Tektronix

J18
LumaColor™ II Photometer
Instruction Manual

070-9021-03

This document applies to firmware version 2.00 and above.

Warning
The servicing instructions are for use by qualified personnel only. To avoid personal injury, do not perform any servicing unless you are qualified to do so. Refer to the Safety Summary prior to performing service.

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Tektronix

EC Declaration of Conformity

We

Tektronix Holland N.V.
Marktweg 73A
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The Netherlands

declare under sole responsibility that the

J18 LumaColor Photometer

meets the intent of Directive 89/336/EEC for Electromagnetic Compatibility. Compliance was demonstrated to the following specifications as listed in the official Journal of the European Communities:

EN 50081–1 Emissions:

EN 55022	Radiated, Class B
EN 55022	Conducted, Class B
EN 60555–2	Power Harmonics

EN 50082–1 Immunity:

IEC 801–2	Electrostatic Discharge
IEC 801–3	RF Radiated
IEC 801–4	Fast Transients
IEC 801–5	Surge

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Tektronix warrants that this product will be free from defects in materials and workmanship for a period of one (1) year from the date of shipment. If any such product proves defective during this warranty period, Tektronix, at its option, either will repair the defective product without charge for parts and labor, or will provide a replacement in exchange for the defective product.

In order to obtain service under this warranty, Customer must notify Tektronix of the defect before the expiration of the warranty period and make suitable arrangements for the performance of service. Customer shall be responsible for packaging and shipping the defective product to the service center designated by Tektronix, with shipping charges prepaid. Tektronix shall pay for the return of the product to Customer if the shipment is to a location within the country in which the Tektronix service center is located. Customer shall be responsible for paying all shipping charges, duties, taxes, and any other charges for products returned to any other locations.

This warranty shall not apply to any defect, failure or damage caused by improper use or improper or inadequate maintenance and care. Tektronix shall not be obligated to furnish service under this warranty a) to repair damage resulting from attempts by personnel other than Tektronix representatives to install, repair or service the product; b) to repair damage resulting from improper use or connection to incompatible equipment; or c) to service a product that has been modified or integrated with other products when the effect of such modification or integration increases the time or difficulty of servicing the product.

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General Safety Summary

Review the following safety precautions to avoid injury and prevent damage to this product or any products connected to it.

Only qualified personnel should perform service procedures.

Injury Precautions

Do Not Operate in Wet/Damp Conditions

To avoid electric shock, do not operate this product in wet or damp conditions.

Do Not Operate in Explosive Atmosphere

To avoid injury or fire hazard, do not operate this product in an explosive atmosphere.

Wear Eye Protection

To avoid eye injury, wear eye protection if there is a possibility of exposure to high-intensity rays.

Product Damage Precautions

Use Proper Power Source

Do not operate this product from a power source that applies more than the voltage specified.

Do Not Operate With Suspected Failures

If you suspect there is damage to this product, have it inspected by qualified service personnel.

Do Not Immerse in Liquids

Clean the probe using only a damp cloth. Refer to cleaning instructions.

Safety Terms and Symbols

Terms in This Manual

These terms may appear in this manual:

WARNING. *Warning statements identify conditions or practices that could result in injury or loss of life.*

CAUTION. *Caution statements identify conditions or practices that could result in damage to this product or other property.*

Terms on the Product

These terms may appear on the product:

DANGER indicates an injury hazard immediately accessible as you read the marking.

WARNING indicates an injury hazard not immediately accessible as you read the marking.

CAUTION indicates a hazard to property including the product.

Symbols on the Product

The following symbols may appear on the product:

DANGER
High Voltage

Protective Ground
(Earth) Terminal

ATTENTION
Refer to
Manual

Double
Insulated

Service Safety Summary

Only qualified personnel should perform service procedures. Read this *Service Safety Summary* and the *General Safety Summary* before performing any service procedures.

Do Not Service Alone

Do not perform internal service or adjustments of this product unless another person capable of rendering first aid and resuscitation is present.

Preface

This manual contains information to support user operation and service of the J18 LumaColor™ II Photometer.

The manual is divided into User and Service sections that are separated by a yellow page.

User Information

The user information details the control and operation of the photometer. This section also provides detailed information for the analysis of the photometer readings. The user information is divided into four chapters:

- Getting Started
- Operating Basics
- Reference
- Specifications

Service Information

The service section details user-level maintenance and repair of the photometer.

- Performance Verification
- Maintenance
- Replaceable Parts
- Appendices
- Glossary and Index

Getting Started

Product Description

The J18 is a digital photometer, radiometer, and colorimeter. The interchangeable J1800 series sensor-heads provide the ability to make a variety of light measurements.

J18 LumaColor™ II Photometer Features

The J18 provides the following features:

- Real-time color measurements
- Auto zero
- Readings in either English or metric units
- RS-232D interface for remote control
- Interchangeable heads for future expansion
- Battery or AC-powered operation (AC adapter available as an optional accessory)
- Backlighted display
- Analog output

Unpacking the J18 LumaColor™ II Photometer

This section describes the accessories that are shipped with the J18. If the contents of the shipping container are incomplete or damaged, contact your Tektronix representative.

The J18 LumaColor™ II Photometer is shipped with the following equipment:

- J18 LumaColor™ II Photometer
- Instruction Manual (this manual)
- Alkaline battery (Installed)
  IEC type 6LR61, NEDA type 1604

Repackaging for Shipment

If you must ship the J18 or one of the J1800 series sensor heads, package it as follows:

1. Use the original carton, or an equivalent carton with dimensions at least three inches greater than the instrument to allow for proper cushioning.
2. Cover the instrument with a polyethylene bag to protect its finish.
3. Cushion the instrument on all sides with packing material. Seal the carton with shipping tape or with an industrial stapler.
4. If you are shipping the product to a Tektronix Service Center, be sure to label the carton with the name of your company, a person to contact at your company, and a description of the problem.

Power Options

The J18 may be powered by either of two sources:

- A non-rechargeable nine-volt alkaline battery
- An external AC power adapter, available as an optional accessory. (See the *Replaceable Parts* section for information about available accessories.)

***NOTE**. When switching between power sources, cycle the photometer power off and then on again to enable the photometer to auto-zero using the new power source.*

Low Battery Warning

When battery voltage is below 7.2 volts, the J18 displays the flashing warning battery icon in the upper left corner of its display. At this point, you should replace the battery (see Figure 1–1).

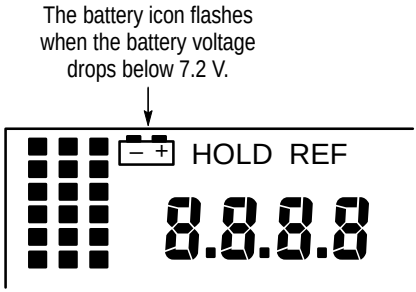


Figure 1–1: Low Battery Warning Icon

If the battery voltage is below 7.2 volts at initial power-on, the J18 will not complete the self-test.

Battery Installation

CAUTION. *Follow the manufacturers' guidelines for the handling and disposal of batteries.*

To replace the alkaline battery (refer to Figure 1–2):

1. Turn off the J18.
2. Open the battery compartment located on the back cover of the J18.
3. Remove the old battery, and replace it with a new one. Arrange the wires so that they will not interfere with the battery cover.
4. Close the battery compartment.
5. Turn on the J18 and make sure that the low-battery warning is not flashing.

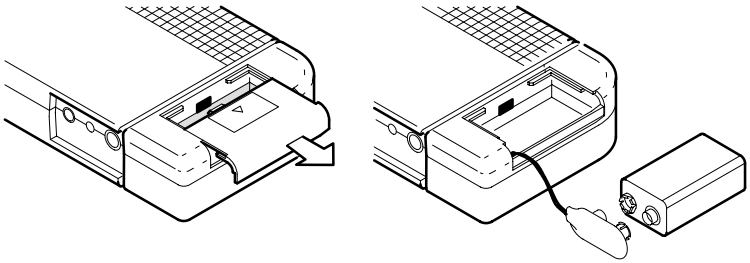


Figure 1–2: Replacing the Battery

Using the Optional AC Power Adapter

The J18 may be powered with the optional external AC power adapter. The power adapter will override the internal battery if one is installed. To ensure accurate measurements, cycle the photometer power off and then on again to permit the photometer to autozero using the new power source.

Plug the pin connector of the adapter into the **EXT. POWER** connector on the side of the J18 (see Figure 1–3). Plug the power adapter into a 120 VAC AC power outlet. (A 220 VAC adapter is also available.)

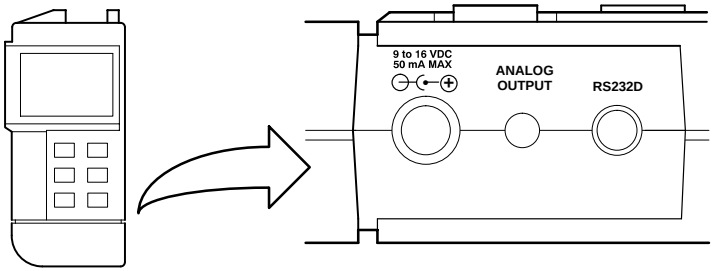


Figure 1–3: Location of J18 Power Adapter Connector

CAUTION. *Be sure that any power supply you use with the J18 provides power within the range of 9 to 16 VDC. Also, the center contact polarity of the adapter is positive (+). A power supply that does not meet these requirements may damage the J18.*

The backlight will be lit at power-on when the J18 is powered by the AC power adapter. The backlight may be turned off, if desired, by pressing the **BACKLIGHT** button.

NOTE*. AC power adapters that provide less than 12 volts may not automatically turn on the backlight.*

Functional Check

The J18 performs a self-test when first turned on. The self-test is successfully completed under the following conditions:

- A "fresh" battery must be installed, or the AC adapter must be attached.
- A recognized sensor head must be attached. (The J18 will not recognize the J1820 sensor head.)

1. Cover the sensor to block out any light before turning on power to the J18.
2. When power is initially turned on, the display reminds you to cover the sensor; see Figure 1–4. If the sensor is uncovered, the display flashes and the self-test does not continue.

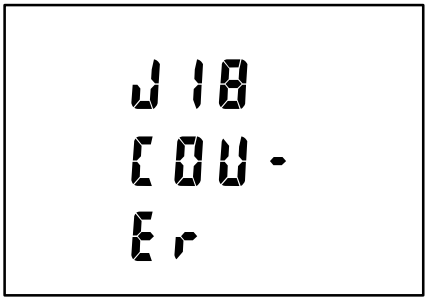


Figure 1–4: Initial Power-On Display

***NOTE**. If the photometer is turned on with the sensor uncovered, cover the sensor and cycle the photometer power off and then on again. This procedure ensures a complete photometer auto-zero.*

3. After the auto-zero is complete, all of the display characters are shown as a display test. See Figure 1–5.

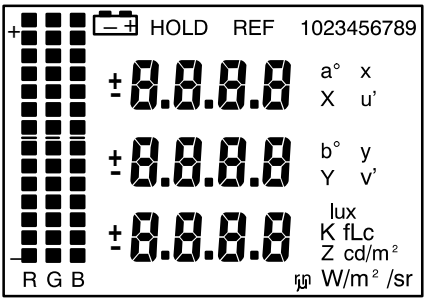


Figure 1–5: Typical Display Test

4. After the display test is complete, the display shows the firmware version that is installed. See Figure 1–6.

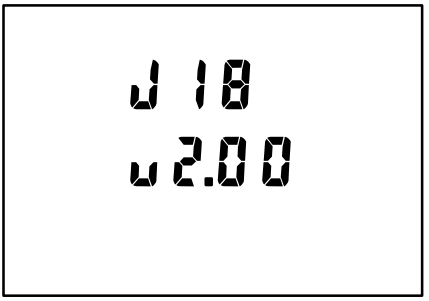


Figure 1–6: Typical Firmware Version Display

5. After the firmware version is displayed, the photometer initially displays zeros until the sensor cover is removed. See Figure 1–7.

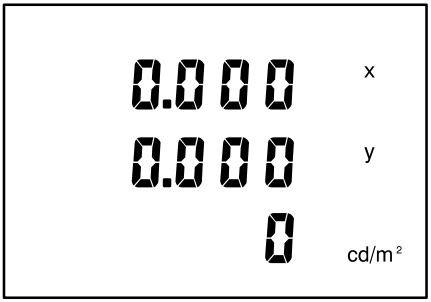


Figure 1–7: Typical Zero Display

6. Remove the cover from the sensor head and aim the sensor to take a measurement. If the sensor head is a multi-channel sensor, the photometer displays the measurement in the selected color coordinate system. See Figure 1–8.

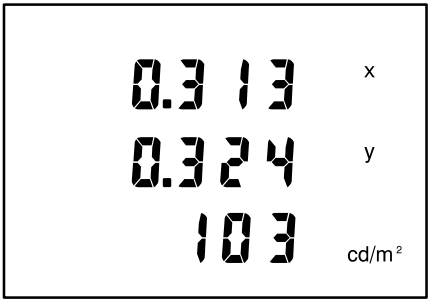


Figure 1–8: Typical Color Chromaticity Display

If the attached sensor head is a single channel sensor, the photometer displays only one value for the measurement. See Figure 1–9.

Figure 1–9: Typical Single Channel Display

7. If a sensor head is not attached, or the sensor head is not recognized, the J18 flashes the error message shown in Figure 1–10.

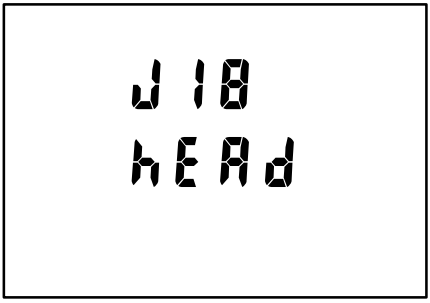


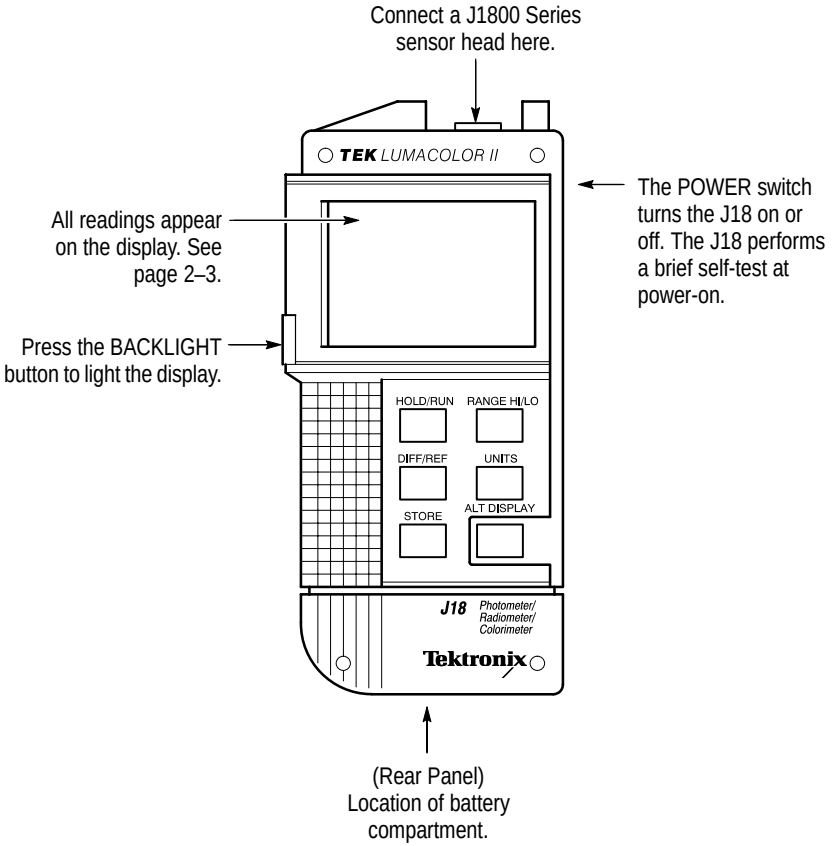
Figure 1–10: Sensor Head Missing or Not Recognized Display

Operating Basics

Functional Overview

This section provides a overview of the controls, indicators, and operation of the photometer.

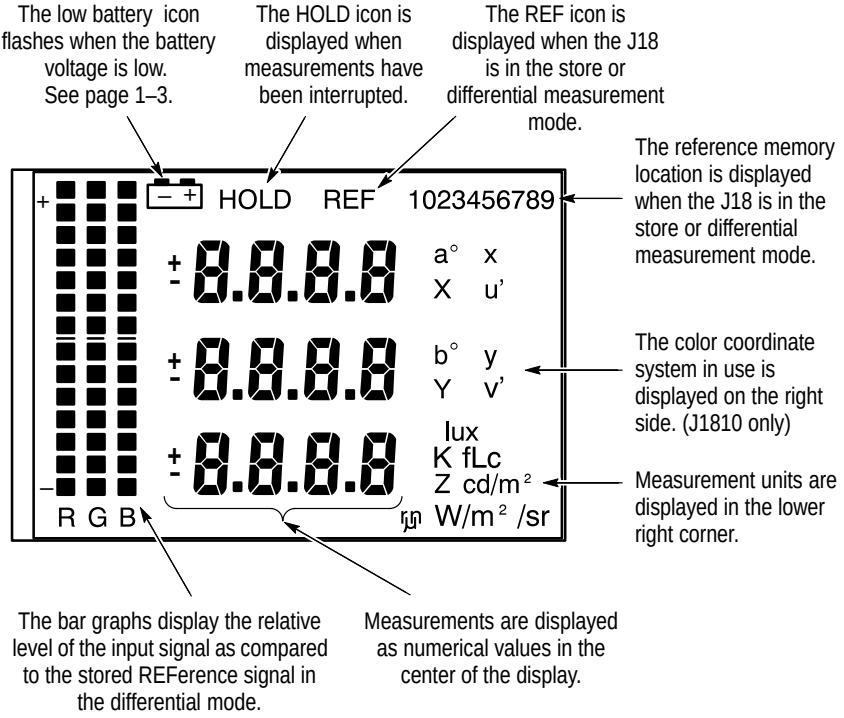
J18 Front Panel



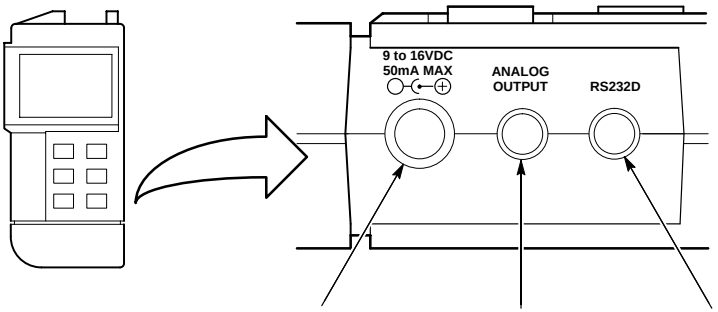
J18 Control Descriptions and Operation

HOLD/RUN 	Press the **HOLD/RUN** button to "freeze" measurements during normal operation. Press the **HOLD/RUN** button to resume measurements or to end differential measurements.
RANGE HI/LO 	Press the **RANGE HI/LO** button to change the sensitivity of the photometer when using single-channel sensors. The photometer display will flash if the light level is too high.
DIFF/REF 	Press the **DIFF REF** button to perform color difference measurements when using the J1810 sensor. Pressing the **DIFF REF** button again steps the photometer through the reference memory locations.
UNITS 	Press the **UNITS** button to change the measurement units. The measurement units available are determined by the sensor head.
STORE 	Press the **STORE** button to store a measurement. Stored measurements can be recalled for differential measurements or later analaysis. (J1810 only)
ALT DISPLAY 	Press the **ALT DISPLAY** button to change coordinate systems when using a color sensor head. The **ALT DISPLAY** button will have no effect with other heads. Refer to Appendix B for information on color coordinate systems.

J18 Display


The low battery icon flashes when the battery voltage is low. See page 1–3.
The HOLD icon is displayed when measurements have been interrupted.
The REF icon is displayed when the J18 is in the store or differential measurement mode.
The reference memory location is displayed when the J18 is in the store or differential measurement mode.
The color coordinate system in use is displayed on the right side. (J1810 only)
Measurement units are displayed in the lower right corner.
The bar graphs display the relative level of the input signal as compared to the stored REFerence signal in the differential mode.
Measurements are displayed as numerical values in the center of the display.
HOLD
REF
1023456789
R G B
a° x
X u'
b° y
Y v'
lux
K fLc
Z cd/m²
W/m² /sr

J18 Side Panel Connections



Connect the optional AC adapter here. See page 1–5.

The analog output output samples the amplifier output before the A-to-D converter. See page 3–9.

Connect the optional RS-232 cable here for data logging to a computer. See page 3–1.

Tutorial

This section lists step-by-step instructions for storing and comparing color measurements.

Conditions

Before operating the photometer, it must meet the following conditions:

- Sensor head installed
- Power on
- Self-test completed without errors or low-battery indication

Refer to the *J1800 Series LumaColor Photometer Sensor Heads Technical Reference* for specific turn-on procedures.

Storing Measurements

NOTE. *The STORE button will only work with the J1810 sensor head.*

1. Press the **HOLD/RUN** button to stop the measurement. See Figure 2–1.

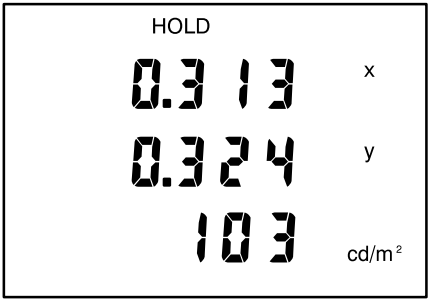


Figure 2–1: Measurement with HOLD

2. Press the **DIFF/REF** button to select the differential measurement mode.

3. Repeatedly press the **DIFF/REF** button to select the desired reference memory location. The reference location is shown on the top of the display. See Figure 2–2. Readings can be stored only in reference locations 1 to 10.

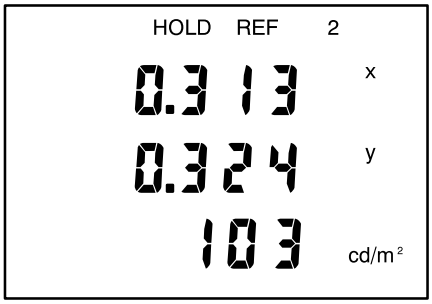


Figure 2–2: Selecting a Reference Memory Position

4. Press the **STORE** button to store the measurement. After storing the measurement, the photometer goes into the differential measurement mode. To return to absolute readings, press the **HOLD/RUN** button to clear the differential display.

Recalling Stored Measurements

To view the values stored in the memory locations, perform the following steps:

1. Press the **DIFF/REF** button to select the differential measurement mode.
2. Repeatedly press the **DIFF/REF** button to step to the desired reference memory location.
3. Press the **ALT/DISP** button so that the memory location begins to flash and the display indicates the values stored in the memory location.
4. Press the **HOLD/RUN** button to return to the differential measurement mode.

5. Press the **HOLD/RUN** button again to return to the direct measurement mode.

Comparing Measurements

NOTE. *The DIFF/REF button will only work with the J1810 sensor-head.*

Press the **DIFF/REF** button to enter the differential mode. Repeatedly press the **DIFF/REF** button to step to a reference memory location.

The differential mode displays the differences between the current and stored values. The color bars on the left side of the display show the relative color differences of the red, green, and blue components. The numeric display indicates the magnitude differences in the color-coordinate system. See Figure 2–3.

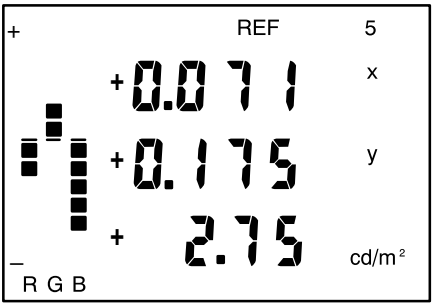


Figure 2–3: Typical Differential Measurement Display

NOTE. *The bargraphs are nonlinear to provide improved resolution when approaching the reference values.*

Factory-stored reference values for video display white levels are stored in memory locations 12 to 19. Use these values to adjust displays to 6500 K white at standard luminance values. Refer to Table 2–1 for luminance values and memory locations.

Table 2–1: Factory Preset 6500 K White Values

Memory Location	fL	cd/m^2
12	5	17.1
13	15	51.4
14	20	68.5
15	25	85.7
16	30	103
17	35	120
18	40	137
19	50	171

The factory-stored reference levels support all units and coordinate systems.

To take differential measurements using the factory-stored reference values, perform the following steps:

1. Press the **DIFF/REF** button to select the differential measurement mode.
2. Repeatedly press the **DIFF/REF** button to step to the desired reference memory location.
3. Press the **HOLD/RUN** button to exit the differential mode.
4. Select the desired units and coordinate system using the **UNITS** and **ALT DISP** buttons.
5. Press the **DIFF/REF** button to display the difference measurement using the reference value selected in step 2.

Reference

RS-232D Operation

You can use the J18 LumaColor™ II Photometer's RS-232D port to remotely control the photometer and to save measurement readings to a file on a computer. All of the functions of the front panel control can be duplicated through the RS-232D port.

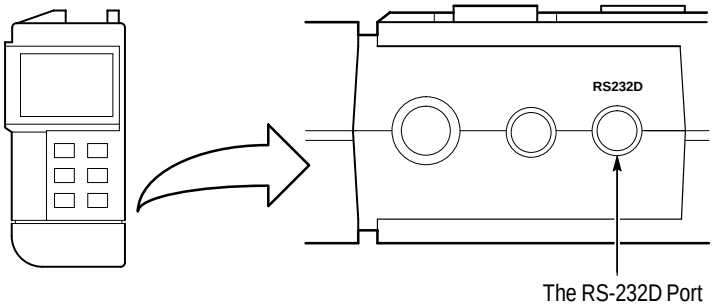


Figure 3–1: Location of the RS-232D Port

The J18 operates with the RS-232 parameters shown in Table 3–1. The terminal or computer you connect to the J18 must match these parameters in order to communicate using the RS-232 port. Also, the terminal should be set with the local echo turned on.

Table 3–1: RS-232D Parameters

Parameter	Value
Baud Rate	2400
Data Bits	8
Stop Bits	1
Data Type	Asynchronous
Operational Mode	Half-duplex (accepts software flow control)

RS-232 Pin Connections

An RS-232 cable is available as an optional accessory to the J18 (refer to *Replaceable Parts* for ordering information). This cable has a 3.5 mm connector for the J18, and a DB-9 female connector for connection to the computer. (Another common RS-232 connector on computers is the DB-25 connector. Adapters are commercially available to convert from the DB-9 connector to a DB-25 connector.)

Figure 3–2 shows the pin connections of the J18 RS-232 port and the optional RS-232 cable.

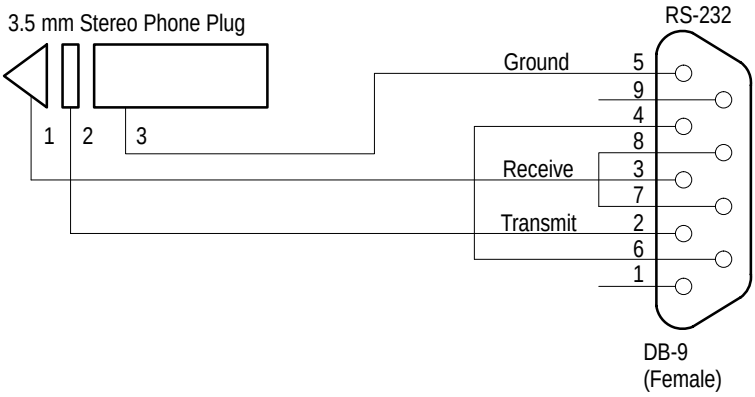


Figure 3–2: RS-232 Pin Connections

Syntax

The data format for measurements consists of a units notation, followed by the floating-point measurement value. Values are displayed with four significant digits, and a one-digit exponent with an optional minus sign. For multiple values. See Figure 3–3.

```
!NEW
x = 0.100E0  y = 0.331E0  LUM = 34.65E–3 cd/m^2
```

Figure 3–3: Sample Measurement Message

Each line is terminated by a carriage return and line feed (CR/LF).

Table 3–2 lists the abbreviations the J18 uses when reporting measurement units over the RS-232D interface.

Table 3–2: Measurement Units

Abbreviation	Usage
cd	candelas
cd/m^2	candelas/meter^2
fc	foot-candles
fL	foot-lamberts
K	kelvins
Lux	lux
W	watts
W/m^2	watts/meter^2
W/m^2/sr	watts/meter^2/steradian
X, Y, Z	1931 CIE tristimulus values
u‘, v‘	1976 CIE-UCS color coordinate system
x, y, units	1931 CIE color coordinate system

Table 3–3 summarizes the syntax conventions of the command set.

Table 3–3: J18 Command Syntax

Symbol	Meaning
!	Begins command. (All commands should be prefaced with an exclamation point.)
{CR}	Carriage return (ASCII 13); recognized as an end-of-command delimiter.
{LF}	Line feed (ASCII 10); also recognized as an end-of-command delimiter.
(white space)	Spaces act as parameter delimiters within commands. The J18 also recognizes commas (**,**) and tabs as parameter delimiters; any of these three characters may be used interchangeably.
italics	Items in italics are names of parameters. Specify the appropriate value when entering the command.

Commands

The J18 LumaColor™ II Photometer recognizes ten commands that duplicate the function of the front panel controls. These commands are summarized in Table 3–4.

***NOTE**. The J18 is a case-sensitive device, so all RS-232 commands should be made in capital letters (upper-case), for example: !NEW.*

Table 3–4: J18 Command Set

Command	Function
!INI{CR}	Initializes the instrument. Puts the J18 in the initial powerup state with no valid data for the attached sensor head.
!ALT{CR}	Same as the ALT DISP button.
!BKL{CR}	Same as the BACKLIGHT button.
!DIF{CR}	Same as the DIFF/REF button.
!HLD{CR}	Same as the HOLD button.
!RGE{CR}	Same as the RANGE HI/LO button.
!STR{CR}	Same as the STORE button.
!UNT{CR}	Same as the UNITS button.
!NEW{CR}	Causes the J18 to report the last measurement taken.
!NEW *n* {CR}	Causes the J18 to report the specified number (*n* = sample size) of measurements beginning with the last one taken. The sample size may be from 1 to 255. A value of $n \geq 128$ or greater causes the J18 to report measurements continuously until another command is sent.

Analog Output

The J18 features an uncalibrated analog output for use with auxillary equipment such as strip chart recorders and analog meters. The analog output is driven by the “Y” luminance channel. This is the same channel that is used for single-channel sensor heads.

The analog output samples the J18 amplifier output before it goes to the D to A converter. Table 3–5 lists the analog output specifications.

Location

The analog output jack is located on the right side panel of the J18.

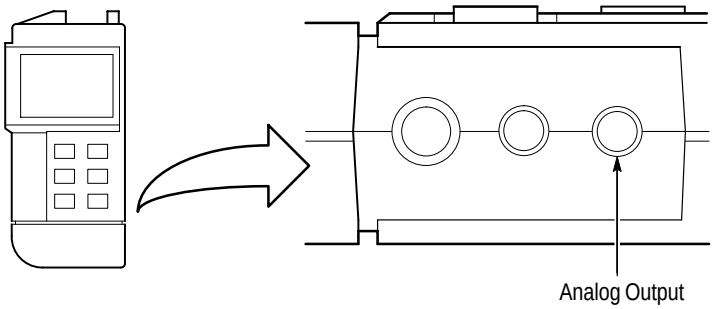


Figure 3–4: Location of the Analog Output

Table 3–5: Analog Output Specifications

Characteristic	Standard
Connection	2.5 mm phone plug, center conductor positive (+)
Time Constant	100 ms
Output Level (typical)	0 to +5 VDC
Output Impedance (typical)	100 kΩ

Specifications

Specifications

Tables 4–1 through 4–5 list the specifications of the J18. Warranted specifications are guaranteed to the customer. Typical specifications are provided for customer convenience and may change.

Table 4–1: Warranted Electrical Specifications

Characteristic	Standard
Accuracy	1% of reading ±2 count (Excluding sensor nonlinearity)
Emissions	EN 50082-1 when used with Tektronix power supply and RS-232 cable.
EMI Immunity	EN-50082-1
ESD Immunity	Up to 8 kV

Table 4–2: Typical Electrical Specifications

Characteristic	Standard
Power Requirements	Alkaline battery, 7 to 10 V IEC 6LR61 NEDA 1604 External Power Supply, 9 to 16 VDC
Battery Life (Typical)	30 hours (IEC 6LR61 battery with backlight off and RS-232 unplugged)
Low Battery Indicator	7.2 V

Table 4–3: Warranted Environmental Specifications

Characteristic	Standard
Temperature	Nonoperating: –55°C to +85°C Operating: –15°C to +55°C Per Tek Std 062–2847–00
Humidity	Nonoperating: 97%, +30°C to +60°C Operating: 97%, +30°C to +55°C

Table 4–4: Typical Mechanical Specifications

Characteristic	Standard
Dimensions	Height: 198 mm (8 inches) Width: 93 mm (3.7 inches) Depth: 34 mm (1.3 inches)
Weight	1.4 kg (3 pounds)

Table 4–5: Warranted Sensor Ranges

Sensor	Range
J1803	0.3 to 300,000 cd/m^2 (nit) 0.1 to 100,000 fL
J1805	0.01 mcd to 10 cd
J1806	0.001 to 200 W/m^2/sr
J1810	0.001 to 0.999 xy and u'v' coordinates (above 3 cd/m^2) 0.3 to 1000 cd/m^2 (nit) 0.1 to 300 fL
J1811	0.1 to 5000 lux (lm/m^2) 0.1 to 500 fc
J1812	0.1 to 2000 mW/m^2 10 nW to 0.2 mW
J1823 (Standard version)	3 to 3,000 cd/m^2 (nit) 1 to 10,000 fL
J1823 (Option 01)	30 to 30,000 cd/m^2 (nit) 10 to 10,000 fL

WARNING

The following servicing instructions are for use only by qualified personnel. To avoid injury, do not perform any servicing other than that stated in the operating instructions unless you are qualified to do so. Refer to all Safety Summaries before performing any service.

Performance Verification

Performance Verification

Performance verification procedures are included in the manual shipped with the J1800 series sensor-heads. If you are checking sensor-heads formerly used with a J17, the J17 verification procedure may be used.

***NOTE**. The J1820 chromaticity sensor-head will not work with the J18. The J1820 sensor-head will only work with the J17 LumaColor™ photometer.*

Maintenance

Service Strategy

The J18 is user serviceable to the circuit-board level. Certain cosmetic parts and connectors may also be replaced by the customer. A list of replaceable parts is in the *Replaceable Parts* chapter.

Basic Troubleshooting lists some operating conditions to check for if you believe the photometer or the sensor-head is not operating correctly.

Board-level Troubleshooting will allow you to isolate most problems to one of the two replaceable circuit boards in the photometer. Use these procedures if you want to repair the photometer yourself.

There are no user-adjustments in the J18.

Troubleshooting

If the J18 LumaColor™ II Photometer or one of the J1800 Series sensor heads does not appear to function correctly, the information in this section will help you isolate the problem.

Basic Troubleshooting

This section lists some common problems and their most likely causes.

The J18 Does Not Power On, or Backlight Does Not Light

Check the battery. Install a fresh battery, and ensure that it is seated correctly. If the optional AC adapter is available, use it to connect the J18 to a power source.

Measurements are Inaccurate

If measurements taken with the J18 are inaccurate or inconsistent, check the operating setup:

- Did you connect the sensor head to the J18 *before* power-on? If not, turn the J18 off, cover the sensor–head, and then turn the J18 back on. The J18 will load data from a sensor head at power-on.
- For luminance, radiance, and chromaticity measurements, make sure that the sensor head is positioned so that the measurement field is entirely filled by the surface to be measured.
- For luminance, radiance, and chromaticity measurements, make sure that the area being viewed by the sensor head is uniformly illuminated.
- Shadowing will occur if the surface is being measured from direction of the illumination. Position the sensor head so that it does not shadow the surface being measured.

- Operating the sensor-head in contact with the surface is not recommended, because reflections may occur between the front surface of the head and the surface to be measured. Placement of the head too close to the surface may also cause shadowing.

  The light shield or suction cup provides adequate spacing between the head and the surface to prevent reflection on backlighted surfaces.

If measurements are still incorrect, the sensor head may require recalibration. Contact your Tektronix representative.

Board-level Troubleshooting

The two circuit boards in the J18 may be replaced. If the J18 does not function, you can use these procedures to isolate the problem to one of the boards. Refer to *Replaceable Parts* for ordering information.

CAUTION. *The following servicing instructions are for use by qualified service personnel only. Once the covers of the J18 are removed, the instrument could be damaged.*

Most functions of the J18 are located on the A1 board. The A2 Display board controls the display, backlight, and keyboard. The general troubleshooting sequence for the J18 is:

1. Verify that the problem is not covered in *Basic Troubleshooting.*
2. Check for a display, backlight, or keyboard problem (indicating the A2 board). If there appears to be a display problem, also check the power supply on the A1 board, which could be at fault.
3. Other problems are due to the A1 board. If a power supply problem is suspected, perform the procedure in *Checking the Power Supply* to verify that the power supply, and not the battery, is at fault.

The A1 Board

Most functions of the J18 are located on the A1 board. *Checking the Power Supply*, later in this section, will allow you to determine whether there is a power supply problem.

The A2 Display Board

The A2 Display board is probably at fault if:

- segments of the display are missing
- the backlight does not operate

To check the display, power on the J18 without a sensor head attached, and note whether all segments of the display are activated.

If the entire display is inactive, or if the backlight does not operate, proceed to *Checking the Power Supply* to rule out a problem with the power supply.

Checking the Power Supply

To check the power supply, you will need:

- $^{3}/_{32}$ inch hex wrench
- Pozidriv® screwdriver
- a voltmeter (for voltages in the range 0 to 15 V)
- Nine-volt, IEC 6LR61-type alkaline battery

1. Remove the battery from the battery compartment.

CAUTION. *Do not apply power to the J18 while disassembling it. Damage to the A2 board could result.*

Static electricity can damage the circuit boards of the J18. Observe static precautions when the covers of the J18 are removed.

2. Using the hex wrench, remove the four screws from the J18 front panel.

3. Remove the back cover of the J18.

4. Remove the five screws that attach the A1 board to the A2 board.
5. Gently pull the two boards apart, taking care not to bend the connector pins on the A1 board.
6. Connect the battery to the A1 board and turn on the power switch.
7. Connect the voltmeter to the V_{BB} test point and ground. Check V_{BB} for a voltage of +7.2 V or higher. Refer to Figure 6–1 for test point locations.

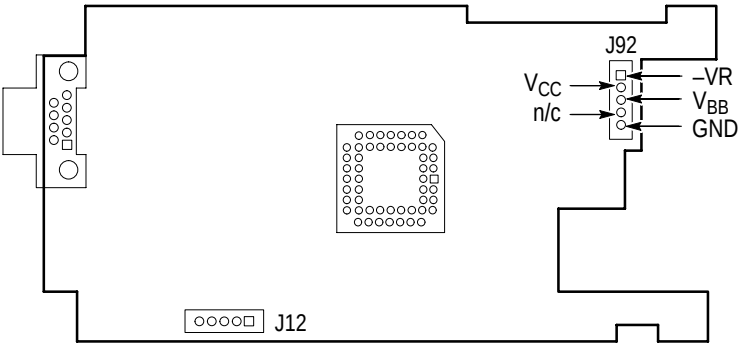


Figure 6–1: Test Point Locations on the A1 Board

If the voltage at V_{BB} is less than +7.2 V, the problem is the battery, not the power supply. If the voltage is +7.2 V or greater, proceed to Step 8.

8. Hold the connection at ground and check for a voltage of +5.75 V ± 0.15 V at the V_{CC} test point.
9. While still connected to ground, check the –VR test point for a voltage of –0.22 V ± 0.04 V.

If the voltages at test points V_{CC} and –VR are correct, the problem is not the power supply. If these voltages are not correct, the A1 board must be replaced.

Replaceable Parts

Replaceable Parts

This section contains a list of the modules that are replaceable for the J18 LumaColor™ II Photometer. Use this list to identify and order replacement parts.

Parts Ordering Information

Replacement parts are available from or through your local Tektronix, Inc. service center or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available and to give you the benefit of the latest circuit improvements. Therefore, when ordering parts, it is important to include the following information in your order:

- Part number
- Instrument type or model number
- Instrument serial number
- Instrument modification number, if applicable

If a part you order has been replaced with a different or improved part, your local Tektronix service center or representative will contact you concerning any change in the part number.

Change information, if any, is located at the rear of this manual.

Using the Replaceable Parts List

The tabular information in the Replaceable Parts List is arranged for quick retrieval. Understanding the structure and features of the list will help you find the all the information you need for ordering replacement parts.

Item Names

In the Replaceable Parts List, an Item Name is separated from the description by a colon (:). Because of space limitations, an Item Name may sometimes appear as incomplete. For further Item Name identification, U.S. Federal Cataloging Handbook H6-1 can be used where possible.

Indentation System

This parts list is indented to show the relationship between items. The following example is of the indentation system used in the Description column:

1 2 3 4 5 Name & Description
Assembly and/or Component
Attaching parts for Assembly and/or Component
(END ATTACHING PARTS)
Detail Part of Assembly and/or Component
Attaching parts for Detail Part
(END ATTACHING PARTS)
Parts of Detail Part
Attaching parts for Parts of Detail Part
(END ATTACHING PARTS)

Attaching parts always appear at the same indentation as the item it mounts, while the detail parts are indented to the right. Indented items are part of, and included with, the next higher indentation. Attaching parts must be purchased separately, unless otherwise specified.

Abbreviations

Abbreviations conform to American National Standards Institute (ANSI) standard Y1.1

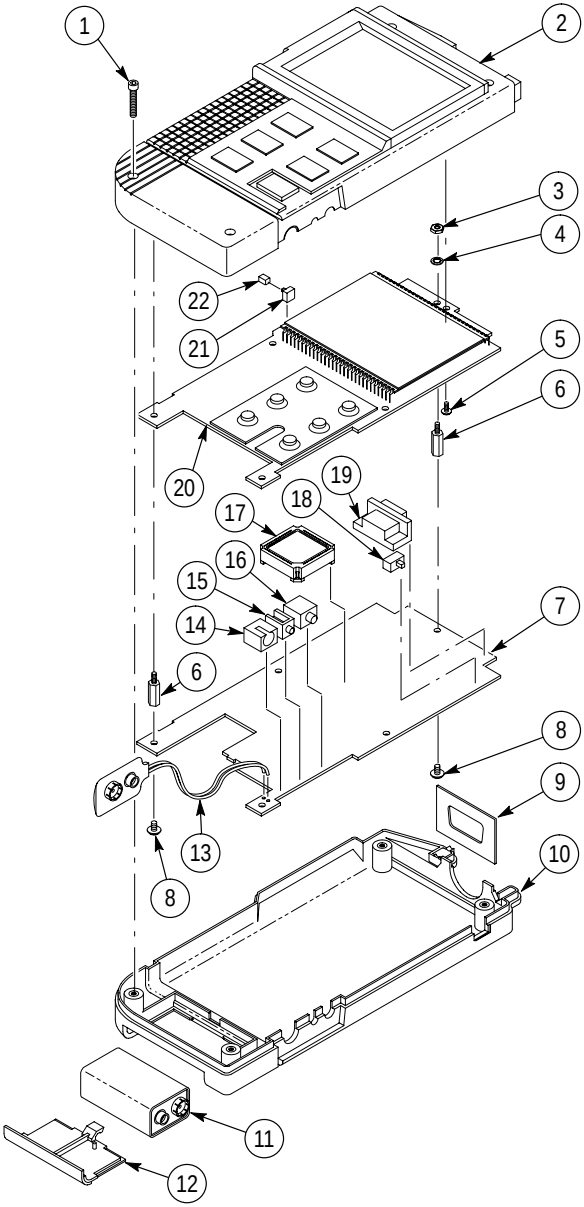


Figure 7–1: J18 Replaceable Parts

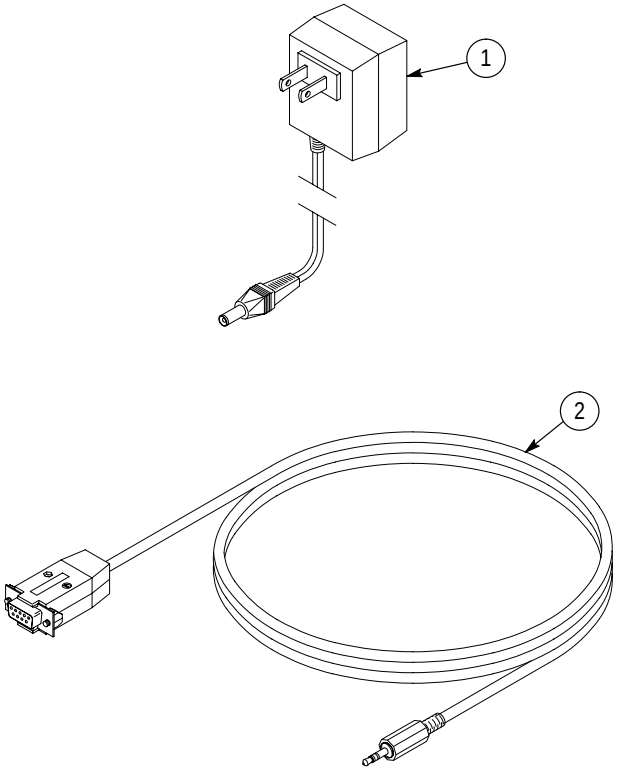


Figure 7–2: J18 Optional Accessories

Fig. & Index No.	Tektronix Part No.	Serial No. Effective Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
7–1–1	211–0789–00		4	SCREW,CAP:4–40,0.625 L,HEX SKT,STL,BLK OXIDE	0KB01	211–0789–00
–2	380–1099–00		1	TOP AS:W/KEYCAPS & GASKET	80009	380109900
–3	210–0405–00		1	NUT,PLAIN,HEX:2–56 X 0.188,BRS CD PL	73743	12157–50
–4	210–0053–00		1	WASHER,LOCK:#2 SPLIT,0.02 THK STL	TK0392	ORDER BY DESC
–5	211–0180–00		1	SCR,ASSEM WSHR:2–56 X 0.25,PNH, BRS,NP,POZ	TK0435	ORDER BY DESC
–6	129–1361–00		5	SPACER,POST:0.460 L,W/4–40 THD ONE END, #2–56 OTHER END,AL,0.188 HEX	TK0588	PER TEK DOCUMEN
–7	671–3501–00 671–3501–01	B010000 B020100	1	CKT BD ASSY:PROCESSOR	80009 80009	671350100 671350101
–8	211–0007–00		5	SCREW,MACHINE:4–40 X 0.188,PNH,STL	TK0435	ORDER BY DESC
–9	386–0045–00		1	PLATE,MTG:CONNECTOR,BLACK ANODIZE	5Y400	386–0045–00
–10	380–1039–00		1	HOUSING,HALF:BOTTOM,ABS	80009	380103900
–11	146–0017–00		1	BATTERY,DRY:;9.0V,500MAH AT 510 OHMS TO 4.8V,1604 CASE	1AR73	MN1604
–12	200–3896–01		1	DOOR ACCESS:BATTERY LID,PLASTIC	80009	200389601
–13	131–1160–00		1	CONN,BATTERY:SNAP ON,;FEMALE/MALE, ACCOM9 VOLT,W/5.0 L CUT & STRIP LEADS, RED,BLACK	0DWW6	ORDER BY DESC
–14	131–5148–00		1	JACK,POWER DC:PCB,;MALE,RTANG,2.0 MM DIAPIN,7 MM H X 3.3 MM TAIL,3 COND, W/SWITCH,MTG POST,DC PWR JACK,1 AMP@12V (J90)	TK2427	ADC–016

Fig. & Index No.	Tektronix Part No.	Serial No. Effective Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
–15	131–5742–00		1	CONN,JACK PHONE:PCB/PNL,;FEMALE, RTANG,2.5MMID,9.0MM HV 4.5 TAIL,5.5 TO CTR LINE OF JACK,W/SHUNT (J20)	TK2449	SJ–251
–16	131–5440–00		1	CONN,JACK PHONE:PCB/PNL,;FEMALE,RTANG, 3 POS,W/SHUNT,3.5MM ID,0.354 H X 0.1378 TAIL, ACCOM 3.5MM JACK,SILVER,5 TERMINAL, STEREO (J80)	TK2449	SJ–500
–17	163–0246–00 163–0246–01	B010000 B020100	1	IC,PROCESSOR:CMOS,MICROCOMPUTER; 8–BIT,212 X	80009 80009	163024600 163024601
–18	260–2481–00		1	SWITCH,SLIDE:DPDT;100MA AT 30VDC,PC MOUNT,0.44 X 0.26,RIGHT ANGLE,SILVER CONTACTS,EXTENDED ACTUATOR (SW90)	91506	MMS22R
–19	131–3925–00		1	CONN,DSUB:PCB,;FEMALE,RTANG,9 POS,0.112 CTR,0.318 MLG X 0.125 TAIL,4–40 THD INSERT,BD RETENTION,30 GOLD (J10)	TK0AY	JEY–9S–1A3F–14
–20	671–3500–00		1	CKT BD ASSY:DISPLAY	80009	671350000
–21	260–2301–00		1	SWITCH,PUSH:SPST;MOM,NO,150 GRM FRC,RIGHT ANGLE,SEALED,EXTENDED ACTUATOR DESIGNED TO ACCEPT BUTTON,50MA,24VDC,100M OHM (SW51)	34361	B3F–3152
–22	366–0720–00		1	PUSH BUTTON:BLACK,0.156 X 0.156 X 0.218 H	61964	B32–1010

Fig. & Index No.	Tektronix Part No.	Serial No. Effective Dscont	Qty	Name & Description 12345	Mfr. Code	Mfr. Part No.
				STANDARD ACCESSORIES		
	070–9021–03		1	MANUAL,TECH:INSTRUCTION,J18,DP	80009	070902102
				OPTIONAL ACCESSORIES		
7–2–1	119–5032–00		1	POWER SUPPLY:1.2W;12V 100MA, UNREGULATED,120VAC 60HZ,183CM CABLE W/5.0MM OD,2.1MM ID COAX PLUG	TK2474	AD–1210 W/OP–05
	119–3297–00		1	POWER SUPPLY:5.4W;9VDC 600MA, UNREGULATED,220VAC 50HZ,183CM CABLE W/5.5MM OD,2.1MM ID COAX PLUG	TK2474	AD–0960B W/OP–0
–2	012–1411–00		1	CABLE,INTCON:RS232 CABLE,72.0 L	1Y013	012–1411–00
	070–9017–02		1	MANUAL, TECH: TECH REF, J1800 SENSORS	80009	070901701

CROSS INDEX – MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip Code
TK0AY	JAPAN SOLDERLESS TERMINAL MFG CO LTD	1–4–1 HIGASH I–MACHI SHINSENRI TOYONAKA–CITY	OSAKA JAPAN
TK0392	NORTHWEST FASTENER SALES INC	7923 SW CIRRUS DRIVE	BEAVERTON OR 97005–6448
TK0435	LEWIS SCREW CO	4300 S RACINE AVE	CHICAGO IL 60609–3320
TK0588	UNIVERSAL PRECISION PRODUCTS	1775 NW 216TH	HILLSBORO OR 97123
TK2427	A/D ELECTRONIC	2121 17TH AVE SE	BOTHELL WA 97021
TK2449	SINGATRON ENTERPRISE CO LTD	20955 LYCOMING ST #201	WALNUT CA 91789
TK2474	OEM (OUTSTANDING ELECTRONICS MANUF LTD) c/o PILLAR INDUSTRIES, INC	1780 EVERGREEN ST	DUARTE CA 91010
TK2548	XEROX BUSINESS SERVICES DIV OF XEROX CORPORATION	14181 SW MILLIKAN WAY	BEAVERTON OR 97077
0DWW6	MICRO POWER ELECTRONICS	7973 SW CIRRUS DRIVE BLDG. #22	BEAVERTON OR 97005
0KB01	STAUFFER SUPPLY	810 SE SHERMAN	PORTLAND OR 97214
1AR73	DURACELL INTERNATIONAL INC BATTERY TECHNOLOGY CO.	S BROADWAY	TARRYTOWN, NY 10591
1Y013	DEANCO, ACACIA DIVISION	3101 SW 153RD DRIVE	BEAVERTON OR 97006
34361	OMRON ELECTRONICS INC.	2105 HAMILTON AVE SUITE 160	SAN JOSE, CA 95125

CROSS INDEX – MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip Code
5Y400	TRIAX METAL PRODUCTS INC DIV OF BEAVERTON PARTS MFG CO	1800 NW 216TH AVE	HILLSBORO OR 97124–6629
61964	OMRON ELECTRONICS INC	1 EAST COMMERCE	SCHAUMBURG IL 60173
73743	FISCHER SPECIAL MFG CO	111 INDUSTRIAL RD	COLD SPRING KY 41076–9749
80009	TEKTRONIX INC	14150 SW KARL BRAUN DR PO BOX 500	BEAVERTON OR 97077–0001
91506	AUGAT IPD	452 JOHN DIETSCH BLVD PO BOX 2510	ATTLEBORO FALLS MA 02763

Appendices

Appendix A: Photometry and Radiometry Reference

This appendix summarizes convenient relationships and formulas used in photometry and radiometry.

Photometric Relationships

In photometry, the spectral sensitivity of the sensor is matched to the average human eye, with a peak at 555 nm.

- An isotropic light source (a source that emits light uniformly in all directions) of 12.6 lumens is 1 candela (1 candle power).
- A 1 candela source at a distance of 1 meter provides an illuminance of 1 lux on a surface, regardless of the reflectance of the surface.
- A 1 candela source at a distance of 1 foot provides an illuminance of 1 footcandle on a surface, regardless of the reflectance of the surface
- Moving a light source further from a surface reduces the illuminance proportionally with the square of the distance (inverse square law). For example, moving a 1 candela source from 1 foot to 2 feet will reduce the illuminance to 0.25 footcandle.
- A perfectly white, diffuse surface illuminated by 1 footcandle has a surface luminance of 1 footlambert.
- A diffuse surface that has a reflectance of less than 100% will have a surface luminance, in footlamberts, equal to the illuminance in footcandles multiplied by the reflectance factor.
- Measurement of the luminance of a large uniformly illuminated surface is essentially independent of distance, since the area viewed by the sensor increases with the square of the distance, exactly compensating for light falloff due to the inverse square law.

Photometric Formulas

$$10.764 \cdot footcandles = lux \quad (lumens/meter^2)$$

$$3.426 \cdot footlamberts = nits \quad (candela/meter^2)$$

$$footcandles \cdot distance^2 \ (in\ feet) = candelas$$

$$lux \cdot distance^2 \ (in\ meters) = candelas$$

$$footcandles \cdot surface\ reflectance\ factor = footlamberts$$

Radiometric Relationships

In radiometry, an ideal sensor has equal sensitivity to all wavelengths of light being measured.

- An isotropic light source (a source that emits light uniformly in all directions) of 12.6 watts produces a radiant flux of 1 watt/steradian.
- 1 watt/steradian at a distance of 1 meter produces an irradiance of 1 watt/meter^2.
- Moving a light source further from a surface reduces the irradiance proportionally with the square of the distance (inverse square law). For example, moving a 1 watt/steradian source from 1 meter to 2 meters will reduce the irradiance to 0.25 watt/meter^2.
- A perfectly white, diffuse surface illuminated by an irradiance of 1 watt/meter^2 has a surface radiance of .318 watt/meter^2/steradian (irradiance divided by π).
- A diffuse surface that has a reflectance of less than 100% will have a surface radiance, in watts/meter^2/steradian, equal to the irradiance multiplied by the reflectance factor and divided by π.
- Measurement of the radiance of a large uniformly illuminated surface is essentially independent of distance, since the area viewed by the sensor increases with the square of the distance, exactly compensating for light falloff due to the inverse square law.

Radiometric Formulas

$$watt/cm^2 \cdot 10000 = watt/meter^2$$

$$watt/meter^2 \cdot distance^2 \quad (in\ meters) = watt/steradian$$

A Note on the Relation of Photometric and Radiometric Data

It is not possible to convert photometric units to radiometric units, or the reverse, except under precisely specified conditions. This is due to the greatly differing spectral sensitivity curves between photometric and radiometric sensors.

For a 555 nanometer, monochromatic source, 1 watt is equal to 683 lumens. Conversion of photometric data to radiometric data for monochromatic sources of other wavelengths may be calculated using the relative sensitivity of the photopic response curve at that wavelength ($y(\lambda)$ in Table B–1). Broader sources must be converted using mathematical integrations of their intensity and the photopic curve at each wavelength.

Appendix B: Chromaticity Reference

The reference material in this appendix can help you categorize and understand chromaticity measurements taken using the J1810 Chromaticity head. This appendix includes:

- The 1931 CIE Chromaticity diagram for x,y readings
- The 1976 CIE-UCS chromaticity diagram for u′, v′ readings
- Spectral tristimulus (X, Y, Z) values for an equal spectral power source, in both graphical and tabular format.

For additional information, we recommend the article “Standardizing CRT Measurements” by Peter Keller, in the April 1984 issue of *Test and Measurement World.*

The 1931 CIE Chromaticity Diagram

The 1931 CIE chromaticity diagram, also known as a Kelly chart, is shown in Figure B–1. The diagram can be used to categorize chromaticity measurements expressed as x, y values. The x, y values are determined from the spectral tristimulus values (X, Y, Z), by the following equations:

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

The main features of the 1931 CIE chromaticity diagram include:

- All colors perceptible to the average human eye fall within the bounded area of the chart.
- A straight line drawn through two colors, and passing through the equal energy point (x = 0.333, y = 0.333), indicates complimentary colors.
- Saturated colors, which are located on the periphery of the bounded area, are monochromatic, except on the purple to red boundary. Colors become progressively less saturated toward the white achromatic region in the center. The degree of saturation is a measure of color purity.
- Boundaries between colors are not distinct; one color blends gradually into the next.
- The ratio of distances between two colors to a third color located on a line drawn between them is proportional to the ratio of intensities of a mixture of those two colors required to produce the third color.

The principal disadvantage of the x,y chart is that equal distances on the diagram do not represent equal perceived color distances.

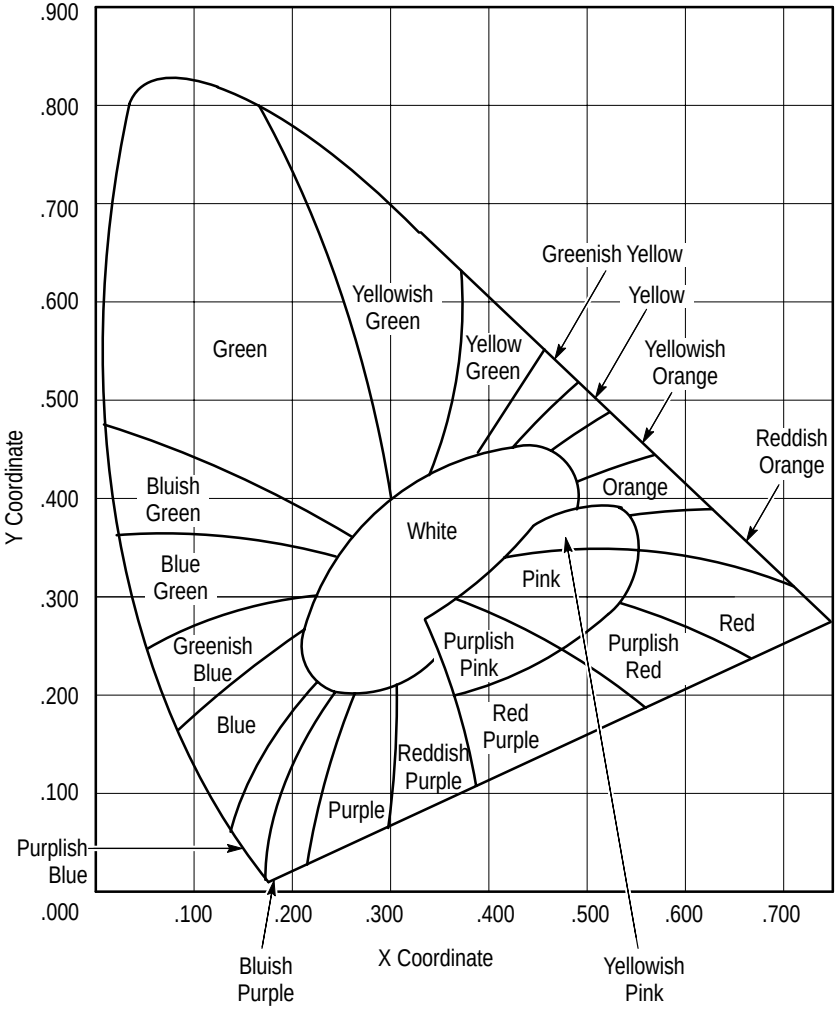


Figure B–1: The 1931 CIE Chromaticity Diagram

Figure B–2 shows the Planckian locus on the 1931 CIE diagram. The numbers along this line indicate the color temperatures (in degrees Kelvin) for blackbody light sources.

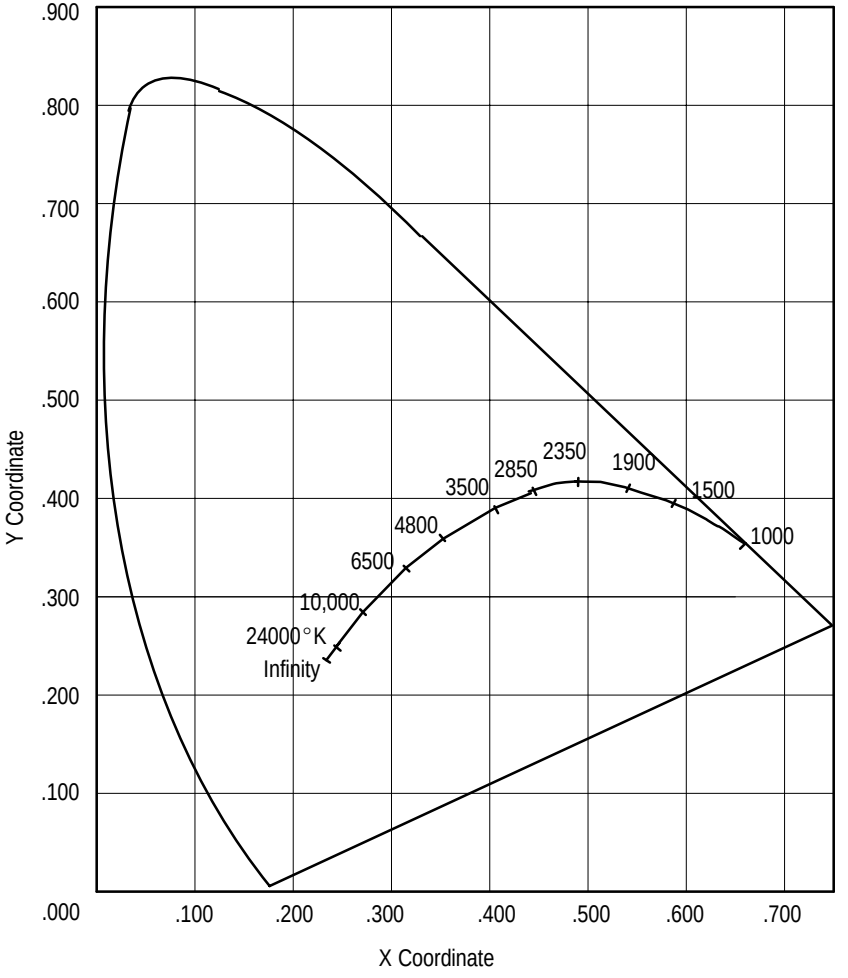


Figure B–2: 1931 CIE Chromaticity Diagram Showing Color Temperature

Figure B–3 shows selected isotemperature lines in the x,y coordinate system. A light source along one of the isotemperature lines will most nearly match the color temperature of a blackbody radiator indicated for that line.

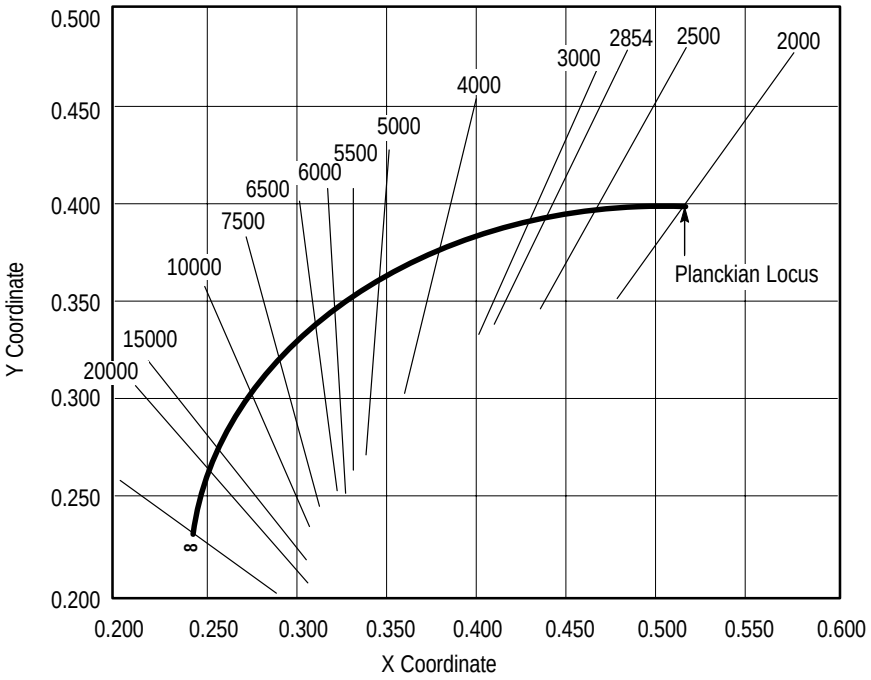


Figure B–3: Correlated Color Temperature Diagram

The 1976 CIE-UCS Chromaticity Diagram

The 1976 CIE-UCS (Uniform Chromaticity Scale) diagram, shown in Figure B–4, can be used to categorize chromaticity measurements expressed as u′, v′ values. u′ and v′ are related to the x and y values of the 1931 CIE chromaticity diagram by the following equations:

$$u' = \frac{4x}{-2x + 12y + 3} \qquad v' = \frac{9y}{-2x + 12y + 3}$$

This diagram is similar to the 1931 CIE chromaticity diagram except for the following:

- Equal distances on the diagram represent approximately equal perceived color differences.
- The equal energy point is u′ = 0.210, v′ = 0.473.

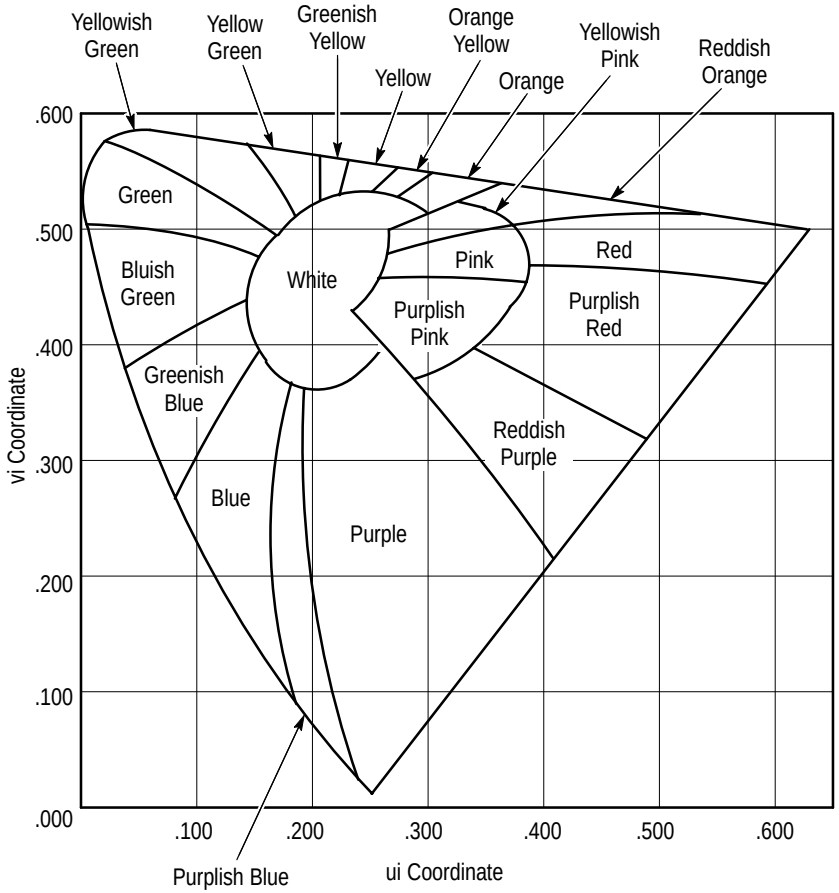


Figure B–4: 1976 CIE-UCS Chromaticity Diagram

Spectral Tristimulus Values

Figure B–5 shows the spectral tristimulus (XYZ) values for a light source of equal spectral power. Table B–1 lists the same data in tabular format.

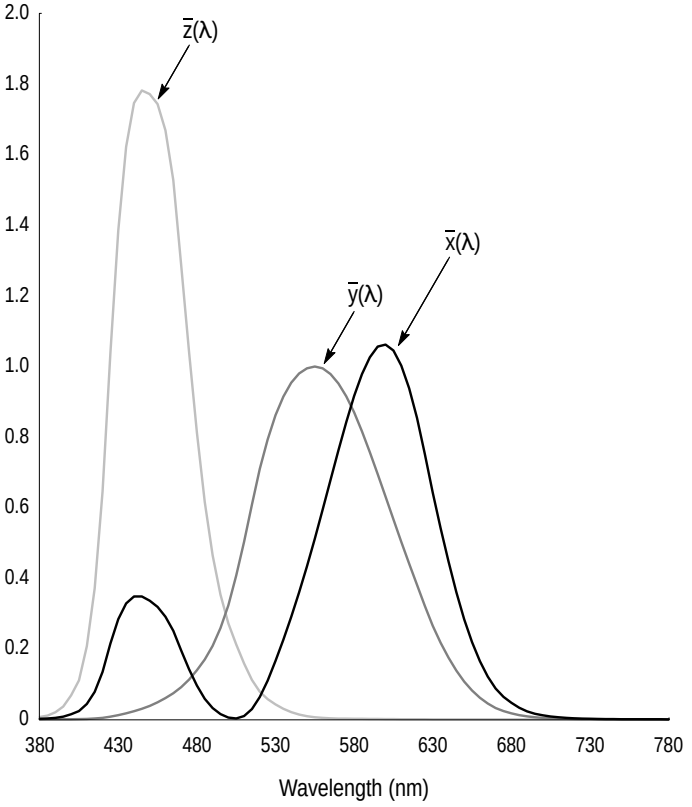


Figure B–5: Spectral Tristimulus Values for Equal Spectral Power Source (CIE 1931 Standard 2° Observer)

Note that $\bar{y}(\lambda)$ is also the photopic curve that represents the relative sensitivity of the average human eye.

Table B–1: Spectral Tristimulus Values for Equal Spectral Power Source (CIE 1931 Standard 2° Observer)

Wavelength (nm)	$\bar{x}(\lambda)$	$\bar{y}(\lambda)$	$\bar{z}(\lambda)$
380	0.0014	0.0000	0.0065
385	0.0022	0.0001	0.0105
390	0.0042	0.0001	0.0201
395	0.0076	0.0002	0.0362
400	0.0143	0.0004	0.0679
405	0.0232	0.0006	0.1102
410	0.0435	0.0012	0.2074
415	0.0776	0.0022	0.3713
420	0.1344	0.0040	0.6456
425	0.2148	0.0073	1.0391
430	0.2839	0.0116	1.3856
435	0.3285	0.0168	1.6230
440	0.3483	0.0230	1.7471
445	0.3481	0.0298	1.7826
450	0.3362	0.0380	1.7721
455	0.3187	0.0480	1.7441
460	0.2908	0.0600	1.6692
465	0.2511	0.0739	1.5281
470	0.1954	0.0910	1.2876
475	0.1421	0.1126	1.0419
480	0.0956	0.1390	0.8130
485	0.0580	0.1693	0.6162
490	0.0320	0.2080	0.4652
495	0.0147	0.2586	0.3533
500	0.0049	0.3230	0.2720

Table B–1: Spectral Tristimulus Values for Equal Spectral Power Source (CIE 1931 Standard 2° Observer) (Cont.)

Wavelength (nm)	$\bar{x}(\lambda)$	$\bar{y}(\lambda)$	$\bar{z}(\lambda)$
505	0.0024	0.4073	0.2123
510	0.0093	0.5030	0.1582
515	0.0291	0.6082	0.1117
520	0.0633	0.7100	0.0782
525	0.1096	0.7932	0.0573
530	0.1655	0.8620	0.0422
535	0.2257	0.9149	0.0298
540	0.2904	0.9540	0.0203
545	0.3597	0.9803	0.0134
550	0.4334	0.9950	0.0087
555	0.5121	1.0000	0.0057
560	0.5945	0.9950	0.0039
565	0.6784	0.9786	0.0027
570	0.7621	0.9520	0.0021
575	0.8425	0.9154	0.0018
580	0.9163	0.8700	0.0017
585	0.9786	0.8163	0.0014
590	1.0263	0.7570	0.0011
595	1.0567	0.6949	0.0010
600	1.0622	0.6310	0.0008
605	1.0456	0.5668	0.0006
610	1.0026	0.5030	0.0003
615	0.9384	0.4412	0.0002
620	0.8544	0.3810	0.0002
625	0.7514	0.3210	0.0001

Table B–1: Spectral Tristimulus Values for Equal Spectral Power Source (CIE 1931 Standard 2° Observer) (Cont.)

Wavelength (nm)	$\bar{x}(\lambda)$	$\bar{y}(\lambda)$	$\bar{z}(\lambda)$
630	0.6424	0.2650	0.0000
635	0.5419	0.2170	0.0000
640	0.4479	0.1750	0.0000
645	0.3608	0.1382	0.0000
650	0.2835	0.1070	0.0000
655	0.2187	0.0816	0.0000
660	0.1649	0.0610	0.0000
665	0.1212	0.0446	0.0000
670	0.0874	0.0320	0.0000
675	0.0636	0.0232	0.0000
680	0.0468	0.0170	0.0000
685	0.0329	0.0119	0.0000
690	0.0227	0.0082	0.0000
695	0.0158	0.0057	0.0000
700	0.0114	0.0041	0.0000
705	0.0081	0.0029	0.0000
710	0.0058	0.0021	0.0000
715	0.0041	0.0015	0.0000
720	0.0029	0.0010	0.0000
725	0.0020	0.0007	0.0000
730	0.0014	0.0005	0.0000
735	0.0010	0.0004	0.0000
740	0.0007	0.0002	0.0000
745	0.0005	0.0002	0.0000
750	0.0003	0.0001	0.0000

Table B–1: Spectral Tristimulus Values for Equal Spectral Power Source (CIE 1931 Standard 2° Observer) (Cont.)

Wavelength (nm)	$\bar{x}(\lambda)$	$\bar{y}(\lambda)$	$\bar{z}(\lambda)$
755	0.0002	0.0001	0.0000
760	0.0002	0.0001	0.0000
765	0.0001	0.0000	0.0000
770	0.0001	0.0000	0.0000
775	0.0001	0.0000	0.0000
780	0.0000	0.0000	0.0000
Totals:	21.3714	21.3711	21.3715

Glossary and Index

Glossary

Area Source
A light source of large angular size.

Blackbody (Planckian Radiator)
A thermal light source having light produced by heating. The intensity and color of a blackbody are primarily dependent on operating temperature.

Chromaticity
The quality of color. Based on wavelength distribution and purity.

Color Temperature
The absolute temperature, in Kelvin, of a blackbody required to produce an equivalent chromaticity from a light source.

Correlated Color Temperature
The absolute temperature of a blackbody required to most closely match the chromaticity of a light source.

Illuminance
The amount of luminous flux received by a unit of surface area. Usually measured in lux (lumens/meter^2) or foot·candles with a sensor spectrally matched to the average human eye.

Inverse Square Law
The falloff of light with distance; light varies inversely with the square of the distance from the source.

Irradiance
The amount of radiant flux received by a unit of surface area. Usually measured in watts/meter^2 or watts/cm^2 with a sensor having equal spectral sensitivity to the wavelengths being measured.

Isotropic Source
A light source that emits light uniformly in all directions.

Luminance
The amount of light emitted or scattered by a surface. Usually measured in candelas/meter^2 (nits)or foot-lamberts with a sensor spectrally matched to the average human eye.

Luminous Flux
The total light from a source, measured in lumens with a sensor spectrally matched to the average human eye.

Luminous Intensity
The luminous flux through a unit of solid angle. Usually measured in candelas (lumens/steradian) with a sensor spectrally matched to the average human eye.

Photometry
Measurement of light as seen by the human eye.

Photopic Correction
The correction of a sensor to match the CIE sensitivity function of the average human eye.

Point Source
A light source of small angular size, such that light appears to come from a point.

Radiance
The amount of radiant energy emitted or scattered by a surface. Usually measured in watts/meter^2/steradian with a sensor having equal spectral sensitivity to all wavelengths being measured.

Radiant Flux
The total radiation from a source, measured in watts with a sensor having equal spectral sensitivity to the wavelengths being measured.

Radiant Intensity
The radiant flux through a unit of solid angle. Usually measured in watts/steradian with a sensor having equal spectral sensitivity to the wavelengths being measured.

Radiometry
The measurement of radiant power. A radiometric sensor is equally sensitive to all wavelengths present in the light being measured.

Reflectance Factor
The ratio of reflected light to received light on a surface.

Tristimulus Values (X,Y,Z)
The amounts of each of three color primaries required to match the color of a light.

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