

Pipette Tool Configuration

Last edited by: Blair, 2023.08.16

A relatively verbose summary of the duet configuration for an OT-2 toolhead. Note that anywhere you see <>, you should remove the greater than/less than signs and fill the field in with information particular to the machine. For more information throughout, see the [Duet GCode Dictionary](#).

1. Set Drive Mapping

```
M584 V<your_drive_number>
```

Define a new axis and tell Duet which drive number you're using. We use the 'V' axis here; if 'V' is already in use, you can also use W/A/B/C. Each driver on the duet boards are labeled ('driver_0', 'driver_1'). Add the number here, and prepend with '1.x' if using an expansion board.

This line should be placed alongside the M584 commands for your other axes in your config file– it has to come before all the other M codes we'll add next.

Example:

```
M584 V1.2 ; pipette plugged into driver 2 on the expansion board
M584 V0   ; pipette plugged into driver 0 on the main board
```

2. Set Stepper Direction

```
M569 P<your_drive_number> S0
```

Set the stepper motor direction. The P field should match the M584 command above. The S field can be either 0 or 1. Add this command alongside the M569 commands for your other motors in your configuration file.

The first time you home the syringe, you should check the direction that it is moving by removing the front plate and watching the draft shaft move. When you first home, it should move towards the endstop. If it is moving the wrong direction: manually engage the endstop, change the S parameter of this line from 0 to 1, and try again. If you don't do this, then the pipette might damage itself as it continues to home in the wrong direction!

Example:

```
M569 V1.2 S0 ; pipette plugged into driver 2 on the expansion board
```

3. Set Motor Current

```
M906 V<peak_current_in_milliamps>
```

Set the peak motor current. For gen1 OT-2 pipettes, this should be 350 milliamps; for gen2, this can be raised to 500 milliamps. Add this command alongside the M906 commands for your other motors in your configuration file.

Example:

```
M906 V350 ; 350mA peak current for gen1 pipette  
M906 V500 ; 500mA peak current for gen2 pipette
```

4. Set Steps per Millimeter & Microstepping

```
M92 V<steps_per_mm>  
M350 V16 I1
```

Set the number of steps per mm and enable 16x microstepping with interpolation. For gen1 pipettes, this should be 48; for gen2 pipettes, 200 (**note:** not yet tested on a gen2!). Add this command alongside the M92 and M350 commands in your configuration file.

While I can't find model numbers & datasheets for these motors online, these numbers match the [OpenTrons API](#):

Gen1: 7.5° step angle and 16x microstepping for the the motor → $(360^\circ/7.5^\circ)*16 = 768$

Gen2: 1.8° step angle and 16x microstepping for the motor → $(360^\circ/1.8^\circ)*16 = 3200$

Example:

```
M92 V48 ; for a gen1 single channel pipette  
M92 V200 ; for a gen2 single channel pipette  
M350 V16 I1 ; set microstepping after M92 command
```

5. Set V Axis Motion Attribute Limits

```
M201 V800  
M203 V10000  
M566 V4000
```

Set the max acceleration (M201), speed (M203) and jerk (M566) for the V axis. Add this command alongside the M201/203/566 commands in your configuration file.

6. Configure Endstop

```
M574 V1 S1 P"^<your_pin_name>"
```

Configure the endstop for the internal pipette limit switch. Note that the carat '^' should be included to enable the pullup resistor, the quotes are necessary, and pins are named as <board_index>.<pin>.in, where pin is labeled on your duet. Add this command alongside the other M574 commands in your configuration file.

Example:

```
M574 V1 S1 P"^0.io3.in" ; pipette endstop plugged into io3 on main board.
```

7. Define Tool

```
M563 P<tool_number> S"<tool_name>"
```

Define your tool! The tool number should be set based on the other tools you already have defined, and you can name your tool whatever human-readable text you'd like to see it as in Duet Web Control.

Note that because we are using the V axis, we do not need to add a D field here (as we might for a syringe or extruder tool).

Example:

```
M563 P1 S"P300 Pipette" ; pipette is tool index 1
```

8. Define Homing Macro

We're now done with our config.g file! Next, we can define the homing routing for the pipette. In Duet Web Control, Navigate to 'System', then add a 'New File' named homev.g. Add the following contents:

```
G91                ; relative moves
G1 V-200 F200 H1    ; big, slow negative move to look for endstop
G1 V1 F100          ; back off endstop
G1 V-10 F100 H1     ; find endstop again, slower
G90                ; absolute moves
```

```
G1 V0.5 F200 ; move to a position of 0.5 to start
```

As mentioned earlier: **The first time you home the syringe, you should check the direction that it is moving by removing the front plate and watching the draft shaft move.** As shown in the image below, the drive shaft should move up and towards the end stop. If you notice the pipette tip ejector starts to engage, then manually stop the motion by pressing the endstop twice (to account for both searches for the endstop in the homing routine), and flip the direction of the motor (see step 2.)



9. Add V homing to homeall

The 'homeall.g' macro is used to home each axis at once. You can call the homev.g macro at the end of this, and the pipette will home while sitting in its parking position. Open homeall.g from the System tab in Duet Web control, and add the following line to the end:

```
M98 P"homev.g"
```

Your pipette should now be configured!

