Digital Refractometer

User Manual

Background Information

Recommendation Tables

STEP Systems GmbH
Soil Testing Equipment - Professional Systems

Duisburger Str. 44
Tel: ++49 (0) 911 96 26 05-0
Fax: ++49 (0) 911 96 26 05-9
D-90451 Nürnberg
e-mail: **info@stepsystems.de**
www.**stepsystems.de**

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Duisburger Str. 44
Tel: ++49 (0) 911 96 26 05-0
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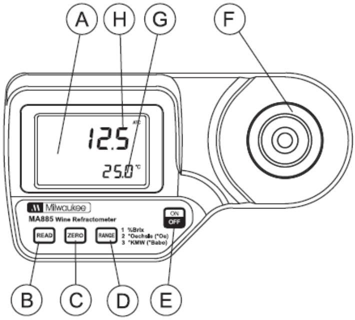
D-90451 Nürnberg
e-mail: **info@stepsystems.de**
www.**stepsystems.de**

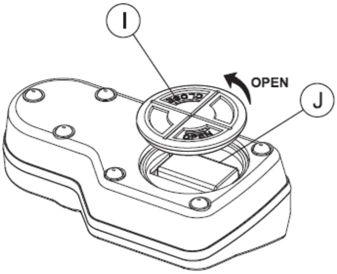
Digital Refractometer

FRONT PANEL



A. LIQUID CRYSTAL DISPLAY (LCD)
B. READ KEY (USER MEASUREMENT)
C. ZERO KEY (USER CALIBRATION)
D. RANGE KEY (MA884 AND MA885)
E. ON/OFF
F. STAINLESS STEEL SAMPLE WELL AND PRISM
G. SECONDARY DISPLAY
H. PRIMARY DISPLAY
FRONT PANEL

BOTTOM



I. BATTERY COVER
J. BATTERY COMPARTMENT

STEP Systems GmbH
Soil Testing Equipment - Professional Systems

Duisburger Str. 44
Tel: ++49 (0) 911 96 26 05-0
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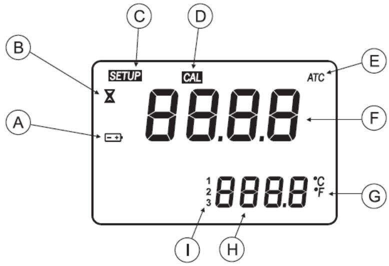
Display



A. BATTERY STATUS ICON (BLINKS WHEN LOW BATTERY CONDITION DETECTED)
B. MEASUREMENT IN PROGRESS TAG
C. SETUP: FACTORY CALIBRATION TAG
D. CAL: CALIBRATION TAG
E. AUTOMATIC TEMPERATURE COMPENSATION (BLINKS WHEN TEMPERATURE EXCEEDS 10-40 °C / 50-104 °F RANGE)
F. PRIMARY DISPLAY (DISPLAYS MEASUREMENT AND ERROR MESSAGES)
G. TEMPERATURE UNITS
H. SECONDARY DISPLAY (DISPLAYS TEMPERATURE MEASUREMENTS; WHEN BLINKING, TEMPERATURE HAS EXCEEDED OPERATION RANGE: 0-80 °C / 32-176 °F)
I. RANGE INDICATOR (REFER TO PAGE 7)

BATTERY REPLACEMENT:

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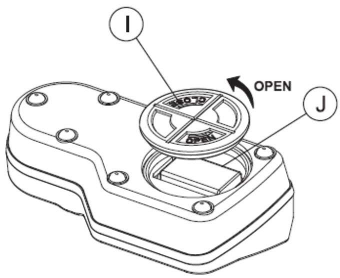

To replace the instrument's battery, follow these steps:

- Turn the instrument OFF by pressing the ON/OFF key.
- Turn instrument upside down and remove the battery cover by turning it counterclockwise
- Extract the battery from its location.
- Replace with fresh 9V battery making certain to observe polarity.
- Insert the back battery cover and fasten it by turning clockwise to engage.

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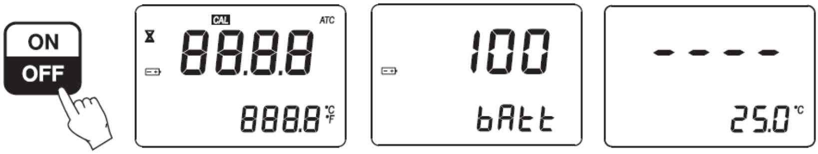
CALIBRATION PROCEDURE

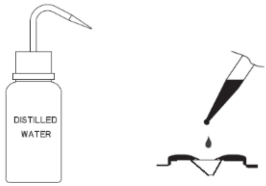
Calibration should be performed daily, before measurements are made, when the battery has been replaced, between a long series of measurements, or if environmental changes have occured since the last calibration.

1. Press the ON/OFF key, then release. Two instrument test screens will be displayed briefly; all LCD segments followed by the percentage of remaining battery life. When the LCD displays dashes, the instrument is ready.



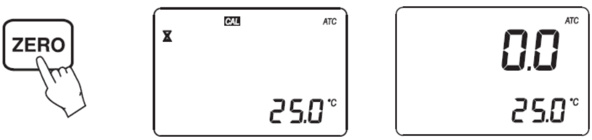
2. Using a plastic pipette, fill the sample well with distilled or deionized water. Make sure the prism is completely covered.

   Note: If the ZERO sample is subject to intense light such as sunlight or another strong source, cover the sample well with your hand or other shade during the calibration.



3. Press the ZERO key. If no error messages appear, your unit is calibrated.

   Note: The 0.0 screen will remain until a sample is measured or the power is turned off.



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4. Gently absorb the ZERO water standard with a soft tissue. Use care not to scratch the prism surface. Dry the surface completely. The instrument is ready for sample measurement.

   Note: If instrument is turned off the calibration will not be lost.

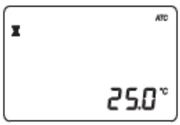
MEASUREMENT PROCEDURE

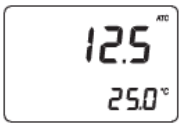
Verify the instrument has been calibrated before taking measurements.
Select the desired measurement unit (see page 7).

1. Wipe off prism surface located at the bottom of the sample well. Make sure the prism and sample well are completely dry.

2. Using a plastic pipette, drip sample onto the prism surface. Fill the well completely.
   Note: If the temperature of the sample differs significantly from the temperature of the instrument, wait approximately 1 minute to allow thermal equilibration.

3. Press the READ key. The results are displayed in unit of interest.
   Note: The last measurement value will be displayed until the next sample is measured or the instrument is turned off. Temperature will be continuously updated.





Note: The "ATC" tag blinks and automatic temperature compensation is disabled if the temperature exceeds the 10-40 °C / 50-104 °F range.

4. Remove sample from the sample well by absorbing on a soft tissue.

5. Using a plastic pipette, rinse prism and sample well with distilled or deionized water. Wipe dry. The instrument is ready for the next sample.

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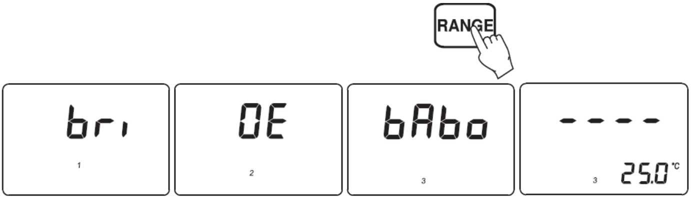
CHANGING MEASUREMENT & TEMPERATURE UNIT

Changing the measurement unit

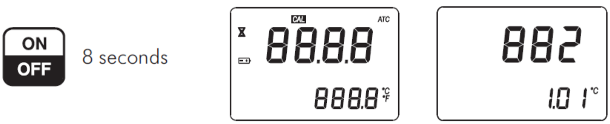
Press the RANGE key to select measurement units %Brix, °Oechsle (°Oe) or °KMW (°Babo). The instrument toggles between the three scales each time the key is pressed and the primary display indicates “bri” for %Brix, “OE” for °Oechsle or “bAbo” for °KMW.
When the instrument displays the screen with 4 dashes theinstrument is ready for measurement. A number on the display indicates the selected unit:
“**1**” denotes %Brix, “**2**” denotes °Oe and “**3**” denotes °KMW, as indicated on the instrument cover.



Changing the temperature unit

To change the temperature measurement unit from Celsius to Fahrenheit (or vice versa), follow this procedure.

1. Press and hold the ON/OFF key continuously for approximately 8 seconds. The LCD will display the “all segment” screen followed by a screen with the model number on the primary display and the version number on the secondary display. Continue pressing the ON/OFF key.



2. While continuing to hold the ON/OFF key, press the ZERO key. The temperature unit will change from °C to °F or vice versa.

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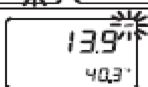
ERROR CODES

Error Code		Description
Err		General failure. Cycle power to instrument. If instrument still has error, contact manufacturer
LO Primary display		Sample is reading lower than the 0% standard used for meter calibration.
HI Primary display		Sample exceeds maximum measurement range.
LO Primary display **Cal** segment ON		Wrong calibration used to zero instrument. Use deionized or distilled water. Press ZERO.
HI Primary display **Cal** segment ON		Wrong calibration used to zero instrument. Use deionized or distilled water. Press ZERO.
t LO Primary display **Cal** segment ON		Temperature exceeds ATC low limit (10°C) during calibration.
t HI Primary display **Cal** segment ON		Temperature exceeds ATC low limit (40°C) during calibration.
Air		Prism surface insufficiently covered.
Elt		Too much external light for measurement. Cover sample well with hand.
nLt		LED light is not detected. Contact manufacturer.
Battery segment blinking		< 5% of battery life is remaining.
Temperature values are blinking **0.0°** or **80°C**		Temperature measurement out of sampling range (0-80°C).
ATC segment blinking		Outside temperature compensation range (10-40°C).
		

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SETUP segment blinking	Factory calibration lost. Contact manufacturer

General Information

The **refractometer** is a measuring device for determining of refractive index of optical media by means of refraction or the total reflection of light.

Other devices determining ripeness of wine, original extract of beer, water content of honey, frost protection of coolant or the specific gravity of the electrolyte of a battery, for example, operate on the same principle. Refractometer can also be used to measure proportion of dissolved substances, eg. sea water salinity, or to determine correction lenses for a human eye.

Refraction refers to the change in direction of a wave due to a local change in its propagation speed caused by - in contrast to diffraction - a change in the absorbance (optical density) of the propagation medium.

Brix Degree (°Brix, Brix, % Brix) is a measurement value for specific density of liquids.

It is mainly used in the fruit industry, in English-speaking countries however, also for determining the must weight in winemaking. So for fruit juices, drinks and generally for sugary products. Since in addition to water they mainly contain various sugars (eg, glucose, fructose, sucrose), its density gives rough estimate of its sugar content.

The value was named after the Austrian-German scientist Adolf F. Brix (1798-1870), who developed it in 1870.

A liquid has one Brix degree (= 1% Brix) if it has the same density as a solution of 1 g sucrose in 100 g water, it has 10 Brix (= 10% Brix) when its density corresponds to a solution of 10 g sucrose in 100 g water.

Sucrose solution here is only the reference substance, the liquid being examined need not necessarily contain sucrose.
1° Brix = 1° Balling = 4° Oe (approximate calculation)

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Tel: ++49 (0) 911 96 26 05-0
Fax: ++49 (0) 911 96 26 05-9
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www.**stepsystems.de**

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Degrees Oechsle is a measurement value of the must weight of wine and is based on the must density. It is common, especially in Germany, Switzerland and Luxembourg; in Austria must weight is measured in Klosterneuburger sugar degrees.

The amount of must weight in °Oe can be obtained from the must density ρ, being measured at 20°C, by the formula $\rho - 1000\ \mathrm{g/l}$. Therefore, a must with the density of 1083 g/l has 83° Oechsle. The Oechsle scale is named after its inventor Ferdinand Oechsle, mechanic from Pforzheim.

Must weight is measured by a special wine scale, which is a calibrated in °Oechsle hydrometer. Alternatively, sugar concentration of the must can also be measured visually by a refractometer.

With the help of the must weight one can determine an estimated alcohol content of the wine (when the wine is fermented, which means all the sugar in wine has been converted into alcohol).

A quality statement about the finished wine arises only partly from the Oechsle value: a higher sugar content in the must suggests a better ripening of the grapes, the decisive factor however is what the vineyard or cellar master makes of it. A must with 80° Oechsle yields 84 grams of pure alcohol per liter, which corresponds to an alcohol content of 10.6% by volume. Sweet late vintages can reach over 300° Oechsle. In general, the must weight of an average vintage in Germany is between 70 and 80° Oechsle.

Klosterneuburger Sugar Degree

The Klosterneuburger Sugar Degree (°KMW) shows sugar content of grape must in percent by weight. The name comes from the wine scale (Mostwaage), developed in 1861 by Baron August Wilhelm von Babo at the Wine School of Klosterneuburg.

The Klosterneuburger sugar degrees are applied especially in Austria.

1° KMW corresponds to about 5° Oechsle. The exact conversion is done by the formula (0.022 x ° KMW + 4.54) x °KMW = °Oechsle

Must weight describes the specific weight (density) of grape must, ie. the mass of the must in proportion to its volume. It serves as an indicator of the expected

Duisburger Str. 44
Tel: ++49 (0) 911 96 26 05-0
Fax: ++49 (0) 911 96 26 05-9
D-90451 Nürnberg
e-mail: **info@stepsystems.de**
www.**stepsystems.de**

alcohol content of the wine after complete fermentation of sugar. Hence, the must weight is also commonly referred to as gradation or alcoholic potency.

Must weight is thus a measure of the proportion of all solved substances in grape must. These are also known as the extract. This extract consists mainly of sugar (dextrose and fructose), acids, glycerin and in small quantities of phenols, pectins, proteins and minerals. Due to the high sugar content, the mass of must is always higher than that of water, ie. the specific weight of grape must is always higher than 1.

The must density can be determined by various physical methods. These include:

- buoyancy of a hydrometer or a hydrostatic balance (hydrometer)
- weighing of mass based on the volume by pycnometer
- measurement of light refraction by refractometer

In addition to different measuring methods, there are also various measurement scales and thus various units used in different countries. In Germany, Luxembourg and Switzerland, for example, the must weight is measured in degrees Oechsle. In Italy, Austria, Hungary, Slovakia and the states of former Yugoslavia measurement in KMW, or degrees Babo, is widely spread.

Degrees Baumé are used in France and Spain. Brix, or the almost identical unit Balling, are mainly applied in English-speaking countries. These units can be mutually converted only by rather complicated formulas, since their relationships to each other are not linear. For this reason, tables are usually used, from which the values can be read accurately enough (see table below).

As a general rule, one can say that 10 grams of sugar per 1000 grams of fermented must yield 0.66% vol. alcohol.

Must weight is an important factor for determining the time of grape harvest. In Germany, Austria and Switzerland the must weight, over the wine law, forms the basis for the classification of wines in quality classes. For each of these classes a so-called minimum must weight is provided, which has to be exceeded. However, especially in warm wine regions the must weight alone means very little. Based only on the must weight, simple French country wines would already belong to the best in Germany. Italian Amarone from Valpolicella (wine) would then be considered as a vintage wine of selected grapes (Beerenauslese). Therefore, in warm wine

Duisburger Str. 44
Tel: ++49 (0) 911 96 26 05-0
Fax: ++49 (0) 911 96 26 05-9
D-90451 Nürnberg
e-mail: **info@stepsystems.de**
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regions also the acid, the pH and the physiological maturity are used for classification of wine into quality classes.

Density	Oechsle	KMW/Babo	Brix/Balling	Baumé	Potential alcohol content
g/l	*Oe*	*KMW*	*Bx*	*Bé*	*vol-%*
1060	60	12	14,7	8,1	8,1
1065	65	13	15,9	8,8	8,8
1070	70	14	17,1	9,4	9,4
1075	75	15	18,2	10,1	10,1
1080	80	16	19,2	10,7	10,7
1085	85	17	20,3	11,3	11,3
1090	90	18	21,4	11,9	11,9
1095	95	19	22,4	12,5	12,5
1100	100	20	23,6	13,1	13,1
1105	105	21	24,7	13,7	13,7
1110	110	22	25,7	14,3	14,3
1115	115	23	26,8	14,9	14,9
1120	120	24	27,8	15,5	15,5
1125	125	25	28,9	16,9	16,9

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Fax: ++49 (0) 911 96 26 05-9
D-90451 Nürnberg
e-mail: **info@stepsystems.de**
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It is no problem to determine concentrations of other suspensions or aqueous solutions (eg color suspension) by means of the refractometer. You need to measure a sample from the liquid using a refractometer only once. The result is 12.9% Brix, for example. Then you make a dry sample of the same substance in a drying oven or a chemical analysis in the laboratory. The result is here 8.2% solids content, for example. Now divide both results, the factor is 1.57. Now you have the correlation of the refractometer to the laboratory result. Now, if you measure with a refractometer in the process or in the field, you only need the values to be divided by 1.57 and you get the actual laboratory value.

The measure of the soluble solids in a liquid (and therefore approximately the sugar content) is usually given in "degrees Brix" (°Brix). Indirectly the measure shows thereby an objective value of the fruit ripeness degree. In the meantime, some EC marketing standards (eg for kiwis and melons) define, that "sufficiently ripe" fruits in terms of the standard must display certain Brix values. The EC marketing standards for kiwis, melons and watermelons acquire explicitly refractometer measurement of Brix value as a base for determination of the harvest maturity of the fruit.

Table of recommended values (in % Brix) for maturity determination (approximate figures)

Duisburger Str. 44
Tel: ++49 (0) 911 96 26 05-0
Fax: ++49 (0) 911 96 26 05-9
D-90451 Nürnberg
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Quality	Bad	Medium	Good	Excellent
		Frucht		
Strawberry	8	12	16	18
Apple	6	10	14	18
Blueberry	4	8	16	22
Blackberry	6	8	12	14
Cantaloupe-Melon	8	12	14	18
Hoey Melon	8	10	14	16
Water Melon	8	12	16	18
Grapes	8	12	18	22
Raspberry	6	8	12	14
Cherry	6	8	14	16
Pear	6	10	14	16
Orange	6	10	16	20

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Quality	Bad	Medium	Good	Excellent
		Vegetables		
Potatoe	3	5	7	10
Endives	4	6	10	12
Asparagus	4	6	8	10
Beans	4	8	10	12
Broccoli	6	8	10	12
Field Peas	4	6	10	12
Marrow Pease	8	10	12	14
Cauliflower	4	6	8	10
Cabbage	6	10	12	14
Turnip	4	6	8	10
Kohlrabi	6	8	10	12
Beetroot	6	8	12	14
Maize	6	10	18	24
Sweet Corn	6	10	18	24
Red Pepper	4	6	8	12
Hot Pepper	4	6	8	10
Parsley	4	6	8	10
Celery	4	6	10	12
Salads	4	6	8	10
Tomatoe	4	6	10	14
Onion	4	6	10	12
Carrot	4	8	14	18

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Refractometrical calculation of the alcohol content in the must

With the refractometer you can indirectly determine the potential alcoholic strength by determining the sugar content of the must.
The higher the sugar content of the must, the higher its density. This means that the light beam has low speed and deviation. This deviation depends on the sugar concentration and other soluble agents, so that the higher the concentration is, the larger the deviation of the incident light beam and vice versa. The refractometer allows the examination of the relationship between the refraction degree and the sugar concentration in various units through the proper application of graduated scale.

Normally, temperature has an influence on the measuring result; our refractometers however have automatic temperature compensation. Thus, no corrections of the results are necessary. Note please that the sample to be measured should be in the temperature range around 20 °C. Avoid measurements of samples with the temperature of more than 30 ° C.

The alcohol content can be calculated by the following formula (valid for the range 15 ... 25 Brix.):

% vol = (0.6757 x ° Brix) – 2.0839

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