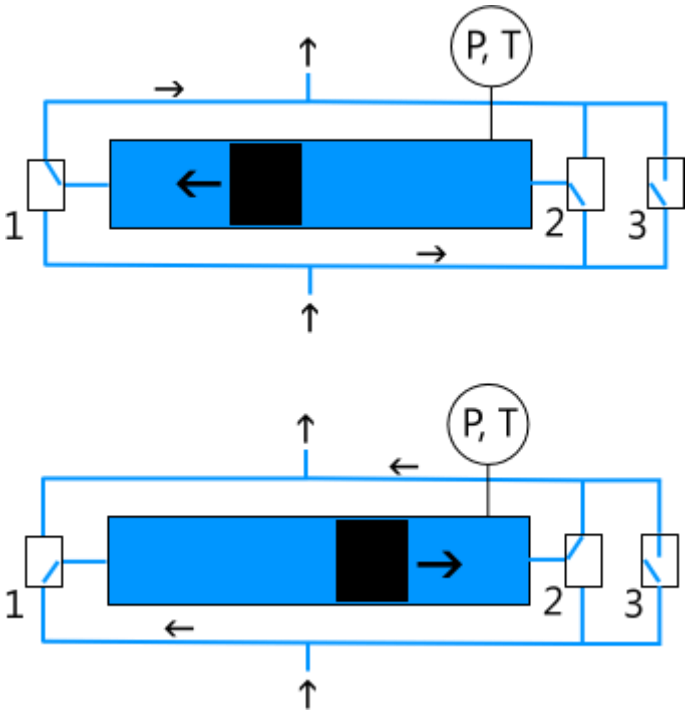
Installation and operation manual ReciFlow Gas

1. Measurement principle



Mechanical operating principle

A piston is placed inside a tube. When gas or liquid is led into the tube on one side of the piston it will make the piston move. Which side the gas/liquid is led in on is controlled by two valves, [1] and [2]. By switching state of the two valves simultaneously the piston is made to reciprocate within the tube.

By measuring the position of the piston the displaced volume can be calculated as the diameter of the piston is known. The flow rate is calculated as the change in displaced volume over time. The flow measurement is continuous as it is done during both directions.

The piston is precision machined to fit into the tube with extremely narrow tolerances. It is made of graphite and the tube is made of borosilicate glass, a combination of materials that make a very good match in terms of similar thermal expansion and low friction. This makes it possible to achieve a virtually leak free viscous seal.

The measurement is volumetric and directly derived from physical quantities such as volume (travel and diameter) and time.

A bypass valve [3] is opened when the instrument is shut off or when it is put into “Bypass” mode. When the bypass valve is open the gas flows directly from the inlet to the outlet of the instrument.

The bypass valve can be omitted in certain versions in order to prevent the gas from flowing freely if the instrument is shut down. This may be preferred if the instrument is used for dosing.

Normalization of readings

Normalization to a set pressure and temperature is done by the ReciFlow since it is compensating the measured volume and flow rate using the readings from the built in precision pressure and temperature sensors.

2. Installation

Orientation

The instrument must be placed in an upright position on a stable surface during operation in order to achieve the best possible accuracy. It will however not be damaged if used in other orientations.

Gas connections

CAUTION: As the piston reciprocates it will change the "order" of the gas sections in a stream. The principle "first in first out" is not applicable here. If for example analysis of the gas concentration is to be done downstream of the flow meter this effect has to be considered. The stroke volume of the piston is about 1ml.

CAUTION: The service interval of the flow meter is limited by the valves used for switching the direction of the flow. Due to this the flow meter is not suited to be permanently installed to measure high flow rates. For detailed info see Datasheet. The valves can however easily be replaced at factory service.

WARNING: Do not exceed the specified maximum pressure.

CAUTION: Do not exceed the maximum specified flow rate. If exceeded, the instrument will automatically be put into the Bypass state.

Filtering

The instrument is equipped with inlet and outlet filters. The filters are of sinter type with a porosity of 10 µm. It is recommended to use an external filter upstream of the instrument with a porosity of 5 µm or lower in order to prevent the internal filter from clogging.

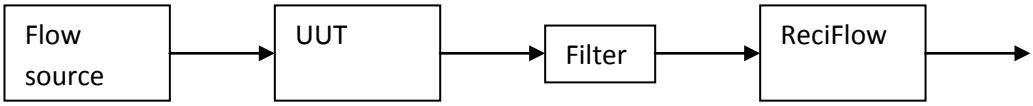
Material compatibility

Check the list of wetted materials listed in the Datasheet. It is up to the user to verify that the gas used will not harm the internal components of the instrument.

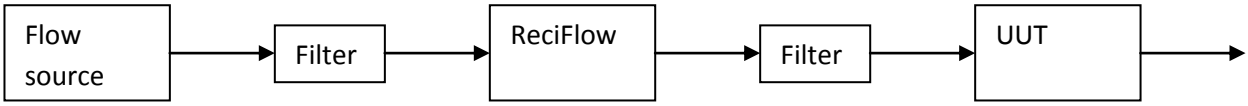
WARNING: Check list of wetted materials for compatibility with the gas. Using a non compatible gas could cause leakage, resulting in personnel injury or death.

Recommended system setup for calibration

Alternative 1:



Alternative 2:



3. Operation

Turning on and off

The on/off button is placed on the left side of the instrument. Press the button for a few seconds in order to turn the instrument on or off.

Power supply

The ReciFlow has an internal NiMH battery which has an operating time of about 4 hours. The battery is charged with the included AC/DC adapter. The instrument can be used, or stored, with the AC/DC adapter permanently connected.

The on/off button will light up when the AC/DC adapter is connected. The color will be red during charging and green when the battery is fully charged.

NOTE: If the AC/DC adapter is disconnected even for a short time when the battery is full (green light), the button will be red when connected again while the charging circuit determines the charging condition of the battery. The light will change to green after about 10 minutes if the battery was fully charged.

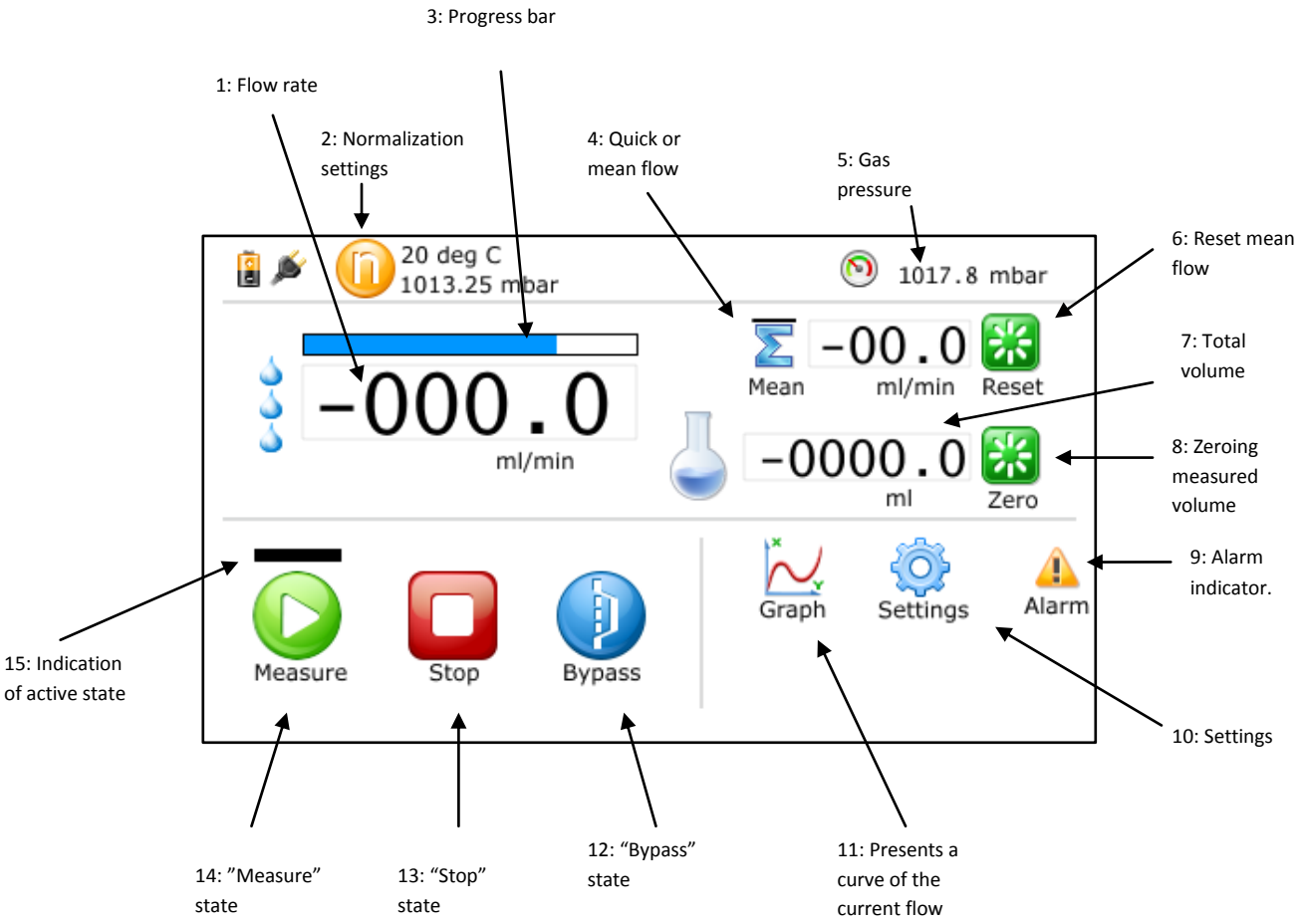
CAUTION: Use only the AC/DC adapter supplied with the instrument.

Warm up time

ReciFlow requires a warm up time of 15 minutes to achieve best possible accuracy.

Graphical user interface description

CAUTION: Do not use sharp objects on the touch screen.



1. The flow rate is presented with the accuracy and precision stated in the specification. The update rate is dependent of the flow rate. A new flow is presented when the progress bar (3) reaches the end.

2. By pressing this button the normalization temperature and pressure level can be set. A number of predefined levels and user defined levels are selectable.

3. A new flow reading is presented when the progress bar reaches the end.

4. Press button to toggle between “Quick” flow and “Mean” flow presentation.
   “Quick“ flow: Useful at low flow rates to get a faster update of the current flow rate. This reading does not have the same accuracy and precision as the flow rate presented in (1).
   “Mean” flow: The mean flow rate is presented with the same accuracy and precision as (1). It is updated at the same time as reading (1). Note: If the flow is zero the mean flow rate is not updated until the reading (1) is updated, i.e. when there is a flow again.

5. Indication of the absolute pressure of the gas in the measurement tube. Note: When there is a flow through the instrument this pressure indication will differ from the barometric pressure due to the pressure drop in the system.

6. By pressing this button the mean flow rate is reset.

7. Indication of the total measured volume. The volume is normalized to the same level as the flow rate.

8. By pressing this button the measured volume is zeroed.

9. Settings:
   a) Normalization levels. Same settings as reached from (2).
   b) System info: serial number, software version, internal temperature, last calibration date, installed options.

10. By pressing this button the flow rate is presented in a graphical view. The accuracy and precision of the flow rate is less than for (1).

11. By pressing this button the instrument is set in the “Bypass” state. A bypass valve is opened to enable the gas to flow directly from the inlet to the outlet without entering the measurement tube.

12. By pressing this button the instrument is set in the “Stop” state. The valves that control the direction of the piston are set to stop the flow. Note: The indicated pressure is the pressure on the outlet side of the instrument.

13. By pressing this button the instrument is set in the “Measure” state. The gas will flow into the measurement tube and the instrument will measure flow rate and volume.

14. Indication of the current state; “Measure”, “Stop” or “Bypass”.

15. Alarm indication. One of the following causes:
    a) Pressure too high. An alarm will sound, the indicator appears and the state is changed to “Bypass”. User action: Lower the pressure and press indicator to acknowledge.
    b) Flow rate too high. An alarm will sound, the indicator appears and the state is changed to “Bypass”. User action: Lower the flow and press indicator to acknowledge.

4. Electrical interfaces

Note: ReciFlow is not designed to support communication on both USB and RS232 interfaces simultaneously. There is only space for one cable at the time.

USB

CAUTION: Be careful when connecting cables to the USB interface. Large forces may easily damage the connector.

The USB interface can be connected either to a flash drive (USB stick) or to a computer (PC). It has different functionality depending on which device it is connected to.

The USB connector is of the type Micro-AB, which means that it can be connected to either a Micro-A or a Micro-B plug.

If a flash drive is connected to the USB interface, it must be connected using a Micro-A plug. A standard type A receptacle to Micro-A converter cable can be ordered as an accessory. The flash drive is used to update the firmware of ReciFlow, see section Software update.

If a PC is connected to the USB interface, it must be connected using a Micro-B plug. Normally, a USB-cable with a standard type A plug in one end and a Micro-B plug in the other is used. When used in this configuration, the ReciFlow will act as a USB communication device (CDC). For the user, it will be configured and act as a traditional RS-232 port on the PC.

The following serial communication settings are required:

· Speed: 115200 baud

· Data bits: 8

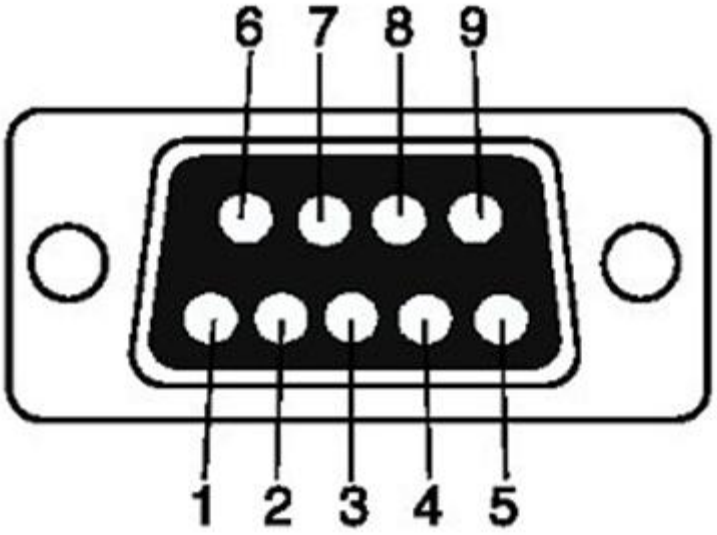
· Parity: none

· Stop bits: 1

· Flow control: none

RS-232

Schematic drawing of the connector on the ReciFlow:



Pin no	Description
1	NC (No internal connection)
2	RxD (Received Data)
3	TxD (Transmitted Data)
4	NC (No internal connection)
5	GND (Ground)
6	NC (No internal connection)
7	RTS (Request To Send)
8	CTS (Clear To Send)
9	NC (No internal connection)

The cable used to communicate with a PC is a standard serial cable.

The protocol used to communicate with the ReciFlow over the RS-232 serial interface is based on master-slave communication, where the ReciFlow is designated as the slave, while the master is normally a PC. The RS-232 serial interface supports only point-to-point communication with the PC. If there is a need to communicate with several ReciFlow and/or other devices, separate cables and separate dedicated ports on the PC are needed for every device.

The following serial communication settings are required:

· Speed: 115200 baud

· Data bits: 8

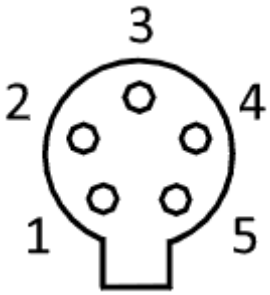
· Parity: none

· Stop bits: 1

· Flow control: RTS/CTS (optional)

Analog output

Connector: Binder 09-9792-30-05



1: 0-5V
2: GND
3: 0-20mA
4: Digital out
5: Digital in

The voltage output and the current output are set to reflect the span presented in the graph view. For example, if the graph is set to present flow rate between 0-200 ml/min, 200 ml/min will be the flow rate equivalent to 5V or 20mA. The accuracy and precision of the flow reading will be less than what is presented in flow indication (1).

The digital in- and output are reserved for future use.

5. Communication protocol

Structure

A communication sequence is normally initiated by the PC. The PC will send a command to the ReciFlow which will acknowledge the command. Commands that will expect data to be returned are defined as requests. When a request is sent, the ReciFlow will acknowledge the request, followed by the requested data.

The ReciFlow will only be allowed to initiate communication in the case a STREAM command has been sent previously from the PC to the ReciFlow.

List of commands and requests

All commands and requests are one byte of data. The command code used always corresponds to an ASCII letter. This simplifies the use of a normal terminal program on the PC to issue commands to the ReciFlow.

List of normal commands:

Command	Code (hex)	ASCII	Description
BYPASS	0x62	'b'	Let the flow bypass the measurement tube
CLRVOL	0x63	'c'	Clear the volume
END	0x65	'e'	End the streaming of data from the ReciFlow
CLRMEAN	0x6C	'l'	Clear the mean flow
MEASURE	0x6D	'm'	Starts a measurement
STOP	0x73	's'	Stop the flow through the flow meter
STREAM	0x74	't'	Receive data from the flow meter automatically when the measurement data is updated. The automatic flow data will be sent using the command code 0x66 (or 'f' in ASCII).

List of request data commands:

Command	Code (hex)	ASCII	Returns	Unit
FLOW	0x66	'f'	Measured flow	µl/min
MEAN	0x6E	'n'	Mean flow	µl/min
PRESSURE	0x70	'p'	Pressure in the measurement tube	Pa
VOLUME	0x76	'v'	Accumulated volume	µl

List of debug commands:

Command	Code (hex)	ASCII	Description
ASCII	0x61	'a'	Switch from binary to ASCII format of the response to data request commands
HELP	0x68	'h'	Special command which will send a list in ASCII format of all commands and requests available
BINARY	0x69	'i'	Switch from ASCII to binary format of the response to data request commands

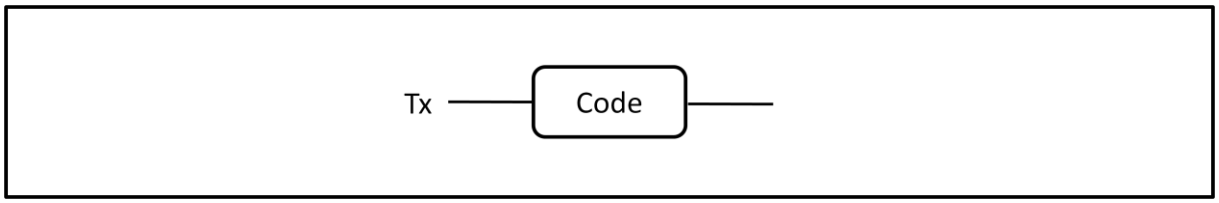
Transmit

The command consists of a single byte code identifying the command or request.

The different types of commands and command codes are listed in the command list section of this document.

Transmit sequence:

(Tx represents communication from the PC to the ReciFlow)

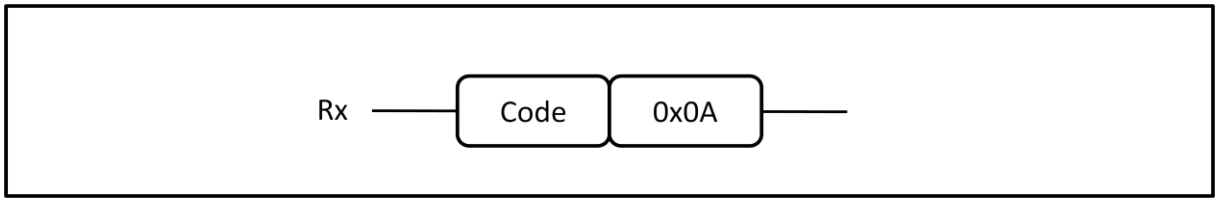


Response (binary)

The response format depends if the transmitted command requested data or not. In both cases the response will start with echoing back the command or request code, and end by sending the hex code 0x0A.

Response to a command:

(Rx represents communication from the ReciFlow to the PC)

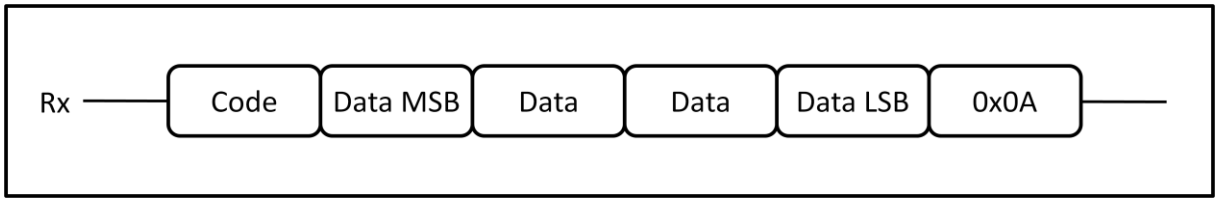


When the transmitted command request data to be returned from the ReciFlow, it will be sent directly following the echoing of the data request command code.

Four bytes of data will be returned. Since the requested data can be negative it is represented as a two's complement (int32).

The data will be returned in big-endian format, that is, the most significant byte (MSB) will be sent first.

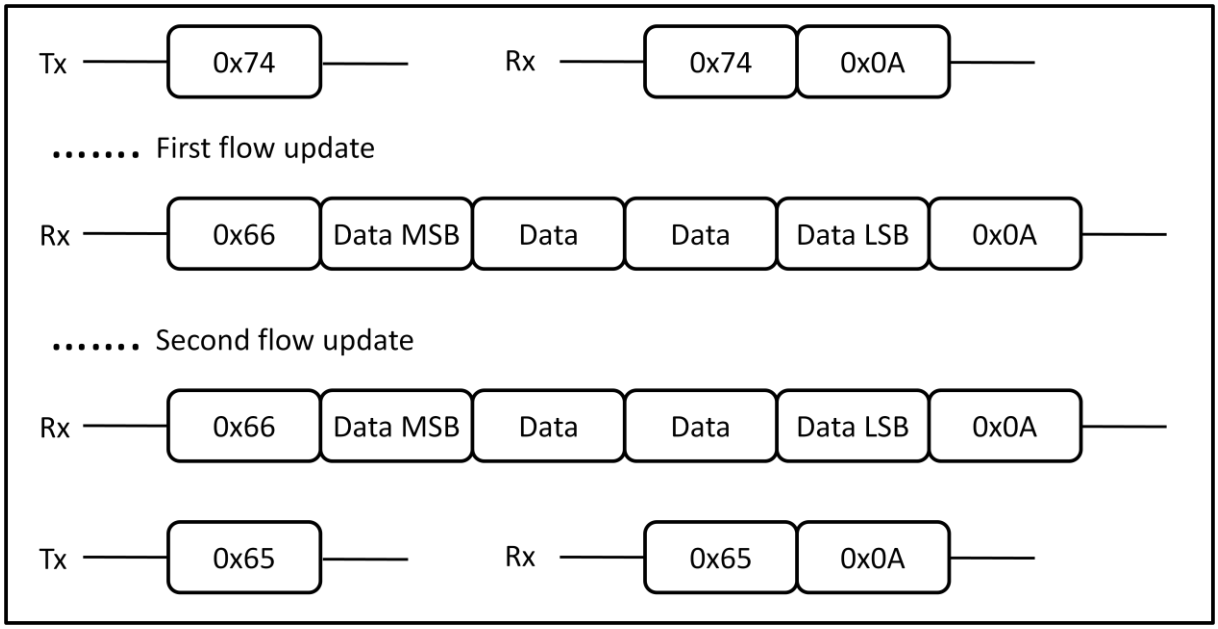
Response to a data request command:



Streaming

It is possible to let the ReciFlow continuously send data to the PC once it has received an updated flow value. This can be useful for logging the flow during a measurement over a period of time. To start the continuous update of flow values, the STREAM command is sent to ReciFlow. It will acknowledge the command in the usual manner, and then keep sending flow responses every time the measured flow is updated. During streaming it is also possible to send other normal commands as well as data request commands. The automatic response can come anytime but it will not interrupt the response to a manual data request command. The streaming will be stopped by sending the END command to the ReciFlow.

Example: Send STREAM command to start data streaming, wait for two flow samples, send the END command to end data streaming.



Text based responses (ASCII)

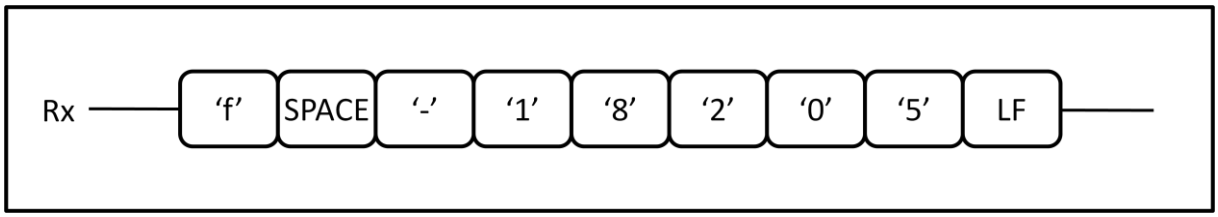
By default, the ReciFlow will produce binary/hex responses to data request commands as described above. There are occasions when a text based response is desired, for instance when using a simple terminal emulation program to communicate over the RS-232 or USB port. The output from the program can then easily be stored or imported in, for instance, Excel.

To instruct the ReciFlow to send text based responses over the communication interface, the ASCII command (character 'a') must be sent to the ReciFlow. To revert back to the normal binary/hex format, the BINARY command must be sent (character 'i').

Once in the ASCII-mode the ReciFlow will respond as described earlier to normal commands. It will however respond differently to request data commands. After echoing the command code, it will send a space character, followed by the ASCII-coded numbers, and then concluding with the line feed character (LF), which has the hex value of 0x0A.

Note that the length of the data packet is not fixed in this case. It will depend on the size and the sign of the actual data in the response. The total packet size will however never exceed 14 bytes.

Example of a response in ASCII-mode to a FLOW command, returning a flow of -18.205 ml/min:



6. Software update and options

Software update

The firmware of ReciFlow can be updated by the user.

Procedure:

1. Place the file with the new software (always called “ReciFile.hex”) in the root or top catalogue on a FAT32 formatted USB memory stick.
2. Connect the memory stick via a Micro-A type converter cable to ReciFlow.
3. Turn on ReciFlow.
4. The ReciFlow will initiate the software upload with two short buzzer signals. The screen will be white during the update. The update will take at least 1-2 minute depending on file size. When the update is finished the ReciFlow will show the start screen or the “Home” screen.
5. Disconnect the memory stick and the adapter and restart ReciFlow.

Troubleshooting:

If the update starts with one long buzzer signal instead of two, the update has encountered a problem. Try one of the following:

- Is the formatting of the memory stick correct?
- Use another memory stick.
- Does the file have the correct name? Must be *ReciFile.hex* exactly.
- Is the file placed in the root or top catalogue of the memory stick?

If no buzzer signal is given and the ReciFlow just starts normally, the wrong type of USB adapter is used.

If the update of the new software is interrupted for some reason (disconnected memory stick, empty battery etc.), the ReciFlow will not be able to start normally. The software update can however be finished by repeating the procedure above.

Installing options

Software options can be installed on ReciFlow. The procedure is the same as for the firmware update described above but the file used is called “ReciOpt.hex”.

Maintenance

Cleaning

Clean the exterior of the instrument with a slightly damp cloth.

The touch panel surface can be cleaned with detergents and cloths suitable for TV or computer screens of LCD type. Apply a small amount of detergent on the cloth, not directly on the touch panel, to avoid spilling into the instrument.

Troubleshooting

Symptom	Possible cause	Action
ReciFlow flow readings differ with several percent from for example the readings of a mass flow meter.	Different normalization levels are used.	Check what normalization levels are used in the mass flow meter. Set the ReciFlow normalization to the same levels (temperature and pressure).
Volume measured by ReciFlow differs from geometrical volume, for example a volume produced with a syringe.	Normalization levels used in ReciFlow differs from the conditions in the volume to be measured.	Set the normalization levels to the conditions in the volume. If the ReciFlow is set to measure volumetrically, an error will occur if the temperature in the volume differs from the internal temperature of the ReciFlow.
Overflow alarm when going from “Stop” to “Measure” state.	Even though the steady state flow is below the specified maximum level, an initial higher flow can be released when turning on the flow if there is a pressure reservoir close to the shut off, i.e. the ReciFlow.	Minimize the volume between the restrictor that is setting the flow rate and ReciFlow.
ReciFlow shuts down when connected to USB or RS232.	Different electrical ground levels.	Make sure all equipment connects to the same common ground. Alternatively, connect ReciFlow power supply to an isolating transformer.
ReciFlow induces pressure and flow fluctuation.	At high flow rates, the change of direction of the piston introduces a short pressure pulse in the tubing.	Add a pneumatic filter after, before, or both after and before ReciFlow.
There is not enough room for both a RS232 cable and a USB	ReciFlow is not designed to support communication on	

stick or cable.	both interfaces simultaneously.	
The pressure drop over ReciFlow is high.	The internal filters may be clogged.	Reverse the direction of the flow through ReciFlow. Use a high flow rate to back flush the filters (put ReciFlow in “Bypass” state). If still too high pressure drop, contact EC Instruments. Always use additional external filters!
ReciFlow will not start measure, flow is blocked.	Piston is in its end position and the direction of the flow is negative.	Alt1: Reverse the direction of the flow for a short time. Alt2: Go to “Bypass”. Raise or lower the connection side of the instrument in order to make the piston move from its end position.
Sound from the valves switching at a high frequency.	If the instrument is tilted without any flow present, the piston will move towards the end of the tube. The valves will try to change the movement of the piston as it reaches the end.	If handling the instrument without flow present, put it in “Bypass” or “Stop” state. Not doing so will not harm the instrument.