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Pack 11

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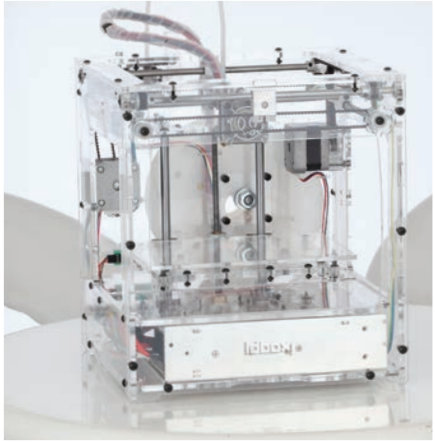

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User Guide 2

In the second part of the User Guide, you test and calibrate your idbox. You check that the axes function correctly, apply grease where appropriate and then make sure the head moves through its full range of movements and at the correct speed. Then, make sure the table moves up and down properly, and that the 'hot end' is working. Finally, calibrate and level the table.

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The next five detailed and easy-to-follow stages of construction for your 3D printer.

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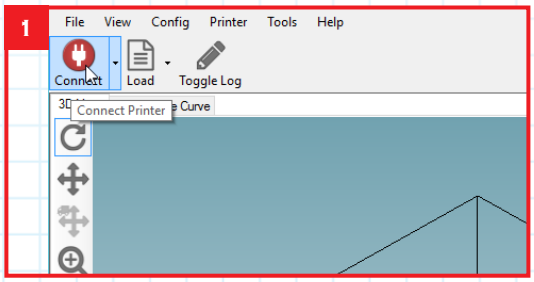
User Guide Section 2: Testing and calibrating the idbox

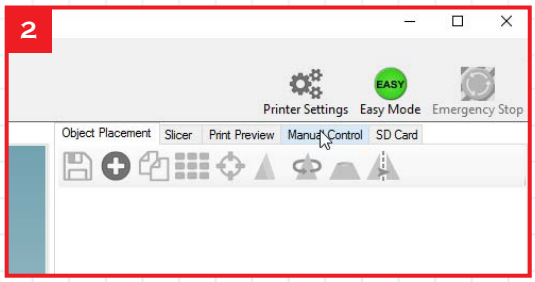
In this section of the User Guide, you set up the printer for printing by performing pre-operation checks to see if everything is working properly. You then perform a number of calibration exercises, including the vital setting up of the modelling table.

At times in this section, you will be using the manual controls in Repetier Host to check the operation of various components of the idbox. The Windows and Mac OS controls do not look the same, but they have similar effects when used. You will also be keying in G-Code commands. Again, where you do this is different for Mac and Windows users, but again the effects are the same.

Using Manual Control (Windows)

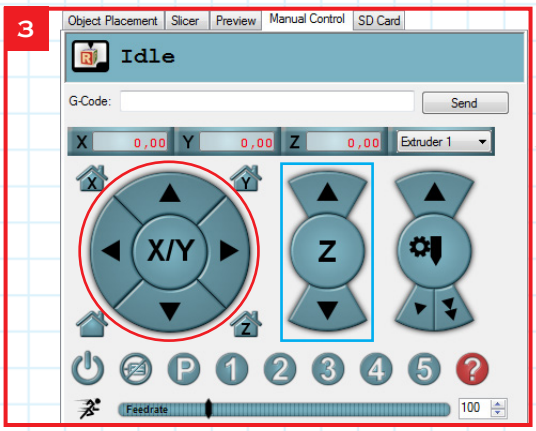


1. With Repetier running, connect to the idbox by clicking the red Connect button on the top left, and confirm that the button turns green.



2. Click the Manual Control tab on the right side of the window.

3. The Manual Control tab for Windows appears, part of which is shown right. The controls for the X-, Y- and Z- axes are listed below.



X- and Y- axis Controllers (ringed in red)

X-axis controls

► Move Right (+) by 0.1/1/10/50mm

◄ Move Left (-) by 0.1/1/10/50mm

Y-axis controls

▲ Move Back (+) by 0.1/1/10/50mm

▼ Move Forward (-) by 0.1/1/10/50mm

Home controls

X-axis home

Y-axis home

Z-axis home

ALL axes home

Z-axis Controller (outlined in blue)

Z-axis controls

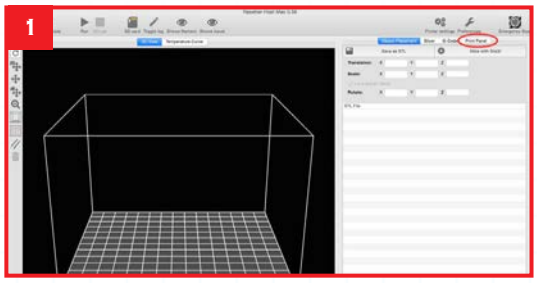
▲ Move Up (+) by 0.01/0.1/1/10mm

▼ Move Down (-) by 0.01/0.1/1/10mm

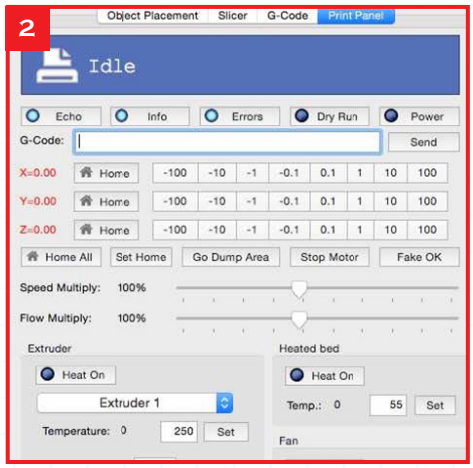
HINT

The head has not been returned to the home position upon the printer being turned on, so the coordinate values (X=0.00 Y=0.00 Z=0.00) are coloured red. This is because when the coordinates shown in Repetier are not confirmed to be reflecting the actual position of the head, the coordinates are displayed in red numbers. Repetier can confirm the coordinates of the head only after a return home command has been given and the head has been confirmed to have reached the home position.

Using Print Panel (Mac OS)



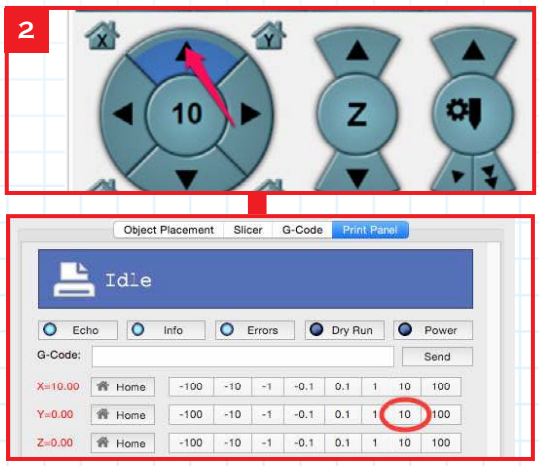
1. With Repetier running, connect to the idbox by clicking the red Connect button on the top left, and confirm that the button turns green. Then click the Print Panel tab (ringed in red, above) on the right side of the window.



2. The Print Panel tab for Mac OS appears, part of which is shown left. There are buttons that you can click to move the print head by preset amounts in the X- Y- and Z-axes, and there are buttons to send the print head to the home positions. Until Repetier 'knows' where the print head is located, the values on the left for the position of the head are in red. It knows when the return home command has been given and the head has been confirmed to have reached the home position.

Check the operation of the X- and Y-axes

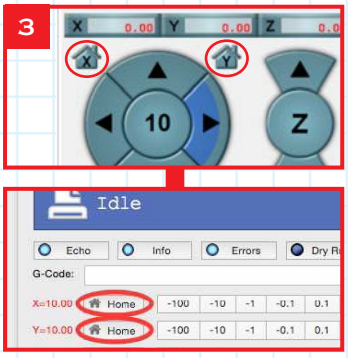
1. First check the operation in the X-axis. Click the 10 button for the X-axis (Windows Manual Control shown top and Mac OS Print Panel shown above) and see if the head moves to the right. The head should move 10mm to the right.



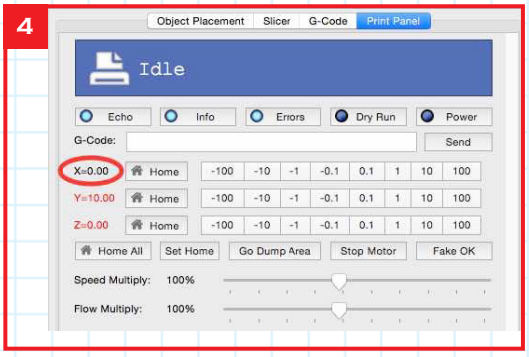
2. Next, check the Y-axis. Click the 10 button for the Y-axis (Windows Manual Control shown upper image top and Mac OS Print Panel beneath) and see if the head moves to the rear. It should move 10mm to the rear.

First movement

When moving the axes for the first time, you will hear a loud thump. This is the sound of the motors changing from an unexcited state to an excited state.



3. Once both X- and Y- axes are confirmed to be operating normally, press the home button for the X-axis, and then the Y-axis (Windows upper image and Mac OS underneath)



4. After pressing the Home button for the X-axis, the head should be at the farthest left and have stopped moving. The value for the X axis changes to a black colour and shows X=0.00. (The image above is for Mac OS.)

5. After pressing the Home button for the Y-axis, the head should be all the way to the front and stopped. The value for the Y-axis changes to a black colour and shows Y = 0.00. (The image above is for Mac OS.)

Greasing the head rods and slider rods

The sliders and head block slide along the rods using oil-less bearings. And while they move without the need for any extra lubricant, they will slide more smoothly if grease is applied. You can easily identify the head rods: they are the ones that move, but do not rotate. These need to have grease spread thinly and evenly along their length. The slider rods rotate and so any grease applied will spread by itself around the rods.

Applying grease

1. Take the grease supplied and apply it evenly to the head rods with your finger.

2. Apply grease to the slider rods, being careful not to apply too much. It will be spread around the slider rods as they rotate in operation.

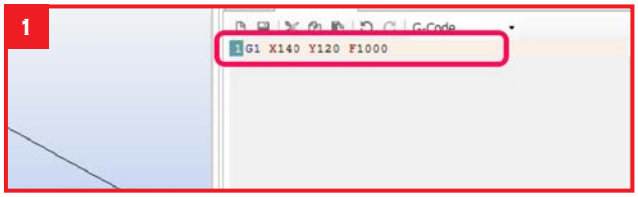
3. Wipe off any excess grease on the ends of the rods with a paper tissue.

4. Spread the grease around by moving the head using G-code sent directly from Repetier to the printer. The instructions for this are in the section below.

Spreading the grease evenly

To spread the applied grease around, you now manually input the G-Code (code for directly controlling the idbox) to move the head and sliders. The procedure for inputting the G-Code differs between Windows and Mac OS.

Windows



1. Click on the Preview tab, then the G-Code Editor sub tab, and enter: G1 X140 Y120 F1000 into the command field. (Make sure to put a space between G1 and X140, X140 and Y120, and Y120 and F1000.) Next, click the Start Print button on the left side of the window. The head will move to the back right (X = 140mm Y = 120mm) at a speed of 1000mm/min. Apply grease to the parts of the rods that were unreachable because of the position of the head.

2. Enter the following G-Code to move the head again. Enter: G1 X0 Y0 F2000 into the G-Code field, and press the Start Print button. The head will move to the front left corner, the home position, at 2000mm/min.

Mac OS

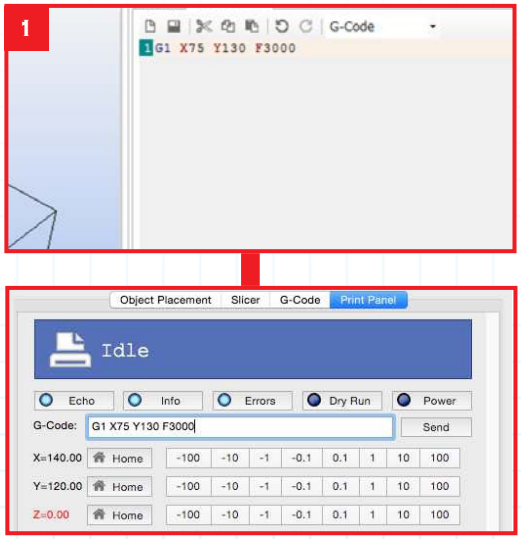
1. Enter: G1 X140 Y120 F1000 into the G-Code field, and press the Send button. (Make sure to put a space between G1 and X140, X140 and Y120, and Y120 and F1000.) The head will move to the back right (X = 140mm Y = 120mm) at a speed of 1000mm/min. Apply grease to the parts of the rods that were unreachable because of the position of the head.

2. Enter the following G-Code to move the head again. Enter: G1 X0 Y0 F2000 into the G-Code field, and press the Send button. The head will move to the front left corner, the home position, at 2000mm/min.

Checking that the head moves properly

It's now time to check that the head moves properly, first by testing its speed of movement, increasing the speed bit by bit, and then by seeing if the head can move across its full range from side to side and front to back, and finally, diagonally. You will continue to control the head by entering values in the G-Code field, sending the G-Code to the printer to command its movements.

Checking head speed

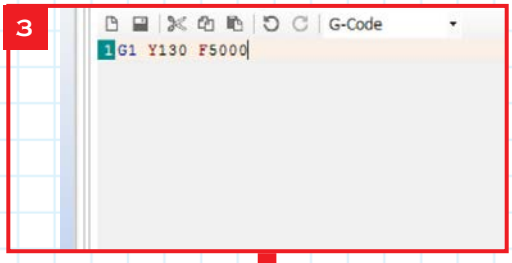


1. Enter G1 X75 Y130 F3000 into the G-Code field, and press the Start Print button for Windows and Send button for Mac OS. The head will move to the centre back point (X = 75mm Y = 130mm) at 3000mm/min.

2. Enter G1 X150 Y0 F4000 into the G-Code field, and press the Start Print button for Windows and Send button for Mac OS. The head will move to the front right side (X = 150mm Y = 0mm) at 4000mm/min.

CAUTION!

After increasing the head movement speed to a certain point, there will be a loud dragging noise accompanied by the head stopping movement (getting caught). This phenomenon is called 'stepping out' and is caused by the head movement being restricted for some reason, resulting in the timing belt and pulley 'sliding', causing the noise. If this happens, first unplug the power cord and then move the head slowly by hand to see if the head gets caught anywhere.



3. Enter G1 Y130 F5000 into the G-Code field, and press the Start Print button for Windows and Send button for Mac. The head will move to the back right side (X = 150mm Y = 130mm) at 5000mm/min. The X value for the destination is retained from the last setting (in this case X = 150mm) and does not have to be entered.

You should now be familiar enough with the G-Code field (whether Mac OS or Windows) to not need pictures of the code that is keyed in. So for the rest of the tests where you are checking that the head moves properly, only the instructions and G-Code are shown.

4. Enter G1 X75 Y0 F6000 into the G-Code field, and press the Start Print button for Windows and Send button for Mac OS. The head will move to the centre front (X = 75mm Y = 0mm) at 6000mm/min.

5. Enter G1 X0 Y130 F7000 into the G-Code field, and press the Start Print button for Windows and Send button for Mac. The head will move to the back left side (X = 0mm Y=130mm) at 7000mm/min.

6. Enter G1 X0 Y0 F8000 into the G-Code field, and press the Start Print button for Windows and Send button for Mac OS. The head will move to the home position (X=0mm Y=0mm) at 8000mm/min.

CLOSE-UP

About G-Code

G-Code makes up the commands that tell the printer what to do. For instance, on these pages, the G1 at the beginning of an entered command is the command to move the head; the second parameter X represents the X-axis coordinate (in mm) to move to; the third parameter Y represents the Y-axis coordinate (in mm); the fourth parameter F represents the velocity (in mm/min). The second, third and fourth parameters can be left out if they are the same as the last values entered previously.

X-axis head movement

Now check the movement along the X-axis at the front, centre and back.

Enter each line of code shown on the right, one line at a time, into the G-Code field, and then press the Start Print button for Windows and Send button for Mac after each line. Make sure the head moves without any problems. The explanations in brackets are not to be entered.

G1 X150 Y0 F8000	(Move to max value of X at front)
G1 X0	(Move to home position of X at front)
G1 Y65	(Move to Y centre point)
G1 X150	(Move to max value of X at Y centre point)
G1 X0	(Move to home position of X at Y centre point)
G1 Y130	(Move to back)
G1 X150	(Move to max value of X at back)
G1 X0	(Move to home position of X at back)

Y-axis head movement

Next, you check the movement along the Y-axis at the left, centre and right.

Enter each line of code shown on the right, one line at a time, into the G-Code field, and then press the Start Print button for Windows and Send button for Mac after each line. Make sure the head moves without any problems. The explanations in brackets are not to be entered.

G1 X0 Y0 F8000	(Move to home position of Y on the left)
G1 Y130	(Move to max value of Y on the left)
G1 X75	(Move to X centre point)
G1 Y0	(Move to home position of Y at X centre point)
G1 Y130	(Move to max value of Y at X centre point)
G1 X150	(Move to the right)
G1 Y0	(Move to home position of Y on the right)
G1 Y130	(Move to max value of Y on the right)

Diagonal head movement

Finally, check combined X-Y axis movement (diagonal movement).

Enter each line of code shown on the right, one line at a time, into the G-Code field, and then press the Start Print button for Windows and Send button for Mac after each line. Make sure the head moves without any problems. The explanations in brackets are not to be entered.

When you've done this, that is the end of the checking of the head movements.

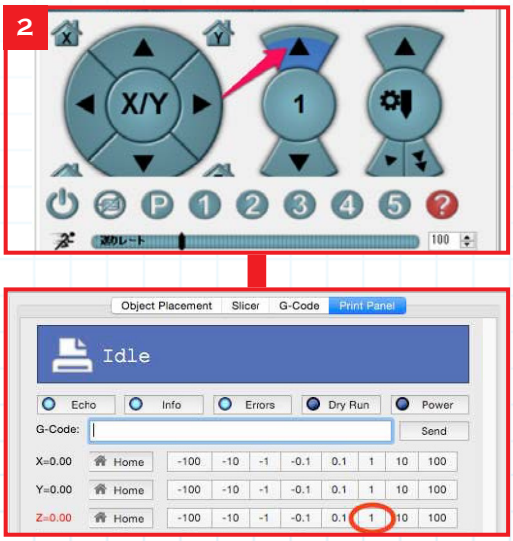
G1 X0 Y0 F8000	(Diagonal movement from back right to home position)
G1 X150 Y130	(Diagonal movement from home position to back right)
G1 X0	(Move to back left)
G1 X150 Y0	(Diagonal movement from back left to front right)
G1 X0 Y130	(Diagonal movement from front right to back left)
G1 Y0	(Move to home position)

Z-axis calibration

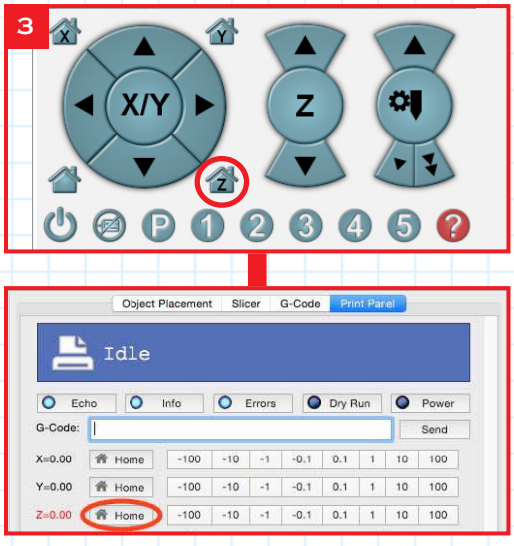
The table moves up and down along two Z-axis rods using linear bushes. The lead screw that passes through the brass nut in between the two linear bushes goes into the Z-axis motor coupling which is turned by the Z-axis motor. By calibrating the path of the brass nut as it moves up and down the lead screw, precise, clean printing is made possible. The first thing to do is to grease the lead screw.

Apply grease to the lead screw and set the Z-axis home position

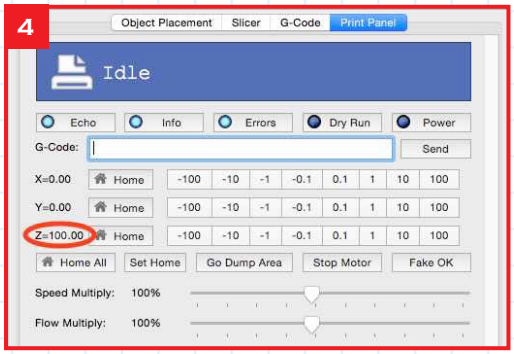
1. Apply grease to the lead screw all the way from directly below the table to the top of the coupling. Not applying grease will cause a squeaking sound when the printer is operating. Note: If there are squeaking sounds during operation, remove any old grease present and apply a new layer.



2. On the Manual Control (Windows) or Print Panel (Mac OS) tab, click the 1 button for the Z-axis to lower the table 1mm at a time. Initially, the brass nut will move over the part of the lead screw where grease was not applied, so it will make a loud squeaking sound. As the table lowers, the squeaking will stop. Continue lowering the table by clicking the 1 button for the Z-axis until the ungreased part of the lead screw is exposed, then apply grease to the previously unreachable places on the lead screw. Continue slowly lowering the table while watching the Z-axis limit switch carefully.



3. Make sure the metal plate or 'dog' attached to the table is able to pass through the U-shaped part of the limit switch. This should already have been checked out during assembly of the Z-axis. Once it is confirmed that the dog can pass through the limit switch, click the Z-axis home button.



4. The Z-axis coordinate will show Z = 100.00 and change from red to black numbers. The Z-axis is now in the home position. (The image on the left is what you will see when using Mac OS.)

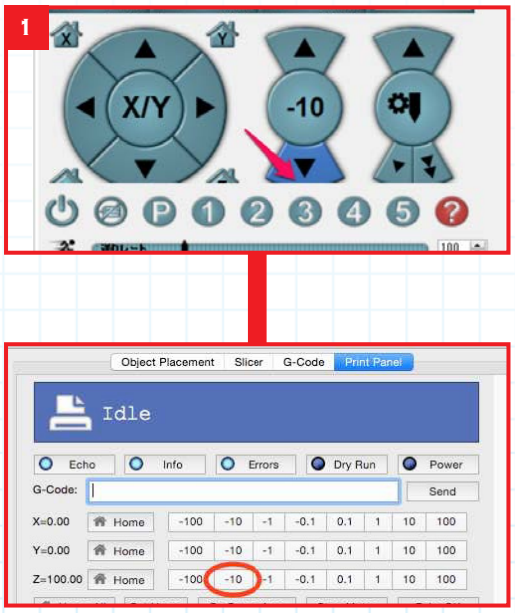
CLOSE-UP

The Z-axis coordinate

The Z-axis coordinate is at Z = 0 when the table is at the highest point (when the nozzle and table are closest together), and the figure increases as the table moves down. This might seem counter-intuitive, but bear in mind that as the table moves down, the Z-axis value rises along with the height of the object being printed.

Check the alignment of the lead screw

Once the table is at the Z-axis home position, it's time to check the Z-axis lead screw's angle. The aim is to get the lead screw parallel to the two Z-axis rods and perpendicular to the table when viewed from all angles and for all heights of the table. You do this by adjusting the position of the Z-axis motor, which up until now has only been loosely fastened to its mounting.



1. On the Manual Control (Windows) or Print Panel (Mac OS) tab, click the -10 button for the Z-axis three times to raise the table 30mm.

2. The table will rise to show a Z-axis coordinate of 70mm. The picture above is the result for Mac OS.

3. Insert your hand under the table and check that you can reach the coupling. If the gap is too small, raise the table another 10mm by clicking the -10 button for the Z-axis.

CAUTION! If the position of the Z axis motor is not calibrated properly, problems such as misalignment of layers may occur.

4. Hold the Z-axis coupling from below the table, and slide the motor so the lead screw stands perpendicular to the table. Look at the lead screw from the front, sides, and above to see if it is parallel to the Z axis rods, if it is perpendicular to the table surface, and positioned properly within the Z-axis top mounting plate. If it is not, adjust the positioning of the Z-axis motor accordingly.

5. After adjusting the Z-axis motor position, click the Z-axis home button again while carefully observing the movement of the front corners of the table. If the Z-axis is misaligned, the horizontal movements in the table will become bigger as it approaches the Z-axis home position. Perform these checks and tests several times to achieve the best results. The end of the lead screw swings around slightly when turning, but this is normal.

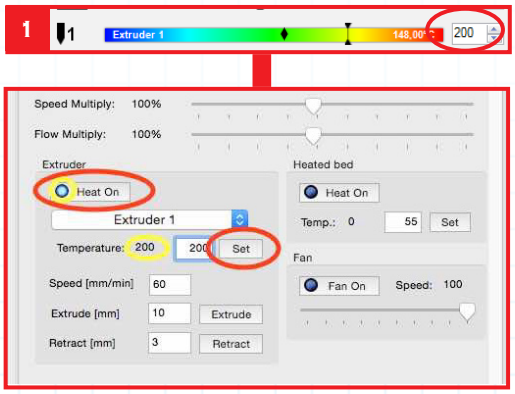
6. Once the position of the Z-axis motor has been optimised, fully tighten the four temporarily fastened screws holding the Z-axis motor in place. Tighten the screws most of the way with the table at a low position, then raise the table and tighten the screws all the way.

This concludes the calibration of the Z-axis.

Check the hot end and adjust the nozzle tightness

In this step, you perform an operation check on the 'hot end' – the printer head unit – by heating it up. Once the hot end has reached the temperature set, the nozzle is tightened up.

Heat up the hot end, then tighten the nozzle



1. For Windows, go to the Manual Control tab and enter 200 into the field ringed in red in the upper image on the left. Click the Extruder 1 icon to remove the red slash, if it is there. If the extruder is being properly heated up, the black ♦ on the temperature bar should gradually move to the right.

For Mac OS, Extruder 1 should be selected in the Extruder section of the Print Panel tab. Enter 200 into the temperature field, then click the Set button next to the field, or click the Heat On button (both ringed in red in the lower image on the left). The hot end will begin heating, the light on the Heat On button will turn on and the temperature setting, to the left of the temperature field, will change to 200.

CAUTION!

The hot end can reach temperatures up to 200°C. Touching the hot end (nozzle, barrel and heater block) directly with your bare skin will cause burns. Additionally, any flammable objects that come in contact with the hot end might be damaged or catch fire.

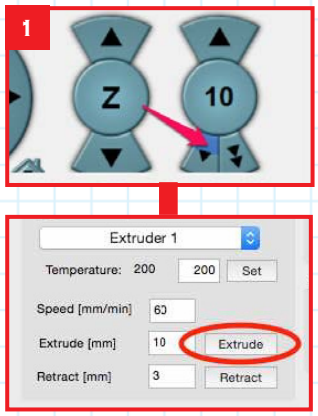
2. After setting the temperature, the temperature displayed on the bottom of the window – next to Extruder or Extruder 1 – will begin rising, and after some time it should stabilise near 200°C/200°C. Slight differences in temperature are tolerable. The numbers shown are the actual nozzle temperature(°C) and the set nozzle temperature(°C).

3. Now that the nozzle temperature increase is confirmed, you can tighten the nozzle. Because the hot end is made up of a combination of different parts made of various materials, such as aluminium, brass and stainless steel, with various thermal expansion coefficients, it is best to tighten in its operational state (when it is hot). Use the heater block wrench to hold the heater block in place, so it does not turn, then use a 6mm spanner to tighten the nozzle. Tighten the nozzle gently until it stops, then tighten only slightly from there. This concludes the operation check of the hot end heating.

Operation Check of Feeder and Application of Grease

Now, perform an operation check of the feeder with the nozzle heated to 170°C. The firmware in the microcomputer board prevents operation of the feeder at nozzle temperatures below 170°C, so make sure that the nozzle temperature is at least 170°C first.

Check the feeder and grease the feeder gear



1. For Windows, confirm that Extruder 1 is selected in the field just above the extrude control (which is to the right of the Z-axis control in the Manual Control tab). Click the button indicated by the red arrow in the upper image on the left where the number displayed becomes 10.

For Mac OS, click the Extrude button in the Extruder section of the Print Panel tab.

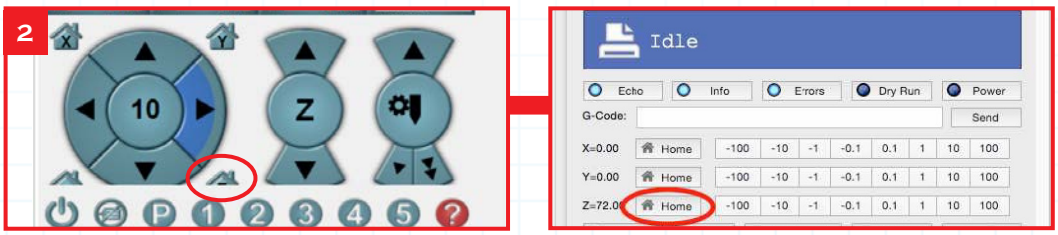
2. The motor in the feeder will begin turning. Confirm that the teeth of the drive roller are turning from down to up. Use your finger to apply grease to the small gear attached to the motor. When the motor stops moving, press the extrude button again. You will be able to see the grease transferring to the large gear. Continue applying the grease, until the large gear makes one complete turn. This concludes the operation check of the feeder and application of grease.

Configuration and calibration of the table

You now configure the Z-axis coordinate (height) and then make sure the table is level. In effect, you are accurately setting the height of the table's modelling surface, so that when Z = 0, the nozzle is neither too close nor too far from the table when printing starts – making sure that the modelling surface is level right across its surface. Please perform the following procedure with the 3mm acrylic board attached to the table using 2 binder clips. Additionally, if you plan on using a BuildTak sheet or any other items on the table surface for the purpose of filament adhesion, such as masking tape, double-sided tape, and so on, fix them onto the table now.

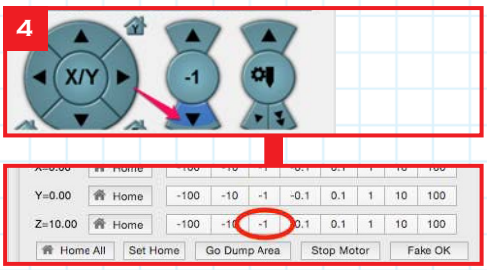
Set the Z = 0 Z-axis coordinate height and level the table

1. Start by turning the hot end heater off: For Windows, click the Extruder 1 icon to turn the hot end heater off. Confirm that there is a red slash through the icon. For Mac OS, click the Heat On button for the extruder to turn off the hot end heater. Confirm that the lamp on the Heat On button for the extruder is off.



2. Click the home button (shown ringed in red above left for Windows and above right for Mac OS), for the Z-axis to return the table to the home position.

3. In the G-Code command field, enter G0 Z10 and press Start Print for Windows and Send for Mac OS. The table will rise to the Z=10.00 coordinate (the image left is for Mac OS).



4. Click the -1 button for the Z-axis to raise the table 1mm at a time, until it is at Z=3.00.

5. You now adjust the height of the table, fine-tuning it so that its height matches that set in Repetier. This fine-tuning of the table height is done using the three knurled nuts on the bottom of the table. When viewed from above, the knurled nuts are at front centre, rear right and rear left. Turning the knurled nuts changes the distance between the table, or modelling surface, and the table base, which has the effect of changing the height of the table. Turning the knurled nuts counterclockwise (when looked at from above) by one full turn, for instance, will lower the table by 0.5mm. The knurled nuts have five protrusions, so turning the nut by the distance between one protrusion and the next changes the table height by 0.1mm.

HINT

Turning a single knurled nut many times at once will put too much pressure between the modelling surface and the table base, making calibration ineffective. To avoid this, turn each knurled nut by one full turn when adjusting by large amounts.

6. Because the table is at Z = 3.00mm in the software, the distance between the table and nozzle should be 3.00mm.You now have to estimate the actual distance between the table and nozzle and adjust as necessary. If the distance is less than 3.00mm, raising the table up to Z = 0.00mm would cause the nozzle to push into the table. If the distance is more than 3.00mm, the table is too low. Use the knurled nuts to adjust the distance between the table and nozzle to just over 3.00mm. Make it slightly too much as a precaution.

7. Click the -1 button for the Z-axis, while carefully watching the distance between table and nozzle, and gradually raise the table to Z = 2.0, Z = 1.0 and finally Z = 0.0. If the table and nozzle are about to hit each other, adjust the table height, lowering the table using the knurled nuts before raising the table further using Repetier. The aim at this stage is to get the table and the nozzle nearly touching when the height in the software is set to Z=0.00.

8. Once the table is at Z = 0.00, calibrate the table so that all four corners are the same height. The appropriate distance between the table and nozzle at Z = 0.0 is just enough of a gap so that a business card can fit through, but there is still slight resistance when moving the card around. This distance is called the 'appropriate gap'. The head should currently be in the home position (at the front left corner of the idbox). This position can be called Position O. Turn the knurled nuts as necessary, so that the table has the appropriate gap at Position O.

CAUTION! While levelling the table, before moving the head along the X- and/or Y-axes, be sure to first click the 1 button for the Z-axis five times to lower the table 5mm. If the table is not level, the nozzle may scrape across the surface and damage the table.

9. Click the 1 button for the Z-axis five times, to lower the table 5mm. Press the 100 button for the X-axis once, and the 10 button for the X-axis five times to move the head to the front right corner. This position can be called Position A. Click the -1 button for the Z-axis five times, while carefully watching the distance between table and nozzle. If the table and nozzle are about to crash into each other, lower the table height using the knurled nut at front centre. Once at Z = 0.0, turn the front centre knurled nut as necessary, so the table has the appropriate gap at Position A.

10. Click the 1 button for the Z-axis five times, to lower the table 5mm. Press the 100 button for the Y-axis once, and the 10 button for the Y-axis three times, to move the head to the back right corner. This position can be called Position B. Click the -1 button for the Z-axis five times, while carefully watching the distance between table and nozzle. If the table and nozzle are about to hit each other, lower the table height using the knurled nut at rear right. Once at Z = 0.0, turn the rear right knurled nut as necessary, so the table has the appropriate gap at Position B.

HINT If you cannot get the distance between the table and the nozzle level across the table surface using the adjustment available from operating the knurled nuts, it might be that something went wrong during assembly. The most likely place is when you added the table to the housing in Stage 47. Go back and check that this procedure was undertaken correctly.

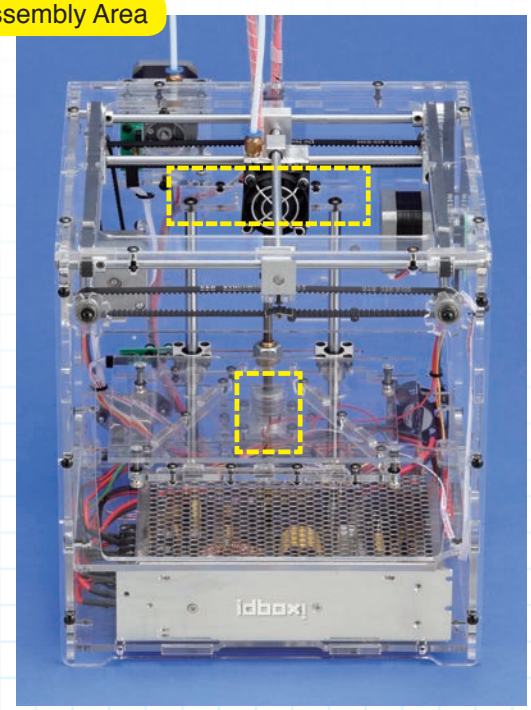
11. Click the 1 button for the Z-axis five times to lower the table 5mm. Press the -100 button for the X-axis once, and the -10 button for the X-axis five times to move the head to the back left corner. This position can be called Position C. Click the -1 button for the Z-axis five times while carefully watching the distance between table and nozzle. If the table and nozzle are about to hit each other, lower the table height using the knurled nut rear left. Once at Z = 0.0, turn the rear left knurled nut as necessary, so the table has the appropriate gap at Position C.

12. Click the 1 button for the Z axis five times, to lower the table 5mm. Press the -100 button for the Y axis once, and the -10 button for the Y axis three times, to move the head back to Position O. Click the -1 button for the Z axis five times, while carefully watching the distance between table and nozzle. If the table and nozzle are about to hit each other, lower the table height using the knurled nuts at front centre and rear left. They should be turned in the same direction an equal number of times. Once at Z = 0.0, turn the front centre and rear left knurled nuts as necessary, so the table has the appropriate gap.

13. In the same way, move the head to Position A. Turn the knurled nut at front centre and rear right as necessary, so the table has the appropriate gap. Move the head to Position B. Turn the rear right knurled nut as necessary so the table has the appropriate gap. Move the head to Position C. Turn the knurled nut at rear left as necessary, so the table has the appropriate gap. Move the head to Position O. Confirm that the table has the appropriate gap. If yes, this concludes the calibration of the table. If not, recalibrate the table at all four corners again, so the table has the appropriate gap all over its surface when Z = 0.

This concludes the calibration of the table.

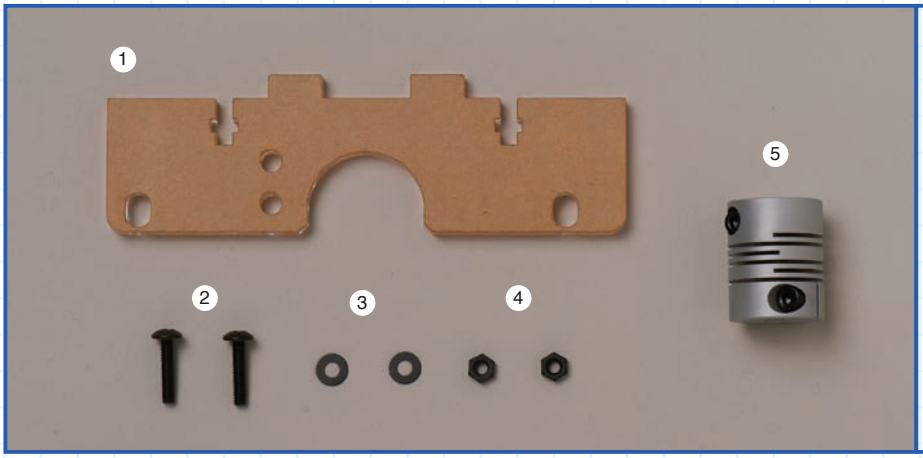
Stage 46 Assembly Area



Stage 46: Temporarily attach the Z-axis top mounting plate and add the Z-axis coupling

In this stage, you work on the Z-axis assembly. You start by loosely attaching the top mounting plate for the Z-axis and add the coupling to the shaft of the Z-axis motor. The mounting plate is then added to the inside of the rear panel of the housing.

When you add the Z-axis top mounting plate to the rear panel of the housing, make sure you have it correctly orientated: viewed from the front, the plate has two small holes (one above the other) which should be on the left when the plate's tabs are inserted into the slots of the panel. The nuts are tightened later on when the table is assembled. The coupling can be put on the motor shaft either way up, it doesn't matter, but make sure it is at the right level in relation to the motor mounting plate.



Stage 46 Components

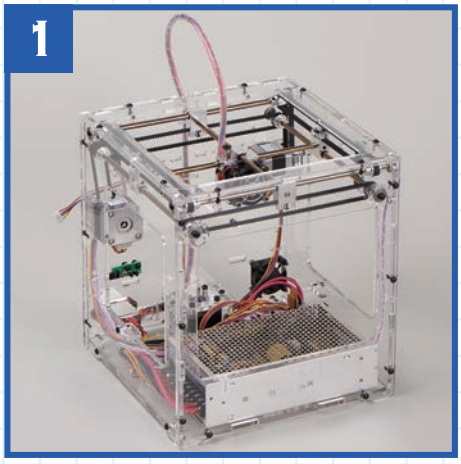
1: Z-axis top mounting plate
2: M3 truss head screws (14mm) x 2
3: M3 washers x 2
4: M3 nuts x 2
5: Coupling (5-5)

You will need

Adhesive tape
Sheet of paper
Allen key (50 x 2.5mm) supplied with Stage 44

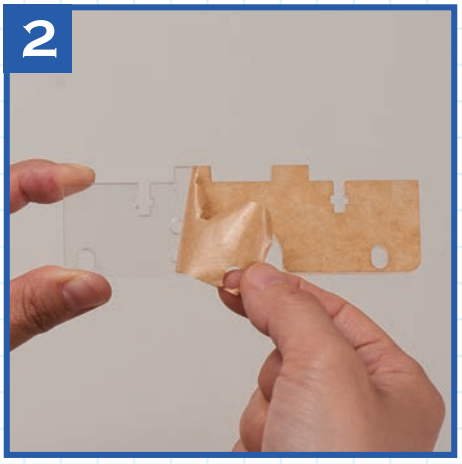
Parts to have ready

1



For this assembly, you will need the printer housing.

2



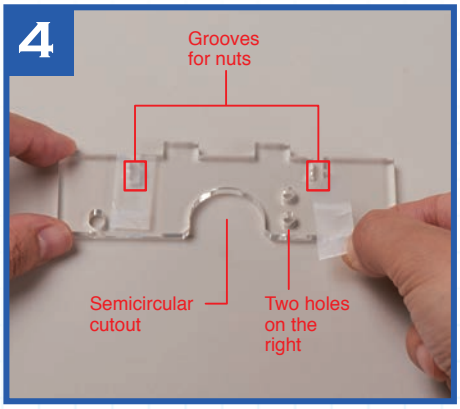
Peel the protective layers off the Z-axis top mounting plate.

Add the Z-axis top plate to the back of the housing

3

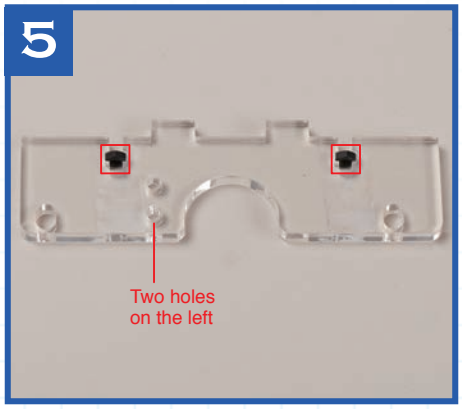
Put an M3 washer on each of the M3 14mm truss head screws supplied with this stage.

4



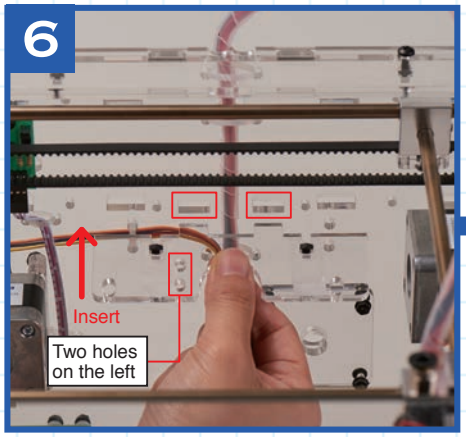
Place the mounting plate on your work surface. Put adhesive tape over the grooves (outlined in red) to prevent the nuts falling out.

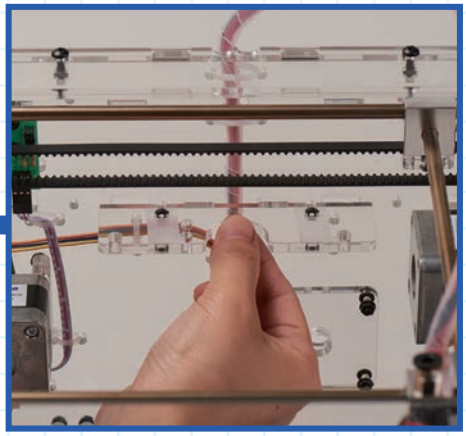
5



Turn the plate over and slot the M3 nuts into the grooves.

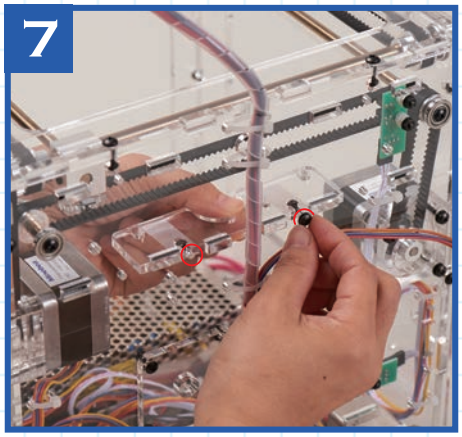
6





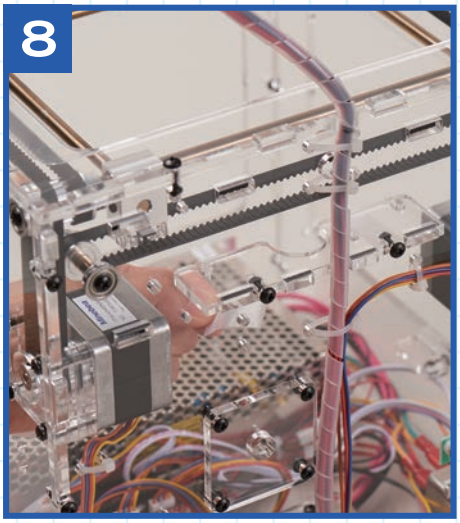
Holding the plate the same way up as in Step 5, insert its tabs into the two slots in the rear panel of the housing, shown outlined in red above left.

7



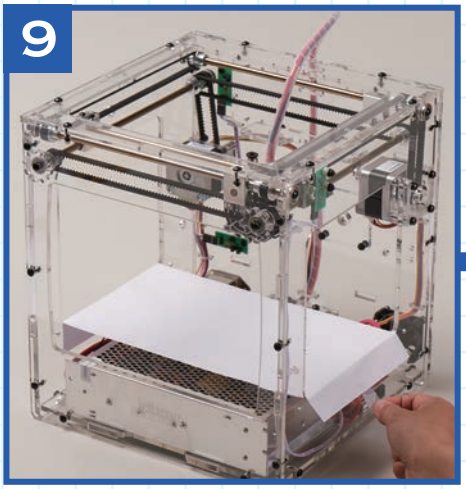
With the rear panel facing you, insert the 14mm truss head screws (with washers) through the screw holes in the rear panel and into the nuts in the plate. Finger tighten them only.

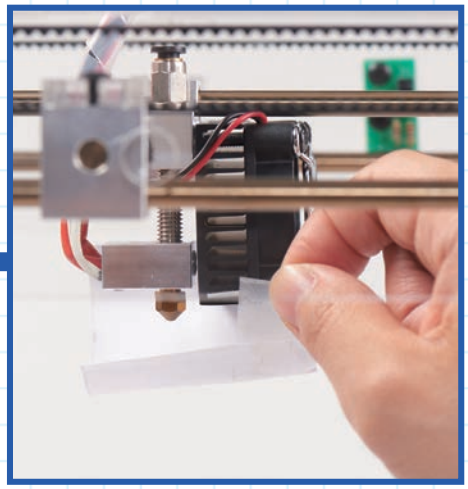
8



Peel off the tape that you used to hold the nuts in place.

9

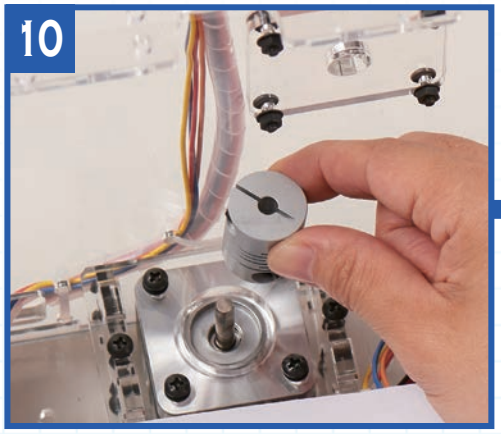


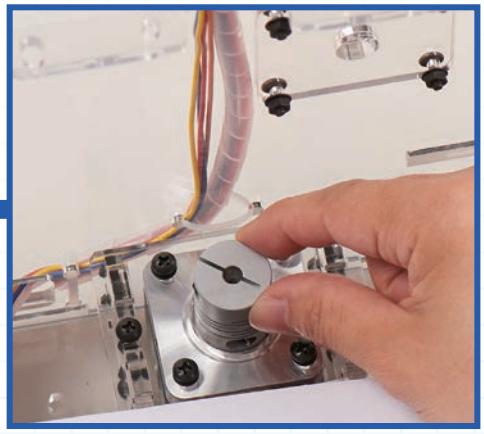


In the next stage, you add the table into the housing. To protect the bottom of the housing and the printer nozzle, use tape to secure a sheet of paper (such as copier paper) over the bottom of the housing and tape some paper over the tip of the nozzle, as shown.

Attach the coupling to the Z-axis motor

10



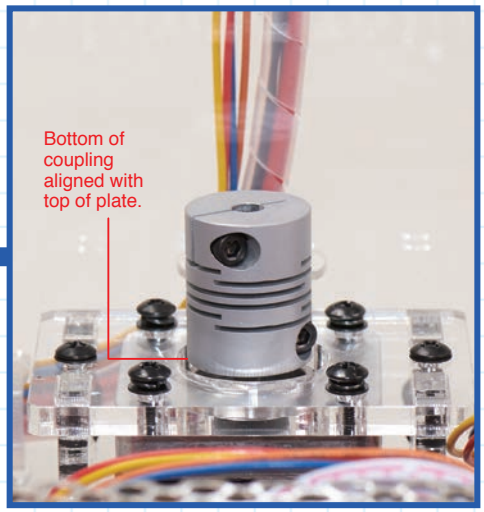


Put the shaft of the Z-axis motor into the hole in the coupling. It does not matter which way up the coupling is positioned.

HINT

If the coupling will not fit over the motor shaft, try loosening its hexagonal bolt using the 50 x 2.5mm Allen key. The coupling is fixed to the motor shaft when the lower hexagonal bolt is tightened. The upper bolt in the coupling is used to grip the Z-axis lead screw.

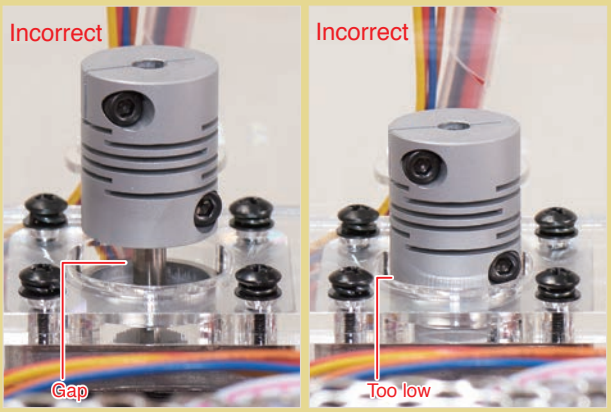
11



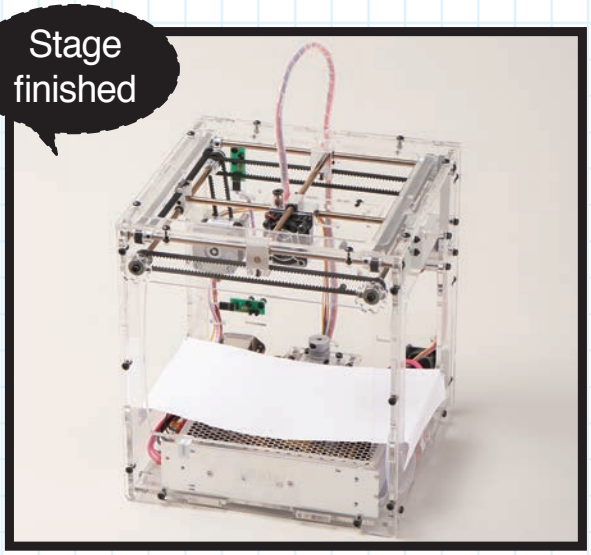
Align the coupling's bottom with the top of the plate that forms the motor mount and tighten the lower hexagonal bolt in the coupling using the 50 x 2.5mm Allen key.

POINT

Look from the side to see if you have the coupling aligned correctly. Ensure its bottom is aligned with the top surface of the mounting plate. There should not be a gap and the bottom of the coupling should not be below the plate. Check that the coupling is on securely after tightening the bolt.

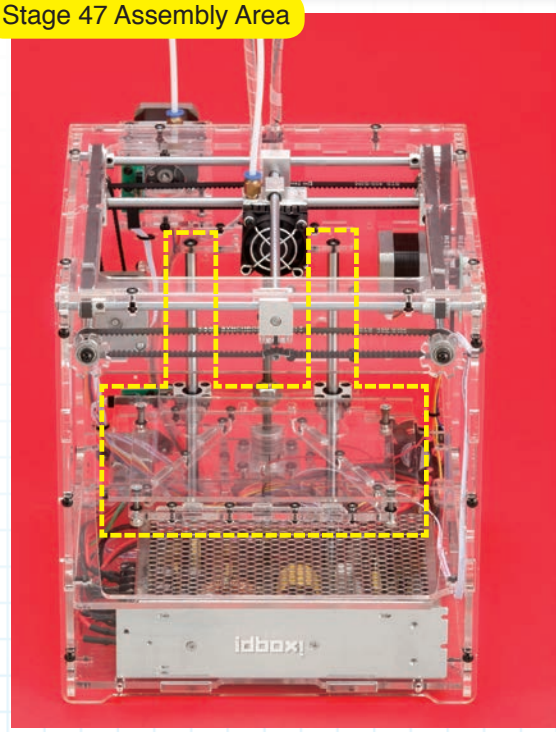


Stage finished



The Z-axis top mounting plate is temporarily attached to the rear housing panel and the coupling is attached to the Z-axis motor. Leave the protective papers in position.

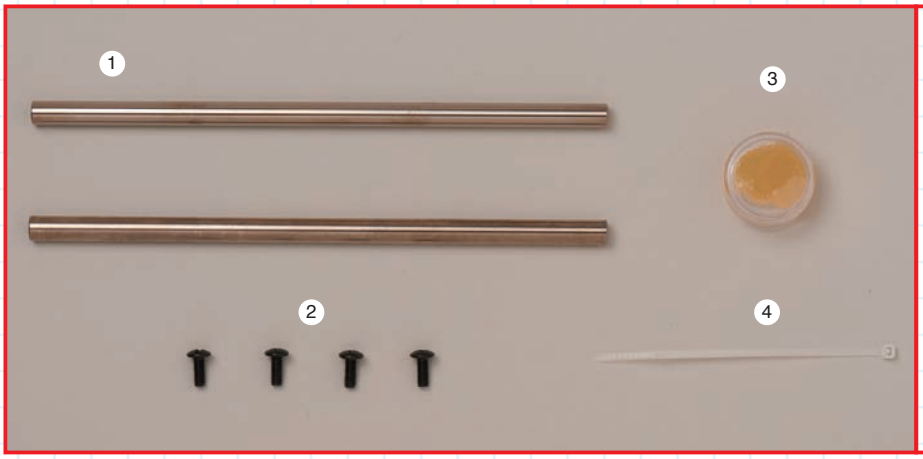
Stage 47 Assembly Area



Stage 47: Pass the Z-axis rods through the linear bushes to attach the table to the housing

In this stage, you first grease the two linear bushes that are attached to the modelling table, then insert the Z-axis rods through the bushes. The tops of the rods are then screwed to the Z-axis upper mounting plate and the bottoms to the bottom of the housing.

There are four columns of steel balls inside each of the linear bushes. The interior of the bushes – and especially the balls – need to be greased before the rods are inserted into the bushes. Next, the table is moved into the housing and the Z-axis rods inserted through the bushes. The rods are then screwed to the Z-axis mounting plate at their tops and to the bottom of the housing at their lower ends.



Stage 47 Components

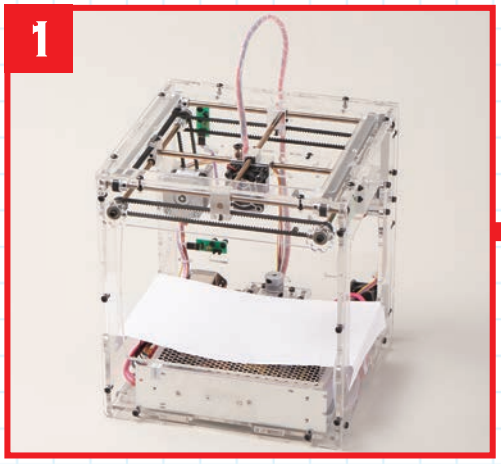
1: Z-axis rods x 2
2: M4 truss head screws (10mm) x 4
3: Grease
4: Cable tie

You will need

Phillips screwdrivers (sizes 1 and 2)

Parts to have ready

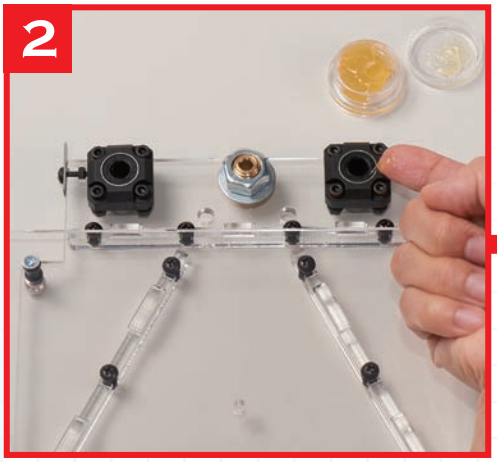
1

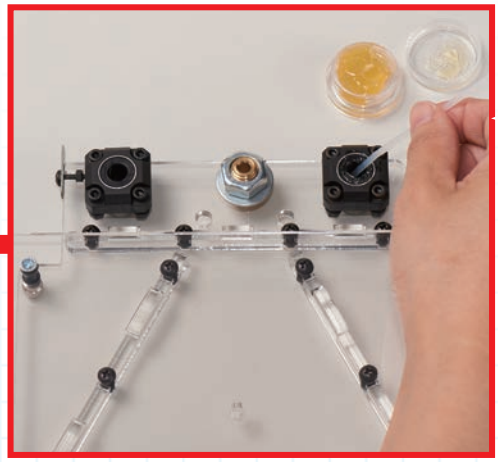


Get ready the printer housing and the table, which you last worked on in Stage 45.

Grease the linear bushes

2





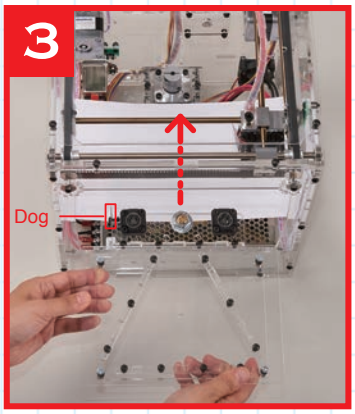
With your finger, put some of the grease supplied into the openings of the linear bushes, then spread it to the bearings inside the bushes using the cable tie supplied.

HINT

Inside each linear bush are four columns of steel balls arranged at 90-degree intervals. Make sure the grease covers all the balls.

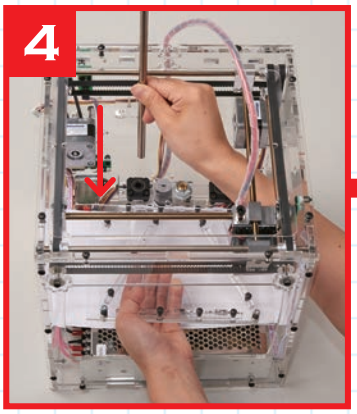
Attach the table by inserting the Z-axis rods into the linear bushes

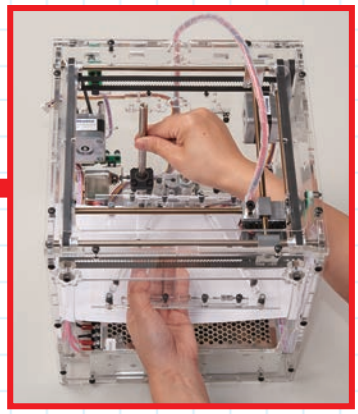
3



With the 'dog' (small metal plate) at the back left of the table, move the table into the housing through the opening in the front panel.

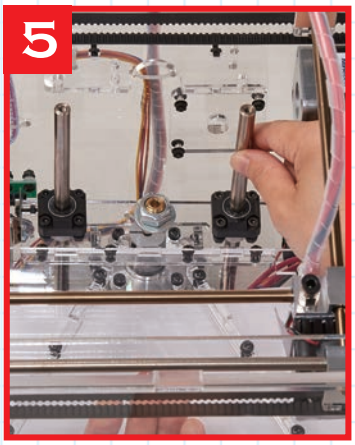
4





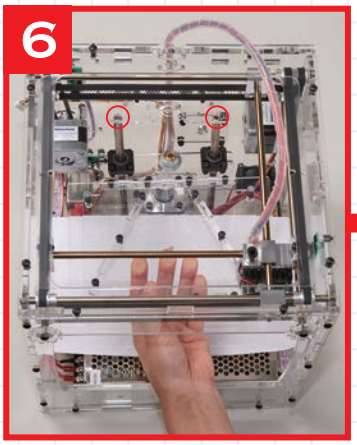
Holding the table with one hand, insert one of the Z-axis rods through the left side linear bush with your other hand. Push the rod gently through the bush until it touches the bottom of the housing.

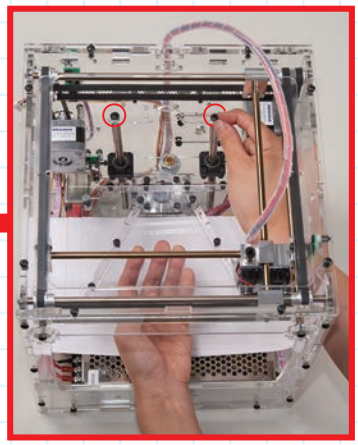
5



Now pass the other rod through the other linear bush until it touches the housing's bottom.

6

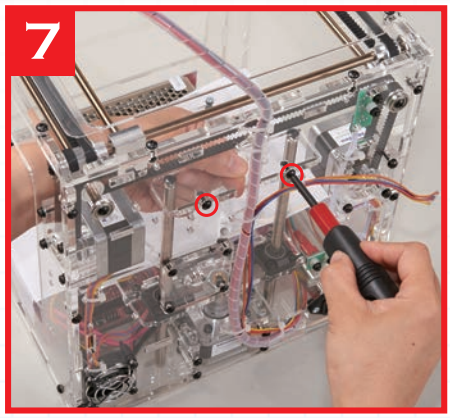




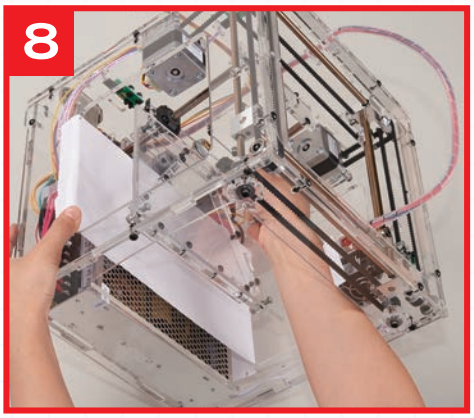
Align the tops of the rods with the holes ringed in red in the Z-axis mounting plate and insert M4 truss head screws through the holes. Finger tighten the screws into the screw holes in the tops of the rods.

POINT

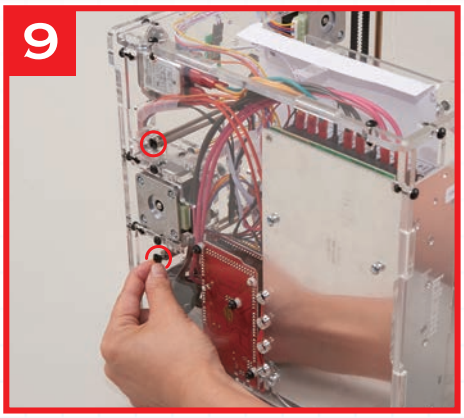
Handle the rods and bushes gently, as the operation of the printer depends on the table being guided up and down smoothly by the rods. If you have to, rest the table on the paper you put over the bottom of the housing.



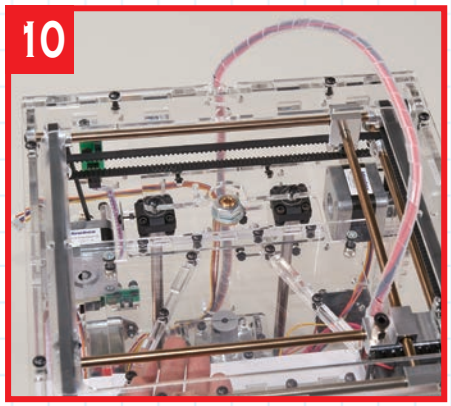
Turn the housing so the rear is facing you and tighten the two screws that hold the Z-axis top plate to the rear of the housing with a size 1 Phillips screwdriver.



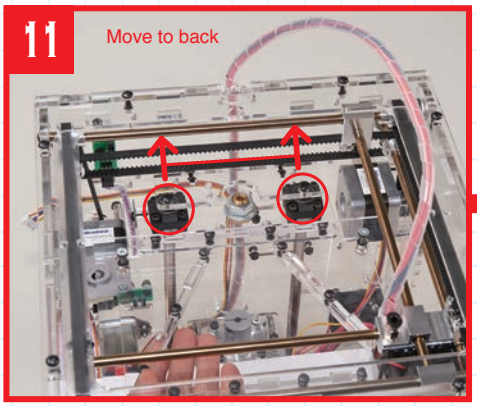
Turn the housing so its front is facing you and, holding the table steady, lie the housing down on its right side.

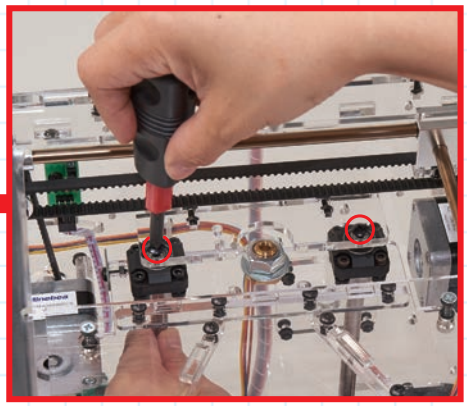


Align the bottoms of both rods with the screw holes (ringed in red) and insert M4 screws through the holes and finger tighten them in the rods' screw holes.

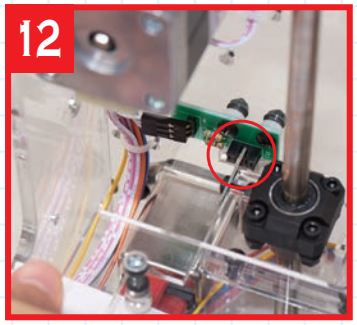


Holding onto the table, turn the housing the right way up. Holding the table level, move the table slowly up to the top of the rods. Do not let the table touch the nozzle.

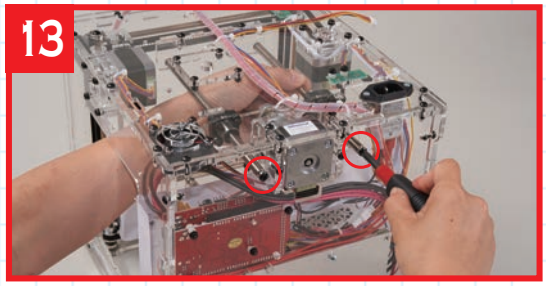




Push the table so the screws (ringed in red) move to the back of the oblong screw holes in the Z-axis top mounting plate. Holding the table in position, grip each rod in turn to stop it spinning while you tighten the screws using the size 2 Phillips screwdriver.



Lower the table slowly and carefully, checking that the metal plate (circled) fits between the sides of the limit switch. If it does not, adjust the position of the switch by loosening its screws with a size 1 Phillips screwdriver and moving the switch until it does. When the switch is in the correct position, tighten its screws.

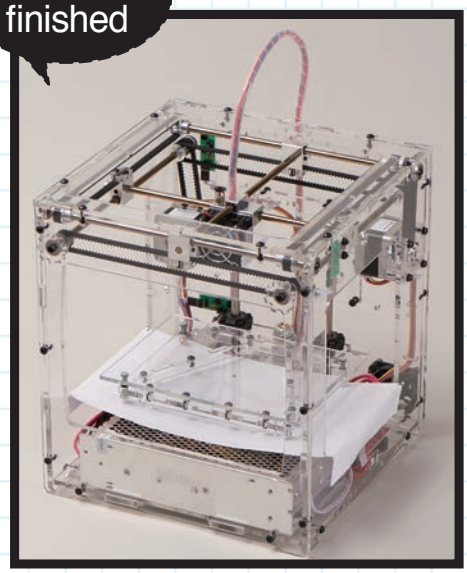


Holding the table at the bottom of the housing, turn the housing so it is on its front, and use a size 2 Phillips screwdriver to tighten the screws to attach the Z-axis rods to the housing's base.

HINT

It is important to tighten the screws at the top of the Z-axis rods with the table at the top, then to tighten the screws at the bottom with the table at the bottom. It's a good idea to keep a hand supporting the table every time you turn the housing.

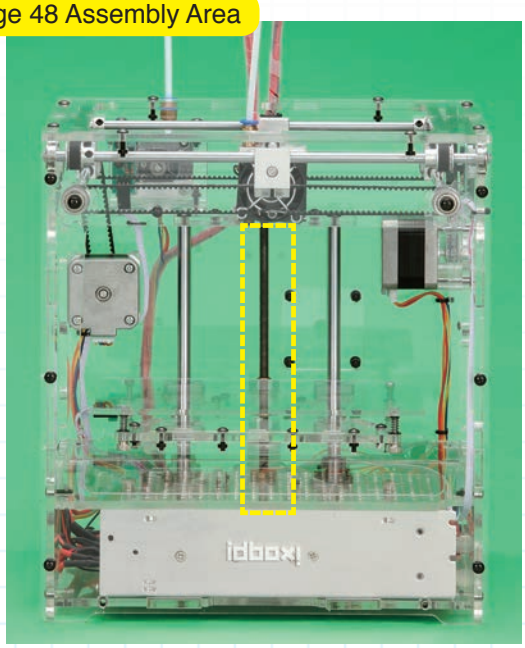
Stage finished



The table has been added to the housing. Keep the protective papers in place for the moment.

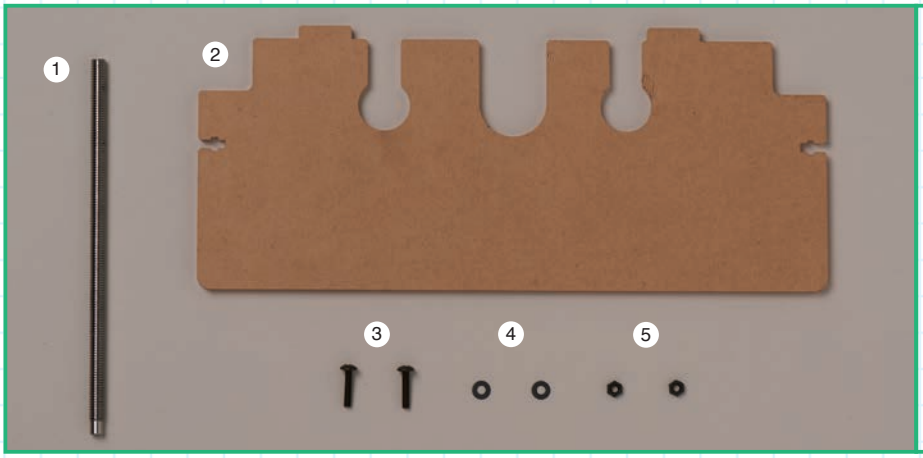
Stage 48: Attach the lead screw to the table and the Z-axis motor coupling

Stage 48 Assembly Area



In this stage, you affix the lead screw through the modelling table's brass nut, then insert its lower end into the Z-axis motor coupling, securing it in place by tightening the coupling's upper hexagonal bolt.

Make sure you get the lead screw the right way up – the end with the unthreaded tip is at the bottom. When you put the lead screw through the brass nut, try not to damage the thread of either the nut or the screw itself. When the lead screw is about halfway through, put its unthreaded tip into the hole in the top of the coupling and clamp it in place by tightening the upper hexagonal bolt.



Stage 48 Components

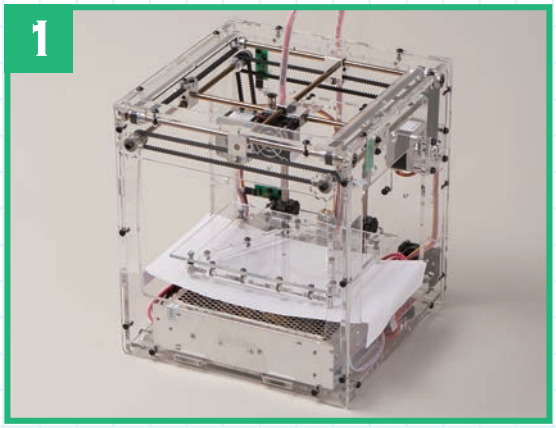
1: Lead screw
2: Bottom cover panel
3: M3 truss head screws (14mm) x 2
4: M3 washers x 2
5: M3 nuts x 2

You will need

Allen key (50 x 2.5mm) supplied with Stage 44

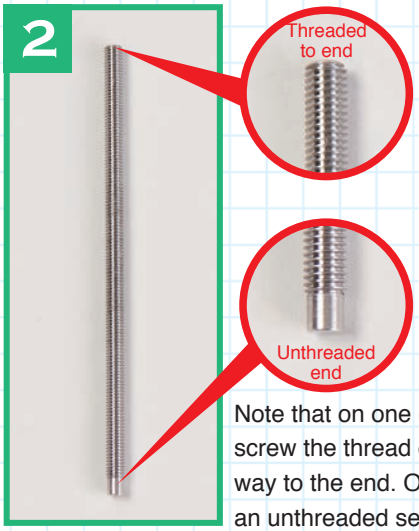
Parts to have ready

1



Take the printer housing. Do not remove the protective covering from the bottom cover panel yet, as this will not be used until a later stage.

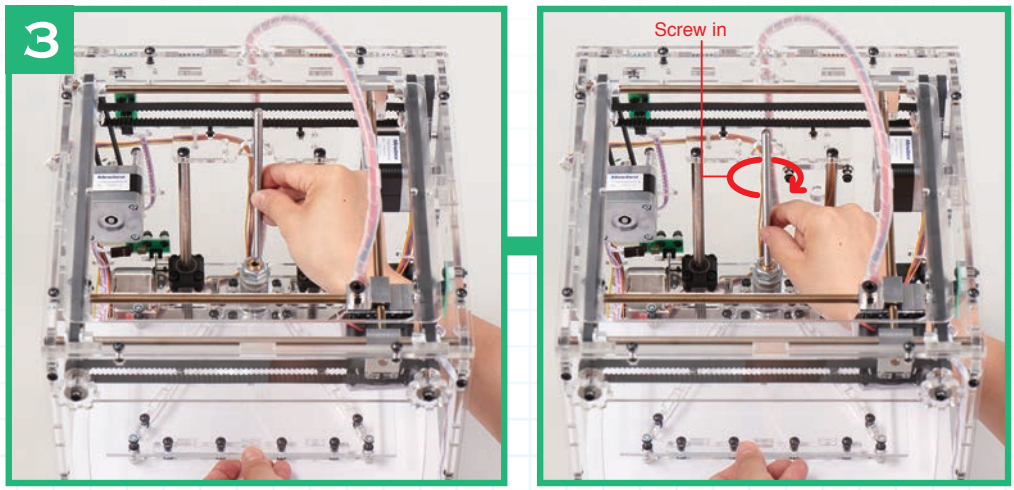
2



Note that on one end of the lead screw the thread continues all the way to the end. On the other end is an unthreaded section.

Fit the lead screw into the brass nut

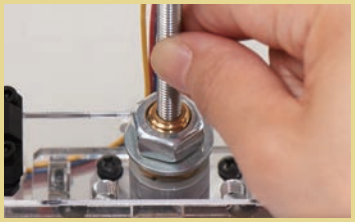
3



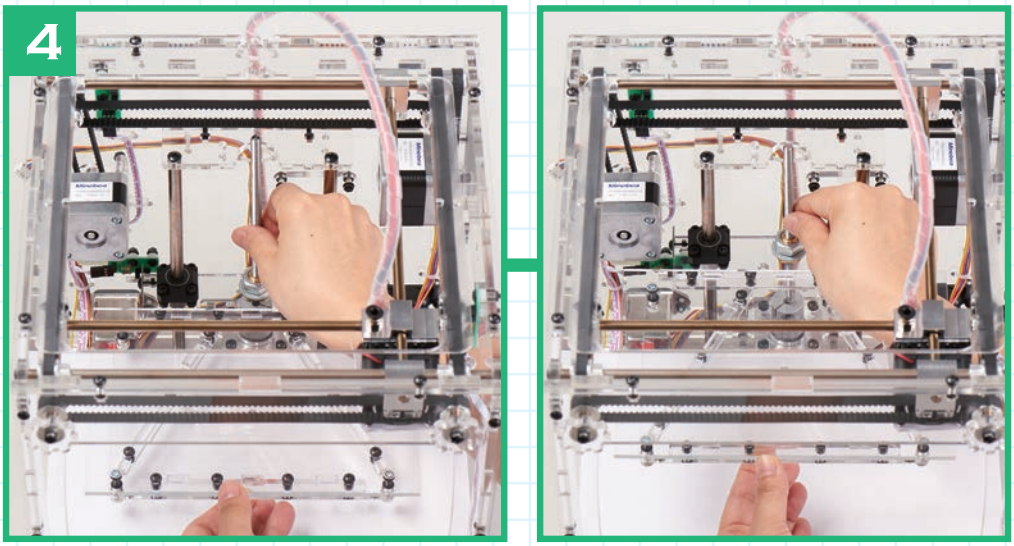
Take the end of the lead screw that has an unthreaded section. Insert it into the brass nut and screw it in by turning it clockwise.

POINT

Take great care when handling the lead screw. The correct operation of the printer in the Z-axis (up and down) depends on the lead screw being in good condition, with no nicks or scratches on its threads. Be very careful to screw it into the brass nut without cross-threading it.



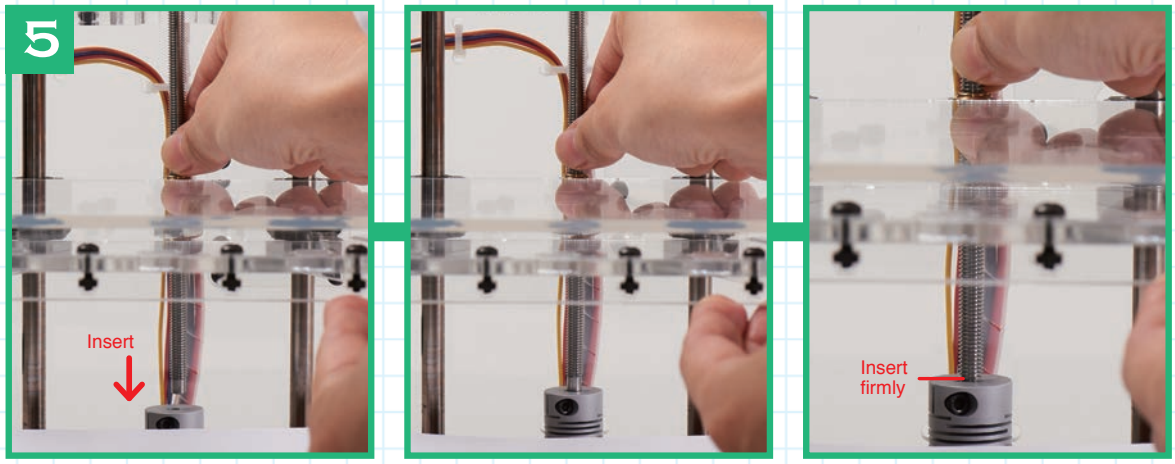
4



Keep the top of the lead screw clear of the timing belt and, as you continue to turn it through the brass nut, support the table as it moves up the lead screw.

Secure the lead screw in the coupling

5

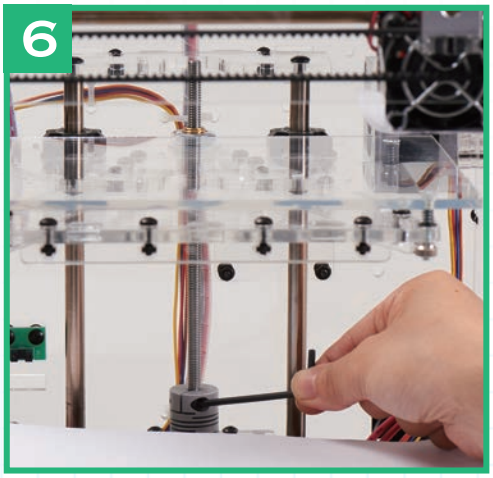


When you have turned about half of the length of the lead screw through the brass nut, insert the unthreaded end of the lead screw firmly into the hole in the top of the Z-axis motor coupling.

HINT

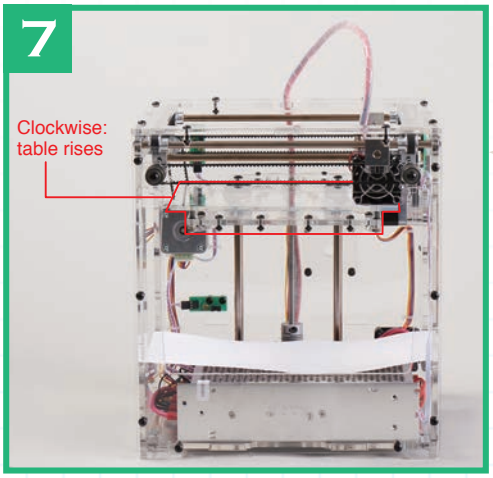
If the hole in the coupling does not align with the end of the lead screw, move the motor in the horizontal plane until it does. If the lead screw's end will not go into the hole, loosen the upper hexagonal bolt in the coupling so the hole opens up.

6



Use the 50 x 2.5mm Allen key to tighten the hexagonal nut in the coupling.

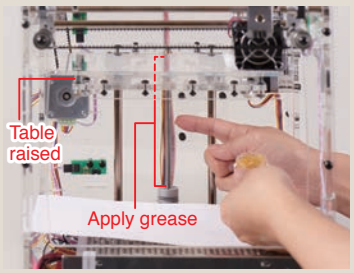
7



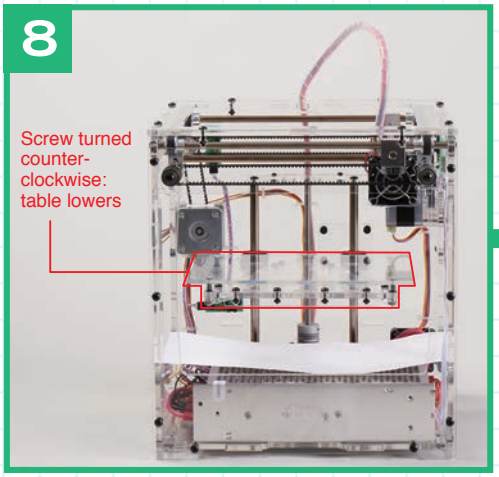
When you rotate the lead screw in a clockwise direction, the table rises.

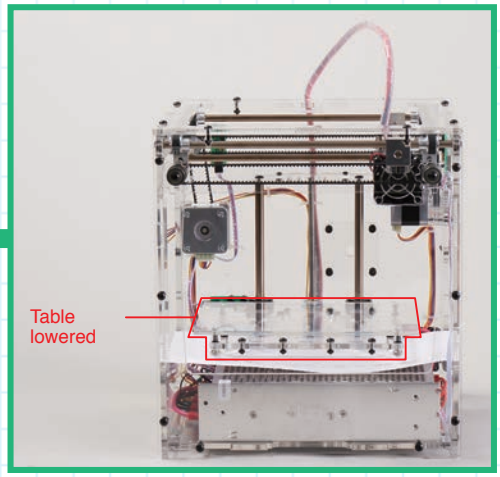
HINT

If you hear a squeaking sound when you rotate the lead screw, raise the table and apply a thin layer of the grease (supplied with Stage 47) to the length of the screw.



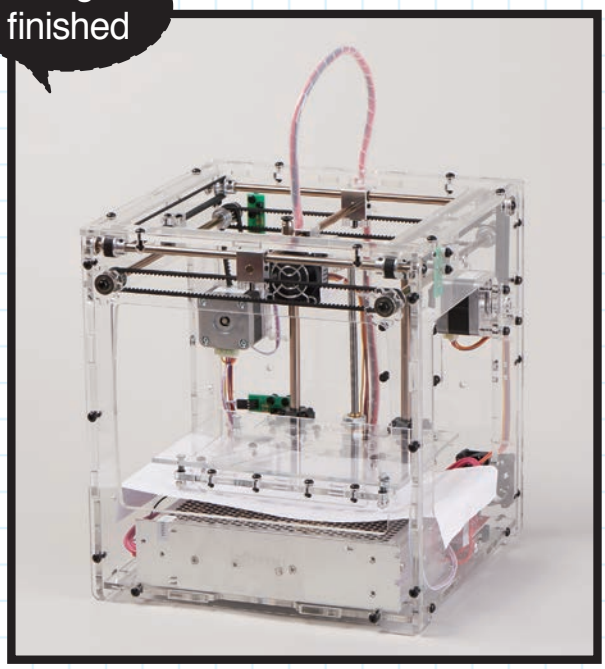
8





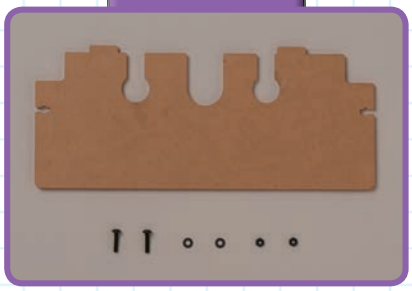
The table is lowered by turning the lead screw counterclockwise. Turn the lead screw until the table is lowered all the way to the bottom.

Stage finished



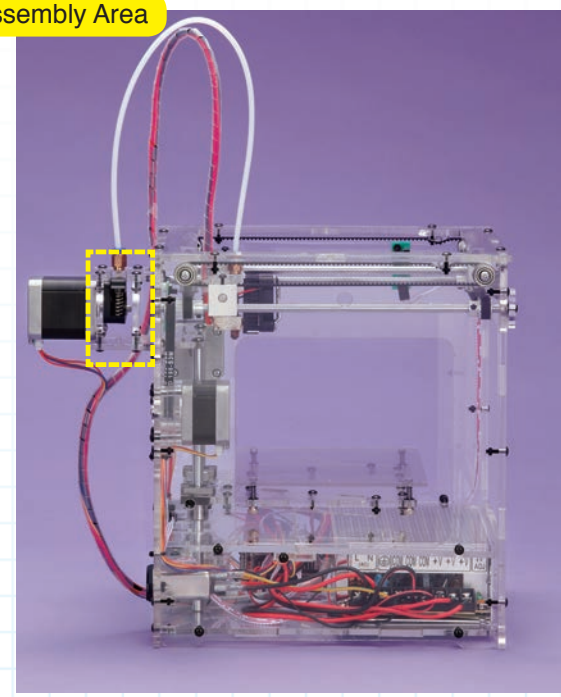
The lead screw has been fitted through the brass nut and its end secured in the Z-axis motor coupling. Put the housing away somewhere safe, ready for the next stage.

Store the parts



Put the unused parts from this stage away safely, for use later.

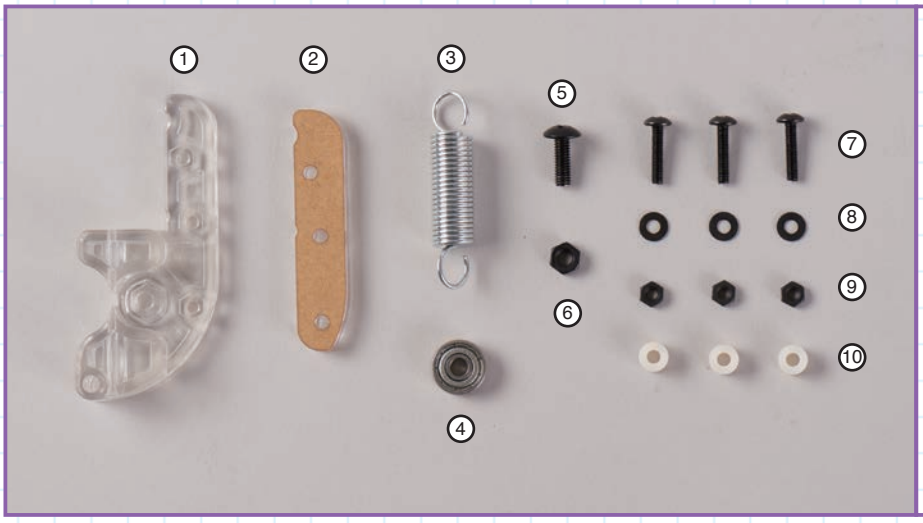
Stage 49 Assembly Area



Stage 49: Assemble the arm of the extruder

In this stage, you start to put together the extruder, the part of the idbox that feeds filament to the head. This time you work on the extruder arm. During assembly, it is important to make sure you get the acrylic panel named ‘arm part B’ the right way round.

The extruder feeds filament to the printer head. The type of extruder used in your idbox is a Bowden extruder, which is installed on the outside of the housing rather than in the printer head itself. A Bowden extruder has several advantages, in that it keeps the weight of the moving parts round the head to a minimum, enabling fast movements of the head and thus faster modelling. The arm you put together this time is used to guide filament to the extruder drive unit. Treat the acrylic parts gently and do not use excessive force when tightening the screws.



Stage 49 Components

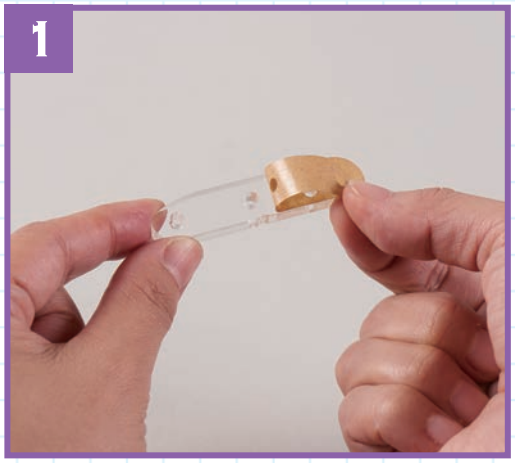
1: Arm part A
2: Arm part B
3: Tension spring
4: Bearing (624ZZ)
5: M4 truss head screw (12mm)
6: M4 nut
7: M3 truss head screws (16mm) x 3
8: M3 washers x 3
9: M3 nuts x 3
10: M3 spacers (5mm) x 3

You will need

Phillips screwdriver (size 1)
Adhesive tape

Parts to have ready

1



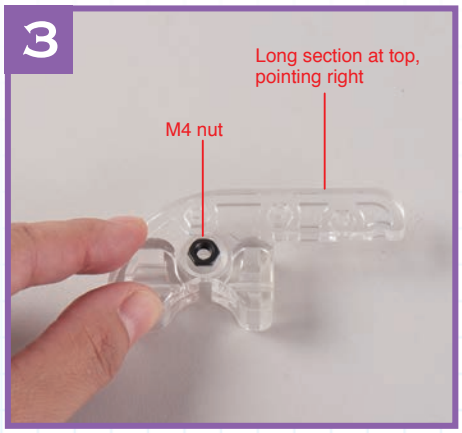
Peel off the protective covering from arm part B.

2

Put an M3 washer on each of the three 16mm M3 truss head screws supplied this time.

Join arm parts A and B

3



Turn arm part A so the long section of the arm is at the top, and pointing right. Push the M4 nut into the hexagonal hole in arm part A, as shown in the photo above.

4

Turn arm part A over so the long section of the arm is pointing to the left. Insert the bearing (624ZZ) into the circular hole above where the nut is positioned. The bearing can go in either way up, since it does not have a flange.

HINT

If the M4 nut falls out when you turn the arm over, hold it temporarily in place with adhesive tape.

5

Insert the 12mm M4 truss head screw through the bearing and tighten it in the nut using a screwdriver.

6

Put an M3 nut in each of the three hexagonal holes ringed in red above.

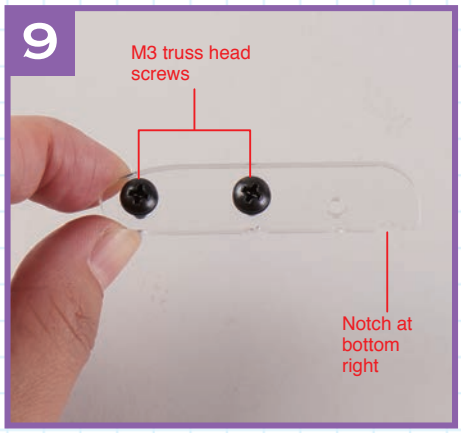
7

Turn the arm over so the long section is at the top and pointing right. If the nuts fall out, secure them temporarily in position with adhesive tape.

8

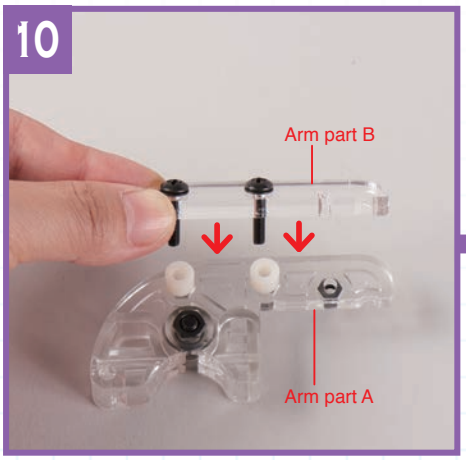
Place a 5mm M3 spacer over each of the two holes shown ringed in red above.

9



Hold arm part B so that the notch is at the bottom right, and put a 16mm M3 truss head screw (with washer on) through each of the two screw holes as shown.

10



Insert the screws in arm part B through the spacers resting on arm part A.

11

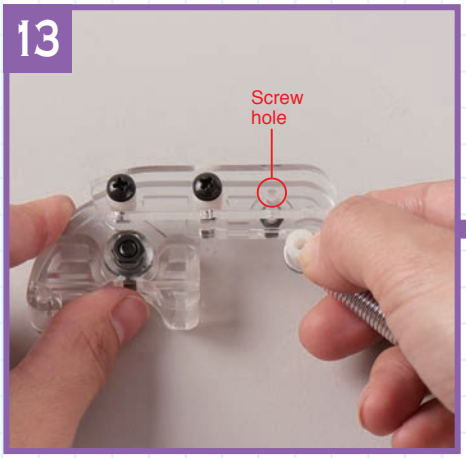
Tighten the screws into the nuts in arm part A using a screwdriver.

Attach the tension spring to the arm

12

Place a 5mm M3 spacer in a hook end of the tension spring.

13



Hold the spacer in place and insert the spring into the gap between the arm parts. Align the spacer with the screw holes in the top and bottom arms.

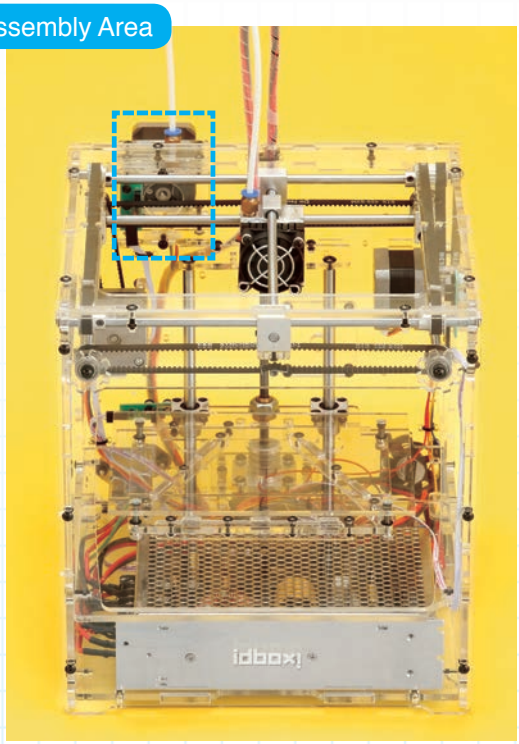
14

Put a 16mm M3 truss head screw (with washer) into the screw hole, through the spacer, and tighten it into the nut below with a screwdriver.

The extruder arm has been assembled. Store it safely for use in a later stage.

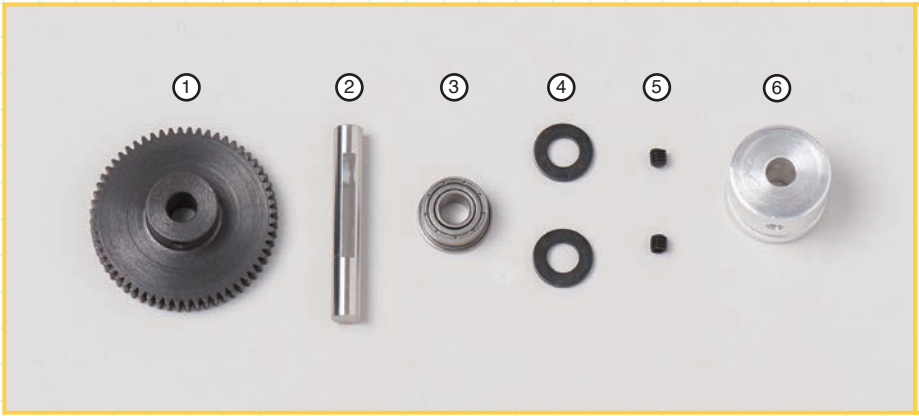
Stage 50: Assemble the extruder's large gear and drive roller

Stage 50 Assembly Area



In this stage, you continue to put together the extruder assembly. This time you attach the large gear to the drive shaft and then add the drive roller to the drive shaft.

This stage is fairly simple, but you must be careful to align and orientate the various components correctly. For instance, when you attach the large gear to the drive shaft, you use the bearing and a washer supplied to act as temporary spacers to set the distance it should be from the end of the drive shaft before screwing it to the shaft with a set screw. When you tighten this screw, it must screw down onto the flat surface of the drive shaft. Similarly, the drive roller's set screw must also be tightened so that it presses against the flat section of the drive shaft.



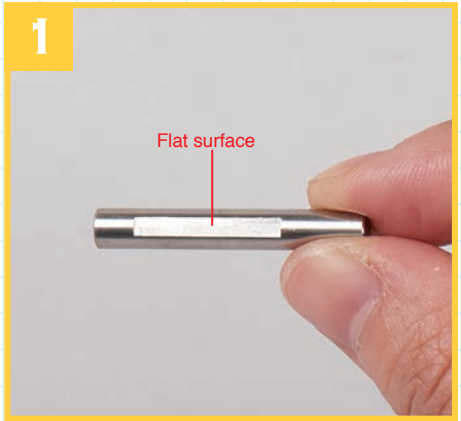
Stage 50 Components

1: Large gear (P0.5-60)
2: Drive shaft
3: Bearing (F685ZZ)
4: M5 washers x 2
5: M3 set screws (3mm) x 2
6: Drive roller

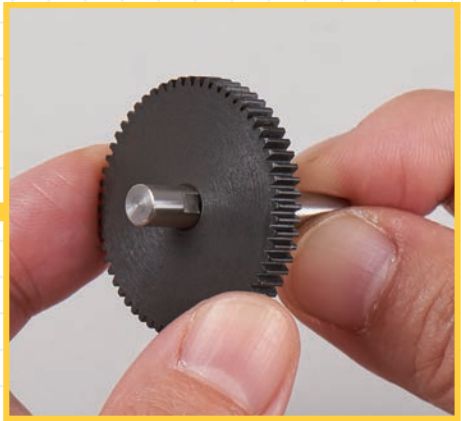
You will need

Allen key (1.5mm) supplied with Stage 30

Attach the large gear to the drive shaft



Look at the drive shaft and you will see that it has a flat surface along part of its length.



Insert the drive shaft into the hole in the centre of the large gear, on the side of the gear with the screw hole. It does not matter which end of the drive shaft you insert. After insertion, the shaft should protrude from the hole in the gear side of the large gear.

3

Put an M5 washer over the end of the drive shaft that protrudes from the gear side of the large gear.

4

Put the bearing (F685ZZ) onto the protruding drive shaft. The bearing can go on either way at this stage.

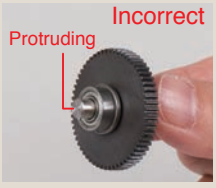
5

Align the end of the drive shaft with the left surface of the bearing.

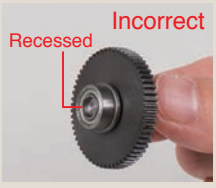
HINT

Align the end of the drive shaft with the left of the bearing to determine the gear's position on the shaft.

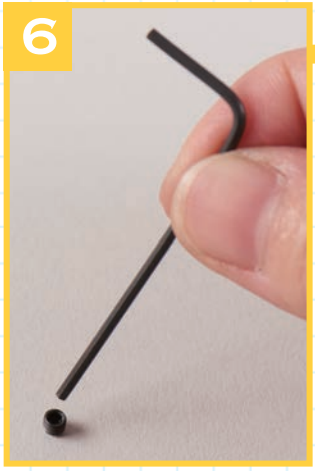
Incorrect

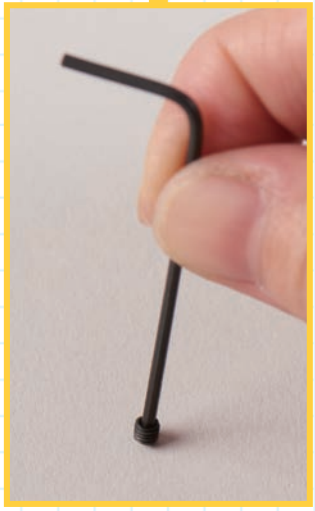


Incorrect



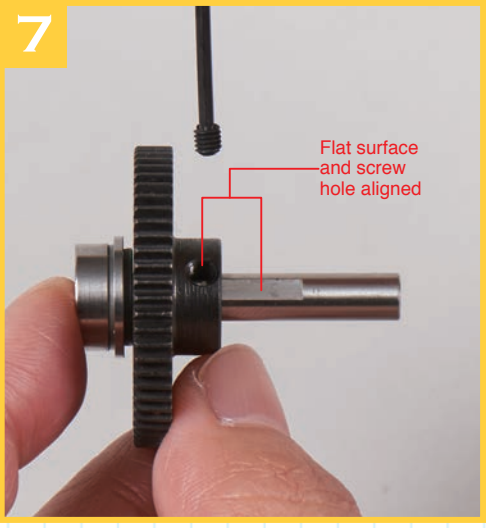
6





Put the end of the 1.5mm Allen key into the hexagonal hole in the head of a 3mm set screw.

7



POINT

For the gear to be held securely to the shaft, the set screw must be tightened so its non-head end is screwed against the flat surface of the drive shaft.

Align the flat surface of the drive shaft with the screw hole in the large gear. Put the set screw into the screw hole and tighten it up.

8

Remove the bearing from the drive shaft.

9

Remove the washer from the drive shaft.

Attach the drive roller to the drive shaft

10

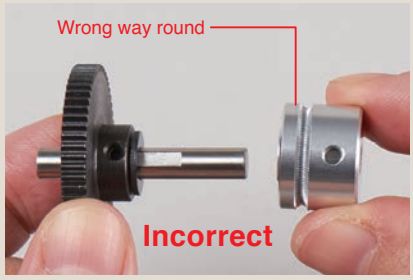
Put the M5 washer you have just removed onto the opposite end of the drive shaft.

11

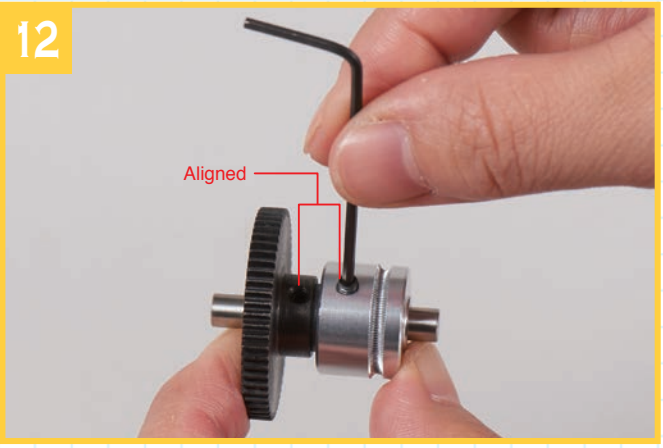
Put the drive roller on the shaft, with the screw hole on the left and groove on the right.

HINT

Make sure you put the drive roller onto the drive shaft with its groove away from the large gear.



12



Slide the drive roller along the shaft so that there is no space between the gear, the washer and the end of the drive roller. Align the screw hole on the drive roller with that in the large gear, then secure the drive roller to the shaft by inserting and tightening a 3mm set screw in the screw hole in the drive roller.

Stage finished

The extruder's large gear has been assembled. Check that your components look like those in the photo above.

Store the parts

You'll need the bearing (F685ZZ) and M5 washer in the next stage, so store them somewhere safe.

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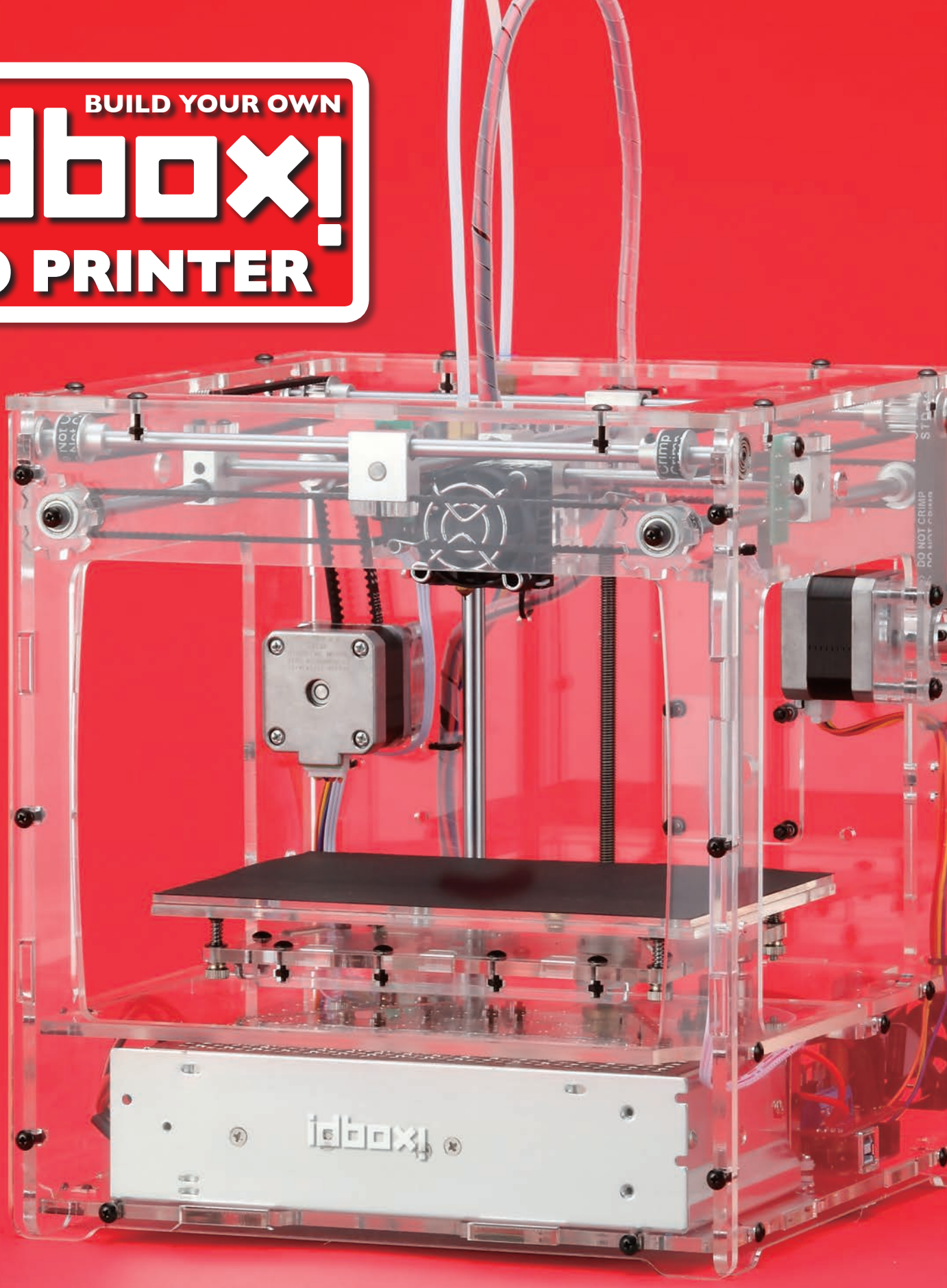

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