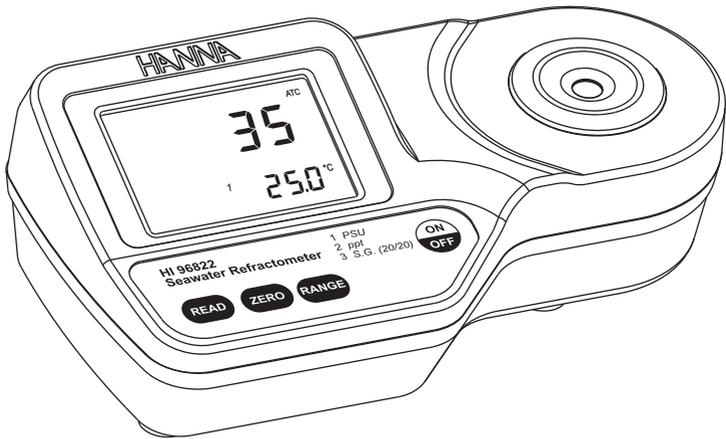# HI 96822

Seawater Refractometer

Dear Customer,

Thank you for choosing a Hanna product. This manual will provide you with the necessary information for the correct use of this instrument. Please read it carefully before using the meter. If you need additional technical information, do not hesitate to e-mail us at tech@hannainst.com. This instrument is in compliance with $C\epsilon$ directives.

TABLE OF CONTENTS

PRELIMINARY EXAMINATION

Remove the instrument from the packing materials and examine carefully to ensure no damage has occurred during shipping. If any damage has occurred, notify your Dealer or closest Hanna Customer Service Center.

Each instrument is supplied with:

- 9 V battery
- Instruction manual

<u>Note</u>: Save all packing material until you are sure that the instrument functions correctly. A defective instrument must be returned in its original packing.

GENERAL DESCRIPTION

The **HI 96822** Digital Refractometer is a rugged portable, water resistant device that utilizes the measurement of refractive index to determine the salinity of natural and artificial seawater, ocean water or brackish intermediates.

The **HI 96822** device benefits from Hanna's years of experience as a manufacturer of analytical instruments. The digital refractometer eliminates the uncertainty associated with mechanical refractometers and is easily potable for ship, shore or home use.

The **HI 96822** refractometer is an optical device that is simple and quick to use. After a simple user calibration with distilled or deionized water, a seawater sample is in introduced to the sample well. Within seconds, the refractive index and temperature are measured and converted into one of 3 popular measurement units; Practical Salinity Units (PSU), Salinity in parts per thousand (PPT), or Specific Gravity (S.G. (20/20)). All conversion algorithms are based upon respected scientific publications using the physical properties of seawater (not sodium chloride). The temperature (in °C or °F) is also displayed on the large dual level display along with helpful message codes.

Key features include:

- IP65 waterproof protection
- Automatic Temperature Compensation (ATC)
- Battery operation with Low Power indicator (BEPS)
- Automatically turns off after 3 minutes of non-use

SPECIFICATIONS

	PSU	PPT	S.G. (20/20)	°C (°F)
Range:	0 to 50	0 to 150	1.000 to 1.114	0 to 80 °C (32 to 176 °F)
Resolution:	1	1	0.001	0.1 °C (0.1 °F)
Accuracy:	±2	±2	±0.002	±0.3 °C (±0.5 °F)

Temperature Compensation: Automatic between 0 and 40 °C (32 - 104 °F)
Measurement Time: Approximately 1.5 seconds
Minimum Sample Volume: 100 μL (cover prism totally)
Light Source: Yellow LED
Sample Cell: Stainless Steel ring and flint glass prism
Case Material: ABS
Enclosure Rating: IP 65
Battery Type / Life: 1 X 9V / 5000 readings
Auto-Off: After 3 minutes of non-use
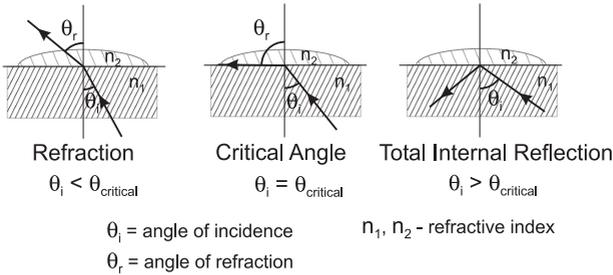Dimensions: 19.2(W) x 10.2(D) x 6.7(H) cm
Mass: 420 g

PRINCIPLE OF OPERATION

Salinity determinations are made by measuring the refractive index of seawater. Refractive Index is an optical characteristic of a substance and the number of dissolved particles in it. Refractive Index is defined as the ratio of the speed of light in empty space to the speed of light in the substance. A result of this property is that light will "bend", or change direction, when it travels through a substance of different refractive index. This is called refraction.

When passing from a material with a higher to lower refractive index, there is a critical angle at which an incoming beam of light can no longer refract, but will instead be reflected off the interface.

Refraction	Critical Angle	Total Internal Reflection
$\theta_i < \theta_{critical}$	$\theta_i = \theta_{critical}$	$\theta_i > \theta_{critical}$

θ_i = angle of incidence
θ_r = angle of refraction

n_1, n_2 - refractive index

The critical angle can be used to easily calculate the refractive index according to the equation:

$$\sin(\theta_{critical}) = n_2 / n_1$$

Where n_2 is the refractive index of the lower-density medium; n_1 is the refractive index of the higher-density medium.
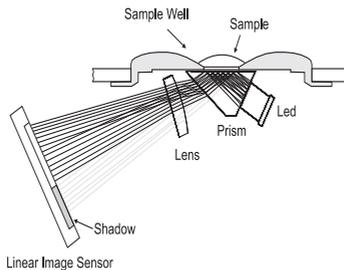
In the **HI 96822** refractometer, light from an LED passes through a prism in contact with the sample. An image sensor determines the critical angle at which the light is no longer refracted through the sample.

Specialized algorithms then apply temperature compensation to the measurement and convert the refractive index to: PSU, PPT or S.G. (20/20).

PSU is defined as a definitive salinity-conductivity ratio relationship. It is based upon the work of the UNESCO, ICES, SCOR and IAPSO. This information is published in The Joint Panal of Oceanographic Tables and Standards. PPT (10^{-3}) is an older used salinity scale where salinity is defined by "the salt content is the weight of the inorganic salts contained in 1 kg of seawater if all bromide and iodide are replaced by an equivalent amount of oxides" (Knudsen, 1901).

Specific Gravity (20/20) is based upon the published relationship between density at 20 °C and the mass of the dissolved salts in the seawater sample (CRC Handbook of Chemistry and Physics, 87th Edition).
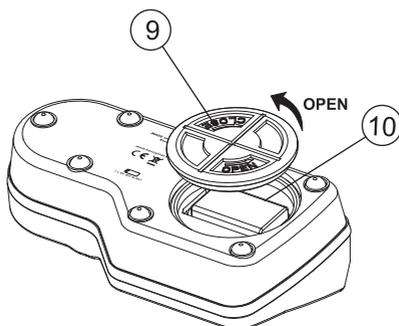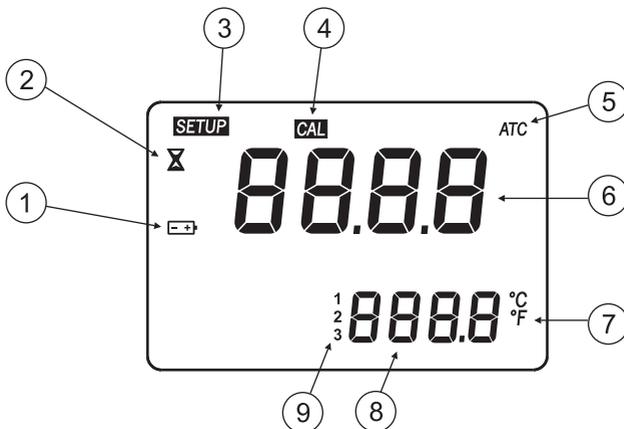
FUNCTIONAL DESCRIPTION

TOP VIEW
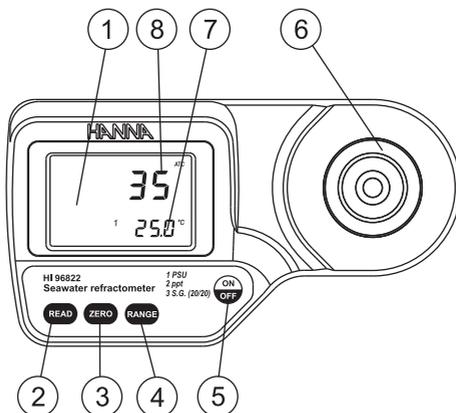
1. Liquid Crystal Display (LCD)
2. READ Key (User Measurement)
3. ZERO Key (User Calibration)
4. RANGE Key (User Measurement Unit)
5. ON/OFF
6. Stainless Steel Sample Well and Prism
7. Secondary Display
8. Primary Display

BOTTOM

9. Battery Cover
10. Battery Compartment

DISPLAY ELEMENTS

1. Battery (blinks when low battery condition detected)
2. Measurement in Progress Tag
3. SETUP: Factory Calibration Tag
4. CAL: Calibration Tag
5. Automatic Temperature Compensation
   (blinks when temperature exceeds 0-40°C / 32-104°F range)
6. Primary Display (displays measurement and error messages)
7. Temperature Units
8. Secondary Display (displays temperature measurements; when blinking, temperature has exceeded operation range: 0-80°C / 32-176°F)
9. Range indicator

MEASUREMENT GUIDELINES

- Handle instrument carefully. Do not drop.
- Do not immerse instrument under water.
- Do not spray water to any part of instrument except the "sample well" located over the prism.
- The instrument is intended to measure seawater solutions. Do not expose instrument or prism to solvents that will damage it. This includes most organic solvents and extremely hot or cold solutions.
- Particulate matter in a sample may scratch the prism. Absorb sample on soft tissue and rinse sample well with deionized or distilled water between samples.
- Use plastic pipettes to transfer all solutions. Do not use metallic tools such as needles, spoons or tweezers as these will scratch the prism.
- Cover sample well with hand if measuring in direct sun.

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. It will briefly display an indication of the measurement units set. 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.

   (For a description of ERROR MESSAGES see page 11).
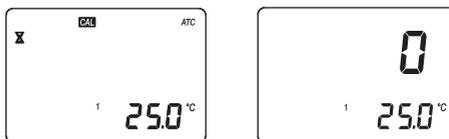
Note: The 0 screen will remain until a sample is measured or the instrument is turned off.

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.

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.

<u>Note</u>: 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.

<u>Note</u>: The last measurement value will be displayed until the next sample is measured or the instrument is turned off. Temperature will be continuously updated.

<u>Note</u>: The "**ATC**" tag blinks and automatic temperature compensation is disabled if the temperature exceeds the 0-40 °C / 32-104 °F range.

4. Remove sample from the sample well by absorbing with 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.

TO CHANGE MEASUREMENT UNIT

Press the **RANGE** key to select measurement units. The instrument toggles between the three measurement scales each time the key is pressed and the primary display indicates "**PSU**", "**PPt**" and "**S.G.**". When the instrument displays the screen with 4 dashes, the instrument is ready for measurement. A number on the display indicates the selected unit: "**1**" denotes PSU, "**2**" denotes PPT and "**3**" denotes Specific Gravity.


TO CHANGE 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.
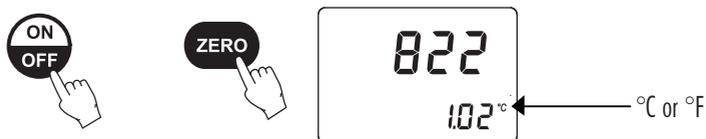
MAKING A STANDARD SOLUTION

Sodium Chloride solutions can be used to check the accuracy of the meter. The table below lists several Sodium Chloride solutions and there expected ppt Seawater value.

To make a Standard NaCl Solution (g/100 g), follow the procedure below:

- Place container (such as a glass vial or dropper bottle that has a cover) on an analytical balance.
- Tare the balance.
- To make an X NaCl solution weigh out X grams of high purity dried Sodium Chloride (CAS #: 7647-14-5: MW 58.44) directly into the container.
- Add distilled or deionized water to the container so the total weight of the solution is 100 g.

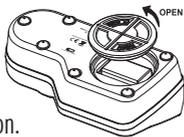|	g of NaCl	g of Water	Total Weight	Expected ppt Seawater Value
5% NaCl	5.00	95.00	100.00	48
10% NaCl	10.00	90.00	100.00	96
15% NaCl	15.00	85.00	100.00	145

BATTERY REPLACEMENT

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

- Make sure the instrument is off.

- Turn instrument upside down and remove the battery cover by turning it counterclockwise.

- Extract the battery from its location.
- Replace with a new 9V battery making sure to observe polarity.
- Insert the back battery cover and fasten it by turning clockwise to engage.

WARRANTY

The **HI 96822** is warranted for two years against defects in workmanship and materials when used for its intended purpose and maintained according to the instructions.
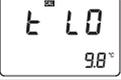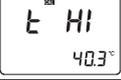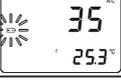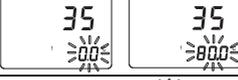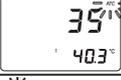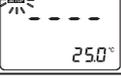
This warranty is limited to repair or replacement free of charge.

Damage due to accident, misuse, tampering or lack of prescribed maintenance is not covered.

If service is required, contact your dealer. If under warranty, report the model number, date of purchase, serial number and the nature of the failure. If the repair is not covered by the warranty, you will be notified of the charges incurred.

If the instrument is to be returned to Hanna Instruments, first obtain a Returned Goods Authorization Number from the Customer Service Department and then send it with shipment costs prepaid. When shipping any instrument, make sure it is properly packaged for complete protection.

To validate your warranty, fill out and return the enclosed warranty card within 14 days from the date of purchase.

ERROR MESSAGES

Error Code	LCD	Description
"Err"	Err 25.0°	General failure. Cycle power to instrument. If error persists, contact Hanna.
"LO" Primary display	LO 25.0°	Sample is reading lower than the 0 standard used for meter calibration.
"HI" Primary display	HI 25.0°	Sample exceeds maximum measurement range.
"LO" Primary display "CAL" segment ON	LO 25.0°	Wrong solution used to zero instrument. Use deionized or distilled water. Press **ZERO**.
"HI" Primary display "CAL" segment ON	HI 25.0°	Wrong solution used to zero instrument. Use deionized or distilled water. Press **ZERO**.
"t LO" Primary display "CAL" segment ON	$t\ LO$ 9.8°	Temperature exceeds ATC low limit (0 °C) during calibration.
"t HI" Primary display "CAL" segment ON	$t\ HI$ 40.3°	Temperature exceeds ATC high limit (40 °C) during calibration.
"Air"	Air 25.0°	Prism surface insufficiently covered.
"ELt"	ELt 25.0°	Too much external light for measurement. Cover sample well with hand.
"nLt"	nLt 25.0°	LED light is not detected. Contact Hanna.
Battery segment blinking	35 25.3°	<5 % of battery life is remaining.
Temperature values are blinking "0.0°C" or "80.0°C"	35 0.0° 35 80.0°	Temperature measurement out of sampling range (0 to 80°C).
"ATC" segment blinking	35 40.3°	Outside temperature compensation range (0 to 40°C).
"SETUP" segment blinking	- - - - 25.0°	Factory calibration lost. Contact Hanna.

Local Sales and Customer Service office