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2020-2021 *FIRST*® Tech Challenge

Game Manual Part 1
Remote Events

FIRST TECH CHALLENGE

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	Revision History		
Section	**Revision**	**Date**	**Description**
N/A	1	7/16/2020	Initial Release
Sponsors	1.1	9/12/2020	Updated Sponsor lockup
Section 5	1.1	9/12/2020	Section 5.2 – Clarified "top" 5 matches counted in a League Tournament
Section 9	1	9/12/2020	Added Judging and Award Criteria section
Appendix E	1	9/12/2020	Added Appendix E – Control Award Submission Form

Section 4	1	10/7/2020	• Section 4.5
			  ○ Changed FTC Live Scoring to FTC Scoring System
			  ○

Section 7	1.1	10/7/2020	• Section 7.3.4, Rule <RS03>
			  ○ Removed "UltimateGoal" from minimum required software version
			  ○ Renamed "REV PC Hub Interface Software" to "REV Hardware Client Software"
			  ○ Updated version number of the REV Hardware Client Software

Section 9	1.1	10/7/2020	Section 9.5.11 – Clarified 22 teams or larger
Appendix E	1.1	10/7/2020	• Renamed engineering notebook to engineering portfolio • Added section for required link for control award submissions • PDF now editable
Section 3	1.1	12/1/2020	• Added exception for Human Player
Section 6	1.1	12/1/2020	• Section 6.2 - Added allowance for number of awards at small events
Section 7	1.2	12/1/2020	• Section 7.2.1 – Corrected error in REV Control Hub definition • Section 7.3.1 – Rule <RG05>, numbered second example within rule • Section 7.3.3 – Rule <RE05>, added REV Servo Power Module to the list
Section 9	1.2	12/1/2020	• Section 9.3.4 – Further clarifications to engineering portfolio requirements • Section 9.3.6 – Removed mention of Mentor Network from Connect Award • Section 9.4.1 – Added that remote teams can show photos of the robot to the judges • Section 9.4.1.1 – Added link to feedback request form • Section 9.5.6 – Updated text box with new recommendations
Sponsors	1.2	2/3/2021	• Updated Sponsor lockup
Section 7	1.3	2/3/2021	• Section 7.3.3 – Corrected rule references in <RE05>a iv. &v. • Section 7.3.3 – Corrected rule references in <RE12>b • Section 7.3.3 – Corrected rule references in <RE13>c
Section 9	1.3	2/3/2021	• Section 9.5.1 – Added suggested criteria for the Inspire Award • Section 9.5.2 – Added suggested criteria for the Think Award • Section 9.5.4 – Added suggested criteria for the Think Award • Section 9.5.10 – Updated "Judges' Award" to "Judges Choice Award"

Contents

1.0 Introduction

1.1 What is FIRST® Tech Challenge?

FIRST® Tech Challenge is a student-centered program that focuses on giving students a unique and stimulating experience. Each year, teams engage in a new game where they design, build, test, and program autonomous and driver operated robots that must perform a series of tasks. To learn more about *FIRST*® Tech Challenge and other *FIRST*® Programs, visit www.firstinspires.org.

1.2 FIRST Core Values

We express the *FIRST*® philosophies of *Gracious Professionalism*® and *Coopertition*® through our Core Values:

- **Discovery:** *We explore new skills and ideas.*
- **Innovation:** *We use creativity and persistence to solve problems.*
- **Impact:** *We apply what we learn to improve our world.*
- **Inclusion:** *We respect each other and embrace our differences.*
- **Teamwork:** *We are stronger when we work together.*
- **Fun:** *We enjoy and celebrate what we do!*

2.0 *Gracious Professionalism®*

FIRST® uses this term to describe our programs' intent.

Gracious Professionalism® is a way of doing things that encourages high-quality work, emphasizes the value of others, and respects individuals and the community.

Watch Dr. Woodie Flowers explain *Gracious Professionalism* in this short video.

3.0 The Competition – Definitions and Rules

3.1 Overview

Students that engage in the *FIRST* Tech Challenge program develop Science, Technology, Engineering, and Math (STEM) skills and practice engineering principles while realizing the value of hard work, innovation, and sharing ideas.

There are two types of competition formats a *Team* might experience this season; Traditional events and remote events. This manual describes remote events; however, some *Teams* may switch between formats depending on social distancing rules within their state/region. Below are descriptions of both formats.

3.1.1 Traditional Events

A traditional *FIRST* Tech Challenge event is typically held in a school or college gymnasium, where *Teams* use *Robots* to compete in the current seasons game challenge. *Teams* participating in traditional events compete with alliance partners in a head to head style of competition on the official *FIRST* Tech Challenge *Playing Field*. *Teams* compete in a series of *Matches* that determine their ranking at a traditional tournament. The size of a traditional event can range anywhere from 8 *Teams* to over 50 *Teams* competing in one place. Traditional events are generally scheduled by the local program delivery partner, and are run by many volunteers including referees, judges, scorekeepers, queuers, and other key volunteers. Traditional events consist of *Robot* inspections, *Robot* competitions, judging interviews (for most competitions), and an overall celebration of *Teams* and their accomplishments. To learn more about traditional events, please read the Game Manual Part 1 – Traditional Events manual.

3.1.2 Remote Events

Remote events were developed to mimic traditional *FIRST* Tech Challenge events, while practicing social distancing guidelines. Since *Teams* are not able to gather and compete in the traditional head-to-head competition format, the season's official full *Playing Field* has been adapted to allow *Teams* to play as a single *Team*. Remote *Teams* may order an official half version of this seasons field, or compete using a modified version of the field, which will be released at kickoff on 9/12/2020. *Teams* will still sign up for events and will be provided a window to submit their own *Match* scores, which will determine their rankings. Unlike traditional events, the scoring of the official *Matches* is done by the *Team*, rather than an event volunteer. *Teams* will participate in judging interviews via video conference.

3.2 Eligibility to Compete in Official FIRST Tech Challenge Competitions:

3.2.1 North America Teams

To compete in an official *FIRST* Tech Challenge competition at any level, a *Team* must be registered and in good standing with *FIRST*.

1. The *Team* must complete the registration process through the Team Registration System.
2. The *Team* registration fee must be paid.
3. Two adults must pass the Youth Protection screening process.

3.2.2 Outside North America

Teams outside of North America are required to register through the Team Registration System. The registration ensures that *Teams* competing remotely will have access to the necessary software application to compete in the current season. Fees will not be due to *FIRST* for the registration. *Teams* outside of North America should consult the program delivery partner in their region for program fees and product purchase.

3.3 Competition Types

There are several types of competitions that *Teams* and other organizers hold throughout the *FIRST* Tech Challenge season and off-season. Competition types are listed in the following section.

3.3.1 Scrimmage
A scrimmage is an unofficial *FIRST* Tech Challenge competition where *Teams* do not advance. *Teams* compete at a scrimmage solely to prepare for an official *Tournament*. A scrimmage can be done in person or via the Internet as a way for *Teams* to practice, learn the rules, and mentor one another during the *Robot* build process.

Anyone can host a scrimmage to prepare for an official competition. *Teams* hosting a scrimmage are encouraged to tell their local Program Delivery Partner that such an event is taking place. *Teams* that choose to create and host a local meet are responsible for finding a location, organizing the format for the day, and inviting other *Teams* to participate. *Teams* may also have to secure the field elements, computers, and other items.

3.3.2 League Meets
A league meet is a competition in which *Teams* compete in *Qualification Matches* only. Rankings from one meet to the next accumulate as outlined in section 5.2. The number of meets a *Team* can play in may vary by region. Whenever possible, it is highly encouraged that *Teams* participate in as many meets as they can. Some standard competition guidelines may be adapted for those regions that participate in the league format. *Teams* should contact their program delivery partner for more information about the scheduling, structure, advancement, and processes that are unique to the league/meet in their region.

3.3.3 Qualifying Tournaments and League Tournaments
Hosted and managed by *FIRST* Tech Challenge program delivery partner or program delivery partner-appointed host. *Qualifying Tournaments* follow the format outlined in section 4.0. *Qualifying Tournaments* are held before *Championship Tournaments*. The number of *Teams* advancing to the state/regional championship tournament depends on the capacity of the state/regional championship tournament, the number of qualifying tournaments, and the number of *Teams* attending the qualifying tournament. The advancement criteria for moving up to the next tournament level is detailed in section 6.0.

3.3.4 Super Qualifying Tournaments
These tournaments are held in regions with a large number of *Teams* and/or leagues. In these regions, *Teams* advance from either a league tournament or qualifying tournament to a super-qualifying tournament, and then to the state/regional championship.

3.3.5 Championship Tournaments
Hosted and managed by a *FIRST* Tech Challenge program delivery partner, championship tournaments uphold certain standards in format, judging, awards, and overall quality. Some championship tournaments require that *Teams* advance from a qualifying tournament or league tournament to advance to the state/regional championship. Championship tournaments may include *Teams* from a geographic region, province, state, country, or several countries. *Teams* should expect a higher level of competition, both on the field and in the judging room at championship tournaments.

3.3.6 World Championship
Hosted and managed by *FIRST,* the world championships, held in Houston, Texas and Detroit, Michigan, are the culminating events for all *FIRST* programs. *FIRST* Tech Challenge *Teams* advance to the world championship through their state/region championship tournament. The world championship includes *Teams* from several countries, and *Teams* should expect a higher level of competition, both on the field and in the judging room.

3.4 Competition Definitions
Alliance Station –The designated *Alliance* area next to the *Playing Field* where the *Drivers* and *Coach* stand or move within during a *Match*.

Competition Area – The *Area* where the *Playing Field is* located.

Drive Team - Up to four representatives two (2) drivers, one (1) coach, and one (1) *Human Player* from the same *Team*.

Human Player – A student *Team* member that supplies *Scoring Elements* during a *Match*.

> It is preferred that the *Human Player* is a student competing on the *Team*. However, for the 2020-2021 season, exceptions can be made to allow an adult mentor, coach, parent, etc. to fill the role as *Human Player* if there are strict social distancing guidelines that do not allow more than a *Team* of one student to meet and participate in official *Matches*.

Playing Field –The area where the game elements are located and where *Robots* play *Matches*.

Qualification Match – A *Match* used to earn *Ranking Points* and *TieBreaker Points.*

Ranking Points/Total Ranking Points – The first basis for ranking *Teams*. For a single *Team* competing remotely, the *Team's* final score for a *Match* is used as their *Ranking Points*. For *Teams* that compete at a traditional tournament, each *Team* receives their *Alliance's* final score for a *Match* as *Ranking Points*. *Total Ranking Points* is the sum of the *Ranking Points* of all non-*Surrogate Matches* that a *Team* plays in a tournament. Please see section 5.0 for further explanation for how this is used to determine a *Team's* ranking.

Robot - Any mechanism that has been built to compete in the game challenge and complies with the *Robot* rules outlined in Section 7 of this manual.

Sports Start – A model of competition where *Teams* start their *Robot* after the 3-2-1 countdown.

Team – An official *FIRST* Tech Challenge *Team* consists of no more than 15 student *Team* members. A *Team* is made up of pre-college students and is designed for students in grades 7-12. Students cannot be older than high school-aged if they are participating *Team* members. All *Teams* in North America are required to register through the Team Registration System. *Teams* must have a minimum of two Lead Coaches or Mentors that have registered through the *Team* Registration System and have passed the Youth Protection Program screening. The *Team* must be in good standing through the registration system to compete in *FIRST* Tech Challenge official tournaments.

Teams outside of North America are required to register through the Team Registration System. *Teams* registered will receive the regular *Team* email blasts, receive access to the Game Q&A system, receive permanent *FIRST* team numbers, and can access nominations for the Dean's List Award.

TieBreaker Points/Total TieBreaker Points – *TieBreaker Points* are used as the tiebreakers when *Teams* have equal *Total Ranking Points.* There are two types of *TieBreaker Points*, *TBP1* and *TBP2*.

> *TBP1*: For a single *Team* competing remotely, the *Team's Autonomous Period* score for a Qualification *Match* is used as their *TBP1*. For *Teams* that compete at a traditional tournament, each *Team* receives their *Alliance's Autonomous Period* score for a *Qualification Match* as *TBP1*. *Total TBP1* is the sum of the *TBP1s* of all non-*Surrogate Qualification Matches* that a *Team* plays in a *Tournament*.
>
> *TBP2*: For a single *Team* competing remotely, the *Team's End Game* specific task score for a *Qualification Match* is used as their *TBP2*. For *Teams* that compete at a traditional tournament, each *Team* receives their *Alliance's End Game* specific task score for a *Qualification Match* as *TBP2*. *Total TBP2* is the sum of the *TBP2s* of all non-*Surrogate Qualification Matches* that a *Team* plays in a *Tournament*.

Please see section 5.0 for further explanation for how this is used to determine a *Team's* ranking.

Tournament – A Tournament is an event that advances *Teams* to the next level of competition within a state/region, or to the world championship. For many *Teams*, a *Tournament* is their culminating event.

3.5 Competition Rules

There are competition rules in the Game Manual Part 1 – Traditional Events, that do not apply to *Teams* competing remotely. Those rules have been removed from this manual; however, the numbering of the rules has been kept the same for consistency between both manuals.

<C01> Egregious behavior by any *Team*, *Team* member, or other representative of the *Team* is not tolerated at a *FIRST* Tech Challenge *Competition*.

<C05> Each registered *Team* may enter only one *Robot* (a *Robot* built to play the current season's game challenge) into the *FIRST* Tech Challenge competition. It is expected that *Teams* will make changes to their *Robot* throughout the season and at competitions.

a. It is against this rule to compete with one *Robot* while a second is being adjusted or assembled at a competition.

b. It is against this rule to switch back and forth between multiple *Robots* at a competition.

c. It is against this rule to register and attend concurrent competitions with a second *Robot*.

d. It is against this rule to use a *Robot* built by another *Team* at a competition.

Violations of this rule will immediately be considered deliberate and egregious.

<C07> *Teams* competing in a meet, league *Tournament*, qualifying *Tournament*, and championship Tournament will compete in no fewer than five (5) *Qualification Matches*, and no more than six (6) *Qualification Matches. Teams* competing remotely will have a total of six (6) *Qualification Matches*.

<C15> All *Team* members, coaches, and their guests must wear ANSI Z87.1 certified safety glasses while in the *Pit* or *Competition Area*. Prescription glasses with ANSI Z87.1 approved Commercial Off-The-Shelf side shields are also allowed.

<C16> Batteries must be charged in an open, well-ventilated area.

<C17> Open-toed or open-backed shoes are not allowed in the *Competition Area*.

<C18> There is no running, skateboarding, roller skating, 'hover boards', and/or flying drones are not allowed at any competition. These can create safety hazards to the *Teams*, spectators, or volunteers attending the competition.

4.0 Remote Competition Overview

Remote competitions are a way for *Teams* to compete while practicing social distancing. *Teams* are required to register with *FIRST* in order to access the cloud-based scoring system where their official *Matches* are submitted. This section of the manual outlines what *Teams* should expect while competing in remote competitions.

4.1 Consent and Release Forms and Team Roster

Each student competing at a *FIRST* Tech Challenge competition must have a signed consent and release form completed by a parent or legal guardian. **Students cannot compete without a signed consent and release form**. These forms can be filled out electronically or by hard copy.

- Electronically – A parent or legal guardian of the student can create a youth team member registration through the *FIRST* website and complete the consent and release form online.
- Hard copy – A hard copy of the form may be printed from the *Team* registration system and filled out be signed by a parent or legal guardian. Either the printed original, or a photocopy of the printed original of the form must be provided to the tournament director or program delivery partner.

The roster, printed from the team registration system must be handed in at event registration. The roster will show that each student's parent or guardian has electronically filled out the consent and release form online with a green checkmark. If the roster from the team registration system is blank or missing *Team* members' names, the coach should write in the names of each student competing. The hard copies of those consent and release forms must be turned in along with the roster.

4.2 Remote Competition Registration

Once a *Team* registers with *FIRST*, they must also register for their competition. For event information such as dates, competition registration, and competition format, *Teams* should contact their local program delivery partner.

4.3 Judging Interviews

Teams that compete in a remote *Tournament* (except for league meets, where judging interviews do not take place) are eligible for judged awards. Judging interviews are held via video conference and will be set up by either the local program delivery partner, a judge advisor, or tournament director.

Further details about judging interviews will be released at a later date.

4.4 Qualification Matches

Qualification Matches are the official *Matches* used to determine a *Teams* ranking. *Teams* will have up to a 7 day* window for the specific remote event(s) they are registered for to submit their six (6) official *Qualification Match* scores to *FIRST*. *Teams* are not required to play *Matches* on a specific date, however any unplayed/unscored *Qualification Matches* not submitted within the allotted timeframe will receive a zero score. *Teams* are ranked using their individual *Team* performance after their remote event ends.

*Please be sure to check with your local program delivery partner for details about the *Match* scoring window.

4.5 FTC Scoring Software

The FTC Scoring software is a Cloud-based application that allows *Teams* to score their *Matches* remotely and provide official scores to *FIRST*. *Teams* receive access to the software once they have registered for the season. Each *Team* can use their firstinspires.org *Team* dashboard user account to access the system and submit their *Qualification Match* scores. It is required that official *Qualification Match* scores are submitted via the FTC Live Cloud application within the allotted timeframe to count toward the *Team's* rankings.

The FTC Live Cloud application is similar to the live scoring system used in traditional events. *Teams* can run the FTC Live Cloud software to use the *Match* timers, displays, and score their *Match* as the *Match* is played.

In order to run the software to score a *Match* as it happens, an Internet connection is required. For *Teams* competing in a location that does not have high speed Internet access, the *Team* may use paper scoresheets to record the status of the *Match*. The *Team* must then ensure that the scores recorded on paper are submitted through the FTC Live Cloud software before the remote event deadline.

More detailed information, including scoring guides, will be available to *Teams* in October 2020.

5.0 Calculating Ranking

5.1 Competition Ranking Calculation

Each *Team* at a competition is ranked according to the following sort order:

1. *Total Ranking Points*; highest to lowest, then
2. *Total TieBreaker Points* (TBP1); highest to lowest, then
3. *Total TieBreaker Points* (TBP2); highest to lowest, then
4. Random electronic selection

Ranking Points and *TieBreaker Points* are awarded at the end of each *Match.*

5.2 League Tournament Ranking Calculation

League *Tournament* rankings are based on the top ten (10) *Matches* from all previous league meets plus the top five (5) *Matches* from the league *Tournament*. The ten (10) league meet *Matches* are selected using the sort order from Section 5.1. *Teams* with fewer than fifteen (15) total *Matches* after the *Qualification Matches* at the League *Tournament* have been played will only be ranked on the *Matches* that they have played.

6.0 Advancement Criteria

6.1 Eligibility for Advancement

Teams are eligible for advancement at any one of the first three tournaments they participate in at any of the following levels, **regardless of the region.** This applies to both *Teams* in North America, and *Teams* outside of North America:

- League Tournament
- Qualifying Tournament
- Super Qualifying Tournament
- Championship Tournament

A *Team* can only earn a spot to one world championship event per season.

Tournament Type	Advances To	Special Considerations
Qualifying Tournament League Tournament Super Qualifying Tournament	State or Regional Championship Tournament	A *Team* is eligible to advance to the next competition tier from one of the first three qualifying, league, or super-qualifying tournaments they attend. A *Team* may participate in more than three tournaments in the same competition tier but are not eligible for consideration for advancement or awards at tournaments beyond their third.
State or Regional Championship Tournament	*FIRST* Tech Challenge World Championship	*Teams* advance from a state or regional championship tournament to **one** of the *FIRST* Tech Challenge World Championships.

6.2 Order of Advancement – Remote Competitions Only

If the *Team* listed has already advanced or there is no *Team* fitting that description (as in Award 3rd place at events of 20 or fewer *Teams*)

1. Inspire Award Winner
2. Highest Ranked *Team* not previously advanced
3. Inspire Award 2nd place
4. Highest Ranked *Team* not previously advanced
5. Inspire Award 3rd place
6. Highest Ranked *Team* not previously advanced
7. Think Award Winner
8. Highest Ranked *Team* not previously advanced
9. Connect Award Winner
10. Highest Ranked *Team* not previously advanced
11. Collins UTC Innovate Award Winner
12. Highest Ranked *Team* not previously advanced
13. Control Award Sponsored by Arm, Inc. Winner
14. Motivate Award Winner

15. Design Award Winner
16. Highest Ranked *Team* not previously advanced
17. Think Award 2nd Place
18. Highest Ranked *Team* not previously advanced
19. Connect Award 2nd Place
20. Highest Ranked Team not previously advanced
21. Collins UTC Innovate Award 2nd Place
22. Highest Ranked *Team* not previously advanced
23. Control Award Sponsored by Arm, Inc. 2nd Place
24. Highest Ranked *Team* not previously advanced
25. Motivate Award 2nd Place
26. Highest Ranked *Team* not previously advanced
27. Design Award 2nd Place
28. Highest Ranked *Team* not previously advanced
29. Think Award 3rd Place
30. Highest Ranked *Team* not previously advanced
31. Connect Award 3rd Place
32. Highest Ranked *Team* not previously advanced
33. Collins UTC Innovate Award 3rd Place
34. Highest Ranked *Team* not previously advanced
35. Control Award Sponsored by Arm, Inc. 3rd Place
36. Highest Ranked *Team* not previously advanced
37. Motivate Award 3rd Place
38. Highest Ranked *Team* not previously advanced
39. Design Award 3rd Place
40. Highest Ranked *Team* not previously advanced
41. Highest Ranked *Team* not previously advanced
42. Highest Ranked *Team* not previously advanced
43. Highest Ranked *Team* not previously advanced
44. Highest Ranked *Team* not previously advanced
45. Highest Ranked *Team* not previously advanced
46. Highest Ranked *Team* not previously advanced
47. Highest Ranked *Team* not previously advanced
48. Highest Ranked *Team* not previously advanced
49. Highest Ranked *Team* not previously advanced
50. Highest Ranked *Team* not previously advanced
51. Highest Ranked *Team* not previously advanced

**Events with 20 or fewer teams may select an award winner, and a single award finalist, rather than a 2nd and 3rd place winner.

7.0 The Robot

7.1 Overview

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.

7.2 Robot Control System

A *FIRST* Tech Challenge *Robot* is controlled by an Android-based platform. *Teams* will use two (2) *Android Devices* to control their *Robot* and compete in a "*Sports Start*" model of competition. One *Android Device* is mounted directly onto the *Robot* and acts as a *Robot Controller*. The other *Android Device* is connected to a pair of gamepads and acts as the *Driver Station*.

For more information, tutorials, and to access our Android Technology forum, please visit:
https://www.firstinspires.org/resource-library/ftc/robot-building-resources

7.2.1 Robot Technology Definitions

Android Device – A smartphone running the Android operating system. See rules <RE06> and <RS03> for a list of allowed smartphones and operating system versions.

Driver Station – Hardware and software used by a *Drive Team* to control their *Robot* during a *Match*.

Java – The recommended programming language for the *Robot Controller*.

Logic Level Converter – An electronic device that allows an encoder or sensor, that operates using 5V logic levels, to work with the *REV Expansion Hub* and/or *REV Control Hub*, which operates using 3.3V logic levels. This device may contain a step-up voltage converter (from 3.3V to 5V) and a dual channel, bidirectional logic level converter. This device may be used directly with a 5V digital sensor or with an *I²C Sensor Adaptor Cable* to a 5V I²C sensor.

I²C Sensor Adapter Cable – An adapter to change the pin orientation of the REV Robotics *Logic Level Converter* to match a Modern Robotics compatible I²C sensor.

Mini USB to OTG (On-The-Go) Micro Cable – The connection between the *Android Device Robot Controller* and the *REV Expansion Hub*.

Op Mode – An *Op Mode* (short for "operational mode") is software that is used to customize the behavior of a competition *Robot*. The *Robot Controller* executes a selected *Op Mode* to perform certain tasks during a *Match*.

OTG Micro Adapter – Connects a USB hub to Micro USB OTG (On-The-Go) port on the *Driver Station* Android device.

REV Control Hub – An integrated electronic device with four (4) DC motor channels, six (6) servo channels, eight (8) digital I/O channels, four (4) analog input channels, and four (4) independent I2C buses. The *REV Control Hub* also serves as the *Robot Controller* when used in place of an *Android Device* connected to *a REV Expansion Hub*.

REV Expansion Hub – An integrated electronic device with four (4) DC motor channels, six (6) servo channels, eight (8) digital I/O channels, four (4) analog input channels, and four (4) independent I²C buses.

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.

REV Robotics Sensors – Sensors designed by REV Robotics that connect to a *REV Control* or *Expansion Hub*.

REV Servo Power Module – An electronic device that boosts the power supplied to 3-wire servos. A *REV Servo Power Module* has 6 input servo ports and 6 matching output ports. It draws power from a 12V source and provides 6V power to each output servo port. A *REV Servo Power Module* can provide up to 15A of current across all output servo ports for a total of 90 Watts of power per module.

Robot Controller – An allowed *Android Device* connected to a *REV Expansion Hub* or *REV Control Hub* located on the *Robot* that processes *Team* written software, reads on-board sensors, and receives commands from the *Drive Team* by way of the *Driver Station*. The *Robot Controller* sends instructions to the motor and servo controllers to make the *Robot* move.

UVC Compatible Camera – A USB Video Class *(UVC) Compatible Camera* is a digital camera that conforms to the USB Video Class specification.

7.3 Robot Rules

Anyone that has attended a *FIRST* Tech Challenge *Tournament* knows that *Teams* think outside the kit-of-parts to create unique and creative *Robot*s. The intent of the *Robot* construction rules is to create a level playing field and a framework for *Teams* to build *Robot*s that safely play the annual game challenge. *Teams* should read all the *Robot* rules before building their *Robot*. *Teams* can also reference our Legal and Illegal Parts List on our website for common legal and illegal *Robot* parts. Some suppliers' websites may claim that a part is *FIRST* Tech Challenge approved. The only official references for the legality of parts and materials are the Game Manual Part 1, the Legal and Illegal Parts List, and the Official Game Q&A Forum.

7.3.1 General Robot Rules

It is the intent of *FIRST* to encourage creativity in design as long as it does not present a safety hazard or unfairly affect the opportunities of any *Teams* to compete. Although there is significant creative freedom allowed in the *Robot* design rules, *Teams* should consider the adverse effects of any design decisions that they make. When considering your *Robot* design and your game strategy, ask yourself the following questions. If the answer to any of these questions is yes, the design part is not allowed:

- Could it damage or disable another *Robot*?
- Could it damage the *Playing Field*?
- Could it injure a participant or volunteer?
- Is there already a rule that restricts this?
- If everybody did this, would the gameplay be impossible?

<RG01> Illegal Parts - The following types of mechanisms and parts are not allowed:

a. Those used in a *Robot* drive system that could potentially damage the *Playing Field* and/or Scoring Elements such as high traction wheels (for example, AM-2256) and high grip tread (for example, Rough top).

b. Those that could potentially damage or flip other competing *Robot*s.

c. Those that contain hazardous materials such as mercury switches, lead, or lead containing compounds, or lithium polymer batteries (except for the *Android Devices'* internal batteries).

d. Those that pose an unnecessary risk of entanglement.

e. Those that contain sharp edges or corners.

f. Those that contain animal-based materials (because of health and safety concerns).

g. Those that contain liquid or gel materials.

h. Those that contain materials that would cause a delay of game if released (for example, loose ball bearings, coffee beans, etc.).

i. Those that are designed to electrically ground the *Robot* frame to the *Playing Field*.

j. Closed gas devices (for example, gas storage vessel, gas spring, compressors, etc.).

k. Hydraulic devices.

l. Vacuum based mechanisms.

<RG02> Maximum Starting Size - 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. To pass inspection a *Robot* must fit within the sizing tool while in its *Match* start configuration without exerting force on the sides or top of the sizing tool. *Robots* may expand beyond the starting size constraint after the start of the *Match*. Preloaded game elements may extend outside the starting volume constraint.

The *Robot* must be self-supporting while in the *Robot* Sizing tool by either:

a. A mechanical means with the *Robot* in a power-OFF condition. Any restraints used to maintain starting size (that is, zip ties, rubber bands, string, etc.) must remain attached to the *Robot* for the entire *Match*.

b. A *Robot* Initialization Routine in the Autonomous *Op Mode* that may pre-position the servo motors, with the *Robot* powered on, to the desired stationary position.

If the *Robot* Initialization routine moves the servos when a program is executed, there must be an indication label on the *Robot*. A warning label placed near the *Robot*'s main power switch is required. Attach the image ("WARNING! - *Robot* moves on Initialization") to your *Robot* near the *Robot* main power switch if servos are commanded to move during the initialization routine. 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).:

<RG03> *Robot Controller* Mount – It is recommended that the *Robot Controller* be accessible and visible by field personnel. If a *Team's Robot Controller* is not accessible or visible to field personnel, the *Team* may not receive adequate support from the field personnel.

The *Robot Controller Android Device* should be mounted so the display screen is protected from contact with the *Playing Field* elements and other *Robot*s. This and other electrical parts (for example, batteries, motor and servo controllers, switches, sensors, wires) make poor bumpers and are unlikely to survive *Robot*-to-*Robot* contact during gameplay.

Important Note: The *Robot Controller* contains a built-in wireless radio that communicates with the *Android Device* in the *Driver Station*. The *Robot Controller* should not be obscured by metal or other material that could block or absorb the radio signals from the *Robot Controller*.

<RG04> *Team* Number Display - *Robot*s 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 *Robot*s 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 and in a contrasting color from their background.

d. *Team* numbers must be robust enough to withstand the rigors of *Match* play. Example robust materials include: 1) self-adhesive numbers (mailbox or vinyl numbers) mounted on polycarbonate sheet, wood panel, metal plate, etc. or 2) Ink jet or laser printed numbers on paper and laminated.

<RG05> Alliance Marker – *Robots* must include a *Team* supplied, *Alliance* specific marker on two opposite sides of the *Robot* to easily identify which *Alliance* a *Robot* is assigned to. The *Alliance* marker must be displayed on the same side of the *Robot* as the *Team* number, within a 3" distance of the number. The *Alliance* marker must be visible to the referees during a *Match*.

a. The red *Alliance* marker must be a solid red square, 2.5 inches x 2.5 inches (6.35 cm x 6.35 cm) +/- 0.25 inches (0.64 cm).

b. The blue *Alliance* marker must be a solid blue circle, 2.5 inches (6.35 cm) +/- 0.25 inches (0.64 cm) in diameter.

c. Both *Alliance* markers must be removeable in order to swap them between *Matches*.

d. The *Alliance* marker must be robust enough to withstand the rigors of *Match* play. Example robust materials include: 1) *Alliance* marker template printed and laminated; 2) mounted on polycarbonate sheet, wood panel, metal plate, etc.

The intent of this rule is to allow easy identification of the *Robot* and their *Alliance* to field personnel. *Alliance* flags will no longer be provided by *Tournament* directors. A template for *Teams* is located on our website.

<RG06> Allowed Energy Sources - Energy used by *FIRST* Tech Challenge *Robot*s (that is, stored at the start of a *Match*), shall come only from the following sources:

a. Electrical energy drawn from approved batteries.

b. A change in the position of the *Robot* center of gravity.

c. Storage achieved by deformation of *Robot* parts. *Teams* must be careful when incorporating spring-like mechanisms or other items to store energy on their *Robot* by means of part or material deformation.

<RG07> Launching *Robot* Parts - Parts of the *Robot* itself may not be launched (i.e. able to move independently of the *Robot*), even if the part that is *launched* is still connected to the *Robot* by a tether (for example, wire, rope, or cable).

<RG08> Launching Game Scoring Elements – *Robot*s can launch (i.e. able to move independently of the *Robot*) scoring elements through the air unless limited by a game specific rule. *Teams* must only *launch* the elements with enough velocity to score. *Launching* elements with excessive velocity could create a safety hazard for other *Teams* and field personnel. If the referees feel that a *Robot* is *launching* scoring elements with excessive velocity, the *Robot* must be re-inspected. *Robot*s must then show that a *launched* scoring element cannot travel in the air more than a 16 ft. (4.88 m) distance or more than 5 ft. (1.52 m) in elevation.

7.3.2 Robot Mechanical Parts and Materials Rules

<RM01> Allowed Materials - *Teams* may use raw and post-processed materials to build their *Robots*, provided these materials are readily available to all *Teams* (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.

<RM02> Commercial Off-The-Shelf Parts - *Teams* may use Commercial Off-The-Shelf (COTS) mechanical parts that have a single degree of freedom. For the *FIRST* Tech Challenge, a single degree of freedom part uses a single input to create a single output. The following are examples of single degree of freedom parts:

- Linear Actuator: a single rotary input results in a single direction linear output
- Pully: rotates around a single axis
- Single Speed Gearbox: a single rotary input results in a single rotary output

It is the intent of *FIRST* to encourage *Teams* to design their own mechanisms rather than buying pre-designed and pre-manufactured solutions to achieve the game challenge. Purchased mechanism kits (for example, grippers) that violate the single degree of freedom rule, either assembled or requiring assembly, are not allowed. COTS drive chassis (for example, AndyMark TileRunner, REV Robotics Build Kit) are allowed provided none of the individual parts violate any other rules. Holonomic wheels (omni or mechanum) are allowed.

Examples of allowed COTS parts:

- Linear Slide Kit
- Linear Actuator kit
- Single Speed (non-shifting) gearboxes
- Pulley
- Lazy Susan
- Lead screws

Examples of illegal multiple degrees of freedom parts:

- Gripper assemblies or kits
- Ratcheting wrenches

<RM03> Modifying Materials and COTS Parts - Allowed materials and legal COTS parts may be modified (drilled, cut, painted, etc.), as long as no other rules are violated.

<RM04> Allowed Assembly Methods - Welding, brazing, soldering, and fasteners of any type are legal methods for assembling a *Robot*.

<RM05> Lubricant - Any COTS lubricant is allowed, if it doesn't contaminate the *Playing Field*, scoring elements or other *Robot*s.

7.3.3 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 consistently 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.

<RE01> Main Power Switch - The *Robot* Main Power Switch must control all power provided by the *Robot* main battery pack. *FIRST* requires *Teams* to use either the TETRIX (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*.

The *Robot* main power switch must be mounted or positioned to be readily accessible and visible to field 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.

<RE02> Battery Mount - 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 *Robot*s or the *Playing Field*. Batteries should be protected from contact with sharp edges and protrusions (screw heads, screw ends, etc.)

<RE03> *Robot* Main Battery – All *Robot* power is provided by exactly one (1) 12V *Robot* main battery. Only one (1) of the approved battery packs is allowed on the *Robot*.

The only allowed *Robot* main power battery packs are:

a. TETRIX (W39057, formally 739023) 12V DC battery pack

b. Modern Robotics/MATRIX (14-0014) 12V DC battery pack

c. REV Robotics (REV-31-1302) 12V DC Slim Battery pack

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

<RE04> Fuses - Fuses must not be replaced with fuses of higher rating than originally installed or according to manufacturer's specifications; fuses may not be shorted out. Fuses must not exceed the rating of those closer to the battery. If necessary, a fuse may be replaced with a smaller rating. Replaceable fuses must be single use only; self-resetting fuses (breakers) are not allowed.

<RE05> *Robot* Power - *Robot* power is constrained by the following:

a. Allowed electronic devices may only be powered by power ports on the *REV Expansion Hub* or *REV Control Hub* except as follows:

   i. The *REV Expansion Hub* and *REV Control Hub* are powered by the *Robot* main battery.

   ii. *REV SPARK Mini Motor Controllers* are powered by the *Robot* main battery.

   iii. Allowed sensors connected to the *REV Expansion Hub* or *REV Control Hub*.

   iv. Light sources per <RE13>.

   v. Video cameras per <RE14>.

   vi. REV Servo Power Module

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.

<RE06> Robot Controller – Exactly one (1) *Robot Controller* is required. An optional *REV Expansion Hub* may be also be added.

<RE07> *Android Devices* - The following *Android Devices* are allowed:

a. Motorola Moto G 2nd Generation

b. Motorola Moto G 3rd Generation

c. Motorola Moto G4 Play (4th Generation)/Motorola Moto G4 Play*

d. Motorola Moto G5

e. Motorola Moto G5 Plus

f. Motorola Moto E4 (USA versions only, includes SKUs XT1765, XT1765PP, XT1766, and XT1767)

g. Motorola Moto E5 (XT1920)

h. Motorola Moto E5 Play (XT1921)

No other *Android Devices* may be used as *Robot Controllers* or *Driver Stations.* See Rule <RS03> for the approved list of Android Operating System versions.

An *Android Device Robot Controller* USB interface may only connect to a *REV Expansion Hub*, or a USB hub.

*The Motorola Moto G4 Play may be sold as either Motorola Moto G Play (4th gen)", or "Motorola Moto G4 Play". Either phone is acceptable however *FIRST* Tech Challenge highly recommends that *Teams* purchase either model number XT1607 or XT1609, as these are the US versions and have been tested and are fully compatible with the *FIRST* Tech Challenge software. *Teams* that have purchased phones with model numbers XT1601, XT1602, XT1603, or XT1604 may continue to use these phones as legal, however there is a potential for issues with these phones not being fully compatible with the software.

<RE08> Control Module Quantities - The Control Module consists of one of the following:

a. A *REV Control Hub*; or

b. An allowed *Android Device* connected to a *REV Expansion Hub*

In addition to “a” or “b” above, you may add:

c. No more than one additional REV Expansion Hub

d. Any quantity of *REV SPARK Mini Motor Controllers*

e. Any quantity of *REV Servo Power Modules*

<RE09> Motor and Servo Controllers – The only allowed Motor and Servo Controllers are: *REV Expansion Hub*, *REV Control Hub*, *REV Servo Power Module*, *REV SPARK Mini Motor Controller,* and VEX Motor Controller 29.

<RE10> DC Motors – A maximum of eight (8) DC motors are allowed in any combination. The only allowed motors are:

a. TETRIX 12V DC Motor

b. AndyMark NeveRest series 12V DC Motors

c. Modern Robotics/MATRIX 12V DC Motors

d. REV Robotics HD Hex 12V DC Motor

e. REV Robotics Core Hex 12V DC Motor

No other DC motors are allowed.

<RE11> Servos – A maximum of twelve (12) servos are allowed. Any servo that is compatible with the attached servo controller is allowed. Servos may only be controlled and powered by a *REV Expansion Hub, REV Control Hub,* or *REV Servo Power Module*. Servos may be rotary or linear but are limited to 6V or less and must have the three-wire servo connector.

The VEX EDR 393 motor is considered a servo. It must be used in conjunction with a VEX Motor Controller 29 and a *REV Servo Power Module.* A maximum of two (2) VEX EDR 393 Motors per *REV Servo Power Module* is allowed.

<RE12> Sensors - Sensors are subject to the following constraints:

a. Compatible sensors from any manufacturer may be connected to the *REV Expansion Hub* or *REV Control Hub*.

b. Compatible sensors from any manufacturer may be connected to the *Logic Level Converter and/or the I^2C Sensor Adapter Cable.* Refer to Rule <RE15.j> for details on the use of *Logic Level Converter* and the *I^2C Sensor Adapter Cable.*

c. Passive electronics may be used as recommended by sensor manufacturers at the interfaces to the sensors.

d. Voltage sensors are allowed; except on an output port of a motor or servo controller.

e. Current sensors are allowed; except on an output port of a motor or servo controller.

f. Simple *I^2C* multiplexers are allowed and they may only be connected to and powered from the *I^2C* connections available on *REV Expansion Hub* or *REV Control Hub*.

g. Voltage and/or current sensors are also allowed to connect between the battery pack and the *REV Expansion Hub* or *REV Control Hub.*

<RE13> Light Sources - Functional and/or decorative light sources (including LEDs) are allowed with the following constraints:

a. Focused or directed light sources (for example: lasers and mirrors) are not allowed except for the REV Robotics 2m Distance sensor (REV-31-1505).

b. Light-source control by compatible ports on the *REV Expansion Hub* or *REV Control Hub* is allowed.

c. Commercial Off the Shelf (COTS) interface modules (without user programmable microprocessors) are allowed between the light source and the components listed in <RE13>b.

d. The only approved power sources for lights are as follows:

   i. Internal (as supplied by the Commercial Off the Shelf manufacturer) battery pack or battery holder.

   ii. *REV Expansion Hub* or *REV Control Hub* Motor-control ports, spare XT30 ports, 5V auxiliary power ports, and I2C sensor ports.

The common rates to trigger seizures is between 3 and 30 hertz (flashes per second), but varies from person to person. While some people are sensitive to frequencies up to 60 hertz, sensitivity under 3 hertz is not common. Please keep in mind that event attendees could have sensitivities to flashing lights.

Teams that choose to install flashing lights should ensure the lights can be turned either completely off or on (not flashing). Tournament directors have the discretion of asking *Teams* to turn their lights to either state if an event attendee or participant has a sensitivity to flashing lights.

Teams may still use LED lights to signal events provided the flash rate is approximately 1 hertz or less (e.g. cannot change states more frequently than approximately once a second). For example:

- *Teams* may signal via LED light that they have a scoring element ready.

<RE14> 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 battery (as supplied by the manufacturer).

b. *UVC Compatible Cameras* are allowed for computer vision-related tasks. It is recommended that *UVC Compatible Cameras* be connected directly to a *REV Control Hub,* or through a powered USB hub that is in turn connected to an *Android Device Robot Controller* through an OTG adapter.

See https://www.epilepsysociety.org.uk/photosensitive-epilepsy#.XuJbwy2ZPsE accessed on 7/10/2020

<RE15> *Robot* Wiring - *Robot* wiring is constrained as follows:

a. USB surge protectors connected to USB cables are allowed.

b. Ferrite chokes (beads) on wires and cables are allowed.

c. A *Mini USB to OTG (On-The-Go) Micro Cable or any combination of* a *Mini USB cable, a USB hub,* and an *OTG Micro Adapter may be* used to connect the *Robot Controller Android Device* to the *Robot* electronics. Note that the *OTG Micro Adapter* may be integrated into the USB hub. These devices may connect to the *Robot* electronics in the following ways:

    i. Built-in USB input port of the *REV Expansion Hub* or *REV Control Hub, or*

    ii. A USB hub that connects to the built-in USB input port of the *REV Expansion Hub* or *REV Control Hub*. If a powered hub is used, it must draw its energy from either

        i. A commercial USB battery pack, or

        ii. A 5V auxiliary power port on a *REV Expansion Hub* or *REV Control Hub*.

d. Anderson Powerpole, and similar crimp or quick-connect style connectors are recommended for joining electrical wires throughout the *Robot*. Power distribution splitters are recommended where appropriate to reduce wiring congestion. All connectors and distribution splitters should be appropriately insulated.

e. Installed connectors (such as battery-pack connectors, battery charger connectors) may be replaced with Anderson Powerpole or any compatible connector.

f. Power and motor control wires must use consistent color-coding with different colors used for the positive (red, white, brown, or black with a stripe) and negative/common (black or blue) wires.

g. Wire and cable management products of any type are permitted (for example, cable ties, cord clips, sleeving, etc.).

h. Wire insulation materials of any type are permitted when used to insulate electrical wires or secure motor control wires to motors (for example, electrical tape, heat shrink, etc.).

i. Power, motor control, servo, encoder, and sensor wires and their connectors may be extended, modified, custom made, or COTS subject to the following constraints:

    i. Power wires are 18 AWG or larger.

    ii. Motor control wires as follows:

        i. 22 AWG or larger for TETRIX Max 12V DC motors and REV Robotics Core Hex (REV-41-1300) 12V DC motors

        ii. 18 AWG or larger for all other 12V DC motors

    iii. PWM (servo) wires are 22 AWG or larger.

iv. Sensor wires should be the same size or larger than the original wiring.

> *Teams* should be prepared during *Robot* inspection to show documentation confirming the wire gauges used; particularly for multi-conductor cables.

j. *Logic Level Converters – Logic Level Converters* that are used to connect a *REV Expansion Hub* or *REV Control Hub* to a 5V-compatible I^2C sensor or a 5V-compatible digital sensor are allowed. Exactly one *Logic Level Converter* per I^2C device and one *Logic Level Converter* per digital sensor are allowed. A *Logic Level Converter* should only draw power from the *REV Expansion Hub* or *REV Control Hub*.

k. Electrically grounding the Control System electronics to the frame of the *Robot* is recommended and only permitted using a *FIRST*-approved, commercially manufactured Resistive Grounding Strap. The only Resistive Grounding Strap approved for use is the REV Robotics Resistive Grounding Strap (REV-31-1269). *Teams* that have electronics with Powerpole-style connectors may also use the REV Robotics Anderson Powerpole to XT30 Adapter (REV-31-1385) in conjunction with the REV Robotics Resistive Grounding Strap. No other grounding straps or adapters are permitted. For additional details on installation of the grounding strap or adapter, please see the Robot Wiring Guide.

<RE16> Modifying Electronics - Approved electrical and electronic devices may be modified to make them more usable; they may not be modified internally or in any way that affects their safety.

> Examples of modifications that are allowed:
>
> - Shortening or extending wires
> - Replacing or adding connectors on wires
> - Shortening motor shafts
> - Replacing gearboxes and/or changing gears
>
> Examples of modifications that are **not** allowed:
>
> - Replacing an H-Bridge in a motor controller
> - Rewinding a motor
> - Replacing a fuse with a higher value than specified by the manufacturer
> - Shorting out a fuse
> - Changing internal servo components to convert a limited rotation angle servo to a continuous rotation servo or the reverse conversion.

<RE17> *Driver Station* Constraints – *Teams* provide their own *Driver Station* and it must comply with the following constraints:

a. The *Driver's Station* must consist only of:

i. One (1) *Android Device*

ii. One (1) OTG Cable

iii. No more than one (1) USB hub

iv. No more than one (1) COTS USB external battery

v. No more than two (2) gamepads

vi. Any components used to hold the above listed legal devices.

b. The *Driver Station Android Device* USB interface may only connect to either:

   i. A Mini *USB to OTG* (On-The-Go) cable or combination of cables connected to a USB Hub, or

   ii. One (1) gamepad, USB cable, and an *OTG Micro Adapter*.

c. One optional COTS USB external battery connected to the USB Hub to charge the *Android Device* is allowed.

d. The only allowed gamepads are listed below. They may be used in any combination.

   i. Logitech F310 gamepad (Part# 940-00010)

   ii. Xbox 360 Controller for Windows (Part# 52A-00004)

   iii. Sony DualShock 4 Wireless Controller for PS4 (ASIN # B01LWVX2RG) operating in wired mode only (i.e., connected through USB 2.0 Type A to Type B Micro cable with Bluetooth turned off)

   iv. Etpark Wired Controller for PS4 (ASIN # B07NYVK9BT) The touch display screen of the *Driver Station* must be accessible and visible by field personnel.

e. The touch display screen of the *Driver Station* must be accessible and visible by field personnel.

Important Note: The *Driver Station* is a wireless device with a built-in wireless radio. During a *Match*, the *Driver Station* should not be obscured by metal or other material that could block or absorb the radio signals from the *Driver Station*.

<RE18> Additional Electronics – Electronic devices that are not specifically addressed in the preceding rules are not allowed. A partial list of electronics that are not allowed includes: Arduino boards, Raspberry Pi, relays, and custom circuits.

7.3.4 Robot Software Rules

<RS01> Device Names - Each *Team* MUST “name” their *Robot Controller* with their official *FIRST* Tech Challenge *Team* number and –RC (for example, “12345-RC”). Each *Team* MUST “name” their *Driver Station* with their official *Team* number and –DS (for example, 12345-DS). *Teams* with more than one *Driver Station* or *Robot Controller Android Device* must name these devices with the *Team* number followed by a hyphen then a letter designation beginning with “A” (for example, “12345-A-RC”, “12345-B-RC”).

<RS02> Recommended Programming Tools - The following tools are recommended for use in the *FIRST* Tech Challenge:

a. FTC Blocks Development tool – a visual, blocks-based programming tool hosted by the *Robot Controller*.

b. FTC OnBot Java Programming tool – a text-based integrated development environment hosted by the *Robot Controller*.

c. Android Studio – a text-based integrated development environment.

d. Java Native Interface (JNI) & Android Native Development Kit (NDK) – *Teams* can incorporate native code libraries into their apps using the JNI framework and the Android NDK.

<RS03> Allowed Software System Versions - The following table lists the *Android Devices*, minimum Android versions, minimum operating system and firmware versions, and minimum FTC software versions allowed per device.

Android Phones		
Device	**Minimum Android Version**	**Minimum FTC Software Version**
Motorola Moto G 2nd Generation	6.0 (Marshmallow)	6.0
Motorola Moto G 3rd Generation	6.0 (Marshmallow)	
Motorola Moto G4 Play (4th Generation) / Motorola Moto G4 Play (See <RE06> for details)	7.0 (Nougat)	
Motorola Moto G5	7.0 (Nougat)	
Motorola Moto G5 Plus	7.0 (Nougat)	
Motorola Moto E4 (USA versions only, includes SKUs XT1765, XT1765PP, XT1766, and XT1767)	7.0 (Nougat)	
Motorola Moto E5 (XT1920)	7.0 (Nougat)	
Motorola Moto E5 Play (XT1921)	7.0 (Nougat)	

REV Hubs		
Device	**Minimum Software**	**Minimum FTC Software Version**
REV Control Hub	O/S Version 1.1.1	6.0
REV Expansion Hub	Firmware version 1.8.2	
Note: The REV Hardware Client Software is used to install firmware and Operating Systems onto the REV Hubs. Its minimum version number is 1.0.0.		

IMPORTANT: Rules <RS02> or <RS03> do not require that *Teams* upgrade to the latest version of the software. A mandatory upgrade (announced by *FIRST*) would only be required if *FIRST* determined there was a critical software fix that must be adopted by *Teams*. *Teams* must install the upgrade before the time of competition. Additionally, beta versions of the software are allowed at official tournaments. Mandatory upgrades will be communicated in the following ways:

- Via *Team* Blast – The mandatory upgrade and version number will be communicated to *Teams* on the *Team* Blast, which will also show the date the required upgrade must be made.
- Online – the minimally required software will be listed on our Technology Resources page, with the date *Teams* are required to make the mandatory software upgrade.
- Forum – The minimally required software will be listed in the Technology Forum page, with the date *Teams* are required to make the mandatory software upgrade.

Templates for all programming choices are available through the links located at http://www.firstinspires.org/node/5181.

<RS04> Autonomous to Driver-Controlled Transition - *Teams* that expect to operate their *Robot* during the Autonomous period must demonstrate during Field Inspection the *Driver Station* switches the *Robot Controller* between Autonomous mode and Driver-Controlled mode.

<RS05> *Robot Controller* App - The *Robot Controller Android Device* (if used) must have a designated "FTC *Robot Controller"* app that is the default application for the *REV Expansion Hub.* The *Robot Controller* App

must not be installed on the *Driver Station Android Device*.

<RS06> *Driver Station* App – *Teams* must install the official "FTC *Driver Station"* app onto their *Driver Station Android Device* and use this app to control their *Robot* during a *Match*. The *Driver Station* software version number must match the version number of the *Robot Controller* app. The *Driver Station* App must not be installed on the *Robot Controller Android Device*.

<RS07> *Android Device* and *REV Control Hub* Operating System Settings - The *Robot Controller* and *Driver Station* must be set to:

a) Airplane mode must be turned on (does not apply for *Teams* using the *REV Control Hub*).

b) Bluetooth must be turned off

c) Wi-Fi must be turned on.

d) *REV Control Hub* password must be different than the factory default value of "password."

<RS08> Software Modification -

a) *Teams* are not allowed to modify the *FIRST* Tech Challenge *Driver Station* App in any fashion.

b) *Teams* are required to use the *FIRST Robot Controller* SDK, and are not allowed to remove, replace, or modify the portions of the SDK which are distributed as binary .AAR files.

> The intent of this rule is for *Teams* to download the official version of the SDK from *FIRST a*nd make modifications to add *Team* created code*.*
>
> Reengineered, reverse engineered, or modified versions of the official *FIRST* SDK are not allowed.

<RS09> *Driver Station* Communication - Communication between the *Robot* and *Driver Station* is only allowed via the *Robot Controller* and *Driver Station* applications.

Communication between the *Robot Controller* and the *Driver Station* is limited to the unmodified mechanisms provided by the official *FIRST* Tech Challenge (FTC) software, which consists of the official FTC Software Development Kit (SDK), the FTC *Robot Controller* app, and the FTC *Driver Station* app. *Teams* are not permitted to stream audio, video or other data using third-party software or modified versions of the FTC software. *Teams* may only use the unmodified telemetry feature included with the FTC software to transfer additional data between the *Robot Controller* and the *Driver Station*. Software that is preinstalled by an approved phone's manufacturer and cannot be disabled is exempt from this constraint.

During a *Match*, a *Team's Robot Controller* and a *Team's Driver Station* are not allowed to be connected wirelessly to any other device besides each other.

8.0 Robot Inspection

8.1 Description

Teams are highly recommended to conduct a *Robot* and Field self-inspection prior to competing. These inspections will ensure that all *Robot* rules and regulations are met. The official "*Robot* & Field Inspection Checklists" are located in Appendices B and C.

9.0 Judging and Award Criteria

9.1 Overview

This section provides descriptions of:

- Engineering Notebook Requirements and Recommendations
- Engineering Portfolio Requirements and Recommendations
- How Judging Works
- *FIRST* Tech Challenge Award Criteria

Teams have spent a significant number of hours designing, building, programming their *Robot*, and learning what it takes to be part of a *Team*. For many *Teams*, the event is the reward for all their hard work throughout the season. While there are several types of events, they all offer a fun and exciting way for *Teams* to show the results of their efforts.

The judged awards give us the opportunity to recognize *Teams* who embody important values like *Gracious Professionalism*®, teamwork, creativity, innovation, and the value of the engineering design process. These judging guidelines are a part of the road map to success.

FIRST Tech Challenge provides Judging feedback for teams who submit a completed Judging Feedback Request form. When receiving feedback, Teams should note that the judging is a subjective process; and students are encouraged to learn the important life skill of self-evaluation to help them prepare for their Judged Interview. This helps students prepare for professional interviews while developing other real-world life skills. For a copy of the *FIRST* Tech Challenge team Judging Session Self-Reflection Sheet please visit the website: http://www.firstinspires.org/node/5226

9.2 Engineering Notebook

9.2.1 Overview

This section describes the engineering notebook.

9.2.2 What is an Engineering Notebook?

One of the goals of *FIRST* and *FIRST* Tech Challenge is to recognize the engineering design process and “the journey” that a team makes in the phases of creating their robot, including:

- Problem Definition
- Information Gathering
- Brainstorming Solutions
- Concept Design
- System Level Design
- Testing
- Design Improvement
- Production
- Promotion
- Budgeting
- Planning
- Outreach

Throughout the process of building and designing a *Robot, Teams* will draw ideas on paper, encounter obstacles, and learn valuable lessons. This is where teams will use an engineering notebook. These notebooks follow the *Team* from kickoff throughout the competitions.

The Engineering Notebook is an optional item but is a fundamental source of information for the team to use to be able to create the Engineering Portfolio.

Judges may ask the team for their engineering notebook to better understand the journey, design, and *Team* and to get more details and background than would be in the team's Engineering Portfolio.

The engineering notebook is the documentation repository of the *Team*, outreach and fund-raising efforts, *Team* plans, and the Robot design. This documentation can include sketches, discussions and team meetings, design evolution, processes, obstacles, and each *Team* member's thoughts throughout the journey for the entire season.

In the *FIRST* Tech Challenge, engineering notebooks can include business planning, outreach goals and achievement, and a *Team's* insights into what it is to be a *FIRST* Tech Challenge *Team*.

A new notebook must be created for each new season. Teams may consider their new season as beginning after their final event for the previous season.

9.2.3 Engineering Notebook Formats

Teams may choose to record their season with either handwritten or electronic documents. There is no distinction made between handwritten and electronic engineering notebooks during judging; each format is equally acceptable.

- Electronic: *Teams* may choose to use electronic programs to create their engineering notebook.
- Handwritten: *Teams* can choose to add handwritten text, drawings or cad drawings, but recognize that the team may need to scan (or take a picture) of each page.

For judging at a Remote Event, Teams should create a single file that is a sharable, non-editable version (such as a PDF) of their engineering notebook. Teams may be asked to upload their engineering notebook in the Remote Event Hub after the initial team interview is completed.

For judging purposes at a Traditional event, Teams should have a physical copy of their Engineering Notebook available in the team's pit area for Judges to look at as needed.

9.2.4 Engineering Notebook Requirements

- The *Team* number must appear on the outside front cover of the engineering notebook. **Engineering notebooks will not be considered without this information.**

A *Team* number on outside front cover makes it easy for Judges to know who created the Engineering Notebook they are reviewing. This is a required component of the Engineering Notebook.

9.2.5 Engineering Notebook Recommendations

- We strongly recommend that a one-page Summary be included in the notebook near the front that connects the information from the Engineering Portfolio to the relevant section or pages in the Engineering Notebook. This will help the judges quickly find additional information relevant to the specific award(s).
- The engineering notebook could include:
    a. Engineering content that includes the *Robot* design processes.

b. *Team* information that includes information about the *Team* and outreach activities.
c. A *Team* plan. This could be a business plan, a fund-raising plan, a strategic plan, a sustainability plan, or a skills development plan.

Judges may not need to reference your team's Engineering Notebook. We expect that the higher the quality of information in the Engineering Portfolio, the less likely judges will need to reference the Team's Notebook.

9.2.6 Engineering Notebook Examples

Scanned copies of engineering notebook examples are posted on the *FIRST* website. *Teams* are encouraged to look over these as great examples of what the judges will look for when reading through the engineering notebooks.

9.3 Engineering Portfolio

9.3.1 Overview

This section describes the requirements for creating the engineering portfolio, including formatting guidelines.

9.3.2 What is an Engineering Portfolio?

An Engineering Portfolio is a short and concise summary of the team's Engineering Notebook.

Whereas the engineering notebook is a complete documentation of the *Team*, outreach and fund-raising efforts, *Team* plans, and the Robot design. The Engineering Portfolio should include sketches, discussions and team meetings, design evolution, processes, obstacles, goals and plans to learn new skills, and each *Team* member's concise thoughts throughout the journey for the season, the Engineering Portfolio is like the Team's CV or Resume.

9.3.3 Engineering Portfolio Formats

Teams may choose to document their summary portfolio with either handwritten or electronic documents. There is no distinction made between handwritten and electronic engineering portfolios during judging; each format is equally acceptable.

- Electronic: *Teams* may choose to use any electronic programs to create their engineering portfolio. For Remote Event judging, *Teams* must create a single file that is a sharable, online, non-editable version (such as a PDF) of their engineering Portfolio. For Traditional Events, Teams must print their Engineering Portfolio.

- Handwritten: *Teams* can choose to create a handwritten version but for Remote Judging Events, this is discouraged due to difficulties in scanning into a readable, sharable, online version.

9.3.4 Engineering Portfolio Requirements

- In order to be considered for Judged Awards, a team must submit an Engineering Portfolio.
- The total number of pages for an Engineering Portfolio must not exceed 15 pages, plus a cover sheet.
    a. Pages must be the equivalent of Standard A sized paper (US 8.5 x 11) or Standard A4 sized paper (EU 210 **x** 297 mm).
    b. Fonts used must be a minimum of 10 points
- The Control Award Submission Form is not a part of the Engineering Portfolio, and does not count in this total.
- The *Team* number must appear on the top of the front page of the engineering portfolio. **Engineering portfolios will not be considered without this information.**

A *Team* number on the top of every page makes it easy for Judges to know who created the Engineering Portfolio they are reviewing. The *Team* number on the front page is a required component of the Engineering Portfolio.

- Engineering Portfolio must be submitted in a PDF Format
- Engineering Portfolio may not include links to videos or other files.

9.3.5 Engineering Portfolio Recommendations

- We strongly recommend the Team number is at the top of each page.
- The Engineering Portfolio could include:
    a. Summary of the Engineering content that includes the *Robot* design processes.
    b. Summary of the *Team* information that includes information about the *Team* and outreach activities.
    c. Summary of the *Team* plan and information about the Team overall. The Team plan could be a business plan, a fund-raising plan, a strategic plan, a sustainability plan, or a plan for the development of new skills.

It is a good idea to connect the Award criteria to specific content in your Engineering Portfolio!

Teams can use the Self-Assessment sheet (coming soon!) as a way to be sure their Engineering Portfolio provides answers for each of the requirements for specific awards.

9.3.6 Engineering Portfolio Requirements by Award

The chart below provides a quick outline of the engineering notebook requirements by award:

Engineering Portfolio Requirements by Award	
Inspire Award	• *Team* must submit an engineering Portfolio. The engineering portfolio must include summary information about the *Robot* design, information about the *Team*, and a *Team* plan. The entire engineering portfolio must be high quality, thoughtful, thorough, concise and well-organized. The team should have an engineering notebook available for the judges to review that provides the detailed information to support the information in the Portfolio.
Think Award	• Engineering Portfolio must have engineering content. The engineering content could include entries describing examples of the underlying science, mathematics, and game strategies in a summary fashion. • The engineering Portfolio must provide examples that show the *Team* has a clear understanding of the engineering design process including examples of lessons learned. • The portfolio should inspire the judges to want to see the detailed engineering content in the Engineering Notebook. • Portfolio format is less important but enables the judges to understand the team's design maturity, organizational capabilities and overall team structure. • Portfolio could reference specific experiences and lessons learned but should capture the summary of the current status of the Team and their robot design. • Portfolio could also summarize experiences and lessons learned from outreach with concise tables of outcomes • Portfolio could also summarize how they acquired new mentors and/or acquired new knowledge and expertise from their mentors

	• Portfolio could contain summary of overall Team Plan. • Portfolio could contain information about the plans to develop skills for team members. • Portfolio could be organized in a logical manner.
Connect Award	• *Team* must submit an engineering portfolio. • Portfolio must include a Team plan that covers the Team's goals for the development of team member skills, and the steps the team has or will take to reach those goals. Examples of what the plan could include are timelines, outreach to science, engineering, and math communities, and training courses. • Portfolio must include a summary of how they acquired new mentors or acquired new knowledge and expertise from their mentors.
Collins Aerospace Innovate Award	• *Team* must submit an engineering portfolio. • The engineering portfolio must include examples of the team's engineering content that illustrate how the *Team* arrived at their design solution. • The portfolio should inspire the judges to want to see the detailed engineering content in the Engineering Notebook.
Control Award, sponsored by Arm, Inc.	• The Team must submit an engineering portfolio. The engineering portfolio must include engineering content that documents the control components. • The Team must submit a Control Award submission form as a separate document. Teams should identify the control aspects of their robot that they are most proud of, and should not exceed 2 pages.
Motivate Award	• *Team* must submit an engineering portfolio. • The engineering portfolio must include a Team organization plan, which could describe their future goals and the steps they will take to reach those goals. Examples of what the plan could include are team identity, fund-raising goals, sustainability goals, timelines, outreach to non-technical groups, finances, and community service goals. • The Team is an ambassador for FIRST programs. • Team can explain the individual contributions of each team member, and how these apply to the overall success of the team
Design Award	• Team must submit an engineering portfolio that includes examples of Robot CAD images or detailed Robot design drawings. • The portfolio should inspire the judges to want to see the detailed design content and design journey in the Engineering Notebook.

9.4 Judging Process, Schedule, and Team Preparation

The schedules at the *FIRST* Tech Challenge Tournaments may vary from site to site. At traditional events, judging interviews are scheduled for before the start of match play. For Remote events, Judging will take place during a pre-determined window of time. Exact times for both the matches and meeting with judges cannot be given within this manual. All *Teams* receive the schedule before or during check-in at the competition, or in advance of their scheduled remote interview.

9.4.1 How Judging Works

At *FIRST* Tech Challenge tournaments, there will be four parts to the judging process:

1. Interview with the judges.
    a. *Teams* take part in scheduled, private interviews with a panel of two or more judges.
    b. *Teams* are asked to bring their *Robot* to the judge interview. This is the best chance for teams to explain and show their robot design to the judges in a quiet and relaxed environment. For remote events, Teams should take photos of their robot to show their robot to the Judges as a part of their remote interview.
    c. The interview will last at least 10 minutes.
    d. During the first 5 minutes of the interview, *Teams* have the opportunity to present to the Judges, without interruption. *Teams* are not required to prepare a presentation and will not be penalized if they do not have a prepared presentation. *Teams* will not receive more than 5 minutes for their uninterrupted presentation.
    e. At the five-minute mark, the Judges will begin to ask questions of the *Team*.
2. Evaluation of *Robot* performance at traditional events.
3. Judges follow up with additional interviews in the pits during competition. For remote events, this second interview will be pre-scheduled.
4. Evaluation of the engineering portfolio.

Teams should practice their presentation. The presentation should be concise and should focus on the areas of their _Robot_ and _Team_ journey that the _Team_ would like to highlight.

No awards will be decided based on the judges interview alone. Judges use the guidelines provided in this section to assess each *Team*.

Teams should present their engineering portfolio, their control award submission form, and their judging feedback request form to the judges at the start of their interview unless otherwise directed by the tournament officials. In remote events, the *Team* coach will upload these materials using a link provided to them by the tournament director or local program delivery partner.

After the judges review the submitted engineering portfolio, complete the scheduled *Team* interviews, and evaluate the *Robot* performance, they meet to review their assessments and create a list of top candidates for the various judged awards. Judges may require more discussion with *Teams*.

9.4.1.1 Feedback to Teams

Teams who wish to receive feedback from judges must submit a completed judging feedback request form. Judges will conduct the *Team* interview and review the documentation submitted by the *Team*. After the event, the lead coach/mentor 1 for the *Team* will receive a judging feedback form which has been completed by the event judges via email.

The feedback form is completed by the judges immediately following the formal interview.

9.4.2 Judging Schedule

The judging interviews take place in a separate area or room away from other teams as well as the noise of the competition and pit. *Teams* follow the schedule that outlines *Team* interview times and locations. Sometimes, *Teams* may receive this information in advance, but more often, *Teams* will receive this information when they check-in on the morning of the event. For Remote events, Team Coaches will receive the team's Judging Schedule in advance of the event.

As much as possible, *Teams* should familiarize themselves with where and how judging will occur and allow enough time to get there. We expect that all *Teams* arrive at the judge queuing area five minutes before their scheduled judging interview. This helps us keep the event running on time.

9.4.3 Team Preparation

Teams are encouraged to read and understand the award requirements for each award to assess where they are within an award category and help them establish higher goals. These guidelines are the same ones used by the judges during each tournament, and at the *FIRST* Tech Challenge World Championship Tournaments. Please see the Award Categories section of this manual for award requirements and look over the Engineering Portfolio Requirements by Award to ensure the *Team's* engineering portfolio meets the criteria by award. *Teams* should attend judging workshops and judging practice days if they are available in their region. Practice makes for a better presentation, and practice in front of others could help a *Team* identify gaps in their presentation. Judging self-reflection sheets are another tool that *Teams* can use to prepare for their judging interview.

During the *Team's* interview, the judges want to know highlights about the *Team*; what the *Team* learned during the competition season; and the experiences that were gained. *Team* representatives' abilities to answer the questions or elaborate on *Robot* design functions or qualities are evaluated during the *Team* interview. Check with the tournament director to see if mentors and coaches can watch the *Team* interview. Mentors and coaches may not contribute to the judging interviews. Mentors and coaches should always keep in mind that *FIRST* Tech Challenge is a student-centered activity. It is about giving the students a unique and stimulating experience in all aspects of the program.

9.4.4 Video Award Submission Guidelines for Compass and Promote Awards

The submission process for this award may vary by tournament. The Compass and Promote awards are not offered at all events. Please check with the tournament director for details. Winning videos will be submitted to *FIRST* and used to promote the higher values of *FIRST* Tech Challenge. *Teams* can also send their Promote videos directly to *FIRST*; however, these submissions will not be formally judged. If you'd like to send your Promote video to *FIRST*, please email ftcteams@firstinsires.org with the subject line "Promote Award Video".

- The video must be submitted at least one week before tournament day. Instructions for submitting videos may vary from tournament to tournament. Please check with the tournament director for details.
- Videos must be submitted in AVI, WMV, MOV or better format. Submission through use of a streaming service such as YouTube is not acceptable. Remember the winning video may be shown on a large screen during the awards ceremony. *Teams* should use the best resolution available for the final version.
- Only one video submission per *Team* will be considered. *Teams* may submit new or updated videos at each tournament.
- *Teams* must have permission from the copyright owners for music used in the video and indicate this in their video.

9.5 Award Categories

Each award listed below has a list of non-negotiable requirements. Please note that each award has a set of required criteria. *Gracious Professionalism*® is listed as the first criteria for every award. This is a mandatory requirement for every *FIRST* Tech Challenge award. *Teams* who behave in an ungracious way are not eligible for consideration for any award at the event.

9.5.1 Inspire Award

This judged award is given to the team that best embodies the 'challenge' of the *FIRST* Tech Challenge program. The *Team* that receives this award is a strong ambassador for *FIRST* programs and a role model *FIRST Team*. This *Team* is a top contender for many other judged awards and is a gracious competitor. The Inspire Award winner is an inspiration to other *Teams*, acting with *Gracious Professionalism*® both on and off the playing field. This *Team* shares their experiences, enthusiasm and knowledge with other team, sponsors, their community, and the Judges. Working as a unit, this *Team* will have showed success in performing the task of designing and building a *Robot*.

The Inspire Award celebrates a *Team* that, in the opinion of the Judges, is a strong contender in many award categories. The reliability of the *Robot* during the *Robot* competition is one aspect of this award, but it does not carry more weight than any requirement.

Required criteria for the Inspire Award:

- ***Team* shows respect and *Gracious Professionalism*® to everyone they meet at a *FIRST* Tech Challenge event.**
- ***Team* is a strong contender for several other judged awards. The Inspire Award celebrates the strongest qualities of all the judged awards.**
- **The *Team* is an ambassador for *FIRST* programs. They demonstrate and document their work in their community.**
- ***Team* is positive and inclusive, and each team member contributes to the success of the *Team*.**
- **Team must submit an engineering portfolio. The engineering portfolio must include engineering content, team information and a team plan. The entire engineering portfolio must be high quality, thoughtful, thorough, concise, and well-organized.**
- ***Robot* design is creative and innovative, and the *Robot* performs reliably on the field. The *Team* communicates clearly about their *Robot* design and strategy to the judges.**
- ***Team* interview session is professional and engaging.**

Strongly suggested criteria for the Inspire Award:

- The *Team* should have an engineering notebook available for the judges to review that provides the detailed information to support the information in the portfolio.

9.5.2 Think Award

Removing engineering obstacles through creative thinking.

This judged award is given to the *Team* that best reflects the journey the *Team* took as they experienced the engineering design process during the build season. The engineering content within the portfolio is the key reference for Judges to help identify the most deserving *Team*. The *Team's* engineering content must focus on the design and build stage of the *Team's Robot*.

Additional detailed information that is helpful for the Judges would be in the team's Engineering Notebook and would include descriptions of the underlying science and mathematics of the *Robot* design and game

strategies, the designs, redesigns, successes, and opportunities for improvement. A *Team* is not a candidate for this award if their portfolio does not include engineering content.

Required criteria for the Think Award:

- ***Team* shows respect and *Gracious Professionalism*® to everyone they meet at a *FIRST* Tech Challenge event.**
- Engineering portfolio must have engineering content. The engineering content could include entries describing examples of the underlying science, mathematics, and game strategies in a summary fashion.
- The engineering portfolio must provide examples that show the *Team* has a clear understanding of the engineering design process including examples of lessons learned.
- The portfolio should inspire the judges to want to see the detailed engineering content in the engineering notebook.
- Portfolio format is less important but enables the judges to understand the team's design maturity, organizational capabilities and overall team structure.
- Portfolio could reference specific experiences and lessons learned but should capture the summary of the current status of the Team and their robot design.
- Portfolio could also summarize experiences and lessons learned from outreach with concise tables of outcomes

Strongly suggested criteria for the Think Award:

- *Teams* should flag or provide a reference to 6 to 8 pages of the engineering notebook(s) to support the engineering content included in the engineering portfolio.
- Engineering portfolio could summarize how the *Team* acquired new mentors or acquired new knowledge and expertise from their mentors.
- Engineering portfolio could contain summary of overall *Team* plan.
- Engineering portfolio could contain information about the plans to develop skills for *Team* members.

9.5.3 Connect Award

Connecting the dots between community, *FIRST*, and the diversity of the engineering world.

This judged award is given to the *Team* that most connects with their local science, technology, engineering and math (STEM) community. A true *FIRST* team is more than a sum of its parts and recognizes that engaging their local STEM community plays an essential part in their success. The recipient of this award is recognized for helping the community understand *FIRST*, the *FIRST* Tech Challenge, and the *Team* itself. The *Team* that wins the Connect Award actively seeks and recruits engineers and explores the opportunities available in the world of engineering, science and technology. This *Team* has a clear *Team* plan and has identified steps to achieve their goals.

Required criteria for the Connect Award:

- ***Team* shows respect and *Gracious Professionalism*® to everyone they meet at a *FIRST* Tech Challenge event.**
- *Team* must submit an engineering portfolio.
- Portfolio must include a *Team* plan that covers the *Team's* goals for the development of team member skills, and the steps the *Team* has taken or will take to reach those goals. Examples of what the plan could include are timelines, outreach to science, engineering, and math communities, and training

courses.

Portfolio must include a summary of how the *Team* acquired new mentors or acquired new knowledge and expertise from a mentor. Working with mentors from *FIRST*'s Mentor Matching site is an acceptable way to learn from mentors.

Strongly suggested criteria for the Connect Award:

- *Team* provides clear examples of developing in person or virtual connections with individuals in the engineering, science, or technology community.
- *Team* actively engages with the engineering community to help them understand *FIRST*, the *FIRST* Tech Challenge, and the team itself.

9.5.4 Collins Aerospace Innovate Award

Bringing great ideas from concept to reality.

The Collins Aerospace Innovate Award celebrates a *Team* that thinks outside the box and has the ingenuity, creativity and inventiveness to make their designs come to life. This judged award is given to the *Team* that has the most innovative and creative *Robot* design solution to any specific components in the *FIRST* Tech Challenge game. Elements of this award include elegant design, robustness, and 'out of the box' thinking related to design. This award may address the design of the whole *Robot* or of a sub-assembly attached to the *Robot*. The creative component must work consistently, but a *Robot* does not have to work all the time during *Matches* to be considered for this award. The ***Team's*** engineering portfolio must include a summary of the design of the component or components and the ***Team's Robot*** to be eligible for this award. Entries must describe how the *Team* arrived at their solution.

Required criteria for the Collins Aerospace Innovate Award:

- ***Team* shows respect and *Gracious Professionalism*® to everyone they meet at a *FIRST* Tech Challenge event.**
- ***Team* must submit an engineering portfolio.**
- **The engineering portfolio must include examples of the *Team's* engineering content that illustrate how the *Team* arrived at their design solution.**
- ***Robot* or robot sub-assembly must be creative, elegant and unique in its design.**
- **Creative component must be stable, robust, and work reliably.**

Strongly suggested criteria for the Collins Aerospace Innovate Award:

- The portfolio should inspire the judges to want to see the detailed engineering content in the engineering notebook.

9.5.5 Control Award, sponsored by Arm Inc.

Mastering robot intelligence.

The Control Award celebrates a *Team* that uses sensors and software to increase the ***Robot's*** functionality in the field. This award is given to the *Team* that demonstrates innovative thinking to solve game challenges such as autonomous operation, improving mechanical systems with intelligent control, or using sensors to achieve better results. The control component should work consistently in the field. The ***Team's*** engineering portfolio must contain a summary of the software, sensors, and mechanical control, but would likely not include copies of the code itself.

Required criteria for the Control Award, sponsored by Arm, Inc.:

- ***Team* shows respect and *Gracious Professionalism*® to everyone they meet at a *FIRST* Tech Challenge event.**
- ***Team* must apply for the Control Award by filling out the Control Award Submission Form, located in Appendix E. The Control Award Submission Form should not exceed 2 pages.**
- **The team must submit an engineering portfolio. The engineering portfolio must include engineering content that documents the control components.**
- **Control components must enhance the functionality of the *Robot* on the playing field.**

Strongly suggested criteria for the Control Award, sponsored by Arm, Inc.:

- Advanced software techniques and algorithms are encouraged.
- Control components should work reliably.
- Additional detailed information can be included in the *Team's* engineering notebook
- Learnings from the team about what they tried and what didn't work with regards to sensors, hardware, algorithms and code

The Control Award is different from other awards because *Team* must apply for this award. A *Team* applying for this award must turn in their Control Award submission form to the judges at the event. This award focuses on a *Team's* ability to program a robot that can reliably and efficiently carry out tasks during *Match* play, in a way that improves their ability to score during a match.

The judges should look for:

- What sensors and hardware the *Team* is using on the *Robot*; what worked, what didn't, and why.
- What algorithm or code the team has programmed their *Robot* with; what worked, what didn't, and why.
- The judges should pay attention to the program and design process. The design process is more critical than the code itself.

Documenting the learning from failure – what didn't work – and understanding how to improve the team's design process is what we are assessing.

Teams must fill out and turn in the Control Award submission form to be considered for the Control Award. A Control Award binder or notebook is not an acceptable submission. Additional Control information should be located in the engineering notebook.

9.5.6 Motivate Award

Sparking others to embrace the culture of *FIRST*!

This *Team* embraces the culture of *FIRST* and clearly shows what it means to be a team. This judged award celebrates the *Team* that represents the essence of the *FIRST* Tech Challenge competition through Gracious Professionalism and general enthusiasm for the overall philosophy of *FIRST* and what it means to be a *FIRST* Tech Challenge Team. This is a *Team* who makes a collective effort to make *FIRST* known throughout their school and community, and sparks others to embrace the culture of *FIRST*.

Required criteria for the Motivate Award:

When doing community outreach, teams should be prepared to talk about *FIRST*, and spread awareness of the program.

- ***Team* shows respect and *Gracious Professionalism*® to everyone they meet at a *FIRST* Tech Challenge event.**
- ***Team* must submit an engineering portfolio. The engineering portfolio must include a *Team* organization plan, which could describe their future goals and the steps they will take to reach those goals. Examples of what the plan could include are team identity, fund-raising goals, sustainability goals, timelines, outreach, finances, and community service goals.**
- **The *Team* is an ambassador for *FIRST* programs.**
- ***Team* can explain the individual contributions of each team member, and how these apply to the overall success of the team.**

Strongly suggested criteria for the Motivate Award:

- *Team* as a whole takes part in their presentation, and actively engage with the judges.
- *Team* shows a creative approach to materials that market their *Team* and *FIRST*.
- *Team* can clearly show the successful recruitment of people who were not already active within the STEM community.
- *Team* could also summarize experiences and lessons learned from outreach

9.5.7 Design Award

Industrial design at its best.

This judged award recognizes design elements of the *Robot* that are both functional and aesthetic. The Design Award is presented to *Teams* that incorporate industrial design elements into their solution. These design elements could simplify the *Robot's* appearance by giving it a clean look, be decorative in nature, or otherwise express the creativity of the *Team*. The *Robot* should be durable, efficiently designed, and effectively address the game challenge.

Required criteria for the Design Award:

- ***Team* shows respect and *Gracious Professionalism*® to everyone they meet at a *FIRST* Tech Challenge event.**
- ***Team* must submit an engineering portfolio with an engineering content which could be CAD images or robot drawings of the Team's overall design and/or components**
- ***Team* also documents and implements strong industrial design principles, striking a balance between form, function, and aesthetics.**

Strongly suggested criteria for the Design Award:

- *Robot* distinguishes itself from others by its aesthetic and functional design.
- Basis for the design is well considered (that is inspiration, function, etc.).
- *Robot* design is effective and consistent with *Team* plan and strategy.
- The engineering portfolio should inspire the judges to want to see the detailed design content and design journey in the engineering notebook.

9.5.8 Promote Award (Optional)

This judged award is optional and may not be given at all tournaments. Your Judge Advisor will have information about the judging for this award.

The Promote Award is given to the *Team* that is most successful in creating a compelling video message for the public designed to change our culture and celebrate science, technology, engineering and math. *Teams* must submit a one-minute long public service announcement (PSA) video based on the PSA subject for the season.

Team may win the Promote Award only once at a Championship level event and only once at a qualifying level event.

PSA Subject for 2020-2021 season:

"Why does *FIRST* Tech Challenge work?"

Required criteria for the Promote Award:

- **Video must meet the following criteria:**
  - **Video must follow *FIRST* branding and design standards.**
  - **Video cannot be longer than 60 seconds.**
  - **Video must be of a high quality, as submissions may be used later to promote *FIRST*.**
  - ***Team* must have rights to music used in the video.**
  - **Music and permissions must be listed in video credits.**
  - **Video must have strong production value.**
  - **Video must be submitted by the deadline given by the Tournament Director.**
- ***Team* must present a thoughtful and impactful video which appeals to the public.**
- **Creativity in interpreting the yearly theme is required.**
- **Follow** video award submission guidelines**.**

9.5.9 Compass Award (Optional)

A beacon and leader in the journey of the *FIRST* Tech Challenge.

This judged award is optional and may not be given at all tournaments. Your Judge Advisor will have information about the Judging for this Award.

The Compass Award recognizes an adult coach or mentor who has given outstanding guidance and support to a *Team* throughout the year and demonstrates to the *Team* what it means to be a Gracious Professional. The winner of the Compass Award will be chosen from candidates nominated by *FIRST* Tech Challenge student *Team* members, via a 40-60 second video submission. The video must highlight how their mentor has helped them become an inspirational *Team*. We want to hear what sets the mentor apart.

Required criteria for the Compass Award:

- **Video must meet the following criteria:**
  - **Video must follow *FIRST* branding and design standards.**
  - **Video cannot be longer than 60 seconds.**
  - **Video must be of a high quality, as submissions may be used later to promote *FIRST*.**
  - ***Team* must have permission from the copyright owners for music used in the video.**
  - **Music and permissions must be listed in video credits.**
  - **Video must be submitted by the deadline given by the Tournament Director.**
- **Video highlights the mentor's contribution to the *Team* and demonstrates what sets the mentor apart.**

- **Follow** video award submission guidelines.

9.5.10 Judges' Choice Award

This award is optional and may not be given at all tournaments.

During the competition, the judging panel may meet a *Team* whose unique efforts, performance or dynamics merit recognition, but doesn't fit into any of the existing award categories. To recognize these unique *Team*, *FIRST* offers a customizable Judges Choice Award. The judging panel may select a *Team* to be honored, as well as the name of the Judges Choice Award. The Judges Choice Award recognizes a *Team* for their outstanding efforts but does not factor into the advancement criteria.

9.5.11 Top Ranked Team Award

Teams ranked 1 through 6 (at tournaments with 22 teams or larger), or *Teams* ranked 1 through 4 (at tournaments with 21 or fewer teams).

10.0 Dean's List Award

In an effort to recognize the leadership and dedication of ***FIRST's*** most outstanding secondary school students, the Kamen family sponsors an award for selected 10th and 11th grade students known as the *FIRST* Robotics Competition and *FIRST* Tech Challenge Dean's List.

Similar to the very prestigious National Merit Scholarship Award winners, there are three (3) "categories" of *FIRST* Dean's List Award students:

1. ***FIRST* Dean's List Semi-finalists – comprised of the two (2) students in their 10th or 11th grade school year nominated by each *Team*.**
2. ***FIRST* Dean's List Finalists – comprised of the students (2, 3, or 4, depending on the region) selected at** each State/Regions Championship.
3. ***FIRST* Dean's List Winners – comprised** of the ten (10) *FIRST* Robotics Competition and ten (10) *FIRST* Tech Challenge students selected from the applicable *FIRST* Dean's List Finalists at the *FIRST* Championship.

The students who earn *FIRST* Dean's List Award status as a Semi-finalists, Finalist or Winner, are great examples of student leaders who have led their *Teams* and communities to increased awareness for *FIRST* and its mission. These students have also achieved personal technical expertise and accomplishment. It is ***FIRST's*** that these individuals will continue, post-award, as great leaders, student alumni, and advocates of *FIRST*.

Prestigious colleges have expressed great interest in meeting *FIRST* Dean's List's Award winners and *FIRST* hopes that each *Team* will take advantage of the opportunity to nominate the most qualified students as *FIRST* Dean's List Nominees!

For more information on the Dean's List Award, and to see past *FIRST* Tech Challenge winners, please visit our website! http://www.firstinspires.org/Robotics/ftc/deans-list

10.1 Eligibility

Every registered *FIRST* Tech Challenge *Team* can submit up to two (2) students as *FIRST* Dean's List Award Semi-Finalists.

- Students must be a sophomore (grade 10) or junior (grade 11) to be eligible for this award.
    - Note: For regions of the world that do not use grade levels such as this to identify years of schooling: This award is intended for students who are two (2) to three (3) years away from entering college or university. Students that would be attending college or university in the next academic year are not eligible. Mentors will be asked for the year of graduation during the nomination process.
- The coach or mentor nominating the student(s) must submit an essay explaining why the student should receive this award. The essay must be 4,000 characters or less.

10.2 Criteria

Criteria for selection of the *FIRST* Dean's List shall include, but not be limited to a student's:

- Demonstrated leadership and commitment to *FIRST* Core Values
- Effectiveness at increasing awareness of *FIRST* in their school and community
- Interest in and passion for a long-term commitment to *FIRST*
- Overall individual contribution to their *Team*
- Technical expertise and passion

- Entrepreneurship and creativity
- Ability to motivate and lead fellow *Team* members

10.3 Dean's List Nominations

There are specific instructions on how to submit Dean's List Nominations. There are two sets of instructions, The Dean's List Nomination Guide – US, and the Dean's List Nomination Guide – International. Please visit our website for a copy of the guides, which provides in depth information about the Dean's List, and step by step visual aids to complete the nominations.

Appendix A – Resources

Game Forum Q&A

https://ftcforum.firstinspires.org/
Anyone may view questions and answers within the *FIRST*® Tech Challenge game Q&A forum without a password. To submit a new question, you must have a unique Q&A system username and password for your team.

FIRST Tech Challenge Game Manuals

Part 1 and 2 - https://www.firstinspires.org/resource-library/ftc/game-and-season-info

FIRST Headquarters Pre-Event Support

Phone: 603-666-3906
Mon – Fri
8:30am – 5:00pm
Email: Firsttechchallenge@firstinspires.org

FIRST Websites

FIRST homepage – www.firstinspires.org

FIRST Tech Challenge Page – For everything *FIRST* Tech Challenge.

FIRST Tech Challenge Event Schedule – Find *FIRST* Tech Challenge events in your area.

FIRST Tech Challenge Social Media

FIRST Tech Challenge Twitter Feed - If you are on Twitter, follow the *FIRST* Tech Challenge Twitter feed for news updates.

FIRST Tech Challenge Facebook page - If you are on Facebook, follow the *FIRST* Tech Challenge page for news updates.

FIRST Tech Challenge YouTube Channel – Contains training videos, game animations, news clips, and more.

FIRST Tech Challenge Blog – Weekly articles for the *FIRST* Tech Challenge community, including outstanding volunteer recognition!

FIRST Tech Challenge Team Email Blasts – contain the most recent *FIRST* Tech Challenge news for teams.

Feedback

We strive to create support materials that are the best they can be. If you have feedback about this manual, please email firsttechchallenge@firstinspires.org. Thank you!

Appendix B – Robot Inspection Checklist

Team Number: _____ Robot Inspection Status (circle): **PASS / FAIL**

Team	Insp.	Robot Size Inspection	Rule #
		Robot is presented at inspection with all mechanisms (including all components of each mechanism), configurations, and decorations that will be used on the Robot during the competition.	<I7>
		Separately test the Robot in all of its unique starting (pre-match setup) configurations. The Robot fits within the Sizing Tool without exerting undue force on the Sizing Tool sides and top.	<I7>a RG02>
		Robot Motion Warning Label is attached if servo motors move during the Robot initialization.	<RG02>
✔	✔	**General Robot Rules**	**Rule #**
		Robot does not contain any components that could damage the Playing Field or other Robots.	<RG01>a&b
		Robot does not contain materials that are hazardous.	<RG01>c
		Robot poses no obvious unnecessary risk of entanglement.	<RG01>d
		Robot does not contain sharp edges or corners.	<RG01>e
		Robot does not contain animal-based, liquid, or gel materials.	<RG01>f&g
		Robot does not contain materials that would cause a delay of game if released.	<RG01>h
		Robot does not contain elements that electrically ground the Robot frame to the Playing Field.	<RG01>i
		Robot does not contain closed gas devices.	<RG01>j
		Robot does not contain hydraulic devices.	<RG01>k
		Robot does not contain vacuum based mechanisms.	<RG01>l
		Team number is visible from at least 2 sides and meets requirements.	<RG04>
		Alliance Markers are present and meet requirements.	<RG05>
		Energy used by the Robot, (i.e., stored at the start of a Match), shall come only from approved sources.	<RG06>
		Robot is not capable of launching its own components.	<RG07>
✔	✔	**Robot Mechanical Parts and Materials Rules**	**Rule #**
		All components on the Robot are from allowable raw materials and Commercial Off The Shelf products.	<RM01> <RM02>
✔	✔	**Robot Electrical Parts and Materials Rules**	**Rule #**
		The Main Power Switch is installed properly, labeled, readily accessible, and visible to competition personnel. The TETRIX, REV, and MATRIX switches are the only allowed Main Power Switch.	<RE01>
		All batteries are securely attached to the Robot in a location where they will not make direct contact with other Robots or the Playing Field.	<RE02>
		Exactly one (1) Robot Main Battery Pack of an approved type is on the Robot and it is properly connected to the Main Power Switch and either the REV Expansion Hub or REV Control Hub.	<RE03> <RE05>a(i)
		Where present, fuses must not be replaced with fuses of higher rating than originally installed or according to manufacturer's specifications. Replaceable fuses are single use only.	<RE04>
		Allowed electronic devices are powered by power ports on the REV Expansion Hub or REV Control Hub except as noted in <RE05>a&b, <RE12>, and <RE13>.	<RE05>a
		The REV Expansion Hub and/or REV Control Hub is powered by the Robot main battery.	<RE05>a(i)
		REV SPARK Mini Motor Controllers are powered by the Robot main battery.	<RE05>a(ii)
		Allowed sensors may only receive power from the REV Expansion Hub or REV Control Hub	<RE05>a(iii)
		Light sources (including LEDs) are not focused or directed in any way, except for the REV Robotics 2m Distance Sensor. Light sources are powered by allowed methods.	<RE05>a(iv) <RE13>

		Video recording devices, if used, are powered by an internal battery and their wireless communication capability is turned off.	<RE05>a(v) <RE14>
		The Robot Controller Android device (if used) is powered by its internal battery or by the built-in charging feature of the REV Expansion Hub.	<RE05>b
		Exactly one Robot Controller a) Android Device + REV Expansion Hub or b) REV Control Hub) is required. One additional REV Expansion Hub is allowed.	<RE06> <RE08>
		The only allowed Motor and Servo Controllers are: REV Expansion Hub, REV Control Hub, REV Servo Power Module, REV Spark Mini Motor Controller, and VEX Motor Controller 29.	<RE09>
		Robot contains no more than eight (8) DC motors of the allowed models.	<RE10>
		Robot contains no more than twelve (12) servos. They must be compatible with the attached REV Expansion Hub, REV Control Hub, REV Servo Power Module, or VEX Motor Controller 29 and not exceed the manufacturer specifications for the controller.	<RE11>
		Robot contains only allowed sensors and they are connected only to the REV Expansion Hub or the REV Control Hub.	<RE12>
		Power and motor control wires must use consistent color coding with different colors used for the positive (red, white, brown, or black with a stripe) and Negative/Common (black or blue) wires.	<RE15>f
		Power, motor control, servo and sensor wires are the correct size.	<RE15>i
		If electronics are grounded to the *Robot* frame, the only approved method is the REV Robotics Resistive Grounding Strap. If needed, the REV Robotics Anderson Powerpole to XT30 adapter may connect to the Resistive Grounding Strap. No other grounding straps or cables are allowed.	<RE15>k
		Approved electrical and electronic devices may be modified to make them more usable; they may not be modified internally or in any way that affects their safety.	<RE16>
✔	✔	**Wheel/Tread Playing Field Damage Test - Optional**	**Rule #**
		Robot did not damage the Playing Field tile. [This is an optional test that is performed only when an Inspector believes that the drivetrain tread may damage a Playing Field tile.]	<I7>

General Comment(s) or Reason(s) for Failure (if any):

Robot Inspector

Appendix C – Field Inspection Checklist

Team Number: _____ Field Inspection Status (circle): **PASS / FAIL**

✔		Drive Team Members Present	Rule #
		Coach (required), driver 1 (required); driver 2 (optional); *Human Player* (optional)	<C06>
✔		**Driver Station and Robot Controller Hardware Rules**	**Rule #**
		Driver Station consists only of one Android device (Circle): Motorola Moto G 2nd Generation, Motorola Moto G 3rd Generation, Motorola Moto G4 Play, Motorola Moto G5, Motorola G5 Plus, Motorola Moto E4, Motorola Moto E5, or Motorola Moto E5 Play.	<RE07> <RE17>a
		Robot Controller Android device (if used) is one of the following models (Circle): Motorola Moto G 2nd Generation, Motorola Moto G 3rd Generation, Motorola Moto G4 Play, Motorola Moto G5, Motorola G5 Plus, Motorola Moto E4, Motorola Moto E5, Motorola Moto E5 Play. The Android device's USB interface only connects to a REV Expansion Hub or a USB hub.	<RE07>
		Driver Station Android device USB interface is only connected to either a Mini USB to OTG cable or combination of cables connected to one USB Hub, or one gamepad.	<RE17>b
		No more than one (1) optional Commercial Off The Shelf USB external battery connected to the Driver Station USB hub is allowed.	<RE17>c
		The Driver Station consists of no more than two of the allowed gamepads (Logitech F310, Xbox 360, wired Sony DualShock 4 for PS4, or Etpark Wired Controller for PS4) in any combination.	<RE17>a&d
		The touch display screen of the Driver Station must be accessible and visible to field personnel.	<RE17>e
DS	**RC**	**Driver Station (DS) and Robot Controller (RC) Software Rules**	**Rule #**
		Android operating system satisfies the requirements: Motorola Moto G 2nd Generation and Motorola Moto G 3rd Generation – version 6.0 or higher. All other allowed Android devices – version 7.0 or higher.	<RS03>
		REV Control Hub (if used) operating system is version 1.1.1 or higher.	<RS03>
		REV Expansion Hub (if used) firmware version is 1.8.2 or higher.	<RS03>
		Android phones are set to airplane mode, Wi-Fi is turned on, and Bluetooth is turned off.	<RS07>
NA		REV Control Hub (if used) has Wi-Fi turned on, Bluetooth is turned off, and the password is different than the factory default value of "password".	<RS07>
		Android devices are not connected to any local networks.	<RS09>
		Android phone(s) and REV Control Hub (if used) are named with the official team number followed by –DS or –RC as appropriate.	<RS01>
		All remembered Wi-Fi Direct Groups and Wi-Fi connections on Android devices have been removed.	
		DS and RC apps are version 6.0 or higher and the DS and RC apps have the same version numbers.	<RS03>
		Communication between the Robot and Driver Station is only through the RC and DS applications. Out of band communication is not allowed.	<RS09>
	NA	Driver Station uses the official FTC Driver Station app to control the Robot.	<RS06>
NA		The FTC Robot Controller app on the Android phone (if used) is the default application, the application launches, and no other messages pop up.	<RS05>
NA		Robot Controller is set to the correct Wi-Fi channel (if required by the competition).	<C14>
✔		**Robot Operation Verified at the Playing Field**	**Rule #**
		Robot Controller connects with the Driver Station.	
		Robot switches between autonomous and driver-controlled operation correctly.	<RS04>
		Robot starts and stops when commanded by the Driver Station.	
		The Stop Button, when pressed on the Driver Station, functions and stops the robot.	
		The team understands how to disable their Robot, if instructed to do so by a referee.	

✔	Queuing Process Information Provided at the Playing Field	Rule #
	Team understands that software changes are not allowed in the Queue Area.	
	Team understands that the match schedule is only an estimate. Matches may start prior to or after the scheduled time. It is the team's responsibility to monitor schedule changes and show up when required.	
	Team knows that they are responsible for attaching their Team Supplied Alliance Marker on two sides of their robot before they approach the competition playing field.	<RG05>

General Comments or Reason(s) for Failure (if any):

Field Inspector

Appendix D – Control Award, Sponsored by Arm, Inc. Submission Form & Instructions

To be considered for the Control Award Sponsored by Arm, Inc., *Teams* must submit a Control Award Submission Form. On this form, *Teams* identify and summarize the key control elements that make their *Robot* unique. Included is a description of key observable actions for judges to look for as well as the sensor and algorithm use that make it all possible. Judges will use this form for both evaluating control designs and when observing *Robots* on the competition field.

Information on this form will typically fit on one page, with no more than two (2) pages submitted.

Autonomous Objectives
List the overall actions that the *Robot* can complete. These should include scoring actions as well as other positioning and defensive operations. The *Robot* does not have to do accomplish all these in every program but should be demonstrable in at least one autonomous program.

Sensors Used
List the sensors used to control the *Robot* and a brief description of how they are used.

Key Algorithms
List the key algorithms that make your *Robot* unique or are vital to its success on the field. Particularly complex or unique algorithms or those that integrate the use of multiple sensors are good candidates to highlight here.

Driver Controlled Enhancements
List any advanced control elements that are used during the *Driver-Controlled Period* to enhance performance. These may include signaling operations when a certain condition is detected on the field, auto-complete functions, fail-safe algorithms, or just any enhancements that make the control of the *Robot* easier or more efficient for the driver.

Autonomous Program Diagrams
For *Autonomous* operations, *Teams* should draw and label a typical path the *Robot* takes. The labeled points identify key observable actions the *Robot* makes. For each labeled point, a brief description of what is taking place should be noted (see example below). Especially describe those key operations where adjustments are made to ensure accurate and repeatable performance.

For *Teams* with multiple *Autonomous* programs, it is not necessary to document every program on a separate sheet. It is sufficient document the most commonly used or complex programs and note variances for the rest.

Additional Summary Information (optional)
For those *Teams* that have developed many different control features, they may want to provide additional information to assist the judges in understanding their work. This is a place where *Teams* can provide more detailed information about their designs. It should be organized such that separate topics are easily identified and can be quickly found.

Appendix E – Control Award, Sponsored by Arm, Inc. Submission Form

****Please turn in this sheet during your judge interview along with your engineering portfolio****

Team #	Team Name:

Required for Remote Submissions – Please provide a link to a video recording of the controls described in this submission form:

Autonomous objectives:

Sensors used:

Key algorithms:

Driver controlled enhancements:

Engineering portfolio references:

Autonomous program diagrams: