Basic ‘Bot Guide for REV
Part 2- Armature
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Visit the FIRST website for programming instructions and game rules. ......... Error! Bookmark not defined.

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Introduction

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.

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!

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.
Introduction to this Guide

About This Guide
The Basic ‘Bot Guide is designed to be a resource for teams looking for a step-by-step instructional for building a robot and a basic armature for the FIRST Tech Challenge competition. There are multiple versions of this guide, previously called the “Push Bot Guide”.

This version the Basic ‘Bot Guide for REV-Part 2 has been created to use the new and differing parts in the 2020-2021 season’s REV kit of parts and builds upon the 2020-2021 Basic ‘Bot Guide for REV- Part 1 which was released earlier in the season.

Parts
- REV FTC Competition Set
  - Tools included with the REV FTC Competition Set
- Electronics Modules and Sensors set
- Control & Communication Set 1 or 2
- (Optional) Only the tools included in the FTC Competition Set will be needed to build the chassis. The screws and nuts are a standard size and having more tools may allow more students to participate at the same time.
- (Optional) A ruler is not needed to build this robot, but it is necessary to make sure that the robot is competition ready

Tips and Tricks
- Make sure that set screws are installed in every axle hub, motor hub, and axle collar.
- Refer to the legend provided in the Kit of Parts, if any parts are unfamiliar.
- Make sure that all assemblies are square. It is hard to drive a crooked robot straight!
- The drive wheels are powered by two DC motors located on the back of the robot, which are relatively heavy. This weight is needed to help the wheels grip the surface better.
- Omni wheels should be located on the front of the robot, which allows the robot to turn more easily. The omni wheels can slide sideways with very little friction due to the rollers.
- Unless otherwise noted, the top image in each step shows the necessary parts; the lower image shows the completed assembly.
Armature

Tower Base

Step 1: Prepare Upper Brackets (Make 4)

Parts Needed:
REV-41-1480 - metal 90 degree bracket (1 x 4)
REV-41-1359 - M3 x 8mm screw (4 x 4)
REV-41-1361 - M3 nyloc nuts (4 x 4)

Figure 1 - Unassembled View

Figure 2 - Assembled View of One

Figure 3 - Assembled View of All Four
Step 2: Add Upper Brackets to Beams (Make 2)

**Parts Needed:**
REV-41-1430 - Extrusion, 150mm - 45 degree ends (4)
Assemblies from previous step

---

**Figure 4- Unassembled View**

**Figure 5- Assembled View**
Step 3: Prepare Cross Brace Support Brackets (Make 4)

**Parts Needed:**
- REV-41-1320 - plastic inside corner bracket (1 x 4)
- REV-41-1359 - M3 x 8mm screw (4 x 4)
- REV-41-1361 - M3 nyloc nuts (4 x 4)

*Gracious Professionalism*® - “Doing your best work while treating others with respect and kindness - It’s what makes FIRST, first.”
Step 4: Add Brackets to Cross Brace

**Parts Needed:**
- REV-41-1431 - Extrusion, 225mm - 90 degree ends (2)
- Assemblies from the previous step

**Figure 9 - Unassembled View**

**Figure 10 - Assembled view**
Step 5: Add Screws to Cross Brace

Parts Needed:
REV-41-1359 - M3 x 8mm screw (16)
Assemblies from the previous step

Figure 11- Unassembled View

Figure 12- Assembled View

Gracious Professionalism® - “Doing your best work while treating others with respect and kindness - It’s what makes FIRST, first.”
Step 6: Add Cross Braces to Beams

Parts Needed: Assemblies from previous steps

Figure 13- Unassembled View

Figure 14- Assembled view

Helpful Hint

- Upper cross brace touches metal bracket of support arm.
- Lower cross brace touches upper cross brace.
Step 7: Prepare Tower/Chassis Brackets (Make 6)

Parts Needed:
- REV-41-1307 - plastic 45 degree bracket (1 x 6)
- REV-41-1359 - M3 x 8mm screw (5 x 6)
- REV-41-1361 - M3 nyloc nuts (5 x 6)

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Step 8: Add Tower/Chassis Brackets to Tower Base

Parts Needed:
Assemblies from previous steps

Figure 18- Unassembled View

Figure 19- Assembled View
Step 9: Add Tower Base to Chassis

![Figure 20- Temporarily Remove Omni Wheels](image1)

![Figure 21- Add Tower Base Assembly](image2)

![Figure 22- Assembled View](image3)

**Parts Needed:**
- Chassis
- Tower Base - assembly from the previous step

**Helpful Hint**
- Tower brackets should be against rear wheel brackets.

**Gracious Professionalism®** - “Doing your best work while treating others with respect and kindness - It’s what makes FIRST, first.”
Tower Gear Assembly

**Step 1: Prepare Brackets (Make 8)**

Parts Needed:
- REV-41-1321 - plastic lap corner bracket (1 x 8)
- REV-41-1359 - M3 x 8mm screw (1 x 8)
- REV-41-1361 - M3 nyloc nuts (1 x 8)

![Figure 23- Unassembled View](image)

![Figure 24- Assembled View](image)
Step 2: Add Brackets to Beam (Make 2)

Parts Needed:
REV-41-1431 - Extrusion, 225mm - 90 degree ends (1 x 2)
Assemblies from previous step

Figure 25- Unassembled View

Figure 26- Assembled View

Helpful Hint
- Lower brackets (brackets on right in image) are 20mm from the right end of the extrusion.
- Upper brackets (brackets on left in image) are 90mm from the right end of the extrusion.

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Step 3: Add Beams to Base

Parts Needed:
Assemblies from previous steps
Robot (chassis plus new assemblies)

Figure 27- Unassembled View

Figure 28- Assembled View

Helpful Hint
- There should be 40mm between the right beam and the inside of the tower base (yellow arrow).
- There should be 60mm between beams (red arrow).
Step 4: Assemble Gear Motor

**Parts Needed:**
- REV-41-1291 HD hex motor (1)
- REV-41-1607 UltraPlanetary Mounting Plate (1)
- M3 x 8mm button head screws (supplied with motor) (2)

*Figure 29- Unassembled View*

*Figure 30- Assembled View*
Step 5: Assemble Motor Gears

**Parts Needed:**
- Assembly from previous step
- REV-41-1601 - UltraPlanetary Cartridge 3:1 (1)
- REV-41-1602 - UltraPlanetary Cartridge 4:1 (1)
- REV-41-1603 - UltraPlanetary Cartridge 5:1 (1)
- REV-41-1604 - UltraPlanetary Output Stage (1)
- M3 x 40mm screw (supplied in kit) (6)

**Helpful Hint**
- Note the order of gear ratio sets on motor.
- The highest ratio (5:1) is closest to the motor as recommended by REV.
Step 6: Prepare Motor Bracket

Parts Needed:
- REV-41-1623 - UltraPlanetary bent bracket (1)
- REV-41-1359 - M3 x 8mm screw (2)
- REV-41-1361 - M3 nyloc nuts (2)

Figure 33- Unassembled View

Figure 34- Assembled View

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Step 7: Mount Motor to Bracket

Parts Needed:
Assemblies from previous steps
REV-41-1359 - M3 x 8mm screw (5)

Figure 35- Unassembled View

Figure 36- Assembled View
Step 8: Add Gears to Motor

**Parts Needed:**
- Assembly from previous step
- REV-41-1334 - 45 tooth gear (2)
- REV-41-1125 - M3 x 35mm screw (5)

**Figure 37- Unassembled View**

**Figure 38- Assembled View**

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Step 9: Add Motor To Tower

Parts Needed:
Assembly from the previous step
Chassis & Tower Base

Figure 39- Unassembled View

Figure 40- Assembled View

Helpful Hint
- Leave motor bracket loose.
Step 10: Prepare Pillow Blocks (Make 4)

Parts Needed:
- REV-41-1317 - bearing pillow block (1 x 4)
- REV-41-1359 - M3 x 8mm screw (2 x 4)
- REV-41-1361 - M3 nyloc nuts (2 x 4)

Figure 41 - Unassembled View

Figure 42 - Assembled View

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Step 11: Assemble Mid Gear Set

Parts Needed:
- REV-41-1332 - 30 tooth gear (1)
- REV-41-1337 - 90 tooth gear (1)
- REV-41-1347 - 75mm hex shaft (1)
- REV-41-1322 - end cap bearing (2)
- Pillow block assemblies from previous step (2 of 4)

---

**Figure 43- Unassembled View**

**Figure 44- Assembled View**
Step 12: Add Mid Gear Set to Robot

Parts Needed:
- Assembly from the previous step
- Chassis & Tower Base

Helpful Hint
- Leave assembly loosely attached to robot.
Step 13: Prepare Upper Gear

Figure 47 - Unassembled View

Figure 48 - Assembled View

Helpful Hint
- Leave screws loose.

Parts Needed:
- REV-41-1331 125 tooth gear (1)
- REV-41-1360 - M3 x 16mm screw (2)
- REV-41-1361 - M3 nyloc nuts (2)
Step 14: Assemble Upper Gear Set

**Parts Needed:**
- Assembly from previous step
- Pillow block assemblies from a previous step (2 of 4)
- REV-41-1347 - 75mm hex shaft (1)
- REV-41-1322 - end cap bearing (2)
- REV-41-1323 - 15mm spacer (1)

*Figure 49- Unassembled View*

*Figure 50- Assembled View*
**Step 15: Add Upper Gear Set to Robot**

![Unassembled View](image1)

*Figure 51- Unassembled View*

![Assembled View](image2)

*Figure 52- Assembled View*

**Parts Needed:**
- Assembly from previous step
- Chassis & Tower Base
Step 15: Continued - Final Positioning of Gear Train

Figure 53- Assembled View

Helpful Hint

- Upper gear set pillow blocks are flush with the end of the beams.
- Screw heads in gear are to the right. Small gear of mid gear set is snug against upper gear.
- Right gear of lower (i.e. motor) gear set is snug against large gear of mid gear set.
- Tighten all screws securely.

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Tower Arm & Gripper

**Step 1: Prepare Servo Bracket**

**Parts Needed:**
- REV-41-1485 - metal bent servo bracket (1)
- REV-41-1359 - M3 x 8mm screw (3)
- REV-41-1361 - M3 nyloc nuts (3)

*Figure 54 - Unassembled View*  
*Figure 55 - Assembled View*
Step 2: Assemble Gripper Servo

Parts Needed:
Assembly from previous step
REV-41-1097 - smart robot servo (1)
REV-41-1359 - M3 x 8mm screw (4)
REV-41-1361 - M3 nyloc nuts (4)

Figure 56- Unassembled View

Figure 57- Assembled View

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Step 3: Add Servo Horn

Parts Needed:
- Assembly from previous step
- REV-41-1828 - servo horn (1)
- Screw from servo kit (1)

Figure 58- Unassembled View

Figure 59- Assembled View
Step 4: Prepare Rod End Bracket

Parts Needed:
- REV-41-1304 - Rod end bracket (1)
- REV-41-1359 - M3 x 8mm screw (2)
- REV-41-1361 - M3 nyloc nuts (2)

Figure 60- Unassembled View

Figure 61- Assembled View
Step 5: Attach Rod End Bracket to Servo

![Unassembled View](image1)

![Assembled View](image2)

Parts Needed:
- Assemblies from previous steps
- REV-41-1359 - M3 x 8mm screw (2)
Step 6: Prepare 90 Degree Brackets

Parts Needed:
REV-41-1305 - 90 degree bracket (1)
REV-41-1359 - M3 x 8mm screw (2)
REV-41-1361 - M3 nyloc nuts (2)

Figure 64- Unassembled View

Figure 65- Assembled View

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Step 7: Add Servo to Beam

**Parts Needed:**
- REV-41-1431 - Extrusion, 225mm - 90 degree ends (1)
- Assemblies from previous steps

**Figure 66- Unassembled View**

**Figure 67- Assembled View**

**Helpful Hint**
- End of 90-degree bracket is 19 mm past end of beam.
Step 8: Prepare Ring Release Assembly

Parts Needed:
- REV-41-1305 - 90-degree bracket (3)
- REV-41-1360 - M3 x 16mm screw (2)
- REV-41-1361 - M3 nyloc nuts (2)

Helpful Hint
- Leave all screws loose.

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Step 9: Add Ring Release Assembly to Servo Beam

Parts Needed:
Assemblies from previous steps

Figure 70- Unassembled View

Figure 71- Assembled View
Step 10: Add Servo Bracket to Arm

**Parts Needed:**
- REV-41-1432 - Extrusion 420mm 90 degree ends (1)
- Assembly from previous step

*Figure 72- Unassembled View*

*Figure 73- Assembled View*
Step 11: Prepare Ring Holder Support Bracket

**Parts Needed:**
- REV-41-1303 - 15mm plastic motion bracket (1)
- REV-41-1359 - M3 x 8mm screw (2)
- REV-41-1361 - M3 nyloc nuts (2)

**Figure 74- Unassembled View**

**Figure 75- Assembled View**
Step 12: Add Corner Bracket to Ring Holder Support Bracket

Parts Needed:
- REV-41-1320 - 15mm inside plastic corner bracket (1)
- REV-41-1360 - M3 x 16mm screw (2)
- REV-41-1361 - M3 nyloc nuts (2)
- Assembly from the previous step

Figure 76- Unassembled View

Figure 77- Assembled View

Gracious Professionalism® - “Doing your best work while treating others with respect and kindness - It’s what makes FIRST, first.”
Step 13: Add Motion Bracket to Ring Holder Assembly

**Parts Needed:**
- REV-41-1303 - 15mm plastic motion bracket (1)
- REV-41-1360 - M3 x 16mm screw (2)
- REV-41-1361 - M3 nyloc nuts (2)

Assembly from previous step

**Figure 78- Unassembled View**

**Figure 79- Assembled View**
Step 14: Add Second Motion Bracket to Ring Holder Assembly

**Parts Needed:**
REV-41-1303 - 15mm plastic motion bracket (1)
REV-41-1359 - M3 x 8mm screw (2)
REV-41-1361 - M3 nyloc nuts (2)
Assembly from previous step

*Gracious Professionalism®* - “Doing your best work while treating others with respect and kindness - It’s what makes FIRST, first.”
Step 15: Add Second Corner Bracket to Ring Holder Assembly

Parts Needed:
- REV-41-1320 - 15mm inside plastic corner bracket (1)
- REV-41-1360 - M3 x 16mm screw (2)
- REV-41-1361 - M3 nyloc nuts (2)

Figure 82- Unassembled View

Figure 83- Assembled View
Step 16: Add Ring Holder to Arm

**Parts Needed:**
Assemblies from previous steps

**Helpful Hint**
- Adjust position of ring holder assembly so that the ring release assembly can swing past it.
Step 17: Add Arm/Gripper to Tower Gear Assembly

Parts Needed:
Assembly from the previous step
Robot

Figure 86 - Unassembled View

Figure 87 - Assembled View

Helpful Hint
- The arm attaches to the two screws on the large gear.
- The bottom edge of the end of the arm should be approximately 10cm from the gear. (red arrow)
Step 18: Add Battery Mounting Plate

Parts Needed:
- Robot
- REV-41-1166 battery holder plate
- REV-41-1359 - M3 x 8mm screw (1)
- REV-41-1361 - M3 nyloc nuts (1)

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Step 19: Plug in Motor and Servo

**Parts Needed:**
- Assembly from the previous step
- Motor power wire from motor kit. (1)
- REV-11-1130 36 inch PWM cable (1)

**Helpful Hint**
- The motor is plugged into motor port 2.
- The servo is plugged into servo port 0 being careful to orient properly.
Step 20: Add Battery to Robot

Parts Needed:
Robot
REV-31-1302 12V slim battery (1)
REV-41-1161 zip ties (as required)

Figure 92- Unassembled View

Figure 93- Assembled View

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Final Steps

What’s Next?

- After the gripper/release mechanism is complete the servo left and right positions need to be programmed with the servo programmer. When closed, the 90-degree bracket on the short end of the gripper mechanism should just touch the ring holder assembly. When open, the release assembly should swing past the ring holder assembly to ensure the ring is pushed off of the robot.
- If necessary, the length of the arm can be adjusted so that when the gripper is closed and the ring holder is on the floor, the robot will be less than 18 inches long. If desired, a more protected location may be found for mounting the battery to limit the possibility of damage during a match. You have now constructed the armature of your Basic ‘Bot, however, programming will be needed to make the robot functional.
- Testing should be done to determine whether anything needs to be changed or optimized for the season’s game rules. Testing will also show whether more cables need to be secured or re-routed.
- Numbers and other stickers will be needed to make the robot competition ready. Check the game rules for all the applicable stickers and placement.
- Make sure to also go over the robot checklists:
  - [Robot Self-Inspection Checklist](#)
  - [Robot Reliability Checklist](#)

Visit the [FIRST website](#) for programming resources, robot building resources, more instructions and game rules.
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**

**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](http://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.
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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!