# Ultimaker 2 Aluminum Extrusion Clone

**Build Instructions**

## Axis Definitions

- X-axis - Facing the front of the machine the axis is **LEFT-to-RIGHT**
- Y-axis - Facing the front of the machine the axis is **FRONT-to-BACK**
- Z-axis - Facing the front of the machine, the axis is **TOP-to-BOTTOM**

All references to direction (top/bottom/left/right) are based on facing the front of the machine.

⚠️ The X/Y/Z axis labels are based on the orientation of the linear rods, and not the direction that those rods move the printhead. However, for the Motor Mounts, the axis label is based on the direction the motor moves the printhead. This follows the sames conventions that the Ultimaker 2 assembly manual uses.
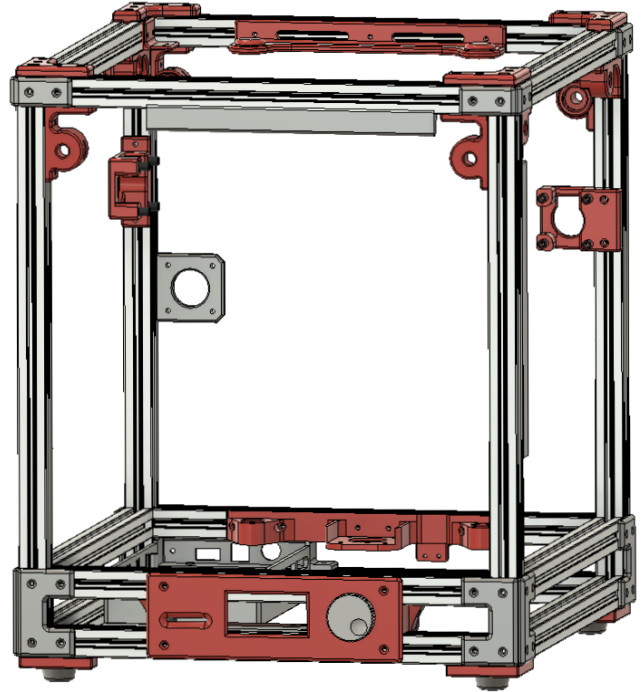
## How to use this manual

This manual is meant to be a supplement to the Ultimaker 2 assembly manual. The majority of the assembly can be inferred from the UM2 manual, but this manual will fill in for the following parts:

- Building the Frame
- Installing the Mainboard & OLED Display
- Other Parts used to build this Printer
- 1.75 Filament modifications
- Firmware installation

# Parts List

This list is mostly complete for the parts required to assemble the frame and mount all hardware/parts.

**Tools**

- ·   M5 metric Tap (possibly optional)
- ·   Various metric hex keys
- ·   Blue (medium) Loctite

**Hardware**

- ·   6x   308mm 20x20 Extrusions (X-axis)
- ·   6x   334mm 20x20 Extrusions (Y-axis)
- ·   4x   395mm 20x20 Extrusions (Z-axis)
- ·   6x   M2.5x16mm socket head screws
- ·   4x   M3x6mm button head screws
- ·   5x   M3x8mm socket head screws
- ·   16x   M3x12mm flat head screws
- ·   75x   M3x10mm socket head screws
- ·   57x   M3x10mm flat head screws
- ·   30x   M3x30mm socket head screws
- ·   8x   M5x10mm socket head screws
- ·   12x   M3 Nuts
- ·   4x   M3 Washers
- ·   150+   Misumi pre-assembly nuts

**3D Printed Parts**

- ·   4x   Top Bracket (A)
- ·   4x   Bottom Bracket (B)
- ·   8x   Sides Top Bracket (C)
- ·   8x   Sides Bottom Bracket (D)
- ·   1x   Z-axis Top Bracket (E)
- ·   1x   Z-axis Bottom Bracket (F)
- ·   1x   Z-axis Limit Switch Bracket (G)

**3D Printed Parts (cont.)**

- ·   1x   X-axis Front Left Gantry Bracket (H)
- ·   1x   X-axis Front Right Gantry Bracket (R)
- ·   1x   X-axis Back Left Gantry Bracket (I)
- ·   1x   X-axis Back Right Gantry Bracket (S)
- ·   1x   X-axis Limit Switch Bracket (W)
- ·   1x   X-axis Motor Mount (X)
- ·   1x   Y-axis Front Left Gantry Bracket (P)
- ·   1x   Y-axis Front Right Gantry Bracket (Q)
- ·   1x   Y-axis Back Left Gantry Bracket (J)
- ·   1x   Y-axis Back Right Gantry Bracket (K)
- ·   1x   Y-axis Motor Mount (L)
- ·   1x   Extruder Mount (M)
- ·   8x   Motor Mount Spacer
- ·   1x   Mainboard Enclosure (N)
- ·   1x   Mainboard Faceplate (Y)
- ·   2x   Mainboard Enclosure Spacer
- ·   1x   Bowden Support Bracket (O)
- ·   3x   LED Brackets (T)
- ·   1x   OLED Faceplate (U)
- ·   1x   OLED Electronics Bracket (V)
- ·   1x   OLED Front Electronics Bracket
- ·   4x   OLED Electronics Spacer
- ·   1x   Knob
- ·   2x   Gantry Spacer 5mm
- ·   5x   Gantry Spacer 10mm
- ·   1x   Gantry Spacer 25mm

⚠️ Attaching the *Top and Bottom Brackets (A/B)* to the top of the Z-axis extrusions with the M5 screws may require that you use a M5 tap to create a channel for the screw. It's possible that you can just screw the M5 screws into the center core w/o tapping.

# Building the Frame

Congratulations, you're starting with the most tedious part of the entire build!  :-)  It's important to make sure you insert all pre-assembly nuts on the correct extrusions… or you'll have to partially disassemble to insert them later.

We will build the frame in 2 parts and then join them together. Gantry parts have their part-names imprinted on the part.

When attaching a 3D part to an extrusion, put the screws through the part and then loosely put the pre-assembly nuts on the back side. Then just slide the part onto the extrusion. This won't be possible in all scenarios, but do it when you can.

Don't use Loctite while assembling the frame. First build the entire frame. Once all parts are attached and confirmed to fit correctly you can then add loctite, one-by-one, to each screw that holds a 3D printed part. This will make sure that vibrations from printing won't cause parts to loosen over time.

# Part 1 - Front View

O

A

W

X-Axis

Y-Axis

I

J

E

H

K

Left
Side

L

Back
Side

M

F

N

G
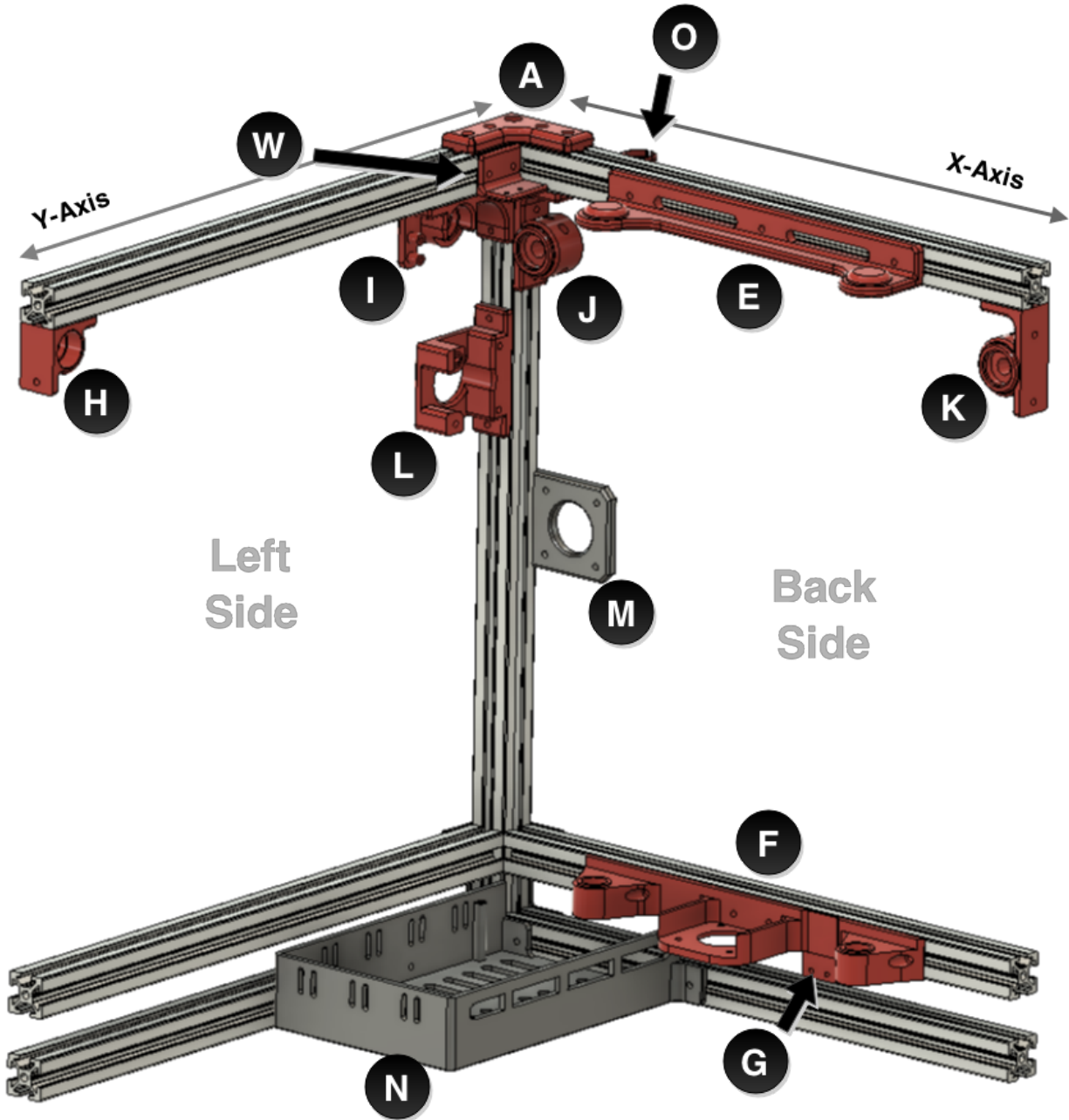
Part 1 - Back View
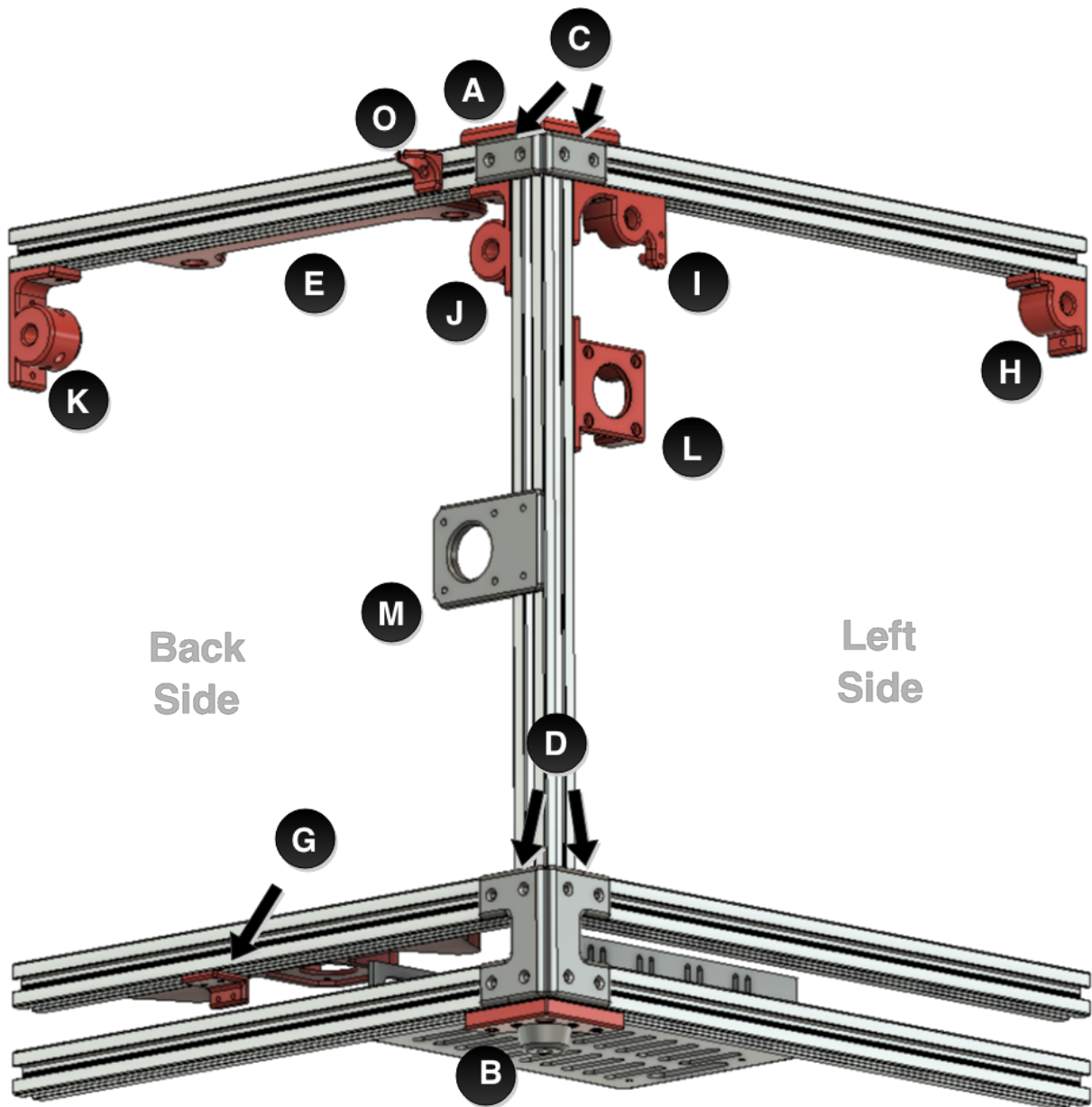
# Building the first part of the Frame

We will start with the left-back corner of the frame.

1. Attach *Z-axis Top (E)* to an X-axis extrusion using 3x M3x10 socket head screws. On the opposite side, attach *Bowden Support Bracket (O)* using 1x M3x8mm socket head screw.
2. Attach *X-axis Limit Switch bracket (W)* to a Y-axis extrusion using 2x M3x8 socket head screws.

3. Attach *Motor Mount Y-axis (L)* to a Z-axis extrusion using 2x M3x10 socket head screws. On the opposite side, attach the *Extruder Motor Mount (M)* using 2x M3x10 socket head screws.
4. Join the Y-axis extrusion with the Z-axis extrusion and X-axis extrusion using 2x *Sides Top Brackets (C)* with 4x M3x10 flat head screws. Make sure that the Motor Mount Y-axis is oriented correctly.
5. Slide the *X-axis Limit Switch Bracket (W)* to the corner of the extrusions.
6. Attach *Gantry X-axis Back Left (I)* to the Y-axis extrusion and Z-axis extrusion using 3x M3x10 socket head screws. Orient so that the bearing opening faces inward.
7. Attach *Gantry Y-axis Back Left (J)* to the X-axis extrusion and Z-axis extrusion using 3x M3x10 socket head screws. Orient so that the bearing opening faces inward.
8. Attach *Top Bracket (A)* to the frame you just created using 4x M3x10 flat head screws and 1x M5x10 screw.
9. Attach *Gantry X-axis Front Left (H)* to the other end of the Y-axis extrusion using 2x M3x10 socket head screws. Orient so that the bearing opening faces inward.
10. Attach *Gantry Y-axis Back Right (K)* to the other end of the X-axis extrusion using 3x M3x10 socket head screws. Orient so that the bearing opening faces inward.
11. Take 4x *Sides Bottom Bracket (D)* and put 4x M3x10 flat head screws thru each part and attach 4 pre-assembly nuts loosely.
12. Slide the long side of the *Sides Bottom brackets (D)* on the outer sides of the bottom of the Z-axis. This will allow you to attach the bottom sets of the X/Y axises.
13. Attach *Z-axis Bottom (F)* to a new X-axis extrusion using 6x M3x10 socket head screws. On the bottom of the extrusion (facing the front of the Z-axis Bottom part) attach the *Z-axis Limit Switch bracket (G)* using 2x M3x8mm socket head screws.
14. Attach *Mainboard Enclosure (N)* to a new Y-axis extrusion using 2x M3x10 socket head screws.
15. On the Y-axis, attach the Y-axis extrusion with the *Mainboard Enclosure (N)* to the upper connector of the *Sides* **Bottom Bracket (D),** connecting it to the to Z-axis extrusion. Make sure the *Mainboard Enclosure (N)* is oriented upward and pushed into the corner of the frame. Use 2x M3x10 socket head screws to mount the enclosure to the X-axis extrusion.
16. On the Y-axis, attach a new Y-axis extrusion to the upper connector of the *Sides* **Bottom Bracket (D),** connecting it to the to Z-axis extrusion.
17. On the X axis, attach a new X-axis extrusion to the lower connector of the *Sides Bottom Bracket (D),* connecting it to the Z-axis extrusion. Add 2 preassembly nuts to the frontside of this X-axis extrusion to connect the *Mainboard Enclosure (N)*. Also add 1 preassembly nut to the topside of this X-extrusion, to later secure the **Mainboard Faceplate (Y)**. Use an M3x10 socket head screw to hold it in place to it does not fall out during assembly.
18. On the X axis, attach the new X-axis extrusion to the upper connector of the *Sides Bottom Bracket (D),* connecting it to the Z-axis extrusion. Make sure that both the *Gantry Z-axis Top/Bottom brackets (E/F)* are oriented correctly.
19. Attach *Bottom Bracket (B)* to the frame using 4x M3x10 socket head screws and 1x M5x10 screw.

# Part 2 - Front View

X-Axis

Y-Axis

**C**

**A**

**S**

**P**

**T**

**R**

**Q**

**Front Side**

**Right Side**

**T**

**D**

**U**

**B**
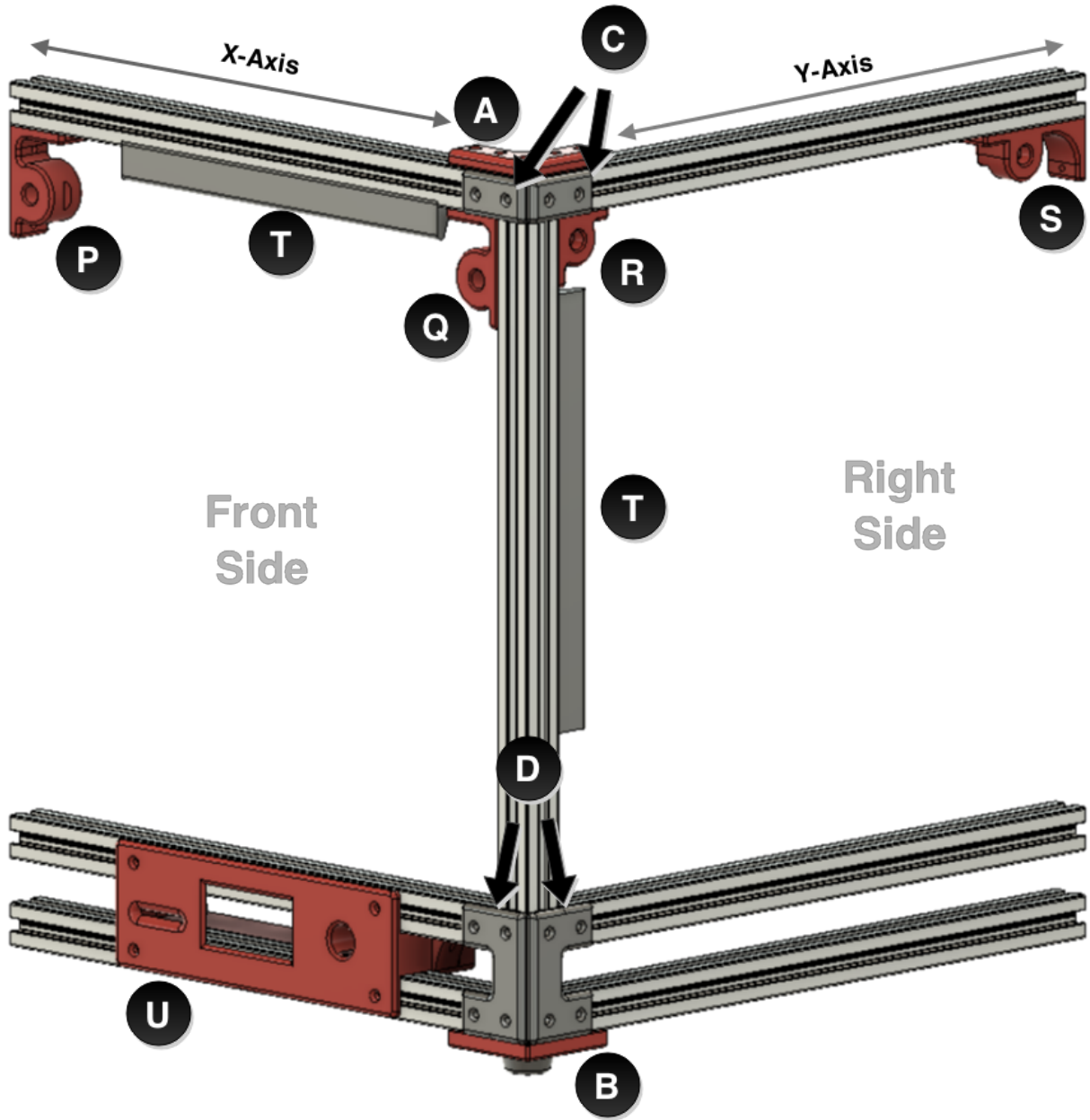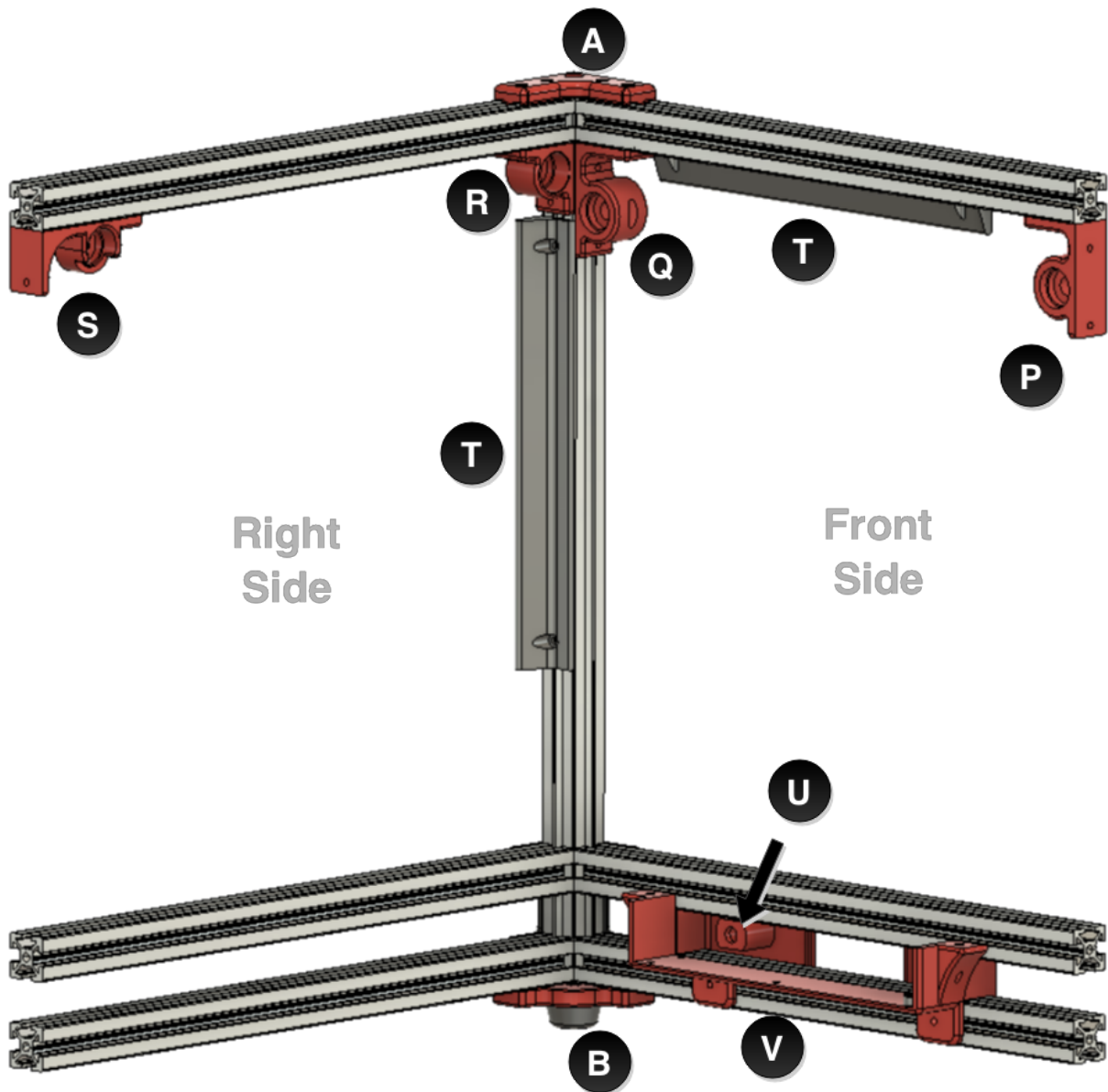
# Building the second part of the Frame

For this section, we'll start with the front-right corner of the frame.

1. Attach 1x *LED Bracket (T)* to an X-axis extrusion using 2x M3x10 socket head screws.
2. Attach 1x *LED Bracket (T)* to a Z-axis extrusion using 2x M3x10 socket head screws.
3. Join the X-axis extrusion with the Z-axis extrusion and a new Y-axis extrusion using 2x *Sides Top Bracket (C)* with 4x M3x10 flat head screws. Make sure the *LED Bracket (T)* is oriented so the flush side is facing outward of the frame.

4. Attach *Gantry X-axis Front Right (R)* to the Y-axis extrusion and the Z-axis extrusion using 3x M3x10 socket head screws. Orient so that the bearing opening faces inward.
5. Attach *Gantry Y-axis Front Left (Q)* to the X-axis extrusion and the Z-axis extrusion using 3x M3x10 socket head screws. Orient so that the bearing opening faces inward.
6. Attach *Top Bracket (A)* to the frame you just created using 4x M3x10 flat head screws and 1x M5x10 screw.
7. Attach *Gantry X-axis Back Right (S)* to the other end of the Y-axis extrusion using 2x M3x10 socket head screws. Orient so that the bearing opening faces inward.
8. Attach *Gantry Y-axis Front Left (P)* to the other end of the X-axis extrusion using 3x M3x10 socket head screws. Orient so that the bearing opening faces inward.
9. Take 4x *Sides Bottom Bracket (D)* and put 4x M3x10 flat head screws thru each part and attach 4 pre-assembly nuts loosely.
10. Slide the long side of the *Sides Bottom brackets (D)* on the outer sides of the bottom of the Z-axis. This will allow you to attach the bottom sets of the X/Y axises.
11. Attach *OLED Electronics Bracket (V)* to an unused X-axis extrusion using 2x M3x10 socket head screws.
12. On the X-axis, attach the X-axis extrusion, with the *OLED Electronics Bracket (V)*, to the lower connector of the *Sides Bottom Bracket (D)*. Make sure the *OLED Electronics Bracket (V)* is oriented correctly. Add 2 preassembly nuts to the frontside of this X-axis extrusion to secure the *OLED Faceplate (U)*.
13. On the X-axis, attach an unused X-axis extrusion to the upper connector of the *Sides Bottom Bracket (D)* connected to the Z-axis extrusion. Add 2 preassembly nuts to the frontside of this X-axis extrusion to secure the *OLED Faceplate (U)*.
14. Attach the *OLED Faceplate (U)* to the 2 X-axis extrusions from the previous steps with 4x M3x10 flat head screws.
15. On the Y-axis, attach 2 unused Y-axis extrusions to the upper and lower connectors of the *Sides Bottom Bracket (D)*.
16. Attach *Bottom Bracket (B)* to the frame using 4x M3x10 socket head screws and 1x M5x10 screw.

Now it's time to join both frame parts together.

# Joining the 2 Frame Parts

1. Temporarily stand the 2 sections together to create the boxed frame. Part 1 of the frame should be oriented to the back-left and part 2 will be in the opposite front-right corner.
2. Attach *Motor Mount X-axis (X)* to an unused Z-axis extrusion using 2x M3x10 socket head screws. This extrusion will be positioned at the back-right with the *X-axis Motor Mount (X)* oriented correctly.
3. Attach 1x *LED Bracket (T)* to the last unused Z-axis extrusion using 2x M3x10 socket head screws. This extrusion will be positioned at the front-left with the *LED Bracket (T)* flush side facing outward.
4. With all parts in position, use the remaining *Sides, Top and Bottom Brackets (C/D/B)* to complete the boxed frame.
5. Attach the 4 rubber feet to the *Bottom Brackets (B)* using 4x M3x10 socket head screws. Use a washer to keep the screw from pulling thru the rubber foot.

# Installing the Mainboard & OLED Display

The UM2 assembly guide should be used for electronics installation/wiring. The following instructions will assist in mounting the electronics.

## Mainboard

1. Attach the **Mainboard Faceplate (Y)** to the UM2 Mainboard using 2x M3x10 flat head screws and 2 M3 nuts
2. Slide the mainboard in between the 2 lower rear X-axis extrusions. Before sliding the mainboard to its final position, use 2x M3x30mm screws to hold the 2x **Mainboard Enclosure Spacers** in place.
3. As you continue to slide the mainboard over the spacers, push the screws through the holes on the mainboard and secure with 2x M3 nuts.
4. Move the pre-assembly nut on the top of the lower extrusion to align with the faceplate and loosely attach with an M3x10mm socket head screw. This is a tight space and a bit of a pain to tighten, so save this for very last once you know things are working.
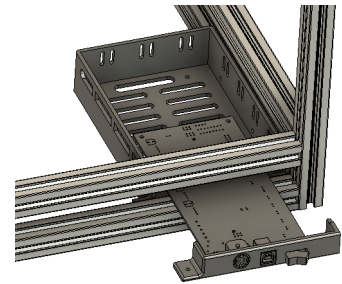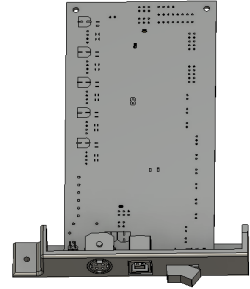
## OLED Electronics

During the Frame assembly, the **OLED Faceplate (U)** and **OLED Electronics Bracket (V)** were attached to the frame for convenience.

1. Remove **OLED Faceplate (U)** and **OLED Electronics Bracket (V)** from the frame.
2. Attach **OLED Front Electronics Bracket** to the underside of the OLED controller using 2x M3x10mm flat head screws and 2x M3 nuts.
3. Attach the OLED controller to the **OLED Electronics Bracket (V)** with 4x **OLED Electronics Spacers** using 4x M3x10mm flat head screws and 4x M3 nuts.
4. Reattach the **OLED Electronics Bracket (V)** to the frame.
5. Gently lay the OLED display into the faceplate. Use gaffers tape (or similar) to hold the OLED in place. Using a strip across all 4 sides.
6. Move the **OLED Faceplate (U)** into the correct position and then plug the display into the controller. Once plugged in, align the pre-assembly nuts and reattach to the frame.
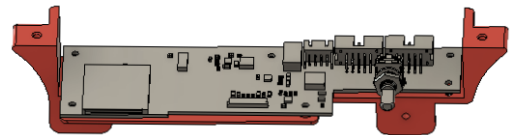
# Other Parts used to build this Printer

**The Extruder**

https://www.youmagine.com/designs/alternative-um2-feeder-version-two

I am using the *UM2 extruder alternative* v2 **by |Robert|** on both printers. If you are choosing the 1.75mm route, use the information in **1.75 Filament Modifications**.

**Fan Mount**

https://www.youmagine.com/designs/ultimaker-2-fan-mount--2 **by Spirit**

This fan mount has been working pretty well. You need to print it in ABS (or nylon/PC).

# 1.75 Filament Modifications

These instructions are for modifying the UM2 to use 1.75 filament.

Print the following files:

- ● **Extruder Body** - Modified for 1.75 filament using a 4mm OD PTFE filament.
- ● **Extruder Guide** - Modified for 1.75 filament.
- ● **Printhead Adapter** - Used on the printhead to create a channel to hold a PTFE coupler.

Parts to buy:

- ● **Bowden couplers** - You will need 2. You can purchase here:
  http://www.filastruder.com/collections/e3d-spare-parts-and-accessories/products/bowden-couplings-threaded-1-75mm
- ● **PTFE tubing - 2mm ID / 4mm OD** - McMaster Carr

Instructions on assembling the extruder can be found with the source files on YouMagine.

To install the couplers:

- ● Use a metric M10 tap to create a path for the plastic couplers. You will tap both the Extruder Body and the Printhead Adapter.
- ● On the Extruder Body, the coupler interferes with the placement of the Guide. I filed down one flat side of the coupler to allow it to fit properly. It's not perfect, but it works.

# Installing the Firmware

To get started:

- Download Arduino IDE  (I tested with v1.0.6 and 1.6.4)
- Download the firmware: https://github.com/Ultimaker/Ultimaker2Marlin

The **Ultimaker2Marlin** firmware includes a library that is included and already defined in the Arduino IDE, which causes a compilation error. To resolve this error, you will have to delete (or temporarily move) the library from the arduino IDE folder.

I used the OSX version, so the path may slightly vary.

### v1.0.6

- Delete folder: */Contents/Resources/libraries/LiquidTWI2*
- Delete file: */Content/Resources/libraries/Wire/utility/twi.c*

### v1.6.4

- Delete folder: */Contents/Java/hardware/arduino/avr/libraries/Wire*

If you didn't make any adjustments to the build, you can upload the firmware as-is and you're done. If you did make changes, you'll have to make adjustments in the configuration.h file.