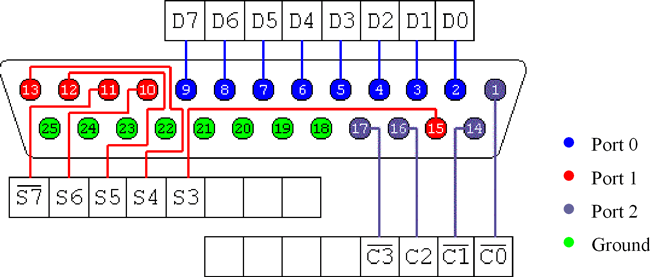
**PARALLEL PORT**

Presentation can send digital outputs and receive digital inputs via the parallel port. But pins on parallel port are floating, so it’s not ideal for using as digital output. We use it only for digital input.

Pins from the parallel port:



Presentation can use these as output pins: 2, 3, 4, 5

Presentation can use these as input pins: 11, 12, 13, 15

Connections to be soldered, from parallel port cable:

Pin 2 not used

Pin 3 not used

Pin 4 not used

Pin 5 not used

Pin 11 not used

Pin 12 --> connect to Lickometer port1 signal

Pin 13 --> connect to Lickometer port2 signal

Pin 15 not used

Pin 25 --> GND of the DAQ unit

**DAQ (Measurement Computing or National Instruments)**

Presentation can send or receive digital inputs/outputs via an DAQ, but not both at the same time. So we only use DAQ for digital outputs.

If using NI DAQ, we may use analog outputs: AO 0, AO 1, USER1, USER2 to send to PClamp synchronize Ephys. But there is no analog output in MCQ-DAQ. The digital output there P0.2 = DIO 2, P0.3 = DIO 3, and so forth.

Connections to be soldered / connected, from DAQ:

GND --> pin 25 of parallel port

GND --> connect to detector PCB

+V0 or +5V --> connect to detector PCB

GND --> negative wire of solenoid valve input of iso PCB

DIO 2 --> positive wire of solenoid valve input for left water of iso PCB

DIO 3 --> positive wire of solenoid valve input for right water of iso PCB

DIO 4 --> positive wire of solenoid valve input for air puff of iso PCB

IF synchronizing Ephys and imaging with behavior:

DIO 5 --> positive wire of BNC to Ephys amplifier

GND --> negative wire of BNC to Ephys amplifier

IF triggering laser for optogenetics:

DIO 0 --> USER1 of DAQ -> trig 2 of Master8

DIO 1 --> USER2 of DAQ -> trig1 of Master8

IF motorizing lickometer:

DIO 6 --> pin 2 of Arduino

DIO 7 --> pin 3 of Arduino

GND 🡪 GND of Arduino

Connections to servo

Red line 🡪 voltage barrel positive 🡪 5V power supply positive

Black line 🡪 voltage barrel negative 🡪 5V power supply negative

Black line 🡪 voltage barrel negative 🡪 GND of Arduino

Signal line (white or other color) 🡪 pin 9 of Arduino

**PARTS LIST**

- Restraint platform

- Audio-visual cart with cabinet (McMaster-Carr, 4731T74, $196.92)

- Soundproof foam (Adhesive back, 1" thick, 5692T49, McMaster-Carr, $13.21/ft, needs ~4 ft)

- Large breadboard (8"x8" MB8, ThorLabs, $82)

- 4 Posts (4” tall and 1” tall; TR4/TR1, ThorLabs, $5.87\*4 + $4.74\*4)

- 1 Small breadboard (6”x4” MB4, ThorLabs $49.40)

- 2 S/S posts (TR1, ThorLabs $4.74\*2)

- 2 M2.5 screws (91290A100, McMaster-Carr $10.48 for many)

- 2 Thumb nuts (96115A410, McMaster-Carr $1.06)

- 1 Mounting base (BA1, ThorLabs $5.04) to clamp down the acrylic tube

- 1 Acrylic tube (8486K433, McMaster-Carr $19.88 for 2 tubes)

- Cut for head-end, 1" from tube's end, ~3/4 way in lateral, using bandsaw

- Cut for tail-end, 2" from tube's end, ~3/4 way in lateral, using bandsaw

- 1 Custom headplate holder, stainless steel 304, uncoated (eMachineShop.com, 10 for $559.46; 20 for $690.35; ~3 week lead time)

- Custom headplates, stainless steel (eMachineShop.com)

total = $471

- Computer control

- 1 Desktop computers w/ monitor. If using visual stimulus, needs a video card with 2 output (HDMI and/or VGA) for Presentation to simultaneously display the progress screen and present the visual stimuli. (~$500 including monitor)

- 1 PCIe parallel port adapter card (StarTech, Amazon.com, $23.30)

- 1 DAQ device (Measurement Computing USB-201 $99)

- 1 Parallel port 25-pin cable (McMaster-Carr, 7925K62, $8.86)

- 1 Computer speaker (Logitech S120, Amazon $11.03)

- 1 Webcam (IR camera Q-CAM 860ML, EBay ~$20)

- Software (Presentation, Neurobehavioral Systems, $99/1year license)

total = $761

- 1 Detector PCB (x2 units for left sprout, right sprout)

- 2 Relay SPDT 5VDC 1ms pull-in-3.8V DIP relay (306-1046-ND, Digikey, $6.00)

- 2 14-pin DIP socket (526192, Jameco, ~$0)

- 4 10Mohms ½ watt resistors (662377, Jameco, ~$0)

- 2 47Kohms ½ watt resistors (662477, Jameco, ~$0)

- 4 2N2222A transistors (178511, Jameco, ~$0)

- Solderable prototype breadboard (2191402, Jameco $4.49)

- Battery snap, 6”, 26AWG (109154, Jameco $0.26)

- 9V alkaline battery (198731, Jameco $2.25)

- 1 Metal box enclosure (L107-ND, Digikey $16.67)

total = $30

- 1 Isolator PCB (x3 units for left water, right water, air puff)

- 1 24V Power supply (T383-P5P-ND, Digikey $18.30)

- DC Power connector (CP-002AH-ND, Digikey)

- 3 Green LED

- 3 Red LED (e.g. 516-1750-1-ND, Digikey)

- Resistors (2k, 5.1k, 10kohm)

- 3 Transistors (2N3904, 2N3904TFCT-ND, Digikey)

- 3 Optoisolators (4-DIP and 0.3", TLP621BLTF-ND, Digikey)

- Lickometer with 2-port

- 1 Custom lickometer part (3D printed)

- 1 Custom angled adapter to connect servo to post (3D printed)

- 1 Post (2” tall, ThorLabs TR2, $5.19)

- 1 Post holder (2” tall, ThorLabs PH2, $7.70)

- 2 Solenoid valve for water (MB202-V-A-3-0-L-204, Gems Sensor Solenoid Valve, Bordewieck Engineering Sales Co. $32;

Pre 2016 (this valve is designed for air, and would rust): EV-2-24VDC, Clippard $22.90\*2 and CT4-PKG, Clippard $2.95)

- 15ft 1/8" i.d. plastic tubing for water/air

- 2 adapter to connect water tubing to syringe needles (Tubing luer M-F, 30600-60, Cole Palmer)

- 2 metal syringe needles (e.g. Terumo Surflo IV Catheter, 18G x 1 ¼”, $0.80)

- 1 XYZ dovetail stage (ThorLabs ; RC3, $25.52; RC1, $20.70, RLA0300, $24.30)

total = $133

- Motorizing lickometer

- USB A/B male/male connector to program Arduino

- Arduino UNO board (Arduino UNO R3, DIP, 14DIO, Jameco 2151486, $27.95)

- Servo 180deg range, 4.8-6V (Servo, sub-micro, Jameco 283039, $14.95)

- 5V power supply (5VDC, 4A, wall, Jameco 379623, $11.95)

- Jumper wire pack (Jameco 2150467, $11.95)

- 1 DC Power connector, same one used as isolator PCB

total = $57

Optional

IF using visual stimulus, 1 small monitor (XENARC 700YV, 7"diagonal $299)

IF need to calibrate water flow, 2 IV administration tubing (IV60, 60 drops/mL, 1 unit, 72" long, Oasis)

IF want extra-fine Z-axis control of lickometer

- 1 Z manipulator (ThorLabs DT12, $66.60; DT12A, $34.65)

**NOTES ON ASSEMBLY**

Initial setup

1. Install - Presentation from Neurobehavioral Systems (install version 16.x; for some reason, version 17.0 does not recognize PCIe adapter for parallel port)

- VirtualVCR from Sourceforge

- VGA Gamer from Webcam CD

- Measurement Computing software from CD.

- Arduino software from Arduino webpage

2. Solder all the components for 2 detector circuits onto the PCB. The circuit follows Slotnick’s paper (J Experimental Analysis of Behavior, 91 253, 2009), with the following differences:

* Using SPDT instead of SPST relay, so that the output voltage can be pinned to 0 or 5V. In the original design using SPST, when the relay is open, the output voltage is floating, causing error in parallel port reading.
* The SPDT contains a diode within the package, so there is no need for external diode
* For SPDT, connect ground to pin 1, 5V to pin 14, and output voltage to pin 7 or 8.
* Check to see 9V from C to E for both transistors





3. For lick detection:

The lickometer ground wire attaches to SS headplate holder via alligator clips

The lickometer port 1 wire solder onto the left-lick metal syringe needles

The lickometer port 2 wire solder onto the right-lick metal syringe needles

Super glue the metal syringes onto the lickometer 3D printed piece, with the two sprout ends separated by ~3 mm

If properly hooked up, voltage across isolator left side, goes from 0 to 1.1V when driven, isolator right side goes from 24 to 0.2V, transistor C to E ~24V

4. Solder all components onto the isolator PCB.





5. Cut the parallel port 25-pin cable in half. Identify using voltmeter which wires correspond to pins 2, 3, 11, 12, 13, 25 and label them. Connect all the wires from Parallel Port cable according to Section 1.

6. Connect the rest of the wires to/from DAQ and parallel port cable according to Section 2.

7. Assembly the servo motor for motorizing the lickometer:

- Load the code into Arduino board: from Arduino software, Tools 🡪 Serial Port 🡪 Com3 check; Press reset button on the physical board; click Verify/Compile; click Upload; status should read “Done uploading”

- Using jumper wire pack: connect pin 9 of Arduino to control pin of servo (colored wire); also wire up 5V power supply to servo, power (red wire) and ground (black wire)

8. Put all the PCB and all the wirings inside the metal box enclosure. Put a piece of paper or cardboard in the metal enclosure, so the exposed metals on the PCB do not short-circuit on the enclosure.

9. Set up water lines:

For each water line, connect tubings so water starts from a 5mL syringe 🡪 IN of clippard valve 🡪 OUT of clippard valve 🡪 luer tubing adapter 🡪 metal syringe needle to be inserted into the 3D printed lickometer

10. In Presentation, configure “Settings”:

Set these parameters for both the Default and the current .sce

- Input Ports: add response device, choose LPT1 or LPT3, status port, no mask, inversion mask = 0, no interrupt, check box for independent lines, uncheck Log Code (otherwise saved logfiles will be >20MB)

Note: depending on how the parallel port is configured, it may be LPT1, or LPT3, etc, just use whatever the computer has assigned the parallel port

- Output Ports: (1), Port: USB-201 DAQ, data source: AUXPORT, register span: 1, check independent lines, no delay codes, inversion mask: 0

- Responses: Set the Active Buttons so #1 is Spacebar from device of Keyboard, #2 is 2(Start) from device of Parallel Port, #3 is 3(Start) from device of Parallel Port. You may have to add the device of Parallel Port on the list of response devices. If you don’t see the buttons on the Parallel Port, then the Input Ports was not configured properly.

- Advanced: Random number generator: Mersenne Twister

- Logfiles: check Prefix subject name, check Append counter if exists, Subject Name/ID set to Prompt

- Genera: uncheck Wait for return to start; check Never show report

If the Measurement Computing DAQ is not recognized under Port menu, run the software that came with the DAQ called InstaCal which should automatically detect the USB201 unit.

11. Set up Webcam in VirtualVCR. Should recognize the webcam as ‘VGA Gamer’. Turn on ‘auxillary’ light, which is the IR LED. Monochrome.

Check to see the different components are working correctly:

9. Check the lickometer photodetector – in Presentation, under Port Input, make sure “Log Codes” box is checked, press the Test button. You should see Response #2 or 3 flashes depending when you complete the lickometer circuit. That is, when you use hands to hold the leads to the lickometer ground + lickport 1, or ground + lickport 2.

10. Check the solenoid valves – in Presentation, under Port output, with the USB/AUXPORT, Test, set code to 4 or 8 or 16, pulse length 50ms. Should see the individual green LED light up when the pulse was sent. Now connect the 24V onto the DC power barrel of the circuit board, should see all the red LEDs light up. Send the pulses again, should hear each of the solenoid valve make a clicking sound.

Maintenance:

Check 9V alkaline battery – depending on usage, in several weeks if voltage drops below 7.5V then lick detection becomes unreliable.