

SMART 2
.....
Colorimeter

**OPERATOR'S
MANUAL**



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1919-MN

TABLE OF CONTENTS

GENERAL INFORMATION

Packaging & Delivery	5
General Precautions	5
Safety Precautions	5
Limits of Liability	5
Limited Warranty	6
Limitations	6
Specifications	6
Statistical and Technical Definitions	
Related to Product Specifications	7-8
Contents and Accessories	8
EPA Compliance	8
CE Compliance	9

CHEMICAL TESTING

Water Sampling for Chemical Analysis	10-11
Filtration	11
An Introduction to Colorimetric Analysis	12
Reagent Blank	13
Colorimeter Tubes	13
Meter Care	13
Selecting an Appropriate Wavelength	13-14
Calibration	14-16
Calibration Curves	14-16
Standard Additions	16-17
Sample Dilution Techniques & Volumetric Measurements	17
Interferences	18
Stray Light Interference	18

OPERATION OF THE SMART 2 COLORIMETER

Overview	19
Power Source	19
Components	20
Quick Start	21-22

GENERAL OPERATING PROCEDURES

The Keypad	23
Sample Holders	23
The Display & the Menu	24-25
Looping Menu	26

TESTING

Testing Menu	27
Sequences of Tests	28
General Testing Procedures	29
Testing With the Pre-Programmed Tests	29-30

TABLE OF CONTENTS (cont.)

Calibrating LaMotte Pre-Programmed Tests.....	31-32
Measuring in the %T/ABS Mode.....	33-34

EDITING MENU

Edit a Sequence	35-36
Adding or Deleting Tests	36-38
Edit User Tests	39
Naming the Test	40-41
Selecting the Vial and Wavelength	42
Entering a New Calibration	43-44
Selecting the Numerical Format of the Result	45
Selecting Units of Concentration	46
Setting the Clock.....	47
Turning the Data Logger On and Off.....	48
Factory Setup.....	49
Setting the Power Saver Function	49

PC LINK

Output	50
Computer Connection.....	50

BATTERY OPERATION

Replacing the Battery	50
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MAINTENANCE

Cleaning	51
Meter Care.....	51
Meter Disposal.....	51

TROUBLESHOOTING GUIDE

Error Messages.....	52
Helpful Hints	53

SMART2 COLORIMETER TEST INSTRUCTIONS

APPENDIX

GENERAL INFORMATION

■ PACKAGING & DELIVERY

Experienced packaging personnel at LaMotte Company assure adequate protection against normal hazards encountered in transportation of shipments. After the product leaves the manufacturer, all responsibility for its safe delivery is assured by the transportation company. Damage claims must be filed immediately with the transportation company to receive compensation for damaged goods.

Should it be necessary to return the instrument for repair or servicing, pack instrument carefully in suitable container with adequate packing material. A return authorization number must be obtained from LaMotte Company by calling 1-800-344-3100. Attach a letter with the authorization number to the shipping carton which describes the kind of trouble experienced. This valuable information will enable the service department to make the required repairs more efficiently.

■ GENERAL PRECAUTIONS

Before attempting to set up or operate this instrument it is important to read the instruction manual. Failure to do so could result in personal injury or damage to the equipment.

The SMART2 Colorimeter should not be stored or used in a wet or corrosive environment. Care should be taken to prevent water or reagent chemicals from wet colorimeter tubes from entering the colorimeter chamber.

NEVER PUT WET TUBES IN COLORIMETER.

■ SAFETY PRECAUTIONS

Read the labels on all LaMotte reagent containers prior to use. Some containers include precautionary notices and first aid information. Certain reagents are considered hazardous substances and are designated with a * in the instruction manual. Material Safety Data Sheets (MSDS) are supplied for these reagents. Read the accompanying MSDS before using these reagents.

Additional emergency information for all LaMotte reagents is available 24 hours a day from the Poison Control Center listed in the front of the phone book. Be prepared to supply the name and four-digit LaMotte code number found on the container label or at the top of the MSDS. LaMotte reagents are registered with a computerized poison control information system available to all local poison control centers.

Keep equipment and reagent chemicals out of the reach of young children.

Protect Yourself and Equipment: Use Proper Analytical Techniques

■ LIMITS OF LIABILITY

Under no circumstances shall LaMotte Company be liable for loss of life, property, profits, or other damages incurred through the use or misuse of its products.

■ LIMITED WARRANTY

This instrument is guaranteed to be free from defects in material and workmanship for a period of two (2) years from original purchase date. In the event that a defect is found during the warranty time frame, LaMotte Company agrees that it will be repaired or replaced without charge except for the transportation costs. This guarantee does not cover batteries.

This product can not be returned without a return authorization number from Lamotte Company. For warranty support or a Return Authorization Number, contact LaMotte Company at 1-800-344-3100 or tech @ lamotte.com.

■ LIMITATIONS

This guarantee is void under the following circumstances:

- Damage due to operator negligence, misuse, accident or improper application.
- Damage or alterations from attempted repairs by an unauthorized (non-LaMotte) service.
- Damage due to improper power source, AC adapter or battery.
- Damage caused by acts of God or natural disaster.
- Damage occurred while in transit with a shipping carrier.

LaMotte Company will service and repair out-of warranty products at a nominal charge.

■ SPECIFICATIONS

■ INSTRUMENT TYPE: Colorimeter

<i>Readout</i>	Graphical 4 line, 16 character per line LCD
<i>Wavelengths</i>	430nm, 520 nm, 570 nm, 620 nm
<i>Wavelength Accuracy</i>	± 2
<i>Readable Resolution</i>	Determined by reagent system
<i>Wavelength Bandwidth</i>	10 typical
<i>Photometric Range</i>	-2 to + 2AU
<i>Photometric Precision</i>	± 0.001AU at 1.0AU
<i>Photometric Accuracy</i>	± 0.005AU at 1.0AU
<i>Sample Chamber</i>	Accepts 25 mm diameter flat-bottomed test tubes, 10 mm square cuvettes, 16 mm COD test tubes
<i>Light Sources</i>	4 LEDs
<i>Detectors</i>	4 silicon photodiodes with integrated interference filters
<i>Modes</i>	Absorbance, pre-programmed tests
<i>Pre-Programmed Tests</i>	YES, with automatic wavelength selection
<i>User Defined Tests</i>	Up to 10 user tests can be input
<i>RS232 Port</i>	8 pin mini-DIN, 9600b, 8, 1, n
<i>Power Requirements</i>	<i>Battery Operation:</i> 9 volt alkaline, <i>Line Operation:</i> 110/ AC; 50/60 Hz with adapter, 6V 500 mA DC
<i>Dimensions (LxWxH)</i>	8.5 x 16.2 x 6.7 cm, 3.4 x 6 .4 x 2.6 inches
<i>Weight</i>	312 g, 11 oz (meter only)
<i>Data Logger</i>	350 test results stored for download to a PC

■ STATISTICAL AND TECHNICAL DEFINITIONS RELATED TO PRODUCT SPECIFICATIONS

Method Detection Limit (MDL): “The method detection limit (MDL) is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte.” Note that, “As Dr. William Horwitz once stated, ‘In almost all cases when dealing with a limit of detection or limit of determination, the primary purpose of determining that limit is to stay away from it.’”²

1. CFR 40, part 136, appendix B
2. Statistics in Analytical Chemistry: Part 7 – A Review, D. Coleman and L Vanatta, American Laboratory, Sept 2003, P. 31.

Precision: Precision is the numerical agreement between two or more measurements.³ The precision can be reported as a range for a measurement (difference between the min and max). It can also be reported as the standard deviation or the relative standard deviation. It is a measure of how close together the measurements are, not how close they are to the correct or true value. *The precision can be very good and the accuracy very bad. This is a useful measure of the performance of a test method.*

3. Skoog, D.A., West, D. M., *Fundamental of Analytical Chemistry*, 2nd ed., Holt Rinehart and Winston, Inc, 1969, p. 26.

Accuracy: Accuracy is the nearness of a measurement to the accepted or true value.⁴ The accuracy can be expressed as a range, about the true value, in which a measurement occurs (i.e. ± 0.5 ppm). It can also be expressed as the % recovery of a know amount of analyte in a determination of the analyte (i.e. 103.5 %). *This is a useful measure and what most customers are interested in when they want to know about the performance of a test method.*

4. Skoog D.A., West D. M., *Fundamental of Analytical Chemistry*, 2nd ed., Holt Rinehart and Winston, Inc, 1969, p. 26.

Resolution: Resolution is the smallest discernible difference between any two measurements that can be made.⁵ For meters this is usually how many decimal places are displayed. (i.e. 0.01). For titrations and various comparators it is the smallest interval the device is calibrated or marked to (i.e. 1 drop = 10 ppm, 0.2 ppm for a DRT, or \pm half a unit difference for an octaslide or color chart). Note that the resolution many change with concentration or range. In some cases the resolution may be less than the smallest interval, if it is possible to make a reading that falls between calibration marks. This is often done with various comparators. *One caveat is, that resolution has very little relationship to accuracy or precision. The resolution will always be less than the accuracy or precision but it is not a statistical measure of how well a method of analysis works. The resolution can be very very good and the accuracy and precision can be very, very bad! This is not a useful measure of the performance of a test method.*

5. Statistics in Analytical Chemistry: Part 7 – A Review, D. Coleman and L Vanatta, American Laboratory, Sept 2003, P. 34.

Sensitivity: Sensitivity is the resolution based on how this term is used in LaMotte catalogs. This term is not listed in any of the references. Sometimes it is used for detection limit. It is a confusing term and should be avoided.

Repeatability: Repeatability is the within-run precision.⁶ A run is a single data set, from set up to clean up. Generally, one run occurs on one day. However, for meter calibrations, a single calibration is considered a single run or data set, even though it may take 2 or 3 days.

6. Jeffery G. H., Basset J., Mendham J., Denney R. C., *Vogel's Textbook of Quantitative Chemical Analysis*, 5th ed., Longman Scientific & Technical, 1989, p. 130.

Reproducibility: Reproducibility is the between-run precision.⁷

7. Jeffery G. H., Basset J., Mendham J., Denney R. C., *Vogel's Textbook of Quantitative Chemical Analysis*, 5th ed., Longman Scientific & Technical, 1989, p. 130.

■ CONTENTS AND ACCESSORIES

■ CONTENTS

SMART2 Colorimeter

Test Tubes, with Caps

Power Supply, 110/220V

SMART2 Colorimeter Quick Start Guide

SMART2 Colorimeter Manual

■ ACCESSORIES

COD Adapter

Code 5-0087

UDV Adapter

Code 5-0086

Small Field Carrying Case

Code 1919-GCS150

Large Field Carrying Case

Code 1919-BCS440

SMARTLink2 Program & Interface Cable (3.5 disk)

Code 1912-3

SMARTLink2 Program & Interface Cable (CD)

Code 1912-CD

■ EPA COMPLIANCE

The SMART2 Colorimeter is an EPA-Accepted instrument. EPA-Accepted means that the instrument meets the requirements for instrumentation as found in test procedures that are approved for the National Primary Drinking Water Regulations (NPDWR) or National Pollutant Discharge Elimination System (NPDES) compliance monitoring programs. EPA-Accepted instruments may be used with approved test procedures without additional approval.

■ CE COMPLIANCE

The SMART2 Colorimeter has earned the European CE Mark of Compliance for electromagnetic compatibility and safety.

DECLARATION OF CONFORMITY

**Standards to which
Conformity Declared:**

EN61326:1998, IEC61326:1997,
IEC61000-4-2:1995, IEC61000-4-3:1995
IEC61000-4-4:1995, IEC61000-4-5:1995
IEC61000-4-6:1996, IEC61000-4-11:1994,
EN61000-3-2:1995, EN61000-3-3:1994-12,
EN55011/CISPR11, FCCCFR47 Part 15,
EN61558

Manufacturer's Name:

LaMotte Company

Manufacturer's Address:

802 Washington Avenue
PO Box 329
Chestertown, MD 21620

Type of Equipment:

Colorimeter

Model Name:

SMART 2

Year of Manufacture:

2001

Testing Performed By:

Windermere
2000 Windermere Court
Annapolis, MD 21401

*I, the undersigned, hereby declare that the equipment specified above
conforms to the above Directive and Standards*

Chestertown, Maryland

Place

1/15/02

Date



Signature

Scott H. Steffen

Name

VP New Products & Quality

Position

CHEMICAL TESTING

■ WATER SAMPLING FOR CHEMICAL ANALYSIS

■ Taking Representative Samples

The underlying factor to be considered for any type of water sampling is whether or not the sample is truly representative of the source. To properly collect a representative sample:

- Sample as frequently as possible.
- Collect a large sample or at least enough to conduct whatever tests are necessary.
- Make a composite sample for the same sampling area.
- Handle the sample in such a way as to prevent deterioration or contamination before the analysis is performed.
- Perform analysis for dissolved gases such as dissolved oxygen, carbon dioxide, and hydrogen sulfide immediately at the site of sampling. These factors, as well as samples for pH, cannot be stored for later examination.
- Make a list of conditions or observations which may affect the sample. Other considerations for taking representative samples are dependent upon the source of the sample. Taking samples from surface waters involves different considerations than taking samples from impounded and sub-surface waters.

■ Sampling of Open Water Systems

Surface waters, such as those found in streams and rivers, are usually well mixed. The sample should be taken downstream from any tributary, industrial or sewage pollution source. For comparison purposes samples may be taken upstream and at the source of the pollution before mixing.

In ponds, lakes, and reservoirs with restricted flow, it is necessary to collect a number of samples in a cross section of the body of water, and where possible composite samples should be made to ensure representative samples.

To collect samples from surface waters, select a suitable plastic container with a tight fitting screw cap. Rinse the container several times with the sample to be tested, then immerse the container below the surface until it is filled to overflowing and replace the cap. If the sample is not to be tested immediately, pour a small part of the sample out and reseal. This will allow for any expansion. Any condition which might affect the sample should be listed.

Sub-surface sampling is required to obtain a vertical profile of streams, lakes, ponds, and reservoirs at specific depths. This type of sampling requires more sophisticated sampling equipment.

For dissolved oxygen studies, or for tests requiring small sample sizes, a Water Sampler (LaMotte Code 1060) will serve as a subsurface or in-depth sampler.

This weighted device is lowered to the sampling depth and allowed to rest at this depth for a few minutes. The water percolates into the sample chamber displacing the air which bubbles to the surface. When the bubbles cease to rise, the device has flushed itself approximately five times and it may be raised to the surface for examination. The inner chamber of the sampling device is lifted out and portions of the water sample are carefully dispensed for subsequent chemical analysis.

A Snap-Plunger Water Sampler (LaMotte Code 1077) is another “in-depth” sampling device which is designed to collect large samples which can be used for a multitude of tests. Basically, this collection apparatus is a hollow cylinder with a spring loaded plunger attached to each end. The device is cocked above the surface of the water and lowered to the desired depth. A weighted messenger is sent down the calibrated line to trip the closing mechanism and the plungers seal the sample from mixing with intermediate layers as it is brought to the surface. A special drain outlet is provided to draw off samples for chemical analysis.

▪ **Sampling of Closed System**

To obtain representative samples from confined water systems, such as pipe lines, tanks, vats, filters, water softeners, evaporators and condensers, different considerations are required because of chemical changes which occur between the inlet and outlet water. One must have a basic understanding of the type of chemical changes which occur for the type of equipment used. Also, consideration should be given to the rate of passage and retaining time for the process water.

Temperature changes play an important part in deciding exactly what test should be performed. Process water should be allowed to come to room temperature, 20–25°C, before conducting any tests.

When drawing off samples from an outlet pipe such as a tap, allow sample to run for several minutes, rinsing the container several times before taking the final sample. Avoid splashing and introduction of any contaminating material.

■ **FILTRATION**

When testing natural waters that contain significant turbidity due to suspended solids and algae, filtration is an option. Reagent systems, whether EPA, Standard Methods, LaMotte or any others, will generally only determine dissolved constituents. Both EPA and Standard Methods suggest filtration through a 0.45 micron filter membrane, to remove turbidity, for the determination of dissolved constituents.** To test for total constituents, organically bound and suspended or colloidal materials, a rigorous high temperature acid digestion is necessary.

**LaMotte offers a filtering apparatus: syringe assembly (Code 1050) and membrane filters, 0.45 micron, (Code 1103).

■ AN INTRODUCTION TO COLORIMETRIC ANALYSIS

Most test substances in water are colorless and undetectable to the human eye. To test for their presence we must find a way to “see” them. The SMART2 Colorimeter can be used to measure any test substance that is itself colored or can be reacted to produce a color. In fact a simple definition of colorimetry is “the measurement of color” and a colorimetric method is “any technique used to evaluate an unknown color in reference to known colors”. In a colorimetric chemical test the intensity of the color from the reaction must be proportional to the concentration of the substance being tested. Some reactions have limitations or variances inherent to them that may give misleading results. Many such interferences are discussed with each particular test instruction. In the most basic colorimetric method the reacted test sample is visually compared to a known color standard. However, accurate and reproducible results are limited by the eyesight of the analyst, inconsistencies in the light sources, and the fading of color standards.

To avoid these sources of error, a colorimeter can be used to photoelectrically measure the amount of colored light absorbed by a colored sample in reference to a colorless sample (blank).

White light is made up of many different colors or wavelengths of light. A colored sample typically absorbs only one color or one band of wavelengths from the white light. Only a small difference would be measured between white light before it passes through a colored sample versus after it passes through a colored sample. The reason for this is that the one color absorbed by the sample is only a small portion of the total amount of light passing through the sample. However, if we could select only that one color or band of wavelengths of light to which the test sample is most sensitive, we would see a large difference between the light before it passes through the sample and after it passes through the sample.

The SMART2 Colorimeter passes one of four colored light beams through one of four optical filters which transmits only one particular color or band of wavelengths of light to the photodetector where it is measured. The difference in the amount of colored light transmitted by a colored sample is a measurement of the amount of colored light absorbed by the sample. In most colorimetric tests the amount of colored light absorbed is directly proportional to the concentration of the test factor producing the color and the path length through the sample. However, for some tests the amount of colored light absorbed is inversely proportional to the concentration.

The choice of the correct wavelength for testing is important. It is interesting to note that the wavelength that gives the most sensitivity (lower detection limit) for a test factor is the complementary color of the test sample. For example the Nitrate-Nitrogen test produces a pink color proportional to the nitrate concentration in the sample (the greater the nitrate concentration, the darker the pink color). A wavelength in the green region should be selected to analyze this sample since a pinkish-red solution absorbs mostly green light.

■ REAGENT BLANK

Some tests will provide greater accuracy if a reagent blank is determined to compensate for any color or turbidity resulting from the reagents themselves. A reagent blank is performed by running the test procedure on 10 mL of demineralized water. Use sample water to **SCAN BLANK**. Insert the reagent blank in the colorimeter chamber and select **SCAN SAMPLE**. Note result of reagent blank. Perform the tests on the sample water as described. Subtract results of reagent blank from all subsequent test results. NOTE: Some tests require a reagent blank to be used to **SCAN BLANK**.

■ COLORIMETER TUBES

Colorimeter tubes which have been scratched through excessive use should be discarded and replaced with new ones. Dirty tubes should be cleaned on both the inside and outside. Fingerprints on the exterior of the tubes can cause excessive light scattering and result in errors. Handle the tubes carefully, making sure the bottom half of the tube is not handled.

LaMotte Company makes every effort to provide high quality colorimeter tubes. However, wall thicknesses and diameter of tubes may still vary slightly. This may lead to slight variations in results (e.g. if a tube is turned while in the sample chamber, the reading will likely change slightly). To eliminate this error put the tubes into the sample chamber with the same orientation every time.

The tubes that are included with the colorimeter have an index mark to facilitate this. If possible, use the same tube to **SCAN BLANK** and **SCAN SAMPLE**.

■ METER CARE

The optical system of the SMART2 must be kept clean and dry for optimal performance. Dry the colorimeter tubes before placing them in the chamber to avoid introducing moisture. For best results store the instrument in a area that is dry and free from aggressive chemical vapors.

■ SELECTING AN APPROPRIATE WAVELENGTH

The most appropriate wavelength to use when creating a calibration curve is usually the one which gives the greatest change from the lowest reacted standard concentration to the highest reacted standard concentration. However, the absorbance of the highest reacted standard concentration should never be greater than 2.0 absorbance units. Scan the lowest and highest reacted standards at different wavelengths using the absorbance mode to find the wavelength which gives the greatest change in absorbance without exceeding 2.0 absorbance units. Use this wavelength to create a calibration curve.

Below is a list of suggested wavelengths for the color of the reacted samples. Use these as a starting point.

Sample Color	Wavelength Range
Yellow	430
Pink	520
Red	570
Green and Blue	620

■ CALIBRATION

As with all pre-calibrated meters, it is highly recommended, even if not required by regulations, that the user periodically verify the performance of the meter by running standards with a predetermined concentration. Results outside of specification are an indication that the meter needs to be adjusted. This can be done following the user calibration described on page 31. If the user calibration fails to properly adjust the meter then the meter should be returned to LaMotte Company for recalibration. (See page 5).

■ CALIBRATION CURVES

The Smart2 Colorimeter contains tests for the LaMotte reagent systems (see Page 49). The first step in using a non-LaMotte reagent system with your Smart2 Colorimeter is to create a calibration curve for the reagent system. To create a calibration curve, prepare standard solutions of the test factor and use the reagent system to test the standard solutions with the Smart2 Colorimeter. Select a wavelength for the test as described above.

Plot the results (in ABS or %Transmittance) versus concentration to create a calibration curve. The calibration curve may then be used to identify the concentration of an unknown sample by testing the unknown, reading Absorbance or %T, and finding the corresponding concentration from the curve. The linear range of the reagent system can be determined and this information can be used to input a User Test into the Smart2 Colorimeter (see EDIT USER TESTS, page 36).

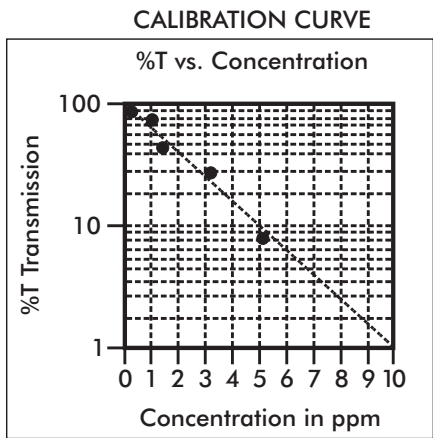
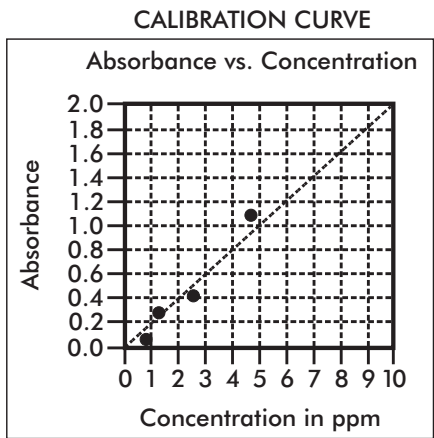
■ PROCEDURE

1. Prepare 5 or 6 standard solutions of the factor being tested. The concentration of these standards should be evenly distributed throughout the range of the reagent system, and should include a 0 ppm standard (distilled water). For instance, the solutions could measure 0, 10%, 30%, 50%, 70%, and 90% of the system's maximum range.
2. Turn on the Smart2 Colorimeter. Select the appropriate wavelength from the absorbance mode. Be sure to select the appropriate wavelength for the color produced by the reagent system.

- Use the unreacted 0 ppm standard to standardize the colorimeter by using it to scan blank.
- Following the individual reagent system instructions, react each standard solution beginning with 0 ppm. Continue with standards in increasing concentration. Record the reading and the standard solution concentration on a chart. Readings can be recorded as percent transmittance (%T) or absorbance (A).
- Plot results on graph paper or computer using any available plotting program. If results are as %T versus concentration, semilog graph paper must be used. Plot the standard solution concentrations on the horizontal, linear axis, and the %T on the vertical, logarithmic axis. If results are as absorbance versus standard solution concentration, simple linear graph paper can be used. Plot the standard solution concentration on the horizontal axis, and the absorbance on the vertical axis.
- After plotting the results, draw a line, or curve, of best fit through the plotted points. The best fit may not connect the points. There should be approximately an equal number of points above the curve as below the curve. Some reagent systems will produce a straight line, while others produce a curve. Many computer spreadsheet programs can produce the curve of best fit by regression analysis of the standard solution data.

NOTE: Only reagent systems which produce a straight line can be used for a User Test.

A sample of each type of graph appears below:



■ PREPARING DILUTE STANDARD SOLUTIONS

Standard solutions should be prepared to create a calibration curve. Standard solutions can be prepared by diluting a known concentrated standard by specified amounts. A chart or computer spreadsheet can be created to determine the proper dilutions. Use volumetric flasks and volumetric pipets for all dilutions.

1. In Column A – Record the maximum concentration of test as determined by the range and path length.
2. In Column B – Record the percent of the maximum concentration the standard solution will be.
3. In Column C – Calculate the final concentration of the diluted standard solutions by multiplying the maximum concentration (In Column A) by the % of maximum concentration divided by 100. ($C = A \times \frac{B}{100}$).
4. In Column D – Record the final volume of the diluted sample (i.e. volume of volumetric flask).
5. In Column E – Record the concentration of the original standard.
6. In Column F – Calculate the milliliters of original standard required ($C \times \frac{D}{E} = F$).

A sample chart appears below:

A	B	$C = A \times \frac{B}{100}$	D	E	$F = C \times \frac{D}{E}$
Maximum concentration of test	% of Maximum concentration	Final concentration of Diluted Standard	Volume of Standard	Concentration of Original Standard	mL of Original Standard Required
10.0 ppm	90	9.0 ppm	100 mL	1000 ppm	0.90 mL
10.0 ppm	70	7.0 ppm	100 mL	1000 ppm	0.70 mL
10.0 ppm	50	5.0 ppm	100 mL	1000 ppm	0.50 mL
10.0 ppm	30	3.0 ppm	100 mL	1000 ppm	0.30 mL
10.0 ppm	10	1.0 ppm	100 mL	1000 ppm	0.10 mL
10.0 ppm	0	0 ppm	100 mL	1000 ppm	0 mL

■ STANDARD ADDITIONS

A common method to check the accuracy and precision of a test is by standard additions. In this method a sample is tested to determine the concentration of the test substance. A second sample is then “spiked” by the addition of a known quantity of the test substance. The second sample is then tested. The determined concentration of the spiked sample should equal the concentration of the first plus the amount added with the spike. The procedure can be repeated with larger and larger “spikes.” If the determined concentrations do not equal the concentration of the sample plus that added with the “spike”, then an interference may exist.

For example, a 10.0 mL water sample was determined to contain 0.3 ppm iron. To a second 10.0 mL sample, 0.1 mL of 50 ppm iron standard was added. The

concentration of iron due to the “spike” was $(0.10 \text{ mL} \times 50 \text{ ppm})/10.0 \text{ mL} = 0.50 \text{ ppm}$. The concentration of iron determined in the spiked sample should be $0.3 + 0.5 = 0.8 \text{ ppm}$ iron. (Note: any error due to the increased volume from the “spike” is negligible).

LaMotte offers a line of calibration standards which can be used to generate calibration curves and perform standard additions.

■ SAMPLE DILUTION TECHNIQUES & VOLUMETRIC MEASUREMENTS

If a test result using the Smart2 Colorimeter gives an over range message then the the sample must be diluted. The test should be repeated on the diluted sample to obtain a reading which is in the concentration range for the test. (Note: This is not true for colorimetric determination of pH.)

Example:

Measure 5 mL of the water sample into a graduated cylinder. Add demineralized water until the cylinder is filled to the 10 mL line. The sample has been diluted by one-half, and the dilution factor is therefore 2. Perform the test procedure, then multiply the resulting concentration by 2 to obtain the test result.

The following table gives quick reference guidelines on dilutions of various proportions. All dilutions are based on a 10 mL volume, so several dilutions will require small volumes of the water sample. Graduated pipets should be used for all dilutions.

Size of Sample	Deionized Water to Bring Volume to 10 mL	Multiplication Factor
10 mL	0 mL	1
5 mL	5 mL	2
2.5 mL	7.5 mL	4
1 mL	9 mL	10
0.5 mL	9.5 mL	20

If the above glassware is not available, dilutions can be made with the colorimeter tube. Fill the tube to the 10 mL line with the sample then transfer it to another container. Add 10 mL volumes of demineralized water to the container and mix. Transfer back 10 mL of the diluted sample to the tube and follow the test procedure. Continue diluting and testing until a reading, which is in the concentration range for the test, is obtained. Be sure to multiply the concentration found by the dilution factor (the number of total 10 mL volumes used).

Example:

10 mL of sample is diluted with three 10 mL volumes of demineralized water; the dilution factor is four.

■ INTERFERENCES

LaMotte reagent systems are designed to minimize most common interferences. Each individual test instruction discusses interferences unique to that test. Be aware of possible interferences in the water being tested.

The reagent systems also contain buffers to adjust the water sample to the ideal pH for the reaction. It is possible that the buffer capacity of the water sample may exceed the buffer capacity of the reagent system and the ideal pH will not be obtained. If this is suspected, measure the pH of a reacted distilled water reagent blank using a pH meter. This is the ideal pH for the test. Measure the pH of a reacted water sample using the pH meter. If the pH is significantly different from the ideal value, the pH of the sample should be adjusted before testing.

Interferences due to high concentration of the substance being tested, can be overcome by sample dilution (see page 16)

■ **STRAY LIGHT INTERFERENCE**

When scanning samples in 16 mm tubes, such as COD, the sample chamber lid can not be closed. The COD adapter minimizes stray light. To further reduce stray light interference, do not scan sample in direct sunlight.

OPERATION OF THE SMART2 COLORIMETER

■ OVERVIEW

The SMART2 Colorimeter is a portable, microprocessor controlled, direct reading colorimeter. It has a graphical 4 line, 16 character liquid crystal display for graphical, alphabetical and numerical messages. The operation is controlled with the keypad through menu driven software in response to selections shown on the display.

The test library consists of 100 LaMotte tests (not all 100 may be available at present) and 10 "User Tests". The LaMotte tests are precalibrated for LaMotte reagent systems. The colorimeter displays the results of these tests directly in units of concentration. The 10 "User Tests" may be used to enter additional calibrations. All of these tests may be arranged in any of 3 sequences. These sequences can be modified a limitless number of times to meet changing testing needs.

The optics feature 4 different colored LEDs. Each LED has a corresponding silicon photodiode with an integrated interference filter. The interference filters select a narrow band of light from the corresponding LED for the colorimetric measurements. The microprocessor automatically selects the correct LED/photodiode combination for a test.

A RS-232 serial port on the back of the colorimeter, and optional software, allows the SMART2 to be interfaced with an IBM compatible personal computer for real time data acquisition and data storage. This port also allows an interface with a RS-232 serial printer.

Due to its portability, alternate power sources, and rugged construction, the SMART2 Colorimeter is ideal for lab and field use.

■ POWER SOURCE

The SMART2 Colorimeter uses a 500 mA AC adapter. Please refer to the Parts List for the code number for the correct adapter.

USE OF ANY AC ADAPTER OTHER THAN THE ONE SPECIFIED FOR USE WITH THE Smart2 COLORIMETER MAY DAMAGE THE METER AND WILL VOID THE WARRANTY. Do not use the adapter sold with the original SMART Colorimeter.

To use the adapter, slide the connector pin from the AC adapter into the small hole on the left side of the meter. Plug the AC adapter into an appropriate wall socket or power source.

■ COMPONENTS

Figure 1 shows a diagram of the Smart2 Colorimeter and its components.

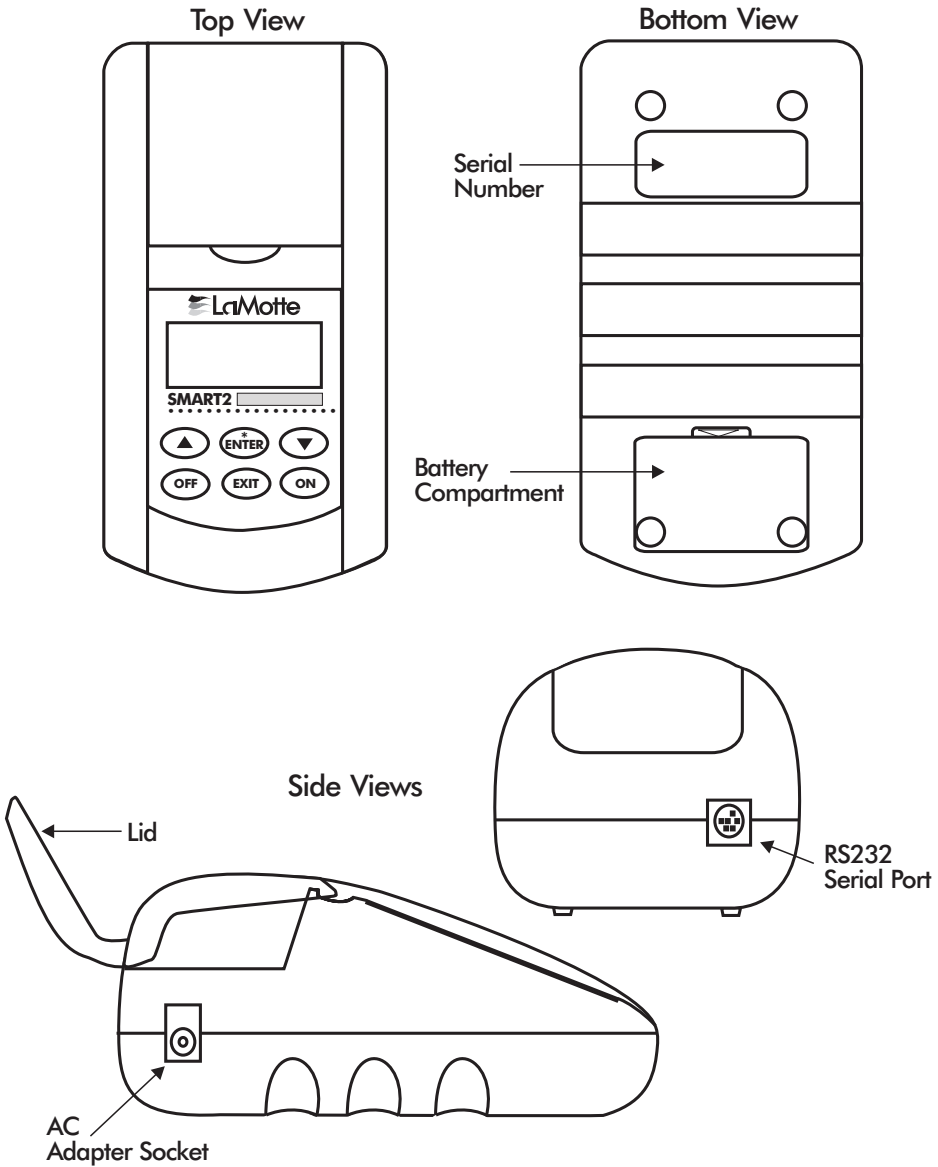


Figure 1

■ QUICK START

Some quick instructions to get into testing.

1. Press **ON** to turn on the SMART2. The LaMotte logo screen will appear for about 2 seconds and then the Start screen appears. Press ***/ENTER** to start testing.

VER 1.0
Smart2
* Start

2. The Main Menu will appear. Press ***/ENTER** to select TESTING MENU.

MAIN MENU
*Testing Menu
Editing Menu
PC Link

3. Press ***/ENTER** to select All Tests.

TESTING MENU
*All Tests
Sequence 1
Sequence 2

4. Press ▼ or ▲ to move the * to the desired test.

ALL TESTS
*001 Alk - UDV
002 Aluminum
003 Ammonia - NLF

5. Press ***/ENTER** to select test.

ALL TESTS
*015 Chlorine
016 Cl F-UDV
017 Cl Liq-DPD

6. Insert blank, press ***/ENTER** to scan blank.

015 Chlorine
* Scan Blank

7. The screen will display Blank Done for about 1 second.

015 Chlorine
Blank Done
* Scan Blank

8. Insert the reacted sample. Press ***/ENTER** to scan sample. The SMART2 will scan the sample and display the concentration.

015 Chlorine
* Scan Sample

9. After recording test result, scroll with ▼ or ▲ and make another selection with ***/ENTER**. Press **EXIT** to escape to previous menus.

015 Chlorine
1.28 ppm
* Scan Sample

GENERAL OPERATING PROCEDURES

The operation of the SMART2 Colorimeter is controlled by a microprocessor. The microprocessor is programmed with menu driven software. A menu is a list of choices. This allows a selection of various tasks for the colorimeter to perform, such as, scan blank, scan sample, and edit test sequences. The keypad is used to make menu selections which are viewed in the display. There are three selections accessible from the MAIN MENU: Testing Menu, Editing Menu and PC Link.

■ THE KEYPAD

The keypad has 6 buttons which are used to perform specific tasks.

ON	This button is used to turn the colorimeter on.
▼	This button will cause the display to scroll down through a list of menu choices. It will move through a list viewed in the display. It will auto scroll when held down.
▲	This button will cause the display to scroll up in a list of menu choices. It will move through a list viewed in the display. It will auto scroll when held down.
ENTER *	This button is used to select the menu choice adjacent to the “*” in a menu viewed in the display.
EXIT	This button is an exit or escape button. When pressed, the display will exit from the current menu and go to the previous menu.
OFF	This button turns the colorimeter off.

■ SAMPLE HOLDERS

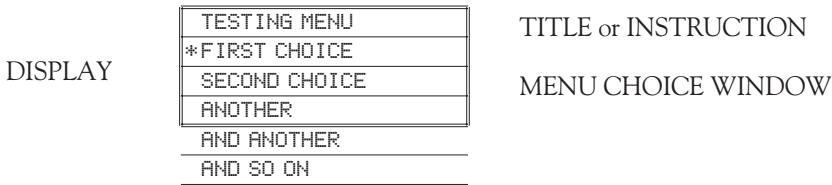
The sample chamber is designed for 25 mm round tubes. Additional sample holders for 16 mm COD tubes and for 1 cm square UDV cuvettes are available for the SMART2 Colorimeter.

Position the COD adapter in the SMART2 chamber so that the grooves in the adapter are aligned with the ridges located at the rear of the chamber. The adapter should be inserted with the small hole, containing the ball plunger, at the top. The ball plunger can be adjusted with a small screwdriver to control the tightness of the fit of the tube in the adapter.

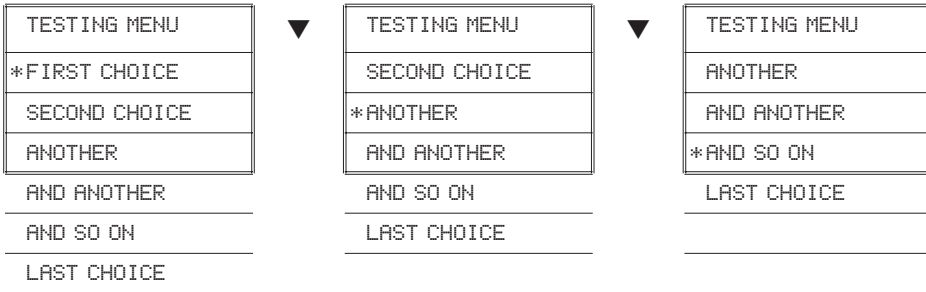
■ THE DISPLAY & THE MENUS

The display allows menu selections to be viewed and chosen. These choices instruct the colorimeter to perform specific tasks. The menus are viewed in the display using two general formats which are followed from one menu to the next. Each menu is a list of choices or selections.

There are four lines in the display. The top line in each menu is a title or pertinent instruction. The top line does not change unless a new menu is selected. The second and third lines are used in two ways. One way is to display menu choices. The second way takes advantage of the graphical capabilities of the display. Both lines are used to display important messages, such as test results, in a large, easy to read format. The fourth line is used for menu choices.

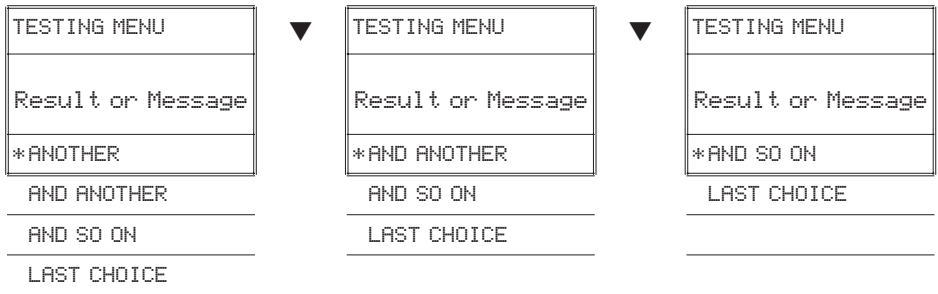


Think of the menu choices as a vertical list in the display which moves up or down each time an arrow button is pressed. This list or menu is viewed through a window, the menu choice window, in the display. The menu choice window is the lower 2 or 3 lines of the display. Pushing the arrow buttons brings another portion of the menu into menu choice window. This is referred to as scrolling through the menu.



An asterisk, “*”, will start in the far left position of the top line in the menu choice window. As the menu is scrolled through, different choices appear next to the “*”. The “*” in the display corresponds with the ***/ENTER** button. Pushing the ***/ENTER** button selects the menu choice which is adjacent to the “*” in the menu choice window.

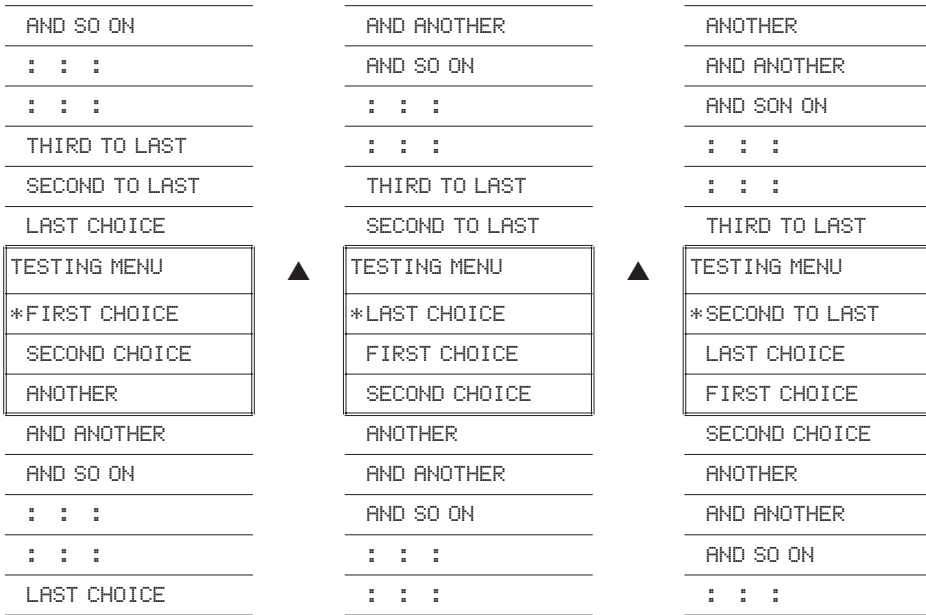
The second general format of the display takes advantage of the graphics capabilities of the display. The top line of the display is still a title line. The middle two lines of the display are used to display important messages, results or graphics in a large, easy to read format. The menus work in the same way as described previously but only one line of the menu is visible at the bottom of the display.



As described previously, the **EXIT** button allows an exit or escape from the current menu and a return to the previous menu. This allows a rapid exit from an inner menu to the main menu by repeatedly pushing the **EXIT** button. Pushing **OFF** at any time will turn the colorimeter off.

■ LOOPING MENUS

Long menus, such as *All Tests*, incorporate a looping feature which allow the user to quickly reach the last choice in the menu from the first choice. In a looping menu the last choices in the menu are above the first choice and scrolling upward moves through the menu in reverse order. Scrolling downward moves through the menu from first choice to last but the menu starts over following the last choice. So all menu choices can be reached by scrolling in either direction. The diagrams below demonstrate a looping menu.



TESTING

■ TESTING MENU

The Testing Menu is used to run all LaMotte pre-programmed tests, **USER TESTS** and **Absorbance** test at one of four wavelengths. Testing from any of three sequences can also be done.

1. Press the **ON** button to turn on the SMART2 Colorimeter. The LaMotte logo will appear for about 2 seconds and the the Start screen appears. Press the ***/ENTER** button to begin testing.

VER 1.0
Smart2
* Start

2. The **MAIN MENU** will appear. Press the ***/ENTER** button to select Testing Menu.

MAIN MENU
*Testing Menu
Editing Menu
PC Link

3. Scroll with the ▼ or ▲ buttons and make a selection with the ***/ENTER** button. **All Tests** has all the available tests. The three sequences have selected tests and **Absorbance** has %T/ABS tests.

TESTING MENU
*All Tests
Sequence 1
Sequence 2
Sequence 3
Absorbance

■ SEQUENCES OF TESTS

SEQUENCE 1, SEQUENCE 2, and SEQUENCE 3 are alterable sequences. They may be edited using the Editing Menu. Any of the LaMotte pre-programmed tests or User Tests may be placed in these sequences in whatever testing order that is preferred. Some examples of typical sequences are given below.

SEQUENCE 1	SEQUENCE 2	SEQUENCE 3
*015 Chlorine	*002 Aluminum	*003 Ammonia-N LF
079 Phosphate H	035 Cyanide	032 Cu-DDC
009 Bromine-LR	041 Fluoride	064 Nitrate-N L
076 pH TB	053 Iron Phen	067 Nitrite-N L
061 Moly-HR	055 Manganese L	074 pH CPR
086 Silica Hi	064 Nitrate-N L	078 Phosphate L
045 Hydrazine	067 Nitrite-N L	085 Silica Lo
032 Cu-DDC	077 Phenol	
051 Iron Bipyr	078 Phosphate L	
	090 Sulfide-LR	

These alterable sequences allow a series of tests to be setup that are run frequently. The order of the individual tests in the sequence is determined by the user. After running a test, use the * button to select the next test in the sequence. Continue this pattern until the entire sequence has been completed.

All Tests is a fixed sequence containing the LaMotte pre-programmed tests, User Tests, and Absorbance tests.

Modification of the alterable sequences is accomplished through the Editing Menu. This menu is explained in greater detail in EDITING MENU (p. 32).

Pressing the **EXIT** button while in a sequence menu will escape back to the Testing Menu.

Pressing the **OFF** button at any time will turn the colorimeter off.

■ GENERAL TESTING PROCEDURES

The following are some step by step examples of how to run tests from the Testing Menu. These test procedures are designed to be used with LaMotte SMART Reagent Systems.

LaMotte Company continuously updates the list of pre-programmed tests as the calibrations become available. Pre-programmed calibrations can be added to the SMART2 Colorimeter in the field. A Windows-based computer running a Windows Operating System and an 8 pin mini-DIN/9 pin F D-submin serial cable (order Code 1771) are required.

Call LaMotte Technical Services at 1-800-344-3100 (410-778-3100 outside the USA) or email at tech@lamotte.com for a current list of available calibrations and downloading instructions.

■ TESTING WITH THE LaMOTTE PRE-PROGRAMMED TESTS

Press ON to turn on the Smart2 Colorimeter. The LaMotte logo will appear for about 2 seconds and then the Start screen appears. Press the ***/ENTER** button to start testing.

VER 1.0
Smart2
*Start

The MAIN MENU will appear. Press the ***/ENTER** button to select Testing Menu.

MAIN MENU
*Testing Menu
Editing Menu
PC Link

Press the ***/ENTER** button to select All Tests.

TESTING MENU
*All Tests
Sequence 1
Sequence 2

Press the ▼ button to move to the 002 Aluminum to *.

ALL TESTS
*001 Alk - UDV
002 Aluminum
003 Ammonia - NLF

Press the ***/ENTER** button to select
002 Aluminum.

ALL TESTS
*002 Aluminum
003 Ammonia - NLF
004 Ammonia - NLS

The SMART2 Colorimeter is ready to scan at the correct wavelength. Place the blank in the sample chamber, close the lid and press the ***/ENTER** button to scan blank.

NOTE: Do not keep the button depressed.

002 Aluminum
*Scan Blank

The screen will display Blank Done for about 1 second. Scan Sample will be positioned next to *.

002 Aluminum
Blank Done
*Scan Blank

Place the reacted sample in the chamber, close the lid and press the ***/ENTER** button to scan sample. The colorimeter will scan the sample and the results screen will appear.

002 Aluminum
*Scan Sample

Record test result. To repeat the test, press the ***/ENTER** button to scan the sample again. The last blank scanned is used to zero the colorimeter for repeated scans. A different blank can be used by pressing the **▲** button to scroll back to Scan Blank and then scanning another blank. Scroll with the **▼** or **▲** buttons and make another selection with the ***/ENTER** button. The %T or Absorbance of the last test can be viewed by choosing %T/Abs. Press the **EXIT** button to escape to previous menus.

NOTE: The menu loop in this screen so either the **▲** or **▼** buttons will lead to the menu selection needed.

002 Aluminum
0.09 ppm
*Scan Sample
Next Test
Previous Test
%/Abs
Calibrate
Scan Blank

■ CALIBRATING LaMOTTE PRE-PROGRAMMED TESTS

The LaMotte Pre-Programmed Tests have been pre-calibrated. Recalibration of the pre-programmed tests by the user is not possible. However, a procedure to standardize the calibration can be performed to obtain the most accurate readings or to meet regulatory requirements.

The LaMotte Pre-Programmed tests are standardized with one standard solution. To standardize over the full range of the test, the concentration of the standard should be chosen from the high end of the range. Alternatively, if samples do not cover the full range of the test, a standard should be chosen that is close to the concentration of the samples.

The standardization procedure should be followed as often as required by regulations and laws for compliance monitoring.

In the example below the Aluminum calibration will be standardized.

Prepare a standard solution to be tested. Use 0.10 ppm aluminum.

Use the ▲ or ▼ button to scroll to 002 Aluminum. Follow instructions in the SMART2 Manual for testing the aluminum standard. Scan the blank.

002 Aluminum
*Scan Blank

The screen will display Blank Done for about 1 second. Scan Sample will be positioned next to *.

002 Aluminum
Blank Done
*Scan Sample

Place the reacted sample in the chamber, close the lid and press */ENTER to scan sample. The result will be displayed.

002 Aluminum
*Scan Sample

The displayed result can now be standardized. Use the ▲ or ▼ buttons to scroll to Calibrate. Press */ENTER to select.

002 Aluminum
0.09 ppm
*Scan Sample
Next Test
Previous Test
%T/Abs
Calibrate
Scan Blank

A reverse font (dark background with light characters) will appear to indicate that the reading can be adjusted. Use ▲ or ▼ to scroll to the concentration of the sample, 0.10 ppm in this example.

```
002 Aluminum
0.09
*Calibrate
```

Set the calibration by pressing ***/ENTER** to select Calibrate.

```
002 Aluminum
0.10
*Calibrate
```

Two menu choices will be offered, Set Calibration and Factory Setting. Set the calibration by pressing ***/ENTER** to select Set Calibration; or use ▲ or ▼ to scroll to and select Factory Setting to revert to the factory calibration.

```
002 Aluminum
0.10
*Set Calibration
Factory Setting
```

The meter will display the message "Storing" and return to 002 Aluminum test.

```
Storing
```

The calibration for 002 Aluminum has now been standardized and can be used for testing. The standardization can be removed by repeating the calibration and selecting Factory Setting.

```
002 Aluminum
*Scan Sample
Next Test
Previous Test
%/Abs
Calibrate
Scan Blank
```

■ MEASURING IN THE ABSORBANCE MODE

Press **ON** to turn on the SMART2 Colorimeter. The LaMotte logo will appear for about 2 seconds and then the Start screen appears. Press the ***/ENTER** button to start testing.

VER 1.0
Smart2
*Start

The **MAIN MENU** will appear. Press the ***/ENTER** button to select **Testing Menu**.

MAIN MENU
*Testing Menu
Editing Menu
PC Link

Press the **▼** button to scroll to **Absorbance**.

TESTING MENU
All Tests
Sequence 1
Sequence 2
Sequence 3
*Absorbance

Press the ***/ENTER** button to select **Absorbance**.

TESTING MENU
*Absorbance

Press the **▼** or **▲** buttons to move to the desired test.

Absorbance
*101 Abs 430
102 Abs 520
103 Abs 570
104 Abs 620

Press the ***/ENTER** button to select test.

Absorbance
*102 Abs 520
103 Abs 570
104 Abs 620

Insert blank, press the ***/ENTER** button to scan blank.

102 Abs 520
*Scan Blank

The screen will display **Blank Done** for about 1 second.

102 Abs 520
Blank Done
*Scan Blank

Insert the reacted sample. Press the ***/ENTER** button to scan the sample.

102 Abs 520
*Scan Sample

Record test result. To repeat the test, press the ***/ENTER** button to scan the sample again. The last blank scanned is used to zero the colorimeter for repeated scans. A different blank can be used by pressing the **▲** button to scroll back to **Scan Blank** and then scanning another blank. Scroll with **▼** or **▲** and make another selection with ***/ENTER**. The %T or Absorbance of the last test can be viewed by choosing %T/Abs. Press **EXIT** to escape to previous menus.

NOTE: The menu loop in this screen so either **▼** or **▲** will lead to the menu selection needed.

NOTE: The Calibrate function does not work in the Absorbance mode.

102 Abs 520
0.95
*Scan Sample
Next Test
Previous Test
%T/Abs
Calibrate
Scan Blank

EDITING MENU

The EDITING MENU allows the user to edit sequences, edit user tests, set the clock, edit the logging function, and set the power saving function.

■ EDIT A SEQUENCE

The EDIT SEQUENCE menu allows three alterable test sequences (SEQUENCE 1, SEQUENCE 2, and SEQUENCE 3) to be edited.

Press **ON** to turn on the SMART2 Colorimeter.
The LaMotte logo will appear for about 2 seconds and then the Start screen appears. Press the ***/ENTER** button to start testing.

VER 1.0
Smart2
*START

The Main Menu will appear. Press the ▼ button to scroll to Editing Menu.

MAIN MENU
*Testing Menu
Editing Menu
PC Link

Press the ***/ENTER** button to select Editing Menu.

MAIN MENU
*Editing Menu
PC Link

The Editing Menu appears. Press the ***/ENTER** button to select Editing Sequence.

EDITING MENU
*Edit Sequence
Edit User Test
Set Clock

The Edit Sequence menu appears. Press the ***/ENTER** button to scroll to select Edit Sequence 1.

EDIT SEQUENCE
*Edit Sequence 1
Edit Sequence 2
Edit Sequence 3

Sequence 1 appears.

EDIT SEQUENCE 1
*015 Chlorine
079 Phosphate H
009 Bromine-LR

■ ADDING OR DELETING TESTS

There are three ways to alter a sequence: *Insert Before*, *Insert After*, and *Delete*. *Insert Before* adds a new test to the sequence before the selected test. *Insert After* adds a new test to the sequence after the selected test. *Delete* is used to remove an existing test from a sequence.

Below is a step by step example of how to add a test to *SEQUENCE 1* starting from the *EDIT SEQUENCE 1* menu.

Press the ▼ button to scroll to 009 Bromine-LR.

EDIT SEQUENCE 1
015 Chlorine
079 Phosphate H
*009 Bromine-LR

Press the */ENTER button to select 009 Bromine-LR.

EDIT SEQUENCE 1
*009 Bromine-LR
076 pH TB
060 Moly-LR

Press the */ENTER button to select *Insert Before*.

EDIT SEQUENCE 1
*Insert Before
Insert After
Delete

The *ALL TESTS* menu appears. Press the ▼ button to move the 002 Aluminum to *.

ALL TESTS
*002 Aluminum
003 Ammonia-N LF
004 Ammonia-N LS

Continued...

Press the ***/ENTER** button to select
002 Aluminum.

ALL TESTS
*002 Aluminum
003 Ammonia-N LF
004 Ammonia-N LS

Sequence 1 appears in EDIT SEQUENCE 1 menu and 002 Aluminum is now before Bromine-LR in the sequence. All changes to Sequence 1 are automatically saved. Press the **EXIT** button to exit the EDIT SEQUENCE 1 menu and return to the EDIT SEQUENCE menu or continue editing.

EDIT SEQUENCE 1
*015 Chlorine
079 Phosphate H
002 Aluminum
009 Bromine-LR
076 pH TB
060 Moly-LR

The EDIT SEQUENCE menu appears. Select another sequence to edit or press the **EXIT** button to return to the EDITING MENU. Press the **EXIT** button again to return to the MAIN MENU.

EDIT SEQUENCE 1
*Edit Sequence 1
Edit Sequence 2
Edit Sequence 3

Below is a step by step example of how to delete a test from SEQUENCE 1 starting from the EDIT SEQUENCE 1 menu. The test 002 Aluminum, added in the previous example, will be deleted.

Press the **▼** button to scroll to 002 Aluminum.

EDIT SEQUENCE 1
*015 Chlorine
079 Phosphate H
002 Aluminum
009 Bromine-LR
076 pH TB
060 Moly-LR

Press the ***/ENTER** button to select
002 Aluminum.

EDIT SEQUENCE 1
*002 Aluminum
009 Bromine-LR
076 pH TB

Press the ▼ button to scroll to Delete.

EDIT SEQUENCE 1
*Insert Before
Insert After
Delete

Press the */ENTER button to select Delete.

EDIT SEQUENCE 1
*Delete

Sequence 1 appears in the EDIT SEQUENCE 1 menu and 002 Aluminum has been deleted. All changes to SEQUENCE 1 are automatically saved.

Press the **EXIT** button to exit the EDIT SEQUENCE 1 menu and return to the EDIT SEQUENCE menu or continue editing.

EDIT SEQUENCE 1
*015 Chlorine
079 Phosphate H
009 Bromine-LR
076 pH TB
060 Moly-LR

The EDIT SEQUENCE menu appears. Select another sequence to edit or press the **EXIT** button to return to the EDITING MENU. Press the **EXIT** button again to return to the MAIN MENU.

EDIT SEQUENCE 1
*Edit Sequence 1
Edit Sequence 2
Edit Sequence 3

■ EDIT USER TESTS

If a test other than the LaMotte programmed tests is performed regularly, a calibration for it may be entered in one of the 10 User Tests. These tests are originally named "User Test 1 - 10". It will be possible to rename the test, select a wavelength, enter a new calibration, select the number of decimal places used to display the results, and select the units. A User Test may be added for a reagent system for which no precalibrated test exists. A calibration of a LaMotte reagent system may also be entered. The calibration of a User Test can be changed at any time.

The User Tests have the ability to handle 2 data points. The colorimeter will determine the absorbance of the standards and calculate a response that will be stored to determine the concentration of future samples of unknown concentration. These standards should cover all the concentrations for the range of the test being performed and be scanned beginning with the low concentration and finishing with the high concentration (for more information about this, see CALIBRATION CURVES, page 13). Prepare these solutions prior to entering a new calibration.

NOTE: A calibration procedure must be performed before using any of the User Tests.

The User Tests can be placed in any of the alterable sequences using EDIT SEQUENCES.

To edit a User Test, start at the EDITING MENU. Scroll down to Edit User Test.

EDITING MENU
*Edit Sequences
Edit User Test
Set Clock

Press the ***/ENTER** button to select the Edit User Test.

EDITING MENU
*Edit User Test
Set Clock
Edit Logging

From the EDIT USER TEST menu, select the User Test to be entered or changed. In this example, choose 105 User Test 01. Use the ▼ and ▲ buttons to scroll to other User Tests if desired. Select the User Test by pressing the ***/ENTER** button.

EDIT USER TEST
*105 User Test01
106 User Test02
107 User Test03
108 User Test04
: : :
114 User Test10

■ NAMING THE TEST

A User Test can be up to 11 characters long. The menu choices for each character are 26 upper case letters A to Z, 26 lower case letters a to z, ten numerals 0 to 9, a space (SP), a dash (-) and a decimal point (.). The existing name is displayed on the bottom line of the display. A cursor will be over the character which is to be edited and that character is also displayed in the center of the display. The character can be changed by using the ▼ and ▲ buttons to scroll to other characters. Use the ***/ENTER** button to select a character. The edited name is saved at any time by pressing **EXIT** or by pressing the ***/ENTER** button after selecting the eleventh character.

From the `Edit User Test01` menu press the ***/ENTER** button to select `Name The Test` and change the name of User Test 01.

EDIT USER TEST01
*Name The Test
Select Vial/WL
New Calibration
Decimal Places
Select Units

The cursor is over the letter "U" in `105 User Test01` and the letter "U" is displayed in the large font in the center of the display.

NAME THE TEST
U
105 User Test01

Change the name to H2O. Use the ▼ and ▲ buttons to scroll to the letter "H" into the center of the display. Press the ***/ENTER** button to select the letter "H".

NAME THE TEST
H
105 User Test01

The letter "H" has been entered in the first position of the name and the cursor has moved to the second letter "S".

NAME THE TEST
S
105 User Test01

Use the ▼ and ▲ buttons to scroll to the number "2" into the center of the display. Press the ***/ENTER** button to select the number "2".

NAME THE TEST
2
105 Huser Test01

Continued...

The number “2” has been entered in the second position of the name and the cursor has moved to the third letter “e”.

NAME THE TEST
e
105 H2er Test01

Use the ▼ and ▲ buttons to scroll to the letter “0” into the center of the display. Press the ***/ENTER** button to select the letter “0”.

NAME THE TEST
0
105 H20r Test01

The letter “0” has been entered in the third position of the name and the cursor has moved to the fourth letter “r”. Press the **EXIT** button to save the name entered up to this point.

NAME THE TEST
r
*105 H20r Test01

The meter will display the message “Storing” and return to the EDIT USER TEST01 menu.

Storing

EDIT USER TEST01
*Name The Test
Select The Vial/WL
New Calibration
Decimal Places
Select Units

■ SELECTING THE VIAL AND WAVELENGTH

The Smart2 Colorimeter has three different vials (the 25 mm 0290 tube, UDV's and COD tubes) and 4 different wavelengths (430, 520, 570, and 620 nm). The colorimeter uses different settings for each of the twelve combinations of vial and wavelength. These twelve settings are called channels. Choose the channel with the correct wavelength and vial for the test.

Use the ▼ button to scroll to `Select Vial/WL` and press ***/ENTER** button to select.

EDIT USER TEST01
*Name The Test
Select Vial/WL
New Calibration
Decimal Places
Select Units

Use the ▼ and ▲ buttons to scroll to the appropriate channel and press ***/ENTER** button to select.

NOTE: This is a looping menu.

: : :
Ch11 620nm COD
Ch12 570nm COD
SELECT CHANNEL
*Ch1 520nm 25mm
Ch2 430nm 25mm
Ch3 620nm 25mm
Ch4 570nm 25mm
Ch5 520nm UDV
Ch6 430nm UDV
: : :

The meter will display the message "Storing" and return to the EDIT USER TEST01 menu.

Storing

EDIT USER TEST01
*Select The Vial/WL
New Calibration
Decimal Places
Select Units

■ ENTERING A NEW CALIBRATION

To enter a new calibration two reacted standards solutions of known concentration are required: a “low standard” and a “high standard”. These should be ready to use.

Use the ▼ button to scroll to **New Calibration** and press ***/ENTER** button to select.

EDIT USER TEST01
*Select Vial/WL
New Calibration
Decimal Places
Select Units

Input the concentration of the **LOW STANDARD** by using the ▼ and ▲ buttons to scroll the first digit of the concentration into the first position on the display. Press ***/ENTER** button to select that digit (1 for this example).

LOW STANDARD
0.....
*Continue

The number “0” is always the starting point for the next digit. Continue selecting digits or a decimal point to enter the concentration (up to seven characters).

LOW STANDARD
10.....
*Continue

“1.5” has been entered in this example. Press ***/ENTER** button four times to input “0” as the last four digits. Pressing ***/ENTER** after selecting the last digit saves the concentration.

LOW STANDARD
1.5000.....
*Continue

Input the concentration of the **HIGH STANDARD** by using the same method as for the low standard.

HIGH STANDARD
0.....
*Continue

Place a clear blank in the sample chamber. Press the ***/ENTER** button to scan the blank.

Insert Blank
*Continue

The screen will display Blank Done for about 1 second.

Blank Done
*Scan Blank

Place the reacted low standard in the sample chamber. Press ***/ENTER** to scan the low standard.

Insert Lo Standard
*Continue

Place the reacted high standard in the sample chamber. Press ***/ENTER** to scan the high standard.

Insert Hi Standard
*Continue

The meter will display the message "Storing" and return to the EDIT USER TEST01 menu.

Storing

EDIT USER TEST01
*New Calibration
Decimal Places
Select Units

■ SELECTING THE NUMERICAL FORMAT OF THE RESULT

To input tests with very different ranges, the number of decimal places displayed for a result can be selected. A test which ranges from 20 to 1000 ppm should not be displayed with three decimal places. A test with a range from 0.010 to 0.500 needs three decimal places (the microprocessor will always calculate the concentration to many more significant figures than will be displayed). Menu choices of 0, 1, 2, or 3 decimal places will be given for the display.

Use the ▼ button to scroll to `Decimal Places` and press ***/ENTER** button to select.

EDIT USER TEST01	
*New Calibration	
Decimal Places	
Select Units	

Use the ▼ button to scroll to the number of decimal places to be shown and press ***/ENTER** to select.

DECIMAL PLACES?	
*None	0
One	0.0
Two	0.00
Three	0.000

The meter will display the message "Storing" and return to the `EDIT USER TEST01` menu.

Storing

EDIT USER TEST01	
*Decimal Places	
Select Units	

■ SELECTING THE UNITS OF CONCENTRATION

The SMART2 Colorimeter has seven options for units of concentration. They are No Units, ppm, pH, FTU, ppb, ppt and mgL.

Use the ▼ button to scroll to `Select Units` and press ***/ENTER** to select.

EDIT USER TEST01
*Decimal Places
Select Units

Use the ▼ button to scroll to the appropriate unit and press ***/ENTER** to select.

SELECT UNITS
*No Units
ppm
pH
FTU
ppb
ppt
mgL

The meter will display the message "Storing" and return to the EDIT USER TEST01 menu.

Storing

EDIT USER TEST01
*Select Units

■ SETTING THE CLOCK

Setting the clock allows the correct time and date stamp to be stored with each reading in the data logger and with each reading sent out the serial port.

From the EDITING MENU use the ▼ button to scroll to Set Clock. Press ***ENTER** to select.

EDITING MENU
*Edit Sequences
Edit User Test
Set Clock
Editing Logging
Factory Setup
Set PWR Save

The current date and time are displayed as month - day - year on the first line and as hours : minutes : seconds on the second line. A two-digit number is displayed for each setting. Use the ▼ and ▲ buttons to scroll to the appropriate number and press ***ENTER** to select. The cursor will move to the next digit. Set all subsequent numbers in the same manner. Selecting the final digit in the seconds field stores the date and time and returns to the EDITING MENU.

NOTE: These are looping menus.

SET TIME
MM - DD - YY
HH : MM : SS

EDITING MENU
*Set Clock
Editing Logging
Factory Setup
Set PWR Save

■ TURNING THE DATA LOGGER ON AND OFF

The default setting for the datalogger is “Enabled” or turned off. If there is no need for data logging, this setting is suggested. If data logging is needed, the data logger can be “Enabled” or turned on.

From the EDITING MENU use the ▼ button to scroll to Edit Logging. Press ***/ENTER** to select.

EDITING MENU
*Edit Sequences
Edit User Test
Set Clock
Editing Logging
Factory Setup
Set PWR Save

The current setting is always displayed next to the *. To change the setting, use the ▼ or ▲ buttons to scroll to the other setting. Press ***/ENTER** to select.

EDIT LOGGING
*Enabled
Disabled

The meter will display the message “Storing” and return to the EDITING MENU.

Storing

EDITING MENU
*Editing Logging
Factory Setup
Set PWR Save

■ FACTORY SETUP

The Factory Setup menu is used in the manufacturing of the SMART2 Colorimeter. This menu is not for use by the operator in the field.

■ SETTING THE POWER SAVING FUNCTION

The SMART2 Colorimeter has a power saving function that turns the meter off after an interval of inactivity. If no buttons have been pressed during that interval the meter will turn itself off. This interval can be disabled or set for 5, 15, 30 or 60 minutes. The default setting is 5 minutes.

From the EDITING MENU use the ▼ button to scroll to Set PWR Save. Press ***/ENTER** to select.

EDITING MENU
*Edit Sequences
Edit User Test
Set Clock
Editing Logging
Factory Setup
Set PWR Save

The current setting is always displayed next to the *. To change the setting, use the ▼ or ▲ buttons to scroll to the appropriate setting. Press ***/ENTER** to select.

Disabled
AUTO SHUTOFF
*5 Minutes
15 Minutes
30 Minutes
60 Minutes

The meter will display the message "Storing" and return to the EDITING MENU.

Storing

EDITING MENU
*Set PWR Save

PC LINK

The SMART2 Colorimeter may be interfaced with any Windows-based computer by using the LaMotte SMARTLink2 Program and Interface Cable (Order Code 1912-3 [3.5 disk] or 1912-CD [compact disk]). The program stores customer information and test data in a database. It can be used to download data stored in the Smart2 datalogger for each test site.

The colorimeter may also be interfaced with an RS-232 serial printer, using an interface cable (Order Code 1772) and setting the printer configuration to the Output as described below.

Choose PC Link from the Main Menu. The user can download the entire datalogging buffer. Downloading does not delete or empty the datalogger.

■ OUTPUT

RS-232 compatible, asynchronous serial, 9600 baud, no parity, 8 data bits, 1 stop bit.

■ COMPUTER CONNECTION

RS-232 interface connection, 8 pin mini-DIN/9 pin F D-submin. (Order Code 1772).

BATTERY OPERATION

The colorimeter may be run on battery power or AC using the AC adapter. If using the meter as a benchtop unit, keep it plugged in if possible. If used on only battery power, always have a spare battery on hand.

If the battery power is low, the SMART2 will display "LOW BATT" and turn off.



LOW BATT

■ REPLACING THE BATTERY

The SMART2 Colorimeter uses a standard 9-volt alkaline battery that is available worldwide. The battery compartment is located on the bottom of the case.

To replace the battery:

1. Open the battery compartment lid.
2. Remove the battery and disconnect the battery from the polarized plug.
3. Carefully connect the new battery to the polarized plug and insert it into the compartment.
4. Close the battery compartment lid.

MAINTENANCE

■ CLEANING

Clean with a damp, lint-free cloth.

DO NOT ALLOW WATER TO ENTER THE COLORIMETER CHAMBER OR ANY OTHER PARTS OF THE METER.

■ METER CARE

The optical system of the SMART2 must be kept clean and dry for optimal performance. Dry the colorimeter tubes before placing them in the chamber to avoid introducing moisture. For best results store the instrument in an area that is dry and free from aggressive chemical vapors.

■ METER DISPOSAL

Waste Electrical and Electronic Equipment (WEEE)

Natural resources were used in the production of this equipment. This equipment may contain materials that are hazardous to health and the environment. To avoid harm to the environment and natural resources, the use of appropriate take-back systems is recommended. The crossed out wheeled bin symbol on the meter encourages you to use these systems when disposing of this equipment.



Take-back systems will allow the materials to be reused or recycled in a way that will not harm the environment. For more information on approved collection, reuse, and recycling systems contact your local or regional waste administration or recycling service.

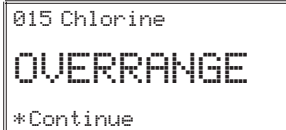
TROUBLESHOOTING GUIDE

■ ERROR MESSAGES

▪ OVER RANGE

If the message **OVERRANGE** is displayed when scanning a sample, the sample may be over range or under range. If the sample is over range the sample should be diluted and tested again (see Sample Dilution Techniques and Volumetric Measurements, page 16).

If **OVERRANGE** is displayed, press the ***ENTER** button to continue testing on diluted samples.

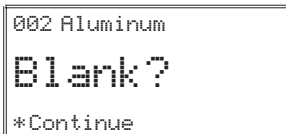


015 Chlorine
OVERRANGE
*Continue

▪ BLANK

If the message **Blank?** is displayed when scanning a sample, the sample had a lower reading than the blank. Review test procedure to determine whether a reagent blank is required. Visually check for color development in reacted sample. Repeat test if necessary.

If **Blank?** is displayed, press the ***ENTER** button to continue. Check to see if the meter was blanked properly.



002 Aluminum
Blank?
*Continue

■ CALIBRATION

As with all pre-calibrated meters, it is highly recommended, even if not required by regulations, that the user periodically verify the performance of the meter by running standards with a predetermined concentration. Results outside of specification are an indication that the meter needs to be adjusted. This can be done following the user calibration described on page 31. If the user calibration fails to properly adjust the meter then the meter should be returned to LaMotte Company for recalibration. (See page 5).

■ HELPFUL HINTS

▪ STRAY LIGHT

The SMART2 Colorimeter should have no problems with stray light. Make sure that the sample compartment lid is always fully closed, except when testing COD with the adapter.

