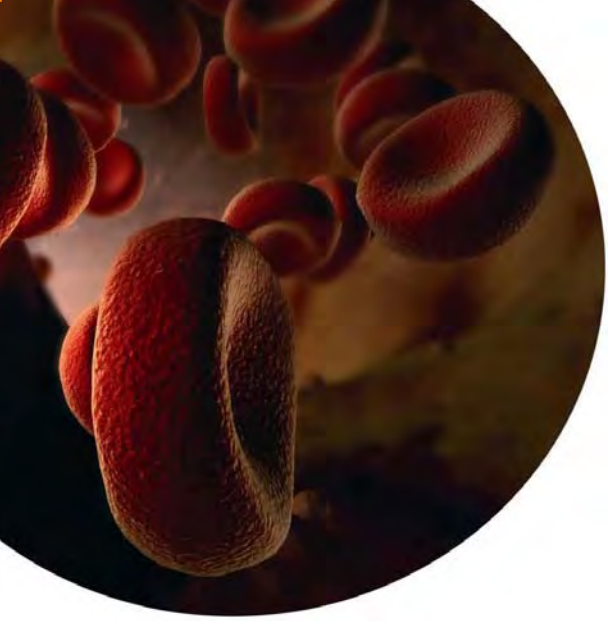

ExiGo Pump

LabVIEW Manual

www.cellixltd.com

cellix

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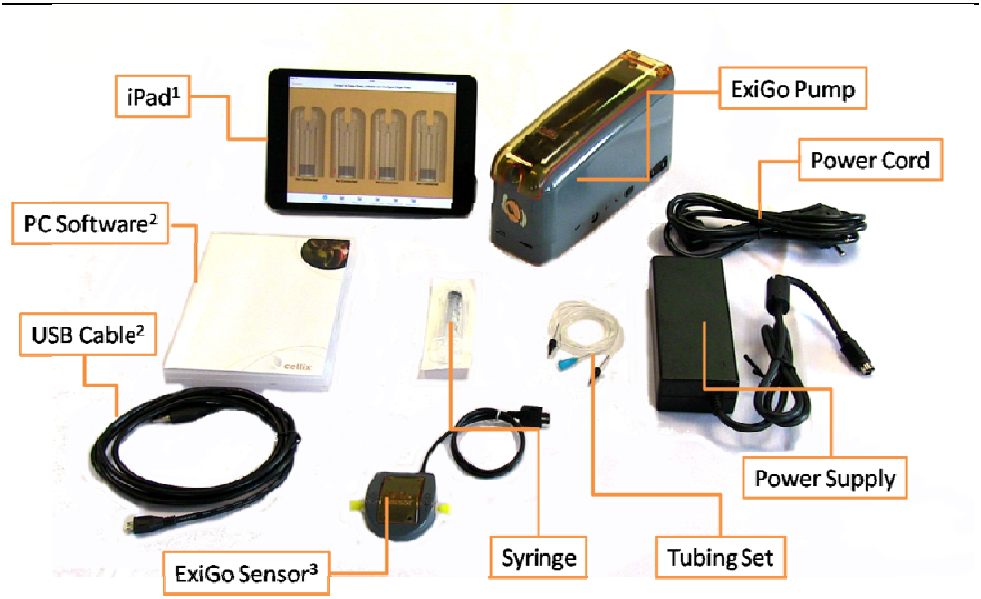
Tel: +353-1-4500-155 Fax: +353-1-4500-158 Email: info@cellixltd.com

1. ExiGo Pump Box Contents

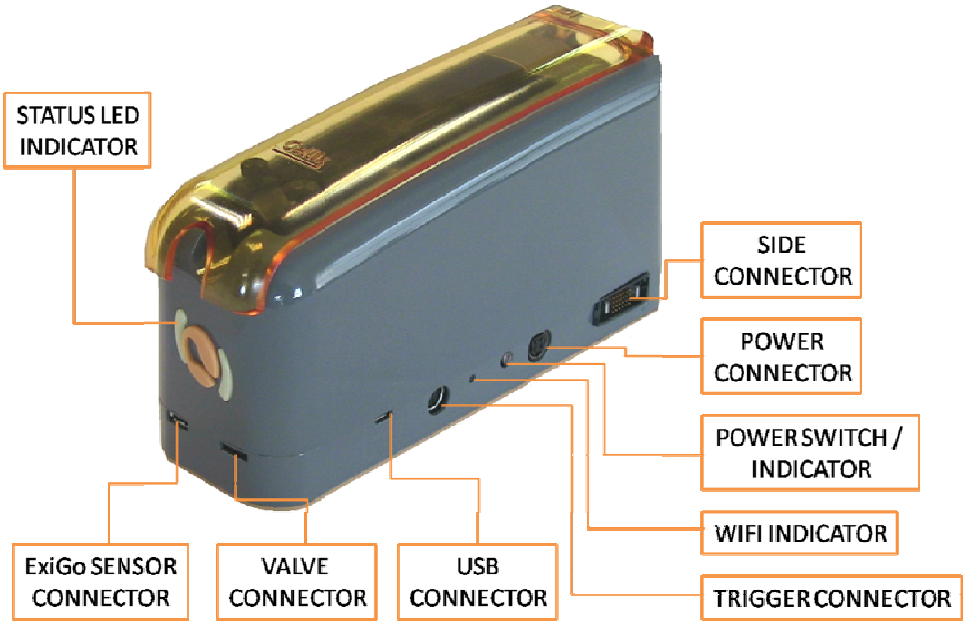


[1] iPad Bundle only

[2] PC Software Bundle only

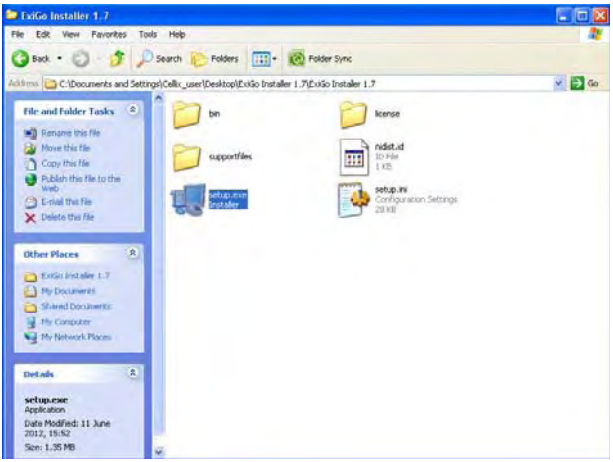
[3] Purchased separately

2. ExiGo Pump Overview

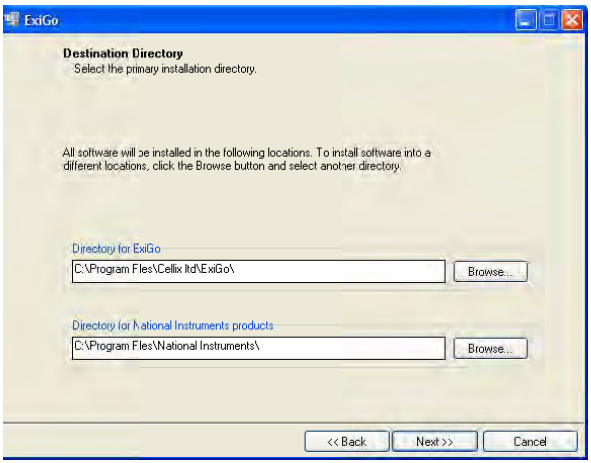


3. LABVIEW INSTALLATION

Please complete the following steps:

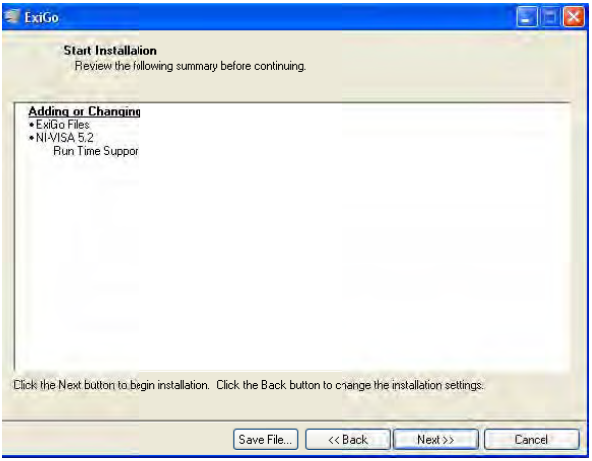


1. Open the LabVIEW installation CD and open the file **Setup.exe**[1]. Alternatively you can download the files from our webpage www.cellixltd.com

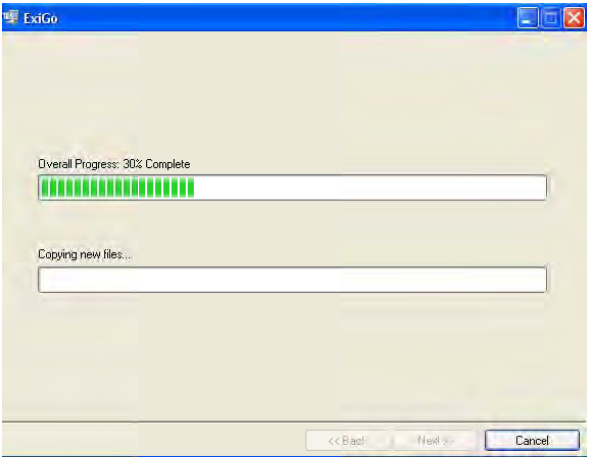


2. Select the destination folder and click *Next*.

[1] You may require Administrator rights. Please contact your system administrator in case you cannot perform the installation.

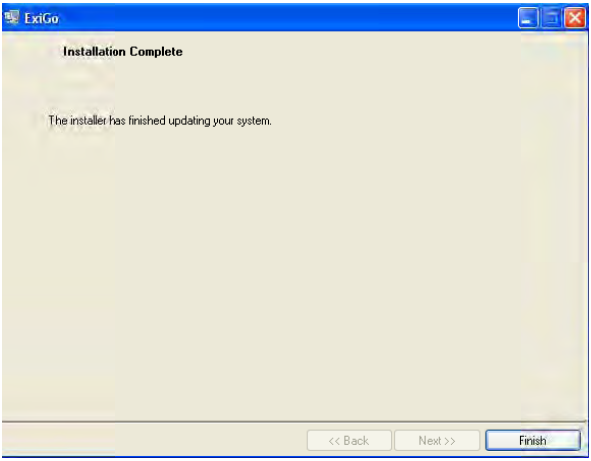


3. Click *Next*[2]



4. Wait until the installation is complete.

[2] Please note that the content of this window may vary on each computer, depending on previous versions installed.



5. Once the installation is complete, click *Finish*.

6. Restart your computer if required.

4. EXIGO DRIVERS INSTALLATION

Prior to proceeding with the installation of the ExiGo drivers; please introduce the LabVIEW installation CD which contains the drivers in your PC. Alternatively you can download the latest version of the drivers from www.cellixltd.com.

4.1 Installation on Windows XP

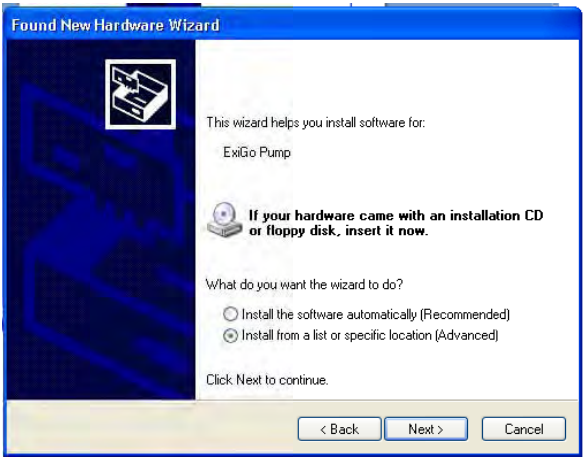
1. Connect the power supply to the Power connector and press the power switch until the Status LED indicator turns on.

2. Connect the USB cable to the ExiGo USB connector and plug it into your PC.

3. The PC should detect the new device and commence with the installation of the drivers

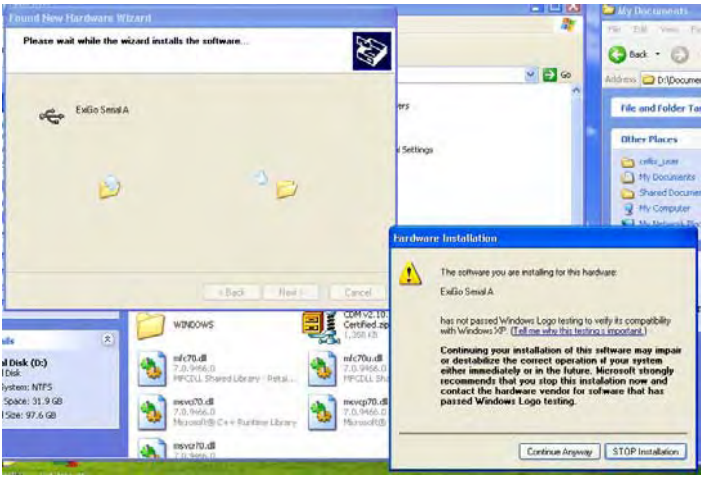
4. Click *Next >*

5. Select *No, not this time* and click *Next >*

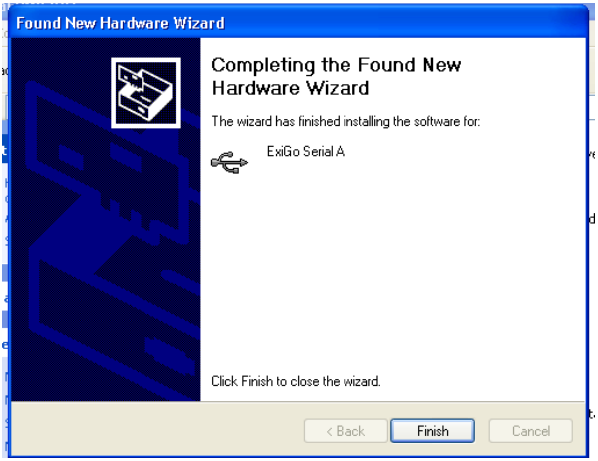


6. Select *Install from a list or specific location (Advanced)*

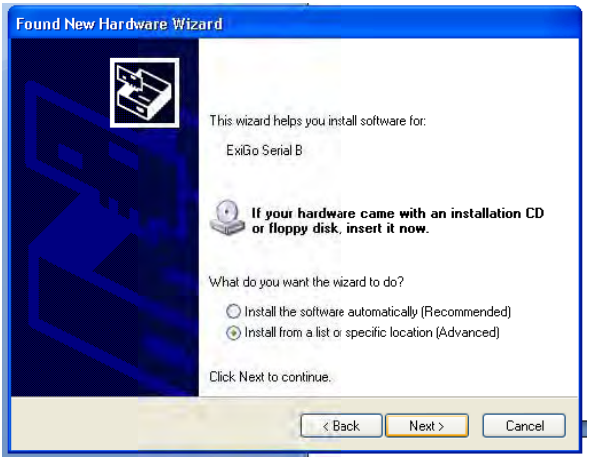
7. Click *Browse* and select the location of the ExiGo USB Drivers. If using the LabVIEW CD, click *Search removable media (floppy, CD-ROM...).* Then click *Next >*



8. The driver installation should commence. If a warning appears, click *Continue Anyway*



9. The driver has been installed successfully.



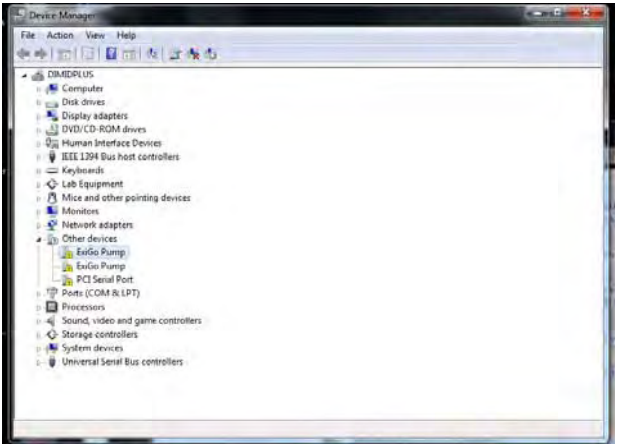
10. Repeat steps 6 to 9 until all the drivers are installed properly.

4.2 Installation on Windows 7

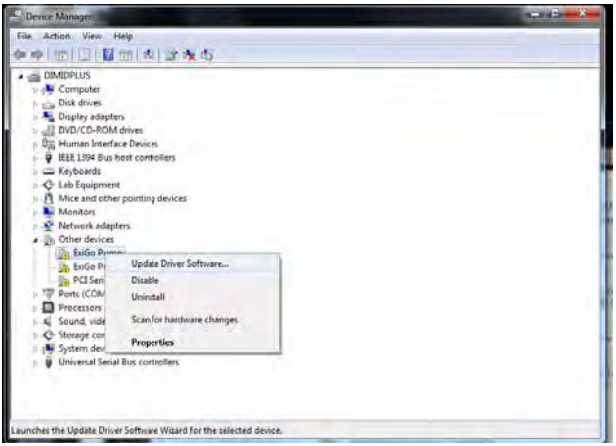
1. Connect the power supply to the Power connector and press the power switch until the Status LED indicator turns on.

2. Connect the USB cable to the ExiGo USB connector and plug it into your PC.

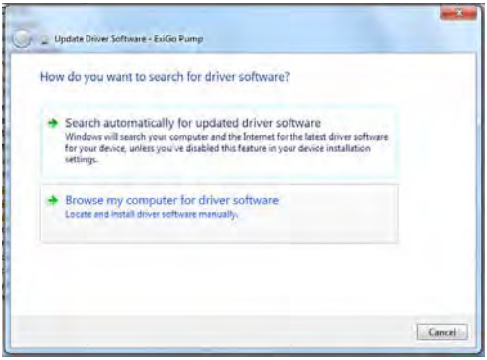
3. Open the Device Manager (Start→ Control Panel → System → Device Manager)



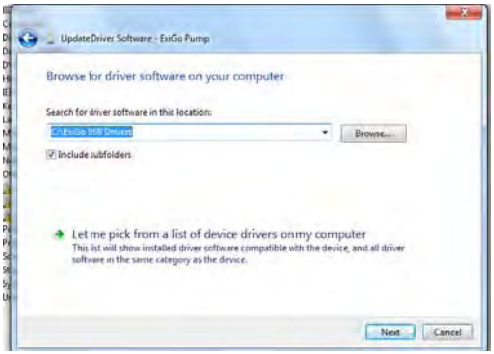
4. Within the tab “Other Devices”, right click on ExiGo Pump and select Update Driver Software...



5. Select “Browse my computer for driver software”

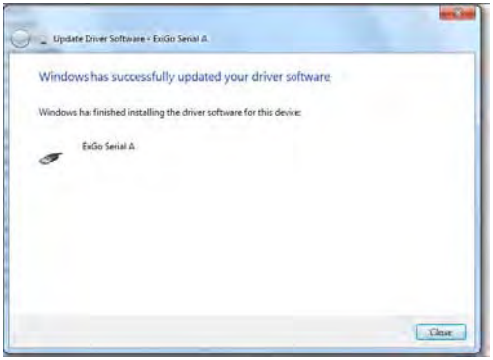


6. Click “Browse” and select the ExiGo USB Drivers folder

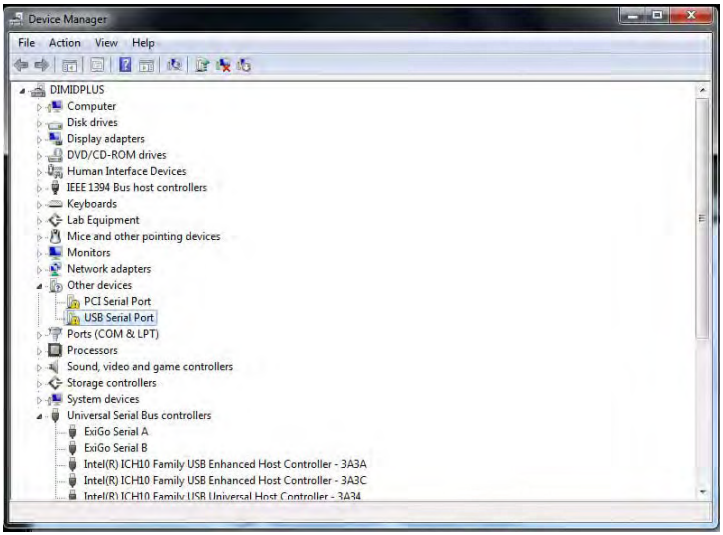


7. If your PC displays a warning, click on Install this driver software anyway

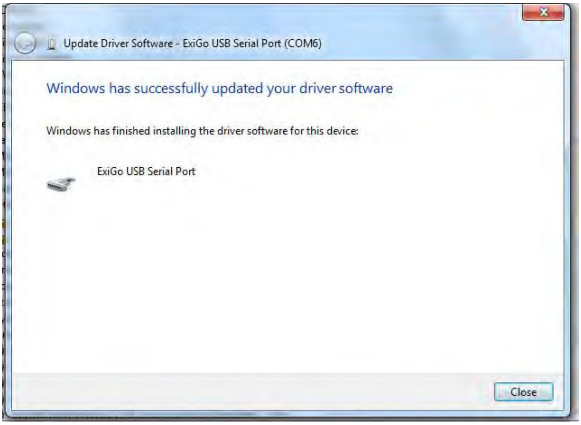
8. The driver has been installed successfully



9. Repeat Steps 4 to 8 for the second ExiGo Pump on the Device manager.



10. After the installation is complete, a third device might be detected by your PC (USB Serial Port). If so, complete steps 4 to 8 for the new device.



11. Installation completed!

5. LED STATUS COLOURS EXPLANATION

Color	Effect	Meaning
	Flashing	Pump is booting up. Please wait until Status LED changes its colour prior to connect the pump.
	2 Flashes and fades out	Pump not initialized and **no sensor detected** at boot time
	2 Flashes and fades out	Pump not initialized and **sensor detected** at boot time
	Flashing	Initializing Pump
	Static	Pump ready with no assay programmed
	Rotating	Pump running in manual mode

	Static	Pump ready with assay programmed
	Rotating	Pump running in assay programmed mode
	Flashing	Critical error. Please contact Cellix technical support.

6. LabVIEW User Interface Start and Overview

The LabVIEW user interface is comprised of three different windows:

Main

This window allows the user to:

- Initialize the pump.
- Set the syringe.
- Move the pump to the initial position required by the assay.

Manual

This window allows the user to:

- Run the pump in manual mode.
- Visualize the measured flow rates.
- Record the measured flow rates.
- Set PID parameters.

Program

This window allows the user to:

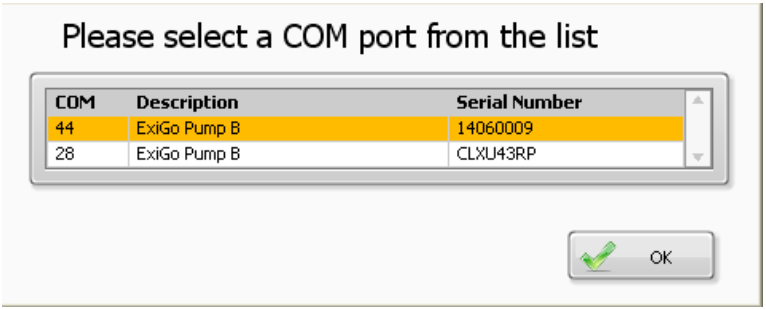
- Create a custom waveform and program the pump with it.
- Visualize the running assay status.

7. Selecting the correct COM port

The ExiGo LabVIEW interface should be capable of determining the correct COM port and establishing communication with the pump automatically. However, in some cases, it may be required for the user to select the adequate COM port, for example, if two or more ExiGo pumps are connected to different USB ports in the PC.

7.1 More than 2 ExiGo pumps detected

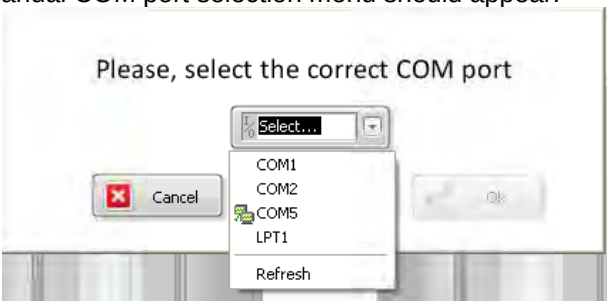
If there are more than 2 ExiGo pumps connected (each to an independent USB port), the following dialog should appear.



Please, select the correct COM port for the pump you would like to connect to:

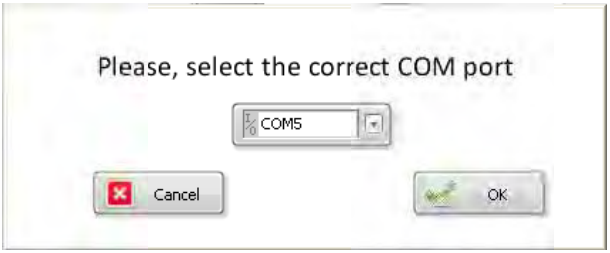
7.2 Pump not automatically detected

When the LabVIEW User Interface is not able to detect the ExiGo pump connected, a manual COM port selection menu should appear.



Please, select the correct COM port for your ExiGo pump and click ok.[3]

[3] If your COM port is not in the list, please ensure that the USB cable is properly connected between the ExiGo pump and the PC, then click Refresh and try again.

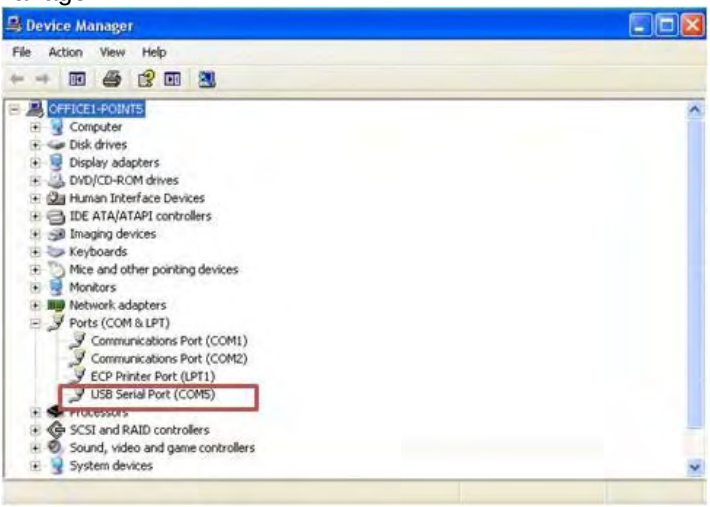


7.3 How to manually find the correct COM port

To manually check the COM port assigned to an ExiGo pump, open the **Device Manager**. Within the section **"Ports (COM & LPT)"**, the ExiGo COM port should appear under the name *"USB Serial Port"* or *"ExiGo USB Serial Port"*.

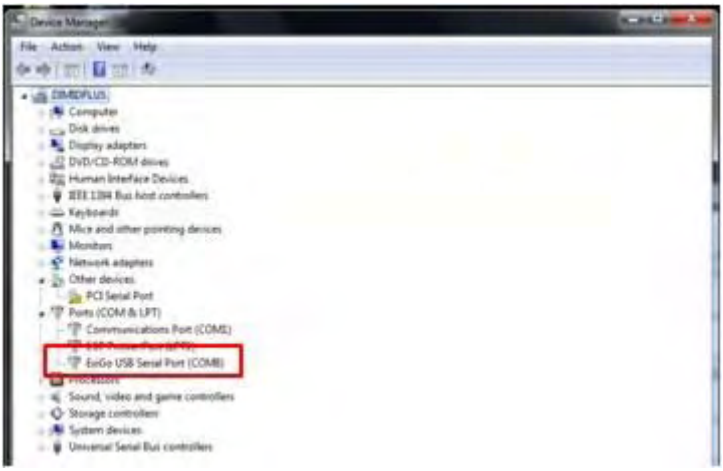
Windows XP:

To Open the Device manager click Start → Control Panel → System → Hardware → Device Manager



Windows 7

To Open the Device manager click Start→ Control Panel → System → Device Manager


Device Manager
File Action View Help
DIMDPLUS
Computer
Disk drives
Display adapters
DVD/CD-ROM drives
Human Interface Devices
IEEE 1394 Bus host controllers
Keyboards
Mice and other pointing devices
Monitors
Network adapters
Other devices
PCI Serial Port
Ports (COM & LPT)
Communications Port (COM1)
ExiGo USB Serial Port (COM8)
Sound, video and game controllers
Storage controllers
System devices
Universal Serial Bus controllers

8. HOW TO INITIALIZE THE PUMP

1 **2**

The NOT INITIALIZED status means that the pump MUST be initialized prior to starting the assay. In order to initialize the pump, please follow the next steps:

1. Remove any installed syringe on the pump[4]. Then double click on the pump's plunger image to begin the initialization.
2. The user interface will ask for confirmation and then it will move the pump to the home position. Once the Pump is initialized, the status will change to STOPPED.

[4] ⚠**Warning:** Failure to remove any installed syringe may cause the pump to malfunction during the initialization.

9. How to set the Syringe type

The type of syringe to be used during the experiment must be defined prior to running the assay. In order to set the syringe, please complete the following steps:

1

Figure 1

2

Figure 2

3

Figure 3

1. Double click on the syringe image in the user interface.
2. A Syringe Selector window will appear.*
3. Select the desired syringe and click SET or double click on the selected syringe to set it.

*Note: the syringes accepted are the following:

Hamilton Syringes	
700 Series	
Part Number	**Description**
80601	100 µL, Model 710 LT SYR
80701	250 µL, Model 725 LT SYR
80801	500 µL, Model 750 LT SYR
1000 Series	
Part Number	**Description**
81301	1mL, Model 1001 LT SYR
BD Plastipak Syringes	
Part Number	**Description**
300013	1 mL Syringe. Luer tip
300185	2.5 mL Syringe. Luer tip
302187	5 mL Syringe. Luer tip

9.1 Clamping the syringe

1

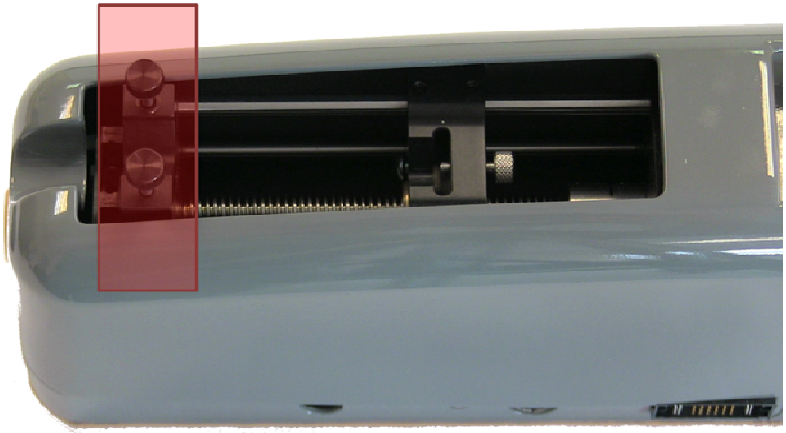


Figure 4

Remove the syringe clamp.

2

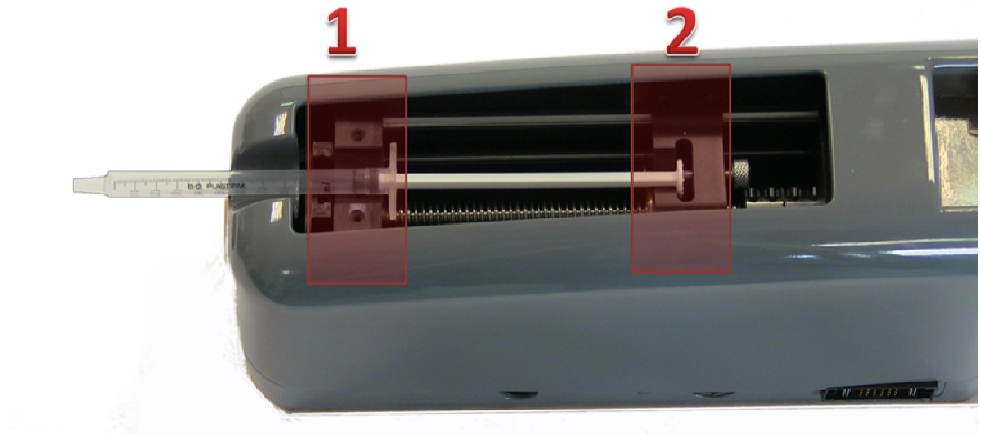


Figure 5

Place the syringe in the pump with the body resting on the front of the pump (position 1 in Figure 5) and the plunger resting on position 2. Move the position of the pump's plunger if required (see section 10).

3

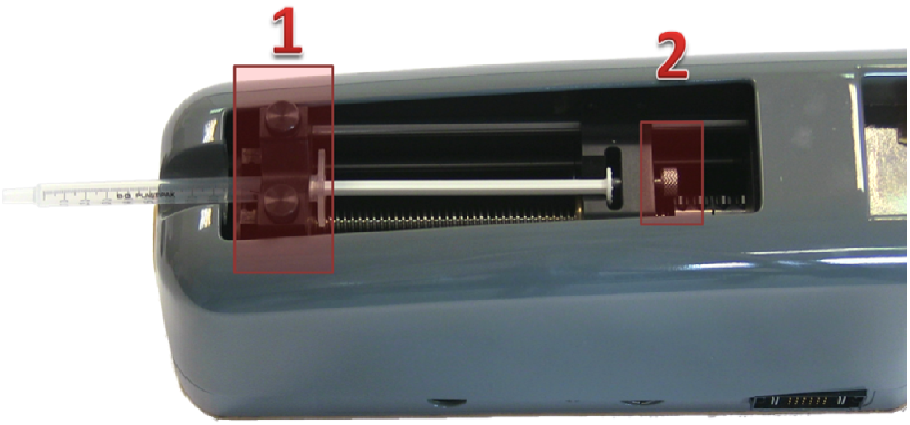
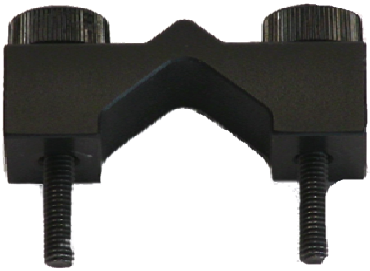
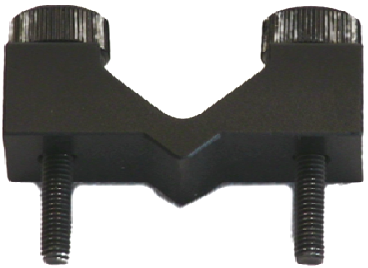
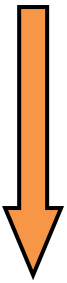


Figure 6

Put the syringe clamp back in place (Figure 6 position 1) and tighten the screws firmly. Tighten the thumb screw (Figure 6 position 2) to secure the syringe plunger.

Please note that the syringe clamp is reversible, depending on the syringe to be installed. See table below:

5ml Syringe	Smaller Syringes	Clamping Direction
		

10. MOVE THE PUMP TO THE ASSAY REQUIRED POSITION[5]

In most cases, the position of the pump after initialization will be not suitable for placing the syringe. In order to move the pump, simply drag the pump plunger on the user interface and drop it to the required position. An indicator of the approximate volume displaced during the pump movement will appear.

1

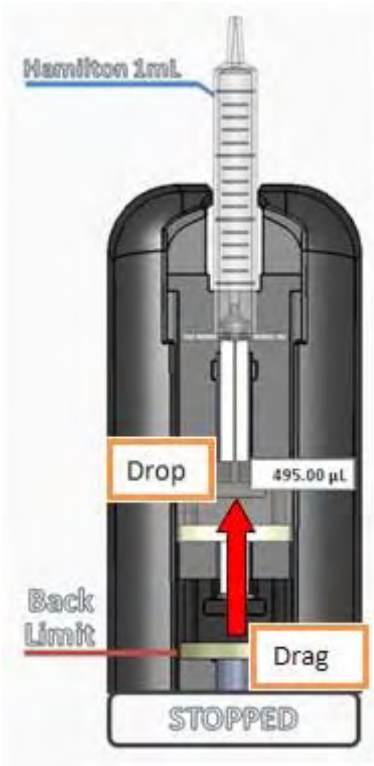


Figure 7

2

Figure 8

[5] ⚠**Warning:** It is strongly recommended to remove any installed syringe prior to move the pump's plunger. Failure to do so may cause the pump to malfunction during the displacement process.

11. MANUAL ASSAY: HOW TO SET THE FLOW RATE

There are two possibilities to set the flow rate manually. One is in Flow Rate Units (L/min) and the other in Shear Stress units (dyne/cm^2):

- Flow Rate Units:

1

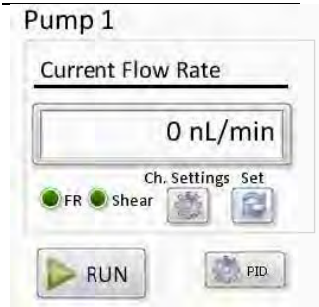


Figure 9

2

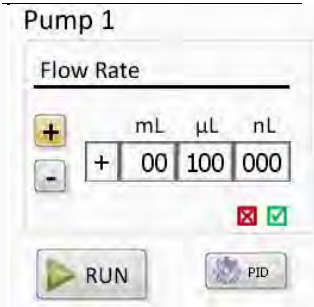


Figure 10

3

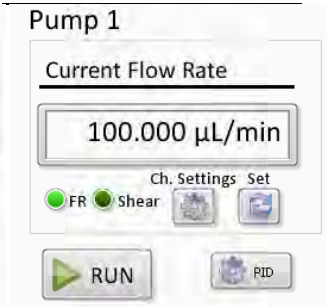


Figure 11

1. Click in the flow rate indicator
2. Set the desired flow rate value. Use the + and - controls to change to positive or negative flow rate. Click ☑ to accept the changes
3. The introduced flow rate should appear now within the flow rate indicator. Press in order to update the pump flow rate set point.
4. Once the flow rate has been set, press the RUN button to start the assay.

➢ Shear Stress Units

1

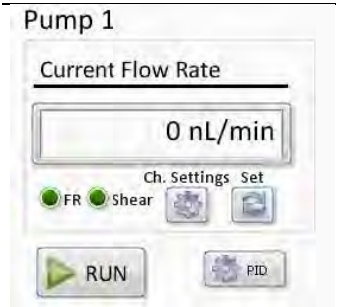


Figure 12

2

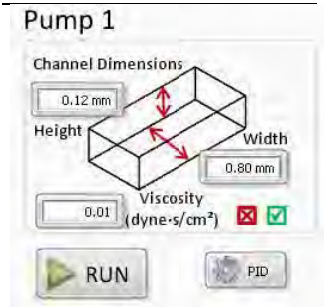


Figure 13

3

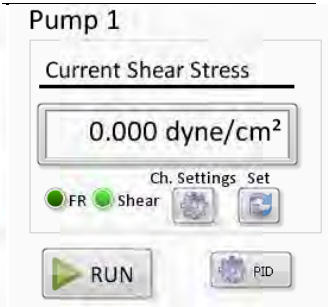


Figure 14

4

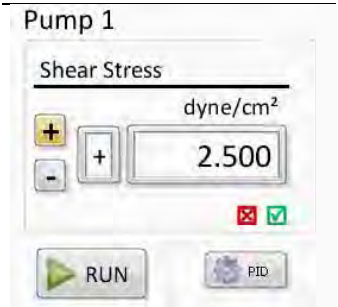


Figure 15

5

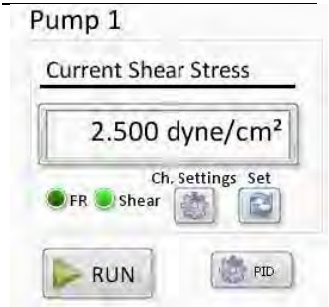


Figure 16

1. Click the **Ch. Settings** Button
2. Enter the fluidic channel dimensions[6] and the viscosity of the liquid to be used;
3. Change the indicator to dynes by clicking the **Shear** button Shear
4. Introduce the desired shear stress. Use the + and - controls to change to positive or negative shear stress. Click to accept the changes.
5. The introduced shear stress should appear now within the flow rate indicator. Press in order to update the pump flow rate set point. Once the shear stress is set press the RUN button to start the assay.

[6] Check the microfluidic chip manufacturer's datasheet

12. EXIGO FLOW SENSOR: VISUALIZING THE FLOW RATES

The performance of the ExiGo pump can be significantly increased by means of using an ExiGo sensor to obtain a real-time flow rate feedback.

Each ExiGo Flow Sensor is plug-and-play; therefore it can be connected to the pump at any moment.

Once the sensor is connected and recognized by the pump, a “Flow Sensor” indicator will appear in LabVIEW. Please see Figure 17.

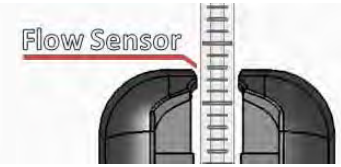


Figure 17

Immediately after plugging-in the ExiGo Sensor, the real time flow rate measurements will appear within the Manual Tab.

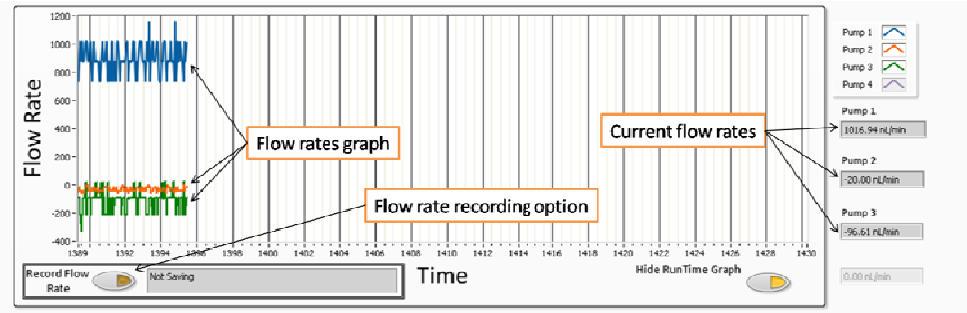


Figure 18

It is possible to record the measured flow rates within a particular assay as well as when running in manual mode. Please refer to section 14 for more details.

13. SETTING THE PID PARAMETERS

In order to get the best performance and accuracy of the ExiGo pump as well as a fast dynamic response, the PID controller must be turned on.[7]

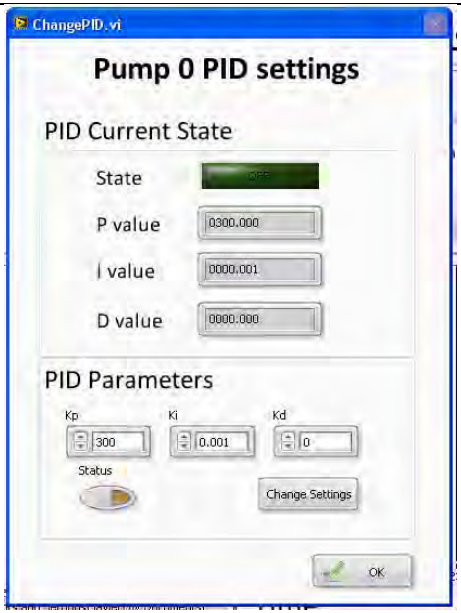


Figure 19

Proportional (P): The proportional gain defines how quickly the system will change its output to reduce the existing error (Flow rate set point minus current flow rate). Therefore, the proportional parameter will increase the speed of the control system response. However, if the proportional value is too large, the system will begin to oscillate. Using **P** parameter on its own may lead to a Steady-State error (offset) between desired flow rate and current flow rate.

Integral (I): The integral term sums the instantaneous flow rate error over time and gives the accumulated offset that should have been corrected. Thus, its main purpose is to drive the flow rate Steady-State error to zero.
A large value of the Integral parameter may cause the system to overshoot the set point value and even oscillate.

Derivative (D): The derivative term is proportional to the rate of change of the system output (pump flow rate). Therefore it "predicts" the system behaviour decreasing the system output if the flow rate is changing rapidly. This parameter helps to reduce overshoot and settling time but an incorrect value may cause the system to become unstable.

[7] The PID cannot be turned on if an ExiGo Sensor is not connected to the ExiGo pump. If you purchased an ExiGo pump without an ExiGo flow sensor you can still use the pump without the PID controller. Please contact Cellix Ltd. if you wish to purchase one.

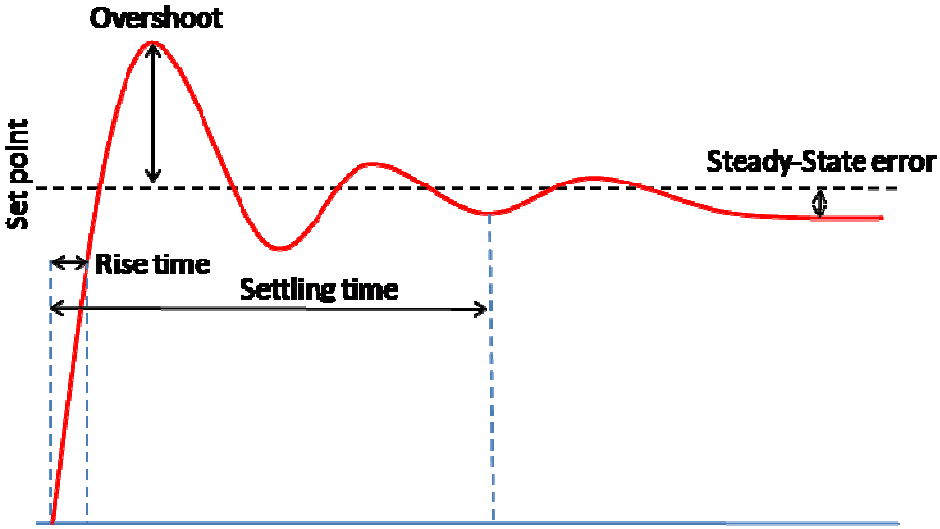


Figure 20

How to tune PID:

1. Set all parameters to 0.
2. Increase **P** and change the set point until the dynamic response of the pump is fast enough without oscillating.
3. Increase gradually **I** value in order to minimize the Steady-State error. Integral parameter can be any value between 0 and 1 but it is very sensitive and may cause the system to oscillate. Therefore it is recommended to start using a value of 0.001. A value over 0.1 will probably lead the system to become unstable.
4. In case of a large overshoot when changing the set point, increase the **D** value gradually until the optimal ratio overshoot/response time is achieved. However, a large value of **D** may slow down the dynamic response of the system.

14. PROGRAM MODE: DEFINING A CUSTOM WAVEFORM

It is possible to program the ExiGo pump in order to have a precise control of the flow rates and duration of a certain experiment.

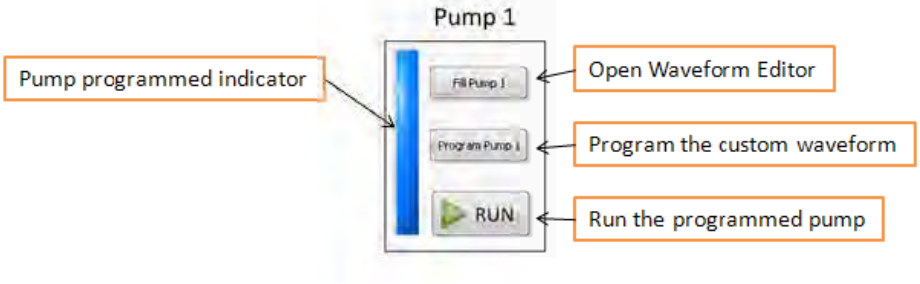


Figure 21

1. Click “Fill Pump X” in order to open the Waveform Editor.
2. Create your custom Waveform and click OK.
3. Click “Program Pump X” button to program the selected pump.
4. Repeat steps 1 to 3 for the remaining pumps.
5. Click 

to run a particular pump or 

to run all the programmed pumps simultaneously.

14.1 Waveform Editor

The waveform Editor allows you to create a custom Waveform for your ExiGo pump.
You can add 4 different elements to your waveform:

- Constant Flow/Pause
- Ramp
- TrainPulses
- Sine

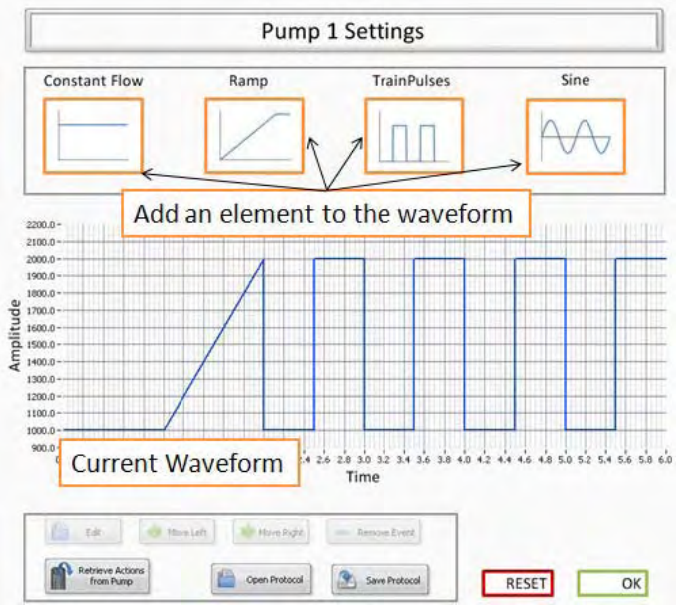
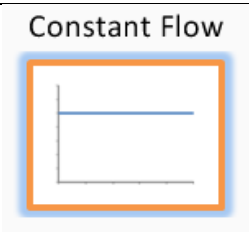
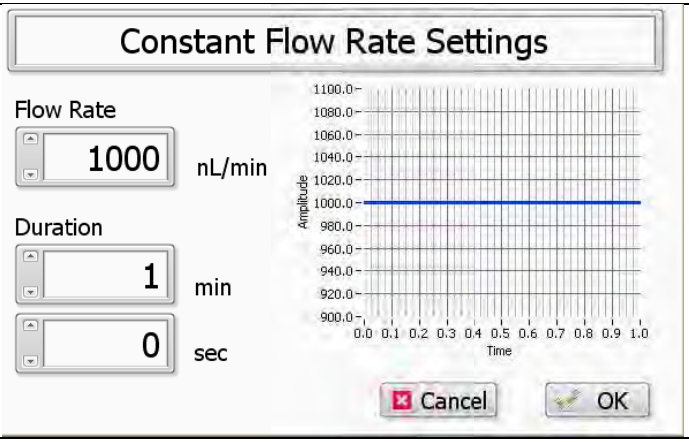
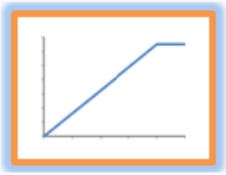
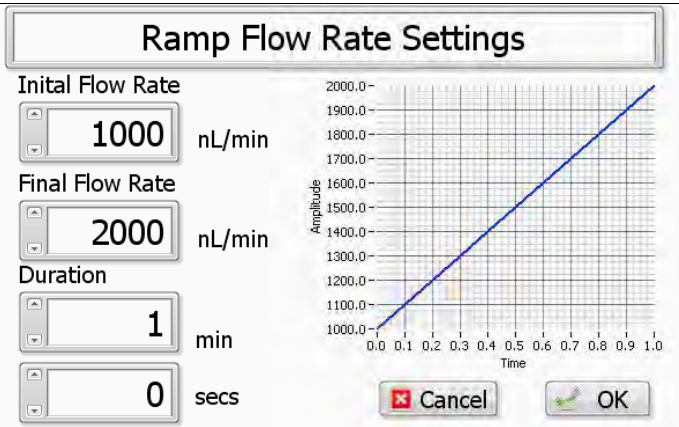
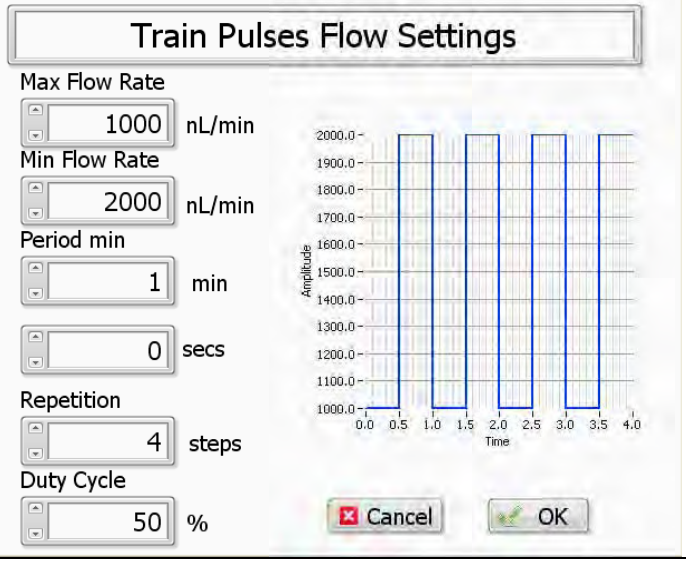


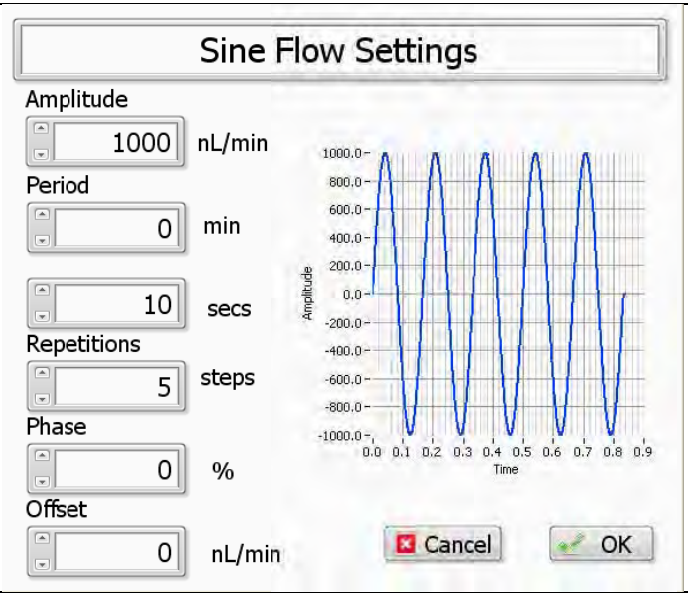
Figure 22





Flow Rate	Flow rate set point for the constant step. Set to 0 if you would like to create a pause.
Duration	Duration of the constant step in minutes and seconds.

Ramp 	
Initial Flow Rate	Initial Flow Rate of the Ramp
Final Flow Rate	Final Flow Rate of the Ramp
Duration	Duration of the ramp in minutes and seconds
TrainPulses 	
Max Flow Rate	Maximum flow rate of the Pulse(s)
Min Flow Rate	Minimum flow rate of the Pulse(s)
Period	Duration of **one** full cycle of the Pulses in minutes and seconds
Repetitions	Number of Pulses of the Train Pulse Step
Duty Cycle	Ratio between the maximum and minimum flow rate of the Pulse(s). For instance Duty Cycle = 60 means that the Pulse(s) will remain 60% of the period on minimum flow rate and 40% of the period on maximum flow rate



Amplitude	Amplitude is measured between the centre of the sine wave and its maximum value
Period	Duration of **one** full cycle of the sine wave in minutes and seconds[8]
Repetitions	Number of full cycles of the sine wave step
Phase	The starting angle of the sine wave cycle (from 0 to 360 degrees)
Offset	Defines the position of the centre of the sine wave regarding the zero position.

14.2 Open/Save custom waveforms

You can load and/or save a custom waveform into your PC using the following buttons:

To load a previously saved protocol and program it into your ExiGo pump.

To save your custom waveform into your computer.

If your ExiGo pump is currently programmed with a custom waveform, you can retrieve it and modify it.

[8] The full duration of the sine wave is determined by Period x Repetitions

15. RECORDING THE FLOW RATE DATA

It is possible to record the measured flow rates during a certain experiment in a log file. In order to generate the log file, please complete the following steps:

Figure 23

1. Click the Record Flow Rate Button to start recording the data

Figure 24

2. The log file will be created automatically using the current date and time as a filename.[9,10,11]

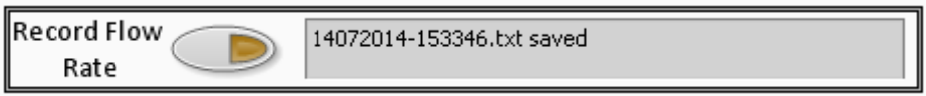


Figure 25

3. Click the Record Flow Rate Button again to stop recording the data and create the log file. The indicator will show the name of the log file created
4. The created log file will have a format similar to the following example

Date	Time	Pump 1 FR	Pump 2 FR	Pump 3 FR	Pump 4 FR
14/07/2014	15:33:46.23	879.660000	-38.500000	-100.000000	0.000000
14/07/2014	15:33:46.26	879.660000	-38.500000	18.640000	0.000000
14/07/2014	15:33:46.32	879.660000	-38.750000	-96.610000	0.000000
14/07/2014	15:33:46.39	738.980000	-20.000000	-96.610000	0.000000
14/07/2014	15:33:46.45	879.660000	-20.000000	-213.550000	0.000000

[9] The log file will be saved by default within the path C:\Documents and Settings\<user>\My Documents\LabVIEW Data

[10] The user can modify the filename after the recording is completed.

[11] If the recorded data becomes very large, the software will automatically create several log files of smaller size with a different index added to its filename: for instance:
08052014-161119.txt,
08052014-161119_1.txt
08052014-161119_2.txt

For more information on the ExiGo Pump or any other Cellix product or service, please call:

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