2018 WEST MICHIGAN FTC KICKOFF

FTC ROBOT RULES, COMPONENTS, AND TIPS

Presented by: Chad Potinsky
AGENDA

- Robot Mechanical Components
- Robot Build Tips
- Robot Electrical Components
- Robot Inspection
- Q&A
NOTE: (DISCLAIMER)

- This presentation only highlights in our opinion, key points of the Part 1 manual on components and build rules. It does not relieve your team of the responsibility to read and question the rules and monitor the FTC forum for rule changes.

- Several of many important items we will not address are: required robot identification, the required alliance flag holder, the launching of robot parts or game elements and the requirement to use only original size and unmodified fuses and circuit protection devices.

- The FTC forums are available at www.FIRSTinspires.org. Go to the FTC program and Click on the “Read More” link by the FIRST Relic Recovery icon. The FTC forum link is located on the bottom of any of the “Quick Link” pages that are listed on the right side of the lead game page.
• Section 8: The Robot

A FIRST Tech Challenge Robot is a remotely operated vehicle designed and built by a registered FIRST Tech Challenge Team to perform specific tasks when competing in the annual game challenge. This section provides rules and requirements for the design and construction of a Robot. Teams should be familiar with the Robot and game rules before beginning Robot design.

• Section 9: Robot Inspection

The FIRST Tech Challenge Robot will be required to pass Robot and Field inspections before being cleared to compete. These inspections will ensure that all Robot rules and regulations are met. Initial inspections will take place during Team check-in/practice time.
SECTION 8.2: ROBOT TECHNICAL DEFINITIONS

Core Device Interface Module
Core Servo Controller
Core Motor Controller
Op Mode
REV Expansion Hub
MINI USB to OTG (On-The-Go) Micro Cable
REV Servo Power Module
Logic Level Converter
Java
OTG Micro Adapter
Driver Station
UVC Compatible Camera
REV SPARK Mini Motor Controller
I2C Sensor Adapter Cable
REV Expansion Hub
UVC Compatible Camera – A USB Video Class (UVC) Compatible Camera is a digital camera that conforms to the USB Video Class specification. UVC Compatible Cameras have USB Type A cables and are powered by the Robot Controller through a non-powered USB hub that is connected to the Robot Controller through an OTG adapter.
**REV SPARK Mini Motor Controller** - An electronic device that accepts a PWM control signal (from a servo controller) and supplies 12V power to a DC motor.
<RG01> ILLEGAL PARTS

Those that could potentially damage the Playing Field and/or Scoring Elements. For example, high traction wheels *(for example, AM- 2256)* and high grip tread *(for example, Rough top)* when used in a Robot drive system that may damage the Playing Field are not allowed.

Black tire marks on an Element is not considered *Playing Field* damage. However, digging a hole into the *Playing Field* tiles can be considered damage.
Illegal Parts

- Those that could potentially damage or flip other competing Robots
- Those that contain hazardous materials
  - such as mercury switches, lead, or lead...
- Those that pose an unnecessary risk of entanglement.
- Those that contain sharp edges or corners.
- Those that contain animal-based materials (because of health and safety concerns).
- Those that contain liquid or gel materials.
- Those that contain materials that would cause a delay of game if released (for example, loose ball bearings, coffee beans, etc.).
- Those that are designed to electrically ground the Robot frame to the Playing Field.
- Closed gas devices (for example, gas storage vessel, gas spring, compressors, etc.).
- Hydraulic devices.
How To Use This Document:

The Legal and Illegal Parts List is intended to provide visuals of the most common legal and illegal parts. This document is to serve as a guide, however is NOT an all-inclusive list. Teams and volunteers should be sure to read all of the robot build rules in the Game Manual Part 1, and should always reference the Game Q&A forum for additional build rule clarifications.
FIRST publishes a document on Legal and Illegal Parts

**This link is not in the manual, only found on the FIRST website!!! Be aware of these parts**


Not all parts, legal or illegal, are in this document. It is only a reference with some common items questioned.

### The following parts are ILLEGAL for the 2018-2019 FIRST Tech Challenge

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Description</th>
<th>Picture / Diagram</th>
</tr>
</thead>
<tbody>
<tr>
<td>AUL3025</td>
<td>Modern Robotics Core Legacy Module</td>
<td><img src="image1.png" alt="Modern Robotics Core Legacy Module" /></td>
</tr>
<tr>
<td>W991445 (*)</td>
<td>HiTechnic Servo Controller HiTechnic DC Motor Controller</td>
<td><img src="image2.png" alt="HiTechnic Servo Controller HiTechnic DC Motor Controller" /></td>
</tr>
<tr>
<td>W991444</td>
<td>(Legacy Sensors for LEGO and NXT)</td>
<td><img src="image3.png" alt="Legacy Sensors for LEGO and NXT" /></td>
</tr>
<tr>
<td>W40234 &lt;R 02 L&gt;</td>
<td>TETRIX® Prime Gripper Arm Kit</td>
<td><img src="image4.png" alt="TETRIX® Prime Gripper Arm Kit" /></td>
</tr>
</tbody>
</table>

**Examples of some illegal parts**
The maximum size of the Robot for starting a match is 18 inches (45.72 cm) wide by 18 inches (45.72 cm) long by 18 inches (45.72 cm) high. A Robot Sizing Tool will be used as the official gauge to make sure Robots comply with this rule.

TIP: Design your Robot to be 0.25+” smaller To account for “stuff”
Robots must not weigh more than 42 pounds including battery. To account for variances between scales, there will be a .5 pound (.23kg) overage allowance on top of the 42 pound weight limit. This weight constraint does not include the Alliance Flag or Team Marker. If a Team is using multiple mechanisms that will be swapped out from one match to the next, all components and the robot must be weighed together during weight inspection and must not weigh more than 42 pounds.
Robots MUST prominently display their Team number (numerals only, for example “12345”) on two separate signs.

a) The judges, referees, and announcers must be able to easily identify Robots by Team number.

b) Team number must be visible from at least two opposite sides of the Robot (180 degrees apart).

c) The numerals must each be at least 2.5 inches (6.35 cm) high, at least 0.5 inches (1.27 cm) stroke width, and in a contrasting color from their background. Teams can use Arial Font, Bold, 250 point to meet the minimum size requirements.

d) Team numbers must be robust enough to withstand the rigors of match play. Example robust materials include: 1) self-adhesive numbers (that is, mailbox or vinyl numbers) mounted on polycarbonate sheet, wood panel, metal plate, etc.; 2) Ink jet or laser printed numbers on paper and laminated.
Robots are allowed to launch Scoring Elements through the air unless limited by a game specific rule. It is expected that Teams will launch the elements with just enough velocity to score. If the referees feel that a Robot is launching Scoring Elements with excessive velocity that would cause a safety issue if they were to leave the field, the Robot will be required to be inspected. Robots must then demonstrate that a launched Game Element cannot travel in the air more than a distance of 16 ft. (4.88 m) or more than 6 ft. (1.83 m) in elevation.
Teams may use raw and post-processed materials to build their Robots, provided they are readily available to the majority of Teams from standard distributors (for example, McMaster-Carr, Home Depot, Grainger, AndyMark, TETRIX/PITSCO, MATRIX/Modern Robotics, REV Robotics, etc.).

Examples of allowed raw materials are:
- Sheet goods
- Extruded shapes
- Metals, plastics, wood, rubber, etc.
- Magnets

Examples of allowed post-processed materials are:
- Perforated sheet and diamond plate
- Injection molded parts
- 3D printed parts
- Cable, string, rope, filament, etc.
- Springs of all types: compression, extension, torsion, surgical tubing, etc.
<RM01> ALLOWED MATERIALS – BUILD OPTIONS

You have choices! Choose what is best for your team.

Custom Built Parts
ServoCity (Actobotics)
• 25% discount to FIRST Teams
• More options than Tetrix / Matrix
• Free Parts with newsletter
• Videos to learn from
• Return unused parts
Teams may use Commercial Off The Shelf (COTS) mechanical parts that have a single degree of freedom. A single degree of freedom is a system whose motion is defined just by a single independent co-ordinate (or function).

Examples of allowed single degree of freedom parts:
- Linear Slide
- Single speed (non-shifting) Gearboxes
- Pulley
- Lazy Susan
- Lead Screws

Examples of illegal multiple degrees of freedom parts:
- Gripper assemblies or kits
- Ratcheting wrenches

COTS drive chassis (for example, AndyMark TileRunner, REV Robotics Build Kit) are allowed provided none of the individual parts violate any other rules.
COTS EXAMPLES

Single Speed Gearboxes

Grippers – more than 1 degree of motion

Drawer Slides

Lead Screw

Cascading X-Rail Slide Kit
COTS DRIVE CHASSIS ALLOWED
OTHER MECHANICAL RULES...

- **<RM03> Holonomic Wheels** - Holonomic wheels (omni or mechanum) are allowed.

- **<RM04> 3D Printed Parts** - 3D printed parts are allowed.

- **<RM05> Modifying Materials and COTS Parts** - Allowed materials and legal COTS parts may be modified (that is, drilled, cut, painted, etc.), as long as no other rules are violated.
**BUILD TIPS - FASTENERS**

- **Fastener Recommendations:**
  - Use Lock nuts (#6-32 ~ $2.67 at McMaster-Carr for 100)
  - Use steel set screws in collets
    - Deeper hex hole = less wrench stripping
    - Deeper hex hole = ability to tighten better
  - Tip styles – Different tip styles can hold better but may damage the shafts. Use these only if you need the extra bite
  - Use Alloy Steel Screws in critical areas
    - This can improve the shear strength by several hundred lbs
SHAFT CONSIDERATIONS

- **TETRIX MAX** - Motor Shafts 6mm D shaft. Axles 3/16" D shaft. Soft stainless steel alloy. Prone to twist under high load, bronze bushings through frame is the common bearing. Some teams grind a flat on to 4041 steel rod.

- **REV Robotics** – Motor shafts and axles are all 5mm hex. Delrin bearings with mounts for 19mm extrusion channel.

- **AndyMark** – 6mm D motor shafts and axles. Flanged 6mm bearings. New “NUB system to connect to wheels and gears.

- **ServoCity** – a variety of options. They have a complete system of adapters to match the TETRIX MAX products

- **VEXPro** – 3/8" or ½" hex shaft to build like FRC.

- **McMaster Carr** 3/16" shafts work great but don’t have a flat for set screws. We prefer a 4140 material for high strength.
**BUILD TIPS: TETRIX BEAMS**

- To provide more mounting options in the Tetrix components, double drill the hole patterns
  - Align 2 Tetrix parts together offsetting so that the holes overlap where there are none
  - Use a fastener on each end of the part (long parts center also) to hold together.
  - Using a drill press or hand drill, drill holes where none exist to create additional hole patterns.
- Great way to also get students working with tools and having tasks to perform.

Idea and picture for Double Drilling found on the Cougar Robotics (FTC 4251) website.
BUILD TIPS: STRONGER DRIVEN SYSTEMS

- Design for strength:
  - Use on both sides to stabilize the system and improve strength
  - Counterbore to sink heads flush to save space
    - Requires special C’Bore tool (approx. $25)
Robot Electrical Parts and Materials Rules

There are many possible ways to build and wire a Robot. These rules provide specific requirements on what is and is not allowed. Teams must ensure that electrical and electronic devices are used consistent with manufacturer’s requirements and specifications. Teams are encouraged to review the FIRST Tech Challenge Robot Wiring Guide for suggestions on how to build a Robot with safe and reliable wiring.

Robot Wiring Guide is found at www.FIRSTinspires.org under the FTC program game materials.

(This link is in the manual)
The Robot Main Power Switch must control all power provided by the Robot main battery pack. FIRST requires Teams to use either the TETRIIX (part # W39129), MATRIX (part # 50-0030), or REV (REV-31-1387) power switch. This is the safest method for Teams and field personnel to shut down a Robot.

If using Modern Robotics - NOTE! It is no longer allowed use of the built-in switch on the PDM as the main disconnect.

The Robot main power switch MUST be mounted or positioned to be readily accessible and visible to competition personnel. A Main Robot Power label must be placed near the Main Power Switch of the Robot. Attach the image ("POWER BUTTON") to your Robot near the Main Power Switch. To be easily seen by field personnel the label should be at least 1 in x 2.63 in (2.54 cm x 6.68 cm, Avery Label # 5160) and placed on a flat surface (not wrapped around corners or cylinders).

The Robot Main Power Switch should be mounted on the Robot so it is protected from Robot-to-Robot contact to avoid inadvertent actuation or damage.
Robot power is constrained by the following:

a. Allowed electronic devices may only be powered by power ports on the Core Power Distribution Module or the REV Expansion Hub except as follows:
   
i. The Core Power Distribution Module or REV Expansion Hub is powered by the Robot main battery. If a hybrid of Modern Robotics modules is used with the REV Expansion Hub, the REV Expansion Hub must be powered from a power port on the Core Power Distribution Module.
   
ii. Allowed sensors connected to the Core Device Interface Module, the Core Legacy Module, and the REV Expansion Hub.
   
iii. Light sources per <RE12>.
   
iv. Video cameras per <RE13>.

b. The Robot Controller Android device must be powered by its own internal battery or by the built-in charging feature of the REV Expansion Hub; external power is not allowed.

c. A second REV Expansion Hub is allowed to be connected to and powered by the extra XT30 power port on a Robot’s first REV Expansion Hub. No other devices are allowed to draw power from the XT30 power ports on a REV Expansion Hub.
Batteries MUST be securely attached (for example, VELCRO, zip tie, rubber band) to the Robot in a location where they will not make direct contact with other Robots or the Playing Field.

The only allowed Robot main power battery packs are:

a. TETRIX (W39057, formally 739023) 12 VDC battery pack
b. Modern Robotics/MATRIX (14-0014) 12 VDC battery pack
c. REV Robotics (REV-31-1302) 12 VDC Slim Battery pack

Note: There are similar looking batteries available from multiple sources but the ONLY legal batteries are those listed above.
TETRIX BATTERY TIP

Recommended to change to an Anderson connector

When changing use the proper crimping tool. Your local FRC team may have one to borrow.
Warning: The Modern Robotics Core Power Distribution Module is not reverse-polarity protected. If the wires are inadvertently reversed (red to black, black to red) (Figure 9), the Core Power Distribution Module will be damaged. Additionally, the battery should never be plugged into the distribution ports (Figure 10).
Robot control module quantities are constrained as follows:

a. Exactly one (1) Core Power Distribution Module is required for Teams using any Modern Robotics Core Control Modules.

b. No more than two (2) Core Device Interface Modules are allowed.

c. Any quantity of Core Motor, or Core Servo Controllers are allowed.

d. Any quantity of REV Servo Power Modules is allowed.

e. No more than two (2) REV Expansion Hubs are allowed.

f. Any quantity of REV SPARK Mini Motor Controllers are allowed.

g. The REV Control Hub is not allowed.

h. The Core Legacy Module is not allowed.
A maximum of eight (8) DC motors are allowed. The only allowed motors are:

- TETRIX 12V DC Motor
- AndyMark NeveRest series 12V DC Motors
- Modern Robotics/MATRIX 12V DC Motors
- REV Robotics HD Hex 12V DC Motor
- REV Robotics Core Hex 12V DC Motor

No other DC motors are allowed.
<RE13> VIDEO CAMERAS

a. Self-contained video recording devices (GoPro or similar) are allowed providing they are used only for non-functional post-match viewing and the wireless capability is turned off. Approved self-contained video cameras must be powered by an internal (as supplied by the manufacturer) battery.

b. **UVC Compatible Cameras** are allowed for computer vision-related tasks. **UVC Compatible Cameras** should be powered by the **Robot Controller** through a non-powered USB hub that is connected to the **Robot Controller** through an OTG adapter.
NEW PRODUCTS 2018: REV ROBOTICS

USB RETENTION MOUNT AND CABLE
XT30 POWER DISTRIBUTION BLOCK
SPARKMINI MOTOR CONTROLLER

NEW FTC ELECTRONICS
The SPARKmini, Color Sensor V2, and 2m Distance Sensor are here to help you kick things up a notch.

WWW.REVROBOTICS.COM
8.4 TEAM MARKER RULES

The Team Marker is a new, game specific scoring element that will be used in the ROVER RUCKUS™ game. The Team Marker must pass Inspection before it allowed to be used in a Match.

<TM01> Material Constraints - The Team Marker is subject to the Robot Mechanical Parts and Materials Rules in section 8.3.2.

<TM02> Size Constraints - The maximum size of the Team Marker is 4 inches (10.16 cm) by 4 inches (10.16 cm) by 8 inches (20.32 cm). The minimum size of the Team Marker is 3 inches (7.62 cm) by 3 inches (7.62 cm) by 4 inches (10.16 cm).

<TM03> Team Number - Team Markers must be labeled with their Team number (numerals only, for example “12345”) The letters must be legible when viewed from a distance of 12 inches away. The Team number needs to appear only once on the Team Marker.

Examples from the FIRST Blog on July 11, 2018
9.0 ROBOT INSPECTION

Robot Inspection
Teams are required to conduct a self-inspection of their Robot and submit the completed Robot Inspection forms to the Robot Inspectors. Teams should go through each checklist at least a week before the competition to make sure their Robot is made up of legal parts. Teams should bring their self-inspection sheets to the competition and hand them in to the Robot and Field Inspectors.
BUILD TIPS: ROBOT SIZE

- Design within the 18" x 18" x 18" box
  - Make the frame and height short by at least ¼" to ½"
  - The robot can expand larger during game play
- At inspection the robot will need to fit into an inspection box.
  - Build an inspection box, add a lid, and use it to safely transport your robot.
- Sizing Box Plans:
OPEN Q&A