

Hardware Set-up Guide

Respironics-compatible Capnometer

1 Introduction

This document explains how to get up and running with the Respironics-compatible capnometer which I rent to clients as part of my Stress Resilient Mind programme, and which is also available for sale from the StressResilientMind.co.uk website.

There are two main sides to set-up – physical aspects and then configuring the software to communicate with it. These are covered in sections 3 and 4 below. Section 2 gives background information on the device – it's not necessary to read it, to start using the device.

2 About the Device

The device is manufactured in China. Although it is designed for use in hospitals and clinics I offer it for training and education purposes only.

The device connects to a PC via USB, from which it draws the small amount of power needed for its operation – no batteries are required. It contains a small pump for drawing air into the device, which is then analysed.

The following is a summary of features:

- Continuous measurement of partial pressure of carbon dioxide
- USB connection to PC
- Non-dispersive infrared (NDIR) technology
- Sample rate of air 50 mL/min
- Barometer pressure and temperature compensation
- Range calibration in 0 - 15% by manufacturer
- Fast warm-up time ensures full accuracy within 2 minutes
- Oxygen, N2O and anaesthetic compensation for accurate measurement
- Low power consumption less than 1.5W

A full technical spec is provided as an appendix of this document.

3 Physical Set-up

This section describes how to use the device to sample your breath. Figure 1 below shows the device.



Figure 1 – The capnometer. On the right you see the device with a card lanyard for easy positioning (you can wear the lanyard around your neck).

The device should be in an upright position for operation. I personally use the device attached to an id card lanyard, using velcro tape, which I can then wear around my neck.

3.1 Nasal Cannula

The device is provided with a nasal cannula, which is essentially a tube for transporting exhaled air from the nostril into the device. Figures 3 below shows one.

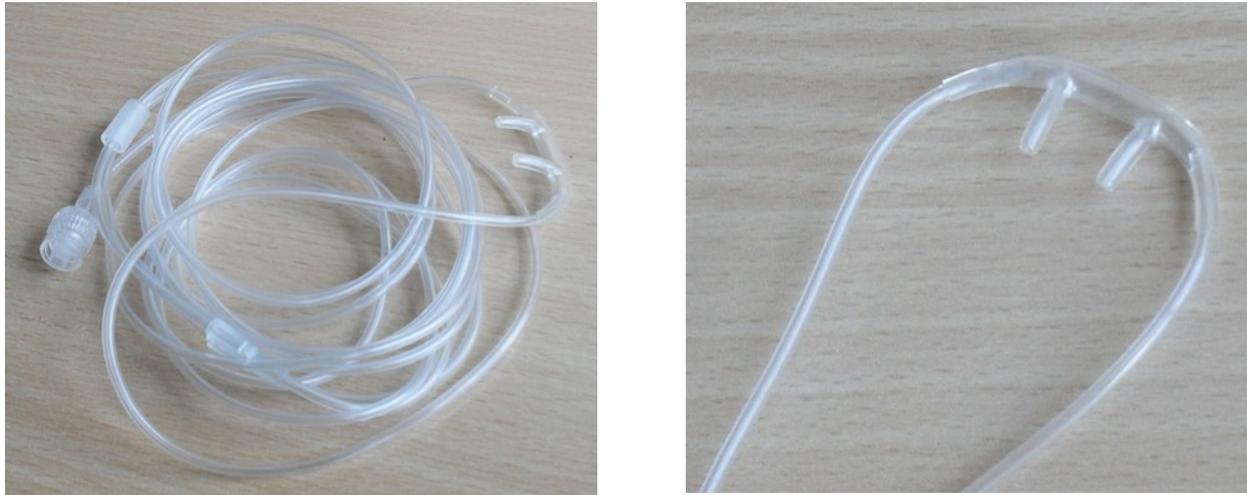


Figure 3 – A nasal cannula, shown whole on the left and just the nose fittings on the right

The tube runs from the nostrils around the top of the ears and then under the chin. There is a small slider on the cannula which you should move up under the chin. This helps maintain the position of the cannula but should not be tight to the chin.

The cannula provided is rather long, and because the exhaled air must travel the length of it, causing a very slight delay in measurement. Whilst this is probably not significant, I personally prefer to cut the cannula so that it is just a couple of feet in length, and hold the end just inside the nostril using microporous (surgical) tape.

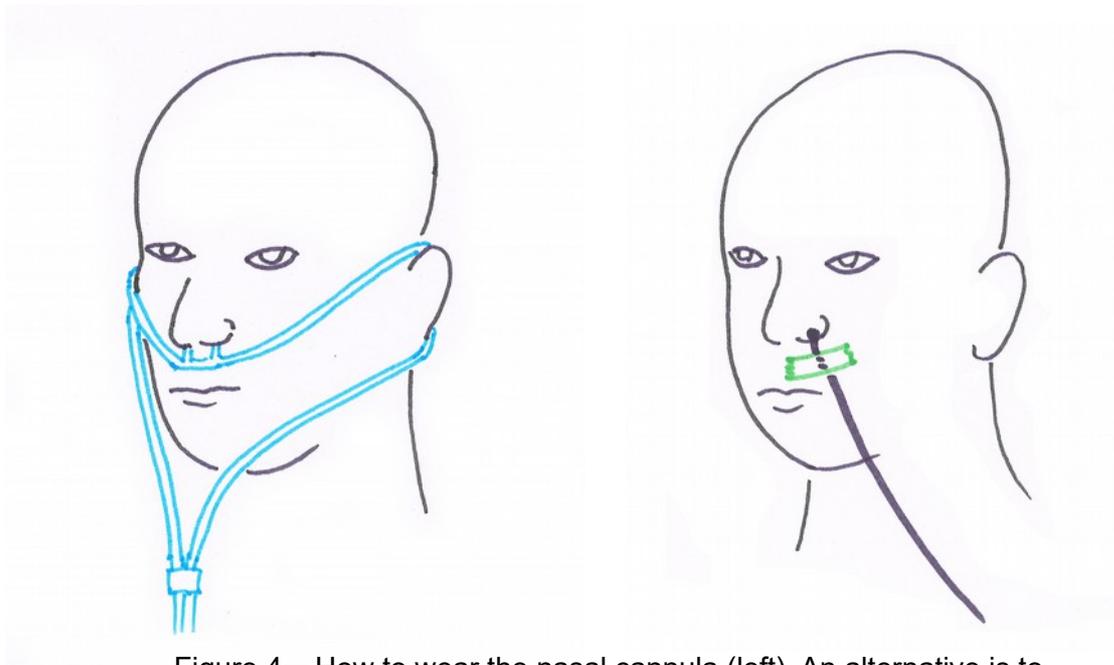


Figure 4 – How to wear the nasal cannula (left). An alternative is to cut the pipe and tape the end just inside the nostril (right).

The cannula attaches to the capnometer via the water filter, which is described in section 3.2 below. Figure 5 shows the connection point. There is a screw fitting – **don't over-tighten** this as it can easily crack the plastic fitting which will cause the device to read inaccurately. Twist the cannula until it only just bites, no tighter than that.



Figure 5 – Water filter, with nasal cannula screw fitting indicated (left) and the direction of movement for replacing the filter indicated (right)

Cannulae can be re-used many times. For reasons of hygiene, most people prefer one per person. Sometimes the cannula gathers condensation if used for long periods. It is better to dry it out before the next use. In the worst case condensation can actually block the flow of air to the capnometer.

3.2 Water Filter

Exhaled air contains moisture which needs to be filtered before analysis. A replaceable water filter is fitted to the device, as shown in figure 5 above.

Water collects slowly in the reservoir. When the reservoir is more than half full, it is time to replace the filter.

To detach a filter, pull it at the bottom (light blue plastic part) directly away from the body of the device and slightly upwards (note the arrow in figure 5 right, above).

To attach a new filter, first note there are two plastic pipes at the top. Connect these to the device first, making sure to align them exactly right, then snap the bottom into place.

4 Computer & Software Set-up

This section describes how to establish communication between the device and the Mind-Body Training Tools software applications, so that you can run biofeedback sessions.

Mind-Body Training Tools only works on Windows-based systems.

4.1 Device Driver: USB to Serial Converter

When you connect the device to your PC via a USB port, Windows will attempt to find a driver for the device. In most cases Windows will find the right driver automatically, and you don't need to worry too much about the technicalities. In some cases you'll need to read the following section.

Once connected to the USB port, the device draws power and you should be able to hear its pump working if you put your ear close.

4.1.1 Technical Details

If Windows doesn't find a driver, e.g. because you have an older version or there is no internet connection, I provide one with the Mind-Body Training Tools software. Look for a file called “CH341SER_driver” (an executable file, or .exe file) and run it. It's located in a folder called “device_drivers” then a sub-folder called “capnometer”.

Once Windows has installed a device driver, it sets up a virtual serial port, or COM port. A serial port is an old (pre-USB) type of port, which modern computers don't have, but the serial communications protocol is still used by some devices including this capnometer. That's why Windows sets up an “emulated” serial port. You should now be able to see this virtual COM port in Windows device manager.

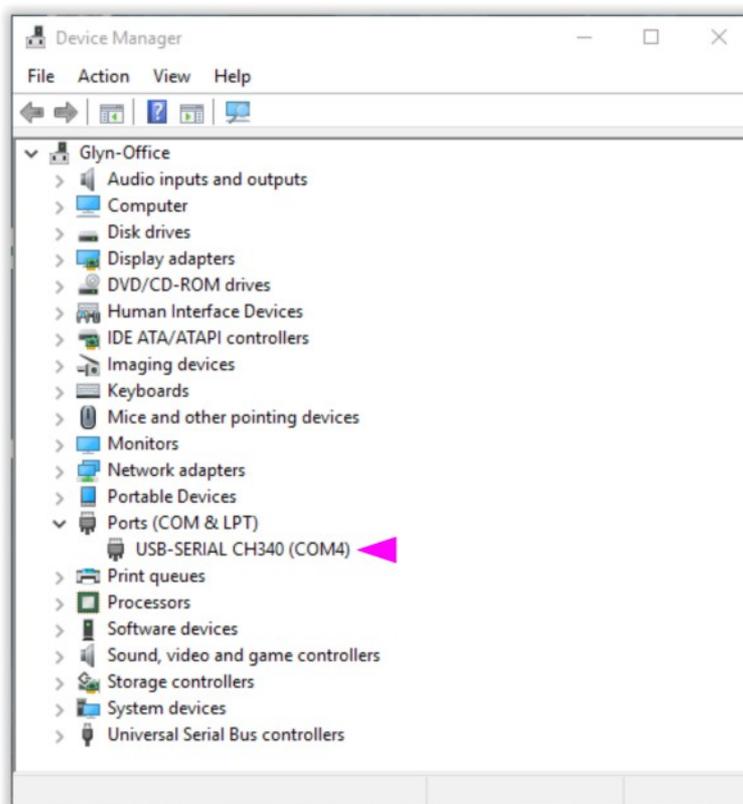


Figure 6 – Windows device manager, with the virtual COM port associated with the capnometer indicated (COM4)

To start your device manager, in Windows 10 you can right-click on the Windows start button, and then select device manager from the pop-up menu. (In earlier versions of windows, search for the device manager in the Windows control panel.) Figure 6 above shows the device manager with the virtual COM port associated with the capnometer highlighted.

If you unplug the device, you should see this port disappear – and then re-appear when you reconnect the capnometer.

Notice the COM port has a number (e.g. COM4 in figure 6). You may need this later on (see section 4.2.1).

4.2 Set-Up Instructions

- **STEP 1: Select the device type in the Mind-Body Training Tools platform program.**

From the set-up tab, click the button, “Device Set-up”.

In the drop-down list control for the capnometer source, select “Respironics-compatible” - see figure 7 below.

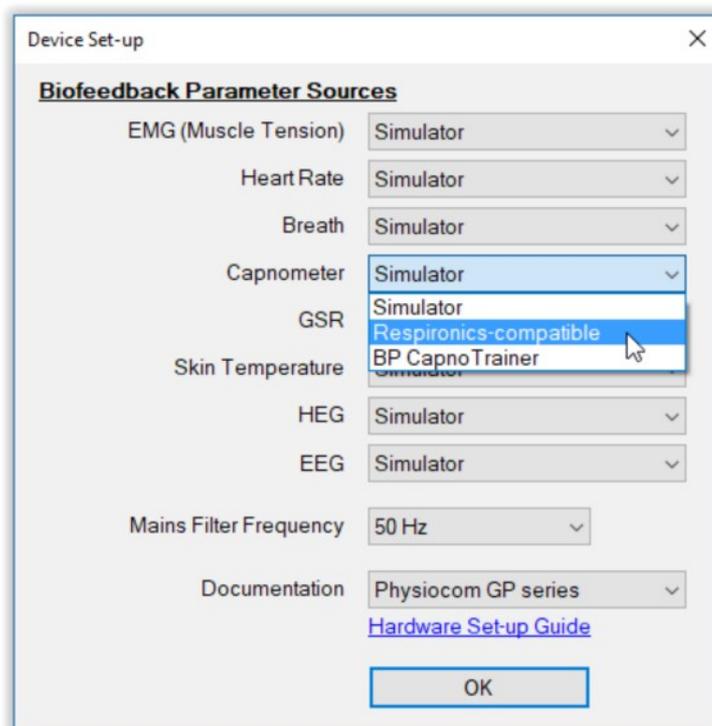


Figure 7 – Device set-up dialog (platform program)
– note the selection, “Respironics-compatible”

- **STEP 2: Connect the capnometer to your PC via a free USB port.**
- **STEP 3: Launch the capnometry application**

From the capnometry tab of the Mind-Body Training Tools platform program, click one of the buttons to launch an application. I suggest starting the the Basic Capnometry application.

- **STEP 4: Press play button**

With a little luck, you should see the red square “lamp” in the top right of the application window (labelled 3 in figure 8 below) turn green, and a trace appear in the charts. (If this doesn't happen, you need to configure the COM port – see section 4.2.1 below.)

You can now connect your cannula and start biofeedback.

4.2.1 Configuring the COM Port

If the device doesn't work first time, i.e. the red lamp doesn't turn green when you press play, there are further steps required, to configure the connection between software and device.

You should click the button labelled “Capnometer” in the top right corner of the application window, shown in figure 8 below and labelled “1”. A dialog box opens, shown in figure 9 below.

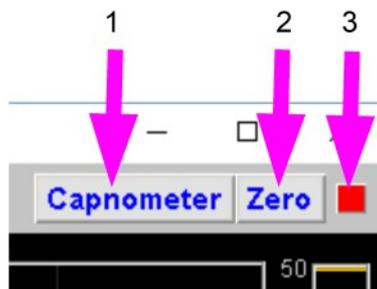


Figure 8 – Capnometer device configuration controls (top right of application window)

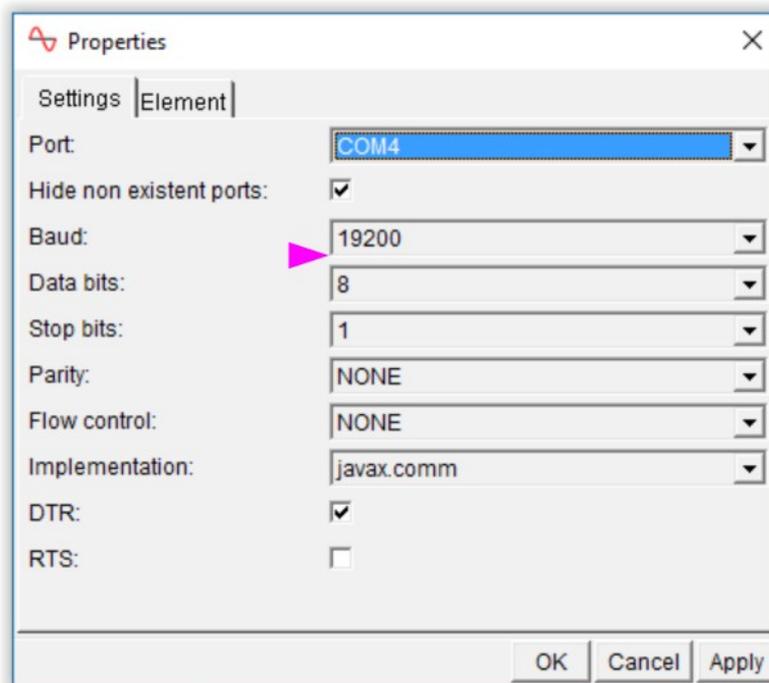


Figure 9 – Capnometer device dialog, opened from the Basic Capnometry application

You should make sure the individual settings are as they should be. The key one is the top one, which tells the software which COM port to read capnometry data from. If you have more than one COM port on your computer, the application may have defaulted to the wrong one.

You need to know which is the right one. For this you need to go to the Windows device manager – please read section 4.1.1 above. If necessary, disconnect and then reconnect your capnometer, and note the change in the device manager.

Then select the correct COM port, e.g. COM4 in figure 9 above.

The remaining settings should be right by default, but figure 9 above shows the correct settings.

Once you've got things working, the software remembers your settings and they should be the same next time you run a session. The only likely complication is having more than one COM port on your system.

4.3 Running Applications with Other Devices

When using the capnometer with either the Capnometry & EMG application or the capnometry & HRV application, you'll be using a separate device to measure the other parameter.

Some devices are like the capnometer insofar as they appear as a virtual COM port in Windows. In particular this is the case with the Contec finger pulse oximeter which is used for measuring heart rate and which I have available for rent as part of the Stress Resilient Mind programme.

In such cases you need to make sure the software knows which device is the capnometer. To do this, follow the steps described above, using Windows device manager to note which device is which. You also need to set the correct COM port for the second device.

Please note sometimes you have to restart the application before the settings take effect.

4.3.1 Zeroing The Capnometer

When there is no exhaled air flowing into the capnometer, the signal (PP CO₂) should go to zero. You can see this happens in figure 10 below (note the arrow) at least for the first few breaths (later the breathing is so rapid it doesn't have time). Sometimes this doesn't happen, and if you see that the trace hovers a few points above zero, you need to take steps to re-zero your device. In fact it's a good idea to do this every so often anyway, because if the signal drifts the other way, i.e. below zero, you won't see it.

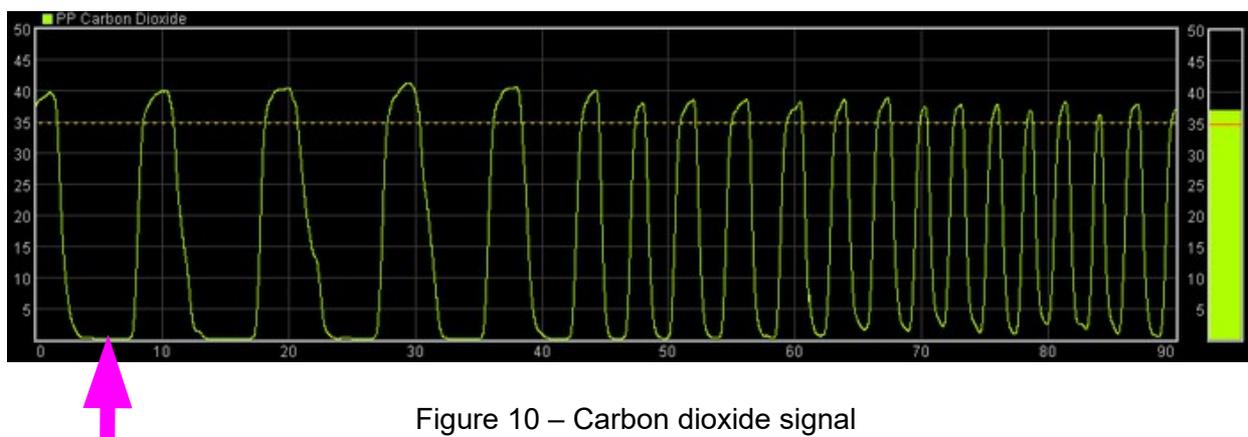


Figure 10 – Carbon dioxide signal

In summary, zeroing the capnometer is in effect re-calibrating its signal.

There is a button in the top right corner of the application, labelled “Zero” (2 in figure 8 above) that allows you to do this from within the software.

For zeroing to work properly, the device must be disconnected from your breath for at least several seconds before you click Zero. When you click, you should see the trace drop out from the short-term display and the lamp turn red for a period of a few seconds. If this doesn't happen, wait longer, and then click again.

5 Trouble-shooting

If things aren't working for any reason, here are some steps to take, to investigate.

Listen to the device – putting your eye close, you should hear a gentle whir of the pump, when it is connected to the USB port.

If you've connected it via a usb hub or extension, it's possible the device is not able to draw the power through the hub. If you don't hear the pump, this may be the reason.

If you don't see the red status lamp turn green when you press play, check the COM port configuration, as described in section 4.2.1 above. Especially check you can see the device listed as a COM port in Windows device manager.

If the device doesn't appear in your device manager when you connect it to a USB port, it may be because the device driver hasn't installed properly. A driver is included with the Mind-Body Training Tools installation files, as described in section

5.1 Manufacturer's Test Software

The manufacturer provides a very simple software program that you can use to test your device. This is worth trying if you can't get it to work in Mind-Body Training Tools.

This program is included in the Mind-Body Training Tools installation files. It's in a folder called “device_drivers” then a sub-folder called “capnometer”. The program executable file (.exe file) is called “test_program”. It runs straight off, without needing installation.

Appendix: Manufacturer's Technical Spec

The following is the technical spec provided by the manufacturer.

Transducer Type	Sidestream CO2 sensor
Sample Rate	50 mL/min, ± 10 mL/min.
Principle of Operation	Non-dispersive infrared (NDIR) single beam optics, dual wavelength, no moving parts
Initialization Time	Capnogram displayed in less than 5 seconds Reaching full specifications within 5 minutes.
CO2 Measure Range	0 - 114 mmHg 0 - 15% 0 - 15.2kPa
CO2 Resolution	0.1 mm Hg 0 to 50 mm Hg 0.25 mm Hg 50 to 114 mm Hg
CO2 Accuracy	0 – 40 mmHg ± 2 mmHg 40 – 114 mmHg $\pm 5\%$ of reading
Respiratory Rate	Range 2 to 120 Breaths Per Minute (BPM) Accuracy ± 1 breath
Calibration	No routine user calibration required
Compensation	Automatic Barometer Pressure 400 - 800 mmHg. User selectable O2 / N2O compensation.
Voltage Requirements	5.0 VDC $\pm 5\%$
Power Consumption	Less than 1.5 Watts typical.
Temperature and Humidity	Operating: 0 C to 40 C, 10 to 90% RH, non-condensing Storage: -40 C to 70 C, <90% RH, non-condensing
Data Interface	RS232, bi-directional, 19200 baud rate, standard N-8-1. Fully compatible with Respironics LoFlo communication protocol