INSTRUCTION MANUAL

HI96822

Digital Seawater Refractometer

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Dear Customer,

Thank you for choosing a Hanna Instruments® product.
Please read this instruction manual carefully before using this instrument as it provides the necessary information for correct use of this instrument, and a precise idea of its versatility.
If you need additional technical information, do not hesitate to e-mail us at tech@hannainst.com.
Visit www.hannainst.com for more information about Hanna Instruments and our products.

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1. PRELIMINARY EXAMINATION

Remove the instrument and accessories from the packaging and examine it carefully. For further assistance, please contact your local Hanna Instruments® office or email us at tech@hannainst.com.

Each HI96822 instrument is supplied with:

- Plastic pipette
- 9 V battery
- Quick reference guide with QR code for manual download and instrument quality certificate

Note: *Save all packing material until you are sure that the instrument works correctly. Any damaged or defective item must be returned in its original packing material with the supplied accessories.*

2. GENERAL DESCRIPTION

The HI96822 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 HI96822 device benefits from Hanna Instruments' years of experience as a manufacturer of analytical instruments. The digital refractometer eliminates the uncertainty associated with mechanical refractometers and is easily portable for ship, shore or home use.

The HI96822 refractometer is an optical device that is simple and quick to use. Samples are measured after a simple user calibration with distilled or deionized water. 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

3. SPECIFICATIONS

PSU	Range	0 to 50 PSU
	Resolution	1 PSU
	Accuracy	±2 PSU
ppt	Range	0 to 150 ppt
	Resolution	1 ppt
	Accuracy	±2 ppt
Specific Gravity S.G. (20/20)	Range	1.000 to 1.114 Specific Gravity
	Resolution	0.001 Specific Gravity
	Accuracy	±0.002 Specific Gravity
Temperature	Range	0.0 to 80.0°C (32.0 to 176.0 °F)
	Resolution	0.1 °C / 0.1 °F
	Accuracy	±0.3 °C / ±0.5 °F
Temperature compensation		Automatic 0.0 to 40.0 °C (32.0 to 104.0 °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		IP65
Battery type / life		9 V / 5000 readings
Auto-off		After 3 minutes of non-use
Dimensions		192×102×69 mm (7.6×4.1×2.7")
Weight		350 g (12.3 oz.)

4. PRINCIPLE OF OPERATION

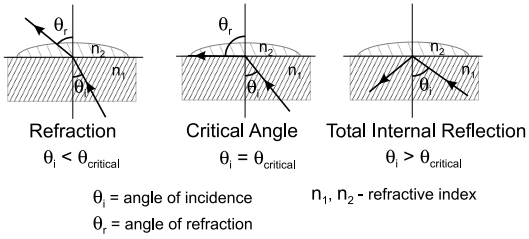
Salinity determinations are made by measuring the refractive index of seawater.
Refractive Index is an optical characteristic of a substance and the number of dissolved particles in it. Refractive Index is defined as the ratio of the speed of light in empty space to the speed of light in the substance. 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.
The critical angle can be used to easily calculate the refractive index according to the equation:

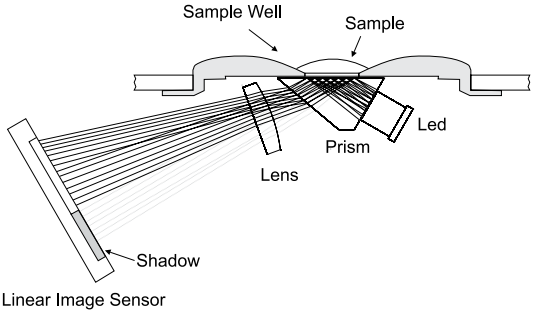
$$\sin(\theta_{critical}) = n_2 / n_1$$

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 HI96822, 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.



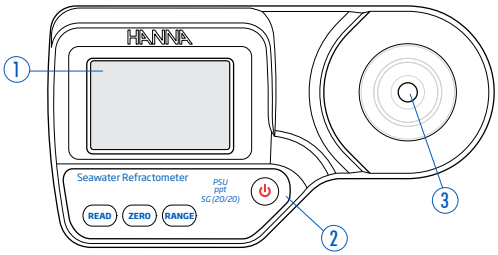
Specialized algorithms then apply temperature compensation to the measurement and convert the refractive index to: PSU (Practical Salinity Units), ppt (part per thousand) or S.G. (Specific Gravity) (20/20).

PSU is defined as the conductivity ratio of seawater to a standard KCl solution. It is based upon the work of the UNESCO, ICES, SCOR and IAPSO. This information is published in The Joint Panel of Oceanographic Tables and Standards. An older salinity scale is ppt (10^{-3}), 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).

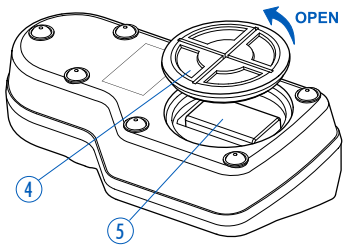
Specific Gravity (20/20) is based upon the published relationship between density at 20 °C and the mass of dissolved salts in the seawater sample (CRC Handbook of Chemistry and Physics, 87th Edition).

5. FUNCTIONAL DESCRIPTION

Top View



Rear View

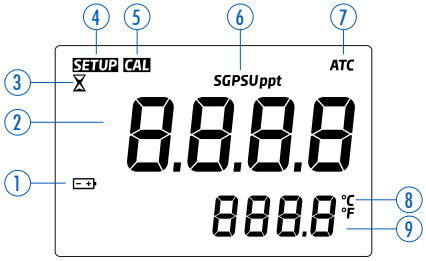


1. Liquid Crystal Display (LCD)
2. Keypad
3. Stainless steel sample well and prism
4. Battery cover
5. Battery compartment

Keypad

- ON/OFF
- READ User measurement
- ZERO User calibration
- RANGE User measurement unit

Display Elements



1. Battery (blinks when low battery condition detected)
2. Primary display (displays measurement and error messages)
3. Measurement in progress tag
4. SETUP: factory calibration tag
5. CAL: calibration tag
6. Measurement units
7. Automatic temperature compensation
   (blinks when temperature exceeds 0.0 to 40.0 °C / 32.0 to 104.0 °F range)
8. Temperature units
9. Secondary display (displays temperature measurements; when blinking, temperature has exceeded operation range: 0.0 to 80.0 °C / 32.0 to 176.0 °F)

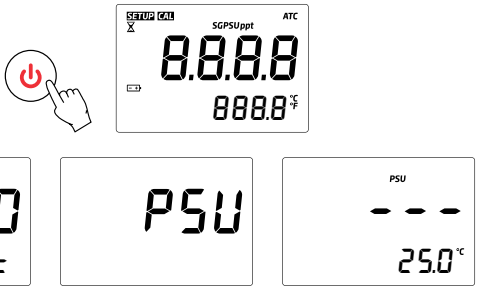
6. MEASUREMENT GUIDELINES

- 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 with a 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.
- To reduce the effects of evaporation or absorption of water when taking readings over a period of time, the prism and sample well can be covered with plastic wrap.

7. CALIBRATION PROCEDURE

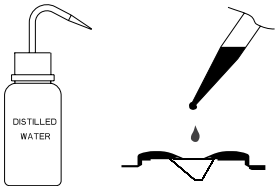
Calibration should be performed daily, before measurements are made, when the battery has been replaced, between a long series of measurements, or if environmental changes have occurred since the last calibration.

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. The meter will briefly display an indication of the measurement units set. When 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 (see Error Messages section).

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

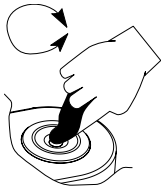
4. Gently absorb the ZERO water standard with a soft tissue.
   Use care not to scratch the prism surface.
   Dry the surface completely.
   The instrument is ready for sample measurement.

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

8. MEASUREMENT PROCEDURES

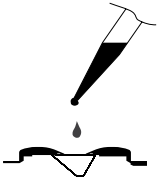
Verify the instrument has been calibrated before taking measurements.

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.

   Note: *If the temperature of the sample differs significantly from the temperature of the instrument, wait approximately 1 minute to allow thermal equilibration.*

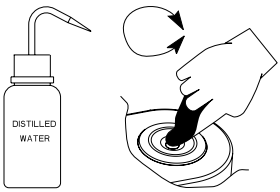


3. Press the **READ** key. The result is displayed in the selected units of interest.

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.*

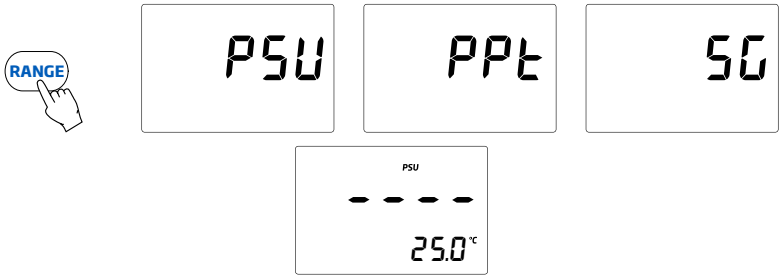
The ATC tag blinks and automatic temperature compensation is disabled if the temperature exceeds the 0.0 to 40.0 °C / 32.0 to 104.0 °F range.

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 **"SG"**. When the instrument displays the screen with 4 dashes, the instrument is ready for measurement.



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.

9. MAKING A NaCl STANDARD SOLUTION (g/100 g)

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

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

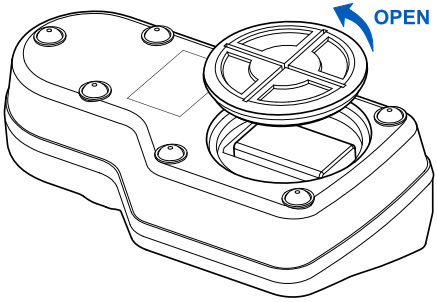
- Place container (such as a glass vial or dropper bottle that has a cover) on an analytical balance.
- Tare the balance.
- To make an X NaCl solution weigh out X grams of high purity dried Sodium Chloride (CAS #: 7647-14-5: MW 58.44) directly into the container.
- Add distilled or deionized water to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

	g of NaCl	g of Water	Total Weight	Expected ppt Seawater Value
3.5% NaCl	3.50	96.50	100.00	34
10% NaCl	10.00	90.00	100.00	96

10. BATTERY REPLACEMENT

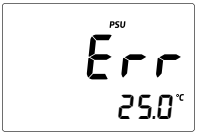
To replace the instrument's battery, follow these steps:

- 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 9 V battery making sure to observe polarity.
- Insert the back battery cover and fasten it by turning clockwise to engage.



11. ERROR MESSAGES

"Err"
General failure. Cycle power to instrument.
If error persists, contact your local Hanna Instruments® office.



"LO" primary display
Sample exceeds minimum measurement range.

"HI" primary display
Sample exceeds maximum measurement range.

"LO" primary display Cal segment ON
Wrong solution used to zero instrument.
Use deionized or distilled water. Press **ZERO**.

"HI" primary display Cal segment ON
Wrong solution used to zero instrument.
Use deionized or distilled water. Press **ZERO**.

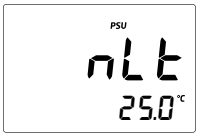
"t LO" primary display Cal segment ON
Temperature exceeds ATC low limit (0.0 °C) during calibration.

"t HI" primary display Cal segment ON
Temperature exceeds ATC high limit (40.0 °C) during calibration.

"Air"
Prism surface insufficiently covered.

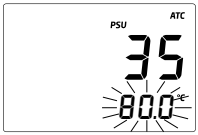
"ELt"
Too much external light for measurement.
Cover sample well with hand.

"nLt"
LED light is not detected.
Contact your local Hanna Instruments® office.



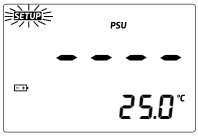
Battery segment blinking
< 5 % of battery life is remaining.

Temperature values are blinking "0.0 °C" or "80.0 °C"
Temperature measurement out of range (0.0 to 80.0 °C).



ATC segment blinking
Outside temperature compensation range (0.0 to 40.0 °C).

SETUP segment blinking
Factory calibration lost.
Contact your local Hanna Instruments office.



12. ACCESSORIES

Ordering Information	Product Description
HI740157P	Plastic refilling pipette (20 pcs.)
HI740029P	9 V battery (10 pcs.)

CERTIFICATION

All Hanna® instruments conform to the **CE European Directives** and **UK standards.**

Disposal of Electrical & Electronic Equipment. The product should not be treated as household waste. Instead, hand it over to the appropriate collection point for the recycling of electrical and electronic equipment, which will conserve natural resources.

Disposal of waste batteries. This product contains batteries, do not dispose of them with other household waste. Hand them over to the appropriate collection point for recycling. Ensuring proper product disposal prevents potential negative consequences for the environment and human health. For more information, contact your city, your local household waste disposal service, or the place of purchase.

RECOMMENDATIONS FOR USERS

Before using this product, make sure it is entirely suitable for your specific application and for the environment in which it is used. Any variation introduced by the user to the supplied equipment may degrade the meter's performance. For your and the meter's safety do not use or store the meter in hazardous environments.

WARRANTY

HI96822 is warranted for two years against defects in workmanship and materials when used for its intended purpose and maintained according to instructions.

This warranty is limited to repair or replacement free of charge. Damage due to accidents, misuse, tampering or lack of prescribed maintenance is not covered.

If service is required, contact your local Hanna Instruments® office. If under warranty, report the model number, date of purchase, serial number, and the nature of the problem. If the repair is not covered by the warranty, you will be notified of the charges incurred. If the meter is to be returned to Hanna Instruments, first obtain a Returned Goods Authorization number from the Technical Service department and then send it with shipping costs prepaid. When shipping any instrument, make sure it is properly packed for complete protection.