MADD TECHNOLOGIES SARL

Instruction for use SalinoMADD

Easy & rapid gauging

MADD TECHNOLOGIES SÀRL – Avenue des Sports 42 – CH-1400 Yverdon-les-Bains – Switzerland
Tel: +41 24 445 31 16 – Fax: +41 24 445 21 23 – Email: info@madd.ch – www.madd.ch

Contents

Dear customer,

Thank you for purchasing this device **SalinoMADD**. This gauging device allows you to measure the flow of rivers very fast and easily according to the tracer dilution method.

The **SalinoMADD** is shipped in a sturdy carrying case. It is strongly recommended to always replace the device, the probe and accessories into this suitcase, which will ensure the best protection. Although it was designed for use in difficult conditions, it is a piece of precision equipment that must be protected from impact. Handled with a minimum of precautions, **SalinoMADD** will help you for long time!

In order to best use your new system, please read this manual and observe the manipulations described below.

Content

Upon delivery of a device **SalinoMADD**, the package contains the following materiel:

- A carrying case in polypropylene with rubber-foam inserts
- A SalinoMADD measuring unit with 4 alkaline batteries 1,5V
- A probe for water salinity and temperature with 10 meters cable and connector
- A straight calibrated measure for 100ml.
- 5 doses of 20 ml calibration solution
- A CD "SalinoMADD" containing
  - The software SalinoMADD
  - This instruction manual
  - A notice about the gauging method
  - A demo video of a gauging with SalinoMADD
- A serial cable for the communication between SalinoMADD and a PC

The device is delivered **ready to use** and **calibrated**.

Warranty

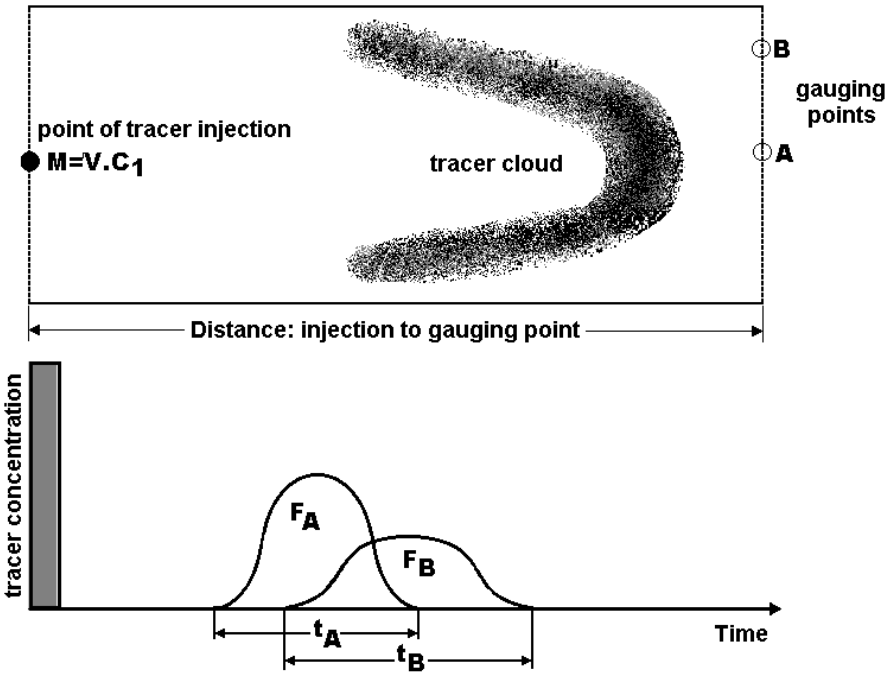
The device is delivered with a factory warranty for one year from the date of the invoice. Repairs are made in our workshop; no further benefit can be taken into account without written confirmation of MADD Technologies. It is understood that this warranty is available only if the device SalinoMADD was used in conditions for which it was expected, as described below. Any other manipulation should be done at risk and peri of the user.

Gauging method by tracer dilution

The device **SalinoMADD** uses the tracer dilution method to determine the stream flow of the measured watercourse.

Principle

The main principle of this method consists to inject into a watercourse a concentrated solution of tracer. Downstream, at a distance large enough from the injection point for a good mix with the river water, the tracer concentration is measured during the passage of the tracer could. This dilution is a function of flow rate, assumed constant along the section concerned during the measurement time.



The following conditions are necessary for the application of the dilution method:

- The flow of the river should remain roughly constant during the measurement;
- The tracer must pass totally through the gauging sector;
- At the measuring point, the mixture should be such that at each point of the section of the river must spend the same amount of tracer.

According to the above conditions, this method is especially adapted in case of low depths, very high speed or in presence of turbulences that does not guarantee a stable speed, like rivers or streams. As against, it is not suitable for measuring flow in concrete channels which does not permit the mixing of the water.

Cooking salt as tracer

The cooking salt, sodium chloride (NaCl), is an ideal tracer: it is very easy to find, cheap and has a high degree of dilution in water. Furthermore, it is not harmful to the fauna and flora at the concentrations used and it is few absorbed by vegetation and materials of the bed of the river. Finally, it is very easy to measure its concentration with a conductivity probe.

In this case, the operator injects into the river a known mass of salt M diluted in a volume of water of the river. Downstream, is placed a conductivity probe that will measure the electrical conductivity of water throughout the duration T of passage of the cloud of salt. A linear relationship exists between the conductivity of water and dissolved salt concentration. The concentration curve can therefore be deduced in function of time C_t. The flow Q is then obtained by integrating the concentration over time:

$$Q = \frac{M}{\int_0^T (C_t - C_0)\, dt}$$

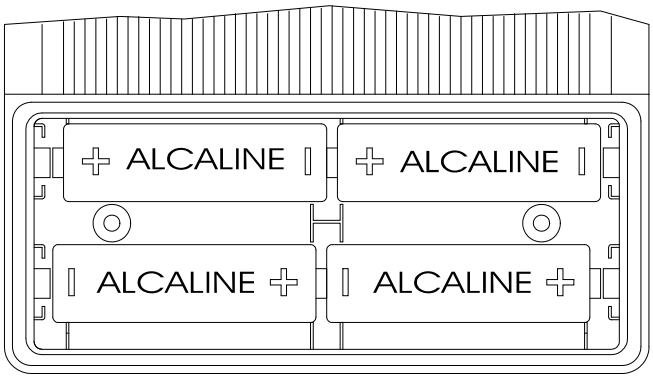
Q : flow of the water course [l/s]
M : mass of the injected tracer [mg]
C_t : water salinity at time t [mg/l]
C_0 : basic water salinity [mg/l]
T : duration of gauging [s]

First steps with the SalinoMADD

Replacing dry cells

The batteries are accessible on the back of the device. Unscrew the two screws of the battery cover, remove the old batteries and replace the 4 alkaline dry cells respecting polarity as indicated inside the housing. Close the lid.

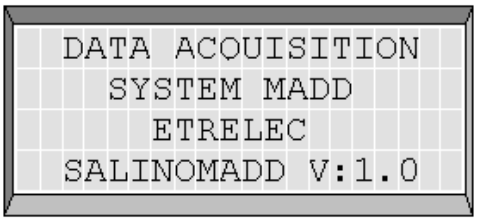
A set of new cells has a voltage of 6V. This voltage is displayed in the main menu. When this voltage downs below 3V, it is necessary to change the batteries. The autonomy is approximately 30 hours in normal use with one set of alkaline manganese batteries, type. AAA, AM3, LR6, Mignon, UM3 etc.



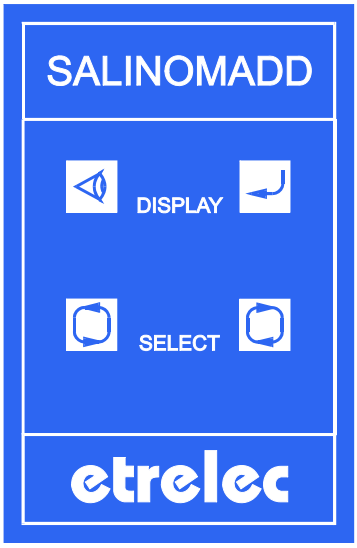
Power on the unit

To switch on the **SalinoMADD**, just press the button ◁ .

At this time the display on right for 2 seconds. It contains also the software version, useful for eventual future updating.



Functions of the sensor touches



SalinoMADD possess four function buttons disposed on the front panel:

◁ Switch on the unit.

↵ Confirm the chosen parameters displayed.

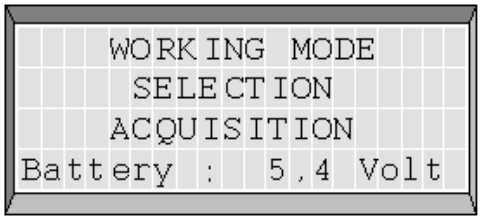
▭ Go to the next option. Increase numerical values step by step at the programming of gauging sites.

▭ Back to the last option. Return to the main menu.

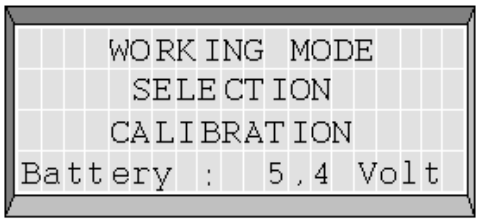
Main menu

Two seconds after the start (see above), the main menu **ACQUISITION** appears automatically. With help of the button , it permits the selection between the 3 functions as illustrated below. The fourth function switches off the device. The button confirms the function selected.

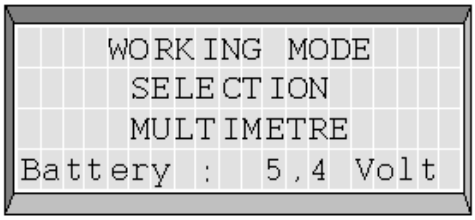
- **ACQUISITION mode:** This mode permits to launch a gauging acquisition and to introduce data for a gauging site.



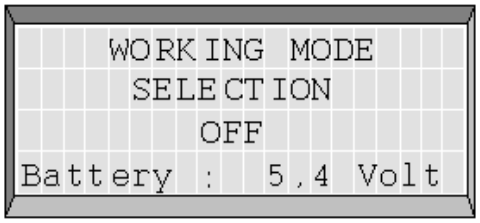
- **CALIBRATION mode:** The calibration of the probe can be done in this mode in order to correct eventual deviations of the salinity measurement.



- **MULTIMETRE mode:** Mode used to do continuous measurements. It displays salinity in milligrams of salt per litre of water, the water temperature in °C as well as the conductivity in µS. per cm.



- **END mode:** This permits to switch off the device.

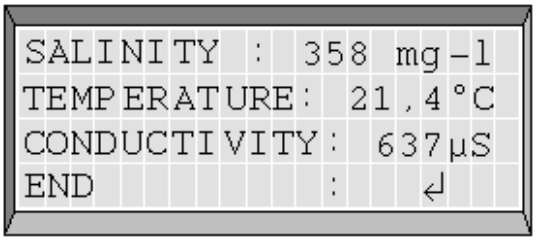


Above illustrations shows that the battery power is always clearly displayed in order to prevent starting operation with nearly empty cells

Working in multimetre mode

The multimetre mode is used for punctual measurements of water quality. The probe must be connected to the **SalinoMADD** before switching it on.

On **MAIN MENU** select **MULTIMETRE** with touch ↻ and press ↵. At this moment the instrument measures continuously salinity, temperature and the conductivity of the water.



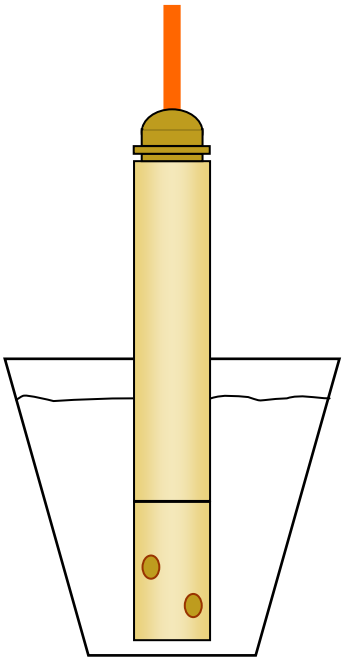
To return to the **MAIN MENU**, press ↵. In this mode, the device will automatically switch off after about 4 minutes.

Calibration of the probe

Cleaning of the probe

Ensure that the probe is clean before starting calibration. Clear the electrodes from calcareous deposits using a specific cleaning agent (Durgol, cleaning vinegar etc.).

In this goal, pour cleaning agent into a recipient up to the level necessary for complete immersion of the probe's glass part which should remain in the cleaning liquid for about 20 minutes. Rinse the probe thoroughly in order to clear off completely the cleaning liquid, let it dry and then place it into previously prepared half-litre of pure water.



Preparation of the calibration

Following preparation is necessary before calibrating the probe for salinity gauging.

1. With the 100 ml calibrated tube prepare 2 doses i.e. 200 ml of demineralized water with a conductivity not exceeding 10 µS (or a resistivity of minimum 100'000 Ω)
2. Pour this water into a cleaned 1 litre plastic measure. For maximum measurement accuracy, it is also possible to weigh the water i.e. 200 g of demineralized water.
3. Immerse the probe in this water and connect it to the **SalinoMADD**, which must be switched off beforehand.

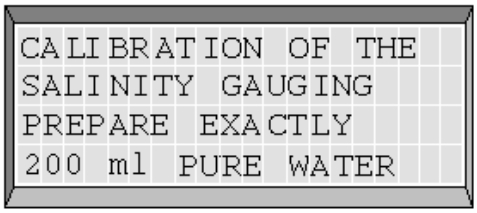
Before starting the calibration, the probe should have the waters temperature, which can be checked by putting the device in **MULTIMETRE** mode. Ensure that the temperature remains stable. Once all parameters meet these conditions, the calibration can be launch. Only few seconds are necessary.

Calibration

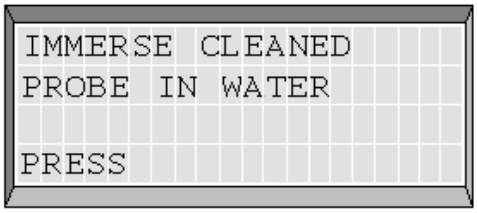
In the **MAIN MENU**, select **CALIBRATION** with touch ↻ and press ↵. The calibration is done in the following 4 points: at 0 mg/l, at 1200 mg/l, at 825 mg/l and at 426 mg/l.

The message displayed here refers to instructions on previous page.

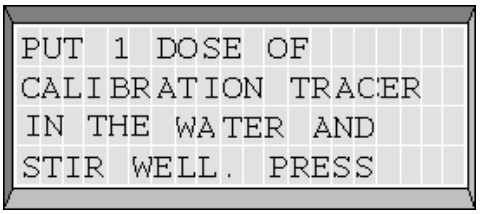
The following display appears about 5 seconds later. If everything has been put into place, press ↵.



The first calibration step is the determination of the zero point. It is obtained using pure water as reference. While **CALIBRATION OFFSET** is on display, 16 measurements are done. The average of these measurements finishes the zero calibration which is saved provisionally



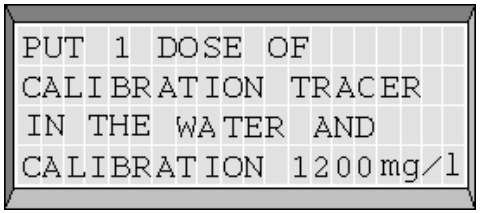
When this display appears, pour 20 ml of calibration liquid into pure water and use probe to stir it well in order to get a homogenous mixture. At this moment the solution contains 1200 mg of salt per liter of water. Press ↵



The second calibration step does 16 measurements as well.

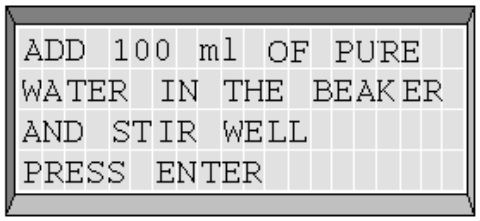
While these are being carried out, **CALIBRATION 1200 mg/l** stays on display.

At the end of the display, the average value of the 16 measurements is saved provisionally.



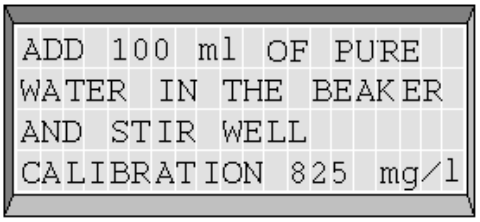
The next step permits to do the third point of the calibration.

Adding 100 ml of pure water into the 0,2 liter solution, the salinity reaches 825 mg per liter.



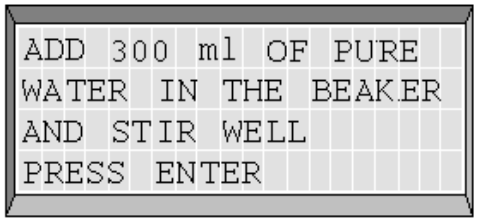
The display indicates the procedure in course showing **CALIBRATION 825 mg/l**.

At the end, the average value of 16 measurements is saved and the **SalinoMADD** continues to the next phase.

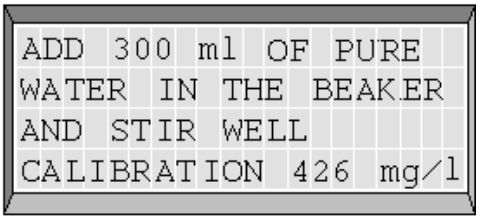


The calibration of the fourth and last point is done by adding 300 ml of pure water into the beaker, that raises the salinity to 425,8 mg per litre.

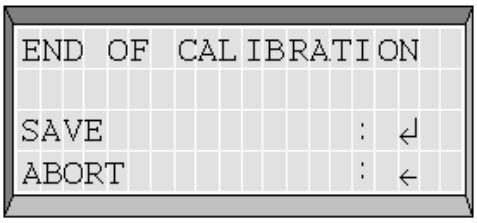
Stir well to ensure homogenous solution and press ↵.



The display taking into account the variations shows now **CALIBRATION 426 mg/l.** Having saved the average value of 16 measurements, the **SalinoMADD** passes to the final phase of calibration.



The **SalinoMADD** will automatically calculate the precise values of the 4 measured calibration points. It will furthermore determine the curve's non-linearity and calculate necessary corrections. All these parameters are saved provisionally and the screen passes on to the following display.



This display specifies the end of the calibration of the salinity. At this moment is still possible to abort the calibration procedure by pressing ↩

If the calibration is ok, confirm by pressing ↵. This will store the calibration data and these will be maintained even during the exchange of batteries.

Either command **SAVE** or **ABORT** will return to **MAIN MENU**.

Preparing doses for calibration

Although your **SalinoMADD** supplier can supply calibration doses, it is useful to be in a position to prepare own doses, particularly when salt other than chloride sodium is chosen.

The necessary material

- A precision scales with 0,1 g graduations, accuracy < 0,1 %.
- A glass measure with volume scales, accuracy < 0,1 %.
- A number of small plastic bottles with a content of at least 20 ml each
- A pipette or syringe 20 cc accurately calibrated
- An adequate quantity of salt for water flow gauging
- 1 liter of demineralised water with a conductivity not exceeding 10 µS/cm or a resistivity of at least 100'000 ohms.

The preparation of doses

- Weigh out precisely 13,2 g of salt and pour it into a glass.
- Add demineralised water to make up 1 liter of solution
- Stir it well in order to obtain a homogenous solution
- Using a pipette, transfer the solution into small plastic bottles by doses of 20 ml

Each dose will contain: *(13,2 g / 1000 ml) * 20 ml = 264 milligrams of salt*, added into 200 ml of pure water, which results: *200+20=220 ml of water containing 264 milligrams of salt.*

Then: *264 mg / 220 ml * 1000 = **1200 milligrams of salt per litre**.*

WARNING

The gauging accuracy depends on the precision of the calibration, which depends on the precision of the preparation of calibration doses described above. A deviation of only 0,1 gram from the required weight of salt results in a gauging error of 0,75 %. A deviation of 10 ml from the required volume of water results in a gauging error of 1 %.

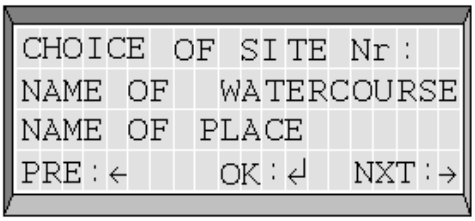
Under certain circumstances and for practical reasons, smaller or bigger doses of calibration liquid may be needed, but the quantity of salt will always have to be proportional to the total quantity of solution, e.g. : 6,6 grams of salt for 0,5 litre solution or 26,4 g of salt into 2 litres solution. Or if you want to use 10 grams of salt, you have to add pure water up to a total of 757,5 ml of solution.

Programming the gauging site

Selection of the site

The **SalinoMADD** may contain up to 15 pre-programmed sites. This programming is usually carried out at home, although it can be done anywhere by means of a laptop.

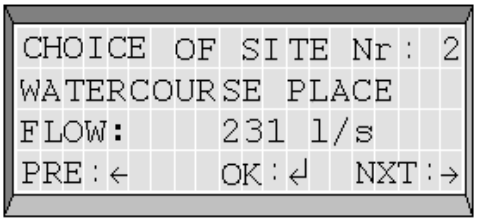
Make sure the **SalinoMADD** is switched off and then connect the probe. Having switched on the unit and selected **ACQUISITION** mode the display shows the name of the first programmed site.



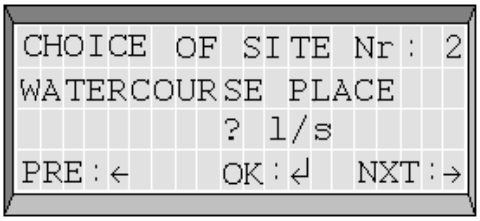
Here are the options you can select:

- Next site
- Previous site
- Accept the displayed site

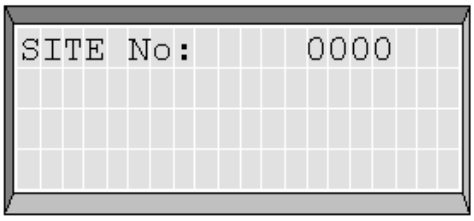
If this site has been already gauged, the result will be displayed here or a ? will appear if gauging was not complete and if no result could be obtained. By choosing a site previously gauged, the measurements data will be replaced upon **Start** by the new gauging data.



If a site has not been pre-programmed, it is always possible to register a site number on site. In this case, having confirmed the gauging site, a site number for further reference can be registered. The numeral chosen with the cursor can be stepped up by pressing touch ↻ and the cursor can be moved to the next numeral pressing ↲.

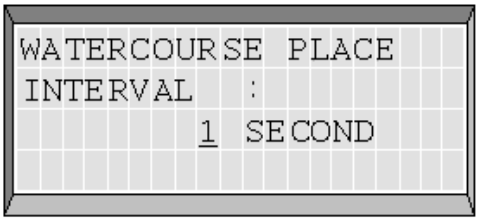


If no site number is desired, just leave the number 0000 (pressing 4x ↲). A registered site number cannot be erased nor altered.



Selecting intervals

After the selection of a gauging site, the display shown at right will appear. You can select the desired interval between measurements by pressing touch ↻.



Choosing the interval between 1, 2, 4, 8, 16, or 32 seconds is directly related with the laps of time the salt cloud needs to completely pass by the gauging site. The total disposable memory for one gauging site being **955 measurements**, the interval may allow data acquisition during ¼ hour, ½ hour, 1 hour, 2 hours, 4 ¼ or 8 ½ hours.

It is important to adapt the interval to the characteristics of the water course:

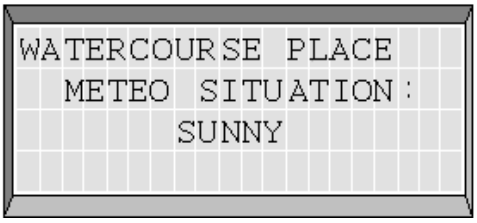
- If the watercourse is rapid and turbulent, the injected tracer will be quickly uniformly mixed and this will permit a fast gauging with an injection of the tracer at a short distance from the gauging area. In this case a shorter interval is chosen.
- If the water flow is high, the distance of the tracer injection point from the gauging area will be long and the time for the tracer cloud to pass by the gauging site will be longer. The interval will have to be longer as well. Experience in gauging with tracers will make the choice of sites and gauging parameters easier.

NB: All operations to select values like the increment of digits, the quittance of option or the confirmation of menus are always done with help of the 3 touches of the front panel and their explanation will therefore no longer be repeated.

Choice of the meteorological situation

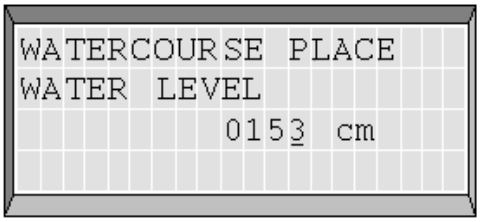
The **SalinoMADD** contains a number of meteorological situations among which you will choose the appropriate setting corresponding to the situation at the time of measurement.

Sunny	Rainy	Snow
Overcast	Rain & hail	Cloudy
Rain & wind	Cold & frost	Stormy
Nice & hot	Strong rain	



Introduction of the water level

Having selected one of above listed meteorological situations, you can enter the water level of the water course to be gauged. The water level measured on site permits to correlate measured water flow with the water level. After a number of measurements at different heights, it will be possible to establish a formula or at least a relationship between measured water level and water flow.



Start by selecting the unit in mm, cm or meters before stepping up numbers up to the desired value by pressing the touch . The first digit chosen, go on to the next one by pressing touch and so on until the desired value is complete.

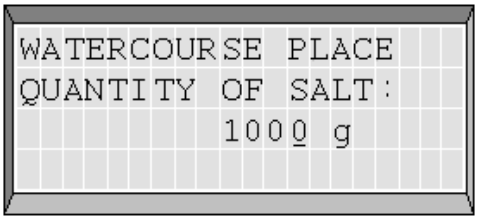
Quantity of injected salt

The next step is the introduction of the salt quantity that will be injected into the water course for the gauging. The recommended quantity of 2 to 12 grams per litre/second of water flow depends on the distance to the injection point necessary for a good mixture. The longer the distance, the bigger the tracer dilution and then the smaller the increase in salinity in the gauging area.

To obtain good results, this instrument requires a salinity increase of 10% or at least 15 milligrams per litre compared with the natural salinity of the water course.

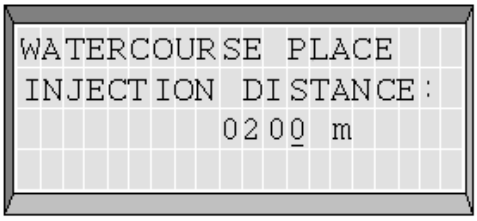
This quantity of injected salt should be known with precision because it is an important factor for the water flow calculation.

The **SalinoMADD** accepts values from 1g to 1000kg.



Distance to point of injection

This distance depends on the nature and the length of the water course the salt cloud has to travel though until it is evenly spread over its entire section. The more the water course is turbulent, the faster mixture and dilution are achieved and the shorter the distance to point of injection, like in a mountain torrent. In case of a canalized water course nearly straight or with reservoirs, the flow will be slower, the distance to point of salt injection will be greater and more salt will be required.



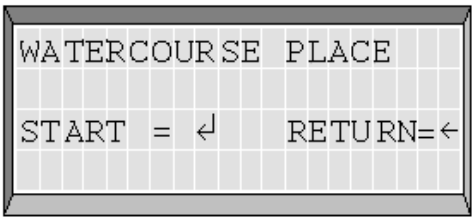
This distance is recorded **for information only** since it does not enter into the water flow calculation.

End of data inputs

All necessary data inputs having been recorded in the **SalinoMADD**, the acquisition can go on.

The data has been safely stored and the unit will restart and return to its initial state within a few seconds.

.



Gauging acquisition on site

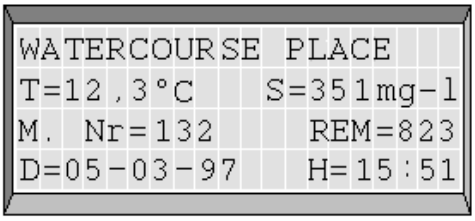
Before starting the acquisition

Before launching the acquisition, select the site and its indications (see above).

Make sure that the probe has reached the water's temperature before starting the data acquisition. The water salinity is directly dependent on the water temperature which is measured to correct the salinity and thus bring it to a standard 20° C. Just use the **MULTIMETRE** mode to control the temperature stability.

Beginning of data acquisition

After the **START** of the acquisition, the **SalinoMADD** begins the measurements according to the programmed interval. At each measurement, salinity and water temperature values are displayed on screen. These measurements are checked to detect the arrival of the salt cloud.

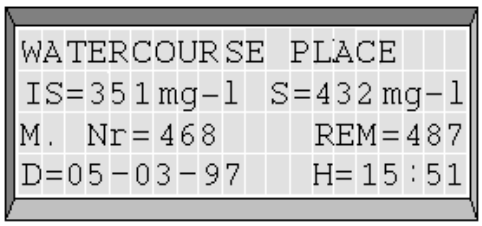


For correct operation, the device should do **at least 100 measurements before the arrival of the salt cloud**.

Then both following situations may appear:

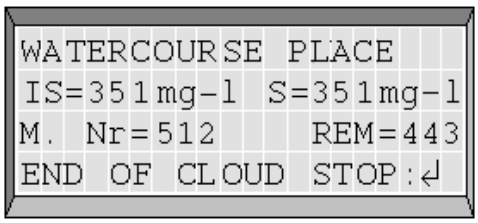
- The first one occurs when the salt cloud arrives between the 100th and the 240th measurement. In this case, the device records the initial salinity before the arrival of the salt cloud. It will also record the memory address of the start. It then continues recording the data.
- The second situation appears when more than 240 measurements having been recorded and that the salt cloud has not arrived yet. In this case, the **SalinoMADD**, in order to prevent wasting memory space, will delete the oldest measurements and record the new ones. As soon as the salt cloud is detected, the memory address of the start and initial salinity are memorized and the data acquisition continues normally.

As soon as the salt cloud has been detected, the display shown here appears. Instead of the now useless temperature indication, the initial salinity **IS** is displayed. At the end of the acquisition procedure, the salinity should have reached again this initial value. The value on the left (**M .Nr = 468**) indicates the number of measurements already recorded while the value on the right (**REM = 487**) shows the number of remaining measurements. Current date and time are shown on the fourth line.



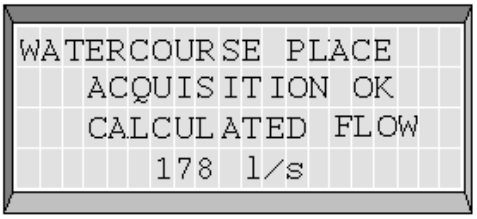
End of data acquisition

During the rest of the procedure, the **SalinoMADD** will try to detect the end of the salt cloud. The operator will follow the evolution as well. When the water salinity come back to its initial value, the display will normally say **END OF CLOUD - STOP**: ↵. The operator will ensure that the salinity has dropped to its initial value. If so he can stop the procedure as indicated on the display. If not, he will await the end of the salt cloud before stopping. The **SalinoMADD** does not switch off automatically unless the memory of the site in question is exhausted. At this moment or when pressing touch ↵, the memory address of the end the cloud, the values of the initial, maximum and final salinity and the exact time at the end of the gauging are recorded in the memory of the site. At the end of the measuring procedure, the results are displayed.

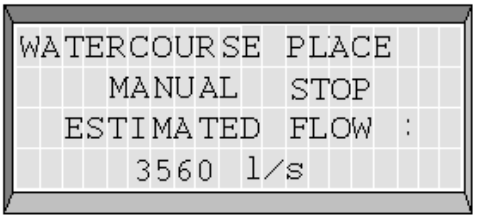


Display of the results

The procedure having run normally, the module having detected the beginning and the end of the salt cloud, it will now, upon pressing touch ↵, display the data as shown here at the right. If at the moment of the display **END OF CLOUD** the measurement of salinity has reached its initial value, we may take it for granted that all the injected salt has passed though the gauging area. We may then graphically check the quality of the salt dilution on the PC with help of the **SALINOMADD** software and eventually correct the points of beginning and end of salt cloud.

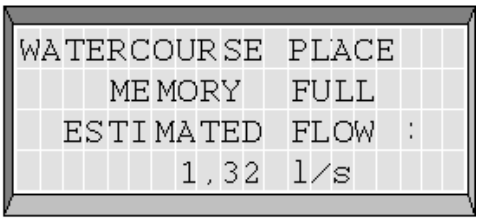


It may happen that the **SalinoMADD** does not detect the end of the cloud and thus the operator should interrupt manually the procedure. In this case the display says **MANUAL STOP, ESTIMATED FLOW**. The estimated value should in fact be correct because the beginning of the cloud had been detected correctly by the module and the end by the operator.



When the memory of a site is full, the device displays **MEMORY EXHAUSTED**. Various raisons can be the cause:

- The length of the salt cloud has exhausted the memory size.
- The **SalinoMADD** has not detected the end of the salt cloud and the operator did not stop it.
- The end of the cloud has detected, but the 100 preliminary measurements had not been recorded.

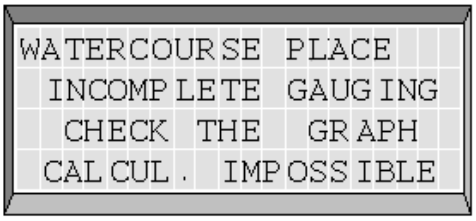


In any case, check the gauging curve in the graph and decide if the gauging is good or not.

End of acquisition due to errors

If the **SalinoMADD** has not been in position to collect a sufficient amount of parameters for the calculation of water flow, it will explain it on the screen.

In this case, it may be necessary to repeat the gauging procedure. The operator, who is equipped with a laptop with **SALINOMADD** software, can check the gauging curve on site and therefore leaves the site with the assurance of perfect gauging results.



Tips for practical use

- Prepare, whenever possible, gauging site programming in advance. It makes the actual data acquisition work much easier.

- Upon arrival at the measurement site, place immediately the probe into the water. It will then reach fast the water temperature.

- Try to position the probe in a place where the water course is not too turbulent. Always avoid the phenomenon of cavitation around the probe. It can perturb the measurements and cause air bubbles between the probe's electrodes.

- Do not connect the probe to the **SalinoMADD** when switched on. If this happens however, the **SalinoMADD** may be blocked and can not be switched on again. It is then necessary to remove the alkaline batteries for a moment and put them back in place again. In this case, recorded data, date and time are lost. The unit is still in working condition but names of sites, localities and operators can always be introduced later at the office.

- Don't forget that the **SalinoMADD** must record at least 100 measurements prior to the arrival of the salt cloud. The time needed for these measurements is proportional to the gauging intervals as shown below:

INTERVAL	RECORDING BEFORE CLOUD ARRIVES
1 second	1 minute 40 seconds
2 seconds	3 minutes 20 seconds
4 seconds	6 minutes 40 seconds
8 seconds	13 minutes 20 seconds
16 seconds	26 minutes 40 seconds
32 seconds	53 minutes 20 seconds

- It is preferable to dilute the salt in water taken from the river to be gauged and then inject the total mixed solution at once into the water course (max. 300 g of salt per litre). Avoid not yet dissolved salt to sink to the bottom of the riverbed.

- The most important point for successful gauging is in fact the good dissolution and mixture of the salt in the water course. Some turbulences caused by a few stones or tiny waterfalls favours the mixing process. In a straight and flat riverbed or a canal placing some stones can help the mix.

- Small side streams of the water course and basins may slow down part of the current which does not favour the mixing process.

- A higher speed of the current is a positive factor for the mixing process and a rapid passage of the salt cloud favours the measuring since the threshold of natural salinity varies very little.

- Gauging in tunnels, straight canals with a current speed of 1 meter/second gives good results even at long distances (e.g. more than 3000 m) from point of salt injection.

Technical characteristics

PARAMETRES	VALUES
Power supply	4 alkaline cells 1.5V, type AAA, AM3, LR6, UM3, MIGNON
Autonomy	Approx. 30 hours in normal conditions
Measuring range of salinity	Salinity : 0 to 2000 mg/l Conductivity : 0 to 3600 µS/cm
Sensitivity of salinity	1 mg/l
Precision of salinity	± 1 % max.
Ratio conductivity/salinity	1.780 µS/mg/l
Measuring range of temperature	0 to 40 °C
Precision of temperature	± 0.2° C
Cable length of the probe	10 metres
Weight of the device with probe	1,570 kg
Total weight of the suitcase	2,700 kg

SALINOMADD SOFTWARE

SOFTWARE POSSIBILITIES

The main purpose of this software is to evaluate the acquired gauging data as graphs on PC or laptop. It presents a clear picture of the acquisition quality.

Functions of the software:

- Preparing, by group of 15, the parameters of the gauging sites.
- Upload into the **SalinoMADD** a group of 15 gauging sites.
- Setting date and time.
- Reading on site data recordings and saving them.
- Visualization of the gauging graph for each site.
- Eventual modification of major parameters of measuring sites.
- Subsequent calculation of water flow in accordance with the part of curve taken into account.
- Saving processed data files.
- Exporting formatted data for use in spreadsheets.
- Printing gauging card with graphs.

PRACTICAL SOFTWARE USE

The **SALINOMADD** software running under Windows® is a very easy to use tool which does not require any special know-how. It includes online help explaining the functions in details and at any time. All commands are clearly defined on the touches for graphic functions - just click on them with the mouse.

INSTALLATION OF THE SALINOMADD SOFTWARE

1. Insert the installation CD in your CD drive.
2. Select the language you wish to use and then follow the on-screen installation instructions.
3. If the launch of the application is not automatic, please launch it manually:
   Click on **Start**, select **Run...**, type **D:\Autorun\AUTO-G.exe** and click **OK**

Warning:

When you transfer the data from **SalinoMADD** to PC, or when you store the site programming from PC to **SalinoMADD** or during time setting, don't switch on SalinoMADD !