PHOTO RESEARCH®

a JADAK Brand

PR-7XX SpectraScan®

User's Manual

PHOTO RESEARCH
7279 William Barry Blvd.
North Syracuse, NY 13212-3349
Phone: (315) 701-0678
Fax: (315) 701-0679
Email: sales.pr@photoresearch.com
URL: www.photoresearch.com

Notice

The information contained in this document is subject to change without notice. If there are any questions pertaining to the use of this system, contact JADAK.

Jadak and Novanta shall not be liable for errors contained herein or for incidental consequential damages in connection with the furnishing, performance, or use of this system.

Customer Support

PHOTO RESEARCH, Inc. has support services available to users in case of problems using the PR-7XX.

PHOTO RESEARCH, Inc. personnel are available from 8:00 AM to 4:30 PM (Eastern Time) Monday through Friday, except legal holidays, to aid in technical support.

Call (315) 701-0678, FAX: (315) 701-0679 or e-mail:

service.pr@photoresearch.com for instrument repair or calibration
support.pr@photoresearch.com for technical support.

If calling, please have the following information ready:

- Instrument Model
- Instrument Serial Number
- This manual
- Any printed data you feel might aid in resolving the problem - such as test data.

Table of Contents

Table of Figures

Chapter - 1 INTRODUCTION

The PR-7XX SpectraScans are the newest additions to the already world renowned SpectraScan colorimeter series of instruments. These laboratory grade spectroradiometers utilize a cooled, fast-scanning photo diode array, a 3.5" color touch screen display, and AutoSync® for automatically synchronizing the exposure time to the source refresh rate ensuring the utmost accuracy. Other features include an external trigger port allowing remote measurement activation from a push button or peripheral device, a USB Interface and a Secure Digital (SD) card for measurement storage. The spectral range of the PR-730, PR-740, and PR-788 is visible (380 nm to 780 nm) while the PR-735 and PR-745 extends the spectral range into the near infrared (380 nm to 1080 nm).

For wireless control, the PR-7XX can be supplied with a Class 1 Bluetooth® interface for operation of up to 100 meters (330 feet) from the controller.

For the ultimate in portability, a Li-ion battery is available providing over 8 hours of operation on a single charge.

STANDARD EQUIPMENT

The standard PR-7XX includes:

- SpectraScan (PR-7XX).
- MS-75 Lens.
- USB 1.1 Port.
- Secure Digital (SD) Card.
- AC-740-6 – 6' Universal input AC Adapter.
- USB-10 – 10 ft (3.05 m) USB Interconnecting Cable.
- CD with drivers, Instruction Manual and demo version of SpectraWin software.
- NIST Traceable Calibration - (certified for one year).
- Remote Mode Software

Chapter - 2 SYSTEM OVERVIEW

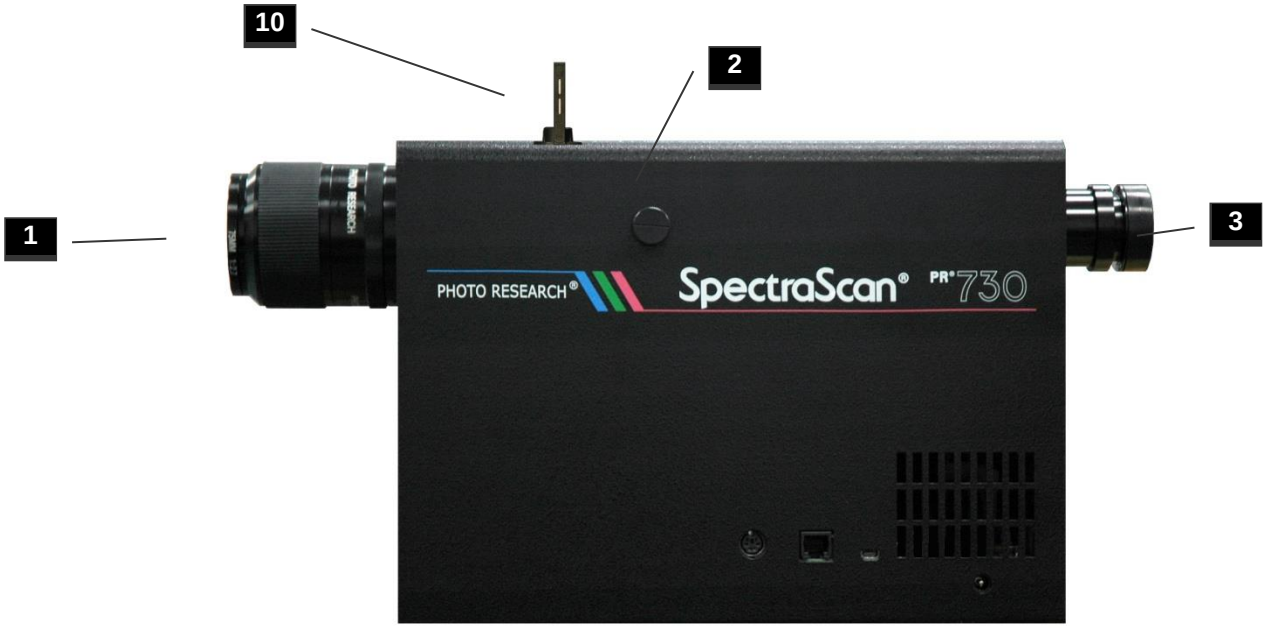


FIGURE 1 - PR-7XX SPECTRASCAN SIDE VIEW

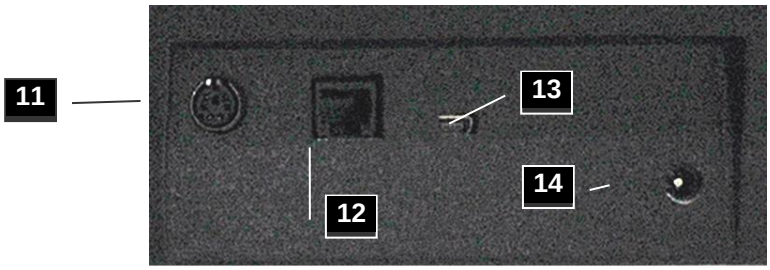


FIGURE 2 - I/O PANEL ENLARGEMENT

Chapter 2 – System Overview

FIGURE 3 - PR-7XX REAR VIEW

Reference	Description	Function	Reference	Description	Function
1	Objective Lens	Focusing on target	8	3.5 in. Color Touch Screen Display	System Menus / Measurement Results
2	View Finder Shutter Control	Open/Close view finder	9	SD Card Slot	Data Storage
3	View Finder	View target / measuring aperture / focus on aperture	10	Bluetooth Antenna	Wireless Communication
4	Measure Switch	Execute measurement	11	I/O Connector Panel	Interface / Power connection
5	Power Switch	Turn On (I) / Off (O) unit	12	RS232 Connector (Optional)	Serial Communication
6	Status Indicators P- Power C - Charge F - Fault	Instrument status indicators	13	USB Connector	USB Communication
7	5 way function switch	Menu navigation	14	DC Power connector	Power in

TABLE 1 - PR-7XX FUNCTIONAL OVERVIEW.

Chapter 2 – System Overview

LCD SCREEN

The PR-7XX features an on-board, 3.5" high resolution, full color touch screen LCD display. The area visible to the user is called the active area. The active area of the LCD display contains the graphical user interface of the PR-7XX. All setup options and measurements including spectral and CIE graphs are controlled and viewed directly on the vivid color display.

GRAPHICAL USER INTERFACE (GUI)

The Graphical User Interface (GUI) is what is displayed on the active area of the display. The GUI allows the user to navigate through the PR-7XX menu system. Menu items can be selected simply by touching the screen on the item of choice, **or** by using the 5 Way Function Switch. To use the 5 Way Switch, press the arrow keys to highlight the selection, then press the Enter (center) key to select the highlighted choice.

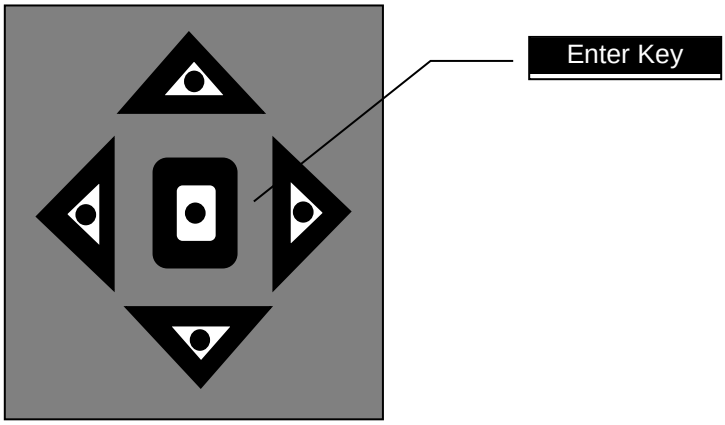


FIGURE 4 - 5 WAY FUNCTION SWITCH

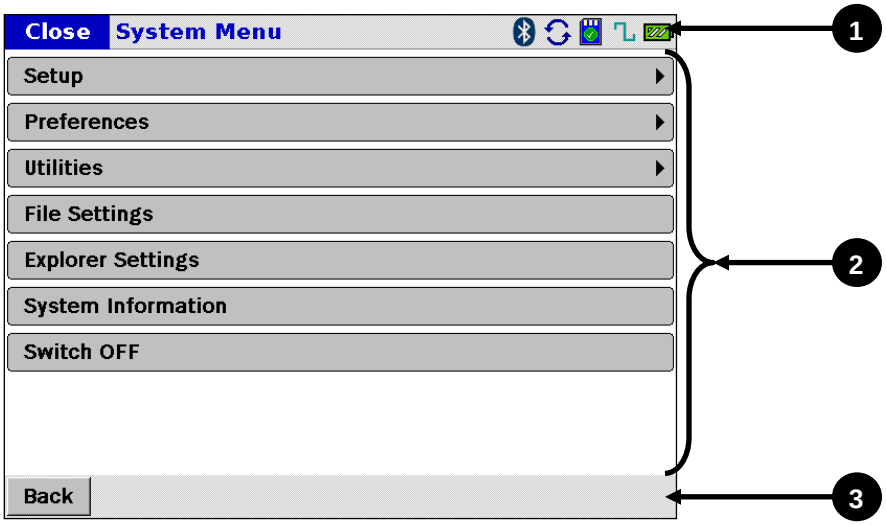


FIGURE 5 - PR-7XX SYSTEM MENU.

Chapter 2 – System Overview

The Graphical User Interface consists of three major panes:

Item	Description
1	Title bar
2	Active pane
3	Command bar

TABLE 2 - GUI PANE DESCRIPTION.

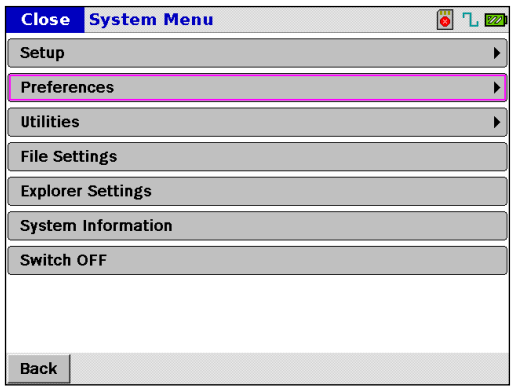
The flow of the menu navigation on the PR-7XX is similar to that of a tree structure. In a tree structure there are roots and extending from the roots are branches (sub menus), indicated by the following icon (▸) which have more branches or end nodes (leafs). Traversing back to the root is as simple as touching the back (Back) icon, located at the bottom left corner of the GUI.

The following example depicts the tree structure mentioned, by navigating to the ***Date & Time*** setup screen from ***System Menu***.

Navigation Steps:

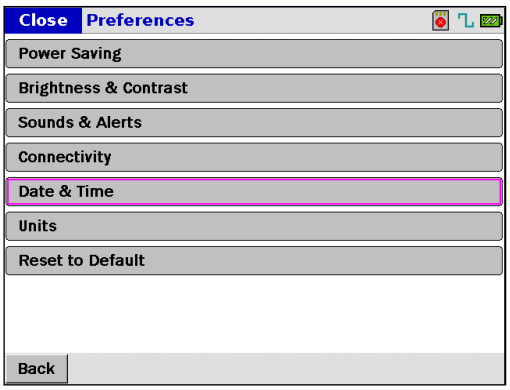
Preferences → Date & Time

Root



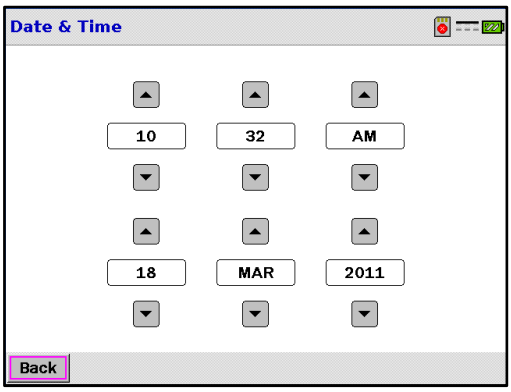
From ***System Menu*** navigate to and select *Preferences.*

Branch



From ***Preferences*** navigate to and select *Date & Time.*

End Node (Leaf)



To traverse back to the ***System Menu*** simply touch the **Back** button twice.

Chapter 2 – System Overview

TITLE BAR

The title bar displays the current active menu location (**1**) and critical system status information (**2**). A detailed list of system status icons can be found in the system status section of this manual.

Figure 6 - PR-7XX Title bar.

SYSTEM STATUS ICONS

The system status icons display current instrument state and status. They are triggered either by a selection made in the instrument setup section or by the instrument. Below are all system status icons and their corresponding indication.

	ICON	DESCRIPTION
Battery Charge % (Optional for PR-7XX)		AC Adaptor Active
	Green w / 2½ bars	100% Charge
	Green w / 1½ bars	66% Charge
	Yellow w / ½ bar	33% Charge
	Orange w / ½ bar blinking	Low Battery (<= 5%)
SYNC	**No Icon**	Manual Sync Mode (20 – 400 Hz)
		Sync Disabled
		Automatic Sync
Auto Save	**No Icon**	Auto Save to SD card disabled.
		Auto Save On & SD Card Detected.
		Auto Save on & No SD card detected.
Bluetooth	No Icon	Bluetooth Off
		Bluetooth On
Timed Measurements	No Icon	Timed measurements disabled
		Timed measurements enabled

Table 3 - PR-7XX Status Icon List

Detailed information pertaining to the system status icons can be found in their respective sections of the manual.

COMMAND BAR

The command bar is located at the bottom of the GUI, and displays the active navigation and control buttons based on the active pane. There are three main expected command bar views:

BACK BUTTON

Whenever the back button Back is displayed the user can traverse back to the previous menu or, if desired, back to the root. Touching the Back button also causes current settings to be saved when in the *Instrument Setup* or *Preferences* screens.

MAKING MEASUREMENTS

After a measurement is executed or while it is in progress, the *Command Bar* displays the following icons. The following functions are available and can be executed if not grayed out.

FIGURE 7 : PR-7XX MEASUREMENT COMMAND BAR.

1) Navigate ***Back*** to the previous menu screen.
2) ***Abort*** a measurement (active if the abort button is **RED**).
3) ***Save*** measurements to the **SD** card (if SD card is inserted)
4) Scroll through data sets in measurement result screens < > .
5) Display ***Line*** or ***Hist*****.** **(**histogram) formatted spectral plots in the Spectral screen.

VIEWING MEASUREMENTS

When at the root *Measurement Screen*, the user can navigate through the measurements using the following command bar. **Note that all measurements in RAM will be lost when the instrument is powered off.**

FIGURE 8 - PR-7XX MEASUREMENT VIEW COMMAND BAR.

From the command bar, the user can execute the following:

1) Navigate to ***Prev*** **(**previous) measurement in RAM or SD card.
2) Navigate to ***Next*** measurement in RAM or SD card.
3) Jump to a particular measurement in RAM or SD card using ***Go To***.
4) Navigate through measurement results screen < > .
5) Display ***Line*** or ***Hist*****.** **(**histogram) plot when the Spectral screen is being displayed.

Chapter 2 – System Overview

SYSTEM INFORMATION

The system status screen is displayed when the unit is first powered on, and shows system information such as serial number, calibration due date, firmware version, ownership information and instrument bandwidth. This screen can be viewed at any time by navigating to ***Menu → System Information***.

FIGURE 9 - PR-7XX STARTUP / SYSTEM INFORMATION SCREEN.

I/O PORTS

The connector panel is located on the left side of the PR-7XX instrument when looking from the view finder side (rear) of the instrument (see Figure 1). The panel consists of the following connectors:

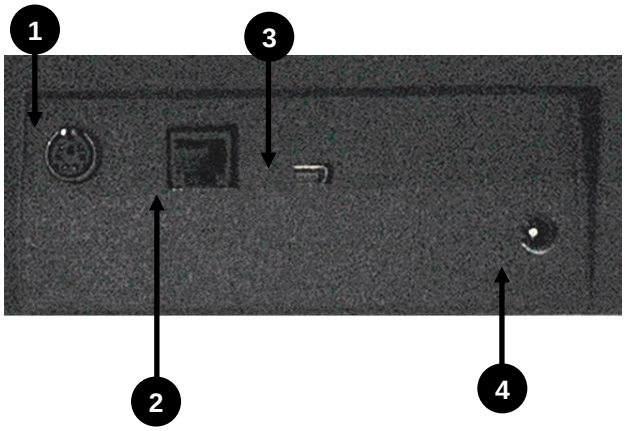


FIGURE 10 - PR-7XX I/O CONNECTOR PANEL.

Item	Description
1	External Trigger Connector
2	RS232 Connector (optional)
3	USB Connector
4	Power Connector

EXTERNAL TRIGGER CONNECTOR

(**#1** IN **FIGURE 10**)

The PR-7XX is equipped with a 6 pin mini-DIN connector that can be utilized for externally triggering a measurement, and subsequently sending a signal (simple DC signal or pulse) to a source capable of being externally triggered - such as a xenon strobe lamp.

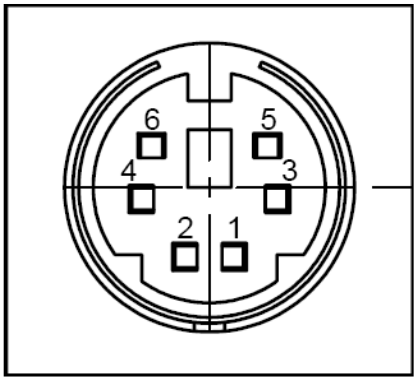


FIGURE 11 - EXTERNAL TRIGGER PIN-OUT.

The pin designations for the connector are:

PIN #	NAME	FUNCTION
1	**VDD**	+5V @ 25mA Max.
2	**GND**	Ground
3	**IN**	Trigger Input – Contact Closure,
4	**SPARE**	N/C
5	**OUT +**	Trigger Output high side
6	**OUT -**	Trigger Output low side

Table 4 - PR-7XX external trigger pin out.

The following are sample driving circuits for the external trigger input and output.

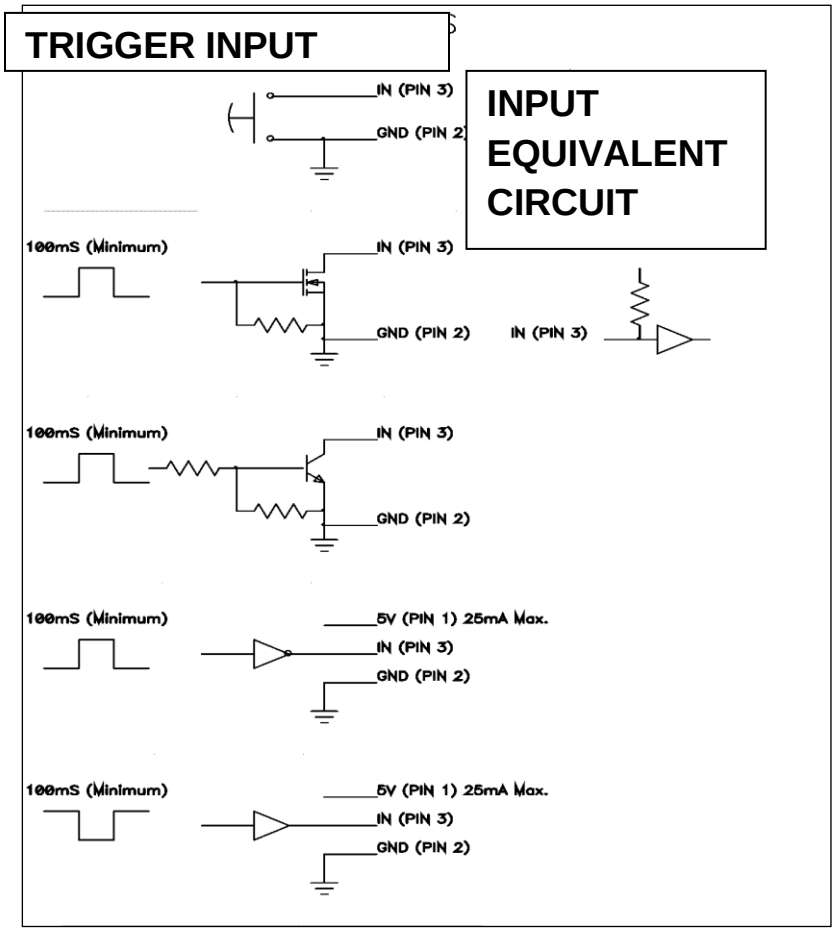


FIGURE 12 - SAMPLE EXTERNAL TRIGGER INPUT CIRCUIT DRIVERS.

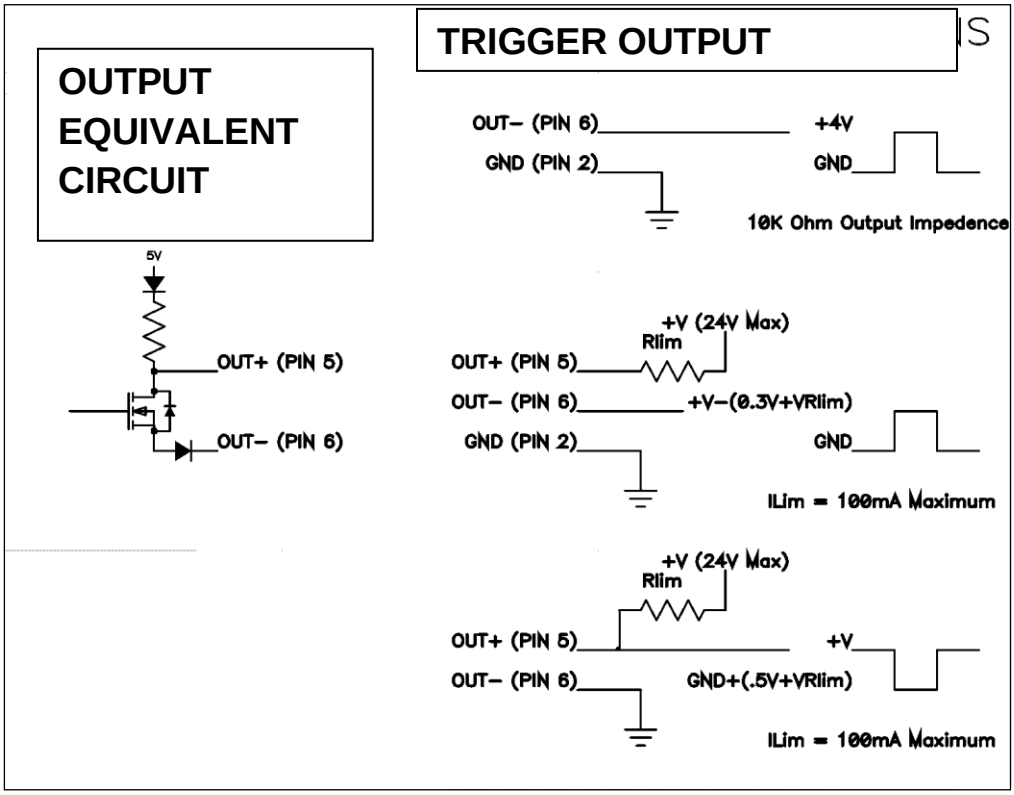


Figure 13 - Sample external trigger output circuit.

RS-232 CONNECTOR - OPTIONAL
(#2 IN **FIGURE 10)**

For Remote Mode applications requiring traditional RS-232 communications, an optional RS-232 interface can be installed. This option adds an RJ-12 jack to the PR-7XX system allowing the user to connect the PR-7XX to a PC's RS-232 port using the included RJ-12 to DB-9 adapter.

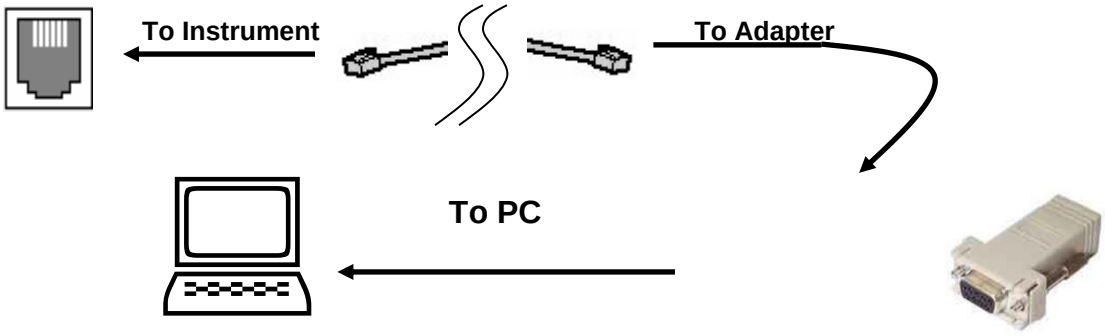


Figure 14 - PR-7XX RS-232 option.

Items Included with the RS-232 Option:

1) RJ-12 Jack on PR-7XX.
2) RJ-12 to DB-9 adapter.
3) 6 ft. (1.83 m) RJ-12 cable.

Please contact factory for custom RJ-12 cable lengths.

MINI USB 1.1 CONNECTOR
(#3 IN **FIGURE 10)**

The PR-7XX is equipped with a Mini-B USB connector, providing remote communication. The USB interface can also be used to charge the instrument battery when plugged into an active PC.

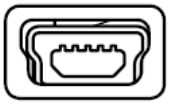


Figure 15 - Mini-B USB connector.

POWER CONNECTOR
(#4 IN **FIGURE 10)**

The PR-7XX power (AC Adapter) supply connector.

CONNECTING THE AC ADAPTER

1. Insert the AC power cord into an appropriate AC source.
2. Insert the AC power cord into the AC Adapter body.
3. Insert the small round DC connector located on the opposite end of the adapter into the AC Adapter receptacle.
4. The **P** (Power) status indicator on the rear control panel is illuminated.

MS-75 STANDARD OBJECTIVE LENS

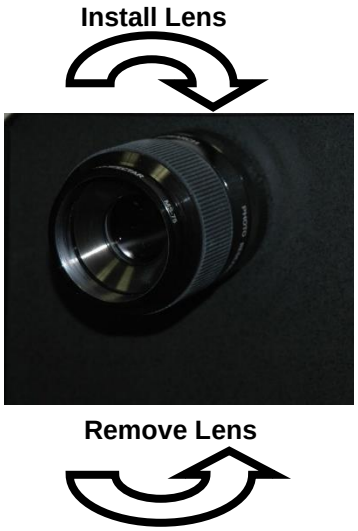
The standard objective lens for the PR-7XX is the MS-75 - a 75mm f/2.8 MacroSpectar® lens that focuses from 1:4 magnification (at 14” from the target) to infinity. This objective lens enables the PR-7XX to perform a variety of measurements including luminance, radiance, spectral radiance, chromaticity, correlated color temperature (CCT), Color Rendering Index (CRI), dominant wavelength, etc. For applications other than radiance or luminance the PR-7XX can be supplied with optical accessories such as a cosine receptor for irradiance / illuminance, LR-730 LED Analyzer for testing LED's for CIE 127 conformity, fiber probe for remote non-line-of-sight luminance testing, and a series of magnification lenses for small spot size analysis. Refer to the Optional Accessory section for more information on all available optical accessories.

Figure 16 - MS-75 objective lens.

Installing and / Removing the Standard Lens

The standard objective lens is installed by aligning the lens thread with the instrument's lens mount thread and rotating clockwise while grasping the rubber ring toward the rear of the lens (see **Figure 16**). The thread should offer minimum resistance during installation.

Full details including spot size versus working distance for all available lenses for the PR-7XX can be found in the Specifications sections section of this manual.



Removing the Objective Lens

1. Grasping the rear rubber ring (see **Figure 16**) turn the lens counterclockwise until the lens separates from the lens mount.

Installing the Objective Lens

1. Grasping the rear rubber ring (see **Figure 16**) turn the lens clockwise until the lens seats on the lens mount.

Warning: Hand tighten only! Do not over tighten as permanent damage may occur.

Software

Following are all optional software packages that are available for the PR-7XX systems.

SpectraWin™ 2 Software

SpectraWin 2 Lite

Full featured, menu driven, Windows software that calculates luminance, CIE chromaticity, correlated color temperature, dominant wavelength and excitation purity (saturation) from measured spectral data and provides features such as graphically represented spectral distribution and CIE color space (1931 and 1976), data manipulation (math functions) save/recall binary or ASCII files, print graphics screens or tabular data, reflectance / transmittance, L*a*b*u*v* measurements, ΔE* Color Difference and Color Rendering Indices (CRI) of lamp sources.

SpectraWin 2 Pro

Includes all of the capabilities of SpectraWin Lite and adds support for Macro scripting, allowing the end user to create macros that can generate automated test sequences.

Note: SpectraWin 2 software is compatible with Microsoft Windows XP or higher (Vista, Windows 7, Windows 10) 32- or 64-bit operating systems.

All software is serialized to an instrument. One licensed copy is required per instrument.

SpectraWin 2 RGB Display Cal Module

SpectraWin Lite or Pro optional module designed for spectrally based white point calibrations of CRT's, LCD's, PDP's and digital projectors. Calibration is based on "learned" RGB values or user entered Y (luminance) , xy (CIE 1931 chromaticity point), values. Calibration is facilitated by on-screen graphical feedback of an RGB bar graph within a CIE diagram - must be purchased with SpectraWin 2.

All software is serialized to an instrument. One licensed copy is required per instrument.

Windows Software Development Kit (SDK)

Fully documented library API that can be used in C++, Visual Basic, and LabView programming environments that allows for measurement control and data transfer from the PR-7XX and is designed for development of customer software for integration with the PR-7XX. Includes SpectraWin 2 Lite software.

All software is serialized to an instrument. One licensed copy is required per instrument.

User Self Calibration Software

Single Unit License

Provides complete recalibration capabilities for the PR-7XX including wavelength accuracy, spectral intensity, linearity and accessory calibration. This option requires a helium wavelength calibration source (WC-100 or equivalent) and variable spectral radiance/ luminance standard (LRS-455 or equivalent).

5 Unit License

Same capabilities as single unit license but for 5 PR-7XX instruments. The instrument's serial numbers must be specified at time of purchase.

10 Unit License

Same capabilities as single unit license but for 10 PR-7XX instruments. The instrument's serial numbers must be specified at time of purchase.

Optical Accessories

The following optical accessories can be added to your existing PR-7XX. They require calibration with the instrument to insure accurate results. They can be calibrated by the user using the User Self Calibration software.

Neutral Density (ND) Filters

Neutral density filters are used to attenuate the incoming optical radiation (light level). They can be used on applications where the light source may be too intense and saturate the instrument causing the PR-7XX to report a "*Light Overload"* condition. ND filters can be mounted on the standard MS-75 lens or the optional SL-1X lens.

The following table lists all available ND filters and their respective characteristics.

Neutral Density Filter	Density	Signal Attenuation	% Transmission
ND-0.3	0.3	2 times	50
ND-0.7	0.7	5 times	20
ND-1	1	10 times	10
ND-2	2	100 times	1
ND-3	3	1000 times	0.1

Table 5 - Neutral density filters for the PR-7XX.

Reflectance Standard (RS-3 and SRS-3)

The 2" diameter (51 mm) PTFE reflectance standard can be used for making ambient light measurements, measurements of point sources (e.g. lamps) or measurements of the illuminating source for reflectance or L*a*b* calculations. The reflectance standard features a Society of Automotive (SAE) ¼ - 20 threads, black anodized, aluminum case for mounting to an optical table or other appropriate fixture.

RS-3

The RS-3 is un-calibrated - all spectral reflectance correction factors are set to 1.00.

SRS-3

Spectrally calibrated for absolute spectral reflectance - includes spectral reflectance factors and certificate of calibration.

IS-730 Integrating Sphere

An integrating sphere is designed to measure the total luminous and radiant power of small point sources such as miniature lamps, light emitting diodes (LED's) etc. over 4π steradians. Using this accessory, Radiant and Luminous Flux (watts and lumens), correlated color temperature (CCT) and chromaticity coordinates can be measured. The input of the integrating sphere accepts virtually any discrete LED or small lamp with two leads. This accessory replaces the MS-75 during use.

Please consult factory for other special sizes.

CR-730 Cosine Receptor

The cosine receptor can be used for applications where it is required to know the amount of light incident on a surface or object. For example, irradiance or illuminance measurements of light incident on a projector screen or to design light fixturing for a building or office space. A unique feature of this accessory is that it can be oriented 360 degrees about the optical axis of the instrument providing flexability for a wide range of applications. The cosine receptor replaces the standard MS-75 lens and reports irradiance in watts/m² and illuminance measurements in footcandles (fc) or lux depending on the unit type selected in the instrument's *Preferences* menu.

LA-730 Luminance Adapter

For contact measurements of radiance and luminance. Adapter covers 0.52" (13.2 mm) diameter and replaces the MS-75 during use.

FP-730 Flexible Probe

A long probe designed for contact measurements of luminance and radiance. Probe tip is 0.125" (3.18 mm) diameter and replaces the MS-75 during use. 4 foot (121.96 cm) and 10 foot (304.8 cm) lengths are available.

LR-730 Light Emitting Diode (LED) Analyzer

This patented optical accessory is designed to test discrete LED's for compliance to the CIE 127 specification. With this add-on accessory both CIE 127 conditions A (far) and B (near) can be measured. Both conditions can be tested with the flip of a lever from 'A' to 'B'. No need to change tubes or even remove the LED between tests. The accessory is calibrated for radiant and luminous intensity (millicandelas) and accepts T1 (3 mm) packages - replaces the MS-75 during use. *Consult factory for alternate LED sizes.*

Variable Focus Lenses

MS-7.5 mm – MacroSpectar® Wide-Field Lens

MacroSpectar® Wide-Field lens with a 3.94" (10 cm) to infinity working distance. Suitable for large area coverage at short distances for non-contact color quality control (L*a*b*) measurements. See the Specifications section for field coverage and working distance. Replaces the MS-75 during use.

MS-75 – MacroSpectar Lens

MacroSpectar Lens focusable from 14" (35.56 cm) to infinity. This is the Standard Objective Lens for the PR-7XX.

SL-0.5X - Supplementary Lens

0.5X (1:2) magnification lens that provides a field coverage midway between the MS-75 and SL-1X lenses. Threads into the MS-75 during use. See the Specifications section for field coverage and working distance.

SL-1X - Supplementary Lens

1X (1:1) magnification lens for luminance/radiance measurements. Threads into the MS-75 lens during use. See the Specifications section for field coverage and working distance.

Fixed Focus Lenses

MS-2.5X - MicroSpectar™ Lens

A 2.5X (2.5:1) magnification, fixed focus lens for luminance/radiance measurements - replaces the MS-75 lens during use. See the Specifications section for field coverage and working distance.

Chapter - 3 THEORY OF OPERATION

The PR-7XX are true Spectroradiometers. They collect the optical radiation (light) through the objective lens or other optical accessory. The signal then passes through the aperture (hole) in the aperture mirror to the diffraction grating (see Figure 18). The grating breaks up the light into its component wavelengths much like a prism turns white light into a rainbow. A broad band source of light such as the sun emits radiation at all wavelengths throughout the visible spectrum. When the diffraction grating is exposed to this type of light, it will refract the light at several angles thus creating a dispersed spectrum much like a rainbow. Similarly, if the grating is exposed to a source such as a laser which emits a nearly monochromatic wavelength of light, only the wavelength(s) of the laser will be refracted.

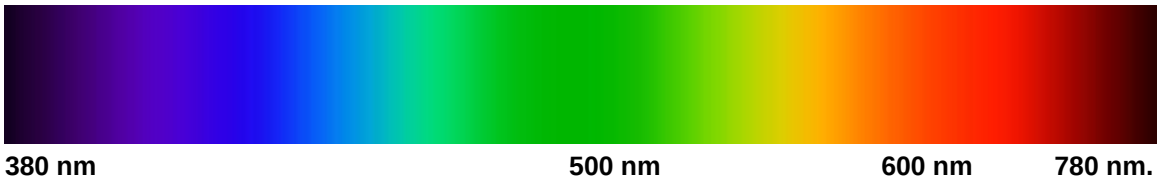


FIGURE 17 – SPECTRUM MEASURED BY THE AND PR-7XX

For the PR-730, PR-740, and PR-788, the measurement wavelength range is 380 nanometers (nm) (violet) to 780 nm (deep red) – the visible band of the electromagnetic spectrum (see

Figure 17). For the PR-735 and PR-745, the measure band is 380 nm to 1080 nm, which includes both the visible spectrum and part of the near infra-red spectrum.

The diffracted spectrum is then dispersed onto the detector. The detector is comprised of 512 individual elements. Thus, each of the detector elements in both instruments samples a unique color.

During a measurement, the diffracted optical radiation (light) is sampled for a period of time determined by the Adaptive Sensitivity™ algorithm. Adaptive Sensitivity automatically determines the correct integration (exposure) time on the detector based on the available signal. Following the light measurement, a measurement of the dark current of the detector is made for the same length of time that was used for the light measurement. The dark measurement is then subtracted from the light measurement yielding the contribution of light for each detector element.

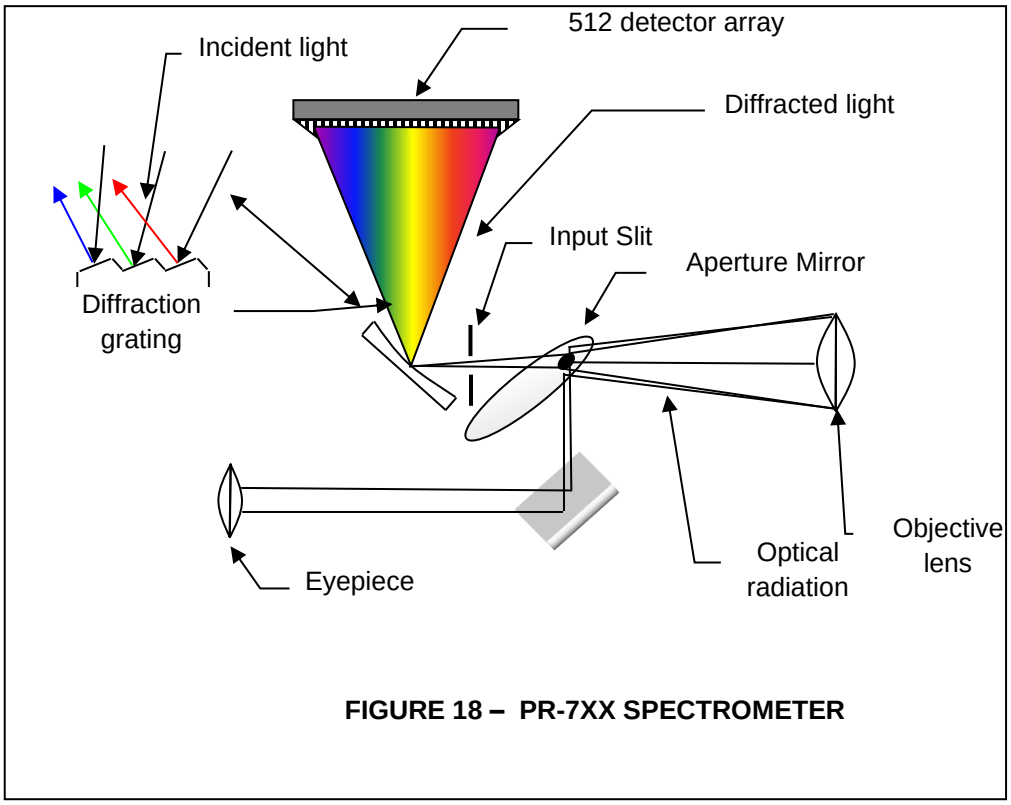


FIGURE 18 – PR-7XX SPECTROMETER

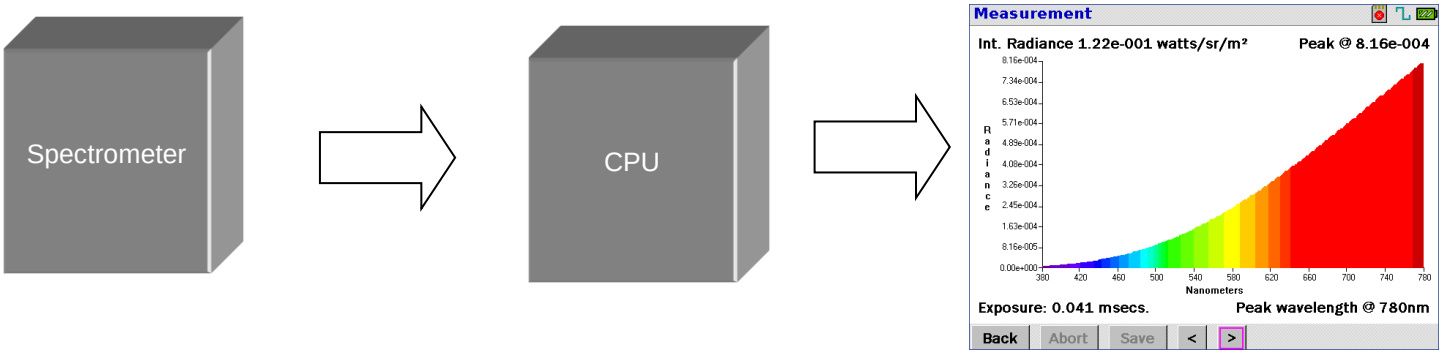


FIGURE 19 - PR-7XX SIMPLIFIED BLOCK DIAGRAM

The uncorrected or 'raw' spectrum is corrected using factors established during the factory calibration of the instrument. These factors include wavelength accuracy correction, spectral distribution correction and photometric correction. The wavelength calibration is performed using a helium spectral line source. The line source provides known spectral emission lines that the software uses to map the dispersion of the grating to the multi-element detector. The helium lines used during the wavelength calibration of the PR-730, PR-740, and PR-788 are 388.6 nm, 447.1 nm, 471.3 nm, 587.6 nm, 667.8 nm, 706.5 nm and 728.13 nm.

Chapter 3 – Theory of Operation

For the PR-735 and PR-745, a Mercury Argon spectral line source is used. The calibration lines are 404.7 nm, 435.8 nm, 546.1 nm, 696.5 nm, 763.51 nm, 811.53 nm, 912.3 nm and 1013.97 nm.

Next, spectral correction factors are established using a continuous source with known intensities at each wavelength. These factors ensure that the proper spectral power distribution (SPD) of the target is determined following a measurement and that calculated values such as CIE Chromaticity, based on the measured spectral quantities, are accurately reported. Lastly, a scaling factor (photometric factor) is applied ensuring the proper photometric levels such as luminance or illuminance are displayed.

Calculations

The corrected spectral data is then used to calculate CIE photometric and colorimetric values including luminance, CIE 1931 x, y and 1976 u', v' chromaticity coordinates, correlated color temperature in Kelvins and dominant wavelength. Following are some of the basic calculations used to generate photometric and colorimetric parameters:

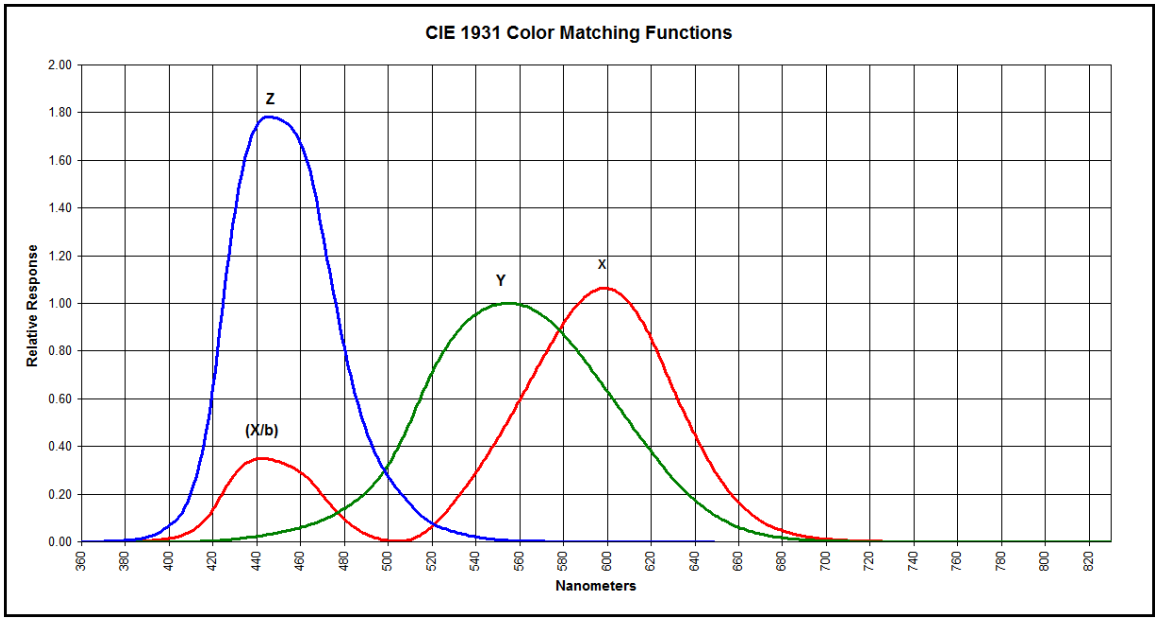


FIGURE 20 - CIE 1931 TRISTIMULUS FUNCTIONS

CIE XYZ Tristimulus and Photometric Values

Where X, Y, and Z are the three CIE Tristimulus values. X represents the red component, Y is the green component, and Z is the blue component.

$$X = 683 \int_{380}^{780} S(\lambda)\overline{X}(\lambda)\Delta(\lambda)$$

$$Y = 683 \int_{380}^{780} S(\lambda)\overline{Y}(\lambda)\Delta(\lambda)$$

$$Z = 683 \int_{380}^{780} S(\lambda)\overline{Z}(\lambda)\Delta(\lambda)$$

Y also serves as the photometric value – when using the standard MS-75 lens, Y gives candelas / meter² - the SI unit for luminance. To find footlamberts (English unit of luminance), multiply cd/m² by 0.2919.

683 is a constant used to convert lumens to watts. There are 683 lumens per watt at 555 nm for photopic (daylight) vision.

S(λ) = the corrected spectral data, $\overline{X}(\lambda), \overline{Y}(\lambda), \overline{Z}(\lambda)$ are the three CIE Tristimulus functions (curves) and $\Delta(\lambda)$ is the data increment – for the PR-730, PR-740, and PR-788 the increment is 1 nm and 2 nm for the PR-735 and PR-745.

Once the three Tristimulus values (X, Y, Z) have been derived, useful colorimetric values such as CIE 1931 x, y and CIE 1976 u', v' can be calculated by the following formulae:

CIE 1931 x, y

$$x = \frac{X}{X + Y + Z}$$

$$y = \frac{Y}{X + Y + Z}$$

CIE 1976 u', v'

$$u' = 4X / (X + 15Y + 3Z)$$

$$v' = 9Y / (X + 15Y + 3Z)$$

Chapter - 4 BASIC SETUP PROCEDURES

INTRODUCTION

This section provides instructions and set-up procedures prior to making measurements with the PR-7XX. For the location of components referred to in this section, please see the **Introduction** section of this manual.

BEFORE YOU BEGIN USING THE INSTRUMENT

Prior to beginning operations, we suggest a couple of steps to help maximize the functionality and longevity of your new instrument. Namely, calibrating the touch screen.

CALIBRATING THE TOUCH SCREEN DISPLAY

The touch screen display for the PR-7XX should be calibrated prior to general use to ensure that it responds properly to requested commands. To calibrate the screen:

FIGURE 21 - INITIAL SCREEN

1. Turn the instrument on. After initialization, touch **Menu** in the upper left hand corner of the screen. The following screen appears:

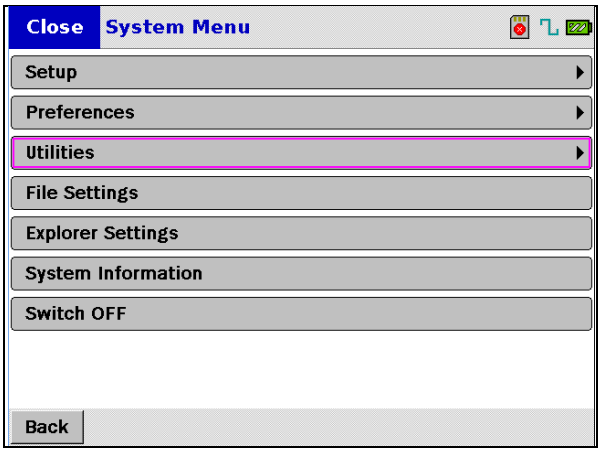


FIGURE 22 - SYSTEM MENU

2. Touch **UTILITIES**.
3. Touch **Calibrate Touch Screen.** The following screen appears:

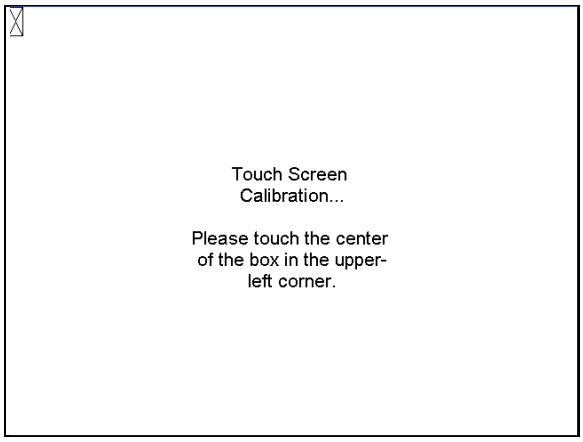


FIGURE 23 - CALIBRATE TOUCH SCREEN

4. Using a pointed object, begin the calibration by touching the center of the **X** in the upper-left-hand corner of the screen.
5. You will be prompted to touch 8 additional areas of the screen during the process.
6. Touch **Back** when finished.

SETTING INSTRUMENT PREFERENCES

Several hardware parameters of the PR-7XX can be adjusted to the users requirements. They include *Power Saving, Brightness and Contrast, Sounds and Alerts, Connectivity*, *Date and Time, Units, and RS-232 Connectivity (Optional).*

1. To access the **Preferences** menu, navigate to the ***System Menu*** *by either* touching **Menu** in the upper left corner of the display, or **Back** in the lower left corner of the display until the menu appears.

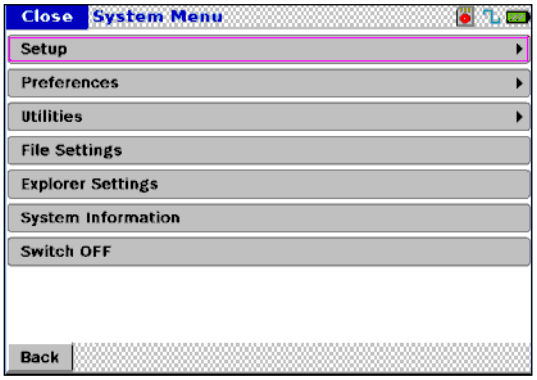


FIGURE 24 - SYSTEM MENU

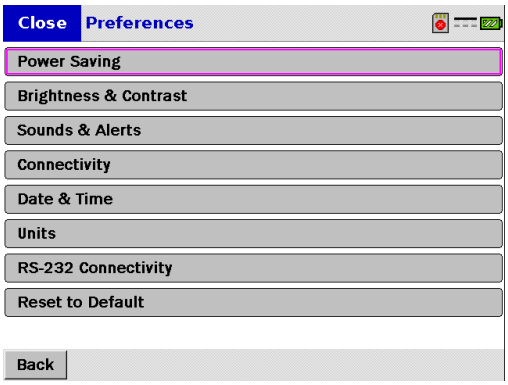


FIGURE 25 - PREFERENCES MENU

How to Adjust Power Savings Settings

The *Power Saving* feature is used to automatically turn off the display or the instrument if left on and unattended. This is especially useful if your instrument has been equipped with the *optional Li-ion battery* for portable operation. The user can select to enable or disable this feature.

1. Touch **Power Saving** from the *Preferences* menu.

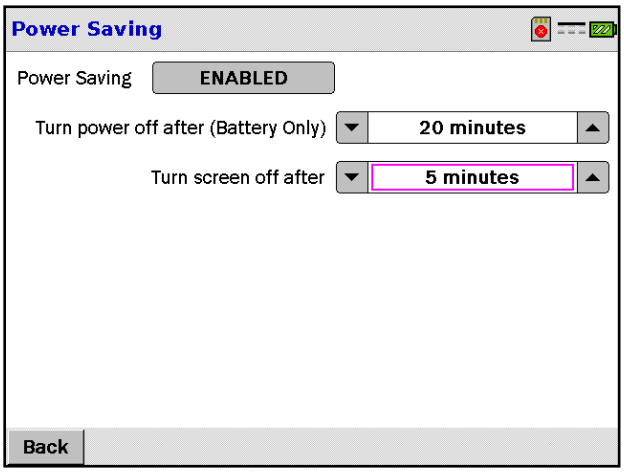


FIGURE 26 - POWER SAVING MENU

2. The current status of the Power Saving feature is displayed in the window adjacent to *Power Saving.* In the preceding example, *Power Saving* is **Enabled**. Touch this field to **Disable** Power Saving. It will then read **Disabled.** If enabled, the count down time starts after the last command (screen touch) issued to the instrument.
3. To change the default time for power down turns, touch the ▼ or ▲ icons adjacent to the *Turn power off after (battery only)* field to scroll through choices. Choices are *5 to 30 minutes* or *Never*. If the instrument does shut down, it must be restarted using the on / off (O/I) key.
4. If you wish the screen to turn off after a pre-determined time, touch the ▼ or ▲ icons adjacent to the *Turn screen off after* field. Choices are *1 to 10 minutes* or *Never.* If the screen does turn off, it can be restarted by simply touching the screen, or any of the other keys.
5. Touch **Back** when finished making selections.

How to Adjust Brightness and Contrast

Brightness and **Contrast** adjusts the appearance on the display. To access and adjust Brightness and Contrast:

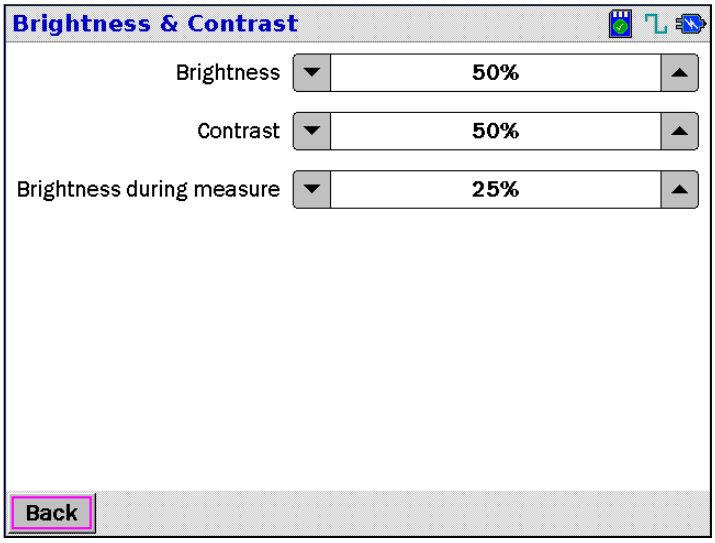


FIGURE 27 - BRIGHTNESS AND CONTRAST SCREEN

1. From the *Preferences* menu, touch **Brightness and Contrast.**
2. To adjust the general brightness of the PR-7XX display, touch the ▼ or ▲ icons on either side of the *Brightness* field. The brightness level is adjustable from 5% to 100%.
3. To adjust the screen contrast, touch the ▼ or ▲ icons next to the *Contrast* field. The contrast is adjustable from 0% to 100%.
4. The PR-7XX screen brightness during a measurement can be set by touching the ▼ or ▲ icons adjacent to the *Brightness during measure* field**.** Settings range from 0% (off) to 100%.

Note: When measuring low light levels, set the "*Brightness during measure*" level to 0% so that the display light level does not contribute to the outcome of the measurement.

5. Touch **Back** when finished.

How to Enable and Disable Instrument Sounds and Alerts

The PR-7XX can audibly alert the user to various instrument conditions including:

Button Click – A sound is generated each time the touch screen is actuated.

Shutter Sounds – A beep accompanies each measure shutter action at the transition between light and dark measurements, and at the end of the measurement sequence.

Measurement Complete Alerts – A beep is sounded at the end of the measurement.

and

Low Battery Warning (optional). – If your PR-7XX is equipped with the optional Li-ion battery, an alert is sounded if the battery charge drops to 5% or less. Make sure to recharge the battery at this point for continued operation.

To enable and disable these features:

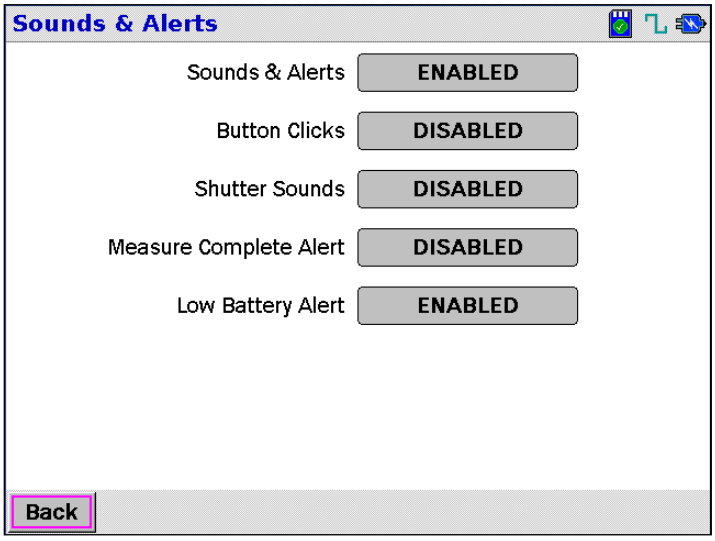


FIGURE 28 - SOUNDS AND ALERTS SCREEN

1. From the *Preferences* menu, touch **Sounds & Alerts.**
2. The **Sound and Alerts** is the general category under which all Sounds and Alerts fall under. The window to the right of the field descriptor displays the status of that feature. To enable or disable all sounds, touch the **Sounds & Alerts** field. This field must be set to **Enabled** in order to gain access to the fields below it.
3. If **Sounds & Alerts** is enabled, touch any field next to its descriptor to toggle between **Enabled** and **Disabled**.
4. Touch **Back** when finished.

USB Hub Type Connectivity Options

If you purchased the optional battery for the PR-7XX, it can be recharged via the USB interface. The USB power type in this menu defines how the battery is charged. Choices are **High Power (default), Low Power** and **None.** With **High Power** selected, the PR-7XX expects the PC to supply 500 mA at the USB interface. **Low Power** is for devices that support 100 ma or less. Most modern computers support the **High Power** mode. **The USB interface functions normally for communications purposes regardless of the power state of the USB Hub Type selected.**

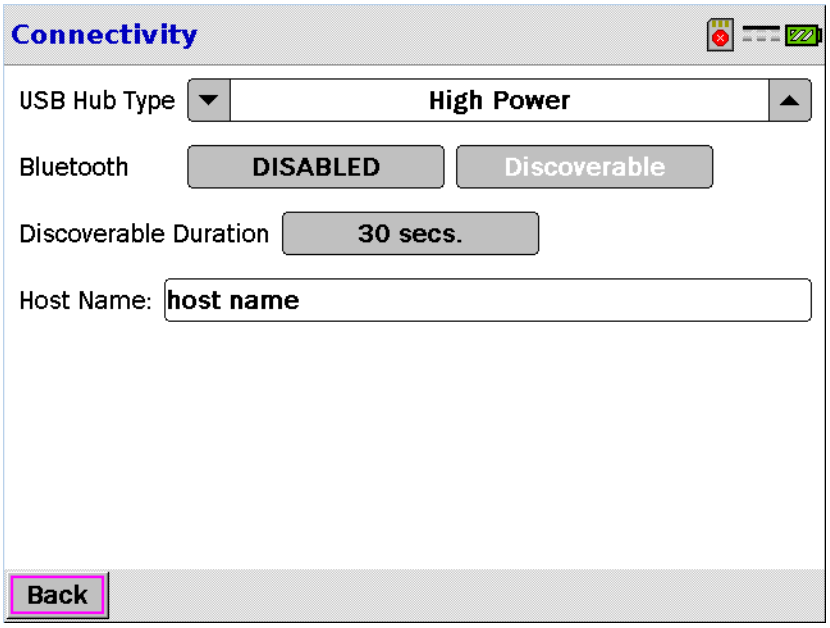


FIGURE 29 - CONNECTIVITY MENU

TO CHANGE THE USB HUB TYPE

1. From the *Preferences* menu, touch **Connectivity.**
2. To scroll through choices, touch the ▼ or ▲ arrows adjacent to the **USB Hub Type** field until the preferred choice appears.
3. Touch **Back** when finished.

SETTING THE DATE AND TIME

The PR-7XX is set to US Eastern Coast date and time at the factory. If the power is disconnected from the instrument, the date and time will be maintained for at least 1 year. To reset the date and time to the local values:

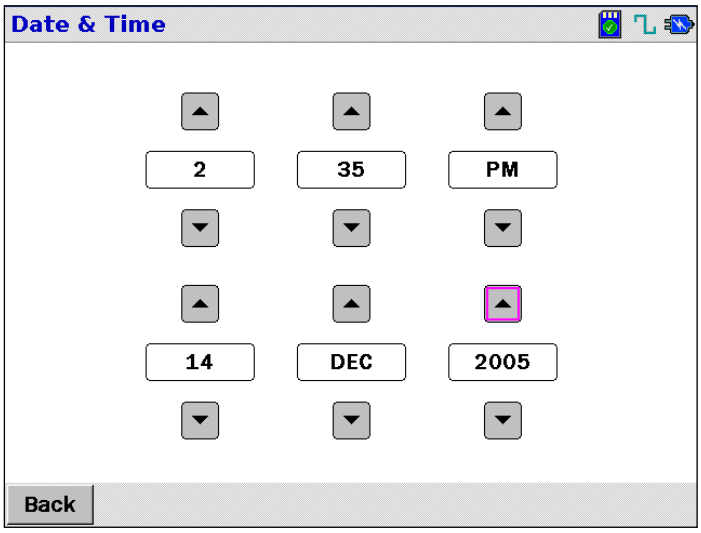


FIGURE 30 - DATE AND TIME SCREEN

1. Touch **Date and Time** from the *Preferences* menu.
2. Touch the ▼ or ▲ icons above or below the field of interest (e.g. Dec. in Figure 30) to scroll to the desired value. The range for the *Year* field is 2005 to 2025.
3. Touch **Back** when finished changing all fields.

CHANGING UNITS

English (footlamberts, footcandles as applicable) and **Metric** (cd/m², lux) can be set globally adjusted using this *Preferences* item. If your PR-7XX is equipped with a luminous intensity accessory such as the LR-730, candelas or millicandelas can be specified.

NOTE: The Units type may be changed following a measurement. Doing so will automatically update all existing measurement values to the selected units.

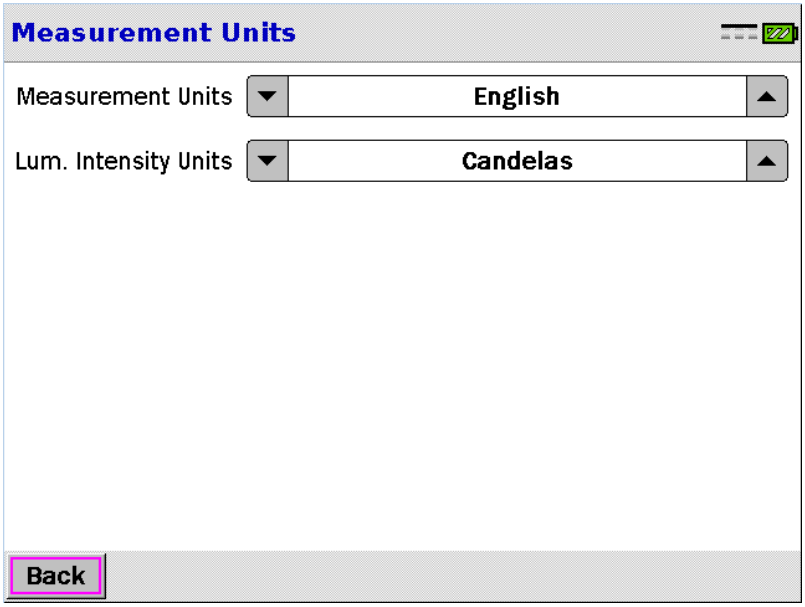


FIGURE 31 - UNITS MENU

To change measurement units:

1. Touch **Units** from the *Preferences* menu.
2. To scroll through choices, touch the ▼ or ▲ arrows adjacent to the **Measurement Units** or **Lum. Intensity** Units fields until the preferred choice appears.
3. Touch **Back** when finished.

RS-232 CONNECTIVITY

If your PR-7XX is equipped with the optional RS-232 interface, use this menu item to configure the baud rate of the interface. Choices are *9600, 19200, 38400, 57600* and *115200* baud.

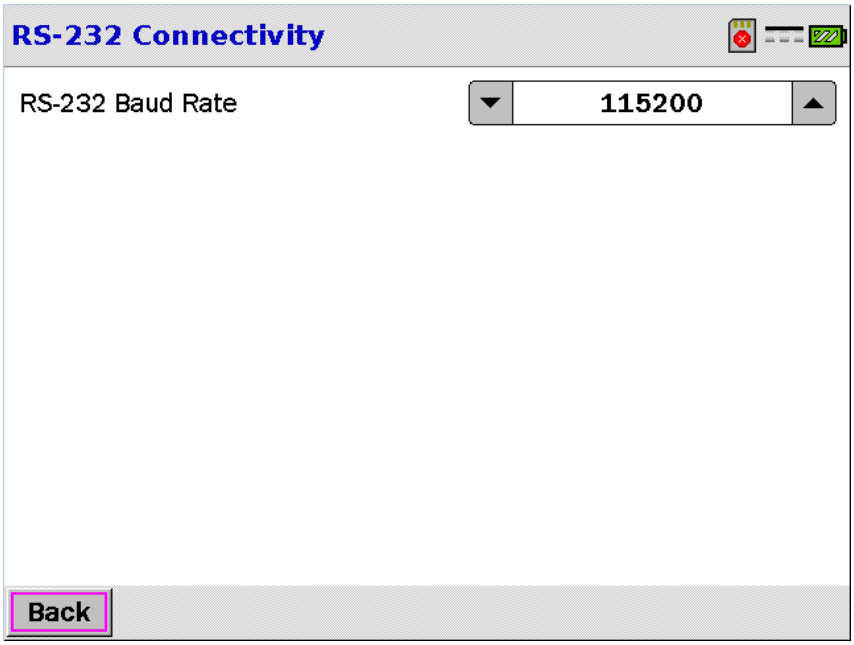


FIGURE 32 - RS-232 CONNECTIVITY

Other unchangeable RS-232 parameters are:

Parameter	Setting
Parity	None
Data Bits	8
Stop Bits	1
Handshake	None

To set the RS-232 Baud rate:

1. Touch **RS-232 Connectivity** from the *Preferences* menu.
2. To scroll through choices, touch the ▼ or ▲ arrows adjacent to the **RS-232 Baud Rate** field until the preferred choice appears.
3. Touch **Back** when finished.

Note: If your instrument was not ordered with the RS-232 interface, this item will not appear in the Preference Menu. Contact Photo Research for information about adding an RS-232 interface to an existing instrument.

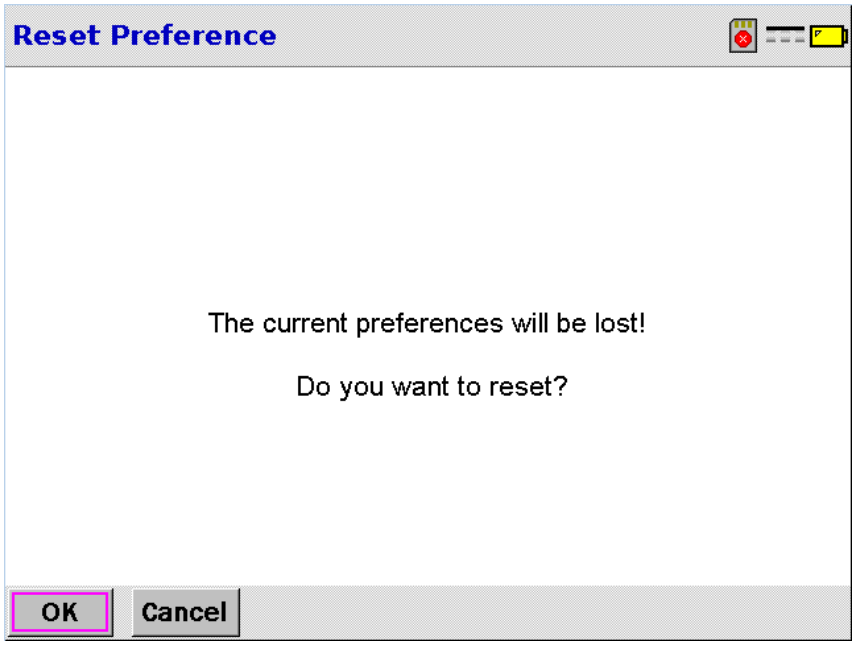
RESET TO DEFAULT

Resets all *Preferences* to their factory default settings. Factory values are:

Parameter	Setting
Power Saving	Enabled
Brightness and Contrast	Brightness: 50% Contrast: 50% Brightness during measure: 25%
Sounds and Alerts	All Enabled
Connectivity	High Power
Date and Time	US Pac. Coast Date and Time
Units	Measurement Units: Metric Lum. Intensity: Candelas
RS-232 Connectivity	Baud Rate: 115200

Setting the Default Parameters:

1. Touch **Reset to Default** from the *Preferences* menu. The following screen appears.



2. Touch **OK** to reset all Preferences or **Cancel** to exit without making changes.

HARD RESET

If the instrument ever becomes unresponsive, perform a hard reset. Press and hold the Power Off (O) and Measure button simultaneously until the instrument shuts itself off. Upon rebooting, the instrument should function normally. If not, contact Photo Research for assistance.

Chapter - 5 SETUP MENU

INSTRUMENT SETUP INSTRUCTIONS

Prior to making a measurement, it is necessary to ensure that the instrument is aware of the accessory the aperture, the exposure (integration) time, the sensitivity mode, the number of measurements to average, the SYNC mode and the Dark Current mode that will be used during the upcoming test to insure that proper calibration factors are applied following the measurement.

FIGURE 33 - MAIN SCREEN

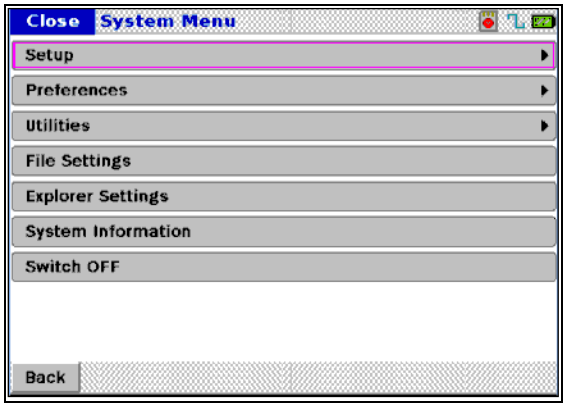


FIGURE 34 - SYSTEM MENU

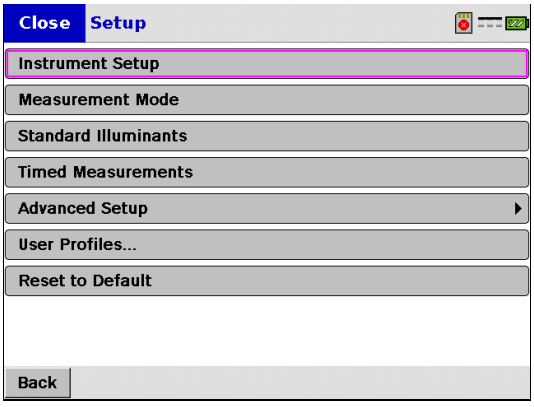


FIGURE 35 - SETUP MENU

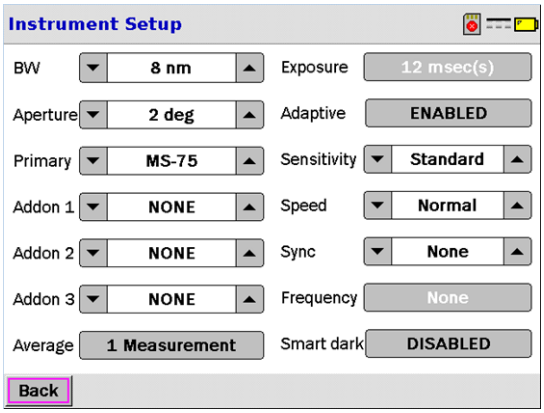


FIGURE 36 - PR-7XX INSTRUMENT SETUP

1. From the main screen, touch **Menu (**or use the navigation keys). The **System Menu** appears.
2. Touch **Setup** and then touch **Instrument Setup.**
3. The **Instrument Setup** menu appears.

HOW TO SELECT THE BANDWIDTH

For those instruments supplied with the variable bandwidth option, this field provides a means for selecting the desired option. If your PR-7XX has a single bandwidth, no choices are available in this field.

To select the Bandwidth:

1. To scroll through choices, touch the ▼ or ▲ arrows adjacent to the **BW** field until the preferred choice appears.

How to Select an Aperture

1. Touch the ▼ or ▲ icon adjacent to the field named **Aperture** field to scroll through aperture selections until the aperture of choice is displayed.

How to Select a Primary Accessory

A **Primary Accessory** is one that replaces the standard MS-75 lens during use. Primary accessories include the MS-75, MS-2.5X, MS-7.5, CR-730, FP-730, IS-730, ICC-730, LA-730, and LR-730.

1) Touch the ▼ or ▲ icon adjacent to the field named **Primary Accessory** to select the accessory to be used in the upcoming measurement.

Warning: Failure to select the proper accessory in use prior to a measurement will cause the instrument to produce erroneous results..

How to Select an Add-on Accessory

An **Add-on** Accessory is one that is used in conjunction with a Primary Accessory. Up to 3 **Add-on Accessories** may be used during a measurement. Examples of Add-on Accessories include all ND filters, the RS-3, SRS-3 SL-0.5X and SL-1X lenses.

1. To select an Add-on Accessory, touch the ▼ or ▲ icon next to the Add-on Accessory field to scroll through calibrated selections until the accessory of choice appears. A maximum of 3 Add-on accessories may be used during a measurement.

How to Set the Number of Measurements to Average

To help improve measurement results, especially measurements where low light levels are being tested, the PR-7XX can be instructed to make consecutive measurements (the range is 1 – 99) and average the results. Following a multiple measurement sequence, the spectra are averaged, and resultant photometric and colorimetric values calculated from the averaged spectra.

1. To set the number of measurements to average, touch the field next to **Average**. The following screen appears:

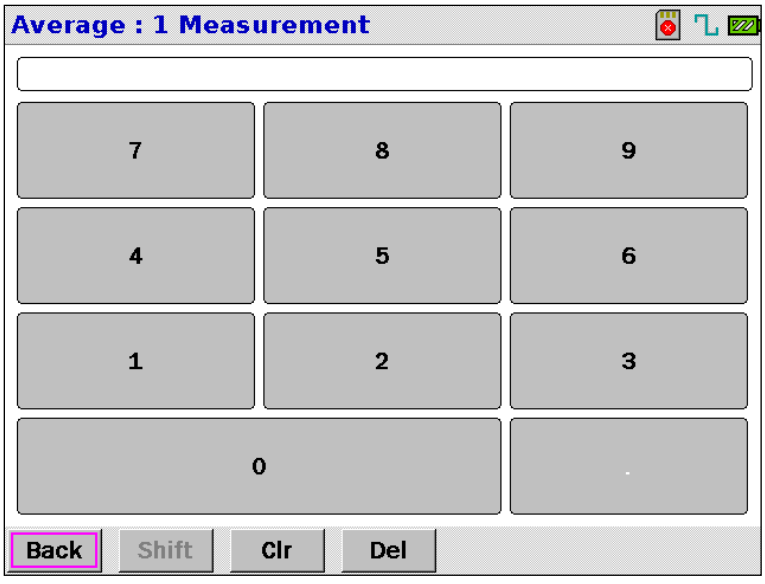


FIGURE 37 – MEASUREMENT AVERAGE ENTRY SCREEN

2. Enter the number of measurements to average. The acceptable range is 1 to 99.

3. Touch the **Back** key when done.

How to Set the Adaptive Exposure Time

The exposure time is the amount of time the detector is exposed to light. The PR-7XX utilizes the patented *Adaptive Sensitivity*™ algorithm that automatically selects the proper exposure time for the available signal insuring the most accurate measurement for the available light. Use the following procedure to set Adaptive Sensitivity to ON.

1. To set the instrument to **Adaptive Sensitivity**, make sure the field next to **Adaptive** reads **Enabled.**

How to Set a Fixed Exposure Time

It may be desirable to set a fixed exposure time for an application. For example, when measuring a display for luminance uniformity, the exposure time will be the virtually identical for each measurement since the luminance levels are very similar for every part of the display. In this example, using Adaptive Sensitivity may make the measurement time longer because of the overhead the algorithm requires in its iterative process to find the ideal exposure time. Use the following procedure to set a fixed exposure time.

1. If the field immediately to the right of **Adaptive** reads *Enabled*, touch the field to set **Adaptive** to *Disabled*.

2. Touch the field adjacent to **Exposure** to display the following data entry menu:

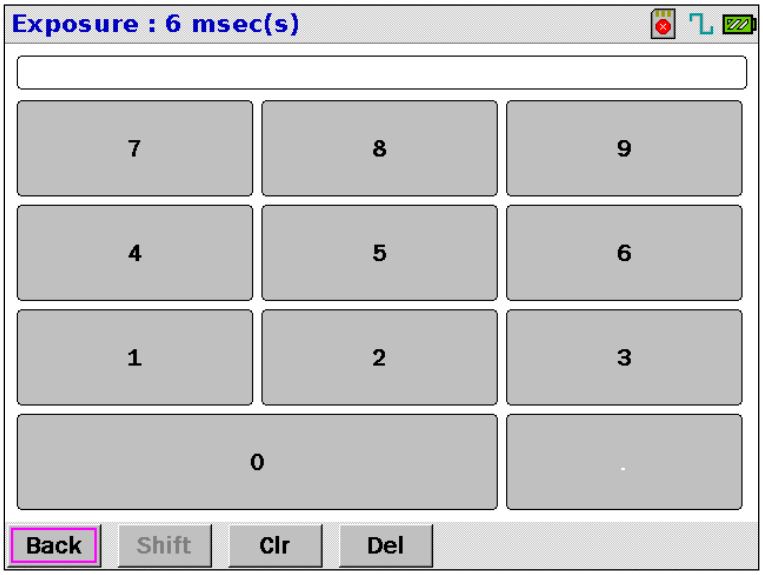


FIGURE 38 – EXPOSURE TIME ENTRY SCREEN

3. Enter the desired exposure time in milliseconds (ms). The range is 7 ms to 120,000 ms (2 minutes) for Standard Sensitivity and 7 to 300,000 ms (5 minutes) for Extended Sensitivity.

Note: The sensitivity range must be set to *Extended* to use the maximum value of 300,000 ms (5 minutes).

4. Touch **Back** when done.

How to Set the Instrument Sensitivity Range

Chapter 5 – Setup Menu

The PR-7XX has two *Adaptive* sensitivity ranges – *Standard* and *Extended.* You can select which range the *Adaptive Sensitivity* algorithm uses. For *Standard* sensitivity, the exposure time range is 7 ms to 120,000 (2 minutes) ms. For *Extended* sensitivity, the exposure time ranges from 7 ms to 300,000 (5 minutes) ms thus *extending* the sensitivity. To set the *Sensitivity* range:

1. Make sure **Adaptive** is set to *Enabled.*
2. Touch the ▼ or ▲ icon in the **Sensitivity** field to toggle between *Standard* and *Extended***.**

How to Set the Measurement Speed

The total time needed to complete a measurement is certainly an important issue. This feature can help speed up measurements by changing the way the Adaptive Sensitivity determines when a measurement is completed. In the *Fast* mode, the total measurement time will be approximately halved. In *2X Fast,* total measurement time will be reduced approximately 4 times, *4X Fast* by approximately 8 times, *8X Fast* by approximately 16 times and *16X Fast* by approximately 32 times..

Caution: To insure measurement quality (accuracy and repeatability) is not adversely affected while using one of the optional measurement speeds (*Fast, 2X Fast or 4X Fast)*, we strongly recommend running tests for accuracy and repeatability prior to using these modes for critical measurements. This is most easily achieved by comparing results with measurements made in the *Normal* mode.

To select a *Speed* mode:

1. Make sure **Adaptive** is set to *Enabled.*
2. Touch the ▼ or ▲ icon in the **Speed** field to toggle between *Normal, Fast, 2X Fast, 4X Fast, 8X Fast or 16X Fast.*

How to Set the SYNC Mode

The PR-7XX can be instructed to automatically adjust the exposure time to the frequency of the source. This can significantly improve the accuracy and precision of the measurement of repetitive (non-DC), intense sources. When measuring these types of sources, the instrument may only be exposed to a very few “pulses” of light. Since the instrument has no way of knowing at what point in the pulse train the measurement started (e.g. leading edge or trailing edge) two successive measurements of the same stimuli may yield unacceptably different results. By knowing the frequency of the source, the exposure time can be adjusted to an even multiple of the frequency thereby insuring that entire pulses are captured improving the accuracy and repeatability of the measurements. This is not an issue if the repetitive source being measured is relatively low level yielding a long (> 1 second) exposure time.

There are three SYNC modes, *None, Automatic* and *Manual.* If set to *None,* obviously no modification of the exposure time will occur. In *Automatic* mode, the instrument samples the rate of the source and in *Manual* mode the user inputs the frequency of the device under test.

To set the *SYNC* mode:

1. Make sure *Adaptive* is set to *Enabled.*
2. Touch the ▼ or ▲ icon in the *SYNC* field to toggle between **None, Custom, Learn,** and **Automatic.**
3. If **Manual** is selected, touch the field adjacent to *Frequency to* access the following data entry screen*:*

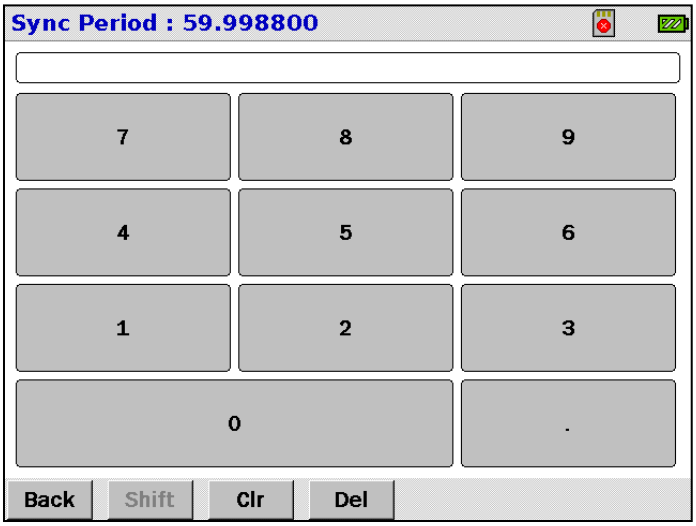


FIGURE 39 - SYNC PERIOD DATA ENTRY SCREEN

4. Touch the numeric keys to enter the SYNC period. The range is 20 to 2000 Hz.
5. Touch **Back** when finished.

How to Set Smart Dark Mode

During a measurement the PR-7XX makes two separate measurements – one of the optical signal (**Light**), and a second measurement of the detector dark current (**Dark**). By enabling the *Smart Dark* feature, the PR-7XX will attempt to use the same dark current values for more than one measurement thus reducing total measurement time by approximately half. The *Smart Dark* feature is used when the instrument determines that the (second or successive) measurement in a series is using the same exposure time as the first measurement. If a fixed exposure time is used for a measurement, *Smart Dark* will be used until the exposure time is changed.

Smart Dark is a useful tool for applications such as display uniformity, or other testing where multiple measurements of the same light level are performed.

To enable *Smart Dark:*

1. Touch the field next to **Smart dark** to toggle between *Enabled* and *Disabled.*

Chapter 5 – Setup Menu

MEASUREMENT MODES

Five **Measurement Modes** are available to the user: **Standard**, **L*u*v***, **L*a*b*** and **RGB Display Cal** and optional **Color Rendering Index (CRI)**.

STANDARD MODE

In Standard Mode the PR-7XX performs a measurement then calculates standard photometric and colorimetric values. Calculated values include Photometric (luminance, illuminance, luminous flux and luminous intensity depending on the accessory in use), CIE 1931 xy, CIE 1960 uv, CIE 1976 u'v', Correlated Color Temperature (CCT), micro-reciprocal Kelvins (mk-1) and deviation of sample from Planck's locus in CIE 1960 uv values.

L*U*V* / L*A*B* MODES

L*u*v* and L*a*b* measurements use photometric and colorimetric values to perform CIE L*u*v* or L*a*b* three-dimensional color difference calculations.

L*u*v* tests are usually made of self-luminous samples such as LCD's, PDP's, EL, OLED and CRT displays. Therefore, they are best made in a dark environment, free of ambient lighting that might influence the results. L*u*v* measurements are typically made in the *Self-Luminous* calculation mode.

L*a*b* tests on the other hand are typically performed of reflective or transmissive materials such as paint or optical filters where it is necessary to provide an external light in order to measure the object. Therefore, *Illuminated* samples must be selected in the L*u*v* or L*a*b* mode. Following the measurement, the light used to illuminate the object is mathematically removed from the measurement. The resultant spectra are then weighted by the white reference (e.g. CIE D-65) as if the sample were being illuminated by the white stimulus. Finally, before color coordinates and eventually L*a*b* values are calculated on the modified spectrum.

Color coordinates of a white reference are used during the calculation of both L*u*v* and L*a*b*. White references stored in the PR-7XX include D65 (daylight at 6500 Kelvins), Illuminant A (Black body radiator at 2856 Kelvins), Illuminant B (daylight at 4875 Kelvins), Illuminant C (daylight at 6772 Kelvins), Illuminant D50 (daylight at 5000 Kelvins), Illuminant D55 (daylight @ 5500 Kelvins) and Illuminant D75 (daylight at 7500 Kelvins).

Following the measurement(s), L*u*v* and L*a*b* values are calculated as follows:

$$L^* = 116\left(Y / Y_O\right)^{1/3} - 16$$
$$u^* = 113L^*\left(u' - u'_O\right)$$
$$v^* = 13L^*\left(v' - v'_O\right)$$

EQUATION 1 - L*U*V*

$$L^* = 116\left(Y / Y_O\right)^{1/3} - 16$$
$$a^* = 500\left[\left(X / X_O\right)^{1/3} - \left(Y / Y_O\right)^{1/3}\right]$$
$$b^* = 200\left[\left(Y / Y_O\right)^{1/3} - \left(Z / Z_O\right)^{1/3}\right]$$

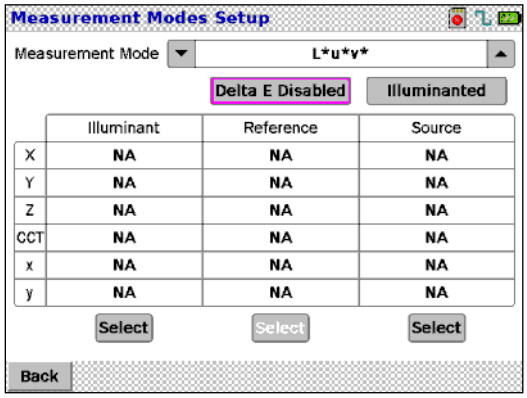
EQUATION 2 - L*A*B*

Where X, Y, Z are the measured Tristimulus values, X_O, Y_O and Z_O are the Tristimulus values of the white illuminant, u' and v' are the CIE 1976 values, and u'_O and v'_O are the CIE 1976 values of the white illuminant.

How to Make L*u*v* or L*a*b* Measurements

1. Touch the ▼ or ▲ icons in the **Measurement Mode** field to select **L*u*v*** or **L*a*b***.

2. To make **L*u*v*** or **L*a*b*** measurements, it is necessary to first select a white reference (**Illuminant**). Touch **Select** at the bottom of the Illuminant column. A screen similar to the following ap**pears:**



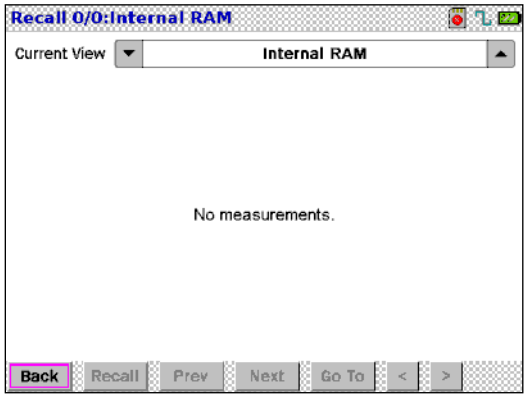


FIGURE 40 - L*U*V* SETUP SCREEN FIGURE 41 - FILE RECALL SCREEN

3. To access factory stored illuminants (Standard Illuminants), touch the ▼ or ▲ icons in the **Current View** field until **Standard Illuminants appears.** An **Illuminant** may also be a previously measured AND STORED file – for example a florescent lamp. If it is desirable to use a previous measurement, then select **Internal RAM** or **External SD Card** (if an SD card is inserted).

   OR

   Press the **MEASURE** button then touch **Back** then **Recall** to accept the measured data.

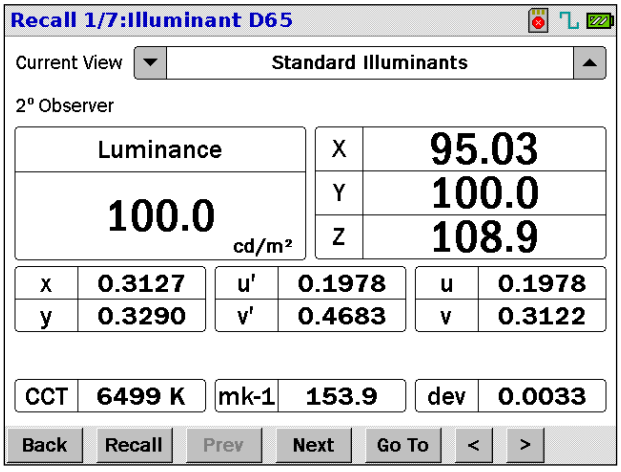


FIGURE 42 - STANDARD ILLUMINANTS SCREEN

4. If using a pre-stored illuminant, at the top of the screen that pops up, the title of the *Illuminant* appears. Touch **Next** (or **Previous**) to scroll through available choices.

5. Touch **Back.**

6. Touch **Recall** to select the displayed illuminant. The *Standard Illuminant* screen updates to show the data of the illuminant selected.

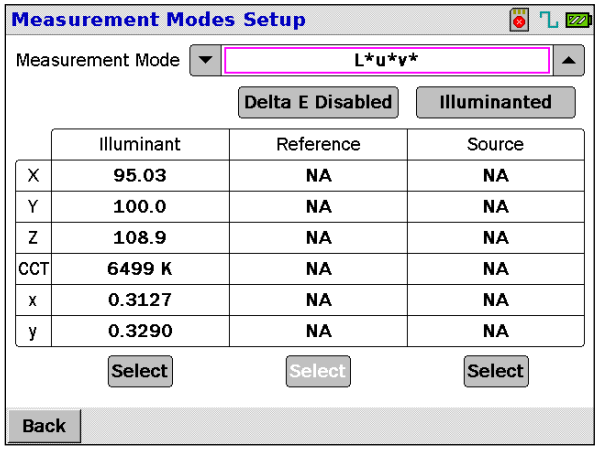


FIGURE 43 - L*U*V* SETUP SCREEN

Touch **Delta E Disabled** to *enable* color difference measurements if desired. If **Delta E** is enabled, **Select** under the *Reference* column becomes activated. The Reference is the "Golden Sample" against which all subsequent samples are compared for color difference calculations. Delta E (CIE ΔE*ab or ΔE*uv) calculates color difference in the respective color systems using the following formulas:

$$\Delta E^*ab = \sqrt{(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2}$$

EQUATION 3 - ΔE*AB

$$\Delta E^*uv = \sqrt{(\Delta L^*)^2 + (\Delta u^*)^2 + (\Delta v^*)^2}$$

EQUATION 4 - ΔE*UV

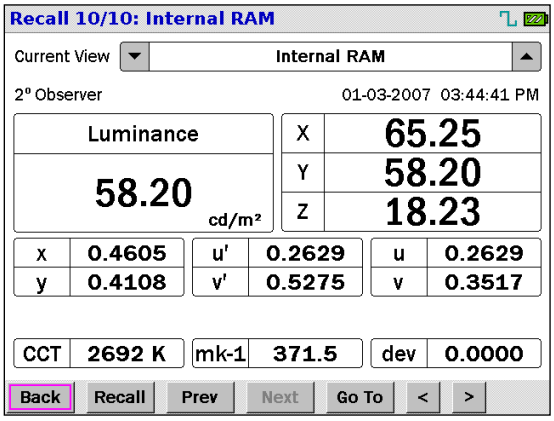
7. To make a *Reference* or *Source* measurement:

If measuring an illuminated sample, the user will need to have a *Reference* and *Source* measurement selected. The *Source* measurement will need to be supplied first. If measuring a self-luminous sample, only the *Reference* measurement is necessary.

In the case of a *Source* measurement, a diffuse reflectance standard, such as the Photo Research RS-3 or SRS-3, is placed in the exact location of the measurement area of the device under test – for example the face of a display.

To make a *Reference* measurement, measure the device under test. If a *Source* measurement was made first, replace the reflectance standard with the sample in the exact same location.

a. Touch **Select** under the *Reference* or *Source* column. The following screen appears:



b. Make sure **Internal RAM** is selected in the **Current View** field.

c. Press the **MEASURE button**.

d. At the completion of the measurement, touch **Back.**

e. To use this measurement, touch **Recall**. To use a previously stored measurement, touch **Prev** or **Next** until the measurement of choice appears and then touch **Recall.**

8. Once the *Illuminant* and *Reference* and (optional) *Source* have been selected and or measured, the PR-7XX is ready to perform L*u*v*, L*a*b* and optional Delta E measurements. To perform these measurements:

a. Press the **MEASURE button**. A result screen similar to the following appears:

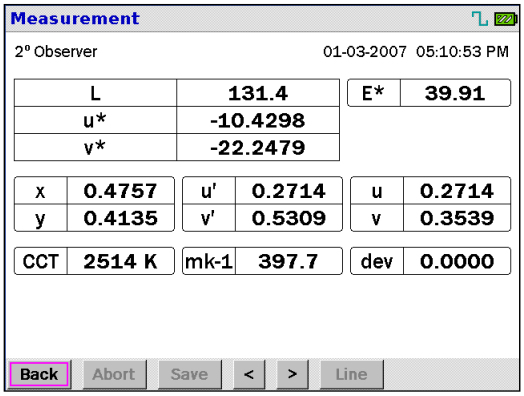


FIGURE 44 - L*U*V* RESULT SCREEN

In this example, **Delta E** has been selected in the *Measurement Mode* setup screen. The displayed values of *x, y, u', v', u, v, CCT, mk-1,* and *dev* are the measured values of the sample.

RGB DISPLAY CAL

The RGB measurement mode is designed to provide the user with a convenient, spectrally based interactive method of performing white point calibrations of CRT's, LCD's PDP's and digital projectors or any other display technology that features adjustable RGB channels.

During use, the user is presented with a bar graph and associated numerical levels indicating the deviation amplitude and direction of the three RGB primaries from the target settings. Once the RGB levels of the display are adjusted to the target values set by the RGB algorithm, the white point is properly adjusted.

Since the PR-7XX are spectrally based systems, color matching can be achieved without having a "golden sample" available as a reference. White point calibrations can be based on user entered target values including luminance and CIE chromaticity coordinates (CIE 1931 x, y values). The user can also select pre-stored phosphor sets (NTSC, EBU, CIE, HDTV and SMPTE) or create phosphor primary chromaticity values through measurement or data entry.

SETTING UP RGB DISPLAYCAL MEASUREMENTS

Prior to making RGB measurements, the proper parameters must be entered into the RGB setup menu to insure correct results.

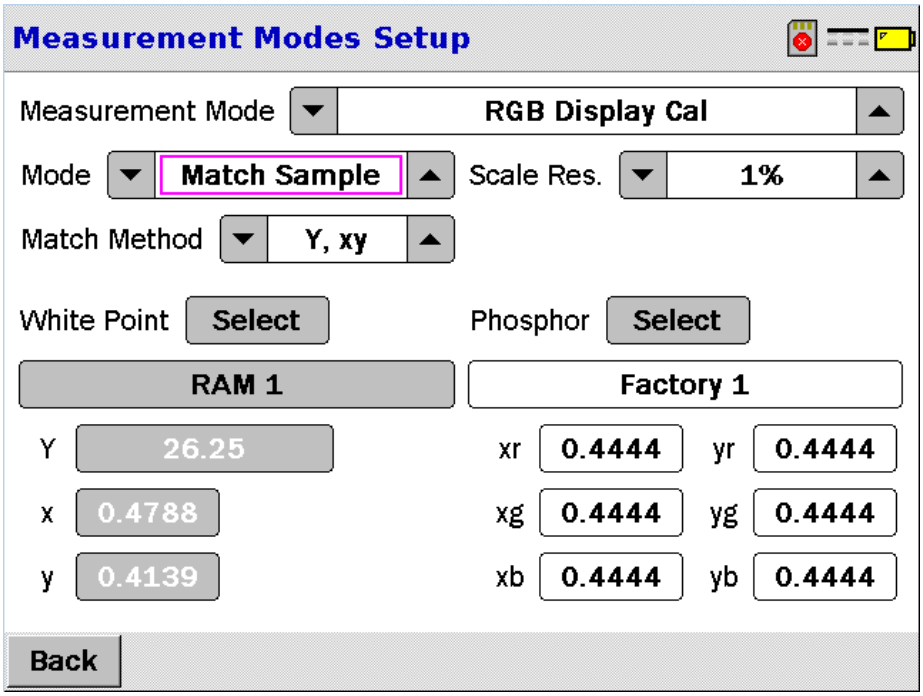


FIGURE 45 - RGB DISPLAY CAL SETUP SCREEN

MODE FIELD

Two options are available in this field: **Match Sample and Match Data.**

In the **Match Sample** mode, white point calibrations are based on a measured reference display – “Golden Sample”.

Match Data mode allows the user to enter target values in terms of luminance (Y) and CIE 1931 x, y values.

Whichever method is chosen, all **RGB** measurements require that a **Phosphor** (either stored or custom) be selected and that a reference white point is set.

SELECTING A PHOSPHOR

Proper white point calibration is dependent on the color characteristics of the display primaries. Phosphor is used as a historical reference to CRT’s. The data for several types of phosphors are pre-stored in the PR-7XX. They are CIE, NTSC, EBU (PAL / SECAM), SMPTE and HDTV. The user may also enter display primary chromaticity values or use measured values.

1. To select a pre-stored phosphor set touch **Select** located to the right of the **Phosphors** window. The following screen appears:

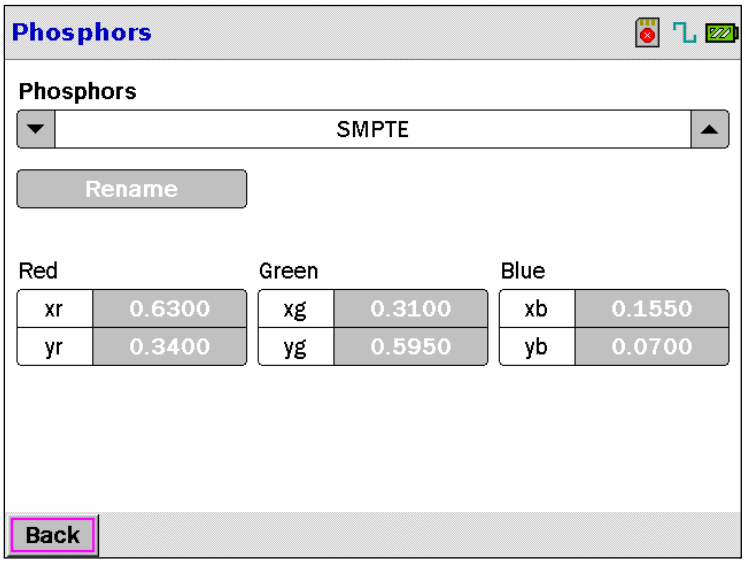
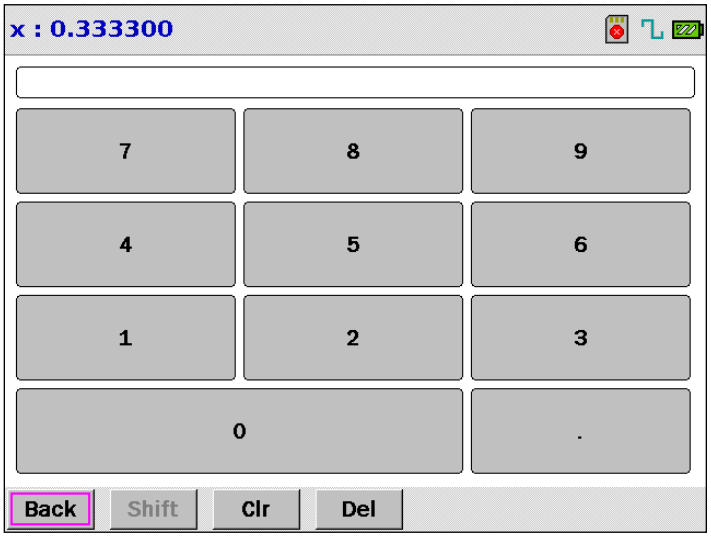


FIGURE 46 - RGB PHOSPHOR SELECT SCREEN



1. Touch the desired values, and then touch **Back** when finished.
2. Repeat for both chromaticity (x, y) values for each primary. If the values are not known, they may first be measured by turning on only one primary at a time (3 measurements total) and noting the resultant CIE x, y values for entry into these fields.

SETTING THE WHITE POINT

The White Point (White Pt.) is the background or ambient illumination under which the display is viewed and has an effect on the perceived color of the display. Several pre-stored CIE recommended illuminants and daylight simulators can be selected. They include CIE Illuminants, A, B, C, D50, D55, D65, D75, and E.

Alternately, ambient sources (room lighting for example) may be measured and used as the White Pt. values.

1. Touch **Select** next to the **White Point** window. The following screen appears:

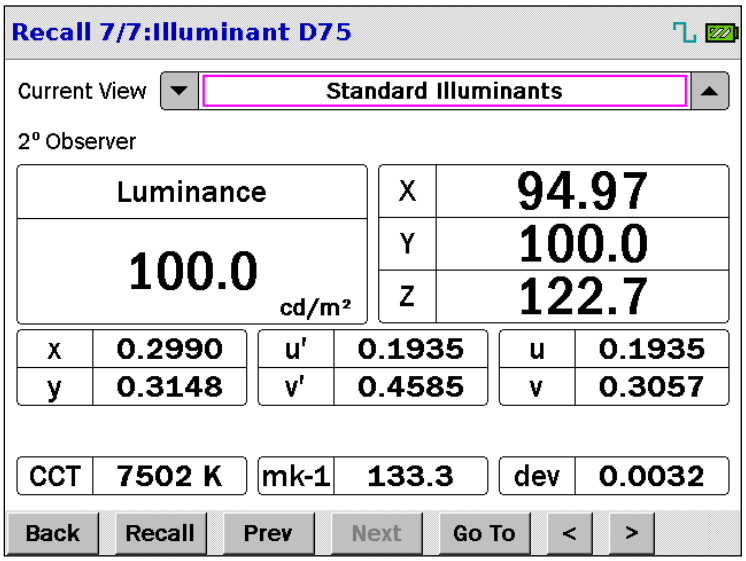


FIGURE 47 - SELECT RGB ILLUMINANT SCREEN

2. Touch the ▲▼ icons adjacent to **Current View** to scroll through available selections. Select **Standard Illuminants**, then touch **Prev** or **Next** to scroll through available choices. The title of the currently

displayed data set appears at the top of the screen – in this example, CIE Illuminant D75.

OR

Touch the ▲▼ icons adjacent to **Current View** to scroll through available selections. Select **Internal RAM** or **External SD Card**, then touch **Prev** or **Next** to scroll through selections. The title of the currently displayed data set appears at the top of the screen – in this example CIE Illuminant D75.

OR

Press the **MEASURE** button to make a measurement of the illuminant.

3. Touch **Recall** to accept the selection.
4. When finished, touch **Back.**

MATCH SAMPLE PROCEDURE

In the **Match Sample** mode, target values for the Reference display are entered by the user.

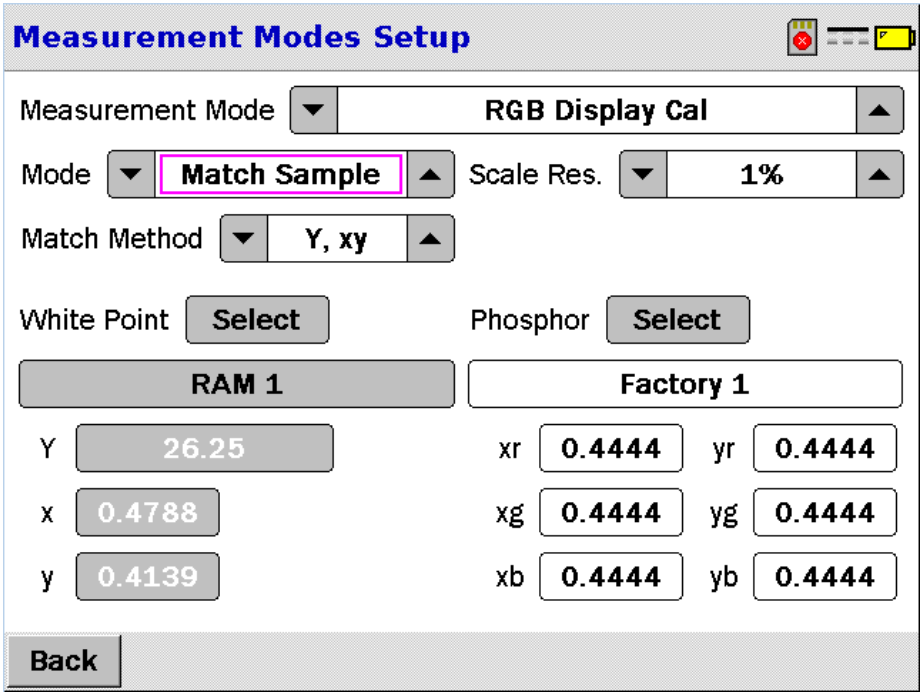
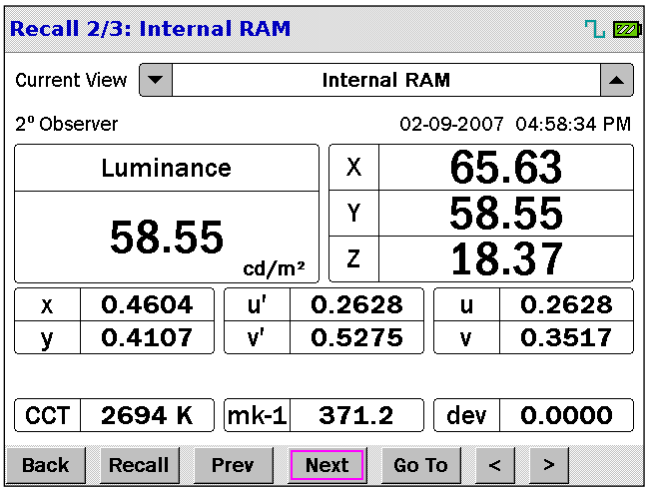


FIGURE 48 - RGB DISPLAY CAL SETUP SCREEN

1. Touch the ▲ ▼ icons adjacent to the **Mode** field to select **Match Sample.**
2. Touch the ▲ ▼ icons adjacent to the **Match Method** field to choose between **Y, xy** (luminance and CIE 1931 xy) or **xy** (CIE 1931 xy only)**.** This instructs the PR-7XX to attempt to perform a complete match including the photometric brightness of the device, or setup the display based solely on the chromaticity points and disregard the brightness.
3. Touch **Select** located next to **White Point**. The **Measurement** screen appears.
4. Set up the display to be measured, then press the **MEASURE** then touch **Recall,** or just touch **Recall** to select the currently displayed values.
5. Touch **Back** to return without making changes**.**

OR

If measurements are stored in RAM or on an SD card, they can be accessed and recalled.



In the preceding example, measurement number 2 of 3 is displayed.

Y x,y (or x,y) Data Entry Procedure

Since the PR-7XX measures the spectral content of the sample, it is possible for the instrument to calibrate the display white point based on user entered values for luminance and CIE chromaticity . The user can select to enter **Y x,y** (luminance and CIE 1931 x, y values) or **x,y.** If **Y x,y** is selected, after calibration of the display, the luminance is properly adjusted to the entered value for **Y**. If **x,y** is chosen, the absolute luminance value is ignored and the display is calibrated based on chromaticity values only.

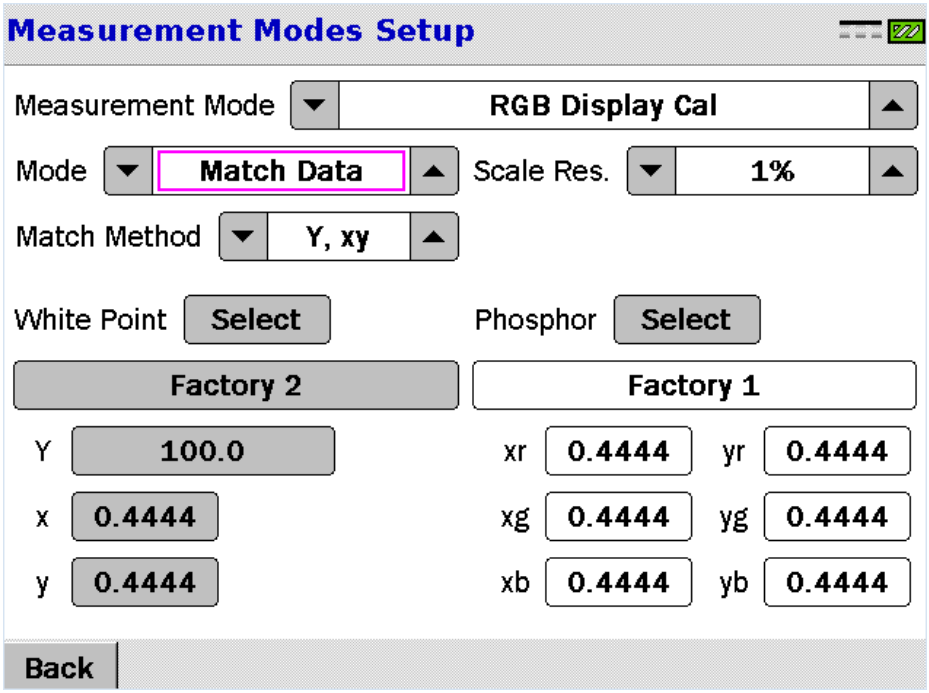


FIGURE 49 - Y XY DATA ENTRY SCREEN

Y x,y Procedure

1. Touch the ▲▼icons adjacent to **Mode** to select **Match Data.**

2. Touch the ▲▼icons adjacent to **Match Method** to display either **Y x,y** or **x,y.**
3. Enter the desired values for **Y, x** and **y** in the fields directly below the **Factory** field by touching any of the fields. This action brings up a data entry screen like the following example for **Y**:

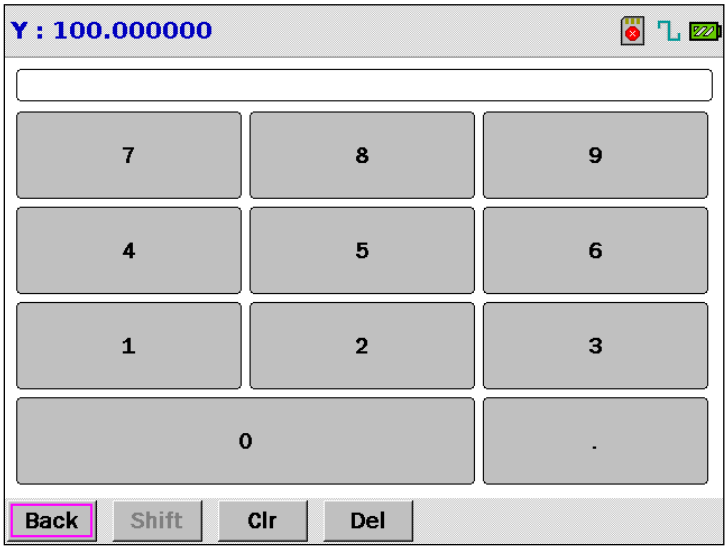


FIGURE 50 - RGB DATA ENTRY

Note: If *xy* is selected, data entry for *Y* is unavailable.

4. Enter the value for **Y,** and then touch **Back.**
5. Repeat for **x** and **y.**

MAKING AN RGB DISPLAY CAL MEASUREMENT

When all parameters have been successfully set, white point calibration can commence.

1. Press the **MEASURE** button to begin the RGB measurement sequence. A screen similar to the following appears:

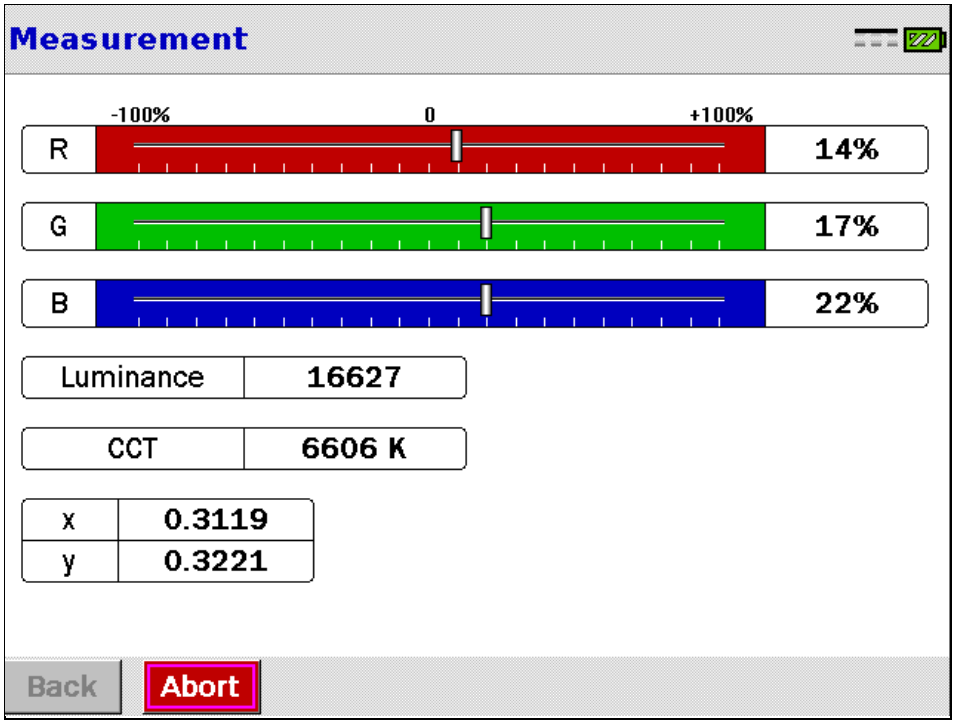


FIGURE 51 - RGB MEASUREMENT SCREEN

2. The instrument will make continuous measurements until the **Abort** key is touched. Adjust the primaries of the display until the vertical indicator bars for **R**, **G** and **B** are all at the center of the respective horizontal colored bars and the % deviation (values to the right of the bars) reads 0.00.

   Note that updated *Luminance, CCT* and *chromaticity* values are continuously displayed during the calibration sequence.

3. Touch **Abort to** stop the measurement.

4. Touch **Back** to exit this screen and return to the Measurement Setup Screen at the completion of the calibration.

COLOR RENDERING INDEX (CRI) – OPTIONAL FOR PR-7XX.

Color Rendering Index is a method of testing luminaires or other light sources for their capability to render the color of an object being illuminated by that source with respect to a standard light source – does the object look the same under both sources. Fourteen reference colors are used to determine the similarities between the test light and the standard with the first eight colors used to calculate the average CRI – see Figure 52.

FIGURE 52 - COLORS USED TO DETERMINE AVERAGE CRI

Chapter 5 – Setup Menu

SETTING UP CRI MEASUREMENTS

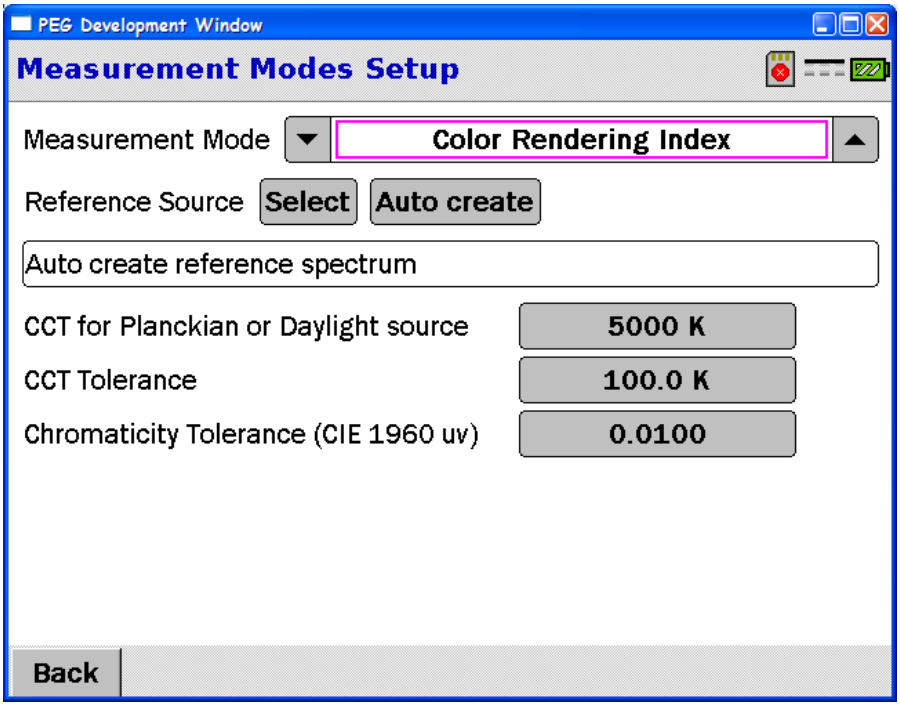


FIGURE 53 - CRI SETUP SCREEN

1. Touch **Setup**.
2. Touch **Measurement Mode.**
3. Touch the ▼▲ icons in the **Measurement Mode** field to scroll to **Color Rendering Index.**
4. Once all selections (explained below) have been made, touch **Back**.

REFERENCE SOURCE

The Reference Source is the standard source that CRI calculations use to compare against the measured sample. The source can be one selected by the user from a previous measurement (e.g. office lighting), standard illuminants, or be auto generated by the PR-7XX.

HOW TO SELECT THE REFERENCE SOURCE

1. Touch **Select.** A screen similar to the following screen appears:

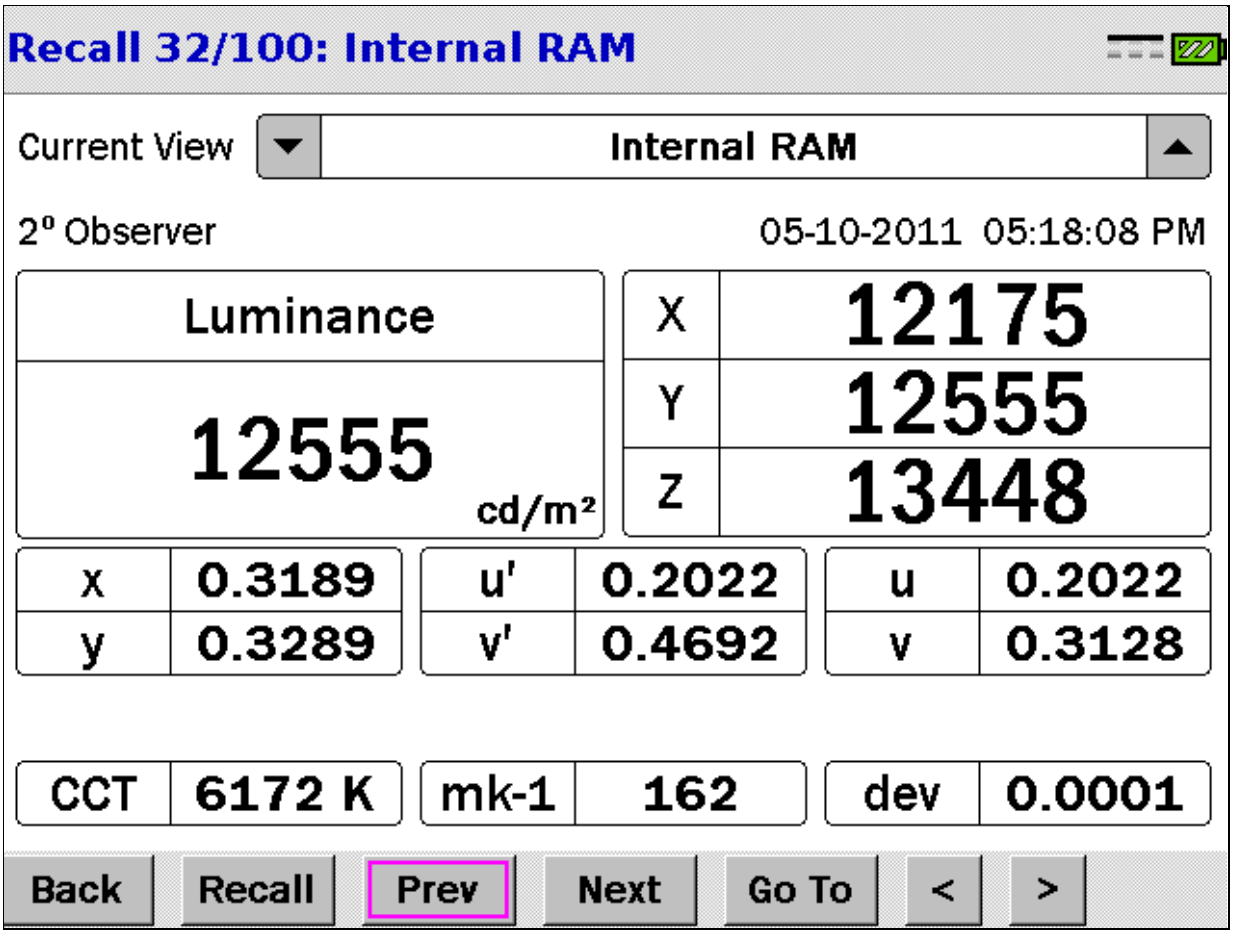


FIGURE 54 - CRI SOURCE SELECT SCREEN

2. If the **Current View,** which indicates the physical location of the measurement to be recalled is not the desired path, touch the ▼▲ icons in that field to toggle between Internal RAM and the location of your choice. Other choices are a file(s) on the SD card or internally stored **Standard** Illuminants.
3. Touch **Prev** or **Next** to select the measurement of choice.
4. Touch **Recall** once the choice has been made.
5. The CRI Setup screen is updated with the selected values.

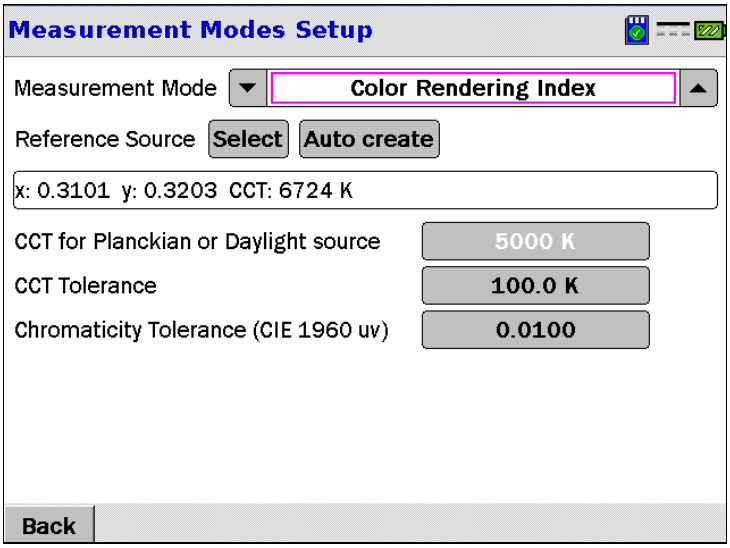


FIGURE 55 - CRI SETUP SCREEN WITH SELECTED SOURCE DATA

AUTO CREATE SOURCE OPTION

If you select **Auto Create Source**, the PR-7XX will automatically generate a reference source based on the measured correlated color temperature of the sample, and the value entered in the **CCT for Plankian or Daylight source** field. If the measured CCT is equal to or lower than the value in this field, the created source will be a blackbody radiator spectrum at or near the CCT of the measured sample. If the measured sample's CCT is greater than the entered CCT, the auto-created reference is based on a daylight type spectrum at or near the CCT of the measure sample.

To enter the **CCT for Plankian or Daylight source**

1. Touch the gray field adjacent to **CCT for Plankian or Daylight source**.
2. In the screen that appears, touch the numbers to create the desired value in Kelvins and then touch **Back.**

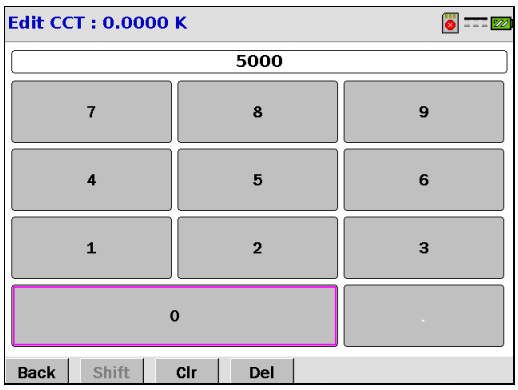


FIGURE 56 - CCT FOR PLANKIAN OR DAYLIGHT SOURCE ENTRY SCREEN

CCT TOLERANCE

If the CCT of the measured sample and the CCT of the Reference Source vary by an amount greater than the value in this field, a warning message is generated. The CRI calculation will be completed.

To enter the **CCT Tolerance**

1. Touch the gray field adjacent to **CCT Tolerance**.
2. In the screen that appears, touch the numbers to create the desired value in Kelvins and then touch **Back.**

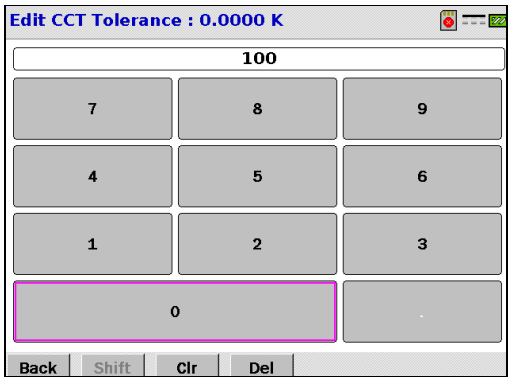


FIGURE 57 - CCT TOLERANCE ENTRY SCREEN

CHROMATICITY TOLERANCE (CIE 1960 UV)

If the distance of the chromaticity point of the sample to that of the Reference Source is greater than the value in this field (CIE 1960 uv units), a warning message is generated. The CRI calculation will be completed.

To enter the **Chromaticity Tolerance**

1. Touch the gray field adjacent to **Chromaticity Tolerance**.
2. In the screen that appears, touch the numbers to enter the desired deviation in CIE 1960 uv units and then touch **Back.**

CRI MEASUREMENT RESULTS

At the completion of a measurement in the CRI measurement mode, the CRI result screen is available. If the CRI result screen is not currently being displayed after the measurement, touch the **< >** icons at the bottom of the measurement result screen to scroll to the CRI results.

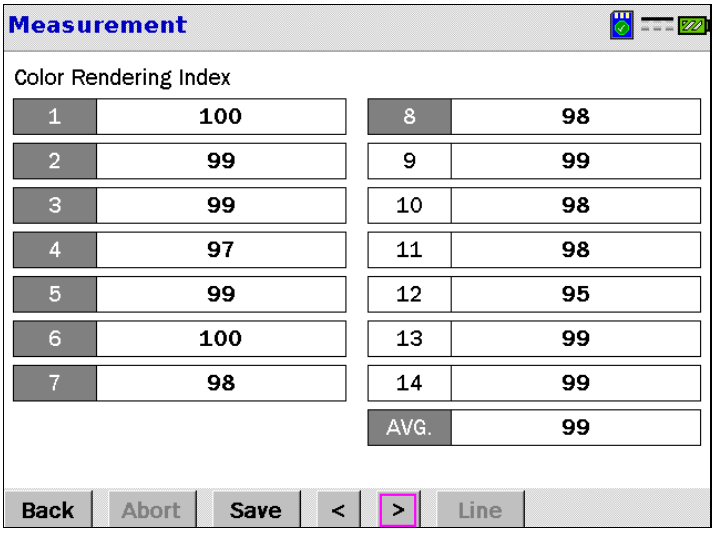


FIGURE 58 - CRI RESULT SCREEN

The results of the 14 indices are reported as is the Average (AVG.) CRI. The grayed fields indicate the index values used to calculate the average. The CRI scale is 0 to 100 with 100 being best.

STANDARD ILLUMINANTS

A Standard Illuminant is a spectral file of a white or near white stimulus that is used for L*a*b*, L*v*v* and RGB measurements and calculations. These illuminants were obtained from the CIE (Commission Internationale d'Eclairge) and include

- **Illuminant A (blackbody radiator at 2856 Kelvins)**
- **Illuminant B (Daylight simulator at 4850 Kelvins)**
- **Illuminant C (Daylight Simulator at 6772 Kelvins)**
- **Illuminant D50 (Daylight Simulator at 5,000 Kelvins)**
- **Illuminant D55 (Daylight Simulator at 5,500 Kelvins)**
- **Illuminant D65 (Daylight Simulator at 6,500 Kelvins)**
- **Illuminant D75 (Daylight Simulator at 7,500 Kelvins)**
- **Illuminant E (equal energy at all wavelengths)**

This feature is informational only. No illuminants can be added or deleted using this function.

1. Touch **Menu** then **Setup** then **Standard Illuminants**. A screen similar to the following appears:

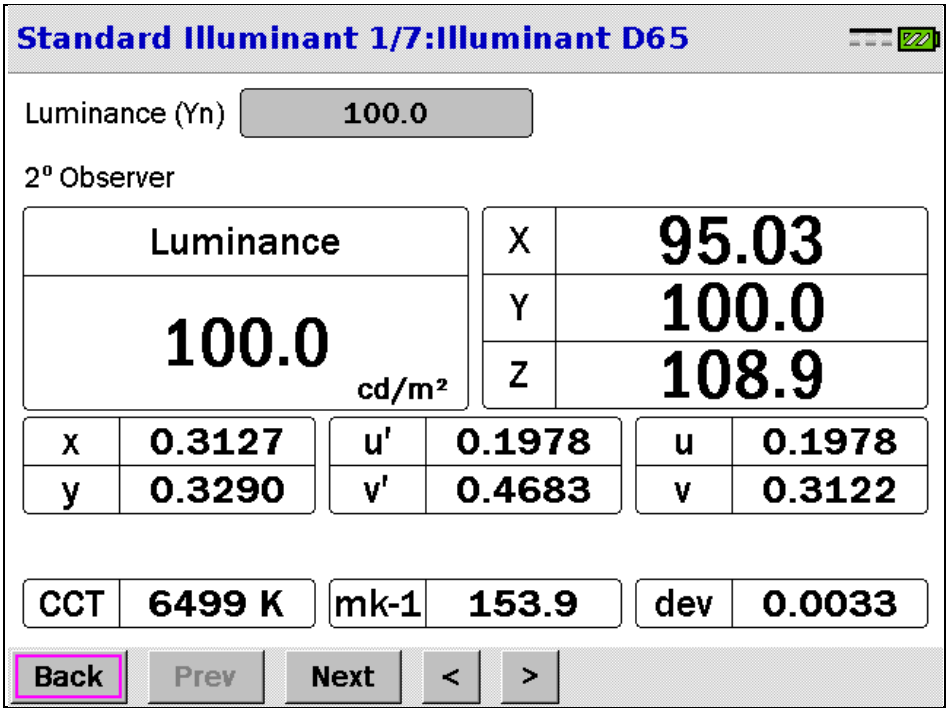


FIGURE 59 - STANDARD ILLUMINANTS SCREEN

1. Touch **Prev** or **Next** to scroll through illuminants.
2. Touch the < > icons to scroll through various data screens for the currently displayed illuminant.
3. Touch **Back** to exit.

TIMED MEASUREMENTS

It may become desirable to make periodic (timed measurements) to, for example, check the drift characteristics at pre-defined intervals for a certain period of time. You may also want to make continuous (repetitive) measurements or a fixed number of measurements. This can be accomplished using the **Timed Measurements** feature.

Note: The *Continuous Measurements* feature should not be confused with the *Measurements to Average* function.

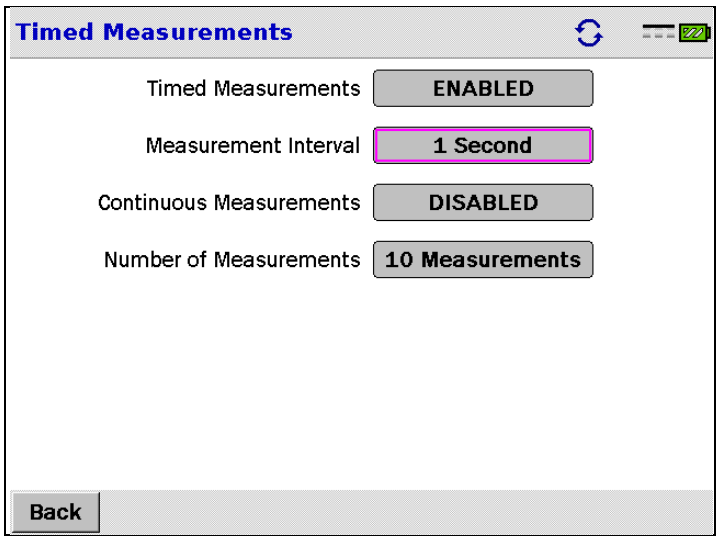


FIGURE 60 - TIMED MEASUREMENTS SCREEN

HOW TO SET TIMED MEASUREMENTS PARAMETERS

1. Navigate to the **Timed Measurements** screen by touching Menu, then Setup then Timed Measurements.
2. If it is desirable to repeat the timed measurement sequence, set **Continuous Measurements** to **Enabled.**
3. Set the time between measurements (in seconds) by touching the **Measurement Interval** filed. The following data entry screen appears:

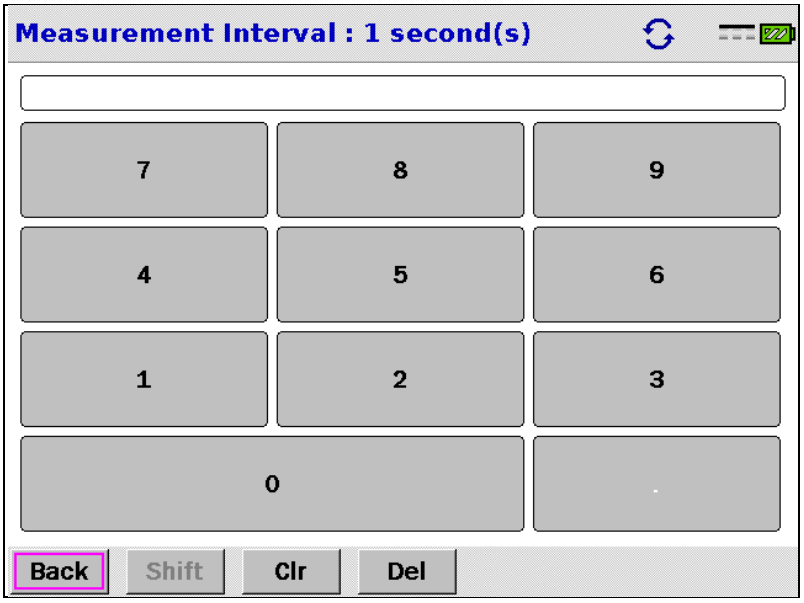


FIGURE 61 - MEASUREMENT INTERVAL ENTRY FIELD

1. Enter the measurement interval (range is 1 to 86400 seconds [24 hours]) then touch **Back**.
2. Touch the **Measurement Button** to initiate the Timed Measurement Sequence.

CONTINUOUS MEASUREMENTS

1. Navigate to the Timed Measurements screen by touching Menu, then Setup then Timed Measurements.
2. Touch the Timed Measurements field to that it displays Enabled.
3. Touch the Continuous Measurements filed until Enabled appears.
4. Press the Measure button to initiate a continuous measurements.

ADVANCED SETUP

CUSTOM SPECTRAL CALIBRATION

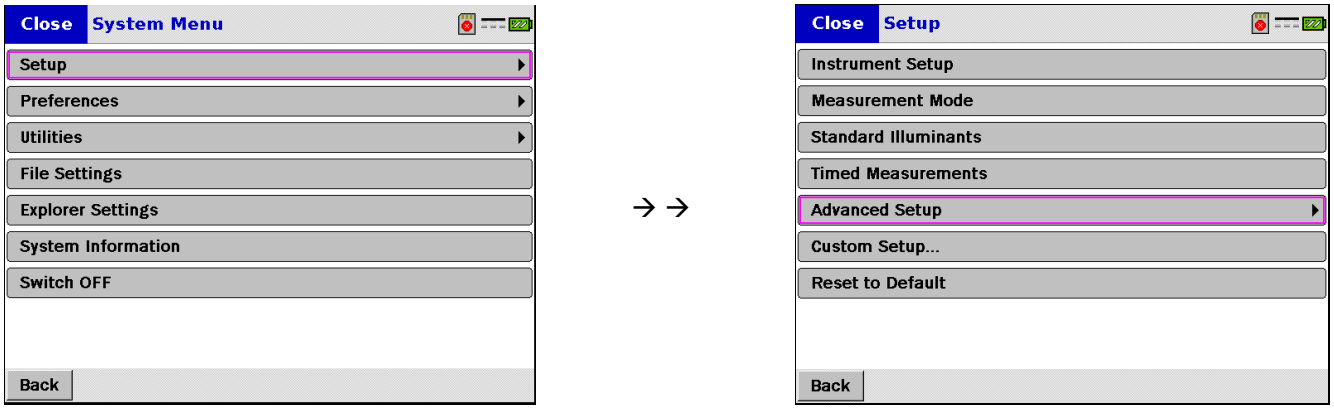
The correlation of two instruments measuring the same sample has always been an issue. This is especially true when comparing results from two different instrument manufacturers, or when the calibration of an instrument is suspect. To help eliminate this problem without requiring full recalibration of the instrument, we have added a Custom Spectral Calibration feature to the suite of features on the PR-7XX. This feature allows the user to establish a set of unique spectral calibration factors for one instrument based on the measurement of a sample from a second instrument. Then, when both instruments analyze the sample in question, they will correlate with exceptional accuracy.

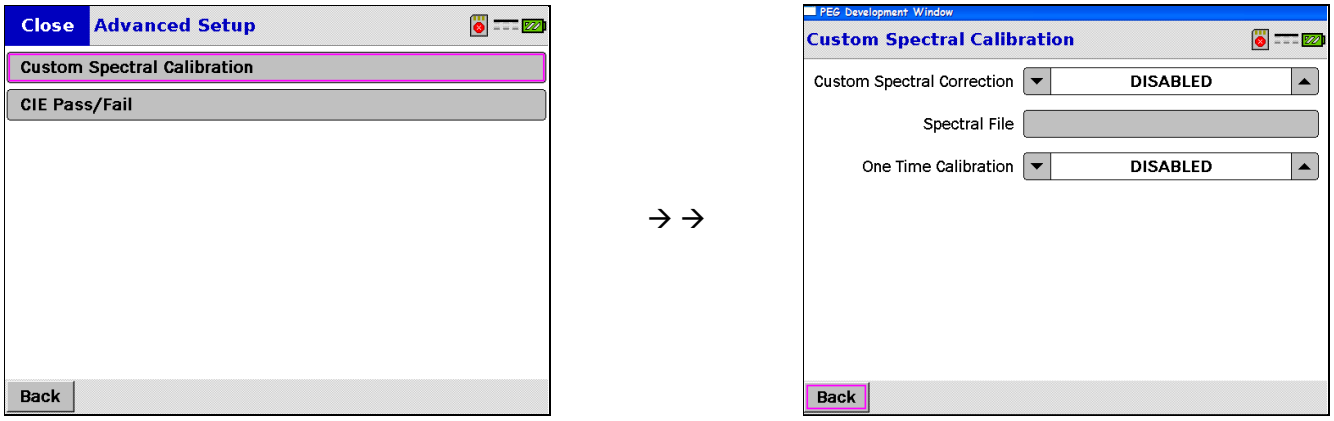
The second (*Source*) instrument can be a Photo Research product, or other spectrally based instrument. The parameters of the spectral data for the two instruments **must** be compatible with each other. The parameters are:

Instrument	Starting WL	Ending WL	WL (Data) Increments in nm
PR-730, PR-740, PR-788	380	780	1
PR-735, PR-745	380	1080	2

ACCESSING THE CUSTOM SPECTRAL CALIBRATION MENU

1. Touch **Setup → Advanced Setup → Custom Spectral Calibration.** The **Custom Spectral Calibration** screen appears.



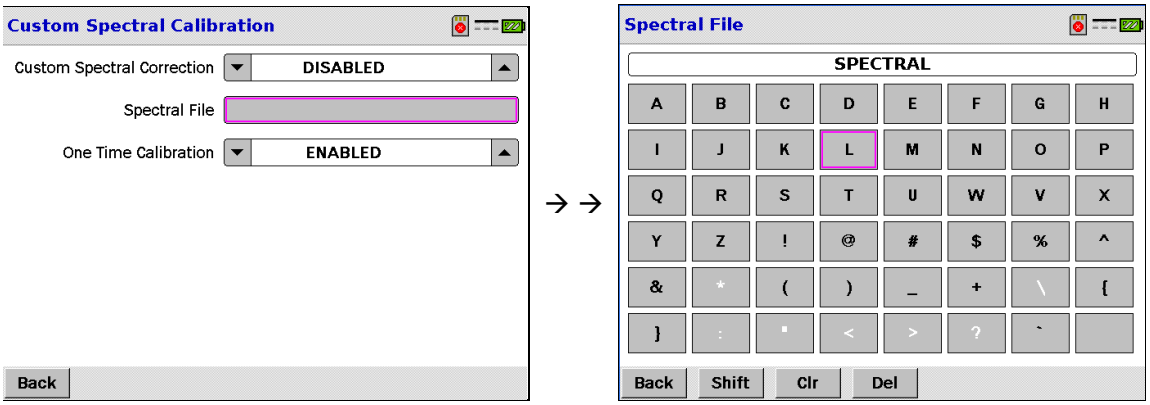


IMPORTING DATA

AS A .MEA FILE

Although it would be unlikely to have to perform this procedure for two PR-7XX instruments, it is possible to save a measurement on the SD card of the *Source* instrument, and then use that measurement data in the *Target* instrument.

1. Create a new file (see Chapter - 7 for more information) on the SD card in the *Source* instrument (see Chapter - 7 for details). Make sure this file does not have the same name as another file on the same card with a **.txt** extension. The software will always try to use files with a **.txt** extension first during the spectral calibration sequence.
2. Measure the sample with the *Source* instrument.
3. Save the measurement to the file from Step 1**. Make sure that this measurement is the only measurement in the file**. If multiple measurements are stored in the file, then the most recent measurement (last measurement saved) will be used to generate spectral factors in the *Target* spectroradiometer.
4. Remove the SD card from the *Source* instrument and insert it into the *Target* instrument.
5. Make sure *Custom Spectral Correction* is **Disabled** and that *One Time Calibration* is **Enabled**.
6. Enter the name of the file from Step 1 by touching the Spectral File field to bring up the Spectral File Dialog.



7. Measure the sample with the *Target* instrument.

8. The **Custom Spectral Calibration** is complete.
9. To use these new factors for subsequent measurements, make sure that *Custom Spectral Correction* is ***Enabled*** and that *One Time Calibration* is ***Disabled***. The settings will rest after each measurement.
10. To restore the Target instrument so that it uses only the factory calibration factors, make sure **Custom Spectral Correction** is set to ***Disabled***.

AS A .TXT FILE

Data from other instruments can be used as the baseline or *Source* values for the Custom Spectral Calibration. The following criteria must be met:

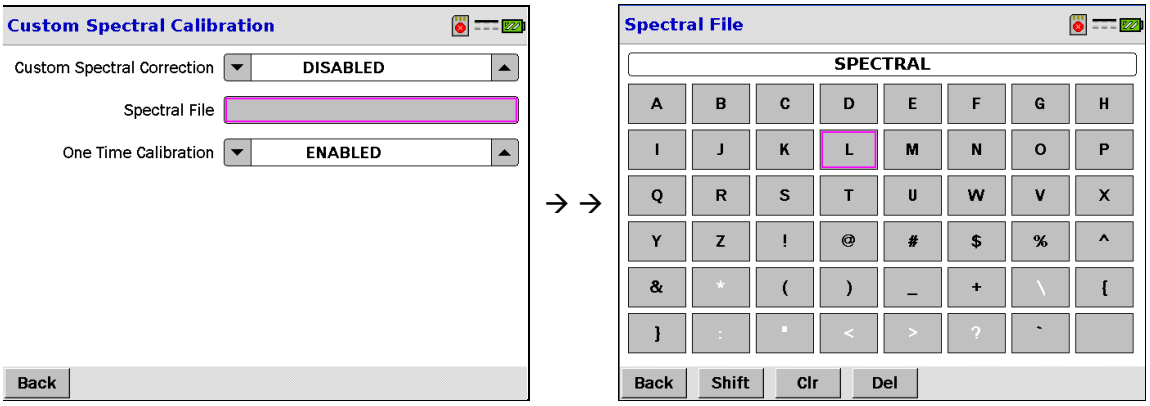
A. The *Source* must have the same starting and ending wavelength points, and the same wavelength (data) increment.
B. The file must have a **.TXT** file extension.
C. The file must have the following file format:

Line 1 – Title (Alpha / Numeric characters only – no spaces)
Line 2 – 380 (Starting Wavelength)
Line 3 – 780 (for PR-730/740/788) or 1080 (for PR-735/745) – Ending Wavelength
Line 4 – 1 (for PR-730/740/788) or 2 (for PR-735/745) – Wavelength (Data) Increment (in nanometers)
Line 5 to Line N – Spectral values

Sample **.txt** File:

```
M1
3.800000e+002
7.800000e+002
1.000000e+000
3.722937e-003
3.729762e-003
3.611207e-003
3.971064e-003
4.476557e-003
4.434512e-003
4.972667e-003
4.636224e-003
5.055876e-003
.
.
.
.
.
.
```

1. Create and save the *Source* spectral values on the SD card. Make sure this file does not have the same name as another file on the same card with a **.txt** extension.
2. Insert the SD card in the *Target* instrument.
3. Make sure **Custom Spectral Correction** is *Disabled* and that **One Time Calibration** is *Enabled*.
4. Enter the name of the file from Step 1 by touching the Spectral File field to bring up the Spectral File Dialog.



11. Measure the sample with the *Target* instrument.
12. The **Custom Spectral Calibration** is complete.
13. To use these new factors for subsequent measurements, make sure that *Custom Spectral Correction* is ***Enabled*** and that *One Time Calibration* is ***Disabled***.
14. To restore the Target instrument so that it uses only the factory calibration factors, make sure *Custom Spectral Correction* is set to ***Disabled***.

CIE Pass / Fail (Optional)

The **CIE Pass / Fail** option provides a convenient means of using the PR-7XX as a "GO / NO GO" CIE colorimeter. Using CIE Pass / Fail, you can create an acceptance region of various shapes and sizes. After a measurement, chromaticity points that fall with the defined region cause the message "**Pass**" to be displayed on screen, and if the measured point is outside the region, "**Fail**" is displayed.

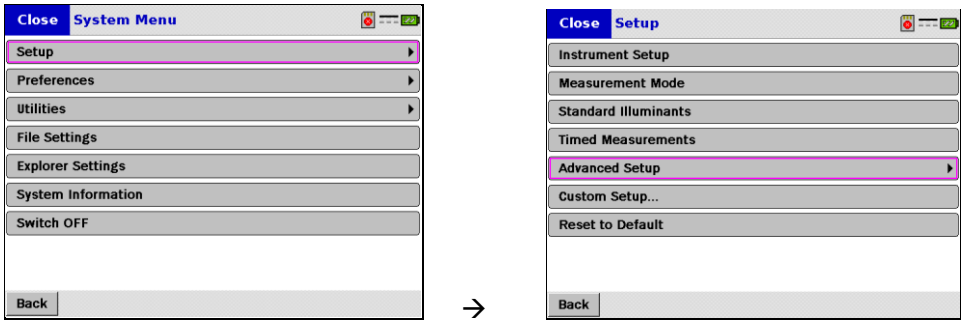
Regions are plotted in the CIE 1931 Chromaticity Diagram x, y coordinates. It is recommended that the user have this diagram handy as a visual aid when plotting regions.

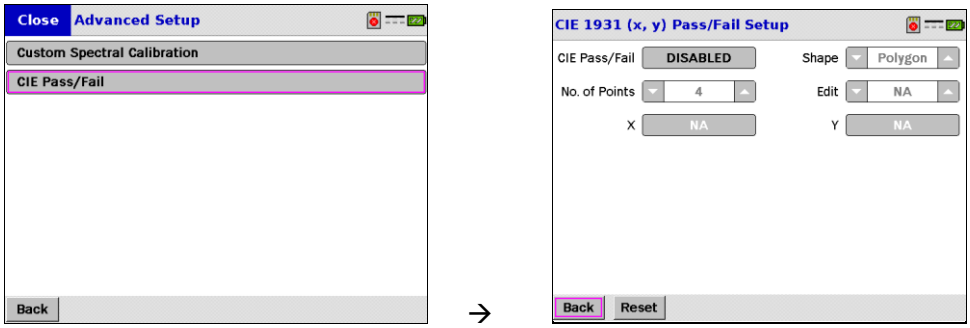
Regions can be defined as Ellipses (or circles), Rectangles (or squares) or polygons (3 - 10 sides).

Using CIE Pass / Fail

Accessing the Pass / Fail Menu:

1. From the main menu, touch **Setup → Advanced Setup → CIE Pass / Fail.**





DEFINING PASS / FAIL REGIONS

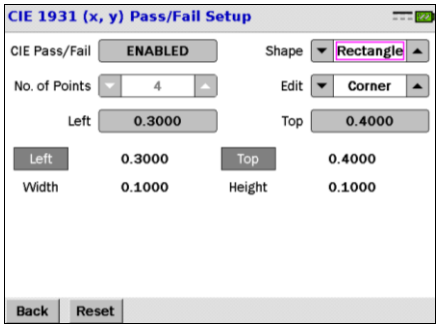
RECTANGLES (OR SQUARES)

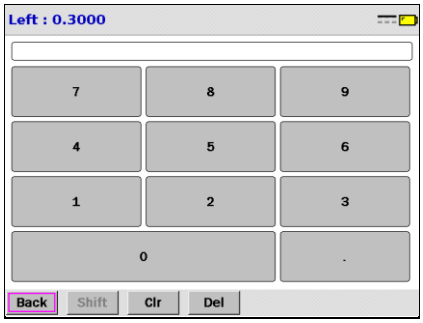
To define a Rectangle or square, two sets of values are entered. The first set is the CIE 1931 x, y coordinate of the upper left hand corner referred to in the Pass / Fail menu as the rectangles are oriented so that the sides are parallel to boundaries (axes) of the CIE diagram.

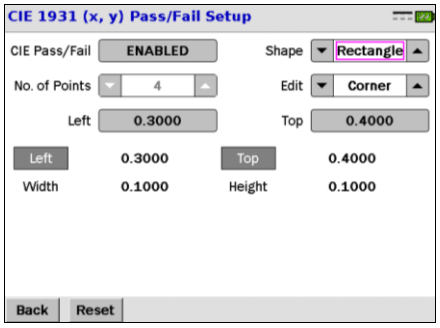
1. Touch the field adjacent to **CIE Pass / Fail** so that it reads **Enabled.**
2. Touch the ▼▲ icons in the **Shape** field until **Rectangle** appears.
3. Define the Upper Left Corner by:
    a. Touching the ▼▲ icons in the **Edit** field until **Corner** appears.
    b. Touch the gray field next to **Left** to display the data entry field for the **Upper Left CIE 1931 x** coordinate.
    c. Enter the value (including the decimal point) then touch **Back.** This value is the **absolute position** of the x coordinate in the CIE 1931 diagram.
    d. Touch the gray field next to **Top** to display the data entry field for the **Upper Left CIE 1931 y** coordinate.
    e. Enter the value (including the decimal point) then touch **Back.** This value is the **absolute position** of the y coordinate in the CIE 1931 diagram.
4. Define the **Size** by:
    a. Touching the ▼▲ icons in the **Edit** field until **Size** appears.
    b. Touch the gray field next to **Width** to display the data entry field for the **Lower Right CIE 1931 x** coordinate.
    c. Enter the value (including the decimal point) then touch **Back.** This value is the **distance** from the Top Left x coordinate in Step 3c.
    d. Touch the gray field next to **Top** to display the data entry field for the **Lower Right CIE 1931 y** coordinate.
    e. Enter the value (including the decimal point) then touch **Back.** This value is the **distance** from the Top Left y coordinate in Step 3e.

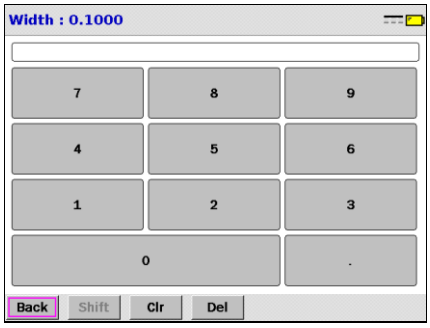
Note: To define a square, the Width and Height values must be identical. For a horizontal rectangle, the Width value must be larger than the Height value, and for a Vertical rectangle, the Height value must be larger than the Width value.

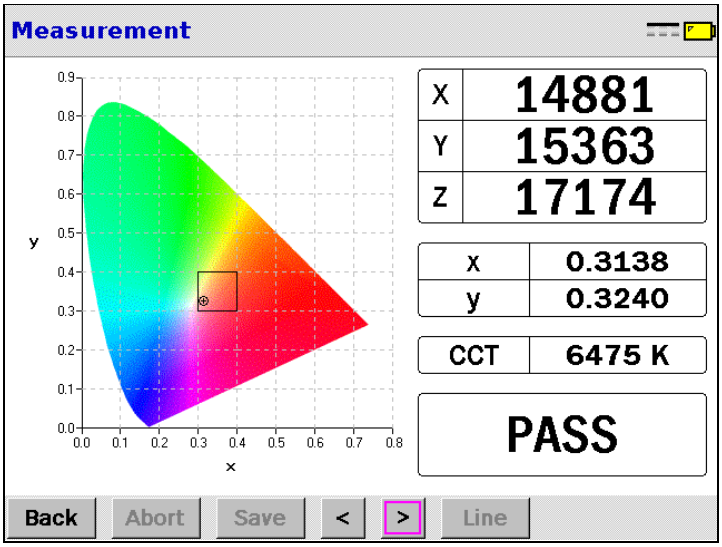
5. Following the measurement, touch the **< >** icons at the bottom of the result screen to scroll to the CIE diagram screen. **Pass** or **Fail** appears in the lower right hand corner of the screen.











ELLIPSES (OR CIRCLES)

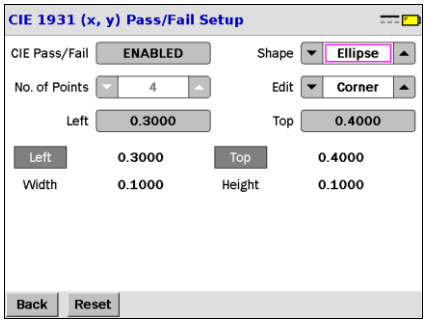
The process for defining an ellipse or square is very similar to defining a rectangle or square. Essentially, a box or rectangle is defined, and the PR-7XX creates an ellipse or circle inside the box.

Note: To define a circle, the Width and Height values must be identical. For a horizontal ellipse, the Width value must be larger than the Height value, and for a Vertical ellipse, the Height value must be larger than the Width value.

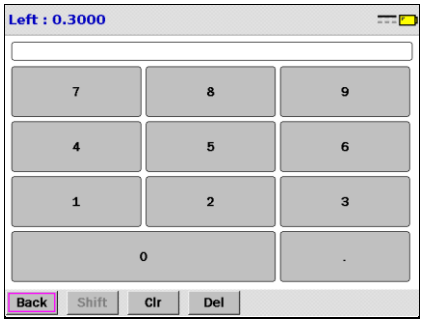
1. Touch the field adjacent to **CIE Pass / Fail** so that it reads **Enabled.**
2. Touch the ▼▲ icons in the **Shape** field until **Ellipse** appears.
3. Define the Upper Left Corner by:
    a. Touching the ▼▲ icons in the **Edit** field until **Corner** appears.

b. Touch the gray field next to **Left** to display the data entry field for the **Upper Left CIE 1931 x** coordinate.
c. Enter the value (including the decimal point) then touch **Back.** This value is the **absolute position** of the x coordinate in the CIE 1931 diagram.
d. Touch the gray field next to **Top** to display the data entry field for the **Upper Left CIE 1931 y** coordinate.
e. Enter the value (including the decimal point) then touch **Back.** This value is the **absolute position** of the y coordinate in the CIE 1931 diagram.

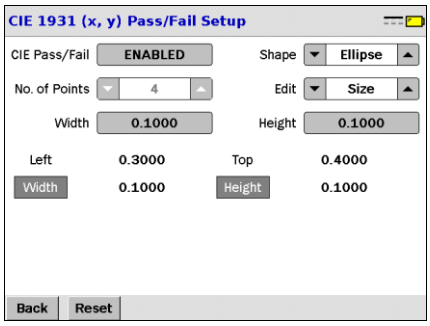
4. Define the **Size** by:
   a. Touching the ▼▲ icons in the **Edit** field until **Size** appears.
   b. Touch the gray field next to **Width** to display the data entry field for the **Lower Right CIE 1931 x** coordinate.
   c. Enter the value (including the decimal point) then touch **Back.** This value is the **distance** from the Top Left x coordinate in Step 3c.
   d. Touch the gray field next to **Top** to display the data entry field for the **Lower Right CIE 1931 y** coordinate.
   e. Enter the value (including the decimal point) then touch **Back.** This value is the **distance** from the Top Left y coordinate in Step 3e.



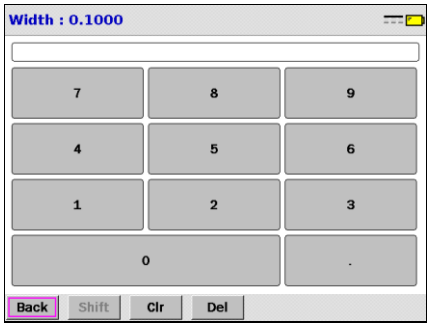
→

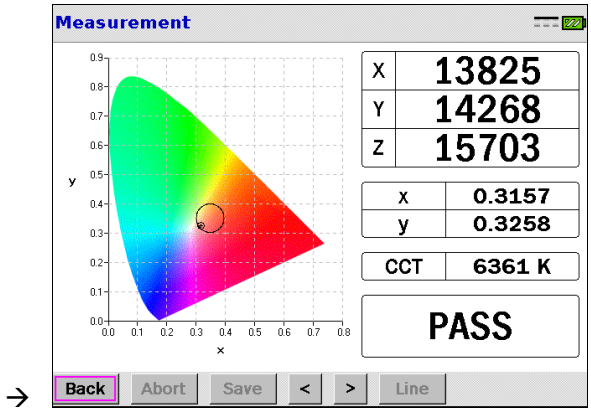


→



→





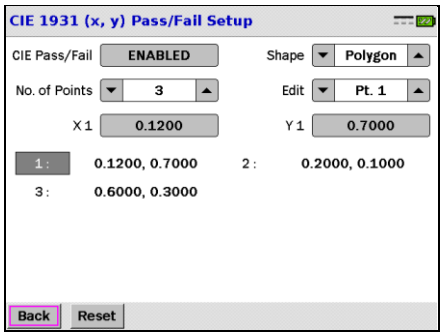
→ Following the measurement, touch the **< >** icons at the bottom of the result screen to scroll to the CIE diagram screen. **Pass** or **Fail** appears in the lower right hand corner of the screen.

POLYGONS

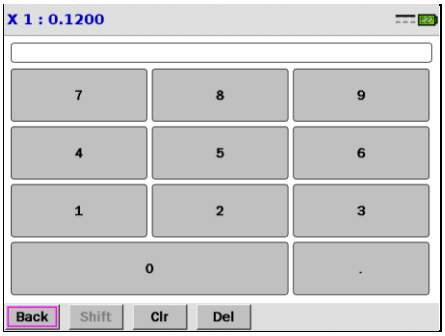
A polygon is generally described as a shape with three or more straight lined sides. The Pass / Fail option provides a method of creating polygonal acceptance regions with up to 10 sides. This can be a useful tool to, for example, define a color gamut and determine whether the sample falls within that gamut.

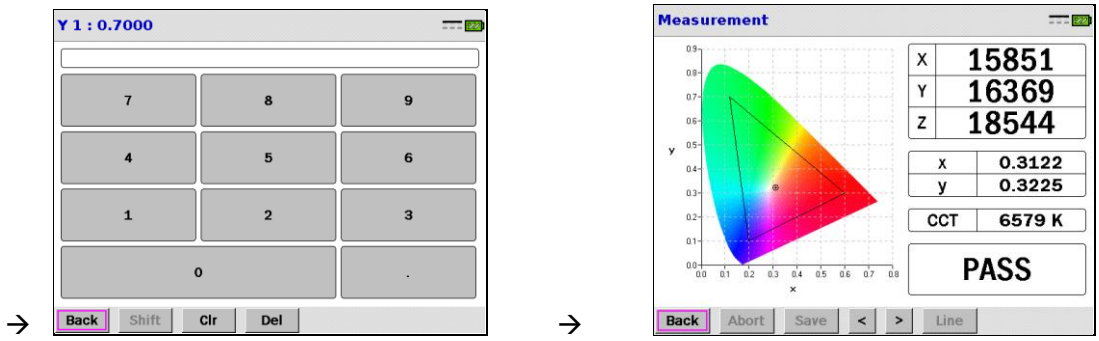
1. Touch the field adjacent to **CIE Pass / Fail** so that it reads **Enabled.**
2. Touch the ▼▲ icons in the **Shape** field until **Polygon** appears.
3. Select the number of points to define by touching the ▼▲ icons adjacent to the **No. of Points** field. The Range is 3 to 10 points.
4. Touch the ▼▲ icons next to the **Edit** field until **Pt. 1** (Point 1) appears.
5. Touch the gray field next to **X1** to access the data entry screen. Enter the CIE 1931 x value for Point 1 (including the decimal point) and then touch **Back**.
6. Touch the gray field next to **Y1** to access the data entry screen. Enter the CIE 1931 y value for Point 1 (including the decimal point) and then touch **Back**.
7. Repeat **Steps 4 – 6** for all remaining points.

Note: The PR-7XX automatically connects the first point (Point 1) to the last point (Point 3 in the example),



→





8. Following the measurement, touch the **< >** icons at the bottom of the result screen to scroll to the CIE diagram screen. **Pass** or **Fail** appears in the lower right hand corner of the screen.

USER PROFILES

Many measurement applications require a specific set of instrument and preference parameters. The **User Profiles** allows you to save up to 10 unique different sets of settings. Some of the saved information includes:

- Instrument setup parameters – aperture, accessory, bandwidth (when applicable), sensitivity type (standard or extended, speed mode, Frequency and Smart Dard Status.
- Preferences including Power Saving mode, Brightness and Contrast, Sounds and Alerts, Advanced Setup Parameters and more.

HOW TO SAVE A USER PROFILE

1. Touch ***Setup***.
2. Touch ***User Profiles*.**
3. The **User Profile** dialog appears.
4. Touch the ▼▲ icons adjacent to the **Profile Name** filed to scroll through User Profile data sets.
5. Touch **Save** to save the setting to the selected profile.

Warning: Saving a profile will overwrite any information currently stored under that profile name.

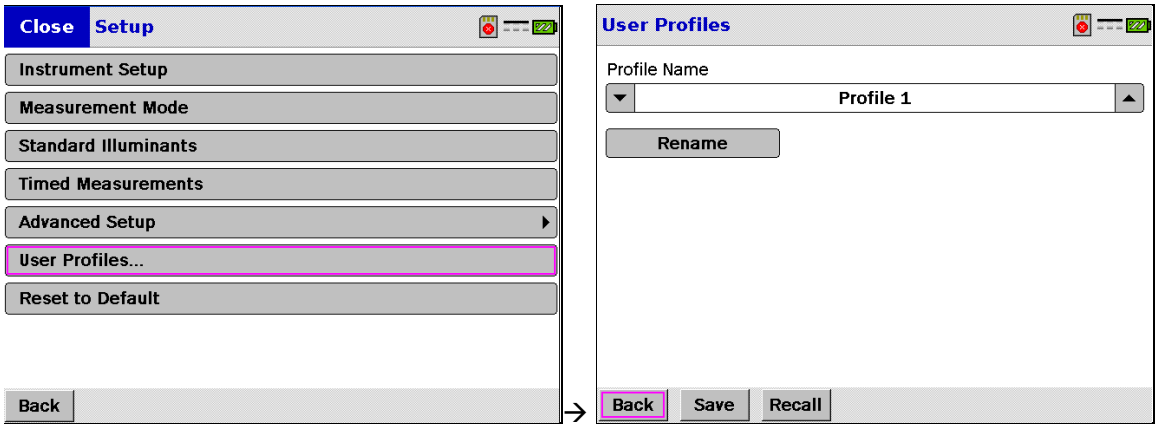
HOW TO RENAME A PROFILE

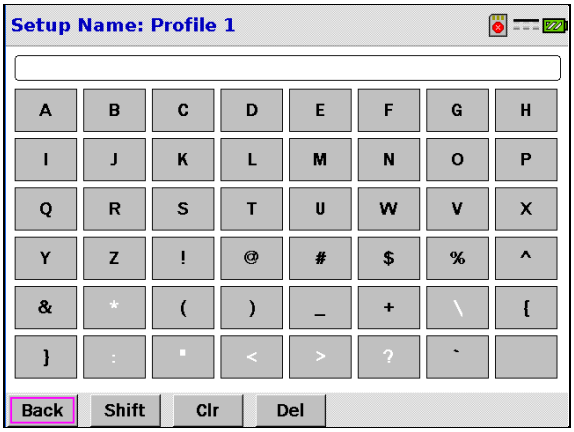
1. Touch the ▼▲ icons adjacent to the **Profile Name** filed to scroll through User Profile data sets.
2. When the target profile name of appears touch ***Rename.***
3. In the dialog, enter the new name of the profile (16 characters max - use the blank square to create a space) by touching the appropriate letter on screen.
4. Touch **Back** when finished.

HOW TO RECALL A PROFILE

1. Touch the ▼▲ icons adjacent to the **Profile Name** filed to scroll through User Profile data sets.
2. When the target profile name of appears touch ***Recall.***

Note: If the selected profile does not contain a saved data set, *Recall* will be grayed out.





RESET TO DEFAULT

Use this feature when you wish to clear all current user set instrument setup and preference. This does not affect any user profiles.

HOW TO RESET TO DEFAULT

1. From the **Setup Menu,** touch ***Reset to Default.***

Warning: **This will clear all current custom setup conditions on the PR-7XX.**

Chapter - 6 UTILITIES FUNCTIONS

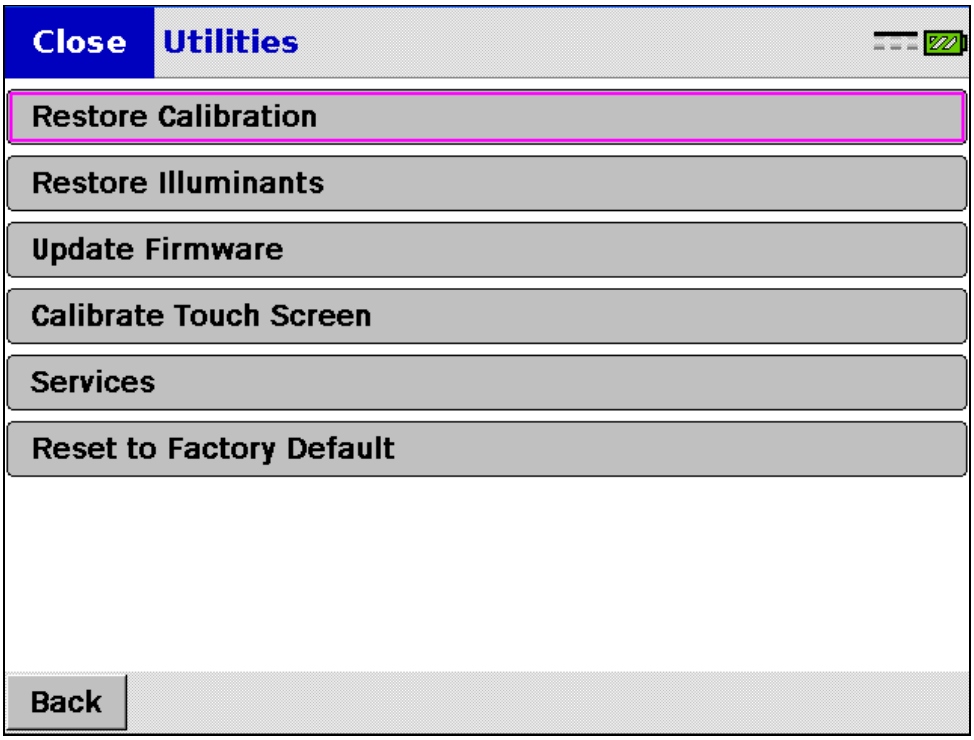


FIGURE 62 - UTILITIES MENU

The Utilities functions include, in addition to calibrating the touch screen described earlier, seldom used features such as **Restoring the Calibration files**, **Restoring Standard Illuminants** and **Updating Firmware**. The **Services** item is not user accessible.

HOW TO RESTORE CALIBRATION/ILLUMINANT FILES

Warning: **This procedure will delete all files and standard illuminants!**

REQUIREMENTS:

1. Secure Digital (SD) card.
2. SD card reader.
3. ZIP file with calibration/standard illuminant information from Photo Research.

RESTORE PROCEDURE

1. Insert a 512 MB SD card into a PC or a USB card reader connected to a PC.
2. Copy all calibration and illuminant files (contact Photo Research to obtain these files) to the SD card.
3. Power on the PR-7XX.
4. Insert the SD card into the instrument.
5. Touch ***Menu.***
6. Touch ***Utilities.***

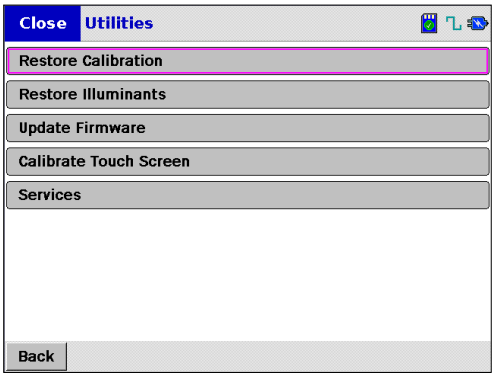


FIGURE 63. PR-7XX UTILITIES MENU.

7. Touch ***Restore Calibration*** to restore all calibration files. If restoring standard illuminants , touch ***Restore Illuminants*** .
8. Once the restore process is successfully completed the instrument will power down.
9. Power on the instrument using the **0/1** key.

Note: If any errors occur during this restore process consult Photo Research immediately.

HOW TO UPDATE THE FIRMWARE

The firmware can be easily updated in the field. Simply insert the SD card with the latest firmware revision and instruct the instrument to update.

Warning: This procedure will delete all current configuration settings!

Note: Calibration and Illuminant factors *DO NOT* have to be restored after a firmware update.

REQUIREMENTS

SECURE DIGITAL (SD) CARD.

1. SD card reader.
2. Latest firmware PR6XXHW.hex file from Photo Research.

UPDATE PROCEDURE

1. Insert a 512 MB SD card into a PC or a USB card reader connected to a PC.
2. Copy the file **PR6xxHW.HEX** supplied by Photo Research to the SD card.
3. Power on the PR-7XX.
4. Insert the SD card.
5. Touch ***Menu.***
6. Touch ***Utilities.***
7. Touch ***Update Firmware***.
8. In the confirmation screen that appears, touch ***Yes*** to continue, or ***No*** to return to the ***Utilities*** menu.

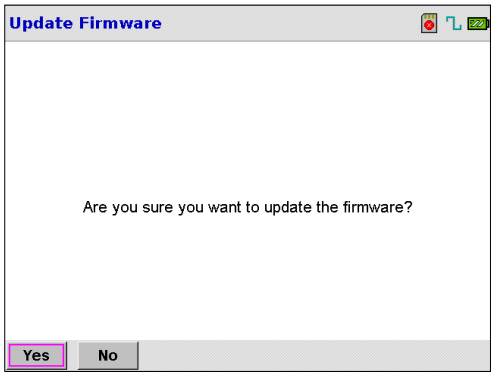


FIGURE 64 - PR-7XX FIRMWARE UPDATE PROMPT.

9. Select **Yes** to update the firmware, **No** to escape without updating.
10. At the screen that appears following the completion of the update, touch ***OK*** to restart the instrument and initialize the new firmware.

Chapter - 7 FILE SETTINGS

The ***File Settings*** options pertain to accessing the Secure Digital (SD) card installed in the card slot of the PR-7XX. If no card is inserted in the slot, these options are not available for change and are grayed out. The ***File Settings*** option allows the user to setup the following features:

Note: Up to 1000 measurements can be stored to a single file name.

- ***Auto Save*** – Allows files to be automatically saved to an SD card (when available).
- ***SD File Field*** - Select measurement file to store measurements to.
- ***New File / Rename / Delete*** measurement files.
- ***Save unsaved measurements to SD card on shutdown*** if measurements exist in RAM.

HOW TO ACCESS THE FILE SETTING SCREEN

1. Touch ***Menu***.
2. Touch ***File Settings***.
3. Touch ***Back*** to exit to the ***Main Manu*** after all options have been selected.

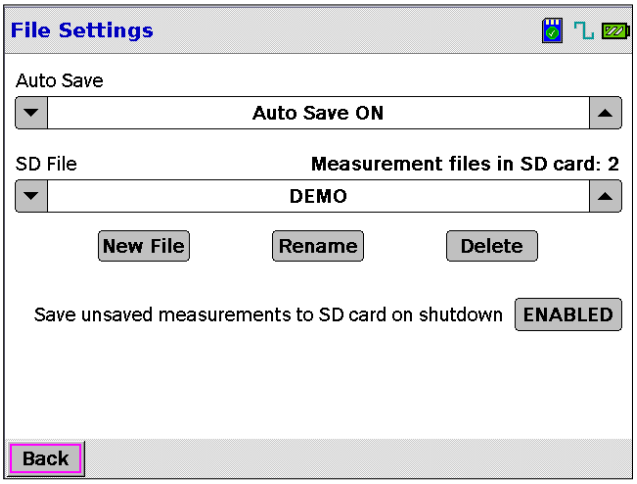


FIGURE 65 - SECURE DIGITAL CARD FILE SETTINGS.

AUTO SAVE

With **Auto Save** set to ON, measurements are automatically saved to the file name in the ***SD File*** field.. Use the ▼or ▲ icons to toggle between *Auto Save **ON*** or *Auto Save **OFF***.

SD FILE FIELD

The ***SD File*** field shows the current measurement file name that measurements are being saved to when ***Auto Save*** is enabled, or when a manual **Save** operation is executed from the measurement result screen..

1. The ▼or ▲ icons are used to scroll through the available file names until the file of choice appears.
2. To create a new file, use the New File function. Refer to the *How to Create a New Measurement File* section for information. If no SD card is present the ***SD File*** field will show the last accessed file (grayed out).

3. If the last accessed measurement file does not exist on the SD card, the following prompt will appear:

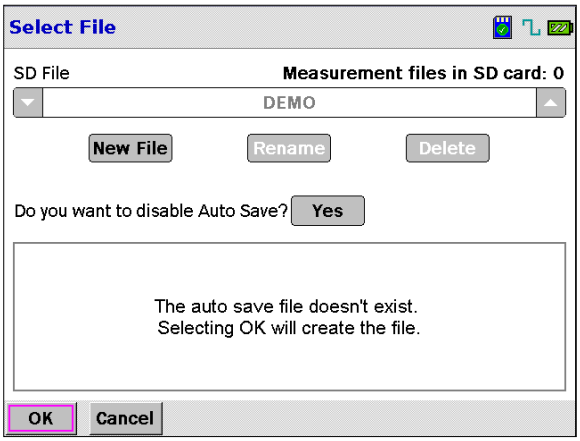


FIGURE 66 - MEASUREMENT FILE DOES NOT EXIST ON SD CARD.

4. To create the file touch ***OK.***

   OR

   To create a new measurement file touch **New File**.

   If **Cancel** is touched the *Select File* screen will appear after every measurement unless ***Auto Save*** is disabled, or until a valid filename appears in the ***SD File*** field..

How to Create a New Measurement File

Multiple measurements files with up to 1000 measurements per file can be saved on the SD card. The file name can be up to 8 characters long with no spaces or extensions.

To Create a new file:

1. Touch **New File**.
2. Enter the desired file name – 8 characters max with no extension. As the characters are touched, they appear in the window at the top of the screen. Touch Shift to display a second set of characters as shown in following example.

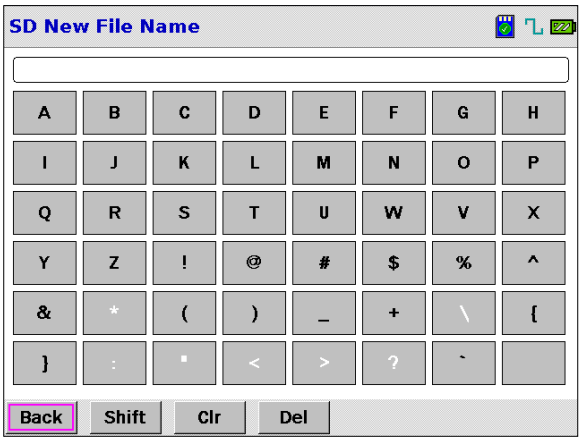


FIGURE 67 - SD CARD NEW MEASUREMENT FILE NAME ENTRY.

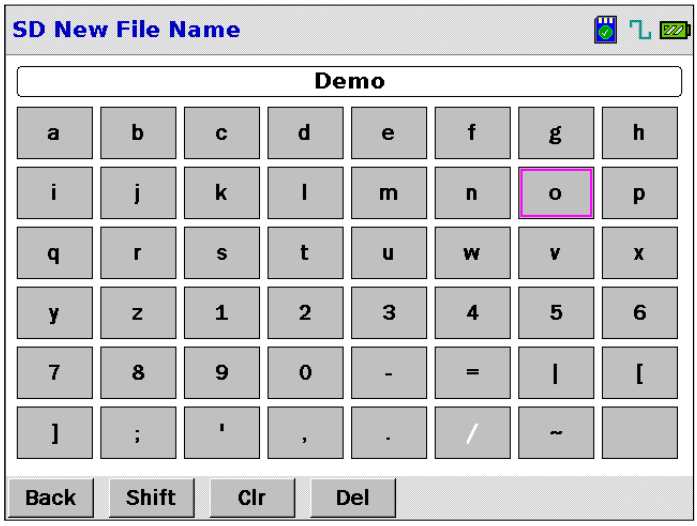


FIGURE 68 - SECOND CHARACTERS SET.

3. Touch ***Back*** to finish and save the file.
4. From this point as long as ***Auto Save*** is enabled, all measurements are saved to the selected file.

How to Delete a Measurement File

To delete a measurement file:

1. Insert the SD card with the measurement file to be deleted.
2. Select the desired file to be deleted in the ***SD File*** field using the ▼or ▲ icons.
3. Touch Delete.

Warning: All measurements in the file will be lost.

How to Rename a Measurement File

1. Insert SD card with the measurement file to be renamed.
2. Select the desired file to be renamed in the ***SD File*** field using the ▼or ▲ icons.
3. Touch Rename.
4. Enter the new name for the file.

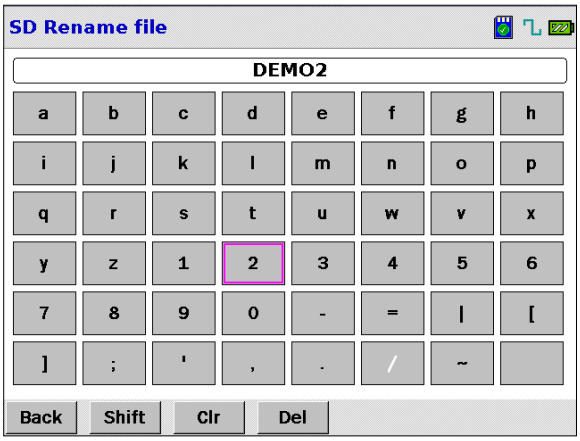


FIGURE 69 - MEASUREMENT FILE RENAME.

5. Touch ***Back*** to complete the process.

How to Set Auto Save on Shutdown

When ***"Save unsaved measurements to SD card on shutdown"*** is enabled the instrument will prompt the user to save all measurements in RAM to the SD Card before shutting down. The user will have 5 minutes (300 sec) to select one of the following options.

1. To save measurements on SD card, touch ***Yes.***
2. To shut down without saving, touch ***No.***
3. To go back to the previous menu and not shut down, touch ***Cancel.***

This prompt will not appear if ***Auto Save*** is enabled, as the measurements are automatically stored following a measurement.

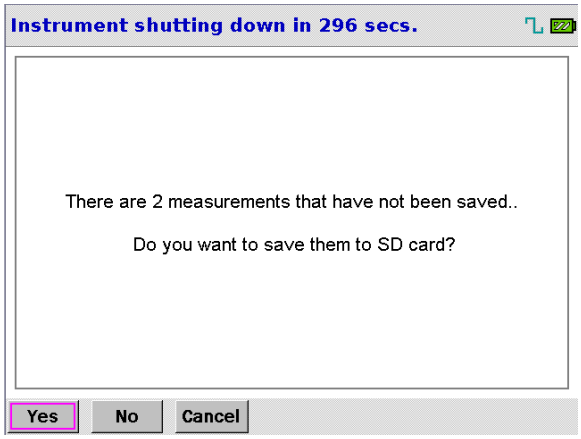


FIGURE 70 - AUTO SAVE ON SHUTDOWN PROMPT.

If no decision is made within 300 seconds (5 min) the instrument will power down and all current measurements will be lost.

Chapter 7 – File Settings

Explorer Settings

Explorer Settings determine the memory location (Internal RAM or External SD card) and file name (if SD is selected) for viewing stored measurements.

Accessing the Explorer Settings Screen

Step 1) Touch ***Menu***.
Step 2) Touch ***Explorer Settings***.

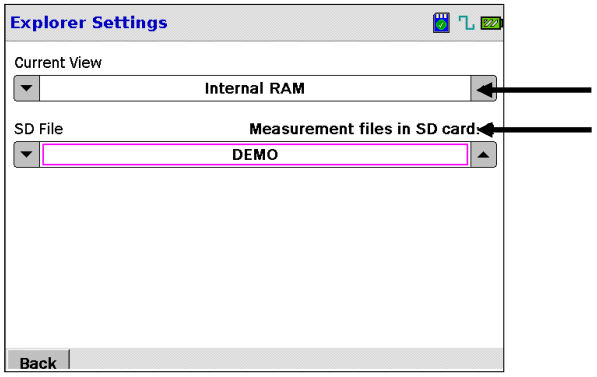


FIGURE 71 - EXPLORER SETTINGS.

Current View

The ***Current View*** option selects the memory location (Internal RAM or External SD). Touch the ▼ or ▲ icons to toggle between *Internal RAM* and *External SD Card*.

SD File

If ***External SD Card*** has been selected as the ***Current View***, the user can select a measurement file to view in the ***File Explorer***. The measurement file can be selected by touching on the ▼ or ▲ icons. Once the desired measurement file has been selected simply navigate back to the ***File Explorer*** to start viewing the measurements contained in the file.

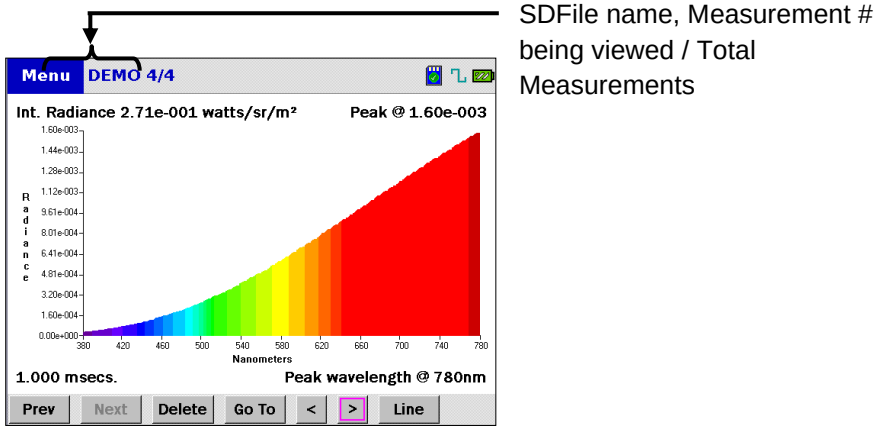


FIGURE 72. FILE EXPLORER.

Chapter 7 – File Settings

How to Recall measurements stored on the SD card

Measurements stored on the SD card can be recalled in three ways.

1. Using the explorer settings, see section for more information,
2. Using SpectraWin 2 (optional) ***Import*** feature, refer to SpectraWin 2 manual for more information
3. Using the in-built ***Remote Control Mode*** capability, see Remote Control Command Detail section for more information.

Measurement Types

The PR-7XX can make of measurements of different radiometric and photometric units depending on the type of accessory being utilized. They include Lumens (Watts), Luminous Intensity (Radiant Intensity), Luminous Flux (Radiant Flux) Luminance (Radiance) and Illuminance (Irradiance). The most typical measurement is one of radiance in watts / steradian / meter² and luminance in footlamberts and cd/m².

Luminance / Radiance

Luminance is defined as luminous flux (lumens) per solid angle (steradians) per unit area being emitted in a given direction and is calculated from *Radiance (watts/steradian/meter²).*

The SI equation for luminance is *cd/m² (lumens/steradian/meter²)*. The English equivalent is *footlamberts (1/π lumens/steradian/foot²)*. The relationship between cd/m² and footlamberts is:

1 footlambert = 3.426 cd/m².

Luminance is measured whenever it is desirable to know the photometric brightness of self-emitting devices, transmissive objects or a surface upon which light is being reflected. Typical applications include display brightness, projector screen brightness etc. Ideally, the object being measured exhibits a uniform emittance pattern over the entire emitting surface.

Luminance measurements using the PR-7XX are made with any of the objective lenses, or with the fiber probe (FP-730) or with the luminance probe (LA-730) only. The lenses include the MS-75, SL-0.5X, SL-1X, SL-2.5X and SL-5X.

In the following example, let's say a projector screen or reflectance standard such as the RS-3 or SRS-3 or equivalent, the light incident on the surface is illuminance, and the light being reflected from the surface is luminance.

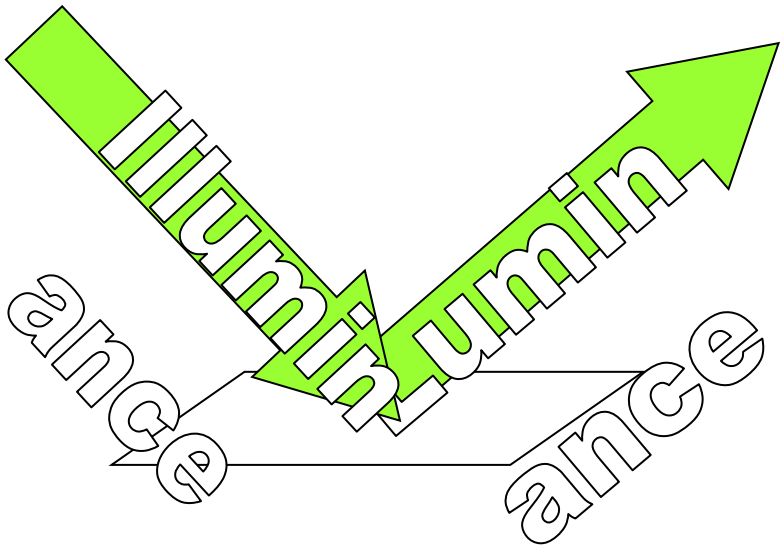


FIGURE 73 - ILLUMINANCE / LUMINANCE CONCEPT

Chapter - 8 How to Make a Luminance / Radiance Measurement

If using an objective lens, the first step is to align and focus the optical system (lens and eyepiece) on the target.

FIGURE 74 - MS-75 LENS

Using an Objective Lenses

Aligning and focusing the Optical System

1. If using the MS-75, make sure the target is out of focus by defocusing the lens. If using a fixed focus lens, such as the MS-2.5X, move either the target or instrument until the target is out of focus.
2. Turn the eyepiece until the measuring aperture (black spot in the center of the field of view) is in sharp focus. If the entire aperture does not focus simultaneously, make sure the **top** and **bottom** of the aperture are in focus.
3. Focus on the target. If using the MS-75 lens, rotate the lens focusing ring until the target is in focus. If using a fixed focus lens, move either the instrument or the target until sharp focus is achieved. **Do not use the eyepiece adjustment to focus on the target.**
4. Make sure the measuring aperture falls within the lit area of the target. Failure to adhere to this step will result in erroneous readings. If possible, or unless otherwise specified, we recommend that the diameter of the aperture cover 50% to 80% of the smallest dimension of the object (e.g. character '1' in Figure 75).

Correct Incorrect

FIGURE 75 - APERTURE ALIGNMENT

5. From the **Instrument Setup** menu, touch the ▲ ▼ icons adjacent to *Primary Accessory* until the lens currently installed appears.
6. Make any other changes in the *Setup* menu such as *Sensitivity, Speed, Average* etc. See Chapter - 5 Setup Menu for full details.
7. Touch the **MEASURE button** to begin a measurement.

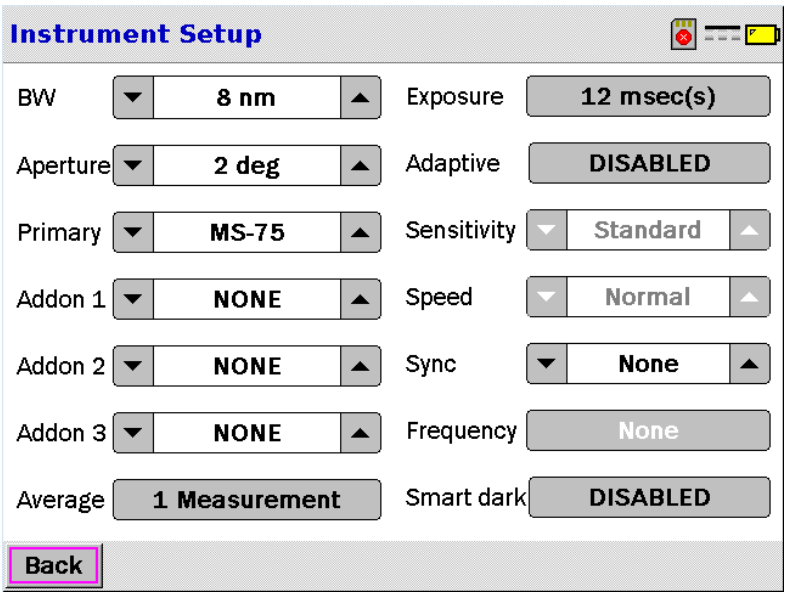


FIGURE 76 - INSTRUMENT SETUP MENU

Chapter 8 – How to Make a Luminance / Radiance Measurement

USING THE FP-730

FIGURE 77 - FP-655 / FP-670

The FP-730 Flexible Probe enables the PR-7XX to measure surface luminance and radiance of backlit sources (e.g. cathode ray tubes, fluorescent lamps and self-luminous displays) that can be placed in contact with the tip of the Probe.

The Flexible Probe is particularly useful for measuring in nearly inaccessible locations. The probe consists of a 24-inch (0.6 meter), flexible fiber bundle and a threaded mounting adaptor. 4 foot and 10 foot versions are available – contact Photo Research for details.

It can also be used to approximate the luminance of more distant sources, averaged over a circular field. The acceptance angle of the probe is approximately 30° at the half-power points and 50° at the 10% response points. The measuring area is 0.125 inch (3 mm) in diameter when the tip of the probe is placed in contact with a Lambertian source.

Warning: **The FP-730 is not recommended for use when measuring LCDs as the act of coming in contact with the device may distort the surface and yield erroneous readings and may cause damage to the display.**

1. Remove the MS-75 Objective lens or other primary accessory by turning it counterclockwise.
2. Install the FP-730 by screwing in clockwise. **Do not over-tighten!**
3. From the **Instrument Setup** menu, touch the ▲ ▼ icons adjacent to *Primary Accessory* until **FP-730** appears. Note that only the largest aperture can be used for this accessory. The instrument will automatically set the **Aperture** selection to the largest system configured aperture.
4. Make any other changes such as *Sensitivity, Speed, Average* etc.
5. Place the front surface of the probe tip in contact with the target. Make sure it is within the lit area of the device under test.
6. Touch the **MEASURE button** to begin a measurement.

Chapter 8 – How to Make a Luminance / Radiance Measurement

USING THE LA-730 LUMINANCE ADAPTOR

FIGURE 78 - LA-730 LUMINANCE ADAPTOR

The Luminance Adaptor enables the PR-7XX to measure surface luminance and radiance of backlit sources (e.g. cathode ray tubes, fluorescent lamps and self-luminous displays) that can be placed in contact with the rubber cup of the Adaptor. It can also be used to approximate the luminance of more distant sources, averaged over a circular field. (The acceptance angle of the adaptor is approximately 12.5° at the half-power points and 14° at the 10% response points. The measuring area is 0.52 inch (13.2 mm) in diameter when the cup of the accessory is placed in contact with a Lambertian source. It features an ambient light shield which eliminates room lighting from affecting the measurement.

Warning: **The LA-730 is not recommended for use when measuring LCDs as the act of coming in contact with the device may distort the surface and yield erroneous readings and may cause damage to the display.**

1. Remove the MS-75 Objective lens or other accessory by turning it counterclockwise.
2. Install the Luminance Adaptor by screwing in clockwise. **Do not over-tighten!**
3. From the **Instrument Setup** menu, touch the ▲ ▼ icons adjacent to *Primary Accessory* until **LA-730** appears.
4. Make any other changes such as *Aperture*, *Sensitivity, Speed, Average* etc.
5. Place the front surface of the rubber cup of the Luminance Adaptor in contact with the target. Make sure it is within the lit area or the device.
6. Touch the **MEASURE button** to begin a measurement.

Chapter - 9 How to Make an Illuminance / Irradiance Measurement

Illuminance / Irradiance

Illuminance is defined as the density of luminous flux incident on a surface, or light falling on a surface per area, and is calculated from *Irradiance (watts/meter²)*. Three factors help determine illuminance: the luminous flux of the source, the angle of incidence of the light falling on the plane, and the distance from the source to the measured plane. Illuminance is given by *lux (lumens per meter²)* and *footcandles (lumens per foot²).* The relationship between footcandles and lux is: *1 footcandle = 10.76 lux.* In the following example, the light falling on the measured plane is the illuminance.

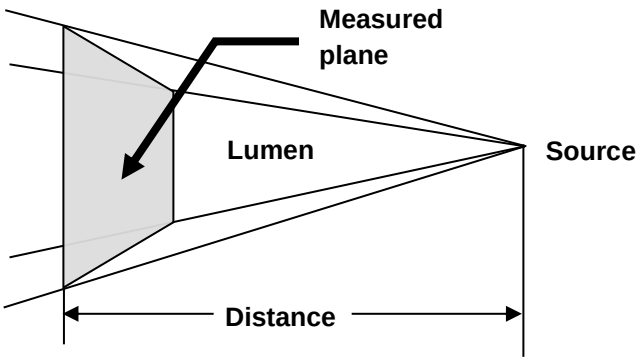


FIGURE 79 - ILLUSTRATION OF ILLUMINANCE

Illuminance measurements are made one of three ways with the PR-7XX. The first method involves the use of the CR-730 cosine receptor. The second method utilizes the use of a reflectance standard such as the RS-3 or SRS-3, and for the third method the ICC-730 integrating sphere accessory is employed.

The CR-730 is a diffuser that serves as the surface upon which the incident light falls. During calibration these accessories are photometrically calibrated using a standard lamp whose candela rating has been certified to NIST standards. By knowing the candelas of the lamp, the illuminance can be calculated by:

$$I = \frac{cd}{d^2}$$

EQUATION 5 - ILLUMINANCE FROM CANDELAS

Where: *I* = Illuminance in *lux* or *footcandles.*

d = Distance in feet (*footcandles*) or meters (*lux*).

Following a measurement, candelas can be calculated by:

$$cd = I * d^2$$

EQUATION 6 - CANDELAS FROM ILLUMINANCE

USING THE CR-730

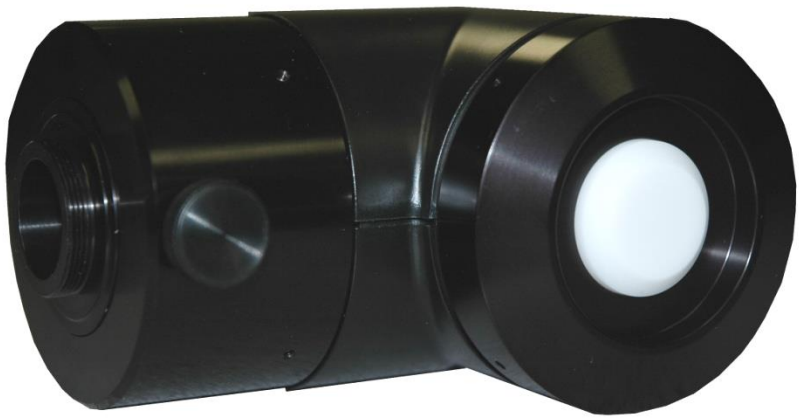


FIGURE 80 - CR-730

1. From the **Instrument Setup** menu, touch the ▲▼icons beneath *Primary Accessory* to scroll to CR-730, depending on the instrument being used. Make any other setup changes (exposure, sensitivity etc.) at this time. The instrument will automatically set the **Aperture** selection to the largest system configured aperture.
2. Remove the current *Primary Accessory* from the instrument turning the accessory counterclockwise.
3. To Install the CR-730:
    a. Loosen the thumb screw located near the mounting threads.
    b. Gently separate the mounting ring from the assembly. If the mounting ring does not readily separate, further loosen the thumb screw.
    c. Install the mounting ring on the instrument by threading clockwise into the PR-7XX lens mount. **Do not over-tighten!**
    d. Insert the main body of the accessory into the mounting ring.
    e. Rotate the receptor to the desired orientation and then tighten the thumb screw. **Do not over-tighten.**

4. Set the white diffuse surface of the CR-730 at the desired distance from the source.
5. Press the **MEASURE** button to begin a measurement.

USING THE RS-3 OR SRS-3 REFLECTANCE STANDARD

THE RS-3 Reflectance Standard has an absolute reflectance of 99% (± 1%) from 370 to 780 nanometers. Focusing the PR-7XX on the plaque allows the resultant luminance reading, in footlamberts (or candelas,meter²), to be converted directly into illuminance values, in footcandles (or lux). It can also be used to establish the 100% level for relative reflectance of materials or to measure the *Source* part of an L*a*b* or L*u*v* test of *Illuminated* samples.

The technique is based on the definition that in the English System, the luminance (in footlamberts) of a perfect Lambertian-diffusing surface is mathematically equal to the illuminance in footcandles which falls on its surface. In metric SI units, illuminance in lux, equals π (3.1416) * luminance (in cd/m²). $lux = \pi * cd / m^2$

This method of measuring illuminance/chrominance is most convenient when physical conditions necessitate *remote* source measurement, such as ambient light falling on a display surface. Since the illuminance measurement is made in the plane of the RS-3 plaque, the measuring instrument does not need to measure the source directly.

Never **touch the surface of the plaque. Any surface damage or discoloration will result in erroneous readings. Always keep the plaque cover closed when not in use.**

Refer to the Cleaning and Handling Instructions for the RS-3 (and SRS-3) at the end of this section.

MEASURING PROCEDURE

The procedure for making illuminance/chrominance, irradiance and reflectance measurements with the RS-3 plaque is as follows:

Remove the protective cover from the reflectance standard and set the reflecting surface in the plane in which it is desired to measure the illuminance/chrominance, irradiance or reflectance.

1. For direct single source measurements, set the reflecting surface of the RS-3 in the measurement plane.

OR

For display surface ambient light measurements, hold the RS-3 plaque against the display screen in the area to be measured.

2. Position the PR-7XX so that it is oriented at approximately 45° to the white surface of the plaque and is sufficiently close so that the measuring aperture is smaller than the image of the light falling on the plaque as seen in the viewfinder.

3. Place the PR-7XX on a sturdy tripod or other suitable support.

4. Align and focus the instrument on the reflecting surface of the standard. Make sure the measuring aperture is within the illuminated area on the plaque.

5. If taking L*u*v* or L*a*b* measurements, select the RS-3 (or SRS-3) as **Add-on Accessory 1** in the *Instrument Setup* menu.

Note: For reflectance measurements, it is not necessary to select RS-3 as an accessory since the measurements are *relative* rather than *absolute.*

6. Press the **MEASURE** button to make a measurement.

CLEANING AND HANDLING INSTRUCTIONS FOR THE RS-3 (AND SRS-3)

Use the following procedure to maintain the unique optical and reflectance properties of the Reflectance Standard. If the material becomes soiled, use a jet of clean dry air to blow the soil off, or rinse with distilled water. A soft bristle brush may be used.

OR

If the material becomes grossly contaminated or scratched, restore its original optical condition by sanding the surface under a stream of running water using a 220-240 grit waterproof emery cloth.

Sand until the surface is totally hydrophobic (water beads and runs off the material immediately).

Rinse with distilled water.

Note: If the emery cloth grit is too fine, the finish will be inadequate as the surface may become too smooth and reflect a high level of specular component (mirror image). Also, if the SRS-3 is refinished, it will be necessary to recalibrate if the standard for optimum accuracy.

Chapter 9 – How to Make an Illuminance / Irradiance Measurement

USING THE ICC-730 INTEGRATING SPHERE

FIGURE 81 - ICC-730 INTEGRATING SPHERE

The ICC-730 is a 3” (76.2 mm) integrating sphere with a 1 inch (25.4 mm) input port. A typical application is determining the illuminance of point sources such as lamps.

MEASURING PROCEDURE

1. From the **Instrument Setup** menu, touch the ▲▼icons beneath *Primary Accessory* to scroll to ICC-730. Make any other setup changes (exposure, sensitivity etc.) at this time (see Chapter - 5 - Setup Menu for more details).
2. Remove the current *Primary Accessory* from the instrument by turning the accessory counterclockwise.
3. Install the ICC-730 by turning clockwise. **Hand tighten only. Do not over-tighten!**
4. Set the front edge of the entrance port to the desired distance from the source. For the best results, the measuring port should be set so that it is perpendicular to the source.
5. Press the **MEASURE** button to begin a measurement.

Chapter - 10 LUMINOUS / RADIANT INTENSITY

Luminous Intensity is the luminous flux per unit solid angle in a given direction and is calculated from *Radiant Intensity (watts/steradian)*. It can be easily thought of as luminous flux (lumens) traveling through a cone (solid angle) in a given direction (for example the forward 180°). Luminous intensity is given in *candelas (lumens / steradian)* or *millicandelas* (1 candela = 1000 millicandelas).

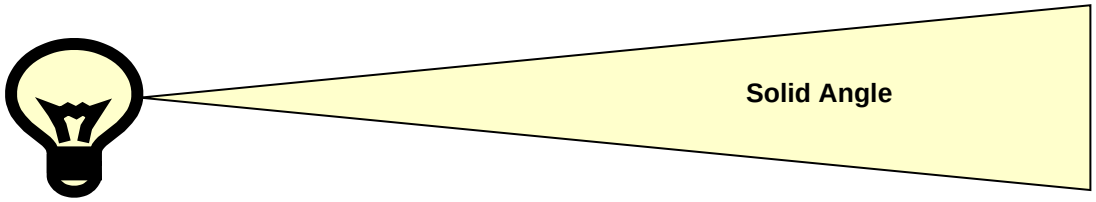


FIGURE 82 - ILLUSTRATION OF LUMINOUS INTENSITY

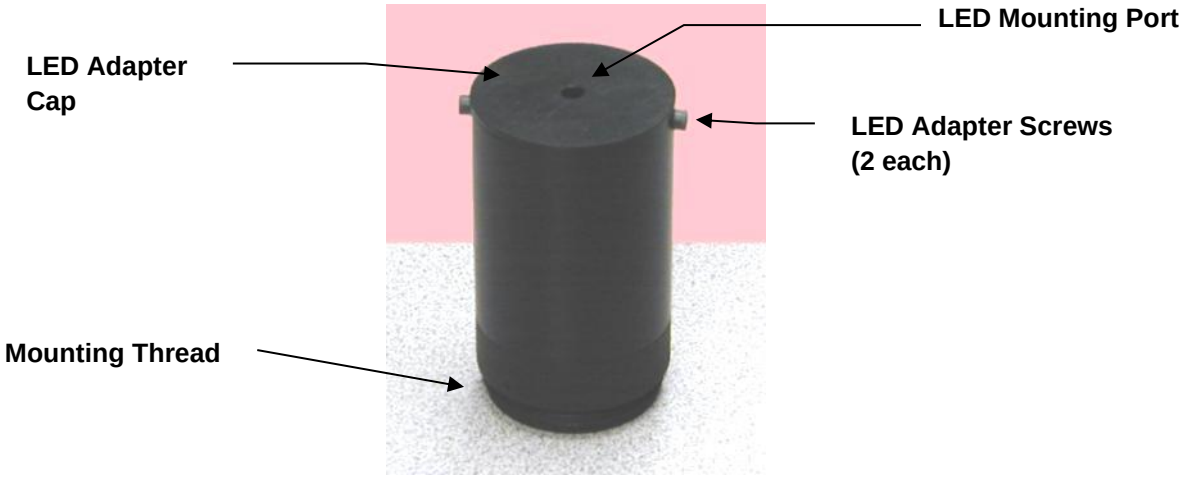


FIGURE 83 - LR-730 LED RECEPTOR

Typical applications for the measurement of luminous intensity include small lamps (in candelas) and LED's (millicandelas). For the measurement of luminous intensity, the PR-7XX can be equipped with the LR-730 LED Receptor. During calibration, these accessories are calibrated using sources where the precise area being sampled is used to calculate candelas as given by $candelas = cd / m^2 * area$ where *area* is the total emitting area of the source.

Chapter 10 – Luminous / Radiant Intensity

How to Make Luminous Intensity / Radiant Intensity Measurements

Description

The **LR-730 LED Receptor** enables the PR-7XX to measure the axial spectral radiant intensity (watts/steradian), luminous intensity (millicandelas), and color of light emitting diodes (LED's).

The **LR-730** consists of a 2.5 inch (63.5 mm) long tube with an LED port on one end and a mounting thread at the other end. The threaded end is installed into the lens mount of the PR-7XX.

During use, the LED's are inserted into the LED port at the open end of the accessory. Two different sized LED ports are supplied with the **LR-730**. One is designed to accept 0.118" (2.99 mm) diameter LED's, and the other accepts 0.205" (5.21 mm) diameter LED's.

Note: **Special adapters can be fabricated for LED's that do not exceed 0.275" (7 mm) in diameter. Contact Photo Research for details.**

Geometrical Considerations

The **LR-730** is designed to measure the emittance of LED's over an 8.3° acceptance cone.

It is important to note that since the intensity distribution of LED's varies with angle, LED's measured using acceptance cones other than 8.3° will produce different results. Generally, measurements through smaller cones will yield higher values, while LED's sampled over larger cones will produce measurements with lower radiant and luminous intensity values. Therefore, as part of the measurement report, it is important to note the acceptance cone sampled during the test.

Procedure - LED Adapter Cap Replacement

If it becomes desirable to switch LED Adapter caps supplied with the **LR-730**, proceed as follows:

1. Loosen and remove the two SAE 4-40 hex cap screws that secure the LED Adapter cap to the main tube.
2. Remove the LED Adapter cap.
3. Insert the new adapter cap making sure to align the threaded holes in the adapter with the through holes in the tube.
4. Replace and tighten the screws. ***DO NOT OVER TIGHTEN THE SCREWS!!***

Making Measurements

1. Remove the MS-75 lens or other accessory by turning counter clockwise.
2. Install the **LR-730** by threading it clockwise into the PR-7XX lens mount. **Do not over tighten.**
3. From the *Instrument Setup* menu, select **LR-730** from the Primary Accessory window by touching the ▲ or ▼ icons.
4. Insert the LED into the adapter port and allow at least a 5 minute warm-up (unless otherwise specified).
5. Make sure the LED is properly seated in the adapter.
6. Touch the **MEASURE button** to begin a measurement.

Chapter - 11 LUMINOUS / RADIANT FLUX

Luminous flux (given in lumens) is the basic unit of photometry and is calculated from radiant flux (given in watts). It represents the total luminous or radiant output of a source over 360°. Typical applications for luminous flux measurements include florescent or incandescent lamps and LEDs, where it is required to know the total output of the source.

The correct way to measure luminous (or radiant) flux is by utilizing an integrating sphere. Integrating spheres possess the ability of (as the name implies) integrating or homogenizing the light over the entire 360° emittance pattern of the device under test.

For the PR-7XX, the IS-730 integrating sphere is available for measuring the luminous and radiant flux of dual-lead LEDs.

OVERVIEW

FIGURE 84 - IS-730 OUTER VIEW

The IS-730 is a 3-inch sphere designed to measure the total luminous flux (lumens) or radiant flux (watts) of LEDs or other small sources such as miniature lamps. This accessory consists of a sphere with an internal baffle and LED Mounting Tube (See Figure 85). During operation, the LED is inserted into the interior end of the Mounting Tube, the Adjustment Screw is set so that the tip of the LED protrudes precisely 0.100 inches into the sphere, and the measurement is conducted. The power cables for the LED (plus and minus current) are connected via mini banana jacks located on the anterior end of the mounting tube.

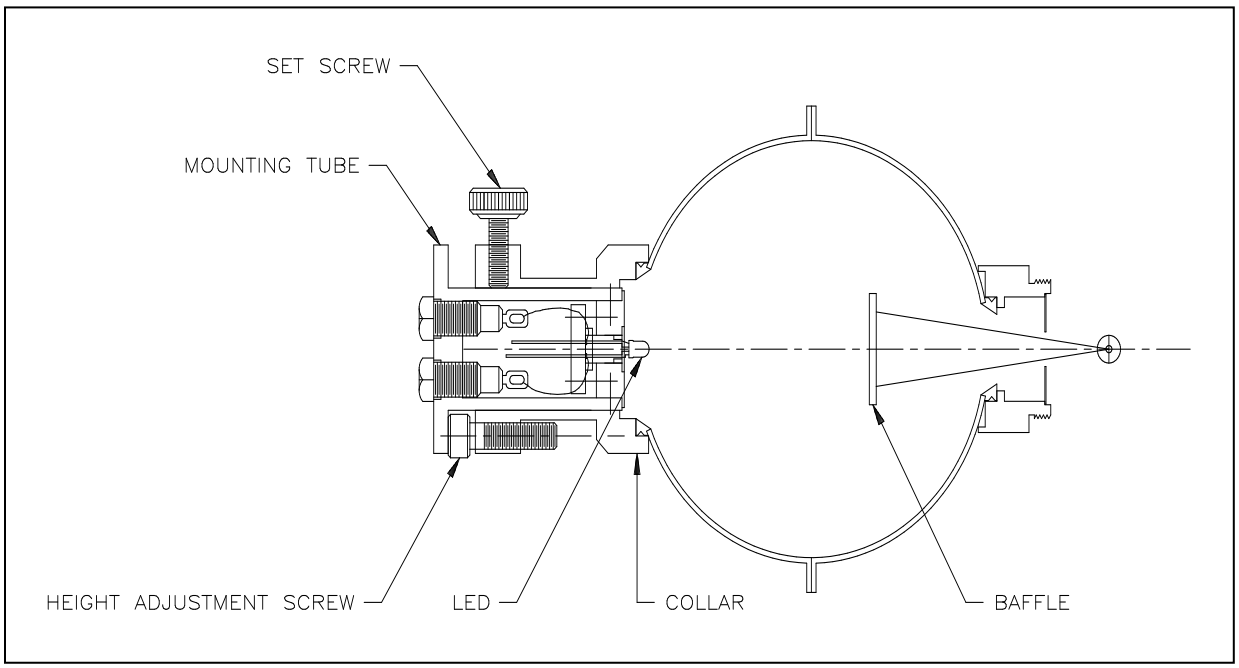


FIGURE 85 – IS-730 INTERNAL VIEW

INSTALLING THE IS-730

1. Remove the current optical accessory from the PR-7XX by turning counterclockwise.
2. Install the IS-730 by carefully threading clockwise into the C mount ring located in the front of the instrument. Make sure the threads turn freely when installing the IS-730.

MOUNTING THE LED

1. Loosen the Set Screw (see Figure 85) by turning it counterclockwise.
2. Remove the Mounting Tube from the Collar by gently pulling away from the sphere. If there is any resistance, further loosen the Set Screw.
3. Insert the leads of the LED into the two miniature sockets located on the interior end of the Mounting Tube. Push the LED in as far as possible. Take care to note the polarization of the leads. For simplicity, the POSITIVE LEAD should be inserted into the socket corresponding to the RED Banana Jack located on the opposite end of the Mounting Tube.

ADJUSTING THE MOUNTING TUBE HEIGHT

1. Referring to Figure 86 – IS-730 HEIGHT ADJUSTMENTposition the tip of the LED so that it is directly adjacent to the Height Adjustment Screw, and resting on the outside surface of the Collar.
2. Adjust the Height Adjustment Screw so that it is just touching the end of the Mounting Tube next to the LED.
3. Attach the LED current source (not supplied) to the Mounting Tube using appropriate miniature banana plugs paying attention to the polarity.
4. Supply the appropriate current to the LED and allow at least 10 minutes warm-up. Make sure the LED is properly lit.
5. Insert the Mounting Tube into the Collar until the Mounting Tube just touches the top of the Height Adjustment Screw.
6. Tighten the Set Screw to hold the Mounting Tube in place. **DO NOT OVER TIGHTEN!**

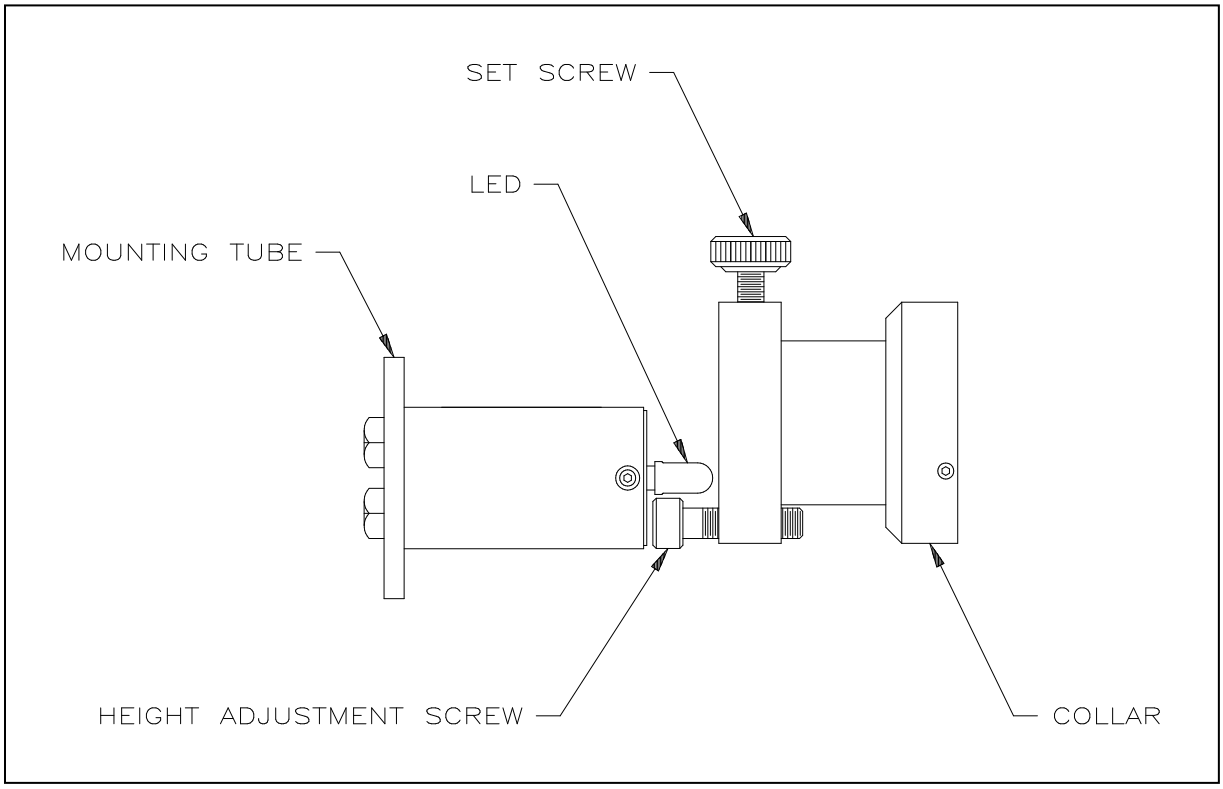


FIGURE 86 – IS-730 HEIGHT ADJUSTMENT

MAKING A MEASUREMENT

1. Touch MENU then Setup then Instrument Setup.
2. Touch the ▲ ▼ icons in the *Primary Accessory* field to select IS-730.
3. Press the MEASURE button to make a measurement.

Chapter - 12 CONNECTIVITY

USB

The PR-7XX is equipped with a Mini-B USB connector allowing for communication with the optional SpectraWin 2® software, or to control the instrument using Remote Mode commands.

INSTALLING THE USB DRIVER

Prior to using Remote Control commands or SpectraWin 2® software, the USB driver must be installed on your personal computer.

1. Turn on the PR-7XX.
2. Connect the PR-7XX to the PC via the USB interface cable.
3. The following screen will appear:

FIGURE 87 - NEW HARDWARE WIZARD.

4. Choose ***No, not at this time*** and click ***Next.***
5. Choose Install from a list or specific location (Advanced) and click Next.

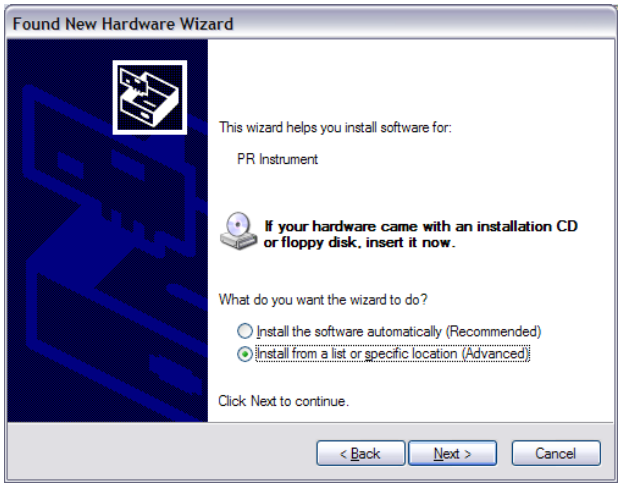


FIGURE 88 - PR-7XX USB DRIVER INSTALL.

6. Insert the CD supplied with PR-7XX into an appropriate CD drive.
7. Click ***Next.***
8. Clic***k on Continue Anyway***.

FIGURE 89 - WINDOWS COMPATIBILITY WARNING FOR PR-7XX USB DRIVER.

9. Open the **Device Manager.**
10. Click on **Ports (COM + LPT).**
11. Use the COM port for **PRInstrument** when connecting with SpectraWin or for programming Remote Mode commands.

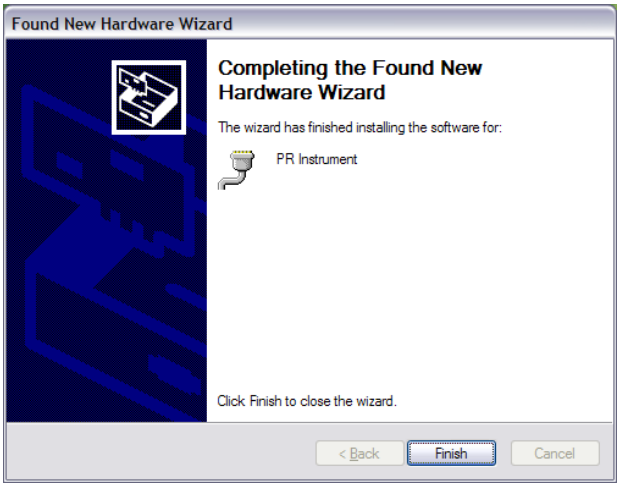


FIGURE 90 - PR-7XX USB DRIVER INSTALL COMPLETE.

USB Hub Type

Virtually all modern computers today supply current through the Universal Serial Bus (USB) hub to power external devices when necessary. Typically, the current supplied is 500 mA. Some external USB hubs supply only 100 mA or no current at all. The *USB Hub Type* option provides the means of selecting the power available to the instrument via the PC for charging the battery. If there is insufficient current available for the USB device (PR-7XX), Windows will issue a warning and the battery will not charge using the USB interface. Normal communications do not rely on the USB Hub Type setting.

Determining USB Hub Power (Windows 7 Only)

1. Type **Device Manager** in the PC search bar and open it.
2. Expand the **Universal Serial Bus controllers** selection by clicking on **>** icon.
3. Right click on **USB Root Hub**.
4. Click on **Properties**.
5. Click on **Power**. The **Total power available** is displayed as illustrated in *Figure* 91.

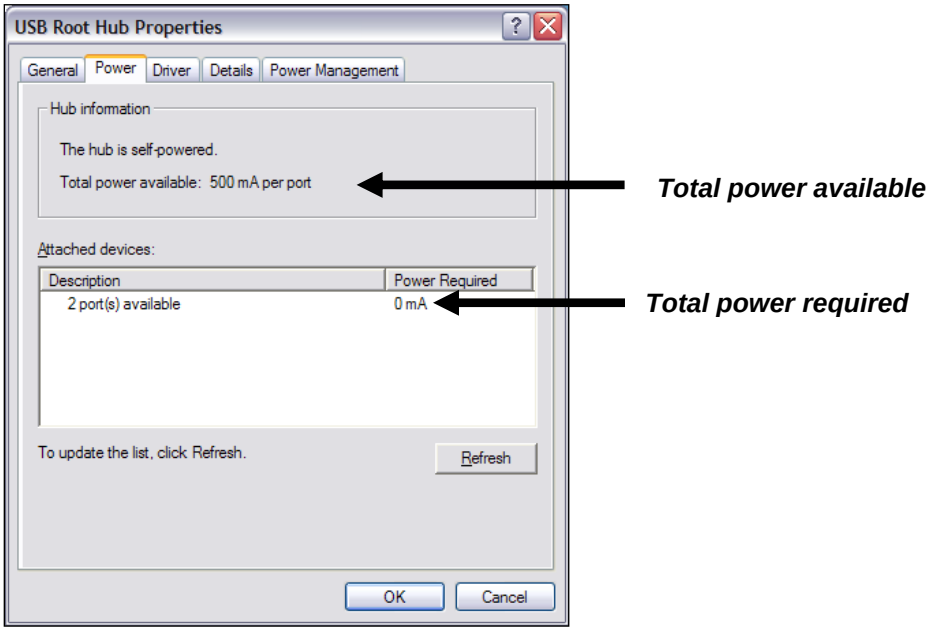


FIGURE 91 - USB POWER SCREEN

SETTING USB HUB TYPE ON THE PR-7XX

The **USB Hub Type** option can be accessed via the **Connectivity** preference option.

Navigate to ***Menu → Preferences → Connectivity***.

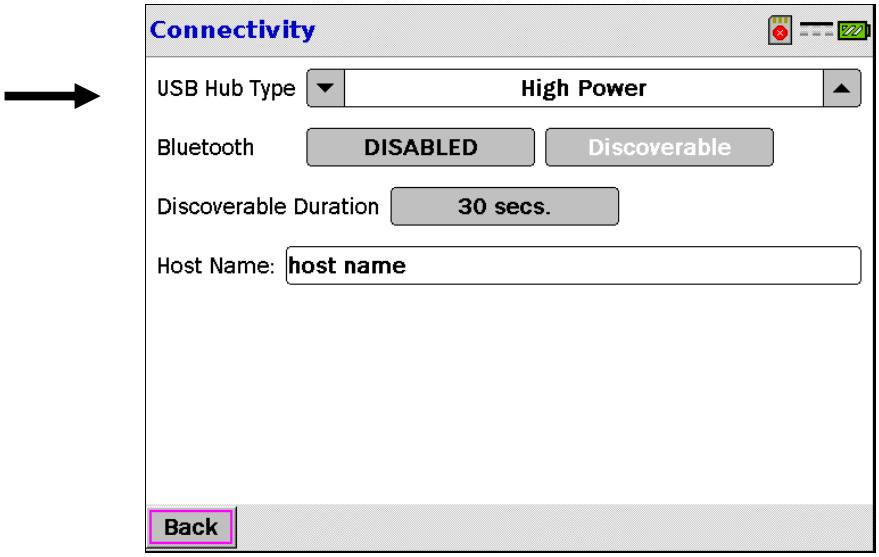


FIGURE 92 - USB CONNECTIVITY MENU.

No Power

Touch the ▲or ▼ icons adjacent to USB Hub Type until **No Power** appears. With No Power selected, the instrument runs entirely on the battery and draws no power from the USB hub the battery is not charged.

Low Power (100mA)

Touch the ▲or ▼ icons adjacent to **USB Hub Type** until **Low Power** appears. The battery charges slowly.

High Power (500mA)

Touch the ▲or ▼ icons adjacent to USB Hub Type until High Power appears. The battery is charged at the fastest rate.

Chapter 12 – Connectivity

RS-232 (OPTIONAL)

The traditional RS-232 I/F allows for interfacing to ATE environments and older generation PC systems. The below diagrams depicts the connection between the PR-7XX and the host computer. To establish a connection between the PR-7XX simply open the appropriate port (using the specified protocol settings) and enter "**PHOTO**", no other hardware handshakes are necessary.

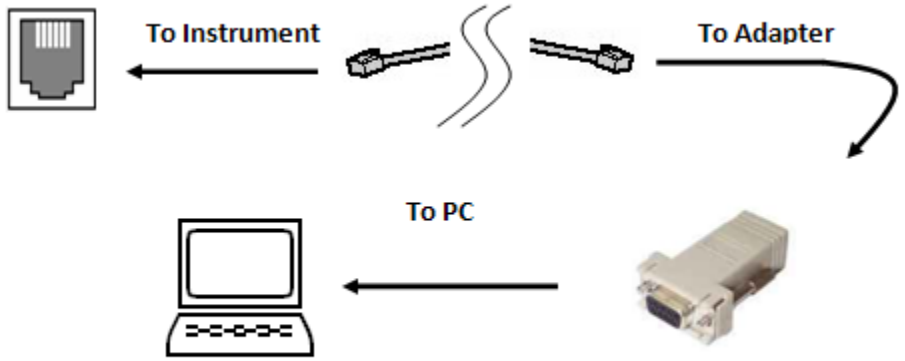


FIGURE 93 - PR-7XX RS-232 OPTION.

HARDWARE PROTOCOL

The RS-232 hardware protocol settings are:

- **Baud Rate**: Selectable (9600 bps, 19.2 Kbps 38.4 Kbps, 57.6 Kbps, 115.2[1] Kbps)
- **Parity**: None
- **Data Bits**: 8
- **Stop Bits**: 1

Selecting RS-232 Baud Rate

1. Navigate to **RS-232 Connectivity**, by touching on **Menu**, then **Preferences**.
2. Touch **RS-232 Connectivity.**
3. The following screen will appear.

[1] Default baud rate.

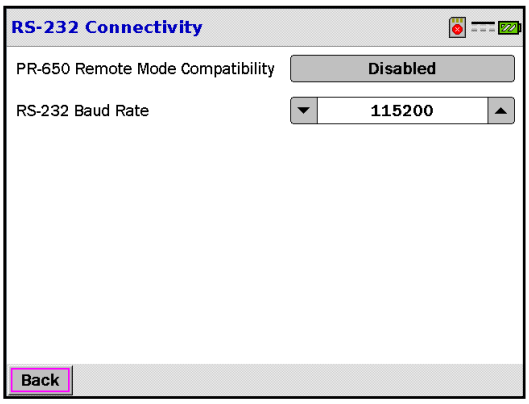


Figure 94 – RS-232 Connectivity, Baud Rate Setup.

4. Touch the ▲ ▼next to the **RS-232 Baud Rate** text field to select the desired speed.

Selectable Speeds:

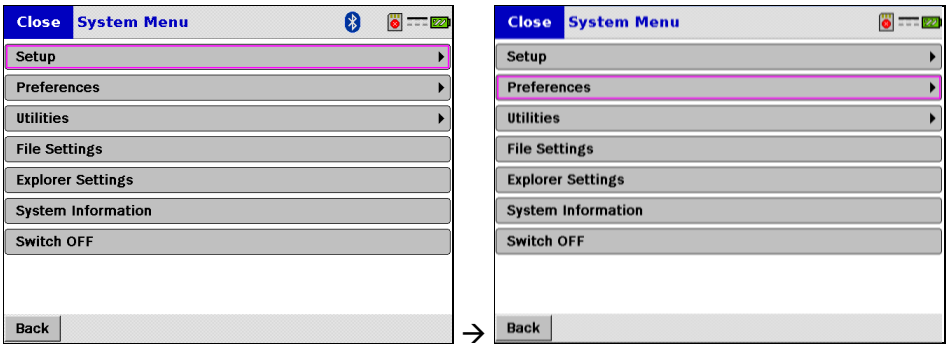
- 9600 bps
- 19.2 Kbps
- 38.4 Kbps
- 57.6 Kbps
- 115.2 Kbps (**default**)

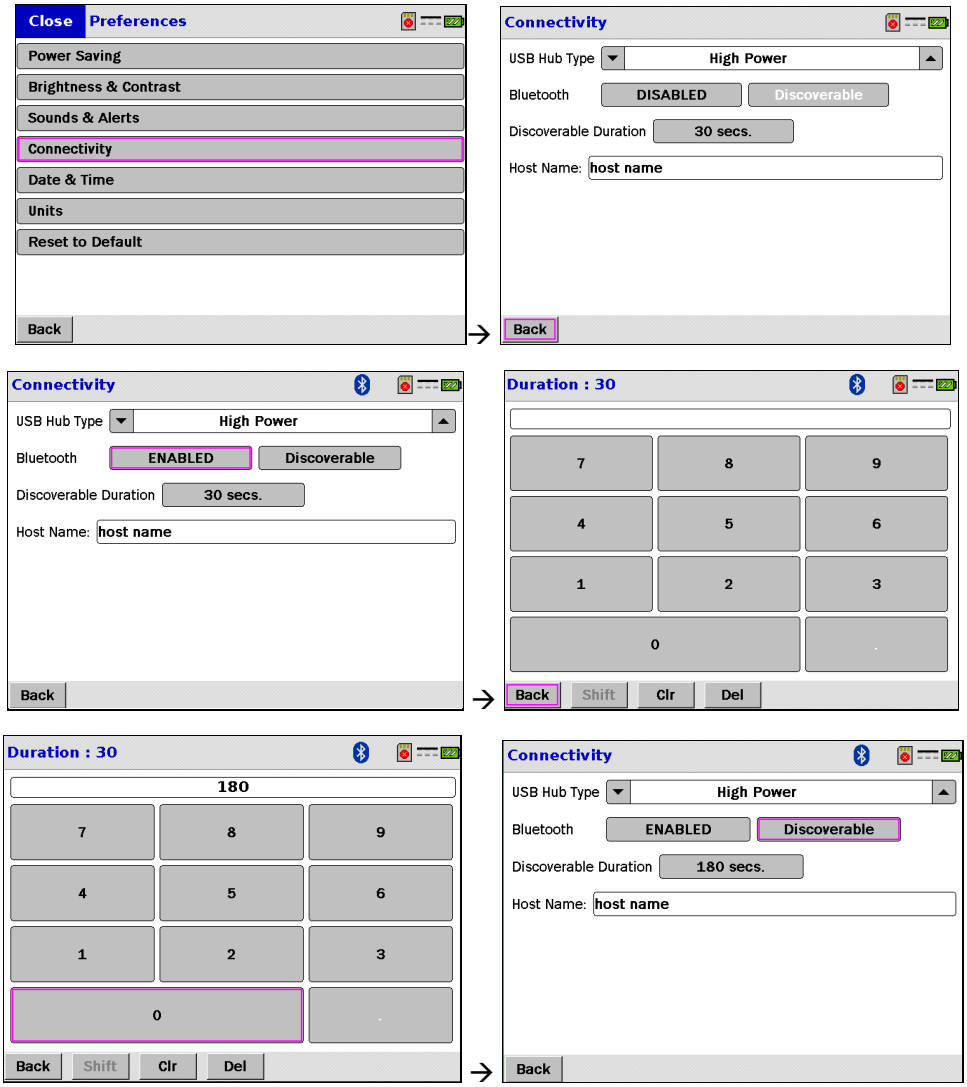
BLUETOOTH (OPTIONAL)

The PR-7XX can be supplied with a wireless, Class 1 Bluetooth interface permitting operations of up to 100 meters (line of sight conditions) from the Host. Bluetooth capability is also required on the PC.

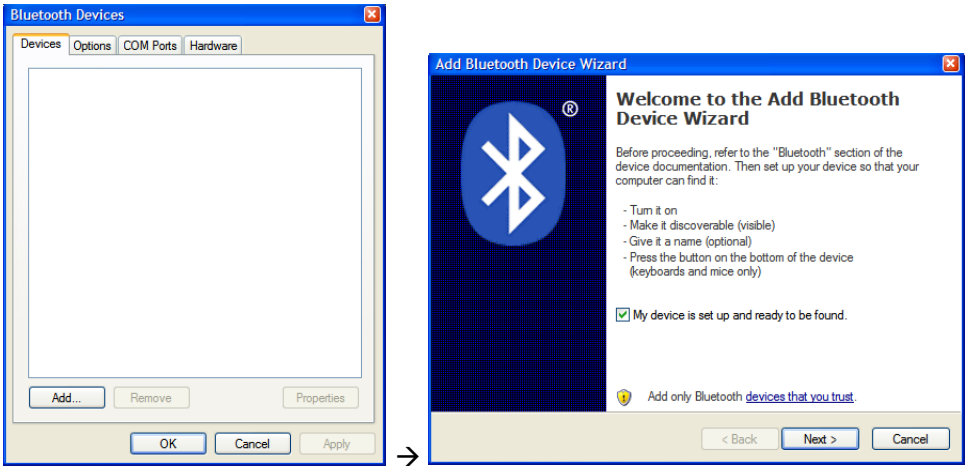
PAIRING THE PR-7XX

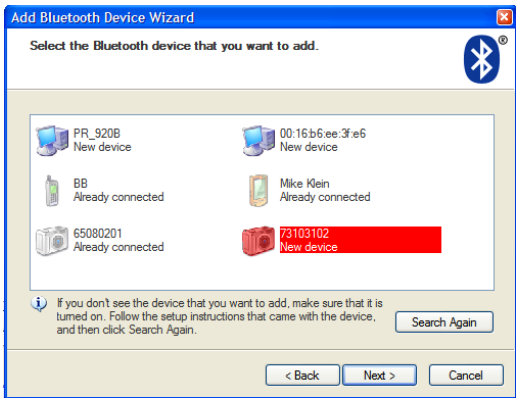
1. Insert the Bluetooth 'dongle' in the PC.
2. Wait until Windows loads drivers for the device. The icon appears in the taskbar.
3. From the main menu of the PR-7XX touch **Setup.**
4. Touch **Preferences.**
5. Touch **Connectivity.** The Connectivity menu appears.
6. In the **Bluetooth** field, touch **Disabled.** The message will change to **Enabled.**
7. Change the duration of the discoverable period by touching **30 secs.** In the **Discoverable Duration.**
8. In the data entry window that appears, touch **180** and then touch **Back.**
9. Touch **Discoverable.** The PR-7XX will remain in discoverable mode for 180 seconds.

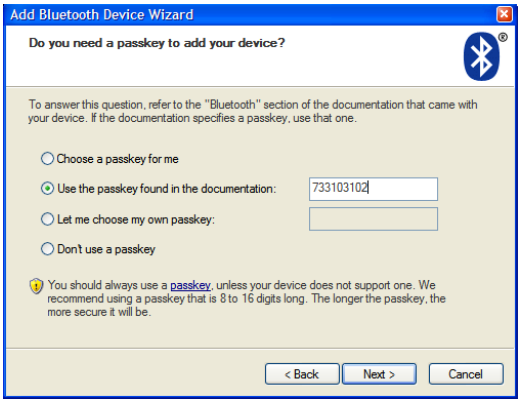


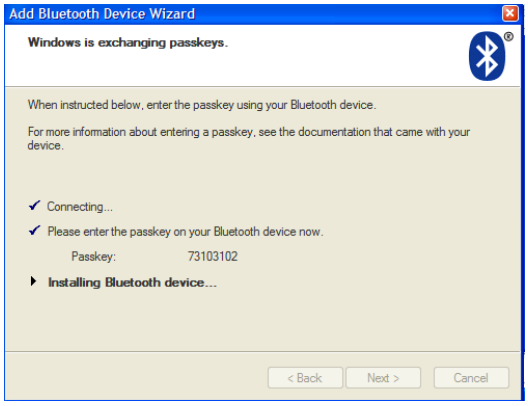


10. Double click the Bluetooth icon on the Taskbar  to open the dialog. A screen similar to the following appears:
11. Click on **Add.**
12. Check the box next to "**My device is set up and ready to be found"** (or equivalent depending on the Windows version in use) and then click **Next.**.
13. Highlight the icon with the serial number of the instrument and then click on **Next.**
14. A dialog appears requesting pairing information. Click **Use the passkey found in the documentation.**
15. Enter the serial number of the instrument as the passkey.
16. After successful pairing, the final dialog appears. Note value of the the **Outgoing COM port.** This COM port should be used for all communications – e.g. SpectraWin 2 software.


Bluetooth Devices
Devices
Options
COM Ports
Hardware
Add...
Remove
Properties
OK
Cancel
Apply
Add Bluetooth Device Wizard
Welcome to the Add Bluetooth Device Wizard
Before proceeding, refer to the "Bluetooth" section of the device documentation. Then set up your device so that your computer can find it:
- Turn it on
- Make it discoverable (visible)
- Give it a name (optional)
- Press the button on the bottom of the device (keyboards and mice only)
My device is set up and ready to be found.
Add only Bluetooth devices that you trust.
< Back
Next >
Cancel


Add Bluetooth Device Wizard
Select the Bluetooth device that you want to add.
PR_920B
New device
00:16:b6:ee:3f:e6
New device
BB
Already connected
Mike Klein
Already connected
65080201
Already connected
73103102
New device
If you don't see the device that you want to add, make sure that it is turned on. Follow the setup instructions that came with the device, and then click Search Again.
Search Again
< Back
Next >
Cancel


Add Bluetooth Device Wizard
Do you need a passkey to add your device?
To answer this question, refer to the "Bluetooth" section of the documentation that came with your device. If the documentation specifies a passkey, use that one.
Choose a passkey for me
Use the passkey found in the documentation:
733103102
Let me choose my own passkey:
Don't use a passkey
You should always use a passkey, unless your device does not support one. We recommend using a passkey that is 8 to 16 digits long. The longer the passkey, the more secure it will be.
< Back
Next >
Cancel


Add Bluetooth Device Wizard
Windows is exchanging passkeys.
When instructed below, enter the passkey using your Bluetooth device.
For more information about entering a passkey, see the documentation that came with your device.
Connecting...
Please enter the passkey on your Bluetooth device now.
Passkey: 73103102
Installing Bluetooth device...
< Back
Next >
Cancel


Add Bluetooth Device Wizard
Completing the Add Bluetooth Device Wizard
The Bluetooth device was successfully connected to your computer. Your computer and the device can communicate whenever they are near each other.
These are the COM (serial) ports assigned to your device.
Outgoing COM port: COM9
Incoming COM port: COM12
Learn more about Bluetooth COM ports.
To close this wizard, click Finish.
< Back
Finish
Cancel

Appendix - 1 REMOTE CONTROL MODE

Remote Control of the PR-7XX is accomplished using commands sent from the PC in ASCII (text) strings to the instrument. These commands are then executed and the requested information including measured values or instrument setup parameters are returned to the PC.

The PR-7XX is controlled from a personal computer over the Universal Serial Bus (USB) interface. This is achieved by using a driver that parses appropriate ASCII (text) commands from the PC application then transmits them over the USB I/F to the PR-7XX.

Communication protocol is identical to RS-232 communications. The USB driver emulates an RS-232 interface including opening a COM port, setting a baud rate, parity, stop bits and flow control. This makes Remote Control operations available for application software written in Microsoft Visual Basic, Microsoft C++ or any other language that is capable of opening communicating via a COM port.

Note: ***While the PR-7XX is in Remote Mode, the instrument's touch screen is disabled.***

INSTALLING THE USB DRIVER

Prior to commencing *Remote Mode* operations, the **PR-7XX Utilities** software including the USB driver must be installed on your Windows based PC running Windows 7 (or later) operating systems. Please refer to the USB portion of the *Connectivity* section for complete installation instructions.

USING REMOTE CONTROL COMMANDS

1. Open the ***Device Manager***.
2. Click on ***Ports* (COM & LPT).**

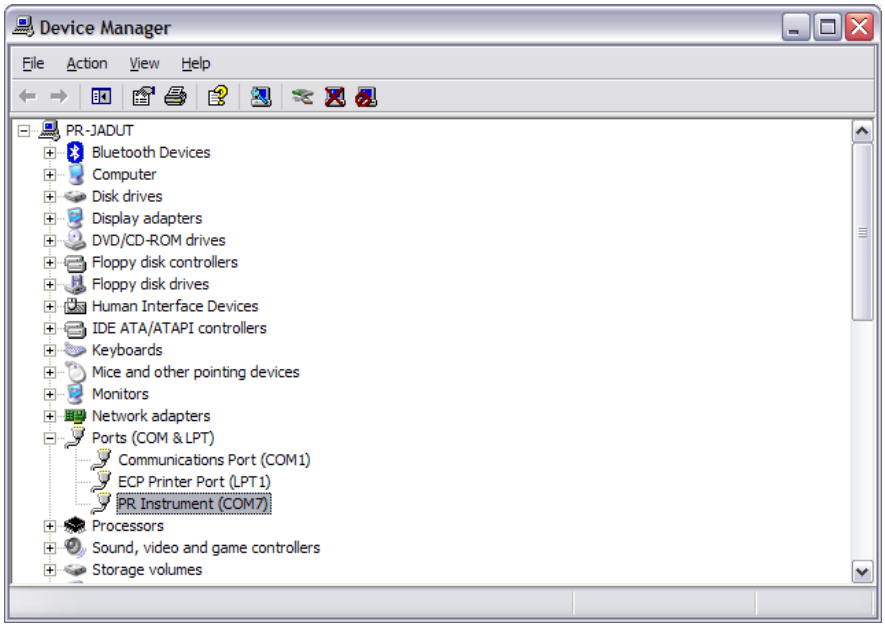


FIGURE 95. - WINDOWS DEVICE MANAGER

3. Note the COM port assigned to the **PR Instrument**.

Appendix 1 – Remote Control Mode

The following PuTTY example provides a simple interface for practicing Remote Mode commands. It is not implied that PuTTY is the only method for utilizing Remote Mode operations.

1. Turn on the PR-7XX.
2. If running on battery power, set **Power Saving** to **Disabled.** This will prevent the PR-7XX from powering off when idle for an extended period of time. See the **Power Savings** section for more details.
3. Connect the PR-7XX to the PC via the USB interface cable or optionally using the RS232 or Bluetooth interface.
4. Open **PuTTY.**
5. In the Configuration window, set the ***Connection type*** to ***Serial***. Make sure that the ***Serial line*** lists the COM port that the instrument is connected to.

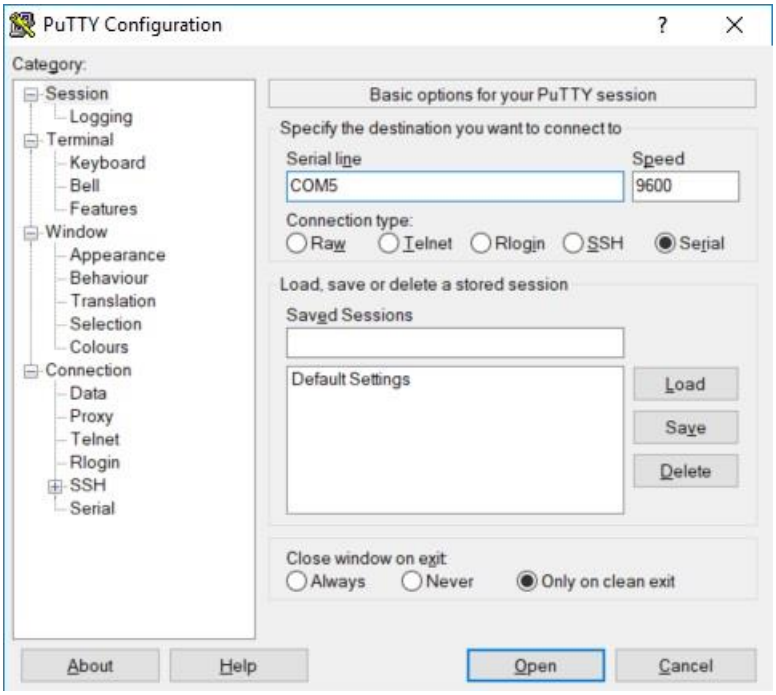


FIGURE 99 – PUTTY CONFIGURATION

6. Click on ***Open***.

ENTERING REMOTE MODE

When communicating with the PR-7XX from an application (e.g. C++, Visual Basic), please note that **single characters and not Strings** must be sent to the instrument.

Entering Remote Mode using PuTTY

1. To enter remote mode, type **PHOTO** (be sure that all letters are capitalized), but not that the letters will not appear**.** It is not necessary to press Enter.

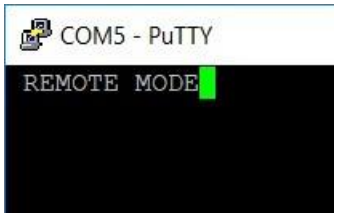


FIGURE 100 – AFTER TYPING "PHOTO"

2. Type **E** then press **Enter.** This enables full echo mode so that the instrument will return characters sent to it.

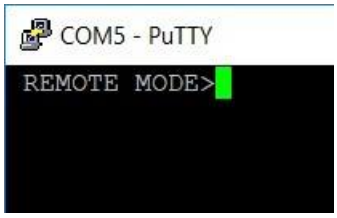


FIGURE 101 – ECHO MODE ENABLED

3. Now you are ready to use remote commands by typing in the command code and hitting **Enter**.

Appendix 1 – Remote Control Mode

REMOTE CONTROL COMMAND SUMMARY

The following table summarizes all valid Remote Control commands and responses from the PR-7XX. Detailed descriptions including parameters passed with each command are detailed in the **Remote Control Command Detail** section.

Command	Description
A	Sends an Abort command to the instrument to prematurely end a measurement.
B	Sets LCD backlight level
C	Clears current session instrument errors
D	Request data from the PR-7XX
E	Toggles the Echo (full duplex) mode
F	Measure frequency of light source
I	Requests instrument status or / error report from PR-7XX
L	Defines measurement title – Maximum of 20 characters.
M	Measure command for the PR-7XX. Returned data depends on the accompanying switches.
O	Data logger commands
P	Monitor the progress of a measurement. Must be used with the 'T' command.
T	Trigger. Initiate a measurement using current instrument set-up parameters. No data is returned. The 'D' command and appropriate switch must be sent to retrieve data following a "T" initiated measurement.
Q	Quit (exit) remote mode.
R	Recall stored measurement
S	Set up measurement parameters
V	View last measurement error code.
X	Sets LCD contrast level.
Z	Reset commands

TABLE 6 - PR-7XX REMOTE MODE COMMAND SUMMARY.

Usage:

<...> Optional Entry,

[...] Mandatory entry

(...) Comment, NOT PART OF THE COMMAND

Note: ***The default values, e.g. apertures, exposure time etc. are those used for the measurement before the instrument was set to Remote Control Mode or, if in Remote Mode, the value from the previous command.***

Appendix 1 – Remote Control Mode

REMOTE CONTROL COMMAND DETAIL

Command	Description
A	**Purpose**: Abort measurement in progress **Syntax**: A[CR] **Response**: 0000, [CR][LF] Measurement aborted. 0001, [CR][LF] No measurement in progress
B	**Purpose**: Set LCD backlight level **Syntax**: Bnn[CR] Bnn = Backlight / Brightness level in percentage. Range of nn = 0 to 100% **Response**: Backlight set to nn %
C	**Purpose**: Clears the current instrument error **Syntax**: C[CR] **Response**: None
D	**Purpose**: Download data from the PR-7xx **Syntax**: D<data code>[CR] **Response**: 0000,<data>[CR][LF] If all OK, else NNNN[CR][LF] (NNNNN = Error code) *Note: <data> in response code refers to the specific measurement data set returned based on the data code sent to the instrument. Refer to the Data Code section for details..*
E	**Purpose**: Full Duplex (Echo) ON / OFF **Syntax**: E[CR] **Response**: None
F	**Purpose**: Measure frequency of light source **Syntax**: F[CR] **Response**: 0000,ff.ff Hertz (Period = nnnnn milliseconds) If all OK else NNNN[CR][LF] (NNNN = Error code)
I	**Purpose**: Return instrument status / error report **Syntax**: I[CR] **Response**: 0000[CR][LF] If all OK, else NNNN[CR][LF] (NNNN = Error code)
L	**Purpose**: Assign measurement description **Syntax**: L<Character String with max length of 20 characters>[CR] **Response**: 0000[CR][LF] If all OK, else NNNN[CR][LF] (NNNN = Error code) Note: Entry remains valid for the duration of the current Remote Mode session or until a new L command is issued. If L[CR] is issued with an empty string, the current description is returned.
M	**Purpose**: Make a Measurement with the PR-7xx **Syntax**: M<data code>[CR] **Response**: 0000,<data>[CR][LF] If all OK, else NNNN[CR][LF] (NNNN = Error code) *Note: <data> in response code refers to the specific measurement data set returned based on the data code sent to the instrument. Refer to the Data Code section for specific information.*
O	Initialize Data Logger Mode. Data Logger Mode acts like a printer, automatically sending measurement result data over the USB interface following a measurement. Data types can be defined by the user through switches. ***Note: Data Logging is supported on PR-7XX firmware versions 2.58 and above only. Contact Photo Research for upgrade information.***

Appendix 1 – Remote Control Mode

Command	Description
P	**Purpose:** Monitor measurement progress. **Syntax**: P[CR] **Response**: 0000,<data>[CR][LF] Measurement has finished or not initiated. 0001 [CR][LF] Measurement in progress.
Q	**Purpose**: Quit (Exit) Remote mode Syntax: Q Response: None
R	**Purpose**: Recall stored measurement data from the PR-7xx **Syntax**: R<data code>,<Measurement #>,<filename.ext>[CR] **Response**: 0000,<data>[CR][LF] If all OK, else NNNN[CR][LF] (NNNN = Error code) **Special Syntax** 1 (Recall from RAM only): **Syntax**: R<data code>,0[CR] Recall last written measurement **Response**: 0000,<data>[CR][LF] If all OK, else NNNN[CR][LF] (NNNN = Error code) **Special Syntax** 2 (Recall from RAM only): **Syntax**: R<data code>,+[CR] Increments the Measurement ID (measurement number) and recalls the data. **Response**: 0000,<data>[CR][LF] If all OK, else NNNN[CR][LF] (NNNN = Error code) *Note: If data code is not specified, code 1 will be sent. If filename.ext is not specified, data returned will be that stored in the internal memory (RAM) of the instrument instead of the SD card.* *<data> in response code refers to the specific measurement data set returned based on the data code sent to the instrument. Refer to the Data Code section for specific information.*
S	**Purpose**: Assign instrument and measurement set up parameters **Syntax**: S[specifier][CR] **Response**: 0000[CR][LF] If all OK 0001[CR][LF] Measurement in progress
T	**Purpose**: Trigger (initiate) a measurement **Syntax**: T[CR] **Response**: 0000[CR][LF] If all OK, else NNNN[CR][LF] (NNNN = Error code)
V	**Purpose**: View / Report last measurement error **Syntax**: V[CR] **Response**: 0000[CR][LF] If all OK, else NNNN[CR][LF] (NNNN = Measurement error code)
X	**Purpose**: Set the display contrast . **Syntax**: Xnnn where nnn is the contrast in % - Range 0 to 100% **Response**: “Contrast set to nnn %” See the Setup Command section for complete details
Z	**Purpose**: Enable Reset Command Mode **Syntax**: ZEnableReset **Response**: 00000,Reset Commands Enabled **Reset Commands:** ZResetPreferences – Reset all Preferences values to factory default. ZResetSetup – Reset all Setup values to factory default. *NOTE: All Reset Commands will shut down the instrument after they are executed.*

Appendix 1 – Remote Control Mode

SETUP COMMANDS

Setup Commands are used to specify instrument and measurement parameters for the next measurement. To specify more than one parameter, sequential setup commands may be sent to the instrument before the measurement is initiated.

The default parameters are those used during the measurement immediately before Remote Mode operations are initiated. If Remote Mode operations are under way, the default setup values for the upcoming measuring are those defined in the last Setup (S_ command).

Setup Command	Description
SA	**Select Add-on Accessory 1** An Add-on accessory is one that is used in conjunction with a primary accessory. For example, a neutral density filter (Add-on Accessory) used with the MS-75 (Primary Accessory). Up to 3 Add-on accessories can be specified for a measurement. **Syntax**: SAn[CR] **Where**: n = Accessory code **Response**: 0000[CR][LF] If all OK, else NNNN[CR][LF] (NNNN = Error code) *Note: Accessory Codes can be found by running report 116 (command D116). See the Data Codes section for specific details.* *Note: To deselect Add-on accessories, send the command SA-1. Selecting a different Primary accessory also deselects Add-on accessories.*
SB	**Select Add-on Accessory 2** An Add-on accessory is one that is used in conjunction with a primary accessory. For example, a neutral density filter (Add-on Accessory) used with the MS-75 (Primary Accessory). Up to 3 Add-on accessories can be specified for a measurement. **Syntax**: SBn[CR] **Where**: n = Accessory code **Response**: 0000[CR][LF] If all OK, else NNNN[CR][LF] (NNNN = Error code) *Note: Accessory Codes can be found by running report 116 (command D116). See the Data Codes section for specific details.* *Note: To deselect Add-on accessories, send the command SA-1. Selecting a different Primary accessory also deselects Add-on accessories.*

Setup Command	Description
SC	**Select Add-on Accessory 3** An Add-on accessory is one that is used in conjunction with a primary accessory. For example, a neutral density filter (Add-on Accessory) used with the MS-75 (Primary Accessory). Up to 3 Add-on accessories can be specified for a measurement. **Syntax**: SCn[CR] **Where**: n = Accessory code **Response**: 0000[CR][LF] If all OK, else NNNN[CR][LF] (NNNN = Error code) *Note: Accessory Codes can be found by running report 116 (command D116). See the Data Codes section for specific details.* *Note: To deselect Add-on accessories, send the command SA-1. Selecting a different Primary accessory also deselects Add-on accessories.*
SD	**Select Dark Current Mode (PR-7XX only)** Two dark current modes are available – Standard and Smart Dark. In Standard Mode, the instrument measures the detector dark current after each light measurement. If Smart Dark is enabled and two successive measurements yield the same exposure time then the dark current values from the first measurement are used for the second (and possibly successive) measurements. **Syntax**: SDn[CR] **Where**: n=Dark Current Mode 0 = Disable Smart Dark 1 = Enable Smart Dark **Response**: 0000[CR][LF] If all OK, else NNNN[CR][LF] (NNNN = Error code)
SE	**Select Exposure Time** Enter the Exposure (Integration) time for the next measurement in milliseconds. Possible values are 12 – 120,000 (6 sec.) for *Standard Mode, and* 12 - 300,000 (5 min.) for *Extended Mode.* See the H specifier for more information on setting *Standard* or *Extended* Modes. To set the instrument to **Adaptive Exposure,** send **SE0** (ttttt = 0) **Syntax**: SEttttt[CR] **Where**: ttttt = exposure time in milliseconds **Response**: 0000[CR][LF] If all OK, else NNNN[CR][LF] (NNNN = Error code)

Setup Command	Description
SF	**Aperture Select** Select the aperture to be used for the next measurement. **Syntax**: SFa[CR] **Where**: a = aperture code **Response**: 0000[CR][LF] If all OK, else NNNN[CR][LF] (NNNN = Error code) *Note: See Data Code 117 for details on aperture codes.*
SG	**Speed Mode** Select the Speed Mode for the next measurement. Choices are Normal, 1X Fast, 2X Fast and 4X Fast. **Syntax**: SGg[CR] **Where**: g = Gain 0 = Normal (DEFAULT), 1 = Fast 2 = 2X Fast 3 = 4X Fast **Response**: 0000[CR][LF] If all OK, else NNNN[CR][LF] (NNNN = Error code)
SH	**Sensitivity Mode** Select the Sensitivity Mode for the next measurement. The two available modes are Standard and Extended. In *Standard* Mode, the exposure time range is 12 ms to 120,000 ms (6 sec.). In *Extended* Mode, the upper limit is extended to 300,000 ms (5 min.). **Syntax**: SHm[CR] **Where**: m = Sensitivity Mode 0 = Standard Mode 1 = Extended Mode **Response**: 0000[CR][LF] If all OK, else NNNN[CR][LF] (NNNN = Error code)
SK	**User Sync Frequency** Enter the frequency (in Hertz) of the source being measured. The range is 20 to 400 Hz. This command works in unison with the *SYNC Mode* setting. See the S specifier for complete details on setting the *SYNC Mode.* **Syntax**: SKfff[CR] **Where**: fff = frequency in Hertz. Range is 20 to 400 **Response**: 0000[CR][LF] If all OK, else NNNN[CR][LF] (NNNN = Error code)

Setup Command	Description
SN	**Cycles to Average** Defines the number of measurements (cycles) to average when calculating photometric and colorimetric values. The average of the spectra are used to calculate other values. The range of cycles to average is 1 to 99. The default is 1. **Syntax**: SNaa[CR] **Where**: aa = Cycles to Average Range 1 to 99 **Response**: 0000[CR][LF] If all OK, else NNNN[CR][LF] (NNNN = Error code)
SO	**CIE Observer** Photometric and Colorimetric values can be calculated using either CIE 2° or 10° Standard Observer data sets. Use this specifier to choose the CIE data set for calculations for the next measurement. The default is 2°. **Syntax**: SOn[CR] **Where**: n = CIE Observer 2 = 2° 10 = 10° **Response**: 0000[CR][LF] If all OK, else NNNN[CR][LF] (NNNN = Error code)
SP	**Primary Accessory** A Primary Accessory is one that replaces the standard objective lens (typically the MS-75) during use and can be used in conjunction with an Add-on Accessory. **Syntax**: SPnn[CR] **Where**: nn = Accessory Code **Response**: 0000[CR][LF] If all OK, else NNNN[CR][LF] (NNNN = Error code) *Note: Accessory Codes can be found by running report 116 (command D116). See the Data Codes section for specific details.*

Setup Command	Description
SR	**Bandwidth Select** For instruments supplied with the Multiple Bandwidth option, instructs the instrument which bandwidth to use during the next measurement. **Syntax**: SRb[CR] **Where**: b = Bandwidth 0 = 2 nm bandwidth (4 nm for PR-735/745) 1 = 4 nm bandwidth (8nm for PR-735/745) 3 = 8 nm bandwidth (14 nm for PR-735/745) **Response**: 0000[CR][LF] If all OK, else NNNN[CR][LF] (NNNN = Error code)
SS	**Sync Mode** Instructs the instrument to adjust the exposure time, when using Adaptive Sensitivity mode, to the nearest even multiple of the refresh rate (frequency) of the source. Choices are *No Sync, Auto Sync, and User Frequency.* In *Auto Sync* mode, the instrument measures the frequency of the source to determine its period. The exposure time is then automatically altered so that it is an even multiple of the source period (1/frequency). *User Frequency* will adjust the exposure time based on a user enter frequency in Hertz as entered using the SK command. See the *User Sync Frequency* section for more details on defining the Sync frequency. **Syntax**: SSf[CR] **Where**: f = Sync mode 0 = No Sync 1 = Auto Sync 3 = User Frequency **Response**: 0000[CR][LF] If all OK, else NNNN[CR][LF] (NNNN = Error code)
SU	**Photometric Units** Select *English* or *Metric (SI)* photometric values to be reported in the applicable Data Codes. **Syntax**: SUn[CR] **Where**: n = Units type 0 = English 1 = Metric (SI) **Response**: 0000[CR][LF] If all OK, else NNNN[CR][LF] (NNNN = Error code)

Setup Command	Description
SW[1, 2]	**Internal ND Filter** The PR-788 has an internal neutral density (ND) filter, which can be used to attenuate the signal the instrument reads. **Syntax**: SWn[CR] **Where**: n = ND mode 0 = No ND filter 1 = ND filter on 99 = Auto ND -1 = returns current state of ND **Response**: 0000[CR][LF] If all OK, else NNNN[CR][LF] (NNNN = Error code)

[1]PR-788 ONLY

[2]The user must actively manage ND mode and state when changing exposure modes (i.e. setting a fixed sets ND mode to fixed). To return to Auto ND, it must be explicitly set AFTER setting AutoExposure.

MEASUREMENT AND DATA SEND CODES

Measurement and Data Send Codes are used to measure (**M** Command) and then specify returned data or acquire values without making a measurement (**D** command).

Either a **D** or an **M** can precede any of the following codes. For example, *M1 or D1 – M602 or D602*. If an M command is sent, a measurement will always be made even if the Data Code does not request measured values. For example, if *M116* is sent to the instrument, a measurement is made then a list of accessories is returned from the instrument.

In the following table, **qqqqq** is the returned error code. If **qqqqq** is all zeros (00000) no error has occurred during the request. All other values for **qqqqq** relate to an error condition. Refer to the Remote Mode Error Code section of the manual for a complete list of error codes and their meanings.

UUUU in the output format is the photometric unit type of the measurement per the following table:

Type	Code	Units	
Luminance	0	fL	cd/m²
Illuminance	1	fc	lux
Luminous Intensity	2	mcd	
Luminous Flux	3	lumens	

TABLE 7 - PHOTOMETRIC UNITS CODES

Note: ***Both qqqqq and UUUU are contained in every output and are not annotated below.***

All data fields are fixed length (except where otherwise noted) and comma delimited. Commas also serve as placeholders for empty fields.

Appendix 1 – Remote Control Mode

DATA CODE SUMMARY

The following table summarizes Data Codes and their meanings. For full details, please see the Expanded Code table following.

Data Code	Description
0	Repeat last response code
1	status, units, Photometric brightness, CIE 1931 x,y
2	status, units, CIE 1931 Tristimulus Values (X, Y, Z)
3	status, units, Photometric brightness, CIE 1976 u', v'
4	status, units, Photometric brightness, Correlated Color Temperature, Deviation from Plancks Locus in 1960 u,v units
5	status, units, Peak Wavelength, Integrated Power, Integrated Photon, WL, Spectral Data at each WL
6	status, units, Photometric brightness, CIE 1931 x, y, CIE 1976 u', v'
7	status, units, Photometric brightness, CIE 1960 u,v
8	status, Raw (uncorrected) light per pixel
9	status, Raw (uncorrected) Dark Current per pixel
10	status, Raw Light minus Dark Current per pixel
11	status, units, Scotopic Brightness
12	status, units, Photometric brightness, CIE 1931 x, y, CIE 1960 u, v
13	status, Gain description, exposure time in milliseconds
14	status, Sync mode description, sync period in milliseconds
15	Status, bandwidth used for last measurement
110	status, Instrument Serial Number
111	status, Instrument Name
112	status, Number of Accessories, Number of Apertures
114	status, Software Version
115	status, Battery status
116	status, Accessory List
117	status, Aperture List
118	status, Bandwidth list
120	status, Hardware configuration
200	status, Last Meas. Max Raw Light Value, Last Meas. Min Raw Light Value, Last Meas. Avg Raw Light Value.
201	status, Same as report 200 for Raw Dark
400	status, Contents of Last Measurement buffer.
401	status, Number of measurements stored in RAM
402	status, Directory of measurements stored in RAM. An error message is generated if there are no stored measurements.
411	status, List of files in SD card and number of stored measurements per file.
412, filename	Status, Directory of stored measurements in the file "filename" in SD card.
601	status, Current Setup Report – comma delimited
602	status, Current Setup Report, with labels.

TABLE 8 - DATA CODE SUMMARY

Appendix 1 – Remote Control Mode

DATA CODE DETAILS

The following table details available Data Codes including data examples. Each field is comma delimited. Most fields are fixed length, however some are variable length and are indicated as such.

As mentioned earlier in this section, these commands may be attached to a **D** or **M** command - for example, **M5** or **D5.** Commands may not be combined.

To make a measurement and return more than one data type, first send the **M** command with the first response code, the send successive codes using the **D** command until all required data types have been returned.

Data Code	Description
1	**Output Format**: qqqqq,U,Y.YYYe+ee,x.xxxx,y.yyyy[CRLF] **where**: Y = Photometric brightness (e.g. Luminance or Illuminance etc.) e = exponent x = CIE 1931 x y = 1931 y **Output Example**: 00000,0,1.865e+01,0.4035,0.4202
2	**Output Format:** qqqqq,U,X.XXXe+ee, Y.YYYe+ee, Z.ZZZe+ee CRLF **where:** X = CIE 1931 Tristimulus X (Red) Y = CIE 1931 Tristimulus Y (Green) Z = CIE 1931 Z (Blue) **Output Example**: 00000,0,6.136e+01,1.865e+01,2.681e+01
3	**Output Format**: qqqqq,U,Y.YYYe+ee,u'.u'u',v'.v'v'v' CRLF **where**: Y = Photometric brightness (e.g. Luminance or Illuminance etc.) e = exponent u'=CIE 1976 u' v'=CIE 1976 v' **Output Example**: 00000,0,1.865e+01,0.2231,0.5227
4	**Output Format**: qqqqq,U,Y.YYYe+ee,CCCCC,d.dddd CRLF **where**: Y = Photometric brightness (e.g. Luminance or Illuminance etc.) e = exponent CCCCC = Correlated Color Temperature in Kelvins d.dddd = CIE 1960 deviation from Planck's Black Body Radiator locus **Output Example** 00000,0,1.865e+01, 3757,0.0129
5	**Output Format**: qqqqq,U,w.wwwe+eee,i.iiie-ee,p.pppe+eeCRLF **where**: w.www = peak wavelength e = exponent i.iii = integrated radiometric value (sum of all spectral data times WL increment) p.ppp = integrated photon radiometric value

	wl,spectral dataCRLF wl,spectral dataCRLF wl,spectral dataCRLF **Output Example**: 00000,0,0.000e+000,1.827e-01,5.147e+01 380,1.627e- 382,9.910e-07 384,5.356e-06 386,5.725e-06 388,8.989e-06 390,1.127e-05
6	**Output Format**: qqqqq,U,Y.YYYe+ee,x.xxxx,y.yyyy,u'.u'u'u'u', v'.v'v'v'v'CRLF **where**: Y.YYY = Photometric brightness (e.g. Luminance or Illuminance etc.) e.ee = exponent x,xxxx = CIE 1931 x y.yyyy = CIE 1931 y u'.u'u'u'u' = CIE 1976 u' v'.v'v'v'v' = CIE 1976 v' **Output Example**: 00000,0,2.041e+01,0.4089,0.4151,0.2283,0.5215
7	**Output Format**: qqqqq,U,Y.YYYe+ee,u.uuuu,v.vvvv CRLF **where**: Y.YYY = Photometric brightness (e.g. Luminance or Illuminance etc.) e.ee = exponent u.uuuu = CIE 1976 u v.vvvv = CIE 1976 v **Output Example**: 00000,0,2.646e+03,0.2081,0.3519
8	**Output Format**: qqqqq, CRLF, lllll CRLF, lllll CRLF, lllll CRLF …… **where**: lllll = Raw signal (light) data (variable length from 1 to 5 digits) for all detector pixels from 0 to 511. **Output Example**: 00000, 3475 3426 3477 3451 3483 3459
9	**Output Format**: qqqqq, CRLF, ddddd CRLF, ddddd CRLF, ddddd CRLF **where**: ddddd = Raw signal (dark current) data (variable length from 1 to 5 digits) for all detector pixels from 0 to 511. **Output Example**:

	00000, 120 135 122 130 131 123
10	**Output Format**: qqqqq, CRLF, ddddd CRLF, ddddd CRLF, ddddd CRLF **where**: ddddd = Raw signal (signal minus dark current) data (variable length from 1 to 5 digits) for all detector pixels from 0 to 511. **Output Example**: 00000, 120 135 122 130 131 123
11	**Output Format**: qqqqq,U,S.SSSe+eeCRLF **where**: S.SSS = scotopic luminance, e+ee = exponent **Output Example**: 00000,0,3.668e+01
12	**Output Format**: qqqqq,U,Y.YYYe+ee,x.xxxx,y.yyyy,u'.u'u'u'u', v'.v'v'v'v'CRLF **where**: Y.YYY = Photometric brightness (e.g. Luminance or Illuminance etc.) e.ee = exponent x.xxxx = CIE 1931 x, y.yyyy = CIE 1931 y u.uuuu = CIE 1960 u v.vvvv = CIE 1960 v **Output Example**: 00000,0,2.041e+01,0.4089,0.4151,0.2283,0.3477
13	**Output Format**: qqqqq,Gain description,nnnnnn msec CRLF **where**: Gain Description is a text description of the Gain Used **Possibilities are**: Normal, Fast, 2X Fast and 4X Fast nnnnnn = Last exposure time in milliseconds **Output Example**: 00000,Fast,16500 msec
14	**Output Format**: qqqqq,Sync mode description,nnnnnn Hertz CRLF **where**: Sync mode description = Sync mode in use. Possibilities are: Auto Sync, User Sync, None nnnnnn = Sync Frequency in Hertz

	Output Example: 00000,User Sync,120.00 Hertz
15	**Output Format**: qqqqq, Bandwidth description nm CRLF **where**: Bandwidth description = The bandwidth used for the last measurement in nm **Output Example**: 00000,8 nm
110	**Output Format**: qqqqq,ssssssss CRLF **where**: ssssssss = Instrument Serial Number **Output Example**: 00000,67065106
111	**Output Format**: qqqqq,mmmmmmCRLF **where**: mmmmmm = Instrument Model **Output Example**: 00000,PR-740
112	**Output Format**: qqqqq,ac,ap CRLF **where**: ac = number of calibrated accessories ap = number of calibrated apertures **Output Example**: 00000,1,4
114	**Output Format**: qqqqq,vvvvv CRLF **where**: vvvvv = Software version **Output Example**: 00000,2.79D
115	**Purpose: Battery Status** (optional) **Output Format**: qqqqq,v CRLF **where**: v = 0, Battery OK v = 1, Battery low **Output Example**: 00000,0
116	**Output Format**: qqqqq,nn,ss,tt,pp,rr CRLF **where**: nn = ID number of accessory ss = Accessory name (variable length) tt = Accessory type – Possibilities are: Primary or Addon pp = Photometry Mode – Possibilities are: Luminance, Illuminance, Luminous Intensity, or Luminous Flux rr = Radiometry Mode – Possibilities are: Radiance Irradiance Radiant Intensity or Radiant Flux **Output Example**: 00000,0,MS-75,Primary,Luminance,Radiance
117	**Output Format**: qqqqq,nn,ss,bw CRLF **where**: nn = ID number of aperture

	ss = Aperture Name bw = Effective Bandwidth **Output Example**: 00000,0,1 deg,0.00 00000,1,1/2 deg,0.00 00000,2,1/4 deg,0.00 00000,3,1/8 deg,0.00
118	**Output Format**: qqqqq,nn,ss,bw CRLF **where**: nn = ID number of bandwidth ss = Aperture Name bw = Effective Bandwidth **Output Example**: 00000,0,2 nm 00000,1,5 nm 00000,2,8 nm
120	**Output Format**: qqqqq,pp,bw,bb,ee,ii,nrp,frp,lrp CRLF **where**: pp = Number of spectral data points. bw = Bandwidth of instrument bb = Starting WL ee = Ending WL ii = WL Increment nrp = Number of detector elements pixels frp = First useable raw pixel number lrp = Last useable raw pixel number **Output Example**: 00000,201,0.00,380,780,2,256,7,247
200	**Output Format**: qqqqq, mxv, mnv, mav CRLF **where**: pp = Number of spectral data points. mxv = Max Value of Raw Light mnv = Min Value mav = Average Value **Output Example**: 00000,42268,2906,11135
201	**Same as D200 for Raw dark values.**
401	**Output Format**: qqqqq, CRLF **where**: qq - Number of stored measurements in RAM **Output Example**: 0000, 6
402	**Output Format**: qqqqq,dt,tm CRLF Directory of stored Measurements in RAM **where**: qq - ID of measurement dt = Date tm = Time

	Output Example: 1,01-30-2007 13:48:26 2,01-30-2007 13:49:09 3,01-30-2007 13:51:03
411	**Output Format**: filename.ext,qqqqq CRLF (List of files in SD Card). **where**: filename.ext = Filename with extension. qq = Number of stored measurements in file. **Output Example**: MK.mea, 1 TSTSAMP.mea, 2
412	**Output Format**: qqqqq,dd-dd-dddd,tt:tt:tt CRLF (Directory of measurements in file) **Syntax:** 412, ffffffff.eee **where**: qqqqqq = ID of measurement dd-dd-dddd = Date tt:tt:tt = Time ffffffff.eee = filename.ext **Output Example**: **00000** **1,07-03-2011 01:17:43** **2,07-03-2011 01:18:01**
601	**Output Format**: qqqqq,<Primary Lens>, <Addon1>, <Addon2>, <Addon3>, <Aperture>, <Units>, <Exposure Mode>,<Exposure Time (see note) > ,<Gain>, <Cycles>, <CIE Observer>, <DarkMode>, <SyncMode>, <CaptureMode>, <SyncPeriod>, <bandwidth>CRLF **Note**: **The exposure time reported in 601 and 602 (following) reports 0 if the instrument is set in Adaptive Exposure mode. To view the exposure time for the last measurement when the instrument is in Adaptive Exposure mode, send the D13 command.** **Output Example**: 00000,0,-1,-1,-1,0,0,0,0,0,1,2,0,0,0,60.00
602	**Output Format**: Current set report with text labels. Dark mode values: for reports [601] and [602] 0 Disable Smart Dark 1 Enable Smart Dark **Output Example**: 00000,MS-75,None,None,None,1 deg,English,Adaptive,0 msec,Normal,1 cycles,2 deg,No Smart Dark, Standard Sensitivity, No Sync,60.00 Hertz

Appendix 1 – Remote Control Mode

Remote Control Error Codes

Remote Control Measurement Errors

Error	Meaning
-0001	Light source not constant.
-0002	Light overload – signal too intense.
-0003	Cannot Sync to light source. Light source frequency below 20Hz, above 400 Hz or signal too low to Sync.
-0004	Adaptive mode error.
-0008	Weak light – insufficient signal.
-0009	Sync Error.
-0010	Cannot Auto Sync to light source.
-0012	Adaptive mode time out. Light source not constant.

Remote Control Parsing Errors

Error	Meaning	Valid Values
-1000	Illegal command	
-1001	Too many fields in setup command	
-1002	Invalid primary accessory code	
-1003	Invalid Addon 1 accessory code	
-1004	Invalid Addon 2 accessory code	
-1005	Accessory is not a primary accessory	
-1006	Accessory is not an Addon accessory	
-1007	Accessory already selected	
-1008	Invalid Aperture index (PR-7XX only)	
-1009	Invalid units code	0 = English 1 = Metric (SI)
-1010	Invalid Exposure value	3 to 6000 ms PR-7XX 6 to 30,000 ms
-1011	Invalid Gain code	0 = Normal 1 = 1X for AC sources 2 = 10X 3 = 100X
-1012	Invalid average cycles	1 to 99
-1013	Invalid Calc Mode	
-1014	Invalid Trigger Mode	
-1015	Invalid CIE observer	2 or 10

Appendix 1 – Remote Control Mode

Error	Meaning	Valid Values
-1017	Invalid Dark measurement mode	0 = Disable Smart Dark 1 = Enable Smart Dark
-1019	Invalid Sync mode	0 = No Sync 1 = Auto Sync 3 = User Frequency
-1021	Measurement title too long	> 20 characters
-1022	Measurement title field empty after sending L command	
-1023	Invalid user Sync period	20 to 400 Hz
-1024	Invalid R command	
-1025	Invalid Addon 3 accessory code	
-1026	Invalid sensitivity mode	0 = Standard Mode 1 = Extended Mode
-1035	Parameter not applicable to this instrument	
-2000	This error code is returned whenever a response code is requested that does not exist, or when no other D command has been sent previously.	

Appendix 2 – Maintenance and Service

ROUTINE MAINTENANCE

The PR-7XX have been designed to give long, trouble-free service requiring minimal routine maintenance. This section gives guidelines for insuring optimum service from your instrument.

CLEANING LENSES / OPTICAL ACCESSORIES

1. Keep the PR-7XX clean and dust-free. Store the instrument in a clean, dry environment, preferably in a storage case when not in use. Dust optical surfaces with a soft camel's-hair brush or blow them off with clean, dry air.

    **Note: Avoid touching optical surfaces**.

2. If the exterior optical surfaces become dirty, clean them as you would any high-quality coated lens. Use lens cleaning fluid or anhydrous alcohol on a piece of lens cleaning tissue or cotton. Do not soak.

    **Do not use acetone or other organic solvents or excessive pressure! Do not soak or allow water to enter the instrument!**

CLEANING EXTERIOR SURFACES

If the exterior plastic surfaces, such as the display face plate or instrument case becomes dirty or full of fingerprints, use a mild dish washing liquid and a slightly damp, nonabrasive cloth to gently remove fingerprints and dirt. **Do not use acetone or other organic solvents or excessive pressure!** Do not soak or allow water to enter instrument!

RECALIBRATION

The PR-7XX is designed to maintain stable calibration for long periods of time and is certified for one year from the factory. However, changes in calibration are inevitable, due to the effects of aging, temperature and dirt accumulation. Therefore, for best results, periodic recalibration is recommended.

To maintain the instrument's accuracy, recalibration checks or recalibration is recommended at one year intervals. Please consult factory for availability of optional user self-calibration.

Please contact the Customer Service Department for a Return Material Authorization (RMA) number, before returning the instrument.

FACTORY REPAIR

IN-WARRANTY REPAIR

If the instrument malfunctions within the one-year warranty period, it will be repaired at no charge to the customer (provided the warranty has not been voided by tampering, physical damage or other abuse).

Note: Any *unauthorized* tampering with the instrument, including opening of the case, automatically voids the warranty. Batteries are not covered under the warranty.

Visit our web site, www.photoresearch.com to assign a Returned Material Authorization (RMA) number to your instrument before returning it to Photo Research for service. The entire instrument including all accessories, should be brought or shipped prepaid to the Photo Research Service Department in Chatsworth, CA, USA (or contact Photo Research for information concerning authorized repair facilities in your area).

Appendix 2 – Maintenance and Service

Pack the instrument and all attachments and accessories in suitable protective packaging, along with a note describing the nature of the malfunction.

The instrument will be returned by a commercial surface transportation method of Photo Research's choice.

If Air Freight or other rapid delivery is desired, the user should include a check or money order to cover the cost of return shipping, or contact Photo Research and supply a shipper account number (e.g. FedEx, UPS etc.) to expedite collect delivery.

Out-of-Warranty Repair

If the instrument is out of warranty, Visit our web site, www.photoresearch.com to assign a Returned Material Authorization (RMA) number to your instrument before returning it to Photo Research for service. The instrument should be brought or shipped prepaid to the Photo Research Service Department (or call Photo Research for locations of authorized repair facilities in your area).

Pack the PR-7XX and *all* attachments and accessories in suitable protective packaging along with a note describing the nature of the malfunction.

Photo Research will evaluate the damage and advise the user of the estimated repair and recalibration costs before proceeding.

APPENDIX 3 – PR-7XX LENS CHART

		Aperture									
Accessory	Working Distance	2°	1°	0.5°	0.25°	0.2°	0.125°	0.1°	.1 x 1	.5 x 1.5	.1 x 2
MS-75	355 mm 305 m	10.5 mm 10.64 m	5.25 mm 5.32 m	2.63 mm 2.66 m	1.32 mm 1.33 m	1.05 mm 1.064 m	0.658 mm 0.655 m	0.525 mm 0.532 m	0.525 x 5.25 mm 0.532 x 5.32 m	2.625 x 7.875 mm 2.66 x 7.98 m	0.525 x 10.5 mm 0.532 x 10.64 m
SL-0.5X	91.4 mm to 137 mm	3.0 mm to 5.08 mm	1.50 mm to 2.54 mm	0.75 mm o 1.27 mm	0.375 mm to 0.635 mm	0.30 mm to .508 mm	0.188 mm to 0.318 mm	0.150 mm to 0.254 mm	0.15 x 1.5 to 0.254 x 2.54	0.75 x 2.25 mm to 1.27 x 3.81 mm	0.15 x 3 mm to 0.254 x 5.08 mm
SL-1X	46 mm to 66 mm	1.78 mm to 2.64 mm	0.89 mm to 1.32 mm	0.445 mm to 0.660 mm	0.226 mm to 0.330 mm	0.178 mm to 0.264 mm	0.111 mm to 0.165 mm	0.089 mm to 0.132 mm	0.089 x 0.89 to 0.132 x 1.32	0.445 x 1.335 mm to 0.66 x 1.98 mm	0.089 x 1.78 mm to 0.132 x 2.64 mm
MS-2.5X	46 mm	1.02 mm	0.51 mm	0.225 mm	0.128 mm	0.102 mm	0.064 mm	0.051 mm	0.051 x 0.51	0.255 x 0.765 mm	0.051 x 1.02 mm
MS-7.5	10 cm 30.5 m	35.0 mm 10.64 m	17.5 mm 5.32 m	8.75 mm 2.66 m	4.38 mm 1.33 m	3.50 mm 1.064 m	2.19 mm 665 mm	1.75 mm 0.532 m	1.75 x 17.5 mm 0.532 x 5.32 m	8.75 x 26.25 mm 2.66 x 7.98 m	1.75 x 35 mm 0.532 x 10.64 m
LA-730	Contact	13.2 mm	13.2 mm	13.2 mm	13.2 mm	13.2 mm	13.2 mm	13.2 mm	13.2 mm	13.2 mm	13.2 mm
FP-730	Contact	3.17 mm	3.17 mm	3.17 mm	3.17 mm	3.17 mm	3.17 mm	3.17 mm	3.17 mm	3.17 mm	3.17 mm