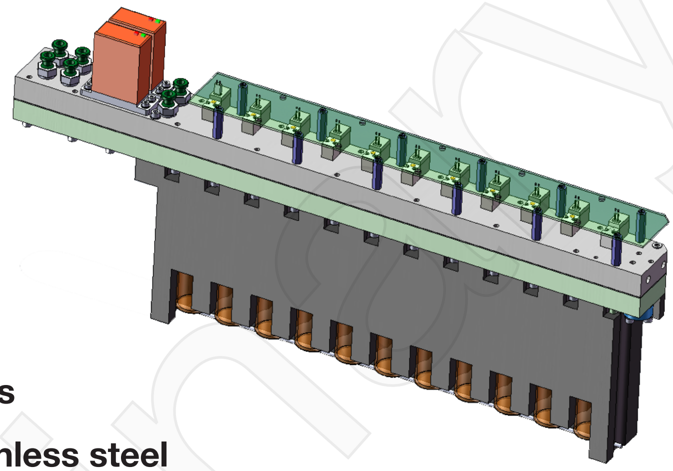
RP Metrix

Scalable Olfactometer Module — LASOM1

Olfactometer Functions



- **Each module supplies 10 odor sources**
- **Scalable to 10 module, 100 odor system**
- **Quick swap odor reservoir components**
- **LED indication of valve states**
- **Integrated with dual mass flow controllers**
- **Odor wetted materials: glass, Teflon, stainless steel**
- **Balanced gas flow independent of odor activation**
- **Single USB 2.0 interface to master module and associated slave modules**

Integrated Laboratory Support Functions

- Programmable sequencer manages olfactometer and external devices
- Valve and digital activity sequenced at 1 ms timing resolution
- Valve driver connectors for 5 external 24-volt devices
- Dual buffered digital I/O connectors – each with 3 inputs and 3 outputs
- Optional mating digital I/O module with optical beam support
- Low speed analog I/O connector – with 4 inputs and 4 outputs
- Logic expansion connector with 13 bi-directional digital circuits
- Optional logic expansion module for external recording system
- High-speed buffered strobe input and strobe output connectors

Broad Programming and Upgrade Capabilities

- Text based symbolic language for on-board sequencer
- Microsoft Windows® Win32 drivers
- Microsoft Windows® control program
- Software interfaces for LabView®, Matlab®, Python®, ActiveX
- Field upgradeable firmware and logic
- Master or slave configurable modules

Overview: The LASOM olfactometer modules are used to present a controlled concentration of user supplied odorants with precise timing. In addition, the olfactometer can control external valves, detect experimental events, *etc*.

A schematic diagram of a system containing a master LASOM module and several slave modules is shown in Fig. 1. Aside from the host-master communication the slave units are identical to the master. The dashed blue line shows the components contained in a single LASOM1 module.

Each odorant is contained in one of 10 glass vials. One additional *dummy* vial is always empty. When no odor is active the carrier gas flows through this vial. When an odor is presented the dummy valve is shut and the valve for that particular odor is opened. Thus at any given time, one and only one valve is open.

Master and Slave modules: There are two module configurations; a *master* module and a *slave* module. A complete system will include one master module and anywhere from 0 to 9 additional slave modules. Each module, master or slave, adds 10 odors to the system. Thus, a minimal system of one master module can present 10 odors, while a system of one master and 3 slaves can present up to 40 odors.

A master module can be configured to function as a slave module, and vice-versa. As a cost savings, a slave module can be shipped with only one mass flow controller. This precludes using it as a master without an upgrade, but a field upgrade kit is available for this purpose.

Connection with host computer: The instrument is controlled by a host computer. Only the master module communicates with the host computer via a USB 2.0 connection. All communication with the slave units is done through the master module. The host computer allows automated management of the odor selections, carrier and dilution gas flows rates, external valve control, digital control of equipment, detection of experimental events, *etc*.

Dilution and carrier gases: Two integrated but independent mass flow controllers permit precise control of the dilution and the carrier gas flows. Clean gas is supplied to both flow controllers. The odorized flow is created by routing clean carrier gas through a selected odor vial during, or in preparation for, a trial. The dilution gas will typically make up the bulk of the flow during a trial. Finally, the two flows, the odorized carrier gas and the dilution gas are mixed and output from the olfactometer.

The flow rates of the dilution and carrier gases are controlled individually by the olfactometer control board and can be set by the user. If multiple olfactometers are used their outputs will typically be mixed before being presented to the subject. The flow rates of the individual olfactometers can be adjusted accordingly using the host computer. For example, let's assume that a if a 1 liter per min (lpm) flow rate is desired in an experiment. If only one olfactometer is used the user might set the dilution gas to 0.1 lpm

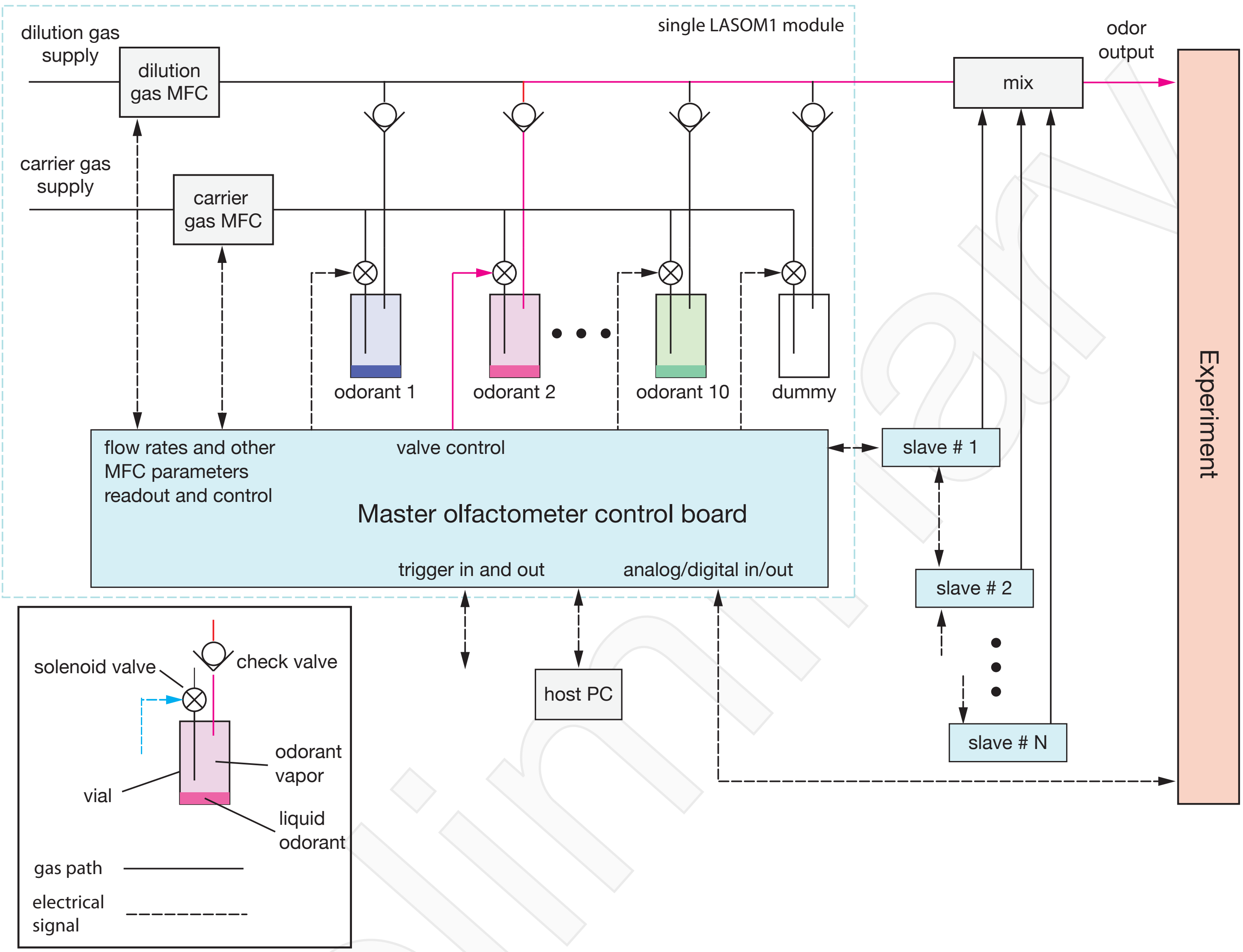


Fig 1. Block diagram of an olfactometer system showing master and slave connectivity. Dashed lines represent electrical signals. Each module contains 10 odors and 10 modules can be linked together into one system. Not all odors and modules are shown to reduce the complexity of the diagram.

and the carrier gas to 0.9 lpm giving a total of 1 lpm. If 4 olfactometers are later used the settings might be 0.1 lpm for the carrier gases and 0.15 lpm for the dilution gases totalling $4 \cdot (0.1+0.15) = 1$ lpm. These settings might change if a user would like to change the dilution of any of the odorants.

In most cases the dilution gas is air and the carrier gas is Nitrogen but a user may request that the system be calibrated for other gases.

Odorant dilution: By changing the relative flow rates of the two mass flow controllers on an olfactometer different odorant dilutions can be realized. Factor of 10 dilutions are readily achieved in this way.

Separation of flow and odor cues : Any odor, or no odor at all, can be electronically selected from the ten odorants contained in vials mounted in the module. When no odor is selected the olfactometer morphology does not change but the carrier gas is routed through a dummy vial that contains no odorant. Typically, this unodorized mixture (carrier gas with no odorant and the dilution gas) is delivered to the subject between trials. This guarantees that the flow characteristics are the same when an odor is presented and when one is not, minimizing flow related cues in the experiment.

Odor presentation - sequence of events: Carrier gas enters the module through a mass flow controller. As an example, let's assume that we want to present odorant #2. The valve pressurizing the vial containing odorant #2 is activated (this control line, and the odorant #2 gas flow are shown in red in Fig. 1). Carrier gas is injected into the vial and mixes with the odorant. It is then exhausted from the vial through a Teflon check valve. The check valve is used to prevent cross contamination of the odors. The odor containing carrier gas is then diluted by the dilution gas and is carried to the experiment. The carrier and dilution gases are typically nitrogen and medical grade air (or zero air) respectively. The use of nitrogen prevents oxidation of sensitive odorants.

External component control: LASOM modules can control external components such as valves, gates, lights, etc. In addition, they can be used to detect experimental events such as lever press, nose pokes, and so on.

External valves have been used to achieve more precise timing of the odors. In this arrangement the LASOM system prepares a steady state odor. A high speed valve in close proximity to the experiment is then used to switch the odor on and off. One of the LASOM board's valve drivers can be used to switch the external timing valve on and off.

Experimental sequencing language: Each olfactometer module has an onboard computer that is used for controlling the odors, external valves, monitoring experimental events, such as nose pokes through an odor port, etc. This onboard computer is, in turn, controlled by a host computer. A text based symbolic sequencing language has been developed that can control a set of olfactometers as well as control and monitor the experiment.

Interaction with popular software packages: Interaction with the sequencer can be done directly in a text file or in various programming languages such as Matlab, LabView and Python.