



**KING OF BOTS**



**ROBOCHALLENGE**

Robo Challenge Build Rules V4.1

25/7/18

## 1. General

### 1.1 Participation

All participants build and operate Robots at their own risk. Robot Combat is inherently dangerous.

### 1.2 Event Rules

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.

### 1.3 Safety Inspections

Robo Challenge will be operating safety & rule compliance checks prior to any robot competing or testing during the event [Tech checks]. It is at the inspector's 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.

### 1.4 Cardinal Safety Rules

Failure to comply with any of the cardinal safety rules set out below by Robo Challenge may result in expulsion from the event or worse, injury and death.

#### 1.5.1 Activation

Proper activation and deactivation of robots is critical. Robots should only be activated in the arena with expressed consent of Robo Challenge and its safety officials. All activation and de-activation of robots must be completed from outside the arena barrier or within specially designated areas.

#### 1.5.2 Weapon Restraints

All Robots not in an arena or official testing area should have secure safety covers over any sharp edges and restraints on any active weapons or pinch hazards.

### 1.5.3 Carrying Cradles

All robots not in an arena or official testing area should be raised on their carrying cradles in a manner so that their motive power cannot cause movement if the robot were turned on, or cannot roll or fall off the pit tables.

### 1.5.4 Restrictions

In some situations the safety inspection team may deem it necessary to place restrictions on your robots operation for safety purposes. It is entirely your responsibility that these restrictions are adhered to at all times.

### 1.5.5 Power Tools

It is expected that builders will follow all basic safety practices such as gloves and goggles when operating any machinery. The use of welders, grinders and other equipment that may produce smoke, debris or other harmful substances is not permitted in the pits area and is only permitted in dedicated workshop areas if available.

## 2. Weight Classification

### 2.1 Weight Limit

The maximum weight limit allowed for the Heavyweight category is 110kg. The maximum weight limit allowed for the Featherweight category is 13.6kg.

### 2.2 Legged Robots

Legged Robots [Walkers] may have an extra 35kg weight allowance bringing the total to 145kg for Heavyweight robots. Featherweight robots may have an extra 4kg bringing the total to 17.6kg. A walker must employ moveable legs to support its weight. Each leg must have at least 2 degrees of freedom. Robots with rolling or sliding mechanisms (Shufflers) will be given a 15kg weight allowance bringing the total to 125kg in the Heavyweight category and an extra 1.5kg for Featherweight robots bringing the total to 15.1kg. For clarification please disclose as much information about your robots drive mechanism during the application stage.

### 2.3 Consumables

Maximum weight includes all consumables such as CO2 gas.

### 2.4 Safety Equipment

Maximum weight does not include safety bars, straps, or similar equipment used to immobilise moving arms or weapons and that are removed during competition.

### 2.6 Interchangeable Weapons

If interchangeable weapons are used, the weight is measured with the heaviest set-up in place. Please see rule 12.11 for interchangeable weapon & armour restrictions.

### 2.7 Size Limit

Robots must not exceed these dimensions. This includes all over hangs and weapons when in the retracted position. Eg. An axe retracted may not exceed these limits however in its 'fired' position it may extend past these dimensions.

Overall Length 1.2 metres

Overall Width 0.8 metres

Overall Height 1.2 meters

### 3. Mobility

#### 3.1 Methods

All Robots must have controlled mobility in order to compete. Methods of mobility include:

##### 3.1.1 Rolling

Rolling on wheels or the whole robot rolling.

##### 3.1.2 Walking

Walking such as linear actuator operated legs.

##### 3.1.3 Shuffling

Shuffling mechanisms such as rotational cam operated legs.

##### 3.1.4 Ground Effect

Ground effect air cushions such as a hovercraft

##### 3.1.5 Jumping

Jumping and hopping.

#### 3.2 Restrictions

Robots are not permitted to use exposed rotating aerofoil, rocket or jet propulsion methods.

### 4. Radio control requirements

#### 4.1 Frequencies

##### 4.1.1 Regulation

Radio systems used at Robo Challenge events MUST be commercially available & comply with restrictions put in place by local regulatory bodies and applicable laws.

##### 4.1.2 Interference

Radio systems MUST NOT cause interference to other frequency users.

#### 4.1.3 Allowed Frequency

At Robo Challenge, only the 2.4ghz DSS (Digital Spread Spectrum) frequencies are allowed for controlling your robot. Please see rule 4.4 regarding exceptions for telemetry systems.

#### 4.2 Failsafes

##### 4.2.1 Dangerous Systems

All systems that are deemed to be 'dangerous' (normally the drive and weapons) must have a 'failsafe' device. This MUST bring the systems to a pre-set 'off' or 'zero' position if the transmitter signal experiences interference or is lost. These devices should also failsafe when the receiver battery is low or if power is completely lost.

##### 4.2.2 Types of Devices

The failsafe(s) may take the form of plug-in commercial devices; electronic circuitry incorporated into receivers or other devices. It could also consist of digital switches, which return to pre-set off position on loss of power. Care should be taken in the selection of devices to ensure they meet the requirements specified above.

#### 4.3 Operation

All device(s) MUST operate to the Tech Checker's satisfaction before the robot will be allowed to compete.

#### 4.4 Telemetry

Radio telemetry is permitted on 433MHz and 2.4GHz. Please notify Robo Challenge if you are using radio telemetry.

### 5. Autonomous/ Semi-Autonomous Robots

Robots that do not require human input for one or more of their functions.

If you are bringing an autonomous robot or a robot with significant autonomous functions please contact Robo Challenge in advance.

#### 5.1 Remote Operation

Any autonomous function of a robot, including drive and weapons, must have the capability of being remotely armed and disarmed.

#### 5.2 Disarming

While disarmed, the robot is not allowed to function in an autonomous fashion.

#### 5.3 Light

In addition to the required main power light, robots with autonomous functions must have an additional clearly visible light, which indicates whether or not it is in autonomous mode.

## 5.4 Deactivation

When deactivated the robot should have no autonomous functions enabled, and all autonomous functions should failsafe to off if there is loss of power or radio signal.

## 5.5 Timeout

In case of damage to components that remotely disarm the robot, the robot will automatically deactivate 4 minutes after being activated.

# 6. Electrical Power

## 6.1 Deactivation

All robots must incorporate a way of removing all power to weapons and drive systems (systems that could cause potential human bodily injury) that can be activated easily without endangering the person turning it off.

### 6.1.1 Removable Link

The main power cut-off MUST be a removable Link, which must NOT be in place unless the robot is in the arena or under the supervision of Robo Challenge Officials. A key or switch is not permitted. If there is more than one Link they must be positioned adjacent to each other. All Links must be removable by hand. The requirement to use a tool to remove the Link is not permitted.

### 6.1.2 Accessibility

The link must be positioned in a visible part of the robot's bodywork which is accessible for a Robo Challenge Marshal when standing behind the arena barrier. The link must be fitted away from any operating weaponry or drive, and this position must be clearly marked.

### 6.1.3 Covers

The link may be fitted under a cover, but the cover must be able to be opened without the use of tools.

### 6.1.4 Kill Switch

If the robot uses an internal combustion engine(s), the "Power" cut-off must take the form of a clearly labelled "Kill" switch. See Section 7 for further details on engines.

### 6.1.5 Inverted Link

Heavy weight robots that are capable of being driven inverted, having a removable link fitted that is only accessible when the robot is the right way up, must have a duplicate link fitted in the opposing panel, so as to allow the robot to be disarmed when inverted.

## 6.2 Cabling

Cabling must be of sufficient grade and suitably insulated for maximum operational current.

## 6.3 Exposed Components

Current must not be carried through exposed components.

#### 6.4 Power Light

All robots must have at least one surface mounted non-filament power light that is illuminated when power is supplied to the robot (i.e. when the link is in). The power light can be any colour but must be non-flashing and be in contrast with its surroundings. All lighting on the robot, including power light or aesthetic lighting, must be powered through the removable links to ensure all lights are off when the removable link is removed.

#### 6.5 Activation

The robot must be able to be activated and de-activated by way of the removable link from outside the arena.

#### 6.6 Voltages

Voltage must not exceed 75V for direct current or 50V for alternating current. Note that batteries may have a higher voltage during charging and care must be taken not to exceed these limits.

### 7. Batteries

For assistance in selecting batteries please contact Robo Challenge.

#### 7.1 Protection

Batteries must be adequately protected within the body shell and securely fixed to minimise the chance of being punctured or coming loose during combat. In addition, packing such as high density foam is recommended to reduce the shock of impacts.

#### 7.2 Terminals

Battery terminals must be protected to prevent short circuits.

#### 7.3 Permitted Types

The only permitted batteries are ones that cannot spill or spray any of their contents when inverted. Standard car and motorcycle wet cell batteries are prohibited.

#### 7.4 Approved Battery Chemistry

NiCd (Nickel-cadmium)

NiMH (Nickel-metal Hydride)

Pb (Sealed Lead Acid)

LiFePo<sub>4</sub> (Lithium Iron Phosphate)

LiPo (Lithium Polymer)

#### 7.5 Parallel Cells

Batteries cells may be connected in parallel to increase capacity and discharge current. Caution must be taken with NiCd and NiMH as these cells may only be connected in parallel during discharge.

## 7.6 Charging

Improper charging may result in fire and/ or explosion.

### 7.6.1 Design

Only chargers specifically designed for the battery chemistry may be used. Chargers will be inspected during the Tech Check to ensure correct operation.

### 7.6.2 Rate of Charge

The rate of charge must not exceed the manufacturer's specification.

## 7.7 Pb (SLA), NiCd, NiMH and LiFePo4

The following battery types can be used without any specific precautions although care must be taken when any battery particularly during charging:

Pb (Sealed Lead Acid, SLA), non-spillable gel type. (e.g. Yuasa, Hawker)

NiCd and NiMH

LiFePo4 (Lithium Iron Phosphate)

## 7.8 LiPo Batteries

Lithium Polymer batteries have specific limitations and extra precautions which must be adhered to.

### 7.8.1 Charging

LiPo batteries MUST be balance charged to prevent damage occurring to the cells. Chargers that do not incorporate an integrated balancing circuitry are not permitted.

### 7.8.2 Voltage Cut-out (Advisory)

The robot should be fitted with an under voltage cut-out or alarm set at or higher than the battery manufacturer's recommendation to prevent the batteries from becoming damaged by over-discharge.

### 7.8.3 Fusing

A fuse rated below the maximum burst discharge of the battery MUST be fitted.

### 7.8.4 Extra Equipment

Roboteers using LiPo batteries must provide a LiPo sack.

### 7.8.5 Inspection

LiPo batteries must be removed from the robot, inspected and placed into a LiPo sack prior to and during the charging process.

### 7.8.6 Charging

Lithium batteries must not be left unattended at any time during the charging process. Leaving batteries unattended while charging will be considered a serious breach of pit safety and may result in you and your robot being removed from the event.

#### 7.8.7 Damage

LiPo batteries showing any evidence of damage or swelling must immediately be placed in a LiPo sack and removed to a safe, well-ventilated area such as outdoors.

### 8. Internal Combustion Engines

#### 8.1 Fuel Capacity

Fuel capacity is limited to 500ml (17floz).

#### 8.2 Fuel Tanks

##### 8.2.1 Plastic

Fuel tanks separate to the engine must be made of an acceptable type of plastic (e.g. nylon).

##### 8.2.2 Metal

If the tank is integral to the engine assembly and is metal, the cap must be plastic or a plastic "pop off" seal fitted.

##### 8.2.3 Protection

The tank must be adequately protected from puncture.

#### 8.3 Fuel Lines

All fuel lines must be of the correct type and held with the correct type of fittings. They must be routed to minimise the chances of being cut.

#### 8.4 Return Spring

A return spring must be fitted to the throttle of all internal combustion engines to return the throttle to "idle" or "off" in the case of servo breakage or failure. This is in conjunction to any failsafe device.

#### 8.5 Clutch

The output of any engines connected to weapons or drive systems must be coupled through a clutch which will de-couple the motor when it is at idle.

#### 8.6 Remote Shut-off

All engines must have a method of remotely shutting off.

#### 8.7 Leaks

Any robot with liquid fuel and oil should be designed not to leak when inverted.

#### 8.8 Non-standard Types



Use of internal combustion engines other than standard piston type (e.g. turbines etc.) are prohibited.

## 9. Pneumatics

### 9.1 Allowed Gases

Pneumatic systems must use Carbon Dioxide [CO<sub>2</sub>] or Air.

### 9.2 Maximum Pressure

The maximum pressure at any point within a pneumatics system must not exceed 1000psi (68bar).

### 9.3 Cylinders

The compressed gas shall be stored in a commercially manufactured gas cylinder of appropriate design, specification and certification. Except where the maximum storage pressure is less than 50psi (3.4bar).

### 9.4 Burst Disc

The gas cylinder must incorporate a burst disc rated below the maximum test pressure of the bottle. Except where the storage pressure is less than 50psi (3.4bar).

### 9.5 Manual Isolation Valve

Gas cylinders charged to pressures of greater than 50psi must incorporate a manual isolation valve that can be operated from outside of the robot without the use of tools except for a 17mm socket. Where the manual isolation valve is not integral to the gas cylinder (for example: the gas is normally released as soon as the cylinder is screwed into its mating pneumatic connection) must have a manual isolation valve immediately after the cylinder which is accessible from outside of the Robot.

### 9.7 Rating

All pneumatic components used with pressures greater than 50psi (3.4bar) must be rated or tested to at least the maximum pressure available in that part of the system. You may be required to provide documentation or certification to support this.

#### 9.7.1 Custom Components

Custom made components, or parts operating above the suppliers maximum working pressure, must be independently tested and certified at 120% of the maximum system pressure available at that point.

#### 9.7.2 Hydraulic Components

Components originally designed for hydraulics use will be de-rated by 50% for pneumatics use.

### 9.8 Pressure Relief Device

A certified pressure relief device must be installed in each part of the pneumatics system where a different operating pressure is used.

#### 9.8.1 Rating

Pressure relief devices must have a rating of 1000psi (68bar) or 110% of the pneumatic component with the lowest 'maximum working pressure' rating protected by that particular pressure relief device, whichever is the lower.

#### 9.8.2 Low Pressure Systems

Pneumatic systems employing pressures less than 50psi or systems employing air compressors that have a maximum output pressure lower than the pneumatic component with the lowest 'maximum working pressure' do not require a pressure relief device.

The pressure relief device(s) dictate the maximum pressure available in that part of the pneumatics system. The pressure relief device(s) must have a flow rate capacity that exceeds the maximum flow rate that can be expected under 'over pressure' conditions. Any attempt to falsify the pressure settings of pressure relief device(s) will be considered as gross misconduct by Robo Challenge and may result in expulsion.

#### 9.8.3 Full Pressure Systems

Non-regulated pneumatic systems or pneumatic systems where the regulator is not directly attached to the gas cylinder require that a 1000psi pressure relief device is fitted.

#### 9.8.4 Regulated Systems

Regulated pneumatic systems that operate at less than 235psi (16bar) and where the regulator is directly attached to the gas cylinder do not require a 1000psi pressure relief device before the regulator. The regulator must be rated to 120% of the gas bottle burst disc pressure. A pressure relief device is required down-stream of the regulator rated at 110% of the component with the lowest 'maximum working pressure' rating.

### 9.9 Pressure Relief Devices

Pressure relief devices should be readily accessible and must be removable for testing purposes.

#### 9.10 Mounting

All pneumatic components must be securely mounted and adequately protected within the body shell. Any component storing gas (i.e. gas cylinders, buffer tanks etc.) must be secured in such a way as it cannot escape the robot even if suffering a rupture.

#### 9.11 Gauges

Pneumatic pressure gauges and pressure test points are not a requirement.

#### 9.12 Dump Valve

All pneumatic systems must incorporate a pressure dump valve which is easily accessible from outside of the robot without the use of tools. This dump valve shall quickly and reliably exhaust all gas downstream of the gas cylinder isolation (or remote isolation) valve including systems with a maximum operating pressure of less than 50psi (3.4bar). If a system requires multiple dump valves, they must be located next to each and securely mounted.

##### 9.12.1 Normally Open

The dump valve shall be left open at all times when the robot is not in the arena or testing areas.

Particular attention should be made that where non-return or quick exhaust valves are used, no part of the system is left pressurized.

#### 9.13 Removable Cylinders

Gas cylinders must be readily removable for inspection and refilling. You should ensure that your gas cylinder connection is compatible with Robo Challenge filling stations.

#### 9.14 Heaters and Boosters

Pneumatic systems using heaters or pressure boosters are not permitted. Heating any pneumatic components, including prior to competition, is strictly prohibited.

#### 9.15 Pressure Equipment Directive

Pneumatic components manufactured from 1 June 2002 shall carry a CE mark. Pneumatic components 'custom made' since 30 May 2002 shall carry a label indicating their non-conformity with the 'Pressure Equipment Directive' and their non-availability for sale. Components manufactured prior to 30 May 2002 are not necessarily required to carry a CE mark.

### 10. Hydraulics

#### 10.1 Pressure

Hydraulic system pressure (In the actuator or cylinder) must be limited to 10,000psi by way of a maximum pressure relief valve.

#### 10.2 Test Point

A hydraulic test point is a mandatory fitment to allow verification of a robots maximum system pressure. A team will need its own test gauge and hose.

#### 10.3 Storage Tanks

Hydraulic fluid storage tanks must be of a suitable material and adequately guarded against rupture.

#### 10.4 Standards

Hydraulic fluid lines and fittings must be to British Standard (BS) and/ or to European DIN specifications.

#### 10.5 Ratings

Hydraulic fluid lines and fittings must be capable of withstanding the maximum working pressures used within the robot.

#### 10.6 Protection

Hydraulic fluid lines must be routed to minimise the chances of being cut or damaged.

#### 10.7 Accumulators

Hydraulic accumulators (pressurised oil storage devices) are banned in whatever form they may take.

## 10.8 Power Sources

Power sources may only be in the form of electric motors or petrol engines.

## 11. Rotational weapons or full body spinning robots

Full body spinning robots with an eccentric mass, are excluded from this section unless they spin over 500 revolutions per minute.

### 11.1 Stopping Time

The spinning element of any rotational weapon must spin down to a full stop in under 60 seconds.

### 11.2 Specifications

If you intend to create a rotational weapon you must provide the exact specification of the weapon in your Robo Challenge application form. The requirements include the following

Weapon mass, including all rotating components such as gears and sprockets

Weapon RPM

Weapon diameter

## 12. Springs and flywheels

### 12.1 Springs

Any large springs used for drive or weapon power must have a way of loading and actuating the spring remotely under the robots power.

#### 12.1.1 Deactivation

Under no circumstances should a large spring be loaded when the robot is out of the arena or testing area. These devices must be made safe before removing the robot from the arena or testing area.

#### 12.1.2 Small springs

Small springs like those used within switches or other small internal operations are excluded from this rule.

### 12.2 Flywheels

Flywheels or similar kinetic energy storing devices must not be spinning or storing energy in any way, unless inside the arena or testing area. These devices must be made safe before removing the robot from the arena or testing area.

#### 12.2.1 Remote Deactivation

There must be a way of generating and dissipating the energy from the device remotely under the robots power to allow safe activation and deactivation of the robot.

#### 12.3 Failsafe

All springs, flywheels, and similar kinetic energy storing devices should fail to a safe position on loss of radio contact or power.

### 13. Weapon Restrictions

The following weapons and materials are forbidden from use: Note: Some of the listed items may be allowed for effects but not as weapons. If you have an application of these items which you feel should be allowed, please include this in your application.

#### 13.1. Invisible Damage

Weapons designed to cause invisible damage to the other robot. This includes but is not limited to:

##### 13.1.1. Electricity

Electricity as a weapon such as Tesla coils, Van-der-Graaf generators, stun guns, or cattle prods.

##### 13.1.2 Radio Frequency

Radio Frequency jamming equipment or similar devices.

##### 13.1.3 Radio Frequency Noise

Radio Frequency noise generated by an IC engine. Use shielding around sparking components.

##### 13.1.4 Electromagnetic Fields

Electromagnetic fields from permanent or electromagnets, which affect another robots electronics.

#### 13.2 Stopping Combat

Weapons or defences, which tend to stop combat completely, of both (or more) robots.

#### 13.3 Rotating Weapons

The speed of any rotating weapons - e.g. circular saws, carbon or steel cutting discs - must not exceed the manufacturer's specification. The manufacturer's specification must be available for inspection.

#### 13.4 Hardened Blades

Commercially manufactured, hardened steel blades that may shatter are not allowed.

#### 13.5 Untethered Projectiles

Projectiles must have a tether capable of stopping the projectile at full speed and be no longer than 2.5m.

### 13.6 Heat and Fire

Heat and fire are forbidden as weapons. This includes, but is not limited to the following:

#### 13.6.1 Generated

Heat specifically generated to damage an opponent

#### 13.6.2 Flammables

Flammable liquids or gases

#### 12.6.3 Explosives

Explosives or flammable solids such as DOT Class C devices, Gunpowder, Cartridge Primers or Military

Explosives, etc.

### 13.7 Smoke and Light

Smoke and light based weapons, which impair the viewing of robots by an Entrant, Judge, Official or Viewer. This includes, but is not limited to the following:

#### 13.7.1 Smoke or Dust

Large quantities of smoke or dust. Limited smoke effects may be allowed.

#### 13.7.2 Lights

Lights such as external lasers and bright strobe lights, which may blind the opponent.

### 13.8 Hazardous Materials

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. If unsure please contact Robo Challenge.

## 14 Weapons Additional

### 14.1 Weapon Restraints

#### 14.1.1 Locking Devices

All high speed weapons (eg. all pneumatic and rotational weapons) must incorporate a secure restraint that locks the weapon in a safe position. The restraint may incorporate locking pins and bars but must be secured in such a way that it cannot be removed inadvertently. The design should ensure that the weapon cannot be fired during the activation process.

#### 14.1.2 Positioning

A Locking devise must be removeable & re-insertable away from the line of fire and without the need for the Arena Marshall to contact any part of the robot.

#### 14.1.3 Invertable

Locking devises must be able to be fitted to a robot that is inverted or on its side without compromising rule 14.1.2.

#### 14.2 Entanglement

Entanglement devises are not permitted.

#### 14.3 Interchangeable Weapons

Robots with interchangeable weapons are permitted under the following conditions.

##### 14.3.1 Weapon Type

All interchangeable weapons must comply with rule 12.1

##### 14.3.2 Weapon Application

All interchangeable weapons must be submitted on the Robo Challenge application and are subject to approval.

For technical queries, rules clarifications & advice please contact Robo Challenge –  
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