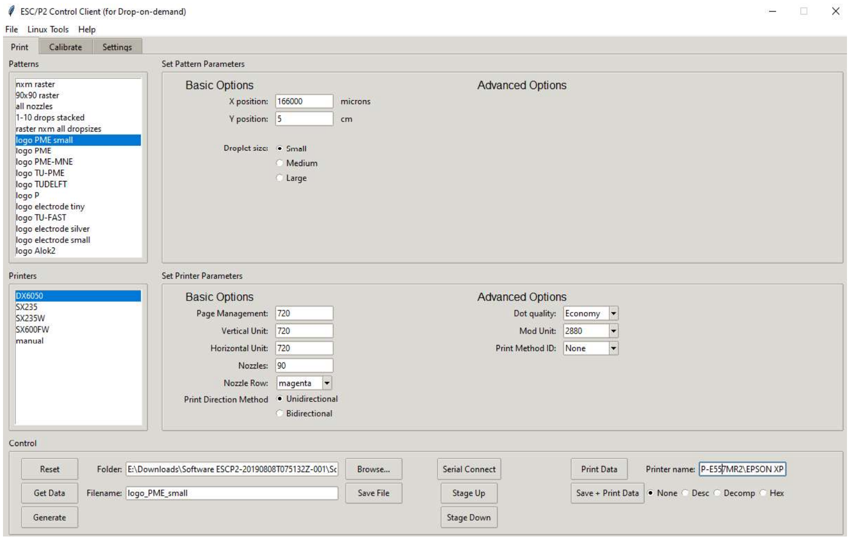
A | Step by step guide Epson Printer

Setup virtual enviroment and ESCP-tweak This chapter is a detailed description of how to print using the Hacked Epson printer using the ESCP-tweak software. The manual will start with the software side and continu with the hardware steps. The Tweak ESCP software is run using python V3 and its is recommended to run in a virtual enviroment. This manual will run the virtual environment using Anaconda and the script using Spyder. Create a new virtual enviroment for the Epson printer based on python V3 and the following packages.
○ Pillow
○ Pyserial
○ Tk
○ Prettytable (requires installation through the terminal using the following command:
"conda install -c conda-forge prettytable". The terminal can be accessed through the arrow symbol next to your virtual environment. Now start the Spyder and run main_gui.py

Setup Network printer
The network location and the printer is required to as input for the Gaphical User Interface (GUI) Figure A.1 to be able to parse the print file to the printer. It is also recommended to hardcode this location into the script in line 2071. Figure A.2.



Patterns
nxm raster
90x90 raster
all nozzles
1-10 drops stacked
raster nxm all dropsizes
logo PME small
logo PME
logo PME-MNE
logo TU-PME
logo TUDELFT
logo P
logo electrode tiny
logo TU-FAST
logo electrode silver
logo electrode small
logo Alok2

Set Pattern Parameters
Basic Options
X position: 166000 microns
Y position: 5 cm
Droplct size: ● Small ○ Medium ○ Large
Advanced Options

Printers
DX6050
SX235
SX235W
SX600FW
manual

Set Printer Parameters
Basic Options
Page Management: 720
Vertical Unit: 720
Horizontal Unit: 720
Nozzles: 90
Nozzle Row: magenta
Print Direction Method ● Unidirectional ○ Bidirectional
Advanced Options
Dot quality: Economy
Mod Unit: 2880
Print Method ID: None

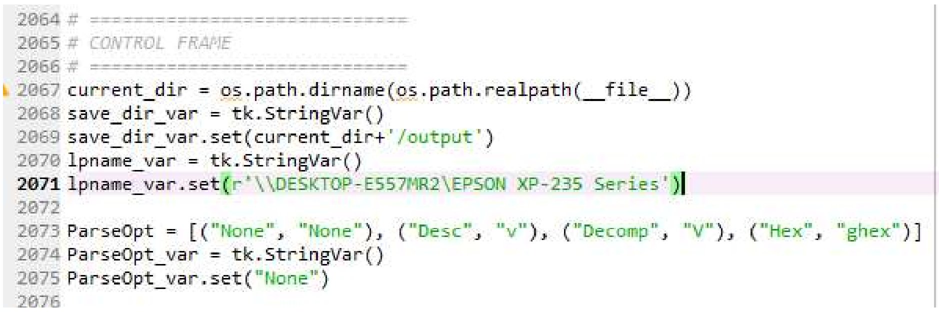
Control
Folder: E:\Downloads\Software ESCP2-20190808T075132Z-001\Sc
Filename: logo_PME_small
Printer name: P-E557MR2\EPSON XP
● None ○ Desc ○ Decomp ○ Hex

Figure A.1: the ESCP-Tweak Graphical User interface.

Using the GUI several print settings can be set according to the scripting of the print pattern. Options include: which color to use, the droplet size and the X and Y position of the print pattern. The Y position change is limited and only possible while printing with a small number of nozzle, it relies on changing the starting nozzle number. By selecting print, a print file will be parsed and send to the printer.

Scripting
The hard coding is done in 3 different sections of the main_gui script. The pattern names listed in Figure A.3 are available in the GUI, they can be defined from line 1344. These parameters define the default values when opening a specific pattern and most importantly the command variable refer to the print pattern definition. The print pattern definitions shown in Figure A.4 can either be used to create simple script, simular to line 356-368, or refer to the create definition, called in line 373, which is discussed in the next section.

Figure A.5 illustrates a brief example script for printing the letter *P*. The start of the script defines the spacing of the droplets. The separation between the individual nozzles is 1/120 inch; therefor there is no control over the *dy* direction,

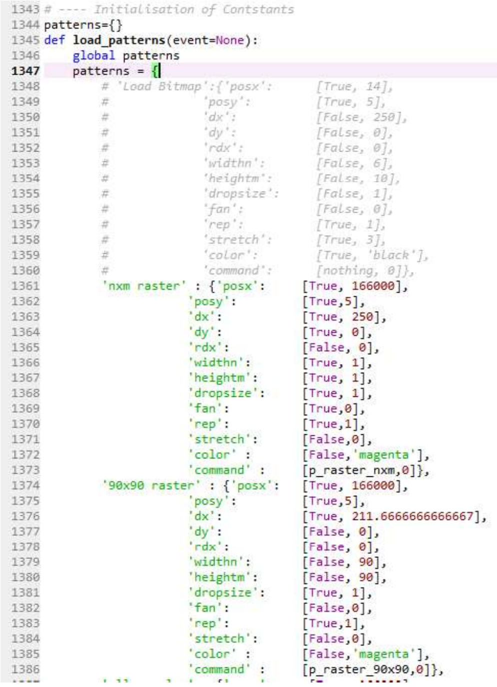


```
# ==============================
# CONTROL FRAME
# ==============================
current_dir = os.path.dirname(os.path.realpath(__file__))
save_dir_var = tk.StringVar()
save_dir_var.set(current_dir+'/output')
lpname_var = tk.StringVar()
lpname_var.set(r'\\DESKTOP-E557MR2\EPSON XP-235 Series')

ParseOpt = [("None", "None"), ("Desc", "v"), ("Decomp", "V"), ("Hex", "ghex")]
ParseOpt_var = tk.StringVar()
ParseOpt_var.set("None")

```

Figure A.2: Example of how to hardcode the printer location in the ESCP-tweak



```
# ---- Initialisation of Contstants
patterns={}
def load_patterns(event=None):
    global patterns
    patterns = {
        # 'Load Bitmap':{'posx':       [True, 14],
        #              'posy':         [True, 5],
        #              'dx':           [False, 250],
        #              'dy':           [False, 0],
        #              'rdx':          [False, 0],
        #              'widthn':       [False, 6],
        #              'heightm':      [False, 10],
        #              'dropsize':     [False, 1],
        #              'fan':          [False, 0],
        #              'rep':          [True, 1],
        #              'stretch':      [True, 3],
        #              'color':        [True, 'black'],
        #              'command':      [nothing, 0]},
        'nxm raster' : {'posx':      [True, 166000],
                      'posy':        [True,5],
                      'dx':          [True, 250],
                      'dy':          [True, 0],
                      'rdx':         [False, 0],
                      'widthn':      [True, 1],
                      'heightm':     [True, 1],
                      'dropsize':    [True, 1],
                      'fan':         [True,0],
                      'rep':         [True,1],
                      'stretch':     [False,0],
                      'color' :      [False,'magenta'],
                      'command' :    [p_raster_nxm,0]},
        '90x90 raster' : {'posx':    [True, 166000],
                      'posy':        [True,5],
                      'dx':          [True, 211.6666666666667],
                      'dy':          [False, 0],
                      'rdx':         [False, 0],
                      'widthn':      [False, 90],
                      'heightm':     [False, 90],
                      'dropsize':    [True, 1],
                      'fan':         [False,0],
                      'rep':         [True,1],
                      'stretch':     [False,0],
                      'color' :      [False,'magenta'],
                      'command' :    [p_raster_90x90,0]},
```

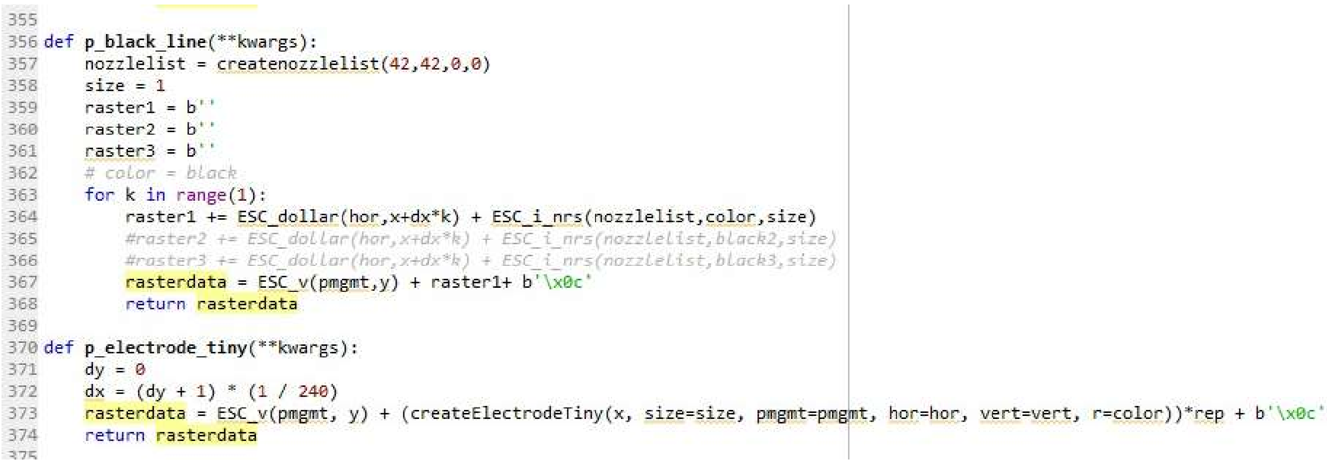
Figure A.3: Script defines the print patterns available in the ESPC GUI.

line 3. However, the distance between vertical lines can be controlled by changing the dx value, line 4, change from 1/120 to 1/240, reduces the drop spacing by half, alternatively this can be set location of the nozzle lists, line 20-22, by changing the value before dx. In this example, there is equal spacing in x and y directions given that $dx = 1/120 Inch$. With the list definition, line 7-9, different nozzles can be selected for the vertical print lines. The letter P in this example is printed using three vertical lines. The first list addresses nozzles 1-5 of the available 42 nozzles in each colour. The second list addresses only two nozzles, and the third addresses three nozzles. The image is created by determining the horizontal position of the nozzle lists, line 20-22. Furthermore, for every nozzle list a specific colour can be selected from the graphical user interface (GUI), representing the different inks, if the value is set to r like line 20, however by hard coding the color like line 21 and 22, the GUI input value have no effect. To print with different inks or colours at the same time, the colours must be hard coded. In addition, droplet sizes can be selected based on the three available options from the Epson firmware. These can again be hard code, specifying, small, medium or large or selected using the GUI, by inputting size.

The print pattern definition, contains all values required to produce a specific print patterns.

Printing

Place a glass microscopic slide on the left side of the printer, in the case of printing with the printer modified for this project. There is a slot at the bottom where the glass slides fits level with the bottom of the printer Figure A.6. The print location for this glass slide is between 110000-190000 microns in the ESPC-Tweak GUI. Otherwise, remove the bottom of the printer using a screw at both sides. Cut the removed part in half and place the right side of the bottom back, this is required for the paper not to get stuck during printing and fill the gap on the left side till the right height. Even though printing on a solid substrate, the printer has a internal paper feed sensor which needs to be tricked. By cutting A4 in $\frac{1}{3}$ strips in the lengthwise direction. These strips can then be place on the right side of the printer. During the printing process the printer will feed

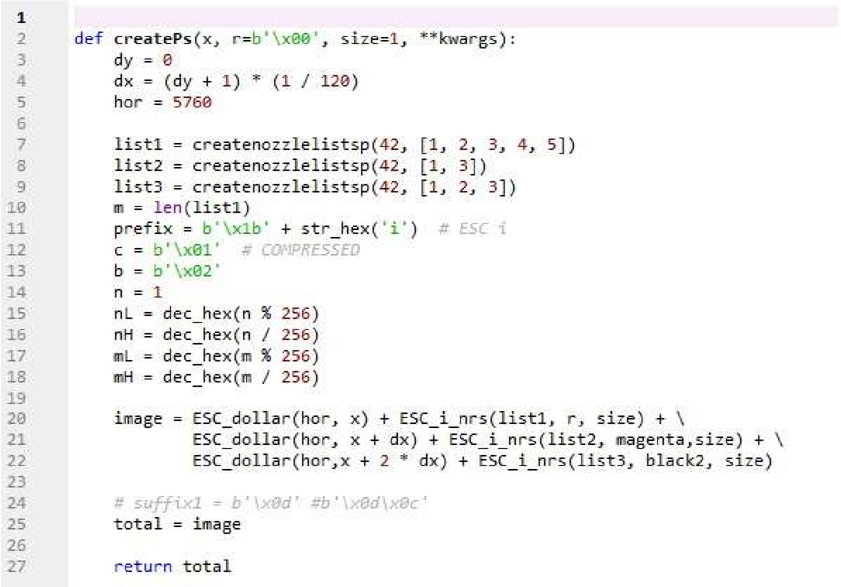


```python

def p_black_line(**kwargs):
    nozzlelist = createnozzlelist(42,42,0,0)
    size = 1
    raster1 = b''
    raster2 = b''
    raster3 = b''
    # color = black
    for k in range(1):
        raster1 += ESC_dollar(hor,x+dx*k) + ESC_i_nrs(nozzlelist,color,size)
        #raster2 += ESC_dollar(hor,x+dx*k) + ESC_i_nrs(nozzlelist,black2,size)
        #raster3 += ESC_dollar(hor,x+dx*k) + ESC_i_nrs(nozzlelist,black3,size)
        rasterdata = ESC_v(pmgmt,y) + raster1+ b'\x0c'
        return rasterdata

def p_electrode_tiny(**kwargs):
    dy = 0
    dx = (dy + 1) * (1 / 240)
    rasterdata = ESC_v(pmgmt, y) + (createElectrodeTiny(x, size=size, pmgmt=pmgmt, hor=hor, vert=vert, r=color))*rep + b'\x0c'
    return rasterdata
```

Figure A.4: Caption



```python

def createPs(x, r=b'\x00', size=1, **kwargs):
    dy = 0
    dx = (dy + 1) * (1 / 120)
    hor = 5760

    list1 = createnozzlelistsp(42, [1, 2, 3, 4, 5])
    list2 = createnozzlelistsp(42, [1, 3])
    list3 = createnozzlelistsp(42, [1, 2, 3])
    m = len(list1)
    prefix = b'\x1b' + str_hex('i')  # ESC i
    c = b'\x01'  # COMPRESSED
    b = b'\x02'
    n = 1
    nL = dec_hex(n % 256)
    nH = dec_hex(n / 256)
    mL = dec_hex(m % 256)
    mH = dec_hex(m / 256)

    image = ESC_dollar(hor, x) + ESC_i_nrs(list1, r, size) + \
            ESC_dollar(hor, x + dx) + ESC_i_nrs(list2, magenta,size) + \
            ESC_dollar(hor,x + 2 * dx) + ESC_i_nrs(list3, black2, size)

    # suffix1 = b'\x0d' #b'\x0d\x0c'
    total = image

    return total
```

Figure A.5: Example script for printing a letter P, constructed out of 3 vertical lines, consisting out of 10 drops in total.

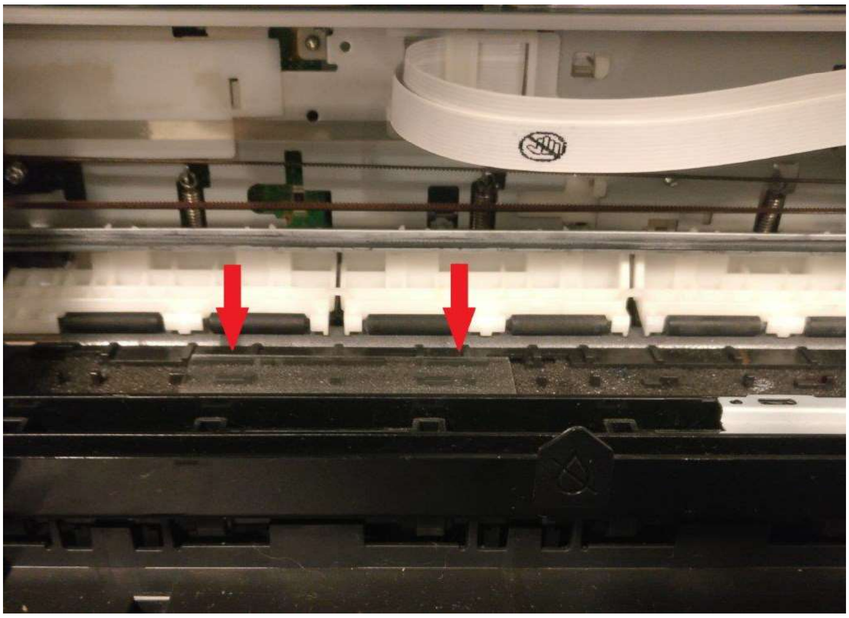


Figure A.6: Epson printer with indication of glasslide location.

a paper sheet through, satisfying the paper sensor condition, in a region not interesting for the actual print process. After printing the printhead will move to a resting position on the right side of the printer. **Be aware** the printhead will still move after a few minutes and hit you trying to take out the sample. Only once it is fully inside the housing of the printer, the printhead is at rest!

B | Cleaning the Epson printhead

This appendix will describe different cleaning techniques for the Epson printhead, which will have to be frequently performed to be able to have all 254 nozzle unclogged.

Software purging

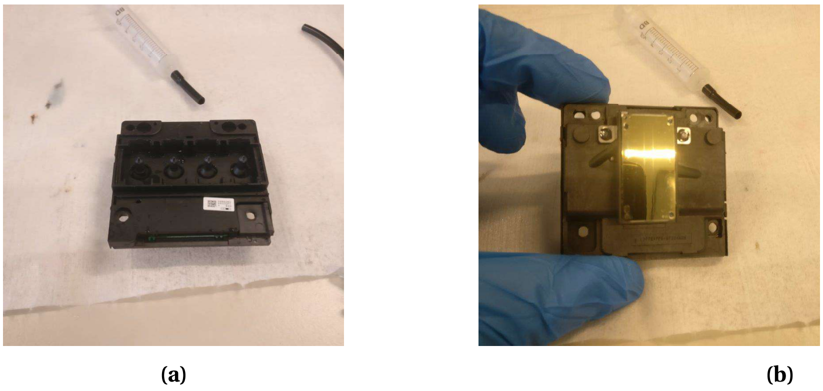
The fastest way to unclog the nozzle is by running a nozzle cleaning cycle, which becomes available after installing the Epson firmware. This will take several minutes and its effectiveness depends on the Ink present in the cartridge.

Flushing with a pippet

One of the best ways to get a good print results is to flush the nozzles with the print ink using a 5.8mm plastic pipet. Move the printhead out of its storing position. Place a piece of Tork paper onto the bottom of the printer and move the printhead over it. Take the ink cartridge you want to print with out of the printer and flush with the ink, untill you see wetting of the paper underneath. Perform a test print, a vertical print line with all nozzles activated is the fastest method.

Taking the printhead out

If none of the other options work, the best way to clean the printhead is to take the printhead out of the printer. Use the following youtube movie to see how https://www.youtube.com/watch?v=Xb7Bc1jGIrA. Once the printhead is out. Place it in a glass dish and clean the top side shown in Figure B.1a thoroughly with DI water and Isopropyl . Once the outside is clean we can now clean the nozzle itself. Place the printhead, with nozzle plate down, shown in Figure B.1b. Flush a glass dish with DI water to hopefully remove most of the dust particles and fill it with a thin layer of cleanroom Isopropyl. Using a syringe with black tubing as shown in the Figure B.1b suck the liquid from the glass dish through the nozzles until only clean liquid comes out. The printhead should now be fully cleaned. Install the printhead back into the printer and purge the printhead with the inkjet ink by creating a word document solely in the color of the ink to print with.



(a) (b)

Figure B.1: Printhead of the Epson XP-235 showing in (a) the topside fully cleaned and (b) the nozzle plate