PHOTO RESEARCH, INC.®

PR-705/715
SpectraScan®
Instruction Manual

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Customer Support

PHOTO RESEARCH, Inc. has support services available to users in case of problems using the PR-705 / 715.

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

Call (818) 341-5151, FAX: (818) 341-7070 or e-mail: *service@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.

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Chapter 1 - Theory of Operation

Description

The PR-705 is a parallel acquisition (fast-scan) spectroradiometer and has a fixed polychromator (diffraction grating), which disperses the majority of the visible spectrum (380 nm to 780 nm for the PR-705, 380 nm to 1068 nm for the PR-715) onto a thermoelectrically cooled, 256 silicon photodiode array detector. Each of the 256 detectors measures a specific color (wavelength), and the entire spectrum is measured simultaneously. The photodiode array is scanned electronically and the entire scan can be done in as little as a fraction of a second. By thermo-electrically cooling the detector, changing the detectors exposure time (Adaptive Sensitivity®) and digitally integrating many scans, the sensitivity and dynamic range is optimized for the source being measured.

PR-705 Block Diagram
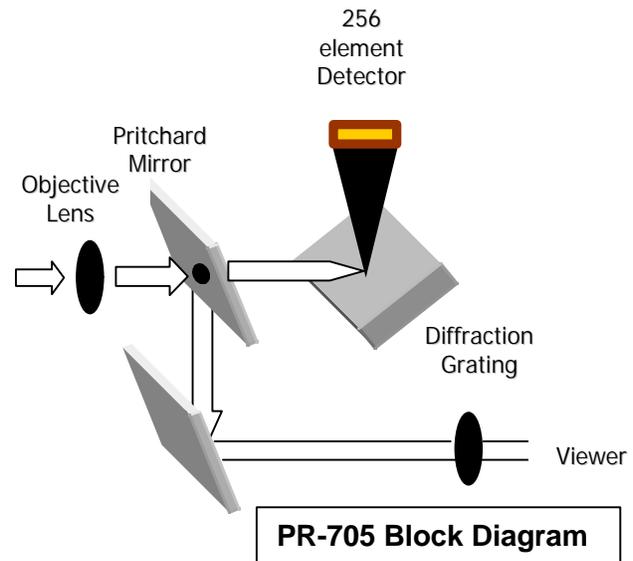
System Components

Hardware

A 486 "computer on chip" controls the PR-705, which is responsible for controlling and or monitoring all motors, communications, measurements and calculations. Silicon memory circuits are used as the "hard drive" for the instrument and, like a traditional hard drive, does not require battery back-up.

Communications

The PR-705 / 715 is equipped with two interfaces to handle communications to the outside world.

A 9 pin, sub-d connector is provided for RS-232C communications, and a Centronics parallel 25-pin connector is available for connecting to a standard DOS printer.

See the "Connectors" sections for complete details.

Data Storage

Following a measurement, data can be stored as binary or text files to the built-in, 1.44 Mbytes floppy disk drive.

Custom Applications

Each PR-705 / 715 is equipped with Remote Mode programming capabilities. Remote Mode programming enables the user to control the PR-705 / 715 from an application program by sending commands and receiving reports in ASCII (text) format.

This provides a powerful tool for Automated Test Equipment (ATE) applications or any task that requires specialized measurement procedures.

SpectraWin Software

An optional operating program, SpectraWin, is available for control and measurements with the PR-705 / 715 from a Windows ('95, '98, NT) based application. SpectraWin utilizes a full Graphical Users Interface (GUI), displays measured results using full color graphs, has numerous pre-canned measurement routines such as reflectance and transmittance and like other Windows based programs, allows cutting and pasting of graphics and or text to other programs (e.g. Microsoft Word and Excel).

Additionally, an option to SpectraWin allows complete on-site re-calibration of the PR-705 / 715. Please call Photo Research for more information.

Measurement Sequences

During a measurement, the optical signal enters the collection optics (the default collection optics for the PR-705 is a 55 mm variable focus objective lens – the MS-55). The objective lens then images the signal on the Pritchard Mirror measuring field (up to six available on a single instrument) which also serves as the entrance slit for the spectrometer. The measuring aperture appears as a black area in the center of the field of view.
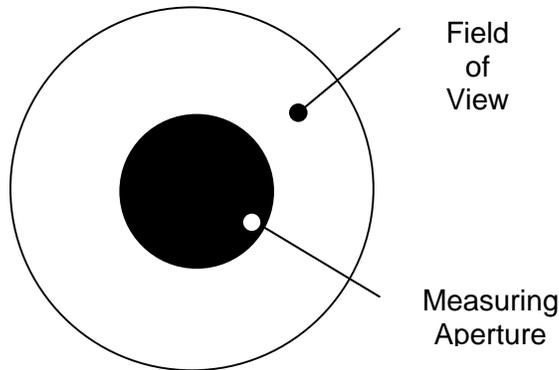
**PR-705 / 715 Measuring
Aperture**

The incoming signal is then imaged onto the
diffraction grating where it is broken up into its
component wavelengths. The diffracted spectrum is
then relayed to the detector, where each of the 256
detectors is illuminated by a discrete band of the
diffracted spectrum.

That part of the scene that does not pass through the
measuring aperture is reflected onto a mirror, which
relays the optical signal to the viewing eyepiece and
ultimately to the observer.

The Adaptive Sensitivity® algorithm automatically
determines the amount of time the detector is
exposed to light. Once the optical signal has been
measured, another measurement is made for the
same amount of time with no light striking the
detector (detector dark-current). The dark-current
measurement is then subtracted from the

measurement of the sample, yielding light signal only.

This information, which during the measurement is converted from an analog to a digital signal by means of a high speed A/D converter, is corrected for wavelength accuracy and intensity per wavelength by factors determined during the calibration of the instrument.

Once the spectral distribution is measured, all other photometric, radiometric and colorimetric values are mathematically calculated. Following a spectroradiometric measurement, the tristimulus values X, Y and Z are obtained by integrating the spectral data with the CIE color matching functions as follows:

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

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

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

where: $S(\lambda)$ is the spectral data, XYZ are the tristimulus values, and $\overline{x}, \overline{y}, \overline{z}$ are the CIE tristimulus functions. Y also serves as the photometric brightness, for example luminance in cd/m^2, or illuminance in lux depending on the type of optical accessory in use.

The calculated tristimulus values are then used to compute CIE chromaticity coordinates and correlated

color temperature, which provides a complete description of the color of the source. CIE Chromaticity is calculated by:

$$\textbf{\textit{CIE 1931 x}} = \frac{\textbf{\textit{X}}}{\textbf{\textit{X + Y + Z}}}$$

$$\textbf{\textit{CIE 1931 y}} = \frac{\textbf{\textit{Y}}}{\textbf{\textit{X + Y + Z}}}$$

$$\textbf{\textit{u'}} = \frac{\textbf{\textit{4X}}}{\textbf{\textit{X + 5Y + 3Z}}}$$

$$\textbf{\textit{v'}} = \frac{\textbf{\textit{9Y}}}{\textbf{\textit{X + 5Y + 3Z}}}$$

Because all values are calculated from the absolute spectral power distribution (SPD), errors arising from filter mismatch common to filter colorimeters are eliminated making highly accurate measurements of narrow band sources like plasma displays, LCD's, LED's, CRT's and other "spiky" sources possible.

PR-705 Calibration

Wavelength Calibration

Because spectroradiometers are wavelength dependent devices, they require a calibration against a source of known spectral emission. In the case of the PR-705, the spectral emission is comprised of helium (He) lines. For the PR-715, the spectral source contains mercury and argon (HgAr) spectral lines. By knowing the spectral emission lines, the spectroradiometers wavelength accuracy, or wavelength peak determination, can be accurately

calibrated. The wavelength calibration is the first phase in the calibration process.

Intensity Calibration

The second phase of a spectroradiometer calibration consists of a calibration for intensity versus wavelength. The standards used for this calibration are the same types used for photometer calibrations such as an integrating sphere source (like the Photo Research Model LRS-455 or LRS-462), or irradiance lamp standard in combination with a calibrated reflectance standard. Spectral standards are calibrated for intensity versus wavelength (spectral intensity calibration). The PR-705 measures the spectral standard, and factors are determined for each wavelength based on the measured value and published data for the standard. This calibration insures that whatever type of spectral sample, the result is an accurate spectral power distribution (SPD).

Chapter 2 - Getting Started

Hardware Setup

The PR-705 / 715 SpectraScan Spectroradiometer is supplied with an AC Adapter Power Supply and RS-232 cable.

The AC Adapter can be used for AC input voltages from 90 to 250 volts. The AC frequency range is from 50 to 60 Hertz (cycles per second).

The RS-232 cable is used to connect the PR-705 (PR-715) to a remote host (PC) for using the optional SpectraWin software package, or to transfer measured data reports from the PR-705 to a PX following a measurement.

The Printer connector supports a standard DOS or Windows Centronics parallel printer. Use this to print measurement results directly from the PR-705 (ASCII text data only - no graphics).

The SYNC Connector is used to make measurements synchronized to an external source. See Appendix E for further details on PR-705 / 715 externally triggered measurements.

ON / OFF SWITCH

DC POWER

SYNC Connector

RS-232

Printer
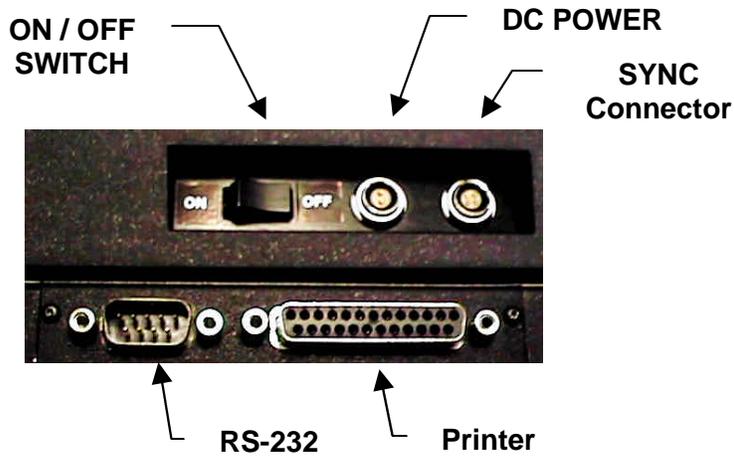
Figure 1.1 - PR-705 Connectors

AC Connector
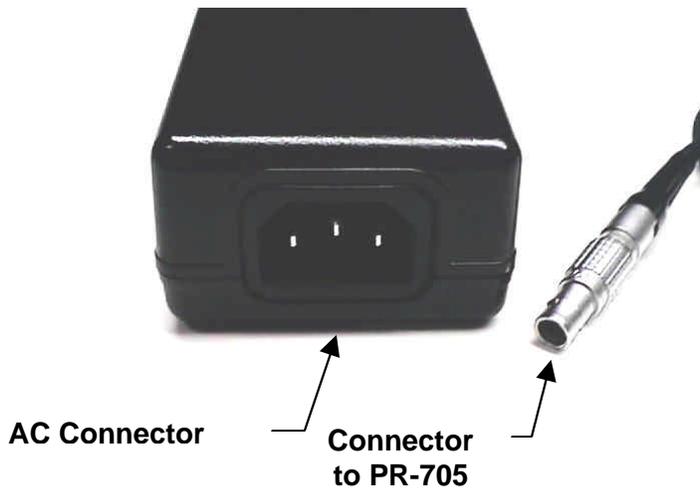
Connector to PR-705

Figure 1.2 - PR-705 AC Adapter

Figure 1.3 - AC Adapter Connection

Connectors

Power

The two pin *Power* socket, located next to the ON / OFF switch, receives the two pin male plug from the PR-705 power supply.

RS-232

The 9 pin female sub-d *RS-232* connector is used to connect the PR-705 to a serial printer or to a PC for running SpectraWin software.

An appropriate RS-232 interface cable is supplied as standard equipment with the PR-705. If extra cable length is required, be sure that the purchased cable is a "straight" cable (pin to pin) and not a "null modem" type (pins 2 and 3 are swapped).

Handshaking

During operation, the PR-705 / 715 uses the RTS and CTS lines for communications handshaking. Therefore, if using a terminal emulator such as Microsoft Windows HyperTerminal, configure the Flow Control to Hardware.

RS-232 Interface Pin Assignments

PIN	Description	Abbreviation
1	Data Carrier Detect	DCD
2	Receive Data	RX
3	Send Data	TX
4	Data Terminal Ready	DTR
5	Signal Ground	
6	Data Set Ready	DSR
7	Request To Send	RTS
8	Clear To Send	CTS
9	Ring Indicator	RI

SYNC

See Appendix E for more details.

Printer

This is a standard Centronics parallel printer connector; the same as found on most desktop and laptop Microsoft DOS or Microsoft Windows based PC's

Hardware Set-up Procedure

STEP 1 -   Make sure the ON / OFF switch is set to OFF.

STEP 2 -   Insert the receptacle on the AC Power Cord into the AC Adapter Power Supply jack. Insert the other end of the AC cord into a suitable wall outlet.

STEP 3 -   Carefully insert the two-pin plug from the PR-705 power supply into the two-pin socket on the PR-705. This is a keyed connector. Rotate the connector

> **Note: Do not use any other power supply except the one supplied by PHOTO RESEARCH to power the PR-705. Irreparable damage could result**

until the orientation keys align, then gently insert the connector until it "clicks".

To remove the connector, pull back on the spring loaded knurled ring and gently pull.

STEP 4 -   (OPTIONAL) – Insert an IBM formatted 3.5" floppy disk in the disk drive located on the side opposite the connectors.

> **Note: If a floppy disk with a valid** *Setup* **file located on the root directory, the PR-705/715 will utilize the setup parameters on the disk.**

STEP 5 - Toggle the ON / OFF Switch to the **ON position**.

The PR-705 will perform a self-test sequence and when finished, will display a screen similar to the following:

```
Detector Stabilizing
       10 min
  Next calibration due
     Dec 09 1999
```

This screen may be exited by pressing the **FRWD** key at any time.

Warning: If a measurement is made before the PR-705 / 715 detector is sufficiently stabilized, inaccurate results may occur.

STEP 6 - Once the detector temperature is stabilized, a screen similar to the following screen appears.

```
       PR-705
  Press MEAS, or FRWD
  for setup options.
  Dec 10 1997 11:53:31
```

STEP 7 -   Press the **FRWD** key to change
instrument set-up parameters, or press
the **MEAS** key to make a measurement
with the current parameters (see
Chapter 3, *Making Measurements)*.

Chapter 3 - Making a Measurement

Overview

In general, a PR-705 measurement consists of a few basic steps. These steps include:

- Focusing and aligning the instrument

- Selecting the setup parameters through the software and

- Executing the measurement.

The remainder of this describes the steps required to make a successful PR-705 measurement.

Focusing and Aligning the PR-705

To insure measurements made with the PR-705 are as accurate as possible, it is important to properly align and focus the instrument onto the target.

Focusing

> Proper focus of the PR-705 is essential to insuring accurate measurement results. If the instrument is not focused correctly, a parallax condition will exist resulting in improper alignment of the measurement aperture on the target.

Focusing Procedure

Step 1 -   Looking into the PR-705 eyepiece, make sure the target is completely out of focus. This can be accomplished by placing a white piece of paper directly in front of the objective lens.

Turn the eyepiece either clockwise or counter clockwise until the vertical center of the measuring aperture is in focus. It is normal that the top and bottom of the aperture may be slightly out of focus when the center is in sharp focus. This is due to the 45° orientation of the Pritchard mirror in relation to the systems optical axis in conjunction with the depth of field of the viewing system.
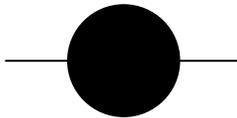
Vertical center of round aperture.

Note: No line appears on the PR-705.

> **Note:**   **The eyepiece must be refocused each time a different operator uses the instrument.**

For smaller apertures, it is possible that the entire aperture will be in sharp focus.

Step 2 -   For **variable focus lenses** (MS-55) turn the focus ring of the lens

until the target is in sharp focus in the vertical center of the field of view.

Step 3 - For **fixed focus lenses** (MS-1X, MS-77, and MS-5X) move either the PR-705 or target until the horizontal center of the field of view is in sharp focus.

Alignment

When using an objective lens, attention must be paid to the proper alignment of the measuring aperture on the target. ***Improper aperture alignment will result in inaccurate results.***

Alignment Procedure

Step 1 - While looking through the eyepiece, align the measuring aperture so that the largest dimension of the measuring aperture is smaller than the smallest dimension of the target. Ideally, the apertures diameter or largest dimension should cover between 50% to 80% of the target.

This is essential for accurate measurement results.
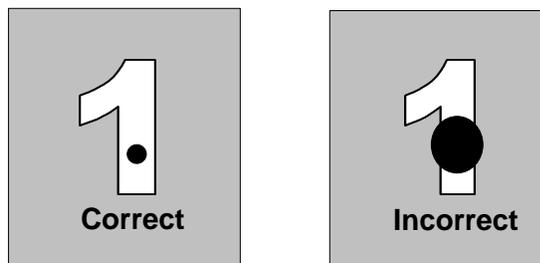
Alignment of Measuring Aperture

In the preceding example, the illustration on the left demonstrates proper alignment.

Refocus the objective lens on the target if necessary after aligning the PR-705. It is not necessary to refocus the eyepiece.

Selecting Setup Parameters

All measurement setup parameters including hardware setup, data display selection and printing options are accessed from one of 8 setup screens. Screen descriptions are detailed in Chapter 5 – *PR-705 Screens.*

Following are procedures covering selection of three primary hardware attributes: optical accessory selection, Aperture selection and Display options.

Selecting an Optical Accessory

Step 1 - Press the **FRWD** until *Setup Screen #1* appears.

Step 2 - Press the ▲ or ▼ key until the **>** symbol is aligned to the left of the *Lens:* field.

Step 3 - Press the **ENTR** key to cause the field to the right of *Lens:* to begin blinking.

Step 4 - Press the ▲ or ▼ key to scroll through calibrated *Lens:* choices.

Step 5 - Press **ENTR** to accept the currently displayed *Lens:.*

Step 6 - Repeat Steps 2 – 5 for the *Add1:* and or *Add2:* fields.

Selecting an Aperture

The PR-705 can be equipped with as many as six apertures (measuring fields). If your system is supplied with more one aperture (standard equipment), use the following procedure to select the aperture to be used for the next measurement.

Step 1 -   Press the **FRWD** key until *Setup Screen #2* appears.

Step 2 -   Press the ▲ or ▼ key until the **>** symbol is to the left of *Aperture:*.

Step 3 -   Press the **ENTR** key to cause the field to the right of *Aperture:* to begin blinking.

Step 4 -   Press the ▲ or ▼ key until the aperture of choice appears.

Step 5 -   Press the **ENTR** key to accept the displayed selection.

Selecting a Data Display Option

Following a PR-705 measurement, the data can be displayed is one of several formats. These display options are described in detail in Chapter 5 – PR-705 screens. The following procedure describes the steps required to select a data display option.

Step 1 -   Press the **FRWD** until *Setup Screen #2* appears.

Step 2 -   Press the ▲ or ▼ key until the **>** symbol is to the lift of *Display:*.

Step 3 - Press the **ENTR** key to cause the field to the right of *Display:* to begin blinking.

Step 4 - Press the ▲ or ▼ key until the display option of choice appears.

Step 5 - Press the **ENTR** key to accept the displayed selection.

Redisplaying Data

Use the following procedure to re-display calculated values other than those displayed following a measurement.

For example, if Yxy, CCT was displayed following a measurement, and now Yxy, u'v' is required:

Step - After a measurement, use **Steps 1-5** from the preceding section to select a Display type (Yxy,u'v' for example).

Step - Press the **Alt** key.

Step - Press the **CALC** key. The measured values are re-displayed. This becomes the default for future measurements.

Starting a Measurement

After hardware and display options have been selected, and if the ▉▉▉ symbol appears in the upper right hand corner of the PR-705 display, a measurement may now commence. To make a measurement:

Step 1 - Press the **MEAS** key to begin the measurement.

Step 2 -   At the completion of the measurement, the measured data is displayed according to the current *Display* selection.

Chapter 4 - PR-705 Keys

This chapter describes the on-board key functions of the PR-705.

All PR-705 / 715 functions are controlled by menus accessible and modified by one or more of the keys on the back control panel. Key locations are illustrated below.
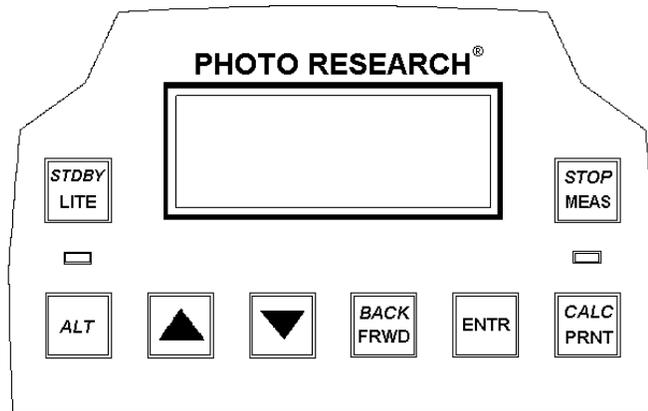
PR-705 / 715 Keys

NOTE: **Many of the PR-705 keys are multi-functional. These keys are denoted by two imprinted words on each key, one in *Italics,* and one in standard type. To actuate the function represented by the standard type, simply press that key. For the actions labeled in *Italics*, press the ALT key first.**

```
┌─────────┐
│ STDBY   │
│         │
│  LITE   │
└─────────┘
```

LITE

Pressing the **LITE** key sequentially changes the intensity of the PR-705 back light. There are four levels of back light - low, medium high and off. Keep pressing **LITE** to toggle between back light levels.

STBY

Press **ALT**, then *STDBY* to put the PR-705 in a standby mode. The standby mode turns off the display only and the message **Standby** appears on the PR-705 display. Press *STDBY* again (do not press **ALT** first) to "wake-up" the PR-705.

```
┌─────────┐
│         │
│   ALT   │
│         │
└─────────┘
```

ALT

The **ALT** key is used to actuate the functions indicated by *Italics* on the PR-705 keys.

By pressing **ALT** once, a small blinking **"a"** appears in the upper right hand corner of the PR-705 display indicating that the *ALT* mode function is active. Pressing another key executes the alternate function then, returns to the standard (non-italic) key functions.

Pressing **ALT** twice displays an upper case **A** in the upper right hand corner of the display, and locks the ALT function so that repetitive actions may be undertaken without the need of pressing **ALT** each time. If another key is not pressed with 12 seconds, the locked ALT function is disabled and the PR-705 returns to the normal mode.
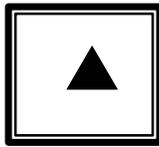
UP ARROW (▲)

The ▲ key is multi-purpose. When scrolling through a menu, use the ▲ key to cause the **>** selection icon to move through the menu.

Once a line item on a menu (for example, a Setup Screen) has been selected, use the ▲ arrow to scroll through available choices. Press and hold the ▲ key to automatically scroll through selections.
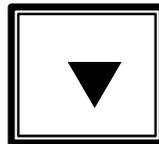
DOWN ARROW (▼)

Like the **UP ARROW** (▲) key, the ▼ key is used to select line items in a menu, and scroll through selections once a line item has been selected. Press and hold the ▼ key to continuously scroll through selections.

```
┌─────────────┐
│ ┌─────────┐ │
│ │ BACK    │ │
│ │         │ │
│ │ FRWD    │ │
│ └─────────┘ │
└─────────────┘
```

BACK / FRWD

Use this key to scroll through the PR-705 menus. Press **ALT** then **FRWD** (*BACK)* to scroll through menus in reverse order. Press and hold the **FRWD** key to continuously scroll through selections.

```
┌─────────────┐
│ ┌─────────┐ │
│ │         │ │
│ │  ENTR   │ │
│ │         │ │
│ └─────────┘ │
└─────────────┘
```

ENTR

The **ENTR** (Enter) key is used to select an item for change from a menu (for example Display Options) denoted by the **>** symbol, and once a choice has been made from within a menu item (for example, selecting a Display Option or setting the time or date), use the **ENTR** key to accept the displayed selection.

```
┌─────────────┐
│ ┌─────────┐ │
│ │  CALC   │ │
│ │         │ │
│ │  PRNT   │ │
│ └─────────┘ │
└─────────────┘
```

CALC ⁄ **PRNT**

Press **PRNT (**PRINT**)** to print measured data from the current display screen to the PR-705 parallel printer port, or to send data to a remote PC over the RS-232 port. The data will be printed according to the parameters set in the *Print Setup.*

By pressing **ALT** then **PRNT (*CALC*),** measured data will be redisplayed depending on the display option. This is useful if a measurement is taken, and the operator wishes to view calculated data other than the data that is currently displayed.

For example, a measurement is taken and Yxy, u'v' is displayed. It is then decided that Yxy, CCT is required. By changing the Display Option, then pressing **ALT PRNT (*CALC*),** the new calculated results will be displayed without requiring another measurement. The *CALC* function is also available if the CIE Observer is changed following a measurement (for example from $2°$ to $10°$ colorimetric observer data), or, for example, if the *Units* are changed from footlamberts to cd/m^2.

```
STOP

MEAS
```

STOP / MEAS

Press the **MEAS** key to begin a measurement sequence. Press **ALT** then **MEAS (*STOP*)** to abort a measurement in progress. All data from the aborted measurement will be lost.

Chapter 5 - PR-705 Screens

Overview

The PR-705 is controlled and data is displayed on the built-in 4 x 20 back lit LCD display.

All hardware options including optical accessories (lenses, reflectance standards etc.), apertures, measurement display options, printing options, time and date and file operations are controlled from one of 8 set-up screens.

NOTE: **Changes to hardware setup parameters are lost when the instrument is turned off. For more information on saving changes, see the *Save, Load Setup* section later in this chapter for more details.**

Screen Icons

During operation, one or more status icons may appear on the PR-705 display. Following are descriptions of the icons.

↑

Indicates that the up arrow key is active. This icon will appear in the lower right hand corner.

⬇

Indicates that the down arrow key is active. This icon will appear in the lower right hand corner of the display.

F

Indicates that the *FRWD* key is active. This icon will appear in the lower right corner of the display.

E

Indicates that the *ENTR* key is active. This icon will appear in the lower right hand corner of the display.

P

Indicates that the *PRNT* key is active. This icon will appear in the lower right hand corner of the display.

▬
■ ■ ■

This icon, which appears in the upper right hand corner of the display, means that a measurement may be started by pressing the *MEAS* key.

a or A

A lower case **"a"** appears in the upper right hand corner of the PR-705 display after the **ALT** Key has been pressed once. This indicates that a keys alternate function, or function indicated by italics is active.

If an uppercase **A** appears in the upper right hand corner, the **ALT** key has been pressed twice and the **ALT** function is locked. It can be released by pressing **ALT** again, or if no other key is pressed within 12 seconds.

Screen Navigation

1. Navigating through the PR-705 on-board software screens is accomplished by using one of 5 keys on the rear control console of the instrument. The five keys are illustrated below.
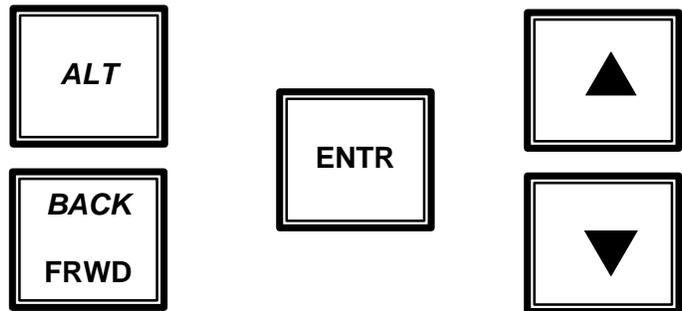
The *BACK* / **FRWD** key is used to scroll through screens. For example, press **FRWD** to go from *Setup Screen #1* to *Setup Screen #2*. Press **ALT** then **FRWD** (same as *BACK*) to go from *Setup Screen #2* to *Setup Screen #1.*

The **UP / DOWN (▲ ▼)** arrow keys are used to select an item from within a menu by causing the **>** symbol to move from one choice to another. These keys are also used to scroll through options that are associated with a menu selection.

Press the **ENTR** key to either select a menu item for change as indicated by the **>** symbol, or to select an option from within a menu item that has been changed.

Once a menu item has been chosen by placing the **>** symbol next to it, press the **ENTR** key to make the options associated with the menu item active for change.

Sample Procedure #1

The following procedure outlines one of the more common menu selection procedures for the PR-705. The procedure involves scrolling through then selecting an option from within a menu item selection. For this example, a *Display Option* will be selected.

Procedure

STEP 1 -   Press **FRWD** until *Setup Screen #2* appears.

STEP 2 - Press the ▲ or ▼ keys until the **>** symbol appears next to *Display:*.

STEP 3 - Press **ENTR**.

STEP 4 - The parameter field next to *Display* begins blinking indicating that this field may now be changed.

STEP 5 - Press the ▲ or ▼ keys to scroll through the available Display options until the item of choice appears.

STEP 6 - Press **ENTR** to select the item.

Sample Procedure #2

This is one of the more involved PR-705 menu operations. The following procedure can also be used to change the internal time or date of the PR-705. The Detector Exposure Time will be changed in this example.

Procedure

STEP 1 - Press **FRWD** until *Setup Screen #3* appears.

STEP 2 - Press ▲ or ▼ until the **>** symbol is next to the left of *Adptv* (or *Fixed)*.

STEP 3 - Press **ENTR.**

STEP 4 - Press ▲ or ▼ until *Fixed* appears.

STEP 5 - Press **ENTR**.

STEP 6 -   Press ▲ or ▼ until the **>** is to the left of *Expsre*.

STEP 7 -   Press **ENTR**.

STEP 8 -   Press **FRWD** until the desired integer begins blinking.

STEP 9 -   Press ▲ or ▼ until the desired integer appears.

STEP 10 -   Press **FRWD** to cause the next field to begin blinking.

STEP 11 -   Repeat STEPS 9 - 10 until the required value appears.

STEP 12 -   Press **ENTR** to accept and exit.

Calculated Values

Following are descriptions for several of the values displayed following a measurement. Since one or more of the following parameters appears in every display screen, this list was compiled in the interest of brevity.

Y

The photometric intensity value with the possibilities being:

- **Luminance** in footlamberts or cd/m^2 for all lenses, and the FP-705 fiber probe accessory. This is the photometric unit for the standard MS-55 lens.

  1 fl = 3.426 cd/m^2.

- **Illuminance** in footcandles or lux for the CR-55, RS-3 or SRS-3.

  1 fc = 10.76 lux

- **Luminous intensity** in millicandelas for the LR-55 or IS-700.

- **Lumens** for the IS-700

  x,y

The CIE 1931 Chromaticity Diagram Cartesian coordinates.

  u',v'

The CIE 1976 Uniform Color Space Cartesian coordinates.

  XYZ

CIE Standard Observer Tristimulus Values calculated from the corrected spectral data.

  CCT

Correlated Color Temperature in Kelvin.

Screen Descriptions

Setup Screen #1 – Accessory Selection

This screen is used to select the optical accessories that will be used for the next measurement including the Primary *Lens* and any ancillary accessories (*Add1* or *Add2*).

> **NOTE: Only those *Lenses* and other accessories calibrated with the PR-705 will appear as choices in the *Lens* or *Add* menus.**

```
        Setup Screen #1
   >Lens:MS-55
     Add1:None
     Add2:None
```

Lens

This field provides a menu for the user to select the Primary Lens to be used for a measurement. The standard *Primary Lens* for the PR-705 is the MS-55 variable focus objective lens. At least one *Lens* <u>must</u> be selected to perform a measurement. Use Sample Procedure #1 to select the *Lens.*

Add1 or Add2

These are optical accessories that may be used in combination with the *Lens*. For example, Neutral Density (ND) Filters such as the ND-700-10 and Reflectance Standards such as the SRS-3. The optical characteristics for these types of accessories remain constant regardless of the type of *Lens* in use. Use Sample Procedure #1 to select an *Add1* or *Add2* optical accessory.

Setup Screen #2 – Display Options, Aperture Selection and Photometric Units Selection

This section will provide instructions selecting the data type displayed following a measurement, the aperture used for the next and subsequent measurements and the photometric units (English or SI) type.

```
        Setup Screen #2
     >Display:Yxy, u'v'
       Aperture:2 deg.
       Units:fL
```

Display

Use *Sample Procedure #1* to select **Display** options. Display options include:

Yxy, u'v'

Sample Result Screen

```
2.919e+1 fL      -        ←——— Y
x=.4476 y=.4074           ←——— x, y
u'=.2560 v'=.5243         ←——— u', v'
                 2°       ←——— 2° observer used
```

Yxy, CCT

Sample result screen

```
2.919e+1 fL        -
x=.4476 y=.4074
CCT=2856K  +.0000 uv
                    2°
```

Correlated Color Temperature and 1960 uv deviation or distance from Planck's blackbody radiator in CIE 1960 uv chromaticity coordinates.

Yu'v', CCT

Sample result screen:

```
2.919e+1 fL        -
u'=.2560 v'=.5243
CCT=2856K  +.0000 uv
                    2°
```

XYZ, CCT

Sample result screen:

```
X=1.098e+2         -
Y=1.000e+2 CT=2856K
Z=3.558e+1 +.0000 uv
                    2°
```

Radiometric

After a measurement with the *Radiometric* display option selected, the following screen appears displaying the integrated (total) radiometric value (*Integr. Radiance* in the sample result screen), the radiometric value at the peak (*Pk Rad.* In the sample result screen) and the wavelength in nanometers (nm) where the peak value occurs.

Sample result screen:

> **Integr. Radiance: -**
> **4.743e+04watts/sr/m2**
> **Pk Rad. 2.417e+02**
> **Peak WL: 780 nm**

Press the ▼ key to view the second of the Radiometric result screens which displays the photon based radiometric quantity (*Photon Rad*) in the following example.

> **Photon Rad.:   -**
> **1.558e+23**
> ** photon/sr/m2/sec**

Aperture

Use this field to select the measuring aperture for the next and subsequent measurements. Only those apertures purchased and calibrated with the PR-705 will appear as choices. Use Sample Procedure #1 to select the aperture.

Units

The *Units* field is used to select either English or Metric (SI) calculated photometric values. The description of the unit follows the type of optical accessory in use. The following tables list the photometric and radiometric values associated with accessories available for the PR-705.

Photometric Units

Accessory	English	Metric (SI)
All lenses and the FP-55 Fiber Probe	fL (foot-lamberts)	Cd/m^2
CR-55, RS-3, SRS-3	fc (foot-candles)	Lux
LR-55	mcd (milli-candelas)	mcd (milli-candelas)
IS-700	mcd or lumens	mcd or lumens

Radiometric Units

Accessory	Radiometric Unit
All lenses and the FP-55 Fiber Probe	$w/sr/m^2$ (watts per steradian per square meter)
CR-55, RS-3, SRS-3	w/m^2 (watts/square meter)
LR-55	w/sr (watts per steradian)
IS-700	w/sr or w (watts)

Setup Screen #3 – Detector Exposure Time, Capture Method and Cycles to Average Selection

From *Setup Screen #3*, data capture parameters such as detector exposure time (*Expsre*), Adaptive Sensitivity or Fixed Exposure time, (*Adptv* in the following example screen), single or continuous

Capture and 1 - 99 *Cycles* to average can be selected.

```
        Setup Screen #3
      >Expsre:00300 Fixed
       Capture:Single
       Cycles:01
```

Expsre

Select from 25 ms to 60,000 ms (1 minute) as a fixed detector exposure time, if the field to the right of *Expsre* is set to *Fixed* as shown above. If this field is set to *Adptv*, the PR-705 will automatically select the proper detector exposure time. Use Sample Procedure #2 to enter the exposure time.

Fixed

Set this field to either *Fixed* or *Adptv.* If set to *Fixed,* the user sets the detector exposure time in the *Exprse* field. When set to *Adptv*, the PR-705 automatically determines the proper exposure time and disregards the value in the *Expsre* field. Use Sample Procedure #1 to change this field.

```
        Setup Screen #3
       Expsre:00300 >Adptv
       Capture:Single
      Chapter 2  Cycles:01
```

Capture

The setting in the *Capture* field commands the PR-705 / 715 to either make a *Single* measurement, or to make *Continuous* measurements.

If *Continuous* is selected, the PR-705 continually makes measurements until **ALT** then **MEAS** (*STOP*) is pressed between measurements (abort sequence). Use Sample Procedure #1 to change this field.

Cycles

For each measurement, the PR-705 will average the number of *Cycles* specified in this field. The range of possible cycles is *1* (factory default) to *99* cycles. During the measurement, the PR-705 / 715 sums the uncorrected measured data then averages these data after all cycles are completed. Photometric and colorimetric are calculated from the averaged data.

Setup Screen #4 – Calculation Mode, Trigger Method and File Operations

```
        Setup Screen #4
   >Calc:Power
     Trigger:Manual
     File Setup
```

Calc

Choices are *Power* and *Energy*.

Power

If *Power* is selected, during the calculation chain the data is divided by the detector exposure time yielding intensity per second. This is the default mode of operation.

Energy

The *Energy* mode is selected whenever there is a requirement to measure short duration (pulsed) sources. In these cases, it is quite possible for the event to be shorter than the minimum exposure time of the PR-705 (10 ms). Therefore, if *Power* was selected, and the result divided by the exposure time, the calculated value would be in error.

By selecting *Energy* the calculated data is not normalized to the detector exposure time. Therefore the displayed results are temporally (time) based. For example, footlambert ∗ seconds instead of footlamberts.

> **NOTE: If *Energy* mode is selected, a Fixed Exposure time _must_ be set**.

Trigger

The *Trigger* field provides the method whereby the PR-705 / 715 will, after initiating a measurement either from the keyboard or from a *Remote Mode* command, accept a pulse from an outside source, then send a trigger pulse to cause a source to activate (e.g. strobe light).

Manual (External Trigger Mode NOT Enabled)

Select this to start measurements by pressing the **MEAS** key on the PR-705 control panel

To make a measurement of a pulsed source using the *Manual* trigger mode:

Step 1 -   Use the **FRWD** key until *Setup Screen #4* appears.

Step 2 -   Set the *Exprse* mode to *Fixed.*

Step 3 -   Set the Exposure time so that enough time is allowed to start the measurement, then trigger the flashing source. For example, 1000 ms (one second).

Step 4 -   Press the **ENTR** key.

Step 5 -   Use the ▲ or ▼keys until the **>** symbol is next to the *Calc:* field.

Step 6 -   Press **ENTR.**

Step 7 -   Use the ▲ or ▼key to display *Energy.*

Step 8 -   Press **ENTR.**

Step 9 -   To begin the measurement,, first press the **MEAS** key, then immediately flash the source.

Step 10 - Following the measurement, all radiometric, photometric and tristimulus values are in terms of temporal quantities. To calculate the DC equivalent values:

$$E_{DC} = \frac{I_e}{P_t * N_p}$$

where:

E_{DC} =   Equivalent DC value

I_e =   PR-705 *Energy* reading

P_t =   Width of a single pulse

N_p =   Number of pulses measured in a single measurement sequence.

External

External triggering is an option to the standard PR-705 features. If your instrument was equipped with this option, please see *Appendix E* for further details.

File Setup

The *File Setup* options are used to define if and how files are stored to the PR-705 on-board disk drive.

The PR-705 creates or checks for three files if a removable disk is present in the drive when the instrument is turned on. These files are useable by the PR-705 only and cannot be directly read by other programs. The files are:

> **NOTE: The numbers (for example: 12345678) in the following file names represent all or part of the serial number of the PR-705.**

- **12345678.MEA**
  This is a binary file that contains measured data and is appended whenever the PR-705 is instructed to store a measurement.

NOTE: **If the maximum number of files is exceeded, the PR-705 issues a message that the maximum number of possible measurements has been stored on this disk. If you wish to continue saving, insert another disk in the PR-705 disk drive.**

- **CU345678.000**
  This is a zero byte file that is used as a record of how many measurement files are currently in 12345678.MEA. After a measurement is stored to the disk, the file extension is incremented by one. For example, CU345678.001 indicates that one file is currently stored on the disk.

- **MX345678.351**
  The extension of this file (in this example 351) is the maximum number of PR-705 measurements that can be stored on the disk currently in the PR-705 disk drive.

Procedure

Step 1 -   Use the **FRWD** key until *Setup Screen #4* is displayed.

Step 2 -   Use the ▲ or ▼ until the **>** symbol appears next to *File Setup.*

Step 3 -   Press **ENTR**.

Step 4 -   The following screen appears:

```
        File Store/Recall
 >Store:Off
   Recall:File #  N.A
 Vol:0106981444
```

Store

This field is used to instruct the PR-705 to either disallow storing measurement data, allow manual (keyboard initiated) storage or unattended (automatic) file storage.

While the PR-705 is storing the measurement data, the following screen will briefly appear

```
 Writing Meas #010 on
 disk 0106981601
```

In the preceding example, the number on the bottom line of the display, 0106981601 is the Volume Label of the disk in the PR-705 disk drive.

If there is no disk in the drive when the *Store* command is given, the following screen appears:

```
        ERROR
 Storage Disk is:
   Not AVAILABLE
 Retry: ⬆ Cancel: ⬇
```

Insert an IBM formatted disk in the drive and press the ▲ key to store the data, or press the ▼ key to cancel the operation.

Following a successful measurement store function, the system returns to the display screen. At this point, the current display screen is updated with the measurement number as shown in the following example:

```
2.919e+1 fL        -
u'=.2560 v'=.5243
CCT=2856K  +.0000 uv
I.D #: 002          2°
```

In the preceding example, the measurement data is saved as file (ID#) 2.

Use Sample Procedure #1 to select the desired option in the *Store Field.*

- **Off**
  No data storage is allowed.

- **Manual**
  Data is saved after a measurement by pressing the **ENTR** key. Alternately, data may be saved after a *CALC* (**ALT PRNT** key sequence) operation by pressing the **ENTR** key.

- **Auto**
  The PR-705 will automatically store data following a measurement.

- If both *Store* and *Print* are simultaneously set to *Auto*, the PR-705 will store the measured data before printing.

Recall

The *Recall* function is used to view and or print previously stored measurement data.

Recall Procedure

STEP 1 - Press the ▲ or ▼ key to place the **>** symbol next to the file number (see following example).
Press the **ENTR** key.

> **File Store/Recall**
> **Store:Manual**
> **Recall:File # >001**
> **Vol:0106981444**

STEP 2 - The least significant digit of the *File* # begins blinking and can now be edited.

STEP 3 - Press the ▲ or ▼ key to change the digit number (press and hold either key to scroll).

STEP 4 - Press **FRWD** to cause the next digit to begin blinking.

STEP 5 - Press the ▲ or ▼ keys to change the digit.

STEP 6 - Repeat Steps 5 – 6 until the desired *File* # appears.

STEP 7 - Press the **ENTR** key to accept the displayed *File #*, and display the values in the current *Display* option mode.

Setup Screen #5 – View Shutter, CIE Observer Selection

Use the options in this screen to command the Viewing Shutter (*View*) to remain *Open* or *Closed* during the measurement and select the CIE Colorimetric Observer (*CIE Obs)* functions to be used for photometric and colorimetric calculations. Use Sample Procedure #1 to select either *View* or *CIE Obs* options.

```
        Setup Screen #5
   >View Sht:Open
     CIE Obs.:2 Degree
```

View

Open

Instruct the viewing (eyepiece) shutter to open during the measurement. This is especially useful if a video camera is used to view the measurement scene. If the shutter is *Open* during the measurement, the light entering the viewing shutter must be controlled or it may cause measurement errors.

Note: Photo Research offers an optional package including a B&W CCD camera and camera power supply, viewing eyepiece camera adapter and B&W monitor. Please call PHOTO RESEARCH for more details.

If in doubt whether to leave this shutter open or closed during a measurement, make sure it is set to the *Closed* position.

Closed (Power on default)

The viewing shutter remains closed during the measurement, then opens when the measurement is completed.

CIE Obs

2 Degree (Power on default)

The CIE 1931 Standard Observer Functions for a 2° visual field are used following the measurement to calculate photometric brightness, CIE 1931 xy, CIE 1976 u'v' chromaticity coordinates and correlated color temperature.
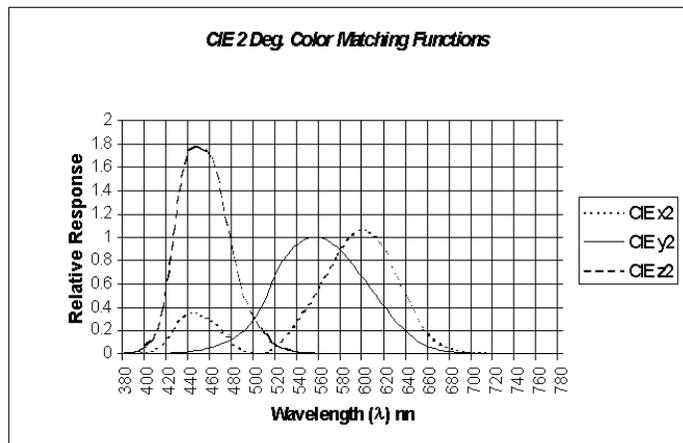
10 Degree

If this option is selected, the 1964 Supplemental Observer Functions are replace the CIE 1931

> **Note: When using the 1964 Standard Observer Functions, the calculated Y (photometric brightness) values are invalid since the CIE defines luminance as being calculated using the 1931 data.**

Standard Observer Functions for the calculation of color.

CIE 1964 Supplemental Observer
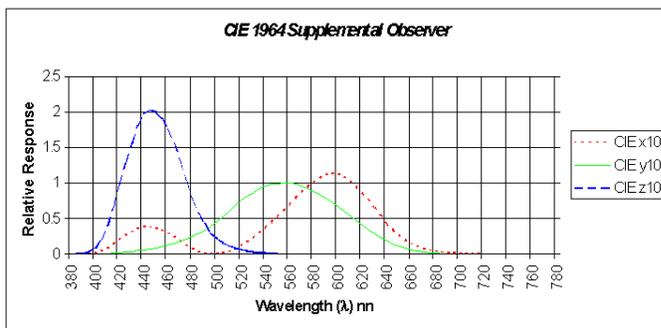
Print Setup

The options available from this menu determine the hard copy printing options for the PR-705. The PR-705 / 715 is capable of printing to a Centronics parallel printer, sending ASCII reports to a host PC. using connectors available on the instrument or saving text files to the built-in floppy disk drive.

Since the PR-705 prints only American Standard Code for Information Interchange (ASCII) formatted text data with no graphics, it will work with virtually any printer: laser jet, ink jet or dot matrix.

Mode

> **Note:** If the *Mode* field is set to *Off*, no other menu choices (*Format or Port)* can be accessed. The *Mode* must be set to either *Manual* or *Auto.*

The mode selection is used to choose between no printing (*Off)*, *Manual* printing or *Auto* printing. Use Sample Procedure #1 to select the print *Mode.*

Off

Select *Off* to disable all printing functions.

Manual

By choosing *Manual,* the data is sent to the selected port after a measurement by pressing the **PRNT** key.

```
          Print Setup
>Mode: Manual
  Format: View Screen
  Port: Parallel
```

Manual store is available following a measurement, or whenever the *Calc* (**ALT PRNT** key sequence) is executed.

Auto

Set the *Mode* field to *Auto* to instruct the
PR-705 to automatically print to the selected *Port* in
the selected *Format* after each measurement. The
Auto store function is only available following a
measurement.

> **Note: If Auto Print and Auto Store are
> enabled simultaneously, the
> PR-705 will store data before
> printing.**

Format

The *Format* field determines what type of report is to
be printed. The choices are *Disp. Scrn, Full Report*
and *Spectral.* Use Sample Procedure #1 to make
changes in the *Format* field.

Disp. Scrn

Prints a copy of what is currently being displayed on
the PR-705 screen. Using this format, up to 12
screens can be printed on an 8.5" x 11" page. To
see hard copy results before the twelfth display is
printed, use your printers form feed function.

Full Report

This two page print out is a full, verbose report of all
measured data including instrument setup
information, measurement time and date,
measurement ID# and disk label if data from a
recalled measurement is being printed. Additionally,
photometric (luminance, illuminance etc., scotopic
luminance), colorimetric (CIE chromaticity

coordinates and correlated color temperature) and radiometric data (integrated and spectral radiometric values) are printed, sent to a PC or saved to disk.

Sample of Full Report (Truncated)

PHOTO RESEARCH Inc.

Instrument   : PR-715
Serial number   : 75981301
Measurement date   : Sun Mar 14 18:43:54 1999

Measurement title :
Measurement I.D # : 0
** on disk labeled :**
Lens or accessory : MS-55
Add on accessory 1 :
Add on accessory 2 :
Measuring field   : 1 deg.
Spectral bandwidth : 20 nm
Average cycles   : 1
Exposure time   : 1249 mS
Scan range   : 380 - 1068 nm
**   increment   : 4 nm**

R A D I O M E T R I C   D A T A

Integrated Radiance = 1.850e-001 watts/sr/m2

Photon Radiance = 5.186e+017 photon/sr/m2/sec

P H O T O M E T R I C   D A T A

Luminance = 1.988e+001 fL
**   = 6.812e+001 Cd/m2**
**   = 2.975e+001 scotopic fL**
**   = 1.019e+002 scotopic Cd/m2**

C O L O R I M E T R I C   D A T A

CIE 1931:   X = 5.945e+001   x = 0.3733
**   Y = 6.812e+001   y = 0.4277**
**   Z = 3.169e+001   z = 0.1990**

CIE/UCS 1961: u = 0.2022   v = 0.3475

CIE/UCS 1976: u'= 0.2022   v'= 0.5212

CIE Observer: 2 degrees

Correlated Color Temperature = 4472 Kelvins, = 223.64 MK-1
Departure from Blackbody Locus = +0.0000 uv

S P E C T R A L   D A T A

Peak Radiance = 1.466e-003 watts/sr/m2 at 568 nm

WL	VALUE	WL	VALUE	WL	VALUE	WL	VALUE
380	5.696e-005	384	7.457e-005	388	1.226e-004	392	1.760e-004
396	2.122e-004	400	2.255e-004	404	2.162e-004	408	2.246e-004

Spectral

This report prints or transmits spectral data only with the following format:

Line 1: Title (PR-705 Serial Number, or Serial Number +Disk Volume +ID# if data has been stored or is a recalled data file).

Line 2: Starting Wavelength (380 nm)

Line 3: Ending Wavelength (780 nm for the PR-705 or 1068 nm since the PR-715)

Line 4: Wavelength Increment (2 nm for the PR-705 or 4 nm for the PR-715).

Line 5 – Line n – Measured spectral data.

This report format is ideal for exporting only spectral data over the RS-232 interface to a remote PC.
Spectral Output Sample (Truncated)

```
75981301
380
1068
4
5.092e-005
7.063e-005
1.272e-004
1.800e-004
2.126e-004
2.258e-004
2.151e-004
2.246e-004
2.613e-004
3.342e-004
5.611e-004
```

Use Sample Procedure #1 to make *Printer Setup* selections.

Port

The *Port* field provides selection for sending data to the on-board *Parallel* printer port or RS-232 *Serial* interface.

Parallel

Select *Parallel* if a standard parallel printer is connected to the PR-705 25-pin sub-d female connector.

Serial

Serial should be selected if the user wishes to "print" (send) data to a remote PC or RS-232 printer. The PR-705 can be connected to a PC via the 9 pin sub-d female connector and supplied RS-232 cable (see the *Connectors* section in Chapter 2 for RS-232 pin-out information).

The RS-232 hardware protocol is:

- **Baud: 9600**
- **Parity: None**
- **Data Bits: 8**
- **Stop Bits: 1**

Floppy

By selecting *Floppy,* an appended text file is created and (or appended) on a disk in the built-in disk drive. The file name is SSSSSSSS.TXT where SSSSSSSS is the serial number of the instrument.

This feature provides a convenient means of taking measurement data directly from the PR-705 / 715 for use in applications such as Microsoft Excel.

A sample of the data output follows:

Note: **If** *Port:* **is set to** *Floppy***, the following format is always stored to disk regardless of the setting in the** *Format:* **field. The definition of each line in the following example corresponds to each lin of the** *Full Report* **format.**

Print to Floppy Sample

```
*** *** ***
PR-715
75981301
Tue Mar 16 17:28:00 1999
---
0
---
MS-55
---
---
1 deg.
20
1
1585
380
1068
4
111
11
1.8528e-001
5.2268e+017
1.9761e+001
```

```
Remainder of spectral data not shown.
```

Date, Time Setup

As the heading implies, this setup screen is used to set the correct date and time for your geographical region.

Use Sample Procedure #2 to navigate through the menus and set the date and time.

```
        Date, Time Setup
      >Date: Dec 15 1997
       Time: 13:07:48
```

Date

Enter the date in Month, Day and Year.

Time

Enter the times in HH:MM:SS (hours must be entered in a 24-hour format).

Save, Load Setup

Once the PR-705 / 715 is turned off using the 1/0 (ON/OFF) switch, all hardware setup information is lost. When it is important to save the setup information, for example for often used measurement setup conditions, the *Save, Load Setup* screen provides a method to easily restore previously entered parameters. so that   Use Sample Procedure #1 to select for *Save to* and *Load from* options.

Because the setup information can be saved or recalled from a removable disk or local memory, multiple setup sets can be saved.

```
        Save, Load Setup
         Save to Disk
        >Load from Disk
```

Save to Memory

Saves the current hardware setup information to memory on-board the PR-705. Only one set of instrument setup parameters can be saved in memory.

Save to Disk

Saves the current hardware setup information to a disk in the built-in floppy drive. Only one set of instrument setup parameters can be saved per disk.

Load from to Memory

Loads the saved setup parameters from the PR-705 on-board memory.

Load from Disk

Recalls a file containing setup parameters from a floppy disk in the built-in disk drive.

Procedure

STEP 1 - Use the **FRWD** key until the *Save, Load Setup* screen appears.

STEP 2 - Use the ▲ or ▼ keys to position the **>** symbol next to either the *Load* or *Save* fields.

STEP 3 - Press the **ENTR** key.

STEP 4 - Use the ▲ or ▼ keys to select *Memory or Disk.*

STEP 5 - Press the **ENTR** key again to execute the selection.

or

Press **ENTR** twice to execute the
currently displayed selection.

Chapter 6 - Maintenance

The PR-705/715 SpectraScan has been designed to give long, trouble-free service requiring a minimum in routine maintenance.

The PR-705 does not require any routine maintenance with the exception of cleaning optical surfaces such as those found on objective lenses. To clean lenses:

Cleaning Lenses

Step 1 -   Remove the objective lens from the instrument. All objective lenses can be removed from the front of the PR-705 by grasping at the base of the lens (part of the lens closest to the instrument)

Step 2 -   Using a lint free cloth such as commercially available lens tissue and lens cleaning fluid or anhydrous alcohol, gently clean the surface using a circular motion. Do not use excessive pressure.

> **Note: Attempting unauthorized repairs beyond the instructions in this manual voids the instrument warranty.**

Re-calibration

The PR-705 / 715 factory calibration is certified for six months. Although the instrument may provide accurate results beyond the six-month period, it is recommended that re-calibration be performed every six months.

Contact PHOTO RESEARCH regarding re-calibration services for the PR-705 / 715.

User Calibration

Contact PHOTO RESEARCH for information on user calibration software and calibration standards (wavelength and intensity).

Factory Repair

In-Warranty Repair

PHOTO RESEARCH warrants trouble free operation for one year from date the instrument leaves the factory. If the instrument malfunctions during the one-year period, it will be repaired at no charge to the customer. The one-year is voided if the PR-705/715 has bee tampered with, is subject to physical damage intentional or unintentional or is misused.

Contact the PHOTO RESEARCH Service Department at 818-341-5151 for a Returned Material Authorization number before sending the instrument in for any reason. When returning the instrument, make sure to include all optical accessories. Accessories that are not returned cannot be calibrated.

Returning an Instrument

When returning an instrument to PHOTO RESEARCH for any reason, contact PHOTO RESEARCH for an Returned Material Authorization RMA number. Instruments returned without an RMA number will not be processed.

Pack the PR-705 / 715, preferably in the original crates or carrying cases.

Shipping Charges

Ship the instrument pre-paid. **Instruments shipped COD will be returned unopened.**

Glossary of Terms

CIE

The Commission Internationale de l'Eclairage (CIE) is the international commission on illumination. They are dedicated to creating and maintaining international standards in the field of lighting.

CIE Chromaticity Coordinates

The proportions of CIE tristimulus values required to define a color in a Cartesian system such as the CIE 1931 Chromaticity Diagram or the CIE 1976 Uniform Color Space. They are designated as x, y, z or u',v' and are the ratios of each of the tristimulus values X, Y and Z in relation to the sum of the three.

CIELAB

Internationally accepted color space model used as a standard to define color within many industries. This 3-dimensional model designates L for the lightness axis, A for the red-green axis and B for the yellow-blue axis.

Correlated Color Temperature (CCT)

Term used to describe the color of white light sources. Specifically, it is the temperature of a Planckian (black body) radiator, which produces the chromaticity coordinates most similar to that of the light source. It is customarily expressed in degrees Kelvin (K).

Filter Photometer

A photometer which incorporates a filter with a response that matches the detector to the 1931 CIE luminous efficiency ($V(\lambda)$) function. Photometric quantities are obtained directly by measuring the light after it passes through the photopic filter.

Hue

The attribute of color by which a color is perceived to be red, green, blue, yellow etc. Achromatic colors like black, white and gray do not exhibit hue.

Illuminance

Luminous Flux incident on a surface per unit area. The SI unit of illuminance is the Lux (lumens/m^2). The English unit of illuminance is the Foot-candle (lumens/ft^2).

1 Lux = .0929 Foot-candles

1 Foot-candle = 10.76 Lux.

Lambertian surface

A perfectly diffusing surface exhibiting the property that the light intensity emitted from any small surface component in a given direction is proportional to the cosine of the angle from the normal to the surface.

Luminance

Luminous Flux emitted from a surface per unit solid angle per unit area in a given direction. The SI unit is the candela per square meter (cd/m^2) and the English unit is the footlambert ($1/\pi$ cd/ft^2).

1 cd/m^2 = 0.2919 footlambert

1 footlambert = 3.426 cd/m^2.

Luminous Efficiency Function

The spectral response of the daylight (2° foveal) vision of the average human observer defined in 1924 by the CIE. Also called the photopic response function. The luminous efficiency function for the dark-adapted (7.5° extra foveal) eye is also known as the scotopic function.

Luminous Flux

Radiant Flux weighed by the 1931 CIE photopic $V(\lambda)$ function. The unit of luminous flux is the Lumen. The luminous flux per steradian from a source whose luminous intensity is one candela is one lumen.

Luminous Intensity (Candlepower)

The luminous flux per unit solid angle emitted or reflected from a point source. The unit of luminous intensity is the candela.

Metamerism

Phenomenon by which spectrally dissimilar radiation produces the same color sensation for an observer. A pair of metameric colors may match under one or more sets of conditions, but will appear to change in hue under spectrally different ambient lighting conditions.

Photometer

An instrument used to measure photometric quantities like luminance, illuminance, luminous flux and luminous intensity. It can either be a filter photometer or a spectroradiometer.

Photometry

The science of measuring visible light based upon the response of an average human observer.

Saturation

The attribute of color perception that expresses the degree of departure from gray of the same lightness - in other words, how monochromatic or pure a color is. A completely saturated color is monochromatic (radiates at a single wavelength).

Spectroradiometer

An instrument for measuring the spectral energy radiated by a source. The spectral data can be used to calculate photometric and colorimetric parameters.

Standard Illuminant

A series of illuminant spectral power distribution curves recommended by the CIE as standard light sources for light measurement. Examples are Illuminants A, B, C, D55, D65 etc.

Standard Observer Functions

Spectral response curves that, when integrated with the spectral power distribution of the sample under test, generate the CIE tristimulus values. These curves approximate the red, green and blue responsivity of human color ($2°$ foveal) vision.

Steradian

The steradian is the unit of solid angle defined as the solid angle subtended at the center of a sphere by an area on its surface equal to the square of the radius. A sphere has 4π steradians

Supplemental Observer Functions

Published in 1964, these spectral response curves, similar to the standard observer functions, are based on a $10°$ observation cone instead or a $2°$ cone. The $10°$ cone includes contributions from both human rods and cones.

Tristimulus Values

The values of the three stimuli required for matching a color. The CIE tristimulus values are designated as X, Y and Z and can be used as a method of color definition.

Visible Light

Electromagnetic radiation in the spectral range from 360 - 830 nm that is visible to the human observer