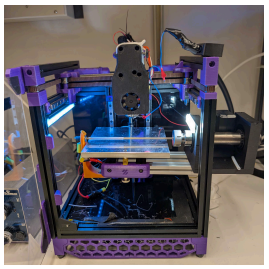
Feb 07, 2025

Addition of a tubular collector to a MEWron melt electrowriting printer



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LMIS1

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OPEN ACCESS

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Protocol status: Working
We use this protocol and it's working

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Abstract

This protocol aims to help researchers and enthusiasts in building a melt electrowriting printer (MEWron) with tubular collector from a Voron printer.
The modification of a FDM printer can potentially be done with many different types but is shown here on a Voron 0.2.

Image Attribution

Materials

- Stepper driver (e.g. https://www.fysetc.com/products/tmc2209-v3-0-uart-stepping-motor-driver-stepsticks-mute-driver-256-microsteps-current-2-8a-peak-vs-tmc2208-tmc2100)
- Jumper cables
- Soldering iron
- Extrusion 15x15x200 mm 2 Misumi: https://rb.gy/j9zq
- Stepper motor 1.5A Nema 17 1 Amazon: https://rb.gy/bcyp
- Shaft gear 20 teeth_2 mm pitch 1 Amazon: https://rb.gy/k7yj
- Chuck bearing ID: 25mm 2 McMaster: https://rb.gy/imp2
- Milling Chuck ST20-NBS8-100 1 Misumi: https://rb.gy/woxz
- Collect 2.5 mm 1 Misumi: https://rb.gy/0v2v
- Timing belt pulley 60 teeth_2 mm pitch 1 Misumi: https://rb.gy/s6x1
- Belt W: 5 mm, 160 mm Length Misumi: https://rb.gy/w5vb
- Tube / Rotary Shaft 2.5 mm 1 McMaster: https://rb.gy/924f
- Tube bearing ID: 2.5mm 1 McMaster: https://rb.gy/ouf6

Safety warnings

In addition to the already substantial and often underappreciated dangers of building and modifying a 3D printer, which involves mains voltage wiring and manually installing and configuring hundreds of watts of electrical heating power into a small box, melt electrowriting (MEW) further introduces a high voltage hazard in the same printer. We thus ask readers to be mindful of these risks and to heed the warnings outlined in the official Voron manuals as well as the following information on safely interacting with high voltage for MEW.

Melt electrowriting requires an electrical potential in the low Kilovolt (kV) regime, and a properly designed system can achieve this easily while operating at below 10 Microamperes (µA) of current. Due to availability, the most used high voltage power supplies have a maximum output of approximately 10 kV and 1 mA, but have their maximum current output reduced to 1% (10 µA) for safe operation in case of arcing or electric shock. Since we anticipate readers to build and experiment with these machines, we ask the readers to err on the side of caution and inform themselves thoroughly based on their specific high voltage sources of the dangers and intricacies of their specific setup before they implement their ideas in practice, and consider safety interlocks, warning lights and proper signage an essential part of their experimental work.

Warning taken from the SI of "MEWron: an Open-Source Melt Electrowriting Platform" (https://doi.org/10.1016/j.addma.2023.103604)

Before start

Read the full protocol before starting and make sure you are accustomed to the work you will perform.
In some regions, work on high voltage may only be performed by authorised personnel.
We always recommend consulting professionals before working on high voltage electrical wiring.
Talk to your local Health and Safety coordinator before conducting any electrical work.
We take no responsibility for any claims, damages, injuries, death, or other liabilities whether in an action of contract, tort or otherwise, arising from, out of or in connection with the protocol or the use or other dealings in the protocol.

Building of a MEWron

1 At first, a MEWron with flat collector should be built.
We recommend applying the high voltage at the nozzle and grounding the collector.
For this, our other protocol can be used:

CITATION

Sönke Menke, Biranche Tandon, Juergen Brugger. Conversion of a Voron FDM printer to a MEWron melt electrowriting printer. protocols.io.
LINK
https://protocols.io/view/conversion-of-a-voron-fdm-printer-to-a-mewron-melt-dmvt466n

3D files can also be found in the corresponsing GitHub:

Dataset

LMIS1 MEWron NAME

https://github.com/EPFL-LMIS1/LMIS1_MEWron/tree/main LINK

2 After building, we recommend printing flat scaffolds to know the printer is working before continuation to modify the printer.

Hardware modification

3 Prior to any modification, we recommend to download the files listed on the GitHub for the tubular MEWron. Please refer to the 3D files for any assembly issues.

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https://github.com/EPFL-LMIS1/LMIS1_MEWron/tree/main LINK

4 Purchase all the parts needed as shown on GitHub or in the SI of Reizabal et al. 2023.

CITATION

Reizabal A, Devlin BL, Paxton NC, Saiz PG, Liashenko I, Luposchainsky S, Woodruff MA, Lanceros-Mendez S, Dalton PD (2023). Melt Electrowriting of Nylon-12 Microfibers with an Open-Source 3D Printer..

LINK

https://doi.org/10.1002/marc.202300424

5 Print all .STL files from the GitHub using the settings recommended to build a Voron.

6 Remove the front door and right side panel from the MEWron, as well as the tophead.

7 Attach the two extrusions underneath the printbed using M3 nuts and bolts.

8 Attach the Mandrel_holder_Lower.stl to the right side of the extrusions, fixing them in width.

9 Assemble the chuck and attach the stepper motor to it using the big bearings and belt. Make sure to point the wires of the motor to the backside of the printer.

10 Attach the mandrel and the Mandrel_support_left.stl on the left underneath the bed. Make sure to have a bearing inserted in the plastic piece.

11 Now you can slide the mandrel in and check if it rotates with the motor upon manual manipulation.

12 Add a HV wire (or ground wire, depending on configuration) to the mandrel using a circular crimped terminal.

The yellow terminals connect the mandrel to the bed, which in itself is grounded via the red terminal.

13 Double check the position of the z-endstop as you have now effectively lowered the range possible to achieve by the printer.

14 Connect the new stepper motor in a free slot on the spyder control board of the printer.
Remember to add an stepper driver and check the voltage supplied to the stepper driver.

15 Double check your work.
Does the Mandrel rotate freely with the motor?
Does the whole config move up and down with the z-axis?
Is the z-endstop triggered when the nozzle touches the mandrel (or in case of alternative positions of the endstop, is this position set to 0)?
Is the mandrel grounded (or attached to a HV source)?
Is the mandrel isolated from other parts (apart from the printbed), especially the stepper motor?

Software modification

16 Start your printer and open the printer.cfg file using an editor of your choosing.

17 You can take the printer_Tubular.cfg file provided on GitHub to compare your work with a working system.

18 Add a new extruder using the "manual stepper" setting from klipper:

Command

Copy this and edit the parameters according to your stepper driver (Klipper)

```
[manual_stepper stepper_1]
step_pin: PE6
dir_pin: !PC13
enable_pin: !PE5
rotation_distance:3
microsteps: 64


#[tmc2209 stepper_1]
[tmc2209 manual_stepper stepper_1]
uart_pin: PC14
interpolate: False
run_current: 0.5
hold_current: 0.3
sense_resistor: 0.110
stealthchop_threshold: 500
```

19 Restart the system and check for errors.
If none occur, check in octoprint with a command like:

```
MANUAL STEPPER=stepper name MOVE=distance SPEED=speed
ACCEL=acceleration SYNC=0.
```

Remember to change stepper name to the name of your stepper (here stepper_1), distance to a value >0, speed to a value like 1, acceleration to a value like 100.

Note

What this command does:

```
MANUAL_STEPPER STEPPER=config_name [ENABLE=[0|1]]
[SET_POSITION=<pos>] [SPEED=<speed>] [ACCEL=<accel>] [MOVE=
<pos> [STOP_ON_ENDSTOP=[1|2|-1|-2]] [SYNC=0]]
```

This command will alter the state of the stepper. Use the ENABLE parameter to enable/disable the stepper. Use the SET_POSITION parameter to force the stepper to think it is at the given position. Use the MOVE parameter to request a movement to the given position. If SPEED and/or ACCEL is specified then the given values will be used instead of the defaults specified in the config file. If an ACCEL of zero is specified then no acceleration will be performed. If STOP_ON_ENDSTOP=1 is specified then the move will end early should the endstop report as triggered (use STOP_ON_ENDSTOP=2 to complete the move without error even if the endstop does not trigger, use -1 or -2 to stop when the endstop reports not triggered). Normally future G-Code commands will be scheduled to run after the stepper move completes, however if a manual stepper move uses SYNC=0 then future G-Code movement commands may run in parallel with the stepper movement.

Explanation taken from klipper: https://www.klipper3d.org/G-Codes.html#manual_stepper_1

20 When the mandrel is moving, you need to fix the rotation_distance value in the printer.cfg file. The value should correspond to a full revolution of the shaft. This value should never change once measured unless the printer.cfg file is changed. The value can be tested using the terminal inside octoprint:

```
MANUAL_STEPPER=stepper_name MOVE=FULL_REVOLUTION SPEED=speed
ACCEL=MANDREL_ACCEL SYNC=0
```

Remember to change stepper name to the name of your stepper from step 18 (here stepper_1), and speed to a value like 1.

21 Double check your work.
More guidance can be found in the report on GitHub, as well as guidance to compute G-codes for the system.

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Printing

22 For printing and code generation, usage of a code generator as the one on GitHub is recommended.

Dataset

LMIS1 MEWron NAME

https://github.com/EPFL-LMIS1/LMIS1_MEWron/tree/main LINK

Further guidance can be found in the protocol below:

CITATION

Sönke Menke, Biranche Tandon, Juergen Brugger. Towards standardisation of parameter reporting for melt electrowriting. protocols.io.
LINK
https://protocols.io/view/towards-standardisation-of-parameter-reporting-for-dkkt4uwn

Protocol references

A. Reizabal, T. Kangur, P. G. Saiz, S. Menke, C. Moser, J. Brugger, P. D. Dalton, S. Luposchainsky, Additive Manufacturing 2023, 71, 103604. DOI **10.1016/j.addma.2023.103604**

MEWron GitHub (EPFL): **https://github.com/EPFL-LMIS1/LMIS1_MEWron**

MEWron GitHub (University of Oregon): https://github.com/mewron/mewron

Stepper driver wiki: **https://wiki.fysetc.com/Silent2209/**

Stepper driver GitHub : https://github.com/Chr157i4n/TMC2209_Raspberry_Pi

Sönke Menke, Biranche Tandon, Juergen Brugger 2024. Conversion of a Voron FDM printer to a MEWron melt electrowriting printer. **protocols.io** https://dx.doi.org/10.17504/protocols.io.q26g71kk3gwz/v1

Citations

Step 1

Sönke Menke, Biranche Tandon, Juergen Brugger. Conversion of a Voron FDM printer to a MEWron melt electrowriting printer
https://protocols.io/view/conversion-of-a-voron-fdm-printer-to-a-mewron-melt-dmvt466n

Step 22

Sönke Menke, Biranche Tandon, Juergen Brugger. Towards standardisation of parameter reporting for melt electrowriting
https://protocols.io/view/towards-standardisation-of-parameter-reporting-for-dkkt4uwn

Step 4

Reizabal A, Devlin BL, Paxton NC, Saiz PG, Liashenko I, Luposchainsky S, Woodruff MA, Lanceros-Mendez S, Dalton PD. Melt Electrowriting of Nylon-12 Microfibers with an Open-Source 3D Printer.
https://doi.org/10.1002/marc.202300424