

# RobotChallenge - Robot Sumo Rules

*Note: All rules are subject to change without notice.*

**Name of Event:** Sumo

**Short Description:** As in the traditional Japanese martial arts, the robots try to push the competitor off the ring.

## Changelog

21.10.2011

- 3.2 5% tolerance for dohyo dimensions
- 4.2 Starting procedure with IR signal
- 6.2 Humanoid robots must touch the opponent

16.03.2011

- 3.2 Height of Nano Sumo Dohyo changed

18.01.2011

- 3.2 Material for dohyos specified, minimum exterior space specified

16.01.2012

- Appendix: added links to further description of the start/stop module

# 1. Definition of the Sumo Match

## 1.1. Definition

A match is fought between two teams, each team having one or more contestants. Only one team member may approach the ring; other team members must watch from the audience. In accordance with the game rules (hereafter referred to as "these rules",) each team competes on a Dohyo (sumo ring) with a robot that they have constructed themselves to the specifications in Section 2. The match starts at the judge's command and continues until a contestant earns two Yuhkoh points. The judge determines the winner of the match.

# 2. Requirements for Robots

## 2.1. General Robot Specifications

- A. The following are specifications for all robots. Additional specifications for Lego Sumo robots are in section 2.2, for Humanoid Sumo robots in section 2.3 and for Mega Sumo robots in section 2.4 respectively.
- B. A robot must fit within a square tube of the appropriate dimensions for the given class.
- C. The total mass of a robot at the start of a match must be under the designated weight for the given class.

Class	Height	Width	Length	Weight
Mega Sumo	Unlimited	20 cm	20 cm	3.000 g
Mini Sumo	Unlimited	10 cm	10 cm	500 g
Micro Sumo	5 cm	5 cm	5 cm	100 g
Nano Sumo	2,5 cm	2,5 cm	2,5 cm	25 g
Lego Sumo	Unlimited	15 cm	15 cm	1.000 g
Humanoid	50 cm	20 cm	20 cm	3.000 g

- D. A robot may expand in size after a match begins, but must not physically separate into pieces, and must remain a single centralized robot. Robots violating these restrictions shall lose the match. Screws, nuts, and other robot parts with a total mass of less than 5 g falling off from a robot's body shall not cause the loss of match.
- E. All robots must be autonomous. Any control mechanisms can be employed, as long as all components are contained within the robot and the mechanism does not interact with an external control system (human, machine, or otherwise).
- F. The robot gets a number for registration purposes. Display this number on your robot to allow spectators and officials to identify your robot.

## 2.2. Requirements for Lego Sumo robots

- A. The robot must only be built out of LEGO® parts. This includes:
  - a. Parts manufactured and distributed by LEGO®
  - b. LEGO® licensed parts from third party manufacturers

### 2.3. Requirements for Humanoid Sumo robots

- A. The robot must be a two legged walking humanoid biped that must shift its center of gravity to maintain its balance when walking.
- B. When walking, one foot must lift off the floor, while the other foot is balancing the robot.
- C. When walking, the foot that balances the robot must have a knee-joint angle greater than 90 degrees. At any point if this is not the case, the robot will not be considered walking.
- D. The feet can be of any shape and form as long as all of the following are maintained:
  - a. The robot's foot is defined as the part of the robot that is contacting the surface of the arena (ground).
  - b. The maximum length (size) of the foot must be less than 50% of the length of the extended robot's leg. The leg length is defined as the distance between where the robots foot touches the ground and the axis that connects the leg to the upper body of the robot.
  - c. The maximum length of the foot must be less than 20 cm.
- E. When robot is standing or walking, a rectangular outline around the left and right feet shall not overlap.
- F. The robot must have 2 arms. Each arm extended length shall not exceed the extended leg length.
- G. The robot must have a head.

### 2.4. Requirements for Mega Sumo robots

- A. For safety reasons the robot must be equipped with an IR kill switch to be operated by the judge. When the judge sends a kill signal the power to the motors shall be cut. The robot builder is responsible for adding such a kill switch on the robot. The technical specifications for the IR receiver are given in the appendix. Contestants can either implement their own hardware or use a prebuilt module offered by the organizers. This module can supply the signal for activating the kill switch.

### 2.5. Robot Restrictions

- A. Jamming devices, such as IR LEDs intended to saturate the opponents IR sensors, are not allowed.
- B. Parts that could break or damage the ring are not allowed. Do not use parts that are intended to damage the opponent's robot or it's operator. Normal pushes and bangs are not considered intent to damage.
- C. Devices that can store liquid, powder, gas or other substances for throwing at the opponent are not allowed.
- D. Any flaming devices are not allowed.
- E. Devices that throw things at your opponent are not allowed.
- F. Sticky substances to improve traction are not allowed. Tires and other components of the robot in contact with the ring must not be able to pick up and hold a standard A4 paper (80 g/m<sup>2</sup>) for more than two seconds.
- G. Devices to increase down force, such as a vacuum pumps and magnets are only allowed in the Mega sumo class. They are not allowed in all other classes.
- H. All edges, including but not limited to the front scoop, must not be sharp enough to scratch or damage the ring, other robots, or players. In general, edges with a radius of

greater than 0,1 mm, as would be obtained with a unsharpened 0,2 mm thick metal strip, should be ok. Judges or competition officials may require edges that they deem too sharp to be covered with a piece of tape.

### 3. Requirements for the Dohyo (Sumo Ring)

#### 3.1. Dohyo Interior

The dohyo interior is defined as the playing surface surrounded by and including the border line. Anywhere outside this area is called the dohyo exterior.

#### 3.2. Dohyo Specifications

- A. The ring shall be circular in shape and of the appropriate dimensions for the given size class.
- B. The border line is marked as a white circular ring of a width appropriate for the given class on the outer edge of the playing surface. The ring area extends to the outside edge of this circular line.
- C. For all given dohyo dimensions a tolerance of 5% applies.

Class	Height	Diameter	Border Width	Material	Minimum Exterior Space
Mega	5 cm	154 cm	5 cm	Steel	100 cm
Mini / Lego	2,5 cm	77 cm	2,5 cm	Wood	50 cm
Micro	1,25 cm	38,5 cm	1,25 cm	Wood	25 cm
Nano	0,4 cm	19,25 cm	0,625 cm	Acryl	25 cm
Humanoid	5 cm	154 cm	5 cm	Wood	100 cm

#### 3.3. Doyho Exterior

There should be a space appropriate for the given class outside the outer edge of the ring. This space can be of any color, and can be of any material or shape as long as the basic concepts of these rules are not violated. This area, with the ring in the middle, is to be called the "ring area". Any markings or parts of the ring platform outside the minimum dimensions will also be considered in the ring area.

### 3.4. How to Carry Sumo Matches

- A. One match shall consist of 3 rounds, within a total time of 3 minutes, unless extended by the judges.
- B. The team who wins two rounds or receives two "Yuhkoh" points first, within the time limit, shall win the match. A team receives a "Yuhkoh" point when they win a round. If the time limit is reached before one team can get two "Yuhkoh" points, and one of the teams has received one Yuhkoh point, the team with one Yuhkoh point shall win.
- C. When the match is not won by either team within the time limit, an extended match may be fought, during which the team who receives the first Yuhkoh point shall win. Alternatively, the winner/loser of the match may be decided by judges, by means of lots, or by a rematch.
- D. One Yuhkoh point shall be given to the winner when the judges' decision was called for or lots were employed.

## 4. Start, Stop, Resume, End a Match

### 4.1. Robot Placing

Upon the judge's instructions, the two teams approach the ring to place their robots on the ring. A cross in the middle divides the sumo ring into 4 quadrants. Robots always have to be placed in 2 opposing quadrants. Each robot has to point in the opposite direction like indicated by arrows on the cross. The robots can be placed anywhere within the quadrant. The judge will remove the cross after positioning of the robots. After placing, the robots may not be moved anymore.

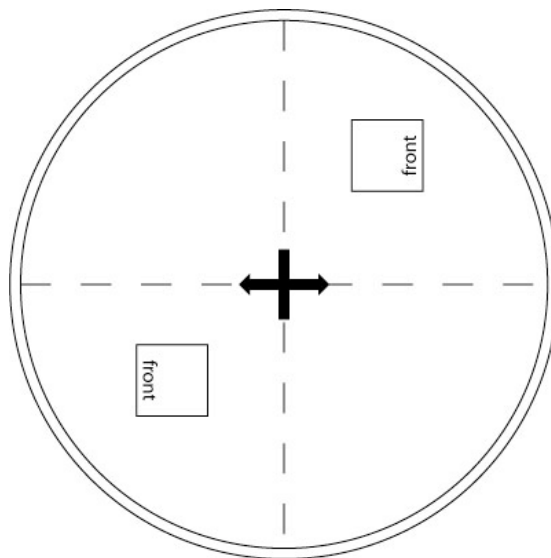


Fig. 1: Robot placement

### 4.2. Start

- A. In Mega, Mini and Micro classes the judge starts every round by sending a start signal with an IR transmitter. As soon as the robots receive the signal the round will start immediately, without any delay. The technical specifications for the IR receiver are

given in the appendix. Contestants can either implement their own hardware or use a prebuilt module offered by the organizers.

- B. In all other classes the judge announces the start of the round. The teams start their robots, and after a five second pause the robots may start operating. During these five seconds, players must clear out of the ring area.

### **4.3. Stop, Resume**

The match stops and resumes when a judge announces so.

### **4.4. End**

The match ends when the judge announces so. The two teams retrieve the robots from the ring area.

## **5. Time of Match**

### **5.1. Duration**

One Match will be fought for a total of 3 minutes, starting and ending upon the judge's command.

### **5.2. Extention**

An extended match, if called for by the judge, shall last for a maximum of 3 minutes.

### **5.3. Time Keeping**

The following are not included in the time of the Match:

- A. The time elapsed after the judge announces Yuhkoh and before the match resumes. The standard delay before the match resumes shall be 30 seconds.
- B. The time elapsed after a judge announces to stop the match and before the match resumes.

## **6. Scoring**

### **6.1. Scoring for Non-Humanoid Robots**

One Yuhkoh point shall be given when:

- A. A team legally forces the body of the opposing robot to touch the space outside the ring, which includes the side of the ring its self.
- B. The opposing robot has touched the space outside the ring on its own.
- C. Either of the above takes place at the same time that the end of the Match is announced.
- D. When a wheeled robot has fallen over on the ring or in similar conditions, Yuhkoh will not be counted and the match continues.

When judges' decision is called for to decide the winner, the following points will be taken into considerations:

- A. Technical merits in movement and operation of a robot
- B. Penalty points during the match
- C. Attitude of the players during the match

The match shall be stopped and a rematch started under the following conditions:

- A. The robots are entangled or orbiting each other with no perceivable progress for 5 seconds. If it is unclear whether progress is being made or not, the judge can extend the time limit for observable progress for up to 30 seconds.
- B. Both robots move, without making progress, or stop (at the exact same time) and stay stopped for 5 seconds without touching each other. However, if one robot stops its movement first, after 5 seconds it will be declared as not having the will to fight. In this case the opponent shall receive a Yuhkoh, even if the opponent also stops. If both robots are moving and it isn't clear if progress is being made or not, the judge can extend the time limit up to 30 seconds.
- C. If both robots touch the outside of the ring at about the same time, and it can not be determined which touched first, a rematch is called.

## **6.2. Scoring for Humanoid Robots**

- A. Knockdown
  - a. A knockdown occurs when a robot is knocked down by its opponent.
  - b. 2 points shall be added to the opponents score.
- B. Slipdown
  - a. A slipdown occurs when a robot falls on its own. 1 point shall be added to the opponents score.
- C. Ringout
  - a. A ringout occurs when any part of a robot contacts the surface outside the arena.
  - b. 3 points shall be added to the opponents score.
  - c. The team of the robot shall be given permission by the judge to place their robot face down within the arena without further penalty provided it can get up within a 10 second countdown.
- D. Knockout
  - a. A knockout occurs when a robot fails to get up within a 10 second countdown.
  - b. A knockout occurs when a robot is unable to move or walk when commanded by a judge within a 10 second countdown.
  - c. When a knockout has been declared the match is immediately ended, and the match shall be awarded to the opponent.
- E. All the points will totaled for opponents for each round.
- F. The match shall be stopped if the robots do not touch each other for more than 15 seconds. This time can be extended by the judge to a maximum of 45 seconds if a clear will to fight is observable.
- G. Determining the Winner
  - a. The robot with the most points will be determined the winner of the match.
  - b. In the event of a tie in the final score, the judge will vote for the winner based upon tactics, aggressiveness and activity. If none of the robots scored a point, the judge may decide that there is no winner of the match.

## **7. Violations**

### **7.1. Violations**

Players performing any of the deeds described in Sections 2.5, 7.2 or 7.3 shall be declared in violation of these rules.

### **7.2. Insults**

A player who utters insulting words to the opponent or to the judges or puts voice devices in a robot to utter insulting words or writes insulting words on the body of a robot, or performs any insulting action, is in violation of these rules.

### **7.3. Minor Violations**

A minor violation is declared if a player:

- A. Enters into the ring during the match, except when the player does so to take the robot out of the ring upon the judge's announcement of Yuhkoh or stopping the match. To enter into the ring means:
  - a. A part of the player's body is in the ring, or
  - b. A player puts any mechanical kits into the ring to support his/her body.
- B. Performs the following deeds:
  - a. Demand to stop the match without appropriate reasons.
  - b. Take more than 30 seconds before resuming the match, unless the judge announces a time extension.
  - c. Start operating the robot within five seconds after the chief judge announces the start of the match.
  - d. Does or says that which disgraces the fairness of the match.

## **8. Penalties**

### **8.1. Penalties**

- A. Players who violate these rules by performing the deeds described in Sections 2.5 and 7.2 shall lose the match. The judge shall give two Yuhkoh points to the opponent and order the violator to clear out. The violator is not honored with any rights.
- B. Each occasion of the violations described in Sections 7.3 shall be accumulated. Two of these violations shall give one Yuhkoh to the opponent.
- C. The violations described in Article 7.3 shall be accumulated throughout one match.

## **9. Injuries and Accidents during the Match**

### **9.1. Request to Stop the Match**

A player can request to stop the game when he/she is injured or his/her robot had an accident and the game cannot continue.



## **9.2. Unable to Continue the Match**

When the game cannot continue due to player's injury or robot's accident, the player who is the cause of such injury or accident loses the match. When it is not clear which team is such a cause, the player who cannot continue the game, or who requests to stop the game, shall be declared as the loser.

## **9.3. Time Required to Handle Injury/Accident**

Whether the game should continue in case of injury or accident shall be decided by the judges and the Committee members. The decision process shall take no longer than five minutes.

## **9.4. Yuhkoh Given to the Player who Cannot Continue**

The winner decided based on Section 9.2 shall gain two Yuhkoh points. The loser who already gained one Yuhkoh point is recorded as such. When the situation under Section 9.2 takes place during an extended match, the winner shall gain one Yuhkoh point.

# **10. Declaring Objections**

## **10.1. Declaring Objections**

- A. No objections shall be declared against the judges' decisions.
- B. The lead person of a team can present objections to the Committee, before the match is over, if there are any doubts in the exercising of these rules. If there are no Committee members present, the objection can be presented to the judge before the match is over.

# **11. Miscellaneous**

## **11.1. Flexibility of Rules**

As long as the concept and fundamentals of the rules are observed, these rules shall be flexible enough to encompass the changes in the number of players and of the contents of matches. Modifications or abolition of the rules can be made by the local event organizers as long as they are published prior to the event, and are consistently maintained throughout the event.

# **12. Liability**

- A. Participating teams are always responsible for the safety of their robots and are liable for any accidents caused by their team members or their robots.
- B. The RobotChallenge organization and the organizing team members will never be held responsible nor liable for any incidents and / or accidents caused by participating teams or their equipment.

# APPENDIX

## Remote start and kill switch

Every round in Mega, Mini and Micro Sumo class is started by the referee sending a start signal with an IR transmitter. As soon as the robot receives the signal the round will start. (This method makes the matches fairer since it eliminates false starts and is also time saving since less restarts is needed). The contestant can choose to either implement all the hardware and software by them self or he/she can simply use a prebuilt module (recommended).

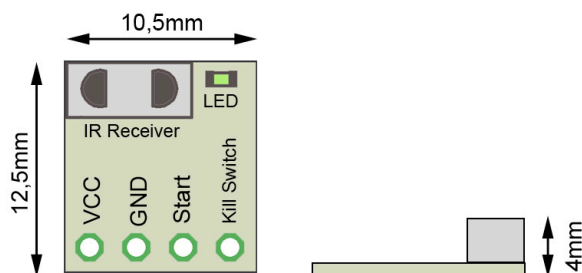
### Kill switch

The kill switch is used to cut power to the motors of the robot, this is used as a safety precaution and is only mandatory in the Mega Sumo class. When the referee sends the stop command the power to the motors has to be cut. The robot builder is responsible for adding such a kill switch on the robot by themselves, however the prebuilt module can supply the signal for activating the kill switch.

### Prebuilt module

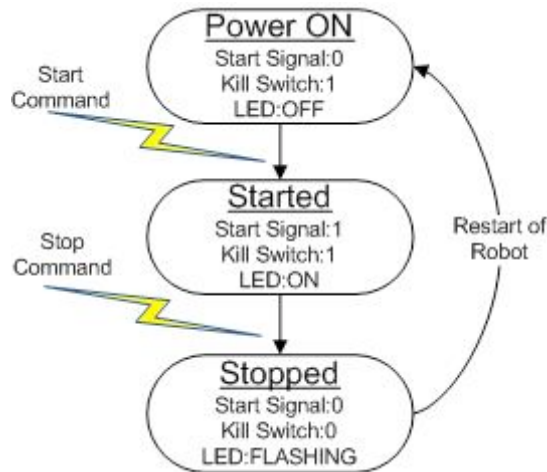
The prebuilt module takes care of all communication and is very easy to implement. The robot only needs to wait for the start pin on the module to go high and then it should start. The module accepts supply voltage (VCC) 3.3-5V. The VCC GND Start has standard 2.54mm pitch.

The prebuilt module can be ordered from the organizer during the online registration.



### Modes of operation

The figure below illustrates the modes of operation of the module. To be less sensitive to noise and disturbances the module will save its current state into a non-volatile memory and if it is resets it will return to the last known state. This means that each match will end with the referee sending the stop command.



*Note: If the LED on the module is on before the referee has sent the start command it means that the module is in the “Started” state. Then the stop command has to be sent and the robot needs to restart for the module to go back to the “Power ON” state.*

To be able to run multiple matches next to each other each dohyo will have its own unique identifier. The prebuilt module can be re-programmed to listen for a new identifier. This is done by the referee by sending a special programming command which updates this identifier.

Robots which use sensors that are based on IR technology with a 38Khz transmitter modulation are encouraged to start their sensors after the start signal is received. This is to minimize the risk of disturbance.

## Explanation of use

You can find detailed information about the usage of the startmodules on:

<http://www.startmodule.com>

## Recommended design for Kill Switch

How to implement Kill switch circuit using a relay

<http://www.startmodule.com/kill-switch-relay/>

How to implement Kill switch circuit using an optocoupler

<http://www.startmodule.com/kill-switch-oc/>

## FAQ

For answers to the most common questions regarding the start systems.

<http://www.startmodule.com/faq/>

## How to implement everything by your own

For those who want to implement everything by their own and not use the prebuilt module a guide for this can be found at:

<http://www.startmodule.com/implement-yourself/>