

BinaryBlocks – Robofest® 2019 Game

Jan 12, 2019 – v1.1 Official Final Version (Changes after US Kick off version are in red)

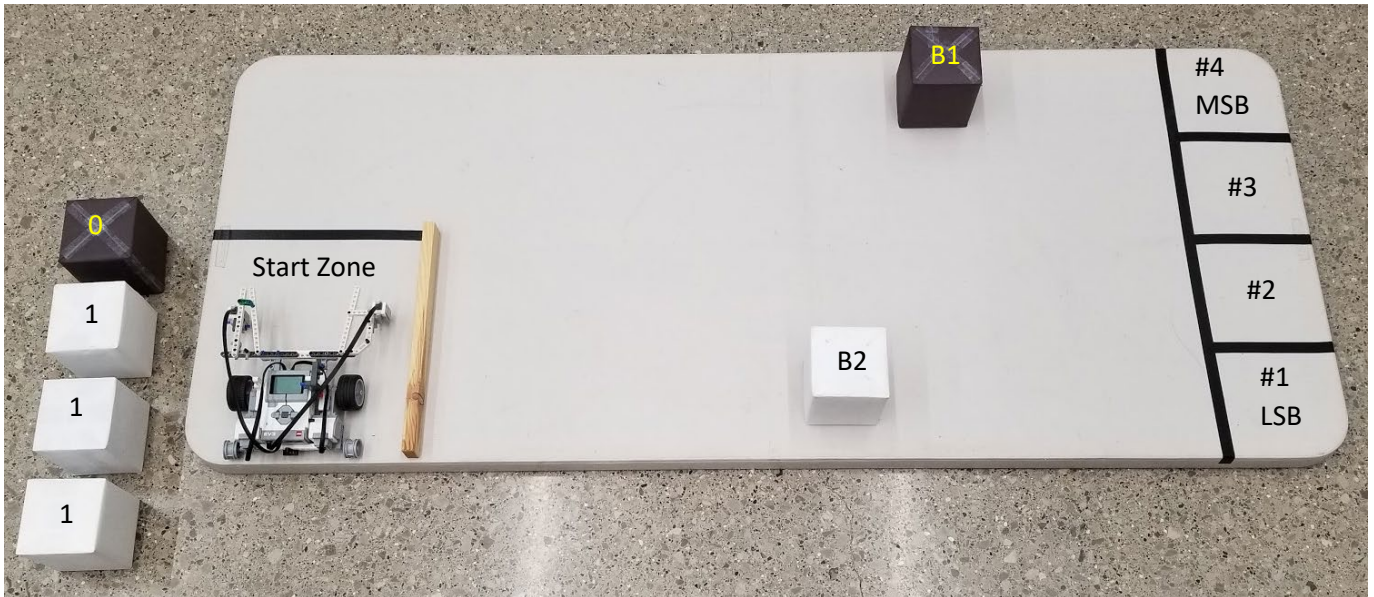


Figure 1 (a): An example of BinaryBlocks Game Initial configuration. Target decimal number is 10. Two extra white blocks are given. (MSB: Most Significant Bit, LSB: Least Significant Bit)

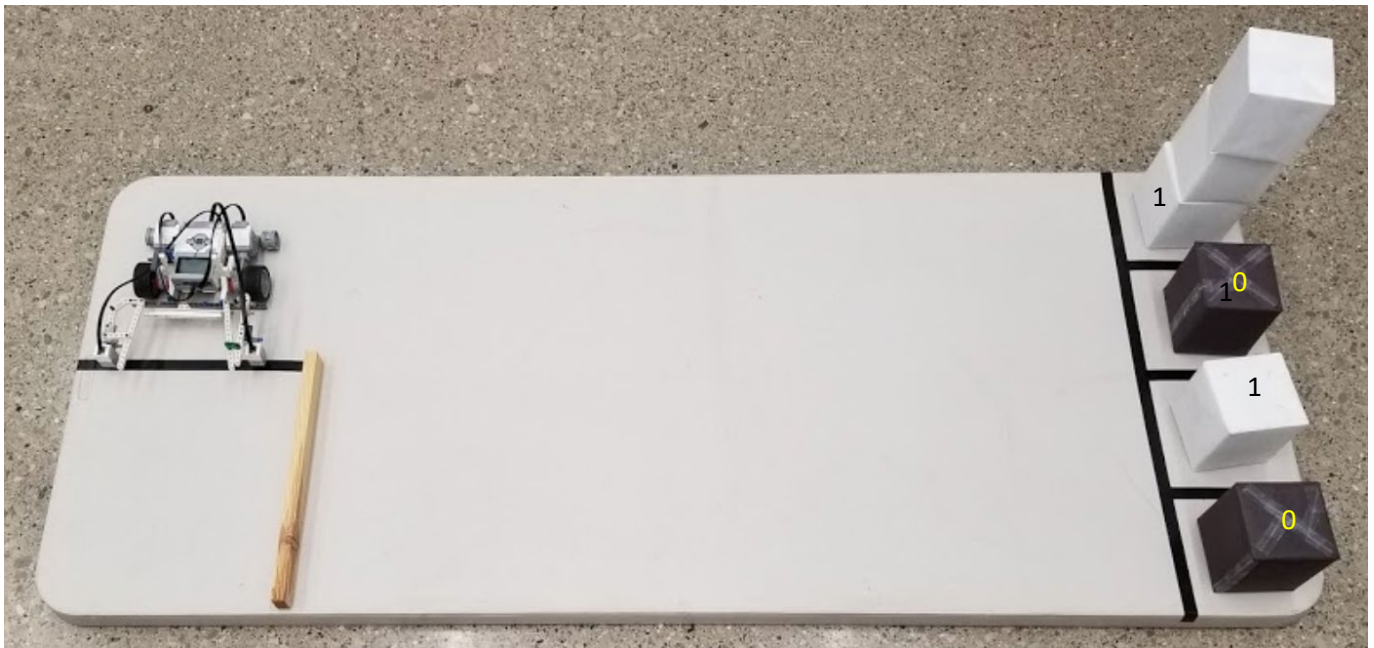


Figure 1 (b): An example of a perfect score case. Game-Ending-Mission is to stop at the Start Zone line.

1. Game Synopsis

Your mission is to build and program an autonomous robot that arranges white and black blocks to represent a 4-bit binary number of a target decimal number that will be unveiled 30 minutes before impounding. Any robot kits may be used in the Robofest Game category. This is one of very unique characteristics of Robofest. Learning objectives of this Game are: binary numbers, logic and proportional logic, geometry, object detection, placing objects, sensing, localization, and navigation.

2. Game details: what the player and robot should do

Figure 1 (a) shows an example of initial Game configuration that is unveiled just before the 30 minute worktime. A human player can load a block on a robot or on the table surface in the start zone when the robot is inside the Start Zone. The robot may only carry or push one block at a time out of the Start Zone. Outside the Start Zone, the robot may carry/push more than one block. There are 4 blocks provided for the 4-bit number plus additional blocks that must be stacked on top of the first same color block from the left. Figure 1 (b) shows the perfect placement of blocks to represent 10 in decimal which is 1010 in binary. As an example for the Jr. Division, two extra white blocks are placed on top of the white block at MSB (or left-most bit) location.

Points are earned based on the number of correct blocks inside each binary bit slot and other factors specified on the score sheet. To earn maximum score for each bit slot, a block must be completely inside the proper slot, not touching the tape and not overhanging the table edge or corner. Due to the rounded corner of the table, slot #1 and #4 require more precise block placement. Details of the scoring will be specified in the Scoring Sheet attached. Examples of scoring can be found in Appendix A.

All the tasks must be done completely autonomously within 2 minutes without any external help. The robot may attempt/complete the tasks in any order except the “Game-Ending-Mission” (see 2.3).

2.1 Unveiling unknown factors and 30 minute work-time

General unknown factors such as lighting condition, table (exact size, color, and texture), Block (exact size, weight, paper shade and texture), etc. are unveiled when teams check-in at the team pit. Other unknown factors (see Table 2. Field Dimension and Unveil Times) as well as “Game-Ending-Mission” (see 2.3 for details) will be unveiled just before the 30 minute work-time for each round. During the work-time, teams are to adjust the robot, change the code, and add programs for the Game-Ending-Mission. All people except contestants and authorized staff/volunteers will be evacuated from the pit/room during the work-time. Robots are impounded at the end of the 30 minutes and remain until all robots have completed the round.

2.2 How to start a Game and supply blocks to the robot

For the starting position, the entire robot must be inside the Start Zone. If the robot will push or carry a block, both the robot and block must be completely inside the Start Zone. A human player may load a block on the robot or on the table surface in the Start Zone. When the robot returns back to the Start Zone and **all the parts of the robot that touch the table surface** completely pass the outside edge of the Start Zone line and **no parts of the Robot are touching the floor (off the table)**, a human player may touch, pick-up, select different program, and re-orient (turn) the robot. The robot does not need to self-stop.

2.3 How to end a Game: Game-Ending-Mission

The Game-Ending-Mission will be unveiled just before the 30 minute work-time for each round. An example of the Game-Ending-Mission is for the robot to **stop** at the Start Zone line - any part of the robot must be on or over the black line. Game competition time will be recorded only when all the other missions as well as this Game-Ending-Mission are perfectly completed. World Championship Game-Ending-Mission will be more challenging than that of qualifying competitions.

3. Detailed rules regarding violations

A. Violations that require a contestant to pick-up the robot: Pick-up penalty

1. If a human player touches the robot intentionally or unintentionally when the robot is not inside the Start Zone.
2. If a human player touches any field material (except Start Zone blocks) intentionally or unintentionally.
3. If additional blocks are placed on the table by the human player outside the Start Zone.
4. If a block is placed in the Start Zone, when the robot is not inside the Start Zone.

5. If one of the above violations occurs, the judges will announce “violation” and give the team the option to either:
 - a. Restart inside Start Zone (with **pick-up** penalty). At that time, the team may request one time full-reset (**full-reset** penalty) or continue as is (without full reset penalty) or
 - b. Declare **end of the run**.

B. Robot drops off the table: Pick-up penalty or No Penalty

If the team picks it up to restart, then a “pick-up” penalty will be applied. There will be no penalty when the robot drops off the table and the team declares the end of the Game. There is no double penalty if the robot drops off the table and is picked up.

C. Full-reset penalty

1. The team may request a complete full-reset any time. If the full-reset is requested when the robot is inside Start Zone, only full-reset penalty will be applied. If the robot is picked up and full-reset is requested, then both pick-up and full-reset penalties are applied.
2. Only one complete full-reset of the playing field is allowed for a run.
 - a. Full-reset is done only by Judges while the 2-minute countdown timer continues to run. Judges shall reset as quickly as possible.
 - b. A full-reset penalty is assessed as defined on the scoring sheet.
 - c. A partial reset (for example resetting one block) is NOT allowed.
3. When the field is full-reset, all the points earned from the previous attempt are lost (cleared).
4. A team may repair their robot and/or select a different program during the full-reset. The 2-minute countdown timer continues to run.

4. BinaryBlocks Game Playing Field

One 6ft plastic folding table is used to construct a playing field as depicted in Figure 2.

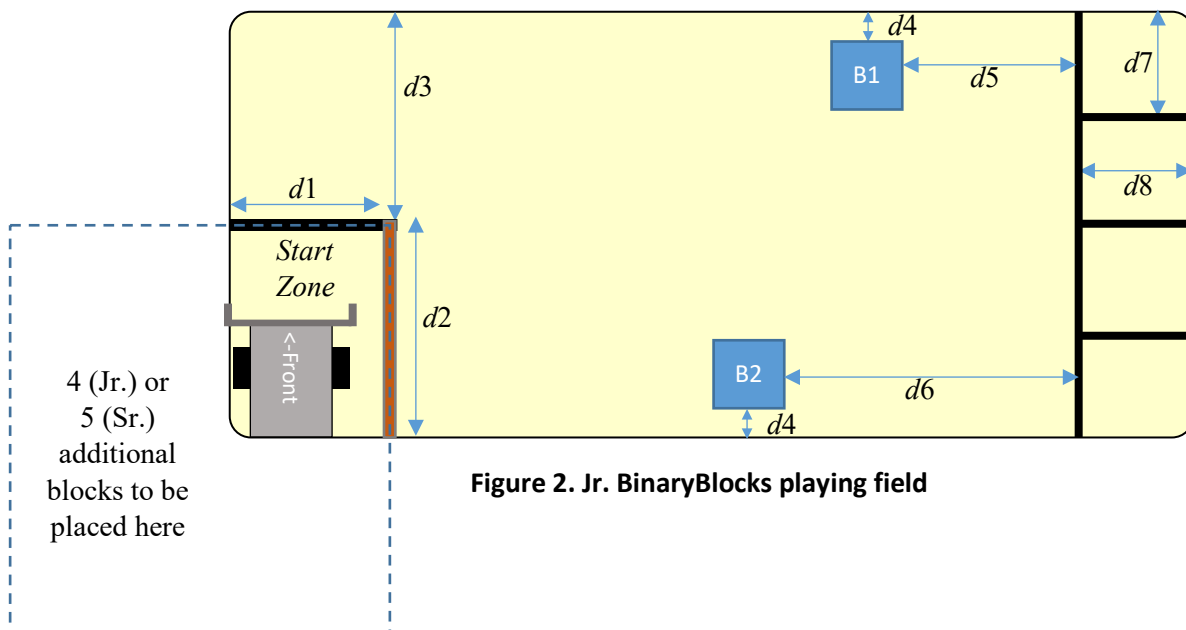


Figure 2. Jr. BinaryBlocks playing field

| | |
|--|---|
| <p>6ft plastic folding tables</p> | <p>The playing field is a 30”x72” (actual size is about 75 x 182cm) plastic folding table that can be purchased at discount stores like Lowes. The recommended brand is “LifeTime”. The four corners of the table are rounded with a radius of 4cm ~ 7cm. The thickness of the table is about 4.5cm. The surface is light in color such as white, gray, or almond; however, the exact</p> |
|--|---|

| | |
|---|--|
| | size, color, brightness, and edge shape of the table is unknown until the competition day. Fold-In-Half plastic tables can be used if the center seam is covered with (masking) tape similar to the table color. The color of the tape would also be an unknown factor in that case. Pieces of plywood cut similarly to the folding tables can also be used if plastic folding tables are not available. The table is placed on floor. To mark the location of blocks, tapes, labels, or markers may be used. The exact color and size of those markers are unknown factors. |
| Floor color under tables | Unveiled at the beginning of competition day. Possibly not homogeneous. However, all the colors should be noticeably darker than the table color. |
| Blocks | Unopened tissue paper boxes wrapped in black or white paper. Exact shade of the paper is unknown till the competition day. Size of a box is about 11cm x 11cm x 13cm (height). We allow ± 1 cm of tolerance since the size of tissue box will vary by vendors and countries. Weight is 145g ~ 185g. Please note that the actual box type to be used is an unknown factor. B1 and B2 block in Figure 1(a) can be either white or black. |
| Wall | The wall is made of a 1.9cm (wide) x 3.7cm (tall) x 35cm (long) pine wood bar attached to the table with VELCRO or Dual-lock. |
| Binary Bit Slots & Start Zone line | Standard black electrical tape. Width is $\frac{3}{4}$ " or 1.9cm. |

Table 1. Field Component Properties/Color

| | Min. value | Max. value | Unveiled when? | Note |
|------|---|------------|--|-------------------------------|
| $d1$ | 35cm | 35cm | Known factor | Inside of the wall (wood bar) |
| $d2$ | 35cm | 35cm | Known factor. Fixed to 35cm | Edge to edge distance |
| $d3$ | $(\text{Table width}) - d2$ | | | Around 40 cm |
| $d4$ | 3cm | 5cm | Unveiled after impounding | |
| $d5$ | 35cm | 50cm | Jr: Unveiled before work-time for each round. Sr: Unveiled after impounding | |
| $d6$ | 35cm | 90cm | | |
| $d7$ | $(\text{Table width} - 1.9 \times 3) / 4$ | | | Around 17.3cm |
| $d8$ | 19 cm | | Known factor | |

Table 2. Field Dimension and Unveil Times

5. Differences between Junior and Senior age divisions

| | Junior (5 th ~ 8 th grades) | Senior (9 th ~ 12 th grades) |
|---|---|--|
| Game-Ending-Mission | Easier | Harder |
| Colors of B1 and B2 | Unveiled before work-time | Unknown. Unveiled after impounding |
| # of blocks to stack on another | 2 | 3 |
| $d5, d6$ | Unveiled before work-time | Unknown. Unveiled after impounding |
| Number of on-board computer controllers | One | No limit |

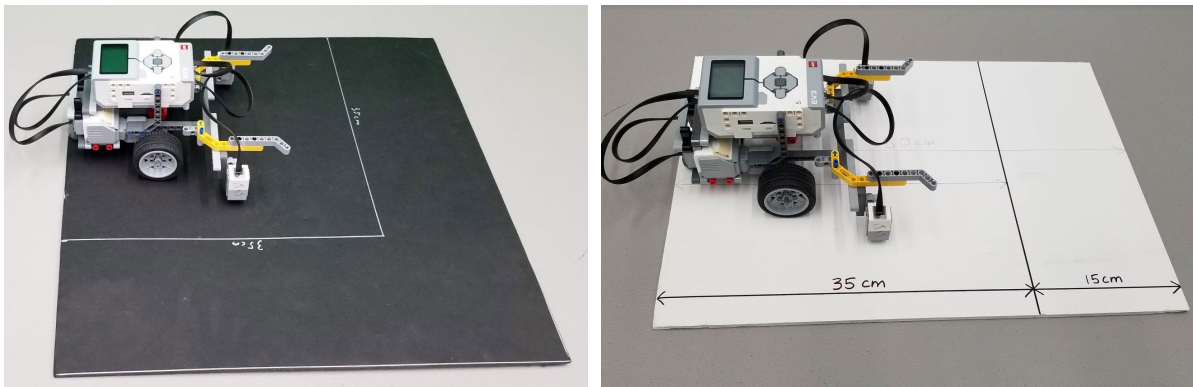
Table 3. Differences between Jr. and Sr. age divisions

6. Robot Specifications (For both Junior and Senior Divisions)

- A. A Robofest team ID tag and team name on top of the robot is required.
- B. At the start, the robot's maximum width and length **including any parts that are attached during a run** are each 35cm. However, after the round starts, the robot may autonomously expand its (width and length) dimensions up to 50 cm. There is no height limitation. During impounding, width and length will be checked as shown in Figure 3. During the checking, all the wheels must touch the floor. Robot connector

wires are allowed to extend beyond the maximum dimensions, but if wires are used for anything other than an electrical connection, they must be within the maximum dimension limits.

- C. Weight limitation: none.
- D. Any number of sensors/sensor types (unless it is harmful to humans).
- E. Any number/type of motors/servo motors (multiplexor is OK to use).
- F. Any material/robot kit may be used to construct your robot including tape, glue, nuts and bolts, rubber bands, etc.
- G. The robot or part of the robot may not use the game elements. For example, do not use a black or white covered tissue box as part of the robot.



Either 50 x 50 cm (left photo) or 50 x 25cm (right photo) board will be used.

Figure 3. How to check robot width and length.

7. Detailed Rules and Procedure to Play Two Rounds and Determine Winners

- A. Only contestants are allowed to access the pit area, team tables, practice fields, and official game fields throughout the competition day, including during the setup time before the opening ceremony, during work time and breaks (adult coaches, mentors, or other volunteers may assist with transporting team materials if necessary, escorted by proctors)
- B. Playing field block locations will be different for each round.
- C. When unknown factors/tasks are unveiled, teams will be provided a hard-copy of unveiled information or the information will be projected on a large screen.
- D. Teams will be given a 30-minute work-time after unknown factors/tasks are unveiled to work on their robots. Five minutes prior to the start of the work time, all people except contestants and authorized staff/volunteers will be **dismissed** from the room.
- E. All teams must submit their robot to the impound area when the 30-minute work-time has expired. Robots may be taken to be impounded early. Only one team member should deliver the robot to the impound table. Penalty may be applied if not impounded in time.
- F. During the impounding process, judges will inspect the robots. (Size of the robot before & after expanding, Team ID, team name, number of computer controllers, etc.)
- G. No power will be supplied at the impound table and the entire robot must be impounded, including rechargeable batteries.
- H. After impounding, the judges will set up official playing fields with blocks.
- I. Teams will compete in a pre-determined order decided by the site host.
- J. During the Game Rounds, all team members must remain in the team spectator area– no pit access allowed.
- K. When a team is called to compete, a maximum of two contestants per team are allowed to retrieve the robot from the impound area and to be present at the playing field during the run.
- L. Contestants must stay near the Start Zone. They should not follow the robot. They can approach the robot only when they decide to pick it up or if the robot is in the Start Zone.
- M. Final scoring is done after the run is over.

- N. A team member must sign the score sheet to confirm the team’s score.
- O. Score shall be displayed to teams to validate data entry.
- P. Winners in each age division will be decided by the **average** total score of the 2 rounds. Tie breakers will be: (1) best score of two rounds, (2) highest time left from best score, (3) rerun, if needed. See an example in Table 4.

| Team Name | Round 1 score | R1 time left | Round 2 score | R2 time left | Avg. Score | (1) Best score | (2) Time left best score | Rank |
|-----------|---------------|--------------|---------------|--------------|------------|----------------|--------------------------|----------|
| Team A | 80 | | 100 | 15 | 90 | 100 | 15 | 1 |
| Team B | 100 | 10 | 80 | | 90 | 100 | 10 | 2 |
| Team C | 90 | | 90 | | 90 | 90 | | 3 |

Table 4. Example of breaking ties

8. Reminders of General Rules, Additional Rules and Restrictions:

- A. Proctors are watching for the following Violations:
 - o Coaches or Parents in the pit area during practice or work-time (except for initial transport of materials).
 - o Coaches or Parents accessing the practice or official game tables at any time.
 - o Verbal/electronic communication between the team and coach/parent while the team is setting up and practicing in the pit area and during work-time.
 - o Team members leave the pit unsupervised during work time before their robot is impounded.
 - o Any team member alters his/her own robot after impounding
 - o Team handles or interferes with another team’s computer or robot, either in the pit or in the impound area.
 - o Destruction of property.
 - o Use of inappropriate words and/or behavior toward team members, other teams, audience, judges or staff.
- B. Any violations can result in deduction of points or disqualification at the judges’ discretion.
- C. If anyone sees any suspicious activities, please notify the nearest volunteer immediately.
- D. Spectators are welcome to take pictures or video, but please make sure your flash is off.

9. Special Notes

- A. Though every effort is made to be consistent and precise in all of the dimensions of the playing field and parts, Robofest assumes a tolerance of ± 5 mm, unless stated otherwise.
- B. If there are multiple playing fields at the competition sites, the Chief Game Judge will check consistency between the playing fields. However, there is no guarantee to make them all identical.
- C. Judges should maintain at least 1 meter distance from the field when the robot is in action.
- D. Final decisions are at the discretion of the Chief Game Judge.

10. FAQs

- A. **Block height size is different from width and length. Can a block be placed or stacked on its side, not the tall way?** *Yes*
- B. **Can the robot bring B1 and B2 blocks to the Start Zone and then player can load on/to the robot?** *Yes. Then the block becomes the same as the block at the Start Zone.*
- C. **Can teams modify the robot and add additional structure when the robot is at the START Zone?** *Yes, but no additional time will be provided. Must be measured as a starting configuration and impounded with the robot.*
- D. **Can dead controller bricks be added to add weight for traction or a counter balance?** *Yes, but you should not connect to any sensors or motors.*

- E. **If the bot brings B1/B2 to the start and I decide to load onto it, can I load more than one or I will have to load the first one, go out of the start zone, return, and load the 2nd?** *A block can be brought back to the Start Zone and then handled by the player, but additional blocks cannot be stacked on top of the first because the robot can leave the Start Zone with only one block. It is permissible, however, for the robot to autonomously stack blocks just outside of the Start Zone, then move the stack to a slot.*
- F. **Expansion – If the robot tips over, does it need to be within the 50x50 cm limit?** *The robot will be measured in the upright position and the team member will be asked to demonstrate any expansion. If tipping over is part of the functionality of the robot, it is considered expansion and any expansion must meet the 50x50 cm max.*
- G. **Please clarify stacked block scoring.** *Full points are received for the correct colored stacked block when bottom block is the correct color and completely in the slot. Partial points will be earned for any other stacked block (the bottom block is the incorrect color or partially in the slot, or the stacked block is the incorrect color).*
- H. **Can students have a Binary Code chart or a Robot Program “Cheat Sheet”?** – *Yes, the chart can be on the robot, too. However, it cannot be electronic (No cell phones or electronic communication in the pit).*
- I. **If the robot falls off the table and is carrying a block, and the block remains on the robot, can the team return the block to the Start Zone and keep it in play?** *No, any blocks on the robot if it is picked up will remain on the floor where the robot fell off the table.*
- J. **Does it matter where the block is when it is pushed off the table? If the block is pushed off when the robot is still in the Start Zone, is it still in play?** *No, any blocks pushed off the table are considered as “played” and cannot be returned to the start zone unless a full reset is selected.*
- K. **Can one block be scored for two slots if it is the only block in both slots?** *Yes, each slot will be scored accordingly. See the scoresheet.*
- L. **Can a team bring its own blocks?** *Site blocks will be used for the competition. Own blocks can be used for practice only.*
- M. **Can controllers be “daisy-chained” (moved together)?** *Junior teams can only have one controller. Senior teams may daisy-chain.*
- N. **Does the robot have to come to the start zone?** *To retrieve a new block or to physically touch/adjust without penalty the answer is yes. The end task will vary and will be unveiled at each competition.*
- O. **How many blocks can be on the floor or touching the floor?** *Up to three blocks can get “on the floor” or “touching the floor” points. One block positioned half on the table & half on the floor counts as one point. Anywhere on the floor counts (Does not need to be adjacent to a slot).*
- P. **Will there be exactly 2 black blocks for every number choice, Limiting the numbers to 3, 5, 6, 9, 10 and 12?** *No, there can be any combination of black and white blocks.*
- Q. **How many pickups are allowed during the run?** *Only 3 pickups are allowed during the run. (See scoresheet) A 4th pickup will end the run.*
- R. **If a robot unintentionally comes apart or loses a piece during the run, the team is allowed to repair it during a pickup in the Start Zone, a pickup or a full reset. If this happens, how will the robot be scored for “robot remains intact throughout the run”?** *The team will receive a “0” for the robot remaining intact.*

11. Related important documents

- Robofest 2018-2019 General Rules document at robofest.net
- Additional FAQs, Rule Clarification, and/or Rule Change documents will be posted on the web at robofest.net

Robofest® 2019 Game BinaryBlocks Scoring Sheet

Updated 1/12/19

Division: Junior / Senior Team Name: _____

Team School / Organization Name: _____ Team Number: _____

Round: First Second Field No.: _____

| Judging Items (to be checked when the Game is ended) | | Check / Count | | Point Value (per count) | Score Earned / Lost | | |
|---|---|---------------|------------|--|-------------------------------------|------------------|----------------|
| Bit Slot #4 (MSB) | Correct color block completely in | 0 (no) | 1 (yes) | 15 | } <i>Max.</i> <i>Max. 15</i> | | |
| | Correct color block partially in* | 0 | 1 | 8 | | | |
| | Incorrect block is completely or partially in* | 0 | 1 | 4 | | | |
| Bit Slot #3 | Correct color block completely in | 0 | 1 | 15 | } <i>Max. 15</i> | | |
| | Correct color block partially in* | 0 | 1 | 8 | | | |
| | Incorrect block is completely or partially in* | 0 | 1 | 4 | | | |
| Bit Slot #2 | Correct color block completely in | 0 | 1 | 15 | } <i>Max. 15</i> | | |
| | Correct color block partially in* | 0 | 1 | 8 | | | |
| | Incorrect block is completely or partially in* | 0 | 1 | 4 | | | |
| Bit Slot #1 (LSB) | Correct color block completely in | 0 | 1 | 15 | } <i>Max. 15</i> | | |
| | Correct color block partially in* | 0 | 1 | 8 | | | |
| | Incorrect block is completely or partially in* | 0 | 1 | 4 | | | |
| Jr | # of correct block(s) stacked on a correct base block** | 0 | 1 | 2 | 12 | } <i>Max. 24</i> | |
| | # of any other stacked block(s) | 0 | 1 | 2 | 9 | | |
| Sr | # of correct block(s) stacked on a correct base block** | 0 | 1 | 2 | 3 | | 8 |
| | # of any other stacked block(s) | 0 | 1 | 2 | 3 | | 6 |
| # of blocks that are on the floor or touching the floor*** | | 0 | 1 | 2 | 3 | 3 | <i>Max. 9</i> |
| The robot was sturdy & remained intact throughout the run | | 0 | 1 | | | 3 | <i>Max. 3</i> |
| A full-reset was done (full-Reset penalty) <i>Note: partial reset is not allowed</i> | | 0 | 1 | | | -3 | |
| Number of pick-ups outside Start Zone (pick-up penalty)**** | | 0 | 1 | 2 | 3 | -1 | |
| Game-Ending-Mission is achieved | | 0 | 1 | | | 13 | <i>Max. 13</i> |
| (*) the block must be on the table surface, not touching the floor (**) Receives full points only when the base block gets 15 (perfect points) (***) Only up to 3 blocks can get points (****) 4 th pickup automatically ends the run | | | | Total Score | | <i>Max. 100</i> | |
| | | | | Time left in seconds <i>Time stops when the robot complete the Game-Ending-Mission. Total score must be 100, otherwise BLANK</i> | | | |

Judge initials: _____

Team player initials: _____

Appendix A. Jr. Judging Examples when the target number is 10 and the Game-Ending-Mission is to stop at the Start Zone line. Assume neither full-reset nor pick-up was done. Also the robot remained intact throughout the run.

| | | |
|--|----------------------------|---|
| | <p>4 3 2 1</p> | <p>Case 1: Perfect score $15+15+15+15+$ $12*2+3+13 = 100$</p> |
| | | <p>Case 2: $8+15+15+15+$ $9*2+3+13 = 87$</p> <p>Base block is not completely in the slot #4</p> |
| | | <p>Case 3: $0+15+15+15+$ $9*2+3+13 = 79$</p> <p>Base block is completely out of the slot zone</p> |
| | | <p>Case 4: $15+15+15+15+$ $12*1+3+13 = 88$</p> <p>One block (*) is not stacked. No point for the block</p> |

| | |
|--|---|
| | <p>Case 5: $15+8+15+15+0+3+13 = 69$</p> <p>Two blocks are not used. Slot #3 block is partially in.</p> |
| | <p>Case 6: $15+0+15+15+12*2+3+13 = 85$</p> <p>For #3, a block is completely out</p> |
| | <p>Case 7: $15+8+15+15+12*2+3+13 = 93$</p> |
| | <p>Case 8: $15+8+8+15+12*2+3+13 = 86$</p> <p>#2 slot has a partial White block and #3 slot has also a partial Black.</p> |

| | |
|--|--|
| | <p>Case 9: $15+0+8+8+$ $12*2+3$ (floor) + $3+13 = 74$</p> <p>Slot #1 block is overhanging corner. A black block is behind the slot zone.</p> |
| | <p>Case 10: $15+15+4$ (wrong color)+$0+$ $12*2+ 3+13 = 74$</p> |
| | <p>Case 11: $15+15+15+4+$ $(9*2)+3+13 = 93$</p> <p>Slot #4 has an incorrect color block stacked; Slot #3 has a stacked block on an incorrect block</p> |
| | <p>Case 12: $15+15+8+4+$ $12*2+3$ (floor) + $3+13 = 85$</p> |

| | |
|--|--------------------|
| | <p>Exercise 1:</p> |
| | <p>Exercise 2:</p> |
| | <p>Exercise 3:</p> |
| | <p>Exercise 4:</p> |

Ex1: $8+4+0+4+0(\text{stack})+6(\text{floor})+3+13 = 38$

Ex2: $8+8+8+4+0(\text{stack})+9(\text{floor})+3+13=53$

Ex3: $8+4(\text{White block counted once})+8+0+0+3+13=36$

Ex4: $4+4+4+4+18(\text{stack})+0+3+13=50$