FlowSeg Software

1 Installation and update process

The software .exe file is native windows application type, so it does not require installation process for itself, and it does not rely on any supporting frameworks (such as .net, c++, java, etc. redistributables), so there is no download or installation for any of those either.

To "install" the software, simply download the .exe file to your preferred location and run it. Windows prevents processes and applications from writing into the Program Files folder, so do not place the .exe there, as the program will want to write files and folders to the disk (measurement logs, configuration files and such), and the default location is under the folder where the program is ran from.

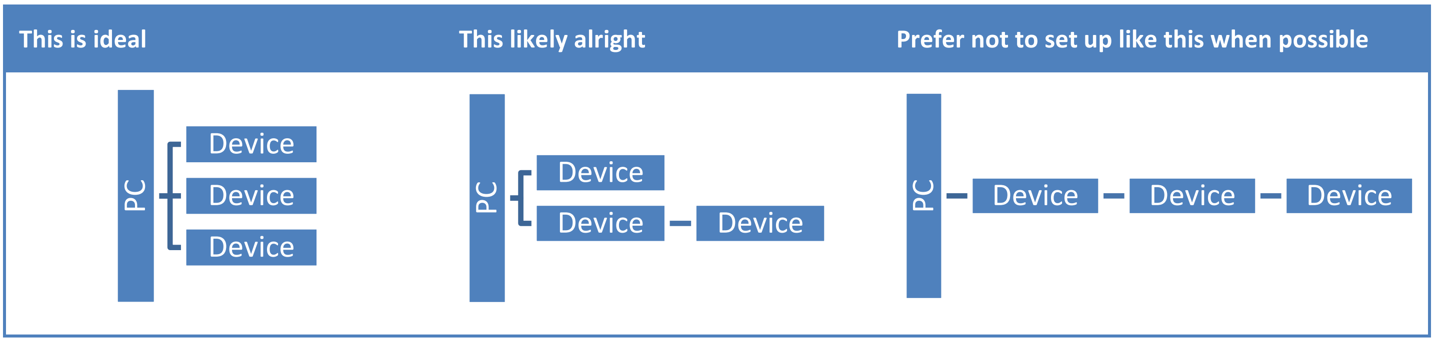
When updating to a new version, it is advised to first make a new folder to archive the previous version. Name the folder with the date of the old version (from the windows title) and place the old .exe file in that folder. This way, in case a new update of the software has a problem, the previous version can be easily restored and used (by copying the .exe back to the main application folder) until the problem with the new update is solved.

1.1 USB drivers

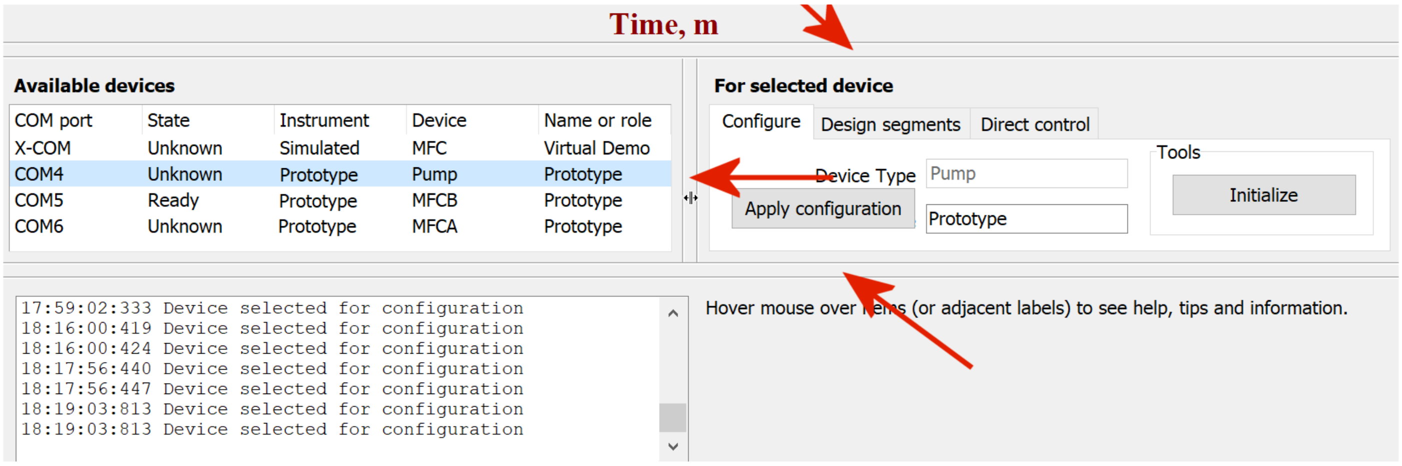
When connecting the instruments to a PC, the USB hardware used in the devices is usually automatically recognized and installed correctly by Windows. In case they are not, on IT department managed computer, old versions of Windows, or for some other reason, the driver installation can be performed with drivers or software downloaded from https://ftdichip.com/drivers/vcp-drivers/ where the correct type is VCP (Virtual COM port).

1.2 USB connections

The depth of USB daisy chain has limits, as each new hub needs to supply power to the hubs downstream. Often the USB ports on the exterior of a computer already come from an internal hub. The build quality of the internal hub and its drivers are main determining factor for the possible depth of the daisy chain. Overall it is advised to avoid deep daisy chains when possible, and in case the PC lacks sufficient USB ports to parallel connect to all devices, acquire high-quality, externally powered USB hub and connect all FlowSeg devices directly to that hub. This keeps the depth of the USB network to a minimum.

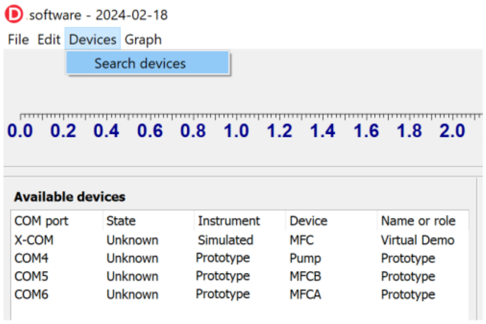


2 Rearranging the form



The form proportions can be resized by dragging on the splitter bars marked above with red arrows. This can be useful on a laptop with a small screen and low resolution.

3 Devices



The software searches for devices from all available COM ports. The process is automatic once initiated by the user from the ***Devices*** menu. All found devices are listed on the ***Available devices*** list-view, with their relevant details.

The first listed device is a virtual device, for the purpose of trying out the software without the need of an actual physical instrument. Some functionality may not work properly for this demonstration device.

COM port Each device has its own COM port for communicating with the software.

State The device state is ***unknown*** at first, when the software does not know better. Once the user has configured the device the state changes to ***ready***, meaning the device can now be operated. When device is performing a segment program, the state is ***segment***, and ***direct*** when in direct control. Once these operations are stopped, the state changes to ***idle***, which is the same as ready.

Instrument The type of the instrument: Gas, Fluid, Custom mixer, etc.

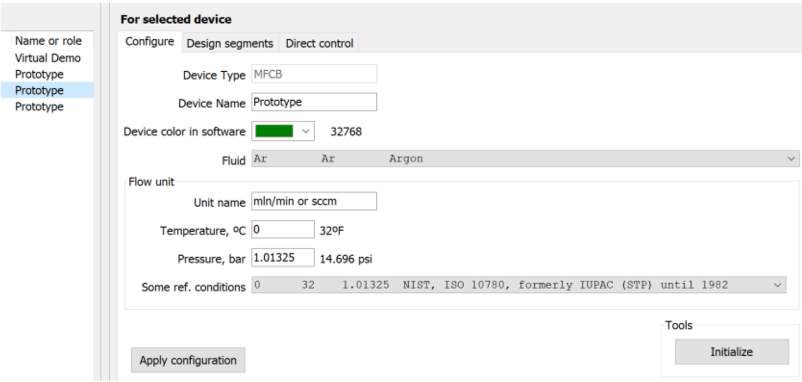
Device An instrument can have a number of devices inside, for example a gas mixer instrument can have one or more mass flow controllers (MFC). Each controller can be individually configured and controlled. MFCs are typically suffixed by the gas line identification, designated by a letter. Thus MFCA is the MFC on gas line A, MFCB on gas line B and so forth, should the instrument only have one device inside, the keyword will not have a suffix, for example most fluid devices only have one syringe pump, designated with word Pump.

Name or role The nickname or purpose of the device, can be edited by user.

Important!

Many actions in the software apply to the currently selected device or currently selected multiple devices. Use ***ctrl*** or ***shift*** and ***left mouse click*** to select multiple devices.

4 Configuring a device



The ***configure*** tab is used to define the parameters of the selected device.

Device type is read only property and shows instrument and device.

The ***Device name*** is nickname or role for the instrument.

Color of the device series on the graph and the color of the thread-communications led.

For MFCs, the ***Fluid*** is any of the hardcoded gases, any user-defined static gas mixture, or a dynamic mixture from another Gas device.

Flow unit is a combination of (flow) ***unit name***, ***reference temperature*** and ***reference pressure.*** The drop down menu allows quick-selecting some typical reference conditions like mln/min or sccm. The unit g/min does not need reference conditions.

In practice, volumetric flow units mean, that if the temperature and the pressure were as defined, the volume of the gas would be the said amount. The actual conditions are almost never the reference conditions, so the reported amount of flow and the actual amount of flow differ even as much as 10%. Furthermore the default, standard and normalized reference conditions have many conflicting definitions that vary between region and sector of industry.

Therefore it is recommended always to stick to the same definition, practice, or use g/min which is independent of conditions.

By default the software and devices use 25°C and 1.01325 bar A as the reference conditions. This way, the actual flow and the reported flow are close to each other for most users.

For ***pump*** type device, the fluid list included distilled H2O and custom user defined liquids. The user may define the ***syringe size*** used in µL, and the ***fluid temperature*** in °C (which affects the fluid density).

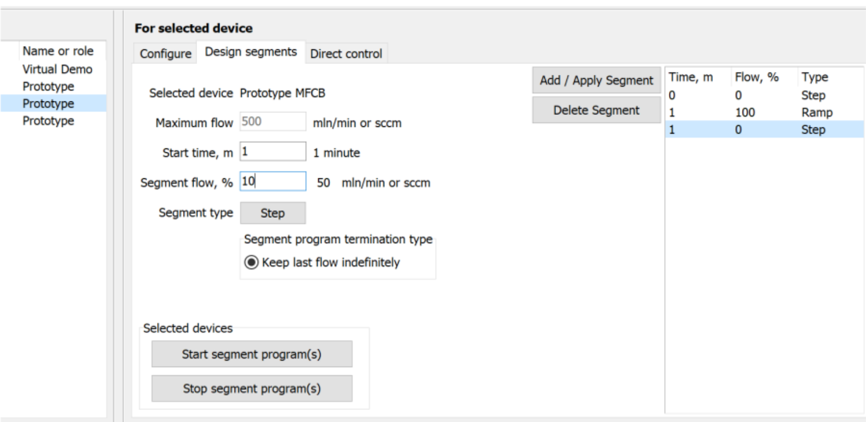
Once all definitions are checked and confirmed, they are applied to the selected device when ***Apply configuration*** is clicked.

This tab also has the ***Tools*** section for special actions.

Initialize performs factory reset and applies the settings necessary for a device to work with the software. This is normally not necessary and should only be done when advised by the device support.

Prime pump performs several cycles of syringe fill/dispense to remove old fluid and or trapped air from the system.

Change syringe moves the plunger to the bottom position for syringe change (and locks the plunger in place until next software reset for safety)



5 Design segments

A ***segment program*** is a list of instructions for a device to follow what time, what flow, and type of transition from one flow to another.

A ***segment*** is one instruction in a segment program. A segment has ***start time*** given in minutes, a ***flow*** given in % of device maximum flow, and ***type*** of transition.

This tab shows maximum flow for the device in user-specified units. The time in minutes is automatically shown as days, hours and minutes. The flow is automatically shown in user-specified flow units. The transition type ***Step*** is immediate while ***Ramp*** is linear transition from previous value to the current value.

It is possible to add and edit segments by clicking the ***Add/Apply Segment*** (a segment is edited if segment is selected, and added if not selected). ***Delete segment*** removes selected segment.

Segment termination type determines what happens after the last segment, the naming of the options is supposed to be self-explanatory:

- Keep last flow indefinitely
- Repeat segment program
- Stop flow (this device)
- Stop flow (all devices)

The ***Start segment program(s)*** button starts the segment programs for all selected devices.

The ***Stop segment program(s)*** button stops the segment programs for all selected devices.

5.1 Load and save segment programs

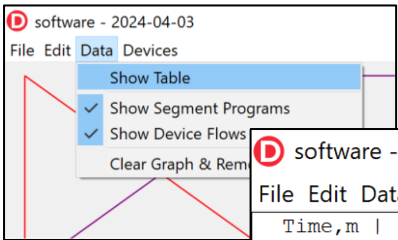
Right-clicking on the segment program list-view (not over existing lines) opens a pop-up menu with 'load' and 'save' options. These said operations allow for text file interaction for easy storing and reusing segment programs.

Should these files be edited manually, the format rules are follows:
Each single line makes one segment of the segment program. A line is made of 3 mandatory items: **Time**, **Setpoint**, **Ramp type**, and an optional **Comment** item, each separated with empty space.

Time and Setpoint are decimal numbers with full stop as separator: 123.456 and the units are minutes and % accordingly. (Do note that for example 10% setpoint means different things on different devices as it is always defined from device maximum theoretical flow.)
Ramp type is either: Step or Ramp
Comment is one chunk of alphanumeric characters a to Z, 0 to 9, %, *, @, / or _ where the _ character will be replaced with space when the program is loaded into the user interface.

5.2 Shared segments overview (Data table)

The data table (enabled from main menu) shows all the segment programs as a tabulated text, and is helpful to have visible while designing segment programs.



software - 2024-04-03
File Edit Data Devices

```
 Time,m |            Time |      X-COM MFC |      COM5 MFCB |      COM6 MFCA |
--------+-----------------+-Setpoint--Type-+-Setpoint--Type-+-Setpoint--Type-+-
  0.000 |                 |                |         0  Step |       100  Step |
  1.000 |              1m |       100  Ramp |       100  Ramp |         0  Ramp |
  2.000 |              2m |       100  Step |         0  Step |                |
  2.500 |          2m 30s |        30  Ramp |                |                |
  3.000 |              3m |        50  Step |                |                |
  3.500 |          3m 30s |        30  Step |                |                |
  4.000 |              4m |         0  Ramp |                |                |
  9.000 |              9m |                |                |        11  Ramp |
```

The table shows following columns.

- User defined time unit
- Human-readable time

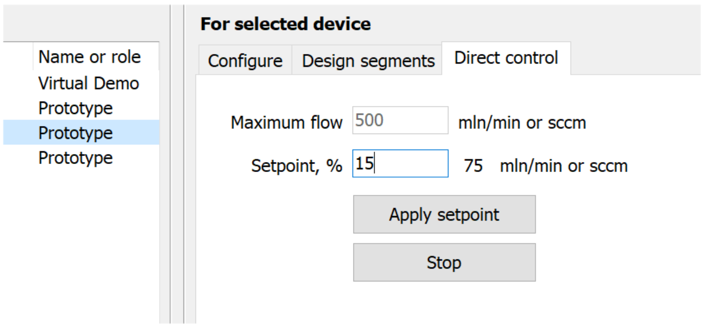
- Device specific column with setpoint in %, and Type of segment. (Notes are omitted in this table), repeated for all present devices.

Should device lack a segment at a time some other device has one, an empty column is added.

5.3 Data view

Same memo has the flows from devices below the Segment table.

7 Direct control



Direct control tab is the simplest way to control (configured) device or devices.

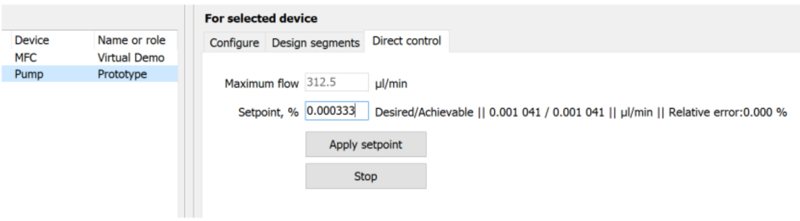
It allows applying a flow ***setpoint*** to one or more devices.

Applying a setpoint to a device will stop any segment program the device may be performing.

To stop the flow and the graph logging, click the ***Stop*** button.

Each device will remember its direct control setpoint even when it is not “Applied” with the button, all it takes for a device to memorize the setpoint is to change the value on the field when a device is selected. When “Apply setpoint” is clicked, and when more than one device is selected, each device is started with its own memorized setpoint.

8 Pump setpoint



The design segments and direct control in previous chapters had images with MFC selected. The functionality and process for Pump is the same, but some additional setpoint information if displayed.

The pump is able to dispense its contents very slowly, allowing setpoint down to 0.000 333 % of the (theoretical) maximum flow. Actual maximum flow is currently limited to ~30% of theoretical maximum flow in order to save syringe lifetime.

Beside the setpoint the resulting desired flow is displayed, as well as the actual achievable flow, and their relative difference.

Input fluid density is currently locked at 0.99819 which is the density of H_2O at 20ºC and the fluid input temperature will not change anything.

9 Pump ramp segments

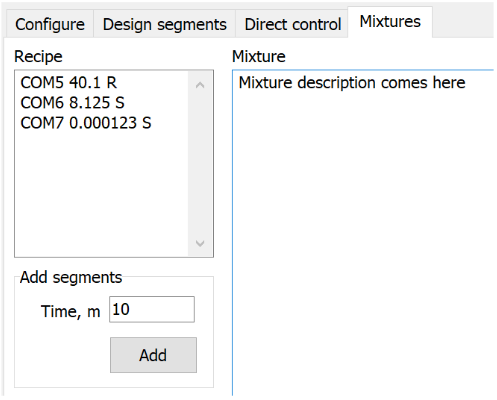
In this manual text “pH_2O” will signify any evaporated fluid content in the made mixture, as this is simpler to write than to say each time something like: “To achieve dynamically changing moisture, or any other evaporated fluid content”

In general ramp is a linear interpolation between start and finish setpoints. This works fine for MFCs, but for pump each setpoint change the pump receives new command, which starts with filling the syringe (which takes brief moment). By the time the device is handled again by the software (this happens many times per second), when performing a ramp-type segment, the interpolated setpoint has already changed, just a bit, and the new command always starts with refilling the syringe. So, a ramp-type segment with the pump would result just as endless loop of refilling the syringe never getting to the dispense part. The problem is solved by only applying new setpoint every 30 seconds.

10 About dynamic fluid content

- In general experiments with changing pH_2O should always advance from dry to moist or from low partial pressure to high. Doing the experiment the other way is slower and the effects on the experiment are gradual and harder to quantify.
- Pump segments are always steps, even when user asks for ramps, in which case the ramp is automatically converted to steps. These “ramp-steps” are always one minute long.
- Dynamic gas flow paired with static pump function produces smooth pH_2O gradients when the one minute long steps are too coarse.

11 Mixture calculations

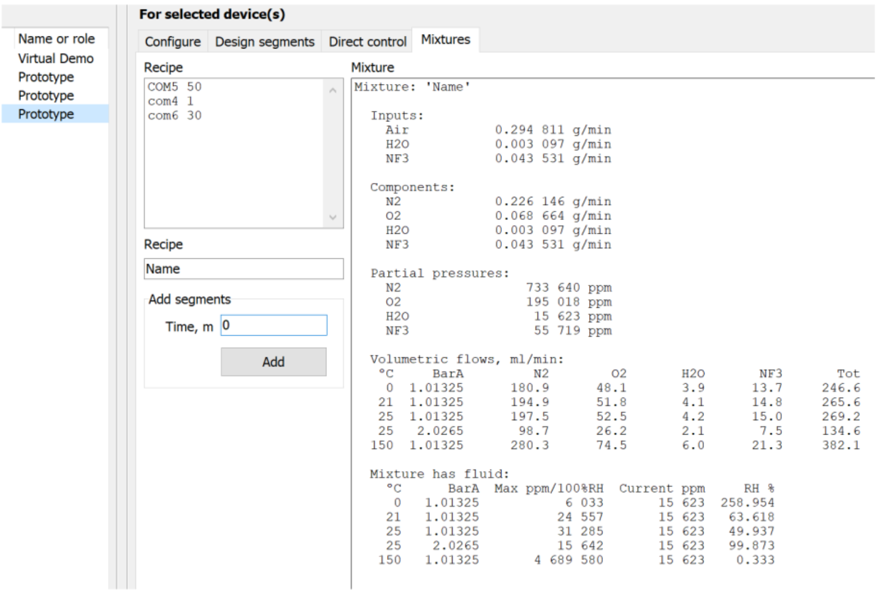


Mixtures tab has the tools to quickly design segment programs based on mixture properties such as partial pressures of each component, total flow, absolute and relative humidity, mass and volumetric flow for each component and totals.

For the mixture designer to work, device(s) must be configured, i.e. they must have a fluid assigned to them to calculate the mixture with.

When suitable mixture design is achieved, it can be sent (***Add*** button) to each participating device as a segment in their segment programs, added to the specified time, with the optional comment. The devices will then achieve said mixture at said time (if their outputs are connected together).

In this early version the mixture design is text based. Each line represents one device source, and the calculations will automatically fetch the gas type and maximum flow for the device to be able to calculate the resulting mixture. The device is defined as capital COM suffixed with integer number matching the devices address. Space separates the device COM port from the desired flow given in % of device maximum flow, where decimals are separated with full stop. For convenience the segment type can be defined here, also separated with space; use R for Ramp and S for Step. The segment type can be omitted, and if so, the default segment type will be Step.



Various flows from various devices, if combined, would make such mixture. Partial pressures, volumetric flows, and even relative humidity is calculated.