How to create PCB using MDX-40A and Fab Modules

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This document was written by Shohei Aoki. Your feedback is welcome.

Please contact to shoaok [at] gmail.com if you have any questions.

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1. Requirements

PCB milling with MDX-40A and Fab Modules was tested in the following environment.

OS: Windows 7 32 bit and Ubuntu 12.04 LTS 32 bit
Software: VPanel (on Windows), Fab Modules (on Ubuntu)
Other script: scale.py (described later)

It means you need two PC to run MDX-40A. After setting the origin point on Windows, you will switch to Ubuntu to send RML data.[1]

[1] I tested using Ubuntu on virtual machine, however, the print command didn't run on Ubuntu on virtual machine.

2. Install software

Windows

Install a driver for MDX-40A and VPanel software from an install disk.

Ubuntu

1. Fab Modules

Go to CBA-MIT website and get the latest copy of the source code.
http://kokompe.cba.mit.edu
Extract the .zip files. Open terminal and go to the location.

```
$ cd /path/to/fab_src
```

Typing following command will install Fab Modules automatically on your Ubuntu system.

```
$ sudo apt-get install python python-wxgtk2.8 python-dev python-pip gcc g++ libpng12-dev libgif-dev make bash okular libboost-thread-dev libboost-system-dev cmake
$ make fab
$ sudo make install
```

2. CUPS and lpr

Type following command to install CUPS and lpr.

```
$ sudo apt-get install cups
$ sudo apt-get install lpr
$ sudo service cups start
```

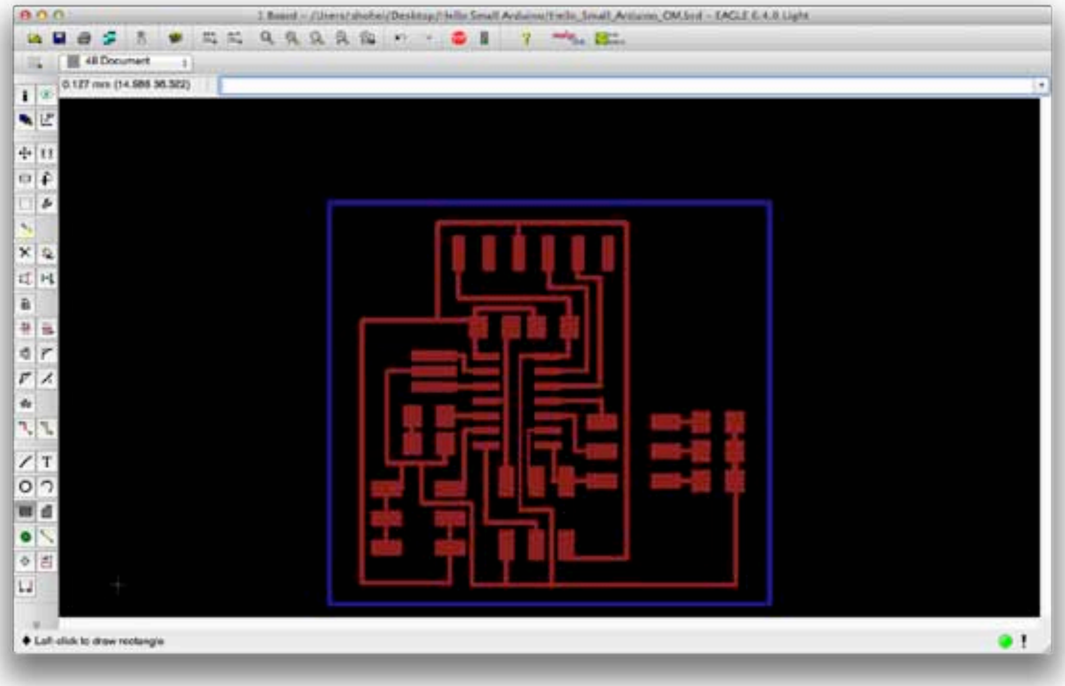
3. Python

Python is already installed in the process above.

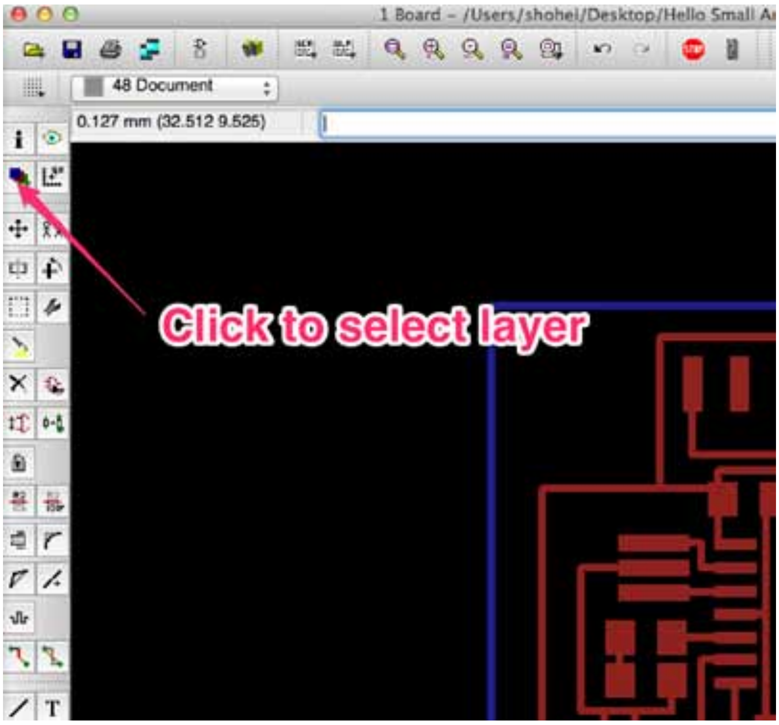
3. Create PNG image with EAGLE

We are going to create a PNG image for milling and cutting outline.

Open your .brd file with EAGLE.

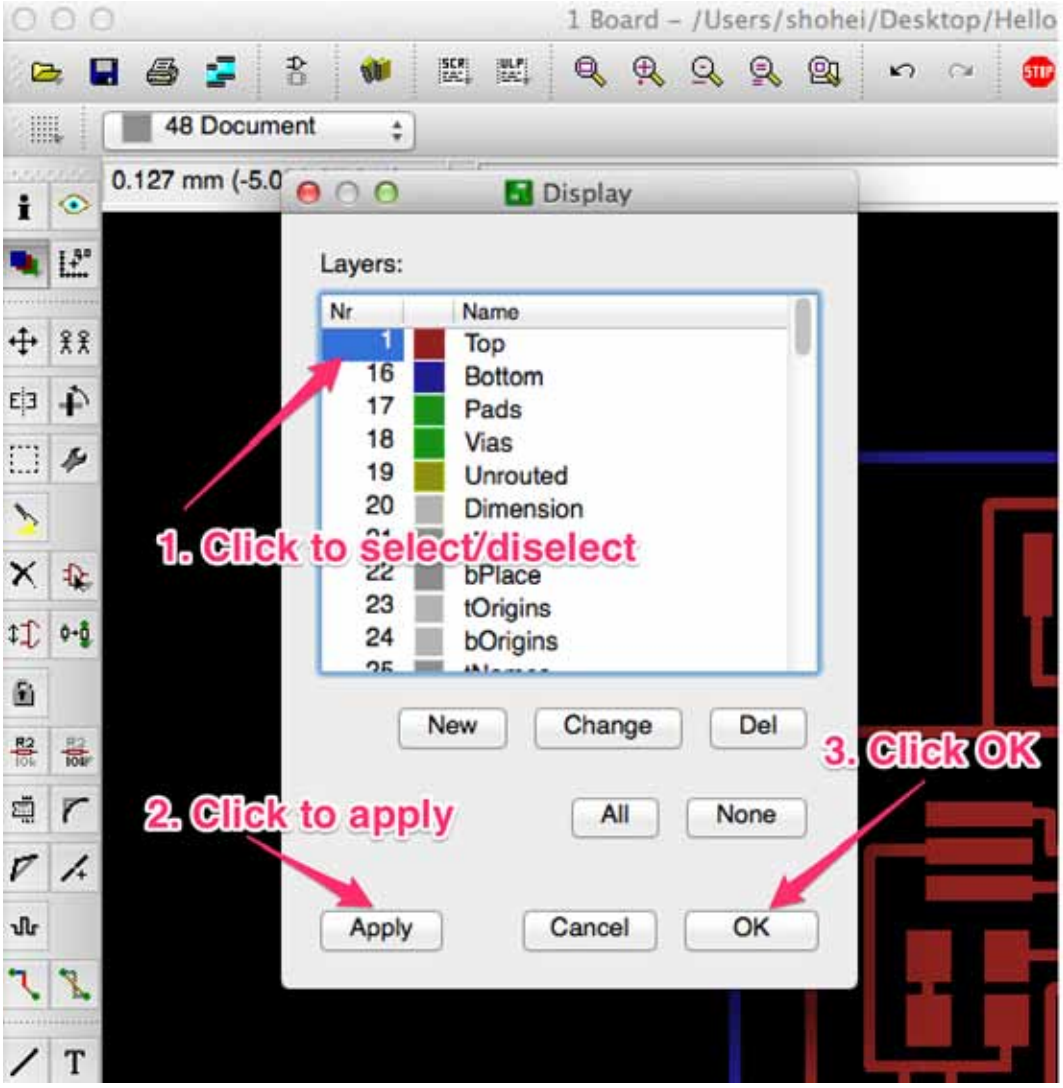

1 Board - /Users/shohei/Desktop/Hello Small Arduino/Hello_Small_Arduino_CM.brd - EAGLE 6.4.0 Light
48 Document
0.127 mm (14.986 36.322)
Left-click to draw rectangle

Select “display” icon to select layer for milling.



Click to select layer

In this case we selected “layer1: Top” layer.



1 Board – /Users/shohei/Desktop/Hello

48 Document

0.127 mm (-5.0

Display

Layers:

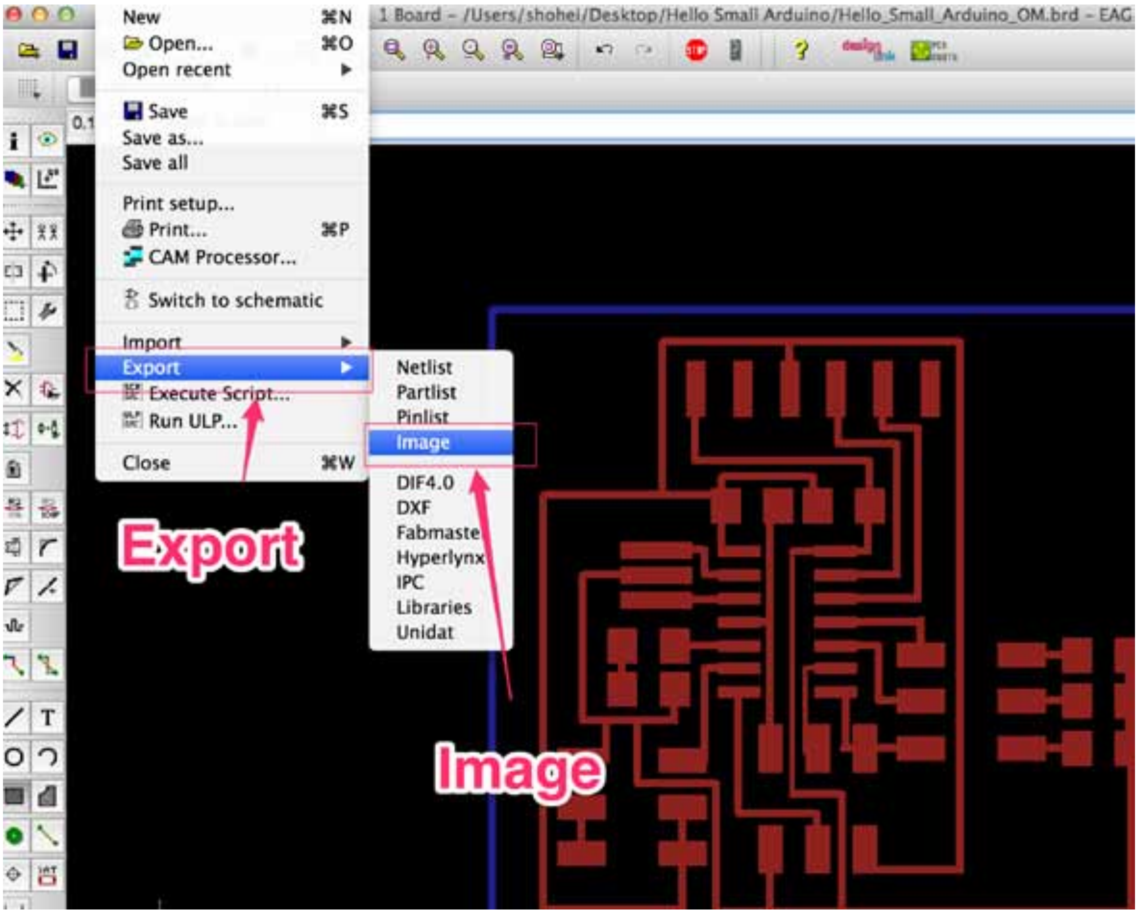
Nr		Name
1	🟥	Top
16	🟦	Bottom
17	🟩	Pads
18	🟩	Vias
19	🟨	Unrouted
20	⬜	Dimension
22	▨	bPlace
23	⬜	tOrigins
24	⬜	bOrigins

1. Click to select/diselect

2. Click to apply

3. Click OK

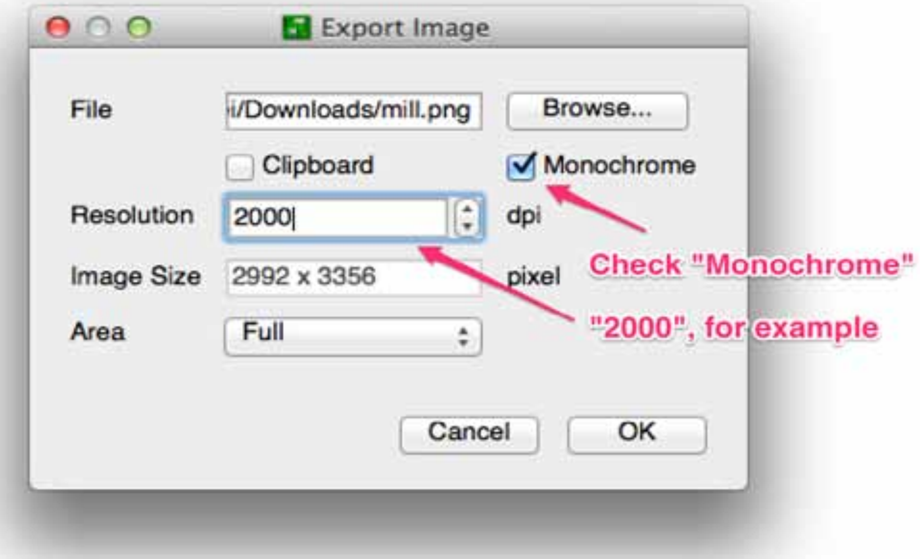
Go to File>Export>Image.



Export

Image

Name a file to output. Don’t for get to check “Monochrome”. Set the



File i/Downloads/mill.png

☐ Clipboard ☑ Monochrome

Resolution 2000 dpi

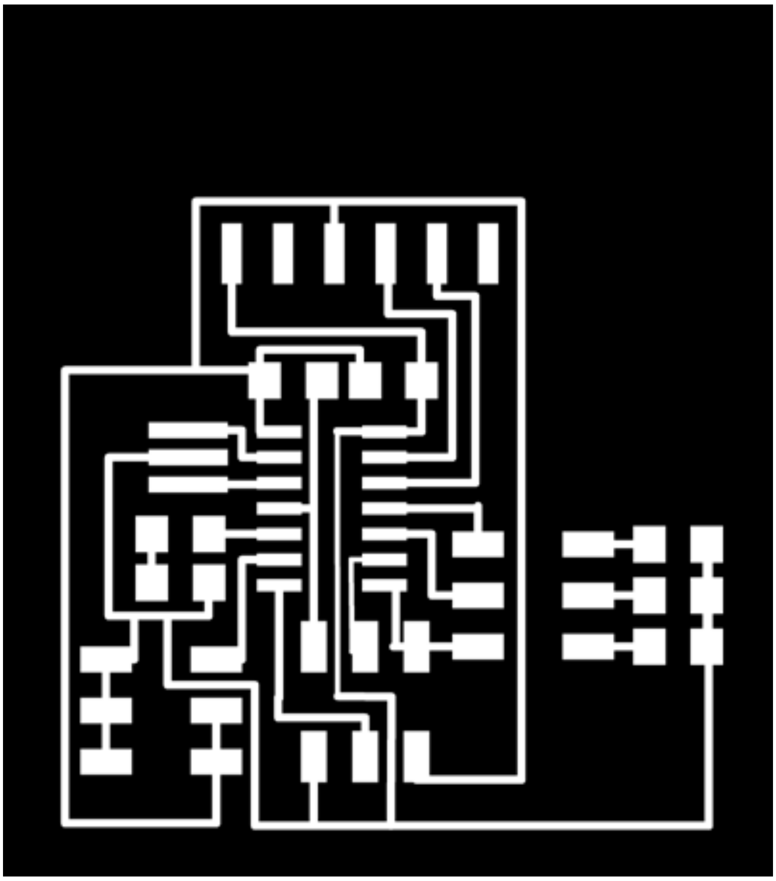
Image Size 2992 x 3356 pixel

Area Full

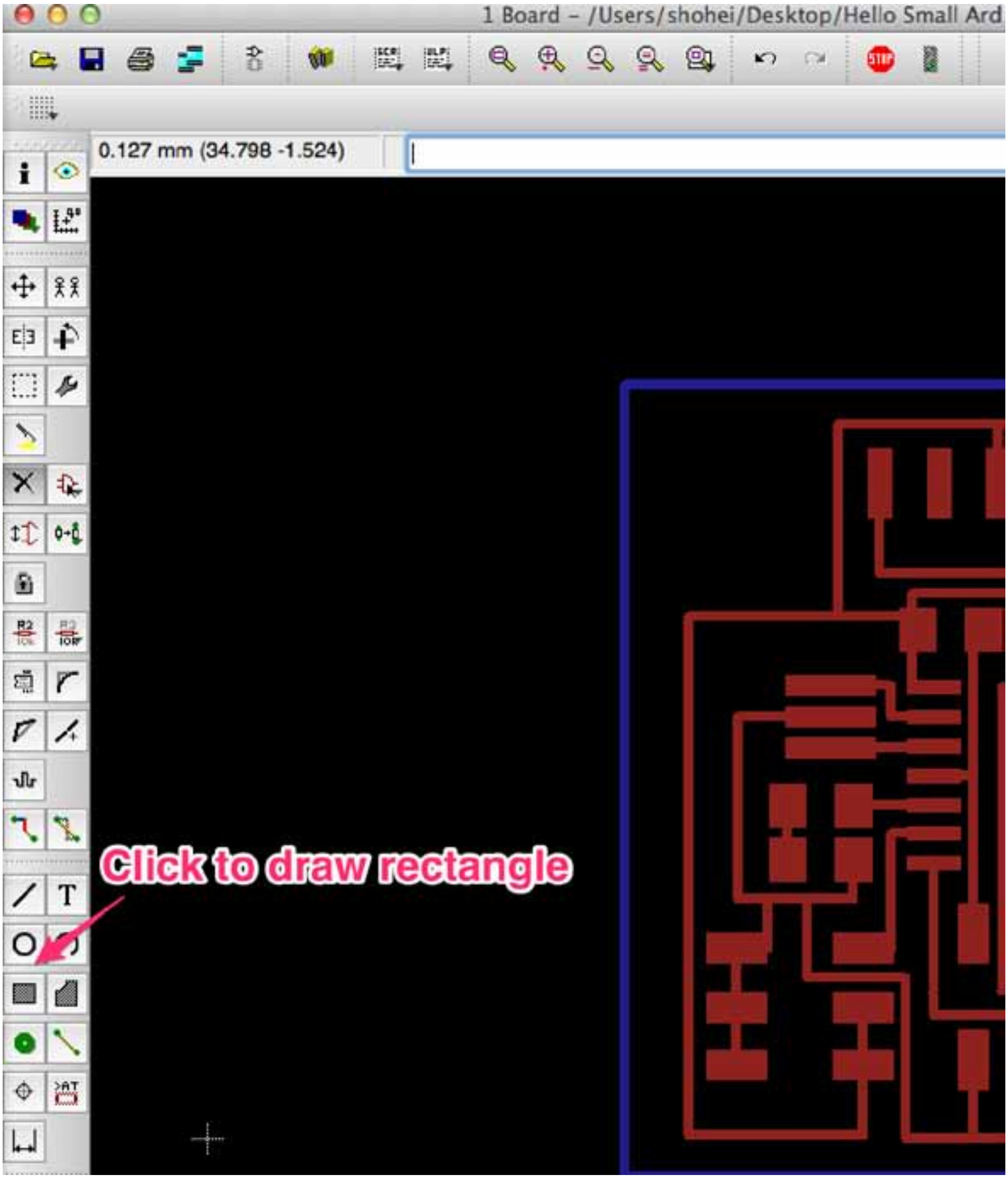
Check "Monochrome"

"2000", for example

resolution high enough (for example, 2000 dpi).
You get a PNG image as below.

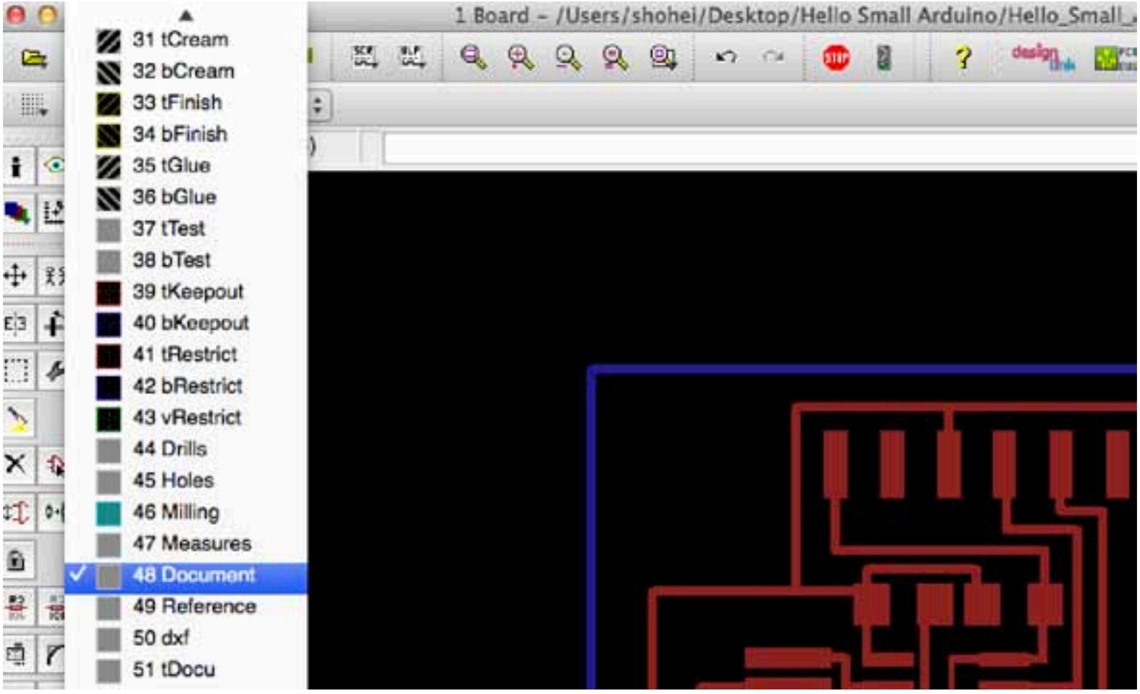


Secondly, we create an image for cutting outline. We draw a rectangle to indicate the area of PCB.
Click a rectangle button as shown below.

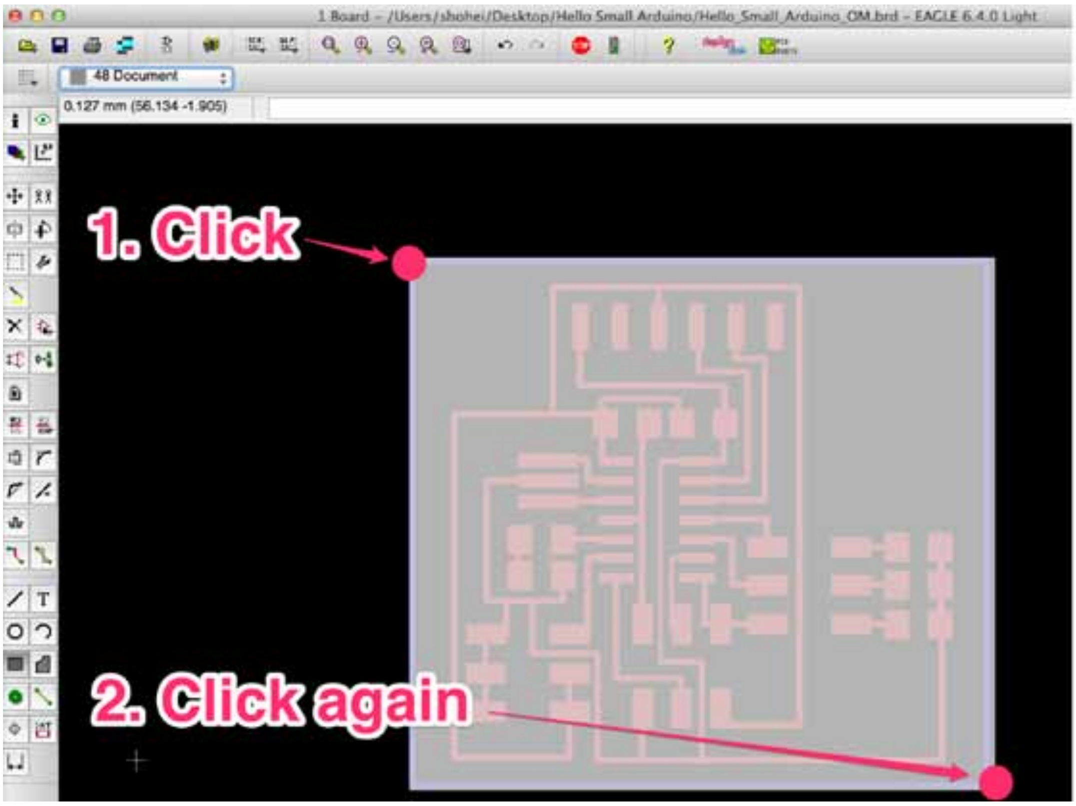


Click to draw rectangle

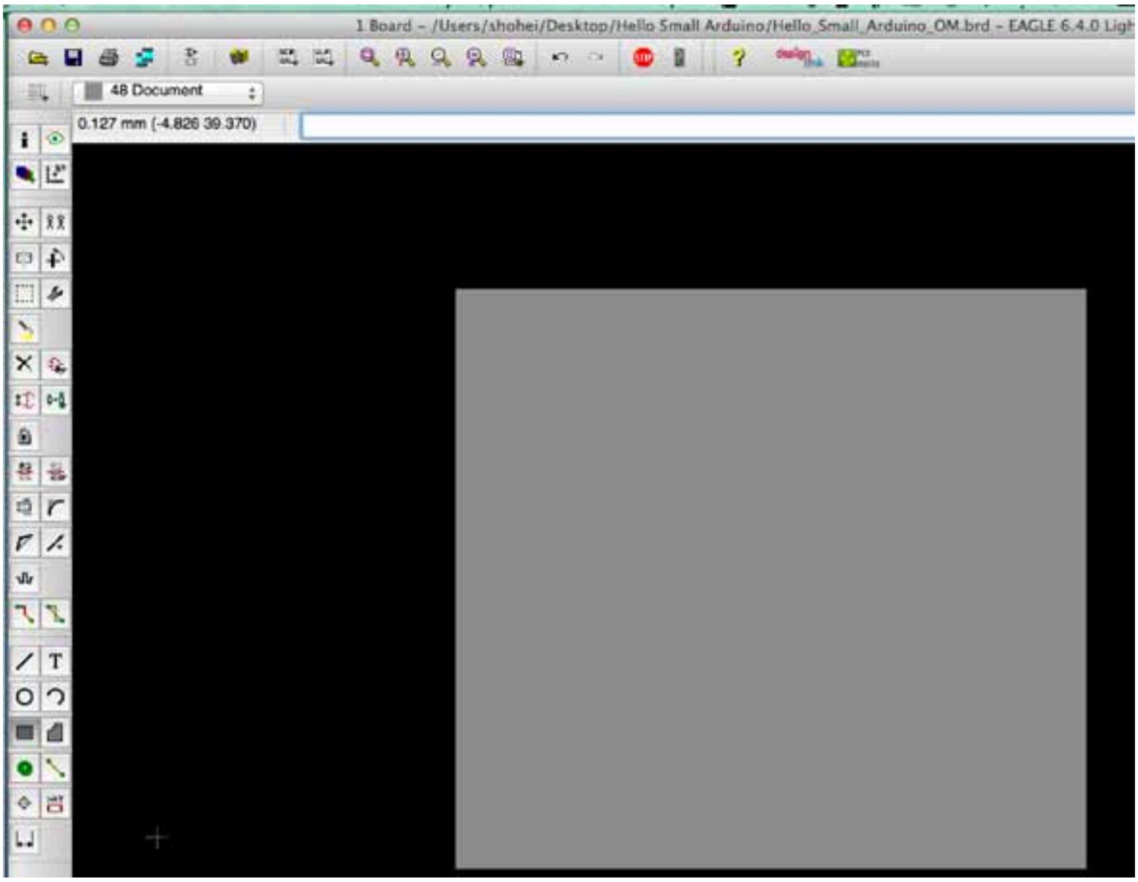
Select “Document” layer. (Actually whichever layer will work)



Draw the rectangle to include whole area of the circuit. Click to put an origin point, and click again after you move cursor to other end of the rectangle.


1 Board – /Users/shohei/Desktop/Hello Small Arduino/Hello_Small_Arduino_OM.brd – EAGLE 6.4.0 Light
48 Document
0.127 mm (56.134 -1.905)
1. Click
2. Click again

Select only Document layer we created now (by clicking “display” button as mentioned above). You just see the rectangle as shown below.

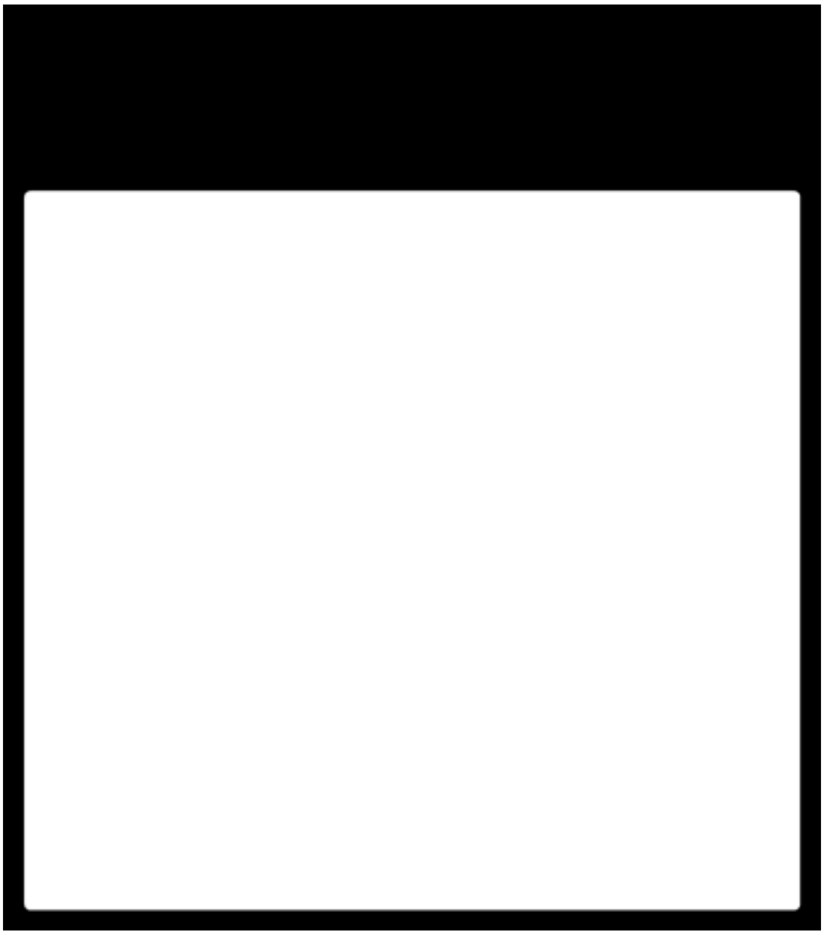


1 Board – /Users/shohei/Desktop/Hello Small Arduino/Hello_Small_Arduino_OM.brd – EAGLE 6.4.0 Ligh

48 Document

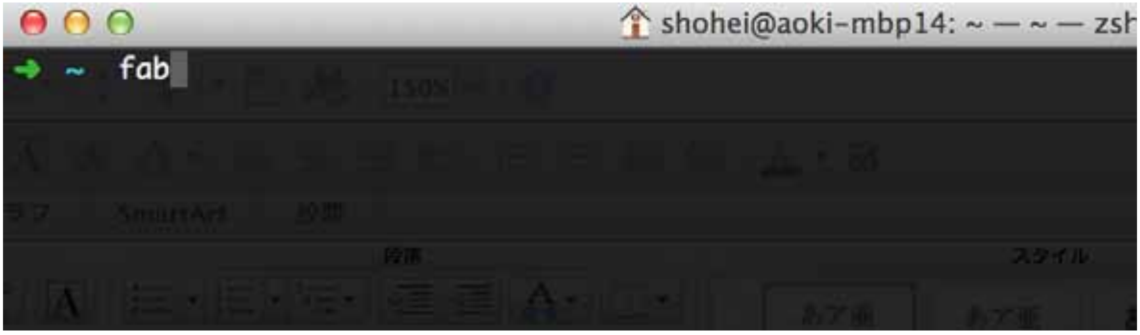
0.127 mm (-4.826 39.370)

Repeat the above process to create the monochrome image.
Finally, you will get a PNG image as below.



4. Create RML with Fab Modules

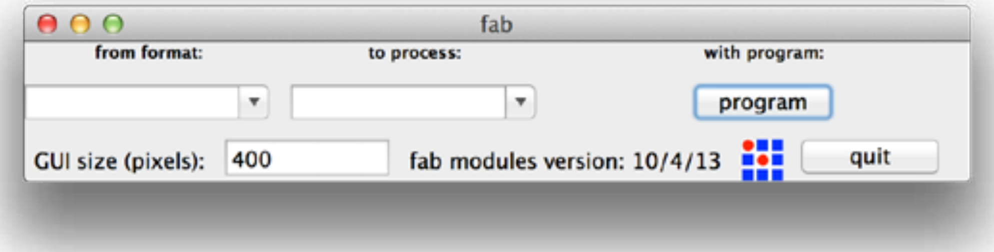
Open a terminal on Ubuntu. Type “fab” and hit enter.



shohei@aoki-mbp14: ~ — ~ — zsh

```
➜ ~ fab
```

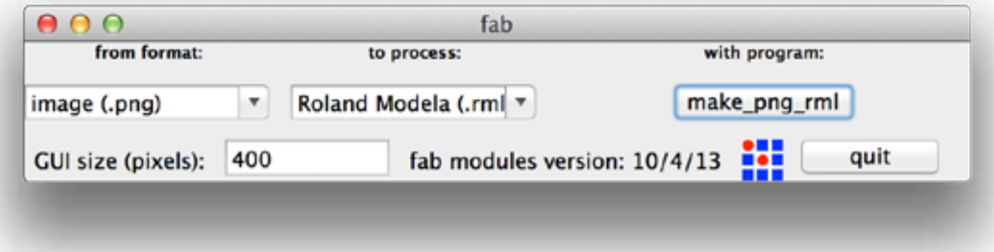
The following dialog will appear.



GUI size (pixels): 400

fab modules version: 10/4/13

Select .png for format and .rml for process. Click make_png_rml program.



from format: image (.png)

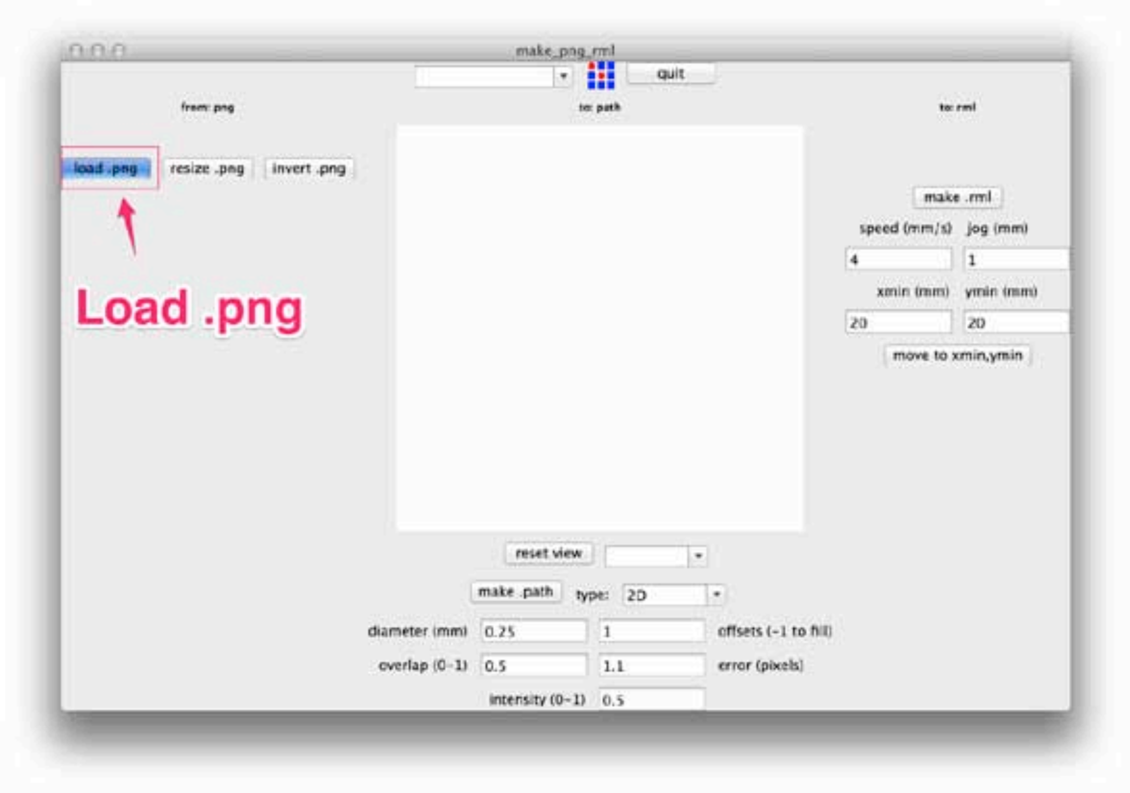
to process: Roland Modela (.rml

with program: make_png_rml

GUI size (pixels): 400

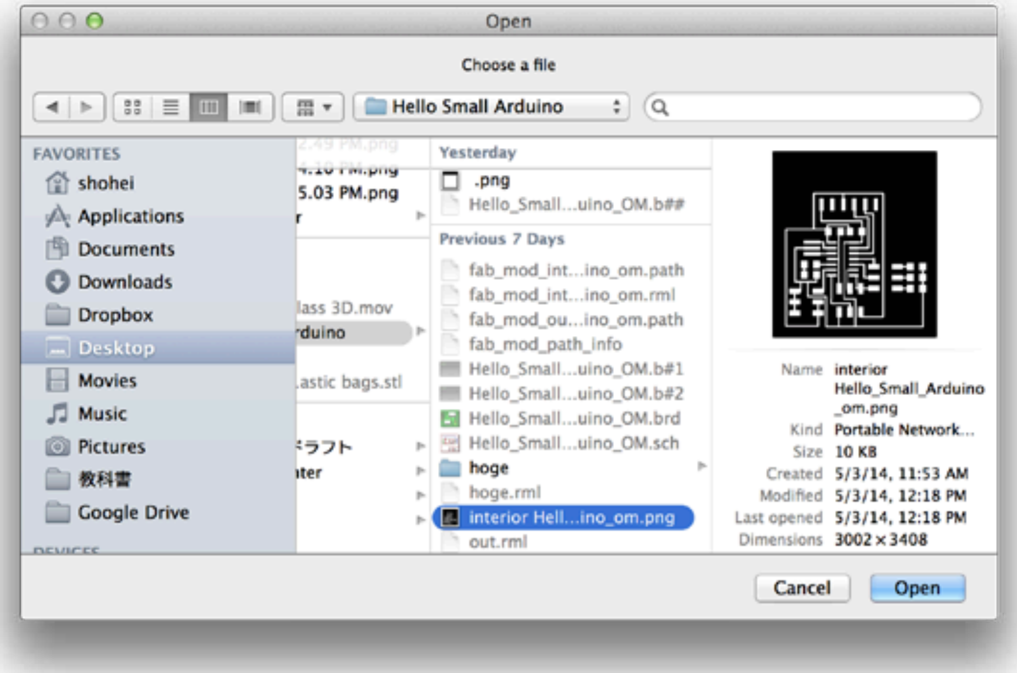
fab modules version: 10/4/13

Click “load” to load png image.



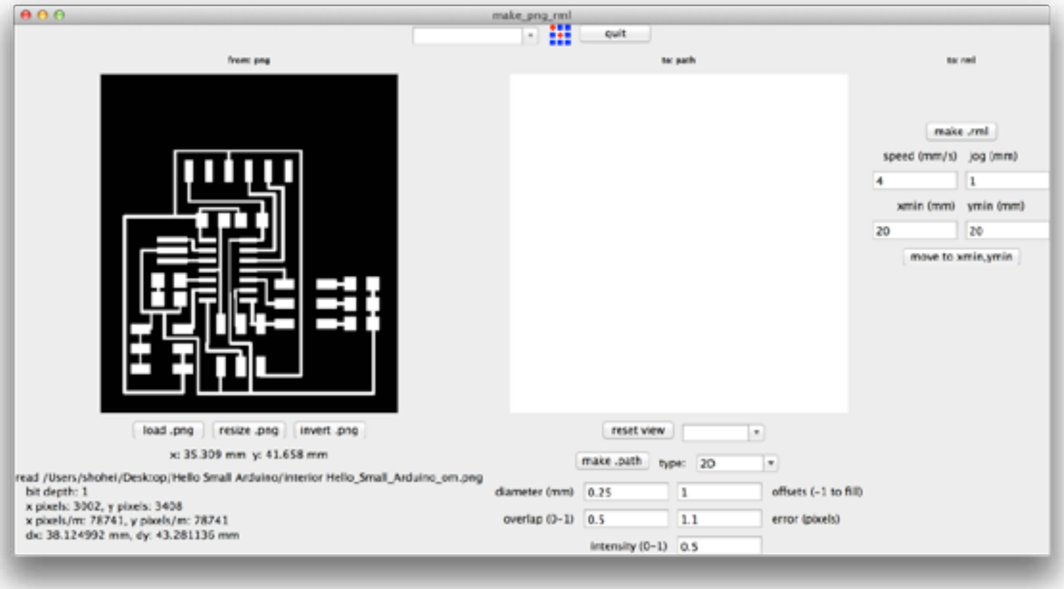
speed (mm/s) 4
jog (mm) 1
xmin (mm) 20
ymin (mm) 20
type: 2D
diameter (mm) 0.25
offsets (-1 to fill) 1
overlap (0-1) 0.5
error (pixels) 1.1
intensity (0-1) 0.5

Choose your PNG image.



Name interior Hello_Small_Arduino _om.png
Kind Portable Network...
Size 10 KB
Created 5/3/14, 11:53 AM
Modified 5/3/14, 12:18 PM
Last opened 5/3/14, 12:18 PM
Dimensions 3002 × 3408

The PNG image loaded.

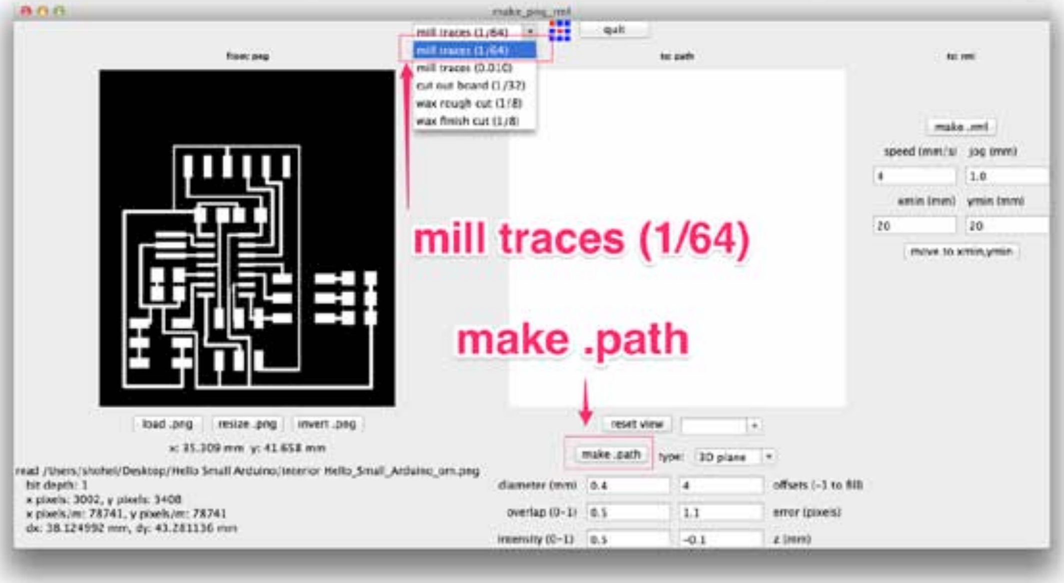


```
x: 35.309 mm  y: 41.658 mm
read /Users/shohei/Desktop/Hello Small Arduino/interior Hello_Small_Arduino_om.png
  bit depth: 1
  x pixels: 3002, y pixels: 3408
  x pixels/m: 78741, y pixels/m: 78741
  dx: 38.124992 mm, dy: 43.281136 mm
```

type: 2D
diameter (mm) 0.25 · 1 offsets (-1 to fill)
overlap (0-1) 0.5 · 1.1 error (pixels)
intensity (0-1) 0.5

speed (mm/s) 4 · jog (mm) 1
xmin (mm) 20 · ymin (mm) 20

Select “mill traces (1/64)” for creating milling file.
Check the parametes. Normally you don’t have to change these values. Click “make .path” to create outline.

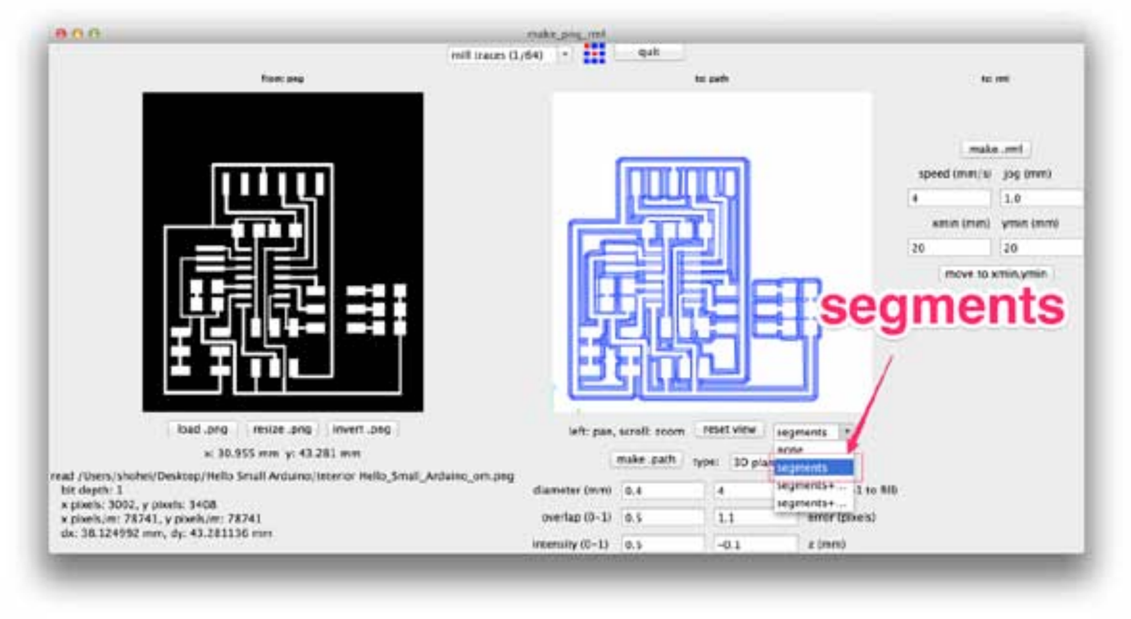


```
x: 35.309 mm  y: 41.658 mm
read /Users/shohei/Desktop/Hello Small Arduino/interior Hello_Small_Arduino_om.png
  bit depth: 1
  x pixels: 3002, y pixels: 3408
  x pixels/m: 78741, y pixels/m: 78741
  dx: 38.124992 mm, dy: 43.281136 mm
```

type: 3D plane
diameter (mm) 0.4 · 4 offsets (-1 to fill)
overlap (0-1) 0.5 · 1.1 error (pixels)
intensity (0-1) 0.5 · -0.1 z (mm)

speed (mm/s) 4 · jog (mm) 1.0
xmin (mm) 20 · ymin (mm) 20

The default preview is complex, so let's switch to simple view. Select "segments" in the dropdown menu.



speed (mm/s): 4
jog (mm): 1.0
xmin (mm): 20
ymin (mm): 20

x: 30.955 mm y: 43.281 mm

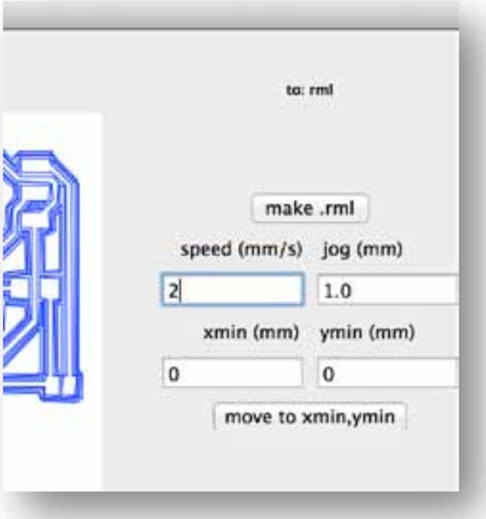
read /Users/shohei/Desktop/Hello Small Arduino/Interior Hello_Small_Ardaino_orn.png
bit depth: 1
x pixels: 3002, y pixels: 3408
x pixels/m: 78741, y pixels/m: 78741
dx: 38.124992 mm, dy: 43.281136 mm

type: 3D plane
diameter (mm): 0.4 — 4 — 1 to 8B
overlap (0-1): 0.5 — 1.1 error (pixels)
intensity (0-1): 0.5 — -0.1 z (mm)

Now we are ready to create a milling script.
Click "make .rml" to create a RML file. We used following parameters for milling.

Table. RML parameters for milling.

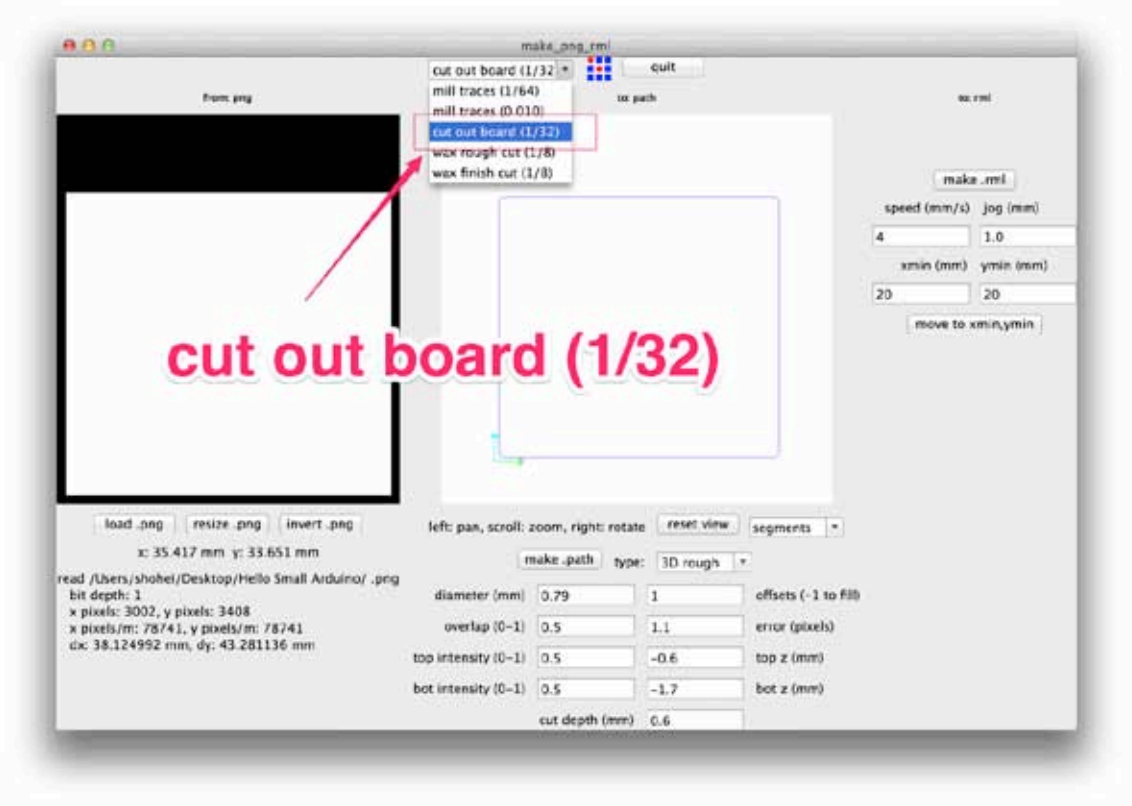
speed(mm/s)	2.0
jog(mm)	1.0(default)
xmin(mm)	0
ymin(mm)	0



speed (mm/s): 2
jog (mm): 1.0
xmin (mm): 0
ymin (mm): 0

Go to the directory where you typed “fab” command.
(It’s your home directory in Ubuntu by default: /home/<username>/)
You can see there is a file generated, whose extension is “.rml” .
This file is a data to send to MDX-40A.

Repeat the process again for another PNG image to create the RML for cutting outline. In this case, select outline PNG image and use “cut out board(1/32”)”.



cut out board (1/32)

speed (mm/s): 4
jog (mm): 1.0
xmin (mm): 20
ymin (mm): 20

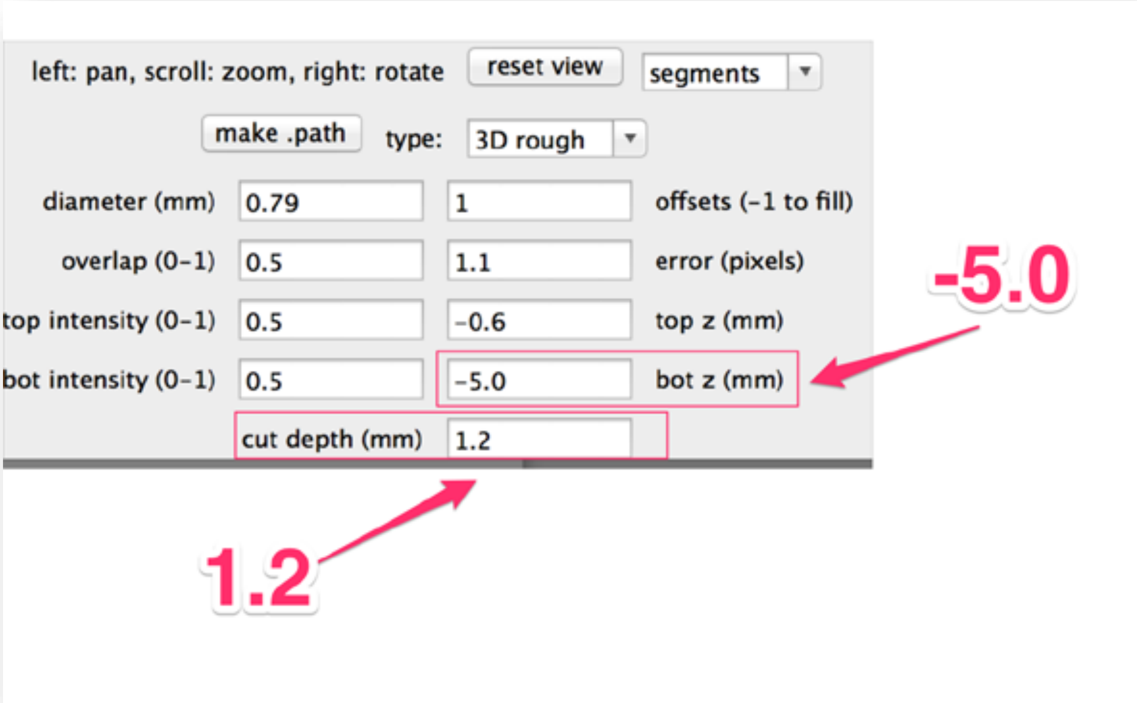
x: 35.417 mm y: 33.651 mm

read /Users/shohei/Desktop/Hello Small Arduino/ .png
bit depth: 1
x pixels: 3002, y pixels: 3408
x pixels/m: 78741, y pixels/m: 78741
dx: 38.124992 mm, dy: 43.281136 mm

type: 3D rough
diameter (mm): 0.79
offsets (-1 to fill): 1
overlap (0-1): 0.5
error (pixels): 1.1
top intensity (0-1): 0.5
top z (mm): -0.6
bot intensity (0-1): 0.5
bot z (mm): -1.7
cut depth (mm): 0.6

Change parameters. Set “bottom Z (mm)” and “cut depth (mm)” to -5.0 and 1.2 respectively.

<u>NOTE: DON’T CHANGE THE VALUE if you are using MDX-15/20</u>



type: 3D rough

diameter (mm) 0.79

offsets (-1 to fill) 1

overlap (0-1) 0.5

error (pixels) 1.1

top intensity (0-1) 0.5

top z (mm) -0.6

bot intensity (0-1) 0.5

bot z (mm) -5.0

cut depth (mm) 1.2

Make another RML file as instructed above.
The parameters are as follows.

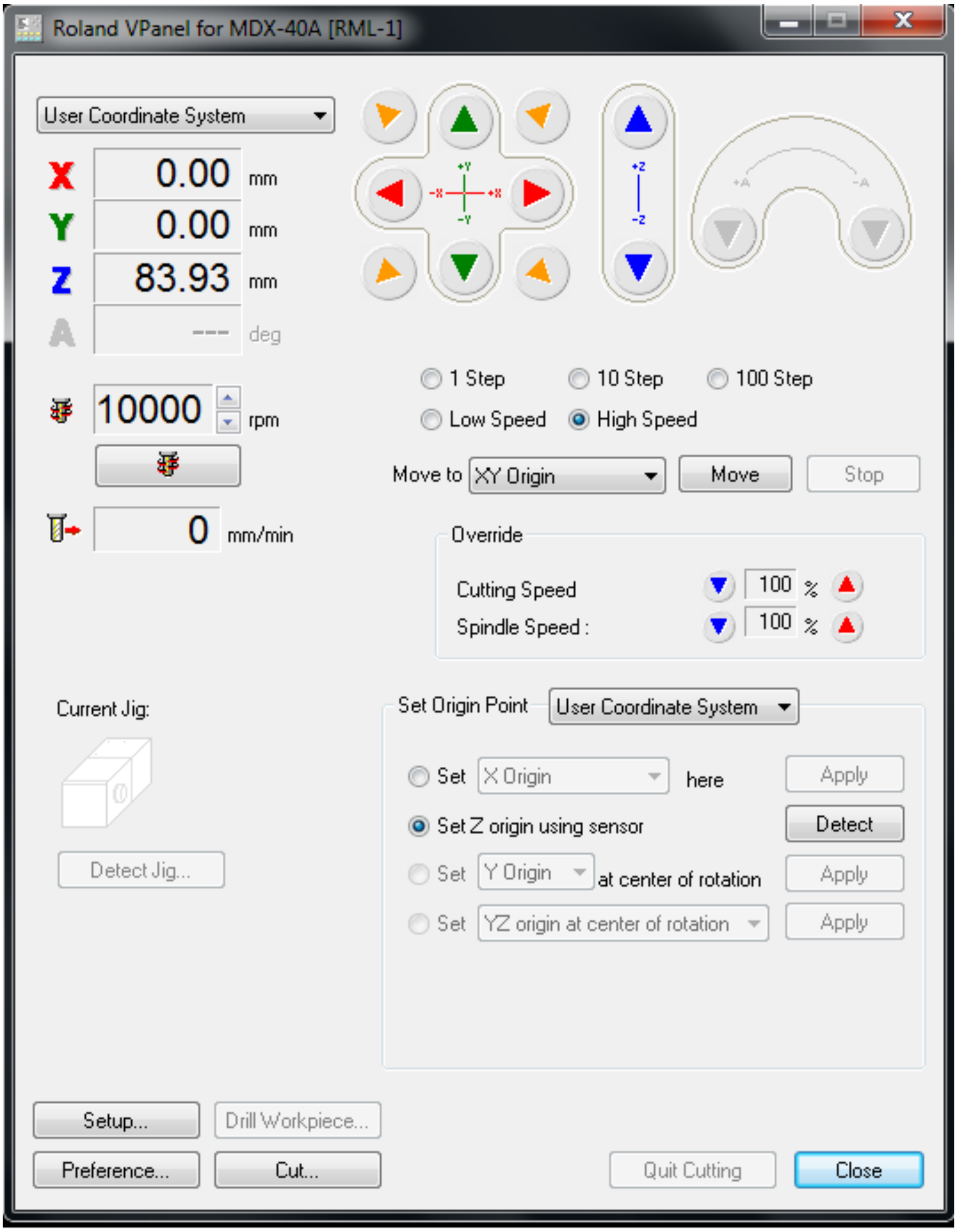
Table. RML parameters for cutting out.

speed(mm/s)	1.0
jog(mm)	1.0(default)
xmin(mm)	0
ymin(mm)	0

Now let’s quit Fab Modules. Pressing <Control>+C kills the current process of Fab Modules.

5. Set origin of MDX-40A

Use VPanel on Windows to set the origin. After you set the origin, unplug the USB and connect it to Ubuntu.
We set the spindle speed as 10,000 RPM.



Roland VPanel for MDX-40A [RML-1]

User Coordinate System

X 0.00 mm
Y 0.00 mm
Z 83.93 mm
A --- deg

10000 rpm

0 mm/min

○ 1 Step ○ 10 Step ○ 100 Step
○ Low Speed ● High Speed

Move to XY Origin

Override
Cutting Speed 100 %
Spindle Speed : 100 %

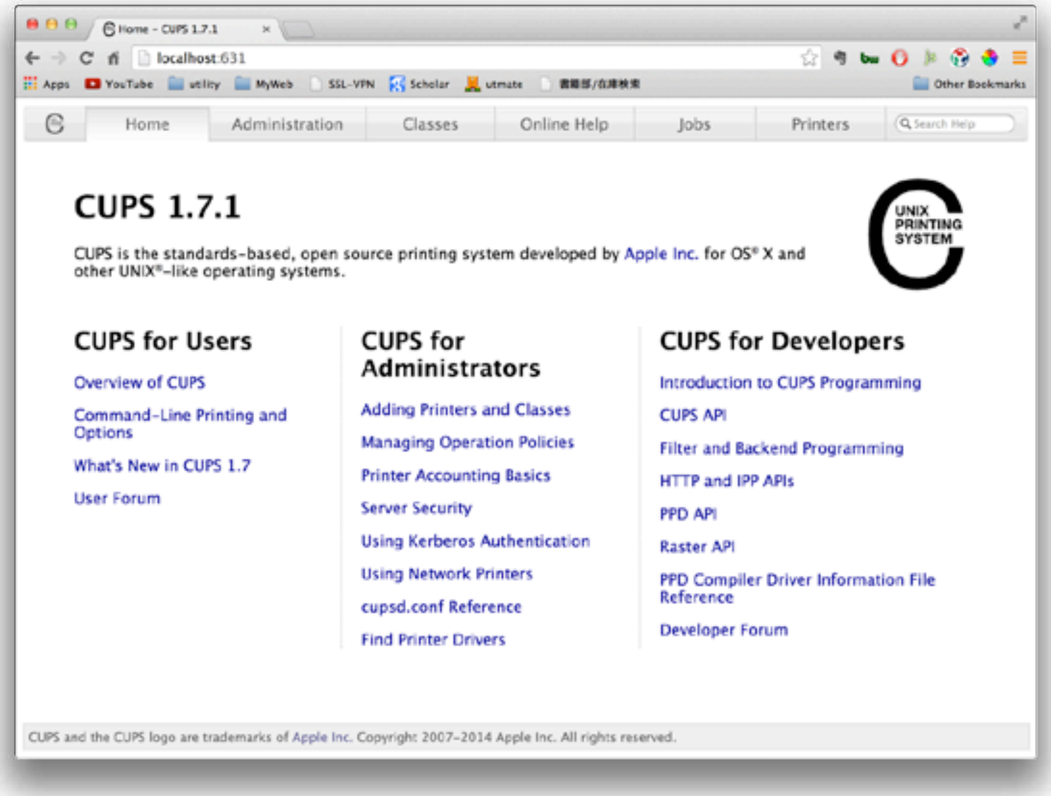
Current Jig:

Set Origin Point User Coordinate System
○ Set X Origin here
● Set Z origin using sensor
○ Set Y Origin at center of rotation
○ Set YZ origin at center of rotation

6. Configure CUPS

CUPS (Common Unix Printing System) is an open source printing system for UNIX-like OS. We use CUPS for communicating MDX-40A, since it doesn't support serial USB. CUPS can be also used for MDX-540 and iModela.

Open following address in your web browser. http://localhost:631



CUPS 1.7.1

CUPS is the standards-based, open source printing system developed by Apple Inc. for OS® X and other UNIX®-like operating systems.

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Command-Line Printing and Options

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PPD API

Raster API

PPD Compiler Driver Information File Reference

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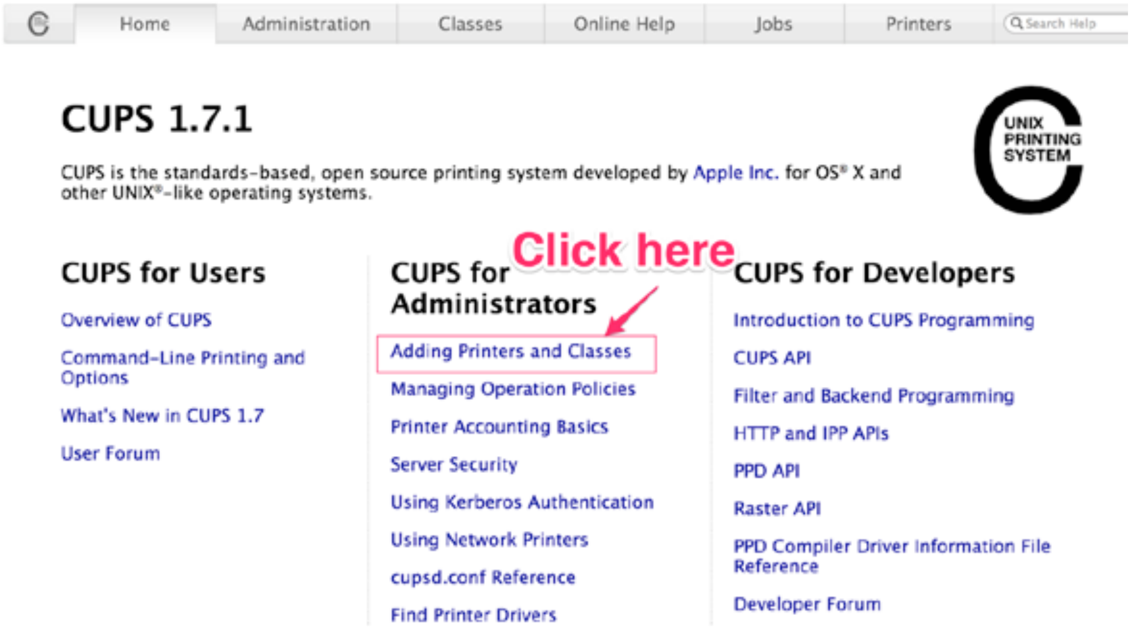
CUPS and the CUPS logo are trademarks of Apple Inc. Copyright 2007-2014 Apple Inc. All rights reserved.

Click “Adding Printers and Classes”. If you are prompted to enter your username and password, enter it according to your system information. (it is login information of your account.)



CUPS 1.7.1

CUPS is the standards-based, open source printing system developed by Apple Inc. for OS® X and other UNIX®-like operating systems.

Click here

CUPS for Users

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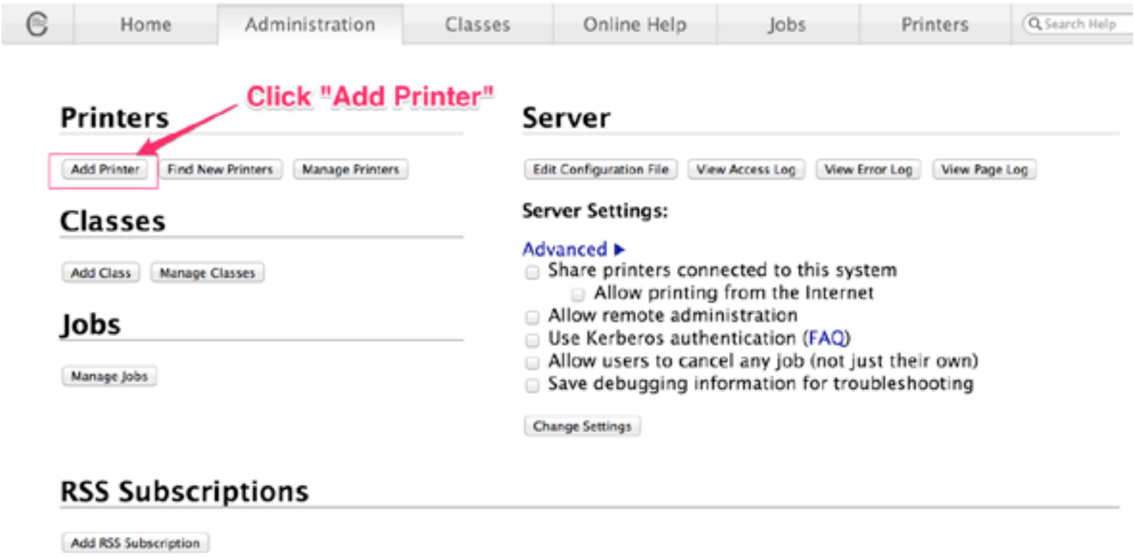
Click “Add Printer”.



Click "Add Printer"

Printers

Classes

Jobs

Server

Server Settings:

Advanced ▸

□ Share printers connected to this system

□ Allow printing from the Internet

□ Allow remote administration

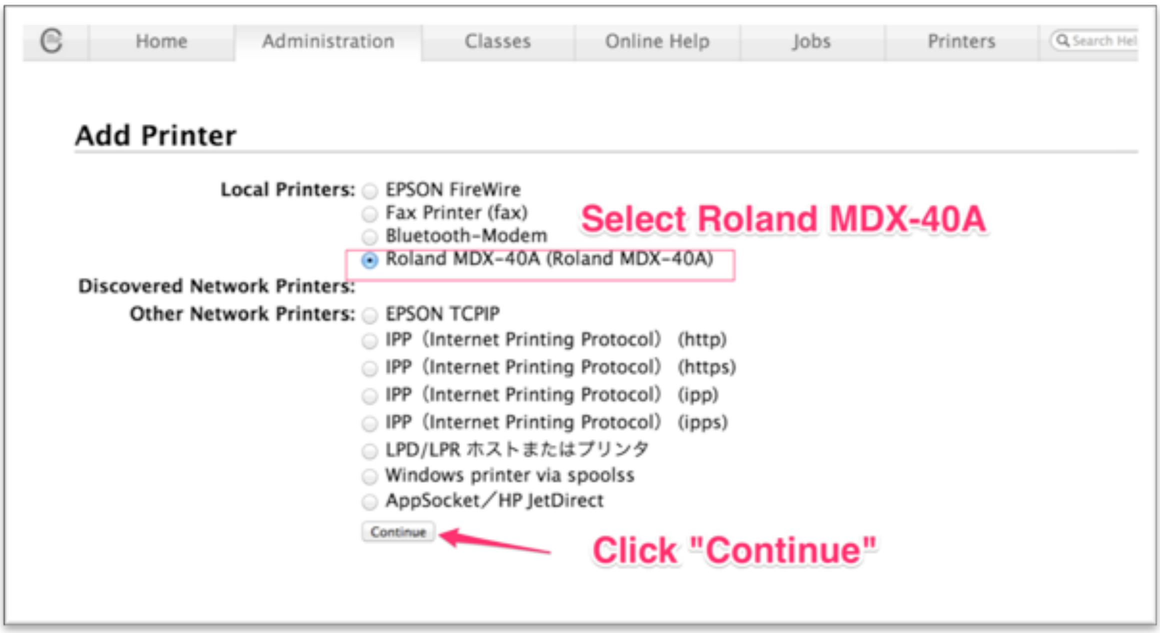
□ Use Kerberos authentication (FAQ)

□ Allow users to cancel any job (not just their own)

□ Save debugging information for troubleshooting

RSS Subscriptions

Select “Roland Modela MDX-40A” and click “Continue”.



Add Printer

Local Printers:
○ EPSON FireWire
○ Fax Printer (fax)
○ Bluetooth-Modem
● Roland MDX-40A (Roland MDX-40A)

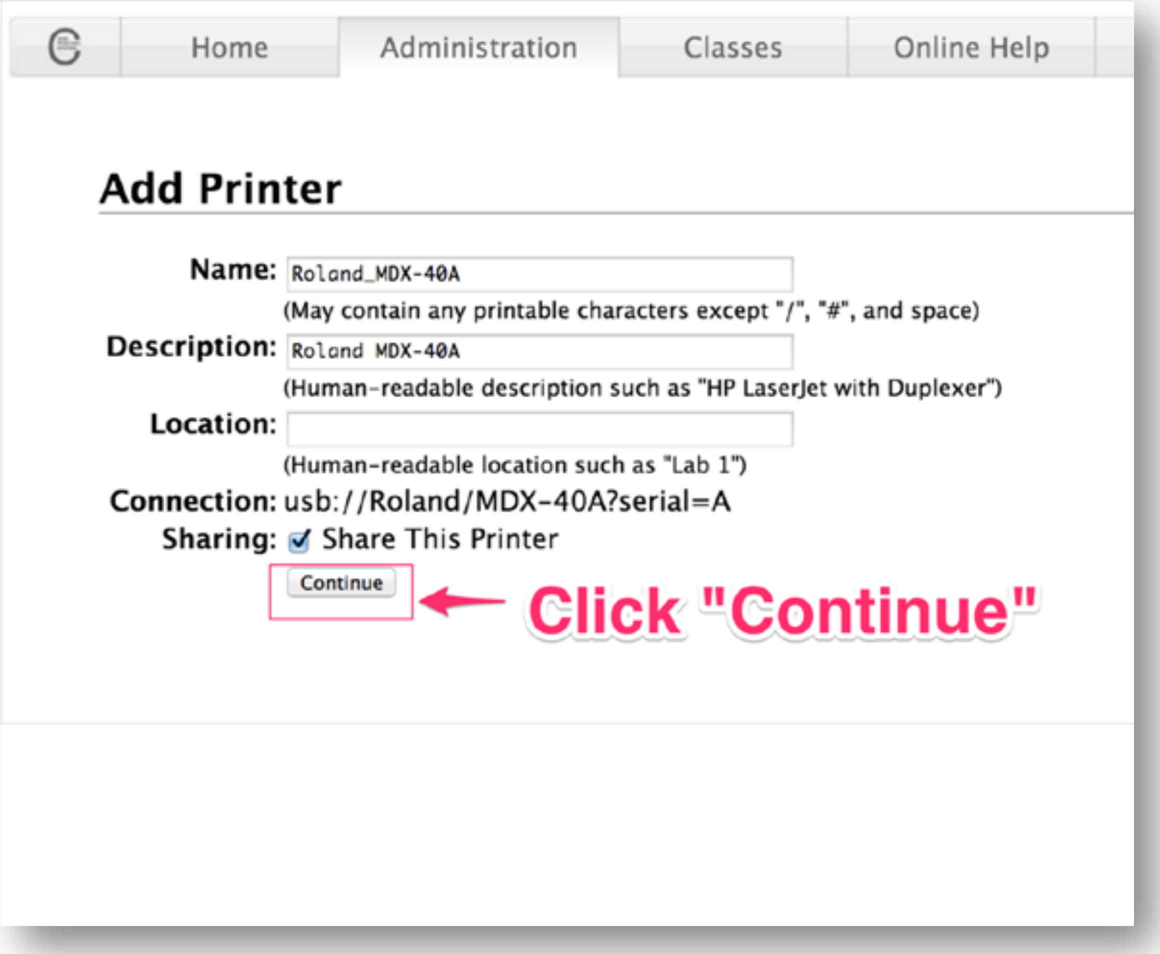
Discovered Network Printers:

Other Network Printers:
○ EPSON TCPIP
○ IPP (Internet Printing Protocol) (http)
○ IPP (Internet Printing Protocol) (https)
○ IPP (Internet Printing Protocol) (ipp)
○ IPP (Internet Printing Protocol) (ipps)
○ LPD/LPR ホストまたはプリンタ
○ Windows printer via spoolss
○ AppSocket/HP JetDirect

Select Roland MDX-40A

Click "Continue"

Click “Continue” to proceed.



Add Printer

Name: Roland_MDX-40A
(May contain any printable characters except "/", "#", and space)

Description: Roland MDX-40A
(Human-readable description such as "HP LaserJet with Duplexer")

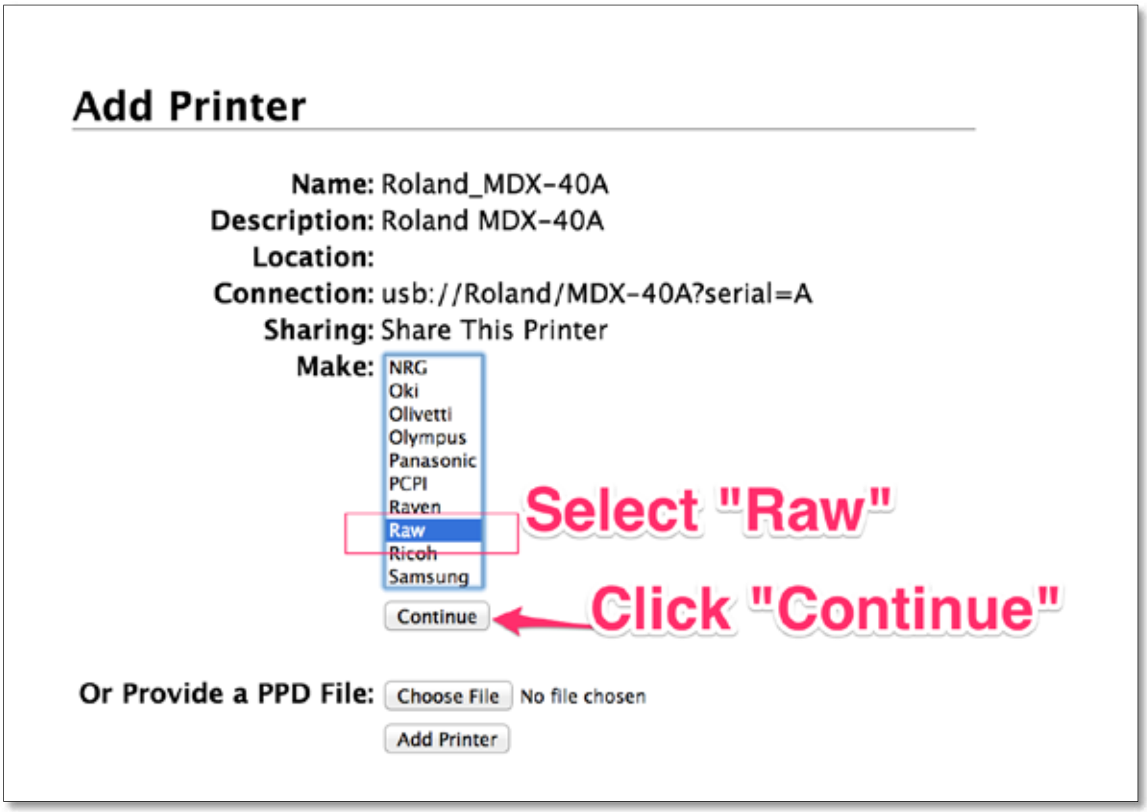
Location:
(Human-readable location such as "Lab 1")

Connection: usb://Roland/MDX-40A?serial=A

Sharing: ☑ Share This Printer

Click "Continue"

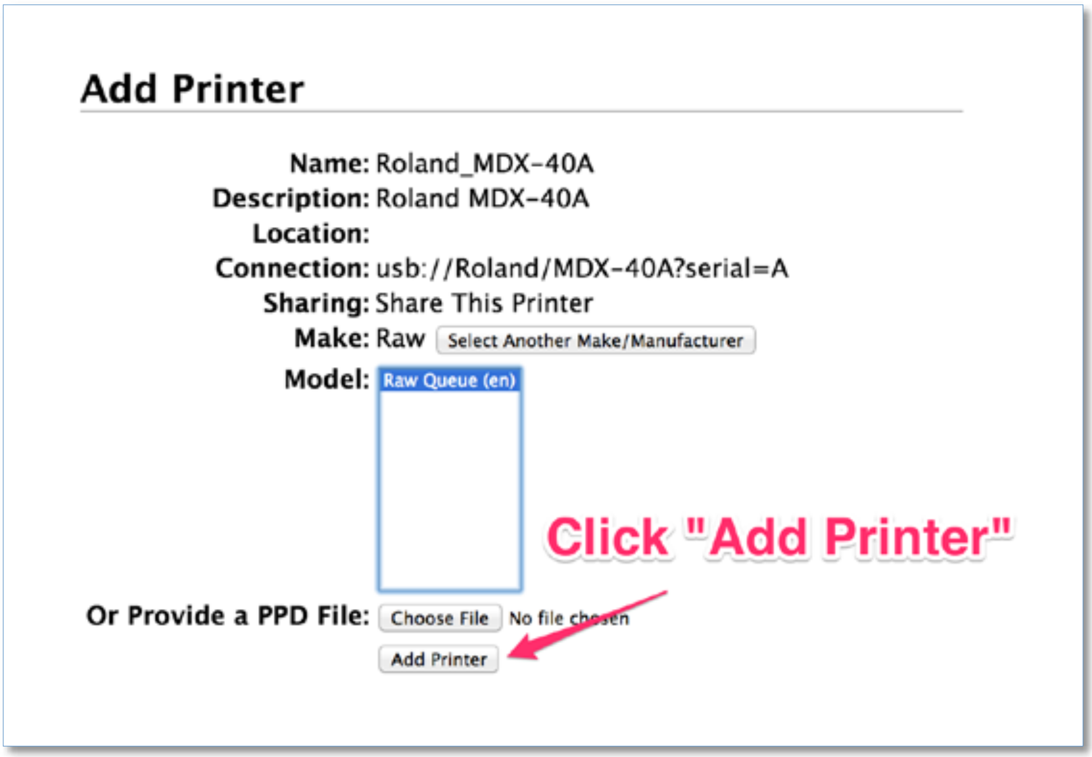
Select “Raw” and click “Continue”.



Add Printer

Name: Roland_MDX-40A
Description: Roland MDX-40A
Location:
Connection: usb://Roland/MDX-40A?serial=A
Sharing: Share This Printer
Make: Raw

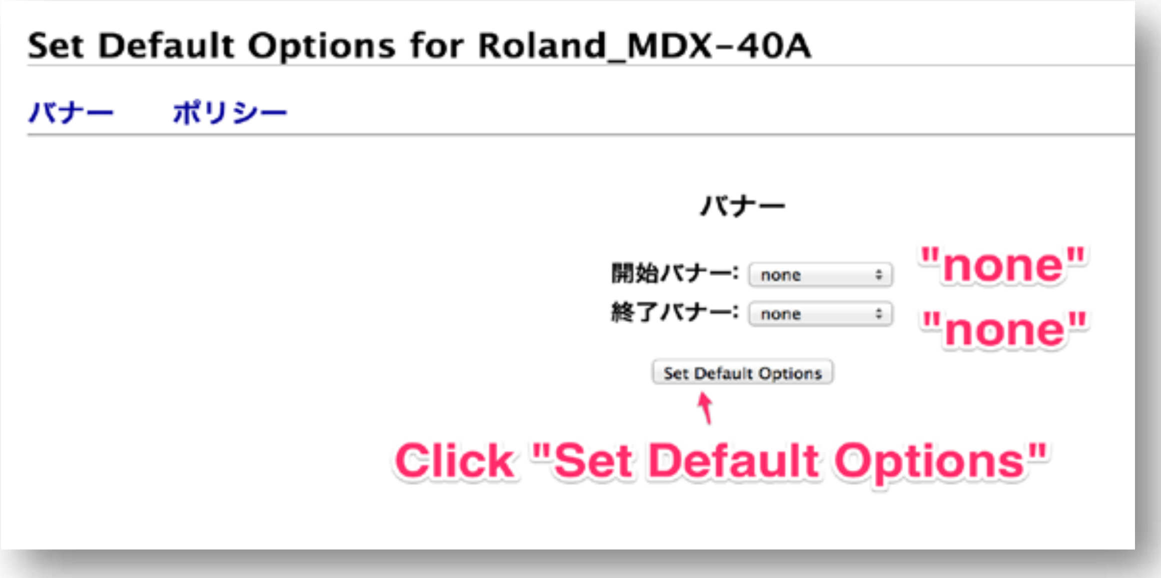
Check if “Raw queue” is selected. Click “Continue”.



Add Printer

Name: Roland_MDX-40A
Description: Roland MDX-40A
Location:
Connection: usb://Roland/MDX-40A?serial=A
Sharing: Share This Printer
Make: Raw
Model: Raw Queue (en)

Click “Set Default Options”. You don’t have to change the default values.



Set Default Options for Roland_MDX-40A

バナー　ポリシー

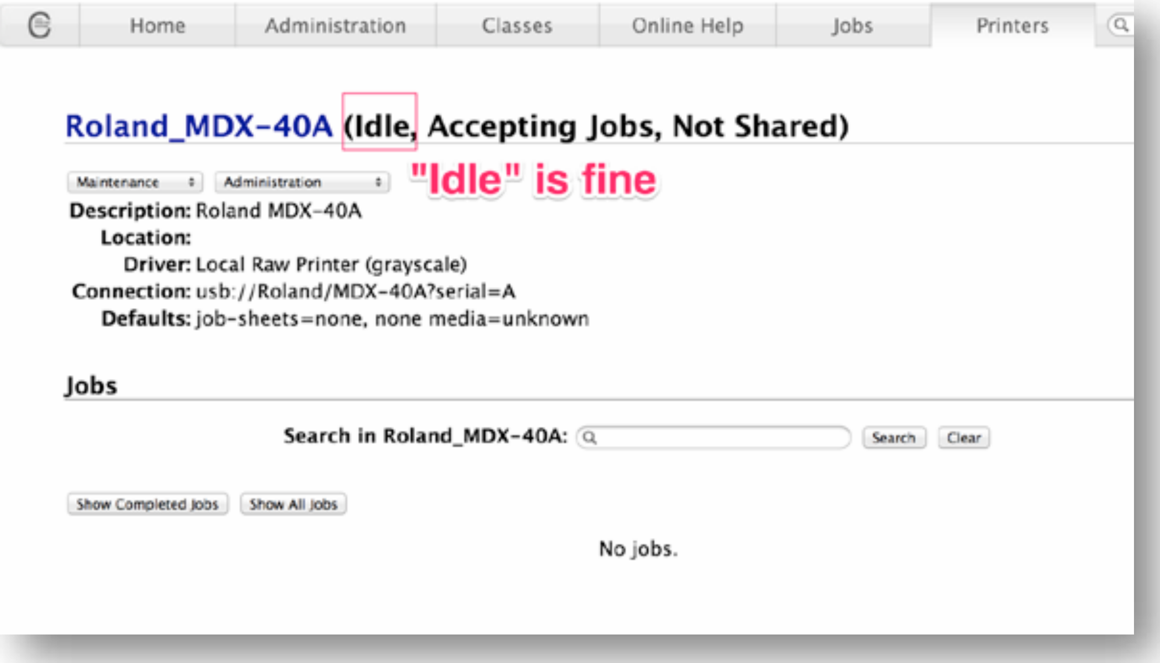
バナー

開始バナー: none

終了バナー: none

Set Default Options

Now you successfully configured CUPS. Added printer is supposed to be named as “Roland_MDX-40A”, and the status should be “Idle”.



Roland_MDX-40A (Idle, Accepting Jobs, Not Shared)

Description: Roland MDX-40A
Location:
Driver: Local Raw Printer (grayscale)
Connection: usb://Roland/MDX-40A?serial=A
Defaults: job-sheets=none, none media=unknown

Jobs

Search in Roland_MDX-40A:

No jobs.

7. Change scale of RML with Python script

The RML files we created in the previous section work fine for MDX-15/20. However, we found out that we have to modify the values of X, Y and Z in the RML files, when we use these files with MDX-40A.

For this, I created the Python script. Save the following text and name it as “scale.py”.

(Make sure that the indentation is complete the same as the text shown below. Python language is sensitive for indentations).

scale.py

```
#!/usr/bin/env python

#-*- coding: utf-8 -*-

import re

import math

print """

###########################################

*** RML scaling script ***

2014 May, Shohei Aoki

For the sake of MDX-40A users and so on...

If you have any problem, please contact:

Shohei Aoki / shoaok [at] GMAIL.COM

###########################################

"""

#scale = 2.3

scale = raw_input("Input the scale you want (default 2.48): ")

if scale == "":

    scale = 2.48

else:

    try:

        scale = float(scale)
    except:
        print "Input a valid number!! Aborting."
        exit()
pu = re.compile("^PU")
z = re.compile("^Z")
input = raw_input("RML file name to convert?: ")
if input == "":
   print "No input file specified. Exit."
   exit()
fin = open(input)
output = raw_input("Output file name?: ")
if output == "":
    fout = open('out.rml','w')
else:
    fout = open(output,'w')
for line in fin:
    newline = -1
if not pu.match(line) == None:
        lat = line.split('PU')[1]
        x = lat.split(',')[0]
        y = lat.split(',')[1].split(';')[0]
        sx = int(int(x) * scale)
        sy = int(int(y) * scale)
        print 'Convert x:'+str(x)+"->"+str(sx)+", Convert y:"+str(y)+"->"+str(sy)
        newline = "PU"+str(sx)+","+str(sy)+";¥n"
elif not z.match(line) == None:
        lat = line.split('Z')[1]
        x = lat.split(',')[0]
        y = lat.split(',')[1].split(';')[0]
        depth = lat.split(',')[2].split(';')[0]
        sx = int(int(x) * scale)
        sy = int(int(y) * scale)
        print 'Convert x:'+str(x)+"->"+str(sx)+", Convert y:"+str(y)+"->"+str(sy)

        newline = "Z"+str(sx)+","+str(sy)+","+depth+";¥n"

if newline == -1:

        fout.write(line)

else:

        fout.write(newline)

        print

        print

        print "Successfully processed. Exit."

fout.close()
```

Open a terminal and change directory to the folder you put the scale.py script.

$ cd /path/to/file_location

Run python with following command.

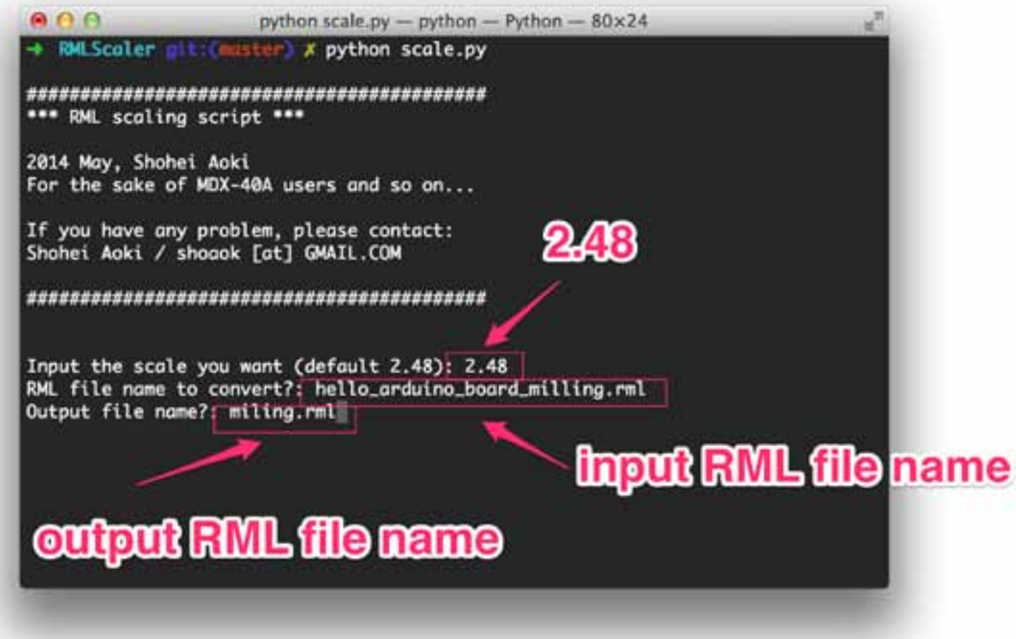
$ python scale.py

Then you will be prompted to input some information.
By default, just put the values as shown in the figure.

Input the scale you want (default 2.48): **2.48**

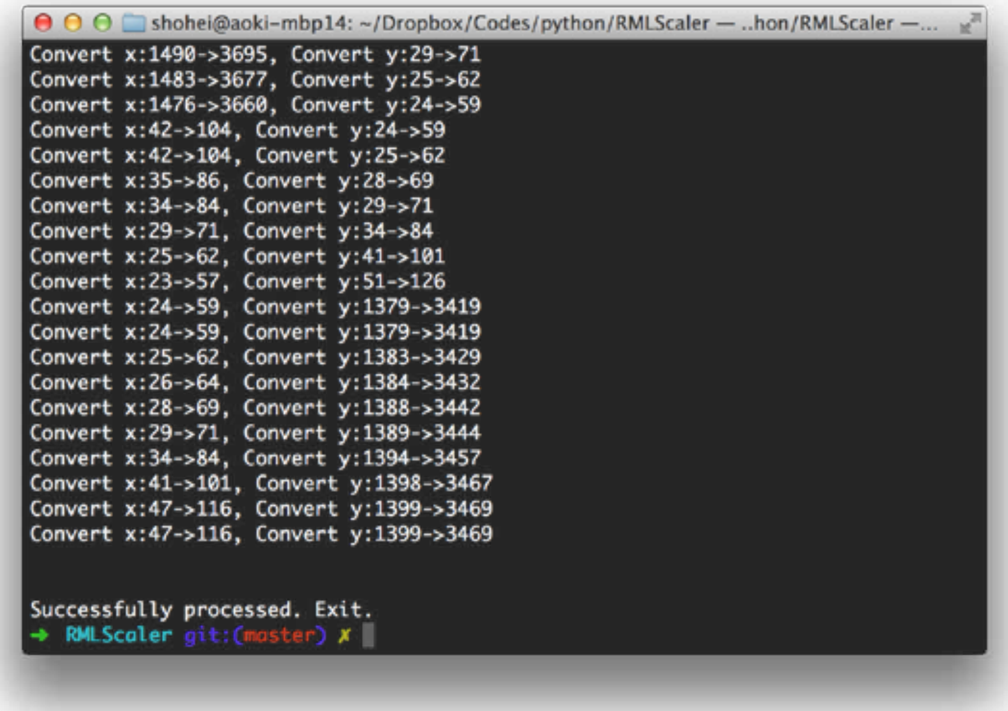
RML file to convert ?: **input_filename.rml**

Output file name?: **output_filename.rml**



```
python scale.py — python — Python — 80×24
➜ RMLScaler git:(master) ✗ python scale.py

############################################
*** RML scaling script ***

2014 May, Shohei Aoki
For the sake of MDX-40A users and so on...

If you have any problem, please contact:
Shohei Aoki / shoaok [at] GMAIL.COM

############################################


Input the scale you want (default 2.48): 2.48
RML file name to convert?: hello_arduino_board_milling.rml
Output file name?: miling.rml
```

Hit enter, and the dimension will be magnified 2.48 times as large as the original size.


shohei@aoki-mbp14: ~/Dropbox/Codes/python/RMLScaler — ..hon/RMLScaler —...

```
Convert x:1490->3695, Convert y:29->71
Convert x:1483->3677, Convert y:25->62
Convert x:1476->3660, Convert y:24->59
Convert x:42->104, Convert y:24->59
Convert x:42->104, Convert y:25->62
Convert x:35->86, Convert y:28->69
Convert x:34->84, Convert y:29->71
Convert x:29->71, Convert y:34->84
Convert x:25->62, Convert y:41->101
Convert x:23->57, Convert y:51->126
Convert x:24->59, Convert y:1379->3419
Convert x:24->59, Convert y:1379->3419
Convert x:25->62, Convert y:1383->3429
Convert x:26->64, Convert y:1384->3432
Convert x:28->69, Convert y:1388->3442
Convert x:29->71, Convert y:1389->3444
Convert x:34->84, Convert y:1394->3457
Convert x:41->101, Convert y:1398->3467
Convert x:47->116, Convert y:1399->3469
Convert x:47->116, Convert y:1399->3469


Successfully processed. Exit.
➜  RMLScaler git:(master) ✗
```

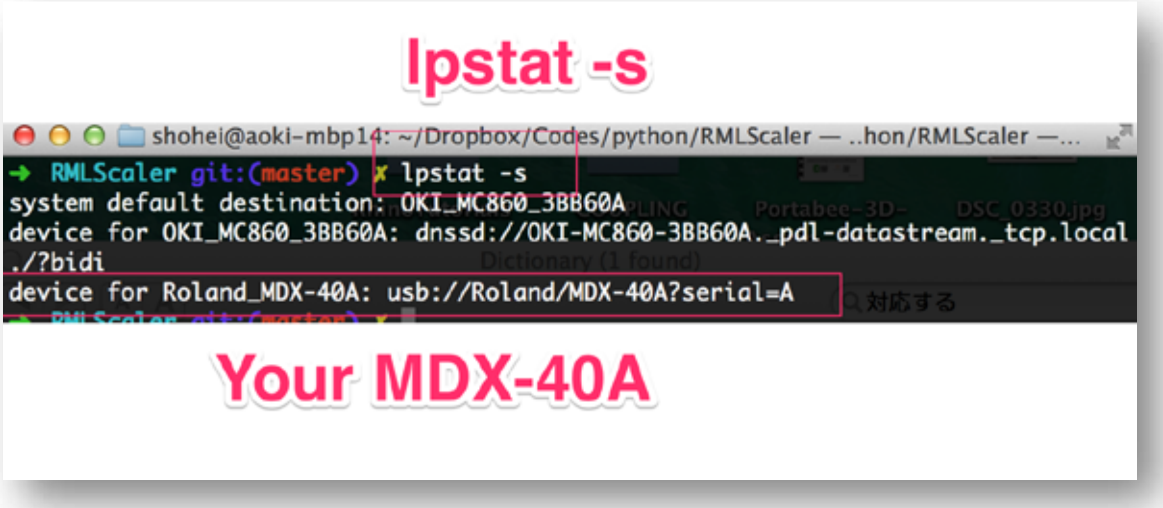
Do the same thing for a RML file of cutting outline.

Make sure you have two modified RML files now. You are ready to print them with MDX-40A.

8. Send RML data to MDX-40A

Attach 1/64” end mill to the spindle and set X,Y,Z origin using VPanel.
Disconnect USB cable of MDX-40A from Windows PC and connect it to Ubuntu PC.
You can check if your PC is recognizing your MDX-40A with following command. Open terminal and type “lpstat -s”.

```
$ lpstat –s
> device for Roland_MDX-40A: usb://Roland/MDX-40A?serial=A
```



```
shohei@aoki-mbp14: ~/Dropbox/Codes/python/RMLScaler — ..hon/RMLScaler —...
→ RMLScaler git:(master) ✗ lpstat -s
system default destination: OKI_MC860_3BB60A
device for OKI_MC860_3BB60A: dnssd://OKI-MC860-3BB60A._pdl-datastream._tcp.local
./?bidi
device for Roland_MDX-40A: usb://Roland/MDX-40A?serial=A
```

Go to the directory where the RML files are located.
Use lpr command to send the RML to the printer.

```
$ lpr –P Roland_MDX-40A milling_data.rml
```

Usually it takes about 30 minutes or so to finish milling, depending on the complexity of your PCB layout.

After milling the PCB layout, change the end mill to 1/32” and set the Z origin. You should not change the X and Y origin at the moment.

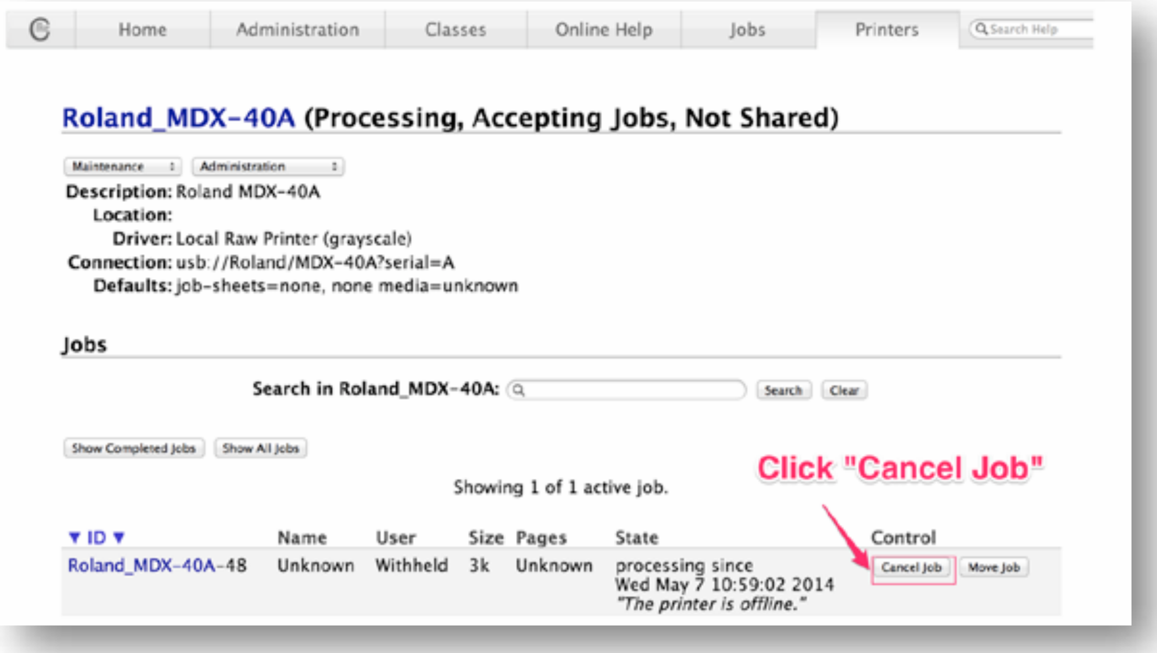
Send the RML data to cut out the board, in the same way.

```
$ lpr –P Roland_MDX-40A cut_out_board_data.rml
```

9. Troubleshooting

1. Cancel job

If you want to cancel a job, you can do it from CUPS.
Go to the following location and click “cancel job”.
http://localhost:631/printers/Roland_MDX-40A



Roland_MDX-40A (Processing, Accepting Jobs, Not Shared)

Description: Roland MDX-40A
Location:
Driver: Local Raw Printer (grayscale)
Connection: usb://Roland/MDX-40A?serial=A
Defaults: job-sheets=none, none media=unknown

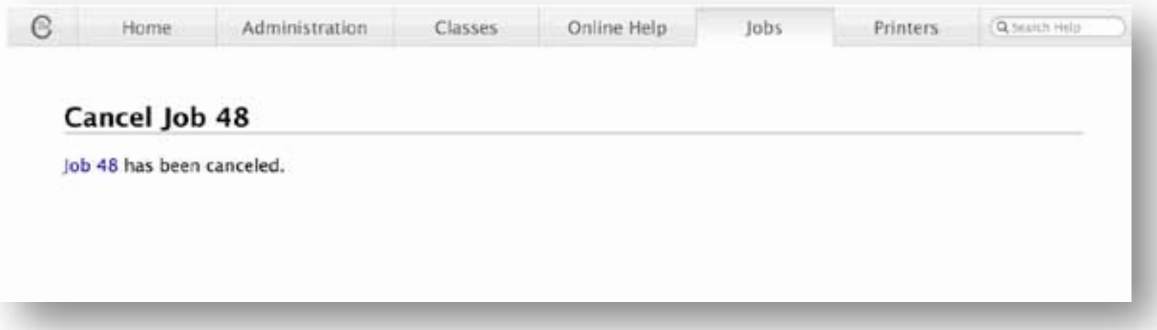
Jobs

Search in Roland_MDX-40A:

Showing 1 of 1 active job.

▼ ID ▼	Name	User	Size	Pages	State	Control
Roland_MDX-40A-48	Unknown	Withheld	3k	Unknown	processing since Wed May 7 10:59:02 2014 *"The printer is offline."*	Cancel Job Move Job

The job is canceled.



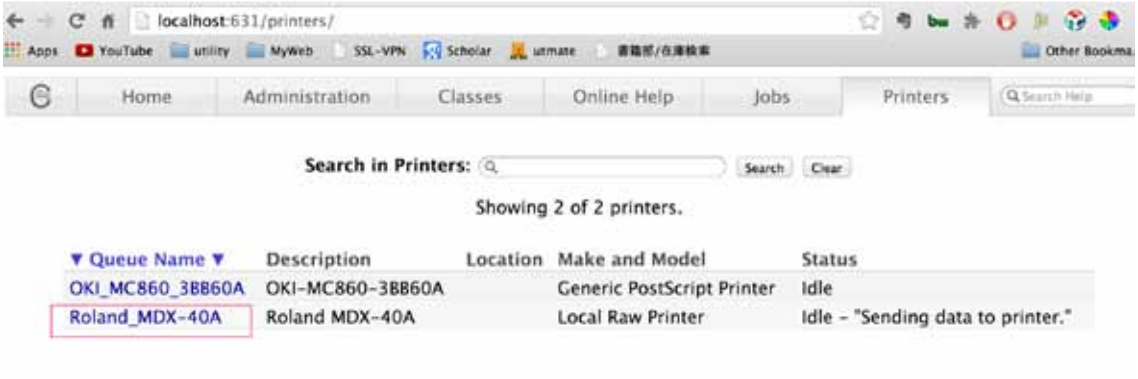
Cancel Job 48

Job 48 has been canceled.

2. Printer is paused

lpr command doesn’t run if the printer status is “Paused”.
This usually occurs after you push emergency stop of MDX-40A.
To resume printer, go to CUPS configuration page. Open following URL in your web browser:
http://localhost:631/printers/

Click Roland_MDX-40A.

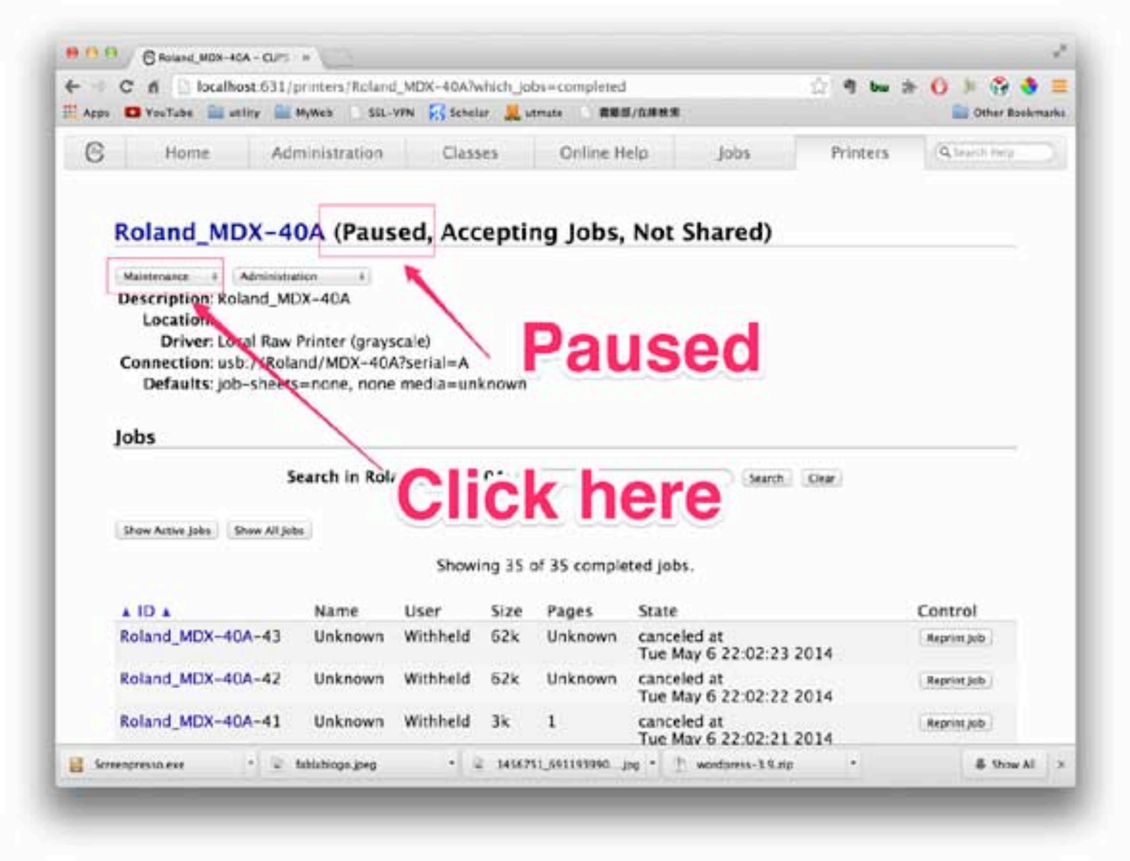


Search in Printers:

Showing 2 of 2 printers.

▼ Queue Name ▼	Description	Location	Make and Model	Status
OKI_MC860_3BB60A	OKI-MC860-3BB60A		Generic PostScript Printer	Idle
Roland_MDX-40A	Roland MDX-40A		Local Raw Printer	Idle - "Sending data to printer."

If the printer state is “Paused”, you have to resume it.
(Otherwise it is no problem.)
Select “Resume printer”. You will be promted to enter your user name and password. Enter the information and the printer will be resumed.



Roland_MDX-40A (Paused, Accepting Jobs, Not Shared)

Description: Roland_MDX-40A
Location:
Driver: Local Raw Printer (grayscale)
Connection: usb://Roland/MDX-40A?serial=A
Defaults: job-sheets=none, none media=unknown

Jobs

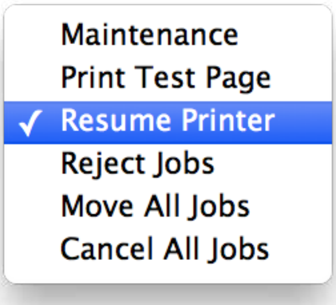
Search in Rol

Showing 35 of 35 completed jobs.

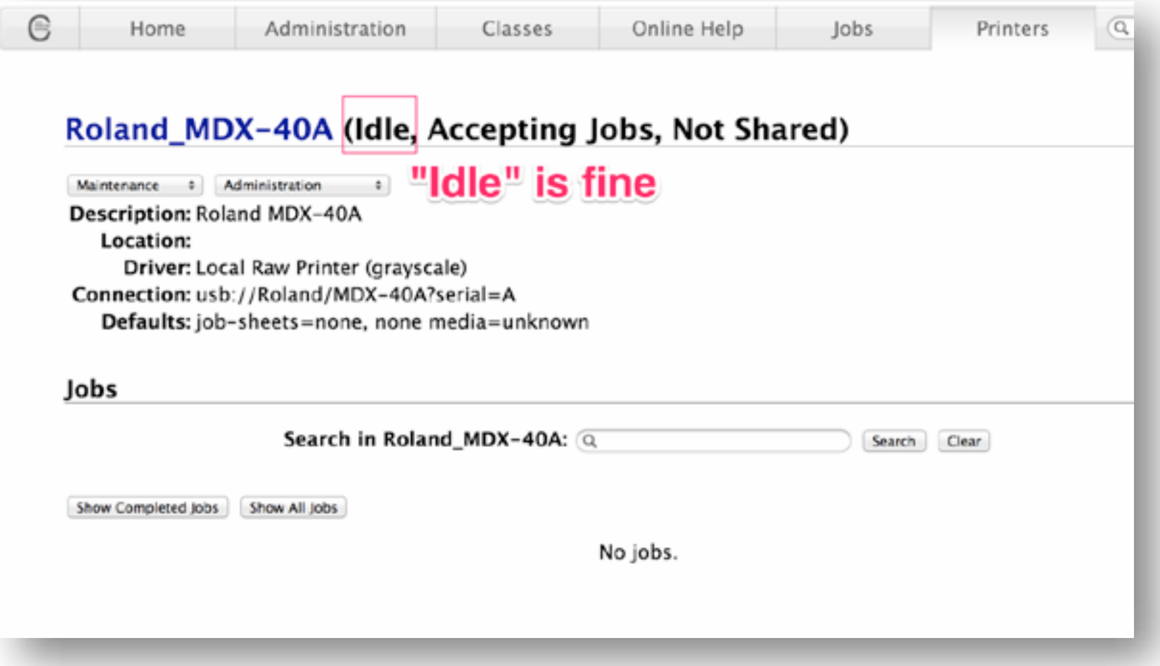
▲ ID ▲	Name	User	Size	Pages	State	Control
Roland_MDX-40A-43	Unknown	Withheld	62k	Unknown	canceled at Tue May 6 22:02:23 2014	Reprint Job
Roland_MDX-40A-42	Unknown	Withheld	62k	Unknown	canceled at Tue May 6 22:02:22 2014	Reprint Job
Roland_MDX-40A-41	Unknown	Withheld	3k	1	canceled at Tue May 6 22:02:21 2014	Reprint Job

Paused

Click here



Check if the printer is “Idle” now.



Roland_MDX-40A (Idle, Accepting Jobs, Not Shared)

Description: Roland MDX-40A
Location:
Driver: Local Raw Printer (grayscale)
Connection: usb://Roland/MDX-40A?serial=A
Defaults: job-sheets=none, none media=unknown

Jobs

Search in Roland_MDX-40A:

No jobs.