessary. These comments will be reviewed by the tournament organizers.

### 8.2 Rule clarification

- 8.2.1 Rule clarification may be made by members of the tournament organizers and the Soccer League Committee, if necessary even during a tournament.

### 8.3 Rule modification

- 8.3.1 If special circumstances, such as unforeseen problems or capabilities of a robot occur, rules may be modified by the tournament organizers, if necessary even during a tournament.

### 8.4 Regulatory statutes

- 8.4.1 Each RoboCupJunior competition may have its own regulatory statutes to define the procedure of the tournament (for example the SuperTeam system, game modes, the inspection of robots, interviews, schedules, etc.). Regulatory statutes become a part of this rule.

### 8.5 Regulations

#### 8.5.A Dimensions

- 8.5.A.1 Robots will be measured in an upright position with all parts extended. A robot's dimensions must not exceed the following limits:

size <sup>[0]</sup>	22.0 cm
height	22.0 cm <sup>[1]</sup>
weight	1100 g <sup>[2]</sup>
ball-capturing zone	3.0 cm
voltage	12.0 V <sup>[3]</sup> <sup>[4]</sup>



[0] Robot must fit **smoothly** into a cylinder of this diameter



[1] The handle of a robot may exceed the height.



[2] The weight of the robot includes that of the handle.



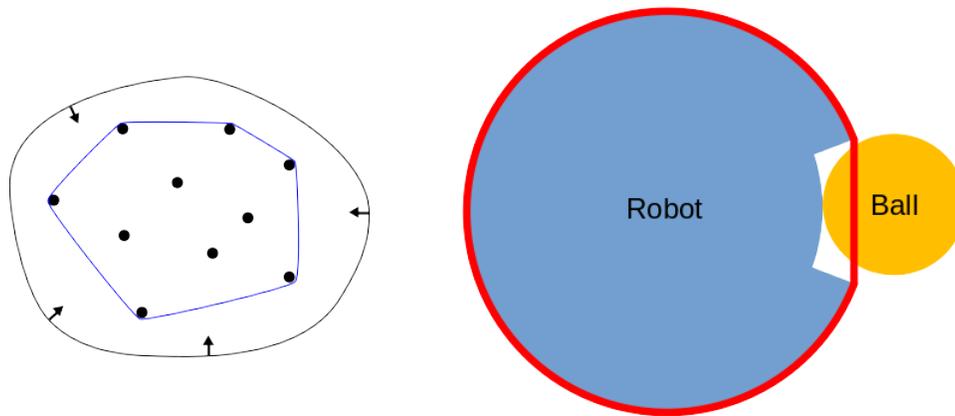
[3] We **strongly** encourage teams to include protection circuits for Lithium-based batteries



[4] Voltage limits relate to the **nominal values**, deviations at the power pack due to the fact that charged will be tolerated.

8.5.A.2 Ball-capturing zone is defined as any internal space created when a straight edge is placed on the protruding points of a robot. This means the ball must not enter the convex hull of a robot by more than the specified depth. Furthermore, it must be possible for another robot to take possession of the ball.

**Figure 3** Think of the convex hull requirement as a rubber band that must fit around all points of the robot, i.e. the ball may not go inside the convex hull (red line) more than allowed



### 8.5.B Infrared interference

- 8.5.B.1 Components designed to emit IR (e.g. ToF, LiDAR, IR distance sensors, IR LEDs/LASERS etc.) are not allowed and tournament organizers will require such devices to be removed or covered up.
- 8.5.B.2 Infrared light reflecting materials must not be visible. If robots are painted, they must be painted matte. Minor parts that reflect infrared light could be used as long as other robots are not affected.

### 8.5.C Limitations

- 8.5.C.1 A robot may use any number of cameras without restrictions on lenses, optical parts, optical systems, and total field of view. Components may be sourced in any way the team sees fit.
- 8.5.C.2 Voltage pump circuits are permitted only for a kicker drive. No voltage may exceed 48V at any time and maximum boost voltage must be available for demonstration and measurement at inspections. When not in use measurement contacts must be protected from accidental touches or short circuits. All other electrical circuits inside the robot cannot exceed 12.0 V. Each robot must be designed to allow verifying the voltage of power packs and its circuits, unless the nominal voltage is obvious by looking at the robot, its power packs and connections.
- 8.5.C.3 Pneumatic devices are allowed to use ambient air only.
- 8.5.C.4 Kicker strength is subject to compliance check at any time during the competition. During gameplay, a referee can ask to see a sample kick on the field before each half when a damaged robot is returned to the field or when the game is about to be restarted after a goal. If the referee strongly suspects that a kicker exceeds the power limit, they can require an official measurement. See [?] for more details.

### 8.5.D Construction



Robots must be constructed exclusively by the student members of a team. Mentors, teachers, parents or companies may not be involved in the design, construction, and assembly of robots.

- 8.5.D.1 For the construction of a robot, any robot kit or building block may be used as long as the design and construction are primarily and substantially the original work of a team. This means that commercial kits may be used but must be substantially modified by the team. It is neither allowed to mainly follow a construction manual, nor to just change unimportant parts.
- 8.5.D.2 Indications for violations are the use of commercial kits that can basically only be assembled in one way or the fact that robots from different team(s), build from the same commercial kit, all basically look or function the same.
- 8.5.D.3 Robots must be constructed in a way that they can be started by the captain without the help of another person.
- 8.5.D.4 Since a contact with an opponent robot and/or dribbler that might damage some parts of robots cannot be fully anticipated, **robots must have all its active elements properly protected with resistant materials**. For example, electrical circuits and pneumatic devices, such as pipelines and bottles, must be protected from all human contact and direct contact with other robots.



All driven dribbler gears must be covered with metal or hard plastic.

- 8.5.D.5 When batteries are transported or moved, it is **strongly** recommended that safety bags be used. Reasonable efforts should be made to make sure that in all circumstances robots avoid short-circuits and chemical or air leaks.



The use of swollen, tattered or otherwise dangerous battery is not allowed.

### 8.5.E Programming

- 8.5.E.1 Robots must be programmed exclusively by student members of the team. Mentors, teachers, parents or companies should not be involved in the programming and debugging of robots.
- 8.5.E.2 For the programming of the robots, any programming language, interface or integrated development environment (IDE) may be used. The use of programs that come together with a commercial kit (especially sample programs or presets) or substantial parts of such programs are not allowed. It is not allowed to use sample programs, not even if they are modified.

## 8.5.F Inspections

- 8.5.F.1 Robots must be inspected and certified every day before the first game is played. The tournament organizers may request other inspections if necessary, including random inspections which may happen at any time. The routine inspections include:
- Weight restrictions (see Rule 8.5.A, Dimensions).
  - Robot dimensions (see Rule 8.5.A, Dimensions).
  - Voltage restrictions (see Rule 8.5.A, Dimensions and Rule 8.5.C, Limitations).
  - Kicker strength limits, if the robot has a kicker (see [?]).
- 8.5.F.2 Proof must be provided by each team that its robots comply with these regulations, for example, by a detailed documentation or logbook. Teams may be interviewed about their robots and the development process at any time during a tournament.

# A Technical Specification for pulsed Soccer Ball

## 1.1 Preamble

- 1.1.1 Answering to the request for a soccer ball for RCJ tournaments that would be more robust to interfering lights, less energy consuming and mechanically more resistant, the Soccer League Committee defined the following technical specifications with the special collaboration from EK Japan and HiTechnic.
- 1.1.2 Producers of these balls must apply for a certification process upon which they can exhibit the RCJ-compliant label and their balls used in RCJ tournaments.
- 1.1.3 Balls with these specifications can be detected using specific sensors but also common IR remote control receivers (TSOP1140, TSOP31140, GP1UX511QS, etc. - on-off detection with a possible gross indication of distance).

## 1.2 Specifications

### 1.2.A IR light

- 1.2.A.1 The ball emits infra-red (IR) light of wavelengths in the range 920nm - 960nm, pulsed at a square-wave carrier frequency of 40 kHz. The ball should have enough ultra-bright, wide-angle LEDs to minimize unevenness of the IR output.

### 1.2.B Diameter

- 1.2.B.1 The diameter of the ball is required to be 74mm. A well-balanced ball shall be used.

### 1.2.C Drop Test

- 1.2.C.1 The ball must be able to resist normal gameplay. As an indication of its durability, it should be able to survive, undamaged, a free-fall from 1.5 meters onto a hardwood table or floor.



### 1.2.D Modulation

- 1.2.D.1 The 40 kHz carrier output of the ball shall be modulated with a trapezoidal (stepped) waveform of frequency 1.2 kHz. Each 833-microsecond cycle of the modulation waveform shall comprise 8 carrier pulses at full intensity, followed (in turn) by 4 carrier pulses at 1/4 of full intensity, four pulses at 1/16 of full intensity and four pulses at 1/64 of full intensity, followed by a space (i.e. zero intensity) of about 346 microseconds. The peak current level in the LEDs shall be within the range 45-55mA. The radiant intensity shall be more than 20mW/sr per LED.

### 1.2.E Battery Life

- 1.2.E.1 If the ball has an embedded rechargeable battery, when new and fully charged it should last for more than 3 hours of continuous use before the brightness of the LEDs drops to 90% of the initial value. If the ball uses replaceable batteries, a set of new high-quality alkaline batteries should last for more than 8 hours of continuous use before the brightness of the LEDs drops to 90% of the initial value.

### 1.2.F Coloration

- 1.2.F.1 The ball must not have any marks or discoloration that can be confused with goals, or the field itself.

## 1.3 Official suppliers for pulsed balls

- 1.3.1 Currently, there is one ball that has been approved by the Soccer League Committee:
- RoboCup Junior Soccer ball operating in MODE A (pulsed) made by EK Japan/Elekit (<https://elekit.co.jp/en/product/RCJ-05R>)
- 1.3.2 Note that this ball was previously called RCJ-05. While you may not be able to find a ball with this name anymore, any IR ball produced by EK Japan/Elekit is considered to be approved by the Soccer League Committee.

## 1.4 Soccer Entry Kicker Power Measurement Device

- 1.4.1 This Kicker Power Measuring Device can measure the power of a robot's kicker. It is easy to build with commonly accessible materials.
- 1.4.2 This device can measure the power of a robot's kicker up to a length of 22cm.



1.4.3

#### 1.4.A Materials

Plastic Board	A4 paper size
M3 Spacers	5
M3 Screw	10



The M3 spacers are different for each league, due to the different size of the ball. For the Lightweight league, please use **40mm** spacer and for the open league please use **25mm** spacer.

#### 1.4.B Device schematics

1.4.B.1 The device schematics can be printed out from the diagram located at the end of the document. Please be advised to check that the software you use to print the schematic does not have a **scale to fit** option activated (i.e. check that it is configured to print at 100% or **actual size** scale).



The device schematics shows a straight line past the 22cm mark, while the photo shows the line at that point to be curved. Either straight or curved lines are acceptable, but a curved line will request more difficult cutting and the attached device schematic is simple enough for quick construction.

#### 1.4.C Example of device construction

- a. Print out the device schematics.
- b. Paste the paper on a plastic board. The incline line (red lines) should be straight.
- c. Cut out along the lines and drill the holes.
- d. The two boards should be connected using the 40mm (Lightweight) or 25mm (Open) spacers.

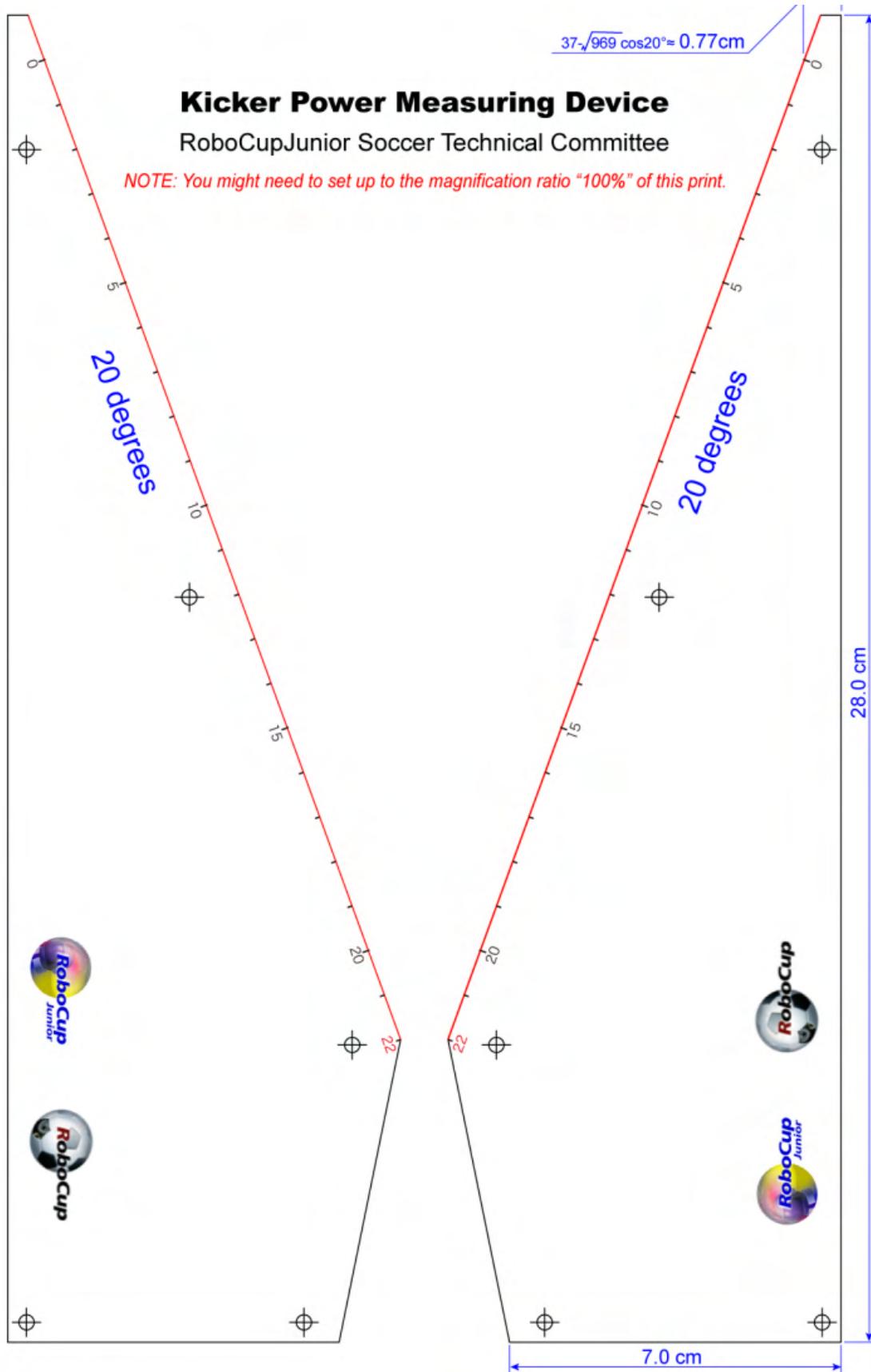


You can find the image of the schematic at [https://github.com/RoboCupJuniorTC/soccer-rules/blob/master/kicker\\_testing\\_schematics.png](https://github.com/RoboCupJuniorTC/soccer-rules/blob/master/kicker_testing_schematics.png)

#### 1.4.D Soccer Lightweight Kicker Power Measurement Procedure

- a. Place a ball at the bottom of the ramp run of the device, and put the robot in front of the ball, aiming the kicker towards the top of the ramp.
- b. Activate the robot's kicker for a single shot.
- c. Measure the distance that the ball traveled on the device. The distance should not exceed 22 cm.





1.4.D.1