ETT Gustometer 2

Gustatory Stimulation

Manual and Tutorial

Revision 2021.1

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Setup

Safety Information

Do not open the device without explicit instructions from ETT customer support. Before opening the device disconnect the AC power supply cable!

Warnings

1. **This device is for research use only!**
2. **Item 1 on the system components list is not MRI compatible.**
3. **Only the tubing and the applicator/mouthpiece are MRI compatible and thus allowed into the magnet room.**
4. **Feed all tubing through an appropriately sized wave guide to avoid damage to the connectors.**

Contact to ETT

Address	Email
Emerging Tech Trans, LLC 2151 Harvey Mitchell Parkway S STE 209 College Station, TX 77840, USA	info@emergingtechtrans.com

Connecting the Device

Before the first power up

After receiving and unboxing the device inspect the ETT Gustometer 2 for visible damage to both the package and the actual device. Do not power on the device if there are visible damages or audibly dislodged parts within the case. Consult with ETT support prior to continuing. If the device passes the inspection, use the provided power cord, and plug in the device. The compatible AC line voltage range is from 100 V to 240 V.

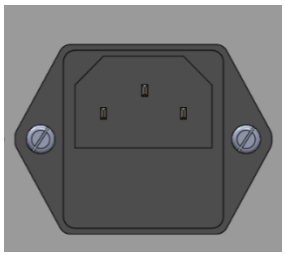

Figure 1 - AC power supply port compatible to most countries' AC line voltage.

System components

Congratulations to your new ETT Gustatometer 2!

System components

1. The ETT Gustometer 2

Figure 2 - Front panel with touch-screen and interface connectors

Figure 3 - Back panel with pumps and inlet and outlet tubing, and air pump output

2. Set of food safe bottles for the stimulants (flavored fluids), up to 8 at a time can be stored on the top of the device

Figure 4 - Provided glass jar with Teflon cap for stimulant storage

3. Customized mouthpiece/applicator (attaches to the RF coil or a provided table clamp; MR and EEG compatible)

Figure 5 - Applicator can clip to RF coil structure and delivers tastant at correct angle without drops getting stuck

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4. PTFE tubing set (8 m, 8 channel) between applicator and device (fed through waveguide on MR penetration panel to connect MR compatible components with the actual device sitting in the control or operator room)

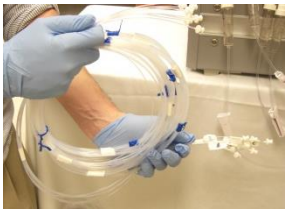


Figure 6 - The long PTFE tubing set with blue protective cover connects the subject mouthpiece with the device

5. PTFE Inlet tubing set between tastant bottles and device

6. Swallow sensor belt with digital input (optional)

7. Coax connector (connects the device trigger in port to the BNC pin of the MR RF trigger converter; not needed on non-Siemens systems)

8. MRI RF Trigger converter (converts an optical trigger from the RF cabinet of the MRI system to a TTL electrical signal that triggers the ETT Gustometer or ETT Olfactometer system; not needed on non-Siemens systems)

System Overview

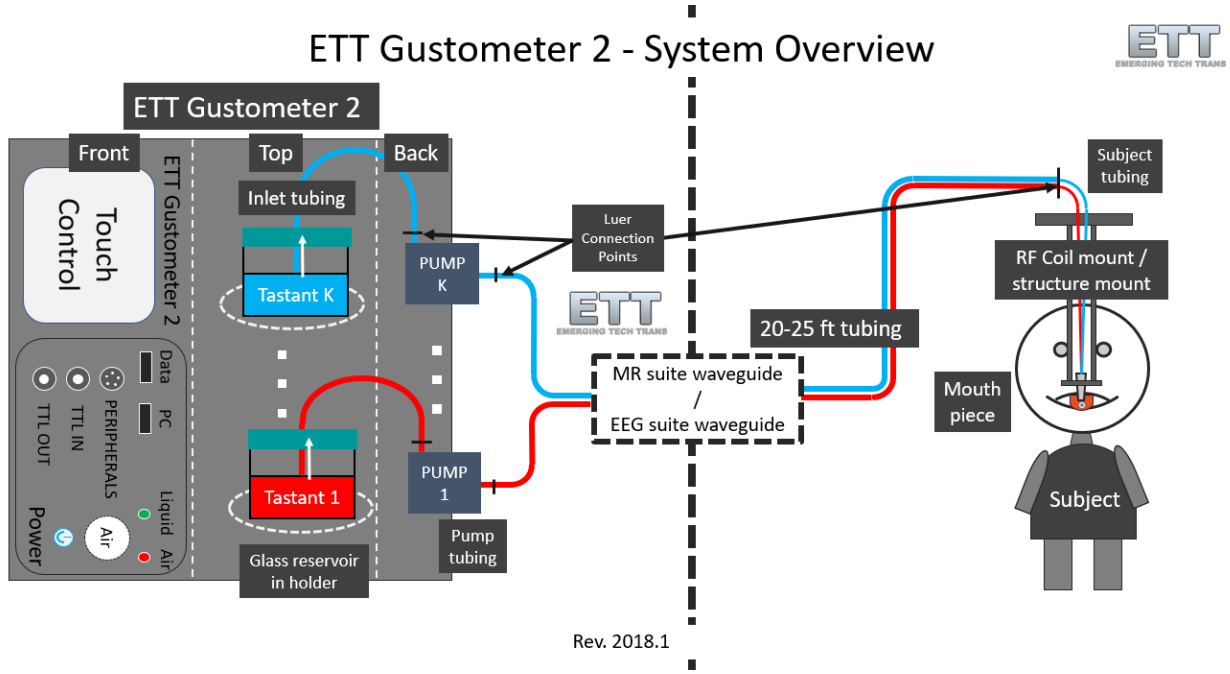


Figure 7 - ETT Gustometer 2 system overview with left - device (non-MR compatible) and right - applicator (mouthpiece) on subject (MR compatible))

The general system setup is shown in Figure 7. It is advisable to first setup the components unrelated to the subject and test everything is connected before setting up a research subject on the patient table.

Warning - *the main device is not MR compatible*.

Only the following components are MR compatible:

- Mouthpiece / tastant applicator
- RF coil mount
- Swallow / respiratory sensor bladders
- Long distance PTFE connection tubing

All other components cannot be brought inside the magnetic field.

Start by setting up the ETT Gustometer 2 outside the experimentation room. Even for EEG experiments it might be advisable to maintain a wall separation between subject and device. Each pump has a slightly different pitch, which might inform the subject which is the currently active stimulus.

Connect the power supply cable and power the Gustometer up by pressing the power button on the front panel. Connect a USB flash drive to the *DATA* port. Optionally connect the various triggers and sensor that may be provided with your system. The ETT Gustometer 2 can easily be triggered with a TTL pulse from and other device via *Trigger in* BNC port. The sent pulse should be at least 1 ms long. To initialize the trigger handler, load a paradigm and press *Trig Start* to wait for a trigger. As soon as the trigger is visible to the device the paradigm starts.

Consult with support@emergingtechtrans.com for more detailed instructions on subcomponents.

Tastant setup

There are up to eight slots for the glass tastant containers with the pre-drilled Teflon caps on top of the Gustometer (Figure 8). As signified by the blue arrow the inlet tubing connects through the cap of the bottle to the top Luer inlet port on the Gustometer. From there the fluid goes through the peristaltic pump. On the back side, each channel has a Luer outlet connector. The eight channel PTFE main tubing set connects from there to the mouthpiece.

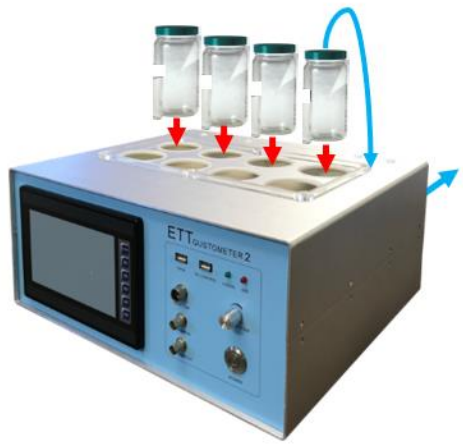


Figure 8 - Up to eight glass containers can be stored on top of the Gustometer – one for each channel.

Tastant applicator / Mouthpiece setup

The mouthpiece setup is the most important part of the experimental setup. To assure data quality during experiments, the mouthpiece must be parallel to the direction of gravity. If the standard mouthpiece as provided with the Gustometer does not suit the needs experimental requirements, contact ETT support for a custom design.

Contact ETT for service or replacement of mouth pieces.

Applicator tubing

Proper routing of the PTFE tubing is important, to allow drop formation especially for small delivery amounts. If mouthpieces are reused, check correct fit after each cleaning cycle and prior each experiment:

- Tubing must extend the panel inside the mouthpiece by about 1 mm (bonded in place after 2016)
- Tubing has no bends or kinks
- Tubing is free of leaks
- Tubing Is straight and the ends are cut at a straight angle

Coil mounting (fMRI package)

The ETT Gustometer 2 comes with a standard mounting system for a Siemens 12 and 20 channel clinical head coil mounts. For other systems we can create a custom fit solution upon request.

The clamp attaches to the upper side of one or two head coil beams. Only friction between the coil and the clamp hold the piece in place. Therefore, it slides easily along the direction of the main magnetic field, to fit many head sizes. It allows also to be adjusted with an angle of up to 5 degrees to fit different face geometries.

Figure 9 – Applicator setup on a Siemens 12CH head coil

The actual mouthpiece is connected to the clamp though a two-rack track, which allows for height adjustments relative to the patient's mouth. A retaining pin holds the two at a fixed elevation during the experiment.

In case of an emergency the clamp allows to easily slide the whole setup upwards, with just the force of the subjects' tongue.

Fitting a subject

During the subject setup it is advised to fit the clamp to the upper part of the head coil first. While the subject gets situated in the coil, slide the mouthpiece into the clamp into the most upward position without securing it yet with the pin. Now slowly join the coil with the subjects' mouth. Confirm with the subject that they get each tastant during the standard test run through all channels.

The first experiment

Before the first experiment can be designed a few thoughts on your options with the ETT Gustometer. Stimuli will be delivered in form of drops of liquid through a system of Teflon tubing through an applicator into the subjects' mouth. These drops of substances that will stimulate the gustatory sensation (tastant) are commonly a chemical of choice dissolved or suspended in distilled water (dH_2O). Alternatively, a specific neutral rinse, which usually mainly consists of distilled water can be chosen as the carrier fluid. If the particle size is small enough even emulsions with high liquid portion are deliverable.

The ETT Gustatometer offers the option to deliver with 7 independent taste channels and one additional rinse channel. The experiment is be split into recurring cycles. During these cycles one will have a determined amount of tastant from one of the taste channels and one or more rinse cycles with a defined bolus.

Typical tastants

Typically, researchers will deliver particles that are easily dissolved in water and where the formulation is reproducible the same for every experiment. Generally, know there are five categories of taste receptors that can detect:

- Sweetness
- Saltiness
- Bitterness
- Sourness
- Savoriness

To get a start, different concentrations of salt (NaCl), sugar/sucrose ($C_{12}H_{22}O_{11}$), caffeine ($C_8H_{10}N_4O_2$) and citric acid ($C_6H_8O_7$) are easy to create with distilled water.

It is important to assure a proper drop formation at the mouthpiece. If the number of drops is set too low for a tastant with a high viscosity, the drop may just grow bigger at the tip of the mouthpiece but not actually fall onto the tongue in time. This aspect should be tested thoroughly and experimentally adjusted to the specific requirements of the study.

Touch-screen operating system

Main Screen

Once the device is started it will present a main screen. From this screen all major features can be controlled. The top horizontal bar contains three main features and the *Help* button. The vertical button on the right side (Figure 10s). The *File Manager* is used to create a subject and run specific folder (see section Creating data files on page 15) on the attached USB flash drive (connected to *DATA* port on front panel).

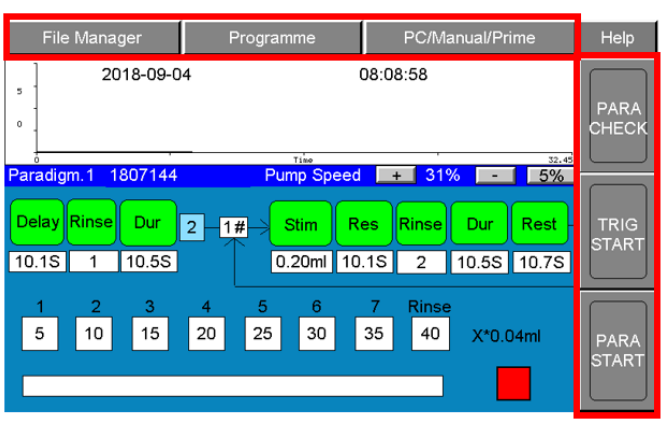


Figure 10 - The main screen contains general settings in the top bar; paradigm test and start on the right side; and current paradigm state information in the main area

The *Program* button will lead to a selection of saved paradigms and allows to create new paradigms. The currently selected paradigm ID is presented on the *Main* Screen on the left section of the dark blue block labeled *Paradigm. N*. It is followed by the current subject ID as it was created in the *File Manager*.

The button *PC/Manual/Prime* opens the *Manual Mode* Screen. Here the user can open and close individual channels as well as prime the whole system automatically. The priming feature is also useful during the cleaning process of the Gustometer tubing (see section Cleaning procedures on page 13).

The button *PARA CHECK* simulates the execution of the paradigm to confirm on screen if timings are accurate. *TRIG START* enables the *Input Trigger* coaxial port on the front panel. If active the paradigm execution will be delayed until the rising edge of a 5V TTL pulse is measured on this port. The *PARA START* button will start the execution of a program created in the *Program* screen.

The *Main* screen also allows to change the current pump speed, displayed as a percentage of the maximum speed. The large light blue area of the screen on the bottom half of the *Main* screen displays the current state of the device within a program. The bottom row displays the current multiplier for channels 1-7 as well as *Rinse* for the current paradigm. The large white bar below shows the progress during paradigm execution. Above the user can quickly see the current paradigm configuration. Starting on the left a general delay time before the paradigm loops start is displayed. Next to it is the number and duration of optional initial rinses.

The section to the right visualizes the actual paradigm loop with the currently used channel ID. *Stim* displays the volume (based on multiplier set below) delivered during this loop. *Res* next to it is the allowed response time after the bolus is delivered.

Each *stimulus* application and *response* period is followed by a settable amount of rinse cycles. To clean the pallet. *Rinse* is the number of times the system rinses with *Duration* being the time after each rinse. That is followed by a *Rest* period until the next paradigm block in the program is administered.

Before a further explanation on the actual paradigm/*Program* designer let's have a look at the *Manual Mode* screen.

Manual mode

The *Manual* screen can be used for both priming as explained below as well as debugging and testing each channel. It also allows to switch to PC control via the ETT Direct Control.

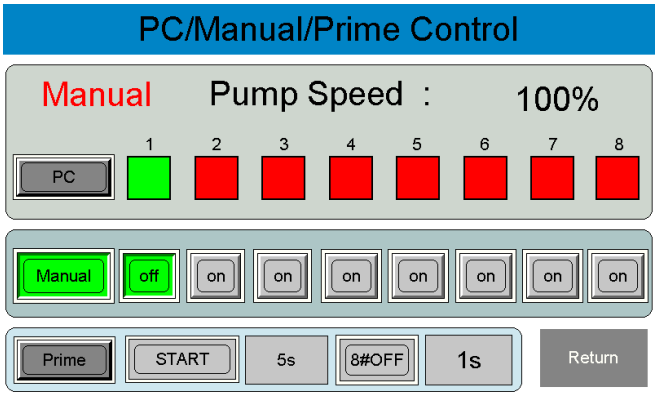


Figure 11 - Activate the Manual button the manually start and stop the peristaltic pumps at the currently set pump speed for each channel

As shown in Figure 11 the devices peristaltic pumps can be started and stopped by clicking the *Manual* button, so it lights up green. Then clicking on any of the channel buttons will start the pump at the currently set pump speed for the channel. No more than two pumps should be activated at one time. The pump speed can be changed on the *Main* screen.

Program / Channel Settings / Setup

The *Program* button on the *Main* screen leads to the *Channel Settings / Setup* screen (Figure 12). In the top left corner, the slot ID for the current paradigm can be selected or changed. This ID is also displayed on the *Main* screen. This table like screen quickly visualizes the settings for each channel.

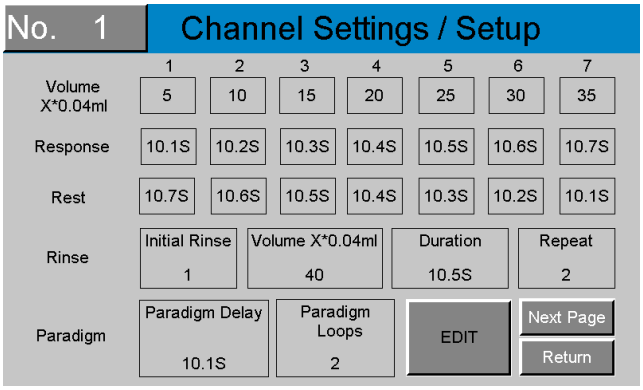


Figure 12 - Channel Settings / Setup screen to change paradigm, stimulus, and rinse timings

The specific settings on this page will be used each time a stimulus ID is called via one of the slots on the next page (*Paradigm Settings / Sequence* Figure 14). The volume for each channel is signified by a multiplier that roughly equals 1 drop for distilled water. Please note that the exact number of drops depends on the liquid used, mouthpiece rotation and other parameters. It is better to rely on actual volume than drops. The time in seconds after drop delivery called *Response* time to allow for a subject response via a visual cue before the rinse cycles start. The number of rinses is set generally for the whole paradigm below as the *Repeat* parameter in the row called *Rinse*. Here also the *Duration* after each rinse, the rinse *Volume,* and the number of optional *initial rinses* at the start of the paradigm can be set here. During the execution of the paradigm loop the rinse cycle is followed by a *Rest* period that can be set for each stimulus. At the bottom of the screen an initial *paradigm delay* (for example to allow for MRI dummy scans) can be set. A *Paradigm Loops* parameter can be used to execute the sequence as set in the next page more than once.

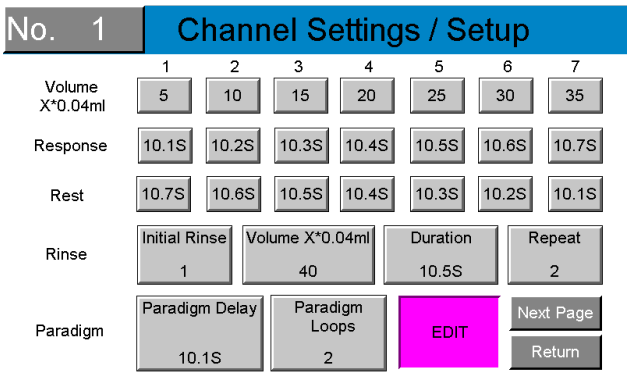


Figure 13 - The Channel Settings screen in edit mode

Use the *Edit* button to make changes and click *Edit* again to save changes for a program as shown in Figure 13. The *Sequence* screen can be edited and saved with the *Set* button. Each of the up to 96 slots can call one of the channels as configured in the *Setup* screen. A 0 means the specific slot is not called. The paradigm as in Figure 14 would have 21 stimuli, starting with 0.2 mL (5x0.04mL) channel 1. After a 10.1 s rating period the paradigm would administer 2 1.6 mL rinse cycles that are each followed by a 10.5 s period during which the subject can swallow. Stimulus 1 is concluded with a 10.7 s rest period. The paradigm would then execute the settings of channel 2. This continues for all channels to channel 7 and is repeated 3 times.

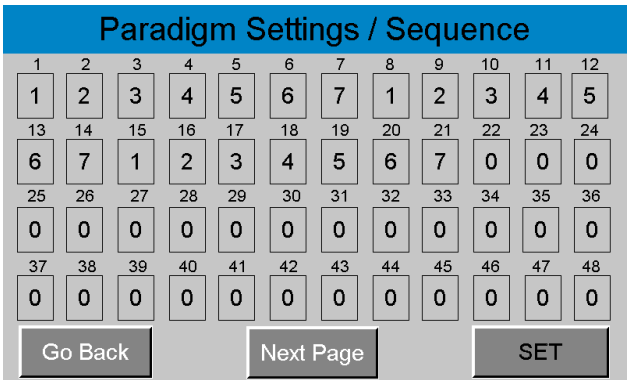


Figure 14 - Page 1 of the paradigm sequence slot overview with each number representing the stimulus channel that is called during the current loop iteration

This form of configuring a paradigm is likely sufficient for most scenarios. The Gustometer 2 can also be controlled via connected PC if the necessary hardware upgrade was purchased. In that case any imaginable paradigm setup could be executed. This would also allow to set different pump speeds throughout the paradigm or deliver based on specific triggers or visual cues.

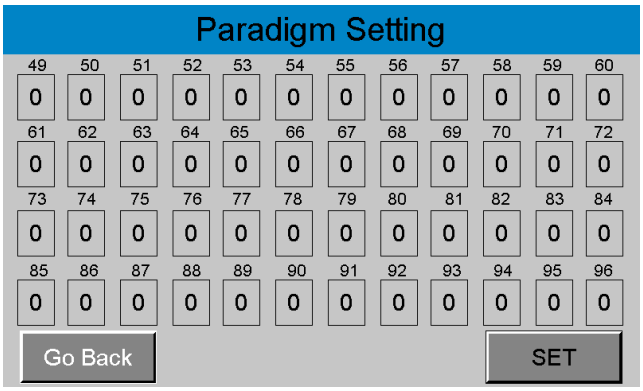


Figure 15 - Page 2 of the paradigm sequence slot overview, with 0 meaning a slot is not used

Resources

Useful information

Storage

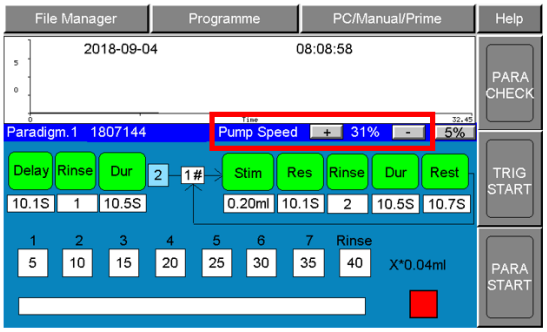
Before storing the ETT Gustatometer 2 the cleaning procedure in the section below should be followed. If the device is not used for an extended period, we recommend detaching and wrapping all tubing from the device. All parts must be dry and free of any experimental residuals. Especially dried solids from an experiment like sugar or salt, can cause problems once the device is reactivated. The disinfected and dried mouthpiece should be stored in a separate bag. A dust free environment is ideal.

Cleaning procedures

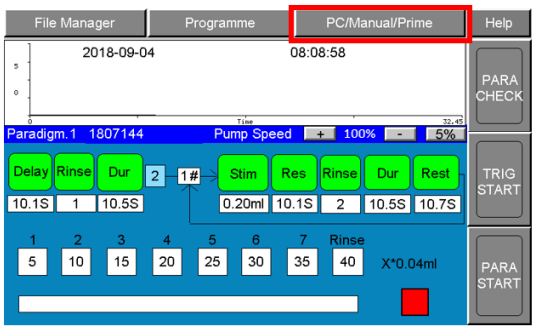
To guarantee optimal subject safety and a long lifespan of your ETT Gustometer 2 and the supplied equipment, we advise to follow these cleaning procedures. They apply *before and after each use cycle*:

Cleaning the tubing

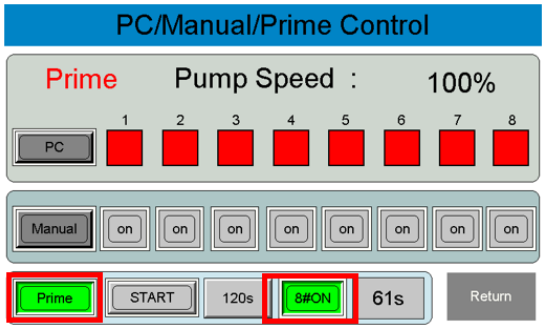
1. Stop all pumps
2. On the touchscreen set the pump speed to 100%



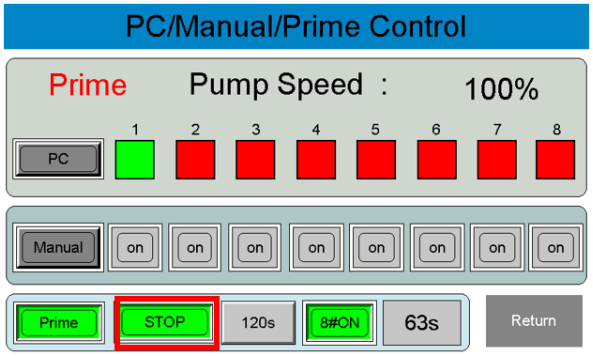
3. Switch the touch-screen to *PC/Manual/Prime*



4. Activate *Prime* and *Channel 8* (Flush)



5. Flush all channels with **distilled water (dH2O)** as follows:
   a. Detach reservoir-bottles
   b. Drain and rinse reservoir bottles
   c. Fill reservoir-bottles with 60-100 ml dH2O
   d. Re-attach reservoir-bottles
   e. In the *PC/Manual/Prime* mode of the touch-OS click *START* to pump distilled water through each line of the whole system



   f. Optionally the duration of priming each channel with distilled water can be adjusted – it should be at least 120s; repeat if necessary
   Be aware to collect the liquid in a container of choice coming out of the mouthpiece end.

6. Repeat step 5 with **70% Ethanol**
7. Optionally repeat step 5 with **distilled water (dH2O)**

8. Repeat step 5 with **no fluid reservoir** connected to the inlet tubing to pump air. All water should be removed from the tubing this way

Cleaning the mouthpiece (tastant applicator)

The mouthpiece is in direct contact with the subject - strict hygiene is very important. The mouthpiece is designed with materials that allow disinfection with 70% alcohol.
Sufficient hygiene is assured via the following steps:

1. Thoroughly rinse the mouthpiece with warm running water directly after the experiment, while rubbing all major particles (saliva, mucus, ...) off the applicator
2. After the rinsing process the mouthpiece should be kept inside a container of freshly filled 70% Ethanol
3. After the mouthpiece is essentially clean it should be rinsed in a fresh container of dH2O
4. The mouthpiece should be dried from outside and inside with clean compressed air.
5. If the tubing is not dry inside, air should stream through each channel until liquid is removed from the tubing (pump with Gustometer without liquid reservoir connected)
6. After the mouthpiece is dry it can be stored in a sealable plastic bag until it is being used again
7. Repeat this procedure prior to use if necessary

At this point a thorough, visual inspection is also advised to catch possible defects before you start your next experiment!

Trouble shooting

- In case the pump initially does not deliver the liquid all the way through the system, disconnect a port right before the next part of the tubing filled already. Wait until the air is slowly pushed out. Additionally, check for leaks or closed valves.
- If the liquid flow at the mouthpiece seems to be inconsistent, pump longer to remove all the air from the tubing. Check that no air is entering the system at any.
- If the flow is still inconsistent check if the tubing on the mouthpiece is accumulating stimulus fluid

Data management

Creating data files

Prior to any experiment a new data file should be created. If not, the data will be appended to the existing data file. To create a new data file / subject ID tap on *File Manager* in the main window (Figure 16) and then create new and assign a name und hit ‘confirm’ to finalize (Figure 17).

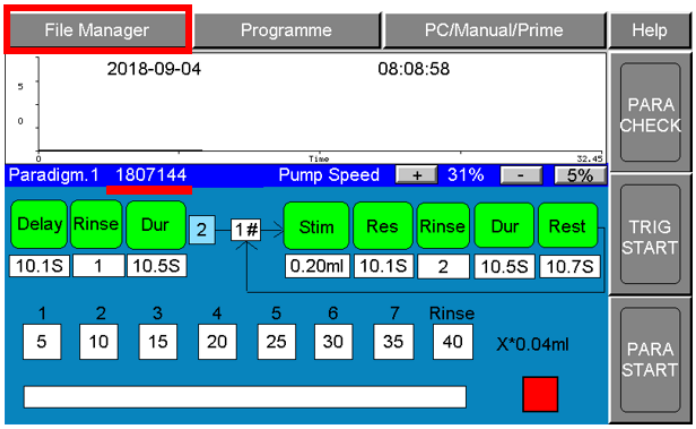


Figure 16 - The current file name is displayed next to the Paradigm ID. It can equal a subject identifier. File Manager can be used to create a new file

Figure 17 - Click Create Data Folder to alter the current name. Then click Confirm to make the change.

Data file

Each paradigm will create a data file (dat.csv) in a subject folder on the connected USB flash drive that logs the device state about every 100 ms. The file contains the current time, input trigger levels, peripheral voltage levels, and the state of each channel including rinse (1-on, 0-off). This along with screen shots of the current paradigm configuration is stored each time the paradigm is executed. If the file name is not changed, new data will be appended to the existing dat.csv in the folder.