

<p>*Note, go back to <RG04>*</p>	<p><i>Moved from <R04>:</i> <RG03> f. Those that contain animal-based materials (due to health and safety concerns). g. Those that contain liquid or gel materials.</p>
	<p><i>Added:</i> <RG03> h. Those that contain materials that would cause a delay of game if released (e.g. ball bearings, coffee beans, etc.). i. Those that are designed to electrically ground the Robot frame to the floor.</p>
<p><i>Removed:</i> <RG09> e. Team numbers and their mounting surface are not required to be made of specifically allowed material so long as the materials do not affect the function or performance of the Robot. Examples of recommended number materials include: i. Self-adhesive numbers (i.e. mailbox, or vinyl numbers) ii. Ink jet or laser printed numbers on laminated paper or adhesive-backed paper.</p>	
<p><RG10> a. Electrical energy derived from the onboard TETRIX or MATRIX battery pack, HiTechnic 9-volt Battery Box for the sensor multiplexer, MATRIX Battery Box for powering the Samantha unit (MATRIX robots only), the battery for the visible LEDs, and the NXT battery. b. Compressed air stored in the LEGO pneumatic system. c. A change in the position of the Robot center of gravity. Rev 1.1 October 30, 2013 18 © FIRST Tech Challenge d. Storage achieved by deformation of Robot parts. Teams must be very careful when incorporating spring-like mechanisms or other items to store energy on their Robot by means of part or material deformation. A Robot may be rejected at inspection if, in the judgment of the inspector, such items are unsafe.</p>	<p><RG10> a. Electrical energy derived from the onboard TETRIX or MATRIX battery pack, HiTechnic 9-volt Battery Box for the sensor multiplexer, MATRIX Battery Box for powering the Samantha unit (MATRIX Robots only), the battery for the visible LEDs, a 9-volt battery connected to an approved prototype board, and the NXT battery. b. A change in the position of the Robot center of gravity. c. Storage achieved by deformation of Robot parts. Teams must be very careful when incorporating spring-like mechanisms or other items to store energy on their Robot by means of part or material deformation. A Robot may be rejected at inspection if, in the judgment of the inspector, such items are unsafe. d. Compressed air and pneumatic devices are not allowed.</p>
<p><RG11> Game elements launched by Robots should not have a velocity greater than that required to reach a maximum of four (4) feet (1.2 meters) above the playing field surface, nor travel a horizontal distance greater than ten (10) feet (3</p>	<p><RG11> Game elements launched by Robots should not have a velocity greater than that required to reach a maximum of five (5) feet (1.5 meters) above the playing field surface, nor travel a horizontal distance greater than ten (10) feet (3 meters) from the point that the game element</p>

<p>meters) from the point that the game element ends contact with the robot.</p>	<p>ends contact with the Robot. Parts of the Robot itself may not be launched.</p>
<p><R01> All LEGO parts are allowed except for the following: a. Any DUPLO parts b. LEGO MINDSTORMS EV3</p>	<p><i>Added:</i> <R01> All LEGO parts are allowed except for the following: a. Any DUPLO parts b. LEGO MINDSTORMS EV3 c. LEGO pneumatics</p>
	<p><i>Added:</i> <R02> i. 2.4 GHZ 4 Channel Wireless Joystick Receiver (Product Id 40377) j. 2.4 GHZ 4 Channel Wireless Joystick Gamepad (Product Id 40377) k. 3.6 to 7.2 Volt NIMH Charger (Product Id 40378) l. TXP Prime Gripper Kit (Product Id 40234) m. TXP Battery pack 5AA cell 1500mAh 6 Volt NIMH (Product Id 40235)</p>
<p><i>Old Rule:</i> <R04> In addition to the TETRIX, LEGO, and/or MATRIX components, teams may use additional raw materials to construct their robots. A Raw Material is defined as a material that is supplied in a simple, extruded form with little or no post forming or machining that is done by the vendor. The following rules pertain to the use of Raw Materials: a. Raw materials may be used in any dimension and quantity. Teams may use these raw materials to make any type of finished part. b. A Raw material can be any type of commonly available material including steel, aluminum, plastic (of any kind), fiberglass, carbon fiber, stone, wood (including paper, plywood, etc.). Also included are castable materials such as polymer resins, rubber, cement, etc. c. To be legal a Raw Material must be readily available to the majority of teams from standard distributors (e.g. McMaster-Carr, Home Depot, Grainger, etc.). Materials that are found in only one region or can only be obtained from a team’s sponsor are not allowed.</p>	<p><i>Replaced by:</i> <R04> In addition to the TETRIX, LEGO, and/or MATRIX components, teams may use additional materials and COTS (Commercial Off The Shelf) components to construct their Robots subject to the following restrictions: a. All raw materials are allowed provided they are readily available to the majority of teams from standard distributors (e.g. McMaster-Carr, Home Depot, Grainger, AndyMark, etc.). Examples of allowable raw materials are:</p> <ul style="list-style-type: none"> • sheet goods • Extruded shapes • Metals, plastics, wood, rubber, etc
<p><R04> In addition to the TETRIX, LEGO, and/or MATRIX components, teams may use additional raw materials to construct their robots. A Raw Material is defined as a material that is supplied in a simple, extruded form with little or no post</p>	<p><i>Replaced by:</i> <R04> In addition to the TETRIX, LEGO, and/or MATRIX components, teams may use additional materials and COTS</p>

<p>forming or machining that is done by the vendor. The following rules pertain to the use of Raw Materials:</p> <p>d. Materials in the form of angle, channel, tubing, sheet, film, blocks, etc. are allowed but these same shapes with post machined features (holes, slots, etc.) are considered to be Commercial Off The Shelf (COTS) and are constrained by Rule <R05>.</p>	<p>(Commercial Off The Shelf) components to construct their Robots subject to the following restrictions:</p> <p>b. All post-processed materials are allowed provided they are readily available to the majority of teams from standard distributors (e.g. McMaster-Carr, Home Depot, AndyMark, etc.). Examples of allowable post processed materials are:</p> <ul style="list-style-type: none"> • perforated sheet and diamond plate • Injection molded parts • 3D printed parts
<p><i>Moved to Robot General Rules <RG03>:</i> <R04></p> <p>e. Due to health and safety concerns, animal based materials are not allowed.</p> <p>f. Liquid materials are not allowed.</p>	
<p><i>Old Rule:</i> <R05></p> <p>The intent of <R05> is to augment the TETRIX, LEGO and MATRIX robot system kits with a few select assemblies/mechanisms that might be useful for this year’s game challenge. For the purpose of this rule, Commercial Off The Shelf (COTS) assemblies are considered to be component parts that have been fitted together or parts that have been pre-formed or pre-fabricated by a supplier to perform a given function. In general, COTS are not permitted with the following exceptions:</p> <p>a. Linear Slides</p> <p>b. Non-motorized Turntables and Lazy Susans.</p> <p>c. Lead Screws and threaded rod plus compatible nuts.</p> <p>d. Servo blocks (ONLY ServoCity Part # SB608SH and SB609SH, no other servo blocks are allowed), shaft adaptors, servo arms, ball links, shaft clamps.</p> <p>e. #25 or #35 chain with associated links.</p> <p>f. Timing belts of any size and pitch.</p> <p>g. Gears of any size and pitch, including non-circular gears such as rack, worm, bevel, etc.</p> <p>h. Sprockets of any size and pitch.</p> <p>i. Pulleys including sheaves, timing belt, etc.</p> <p>j. Springs of any type and material (coil, extension, compression, leaf, etc.) that are used in a safe manner.</p>	<p><i>Replaced by:</i> <R04></p> <p>In addition to the TETRIX, LEGO, and/or MATRIX components, teams may use additional materials and COTS (Commercial Off The Shelf) components to construct their Robots subject to the following restrictions:</p> <p>c. COTS parts and assemblies may only have a maximum of a single degree of freedom. It is the intent of FIRST that teams design and build their devices to achieve the game challenge. Assemblies of COTS components, such as linear slides, and gearboxes are allowed while a pre-fabricated gripper assembly designed to grab the game elements is not. Holonomic wheels (omni or mecanum) are exempt from the one degree of freedom limitation.</p> <p>Examples of single degree of freedom COTS components are:</p> <ul style="list-style-type: none"> • Hinges • Sprockets • Gears of any type, including Rack and Pinion gears • Simple and compound gear trains • Planetary gear trains • Lazy Susan <p>e. All TETRIX, MATRIX, raw materials, and COTS may be modified (e.g.drilled, cut, painted, etc.)</p>

<p>k. Fasteners of any size, including nuts, bolts, screws, shoulder screws, washers, spacers, shaft collars, shaft couplers, rivets, Velcro, etc.</p> <p>l. Bearings of any type and material. Including bushings, roller bearings, etc.</p> <p>m. PVC, CPVC, PEX piping and fittings.</p> <p>n. Extruded or T-slot aluminum construction material along with all compatible brackets and fittings (i.e. 80-20, Macron Dynamics, etc.).</p> <p>o. Wheels of any type up to 4" diameter (as measured at the outer surface of the tread). Wheels that have exposed features likely to cause damage to field and/or game elements are not allowed. Wheels are considered to be the total of the rim (the plastic or other material on the inside), the tire (the rubber or other material on the outside), and the manufacturer provided wheel hub used to mount the wheel to an axle. Individual components of a legal wheel assembly can be used on the robot (as long as wheel and hub are 4" diameter or less).</p> <p>p. Allowable COTS parts may be acquired from any source and in any quantity.</p>	<p>provided no other rules are violated.</p>
<p><i>Old Rule:</i> <R07> Welding, brazing, and soldering are legal methods for assembling a robot.</p>	<p><i>Added:</i> <R05> Welding, brazing, soldering and fasteners of any type are legal methods for assembling a Robot</p>
	<p><i>Added:</i> <R04> d. High traction wheels, eg. AM- 2256, that may damage the playing field are not allowed.</p>
<p><R08> Robot electronics are constrained to the following: a. Exactly one (1) LEGO MINDSTORMS NXT Controller MUST be used. Additional microprocessors are not permitted unless they are an integral part of an allowed part, or attached to the HiTechnic SuperPro Prototype or the NXT Prototype Boards, or are purely decorative in function. The EV3 Controller is not approved for use in FTC Competitions.</p>	<p><R08> Robot electronics are constrained to the following: a. Exactly one (1) LEGO MINDSTORMS NXT Controller MUST be used in FTC competitions. No other Robot Controllers, including the EV3 controller, may be used in FTC competitions.c. Additional electronics are allowed provided they are an integral part of an allowed part, or attached to the HiTechnic SuperPro Prototype or the NXT Prototype Boards, or are purely decorative in function. Approved prototype boards may optionally include a 9-volt battery per <R11>d.i.</p>
<p><R08> Robot electronics are constrained to the following: g. A maximum total of eight (8) TETRIX or eight (8) MATRIX DC motors are allowed and must be</p>	<p><i>Added:</i> <R09> Robot motors and servos are constrained to the following:</p>

<p>controlled by a compatible TETRIX or MATRIX controller. A robot is constructed with either TETRIX or MATRIX DC motors, not both.</p>	<p>b. A maximum total of eight (8) TETRIX /AM-2964 motors (in any combination) or eight (8) MATRIX DC motors are allowed and must be controlled by a compatible TETRIX or MATRIX controller. A Robot is constructed with either TETRIX /AndyMark or MATRIX DC motors, not both.</p>
<p><R08> Robot electronics are constrained to the following:</p> <p>h. A maximum of twelve (12) servos are allowed, provided that they are compatible with and controlled by TETRIX (HiTechnic) or MATRIX controllers. For TETRIX (HiTechnic) Servo Controllers:</p> <p>i. Any combination of the following servos is allowed per servo controller: 180 Degree HiTEC HS-475HB and HS-485HB, Continuous Rotation W39177 and HiTEC HSR-1425CR, hobby servos "standard" size and smaller (i.e. standard, mini, micro) with rated stall current of 800mA or less.</p> <p>ii. Quarter-scale HiTEC HS-755HB and HiTEC 785HB servos may be used. If HS-755HB or HS-785HB servos are used, the number of allowed servos per TETRIX (HiTechnic) Servo Controller is limited as follows:</p> <ul style="list-style-type: none"> • No more than two (2) quarter-scale servos may be connected to a single Servo Controller. • If two (2) quarter-scale servos are attached a controller, only one (1) additional servo of the type Rev 1.1 October 30, 2013 21 © FIRST Tech Challengelisted in <R08>h (i) may be used. • If only one quarter-scale servo is attached a controller, no more than four (4) additional servos of the type listed in <R08>h(i) may be used. 	<p><i>Replaced with:</i></p> <p><R09> Robot motors and servos are constrained to the following:</p> <p>c. A maximum of twelve (12) servos are allowed, provided that they are compatible with and controlled by TETRIX (HiTechnic) or MATRIX controllers. For TETRIX (HiTechnic) Servo Controllers:</p> <ul style="list-style-type: none"> i. Any unmodified quarter-scale or smaller servo is allowed. ii. The sum of the rated stall current for all servos connected to a single Servo Controller must be no greater than 5 Amps per controller.
<p><R08> Robot electronics are constrained to the following:</p> <p>w. Motors, sensors, controllers, and any other electrical components may not be altered from their original state in ANY way unless specifically allowed by the Robot rules.</p>	<p><i>Added:</i></p> <p><R09> Robot motors and servos are constrained to the following:</p> <p>g. Motors, sensors, controllers, and any other electrical components may not be altered from their original state in ANY way unless specifically allowed by the Robot rules. The following motor modifications are allowed:</p>

	<ul style="list-style-type: none"> i. Teams may solder wires to the motor leads ii. Motor shafts may be modified (i.e. cut short, drilled thru, etc.)
	<p><i>Added:</i></p> <p><R09> Robot motors and servos are constrained to the following: Gearboxes may be replaced and repaired with replacement parts that are equivalent (identical in performance) to the original.</p>
<p><R08> Robot electronics are constrained to the following:</p> <ul style="list-style-type: none"> o. LEGO-Approved NXT extension cables are allowed. Approved cables are currently only available from LEGO and HiTechnic. Custom-made NXT cables are not permitted. 	<p><i>Added:</i></p> <p><R10> Robot wiring is constrained as follows:</p> <ul style="list-style-type: none"> a. LEGO-Approved NXT Mindstorm cables are allowed. Approved cables are currently only available from LEGO and HiTechnic. NXT implementation limits cable lengths to 0.9 meter maximum length. NXT Mindstorm cables cannot be modified in any way.
<p><R08> Robot electronics are constrained to the following:</p> <ul style="list-style-type: none"> n. HiTechnic SuperPro Prototype Board, and the NXT Prototype Boards (both solderable and solderless) are allowed with the following constraints: <ul style="list-style-type: none"> i. All power used in the circuits connected to the Prototype Board must be derived from the power connections provided within the board. No batteries or external power sources are allowed. ii. Circuits may connect only to the named connections provided by the Prototype Board (i.e. A4-A0, B5-B0, 3V, 4V, 9V, 5V, GND) or SuperPro Prototype Board (i.e., A3-A0, B7-B0, S3-S0, O1-O0, WR, RD, 3V, 9V, 5V, GND) iii. Communication to the NXT Controller may only occur through the included NXT connector. iv. Any compatible sensor may be connected to the Prototype Board, provided that no other rules are violated. Sensors may be distributed throughout the Robot; they do not need to be physically attached to the Prototype Board. v. Additional circuit boards may be connected to the Prototype Board as needed. vi. The processor included in the Prototype Board may not be reprogrammed. vii. Circuits included as part of the HiTechnic Prototype Board may not cause interference with any Robot Rev 1.1 October 30, 2013 22 © FIRST Tech Challenge on the playing field, any part of 	<p><i>Added:</i></p> <p><R11> Additional Robot electronics are constrained as follows:</p> <ul style="list-style-type: none"> d. HiTechnic SuperPro Prototype Board, and the NXT Prototype Boards (both solderable and solderless) are allowed with the following constraints: <ul style="list-style-type: none"> i. All power used in the circuits connected to the Prototype Board must be derived from the power connections provided within the board including the board's optional additional 9V battery. Circuits may connect only to the designated connections provided by the Prototype Board. (i.e. A4-A0, B5-B0, 3V, 4V, 9V, 5V, GND) or SuperPro Prototype Board (i.e., A3-A0, B7-B0, S3-S0, O1-O0, WR, RD, 3V, 9V, 5V, GND). <ul style="list-style-type: none"> ii. Circuitry that is connected to the HiTechnic SuperPro Prototype Board or the NXT Prototype Board may communicate with the NXT Controller only through the provided NXT interface on the HiTechnic SuperPro Prototype Board or the NXT Prototype Board. Any compatible electronics (including micro-controllers) may be connected to and controlled by the HiTechnic SuperPro Prototype Board or the NXT Prototype Board, provided that no other rules or constraints are violated. iii. Circuitry that is connected to the HiTechnic SuperPro Prototype Board or the NXT Prototype Board may be distributed throughout the Robot.

<p>the field management system or any game element.</p> <p>viii. Non-LEGO certified sensors may only be attached to an NXT Prototype Sensor Board or a SuperPro Prototype Board.</p>	<p>iv. Circuits included as part of the HiTechnic Prototype Board may not cause interference with any Robot on the playing field, any part of the field management system or any game element.</p> <p>v. Circuits implemented on or connected to a HiTechnic SuperPro Prototype Board or the NXT Prototype Board may not communicate in any way with other Robots on the playing field, any part of the field management system, or any other external device.</p>
<p><R08> Robot electronics are constrained to the following:</p> <p>s. Visible light LEDs with their connected electronic circuits are allowed. Power for the LEDs may be provided by the main robot battery pack (TETRIX or MATRIX) or by no more than one (1) battery of any type not to exceed 9 volts. LEDs used as visual cues must be controlled via connections to a HiTechnic SuperPro Prototype Board or the NXT Prototype Board.</p>	<p><i>Added:</i></p> <p><R11> Additional Robot electronics are constrained as follows:</p> <p>e. Visible light LEDs with their connected electronic circuits are allowed; infrared (IR) LED's are NOT allowed.</p> <p>i. Power for the LEDs may be provided by the main Robot battery pack (TETRIX or MATRIX) or by no more than one (1) battery of any type not to exceed 9 volts. LEDs controlled by the Robot must be controlled and powered only by connections to a HiTechnic SuperPro Prototype Board or the NXT Prototype Board.</p> <p>ii. LEDs may not cause interference with any Robot Driver, field personnel, any Robot on the playing field, any part of the field management system or any game element.</p> <p>iii. LEDs may not communicate in any way with other Robots on the playing field, any part of the field management system, or any game element.</p>
<p><R08> Robot electronics are constrained to the following:</p> <p>y. Video recording devices (GoPro or similar) are allowed providing they are used only for non-functional post match entertainment. Cameras must not have built-in wireless capability</p>	<p><i>Added:</i></p> <p><R11> Additional Robot electronics are constrained as follows:</p> <p>f. Video recording devices (GoPro or similar) are allowed providing they are used only for non-functional post match entertainment and the wireless capability is turned off.</p>