ΔA meter®

User's Manual

Sintéleia®

ΔA METER®

User's manual

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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.

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

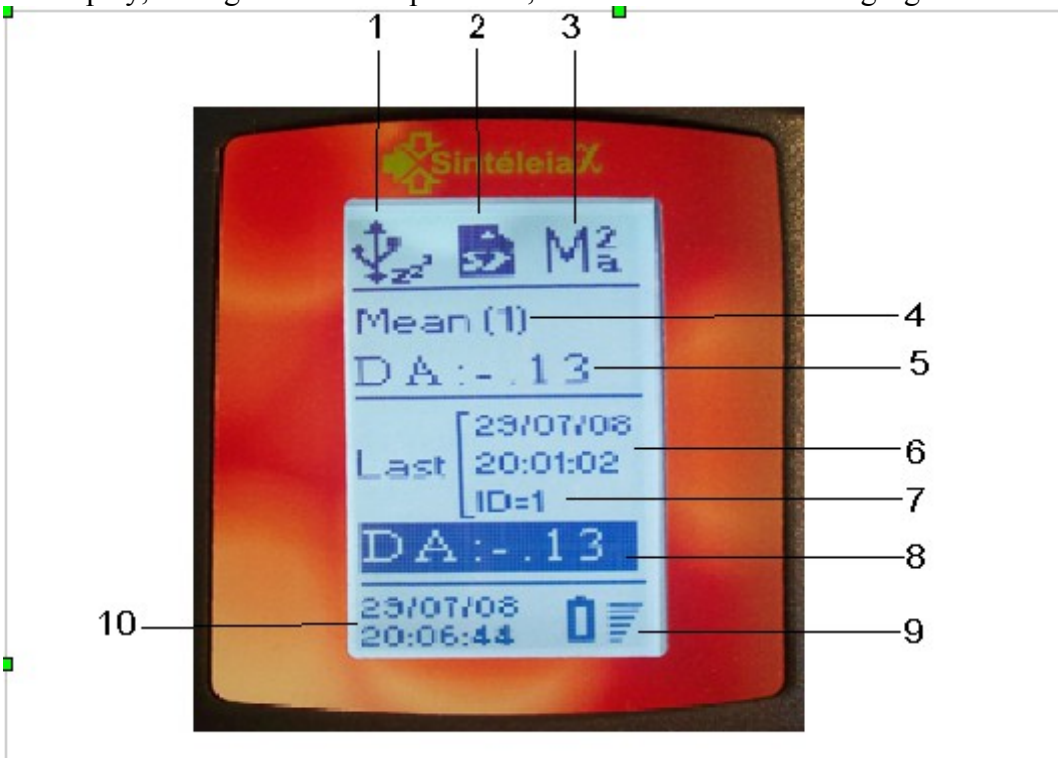
2.3.1 MAIN COMMANDS

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.
   It is also possible to switch off the instrument in a secure way selecting Off in the main menu.
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 DISPLAY

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



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 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

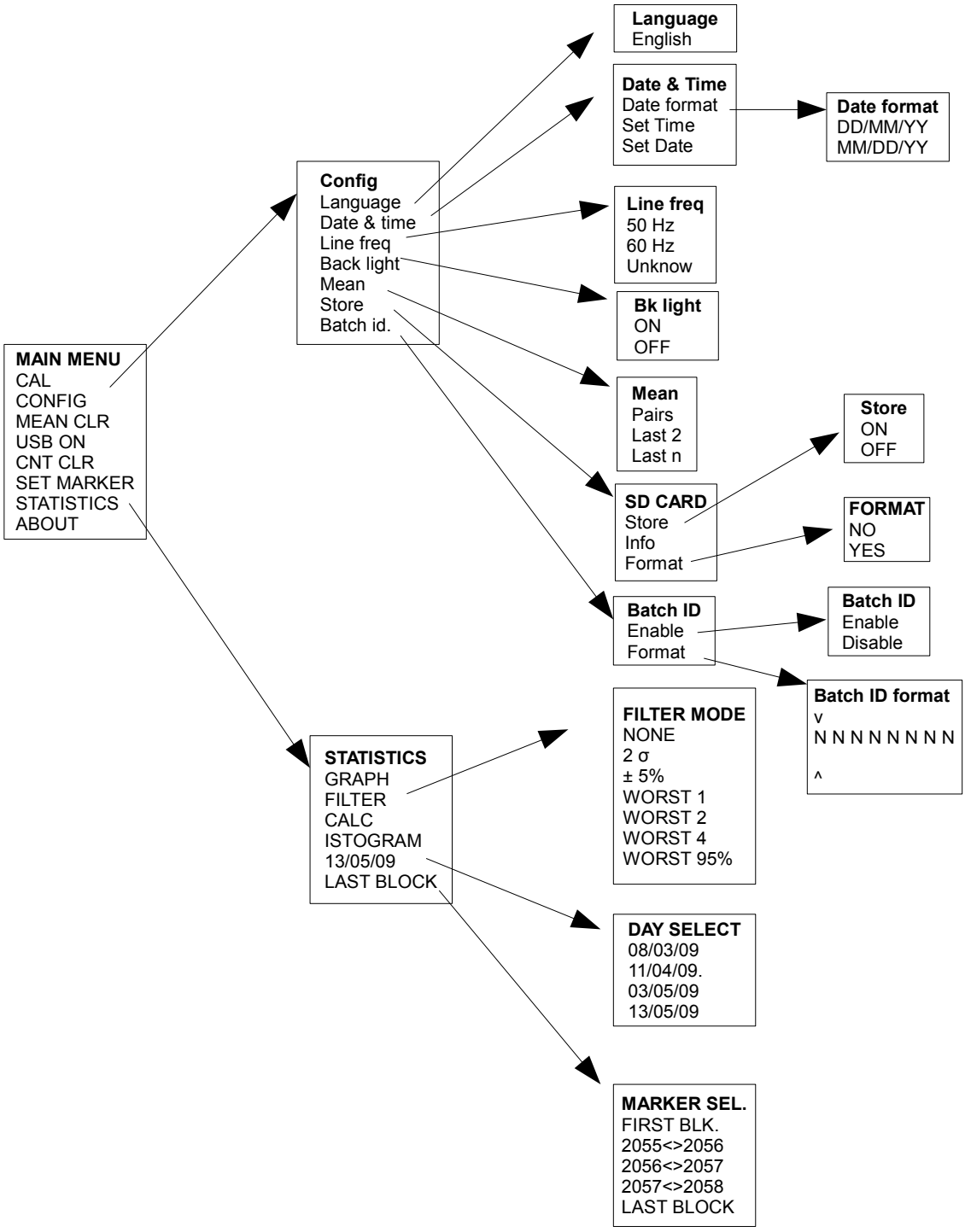
SD Card not configured or not inserted

Average value calculated out of 2 records

Average value calculated out of n records

2.3.3 MENU

Below is shown the tree-like menu structure:



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) **USB ON** puts in operation the USB interface (for about one minute), and enables the exchange of data between a PC and the instrument;
5) **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)
6) **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.
7) **STATISTICS** enables to enter into the statistic functions menu;
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.

2.3.4 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.

2.3.4.1 LANGUAGE SETTING ("LANGUAGE")

Currently is available English language only.

2.3.4.2 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.

2.3.4.3 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.

With the last software version, we suggest you not to choose the last option.

2.3.4.4 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.

2.3.4.5 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.

2.3.4.6 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.

2.3.4.7 BATCH IDENTIFIER CODE SETTING ("BATCH ID")

The "Batch ID" feature (available starting from firmware version 0.27) is a 8-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 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.

Attention: 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.**

The calibration must be performed at least every 24 hours, but, again, it is advisable to repeat it frequently when temperature changes.

It is important to consider that the instrument precision depends on the perfect instrument calibration.

2.3.6 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.

2.3.7 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[3] 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 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.

3 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. 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.

2.4 HISTORICAL DATA

All data acquired by the ΔA Meter®, together with significant events such as calibration and markers, can be stored in backup files on a micro SD memory internal to the equipment. Those data can be downloaded and elaborated at a later stage.

2.4.1 SD CARD

Data are saved on a micro-SD memory card which is provided together with the instrument. It is allowed to insert or extract this card only when the instrument is switched off.

Such an operation, however, is hardly necessary, because data saved on such a card can be operated via the USB interface and must be performed anyway by qualified personnel. Data are stored in a FAT32 file system, so that the card -if removed- can be read by the majority of PCs.

2.4.2 PCS CONNECTION AND SOFTWARE USE DA_METER 1.0

The instrument is equipped with a USB interface, allowing connection with PCs to access data stored in the SD Card.

The actually available software allows to download data on PCs with Windows® XP, Vista, Win7, Win8 operation system. Data are saved in text files. Text files can be read directly, or imported in a spread sheet.

For more information regarding the software use on PCs, read the following chapters.

3 SOFTWARE FOR PERSONAL COMPUTERS

This is the basic version of the software for PC. It works on PC running Windows® XP Operating System (or recent) and allows to connect to one or more ΔA Meter® to download data.

The first step is to install the software provided with the instrument.

3.1 PC SOFTWARE INSTALLATION (WINDOWS® XP, VISTA, 7 & 8)

The PC Software is delivered loaded into the SD-Card of the instrument or is downloadable from www.dameter.com website.

For all 32/64-bit Microsoft Windows® Operating System (Windows® XP, Windows® Vista, Windows® 7 or Windows® 8), you have to install both the USB driver upgrade for the internal USB device of the

instrument and the PC Software, following the procedure below:

1) install the usb driver running "CDM v2.12.04 WHQL Certified.exe", follow the intructions, then connect the DA Meter® to an USB port using the cable supplied with the instrument;

2) Turn-on the instrument by pressing ”ON” pushbutton, the PC at this point has to automatically notice the instrument connected to the USB port and then, the PC will signal you when the device has been properly installed.

3) Unzip SWPC_DA Meter_v_X_X file and move it to the PC's hard disk in the desired position. There's not a particulary position required: you can place it anywhere on the Hard Disk.

4) Make double-click on the PC Software executable file (DA_Meter.exe), use the program by following the user manual.

3.2 HOW TO USE THE SOFTWARE

Once the software in installed, to download data::

1) Select volume and directory on which data have to be saved;
2) start the executable programme ΔA Meter® (its icon should appear on the PC desktop is the software is correctly installed);
3) Connect the ΔA Meter® to a USB port on the PC case by means of the specific cable and switch it on. The pc should detect the connection of a new device;
4) In the instrument menu, select USB ON and push the rightward arrow. The USB interface should activate and stay active for at least a minute;
5) Push the download button on the ΔA Meter® software window. The download sequence starts:
    1. the serial number of the instrument is detected;
    2. in the selected directory a file is created, named: **ΔA_Meter_NXXXXXXXX.txt** (where XXXXXXXX stands for the serial number);
    3. the list of files available on the instrument is read;
    4. data from each file are read and copied at the end of the file ΔA_Meter_NXXXXXXXX.txt (appended);
    5. downloaded files are deleted from the instrument's memory.

3.3 INTERPRETATION OF DATA DOWNLOADED ON PC

When the download is complete, a file named after each instrument from which data have been downloaded is available on PC. The serial number in the file name allows for the instrument identification. Each file contains data in text format. It is easily possible to import such data in a spreadsheet (such us Microsoft Excel in the Office suite or Calc in the OpenOffice[4] suite).

Data are saved in rows separated by a carriage return. Each rows is built of a fixed part, identifying date and time of the event and type of event, and of a variable part. This second part varies depending on the type of event:

1) Format of a row created by a successful calibration event:
   24/07/08; 17:22:12; Cal. Ok (Red[], IR[]); 5390666; 6908846; 488; 9788388
   The string Cal. Ok (Red[], IR[]) identifies the type of event; the following values are those detected by the conversion tool by measuring red light and infra red light at two different level of power. Those data are useful only for diagnostics.
2) Format of a row created by an unsuccessful calibration event:
   24/07/08; 17:22:12; Cal. Not Ok (Red[], IR[]); 5457554; 6908846; 632; 9788388
   The string Cal. Ok (Red[], IR[]) identifies the type of event; the following values are those detected by the conversion tool by measuring red light and infra red light at two different level of power. Those data are useful only for diagnostics.
3) Format of a row created by a successful measure event:
   10/07/08; 16:23:20; Sample ((Sample, BK; Red; IR; ΔA); 13; 32619; 592836; 8006716; 1,447
   The string Sample (Sample, BK; Red; IR; DA) identifies the type of event; the following values are: sample identifier, background luminosity value, infra-red light value, red light value, calculated ΔA value. Data other than the last one are useful only for diagnostics.
4) Format of a row created by the introduction of a marker:
   28/07/08; 10:53:38; Marker ; 1
   After the type of event field (containing the string “Marker”), the marker number is declared.

4 *Our suggestion, if a spreadsheet has to be installed on the PC, is to download from Internet (www.openoffice.org) and install the Open Office suite which comes form free, is based on non proprietary software formats and provides performances comparable to those of similar proprietary software.*

4 SOFTWARE FOR PERSONAL COMPUTER DA_METER 2.0

The DA_Meter version 2.0 is the complete version of the PC software. It works on PC running Windows® XP Operating System and allows to connect to one or more ΔA Meter® to download measured data, visualise or elaborate them, export them in a format which is easily manageable by most spread sheet software application, and upgrading the ΔA Meter® firmware.

The first step is to install the software provided with the instrument. Insert the provided CD and wait for the installation software to start. In case the programme does not start automatically, double-click the file install.exe in the CD.

Once the application is installed and the programme is launched, a small window showing a menu appears.

4.1 MAIN MENU

The first item in the menu (ΔA Meter®) allows to access a sub-menu composed by three items: Check connection, Download data e Firmware upgrade.

The Check connection item opens a window showing the result of a connection check towards the one or more ΔA Meter® instruments connected. These must be switched on and having the USB connection option activated in order to be detected by the PC software. All the connected instruments are then detected.

The Download item opens a window showing the results of the download of data from the connected instruments. All connected and detected instruments are enquired to check whether data are present and how many files can be downloaded. Data are then transferred to the PC and appended in the file specific to each of the instruments. All file are located in the directory specified by means of the Set Data Path item in the Config submenu of the main menu. File are named after the serial number of the pertaining instrument, so that file name shows the following structure: DA_MeterNxxxxxxxx.txt (where xxxxxxxx stands for the serial number of the instrument). At the end of the download process, data are deleted from the instrument memory.

The Firmware Upgrade menu item opens a window allowing to start the upgrading process of instruments' firmware. Detailed instructions will be available on the website together with the necessary update files can be downloaded.

The second item in the main menu (Config) allows to access a 2 items sub-menu: Set Data Path e Select Data File.

The Set Data Path item allows to set the pathname (volume and directory) where data files will be downloaded.

The Select Data File item allows to select, among the available files in the selected directory, the one to be visualised.

The third item in in the main menu, Show, is enabled only when a data file is selected. This item starts the visualisation of the selected file.

The last item in the main menu, About, shows information about the software application.

4.2 DATA VISUALISATION

By selecting the Show item in the main menu, data are visualised in a separated window.

Available menu items allow to show a selection of data (filtering for example data collected in a specific date or data appearing between two markers, or even all the data in the selected file).

It is possible, by means of menu items in the Export sub-menu, to select which kind of records have to be exported on a separate text file and to start the export procedure. This will generate a new file, which can be easily imported by a spreadsheet application for further analysis and statistics.

The visualisation window three tabs appears, allowing to select a visualisation mode out of Graphics, Text e Distribution. Data proposed in the Graphics or Distribution presentation modes can also be printed by means of the Print item.

4.2.1 VISUALISATION IN "GRAPHICS" MODE

The "Graphics" visualisation mode shows data in a graphical format. Each single record of the file (or of the selected filtered set of data) is shown in the graphic map, ordered from left to right.

On the vertical axes the ΔA values of measures are presented, on the horizontal one the records are shown along with their progressive number. Records of measures are marked by a blue ellipse. Markers are identified by a vertical black line showing where the marker itself is located.

Calibration are represented by a vertical green line (for successful calibrations) or by a vertical red line (failed calibrations).

An horizontal red line show the mean value, while an horizontal blue line stands to indicate the median value. A grey horizontal stripe, around the average value, shows the value of the Sigma.

Moving the cursor up or down on the graphic map, it is possible to read on the status bar the ΔA values corresponding to the curso position.

Selecting with the mouse an horizontal zone in the data area it is possible to zoom on the selected area.

4.2.2 VISUALISATION IN "TEXT" MODE

In "Text" mode data are shown in text format inside a scroll box.

Data are listed after some header lines, where the file name, the zoom status, the number of records, the mean and median value of ΔA among the visualised records and so on are proposed.

Data are shown a record each line.

Each line includes the progressive number, date and time of the presented event, the tye of event (measure, marker, successful or failed calibration, unknown type), id number (for marker or measure only) and, only in the case of measures, the ΔA value.

4.2.3 VISUALISATION IN "DISTRIBUTION" MODE

The "Distribution" mode presents the statistical distribution of data. The distribution area (from the minimal to the maximal value) is divided in classes. The number of classes is variable (5, 10 o 50) and it depends on the number of data which are being elaborated[5]. The histogram of the distribution is drawn by means of grey rectangles with blue borders. By moving the cursor over a rectangle it is possible to know all relevant information about the selected rectangle: number of the class (for ex.: *N°10 of 50 (ΔA: 1,28÷1,44)*), the ΔA lower and higher limits for that class, population in the class (for ex.: *44 of 580 (7,6%)*).

A vertical red line shows the mean value of the ΔA pertaining to visualised data. The median value always corresponds to the centre of the visualised area. On the left side of the histogram a ruler is available, on which the percentage values out of the total are presented. On the right side, the number of samples is proposed. The lower side shows a ruler with the ΔA values. The median value is shown in blue colour.

5 Obviously it does not make sense to present a distribution in 50 classes out of a set of 10 data records.

5 ADDENDUM FIRMWARE V0.9.V0.11

With the following versions of firmware to V0.8, some important changes have been introduced, regarding the PC connection. Mainly, the connection procedure has been deeply changed, in order to avoid connection changes. The new firmware is not compatible with the old software version on PC and viceversa. This is the reason why it is necessary to follow the under mentioned order, so to update your equipments:

1. Use your old software on PC to update the firmware of all your equipments
2. Update the software on your PC

Moreover, the new firmware versions have some new functions that allow you to carry out statistical analysis on the same equipment

5.1 STATISTICAL CALCULATION FUNCTION

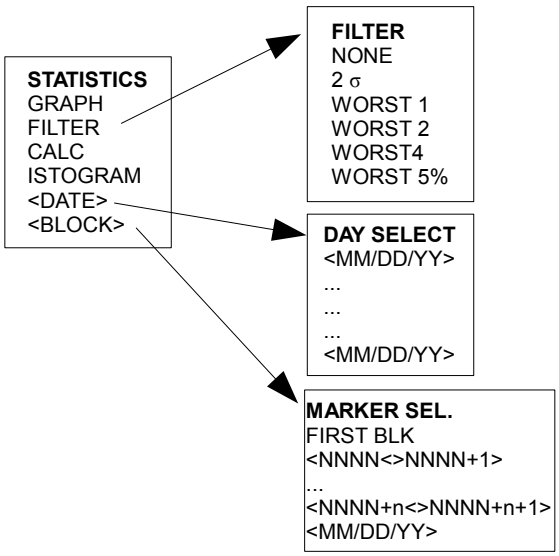
The ΔA Meter® data are precise and repeatable, but they are connected to measures regarding just one object, the fruit, that is highly changeable. This is the reason why it is important to use the statistical calculation methodology, when working on stock. The more complex statistical calculations can 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.

5.1.1 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)
- Ó: 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.

5.1.2 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.

5.2 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:

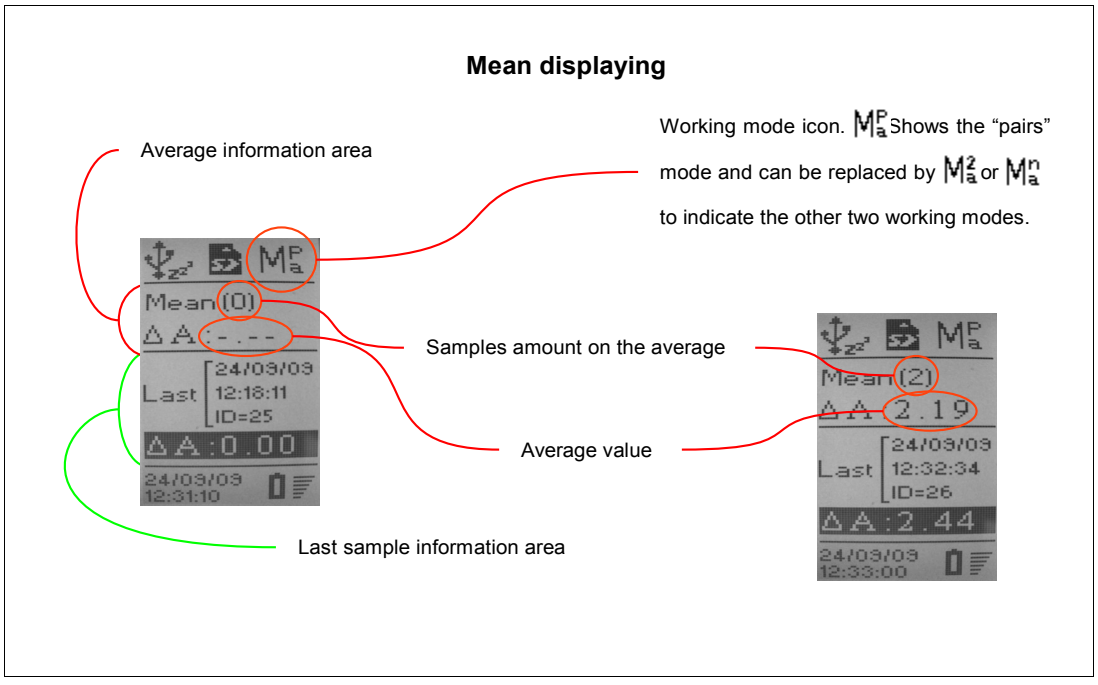
1) it is not possible to carry out statistical operations, if the sample number of a stock is higher than 2000;
2) it is not possible to accede to the files previous to 2000, when the number of files on the disk is higher than 2000;
3) it is impossible to select the marker, when inside each file there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

6 ADDENDUM FIRMWARE V0.21

The DA Meter® firmware, from the 0.21 release, increases some new functions, that are mainly connected to the requirement to link the average of two measurements every 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;



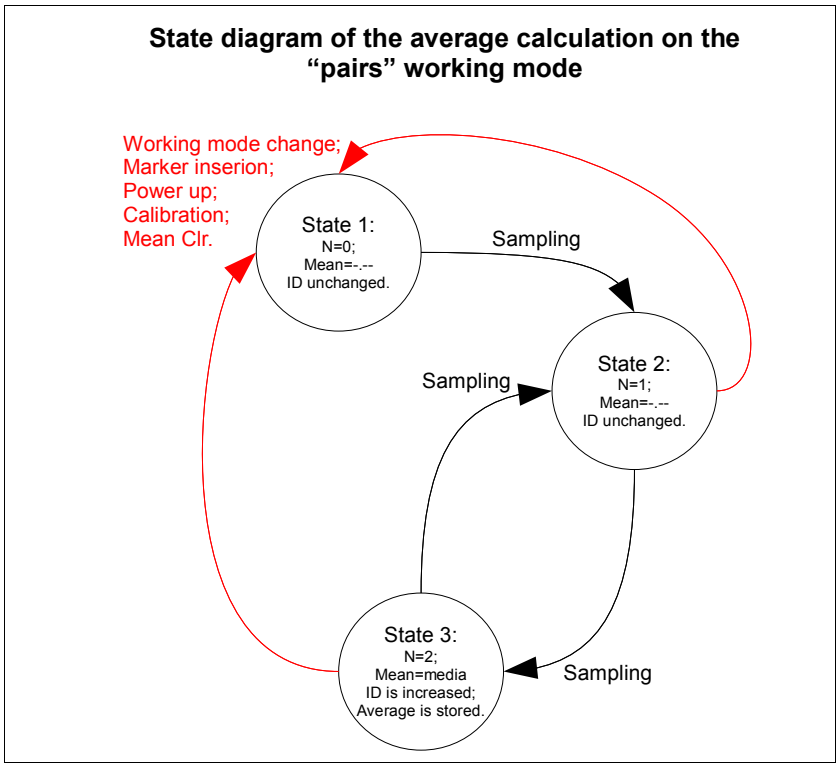
When the DA Meter® works in "**last n**" mode the average is summed up, measure by measure, from the last mean clearing. The amount of the samples is shown on the display, the average value is only shown when the amount of samples is higher than 1.

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.

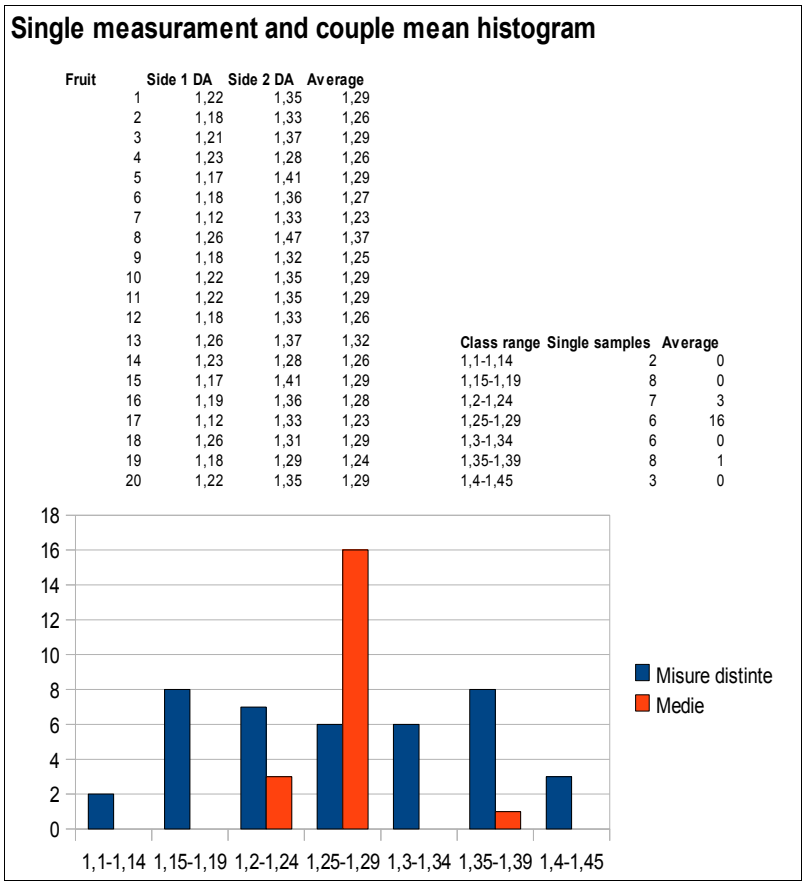
It is important to point out that this working mode allows you to store only the average and not every measurement. The sample amount (ID) increases only in state 3.



- 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, we could wrongly state 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 will not bring us to draw a wrong conclusion 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.



7 PC SOFTWARE ADDENDUM

Starting from 3.1 version, the DA Meter® PC software works with DA Meter® firmware V0.21 and Kiwi Meter firmware V1.3 only. The file format of the PC data is changed and older data file are not compatible with the new one.

The new features are:

1) To process Kiwi Meter data (the kiwi version of the instrument works with two set of wavelenght and store two measures for each sample: one relative to the green wavelenght, the other relative to the red one) and to process the data collected using the new working mode “Mean Pair” the instrument allows to select the measurements to be displayed. In the **Config** menu on the main program window you can find 4 check items: **Show red samples; Show red pairs; Show green samples** and **Show green pairs**, that allows to select wich data you will show on graphs and/or you will export to a spreadsheet.
2) To make possible to compare the histograms coming from different measuring sessions with different samples' numbers, during graph displaying you can set the class' partition intervals on the config menu.
3) For the same, in that menu, it is possible to force the horizontal and vertical display scale of the histogram.

In fact, to compare two histograms, you have to generate them by setting the same class partition (e.g. a class every 0,2 DA), and the same full scale setting both in horizontal and vertical axis. If you let the default automatic settings the graphs will be not comparable.

8 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.

9 GUARANTEE

LIMITATION OF GUARANTEE AND RESPONSIBILITY

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