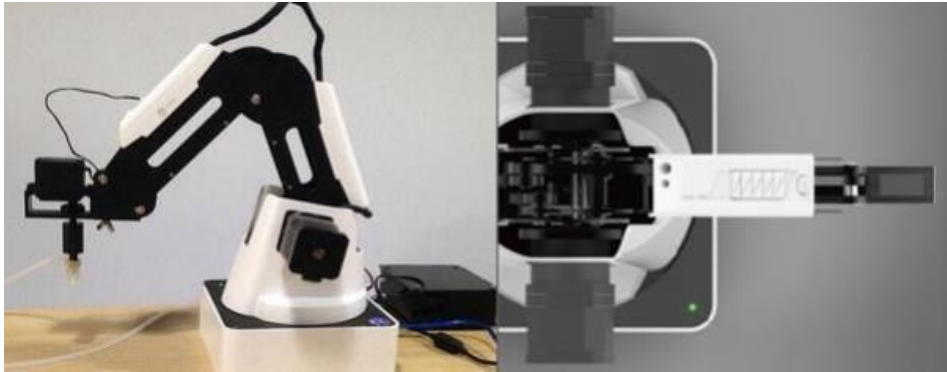


List of Experiments on DOBOT Magician

- ❖ Introduction to the Dobot-Studio
- ❖ Homing
- ❖ Experiment-1, Performing Teaching & Playback Task
- ❖ Experiment-2, Writing and Drawing
- ❖ Experiment-3, Performing Laser Engraving Tasks grey scale engraving
- ❖ Experiment-4, Operating 3D Printing

1 Precautions

1. Please make the Dobot Magician in the workspace with a 45° angle between the Forearm and Rear Arm (as shown in Figure) before starting up. If the LED indicator turns red after starting up, it indicates that the Dobot Magician is at a limited position. Please make the Dobot Magician in the workspace.



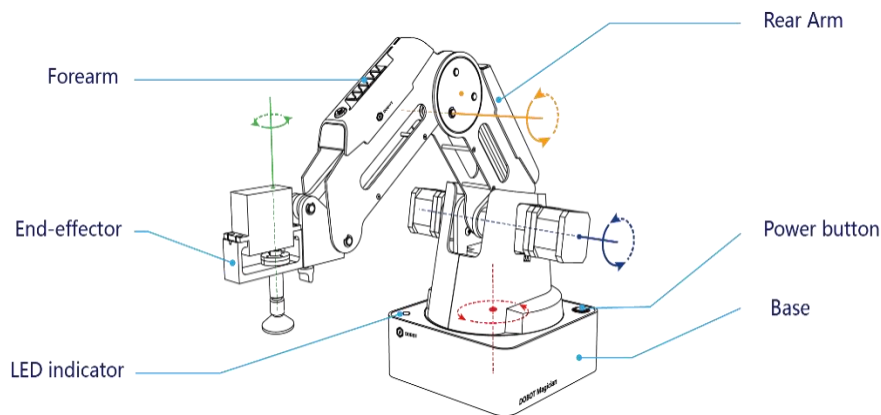
2. Dobot Magician will move slowly to the specific position when shutdown. **DO NOT** put hands into the workspace of the Dobot while running, to avoid bruising or pinching. Only once the LED indicator completely turns off, the Dobot Magician can be powered down.
3. If the coordinates of the Dobot Magician shown on the DobotStudio are abnormal, please press the **Reset** button on the back of the base to reset Dobot Magician or click **Home** on the DobotStudio page to perform homing.
4. During resetting, Dobot Magician will disconnect from the PC automatically and the LED indicator on the base turns yellow. About 5 seconds later, if the LED indicator turns green, it indicates that the reset is successful.
5. During homing, Dobot Magician will rotate clockwise to the limited position and then return to the homing point automatically, and the LED indicator on the base turns blue and is blinking. After homing, if there is a beep sound and the LED indicator turns green, it indicates that the homing is successful.
6. Please turn off the Dobot Magician completely first before connecting or disconnecting external equipment, such as Bluetooth, WIFI, stick controller, infrared sensor, color sensor, etc. Or, it causes damage to your device.
7. Please wear the lasing protective eyeglass when using the laser module. Please protect your eyes and skin from the laser.
8. The heating rod will produce high temperature up to 250°C when

using the 3D printing module, please be careful.

9. Please **DO NOT** operate or turn off Dobot Magician when burning firmware, to avoid machine damage.

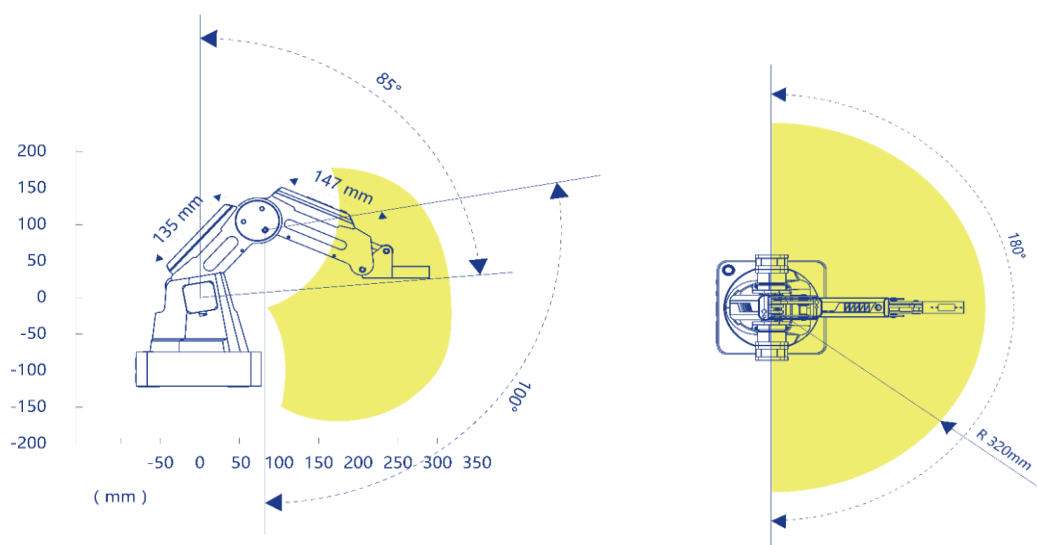
2. Overview

Dobot Magician is a multifunctional desktop robotic arm for practical training education, supporting teaching and playback, blockly graphic programming, script, etc. Installed with different end-effectors, Dobot Magician can realize interesting functions such as 3D printing, laser engraving, writing and drawing. It also supports secondary development by various extensible I/O interfaces, which really makes your creativity and imagination increase without any limitation.



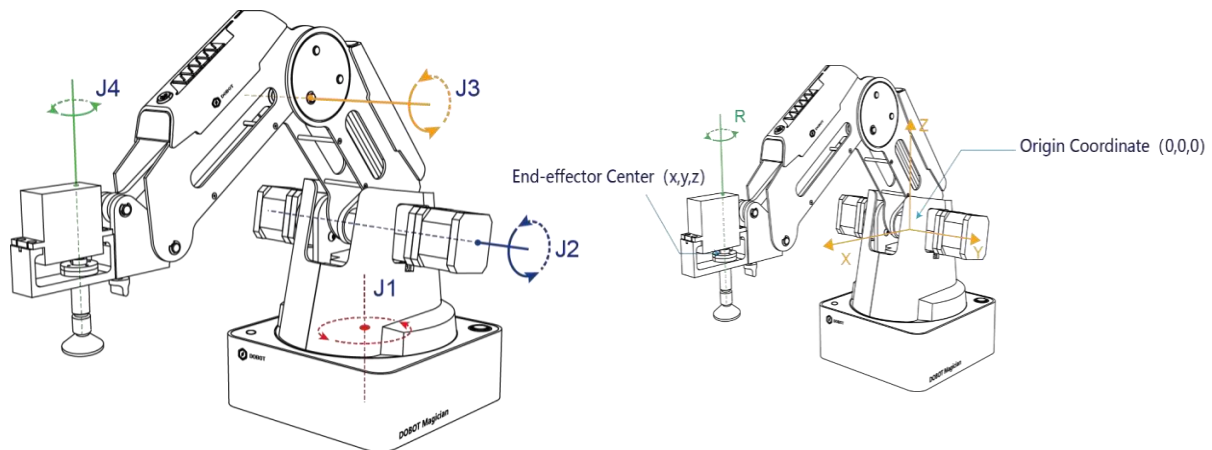
3. Workspace

The workspace is a specification of the configurations that the end-effector of the robot can reach, and has nothing to do with a particular task.



4. Coordinate System

Dobot Magician has two types of coordinate system, the joint one and the Cartesian one, as shown in figures respectively.

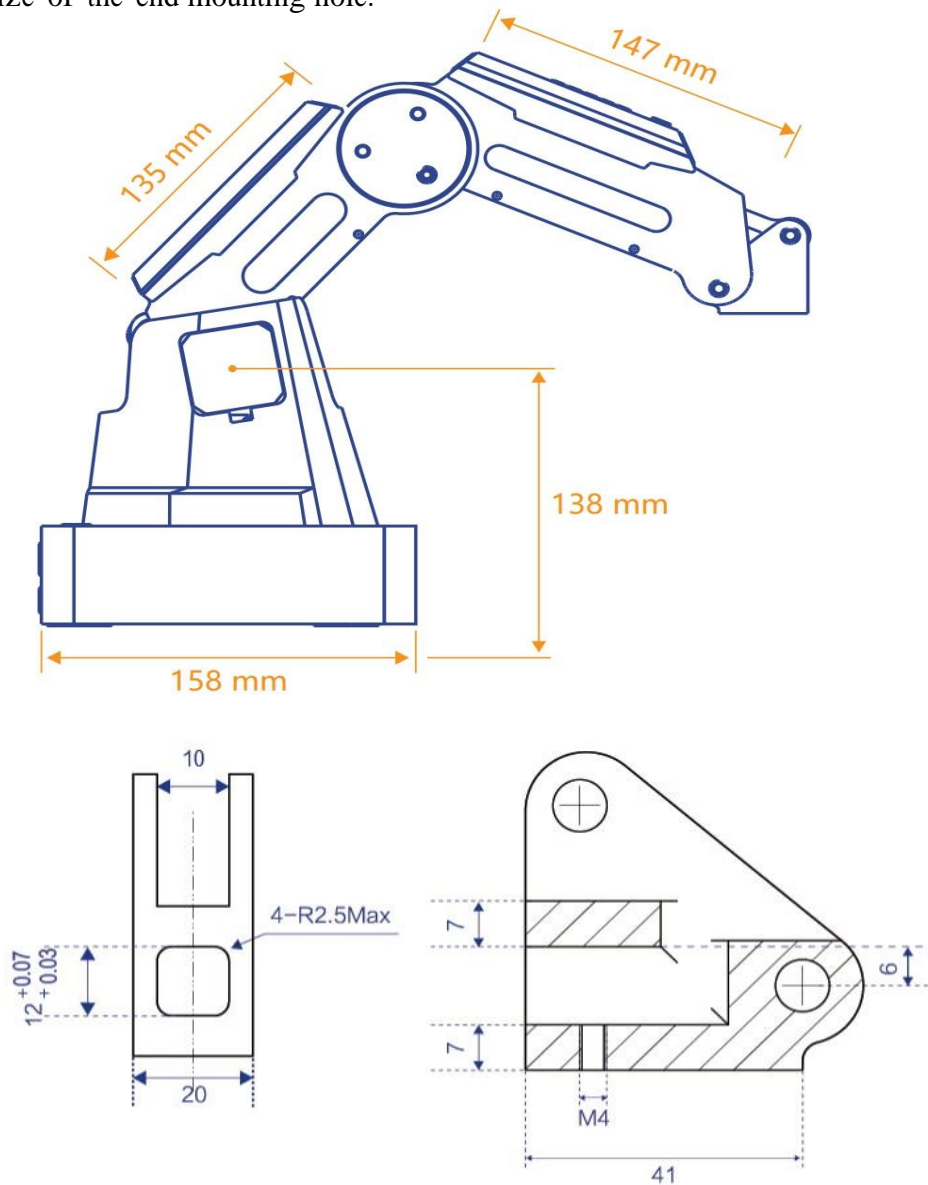


- Joint coordinate system: The coordinates are determined by the motion joints.
- If the end-effector is not installed, Dobot Magician contains three joints: J1, J2, and J3, which are all the rotating joints. The positive direction of these joints is counter-clockwise.
- If the end-effector with servo is installed, such as suction cup kit, gripper kit, Dobot Magician contains four joints: J1, J2, J3 and J4, which are all the rotating joints. The positive direction of these joints is counter-clockwise.
- Cartesian coordinate system: The coordinates are determined by the base.
- The origin is the center of the three motors (Rear Arm, Forearm, base).
- The direction of X-axis is perpendicular to the base forward.
- The direction of Y-axis is perpendicular to the base leftward.
- The direction of Z-axis is vertical upward, which is based on the right hand rule.

- The R-axis is the attitude of the servo center relative to the origin of the robotic arm, of which the positive direction is counter-clockwise. The R-axis only exists once the end-effector with servo is installed.

5. Size:

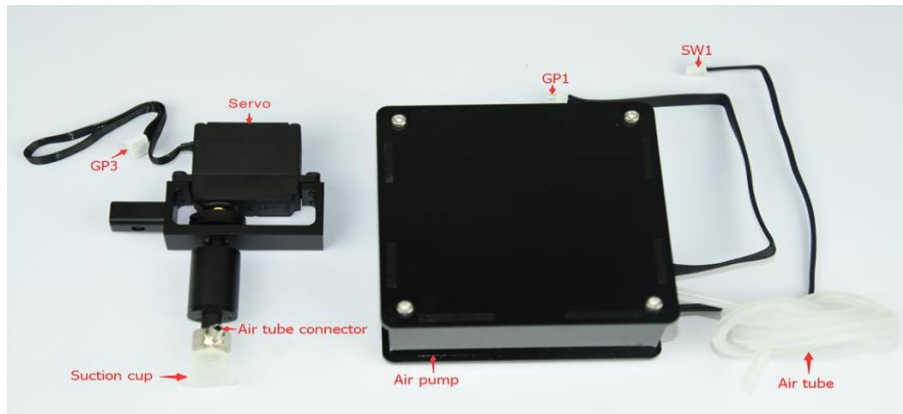
In below figure shows the size of Dobot Magician and another figure shows that the size of the end mounting hole.



Experiment-1: Performing Teaching & Playback Tasks

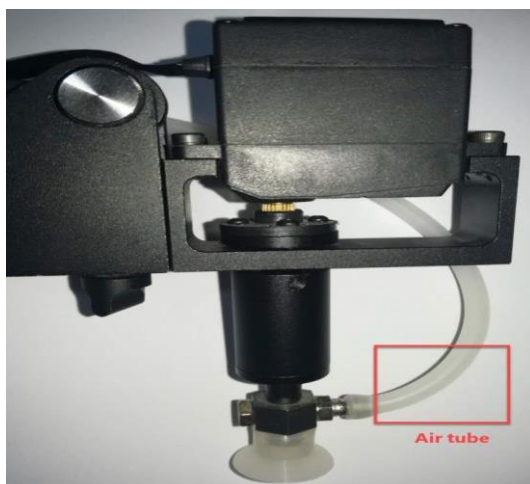
1. Installing a Suction Cup Kit

A suction cup kit is the default end-effector shipped with the Dobot Magician. When using the suction cup kit, an air pump is necessary, as shown in Figure.



2. Procedure

Connect the air pump's power cable SW1 to the SW1 connector on the Dobot Magician base rear panel and the single cable GP1 to the GP1 connector and follow the below given figure to install vacuum and other gripper for further operations.

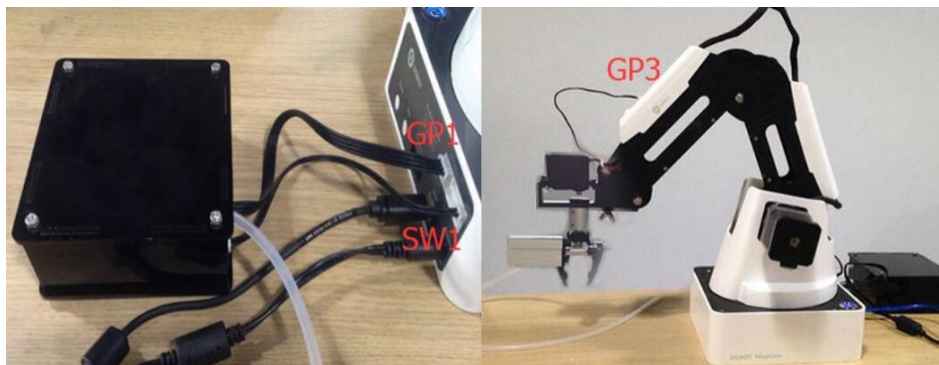


The Forearm

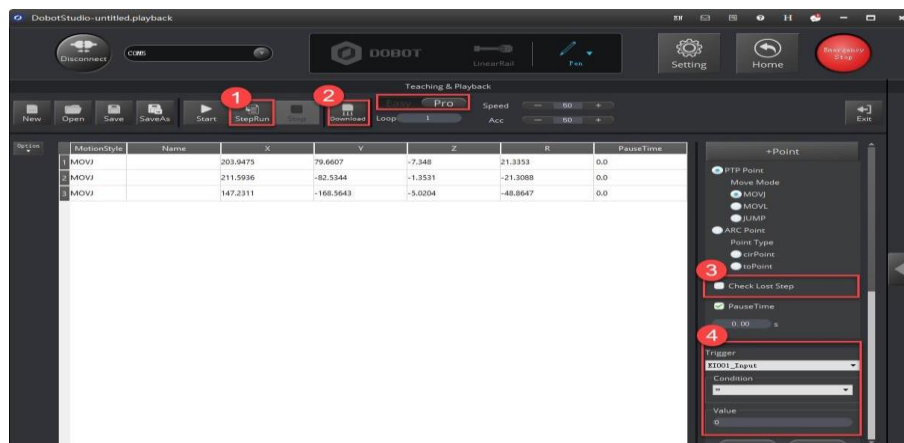


3. Teaching & Playback Page

- The **Teaching & Playback** page in the software to access it, select **Connect > Teaching & Playback** on the **DobotStudio** page.
- In both **Easy** and **Pro** modes, you can switch between **Easy** and **Pro** modes, set loop, speed percentage, and acceleration percentage
- In both **Easy** and **Pro** modes, you can save points, set the motion mode and the pause time for a save point
- In both **Easy** and **Pro** modes, you can edit a highlighted save point such as copy, paste, cut, switch between motion modes, modify name and coordinates
- **Pro** mode: To enter the **Pro** mode from the current **Easy** mode, click the **Easy/Pro** slider, as shown in Figure 5.19. Apart from all the functions in the default **Easy** mode, the **Pro** mode allows the robotic arm to run a save point each time, detect lost-steps, work in offline mode, and perform the multiplexed I/O interface.



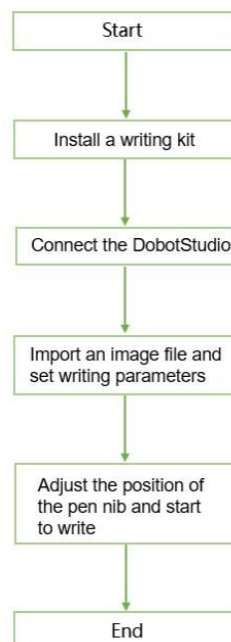
Regarding the jogging speed and acceleration in the Joint coordinate system and Cartesian coordinate system, we recommend that it should be less than 500mm/s if loaded and that less than 800mm/s if not loaded.



- Jog the Dobot Magician in the Cartesian or Joint coordinate system to move the suction cup close enough to the small cube for picking-up. For example, the suction cup reaches this location called position A.
- Select **SuctionCup** on the **Operation Panel** to turn on the air pump to pick up the small cube.
- Set the **PauseTime** to **1** second in the Save Point area.
- Click **+Point** to save the coordinate corresponding to the position A
- Before using offline mode, Dobot Magician needs to be reset by clicking **Home** to make Dobot Magician more accurate. For the details please refer to Appendix A Dobot Magician Homing Operation
- If press down **Key** button for long time, Dobot Magician will execute homing operation directly.

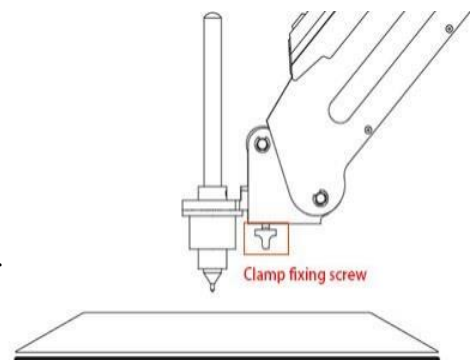
Experiment-2 Writing and Drawing

In below Figure shows the process of writing and drawing.



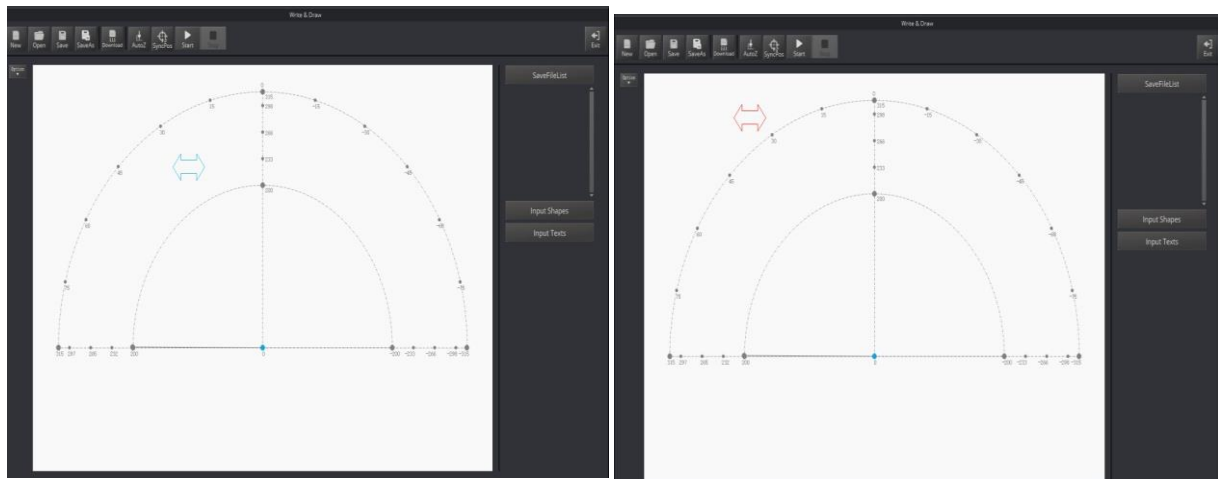
1. Installing a Writing and drawing kit

A writing and drawing kit consists of a pen and a pen holder



2. Connecting the DobotStudio

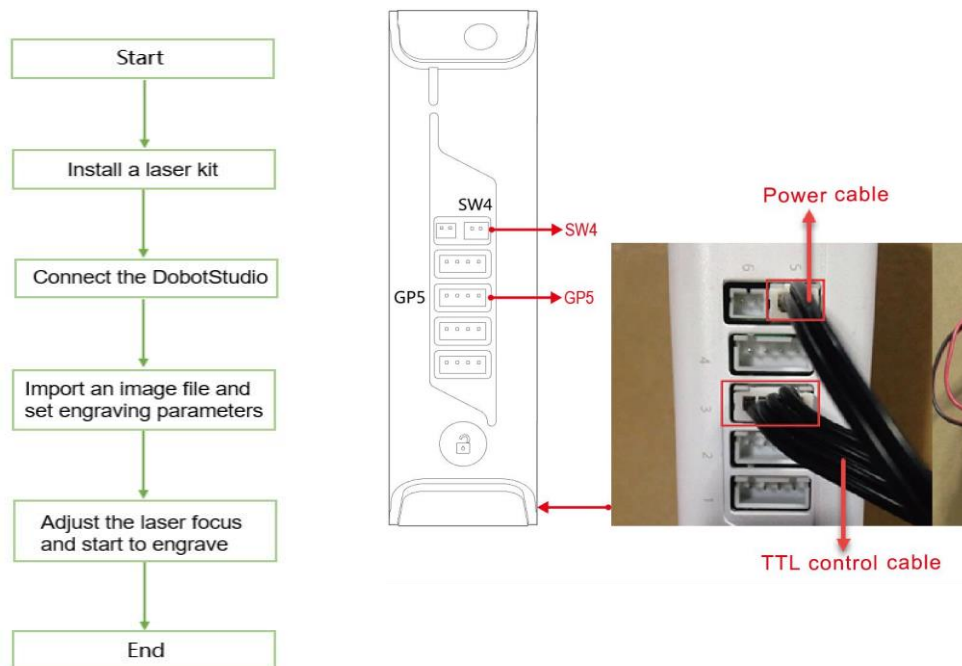
- Launch the Dobot studio and click on the COM port and connect the dobot. If the current firmware of the Dobot Magician is the 3D Printing firmware instead of the Dobot firmware, the **Select tool** dialog box is displayed, asking if you want to switch to the Dobot firmware. In this case, perform the following steps to switch to this firmware.
- The Dobot firmware upgrade window is displayed
- Click **Confirm** to upgrade the Dobot firmware, as shown in Figure 5.40. When the upgrade process bar shows 100%, and a short beep sound is heard, it means that the firmware is upgraded successfully, as shown in Figure 5.41. In this case, the LED indicator turns from red to green. Then click **Quit** to exit
- During the firmware upgrade, do not stop it. Otherwise, errors occur.
- Then click and connect write and draw
- Chose the pen as end effector
- **Importing Image Files and Setting Writing Parameters.** The imported image should be placed within the annular area on the **Write & Draw** page, as shown in Figure. If not, the robotic arm reaches its limited position and cannot draw or write. In this case, the image is highlighted with a red border



- Click **Open** on the **Write & Draw** page to import a built-in PLT or SVG image file from the DobotStudio installation directory *InstallatonDirectory\DobotStudio\config\prefab\system\source*, You can also import your custom PLT or SVG image file.
- Click a shape in the **Input Shapes** area, Click **Input Texts** on the **Write & Draw** page to input texts, and set its style, and then click **OK** to display the text on the annular area
- Click **Open** to import an image file such as BMP, JPEG, or PNG to convert this image to its corresponding SVG file that the DobotStudio supports, as shown in Figure 5.50. Once this image is imported, the **SVG Converter** dialog box is displayed, as shown in Figure 5.51. In this dialog box, drag the slider to set the black and white threshold, and click **Convert Bitmap To SVG** to perform the conversion, and then click **Plot to Main Scene** to display the converted SVG file on the annular area of the **3. Write & Draw** page.

- Click **Write & Draw** to set the Dobot Magician's **Velocity** (mm/s), junction velocity (**JunctionVel**: mm/s), **PlanAcc** (mm/s²), acceleration (**Acc**: mm/s²), **PenUpOffset** (mm), **PenDown** (mm)
- **Adjust the Position of the Pen Nib**, Press and hold the unlock button on the Forearm to move the Dobot Magician to raise and lower the pen nib until it slightly squeezes the paper. You can also jog the robotic arm in the Cartesian or Joint coordinate system to slowly pull the Z axis down to a suitable vertical position for writing,
- Click on AutoZ and SyncoPos and then start for writing. When writing, click **Pause** to pause the writing and **Stop** to halt the writing

Experiment-3, Performing Laser Engraving Tasks and grey scale engraving

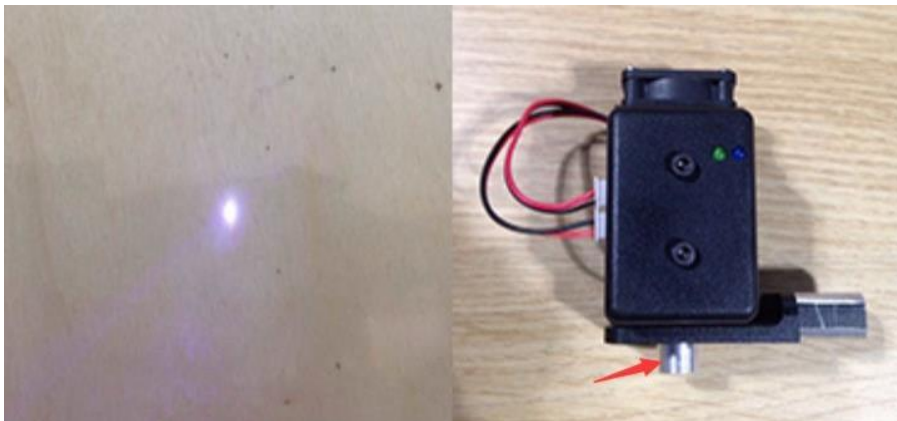


The LaserEngraving is different from the grayscale engraving. The former uses the same firmware and DobotStudio function module as those of the **Write & Draw** function, and it can only engrave a vector graphics by drawing lines while the latter can engrave a grayscale image.

1. **Installing a Laser Kit:** A laser kit includes a laser as shown in above figure



2. Connecting the DobotStudio: Choose leaser as end effector



Importing Image Files and Setting Engraving Parameters

When performing a laser-engraving task, a built-in or a custom image file is required. Only a PLT or SVG image can be used. The built-in image file is located in the directory:

Installation

Directory \DobotStudio\config\prefab\system\source.

Prerequisites A PLT or SVG image file has been created

- ❖ When using a laser, wear lasing protective eyeglass.
- ❖ Never aim the laser at a person's eye and clothes or stare at the laser from within the beam.
- ❖ In the central laser focus, a high temperature heat is created and can burn materials such as papers and wooden boards.
- ❖ Never aim the laser at a person and their clothes.
- ❖ Do not allow the children to play with the Dobot Magician. Monitor the robotic arm while it is running and power off it once the movement is complete.
- ❖ If you cannot set the laser to be at its minimum focus, it's probably because the focal length is long. To shorten the focal length, slightly turn the sliver lens screw (as shown in Figure 5.81) on the bottom of the laser kit.

- ❖ The point marked by a red box, as shown in Figure 5.82, corresponds to the position of the end-effector of the Dobot Magician. This point changes its position only within the annular area when the robotic arm moves.
 - ❖ Once this step is complete, the next time you start to engrave, directly import a PLT or SVG image file without adjusting the position of the laser kit, and click **SyncPos**, and then click **Start** to start engraving on the paper.
 - ❖ When engraving, click **Pause** to pause the engraving and **Stop** to halt the engraving.
- below figure shows the effect of the laser-engraving



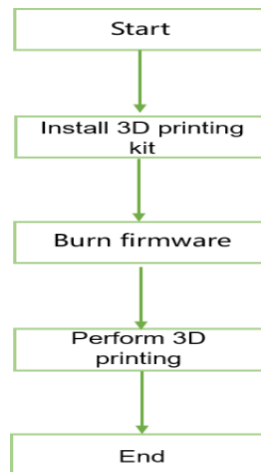
Installing a Grayscale-engraving Kit

- Both grayscale-engraving and laser-engraving use the laser kit as the end-effector.
- Click **Setting** on the **LaserEngraving** page.
- Set the **JunctionVel** (junction velocity), **PlanAcc** (linear acceleration), and **Acc (acceleration)**, for example, set all to 5
- The Dobot Magician automatically moves above the position of the start point of the laser-engraving.
- When engraving, click **Pause** to pause the engraving and **Stop** to halt the engraving. Figure, shows the effect of the laser-engraving



Experiment-4, Operating 3D Printing

After installing 3D printing kit, you can import 3D module into the 3D printing software for 3D printing. Figure 5.118 shows the 3D printing process.



During 3D printing, the 3D printing control software is required. You can use **Repetier Host** or **Cura** software for 3D printing.

Reptier-Host: **Reptier-Host** can slice with the third party slicing (such as CuraEngine, Slic3r, etc), check and modify **G-Code**, control 3D printing manually. More parameter settings make **Reptier-Host** very flexible.

Cure: The slicing of **Cura** is fast and stable. It has strong inclusiveness to 3D model structure and less parameter settings.

4.1 Installing 3D Printing Kit

3D printing kit contains extruder, hot end, motor cable, filament, and filament holder as shown in Figure.



4.2 Operating Repetier Host

Repetier Host has been built into DobotStudio. After burning 3D printing firmware, the **Repetier Host** page will be displayed automatically.

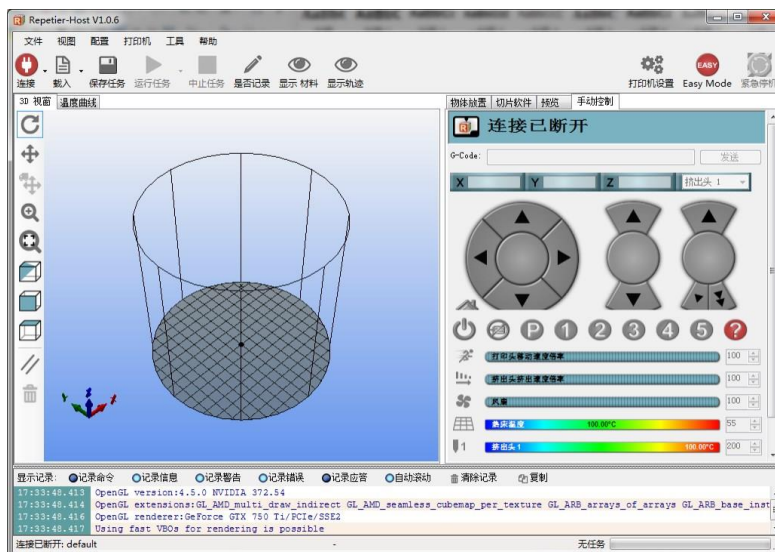
Prerequisites

- ❖ The 3D printing model has been prepared.
- ❖ The printing platform has been prepared and please place it in the workspace of the Dobot Magician.
- ❖ Dobot Magician has been powered on.
- ❖ Dobot Magician has been connected to DobotStudio successfully (Only USB connection is supported).
- ❖ The 3D printing kit has been installed.

Burning Firmware

After burning 3D printing firmware, the **Repetier Host** page is displayed automatically, as shown in Figure.

If the LED indicator on the base turns red, it indicates that the connection of the 3D printing kit is abnormal.



If the current firmware is set for 3D printing when operating 3D printing, you can click **Connect** directly on the DobotStudio page. And then Click **OK** on the **Select tool** page to switch to **Repetier Host**, as shown.

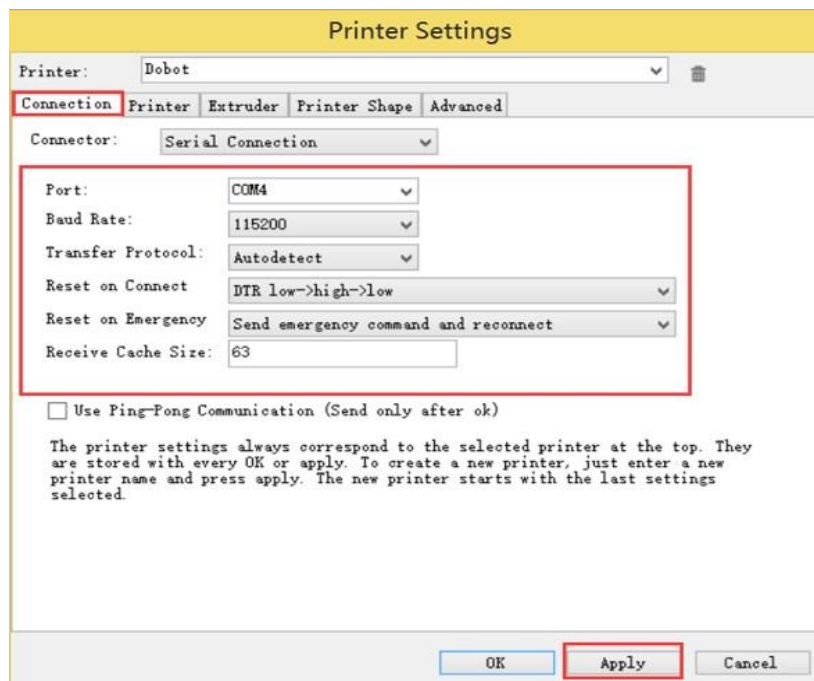
4.3 Performing 3D Printing

Printing parameters only need to be set for the first time.

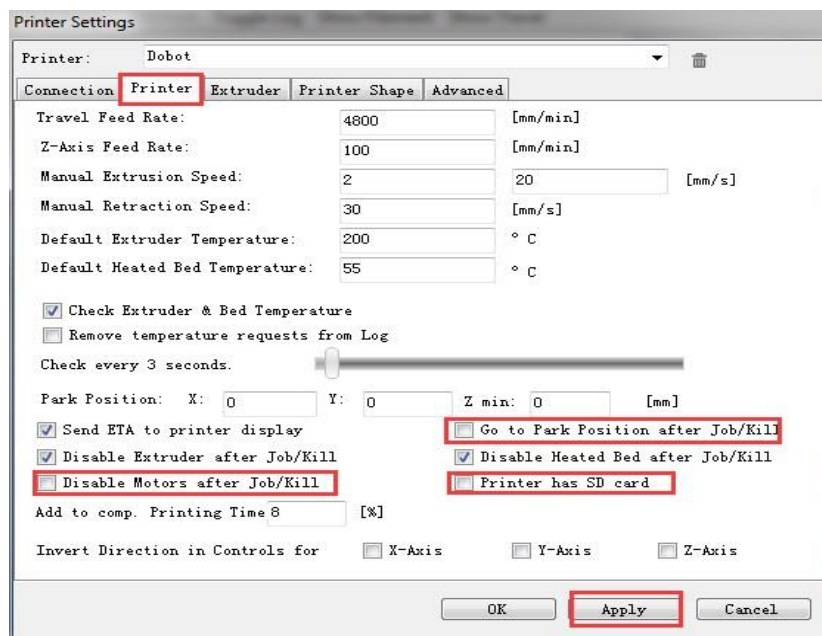
1. Click **Printer Settings** on the top right corner of the **Repetier Host** page. The **Printer Settings** page is displayed.
2. Set the corresponding parameters on the **Connection** tab as shown in the red box of above figure. The other parameters are set by default.

Text extruder.

Text Extruder



3. Click **Apply**.
4. Unselect the corresponding options on the **Printer** tab as shown in the red box of, Figure 5.130 and the other parameters are set by default. Then, click **Apply**.



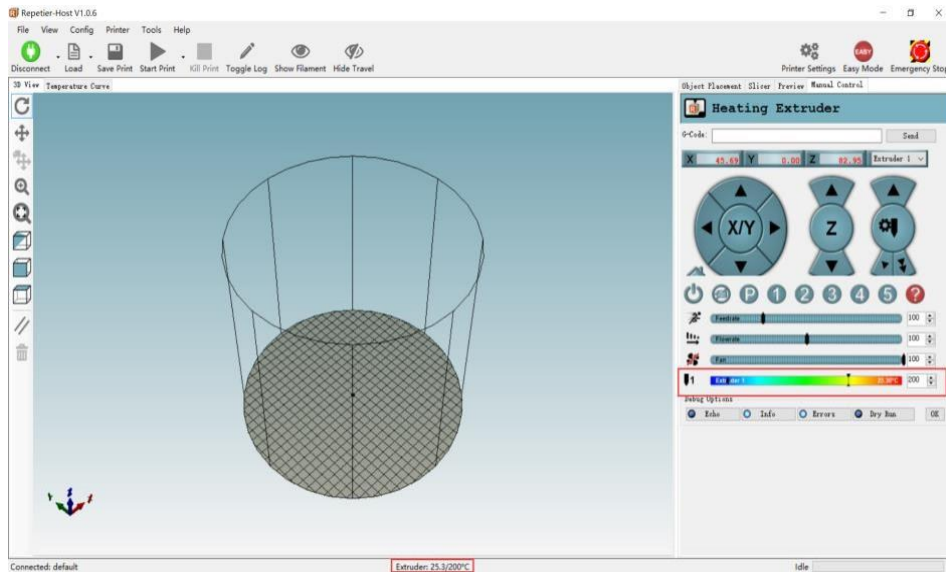
5. Set the corresponding parameters on the **Extruder** tab as shown in the red box of figure, the other parameters are set by default. Then, Click **Apply**.

Before printing, you need to test the extruder to check whether the melted filament flows from the nozzle of the extruder.

The temperature of the extruder should be above 170°C. Dobot Magician will not start 3D printing until the filament is in the melting state. So you need to heat the extruder first.

Set the heating temperature to 200°C on the **Manual Control** tab of the **Repetier Host** page and click, as shown in Figure.

The heating rod will produce high temperature up to 250°C, please be careful. Do not let children play with it alone. The process needs to be monitored when it is running. After the process is completed, please turn off the equipment promptly.



Adjust the printing space and get the printing coordinates.

During printing, if the distance from Dobot Magician to the printing platform is too large or too small to paste the first layer, it can lead to the nozzle blockage. For increasing the stickiness of the first layer, placing a masking paper on the platform is recommended.

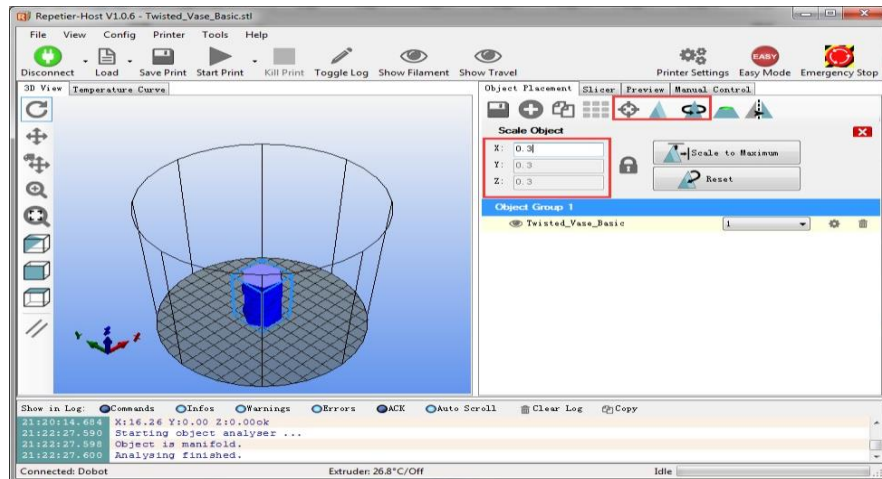
Press the **Unlock** key on the Forearm and drag Dobot Magician to make the printing head contact the surface of the masking paper (The distance between the printing head and the surface of the masking paper is the thickness of a sheet of A4 paper), then release the **Unlock** key.

Input command **M415** on the **G-Code** command window and press **Enter** to get the current coordinates, as shown in Figure. Also, you can press the **Key** button on the bace of the base to get the current coordinates.

If you cannot find the **G-Code** command window, please click **EASY** to close **Easy Mode**.

Click load to import the prepared 3D printing model. You can also load 3D printing models which are DOBOTStudio, the loading path is Installation Directory/ DobotStudio/ attachmentnet/3DmodelStl.

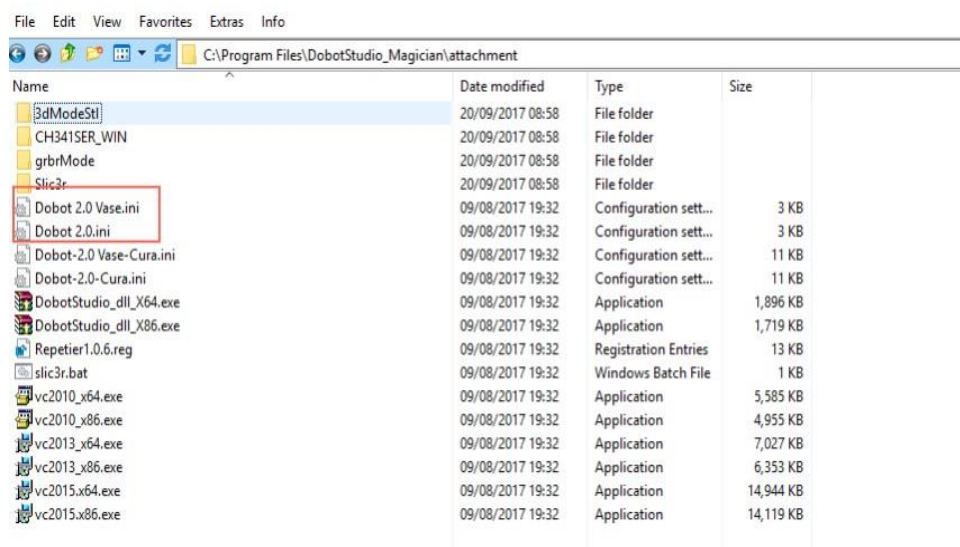
After importing the model, you can center, zoom, or rotate the model on the **Object Placement** page, as shown in the below figure.



Set slicing parameters and slice up: Select **Slic3r** from **Slicer** on the **Slicer** tab of the **Repetier Host** page, and click **Configuration**. Set the slicing parameters on the **Slic3r** page.

The 3D printing effect depends on the slice parameters. This topic provides a configuration sample, you can select **File > Load Config** on the **Slic3r** page to import it directly for printing.

The path of the configuration sample is **Installation directory\DobotStudio\attachment**



Dobot-2.0-Vase.ini is used for printing a thin-walled vase, while Dobot-2.0.ini is used for the filling, the filling rate is 20%.

Save the **Printing Settings**, **Filament Settings** and **Printer Settings** tabs respectively after importing configuration sample

Click **Slici with Slic3r** on the **Slicer** tab of the **Repetier Host** page and click play on the top corner.

Here we choose vase mode to print, and the product after printing as shown in figure

