LabSmith Application Note

Automated Multi-Fluid Injection Using an 8-Position Selector Valve

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This application note describes how to use LabSmith's uProcess components and software to create an automated pressure-driven flow to inject up to seven fluids.

INTRODUCTION

Many microfluidic applications require controlled, sequenced flow of multiple fluids through a chip or microfluidic system. A convenient method for constructing such a system is to pressurize multiple reservoirs containing the individual fluids, then use a selector valve to route each fluid from the reservoirs to the rest of the circuit.

LabSmith's CapTite™ microfluidic connectors and uProcess™ automated valves, sensors and pumps make it straightforward to construct a pressurized system from off-the-shelf components. uProcess software provides a simple scripting interface to sequence the flows.

This application note describes how to use LabSmith's uProcess components, including the AV801 8-position selector valve, to simultaneously pressurize up to seven fluid reservoirs. uProcess software is then used to program automated injection sequences to deliver the reservoir fluids to a microfluidic system.

EXPERIMENTAL SETUP

Figure 1 shows an experimental setup for a 3-fluid pressurized system. All components and fittings are available to purchase for use with 360 µm, 1/32", or 1/16" OD capillary.

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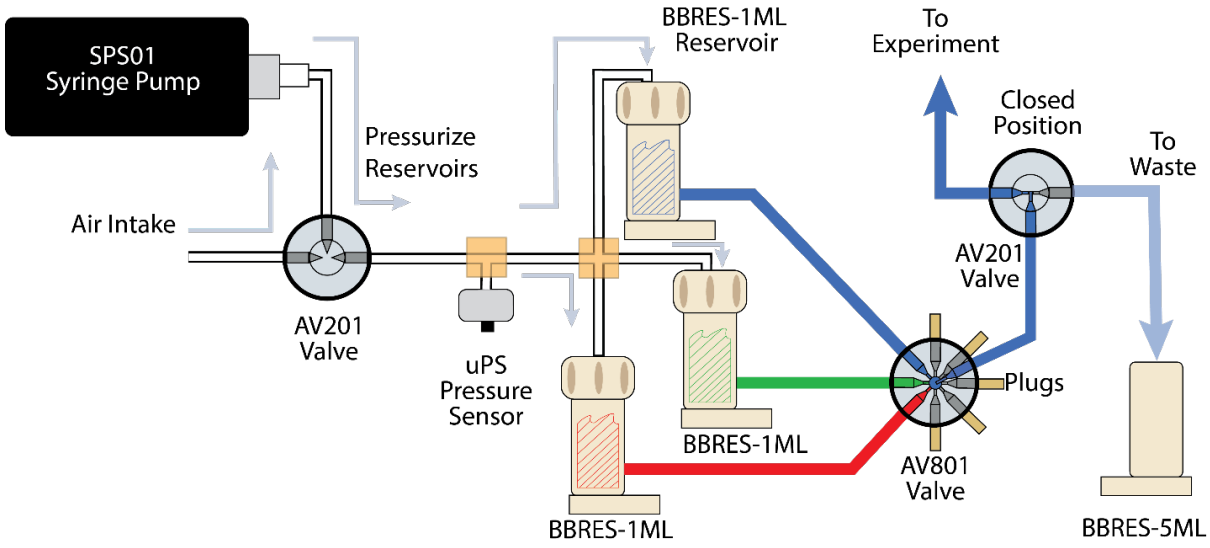

Figure 1. Experimental setup for a 3-fluid pressurized system. The AV801 8-position selector valve is used to inject fluid from each of the reservoirs in sequence.

In this circuit, the fluids are stored in CapTite reservoirs (three are shown, but up to seven can be employed).

The SPS01 syringe pump works in conjunction with an AV201 three-port selector valve to first pull in air, then to push to pressurize the reservoirs. A uPS01 pressure sensor provides the feedback to regulate the pressure.

Central to the operation of the circuit is LabSmith's automated AV801, a bidirectional valve with one common port and eight selectable ports. The AV801 (shown in Figure 2) can be used to select from up to seven sources, with the eighth port serving as a "closed" position. At just 6.6 cm tall, the valve is a fraction of the size of other manufacturers' 8-position valves, making it ideal for this type of experimental setup. One LabSmith 4VM02 Valve Manifold provides the control interface for all three valves in the setup.

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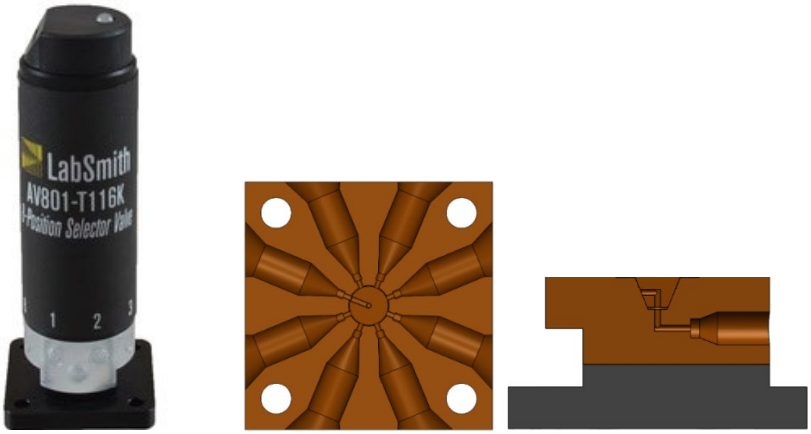

Figure 2. The AV801 selector valve (left), a plan view showing its selector ports (center), and a side view showing the common port and the rotating stem (right).

A detailed list of the LabSmith equipment required for this setup is shown in Table 1.

TABLE 1. Required Components for 3-Fluid Reservoir Setup		
Part Number	**Description**	**Quantity**
uPB-12 or uPB-08	uProcess breadboard	1
EIB200	uProcess USB interface controller	1
SPS01-080	Syringe pump	1
AV801	Nine-port, eight-position valve	1
AV201	Three-port, two-position valve	2
uPS0250 or uPS0800	Pressure sensor	1
4VM02	Valve manifold	1
BBRES-1ML	1 ml breadboard reservoir with cap and o-ring seal	3
BBRES-5ML	5 ml breadboard reservoir for waste	1
C360-100, T132-100, or T116-100	One-piece fitting for connecting capillary to port	24
C360-100 or T116-101	One-piece plug	5
C360-203, T132-203, or T116-203	Tee interconnect	1
C360-204, T132-204, or T116-204	Cross interconnect	1
BB-TOOLS	Hex wrench,Torx wrench, and screws for tightening fittings and mounting to uPB breadboard	1
CAP360-150P, TUBE132-010P, or TUBE116-010P	Capillary tubing	1 m

uPROCESS CONTROL SCRIPT

A sample uProcess automation sequence for the 3-fluid setup can be downloaded here. A snippet of the script is shown in Figure 2.

In this sequence, the syringe first pulls in an air charge. the upstream 2-position valve moves to allow air in, while the downstream 2-position valve moves to its “closed” position so that pressure can build. The upstream 2-position valve then switches to allow air into the circuit, and the syringe begins pushing to pressurize the reservoirs (with feedback from the uPS01 pressure sensor). Once pressure is reached, the AV801 valve opens to each reservoir, in sequence, to inject the fluid for the set time of 5 seconds.

```
Pressurize:
        4VM02: SetValves(3, 0, 0, 0)        ; switch AV201 fill valve to port B (3 = port B)
        4VM02: WaitDone()

        SPS_1:  MoveTo(fill_volume)     ; pull syringe_1 to fill with air
        SPS_1: WaitDone()

        4VM02: SetValves(1, 0, 0, 0)        ; open AV201 fill valve to reservoir port (1 = port A)
        SPS_1:  MoveWith(DChB)
        P22115:         RegUpTo (p_max kPa, DChB)
                                        Loop1:
                  if (SPS_1.IsDone == true)
                        goto Pressurize
                  if (P22115.IsDone == true)
                        goto Inject
                  Wait(1 s)
            Goto Loop1

Inject:
            if (count == 1)
                  pos = position1
            if (count == 2)
                  pos = position2
            if (count == 3)
                  pos = position3

            4VM02: SetValves(3, 0, 0, 0)        ; set AV201 fill valve to port B
            4VM02: WaitDone()

            SPS_1:  MoveTo(fill_volume)     ; pull syringe_1 to fill with air
            SPS_1: WaitDone()
```

Figure 2. A snippet of the uProcess script written to control the sequence of pressurizing the reservoirs and injecting the fluids. The full script for this application can be downloaded here.

The downstream AV201 valve can be used to direct fluid to a waste reservoir between cycles (e.g., for priming or purging the system), returning it to the closed position afterwards so that the syringe pump can once again pressurize the system. This valve should be closed while the AV801 valve is switching in order to prevent momentary injection of the pressurized reservoir fluids while the valve actuates.

Tips:

- Minimize tubing lengths and volumes upstream of the reservoirs to reduce the syringe stroke required to maintain pressure in the reservoir.
- If possible, fill the reservoirs to also minimize the air volume.
- Prime the liquid lines between the reservoirs and the downstream valve prior to injection to remove air bubbles.
- By using multiple, short injection times you can maintain the charge pressure in the reservoirs for longer periods.

To determine the necessary pressure to achieve your desired flow rate, see LabSmith's Application Note: "Pressure Driven Flow with the uProcess Devices and Software."

EXTENDING THE FLOW TO SEVEN LIQUIDS

The same control script can be extended to inject up to seven fluids with one AV801 valve. Depending on the system configuration and requirements (such as total system volume, syringe pump volume, and required injection rates, volumes, and pressure) additional syringe pumps and AV201 valves may be required in order to maintain the injection pressure. Figure 3 shows a 7-fluid system using two LabSmith SPS01 syringes.

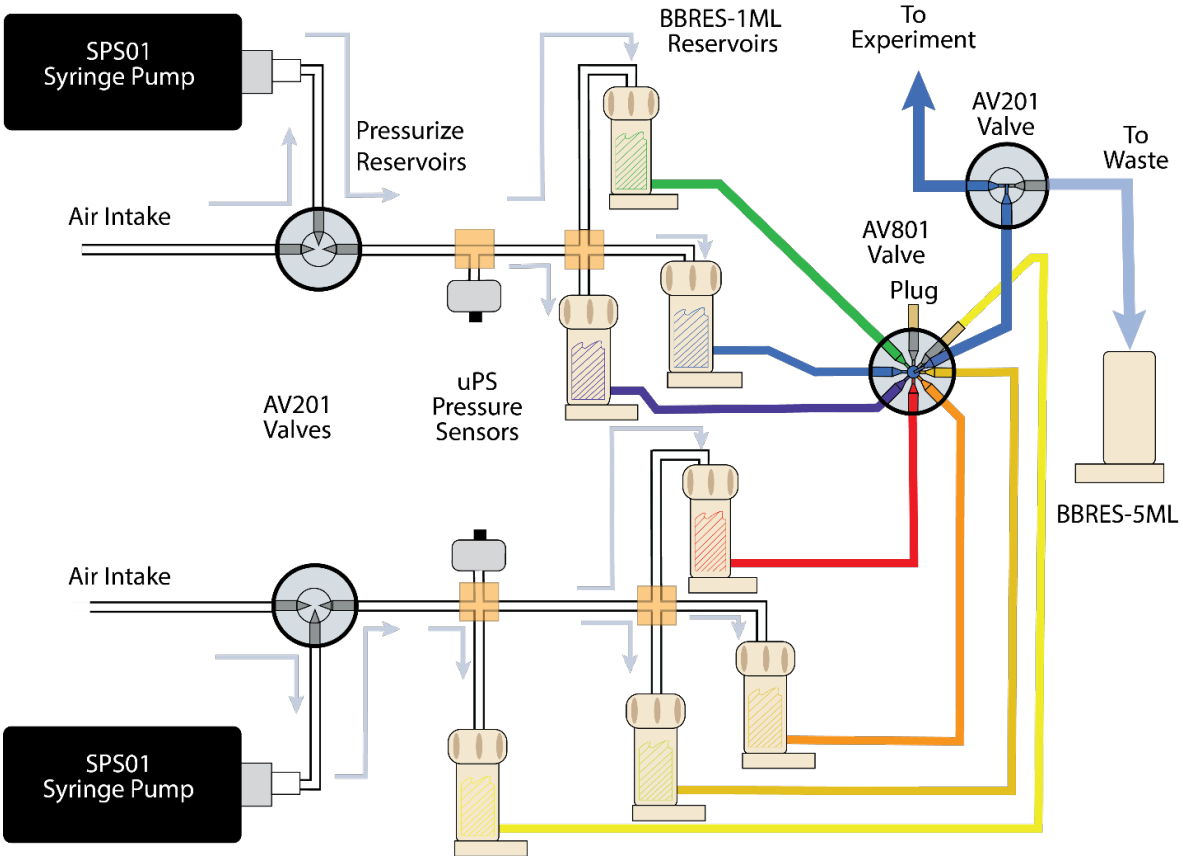

Figure 3. Experimental setup for a 7-fluid system.