Dancer Design Olfactometer Mk3 - Operating Instructions

IMPORTANT SAFETY WARNINGS

The control unit is designed to operate with an inlet pressure of 1 bar or less. Do not connect it to an air supply of higher pressure such as the outlet of a gas cylinder, either directly or via a flow regulator. If an air cylinder is being used a suitable pressure regulator must be fitted between the gas cylinder and the olfactometer.
The Norgren R07 regulator provided with the olfactometer* will drop a higher pressure down to the correct pressure. The maximum inlet pressure of this regulator is 21 bar (300 PSI). Do not connect it to an air supply of higher pressure. If an air cylinder is used the cylinder itself must be fitted with a pressure regulator to reduce the outlet pressure to <21 bar.

* Unless an air pump is supplied

NOTE: Most plastic pneumatic tubing is rated at 10 bar maximum.

Power supply for the unit is 110 – 240V AC. A 2A fuse is contained in the inlet connector. *The unit contains dangerous voltages and should not be opened by unqualified personnel.*
Take care to avoid liquid spills and condensation on the control unit.

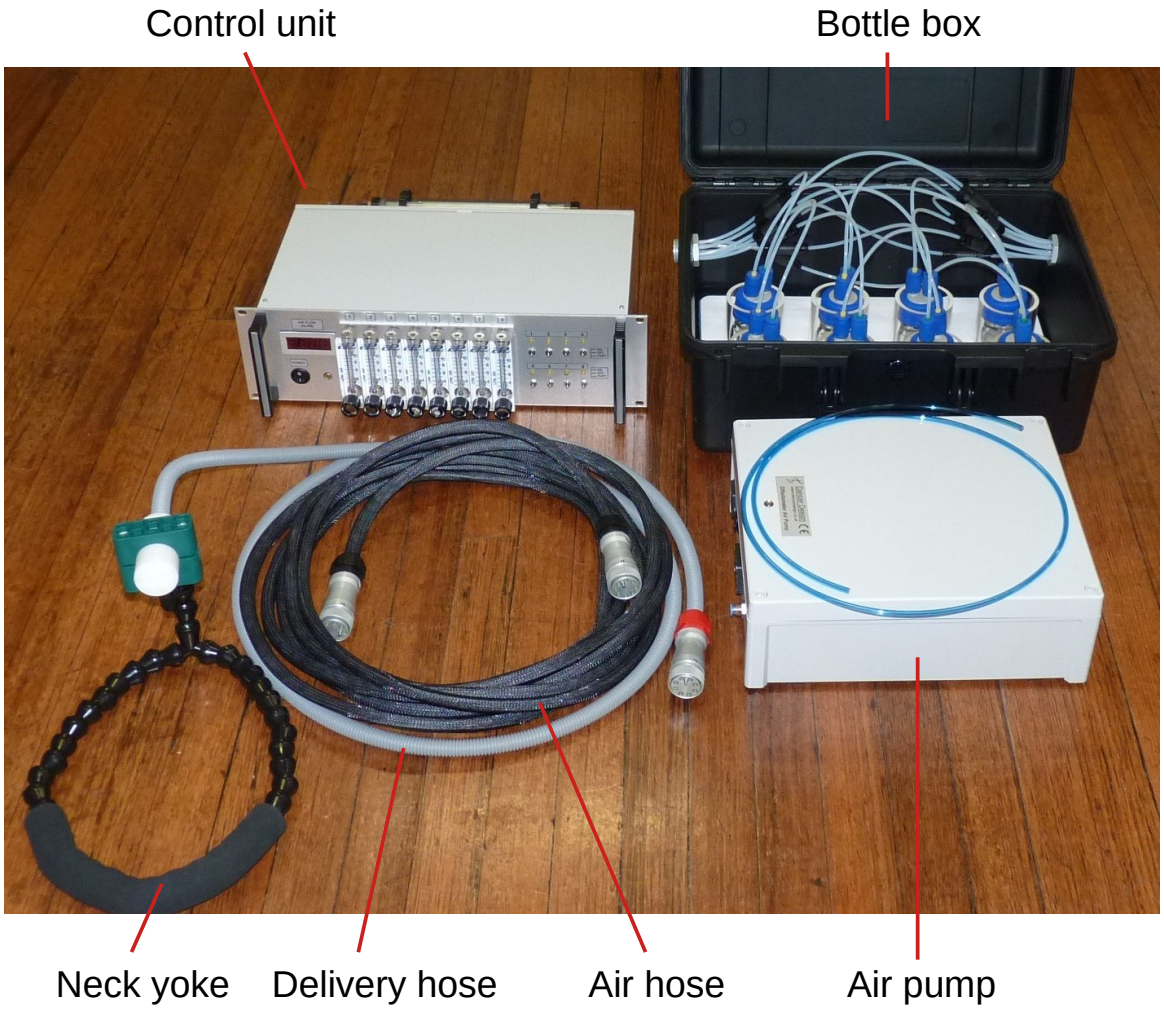
The two hoses (air supply hose and delivery hose) are colour coded black and red respectively. Ensure that the delivery hose (red) is always connected to the outlet of the bottle box which is marked by a red ring.

The nosepiece, nosepiece holder (yoke), delivery hose, bottle box and air hose assembly are all MRI-compatible. The 8-way tubing connectors contain metal and should be kept clear of the bore of the MRI scanner to prevent heating and image artefacts. The control unit, regulator, air cylinder and air pump are not MRI-compatible and must not be taken into an MRI scanner room.

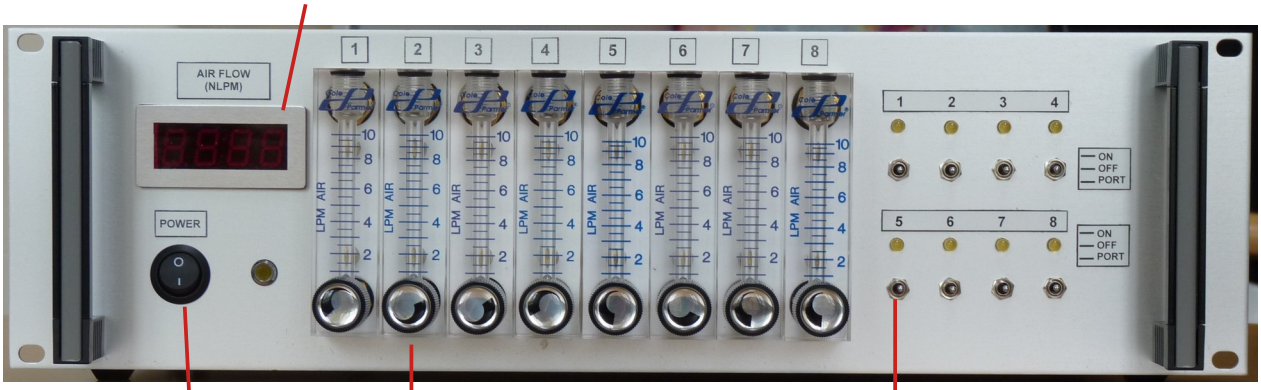
Overview

The Dancer Design olfactometer is designed to supply odorised air to a human subject under computer control. In the control unit, clean, pressurised air from a supply (e.g. air cylinder, air pump) is directed to one or more of eight output channels by an array of valves. The output channels are connected by a hose assembly to a box containing eight odourant bottles. In the bottles the clean air is infused with an odour chemical. Odorised air from the bottles passes out through a non-return valve, through a delivery hose, to a nosepiece in which the odours are mixed and delivered to the subject.
The valves are controlled either by signals on a parallel port (each line of the port controls one valve) or by serial data sent over a USB port.

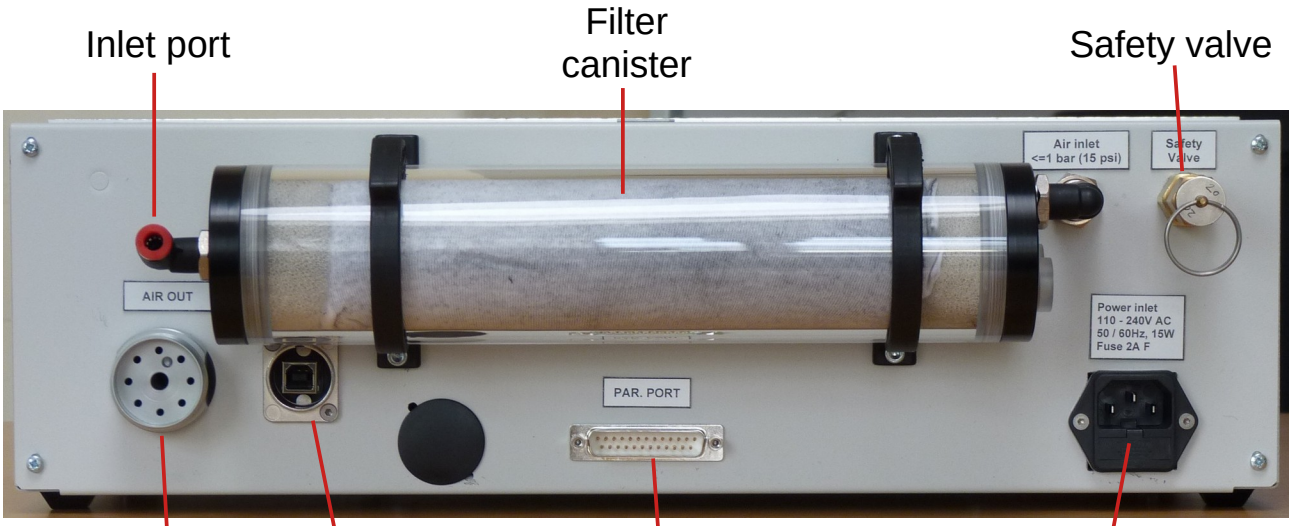
Olfactometer principal components



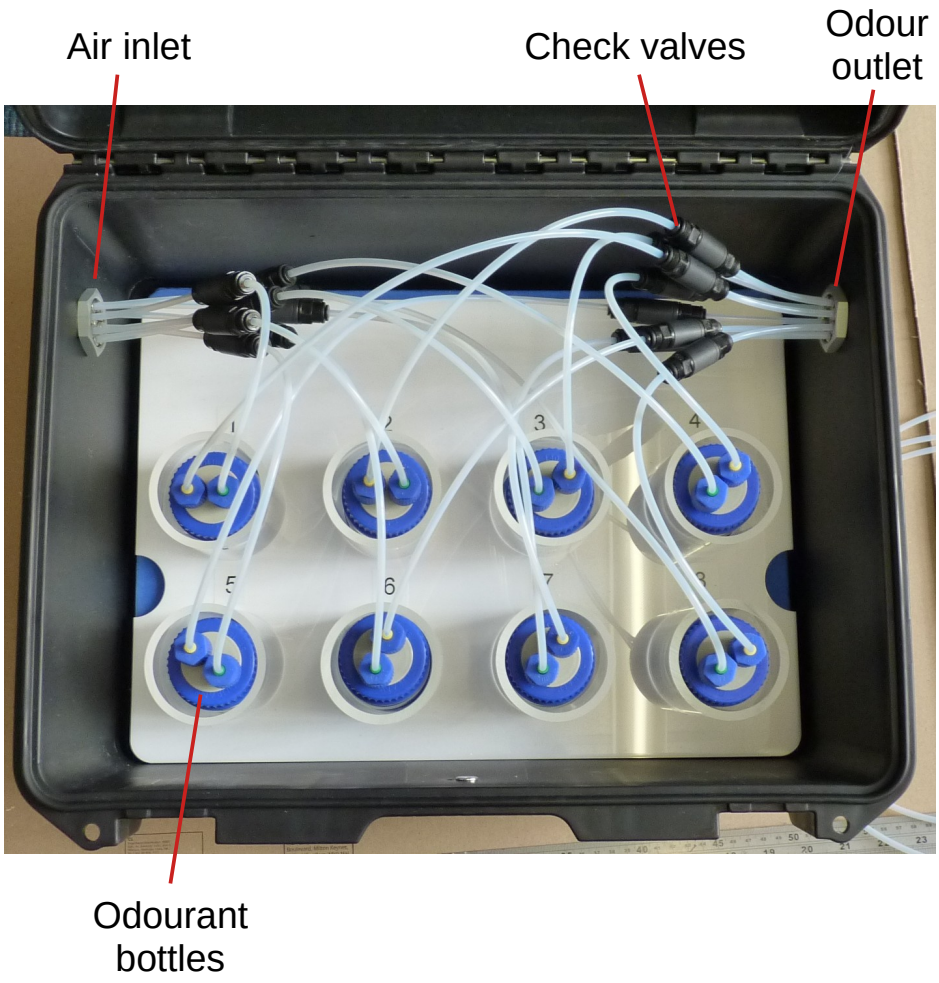
Front panel



Rear panel



Bottle box



Push-in connectors

Push-in connectors are used in the olfactometer. These accept a metric size tube of 4mm or 6mm diameter. The tube end should be cut straight with the tube cutter provided.
To connect a tube, simply push it fully into the connector. There is usually a slight 'click' as the tube enters the o-ring inside the fitting. Sometimes it may be necessary to waggle the tube while pushing it to make it enter the o-ring properly. This is particularly true of the PTFE tubes which are hard to grip because of their smoothness. Where inserting the tube is difficult it may help to lubricate the internal o-ring by coating the 4mm plug provided (red plastic part) with a little silicone oil and inserting it into the fitting.
To disconnect a tube, press down on the plastic ring to release the connector and pull the tube out. Do **not** pull on the tube without depressing the plastic ring because this may damage the tube and/or the connector.

Air supply

Possible sources of air include:

(1) A cylinder of medical air. Do not use any other gas, and do not use industrial compressed air as it may have a strong odour and it may contain particles of oil. The air cylinder should be fitted with a pressure regulator to reduce the pressure down to 10 bar or less. If the regulator fitted to the cylinder is capable of regulating pressure down to ~1 bar then the secondary (Norgren) regulator will not be necessary.

(2) A diving cylinder. This should be fitted with a first stage regulator to reduce the outlet pressure to 9 bar. A standard first stage regulator will do this.

(3) A medical air outlet. These are often fitted with flow regulators which reduce air flow but do not reduce pressure. Such a regulator should **not** be used because it will not supply air at the correct pressure. Instead a pressure regulator should be fitted between the outlet and the control unit.

(4) An olfactometer air pump from Dancer Design.

(5) An air compressor. This must be an oilless type. If the outlet pressure cannot be regulated to ~1 bar then the Norgren regulator must be used in the line from the compressor to the olfactometer.

Internal safety features

The control unit has two features which prevent excessive pressures being applied on its outlets.

1. Internal over-pressure switch
This is an electronic sensor which detects a pressure on the inlet of >1 bar. If it does, all valves are closed and the flow rate display will begin to flash. The fault condition can be

cleared by reducing the inlet pressure. A simple way to do this is to manually operate the pressure relief valve.

2. Pressure relief valve
There is a simple mechanical pressure relief valve on the rear of the control unit. If inlet pressure reaches ~2 bar (30 psi) the pressure relief valve will open, venting the excess pressure. This can be heard as a hissing sound. If this happens then shut off the air supply immediately and investigate the source of the high pressure.

Manual control

All 8 port lines may be controlled by switches on the front panel. Each switch has 3 settings which work like this:

ON	Valve is forced on
OFF	Valve is forced off
PORT	Valve is controlled by the state of the corresponding port pin.

Parallel port control

Each valve is operated by a logic "1" on one of 8 input pins on the parallel port connector. The pinouts of this connector are:

Pin	Function
2	Valve 1
3	Valve 1
4	Valve 1
5	Valve 1
6	Valve 1
7	Valve 1
8	Valve 1
9	Valve 1
18	Ground (0V)

These are the same pins as used on a standard PC parallel port, so if you have a PC with a parallel port, a cable with a 25-way plug and socket wired "straight through" allows you to control the valves by manipulating the 8 data lines in the port. A suitable cable is provided with the olfactometer.
Be aware that many parallel ports initialise with all their lines set to logic "1". To guard against this the controller will close all valves if all port lines are logic "1".

A useful utility for testing port functionality in Windows can be downloaded from:
http://www.xlentelectronics.nl/LPTTest/LPTTestUtility.exe

Note: a USB to parallel converter is not suitable because it does not allow access to the port pins.

Serial port control

The USB port on the rear of the olfactometer connects to an Arduino board inside the control unit. When connected to a PC running Windows this appears as a serial port. Windows will assign a port number to the Arduino automatically. The olfactometer can then be controlled by sending text commands to this port.

To find the port number, open Device Manager:
In Windows 10 press Windows+X to open the menu, and choose Device Manager.
The port should be visible as a COM device under Ports.

Port settings are baud rate 9600, 8 data bits, no parity, one stop bit.

Communications protocol
Note: do not send the " characters!

Individual valve control
"V1 1" = valve 1 on
"V1 0" = valve 1 off
"V2 1" = valve 2 on
etc...

Port control
Format: "DD" + space + decimal string
"DD 0" = all valves off
"DD 1" = valve 1 on
"DD 2" = valve 2 on
"DD 4" = valve 3 on
"DD 8" = valve 4 on
"DD 16" = valve 5 on
"DD 32" = valve 6 on
"DD 64" = valve 7 on
"DD 128" = valve 8 on

The states of multiple valves may be set simultaneously using the port control command, for example:
"DD 17" = valves 5 and 1 on

Get status commands – these return information about the olfactometer
"D?" = get valve status (returns a decimal value showng the state of the valves)

"P?" = get parallel port status (returns a decimal value showing the state of the port)

"F?" = get air flow rate (returns a floating-point value for flow in litres per minute)

"E?" = get over-pressure status (0=good, 1=over-pressure)

Transmitted strings may be terminated with CR or CR+LF
Returned strings are terminated with CR+LF

Note: When the control unit receives commands via the serial port to control the valves, the settings of the parallel port and the front panel switches no longer control the valves. To regain manual control of the olfactometer, simply operate one of the switches momentarily. To regain parallel port control, change the state of any of the port lines.

Individual flowmeters

The flowmeters on the front of the control unit allow the flow rate of air through each line to be independently controlled. Each also gives an approximate indication of flow rate in LPM (litres per minute).
Note that different lengths and diameters of tubing on the outlet side will cause the air flow to be different for different channels. The flow rates can be equalised by adjusting the flowmeter valves.

Setting up the olfactometer – bottle box

Odourants are usually dissolved in an odourless carrier (e.g. polyethylene glycol) and a small amount is held in each bottle. To maximise the surface area for evaporation of the odourant a fibre wick is placed in each bottle.

Method:

Cut wicks for the bottles from the fibre sheet material. Each wick should be approximately 11cm x 5.5cm. Insert one wick into each bottle, forming a horseshoe shape (see picture), before the carrier / odourant mixture is put in.

For each odourant bottle there should be a PTFE tube from the inlet connector to the bottle and another PTFE tube from the bottle to the outlet connector. It is recommended to use the 0.75mm wall tubing here because it is easier to insert into the connectors and less likely to kink.

Check valves on the inlet and outlet sides prevent reverse flow of air through the system. The direction of flow on the check valve cartridge is shown by an engraved band (band = outlet).
The check valve may be disassembled for cleaning. To remove the valve capsule itself, push it out using a small rod (the flat end of a drill bit works well). Take note of the orientation of the valve capsule, and replace it the same way. Use a wider rod to push the capsule back in (a pencil is ideal).

Tubes are held in place by collet-type seals in the cap of the bottle. A short length of nylon tubing secures the 4mm PTFE tube in the 6mm collet. Use green tube for clean air, and yellow tube for odourised air.

Position the end of the inlet tube so that it lies in the middle of the fibre wick, but do ***not*** allow it to dip into the liquid at the bottom of the bottle. If the inlet tube goes into the liquid it will create bubbles which will cause droplets of odourant and carrier to get into the outlet tubes and valve, which will contaminate them.
The end of the outlet tube should be positioned just inside the neck of the bottle.

Tighten all the caps firmly to ensure a good airtight seal.

Setting up the olfactometer – control unit and hoses

Find a position for the control unit where the air hose assembly can reach the bottle box. If the olfactometer is being used in an MRI scanner this will usually be in the control room close to the penetration panel. Depending on the size of diameter of the available waveguides it may be necessary to disassemble one of the connectors to feed the hose through the waveguide (see section on assembly and disassembly of hoses).
If the olfactometer is being controlled by a laptop this may be placed on top of the control unit. Do not place any liquids on the control unit.

Connect the power cable to the control unit.

If an air cylinder is being used:
Connect the air supply to the inlet of the Norgren regulator using the quick-connect coupling. Turn the pressure control dial on the regulator fully anti-clockwise.
Connect the outlet of the Norgren regulator to the inlet of the filter canister using a length of 6mm polyurethane tubing (blue).

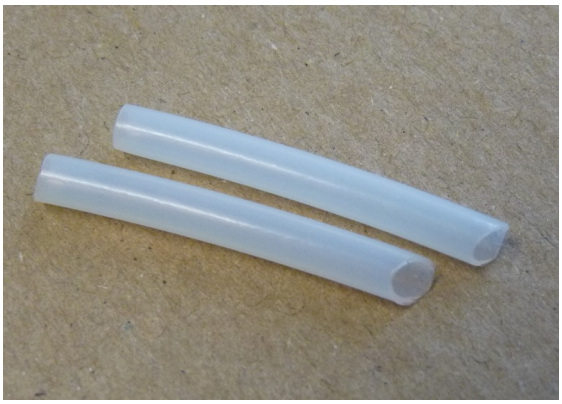
If an air pump is being used:
Connect the outlet of the air pump to the inlet of the filter canister using a length of 6mm polyurethane tubing (blue).

At this point you may check the operation of the control unit.
Set all switches to "Off". Switch on the power to the control unit. You should see a yellow power light and the LED flow rate display should light up. The display should show a value of 0.000.
Turn on the air supply. If using an air pump, switch on the pump. If using an air cylinder, turn the dial on the regulator clockwise until the pressure gauge reads about 0.8 bar.

The flow rate indicator should still show a low value. You may see some fluctuations as the system pressurises, but the flow should return to zero. If it does not then there is a leak inside the control unit; contact Dancer Design for advice about rectifying the problem.
Set any of the switches to "On". You should see a flow of air indicated on the display and by the ball in one of the flowmeters. You should also be able to feel air coming out of the multi-tube outlet connector on the back of the control unit. If necessary, turn the dial on the appropriate flowmeter anti-clockwise to increase the flow.
Continue to test all the channels this way.

Connect the air hose assembly (long hose with black connectors) to the outlet connector by aligning the plug to the socket (note the locating pin!) and screwing in the threaded ring. The ring must be screwed in tightly by hand to ensure a good seal, but take care that the screw threads engage correctly.
Connect the other end of the air hose assembly to the inlet of the bottle box (left hand side, black ring).
Connect the delivery hose to the outlet of the bottle box (right hand side, red ring).

Cut two pieces of PTFE tubing 4-5cm long, cut the ends diagonally as shown and insert the diagonally cut ends into the outlet holes of the nosepiece. These tubes deliver air to the subject. The diagonal cut ensures that the end of the tube is not blocked when it is inserted into the nosepiece. The tubes may be placed just inside the nostrils, or they may be positioned just in front of the nose, or terminate in a mask, according to the preference of the experimenter. Tubes may be sterilised or disposed of after use.



A neck yoke made of LocLine articulated tubing is supplied with the olfactometer. This allows the nosepiece to be positioned just in front of the nose of the subject (see photo).

Using the olfactometer

Computer control

The olfactometer will normally be controlled by software running on a computer sending commands to the control unit either by the parallel port or the serial port. Since most experimenters will wish to use the olfactometer with their programming language of choice we do not provide software with it as standard. However, we can offer support with controlling the device using different languages.
Any programming language or software package capable of controlling the parallel port or sending data through a serial port may be used to control the olfactometer. Examples are MATLAB, PsychoPy, Presentation, E-Prime and LabVIEW. A web search for using these languages to control the parallel port or serial port will yield many examples which may be adapted to control the olfactometer.

The simplest way to use the olfactometer in an experiment is to switch on one air line then switch it off after a certain length of time, to deliver a pulse of odourised air to the participant. For example:

(LPT1 = parallel port, COM1 = serial port)

```
# Switch air line 3 on
0x00000100 → LPT1 or "V3 1" → COM1 or "DD 4" → COM1
# Wait 10 seconds
WAIT 10000
# Switch air line 3 off
0x00000000 → LPT1 or "V3 0" → COM1 or "DD 0" → COM1
```

It is often preferable to have a continuous flow of clean air running through the system and inject an odourant into the air. The benefit of this is that the participant is not given a clue to the onset of a stimulus by the sudden increased flow of air. It also helps clear any odour out of the mixing chamber which helps prevent tainting. One bottle is kept

empty for the clean air.

```
# Switch line 8 (clean air) on at the start
0x10000000 → LPT1 or "DD 128" → COM1
.
.
.
# Switch line 8 off and line 3 on
0x00000100 → LPT1 or "DD 4" → COM1
# Wait 10 seconds
WAIT 10000
# Switch line 8 on and line 3 off
0x10000000 → LPT1 or "DD 128" → COM1
.
.
.
# Switch all lines off at the end
0x00000000 → LPT1 or "DD 0" → COM1
```

Odour tainting and cleaning of parts

As far as is possible the parts of the olfactometer through which odourised air passes are made of materials chosen for their resistance to tainting by odour chemicals. Despite this some tainting due to adsorption of odourants onto surfaces is inevitable. Because of this we recommend dedicating each channel to one particular odourant if this is possible.
There is greatly increased risk of tainting if aerosols are allowed to form in the odourant bottle, therefore the air delivery hose in each bottle should not be allowed to dip into the liquid at the bottom of the bottle.
Odourant solutions should not be left in bottles for extended periods. After use bottles, caps and other parts may be rinsed and disinfected with ethanol or isopropanol. To remove heavier tainting with odours we recommend a specialist cleaner for laboratory glassware, such as Alconox.
The check valves on the outlet side of the bottles should be disassembled for cleaning. Unscrew the end fittings and remove the internal valve capsule. All parts may be cleaned using ethanol, isopropanol or laboratory cleaning solution. Ensure all parts are dried thoroughly before reassembly.

Optionally, nosepieces may be sterilised by autoclaving (not the nylon screws and cable glands) or ethylene oxide.

Delivery hose and nosepiece assembly

The delivery hose consists of 8 thin-walled PTFE tubes (0.5mm wall thickness) inside a corrugated plastic conduit. An 8-way connector at one end connects the hose to the outlet of the bottle box; at the other end is the mixer / nosepiece assembly which is made from acetal.

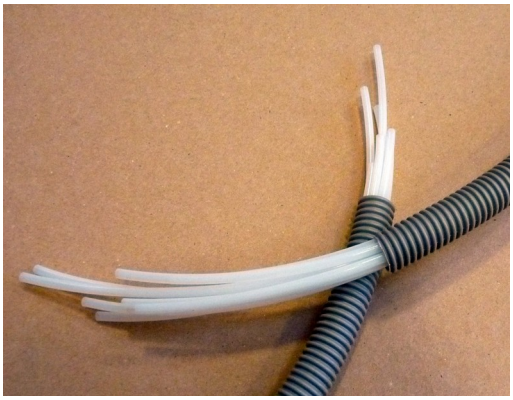
Parts required:

- ~22 metres of PTFE tubing (Altec 01-96-1761)
- 2.5 metre length of corrugated conduit
- 8-way multi-tube connector and shell (Eisele, Germany)
- cable gland, red
- cable gland, white
- nosepiece body, cap and screws
- masking tape

Procedure

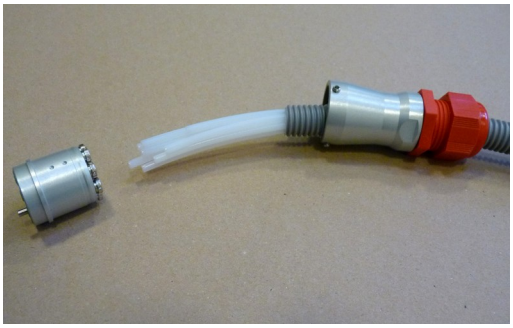
A dust-free floor area is recommended, ideally10 metres or more in length.
Note that it is not necessary to number the tubes because they are all combined in the mixer.

1. Cut 8x 2.5 m lengths of PTFE tubing. Bunch these together at one end and tightly tape them.

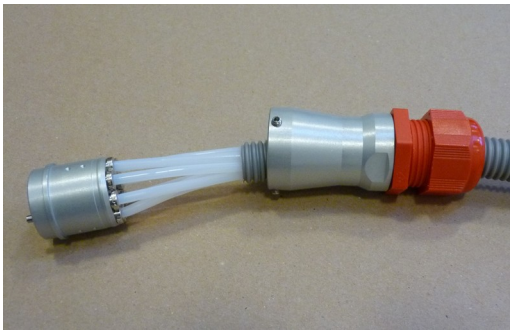


2. Pass the taped end into the conduit and gradually push the rest of the tubes into it until they are completely through. Getting the tubes to go all the way through the conduit can be difficult; to help the process we recommend:

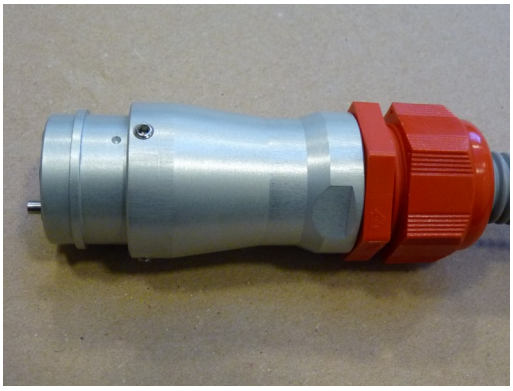
- keeping the tubes as parallel as possible as they are fed in, so they do not cross
- shaking the conduit
- compressing the corrugations in the conduit to free the end of the tubes if it gets stuck.



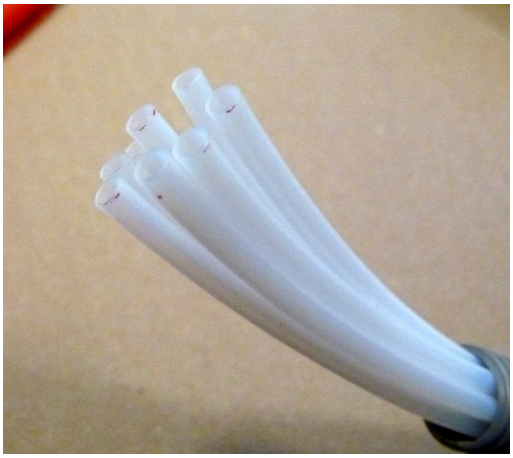
3. Slide the connector shell and gland over the conduit as shown.



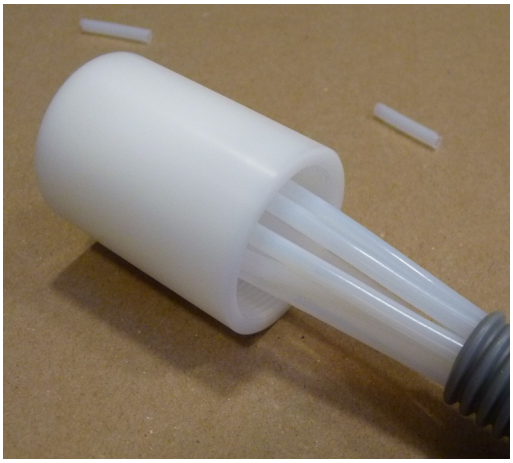
4. Insert the tubes into the 8 ports in the connector, making sure to fit the locking ring before you do this! Lubricating the o-rings with a little silicone oil may help with inserting the tubes (see notes above).



5. Line up the grub screws on the connector shell with the dimples on the connector and push the shell onto the connector. Tighten the grub screws with the hexagon key so that they engage with the first set of dimples on the connector. Tighten the cable gland by hand so that it compresses the conduit.



6. On the opposite end of the hose, cut all the ends of the tubes to the same length. They should protrude about 10cm from the end of the conduit. The conduit may be compressed if the tubes do not protrude far enough. Pass the white cable gland over the conduit.



7. Insert each tube into a hole in the back of the nosepiece. Slide each tube in about half the length of the hole in the nosepiece.

8. Attach the cable gland to the back of the nosepiece and tighten it by hand to compress the conduit

9. Attach the cap to the nosepiece with the 4 nylon screws provided

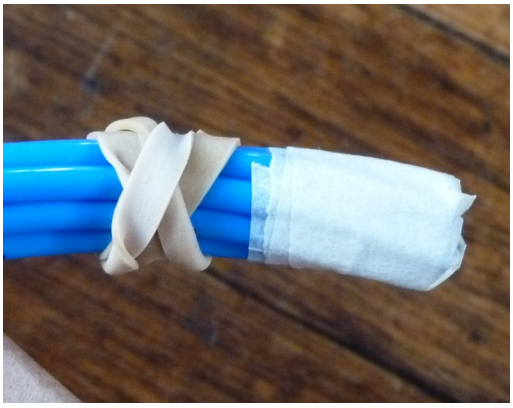
Air hose assembly

The air hose should not become contaminated with odours in normal use, but if it needs to be repaired or if you wish to change the length of the air hose it may be disassembled by removing the connector shells and detaching the tubes from the connectors. The procedure for assembling the hose is detailed below. A dust-free floor area is recommended, ideally10 metres or more in length.

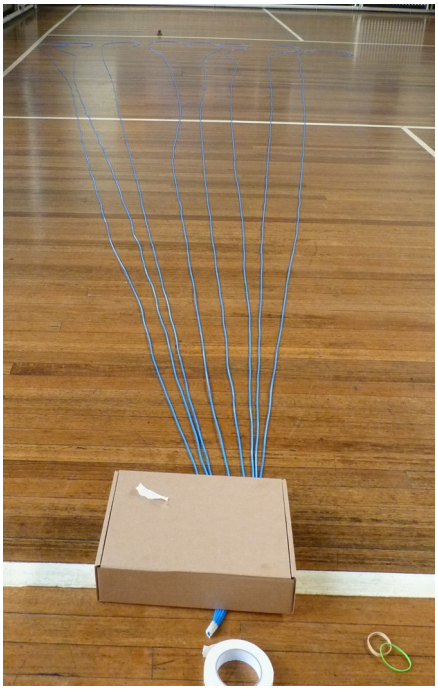
Parts required:

- 3x 25m packs of polyurethane tubing (Legris 1025U04 04)
- ~10m of viscose tubular gauze (Podopro size 1)
- ~10m of braided sleeving, 16mm nominal diameter (Farnell 3267021)
- 2x 8-way multi-tube connector and shell (Eisele, Germany)
- 2x cable gland, black
- Masking tape
- Polyester or similar non-tack tape
- “Sharpie” marker pen

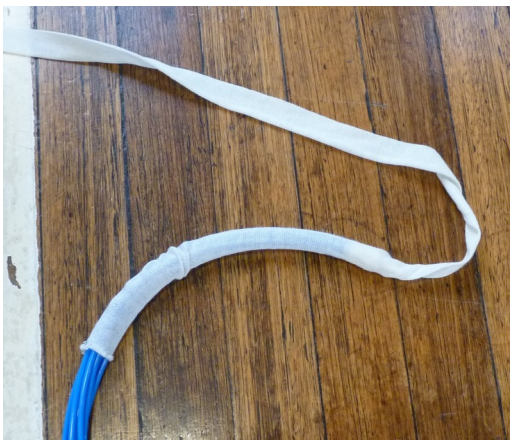
Procedure



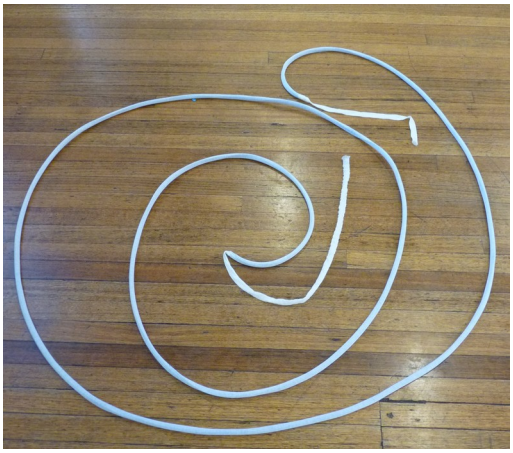
1. Cut 8x 8 metre lengths of PU tubing. Mark both ends of each piece of tube 1 to 8 so that they can be identified. Gather the ends together in a bundle and tape them together with masking tape. Fold the free end of the tape back on itself so that it can be pushed through the tubular gauze without snagging. Leave the opposite ends untaped.



2. Lay them out as shown, with a bean bag or other object to hold them down at the taped end.



3. Begin pushing the tubular gauze over the taped end of the tubes.



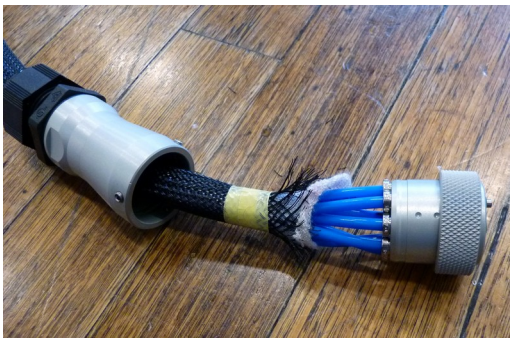
4. Continue moving the gauze along the tubes until they are fully covered. Try to stop the tubes crossing each other while you are doing this, in order to prevent lumps in the hose. Cut the tubular gauze about 50 cm from the taped end.

4. Beginning at the taped end, fold the free tubular gauze over and begin pushing the braided sleeving over the tubes.

5. When the tubes are fully covered apply polyester tape around the braided sleeving to prevent it fraying.

6. Slide the connector shell and gland over the tube assembly as shown.

7. Using scissors, cut the braided sleeving and tubular gauze as shown.



8. Remove the masking tape from the ends of the tubes. Cut back the longest tubes so that they are all the same length. Place the locking ring on the connector and insert each tube into the correct numbered port on the back of the connector. Lubricating the o-rings with a little silicone oil may help with inserting the tubes (see notes above).

9. Line up the grub screws on the connector shell with the dimples on the connector and push the shell onto the connector. Tighten the grub screws with the hexagon key so that they engage with the first set of dimples on the connector. Tighten the cable gland by hand so that it compresses the tubing and sleeving assembly, holding it together.

10. Repeat steps 5 to 9 on the other end of the hose.

Air filter – description and refilling

The air filter which is mounted on the rear of the control unit uses activated carbon to remove impurities and odours from the incoming air stream. The filter can be refilled by following the procedure below. We recommend replenishing the carbon about every 6-12 months if the olfactometer is in regular use.
Suitable carbon may be purchased from retailers of aquarium supplies. Avoid using carbon which contains fine dust.

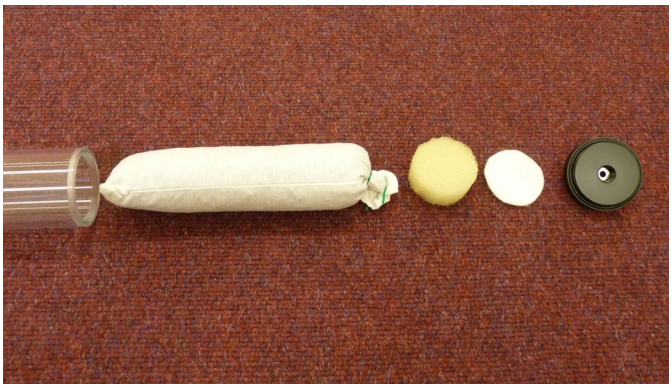
Refilling the filter

Parts required:
Flat blade screwdriver
Activated carbon (~125g)
Filter bag *
Filling ring
2x sponge pad *
2x filter pad *
Plastic bag tie

* Existing parts may be washed in water and reused. Do not use detergents which contain fragrance.

1. Release the clips holding the canister and disconnect the tube between the canister and the inlet port of the control unit, as shown below.

2. Unscrew the cap and remove the filter pad, sponge pad and bag of carbon.



3. Place the filling ring into the neck of the bag and fill with carbon. Remove the ring, twist the opening of the bag and secure it well with a plastic tie.

4. Reassemble the filter, ensuring that the end caps are tightly fastened. Reconnect the filter to the control unit.

Olfactometer dimensions

Control unit (including filter canister)
482 x 375 x 138 mm
Weight 6.1 kg

Bottle box (with bottles)
505 x 382 x 230 mm
6.9 kg

Air pump
342 x 289 x 122 mm
4.0 kg

Air hose length: 8 m
Delivery hose length: 2.5m

Contact information

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