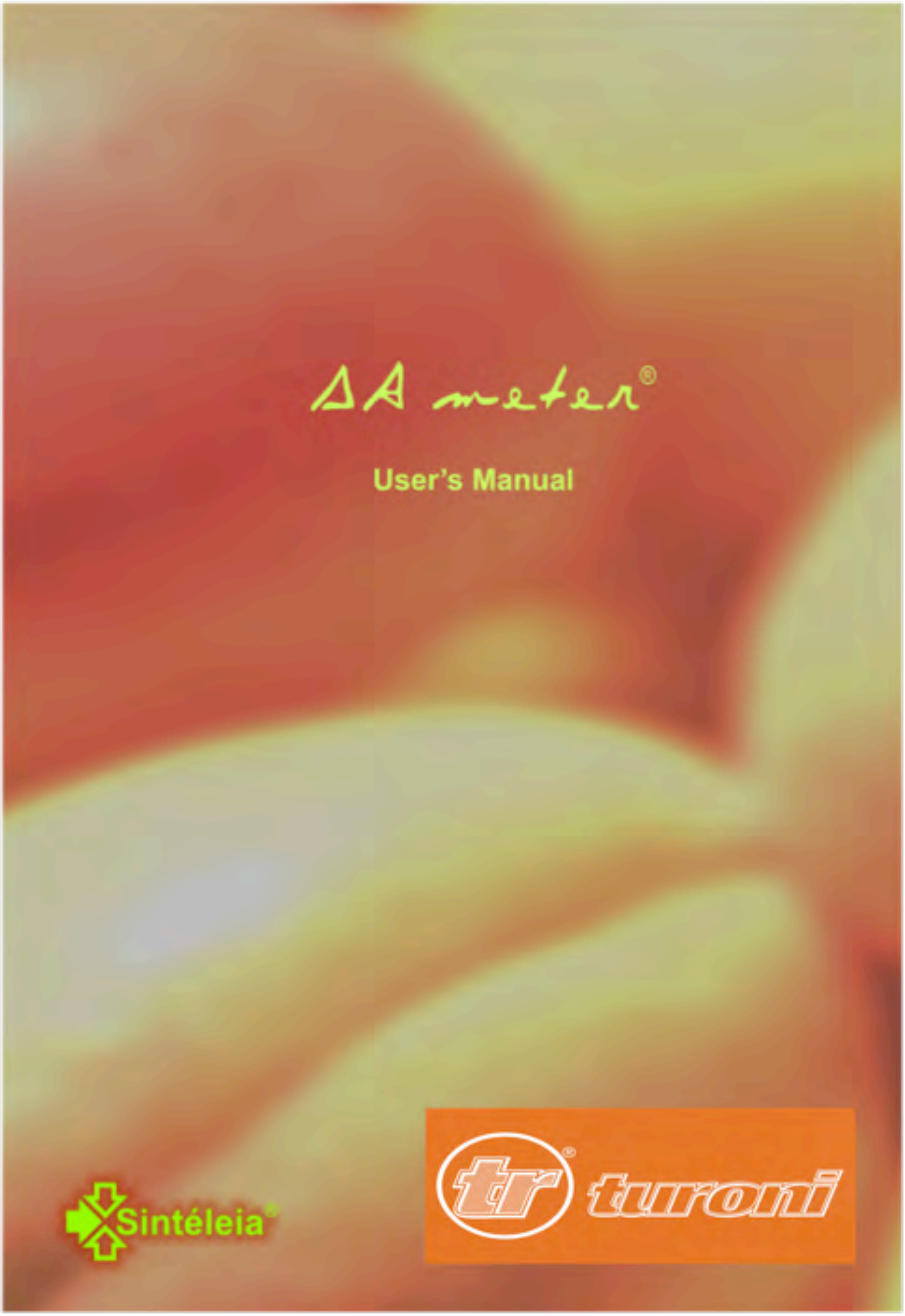

ΔA meter®

User's Manual

Sintéleia®

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Index

INTRODUCTION

The ΔA Meter® is an instrument that, allows to measure the chlorophyll's content in a fruit. The content in chlorophyll in a fruit is a precise index of a fruit's ripening state. Thus, the ΔA-meter allows to know the ripeness state, and the way it works is unrelated to weather, a factor which influences other kind of measurement such as the brix index.

The ΔA Index® , measured with the ΔA Meter®, is useful at many stages in the production and consumption's cycle of fruit. In fact it can be used:

- by the farmer, in order to optimize the trees' pruning, to obtain a very homogeneous product and, as a result, to reduce the number of picking stages;
- by the farmer, during the harvest-time, in order to identify the best moment for the picking and to select samples for the distribution at the staff picking up the fruit;
- at the storekeeper, in order to know the maturation state of the stored fruit and to know, at any time, what is the shelf life that the product is supposed to have;
- at the retailer, in order to buy products at the intended maturation level;
- at the retailer, in order to select the most ripened product to sell.

The ΔA Meter® is also used in the scientific field, to support researches about the activation of the genes that influences the fruit maturation.

Note on reported trademarks in this document:

ΔA Meter® *is an Alma Mater Studiorum - University of Bologna & Sintéleia SrL Registered Trademark;*
ΔA Index® *is an Alma Mater Studiorum - University of Bologna Registered Trademark;*
Sintéleia® *is a Sintéleia SrL Registered Trademark;*
Windows® *is a Microsoft Corporation Registered Trademark;*

1 ΔA Index®

ΔA[1] Index® is an index of the quantity of chlorophyll in a fruit and, as a consequence, of his ripeness state. This index decreases in value during the ripening process of the fruit, until it reaches very low values when the ripening is complete. Each kind of fruit has specifics ΔA Index® values according to the different phases of maturation. These values are unrelated to factors such as weather and temperature. ΔA Index® is in opposition with the saccarometric degree measure and the pulp hardness measure; it provides a different but essential measurement for a correct harvest.

1.1 Outstanding features of the ΔA Index®

The most relevant features of the ΔA Index® are:

1) It is not dependent on the season course. The climatic conditions have indeed an influence on some parameteres, such us the saccharometric index. The average content in sugar is bound to be high, in favourable years, even before the fruit reach the correct ripeness level. On the other hand, bad climatic conditions in specific seasons will prevent fruit to reach an high sugar level even at complete ripeness. As a consequence, the saccharometric index is able to reveal whether a fruit tastes good, while the ΔA Index® allows to know when the fruit, either good or bad tasting, has actually reached the optimal ripeness level. In favourable years, the only consideration of saccharometric indications would anticipate the harvesting too much, having the effect of picking up fruits which is sweet but not as sweet as could be if picked up at the optimal ripeness point. A bad season, at the opposite, the harvesting would be postponed too much, with negative implications in terms of preservability and storability, and without having reached anyway a satisfactory sugar level. By using the ΔA Index® instead, it's possible to always pick up fruit at the optimal ripeness level: when fruits reached the best possible sugar degree before damaging preservability.
2) ΔA Index® varies along with the whole fruit life cycle. Measurable variations are available during the whole life of the fruit, including storage. This allows the ΔA Index® to provide a reliable indicator of fruit ripeness already long time earlier than the moment of picking up, and to continue monitoring the ripeness even after that moment, in the refrigerator and/or at consumption moment. At the opposite, the consistency of the fruit pulp could tend to remain almost unchanged up to consumption moment, while some typologies tend to reach their final colour much earlier than the optimal harvest time, thus not providing a reliable indicator of the ripeness stage of the fruit itself.
3) The measure is neither destructive nor traumatic; it is possible to get measures also directly on the plant by means of a portable instrument which is very practical and simple to use.
4) ΔA Index® measure can be obtained also in a line, thus guaranteeing an optimal distribution of products for storage and for delivery.

1.2 What is the ΔA Index® ?

The ΔA Index® is a ripeness state of fruit that can obtained with a no destructive measurement in any moment of the fruit life cycle.

1.3 What the ΔA Index® is not?

The ΔA Index® is not an index of fruit taste or quality[2]. A perfect ripe fruit could nevertheless be very bad in taste depending on many environmental factors.

1 Read "DA"

2 However, it is obvious that the ΔA Index® at the moment of picking up is expressly connected to fruit perceptible quality. As a matter of fact, with same ΔA Index® at the moment of consumption, a fruit having a low ΔA Index® (ripe fruit) at the harvest is certainly better than a fruit having a high ΔA Index® (sour fruit) at the harvest, because a fruit ripening on the plant is absolutely better than a fruit ripening in storage.

2 The ΔA Meter®

The ΔA Meter® is a portable instrument for the measurement of the ΔA Index® in laboratory and on the field. This equipment combines simplicity of utilization to good quality of taken measures, and enables either to make immediately use of the obtained data or to store them for a future employment. To that extent, it is provided with a SD Card (having a maximum capacity of 2 Gbyte, which is enough to store a quantity of measures absolutely bigger than the real necessities), and with a USB interface which enables linking to a computer immediately.

2.1 Appearance

The equipment looks like a palm instrument, provided with a keyboard and a display on the front of it, and with a sensor on its top.

On the back, the battery case is closed by means of two screws, while on the bottom the USB interface connector and the slot where to insert the SD memory Card are located.

Picture 1: the instrument case

1. Display LCD;
2. Power key
3. Menu key
4. Arrows keys
5. OK key
6. SD memory Card led.

2.2 Maintenance

The instrument is sold with a shockproof bag which protects it from possible knocks.

It's a measure instrument and it's good to take care of it and avoid to expose it to unnecessary solicitations. For this reason, when it is not used, it is suggested to put it back in its bag.

The instrument should not be soiled or wet and, in that case, it has to be cleaned and dried with a soft and dry cloth.

If some liquid penetrate into the instrument, it will occur to remove the battery immediately and to send it to the agent for maintenance.

If corrosive liquids (such as seawater) gets inside the instrument, remove the batteries immediately, rinse with fresh water, making sure that this penetrates and flows inside the unit in order to dilute the possible corrosive agents and send, immersed in fresh water within a sealed container, to the distributor for servicing.

The sensor, situated on the front, must not be put in contact with rotten fruit to avoid to soil it. In that case it can be cleaned softly with some cotton wool.

The rubber strip which serves as lens hood for the sensor, if necessary can be changed with an original replacement. To do this, after it has been removed, it occurs that, before glueing the new one you clean off the glue from the aluminium part of the sensor using a toothpick.

The instrument is provided also with a white reference (a teflon disk), which has $\Delta A=0$. It must be mantained integer and cleaned.

It is possible to wash it with some water and mild soap.

2.2.1 Battery change

The batteries are located on back of the instrument, and are closed by a lid locked by two cross-head screws. To change the battery:

1) Switch off the instrument;
2) Remove the screws and the lid;
3) Remove and change the battery; be careful to place the right polarity to avoid damages;
4) Close the lid with the screws;
5) Switch on the instrument and verify if date and hour are correct. Reset them if necessary;

Use only best quality alkaline batteries. The use of rechargeable battery is not reccommended.

Prefer to use non-rechargeable alkaline ones, wich duration, for a normal use, is more than satisfactory.

Note: Remove the batteries if you don't use the instrument for a long time.

2.3 Operation

2.3.1 Main commands

1) Power On:

   To switch on the instrument push the power key (2) for one second. A beep and some strings appeared on display show you that the instrument is on.

   At this point you can release the switch, and the instrument perform some check and is ready for its use.

   At the end of the startup procedure, the instrument will show a screen similar to that swown on the following figure.

2) Power Off:
   To switch off the instrument press the power key (2) at least for one second. The shut down began. This is the only way to turn off the instrument in secure mode. If this do not happen, a long press (at least 30 second) causes the power down in any case.
3) Menu key:
   Menu key (3) enable to enter in the instrument main menu. It is possible select the menu items with the arrow key (up and down key), To enter into the item press the right key, to leave the item press left key. In the main menu pressing left key you can return at the homr page.
4) Measure:
   Pressing OK (5) key you can take the measurement. Before pressing OK key you must put the sensor in contact with the fruit. Following the correct way to put the sensor.

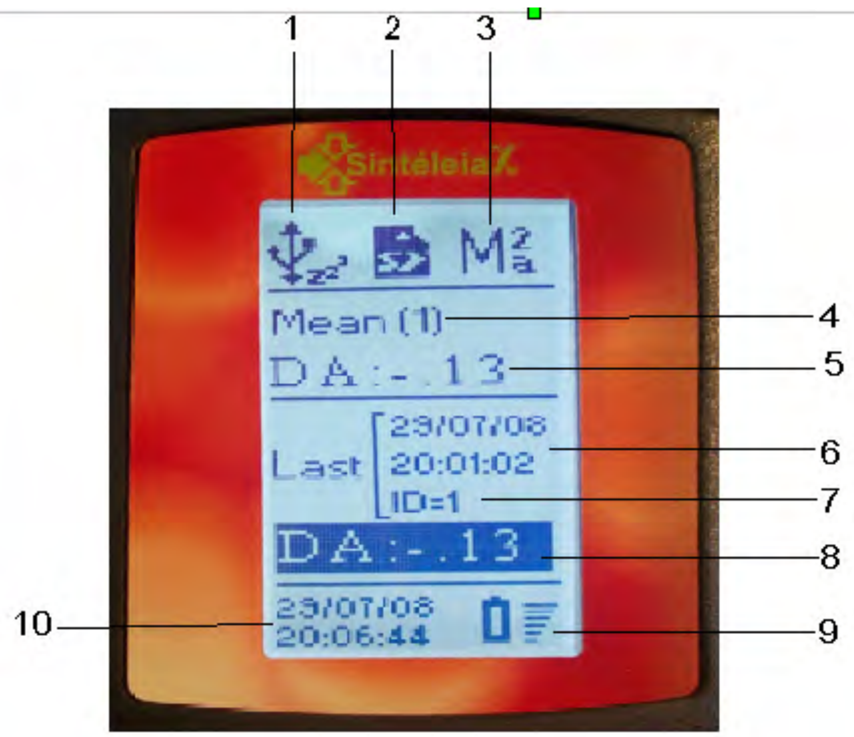
2.3.2 Operating modes

The DA meter can be used in two distinct modes of operation, called "Samples" and "Distribution".

The fundamental difference between the two modes is that in the first case the information relating to the last measurement made is shown on the display, while in the second one the information relating to the current batch of measurements is focused on, allowing the relative statistical information and the subdivision into pre-programmed classes of DA to be displayed graphically. The latter mode of operation makes it much easier to work when evaluating the ripening characteristics and homogeneity of batches of fruit.

2.3.3 Display

2.3.3.1 "Samples" mode



1 – Indicator of USB state.
2 – Indicator of data storage activity on SD Card.
3 – Indicator of the number of sample data used to calculate the average (Pair, Last-2, Last-n).
4 – Number of sample data presently building the average value.
5 – Average value
6 – Date and time of the last data acquisition (record)
7 – Counter of data acquisitions (total number of records)
8 – Value recorded in the last data acquisition
9 – Battery level indicator
10 – Current date and time

The LCD display, during the normal operations in "samples" mode, is shown like in following figure:

The display shows four areas.

The first area at the bottom shows time and date (10), battery state (9).

The second shows the last ΔA Index® value measured (8), with date and time(6) and the measurements index (7).

In the third area, you are the average value (5) of the last *n* data acquisition(4) is proposed.

When, in the configuration menu (see) the value "Mean" is set to *n*, the average value is calculated on all the available values stored since when the last *clear* operation have been performed (main menu, mean clr). If the Mean value is 2, the average is calculated with the two last measurement value (i.e., *n* is equal to 2). This setting is useful when the operator takes two measure for each fruit, and this is the most frequently adopted procedure. The previous configuration, on the other hand, is useful when a significant number of fruit has to be sampled in a stock.

The fourth area shows three symbols: the first shows that the USB connection is on, the second the SD card state, and the third average type selected (2 or plus).

The icons are explained in the following figure:

USB interface not enabled

USB interface enabled

SD Card configured and SD Card writing enabled

SD Card configured but SD Card writing not enabled

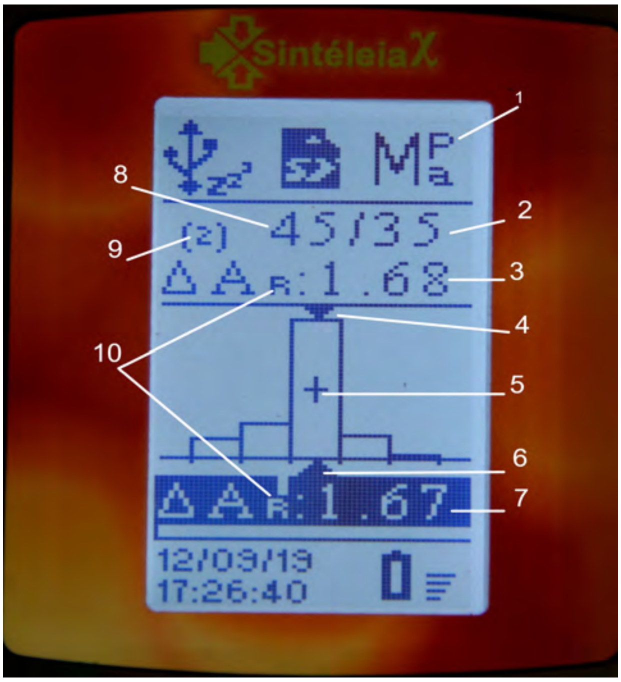
SD Card not configured or not inserted

Average value calculated out of 2 records

Average value calculated out of n records

2.3.3.2 "Distribution" mode

The display, during normal operation in distribution mode, appears, once there is a number of samples greater than or equal to the minimum necessary to obtain statistically significant data, as follows:



1. Type of media set
2. Minimum number of samples to have significant data;
3. numerical value of the last calculated mean;
4. Class of the last calculated mean
5. class of belonging of the average of the lot
6. class of the last measurement carried out
7. numerical value of the last measurement made
8. number of samples in the lot;
9. number of samples in the average calculation, only displayed if the average calculation mode is set to 2 or P.
10. Displayed color, only displayed in instruments with more than one color implemented.

Note: The histogram, if the number of measurements made is less than the minimum, is not displayed.

At this point, it is necessary to clarify the difference between the last calculated average and the batch average.

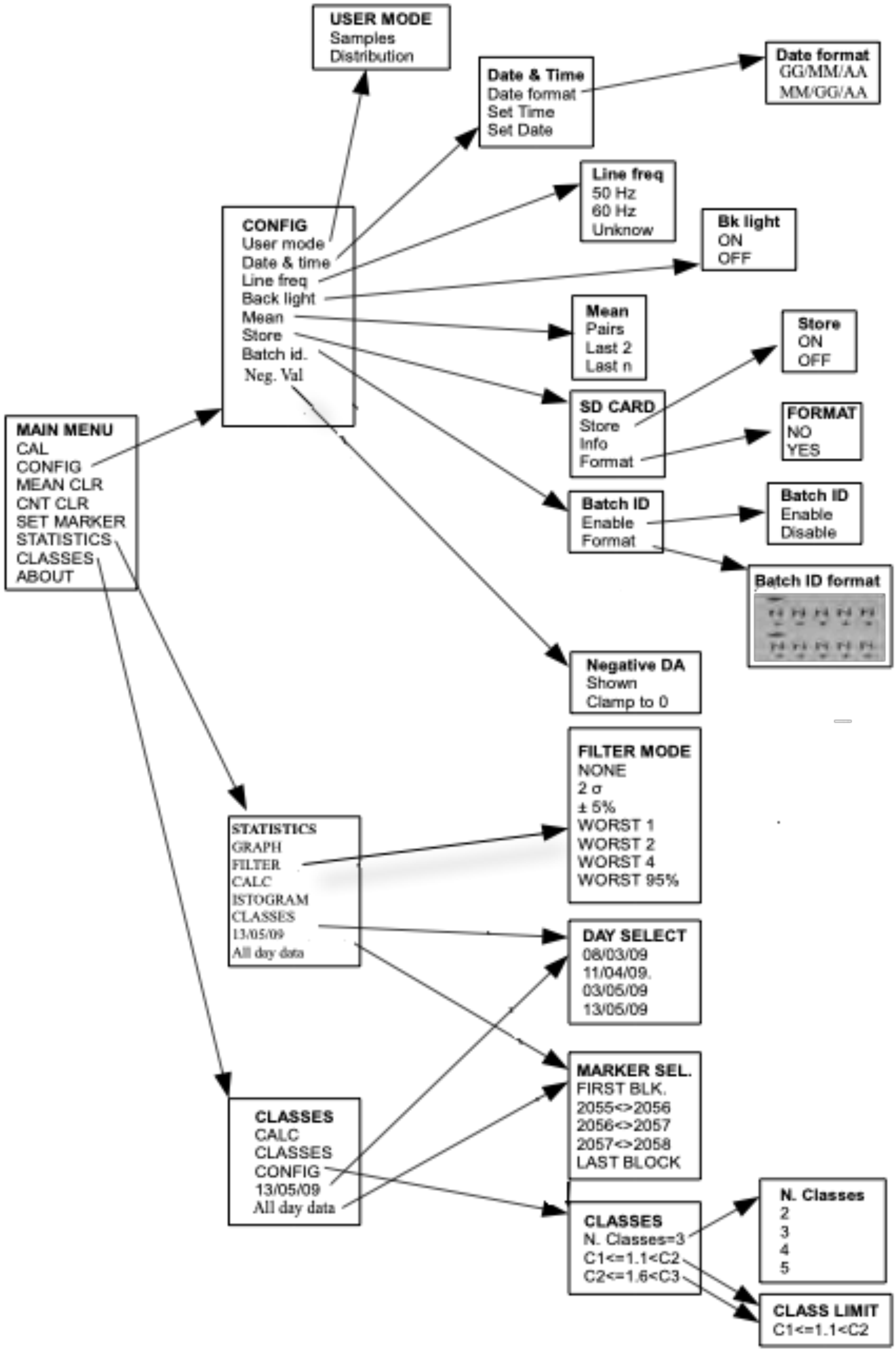
The first refers, in the case of averages set to 2 or P1[3], to the average of 2 samples and, in the case of averages set to N, to the average of the last N samples, i.e., the average of all the samples measured since the last zeroing of the average, which can be performed from the menu with the sequence **Menu→Mean clr** or by pressing the → key when the histogram is displayed in

3 See Chapter 3, on the different ways of calculating from the media.

distribution mode. The second, on the other hand, refers to the average of the samples of the current batch. Considering that in the Distribution mode the average will typically be set to 2 or P, we can say that the value indicated by the arrow 6 and the number 7 will be the one relating to the last sampling carried out and that it will only have a control utility, if there is any doubt that the measurement has been carried out incorrectly; the value indicated by arrow 4 and number 3 will be the one relating to the last fruit measured; the value indicated by the cross 5 will be relative to the average of the samples carried out and will be the only one, together with the numerical values that can be read by selecting the item **Menu→Classes→Calc** in the menu of the instrument, to have a significant statistical significance.

The displayed colour, which can also be present in the samples mode, appears (together with the possibility of selecting it in the configuration menu) only in devices that, like the kiwi meter, have the possibility of working on different wavelengths.

2.3.4 Menu



MAIN MENU
CAL
CONFIG
MEAN CLR
CNT CLR
SET MARKER
STATISTICS
CLASSES
ABOUT
USER MODE
Samples
Distribution
CONFIG
User mode
Date & time
Line freq
Back light
Mean
Store
Batch id.
Neg. Val
Date & Time
Date format
Set Time
Set Date
Date format
GG/MM/AA
MM/GG/AA
Line freq
50 Hz
60 Hz
Unknow
Bk light
ON
OFF
Mean
Pairs
Last 2
Last n
Store
ON
OFF
SD CARD
Store
Info
Format
FORMAT
NO
YES
Batch ID
Enable
Format
Batch ID
Enable
Disable
Batch ID format
Negative DA
Shown
Clamp to 0
FILTER MODE
NONE
2 σ
± 5%
WORST 1
WORST 2
WORST 4
WORST 95%
STATISTICS
GRAPH
FILTER
CALC
ISTOGRAM
CLASSES
13/05/09
All day data
DAY SELECT
08/03/09
11/04/09.
03/05/09
13/05/09
MARKER SEL.
FIRST BLK.
2055<>2056
2056<>2057
2057<>2058
LAST BLOCK
CLASSES
CALC
CLASSES
CONFIG
13/05/09
All day data
CLASSES
N. Classes=3
C1<=1.1<C2
C2<=1.6<C3
N. Classes
2
3
4
5
CLASS LIMIT
C1<=1.1<C2

Main menu:

1) **CAL** activates the calibration, that will explained later on;
2) **CONFIG** enables to enter into Config menu;
3) **MEAN CLR** clears the average ΔA data story, that will explained later on;
4) **CNT CLR** is to set at zero the counter of the samples. This counter is useful when the measurement should be associated to one specific fruit. (like in case of laboratory misuration)
5) **SET MARKER** sets a special record, called marker, in to the data story. This record can be used, for example, to mark start and end of a set of measurements of a particular type of fruit. The marker have a progressive number that is shown at the moment of the writing. Attention: the marker can be written only if the logging function is active. In other case the value of the marker won't be increased.
   It's also possible to associate to each marker a "Batch_ID", e.g. a code of 8 configurable characters to be used to manage the harvesting batches, see its operation at following Functoning Settings paragraph.
6) **STATISTICS** enables to enter into the statistic functions menu;
7) The **CLASSES** item allows access to the menu of the processing functions of the class division.
8) **ABOUT** enables to know some information of the instrument. Pushing ABOUT, you can see above information with more screens, that are listed by pushing every key, but key 2.
   For space reasons, the above screens are vertically arranged.

2.3.5 Functioning setting ("CONFIG" menu)

The instrument has many functioning setting, that is accessible by using the configuration menu. These functions enable the instrument functioning to change according to the different way of use.

2.3.5.1 Setting the instrument operating mode ("USER MODE")

There are two different ways of using the instrument, one with which the individual measurements made together with the batch average are displayed and the other with which, once a batch of at least 35 samples has been acquired, a number below which the information is not statistically significant, in addition to the value of the individual measurements made, the division into programmed classes is displayed in the form of a histogram. This second way is useful to have an immediate check of the degree of ripeness of a lot of fruits and their homogeneity.

Translated with www.DeepL.com/Translator

2.3.5.2 Time and data setting ("Date & Time")

It is possible to achieve the date screen with the following sequence: Menu → Config → Date & Time → Set Date, and moving with the arrows key's positioning on the field to modify. Change the value with the arrows key's (up/down). At the and press the OK key to confirm the values selected.

Likewise, it is possible to achieve the time screen with the following sequence: Menu → Config → Date & Time → Set Time, and moving with the arrows key's positioning on the field to modify.

The item Date Format allows to select the date format: day-month-year or month-day-year, according to the choice.

2.3.5.3 Line frequency setting ("Line freq")

The light ripple is electronically filtered, in order to minimize its influence on the executed measures. This operation is important mainly when the instrument is used in an environment with artificial light, specially with fluorescence lights, because the light ripple is imperceptible to the eyes, but not to the sensor and can affect the measurement precision. The filtering is excellent when the line frequency (usually 50 or 60 Hz) is set on the instrument. It is possible to achieve the date screen with the following sequence: Menu → Config. → Line Freq. Now it is possible to choose between 50 Hz, 60 Hz and Unknown.

WARNING: Selecting Unknow will increase the sampling time, since it will have to be a multiple of both 1/50 of a second and 1/60 of a second, and this will affect battery consumption. Therefore it is preferable to avoid choosing the latter option.

2.3.5.4 Back light option setting ("Back light")

It's possible to achieve the Back light display screen with the following sequence: Menu → Config. → Back Light. By selecting OFF the backlight is not used. By selecting ON the backlight is turned on for some seconds after pressing any key, improving the display reading but also increasing battery consumption.

2.3.5.5 Average calculation setting ("Mean")

On the instrument display, the average value of the last 2 values measured, or of the last n values measured, is shown. It is possible to achieve the average screen by using the following sequence: Menu → Config. → Mean.

The first case ("Pairs") shows the average of the last 2 values measured as a "pair". This is useful when 2 samples of each fruit are measured.

Refer to chapter 6 "Addendum Firmware v.0.21" for a complete description of this mean operations mode.

The second case ("Last 2") shows the average of the last 2 values measured. This is also useful when 2 samples of each fruit are measured. Of course, after the first measure, the average value will not be important, because it will be the average calculation of the fruit first measure with the last measure of the previous fruit.

The third case ("Last n") is useful when a whole stock has to be measured. The Mean shows the mean of the last n. values measured since the average has been cleared with the following sequence: Menu → Mean Clr. Of course the value is not related to the single fruit, but to the whole stock.

2.3.5.6 Logging option setting ("Store")

The instrument has a micro SD card (usually with 2 Gbyte capacity) that is used to store the data logging. By the FORMAT menu, with the following sequence: Menu → Config → Store → Format an SD card can be formatted (the format is FAT32, without using long file names). The operation cancels any file on the SD card, therefore a confirmation is requested.

The sequence: Menu → Config → Store → Info indicates the remaining space on the SD card.

The sequence: Menu → Config → Store → Store enables or disables the information saving process on the SD card.

We suggest you not to enable the saving process when it is not necessary, in order to increase the battery duration.

2.3.5.7 Batch identifier code setting ("Batch ID")

The "Batch ID" feature (available starting from firmware version 0.27) is a 10-character code the user can set to identify a specific marker setting operation, for example to identify an apple batch incoming into the storage room, or, for example, to identify the records acquired on a particular grower's field.

It is possible to set the Batch ID code format from 1 to 8 characters, each character can be set in various modes (numeric, alphabetic, alphanumeric, empty, or hypen), the feature can be enabled by

following the procedure: "Main Menu > CONFIG > Batch id. > Enable".
Before to use the "Batch ID" feature, the user have to set the desired Batch ID pattern by setting the character type for each character.
To enter the pattern's character settings the user have to enter in the format screen following the procedure: "Main Menu > CONFIG > Batch id. > Format"

Here he can finally set each character, as described below:

N	Numeric character (normal)
N+	Numeric character (auto-increment)
A	Alphabetic character (normal)
A+	Alphabetic character (auto-increment)
M	Alphanumeric character (normal)
M+	Alphanumeric character (auto-increment)
"-"	Hypen separator (fixed)
" "	Blank character (fixed)

Each time the user set a Marker with the "Batch ID" feature enabled, the instrument will set a row into the data story and answer the ID code indicating the marker number on the LCD display, followed by a proposed Batch ID, composed using the selected pattern.
For characters "-" and " " the instrument will propose a fixed hypen or blank character;
For "normal" characters the instrument will propose a selectable char identical to the one setted into the previous ID;
For "auto-increment" characters the instrument will propose a selectable char identical to the one setted into the previous ID, but incremented of 1 step.
The setting of different character type can be made using Up and Down keys and the confirmation of the desired pattern will be set using the “V” (ok) key.

For example, if the user have to acquire a batch of apple DA readings at apple field #32, owned by grower "Bob Smith", and he would like to record both grower name and field number, he can set the Batch ID as below:

| A | A | N | N | -|N+|N+|N+|

and then mark each batch as following:

1st batch: "BS32-000"
2nd batch "BS32-001"
...
45th batch: "BS32-045"
and so on

this string will be inserted into the data file at the row corresponding to the marking command, and will identify the samples following that marker.

2.3.5.8 Setting Class Boundaries (CLASSES)

This item allows you to access the CLASSES menu where both the number of classes and the transition thresholds between one class and the next are displayed and can be set.

Selecting the first menu item (N. Classes=x) where x represents the number of classes currently selected, you enter a menu that allows you to choose a value between 2 and 5. By selecting one of the following menu items (which are as many as the number of classes -1) you can set the transition threshold between one class and the next.

RULES: The values of the thresholds must be different and ordered.

This means that, if a value greater than that of the next threshold is inserted for a threshold, the latter (and any subsequent ones) would be modified accordingly and, on the contrary, if a value smaller than the previous one (and any further previous ones) would be inserted, it would be decreased until the above rule is complied with.

2.3.5.9 Setting the wavelength used for the display (Shown color)

If you have a device that uses different wavelengths in the measurement, such as a Kiwi Meter, you can choose which of the measurements to display. The instrument records both measurements if SD CARD storage is enabled, but the matching tests of the measured data and the visualization are carried out only on the selected one.

2.3.5.10 Enabling negative value display (Neg. Val)

Although it makes no sense for DA measurements, when experimenting with particular varieties and different wavelengths it may also be useful to view the negative results of the calculations. These are normally locked to 0 to avoid having negative numbers on the display that can give rise to misunderstandings and it is recommended to enable it only if you are fully aware of what you are doing.

2.3.6 Statistics functions ("STATISTICS" menu)

The Statistics menu, accessible through the main menu, allows you to choose a block of data from those on the SD Card of the device using the last two items of the menu, the penultimate to choose the day on which the data was collected, and the last to choose the block within the day. The block selection can be done according to the progressive block marker if you have disabled the batch id management function through the sequence Main Menu → CONFIG → Batch id. →Enable→Disable, or through the batch id itself if the function is enabled. The other menu items allow, respectively, to display the collected data in graphic form (Graph), in histogram form (histogram) or in statistical indicator form (calc) as indicated in the following chapters.

2.3.7 Class management ("CLASSES" menu)

The Classes menu allows you to manage the data collected not in the form of a pure histogram but represented by arbitrary classes, chosen in such a way as to give them not a numerical meaning but rather a logical meaning.

We can, for example, decide to set the classes according to a possible fate of the fruit as follows:

Number of classes=5;
Excessively mature (DA < of a certain value);
Ready for immediate consumption (DA > of the previous value but less than another value);
Suitable for storage (DA > of the previous value but less than another value);
Suitable for storage (DA > of the previous value but less than another value);
too unripe (DA > of the previous value but less than another value).

Once the classes have been set correctly, working on a significant sample of fruits, we will have a graphic or numerical indication of the frequencies in the individual classes, an indication that, in the case of example, will tell us:
1) if the fruit is more or less homogeneous;
2) the class of the sample.

It is important to know the homogeneity of the sample because uneven fruit becomes difficult to manage logistically while homogeneous fruit, as long as it is sufficiently ripe to have passed the climateric threshold, always has an ideal destination.

The Config item allows you to access the Classes menu (also accessible through the Main Menu → CONFIG → Classes sequence) already described in the paragraph "Setting class boundaries". The last two menu items are similar to those already described in the paragraph "Statistical functions", the item "CALC" allows you to display the frequencies in numerical form, while the item "CLASSES" displays them in graphic form.

2.3.8 Instrument Calibration

To work properly, the instrument has to be calibrated through a reference white. Values for calibration are considered valid for a day maximum, even if it is advisable to repeat the calibration process during the day especially in case of strong temperature changes, which could have an influence on the sensor reactivity.

The calibration is performed by selecting CAL in the main menu, keeping the reference white (supplied together with the instrument) in touch with the sensor and at its centre, and then pressing the confirmation key (5). The calibration process needs around half a second to complete and a continuous beep will be heard; at the end the display will show either OK if the process has been correctly performed, or an error message. If the calibration completed correctly, OK will be displayed and after a few seconds, the instruments will display the menu again. In the event of a calibration failure, it has to be repeated. **During the calibration process the reference white must not move.** A failure could happen because of a bad contact between the sensor and the reference white or of an excess in environmental light. When the calibration process is repeated, be careful to keep the centre of reference white aligned with the centre of the sensor and, when operating open air of in presence of strong light sources, to avoid the direct contact of light keeping the equipment in the shadow of your own body.

<u>Attention</u>: During the calibration process, the instrument can occasionally measure right levels of light sources. It is an absolutely regular event, due to the performance changes that the electronic components and mainly the condensers can have in the long run. When the above happens, the calibration process lasts many seconds and it is pointed out by a prolonged sound. **During that time, the reference white must not be moved.**

Calibration should be performed at least every 24 hours, even if it is good practice:

1. repeat it when the temperature conditions change;
2. do not calibrate when measuring a lot of fruit, but only before or after.

Always keep in mind that the accuracy of the instrument is subject to a perfect calibration of the same.

2.3.9 How to take a measure

To measure it is necessary to put the sensor in touch with the fruit and press the "V" (OK) key (5). In order to obtain results which could be repeated and reliable, it is advisable to measure both the sides of the fruit in their central area, as shown in picture.

Normally, values for the two sides differ, even appreciably; for this reason the two measures are usually taken in order to use their mean value.

If the fruit is characterised by two distinguishable faces, as in the case of the peach in the picture, the correct position is that at the centre of each side, as shown in the next picture. In the case of fruit with a regular shape, not presenting two characterised sides, it is necessary to choose two opposite points.

However, the correct measurement position depends on the fruit type and it has to be decided during the moment of picking up of that specific fruit, together with the reference values.

After having recorded data on the SD Card, they will be available as a series of measure in a file. It could be uneasy to connect such measures with the sample fruits, when it is necessary. To avoid such a problem, to each measure a sample id number is associated, and it is displayed. Such number is recorded together with the measured value, and it is thus possible to connect it with the sample fruits (for example, by marking it on the fruit itself). This will allow to know the fruits to which recorded measures refer, once data are downloaded from the SD Card. By means of the menu item CNT CLR in the main menu it is possible to reset the sample id number. In the same way, when measures are taken on fruits out o f a stock, it is necessary to identify measures related to each specific stock. This is possible through the introduction of markers (menu item SET MARKER in the main menu). Markers appear as specific record inside the data seires stored in the SD Card. Markers are progressively numbered and it's possible to associate them to stocks using a “Batch_ID” properly formatted.

The instrument measures by subtracting ambient light from the light measured, but even so, especially for very transparent fruits, excessive solar radiation can affect the value of the measurement made. It is therefore advisable, if you operate in the open field, to shield the fruit you are measuring keeping it in the shade of your body and using the appropriate accessory.

2.3.10 Explanation of results

Measures obtained by the ΔA Meter® are normally between 0 (corresponding to the maximum level of measurable ripening) and 5 (corresponding to a completely sour fruit). Each variety of fruit shows different ΔA reference indices. Reference values are already available on the producer website for a number of variety, many others will be available soon.

Some key points have to be kept in mind:

1) **Instrumental measures alone are not suitable to completely substitute experience; common sense and experience are necessary to a correct interpretation of obtained results.** The possibility of a measurement error has to be taken into account when obtained data differ very much from what is reasonably expectable. In such cases, verify carefully the instrument calibration[4] and the procedure;

2) To measure a single fruit is not correct when the situation of an entire stock has to be monitored. A certain number of samples has to be measured. The number of necessary samples to have a precise average measure depends on the uniformity of the samples themselves. In case all parameters affecting the ripening process (irrigation, pruning, sun exposure, and so on) are homogeneously distributed on all fruits, a few samples are sufficient. Otherwise, it is necessary to perform an higher number of measures and the harvest strategy could be affected as well (e.g. programming several picking up stages).

3) In case of measuring stocks, the use of statistical methods is suggested to determine the reliability of performed measures. Once a reasonable interval of measure values is identified, it could be useful not to take into account the values external to the interval. As a matter of fact above values could be produced by exterior events (measurement errors or fruits

4 When analyzing data regarding measures repeated on the same fruit samples on a certain time interval, it is important to consider that a measure time course different from a foreseen course is often due to a wrong calibration procedure. <u>It is necessary to always verify the calibration by measuring the reference white, in order to obtain repeatable results. Values different from 0 indicate a wrong calibration process.</u>

developed in anomalous conditions); therefore they cannot be considered. Of course, the number of fruit samples having values external to the interval, must be lower than the fruit samples inside the interval. On the contrary, we could not exclude them and we will have to conclude that the stock is not homogeneous.

2.4 Historical data

All data acquired by the ΔA Meter® , as well as significant events such as calibrations and markers, can be stored in historical files on a microSD memory within the device. This data can then be extracted and processed later.

The specific **ItsRipe** software, which can download data from the device, manipulate and display it in various forms, as well as export it in a spreadsheet compatible format, is available at www.dameter.com and can be freely downloaded upon registration.

2.4.1 SD Card

The data are stored on a micro-SD memory, which is supplied with the device. This memory can only be switched on or off when the device is switched off. This operation should never be necessary, as the data on the SD card are still accessible via USB, and should only be carried out by qualified personnel. The storage uses the FAT32 file system and, consequently, the SD card, if removed, can be read by most personal computers.

The formatting of the SD Card must necessarily be carried out on the target device as the label is customized with the serial number of the device itself, so as to avoid that, by mistake, the data of more than one device can be confused. The format of the label is: SN-XXXXXXXXXX where XXXXXXXX represents the serial number of the device.

2.4.2 PCs connection

Connecting the device to a personal computer closes all the files that may be opened and the SD card becomes visible through the USB port just as if it were an external disk. If the connection is made with the device switched off, it is automatically switched on and off once the USB connection is disconnected.

2.4.3 Files

Data is stored in text files, one for each working day. The title of each file has the format: DDMGMYYYY.TXT where DD represents the day, MM the month and AA the year.

On the SD CARD can be present other files necessary for the correct functioning of the device, but they are not files that have a specific utility for the operator.

2.4.4 Data format

The data is stored in rows, each of which refers to a specific event. The rows have the following format:

LLL; LBL; DD/MM/YY; HH/MM/SS; DATA; <CR><LF>

where LLL indicates the length of the line in bytes, including the final characters <CR><LF>;
LBL is a 3-letter label indicating the type of event;
DD/MM/YY indicates the day on which the event occurred;
HH/MM/SS indicate the time when the event occurred;
DATA are all the data related to the event, always in ASCII form.

The parsing of the structured data is very simple, the reading of the first 8 bytes, in fact, will allow both to establish if the line is of our interest or not and to know how many bytes we will have to skip to read the next one. Even assuming you have more types of events in future versions of the device, the parsing method does not need to be modified.

2.4.5 Stored data

I dati memorizzati in un file iniziano sempre con una serie di linee dedicate all'apparecchio che li ha rilevati e che, in particolare, riportano:

```
040; MAT; 26/08/19; 16:50:29; 19347777  ← numero di matricola dell'apparecchio;
037; HWV; 26/08/19; 16:50:29; 00004     ← versione HW;
037; HWR; 26/08/19; 16:50:29; 00003     ← revisione HW;
037; SWV; 26/08/19; 16:50:29; 00003     ← versione SW;
037; SWR; 26/08/19; 16:50:29; 00002     ← revisione SW;
037; FLT; 26/08/19; 16:50:29; 1.179     ← valore di compensazione del filtro;
```

Tutti i dati successivi possono essere legati alla calibrazione dell'apparecchio:

```
030; CAL; 26/08/19; 16:50:42
064; CLI; 26/08/19; 16:50:42; 00254; 02254042; 00996; 03935953
                                          064;  CLR;  26/08/19;  16:50:42;  00254;
                                       02722054; 00996; 05309556
064; CLG; 26/08/19; 16:50:42; 00209; 00882281; 00996; 01757518
```

All'inserimento di markers o di batch id:

```
037; MRK; 26/08/19; 16:52:59; 00003          ← Marker;
042; BID; 26/08/19; 16:53:41; ABBA1234XX     ← Batch id;
```

O all'effettuazione di misure. In quest'ultimo caso é importante notare che i dati significativi per l'utilizzatore sono, a seconda di come si é impostato il tipo di media dell'apparecchio, il DA medio di una coppia di misure o il DA della singola misura, come nell'esempio seguente:

```
043; IRD; 26/08/19; 16:53:49; H; 02651144
043; RED; 26/08/19; 16:53:49; H; 00109884
040; BKG; 26/08/19; 16:53:52; 00163894
```

Nel caso M=Mn:

```
044; DAr; GG/MM/AA; HH/MM/SS; 00001; 1.824    ← Numero della misura e valore (rosso)
044; DAg; GG/MM/AA; HH/MM/SS; 00001; 1.078    ← Numero della misura e valore (verde)
```

Nel caso M=Mp o M=M2:

```
044; M2r; 26/08/19; 16:53:52; 00001; 1.824    ← Numero della coppia e valore (rosso)
044; M2g; 26/08/19; 16:53:52; 00001; 1.078    ← Numero della coppia e valore (verde)
```

Va notato che tutti i campi dei quali non é stata data la descrizione possono cambiare, a seconda della versione dell'apparecchio, e non hanno utilità per chi effettua le misure ma possono essere significativi, in caso di malfunzionamento, per una prima diagnostica dell'apparecchio.

2.5 Statistical calculation function

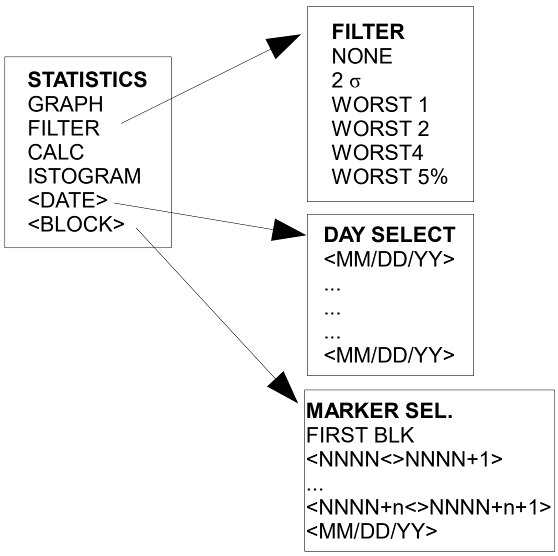
The ΔA Meter® data are precise and repeatable, but they are connected to measures regarding just one object, the fruit, that is highly changeable. This is the reason why it is important to use the statistical calculation methodology, when working on stock. The more complex statistical calculations can be carried out on an external equipment, but the ΔA Meter® enables you to elaborate the data on the same instrument, in order to elaborate your data on the spot.

Data are worked out and, of course, stored on the SD card of the instrument.

It is possible to achieve the statistical function with the key “Statistics” of the main menu, or pressing the down arrow key’s during the functioning.

2.5.1 Statistical calculation menu

Inside the statistical calculation menu (it looks like the following figure), you can find different options that we will explain later. These options enable to select data and to show statistical information in text and graphic mode.



With the last two menu options, you can choose the day and data block . The day selection enables to select the date when data have been collected. As general lines, the last day of data collection is proposed. Arrows key’s (up and down), enable to choose the list of the days when data have been collected and stored. Once the day has been selected (if marker have been set), the data block can be selected. The relevant sub-menu is only available if there is one marker of the selected day.

Once data have been selected, they can be shown in graphic mode with the menu GRAPH. Possible anomalous data will be pointed out. With this mode the selected data will be shown together with two lines representing the filter selection extremities. Data representation scale is automatic and is included between the minimum value ΔA approximated to the nearest whole number below, to the maximum value ΔA, approximated to the nearest whole number above.

When there are anomalous data, (because some measures have been carried out in a wrong way) you can operate with the menu key FILTER and select an algorithm to cancel above data. The possible algorithms are:

- NONE (all data are worked out)

- 2 σ (data that are twice the tolerance on each data from the medium value are excluded)
- WORST 1 (the farthest data from the mean is excluded)
- WORST 2 (the 2 farthest data from the mean are excluded)
- WORST 4 (the 4 farthest data from the mean are excluded)
- WORST 5% (the 5% farthest data from the mean are excluded)

When the filter has been selected, data will be shown in graphic or numeric mode. On the first case, selecting menu CALC on the display, the following values will appear:

- N: nnn/nnn (indicates the sample number that have been worked out, *filtered samples,* and the sample number that were available, *not filtered samples*)
- Mean: n.nnn (indicates the sample mathematic mean down the filter)
- Median: n.nnn (indicates the median value down the filter)
- Mode: n.nnn (indicates the mode sample down the filter. This value is important only in case of one mode distribution)
- Ơ: n.nnn (indicates the sample mean square difference)
- γ: n.nnn (indicates the kurtosis normalized coefficient. This value is important only in case of one mode distribution)

Data regarding qualitative values can be shown in graphic mode at menu key ISTOGRAM.
The distribution histogram, together with a box and moustache diagram, will be shown. The box represents the central quartiles, the moustache represents the first and last data position and the arrow under the histogram represents the data mean value. Data representation scale is automatic and is included between the minimum value ΔA approximated to the nearest whole number below, to the maximum value ΔA, approximated to the nearest whole number above. The number of classes selected for the histogram is automatic as well and it depends on the sample numbers.

2.5.2 Statistical data interpretation

Statistical data allow to obtain sample information. These information enable to know when the stock worked out measures are important, when the stock is homogenous and the reference value of the same stock. This is the reason why some statistical calculations are necessary:

Preliminary remarks:

1. A small number of samples does not enable statistical calculation
2. Sample choice must be fortuitous when sample statistical calculation is carried out

Mean, median and mode

The algebric Mean of N samples is the sum of the all N samples divided for N.
The median of some samples refers to the central value of the samples ordered in increasing or decreasing order
The Mode of some samples is the value of the maximum frequency, it means the value appearing more frequently. More mode distributions are possible; they are distributions having more than one relative frequency maximum. One mode distributions are also possible. Of course we do not expect a multimodal distribution for an homogeneous sample.
Mean, Median and Mode values, for symmetric distributions are the same ones or they are similar. A great difference among these values indicates a no symmetric distribution.

Standard deviation:

The standard deviation σ (sigma) is the square root of the average of the square of the difference between a data series average value and a single data value.
In probability theory and statistics standard deviation is a measure of the variability or dispersion of a population, a data set, or a probability distribution. A low standard deviation indicates that the data points tend to be very close to the same value (the mean), while high

standard deviation indicates that the data are spread out over a large range of values. Nothe that farthest samples from the average value is more important than the nearest samples to the average, in the σ calculation. The standard deviation supplies information regarding data distribution and it is useful to fix a point to eliminate anomalous data. This point is usually fixed in twice σ.

Kurtosis index

Kurtosis index γ (gamma) indicates the data distribution curve shape. It is a “thickness” measure of the tail, it means the levelling degree. It specially calculates the “Fisher” kurtosis index. The kurtosis index value of a “standard” distribution (mesokurtics) is 0. A value lower than 0 indicates a platykurtic distribution; a value higher than 0 indicates a leptokurtic distribution.

Practical rules

It is necessary to measure at least 50 fruits, fortuitously chosen among a stock. We remember you that they are not destructive measures, therefore the 50 fruits will not be wasted; moreover, the instrument is able to measure the fruits in a very short time. It is then necessary to evaluate the graphic of the surveyed values and to point out any anomalous sample. Few anomalous samples can indicate:

1. Extremely different stock, with, i.e. fruits from different provenience
2. A wrong use of the instrument
3. A wrong function of the instrument.

By using filters, you should exclude the anomalous samples and observe the histogram of the collected data. The curve shape has to be one mode shape. More mode shapes indicates en extremely different stock. In case of more modes curves, the obtained values can be not indicatives values of the stock, therefore more complex studies are necessary. Moreover, in case of more mode curves, the mean square difference and the kurtosis index have not sense and you must ignore them. By observing the values obtained, mean, median and mode must be quite similar. The mean square difference has to be low. The kurtosis index does not have to be much lower than 0. Other values regarding the mean square difference and the low kurtosis values, indicates a not homogeneous stock. In this case as well, the obtained values (mean, median, mode) can be not important and more complex studies are necessary.

2.6 Restrictions

There are some restrictions if you want to carry out some statistical data directly on the instrument.

Above restrictions are due to the RAM memory dimension inside the instrument and mainly:

1) it is not possible to carry out statistical operations, if the sample number of a stock is higher than 2000;
2) it is not possible to accede to the files previous to 2000, when the number of files on the disk is higher than 2000;
3) it is impossible to select the marker, when inside each file there are more than 2000 markers

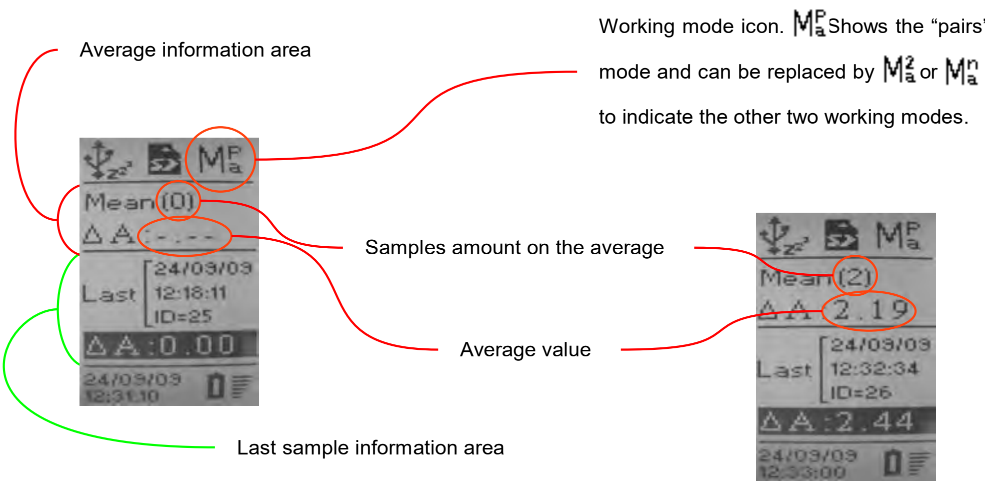
3 Type of accumulation of averages and mean pairs

The firmware of the ΔA Meter® implements some features, mainly related to the need to associate the average of 2 measurements to a single fruit. The above to avoid a bimodal distribution on the study of the sampled data. This is the reason why a third media accumulation mode has been implemented in the software, this mode can be selected in the menu: **Menu→Config→Mean**.

"Last n" and "Last 2", that have not been changed, or the new "Pairs" can be chosen in the above menu:

- The "Last n" working mode allows you to show the average of every sample carried out from the last average clearing (**Menu→Mean Clr**) in a specific part of the display. This is very useful when the average of some samples in a batch is quickly needed, but more statistical evaluation are not requested;
- The "Last 2" working mode allows you to show the average of the last 2 carried out samples in a specific part of the display. This is useful when data regarding an only fruit are requested (usually two samples average are used, one sample taken on the side of the fruit facing the sun and the other one taken on the opposite side) but more statistical evaluation are not requested;
- "Pairs" working mode, just implemented, allows to show and to store the average of a couple of measurements;

Mean displaying

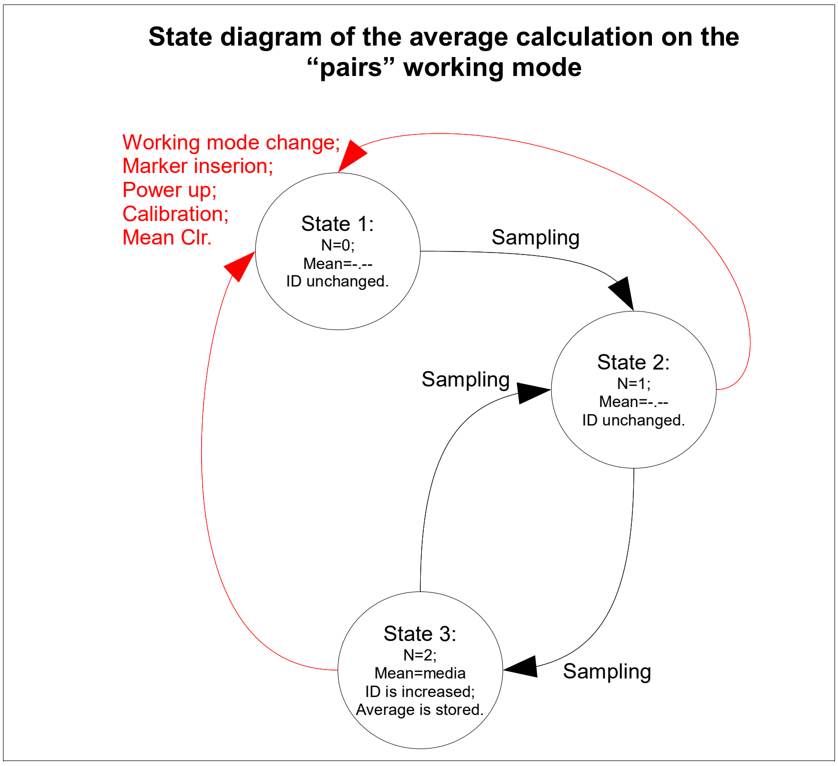


When the DA Meter® works in "**last n**" mode the average is summed up, measure by measure, from the last mean clearing. The amount of the samples is shown on the display, the average value is only shown when the amount of samples is higher than 1.

When the DA Meter® works in "**last 2**" mode the average of the last 2 taken samples is always shown when the amount of samples is higher than 1. This working mode stores every single sample on the SD card, and not the relevant average.

When the DA Meter® works in "**pairs**" mode, the average of the last samples couple is shown. As you can note on the state diagram of the following drawing, after each power on, after each calibration, after a mean clearing, after a marker insertion and after a working mode change, the sample amount value is cleared and the display appears like the left side of the previous drawing (*state 1*). If an additional measurement is carried out on this situation, the display shows 1 regarding the sample amount and -.-- regarding the average value. The measurement is anyway shown on the measure field (*state 2*). If an additional measurement is carried out on this situation, the display shows 2 regarding the sample amount and the average value is shown, like the right side of the previous drawing (*state 3*). The following measurement sets the program on state 2.

It is important to point out that this working mode allows you to store only the average and not every measurement. The sample amount (ID) increases only in state 3.



- N.B. - In "Pair" working mode only the average values of a fruit samples are stored, and not each measurement; the above involves some consequences in the statistical evaluation, mainly in the distribution. In order to better understand the above situation, let's imagine to have a certain amount of fruit that are very similar among them, having a big difference between the DA of the side facing the sun and the DA of the opposite side. With this kind of population, as you can note on the following drawing:

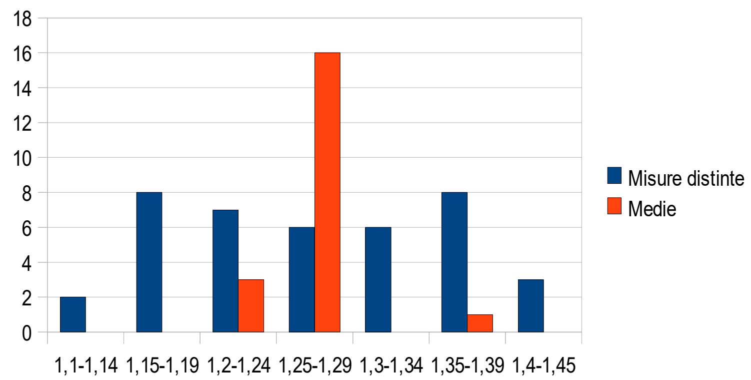
- If we draw a histogram of each sample, we will achieve a bimodal distribution, with both modes coinciding in the average of the more lighting side DA and in the average of the less lighting side DA. Therefore, observing the histogram, <u>we could wrongly state</u> that our population is concentrated in two different classes. As a matter of fact, the blue histogram in the drawing, points out 2 different modes: one mode inside the range 1.15-1.19, the other one inside the range 1,35-1,39.
- Calculating the average of both measures carried out on each fruit, and drawing the average histogram, we will achieve a single modal distribution, that <u>will not bring us to draw a wrong conclusion</u> regarding the population features. As a matter of fact, the orange histogram in the drawing points out one single mode, positioned in the range 1,25-1,29.

The above working mode is useful when statistical evaluation are requested and two samples on each fruit are requested.

Single measurement and couple mean histogram

Fruit	Side 1 DA	Side 2 DA	Average
1	1,22	1,35	1,29
2	1,18	1,33	1,26
3	1,21	1,37	1,29
4	1,23	1,28	1,26
5	1,17	1,41	1,29
6	1,18	1,36	1,27
7	1,12	1,33	1,23
8	1,26	1,47	1,37
9	1,18	1,32	1,25
10	1,22	1,35	1,29
11	1,22	1,35	1,29
12	1,18	1,33	1,26
13	1,26	1,37	1,32
14	1,23	1,28	1,26
15	1,17	1,41	1,29
16	1,19	1,36	1,28
17	1,12	1,33	1,23
18	1,26	1,31	1,29
19	1,18	1,29	1,24
20	1,22	1,35	1,29

Class range	Single samples	Average
1,1-1,14	2	0
1,15-1,19	8	0
1,2-1,24	7	3
1,25-1,29	6	16
1,3-1,34	6	0
1,35-1,39	8	1
1,4-1,45	3	0



4 Technical specifications

- Power supply: 3 AA size alcaline batteries, 1.5 V
- Instrument Weight: 320 g. (with batteries);
- Case weight: 1600 g. (ΔA Meter® and accessories included);
- Connectivity: USB interface (USB2);
- Storage device: socket for micro SD card compatible with SD standard and MMC;
- File system: FAT32;
- Sampling time: 300/500 mS, depending on weather conditions and on fruit opacity;
- Display: backlight graphic LCD;
- Monitor: monitor for automatic update of firmware;
- O.S. for PC-SW app: Microsoft Windows® XP, Vista, Win7, Win8;
- Hardware requirem.: USB port.

5 Guarantee

LIMITATION OF GUARANTEE AND RESPONSIBILITY

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QUESTA GARANZIA È IL SOLO E UNICO RISARCIMENTO DELL’ACQUIRENTE E HA VALORE IN LUOGO DI QUALSIASI ALTRA EVENTUALE GARANZIA, ESPRESSA O IMPLICITA, INCLUSA, TRA L’ALTRO, LA GARANZIA O LA COMMERCIABILITÀ O L’IDONEITÀ AD UNO SCOPO PARTICOLARE. Sinteleia® NON SARÀ RESPONSABILE DI NESSUN DANNO O PERDITA, SPECIALI, INDIRETTI, ACCIDENTALI O CONSEQUENZIALI, INCLUSA LA PERDITA DI DATI, IMPUTABILI A QUALSIASI CAUSA O TEORIA.

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53500 DA Meter

User's manual

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firmware v0.4 and later
software v1.0 and later</td></tr>
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