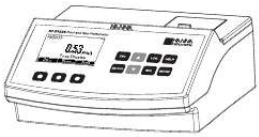
Instruction Manual

HI 83226

Multiparameter Bench Photometer for Pool & Spa Applications



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Manual abstract:

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 2 PRELIMINARY EXAMINATION Please examine this product carefully. Make sure that the instrument is not damaged. If any damage occurred during shipment, please notify your local Hanna Office. Each Meter is supplied complete with: · Four Sample Cuvettes and Caps · Cloth for wiping cuvettes (1 pcs) · Scissors · AC/DC Power Adapter · Instruction Manual Note: Save all packing material until you are sure that the instrument works correctly. Any defective item must be returned in its original packing with the supplied accessories. ABBREVIATIONS EPA: °C: °F: g/L: mg/L: g/L: mL: HR: MR: LR: PAN: TPTZ: US Environmental Protection Agency degree Celsius degree Fahrenheit micrograms per liter (ppb) milligrams per liter (ppm) grams per liter (ppt) milliliter high range medium range low range 1-(2-pyridylazo)-2-naphtol 2,4,6-tri-(2-pyridyl)-1,3,5-triazine GENERAL DESCRIPTION HI 83226 is a multiparameter bench photometer dedicated for Pool & SPA applications. It measures 11 different methods using specific liquid or powder reagents.

The amount of reagent is precisely dosed to ensure maximum reproducibility. HI 83226 bench photometer can be connected to a PC via an USB cable. The optional HI 92000 Windows ® Compatible Software helps users manage all their results. HI 83226 has a powerful interactive user support that assists the user during the analysis process. Each step in the measurement process is help supported. A tutorial mode is available in the Setup Menu. 3 SIGNIFICANCE OF POOL AND SPA TESTING A major family leisure pursuit is the enjoyment of Swimming Pool and Spa facilities world-wide. A basic necessity of Pool water treatment, to ensure such enjoyment, is to maintain the water in a safe and pleasant condition for the bathers. In order to achieve such an objective, swimming pool water requires testing on daily, and sometimes hourly bases for disinfection residuals and pH. Equally important, Calcium Hardness and Alkalinity parameters should be monitored on weekly bases to ensure the pool water is maintained in a balanced condition, thus to avoid system failure because of corrosion or scale formation.

DISINFECTION RESIDUAL AND pH CONTROL In terms of swimming pool treatment, disinfection or sanitizing basically means to rid the pool of bather pollution, destroy bacteria, and control nuisance organisms like algae, which may occur in the pool, filtration equipment, and piping. There are a number of techniques used, namely, chlorine, bromine and ozone dosing systems, of which chlorine is the most common. Chlorine Chlorine is a strong oxidizing agent that destroys mostly organic pollutants, bacteria and can combine with nitrogen containing compounds, forming chloramines. Only a part of the original quantity dosed chlorine, remains active and continues its disinfecting action. From the free chlorine you can distinguish combined chlorine, as that part which combines with nitrogen containing compound and that is less efficient as a disinfectant.

The addition of these two parts gives total chlorine. A pool manager needs to aim perfection where free equals total chlorine, and thus to maintain the combined chlorine concentration near zero. The presence of chloramines is not desired because of the distinctive `swimming pool' smell caused by combined chlorines like di-chloramines. Beside this unpleasant odour it does irritate the eyes and the mucous membranes. Commercially chlorine for disinfection may be available as a gas (Cl2), a liquid like sodium hypochlorite or bleach (NaOCl) or in a solid state like calcium hypochlorite, chloro-hydantoins or chloro-cyanuric acid compounds.

These compounds, once dissolved in water do establish equilibrium between the hypochlorous acid (HOCl) and the hypochlorite ions (OCl^-). Although both forms are considered free chlorine, it is the hypochlorous acid that provides the strongest disinfecting and oxidising characteristic of chlorine solutions. The amount of hypochlorous acid in chlorinated water dependends upon the pH value of the solution. Changes in pH value will effect the HOCl equilibrium in relation to the hydrogen and hypochlorite ion. As depicted by the curve on the next page, HOCl decreases and OCl^- increases as pH increases. At a low pH, almost all the free chlorine is in the molecular form HOCl and at a pH of around 7.5, the ratio between HOCl and OCl^- is 50:50. Since the ionic form OCl^- is a slow acting sanitizer while the molecular HOCl is a fast acting, it is important to measure regularly the pH. As a general rule a pH of about 7.2 is recommended to maintain fast acting disinfection conditions.

4 Bromine In many countries bromine sanitizing has been introduced as an alternative for chlorine, although it is a less strong sanitizer. The advantage of bromine is its stability at higher temperatures (advantageous for hot well pools), and its maintained disinfection power at higher pH. Further it does hardly react with nitrogen compounds, reducing the unpleasant odour,and eye irritation problems. The main disadvantage of bromine is the slower acting disinfecting power, making it less suitable for larger pools. Ozone Ozone is a very strong oxidizing agent that does destroy most difficult to oxidize organic compounds and chloramines. It thus allows the pool manager to remove very efficiently combined chlorine without refreshing frequently large amounts of pool water. In general its application is found just before water passes through the filter units. Its sanitizing power is not pH related. Mainly because of its strong oxidizing power the return water may contain only trace concentrations of ozone. It has to be mentioned that ozone is very unstable and there is anyway the need for low-level chlorination to ensure sanitizing throughout the whole pool.
THE WATER BALANCE AND LANGELIER INDEX (LI) The pool water characteristics need to be maintained in a balanced condition to avoid system failure. Measuring the water balance is extremely important to predict if the water is corrosive, scaling or balanced. A saturation index developed by Dr. Wilfred Langelier is widely used to predict the balance of swimming pool waters. It is an estimation of the solutions ability to dissolve or precipitate calcium carbonate deposits.

A certain level of this precipitation (filming) is desired to insulate pipes and boilers from contact with water. When no protective filming is formed, water is considered to be corrosive. On the other hand scaling does cause failure because of incrustation problems. In the treatment and monitoring of pool water, the pool manager must ensure that related parameters as alkalinity, hardness and pH are duly taken into consideration. 5 Calcium Hardness The presence of calcium in the system is desired to ensure filming on those places where the temperature is relatik that the water becomes corrosive; frequently testing is recommended.

7 SPECIFICATIONS Life of the instrument Silicon Photocell 0 to 50°C (32 to 122°F); max 90% RH non-condensing Power Supply external 12 Vdc power adapter Auto-Shut off built-in rechargeable battery Dimensions 235 x 200 x 110 mm (9.2 x 7.87 x 4.33") Weight 0.9 Kg For specifications related to each single method (e.g. range, resolution, etc.), refer to the related measurement section. Light Life Light Detector Environment PRECISION AND ACCURACY Precision is how closely repeated measurements agree with each other. Precision is usually expressed as standard deviation (SD).

Accuracy is defined as the nearness of a test result to the true value. Although good precision suggests good accuracy, precise results can be inaccurate. The figure explains these definitions. For each method, the precision is expressed in the related measurement section. PRINCIPLE OF OPERATION Absorption of light is a typical phenomenon of interaction between electromagnetic radiation and matter. When a light beam crosses a substance, some of the radiation may be absorbed by atoms, molecules or crystal lattices. If pure absorption occurs, the fraction of light absorbed depends both on the optical path length through the matter and on the physical-chemical characteristics of substance according to the Lambert-Beer Law: -log I/Io = c d or A = c d 8 Where: -log I/Io= Absorbance (A) Io = intensity of incident light beam I = intensity of light beam after absorption = molar extinction coefficient at wavelength c = molar concentration of the substance d = optical path through the substance Therefore, the concentration "c" can be calculated from the absorbance of the substance as the other factors are known. Photometric chemical analysis is based on the possibility to develop an absorbing compound from a specific chemical reaction between sample and reagents. Given that the absorption of a compound strictly depends on the wavelength of the incident light beam, a narrow spectral bandwidth should be selected as well as a proper central wavelength to optimize measurements. The optical system of HI 83226 is based on special subminiature tungsten lamps and narrow-band interference filters to guarantee both high performance and reliable results.

Two measuring channels allow a wide range of tests. Instrument block diagram (optical layout) A microprocessor controlled special tungsten lamp emits radiation which is first optically conditioned and beamed through the sample contained in the cuvette. The optical path is fixed by the diameter of the cuvette. Then the light is spectrally filtered to a narrow spectral bandwidth, to obtain a light beam of intensity Io or I. The photoelectric cell collects the radiation I that is not absorbed by the sample and converts it into an electric current, producing a potential in the mV range.

The microprocessor uses this potential to convert the incoming value into the desired measuring unit and to display it on the LCD. The measurement process is carried out in two phases: first the meter is zeroed and then the actual measurement is performed. The cuvette has a very important role because it is an optical element and thus requires particular attention. It is important that both the measurement and the calibration (zeroing) cuvette are optically identical to provide the same measurement conditions. Most methods use the same cuvette for both, so it is important that measurements are taken at the same optical point.

The instrument and the cuvette cap have special marks that must be aligned in order to obtain better reproducibility. The surface of the cuvette must be clean and not scratched. This is to avoid measurement interference due to unwanted reflection and absorption of light. It is recommended not to touch the cuvette walls with hands. Furthermore, in order to maintain the same conditions during the zeroing and the measurement phases, it is necessary to cap the cuvette to prevent any contamination. 9 FUNCTIONAL DESCRIPTION INSTRUMENT DESCRIPTION 1) 2) 3) 4) 5) 6) 7) 8) Open Cuvette Lid Indexing mark Cuvette point Liquid Crystal Display (LCD) Splash proof keypad ON/OFF power switch Power input connector USB connector 10 KEYPAD DESCRIPTION The keypad contains 8 direct keys and 3 functional keys with the following functions: Press to perform the function displayed above it on the LCD. ESC Press to exit the current screen. Press to access the select method menu. Press to move up in a menu or a help screen, to increment a set value, to access second level functions. Press to move down in a menu or a help screen, to decrement a set value, to access second level functions.

Press to log the current reading. RCL Press to recall the log. Press to display the help screen. Press to access the setup screen. HELP SETUP TIPS FOR AN ACCURATE MEASUREMENT The instructions listed below should be carefully followed during testing to ensure most accurate results. · Color or suspended matter in large amounts may cause interference, and should be removed by treatment with active carbon and filtration. · Ensure the cuvette is filled correctly: the liquid in the cuvette forms a convexity on the top; the bottom of this convexity must be at the same level as the 10 mL mark. COLLECTING AND MEASURING SAMPLES · In order to measure exactly 0.5 mL of reagent with the 1 mL syringe: (a) push the plunger completely into the syringe and insert the tip into the solution. (b) pull the plunger up until the lower edge of the seal is exactly on the 0.

0 mL mark. 11 (c) take out the syringe and clean the outside of the syringe tip. Be sure that no drops are hanging on the tip of the syringe, if so eliminate them. Then, keeping the syringe in vertical position above the cuvette, push the plunger down into the syringe until the lower edge of the seal is exactly on the 0.5 mL mark.

Now the exact amount of 0.5 mL has been added to the cuvette, even if the tip still contains some solution. USING LIQUID AND POWDER REAGENTS · Proper use of the dropper: (a) for reproducible results, tap the dropper on the table for several times and wipe the outside of the dropper tip with a cloth. (b) always keep the dropper bottle in a vertical position while dosing the reagent. (a) (b) · Proper use of the powder reagent packet: (a) use scissors to open the powder packet; (b) push the edges of the packet to form a spout; (c) pour out the content of the packet.

12 USING CUVETTES · Proper mixing of the cuvette is done by shaking the cuvette, moving the cuvette up and down. The movement may be gentle or vigorous. This mixing method is indicated with "shake gently" or "shake vigorously", and one of the following icons: shake gently shake vigorously · Pay attention to push the cuvette completely down in the holder and to align the white point on the cap to the indexing mark on the meter. · In order to avoid reagent leaking and to obtain more accurate measurements, close the cuvette first with the supplied HDPE plastic and then the black cap. stopper · Whenever the cuvette is placed into the measurement cell, it must be dry outside, and free of fingerprints, oil or dirt. Wipe it thoroughly with HI 731318 or a lint-free cloth prior to insertion. · Shaking the cuvette can generate bubbles in the sample, causing higher readings. To obtain accurate measurements, remove such bubbles by swirling or by gently tapping the cuvette. · Do not let the reacted sample stand too long after reagent is added. For best accuracy, respect the timings described in each 13 specific method.

· It is possible to take multiple readings in a row, but it is recommended to take a new zero reading for each sample and to use the same cuvette for zeroing and measurement when possible (for most precise results follow the measurement procedures carefully). · Discard the sample immediately after the reading is taken, or the glass might become permanently stained. · All the reaction times reported in this manual are at 25 °C (77 °F). In general, the reaction time should be increased for temperatures lower than 20 °C (68 °F), and decreased for temperatures higher than 25 °C (77 °F). INTERFERENCES · In the method measurement section the most common interferences that may be present in an average sample matrix have been reported. It may be that for a particular treatment process other compounds do interfere with the method of analysis. HEALTH & SAFETY · The chemicals contained in the reagent kits may be hazardous if improperly handled. · Read the Material Safety Data Sheet (MSDS) before performing tests. · Safety equipment: Wear suitable eye protection and clothing when required, and follow instructions carefully. · Reagent spills: If a reagent spill occurs, wipe up immediately and rinse with plenty of water. If reagent contacts skin, rinse the affected area thoroughly with water. Avoid breathing released vapors. · Waste disposal: for proper disposal of reagent kits and reacted samples, refer to the Material Safety Data Sheet (MSDS). METHOD REFERENCE TABLE Method 1 2 3 4 5 6 Method description Alkalinity Bromine Calcium Hardness Free Chlorine Total Chlorine Free Copper Page 20 22 24 27 29 31 Method 7 8 9 10 11 Method description Total Copper Cyanuric Acid Iron Ozone pH Page 33 35 37 39 42 14 OPERATIONAL GUIDE POWER CONNECTION AND BATTERY MANAGEMENT The meter can be powered from an AC/DC adapter (included) or from the built-in rechargeable battery. Note: Always turn the meter off before unplugging it to ensure no data is lost.

When the meter switches ON, it verifies if the power supply adapter is connected. The battery icon on the LCD will indicate the battery status: - battery is charging from external adapter - battery fully charged (meter connected to AC/DC adapter) - battery capacity (no external adapter) - battery Low (no external adapter) - battery Dead (no external adapter) METHOD SELECTION · Turn the instrument ON via the ON/OFF power switch. · The meter will perform an autodiagnostic test. During this test, the Hanna Instrument logo will appear on the LCD. After 5 seconds, if the test was successful, the last method used will appear on the display.

· In order to select the desired method press the METHOD key and a screen with the available methods will appear. · Press the keys to highlight the desired method. Press Select. 15 · After the desired method is selected, follow the measurement described in the related section. @@The data log can hold 200 individual measurements. @@. Storing data: You can store only a valid measurement. @@You can only delete the last saved measurement. @@@@@@@@Press SETUP to enter the setup mode. Press ESC or SETUP to return to the main screen.

@@Press HELP for additional information. @@Press the Modify key to access the backlight value. @@@@This option is used to set the display's contrast. Press the Modify key to change the display's contrast. @@@@Press the Modify key to change the date/time. @@Use the keys to change the value. @@@@Use the keys to select the desired format. @@@@@@@@When enabled, a short beep is heard every time a key is pressed. @@@@This option is used to set the instrument's ID (identification number). The instrument ID is used while exchanging data with a PC.

Press the Modify key to access the instrument ID screen. Press the keys in order to set the desired value. Press the Accept key to confirm the value or ESC to return to the setup menu without saving the new value. Meter information Press the Select key to view the instrument model, firmware version, language version and instrument serial number. Press ESC to return to the Setup mode.

H E L P MODEE HELP M O D HI 83226 offers an interactive contextual help mode that assists the user at any time. To access the help screens press HELP. The instrument will display additional information related to the current screen. To read all the available information, scroll the text using the keys. Press the Support key to access a screen with Hanna service centers and their contact details.

Press the Accessories key to access a list of instrument reagents and accessories. To exit support or accessories screens press ESC and the instrument will return to the previous help screen. To exit help mode press the HELP or ESC key again and the meter will return to the previously selected screen. 19 ALKALINITY SPECIFICATIONS Range Resolution Accuracy Typical EMC Deviation Light Source Method 0 to 500 mg/L (as CaCO3) 5 mg/L ±5 mg/L ±10% of reading at 25 °C ±5 mg/L Tungsten lamp with narrow band interference filter @ 575 nm Colorimetric Method. At different alkalinity levels a distinctive range of colors from yellow to green and greenish blue will develop. Description Alkalinity Indicator Reagent Quantity/test 1 packet REQUIRED REAGENTS Code HI 93755-0 REAGENT SETS HI 93755-01 Reagents for 100 tests HI 93755-03 Reagents for 300 tests For other accessories see page 46. MEASUREMENT PROCEDURE · Select the Alkalinity method using the procedure described in the Method Selection section (see page 15). · Fill the cuvette with 10 mL of unreacted sample, up to the mark, and replace the cap. · Place the cuvette into the holder and close the lid.

10 mL · Press the Zero key.

The display will show "-0.0-" when the meter is zeroed and ready for measurement. Alkalinity 20 · Remove the cuvette. · Carefully add the content of one packet of HI 93755-0 Alkalinity Indicator Reagent. Replace the cap and shake vigorously for 30 seconds. Note: Pay attention not to spill reagent otherwise full color development may be inhibited. · Press Timer or wait for 2 minutes. Then invert 3 times the cuvette gently again. · Reinsert the cuvette into the instrument and close the lid. · Press Read to start the reading.

· The instrument displays the results in mg/L of alkalinity (CaCO3). 21 BROMINE SPECIFICATIONS Range Resolution Accuracy Typical EMC Deviation Light Source Method 0.00 to 10.00 mg/L 0.01 mg/L ±0.

08 mg/L ±3% of reading at 25 °C ±0.01 mg/L Tungsten lamp with narrow band interference filter @ 525 nm Adaptation of the Standard Methods for the Examination of Water and Wastewater, 20th edition, DPD method. The reaction between bromine and the reagent causes a pink tint in the sample. Description DPD Reagent Quantity 1 packet REQUIRED REAGENTS Code HI 93716-0 REAGENT SETS HI 93716-01 Reagents for 100 tests HI 93716-03 Reagents for 300 tests For other accessories see page 46. MEASUREMENT PROCEDURE · Select the Bromine method using the procedure described in the Method Selection section (see page 15).

@@· Place the cuvette into the holder and close the lid. 10 mL · Press the Zero key. The display will show "-0.0-" when the meter is zeroed and ready for measurement. Bromine 22 · Remove the cuvette and add the content of one packet of HI 93716-0 DPD reagent. Replace the cap and shake gently for about 20 seconds to dissolve most of the reagent. · Reinsert the cuvette into the instrument. · Press Timer and the display will show the countdown prior to the measurement or, alternatively, wait for 2 minutes and 30 seconds and press Read. When the timer ends the meter will perform the reading. · The instrument displays the results in mg/L of bromine.

INTERFERENCES Interference may be caused by: Chlorine, Iodine, Ozone, Oxidized forms of Chromium and Manganese. In case of water with hardness greater than 500 mg/L CaCO3, shake the sample for approximately 2 minutes after adding the reagent. In case of water with alkalinity greater than 250 mg/L CaCO3 or acidity greater than 150 mg/L CaCO3, the color of the sample may develop only partially, or may rapidly fade. To resolve this, neutralize the sample with diluted HCl or NaOH. 23 Bromine CALCIUM HARDNESS SPECIFICATIONS Range Resolution Accuracy Typical EMC Deviation Light Source Method 0 to 500 mg/L (as CaCO3) 5 mg/L ±10 mg/L ±5% of reading at 25 °C ±5 mg/L Tungsten lamp with narrow band interference filter @ 525 nm Adaptation of the Standard Methods for the Examination of Water and Wastewater, 18th edition, Calmagite method. The reaction between calcium and reagents causes a reddish-violet tint in the sample. Description Ca & Mg indicator Alkali solution EGTA solution Quantity 0.5 mL 0.5 mL 1 drop REQUIRED REAGENTS Code HI 93720A-0 HI 93720B-0 HI 93720C-0 REAGENT SETS HI 93720-01 Reagents for 100 tests HI 93720-03 Reagents for 300 tests For other accessories see page 46. MEASUREMENT PROCEDURE · Select the Calcium Hardness method using the procedure described in the Method Selection section (see page 15).

· Rinse a graduated beaker several times with deionized water, fill a 1 mL syringe with the sample, and inject 0.5 mL into the beaker. Fill the beaker up to the 50 mL mark with hardness-free water. · Add 0.5 mL of HI 93720A-0 Calcium indicator solution and swirl to mix.

#1 #2 · Add 0.5 mL of HI 93720B-0 Alkali solution and swirl to mix. Use this solution to rinse 2 cuvettes before filling them up to the 10 mL mark. Calcium Hardness 24 · Add 1 drop of HI 93720C-0 EGTA solution to one cuvette (# 1), replace the cap and invert the cuvette several times to mix. This is the blank. #1 #1 · Place the blank (# 1) into the holder and close the lid. · Press the Zero key. The meter will show "-0.0-" when the meter is zeroed and ready for measurement. · Remove the blank and insert the second cuvette (# 2) into the instrument. #2 · Press Read to start the reading. The instrument displays concentration in mg/L of calcium hardness, as CaCO3. · Press or to access the second level functions. · Press the Chem Frm key to convert the result in mg/L of Calcium (Ca). 25 Calcium Hardness · Press the Unit key to change the current measurement unit.

The results can be converted to French degrees (°f), German degrees (°dH) and English degrees (°E). · Press or to return to the measurement screen. Note: This test will detect any calcium contamination in the beaker, measuring syringes or sample cells. To test cleanliness, repeat the test multiple times until you obtain consistent results. Note: For better accuracy wash glassware with HCl 6N. INTERFERENCES Interference may be caused by excessive amounts of heavy metals. Calcium Hradness 26 FREE CHLORINE FREE CHLORINE SPECIFICATIONS Range Resolution Accuracy Typical EMC Deviation Light Source Method 0.00 to 5.00 mg/L 0.01 mg/L from 0.

00 to 2.50 mg/L; 0.10 mg/L above 2.50 mg/L ±0.03 mg/L ±3% of reading at 25 °C ±0.

01 mg/L Tungsten lamp with narrow band interference filter @ 525 nm Adaptation of the USEPA method 330.5 and Standard Methods for the Examination of Water and Wastewater, 20th edition, 4500-Cl G. The reaction between free chlorine and the DPD reagent causes a pink tint in the sample. Description DPD powder Reagent Quantity 1 packet REQUIRED REAGENTS Code HI 93701-0 REAGENT SETS HI 93701-01 Reagents for 100 tests HI 93701-03 Reagents for 300 tests For other accessories see page 46. MEASUREMENT PROCEDURE · Select the Free Chlorine method using the procedure described in the Method Selection section (see page 15).

@@· Place the cuvette into the holder and close the lid. 10 mL 27 Free Chlorine · Press the Zero key. The meter will show "-0.0-" when the meter is zeroed and ready for measurement. · Remove the cuvette. · Add the content of one packet of HI 93701-0 DPD reagent. Replace the cap and shake gently for 20 seconds. · Reinsert the cuvette into the instrument. · Press Timer and the display will show the countdown prior to the measurement or, alternatively, wait for 1 minute and press Read. When the timer ends the meter will perform the reading.

· The instrument displays the results in mg/L of free chlorine. INTERFERENCES Interference may be caused by: Bromine, Chlorine Dioxide, Iodine, Ozone (all these interferences give positive errors).

Alkalinity above 250 mg/L CaCO3 will not reliably develop the full amount of color or it may rapidly fade. To resolve this, neutralize the sample with diluted HCl. In case of water with hardness greater than 500 mg/L CaCO3, shake the sample for approximately 2 minutes after adding the powder reagent. Free Chlorine 28 TOTAL CHLORINE SPECIFICATIONS Range Resolution Accuracy Typical EMC Deviation Light Source Method 0.00 to 5.00 mg/L 0.01 mg/L from 0.00 to 2.

50 mg/L; 0.10 mg/L above 2.50 mg/L ±0.03 mg/L ±3% of reading at 25 °C ±0.01 mg/L Tungsten lamp with narrow band interference filter @ 525 nm Adaptation of the EPA method 330.

5 and Standard Methods for the Examination of Water and Wastewater, 20th edition, 4500-Cl G. The reaction between chlorine and the DPD reagent causes a pink tint in the sample. REQUIRED REAGENTS POWDER: Code HI 93711-0 Description Quantity DPD Powder Reagent 1 packet REAGENT SETS HI 93711-01 Reagents for 100 tests HI 93711-03 Reagents for 300 tests For other accessories see page 46. MEASUREMENT PROCEDURE · Select the Total Chlorine method using the procedure described in the Method Selection section (see page 15). @@· Place the cuvette into the holder and close the lid.

10 mL 29 Total Chlorine · Press the Zero key. The meter will show "-0.0-" when the meter is zeroed and ready for measurement. · Remove the cuvette. · Add 1 packet of HI 93711-0 DPD reagent. Replace the cap and shake gently for 20 seconds. · Reinsert the cuvette into the instrument. · Press Timer and the display will show the countdown prior to the measurement or, alternatively, wait for 2 minutes and 30 seconds and press Read. When the timer ends the meter will perform the reading. · The instrument displays the results in mg/L of total chlorine.

INTERFERENCES Interference may be caused by: Bromine, Chlorine Dioxide, Iodine, Ozone (all these interferences give positive errors). Alkalinity above 250 mg/L CaCO3 will not reliably develop the full amount of color or it may rapidly fade. To resolve this, neutralize the sample with diluted HCl. In case of water with hardness greater than 500 mg/L CaCO3, shake the sample for approximately 2 minutes after adding the powder reagent. Total Chlorine 30 FREE COPPER SPECIFICATIONS Range Resolution Accuracy Typical EMC Deviation Light Source Method 0.00 to 5.00 mg/L 0.01 mg/L ±0.02 mg/L ±4% of reading at 25 °C ±0.01 mg/L Tungsten lamp with narrow band interference filter @ 575 nm Adaptation of the EPA method.

The reaction between copper and the bicinchoninate reagent causes a purple tint in the sample. Description Bicinchoninate Quantity/test 1 packet REQUIRED REAGENTS Code HI 93702-0 REAGENT SETS HI 93702-01 Reagents for 100 tests HI 93702-03 Reagents for 300 tests For other accessories see page 46. MEASUREMENT PROCEDURE · Select the Free Copper method using the procedure described in the Method Selection section (see page 15). @@· Place the cuvette into the holder and close the lid. 10 mL · Press the Zero key.

The meter will show "-0.0-" when the meter is zeroed and ready for measurement. 31 Free Copper · Remove the cuvette. · Add the content of one packet of HI 93702-0 Copper Reagent. Replace the cap and shake gently for 15 seconds.

· Reinsert the cuvette into the instrument. · Press Timer and the display will show the countdown prior to the measurement or, alternatively, wait for 45 seconds and press Read. When the timer ends the meter will perform the reading. · The instrument displays the results in mg/L of copper. INTERFERENCES Interference may be caused by: Silver Cyanide For samples overcoming buffering capacity of reagent (around pH 6.8), pH should be adjusted between 6 and 8. Free Copper 32 TOTAL COPPER SPECIFICATIONS Range Resolution Accuracy Typical EMC Deviation Light Source Method 0.00 to 5.00 mg/L 0.01 mg/L ±0.

02 mg/L ±4% of reading at 25 °C ±0.01 mg/L Tungsten lamp with narrow band interference filter @ 575 nm Adaptation of the USEPA approved method. The reaction between free copper and the bicinchoninate reagent causes a purple tint in the sample. Description Bicinchoninate Decomplexing Agent Quantity/test 1 packet 1 packet REQUIRED REAGENTS Code HI 93702-0 HI 93702T-0 REAGENT SETS HI 93702T-01, HI 93702-01 Reagents for 100 tests HI 93702T-03, HI 93702-03 Reagents for 300 tests For other accessories see page 46. MEASUREMENT PROCEDURE · Select the Total Copper method using the procedure described in the Method Selection section (see page 15). @@· Place the cuvette into the holder and close the lid. 10 mL · Press the Zero key. The meter will show "-0.0-" when the meter is zeroed and ready for measurement. 33 Total Copper · Remove the cuvette.

· Add the content of one packet of HI 93702-0 Copper Reagent. Replace the cap and shake gently for 15 seconds. · Add the content of one packet of HI 93702T-0 Copper Total Reagent. Replace the cap and shake vigorously for 15 seconds. · Replace the cuvette into the holder and ensure that the notch on the cap is positioned securely into the groove.

· Press Timer and the display will show the countdown prior to measurement or, alternatively, wait for 45 seconds and press Read. When the timer ends the meter will perform the reading. · The instrument displays concentration in mg/L of total copper. Total Copper 34 CYANURIC ACID SPECIFICATIONS Range Resolution Accuracy Typical EMC Deviation Light Source Method 0 to 200 mg/L 1 mg/L from 0 to 100 mg/L; 10 mg/L above 100 mg/L ±1 mg/L ±15% of reading at 25 °C ±1 mg/L Tungsten lamp with narrow band interference filter @ 525 nm Adaptation of the turbidimetric method. The reaction between cyanuric acid and the reagent causes a white suspension in the sample.

Description Powder reagent Quantity 1 packet REQUIRED REAGENTS Code HI 93722-0 REAGENT SETS HI 93722-01 Reagents for 100 tests HI 93722-03 Reagents for 300 tests For other accessories see page 46. MEASUREMENT PROCEDURE · Select the Cyanuric Acid method using the procedure described in the Method Selection section (see page 15). @@· Place the cuvette into the holder and close the lid. · Press the Zero key. The meter will show "-0.0-" when the meter is zeroed and ready for measurement. 10 mL · Add the content of one packet of HI 93722-0 Cyanuric Acid Reagent. Replace the cap and shake gently for about 10 seconds (dissolution is not complete). Cyanuric Acid 35 · Reinsert the cuvette into the instrument. · Press Timer and the display will show the countdown prior to the measurement or, alternatively, wait for 45 seconds and press Read.

When the timer ends the meter will perform the reading.

· The instrument displays concentration in mg/L of cyanuric acid. INTERFERENCES Turbidity preexisting in the sample causes interference during measurement. Cyanuric Acid 36 IRON SPECIFICATIONS Range Resolution Accuracy Typical EMC Deviation Light Source Method 0.00 to 5.00 mg/L 0.01 mg/L ±0.04 mg/L ±2% of reading at 25 °C ±0.01 mg/L Tungsten lamp with narrow band interference filter @ 525 nm Adaptation of the EPA Phenantroline method 315B, for natural and treated waters. The reaction between iron and reagents causes an orange tint in the sample.

Description Iron High Range Reagent Quantity/test 1 packet REQUIRED REAGENTS Code HI 93721-0 REAGENT SETS HI 93721-01 Reagents for 100 tests HI 93721-03 Reagents for 300 tests For other accessories see page 46. MEASUREMENT PROCEDURE · Select the Iron method using the procedure described in the Method Selection section (see page 15). @@· Place the cuvette into the holder and close the lid. 10 mL · Press the Zero key. The meter will show "-0.

0-" when the meter is zeroed and ready for measurement. · Remove the cuvette and add the content of one packet of HI 93721-0 reagent. Replace the cap and shake until dissolution is complete. 37 Iron · Reinsert the cuvette into the instrument. · Press Timer and the display will show the countdown prior to the measurement or, alternatively, wait for 3 minutes and press Read.

When the timer ends the meter will perform the reading. · The instrument displays concentration in mg/L of iron. INTERFERENCES Interference may be caused by: Molybdate Molybdenum above 50 ppm Calcium above 10000 ppm (as CaCO3) Magnesium above 100000 ppm (as CaCO3) Chloride above 185000 ppm. Iron 38 OZONE SPECIFICATIONS Range Resolution Accuracy Typical EMC Deviation Light Source Method 0.00 to 2.00 mg/L 0.01 mg/L ±0.02 mg/L ±3% of reading at 25 °C ±0.01 mg/L Tungsten lamp with narrow band interference filter @ 525 nm Colorimetric DPD Method. The reaction between ozone and the DPD reagent causes a pink tint in the sample.

REQUIRED REAGENTS Code Description Quantity/test HI 93757-0 DPD Powder Reagent 1 packet HI 93703-52-0 Glycine Powder (Optional Reagent) 1 packet REAGENT SETS HI 93757-01 Reagents for 100 tests HI 93757-03 Reagents for 300 tests HI 93703-52 Glycine Powder, Optional Reagent for 100 tests For other accessories see page 46. IMPORTANT NOTE: Chlorine is a strong interferent for ozone determination. If the sample is suspected to contain chlorine residues (free or total chlorine), please follow the alternative measurement procedure described below: · Perform the Standard Measurement Procedure and take note of the reading: value A. · On a fresh sample perform the Additional Measurement Procedure and take note of the reading: value B. · Subtract reading B from reading A to obtain the ozone concentration in mg/L: mg/L (O3) = value A value B. STANDARD MEASUREMENT PROCEDURE · Select the Ozone method using the procedure described in the Method Selection section (see page 15). · Fill the cuvette with 10 mL of unreacted sample, up to the mark, and replace the cap. 10 mL · Place the cuvette into the holder and close the lid. 39 Ozone · Press the Zero key. The display will show "-0.

0-" the meter is zeroed and ready for measurement. · Remove the cuvette. · Add the content of one packet of HI 93757-0 Ozone Reagent. Replace the cap and shake gently for 20 seconds. · Replace the cuvette into the holder and close the lid.

· Press Timer and the display will show the countdown prior to the measurement or, alternatively, wait for 2 minutes and press Read. When the timer ends the meter will perform the reading. · The instrument displays concentration in mg/L of ozone (chlorine free samples only). ADDITIONAL MEASUREMENT PROCEDURE For samples containing chlorine · Select the Ozone method using the procedure described in the Method Selection section (see page 15). · Fill the cuvette with 10 mL of unreacted sample, up to the mark, and replace the cap.

· Place the cuvette into the holder and close the lid. 10 mL Ozone 40 · Press the Zero key. The display will show "-0.0-" when the meter is zeroed and ready for measurement. · Remove the cuvette. · Add the content of one packet of the optional reagent HI93703-52-0 Glycine Powder. Replace the cap and shake gently until completely dissolved. · Add the content of one packet of HI 93757-0 Ozone Reagent. Replace the cap and shake gently for 20 seconds. · Replace the cuvette into the holder and close the lid.

· Press Timer and the display will show the countdown prior to the measurement or, alternatively, wait for 2 minutes and press Read. When the timer ends the meter will perform the reading. · The instrument displays a concentration value refering to chlorine interference. Subtract this value from the reading from the Standard Measurement Procedure: this will be the concentration in mg/L of ozone in the sample. INTERFERENCES Interference may be caused by: Bromine, Chlorine Dioxide, Iodine. Alkalinity above 250 mg/L CaCO3 will not reliably develop the full amount of color or it may rapidly fade. To resolve this, neutralize the sample with diluted HCl. In case of water with hardness greater than 500 mg/L CaCO3, shake the sample for approximately 2 minutes after adding the powder reagent. 41 Ozone pH SPECIFICATIONS Range Resolution Accuracy Typical EMC Deviation Light Source Method 6.5 to 8.

5 pH 0.1 pH ±0.1 pH at 25 °C ±0.1 pH Tungsten lamp with narrow band interference filter @ 525 nm Adaptation of the Phenol Red method. @@@@@@· Place the cuvette into the holder and close the lid.

· Press the Zero key. @@Replace the cap and mix the solution. · Reinsert the cuvette into the instrument. · Press the Read key to start the reading. The instrument displays the pH value.

43 pH ERRORS AND WARNINGS The instrument shows clear warning messages when erroneous conditions appear and when measured values are outside the expected range. These messages are described bellow. No Light: The light source is not functioning properly. Light Leak: There is an excess amount of ambient light reaching the detector. Inverted cuvettes: The sample and the zero cuvettes are inverted. Battery Low: The battery capacity is lower than 10%. Light Low: The instrument cannot adjust the light level. Please check that the sample does not contain any debris. Light High: There is too much light to perform a measurement. Please check the preparation of the zero cuvette.

44 DATA MANAGEMENT The analyzed data can be managed using Hanna's product HI92000, Windows® Compatible Software. STANDARD METHODS Description Alkalinity Bromine Calcium Hardness Chlorine, Free Chlorine, Total Copper, Free Copper, Total Cyanuric Acid Iron Ozone pH 0 to 500 mg/L 0.

00 to 10.00 mg/L 0 to 500 mg/L 0.00 to 5.00 mg / L 0.00 to 5.00 mg / L 0.00 to 5.00 mg/L 0. 00 to 5.00 mg/L 0 to 200 mg/L 0.00 to 5.00 mg/L 0.00 to 2. 00 mg/L 6.5 to 8.5 pH Range Colorimetric DPD Colorimetric DPD DPD Bicinchoninate Bicinchoninate Turbidimetric Phenantroline DPD Phenol Red Method Windows® is registered Trademark of "Microsoft Co." 45 ACCESSORIES REAGENT SETS HI 93701-01 100 free chlorine tests (powder) HI 93701-03 300 free chlorine tests (powder) HI 93701-F 300 free chlorine tests (liquid) HI 93703-52 Glycine Powder, Optional Reagent for 100 tests HI 93711-01 100 total chlorine tests (powder) HI 93711-03 300 total chlorine tests (powder) HI 93701-T 300 total chlorine tests (liquid) HI 93711-03 300 total chlorine tests HI 93702-01 100 free copper tests HI 93702-03 300 free copper tests HI 93702T-01 100 total copper tests HI 93702T-03 300 total copper tests HI 93710-01 100 pH tests HI 93710-03 300 pH tests HI 93716-01 100 bromine tests HI 93716-03 300 bromine tests HI 93720-01 100 Ca hardness tests HI 93720-03 300 Ca hardness tests HI 93721-01 100 iron tests HI 93721-03 300 iron tests HI 93722-01 100 cyanuric acid tests HI 93722-03 300 cyanuric acid tests HI 93755-01 100 alkalinity tests HI 93755-03 300 alkalinity tests HI 93757-01 100 ozone tests HI 93757-03 300 ozone tests OTHER ACCESSORIES HI 740226 5 mL graduated syringe HI 731318 cloth for wiping cuvettes (4 pcs) HI 731321 glass cuvettes (4 pcs) HI 731325W new cap for cuvette (4 pcs) HI 740034 cap for 100 mL beaker (6 pcs) HI 740036 100 mL plastic beaker (6 pcs) HI 740038 60 mL glass bottle and stopper HI 740142 1 mL graduated syringe HI 740143 1 mL graduated syringe (6 pcs) HI 740144 pipette tip (6 pcs) HI 740157 plastic refilling pipette (20 pcs) HI 740220 25 mL glass cylinders with caps (2 pcs) HI 92000 170 mL plastic beaker HI 920013 170 mL plastic beakers (12 pcs) HI 93703-50 60 mL graduated syringe 46 WARRANTY All Hanna Instruments meters are 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.

Damages due to accident, misuse, tampering or lack of prescribed maintenance are 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. Recommendations for Users Before using these products, make sure that they are entirely suitable for your specific application and for the environment in which they are used. Operation of these instruments may cause unacceptable interferences to other electronic equipments, this requiring the operator to take all necessary steps to correct interferences. Any variation introduced by the user to the supplied equipment may degrade the instruments' EMC performance.

To avoid damages or burns, do not put the instrument in microwave ovens. For yours and the instrument safety do not use or store the instrument in hazardous environments. Hanna Instruments reserves the right to modify the design, construction and appearance of its products without advance notice. HANNA LITERATURE Hanna publishes a wide range of catalogs and handbooks for an equally wide range of applications. The reference literature currently covers areas such as: · Water Treatment · Process · Swimming Pools · Agriculture · Food · Laboratory and many others. New reference material is constantly being added to the library. For these and other catalogs, handbooks and leaflets contact your dealer or the Hanna Customer Service Center nearest to you. To find the Hanna Office in your vicinity, check our home page at www.hannainst.com.

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