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# 1 Description

Enviro Station is a device built around the Pimoroni Enviro+ board, an add-on for Raspberry Pi computers. The Enviro Station uses a Raspberry Pi Zero W. The software should run on other Raspberry Pi models from 2 on upwards, however, it would be necessary to tweak some Raspberry Pi Zero specific settings in the MEMS microphone driver.

Enviro Station uses all of the sensors provided by the Pimoroi Enviro+ board and the extra particulate sensor, with the exception of the temperature reading provided by the BME280 chip. This temperature reading is not the ambient temperature as confirmed by the chip's manufacturer and therefore a separate precision temperature sensor in the form of the MCP9808 has been added. The BME280 temperature is however processed and included in the Enviro Station data set and statistics and can be easily enabled for display and recording instead of the MCP9808.

As built, the Enviro Station has the following specs:

*Table 1: Basic specs*

| Measurement | Range | Sensor | Notes |
|---|---|---|---|
| Ambient Temperature | -40 to +125ºC or<br>-40 to 257F | MCP9808<br>0.25ºC typical accuracy | Selectable unit for display but recorded always in Celsius |
| Barometric Pressure | 300 to 1100 mb or<br>225 to 825 mmHg<br>8.86 to 32.48 inchHg<br>4.36 to 15.95 PSI | BME280<br>±1 % (0.. 65ºC) | Selectable unit for display but recorded always in millibar |
| Humidity | 0 to 100% | BME280<br>±3 % (0.. 65ºC) | |
| Harmful Gasses: | Carbon monoxide CO<br>Nitrogen dioxide $NO_2$<br>Ethanol<br>Hydrogen<br>Ammonia<br>Methane<br>Propane<br>Iso-butane | MICS-6814<br>- RED sensor (ohm or ratio)<br>- OX sensor (ohm or ratio)<br>- NH3 sensor (ohm or ratio) | The 3 sensors values can be displayed in Ohm. For each a R0 = clean air value should be configured and then the unit can be switched to ratio (Ohm / R0) instead<br><br>(possibility of conversion to actual gas concentrations in ppm is still under investigation)<br><br>Recording format follows display format (ohm or ratio) |
| Light Intensity | 0.01 to 64000 lux | LTR-559ALS-01 | |

| Measurement | Range | Sensor | Notes |
|---|---|---|---|
| Noise | 0 to 120 dbSPL or<br>0 to 131071 (raw) PCM | SPH0645LM4H-B | The quiet floor PCM needs to be configured to get reasonable dbSPL values.<br><br>Recording format follows display format (dbSPL or PCM) |
| Particulate Matter<br>(by weight) | (in µg/$m^3$)<br>PM1<br>PM2.5<br>PM10 | PMS5003<br><br>PM2.5: 0..500 ± 10% | Particle concentration under atmospheric environment |
| Particulate Matter<br>(by size) | (in µm/L)<br>>0.3 µm diameter<br>>1 µm diameter<br>>2.5 µm diameter<br>>10 µm diameter | PMS5003 | Sensor reports per 0.1L, but values are displayed and recorded *10 to report per L values |

For convenience, some sensors are grouped together, for example all GAS sensors. The groups are shown in Table 2. The effect of grouping is that some settings apply to all elements of a group. For example, recording of the GAS group will always include all three elements, OX, RED and NH3.

*Table 2: Sensor Groups*

| Sensor Group | Containing: |
|---|---|
| Temperature | Temperature |
| Baro+Hum | Barometric pressure and Humidity |
| Gas | OX, RED, NH3 |
| PM (weight) | PM1, PM2.5, PM10 ug/m3 |
| Light | Light |
| Noise | Noise |
| PM (size) | 0.3, 1, 2.5, 10 um/L |
| Time | System Time, Run Time, recording status (not actually a sensor but useful…) |

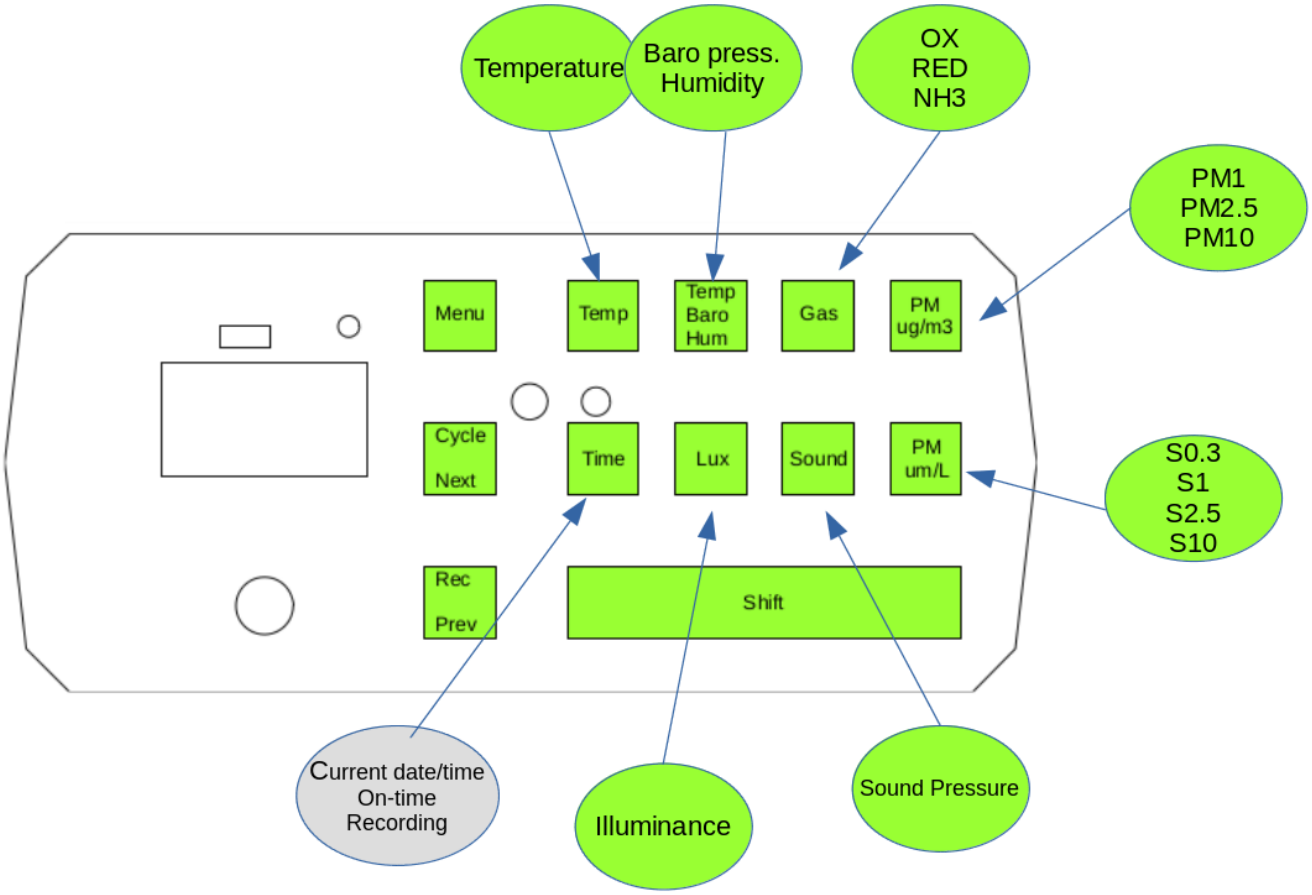



*Figure 1: Sensor Groups assigned to buttons*

Unless notes, the following functions can be selected individually for each Sensor Group. All selectable options apart from min/max display can be saved in a setup file and automatically loaded at startup.

Note the 2nd button which shows Temperature, Barometric pressure and Humidity. The group actually contains only pressure and humidity but I decided its convenient for weather forecast to display temperature as well by this button. The temperature is copied-in from the temperature group but not actually a part of the pressure&humidity group. What this means, if you want to see averages for all 3 values shown by this button or record all 3 items, you need to actually enable averages or recording for temperature separately and do the same again for pressure and humidity.

To simplify the code, it is currently possible to choose some options for the “Time” sensor but they are ignored.

*Table 3 Functions*

| Functions | Details | Notes |
|---|---|---|
| Measurement frequency | Every 1 second | Fixed, applies to each sensor |
| Average value display<br><br>Average value recording | Exponential Moving Average<br>Values older than 1h fade to less than 0.1% | per sensor group<br><br>per sensor group |
| Min value display<br>Max value display<br><br>Min/Max reset | min/max selection is not saved in setup | per sensor group<br>per sensor group<br><br>reset only for all sensor groups together |
| Trend History Depth | Based on averages 1 hour, 1 day, or 7 days ago. | per sensor group |
| Trend display | | per sensor group |
| Recording interval | Off<br>1s, 10s, 30s,<br>1m, 5m, 10m, 15m,<br>1h | global, all selected sensors are recording at the same interval |
| Recording selection | Actual values and/or<br>Average values | per sensor group |
| Unit selection | | only for:<br>• Temperature,<br>• Barometric Pressure,<br>• Gas<br>• Noise |
| Automatic cycle between displays | Cycle time fixed to 10 seconds | global on/off toggle |
| Display sleep time | Off, 30s, 1m, 5m | global setting |

# 2 Operation

## 2.1 Normal mode

During normal operation, the display shows one of the 8 sensor groups.

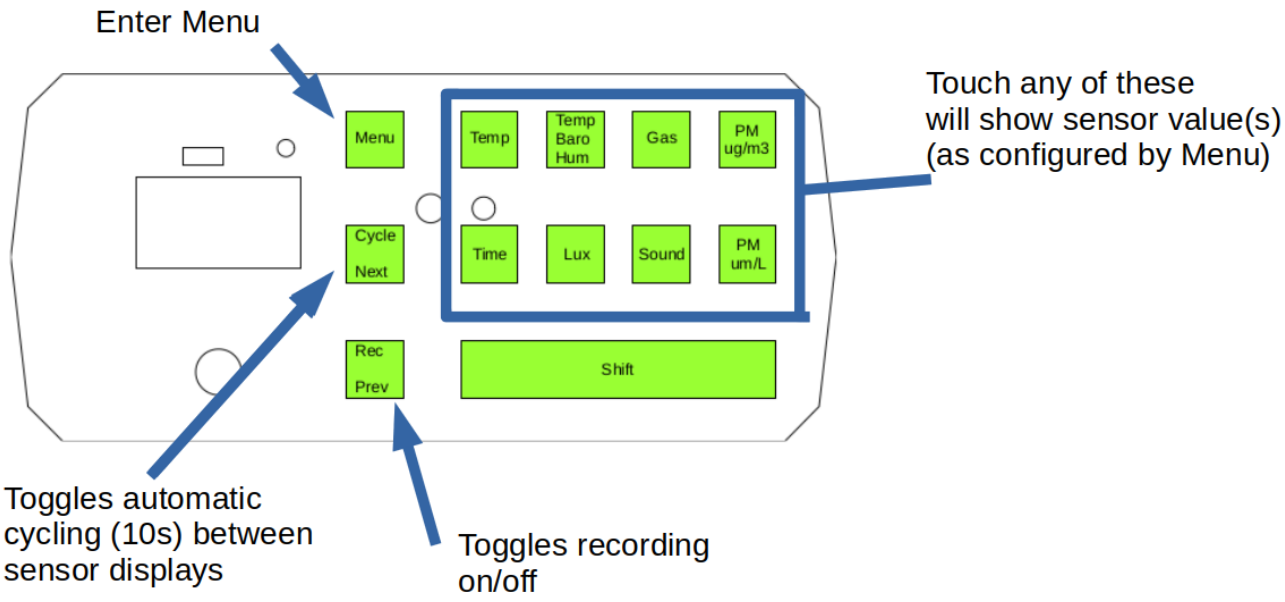



*Figure 2: Operation in Normal Mode*

Touching one of the 8 sensor group buttons, selects that group for display. Touching the cycle button enables or disables the automatic cycling through all 8 groups.

If you press SHIFT together with any of the sensor group buttons (except for TIME), the displayed value toggles between normal, minimum or maximum.

Note that pressing SHIFT together with TIME resets the min/max values for all sensors.

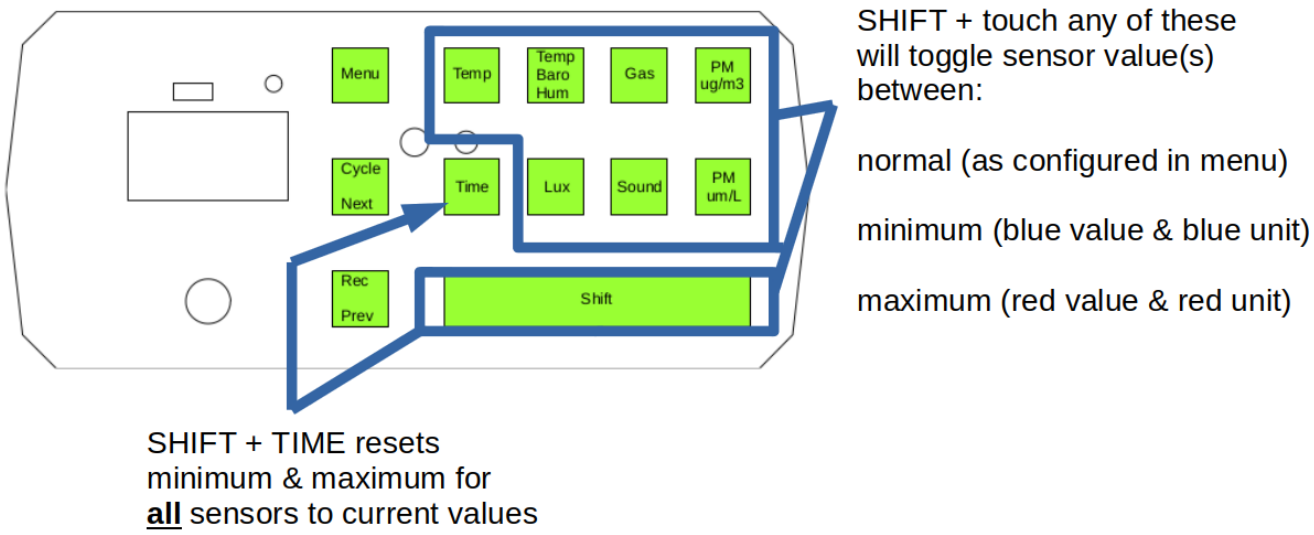


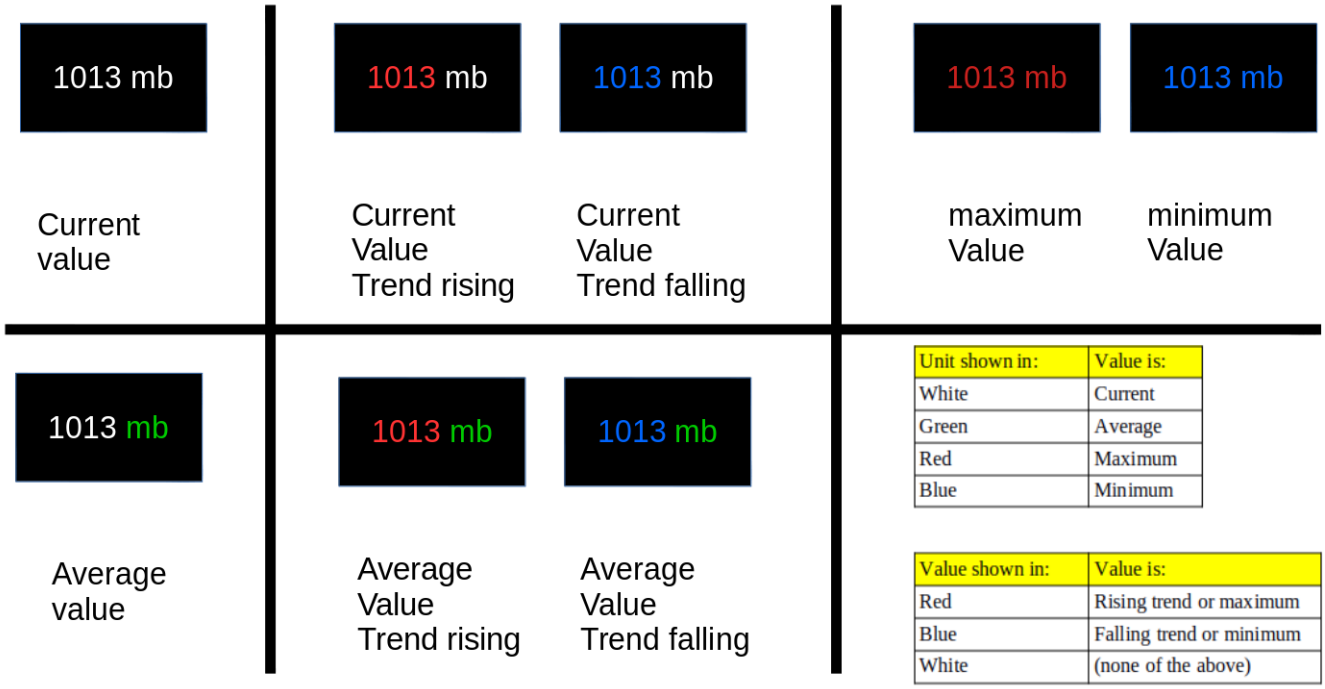

*Figure 3: Selecting min or max values in Normal Mode*

### 2.1.1 Colour coding used in Normal Mode displays

The display uses the last selected or loaded setup values to show:

1. Selected unit format (where applicable)
2. The colour of the unit text indicates:
   (a) white: the value is real-time
   (b) green: the value shown is the average value
   (c) blue: the value shown is the minimum
   (d) red: the value shown is the maximum
3. The colour of the value indicates:
   (a) red: the trend is increasing or maximum value
   (b) blue: the trend is decreasing or minimum value
   (c) white: trend is disabled or the trend is flat (no change)

To recognise whether trend or min/max are displayed, look at the colour of the unit text.




| Unit shown in: | Value is: |
|---|---|
| White | Current |
| Green | Average |
| Red | Maximum |
| Blue | Minimum |

| Value shown in: | Value is: |
|---|---|
| Red | Rising trend or maximum |
| Blue | Falling trend or minimum |
| White | (none of the above) |

*Figure 4: Colour code to recognise what value is shown on the display*

### 2.1.2 Functions in Normal Mode

*Table 4: Functions in Normal Mode*

| Button | Function |
|---|---|
| <any Sensor Button> | Selects that sensor group for display |
| SHIFT+ <any Sensor Button> except TIME | Toggles the display for that sensor group between:<br>• normal = real-time or average with or without trend colouring<br>• min = shows the minimum value(s)<br>• max = shows the maximum value(s) |
| SHIFT+ TIME | Resets the min/max values for all sensors to current real-time value. |
| CYCLE | Toggles the automatic cycling of the display between all 8 sensor groups. |
| REC | If not recording, pressing REC mounts an external USB drive and starts recording with content and frequency based on current recording settings.<br><br>If recording was already in progress, pressing REC stops recording and |

| Button | Function |
|---|---|
| | unmounts the external USB drive. |
| MENU | Starts the MENU |

## 2.2 Menu mode

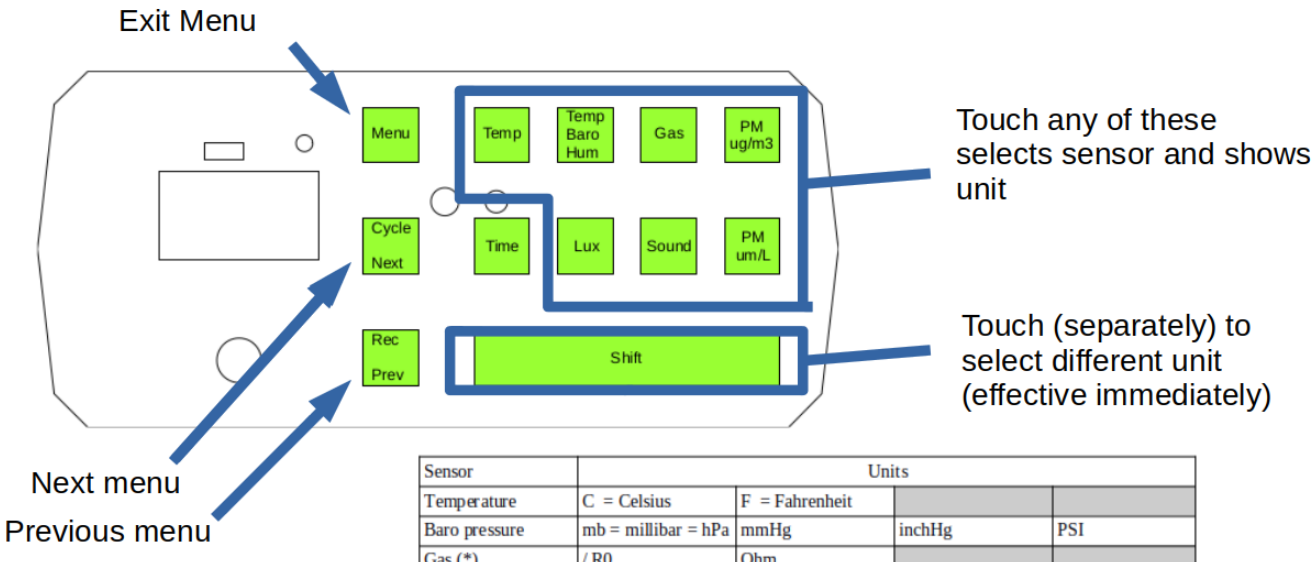
Note that sensor processing and recording continues normally while the MENU is shown.

There are 10 sub-menus to allow extensive configuration of the Enviro Station

- Unit: allows changing of units for some of the sensors
- Average: selecting display of average instead of real-time value
- Trend: selecting display of trend colouring
- Trend-History: selecting the length of the history used for trend
- Recording-values: selecting which real-time values are included in the recording
- Recording-average: selecting which average values are included in the recording
- Recording-time interval: selecting how often the values are recorded
- Sleep Time: selecting if the display should be turned off after some time of inactivity
- Save: saves the current selection in a file to be automatically restored at start-up
- Load: restore the selection from a file

If you are in normal mode, touching MENU brings you into menu mode. Touching MENU again exits the menu mode. Within menu mode, the NEXT and PREV functions move between the different menus.

### 2.2.1 UNIT Menu




| Sensor | Units | | | |
|---|---|---|---|---|
| Temperature | C = Celsius | F = Fahrenheit | | |
| Baro pressure | mb = millibar = hPa | mmHg | inchHg | PSI |
| Gas (*) | / R0 | Ohm | | |
| Noise (*) | dbSPL | PCM | | |

* changing unit resets the statistics for this sensor

*Figure 5: UNIT Menu Operation*

Notes:

1. Not all sensors allow a selection of units.

2. Gas and Noise sensors use unit switching to allow finding suitable values for R0 in case of the gas sensor and the noise floor for the microphone. For these sensors, changing the unit will reset the statistics for those sensors. That is unavailable since it makes no sense to calculate for example an average of some dbSPL values and raw pulse code modulated amplitudes. The unit change also affects the values that are recorded for these sensors.

3. For the other sensors, changing unit is just a display conversion and doesn't affect the underlying statistics at all. The same is true for the recording. The recorded values are always in the default units (first column in Figure 5).

### 2.2.2 AVER (Averages) Menu

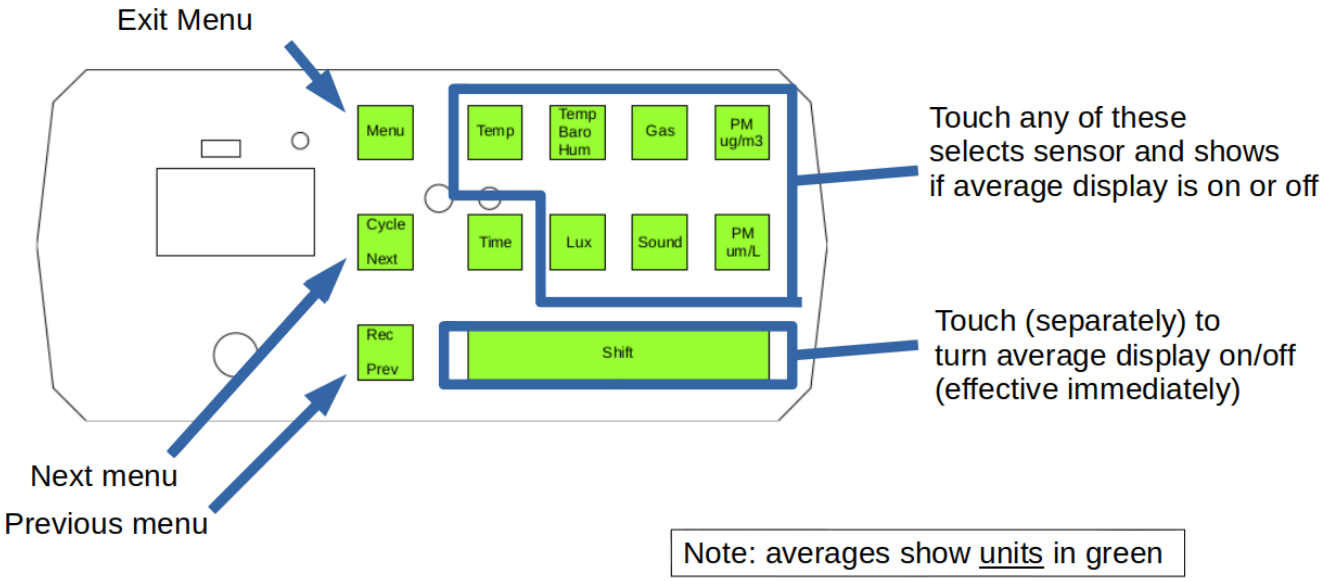



*Figure 6: AVER (Averages) Menu Operation*

This menu allows you to select for each sensor whether you want to see the currently measured value or the average value.

Selection works by touching a sensor which then shows the current selection. Touching SHIFT then toggles that value. In this case you you use SHIFT as a stand-alone key, not together with some other button, that's what I mean with touch "separately".

### 2.2.3 TREND Menu

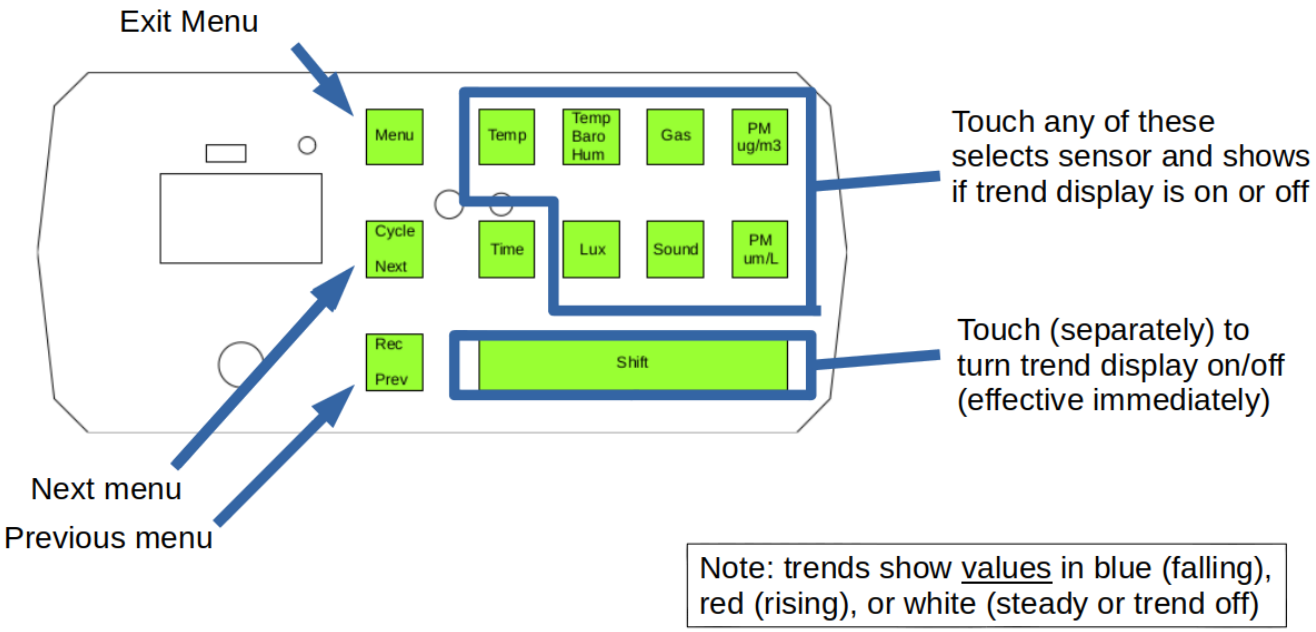



*Figure 7: TREND Menu Operation*

This menu allows you to select for each sensor whether you want to see the trend indicated by colouring the value

Selection works by touching a sensor which then shows the current selection. Touching SHIFT then toggles that value.

### 2.2.4 T-HIS (Trend History) Menu

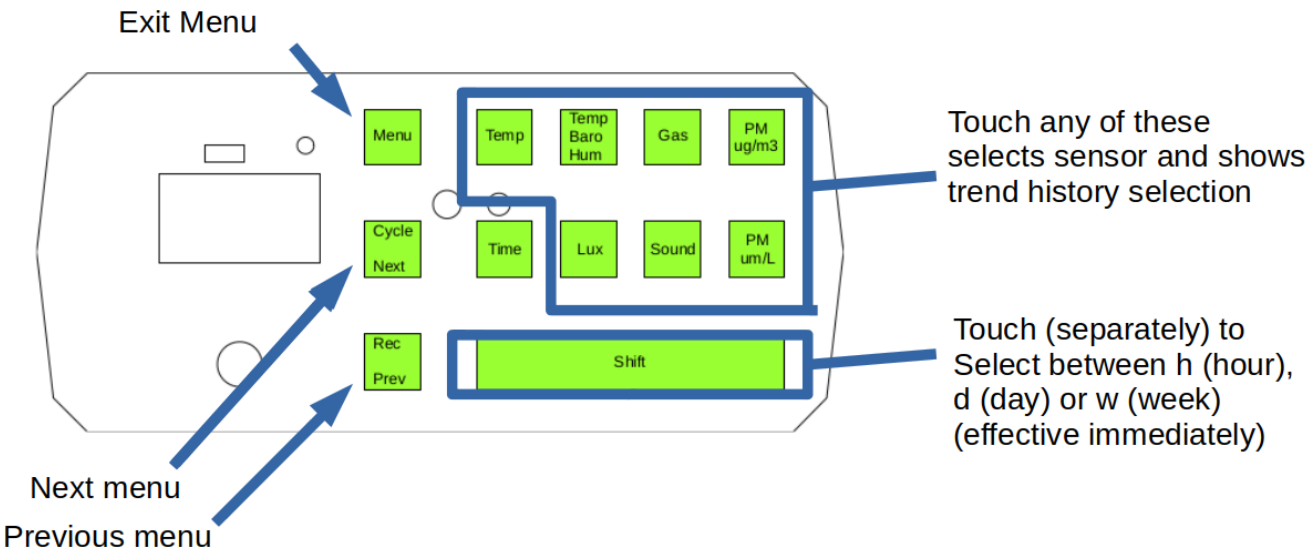



*Figure 8: T-HIS (Trend History) Menu Operation*

The Trend History menu working the same way as the others. You select a sensor and use SHIFT to turn toggle between using a trend history of 1 hour, which is the default, 1 day or 1 week

There is no difference in the trend display to show which history has been selected, but you can always go back to this menu to find out.

### 2.2.5 REC VAL Menu

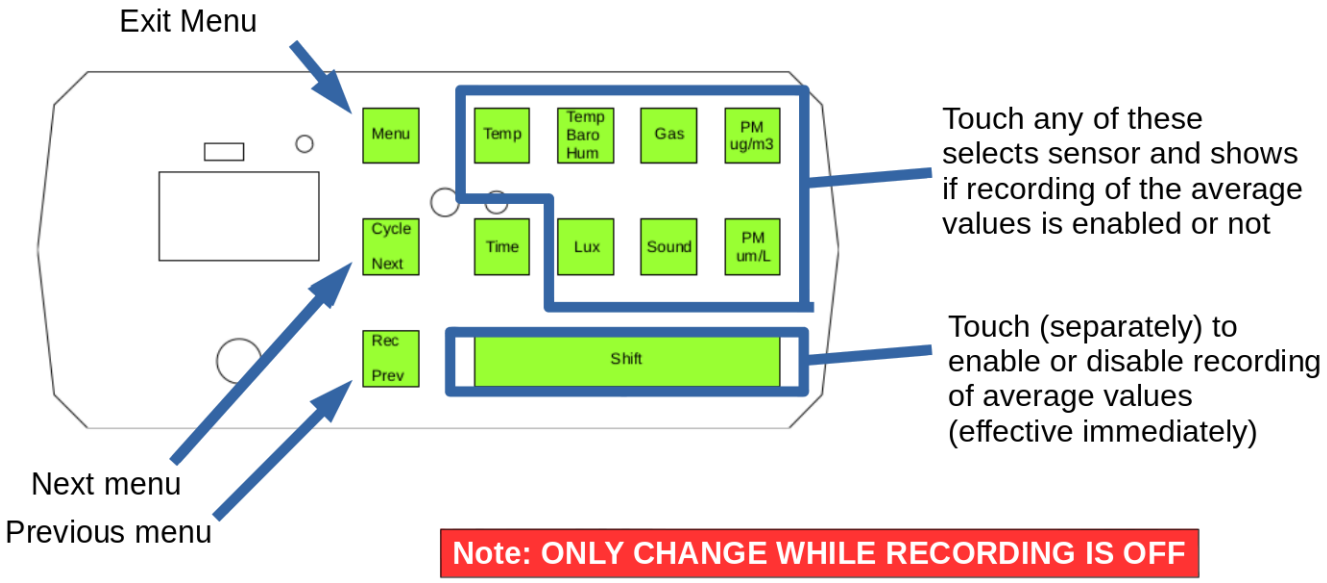



*Figure 9: REC VAL Menu Operation*

With the REC VAL menu, you pick which currently measured values of a sensor group should be included in the recording,

The selection works the same way as for the previous menus

Selecting sensors for recording using REC VAL probably only makes sense if the recording interval is set to 1 recording every second. For longer recording intervals, the REC AVE (averages) selection makes more sense.

Note: You can select both, REC VAL and REC AVE for a sensor group in which both, current and averages are included in the recording.

### 2.2.6 REC AVE (Averages) Menu

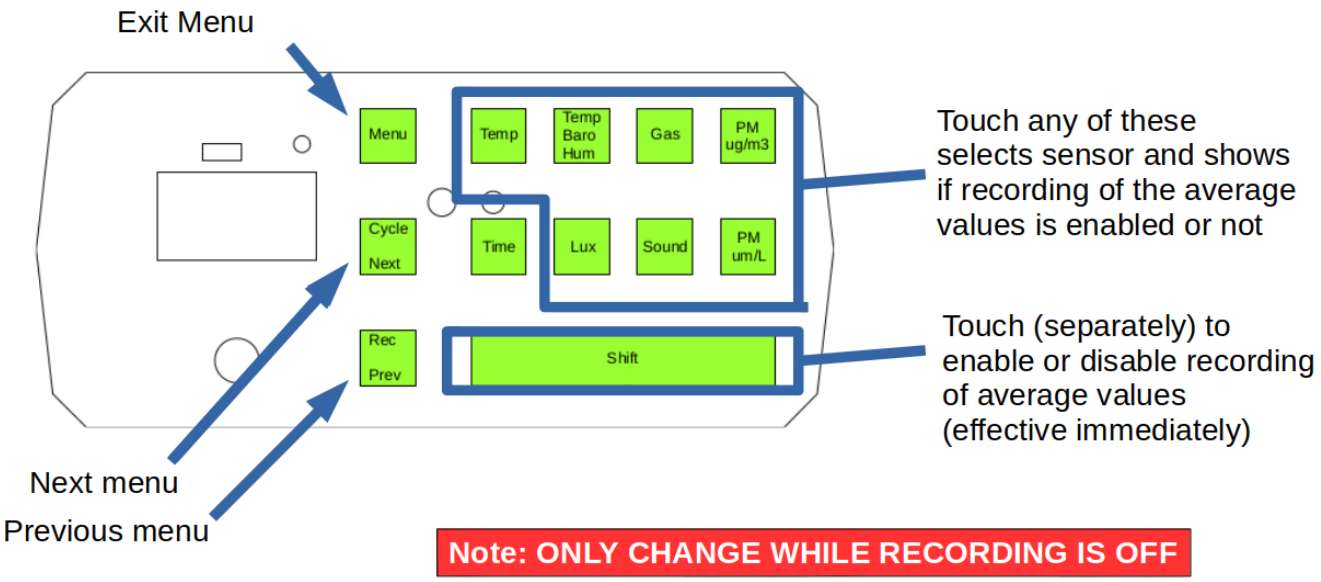



*Figure 10: REC AVE (averages) Menu Operation*

With the REC AVE menu, you pick which average values of a sensor group should be included in the recording,

The selection works the same way as for the previous menus

With the REC VAL menu, you pick which currently measured values of a sensor group should be included in the recording,

The selection works the same way as for the previous menus

Note: You can select both, REC VAL and REC AVE for a sensor group in which both, current and averages are included in the recording.

### 2.2.7 REC TIME Menu

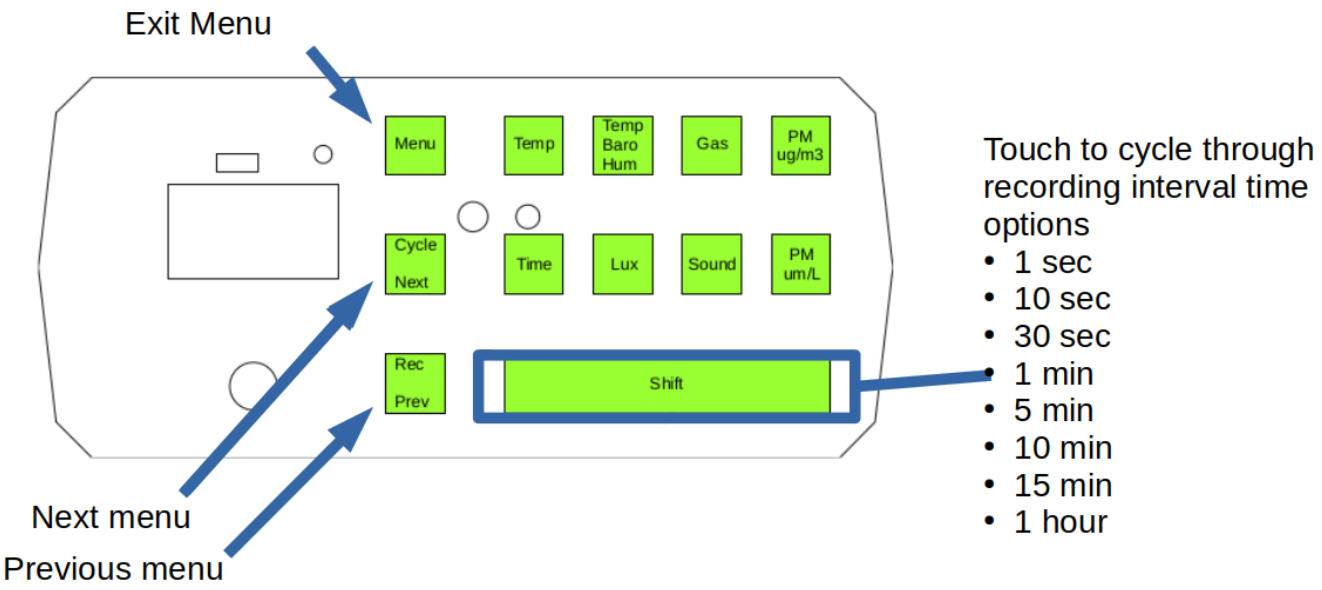



*Figure 11: REC TIME Menu Operation*

REC TIME allows setting of the recording time interval, that is how often the set of values selected by REC VAL or REC AVE are saved in the recording file.

For long term recordings (over days), it is best to select at least 1 min = 1440 entries/24 hours or 5 minutes = 288 entries/24h, otherwise the recording file size gets easily too big for many spreadsheet programs to handle.

### 2.2.8 SleepTime Menu

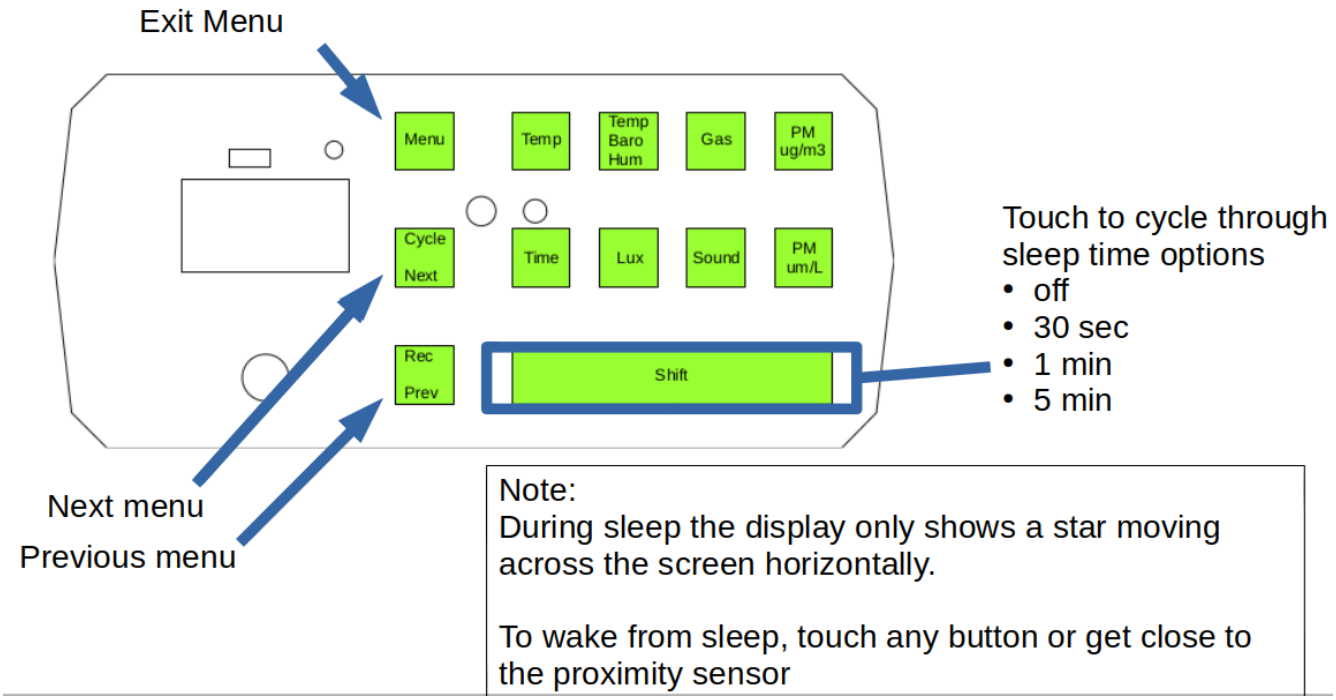



*Figure 12: SleepTime Menu Operation*

SleepTime allows setting of a time after which the display changes to a moving star if not user input was detected during the time. This is actually more a screen saver because processing of sensor data and recording (if enabled) is going on as normal.

### 2.2.9 SAVE Menu

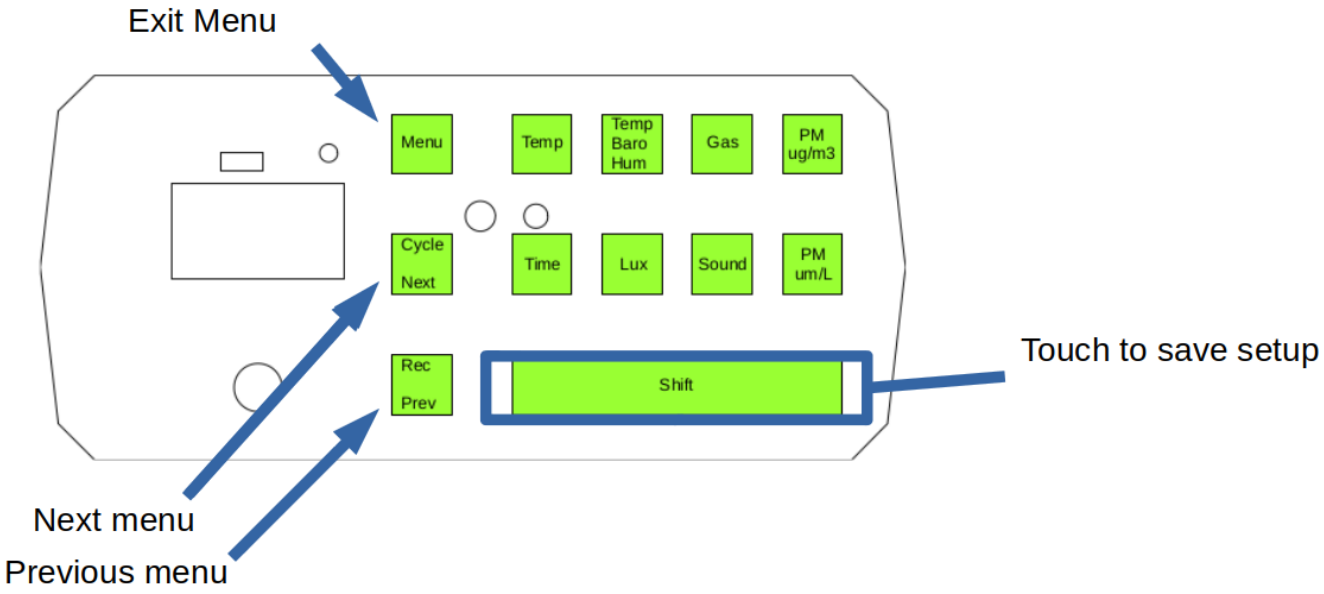



*Figure 13: SAVE Menu Operation*

This menu saves all settings in the setup file.

If no setup file exists, it is created. If a setup file exists, it will be overwritten

### 2.2.10 LOAD Menu

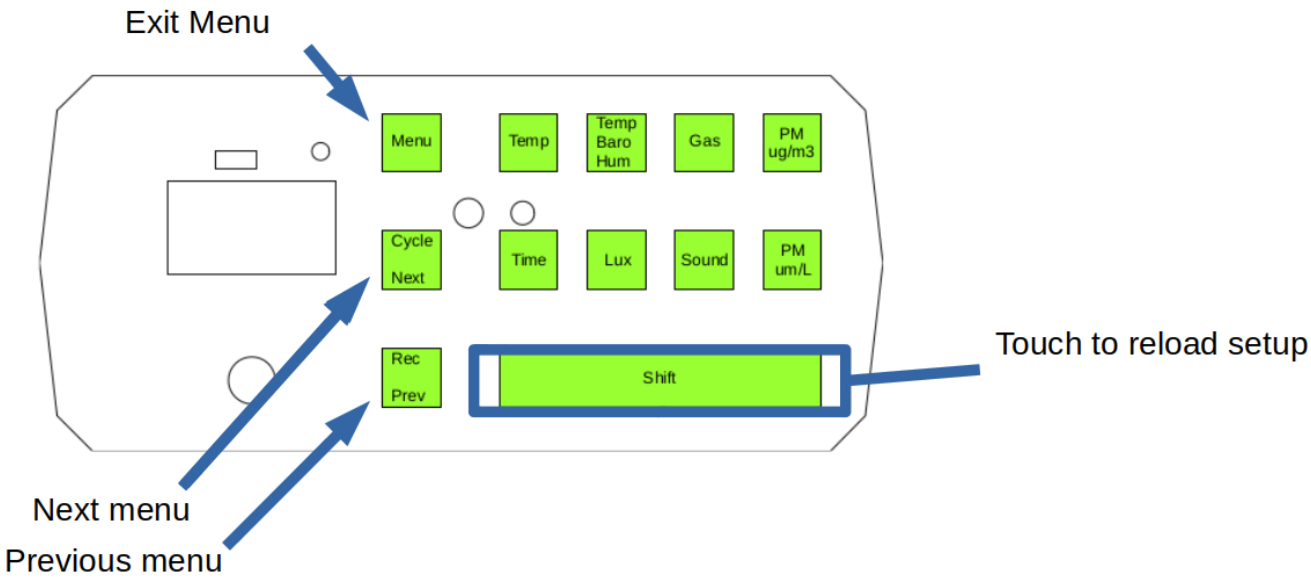



*Figure 14: LOAD Menu Operation*

Normally the setup file is automatically loaded at start-up. With this menu, it can be reloaded if necessary, for example as a quick way to restore settings after playing around with the other menus.

# 3 Calibration

There are two sensors that need some form of calibration: GAS and NOISE.

## 3.1 Gas Sensor: R0

The Gas sensor has three different substrates that each produce a resistance value in Ohm which changes with the presence of gasses to which that substrate is particular sensitive. The Ohm value is also very sensitive to temperature. The sensor itself is heated and needs to come up to operating temperature first. It must also be protected from air flow which would cool it down

Normally, the factory would deliver a R0 value for each of the 3 substrates, giving its Ohm value at a standard temperature in a standard (clean) atmosphere. For the Enviro+, these values are not available and since the values vary in production, taking R0 values from another chip is not an option.

Having R0 would allow showing the ratio of the measured resistance over R0 which in turn could be used to get an idea of the gas concentration based on the graphs (normalized to the ratio) in the data sheet.

### 3.1.1 Finding reasonable R0 values for OX, RED and NH3

In the absence of any proper R0 data, the following procedure can be used to get maybe a reasonable approximation:

1. Select the unit OHM “Ω” for the Gas sensor. This means the values shown and recorded are the raw resistance values.
2. Optional: Put a USB stick into the USB port and select recording of GAS average values with an interval of 1 or 5 minutes. Turn recording on.
3. Put the unit into an environment that you assume is having the cleanest air that you can find. The Enviro-Station can be powered from a USB powerbank, so going outdoors into a park or wood-land is a possibility.
4. Let the unit run for at least an hour., longer is better, and observe the average values reported. The shown resistance values should slowly approach a more or less steady value.

5. When you think the values are no longer changing much, note the resistance values on a paper.
6. Alternatively, if you had used recording, turn off recording, unplug the USB stick and examine the recorded values in a spreadsheet program like Excel. It is useful to plot the values as XY graphs

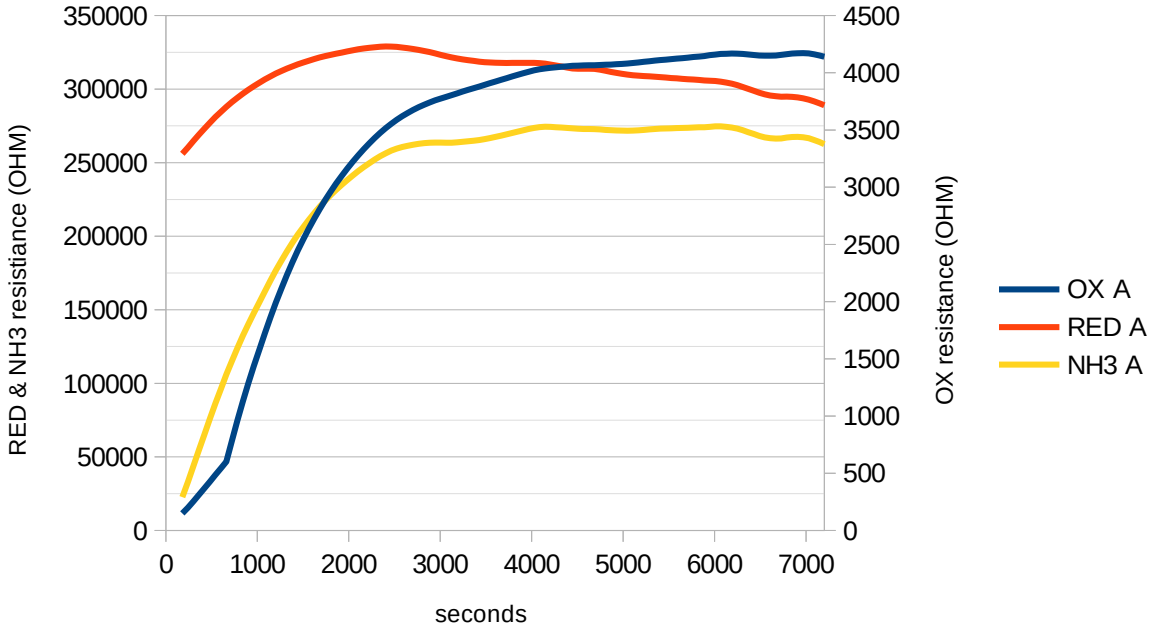



*Figure 15: sample plot of GAS sensor resistance values over 2 hours*

7. As you can see in Figure 15, it takes a while for the values to reach some form of stability and that assumes that neither temperature nor air quality changes significantly during that period. Also your values may be quite different. At least in my unit, RED and NH3 are in the 200-300K range while OX is much lower, around 10K. Note that in Figure 15, RED has not quite settled yet, so a longer measurement period may be needed.
8. Use a text editor (like Mousepad) to edit the SETUP.TXT file and overwrite the OX, RED and NH3 R0 values in there (see Figure 16), taking care not to change anything else.

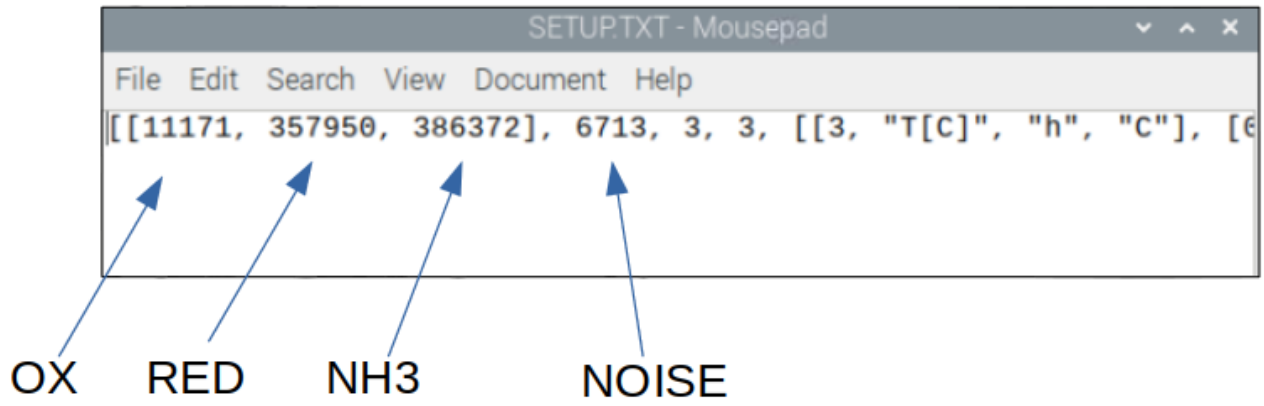



*Figure 16: Locations of the calibration values in SETUP.TXT*

9. If EnviroStation is still running, you can use the MENU LOAD function to load the new setup file, otherwise the new values will be loaded at the next start-up.
10. Switch the Gas Unit to ratio “/” to use the new R0 values. Remember, the values will only approach 1 after one hour or more.

## 3.2 Noise floor

I observed that even in total silence, the PCM value delivered by the MEMS microphone has a significant noise signal which pushes the dbSPL values into unrealistic high values.

There is also a DC offset inherent in the type of MEMS microphone used in the Enviro+.

Calibrating the NOISE floor value will get rid of both.

### 3.2.1 Finding a reasonable NOISE floor value

1. To have any chance of getting realistic-looking dbSPL values, the system noise signal must be determined and then subtracted using the following procedure:
2. Select the unit PCM for the Sound sensor. This means the values shown and recorded are the raw PCM values reported by the microphone

3. Put the unit into an environment that is as quiet as possible. My experience is that this means running it through the night., which means you should either use recording or the Minimum function unless you want to be up all night looking at the values.
4. Let the unit run and record the average PCM values reported and/or enable minimum display for noise.
5. Examine the minimum value or use the recorded PCM values in a spreadsheet to find the minimum and take this as noise floor level.
6. Use a text editor (like Mousepad) to edit the SETUP.TXT file and overwrite the NOISE value in there (see Figure 16), taking care not to change anything else
7. If EnviroStation is still running, you can use the MENU LOAD function to load the new setup file, otherwise the new value will be loaded at the next start-up.
8. When the file is reloaded, switch the Sound sensor to dbSPL to use the new noise floor value.

# 4 Installation

## 4.1 Pre-requisites:

Raspberry Pi Zero W with up-to-date Raspberry Pi OS (Raspbian) BUSTER

Internet access to be able to download packages

User Pi

## 4.2 Prep:

| | |
|---|---|
| 1. System config | Use the Raspberry Pi configuration menu INTERFACES to<br>• enable SSH and/or VNC depending how you want to use it.<br>• Enable: SPI, I2C, Serial Port<br>• Disable: Serial Console, 1-Wire, Remote GPIO<br>If the Configuration program asks you to reboot, do it |
| 2. Create home folder | Create folder:<br>`/home/pi/EnviroStation` |
| 3. Turn off auto-mount | Turn off all auto-mount options in file manager. These don't work when Enviro-Station is auto-started and interfere when running interactively. |

| | |
|---|---|
| | `File → Edit → Preferences → Volume Management`<br>(untick all auto-mount options) |
| 4. USB mount point | Create a mount point for USB sticks:<br>open a terminal window and enter:<br><br>`sudo mkdir /mnt/usb_stick`<br>`sudo chmod a=rw /mnt/usb_stick` |
| 5. Update PIP | Ensure PIP is up-to-date<br>`sudo pip3 install --upgrade setuptools` |
| 6. Setup adafruit stuff | `pip3 install adafruit-circuitpython-ads1x15`<br><br>`pip3 install adafruit-circuitpython-bme280`<br>`pip3 install adafruit-circuitpython-mcp9808` |
| 7. MPR121 | You can use my MPR121 driver or the Adafruit one. Regardless which one you choose eventually, it does not hurt to install the Adafruit one<br><br>`pip3 install adafruit-circuitpython-MPR121` |
| 8. Setup Pimoroni stuff | `sudo pip3 install st7735` |

## 4.3 Sound:

| | |
|---|---|
| 9. Setup sounddevice | `python3 -m pip install sounddevice --user`<br><br>`sudo apt-get install libportaudio2` |
| 10. Follow Adafruit MEMS mic instructions Note: this will take better part of 1h | `cd ~`<br>`wget https://raw.githubusercontent.com/adafruit/Raspberry-Pi-Installer-Scripts/master/i2smic.sh`<br>`chmod +x i2smic.sh`<br>`sudo ./i2smic.sh`<br><br>(select Raspberry Pi Zero and autoload)<br>Reboot |
| 11. Test if microphone | Open Terminal and type: |

| | |
|---|---|
| present | `arecord -l`<br><br>You should see something that starts like this:<br><br>`**** List of CAPTURE Hardware Devices ****`<br>`card 0: sndrpii2scard [snd_rpi_i2s_card], device 0: simple-card_codec_link...` |

## 4.4 Install EnviroStation:

| | |
|---|---|
| 12. Go to PI home folder | Open Terminal:<br><br>`cd ~` |
| 13. Clone Github project | `git clone https://github.com/TheHWCave/EnviroStation` |
| 14. Check that it runs | Find *Home/*`pi/EnviroStation/software and open terminal there`<br><br>`type:`<br><br>`python3 EnviroStation.py`<br><br>The program should start with an error message:<br><br>`error loading setup`<br><br>but no other errors<br><br>to continue setup press control-c to terminate EnviroStation for now and close window |
| 15. Install Pimoroni on/off shim | Open Terminal:<br><br>`cd ~`<br>`curl https://get.pimoroni.com/onoffshim \| bash`<br><br>type Y when the script asks if you wish to continue<br>type Y when the script asks if you wish to reboot |

| | |
|---|---|
| 16. Install EnviroStation as a service | Open terminal in */home/*pi/EnviroStation/software<br><br>sudo cp EnviroStation.service /lib/systemd/system/<br>sudo chmod 644 /lib/systemd/system/EnviroStation.service |
| 17. Enable service | sudo systemctl daemon-reload<br>sudo systemctl enable EnviroStation.service<br>reboot |
| 18. Optional: reduce wear on SD card | Edit<br><br>/etc/fstab<br>add<br>tmpfs /tmp tmpfs defaults,noatime,nosuid 0 0<br>tmpfs /var/log tmpfs defaults,noatime,nosuid,size=16m 0 0<br>find line for / that looks like:<br>PARTUUID=<some hex num>-02 / ext4 defaults,noatime 0 1<br>change to<br>PARTUUID=<some hex num>-02 / ext4<br>defaults,noatime,commit=600,errors=remount-ro 0 1<br><br>credits https://www.raspberrypi.org/forums/viewtopic.php?t=257514<br>HawaiianPi & Jahboater |

Note: By default, EnviroStation.py uses my MPR121 touch pad driver. You can use the stock Adafruit driver instead but it is quite a bit less responsive. I suspect this is because they have not implemented auto-calibration during setup as recommended by the MPR121. Another feature missing in the Adafruit driver is the capability to use a virtual 13$^{th}$ button (based on the capacitance readings from all 12) as a proximity sensor. This is one method used by EnviroStation.py to wake from sleep.

# 5 Notes for building the Station

*Table 5: Bill of Material*

| No | Qty | Item | Source |
|---|---|---|---|
| 1. | 1 | Enviro+ | Pimoroni |
| 2. | 1 | PMS5003 with cable | Pimoroni |
| 3. | 1 | Raspberry Pi Zero W | Various |
| 4. | 1 | MPR21 touch sensor | Ebay, seller: ict2you |
| 5. | 1 | MCP9808 | Ebay, seller: tandy_corporation |
| 6. | 1 | Buzzer | Ebay, seller: switch_elec |
| 7. | 1 | 270 Ohm resistor | Banggood |
| 8. | 1 | USB 2.0 A Male to Micro USB 5 pin Male Left Angle Short Cable Adapter converter | Ebay, seller Innov8wholesaleltd |
| 9. | 2 | Micro usb 5pin male to micro 5pin female with screw panel mount extension cable | Ebay, seller Innov8wholesaleltd |
| 10. | 1 | OnOff SHIM | Pimoroni |
| 11. | 1 | Push-button with red LED | RS-Components Stock 820-7521 |
| 12. | 1 | Enclosure 110x149x71MM Project Box Case PCB Housing in Black or Grey Vented KE3 | Ebay, seller eltop_electronics |
| 13. | 1 | Front Panel PCB | JLCPCB |

List of I2C addresses in use:

| Address (hex) | Device |
|---|---|
| 18 | MCP9808 (precision temperature) |
| 23 | Enviro+: LTR559ALS (Light & Proximity) |
| 49 | Enviro+: AD1015 (Analog to Digital used for Gas sensor |
| 5a | MPR121 (touch sensor) |
| 76 | BME280 (barometric pressure & humidity) |

*Table 6: GPIO use (by GPIO number)*

| Use | GPIO | pin |
|---|---|---|
| I2C SDA | GPIO2 | 3 |
| I2C SCL | GPIO3 | 5 |
| LCD_CS | GPIO7 (CE1) | 26 |
| LCD_DC | GPIO9 (MISO) | 21 |
| LCD backlight | GPIO12 | 32 |
| SHUTDOWN | GPIO4 | 7 |
| ONOFF_BUT | GPIO17 | 11 |
| MICS 6814 heater | GPIO24 | 18 |
| MEMS Microphone Clk | GPIO18 | 12 |
| MEMS Microphone LRCL | GPIO19 | 35 |
| MEMS Microphone DOUT | GPIO20 | 38 |
| PM5003 Enable | GPIO22 | 15 |
| PM5003 Reset | GPIO27 | 13 |
| PM5003 TX | GPIO14 | 8 |
| PM5003 RX | GPIO15 | 10 |
| Beeper | GPIO21 | 40 |

*Table 7: GPIO use (as GPIO header pins)*

| Use | Pin | | Use |
|---|---|---|---|
| Power 3V3 | 01 | 02 | Power 5V |
| I2C SDA | 03 | 04 | Power 5V |
| I2C SCL | 05 | 06 | GND |
| SHUTDOWN | 07 | 08 | PM5003 TX |
| GND | 09 | 10 | PM5003 RX |
| ONOFF_BUT | 11 | 12 | MEMS Microphone Clk |
| PM5003 Reset | 13 | 14 | GND |
| PM5003 Enable | 15 | 16 | |
| | 17 | 18 | MICS 6814 heater |
| | 19 | 20 | GND |
| LCD_DC | 21 | 22 | |
| | 23 | 24 | |
| | 25 | 26 | LCD_CS |
| | 27 | 28 | |
| | 29 | 30 | GND |
| | 31 | 32 | LCD backlight |
| | 33 | 34 | GND |
| MEMS Microphone LRCL | 35 | 36 | |
| | 37 | 38 | MEMS Microphone DOUT |
| GND | 39 | 40 | Beeper |