



# Combotics Robobrawl 2022

## 1 lb Division

The goal of the Robobrawl 1 lb competition is to provide a safe and exciting public display of robotic combat for all. It will take place every fall and spring semester, at locations to be announced. The following sections describe the format of the competition and the rules. Please contact the Robobrawl Committee at [robobrawl.illinois@gmail.com](mailto:robobrawl.illinois@gmail.com).

This event uses the standard RFL Tech Regs (listed later in the document) with modifications.

1. Structure of Robobrawl 1 lb
  - 1.1. The Robobrawl 1 lb tournament is a double-elimination 1 lb weight limit bracket (2lb for walkers, see RFL Tech Regs listed later).
  - 1.2. All parts other than those exempt from the restriction via the exemption list (listed in section 2) must be created from an additive manufacturing technique (3D printing) and must be made from **PLA** or **ABS**.
  - 1.3. All robots must have an active weapon to compete. Active weapon meaning robots need to have a controllable device that creates kinetic energy and has the intent to damage other robots, separate from the drivetrain.
  - 1.4. Heat or fire weapons are not allowed at this event.
  - 1.5. Matches will be 3 minutes in length unless a robot is deemed "inoperable" (cannot demonstrate translational movement) for 10 seconds.
  - 1.6. The winner of the match can be decided upon in 2 ways.
    - 1.6.1. The opposing robot is "knocked out" by ceasing all motion for 10 seconds.
    - 1.6.2. The match reaches the 3 minute time limit and the judges decide the winner (described in section 4)

- 1.7. The competition format is double elimination. Teams will be paired in the first round using a random number generating computer program. The winners will advance within the winners' bracket, and the losers will move to the losers' bracket. See [Wikipedia](#) for information on how double elimination brackets work.
  - 1.8. Competitors will be allowed ample time between matches, but may be asked to compete more frequently as the number of teams still in the bracket decreases.
  - 1.9. Each team will be allocated space in a "pit" area to perform repairs or preparation on their robot.
  - 1.10. Testing of robots must ONLY occur in the test box prepared by iRobotics. Failure to comply will result in forfeiture of all future matches.
2. Exemption list
- Any item on this list can be made from any manufacturing technique, and can be made out of any material. Items on this list may not comprise in any way a significant portion of the robot's frame, armor, or weapon. These items must be applied in their intended use, i.e. bearings must be used to support shafts. The event coordinator reserves the right to judge all of the following and, at their discretion, disqualify any attempts at subverting the intention of the list. If you are unsure of whether your usage will be permitted, contact the event.
- Weapon Teeth
    - Items falling under this exemption must comprise, in total, no more than 50% of the **weapon's** weight, must be used as the attacking edge of weapon, and can not comprise a significant portion of the weapon's structure. Because of this, the weapon must be removable from the robot.
  - Axles and Shafts
  - Bearings
  - Motors
  - Radio Receivers
  - Electronic Speed Controllers
  - Batteries
  - Battery Casing
  - LEDs
  - Switches
  - Wire
  - Electrical Connectors and Insulation
  - Nuts, bolts, screws and other related hardware

- Pulleys, belts, chain, sprockets, gears, shaft couplers, and other general power transmission components
  - Springs
  - Wheels
    - Powered external wheels used for translational movement will not disqualify a robot (they will not count as armor).
    - Idler/non powered wheels are included in this category so long as they are intended to be used in traditional applications (i.e. touching the arena floor and aid in friction reduction for translational movement)
  - Tape, Velcro, Adhesives
  - Glue and Epoxy (do not epoxy the entire robot, that will result in a disqualification)
  - Paint
    - You may paint any part of the robot provided it is not being used to increase the structure integrity in any significant manner.
  - Pneumatics Components
3. Procedure for preparing robots in the arena for a match. Failure to comply with any of these rules could result in forfeiture of the match.
- 3.1. The robot must NOT be operated for any reason prior to the beginning of the match except in the designated testing area.
  - 3.2. The competing robots will be placed in the arena with the manual disconnect weapon switch OFF.
  - 3.3. The drivers will set the controllers/transmitters in the designated area outside the arena with the power switched off.
  - 3.4. Once all robots have been correctly placed in their respective start areas with verification from the head referee, the competitors will turn on power to their robots with the controller remaining off.
  - 3.5. All competitors will then remove the manual weapon stop(s).
  - 3.6. All competitors will exit the arena.
  - 3.7. Once the head judge has verified that everything is safe to proceed, each driver will be instructed by the ref to pick up their controllers and turn on the power.
  - 3.8. Drivers may test that all systems are working properly for their robot while not leaving their starting square (or in the case of a rumble, while not engaging any opponent).
  - 3.9. After all motion of the robots from testing has ceased, the head referee will begin the countdown to begin the match. Each bot will be given a

maximum of one warning per match for motion before countdown has finished. Any more infractions will result in forfeiture.

4. Procedure for powering down robots in the arena after a match has completed.
  - 4.1. The drivers will set the controllers/transmitters in the designated area outside the arena with the power switched off.
  - 4.2. Once they have received verification that it is safe to do so from the head referee, the competitors will enter the arena and insert the manual weapon stop(s).
  - 4.3. Competitors will then power down their robots using the manual disconnect switch(es).
5. Judge decisions.
  - 5.1. If both robots are still operable after the duration of the match, each robot will be scored based on the decisions of the judges
  - 5.2. Each judge will score a bot out of 11 based on the following criteria.
    - 5.2.1. 6 possible points can be awarded for damage inflicted.
    - 5.2.2. 5 possible points can be awarded for aggression.
  - 5.3. Based on these scores, each judge will select the bot they scored higher and “vote” for them.
  - 5.4. The bot that receives the most votes will be the winner for the match.

The next section is the RFL Technical Regs with modifications for this event. This is a more detailed list of rules. As noted, the previous rules take precedence over these if they are in conflict, but the RFL Tech Regs are more in-depth and explain many regulations more comprehensively.

1. General
  - 1.1. All participants build and operate robots at their own risk. Combat robotics is inherently dangerous. There is no amount of regulation that can encompass all the dangers involved. Please take care to not hurt yourself or others when building, testing and competing.
  - 1.2. This rule set is designed to for adjustment by each event depending on its safety concerns. Any parts of these rules [bracketed in red] are parts that may be changed or omitted from event to event. Text that is stricken (~~stricken~~) represents rules that are not applicable to this event.
  - 1.3. If you have a robot or weapon design that does not fit within the categories set forth in these rules or is in some way ambiguous or borderline, please contact this event. Safe innovation is always encouraged, but surprising

the event staff with your brilliant exploitation of a loophole may cause your robot to be disqualified before it ever competes.

- 1.4. Compliance with all event rules is mandatory. It is expected that competitors stay within the rules and procedures of their own accord and do not require constant policing.
- 1.5. Each event has safety inspections. It is at their sole discretion that your robot is allowed to compete. As a builder you are obligated to disclose all operating principles and potential dangers to the inspection staff.
- 1.6. Cardinal Safety Rules: Failure to comply with any of the following rules could result in expulsion or worse, injury and death.
  - 1.6.1. Radios may not be turned on at or near events for any purpose without obtaining the appropriate frequency clip or explicit permission from the event.
  - 1.6.2. Proper activation and deactivation of robots is critical. Robots must only be activated in the arena, testing areas, or with expressed consent of the event and its safety officials.
  - 1.6.3. All robots must be able to be FULLY deactivated, which includes power to drive and weaponry, in under 60 seconds by a manual disconnect .
  - ~~1.6.4. All robots not in an arena or official testing area must be raised or blocked up in a manner so that their wheels or legs cannot cause movement if the robot were turned on. Runaway bots are VERY dangerous. [Omitted]~~
  - 1.6.5. Locking devices: Moving weapons that can cause damage or injury must have a clearly visible locking device in place at all times when not in the arena. Locking devices must be painted in neon orange or another high-visibility color. Locking devices must be clearly capable of stopping, arresting or otherwise preventing harmful motion of the weapon.
  - 1.6.6. Weapon locking pins must be in place when weapon power is applied during a robot's power-on procedure. This includes all powered weapons regardless of the power source or weight class.
  - 1.6.7. It is expected that all builders will follow basic safety practices during work on the robot at your pit station. Please be alert and aware of your pit neighbors and people passing by.
2. Weight Classes. This event offers the listed weight classes in section 2.1. (~~Non-wheeled robots in the 340 class may receive a 35% bonus.~~ There is no weight bonus for shufflers or other forms of locomotion which are predicated on rolling - see 3.1.2 for a definition of a non-wheeled robot.)

2.1.

Rolling	Non-Wheeled
1 pound	2 pounds

2.2. ~~Sportsman Class~~ [Omitted]

3. Mobility

3.1. All robots must have easily visible and controlled mobility in order to compete. Methods of mobility include:

3.1.1. Rolling (wheels, tracks or the whole robot)

3.1.2. Non-wheeled: non-wheeled robots have no rolling elements in contact with the floor and no continuous rolling or cam operated motion in contact with the floor, either directly or via a linkage. Motion is “continuous” if continuous operation of the drive motor(s) produces continuous motion of the robot. Linear-actuated legs and novel non-wheeled drive systems may qualify for this bonus. [If you have questions regarding whether or not your robot qualifies as walking, please contact this event] .

3.1.3. Shuffling (rotational cam operated legs)

3.1.4. Ground effect air cushions (hovercrafts)

3.1.5. Jumping and hopping

3.1.6. Flying (airfoil, helium balloons, ornithopters, etc.) [any robot that leaves the ground above which the opposing robot cannot possibly reach it for more than 5 seconds will be disqualified.]

4. Robot control requirements:

4.1. Tele-operated robots must be radio controlled, or use an approved custom system as described in 4.4.3. Radio controlled robots must use approved ground frequencies [27/49/50/53/75/900/2400 for the United States] .

4.2. Tethered control is not allowed

4.3. Pre 1991 non-narrow band radio systems are not allowed.

4.4. Radio system restrictions for this event with corresponding weight and or weapon restrictions:

4.4.1. Radio systems that stop all motion in the robot (drive and weapons), when the transmitter loses power or signal, are required for all robots with active weapons ~~or any robot over 12lbs.~~ This may be inherent in the robots electrical system or be part of programmed fail-safes in the radio. ~~Robots 1 lb and less []drive fail-safes.~~

4.4.2. All robot radio systems must have a way to change frequencies or coded channels to prevent radio conflicts. Having at least two

frequencies or coded channels available is required . Lack of extra frequencies may result in a forfeit. Digital spread-spectrum radios that use frequency hopping or automatic channel selection qualify under this rule.

- 4.4.3. If you are using a home built control system, or a control system not covered here, you must first clear it with this event.
- 4.4.4. ~~Toy radio systems allowed at this event for robots up to 12 lbs with no active weapons.~~
- 4.4.5. ~~RC systems on the AM band [not] allowed at this event for robots up to 12 lbs with no active weapons.~~
- 4.4.6. ~~All robots that are either: a.) 30 lbs or above or b.) 12 lbs or above with an active weapon MUST use a radio systems on the FM band with [] coding, a digitally coded 900 MHz or 2.4GHz system (for example IFI, Spektrum, etc), or an approved custom control system.~~
- 4.5. This event does not require a separate power switch for the radio, but it is encouraged.
5. Autonomous/Semi-Autonomous Robots: Any robot that moves, seeks a target, or activates weapons without human control is considered autonomous. If your robot is autonomous, contact this event before registration.
  - 5.1. Autonomous robots must have a clearly visible light for each autonomous subsystem that indicates whether or not it is in autonomous mode, e.g. if your robot has two autonomous weapons it should have two “autonomous mode” lights (this is separate from any power or radio indicator lights used).
  - 5.2. ~~Robots in the 12 pound or under classes are exempt from the remaining rules below, but safe operation, arming, and disarming must be demonstrated in safety inspections.~~
  - 5.3. ~~The autonomous functionality of a robot must have the capability of being remotely armed and disarmed. (This does not include internal sensors, drive gyros, or closed loop motor controls.)~~
    - 5.3.1. ~~While disarmed, all autonomous functions must be disabled.~~
    - 5.3.2. ~~When activated the robot must have no autonomous functions enabled, and all autonomous functions must failsafe to off if there is loss of power or radio signal.~~
    - 5.3.3. ~~In case of damage to components that remotely disarm the robot, the robots autonomous functions are required to automatically disarm within one minute of the match length time after being armed.~~

## 6. Batteries and Power

- 6.1. The only permitted batteries are ones that cannot spill or spray any of their contents when damaged or inverted. This means that standard automotive and motorcycle wet cell batteries are prohibited. Examples of batteries that are permitted: gel cells, Hawkers, NiCads, NiMh, dry cells, AGM, Llon, LiPoly, etc. **[If your robot uses a type of battery not listed here, please contact this event for approval]**
- 6.2. All onboard voltages above 48 Volts require prior approval from this event. (It is understood that a charged battery's initial voltage state is above their nominal rated value)
- 6.3. All electrical power to weapons ~~and drive systems~~ (systems that could cause potential human bodily injury) must have a manual disconnect that can be activated within 15 seconds without endangering the person turning it off. (E.g. No body parts in the way of weapons or pinch points.) Shutdown must include a manually operated mechanical method of disconnecting the main battery power, such as a switch (Hella, Whyachi, etc) or removable link. Relays may be used to control power, but there must also be a mechanical disconnect. Please note that complete shutdown time is specified in section 1.6.
- 6.4. All efforts must be made to protect battery terminals from a direct short and causing a battery fire.
- 6.5. If your robot uses a grounded chassis you must have a switch capable of disconnecting this ground. ICE robots are excepted from this rule if there is no practical way to isolate their grounding components. It is **[required]** to contact this event for this exception.
- ~~6.6. All Robots must have a light easily visible from the outside of the robot that shows its main power is activated.~~

## 7. Pneumatics

- 7.1. Example diagrams of typical pneumatic systems in robots over 30lbs:
  - 7.1.1. CO2 based systems  
<http://www.botleague.com/pdf/GeneralPneumaticsCO2.pdf>
  - 7.1.2. High Pressure Air (HPA) based systems  
<http://www.botleague.com/pdf/GeneralPneumaticsHPA.pdf>
- 7.2. Pneumatic systems on board the robot must only employ non-flammable, nonreactive gases (CO2, Nitrogen and air are most common). It is not permissible to use fiber wound pressure vessels with liquefied gasses like CO2 due to extreme temperature cycling.
- 7.3. You must have a safe and secure method of refilling your pneumatic system. **[The RFL recommends the use of standard paintball fill fittings]**

available at many retail outlets and online. For specs see Part#12MPS from Foster, <http://www.couplers.com.>]

- 7.4. Exemptions
  - 7.4.1. Robots 12 lbs and under and systems with gas storage of 2 fl oz or less are exempt from the remaining rules in this section provided that the maximum actuation pressure is 250 PSI or less and all components are used within the specifications provided by the manufacturer or supplier. If the specifications aren't available or reliable, then it will be up to the EO to decide if the component is being used in a sufficiently safe manner .
  - 7.4.2. Pneumatic systems with pressures below 100 PSI, small volumes (12-16g CO2 cartridges), single firing applications, or pneumatics used for internal actuation (as opposed to external weaponry) may also be exempted from the remaining pneumatic rules. You are to contact this event if you would like an exception.
- 7.5. All pneumatic components on board a robot must be securely mounted. Particular attention must be made to pressure vessel mounting and armor to ensure that if ruptured it will not escape the robot. (The terms 'pressure vessel, bottle, and source tank' are used interchangeably)
- 7.6. All pneumatic components within the robot must be rated or certified for AT LEAST the maximum pressure in that part of the system. You may be required to show rating or certification documentation on ANY component in your system.
- 7.7. All pressure vessels must be rated for at least 120% of the pressure they are used at and have a current hydro test date. (This is to give them a margin of safety if damaged during a fight.) If large actuators, lines, or other components are used at pressures above 250psi these will also need to be over-rated and are [] to be pre-approved for this event.
- 7.8. All primary pressure vessels must have an over pressure device (burst/rupture disk or over pressure 'pop off') set to no more than 130% of that pressure vessels rating. (Most commercially available bottles come with the correct burst assemblies, use of these is encouraged)
- 7.9. If regulators or compressors are used anywhere in the pneumatic system there must be an (additional) over pressure device downstream of the regulator or compressor set for no more than 130% of the lowest rated component in that part of the pneumatic system.
- 7.10. All pneumatic systems must have a manual main shut off valve to isolate the rest of the system from the source tank. This valve must be easily accessed for robot deactivation and refilling.

- 7.11. All pneumatic systems must have a manual bleed valve downstream of the main shut off valve to depressurize the system. This bleed valve must be easily accessed for deactivation. This valve must be left OPEN whenever the robot is not in the arena to ensure the system cannot operate accidentally.
  - 7.11.1. It is required to be able to easily bleed all pressure in the robot before exiting the arena. (You may be required to bleed the entire system if it is believed that you have any damaged components.)
- 7.12. All regulated pneumatic systems must have an appropriate gauge scaled for maximum resolution of the pressure on the low-pressure side of the system. HPA (air, nitrogen, or inert gas) systems must have gauges on both the high AND low-pressure sides of regulators. A gauge or other clear visual indication that the system is charged is strongly recommended for all pneumatic systems. Whether specifically required or not.
- 7.13. If back check valves are used anywhere in the system you must ensure that any part of the system they isolate can be bled and has an over pressure device.
- 7.14. Any pneumatic system that does not use a regulator, or employs heaters or pressure boosters, or pressures above 2500psi **[must be pre qualified by this event.]**
8. Hydraulics **[Are not allowed in Robobrawl 1 lb]**
9. Internal Combustion Engines (ICE) and liquid fuels. **[are not allowed in Robobrawl 1 lb]**
10. Rotational weapons or full body spinning robots:
  - 10.1. Spinning weapons must come to a full stop within 60 seconds of the power being removed using a self-contained braking system.
11. Springs and flywheels
  - 11.1. ~~Springs used in robots in the 12 lbs class or smaller are excepted from the rules in this section.~~ Safe operation and good engineering are always required.
  - 11.2. ~~Any large springs used for drive or weapon power must have a way of loading and actuating the spring remotely under the robot's power.~~
    - 11.2.1. ~~Under no circumstances must a large spring be loaded when the robot is out of the arena or testing area.~~
    - 11.2.2. ~~Small springs like those used within switches or other small internal operations are excepted from this rule.~~
  - 11.3. ~~Any flywheel or similar kinetic energy storing device must not be spinning or storing energy in any way unless inside the arena or testing area.~~

- ~~11.3.1. There must be a way of generating and dissipating the energy from the device remotely under the robots power.~~
- ~~11.4. All springs, flywheels, and similar kinetic energy storing devices must fail to a safe position on loss of radio contact or power.}~~
- 12. Forbidden Weapons and Materials. The following weapons and materials are absolutely forbidden from use:
  - 12.1. Weapons designed to cause invisible damage to the other robot. This includes but is not limited to:
    - 12.1.1. Electrical weapons
    - 12.1.2. RF jamming equipment, etc.
    - 12.1.3. RF noise generated by an IC engine. (Please use shielding around sparking components)
    - 12.1.4. EMF fields from permanent or electro-magnets that affect another robot's electronics.
    - 12.1.5. Entangling Weapons or defenses: these are weapons or defenses that can reasonably be expected to stop drive train and/or weapon motion by being wrapped around rotating parts. This includes nets, tapes, strings, and other entangling materials or devices.
    - 12.1.6. Weapons or defenses that that can reasonably be expected to stop combat completely of both (or more) robots.
  - 12.2. Weapons that require significant cleanup, or in some way damages the arena to require repair for further matches. This includes but is not limited to:
    - 12.2.1. Liquid weapons. Additionally a bot may not have liquid that can spill out when the robot is superficially damaged.
    - 12.2.2. Foams and liquefied gasses
    - 12.2.3. Powders, sand, ball bearings and other dry chaff weapons
  - 12.3. Un-tethered Projectiles (see tethered projectile description in Special Weapons section 13.5)
  - 12.4. Heat and fire are forbidden as weapons. This includes, but is not limited to the following:
    - 12.4.1. Heat or fire weapons not specifically allowed in the Special Weapons section (13.2)
    - 12.4.2. Flammable liquids or gases
    - 12.4.3. Explosives or flammable solids such as:
      - 12.4.3.1. DOT Class C devices
      - 12.4.3.2. Gunpowder / Cartridge Primers
      - 12.4.3.3. Military Explosives, etc.

- 12.5. Light and smoke based weapons that impair the viewing of robots by an Entrant, Judge, Official or Viewer. (You are allowed to physically engulf your opponent with your robot however.) This includes, but is not limited to the following:
  - 12.5.1. Smoke weapons not specifically allowed in the Special Weapons section (13.3)
  - 12.5.2. Lights such as external lasers above 'class I' and bright strobe lights which may blind the opponent.
- 12.6. Hazardous or dangerous materials are forbidden from use anywhere on a robot where they may contact humans, or by way of the robot being damaged (within reason) contact humans. **[Contact this event if you have a question.]**
13. Special weapon descriptions allowed at this event:
  - 13.1. Tethered Projectiles **[are]** allowed at this event.
    - 13.1.1. **[ Tethered projectiles must have a tether that can stop the projectile and be no longer than 2 feet. Any tethered projectiles robot needs approval from the event coordinator. ]**
  - 13.2. Heat and Fire **[are not]** allowed at this event. The subsequent rules in this section apply when heat and fire are allowed. Flame weapon rules are subject to change to comply with local fire regulations and fire officials.
  - 13.3. Smoke Effects **[are not]** allowed at this event.

\* If you plan on using the RFL rule set for your event you are welcome to. Our only requirement is that it not be changed other than in the extensible areas, and that it be referred to as the RFL Tech Regs.