Model SLS 9400FC
COLORIMETER

P/N 79-10-052
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TABLE OF CONTENTS

General Information

Introduction

With the ever increasing premium placed on the quality of displayed images in medical diagnostics, broadcasting, video production, animation, education, computer graphics, and advertising, a way to insure accurate color presentation from the display units has become critical. The Model SLS 9400FC Colorimeter has been specifically designed to meet the demand for a low cost, easy to use, high precision instrument to control and allow easy adjustment of the color and brightness on any monitor.

The Model SLS 9400FC has direct application in:

- Video and post production
- TV studios
- Medical Imaging
- Advertising
- Computer Graphics
- Desktop publishing
- CRT manufacturing
- Animation
- Video wall presentations

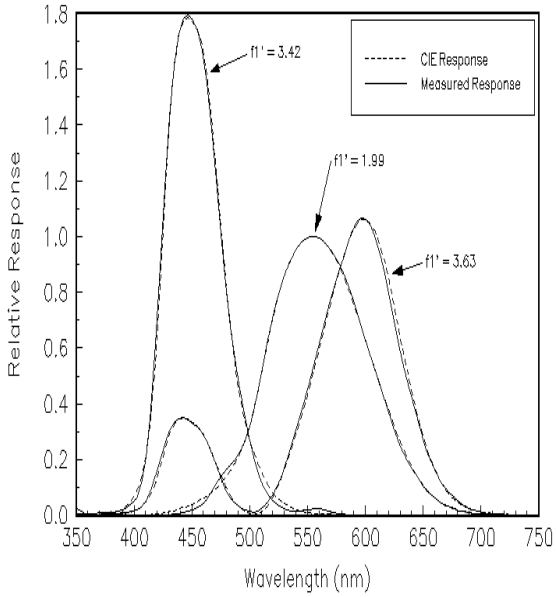
and any other application where the need to control absolute color accuracy is a necessity.

The Model SLS 9400FC Colorimeter consists of a sensor head and a Handheld display unit. A built-in rechargeable battery pack allows the instrument to be operated anywhere and the RS-232 serial communication port makes remote data collection simple.

The key to the extremely high accuracy of the Model SLS 9400FC is it's ability to match the color response of the human eye, as defined by the CIE 1931 standard observer spectral response functions. This match allows the user to make very accurate color and luminance measurements across the full color gamut of a typical color CRT. The accuracy of a colorimeter depends on how closely the instrument's spectral response matches the CIE 1931 standard observer spectral response. The Model SLS 9400FC's unique, proprietary sensor/filter design very closely mirrors these spectral response curves resulting in highly accurate chromaticity measurements that are independent of field rate or the monitor's phosphor yielding precision white balancing capability. Luminance is measured using a detector/filter combination, which closely matches the response of the human eye as defined by the CIE Luminous Efficiency Function. This gives the Model SLS 9400FC the ability to accurately measure the luminance of a monitor.

Model SLS 9400FC Colorimeter

Unlike instruments that use three detectors, or unstable (temperature and time sensitive) interference, plastic or gelatin filters, the Model SLS 9400FC uses four precision silicon photodiodes with highly stable colored glass filters. By using four detector/filter combinations, the Model SLS 9400FC can accurately match the complete set of tristimulus functions.



The Model SLS 9400FC's ergonomic design allows the instrument to rest firmly on a table top, or to be operated with one hand, leaving the other hand free to make any required monitor adjustments. It has an EL backlit 128 x 128 dot matrix LCD display to make measurements in dim lighting conditions.

Measurements can be displayed in three modes. An analog bar graph displaying RGB values used to perform color balance adjustments or two numeric mode options for the display of absolute color coordinates. Simple, precise, portable, and affordable, the Model SLS 9400FC puts laboratory quality measurements in the palm of your hand.

Model SLS 9400FC Features

- Remote computer control using an RS-232 interface (which can be disabled)
- Large EL backlit 128 x 128 graphics LCD display with an anti-glare coating
- A standard ¼-20 post mount insert on both the detector and display unit
- Universal input power supply
- A low profile suction cup (with a deactivation knob)
- Numeric modes
  - CIE 1931 xyY
  - CIE 1976 $u'v'$Y
  - CIE 1931 $\Delta x \Delta y$Y
  - CIE 1976 $\Delta u' \Delta v'$Y
  - CIE 1931 XYZ
- CIE plot modes
  - CIE 1931 xyY
  - CIE 1976 $u'v'$Y
  - CIE 1931 $\Delta x \Delta y$Y
  - CIE 1976 $\Delta u' \Delta v'$Y
- RGB bar graph mode
- 9 reference measurement storage locations
- 9 setup memory storage locations
- 9 phosphor memory storage locations
- 9 white reference memory storage locations
- Display hold
- Battery saver (which can be disabled)
- Calibration reminder
- Field calibration capability

Calibration

The calibration of the UDT Instruments Model SLS 9400FC is traceable to the National Institute of Standards and Technology (NIST) and Physikalisch-Technische Bundesanstalt (PTB).

The Model SLS 9400FC has a built in calibration reminder. This feature informs the user that the instrument needs to be recalibrated when the calibration cycle elapses. When the instrument needs to be recalibrated, the calibration information will be displayed every time the instrument is turned on.

Caution

Use only the battery charger supplied with the instrument. Failure to do so may cause permanent damage to the Model SLS 9400FC and may result in personal injury. To avoid electrical shock, use proper care when using the battery charger.

Electrostatic Sensitive Device

All semiconductor devices are susceptible to electrostatic discharges (ESD). Ensure that the unit is switched off before connecting or disconnecting the detector probe, battery charger, and RS-232 cable. Failure to do so can cause ESD damage and reduce the lifetime of the instrument drastically.

Preparation for use

Model SLS 9400FC Inspection

The Model SLS 9400FC shipping carton contains the following items:

- Model SLS 9400FC colorimeter
- Hardside carrying case
- Universal AC input battery charger with power cord
- RS-232 adapter with cord
- Instruction manual
- Certificate of calibration

The instrument was inspected prior to shipment and was free of mechanical and electrical defects. Immediately after unpacking the instrument, inspect for damage that may have occurred during transit. If any damage is found, a claim should be filed with the carrier and UDT Instruments should be contacted for a Return Materials Authorization (RMA) number.

Storage and Shipping

To prevent damage to the instrument, it is recommended that the package designed for the instrument be used when shipping. The original packaging is intended to be used for shipping, carrying, and storage.

Instrument Identification

The model and serial number of the instrument are located on the "CALIBRATION RECORD" label attached to the back of the Handheld indicator unit and the bottom of the detector head. The serial number of the Handheld and head can also be determined by viewing the "CALIBRATION INFO" screen via the **CONFIGURATION 2** menu (the bottom right icon, see page 3-13).

Input Power Requirements

The Model SLS 9400FC receives its primary power from internal batteries. The approximate lifetime of the batteries is fourteen hours without the backlight and seven hours with the backlight.

Before charging the batteries, turn the instrument **OFF**, plug the battery charger into the instrument, connect the power cord to battery charger and then to the wall socket. With the instrument turned off, the batteries will fully charge in approximately four hours. Because of this fast charging rate, the keypad and the surrounding area will be warm. This is normal and there is no cause for alarm. The operation of the instrument is not affected while the batteries are charging.

NOTE: Due to the nature of NiCd batteries, the batteries may exhibit a reduced charge capacity over time. This is typically caused by repetitive partial discharge/recharge cycles. To maintain maximum battery charge capacity, operate the instrument until the battery is fully discharged before recharging.

The battery charger is configured to supply the proper power to the Model SLS 9400FC independent of the input voltage and frequency. The charger will function with an input voltage ranging from 100 to 240 volts AC at 47 to 63 Hz. The power supply has UL, CSA and TUV certifications .

Turn-on and Check Out Procedure

Connect the detector probe to the handheld unit, **make sure not to over tighten the connector**, and press the **PWR** button. When the power button is depressed the instrument will beep and the icons will be displayed at the bottom of the screen along with a message stating that the instrument is performing a self-calibration. When the self calibration is completed the Model SLS 9400FC will start taking measurements based on the configuration information in the **DEFAULT** setup memory location (see page 3-7 for more information).

The Model SLS 9400FC is fully charged before it leaves the factory. However, if the instrument acts erratically, fully charge the batteries before proceeding with the check out procedure.

Warm Up Period

The Model SLS 9400FC can be used immediately after it is turned **ON**. However, the Model SLS 9400FC will perform best if allowed to stabilize for at least 30 minutes before making precision measurements. This is especially critical when making low luminance level color measurements.

Suction Cup

The Model SLS 9400FC is equipped with a suction cup, which makes it convenient to mount the probe assembly to the CRT and thereby freeing the users hands. For maximum performance, the user needs to verify that the lip of the suction cup and the CRT face are clean, and the knurled suction release valve is fully seated. Failure to do so may result in premature release of the vacuum and may lead to damage of the probe assembly.

To mount the probe assembly on the CRT simply press it against the CRT. To remove, hold detector assembly while pulling back on one of the four nodules on the outside edge of the suction cup until suction is released. Removing the suction cup by pulling directly on the lip or by pulling directly on the detector assembly will cause damage to the suction cup.

In the event the suction mechanism is not needed, the suction cup can be used as a light shade by removing the release valve and defeating the vacuum mechanism. A threaded hole has been provided in the bottom of the probe assembly to store the release valve when not in use.

NOTE: The suction cup has been designed to provide short term mounting capabilities. Should the user require long term and/or fixed positioning, a ¼-20 post mount insert is provided for convenient mounting.

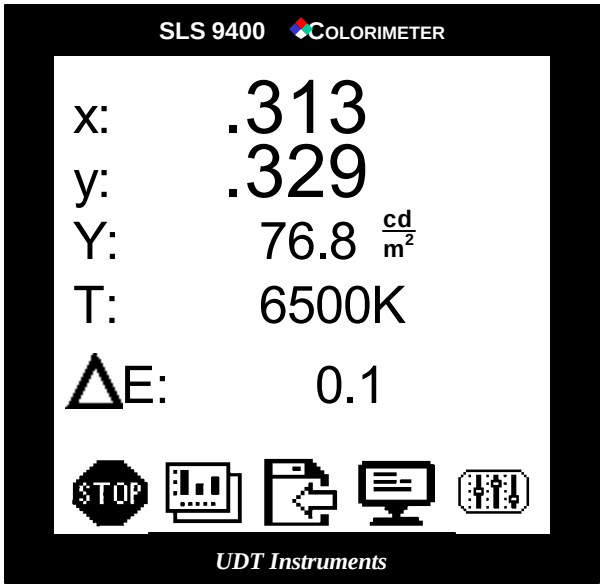
Model SLS 9400FC Operation

Introduction

The Model SLS 9400FC operates in three modes: a numeric display mode, a CIE plot mode, and a RGB bar graph mode.

Numeric Display Mode

The numeric display mode displays the color coordinates of a source, the luminance value in the desired units of measure, the Correlated Color Temperature and the color error ΔE (**CIELUV**). This mode is used to perform absolute or differential color measurements. The color coordinates can be displayed in the following formats:



- CIE 1931 xyY
- CIE 1976 *u'v'* Y
- CIE 1931 ΔxΔyY
- CIE 1976 Δ*u'*Δ*v'* Y
- CIE 1931 XYZ

In the CIE 1931 ΔxΔy and CIE 1976 Δ*u'*Δ*v'* modes, the reference is selected via the **DELTA REFERENCE** menu option in the **CONFIGURATION 2** menu (the bottom right icon, see page 3-13). Upon entry into this mode, the displayed delta values are calculated as follows:

In CIE 1931 ΔxΔy:

- $\Delta x = x_{measured} - x_{ref}$
- $\Delta y = y_{measured} - y_{ref}$

In CIE 1976 Δ*u'*Δ*v'*:

- $\Delta u' = u'_{measured} - u'_{ref}$
- $\Delta v' = v'_{measured} - v'_{ref}$

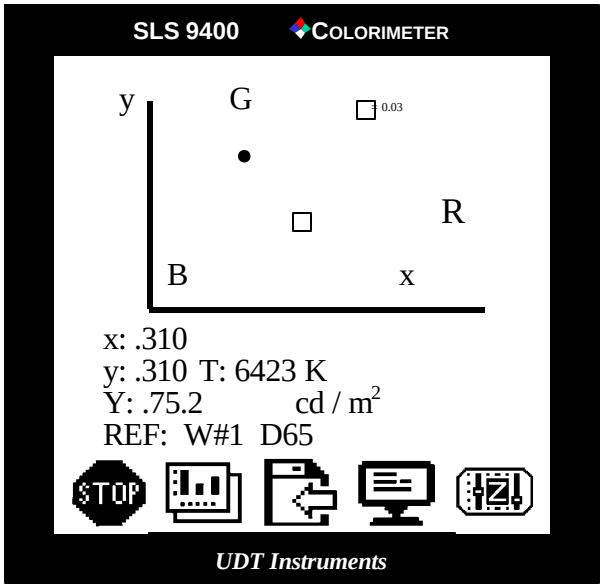
To use a stored measurement value as the reference it must first be stored in one of the numeric modes to be used in the calculations above.

The Correlated Color Temperature (**CCT**) is calculated using the method described by A. R. Robinson in *Color Science: Concepts and Methods, Quantitative Data and Formulae*, 2nd Edition by Wyszecki and Stiles. Valid **CCT** range is 2,500 K to 30,000 K.

The ΔE (**CIELUV**) calculation uses as its reference the value selected via the **DELTA REFERENCE** menu option in the **CONFIGURATION** 1 menu (see **DELTA REFERENCE** explanation, page 3-16). For further explanation of ΔE calculations see Wyszecki and Stiles.

CIE Plot Display Mode

The CIE Plot Mode displays a graphical representation of the difference between the currently measured color coordinates and the color coordinates of the user specified reference **(REF:)** where:



- $x = x_{measured} - x_{ref}$
- $y = y_{measured} - y_{ref}$

and the numeric color coordinates can be displayed in the following formats:

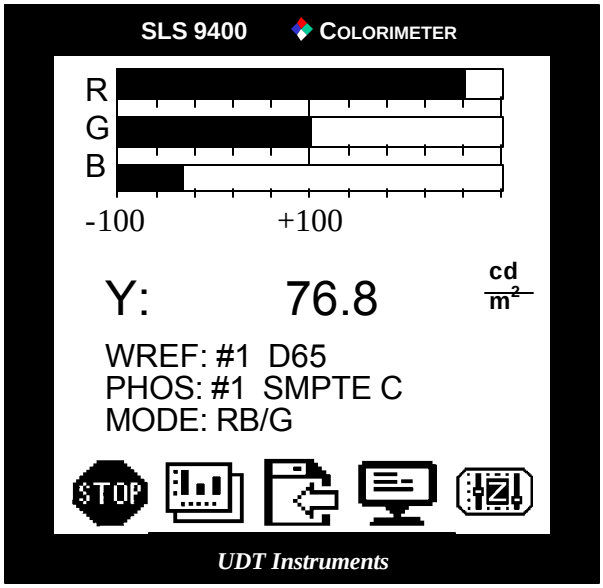
- CIE 1931 xyY
- CIE 1976 *u'v'* Y
- CIE 1931 ΔxΔyY
- CIE 1976 Δ*u'*Δ*v'* Y

The color reference or target is represented by the ☐ in the middle of the graphical area while the "☐ =" (shown at the top of the graphical area) indicates the graphical resolution scale. The resolution scales indicate the magnitude of the color difference and can be adjusted manually using the **ZOOM-CONFIGURATION** icon (see page 3-6). The available resolution levels are:

- 0.05
- 0.03
- 0.004

During use, the color difference has been minimized within the specified graphically resolution when the ■ lies within □. To illustrate, for maximum resolution the size of the target box needs to be set to '□ = 0.004". This sets the length of the sides of the target to indicate a color coordinate deviation of 0.004 in either axis. The CIE plot mode is intended as display mode only. RS-232 communications will follow the **Numeric Display Mode** protocol.

RGB Bar Graph Display Mode



The RGB bar graph mode shows the color balance between the three primary colors, red, green and blue, in an analog format. When the three values are equal, the color balance corresponds to the selected RGB reference. Balance is achieved when the bars are equal lengths centered in the display. Numerical data is also displayed to present the user with quantitative as well as qualitative data. The RGB reference can either be a stored white reference or a stored measurement. The bar graph mode can display:

- Two of the primary colors related to the third
- Three of the primary colors related to three primary colors of a stored measurement

RGB data is calculated per the SMPTE RP 177-1993 using the chromaticity coordinate values corresponding to the selected white reference **(WREF:)** and phosphor **(PHOS:).** These values maybe changed via the **WHITE REFERENCE** and **PHOSPHOR** menu options in the **CONFIGURATION** 1 menu. The RGB data is available over the RS-232 port in response to an **R** command while in the RGB display mode. These values are then normalized and displayed based on the selected bar graph mode **(MODE:)**. For selected bar graph mode **(MODE:)** RG/B, B (blue) is the normalizer and for bar graph mode GB/R, R (red) is the normalizer. As an example, if the selected bar graph mode is RB/G, G (green) is the normalizer, which is held constant, and the R (red) and B (blue) balance is calculated as follows:

- $\Delta R = \frac{(R_{measured} - R_{ref})}{(G_{measured} - G_{ref})} x\,100\%$

- $\Delta G = 0$ *(TheSelectedNormalizer)*

- $\Delta B = \frac{(B_{measured} - B_{ref})}{(G_{measured} - G_{ref})} x\,100\%$

In the event, the user has selected a stored measurement as the **RGB REFERENCE,** the measurement must have been previously stored while in the RGB display mode. With a stored measurement as the RGB reference, the displayed values will be calculated as follows:

- $\Delta R = \frac{(R_{measured} - R_{ref})}{R_{ref}} x\,100\%$

- $\Delta G = \frac{(G_{measured} - G_{ref})}{G_{ref}} x\,100\%$

- $\Delta B = \frac{(B_{measured} - B_{ref})}{B_{ref}} x\,100\%$

The Model SLS 9400FC provides manual (see page 3-15) and automatic RGB bar scaling. In the automatic mode the instrument will automatically adjust the scale of the RGB bars to allow the user to conveniently adjust the colors without having to modify the display resolution. A scale independent numeric readout to the right of each bar will display the actual value of ΔR, ΔG, and ΔB. The three scaling levels are:

- -100% to 100%
- - 25% to 25%
- - 10% to 10%

When the value of ΔR, ΔG, and ΔB equals zero, the color balance corresponds to the selected reference. This is indicated when the bars are centered while the RGB scaling is set to the highest resolution (±10%). The RGB measurements are independent of the luminance level.

NOTE: The RGB calculations are directly dependent on the white reference and the phosphor of the monitor. To ensure accurate rgb measurements it is very important that the correct phosphor type is selected. If the monitor under test does not use either the smpte c or the ebu phosphor, then it is necessary to characterize the phosphor used in the monitor. This can be done by the Model SLS 9400FC's phosphor learn mode or entered manually if the chromaticity coordinate values are known for the primary colors. For further information see the SMPTE Recommended Practice, "Derivation of Basic Television Color Equations", RP 177, for details concerning the proper derivation of rgb data.

Instrument Operation

The Model SLS 9400FC is primarily controlled through five icons displayed at the bottom of the screen. To move between the icons use the left and right arrow keys. To activate the icon function press the enter key. To move around in the menus use the left, right, up, and down keys, and press the enter key to activate a menu selection.

Icons:

The function of each icon and its associated menus are explained in the following section.

Stop:

The stop icon is a toggle switch. When the **ENTER** key is depressed while the stop icon is highlighted, the instrument will stop performing measurements and enters the hold mode. The stop icon will be replaced with a flashing H icon. When the enter key is depressed again the instrument will resume measuring and the stop icon will be displayed. All menus are available in either mode.

Display Mode:

The **DISPLAY MODE** icon will select between the three display modes. Use the up-down arrow keys to scroll through the available display modes and the **ENTER** key to select a new mode. The configuration of each mode will depend on the current setup parameters. When the instrument is in the **HOLD** mode and a new display mode is selected, the instrument will deactivate the **HOLD** mode and changes to the new measurement mode.

Save

The save icon will display the save menu. This menu allows the user to save the current setup parameters, the current measurement, white reference, or phosphor chromaticity coordinates, and the state of RS-232 communications.

View

The view icon will display the view menu. This menu allows the user to view the stored setup, measurement, white reference and phosphor chromaticity coordinates.

Configuration

The configuration icon is used to configure the Model SLS 9400FC setup parameters and to view the current status and calibration information. The zoom-configuration icon indicates manual scaling is active (rgb and cie plot modes). Use the up and down arrow keys to change the scaling resolution. Press the enter key to enter the configuration menu.

Menu Options

Use the up and down arrow keys to scroll through the menus and the enter key to select a function. To allow for faster movement within the save, recall, view, and configuration menus and sub-menus, the left arrow key positions the cursor at the first menu selection and the right arrow key moves the cursor to the exit menu selection.

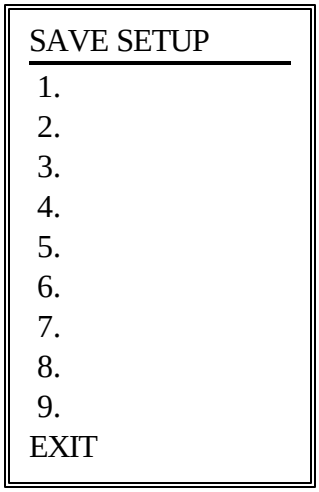
Save Menu

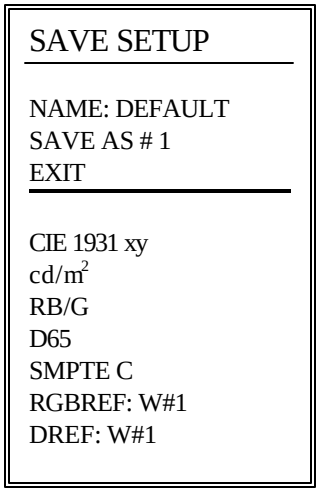
The save menu is used to store and erase setup parameters, measurement values, white reference values, phosphor values, and change the state of RS-232 communications.

SAVE	
SETUP	
MEASUREMENT	
WHITE REFERENCE	
PHOSPHOR	
RS232	**ON**
EXIT	

Save Current Setup

The **SAVE SETUP** menu has nine available memory locations that can be used to store desired setup parameters. To save a setup, select a memory location and press **ENTER**. When a memory location is selected, the menu options **NAME, SAVE AS #, EXIT**, and the current setup information will be displayed. This information consists of:





- Measurement mode
- Luminance units
- Bar graph measurement mode
- White reference
- Phosphor
- Bar graph mode reference
- Differential mode reference

To save a setup, it is first necessary to name the setup memory location. Select **NAME** and press the **ENTER** key. The cursor will move to the first character of the name. Using the up and down arrow keys will change the character, the right and left arrow keys will move the cursor to the next/previous character field. Press **ENTER** when the entry is complete. Scroll down to **SAVE AS #** and press **ENTER**.

The name of the first memory location is preprogrammed to **DEFAULT** and can not be changed. However, the setup parameters can be changed through the configuration menu. The **DEFAULT** memory location will be used when the instrument is turned on.

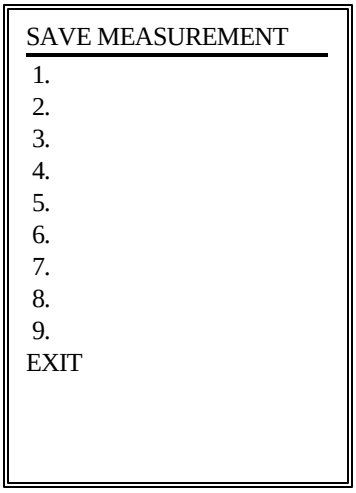
A saved setup contains parameters for both the numeric and the bar graph display modes.

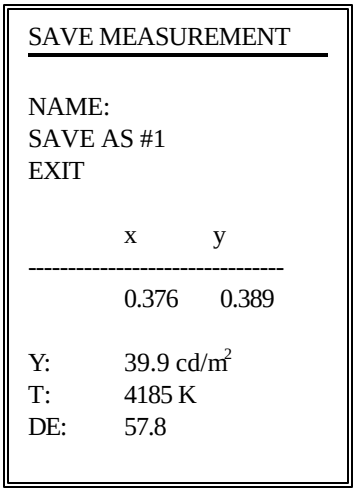
To erase a setup, select **NAME** and press the **ENTER** key. The cursor will move to the first character of the name. Using the up and down arrow keys, change the first character to a blank. Press **ENTER**. The name will be cleared from the display. To complete the erasure, scroll down to **SAVE AS #** and press **ENTER**.

The setup in the first memory location is preprogrammed to **DEFAULT** and can not be erased. Also the instrument will not allow erasure of the setup currently in use. If an attempt is made to erase a currently used setup, the instrument will display the error message "**MEM LOC ERROR**".

Save Current Measurement:

The save **MEASUREMENT** menu has nine available memory locations that can be used to store desired measurements. To save a measurement, select a memory location and press **ENTER**. When a memory location is selected, the menu options **NAME, SAVE AS #, EXIT**, and the current measurement data will be displayed. The format of the data depends on the measurement mode.





	Measurement Modes			
	Numeric		CIE plot	Bar
	xy, *u'v'*, ΔxΔy,Δ*u'*Δ*v'*	XYZ	xy, *u'v'*, ΔxΔy,Δ*u'*Δ*v'*	RGB
Measurement Data	✓	✓	✓	✓
Luminance Value	✓		✓	✓
Color Temperature	✓	✓	✓	
ΔE (**CIELUV**)	✓			

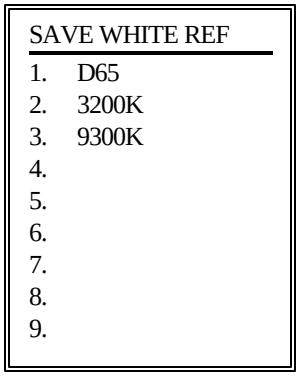
To save a measurement, it is first necessary to name the measurement memory location. Select **NAME** and press the **ENTER** key. The cursor will move to the first character of the name. Using the up and down arrow keys will change the character, the right and left arrow keys will move the cursor to the next/previous character field. Press **ENTER** when the entry is complete. Scroll down to **SAVE AS #** and press **ENTER**. The measurement name in the **SAVE MEASUREMENT** menu will be displayed along with **NUM** indicating the measurement was stored in one of the numeric modes or RGB if it was stored in RGB mode.

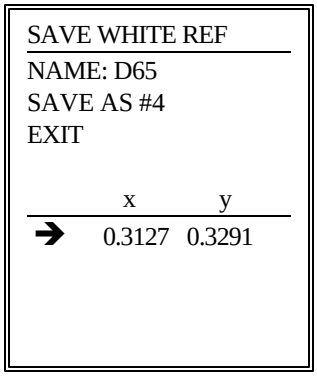
To erase a measurement, select **NAME** and press the **ENTER** key. The cursor will move to the first character of the name. Using the up and down arrow keys, change the first character to a blank. Press **ENTER**. The name will be cleared from the display. To complete the erasure, scroll down to **SAVE AS #** and press **ENTER**.

A measurement can not be cleared if it is currently used as either a **RGB REFERENCE** or a **DELTA REFERENCE**. If an attempt is made to erase a currently used measurement, the instrument will display the error message "MEM LOC ERROR".

Save White Reference:

The save **WHITE REFERENCE** menu has nine memory locations. The first three memory locations contain the preprogrammed white reference chromaticity coordinates for D65, 3200 K and 9300 K. The remaining six memory locations can be programmed by entering the desired values. The values can be entered as xy or *u'v'* chromaticity coordinates. To save a white reference, select a memory location and press **ENTER**. When a memory location is selected, the menu options **NAME, SAVE AS #, EXIT**, ➔, and the current measurement data will be displayed. This information consists of:





- Reading (xy, *u'v'*)

To save a white reference, it is first necessary to name the white reference memory location. Select **NAME** and press the **ENTER** key. The cursor will move to the first character of the name. Using the up and down arrow keys will change the character, the right and left arrow keys will move the cursor to the next/previous character field. Press **ENTER** when the entry is complete. Scroll down to **SAVE AS #** and press **ENTER**.

The entry chromaticity mode can be selected by changing the measurement mode from the configuration menu. Saving a white reference is only accessible while the instrument is in the xy and *u'v'* modes. The current measurement data is displayed and can be manually modified by scrolling to the arrow, ➔, menu selection and pressing **ENTER**. This will position the cursor on the first character of the chromaticity coordinate. Using the up and down arrow keys will change the character, the right and left arrow keys will move the cursor to the next/previous character field. Press **ENTER** when the entry is complete. Scroll to **SAVE AS #** and press **ENTER**.

The white reference chromaticity coordinates are displayed to four decimal places. This is done to prevent round off errors in the calculations. Valid xy coordinates range from 0.0048 to 0.8338

($u'v'$: 0.0159 to 0.6233). The limits have been selected based on tabular data of Table I (3.3.1) Color-Matching Functions an Corresponding Chromaticity Coordinates of the CIE 1931 Standard Colorimetric System, for λ= 360 to 830 nm at 1 - nm Intervals in *Color Science: Concepts and Methods, Quantitative Data and Formulae*, second edition, by Wyszecki and Stiles (1982).

NOTE: The user must use extreme caution when entering chromaticity coordinates manually. Although the instrument performs a limits check on the entered data, it is possible to enter coordinates that satisfy the limits but provide coordinates outside the define color space when transformed between color spaces. For example, entering x & y = 0.0159 (the $u'v'$ lower limit) will pass the xy limits check, and the instrument will accept and use these values. However, when transformed and viewed in the $u'v'$ mode these values are not defined within the $u'v'$ color space.

x = 0.0159 ➔ u' = 0.0061
y = 0.0159 ➔ v' = 0.0453

To erase a white reference, select **NAME** and press the **ENTER** key. The cursor will move to the first character of the name. Using the up and down arrow keys, change the first character to a blank. Press **ENTER**. The name will be cleared from the display. To complete the erasure, scroll down to **SAVE AS #** and press **ENTER**.

A white reference can not be cleared if it is currently used to perform RGB calculations, as a **RGB REFERENCE** or a **DELTA REFERENCE.** If an attempt is made to erase a currently used white reference, the instrument will display the error message "**MEM LOC ERROR**".

Save Phosphor:

The save **PHOSPHOR** menu has nine memory locations. The first two memory locations contain the preprogrammed phosphor chromaticity coordinates for **SMPTE C** and **EBU** standard phosphors. The remaining eight memory locations can be programmed by entering the desired chromaticity coordinates. The values can be entered as xy or $u'v'$ chromaticity coordinates. To save a phosphor, select a memory location and press **ENTER**. When a memory location is selected, the menu options **NAME, SAVE AS #, EXIT, LEARN, R, G, B,** and the current measurement data will be displayed for each phosphor primary color.

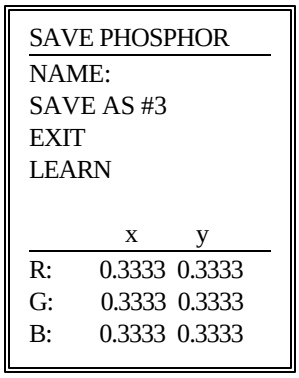
SAVE PHOSPHOR
1. SMPTE C
2. EBU
3.
4.
5.
6.
7.
8.
9.

- Reading R (xy, $u'v'$)
- Reading G (xy, $u'v'$)
- Reading B (xy, $u'v'$)

To save a phosphor, it is first necessary to name the phosphor memory location. Select **NAME** and press the **ENTER** key. The cursor will move to the first character of the name. Using the up and down arrow keys will change the character, the right and left arrow keys will move the cursor to the next/previous character field. Press **ENTER** when the entry is complete. Scroll down to **SAVE AS #** and press **ENTER**. There are two ways to save a phosphor: manual entry mode and learn mode.

Phosphor Manual Entry Mode:

To modify the chromaticity coordinates of a phosphor, scroll to the appropriate menu selection and press **ENTER**. This will position the cursor on the first character of the chromaticity coordinate. Using the up and down arrow keys will change the character, the right and left arrow keys will move the cursor to the next character field. Press **ENTER** when the entry is complete. When all entries are complete scroll to **SAVE AS #** and press **ENTER**.

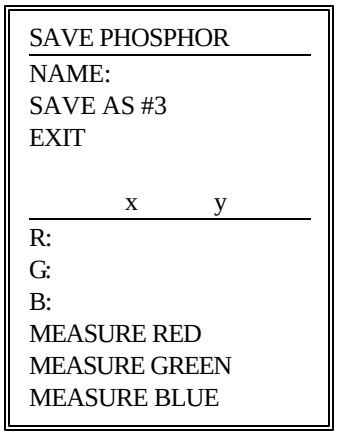


The phosphor chromaticity coordinates are displayed to four decimal places. This is done to prevent round off errors in the calculations. Valid xy coordinates range from 0.0048 to 0.8338 (*u'v'*: 0.0159 to 0.6233). The entry mode can be selected by changing the measurement mode from the configuration menu. Saving a phosphor is only accessible while the instrument is in the xy and *u'v'* modes.

NOTE: The user must use extreme caution when entering chromaticity coordinates manually. Although the instrument performs a limits check on the entered data, it is possible to enter coordinates that satisfy the limits but provide coordinates outside the defined color space when transformed between color spaces. See the ***Save White Reference*** note (page 3-10).

Phosphor Learn Mode:

To enter the learn mode scroll to **LEARN** and press **ENTER**. The user is presented with three menu selections: **MEASURE RED**, **MEASURE GREEN**, and **MEASURE BLUE**. To correctly determine the chromaticity coordinates of each primary color it is necessary to turn on one gun at a time and take a corresponding measurement. When the desired gun is on, scroll to the corresponding measurement selection (ie. if the red gun is on select **MEASURE RED**) and press **ENTER**. The instrument will respond with **PROCESSING...** to indicate that a measurement is underway. When the measurement is complete the chromaticity coordinates will be displayed. Repeat for remaining guns. Scroll to **EXIT**



and press **ENTER**. The user is presented with the **SAVE PHOSPHOR** menu. It is now possible to save the phosphor as described above as well as perform manual manipulation of the phosphor chromaticity coordinates.

In the event of an error, the instrument will prompt the user with an appropriate error message. Remedy the problem and repeat the measurements.

To erase a phosphor, select **NAME** and press the **ENTER** key. The cursor will move to the first character of the name. Using the up and down arrow keys, change the first character to a blank. Press **ENTER**. The name will be cleared from the display. To complete the erasure, scroll down to **SAVE AS #** and press **ENTER**.

A phosphor can not be cleared if it is currently used to perform RGB calculations. If an attempt is made to erase a currently used phosphor, the instrument will display the error message "**MEM LOC ERROR**".

RS232:

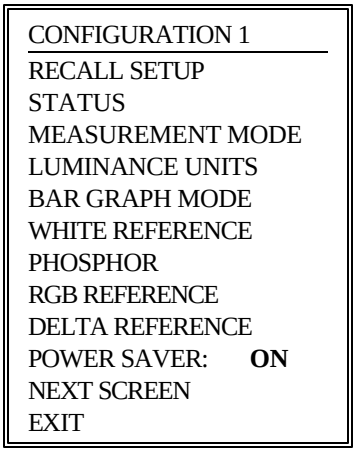
The **RS232** is a toggle that turns RS-232 communications **ON** or **OFF**. When RS-232 is **ON**, the instrument will enable serial port communications. This configuration flag is stored in non-volatile memory. Upon power up, the instrument will use this flag to set the RS-232 configuration. **RS232** should be configured to **OFF** if the serial port is not needed and conservation of battery charge is a concern.

View:

The **VIEW** menu options allow the user to view stored setups, measurements, white references, and phosphors. The format of the view screens is similar to the save menu screens previously described.

Instrument Configuration (screen 1):

Instrument configuration is specified using two configuration menus. The **CONFIGURATION 1** menu will allow the user to fully specify all of the setup parameters for the three display modes. The **CONFIGURATION 2** menu will allow the user to perform a field calibration, well view the calibration information, and allow an authorized user to set the time, date, and calibration due date.



Recall Stored Setup Parameters:

The **RECALL SETUP** allows the user to configure the instrument using previously stored setup parameters. When a setup is recalled it will set the:

- Measurement mode
- Luminance units
- Bar graph measurement mode
- White reference
- Phosphor
- Bar graph reference
- Delta reference

NOTE: If selecting a setup that utilizes a stored measurement, white reference, or phosphor for calculation purposes that no longer exists, the instrument will ignore the setup parameters and default to the parameters of setup #1 **(DEFAULT)**. In the event setup # 1 **(DEFAULT)** also requires reference parameters that no longer exist the instrument will default to display mode of xyY, D65 as the white reference, and SMPTE C as the phosphor.

View Current Setup Parameters:

The **STATUS** displays the current instrument setup parameters. The display will vary depending on the current display mode.

1. In the CIE plot and numeric display mode status displays:

   - MEASUREMENT MODE
   - LUMINANCE UNITS
   - DELTA REFERENCE (in $\Delta x\Delta y$ and $\Delta u'\Delta v'$)
   - SETUP #.
   - POWER SAVER

2. In the RGB bar graph display mode status displays:

   - MEASUREMENT MODE
   - LUMINANCE UNITS
   - RGB REFERENCE
   - PHOSPHOR

STATUS
MEASUREMENT MODE
CIE 1931 xy
LUMINANCE UNITS
Cd/m^2

SETUP #1 DEFAULT
POWER SAVER OFF
EXIT

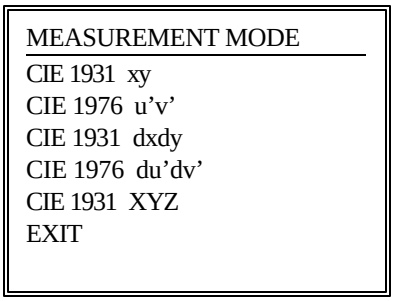
STATUS
MEASUREMENT MODE
RG/B
LUMINANCE UNITS
cd/m2
RGB REFERENCE
W#1 D65
PHOS: #1 SMPTE C
WHITE REFERENCE
#1 D65
SETUP #1 DEFAULT
POWER SAVER OFF
EXIT

- WHITE REFERENCE
- SETUP #
- POWER SAVER

The **SETUP #**, which is located at the bottom of the screen, displays the name of the memory location of the currently loaded setup. If any of the setup parameters previously set have been changed or erased, the **SETUP #** will display **MODIFIED**.

Set Measurement Mode:

The **MEASUREMENT MODE** menu is used to select the desired measurement mode. The available measurement modes are:

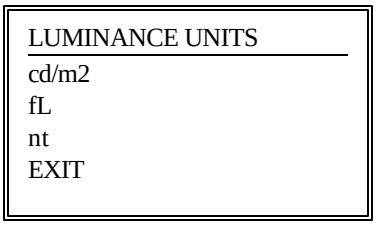


- CIE 1931 xyY chromaticity coordinates
- CIE 1976 *u'v'* Y uniform color space coordinates
- CIE 1931 ΔxΔyY, the delta measurement is performed with respect to either a stored measurement or a stored white reference
- CIE 1976 Δ*u'*Δ*v'* Y, the delta measurement is performed with respect to either a stored measurement or a stored white reference
- CIE 1931 XYZ tri-stimulus values

NOTE: Ideally, the "Y" value in all numeric display modes should be identical. However, the Model SLS 9400FC handles (displays) the CIE 1931 XYZ mode's "Y" value differently than the "Y" values displayed in the remaining display modes. Specifically, the "Y" values displayed in all modes other than the CIE 1931 XYZ mode are of the units fL, cd/m^2 , and NITS which are based on a luminance calibration. In the CIE 1931 XYZ mode, the "Y" value is based on an illuminance calibration (units of lux). This deviation allows UDT Instruments to maintain direct correlation to the in-house calibration standards. In the event CIE 1931 XYZ values based on luminance are desired, the user need only to mathematically compensate by scaling the displayed XYZ values to the "Y" value of the remaining modes.

Luminance Units:

The **LUMINANCE UNITS** menu is used to select the photometric units:

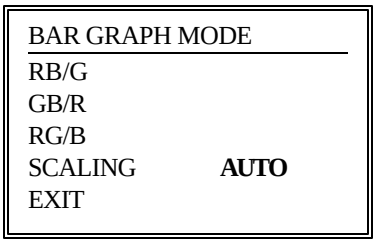


- cd/m^2
- f L

- nt

Bar Graph Mode:

The **BAR GRAPH MODE** menu is used to select the normalizer. RB / G, GB / R, and RG / B normalizing modes are only active when a **RGB REFERENCE** is set to a **WHITE REFERENCE.**



RGB bar graph resolution can be set manually or by the instrument automatically. **SCALING** toggles between **AUTO** and **MAN**. In **AUTO** scaling, the instrument will automatically change the displayed bar graph resolution to provide the optimum resolution of the currently measured color imbalance. When the instrument is in the **MAN** scaling mode, the display will indicate manual zoom operation by displaying "**MAN**" between the bar graph limits and the **CONFIGURATION** icon will change to the **ZOOM CONFIGURATION** icon. The resolution can be modified by pressing the up and down arrows while the **ZOOM CONFIGURATION** icon is highlighted.

The actual numeric value of ΔR, ΔG, and ΔB are displayed independent of the selected resolution. The bar graph resolution does not affect the data provided via the RS-232 port.

The **AUTO** RGB scaling is always the default mode when the instrument is powered up.

White Reference:

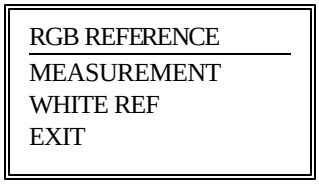
The **WHITE REFERENCE** menu is used to select the desired white reference. This is necessary to perform accurate RGB measurements.

Phosphor:

The **PHOSPHOR** menu is used to select the current monitor phosphor. This is necessary to perform accurate RGB measurements.

RGB Reference:

The **RGB REFERENCE** menu is used to select the reference type used to display the RGB bar graphs. There are two types of references available; either a previously stored measurement (stored in RGB mode) or a white reference. When selecting a measurement as the reference, the bar graphs will be calculated as described previously for delta R, G, and B. Using a white reference as the reference R, G, and B will be calculated using the selected normalizer previously described.



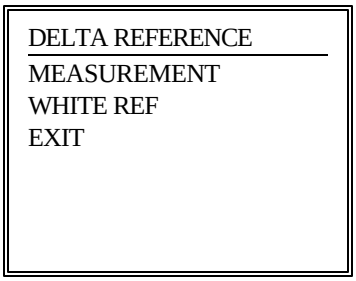
Upon selection of **MEASUREMENT** the instrument will prompt for the selection of a previously store RGB measurement. The instrument will then calculate and display delta R, G, and B. In the bar graph display mode, the **REF:** will indicate M# *<name>*, **PHOS:** will be blank and **MODE:** will indicate RGB/RGB. If an

incorrectly stored measurement is selected, the instrument will ignore this selection, and display an error message.

Upon selection of **WHITE REFERENCE** the instrument will use the same white reference chromaticity coordinates to calculate RGB values and displays them per the previously selected bar graph mode. In the bar graph display mode, the **MODE:** will indicate the previously selected bar graph mode and the **REF:** will indicate W# <*name*>, and **PHOS:** will indicate the phosphor selected in the **CONFIGURATION** menu.

Delta Reference:

The **DELTA REFERENCE** menu is used to select the reference type chromaticy coordinates to be used to calculate the difference between a current reading and a stored reading. There are two types of references available; either a previously stored measurement (stored in **NUM** mode) or a white reference. Upon selection of a reference, the chromaticity coordinates will be retrieved and used to perform the $\Delta x\Delta y$ or $\Delta u'\Delta v'$ (based on **MEASUREMENT MODE** selection), and ΔE (**CIELUV**) calculations.

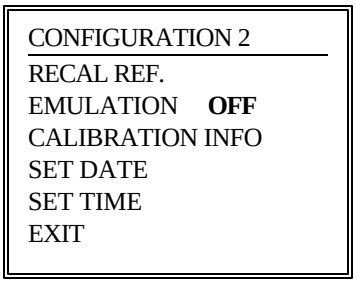


Power Saver:

POWER SAVER is a toggle that turns the power saver **ON** or **OFF**. When the power saver is **ON**, the instrument will automatically turn **OFF** approximately 10 to 20 minutes after the last key is pressed or serial port command is received.

Next Screen:

NEXT SCREEN brings the user to the second configuration menu labeled **CONFIGURATION 2**.

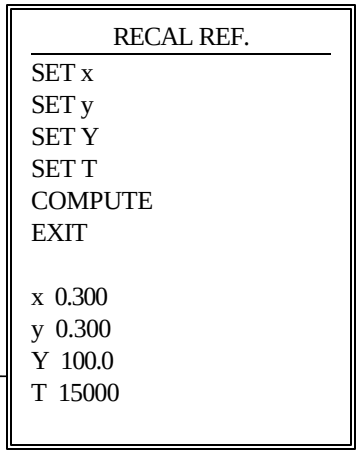


Instrument Configuration (screen 2):

Recal Ref.

RECAL REF. (recalibrate reference) is used when the SLS-9400FC displays a different value than what is predicted from a "known" source. For example, a CRT manufacturer sets up a master CRT to what is believed by the manufacturer to have x and y chromaticity values of .300 and .300, a luminance of 100 cd/m^2, and a CCT of 15,000K. Since the manufacturer wants all other CRTs in the factory to match the master CRT, the SLS-9400FC should display the above values when a new CRT matches the master CRT. To achieve this goal, the manufacturer must perform a field calibration (i.e. recalibrate the reference).

A field calibration is performed by following these steps:



1. From the main screen (which is the first screen seen when the SLS-9400FC is powered up), go to the configuration menu. This is done by selecting the icon at the far right.
2. The SLS-9400FC should now be displaying the first configuration screen where **CONFIGURATION 1** is written across the top of the screen.
3. Select **NEXT SCREEN**. This option is the next to last option.
4. The SLS-9400FC should now be displaying the second configuration screen where **CONFIGURATION 2** is written across the top of the screen.
5. Select **RECAL REF.**. This is the first option.
6. The SLS-9400FC should now be displaying the reference recalibration screen **RECAL REF.** is written across the top of the screen. From this screen, it is possible to recalibrate x, y, Y, and/or T.
7. Choosing one variable at a time, select the variable to be changed. When a variable is selected, a cursor will appear over the first digit of that variable near the bottom of the screen. Use the left and right arrow keys to move the cursor, and use the up and down arrow keys to change the digits. Press the **ENTER** key when finished editing a variable.
8. When all known values are entered, hold the SLS-9400FC head piece to the CRT and select **COMPUTE**. The SLS-9400FC will display a calculation message. Keep the head piece against the CRT until the SLS-9400FC is finished calculating. The **CONFIGURATION 2** screen will then be displayed.
9. Finally, make sure that the emulation mode, which can be seen in the **CONFIGURATION 2** menu, is **ON**.
10. **EXIT** the **CONFIGURATION 2** menu and begin taking measurements.

NOTES:

- The **RECAL REF.** screen has a key debounce feature. Once a variable has been selected to edit, pressing **ENTER** again will not allow the user to leave the editing mode until another key is pressed.
- The values of the variables in the **RECAL REF.** screen do not get saved until **COMPUTE** is selected.
- Sometimes it is desirable to calculate some variables, but not others. For example, one may wish to recalibrate only the x and y values but not the Y and T values. For variables that are not to be recalibrated, set those values to 0 in the **RECAL REF.** menu.

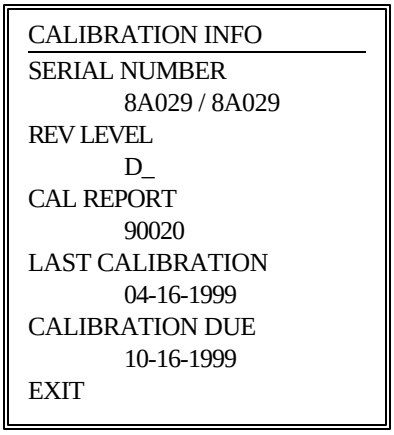
Emulation mode

Emulation mode is set in the "CONFIGURATION 2" screen. The following best summarizes this feature:

- When emulation mode is **ON**, the field calibration is in effect.
- When emulation mode is **OFF**, the SLS-9400FC uses factory set calibration.

Calibration Info:

The **CALIBRATION INFORMATION** displays the:



- SERIAL NUMBER (Handheld/Head)
- REV LEVEL
- CAL REPORT
- LAST CALIBRATION
- calibratio

Time and date settings

The handheld portion of the SLS-9400FC contains a real time clock (RTC) which is set at the factory. It is necessary to keep track of the time and date so that the user can be reminded when the SLS-9400FC is to be sent back to the factory for recalibration. The time and date setting features allow an authorized user to:

- set the time in the RTC
- set the date in the RTC
- set the calibration due date

These features are password protected and require written authorization from UDT Instruments before these parameters may be changed in the field. If either of these options is chosen, the user is presented with a message to enter the password. If an incorrect password is entered, program control is passed back to the **CONFIGURATION 2** menu.

RS-232 Serial Communication Parameters and Commands

Introduction

All instrument features are accessible through the RS-232 serial port (RS-232 enabled).

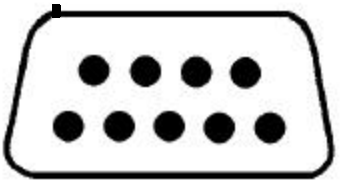
Upon entering a valid command, the instrument will disable further serial port reception, perform the command, and return the appropriate information. All commands sent from the computer, through the RS-232 port, need to be upper case ASCII character strings terminated by a carriage return (ASCII 13) and a linefeed (ASCII 10); ie. **R**__. As a minimum, the instrument will always respond with five status bytes followed by a carriage return and linefeed. Depending on the command, the status information may be prefixed by command response data. After this command/response cycle has been completed, the instrument will be available to process a new command. Therefore the user should wait for the response to the previous command before sending a new command.

NOTE: To ensure proper operation, verify that the instrument is in one of the measurement display modes before issuing a RS-232 command.

The serial port commands and the keypad functions are interrelated. For example, if the instrument has been placed in the **HOLD** mode via the keypad and the serial port receives a **UNITS** command (ie. **U0**__), the instrument will change the luminance units to cd/m^2 and remain in the **HOLD** mode.

Connector Configuration

An 9 pin D-Subminiature connector is provided for RS-232 serial communication. The pin configuration is:



- pin 1 not connected
- pin 2 transmit (out)
- pin 3 receive (in)
- pin 4 not connected
- pin 5 ground
- pin 6 VCC (do not use!)
- pin 7 ground
- pin 8 VCC aux. (do not use!)
- pin 9 not connected

Communication Protocol

The serial port is a duplexed, asynchronous RS-232 port utilizing Tx and Rx only. To ensure proper communication with the Model SLS 9400FC via the RS-232 serial port, the computer's communication parameters must be configured to match the communication parameters of the Model SLS 9400FC.

The default communication parameters are:

- Baud Rate 9600
- Parity None
- Data Bits 8
- Stop Bits 1

Command Nomenclature

#	Storage location for retained setups, measurements, white references and phosphors. Legal values range from 1 to 9 unless otherwise noted. An attempt to access a specified memory location which does not contain proper data will result in an invalid command.
<*name*>	Name assigned to the retained storage location. The name must consist of at least one valid character and can not exceed eight. The valid characters are A →Z, 0 →9, space (^) and underscore (_).

Commands

A summary of the RS-232 commands are in Appendix A.

Readings Averaged: ***ANx:***

Sets the number of A/D readings to be averaged per channel to create a color measurement. The number of averages are calculated as 2^x where valid values of x range from 0 to 4. On powerup, the number of averages is set to 1 (2^0). The instrument accumulates ***x*** number of readings before proceeding to the next channel. After all four channels have been measured, the instrument then calculates the appropriate color coordinates. For values of ***x*** greater than one, the instrument's response times will increase from those listed in Appendix A.

Returned value: Status

Bar Graph Mode: ***BMx:***

Selects the bar graph mode normalizer. This command will select the parameter to be used as the normalizer only when **RGB REFERENCE** is set to a **WHITE REFERENCE.** Color balance in the RGB display mode is displayed relative to the selected normalizer. The x represents an integer value that corresponds to the desired reference value. The available reference values are:

- Green 0
- Red 1
- Blue 2

Returned value: Status

RGB Reference; White Reference: ***BR0:***

Commands the instrument to use the same white reference selected for the RGB calculation as the bar graph reference mode.

Returned value: Status

RGB Reference; Measurement #: ***BR1,#:***

Selects a desired stored measurement to be used as the reference in the bar graph mode. If a vacant measurement is selected the command will be ignored and return measurement vacant. If an incorrectly stored measurement is selected, the instrument will ignore this selection and return an error.

Returned value: Status

Display Disable: ***DDx:***

Disables the display and the keypad. The x represents an integer value that corresponds to the desired mode of the display. The available modes are:

- Display active 0
- Display disabled 1

In the event the instrument is in the **HOLD** mode and the display is disabled, upon receipt of a **DD0** command the display and keypad will become active, and the instrument's operational mode will change from **HOLD** to normal measurement mode.

Returned value: Status

Display Mode: ***DMx:***

Changes the display mode between numeric display mode and bar graph mode. The x represents an integer value that corresponds to the desired display mode. The available display modes are:

- Numeric 0
- Bar 1

The CIE plot mode can not be selected via RS-232.

Returned value: Status

Delta Reference: ***DRy,#:***

Selects the desired memory location, of either a stored measurement or white reference to be used as the reference in the delta mode (ΔxΔy, Δ*u'*Δ*v'*). The y represents an integer value that corresponds to the desired reference type. The available reference types are:

- Measurement 0
- White reference 1

Returned value: Status

Query Stored Setup #: ***E?#:***

Instructs the Model SLS 9400FC to send the information stored in setup #.

Returned value:

The information will be returned in the following fixed format:

- Name xxxxxxxx,
- Chroma mode x, 0: xy, 1: u'v', 2: ΔxΔy, 3: Δu'Δv', 4: XYZ
- Luminance units x, 0: cd/m2, 1: f L, 2: nt
- Display mode x, 0: numeric, 1: bar
- rgb mode x, 0: rb/g, 1: gb/r, 2: rg/b
- RGB reference type x, W: white reference, M: measurement
- RGB Reference # xx,

- White reference # xx,
- Phosphor # xx,
- Delta reference x, W: white reference, M: measurement
- Delta reference # xx
- Space x
- Status xxxxx
- $C_R L_F$ xx

Erase Stored Setup #:
EC#:

Instructs the Model SLS 9400FC to erase the information stored in setup #. Setup memory location 1 and the currently used setup can not be erased, and an attempt to do so will result in an invalid command.

Return value: Status

Save Current Instrument Setup: ***ES#,<name>:***

Instructs the Model SLS 9400FC to save the current instrument parameters in the specified setup memory location # as <*name*> .

The name of memory location 1 can not be changed from its preprogrammed value (**DEFAULT**). If a setup is saved to setup memory location #1, a name is still required but will be ignored. The previously stored setup parameters will be overwritten with new values.

Return value: Status

Implement Stored Setup #: ***EI#:***

Instructs the Model SLS 9400FC to implement the stored setup parameters in the specified setup memory location #.

Returned value: Status

Query Stored Measurement #: ***F?#:***

Instructs the Model SLS 9400FC to send the information stored in measurement #.

Returned value:

The information will be returned in the following fixed format:

- Name xxxxxxxx,
- Chroma mode x, 0: xy, 1: u'v', 2: ΔxΔy, 3: Δu'Δv', 4: XYZ
- Luminance units x, 0: cd/m2, 1: f L, 2: nt
- Display mode x, 0: numeric, 1: bar
- rgb mode x, 0: rb/g, 1: gb/r, 2: rg/b
- rgb reference type x, W: white reference, M: measurement
- rgb Reference # xx,
- White reference # xx,
- Phosphor # xx,
- Delta reference x, W: white reference, M: measurement
- Delta reference # xx
- Measurement (see tables below)
- Space x
- Status xxxxx
- $C_R L_F$ xx

The measurement values returned will depend on the chromaticity mode and the display mode of the instrument when the measurement was stored.

Reading format for chroma modes 0 thru 3 in the numeric display & CIE plot mode:					
	Reading 1	Reading 2	Reading 3	Reading 4	Reading 5
Format	xxxxxx,	xxxxxx,	xxxxx,	xxxxx,	xxxxx
Mode xy	x	y	Y	T	ΔE
Mode *u'v'*	*u'*	*v'*	Y	T	ΔE
Mode ΔxΔy	Δx	Δy	Y	T	ΔE

Mode $\Delta u'\Delta v'$	$\Delta u'$	$\Delta v'$	Y	T	ΔE

Reading format for chroma mode 4 in the numeric display mode:					
	Reading 1	Reading 2	Reading 3	Reading 4	Reading 5
Format	xxxxxx,	xxxxxx,	xxxxxx,	xxxx,	xxxxx
Mode XYZ	X	Y	Z	--	T

Reading format for bar graph display mode:					
	Reading 1	Reading 2	Reading 3	Reading 4	--
Format	xxxxxx,	xxxxxx,	xxxxxx,	xxxxx	--
Bar Mode	R	G	B	Y	--

Erase Stored Measurement #: ***FC#:***

Instructs the Model SLS 9400FC to erase the information stored in measurement #. A measurement can not be erased if it is currently used as either a **RGB REFERENCE** or a **DELTA REFERENCE.** If an attempt is made to erase a currently used measurement an invalid command will result.

Return value: Status

Save Current Measurement: ***FS#,<name>:***

Instructs the Model SLS 9400FC to save the current chromaticity coordinates in a specified measurement memory location # as <*name*>.

Return value: Status

Start Measurements: ***G:***

Deactivates **HOLD** mode and starts taking measurements.

Return value: Status

Halt Measurements: ***H:***

Halts the measurement mode.

Return value: Status

Keypad Disable/Enable: ***Kx:***

Disables/Enables the instrument keypad. When disabled the icons will not be displayed on the screen and all the keys on the keypad will be inactive except the **PWR** switch.

- Keypad active 0
- Keypad locked out 1

Return value: Status

When the display is disabled, this command will always return an invalid command status.

Backlight: ***Lx:***

Controls the backlight.

- On 1
- Off 0

Return value: Status

Chromaticity Mode: ***Mx:***

Sets the chromaticity mode while the instrument is in the numeric display mode. The x represents an integer value that corresponds to the desired mode. The available display modes are:

- x, y, Y, T & ΔE 0
- *u'*, *v'*, Y, T & ΔE 1
- Δx, Δy, Y, T & ΔE 2
- Δ*u'*, Δ*v'*, Y, T & ΔE 3
- X, Y, Z, -- & T 4

Return value: Status

Query Stored Phosphor #: ***N?#,y:***

Instructs the Model SLS 9400FC to send the information stored in phosphor #, in xy (y = 0) or *u'v'* (y = 1) chromaticity coordinates. The information will be returned in the following format:

Return value:

The information will be returned in the following fixed format:

- Name xxxxxxxx,
- x/u'_{RED} 0.xxxx,
- y/v'_{RED} 0.xxxx,
- x/u'_{GREEN} 0.xxxx,
- y/v'_{GREEN} 0.xxxx,
- x/u'_{BLUE} 0.xxxx,
- y/v'_{BLUE} 0.xxxx
- Space x
- Status xxxxx
- $C_R L_F$ xx

Erase Stored Phosphor #: ***NC#:***

Instructs the Model SLS 9400FC to erase the information stored in phosphor #. Phosphor memory locations 1 ,2 and the currently used phosphor can not be erased, and an attempt to do so will result in an invalid command.

Return value: Status

Implement Stored Phosphor #: ***NI#:***

Instructs the Model SLS 9400FC to retrieve the phosphor chromaticity coordinates specified in memory location # for use in calculating RGB values.

Returned value: Status

Download Phosphor: ***ND#,y,D:***

Sends to the SLS 9400FC all the necessary parameters to describe a phosphor and store them in the specified memory location #. Where # represents the memory location 3 to 9, and y determines how the chromaticity coordinates are interpreted by the instrument, either xy (y = 0) or *u'v'* (y =1). The data (D) needs to be in the following format:

- Name <*name*>,
- x/u' RED 0.xxxx,
- y/v' RED 0.xxxx,
- x/u'_{GREEN} 0.xxxx,
- y/v'_{GREEN} 0.xxxx,
- x/u'_{BLUE} 0.xxxx,
- y/v'_{BLUE} 0.xxxx

Valid xy coordinates range from 0.0048 to 0.8338 (*u'v'*: 0.0159 to 0.6233).

NOTE: The user must use extreme caution when downloading chromaticity coordinates manually. Although the instrument performs a limits check on the entered data, it is possible to enter coordinates that satisfy the limits but provide coordinates outside the define color space when transformed between color spaces. See the ***Save White Reference*** note (page 3-10).

Return value: Status

Turn Instrument Off: ***O:***

Turns the Model SLS 9400FC off.

Return value: None

Power Saver: ***Px:***

Enables/Disables the power saver mode.

- On 1
- Off 0

Return value: Status

Query Instrument Info & Calibration Info: Q:

Queries the instrument for its model number, Handheld serial number, head serial number, software revision, and calibration information.

Return value:

- Instrument model 9400FC,
- Handheld S/N xxxxx,
- Head S/N xxxxx,
- Rev level xx,
- Cal Report xxxxx,
- Last calibration (mm-dd-yy) xx-xx-xxxx,
- Calibration due xx-xx-xxxx
- Space x
- Status xxxxx
- $C_R L_F$ xx

Request Readings: R:

Instructs the Model SLS 9400FC to send measurement data. The format of the data will depend on the chromaticity mode and the display mode.

Return value:

Reading format for chroma modes 0 thru 3 in the numeric display & CIE plot mode:					
	Reading 1	Reading 2	Reading 3	Reading 4	Reading 5
Format	xxxxxx,	xxxxxx,	xxxxx,	xxxxx,	xxxxx
Mode xy	x	y	Y	T	ΔE

Mode $u'v'$	u'	v'	Y	T	ΔE
Mode ΔxΔy	Δx	Δy	Y	T	ΔE
Mode $\Delta u'\Delta v'$	$\Delta u'$	$\Delta v'$	Y	T	ΔE

Reading format for chroma mode 4 in the numeric display mode:					
	Reading 1	Reading 2	Reading 3	Reading 4	Reading 5
Format	Xxxxxx,	xxxxxx,	Xxxxxx,	xxxx,	xxxxx
Mode XYZ	X	Y	Z	--	T

Reading format for bar graph display mode:							
	R1	R2	R3	R4	R5	R6	R7
Format	Xxxxx,	xxxxx,	xxxxx,	xxxxx,	xxxx,	xxxx,	xxxx
Bar Mode	R	G	B	Y	%R	%G	%B

followed by;

- Space x
- Status xxxxx
- $C_R L_F$ xx

If the instrument is in the overrange or underrange condition only the status is returned.

Continuous **REQUEST READING** execution may not allow the display to update.

Request Instrument Status: ***S:***

Instructs the Model SLS 9400FC to send the status.

Return value: Status

Set Luminance Units: ***Ux:***

Sets the luminance units of measurement. The x represents an integer value that corresponds to the desired luminance units.

- cd/m^2 0
- f L 1
- nt 2

Return value: Status

Query Stored White Reference #: W?#,y:

Instructs the Model SLS 9400FC to send the information stored in white reference #, either in xy (y = 0) or *u'v'* (y =1) chromaticity coordinates. The information will be returned in the following format:

Return value:

- Name xxxxxxxx,
- x/*u'* 0.xxxx,
- y/*v'* 0.xxxx
- Space x
- Status xxxxx
- $C_R L_F$ xx

Erase Stored White Reference #: WC#:

Instructs the Model SLS 9400FC to erase the information stored in white reference #. White reference memory locations 1, 2 and 3, and the currently used white reference can not be erased. An attempt to do so will result in an invalid command.

Return value: Status

Implement Stored White Reference #: WI#:

Instructs the Model SLS 9400FC to retrieve the white reference chromaticity coordinates specified in memory location # for use in calculating RGB values.

Return value: Status

Download White Reference: ***WD#,y,D:***

Sends to the SLS 9400FC all the necessary parameters to describe a white reference and store them in the specified memory location #. Where # represents the memory location 4 to 9, and y determines how the chromaticity coordinates are interpreted by the instrument, either xy (y = 0) or *u'v'* (y = 1). The data (D) needs to be in the following format:

- Name xxxxxxxx,
- x/*u'* 0.xxxx,
- y/*v'* 0.xxxx

Valid xy coordinates range from 0.0048 to 0.8338 (*u'v'*: 0.0159 to 0.6233).

NOTE: The user must use extreme caution when downloading chromaticity coordinates manually. Although the instrument performs a limits check on the entered data, it is possible to enter coordinates that satisfy the limits but provide coordinates outside the define color space when transformed between color spaces. See the ***Save White Reference*** note (page 3-10).

Return value: Status

Save Current Measurement as a White Reference: WS#,<name>:

Instructs the Model SLS 9400FC to save the current measurement as a white reference in memory location # as <*name*>. Where # ranges from 4 to 9.

Return value: Status

Status Bytes

Byte 1								Byte 2								Byte 3							
7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
OVERALL ERROR	CAL EXPIRED	INVALID COMMAND	BACKLIGHT	OVER RANGE	UNDER RANGE	POWER SAVER			BAR GRAPH MODE	BAR GRAPH MODE	REFERENCE OPTION	REFERENCE READING	REFERENCE READING	REFERENCE READING	REFERENCE READING	DISPLAY MODE	DISPLAY MODE	KEYPAD LOCKOUT	CHROMA MODE	CHROMA MODE	CHROMA MODE	LUMINANCE UNITS	LUMINANCE UNITS

Byte 4								Byte 5							
7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
DISPLAY DISABLE	HOLD	HANDHELD NOT CALIBR	HEAD NOT CALIBRATED	PHOSPHOR VACANT	WHITE REFERENCE VACA	MEASUREMENT VACANT	SETUP VACANT	WHITE REFERENCE	WHITE REFERENCE	WHITE REFERENCE	WHITE REFERENCE	PHOSPHOR	PHOSPHOR	PHOSPHOR	PHOSPHOR

		A T E D			N T										

Status consist of five bytes, a carriage return (ASCII 13) and linefeed (ASCII 10).

NOTE: Status bytes may contain the null character (ASCII 0).

Overall Error:

Overall error indicator. This status will be a 1 when any of the invalid status indicators are true or the unit is in the overrange or underrange condition.

Cal Expired:

This status (1) indicates that the instrument is out of calibration.

Invalid Command:

This status (1) indicates that the Model SLS 9400FC received an invalid command. Typical invalid commands consist of an improper format, excluded __ or a command that is not recognized.

Backlight:

This status indicates whether the backlight is **ON** (1) or **OFF** (0).

Overrange:

This status (1) indicates that the Model SLS 9400FC is in the overrange condition. An overrange condition indicates excessive signal.

The Model SLS 9400FC will automatically attempt to correct the overrange condition. The time necessary to correct the overrange condition will depend on the signal level. Once the overrange condition is corrected, the next status sent will indicate that the instrument is no longer in the overrange condition.

When the Model SLS 9400FC is in the overrange condition and a reading is requested, the instrument will only transmit the status.

Underrange:

This status (1) indicates that the Model SLS 9400FC is in the underranged condition. An underrange condition indicates that there is not enough signal to perform an accurate measurement. The time necessary to correct the underrange condition will depend on the signal level. Once the underrange condition is corrected, the next status sent will indicate that the instrument is no longer in the underrange condition.

When the Model SLS 9400FC is in the underrange condition and a reading is requested, the instrument will only transmit the status.

Power Saver:

This status indicates whether the power saver is **ON** (1) or **OFF** (0) .

Bar Graph Mode:

This status indicates which parameter is being used as the normalizer in the bar graph mode. The valid normalizer values are:

- Green 0
- Red 1
- Blue 2
- RGB / RGB 3

Reference Option:

This status indicates whether a stored measurement (0) or a stored white reference (1) is being used as a reference reading in the bar graph mode or the ΔxΔy (Δ*u'*Δ*v'*) modes.

Reference Reading:

This status indicates which memory location is being used as a reference value based on the *Reference Option*.

Display Disable:

This status indicates whether the display and keypad are enabled (0) or disabled (1).

Hold:

This status (1) indicates that the Model SLS 9400FC is in the **HOLD** mode.

If a reading is requested while the Model SLS 9400FC is in the **HOLD** mode the previous reading will be sent and this reading will continue to be sent upon request until the unit is returned to the measurement mode.

Display Mode:

This status indicates the display mode.

- Numeric 0
- Bar 1

Keypad Lockout:

This status indicates the status of the keypad.

- Keypad active 0
- Keypad locked out 1

Chroma Mode:

This status indicates the numeric display mode.

- x, y, Y, T & ΔE 0
- *u'*, *v'*, Y, T & ΔE 1
- Δx, Δy, Y, T & ΔE 2
- Δ*u'*, Δ*v'*, Y, T & ΔE 3
- X, Y, Z, Y & T 4

Luminance Units:

This status indicates the luminance units used.

- cd/m^2 0
- f L 1
- nt 2

Handheld Not Calibrated:

This status (1) indicates that the indicator unit is not calibrated. This flag is used for UDT Instruments calibration purposes. If at any time this status is a 1 (**TRUE**) contact UDT Instruments for assistance.

Head not Calibrated:

This status (1) indicates that the detector head is not calibrated. This flag is used for UDT Instruments calibration purposes. If at any time this status is a 1 (**TRUE**) contact UDT Instruments for assistance.

Phosphor Vacant:
This status (1) indicates that the phosphor memory location, selected using the *N?* or the *NI* commands, does not contain any information.

White Reference Vacant:

This status (1) indicates that the white reference memory location, selected using the *W?*, *WI*, *DR* or the *BR* commands, does not contain any information.

Measurement Vacant:

This status (1) indicates that the measurement memory location, selected using the *F?*, *DR* or the *BR* commands, does not contain any information.

Setup Vacant:

This status (1) indicates that the setup memory location, selected using the *E?* or the *EI* commands, does not contain any information.

White Reference #:

This status indicates which white reference memory location is being used in the calculation of RGB values.

Phosphor #:

This status indicates which phosphor memory location is being used in the calculation of RGB values.

Appendix B contains several "C" functions and several sample status responses illustrate communications with the Model SLS 9400FC and determine the current instrument status.

Maintenance

This instrument has no user serviceable parts. If the unit is in need of repair, follow the instructions in the Product Warranty and Return Procedures which can be found in Appendix D.

To clean the instrument use a soft damp cloth. Do not use alcohol, acetone or any other chemical solvents. Special care must be taken when cleaning the display window. Failure to do so may damage the anti-glare coating.

Appendix A

Model SLS 9400FC RS-232 Commands and Execution Times

Model SLS 9400FC Control Codes

Command*	Description	# Bytes Ret
ANx	A/D readings to be averaged per channel (2^x)	7
BMx	Bar graph mode (0 /G, 1 /R, 2 /B)	7
BR0	Uses the selected white reference to perform RGB calculations	7
BR1,#	Uses a stored measurement as a reference in the RGB mode, # [1 - 9] represents memory location)	7
DDx	Display Disable (0 off, 1 on)	7
DMx	Display Mode (0 numeric, 1 bar)	7
DRy,#	Delta Mode reference reading (y [0 - 1] represents either a stored reading or white ref, # [1 - 9] represents memory location)	7
E?#	Requests stored setup # [1 -9]	40
EC#	Clears stored setup # [2 - 9]**	7
ES#,<*name*>	Save current setup # [1 - 9] using <*name*> (on # = 1, <name> is ignored)	7
EI#	Implement stored setup # [1 - 9]	7
F?#	Requests stored measurement # [1 - 9]	72
FC#	Clears stored measurement # [1 - 9]	7
FS#,<*name*>	Save current measurement to memory # [1 - 9] using <*name*>	7
G	Start measurement mode	7
H	Halt measurement mode	7
Kx	Keypad lockout (0 active, 1 inactive)	7
Lx	Backlight (0 off, 1 on)	7
Mx	Chroma mode (0 xy, 1 *u'v'*, 2 ΔxΔy, 3 Δ*u'*Δ*v'*, 4 XYZ)	7
N?#,y	Requests stored phosphor # [1 - 9] (y represents mode (0: xy 1: *u'v'*))	58
NC#	Clears stored phosphor memory location # [3 - 9]	7
NI#	Implement stored phosphor # [1 - 9]	7
ND#,y,D	Download phosphor data and store in mem # [3-9], (y represents mode (0: xy / 1: *u'v'*), D represents the data***)	7
O	Turns the Model SLS 9400FC off.	0
Px	Power saver (auto shut down) (0 off, 1 on)	7
Q	Query instrument	55
R	Send current reading (numeric / RGB)	39 / 46
S	Send status	7
Ux	Set photometric units (0 cd/m2, 1 fL, 2 nt)	7
W?#,y	Requests stored white reference # [1 - 9] (y represents mode (0: xy/1: *u'v'*))	30
WC#	Clears stored white reference memory location # [4 - 9]	7
WI#	Implement stored white reference # [1 - 9]	7
WD#,y,D	Download white reference data and store in mem # [4 - 9] (y represents mode (0: xy / 1: *u'v'*), D represents the data***)	7
WS#,<*name*>	Save current reading as a white ref to memory # [4 - 9] using <*name*>	7

* All commands must be followed by a __.

** Can not clear currently used setup memory location.

*** See command description for data format.

Model SLS 9400FC Execution Times (ms)

Command	Description	Disp On	Disp Off
ANx	A/D readings to be averaged per channel	175	175
BMx	Bar graph mode	650	60
BR0	Change white reference used to perform RGB calculations	230	165
BR1,#	Use a store measurement as a reference in the RGB mode	230	165
DDx	Display Disable	320	180
DM0	Display Mode	430	75
DM1	Display Mode	610	210
DRy,#	Delta Mode reference reading	270	155
E?#	Request stored setup	260	80
EC#	Clear stored setup	390	330
ES#,<*name*>	Save current setup	770	605
EI#	Implement stored setup	265	155
F?#	Request stored measurement	280	135
FC#	Clear stored measurement	450	100
FS#,<*name*>	Save current measurement	2180	2180
G	Start measurement mode	300	55
H	Halt measurement mode	180	110
K0	Keypad lockout (off)	440	---
K1	Keypad lockout (on)	200	---
Lx	Backlight	150	55
Mx	Chroma mode	270	175
N?#,y	Request stored phosphor	285	275
NC#	Clear stored phosphor memory location	425	275
NI#	Implement stored phosphor	247	165
ND#,y,D	Download phosphor data	1160	1160
Px	Power saver	175	175
Q	Query instrument	300	115
R	Send current reading (Numeric)	329	304
R	Send current reading (RGB)	329	282
S	Send status	180	100
Ux	Set photometric units (Numeric)	250	180
W?#,y	Request stored white reference	275	115
WC#	Clear stored white reference memory	385	360
WI#	Implement stored white reference	230	165
WD#,y,D	Download white reference data	680	580
WS#,<*name*>	Save current reading as a white ref	935	935

NOTE: The times listed are average values. Actual execution is dependent on program flow and interrupt latency. This table was created while the number of averages was set to one.

Appendix B

Model SLS 9400FC Sample "C" Functions & Status

```
char crlf[3];                                   /* carriage return / linefeed termination characters */
int      fileId;                                /* open file id */

/* This function will set the Model SLS 9400FC to numeric display mode, xyY measurement mode and perform a  */
/* measurement.  The measurement will be parsed and stored in a structure named DATA.                       */

void main(void){
  char wrtBuf[6];                               /* string to store SLS 9400FC command */
  char rdBuf[80];                               /* string to store returned value from COM port */

  int      cnt;                                 /* loop counter */

  struct  {                                     /* defining data structure */
    double x;                                   /* chromaticity coordinate x value */
    double y;                                   /* chromaticity coordinate y value */
    double Y;                                   /* luminance value */
    int T;                                      /* correlated color temperature value */
    double Delta_E;                             /* ΔE (CIELUV) value */
  }data;                                        /* structure name */

  crlf[0] = 13;                                 /* decimal value of the carriage return character */
  cflf[1] = 10;                                 /* decimal value of the linefeed character */

  fileId = fopen("COM1", "r+");                 /* open COM1 in read/write mode and return file id */

  sprintf(wrtBuf, "DM0%s", crlf);               /* set instrument to numeric mode  */
  fputs(wrtBuf, fileId);                        /* write data string to open file */
  for(cnt = 0; cnt < 10000; cnt++);             /* delay to perform operations and send data */
  numberRd = rdData(rdBuf);                     /* read status */
  if(numberRd == 7)                             /* check to make sure that 7 status bytes were received */
    detStatus(rdBuf, numberRd, statusBytes);    /* determine status */
  else                                          /* incorrect number of bytes were received  display error message to the standard output */
    printf "Display Numeric Mode: Expected 7 bytes, received %i bytes", numberRd);

  sprintf(wrtBuf, "M0%s", crlf);                /* set instrument to xyY measurement mode  */
  fputs(wrtBuf, fileId);                        /* write data string to open file */
  for(cnt = 0; cnt < 5000; cnt++);              /* delay to perform operations and send data */
  numberRd = rdData(rdBuf);                     /* read status */
  if(numberRd == 7)                             /* check to make sure that 7 status bytes were received */
    detStatus(rdBuf, numberRd, statusBytes);    /* determine status */
  else                                          /* incorrect number of bytes were received  display error message to the standard output */
    printf "xyY Measurement Mode: Expected 7 bytes, received %i bytes", numberRd);

  sprintf(wrtBuf, "R%s", crlf);                 /* create read string */
  fputs(wrtBuf, fileId);                        /* write data string to open file */
  numberRd = rdData(rdBuf);                     /* read data and status */
  if(numberRd >= 7)                             /* determine that at least 7 bytes were received */
  {
    detStatus(rdBuf, numberRd, statusBytes);    /* determine status */
```

```
      if(numberRd == 49)                                    /* if 49 bytes were received then a valid reading was received */
         sscanf(rdBuf, "%f%f%f%i%f", &data.x, &data.y, &data.Y, &data.T,&data.Delta_E);      /* parse measured values */
   }
   else                                 /* incorrect number of bytes were received  display error message to the standard output */
      printf("Reading: Expected 49 bytes, received %i bytes", numberRd);
   fclose (fileId);                                                                        /* close open file */
}
/* This function reads data from the COM port until  carriage return / linefeed termination charactersare detected.          */
/* Once the termination characters are detected, the character array containing either the status or the valid data will       */
/* be returned allong with the number of bytes read.                                                                          */

int rdData(char string[80])
{
   int      rdBuf;                                                                  /* character read from com port */
   int      numberRd;                                                  /* total number of bytes read from com port */
   int      number;                                                       /* number of bytes read from com port */

   numberRd = 0;                                                        /* set total bytes read from COM port */
   number = 1;                                                        /* set current bytes read from COM port */

   while(number > 0)                                  /* read COM port until a crlf is encountered or 0 bytes are received*/
   {
      rdBuf = fgetc(fileId);                                                          /* read byte from open file */
      if(rdBuf ==crlf[1])                                  /* determine if byte received was the linefeed character */
         if(string[numberRd - 1] == crlf[0])          /* determine if the previous byte was the carriage return character */
            number = 0;                                  /* if carriage return and linefeed were receive exit loop */
      string[numberRd] = rdBuf;                                                    /* put character read in character array */
      numberRd++;                                             /* increment number of bytes read from com port */
   }
   return(numberRd);                                          /* return the number of bytes read from com port */
}

/* This function will determine the instrument status                                                                         */

void detStatus(char buf[80], int numberRd,int statusBytes[23])
{

   /* int statusBytes[23];    status byte response                                                                            */
   /* [0] overall error             (0 no error / 1 error)                                                                   */
   /* [1] out of calibration        (0 in calibration / 1 out of calibration)                                                */
   /* [2] invalid command           (0 valid / 1 invalid)                                                                    */
   /* [3] backlight                 (0 off / 1 on)                                                                           */
   /* [4] overrange                 (0 normal / 1 overrange)                                                                 */
   /* [5] underrange                (0 normal / 1 underrange)                                                                */
   /* [6] power saver               (0 off / 1 on)                                                                           */
   /* .   */
   /* .   */
   /* .   */
```

```
int   stat1Byte;
int   stat2Byte;
int   stat3Byte;
int   stat4Byte;
int   stat5Byte;

stat1Byte = buf[numberRd - 7];          /* moving status byte from a char array to an integer.  If the status byte */
if(stat1Byte < 0)                       /* is > 128 then the result will be negative add a fixed value to make the*/
   stat1Byte += 0x0100;                                                                  /* status byte possitive */

if(stat1Byte & 0x80)
   statusBytes[0] = 1;                                  /* check status byte 1 bit 8 to determine if an error occured*/
else
   statusBytes[0] = 0;
if(stat1Byte & 0x40)
   statusBytes[1] = 1;                 /* check status byte 1 bit 7 to determine if instrument is out of calibration*/
else
   statusBytes[1] = 0;

if(stat1Byte & 0x20)
   statusBytes[2] = 1;                  /* check status byte 1 bit 6 to determine if an invalid command was sent */
else
   statusBytes[2] = 0;

if(stat1Byte & 0x10)
   statusBytes[3] = 1;                                  /* check status byte 1 bit 5 to determine if the backlight is on*/
else
   statusBytes[3] = 0;

if(stat1Byte & 0x08)
   statusBytes[4] = 1;                 /* check status byte 1 bit 4 to determine if an overrange condition occured*/
else
   statusBytes[4] = 0;

if(stat1Byte & 0x04)
   statusBytes[5] = 1;                /* check status byte 1 bit 3 to determine if an underrange condition occured*/
else
   statusBytes[5] = 0;

if(stat1Byte & 0x02)
   statusBytes[6] = 1;                  /* check status byte 0 bit 2 to determine if the power saver feature is on */
else
   statusBytes[6] = 0;
.
.                                                                  /* repeat the above for the remaining status bytes */
.
.
}
```

Status	00 11 00 40 11	b2 78 2a 40 46	52 33 31 c0 42
Error	No	Yes	No
Cal expired	No	No	Yes
Invalid command	No	Yes	No
Backlight	Off	On	On
Overrange	No	No	No
Underrange	No	No	No
Power saver	Off	On	On
Bar graph mode	RB/G	RG/B	GB/R
Reference option	Stored White Ref	Stored White Ref	Stored Measurement
Reference reading	1	9	3
Display mode	Numeric	Numeric	Numeric
Keypad lockout	Off	On	On
Chroma mode	xy	$\Delta u'\Delta v'$	XYZ
Luminance units	cd/m^2	nt	f L
Display Disable	Off	Off	On
Hold	Off	On	On
Handheld not calibrated	No	No	No
Head not calibrated	No	No	No
Phosphor vacant	No	No	No
White ref vacant	No	No	No
Measurement vacant	No	No	No
Setup vacant	No	No	No
White reference	1	4	4

Phosphor	1	6	2

Appendix C

Product Specifications

Model SLS 9400FC Colorimeter

Display	128x128 Liquid Crystal Graphics
Displayed Precision (x, y, *u'*, *v'*)	3 Digits
Display Modes (Numeric & CIE plot)	CIE 1931 x, y, Y, T, ΔE CIE 1931 Δx, Δy, Y, T, ΔE CIE 1976 *u'*, *v'*, Y, T, ΔE CIE 1976 Δ*u'*, Δ*v'*, T, ΔE CIE 1931 X, Y, Z, T (numeric only)
Display Modes (Analog)	Bar graph with respect to R, G, B or a stored measurement
Luminance Units	cd/m^2, f L, nt
Range x,y (*u'*, *v'*)	0.0048 to 0.8338 (0.0159 to 0.6233)
Range Y	0.2 to 1,500 cd/m^2
Range CCT	2,500 to 16,667 °K

Accuracy	D65	Full Range
x, y, *u'*, *v'*	±0.002	±0.002
Luminance	< 2.0 % ±1 digit	< 2.0 % + ±1 digit
RGB Bars	< 1.0 %	< 1.0 %
CCT	± 50 K	± 3.0 %

Repeatability	D65	Full Range
x, y, *u'*, *v'*	±0.001	±0.001
Luminance	±0.3 % ±1 digit	±0.3 % ±1 digit
RGB Bars	< 1.0 %	< 1.0 %

Sensor Configuration: 4 Detectors Matched to CIE 1931 Color Functions.
Typical f_1':
X = 3.63
Y = 1.99
Z = 3.42

Model SLS 9400FC Colorimeter

Sensing Area	38 mm (1.5")
Working Distance	In Contact with CRT
Update Rates	
Screen:	> 3 Times/Second
RS-232 (Display Enabled):	> 3 Times/Second
RS-232 (Display Disabled):	> 3 Times/Second
Communication Rate	9600 Baud
Memory Locations	
Setup	10
Measurement 10	
White Reference	10 (preprogrammed with D65, 3200 K, 9300 K)
Phosphor	10 (preprogrammed with SMPTE C and EBU)

Measurement, white reference, and phosphor coordinate entry can be in either xy, *u'v'* via numeric entry, direct measurement, or RS-323 communication port.

Power Source (DC)	Rechargeable Integral Battery Pack
Recharge Time	< 4 Hours
Battery Life	
Backlight Off	14 Hours
Backlight On	7 Hours
Power Source (AC)	Universal input Desktop Power Supply TUV, CSA, UL Approved
Sensor Assembly	
Diameter of active area	38 mm (1.50")
Diameter of suction area	78 mm (3.05")
Length	144 mm (5.67")
Weight	290 g (0.64 lb.)
Cable length	1 m (39.4")
Display Unit	
Height	130 mm (5.10")
Width	100 mm (3.90")

Length	280 mm (11.0")
Weight	762 g (1.68 lb)
Power Supply	
Height	41 mm (1.63")
Width	75 mm (2.93")
Length	148 mm (5.81")
Weight	417 g (0.92 lb)
Cable length	1.5 m (59.0")
Case	
Height	190.5 mm (7.50")
Width	508.0 mm (20.0")
Length	431.8 mm (17.0")
Weight	5.0 kg (11.1 lb.)

Test Conditions: Illuminate D65: Measurements taken with standard monitor adjusted to 6500 K and luminance values of 10 cd/m^2 (3 f L) in the temperature range of 15° C to 30° C (59° F to 86° F).

Full Range: Measurements referenced to a laboratory standard traceable to both PTB & NIST over the full color gamut of a typical CRT.

Appendix D

Product Warranty

Product Warranty

Warranty Provisions

UDT Instruments warrants the items delivered hereunder to be free from defects in material and workmanship, and to conform to current UDT Instruments specifications at the time of sale. Purchaser shall have a period of one year from date of acceptance of the items to return deficient items to UDT Instruments for correction. Material will be considered accepted 30 days after receipt by purchaser unless UDT Instruments is notified of acceptance earlier.

UDT Instruments agrees to repair or replace at the place of manufacture, without charge, all items returned, *transportation prepaid*, for inspection at the UDT Instruments factory within the warranty period, provided: (1) such inspection discloses to the satisfaction of UDT Instruments that the defects are as above specified; and, (2) the material has not been subjected to misuse, improper maintenance, negligence or accident, damaged by excessive radiation, voltage, current or otherwise damaged by misuse.

The item returned shall only be accepted when accompanied by a written statement setting forth the nature and suspected cause of the alleged deficiencies.

This warranty is expressly in lieu of all other warranties, express, implied or statutory, and all other obligations or liabilities on the part of UDT Instruments. In no event shall UDT Instruments be liable for claims, demands or damages of any nature, however denominated, except that UDT Instruments liability shall be to repair defective items at its factory or supply replacement parts in accordance with the terms of this warranty.

When equipment is shipped FOB UDT Instruments's factory, and when said equipment fails to perform according to specifications upon receipt, a claim should be made immediately against the shipping agency.

Shipment and Payment

UDT Instruments payment terms are Net 30 days. Shipment will be FOB

UDT Instruments
8581 Aero Drive
San Diego, CA 92123
Phone (858) 279-8035
Fax (858) 576-9286

Warranty Return Procedure

NOTE: If this device has warranty and calibration seals, all warranties and calibrations are void if these seals are broken.

1. Please review terms of purchase and date of shipment to determine if product is warranted and whether or not it is within warranty period. Adjustment cannot be made for product out of warranty.

2. If product is subject to warranty, prior to return of product, telephone, write or FAX UDT Instruments at the above address.

Product malfunctions should be reported to the sales department at the earliest possible time, since there are many occasions when technical assistance may obviate the need for returning products or can prevent product damage. Upon verification that warranty service is required, the sales department will issue a Return Material Authorization Number (*RMA number*). The *RMA number* must appear on the outside of the shipping container for proper receipt.

3. It is necessary in all instances that the "*Return Report*" form be completed. Please photocopy and fill out the *Return Report* located in your manual.

4. Repack the product carefully in the same manner it was originally packaged, preferably using the original shipping carton and packaging material. Pack the completed *Return Report* with the product making sure that the *RMA number* is clearly visible on the outside of the container. Ship the product *prepaid* to UDT Instruments.

5. UDT Instruments will advise your company of its findings as to warranty consideration at the earliest possible time.

Appendix E

Return Report

UDT Instruments • 8581 Aero Drive • San Diego, CA 92123 Phone (858) 279-8035 Fax (858) 576-9286

Return Report

Include a copy of this form when returning an instrument for service or repair.

Company Name: _____ RMA #: _____

Users Name: _____

Address: _____

City: _____ Zip: _____

Phone: _____ Fax #: _____

Instrument Information:

Model #: _____ S/N: _____

Detector Information:

Model #: _____ S/N: _____

Problem Description:

Describe the problem, include the instrument setup (Detailed in formation will help speed the repair process):

_____

_____

_____

_____

_____

How many hours did the instrument operate before the problem was noticed?

_____

_____

Other comments:

_____

_____

_____

_____

_____

Index

Notes

Notes

Notes