

Instruction Manual

Tektronix

J17
LumaColor™ Photometer
070-8531-04

This document applies for firmware version 1.00 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 all safety summaries prior to performing service.



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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.

While using this product, you may need to access other parts of the system. Read the *General Safety Summary* in other system manuals for warnings and cautions related to operating the system.

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.



Static-Sensitive Devices

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

Preface

This is the Instruction Manual for the J17 LumaColor™ Digital Photometer/Radiometer/Colorimeter. This manual covers all operating instructions for the J17.

This manual is divided into the following sections:

- *Getting Started* contains a product description and initial setup information.
- *Operating Basics* contains a functional overview of the photometer controls, display, and connections.
- *Reference* provides information on the RS-232 interface and color measurement techniques.
- *Specifications*
- *Performance Verification*
- *Maintenance*
- *Replaceable Parts*
- *Appendices* contains chromaticity reference information in the form of graphs and lookup tables. It also contains descriptions of optional accessories.
- *Glossary*
- *Index*

For additional information on the operation and specifications of the sensor heads, please refer to the *Technical Reference* manual that came with your sensors.

Getting Started

Product Description

The J17 is a handheld digital light measurement device. The interchangeable J1800 Series sensor heads, designed for use with the J17 Photometer, provide the ability to make photometric, radiometric, and colorimetric measurements.

J17 Photometer Features

The J17 provides the following features:

- Autoranging
- Auto zero
- Readings in either English or metric units
- RS-232D interface
- Interchangeable heads for future expansion
- Battery or AC-powered operation (AC adapter available as an optional accessory)
- Backlighting display

Product Description

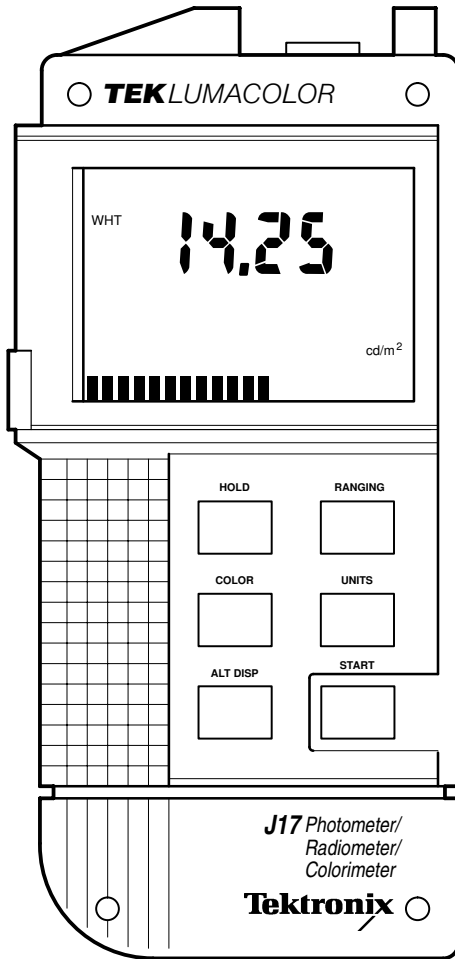


Figure 1-1: The J17 Photometer

Unpacking the J17 Photometer

The J17 Photometer is shipped with the following equipment:

- J17 Photometer
- Instruction Manual
- Alkaline battery (already installed in the J17)

Repackaging for Shipment

If you must ship the J17, package it as follows:

- Step 1:** Use the original carton, or an equivalent carton with dimensions at least three inches greater than the instrument to allow for proper cushioning.
- Step 2:** Cover the instrument with a polyethylene bag to protect its finish.
- Step 3:** Cushion the instrument on all sides with packing material. Seal the carton with shipping tape or with an industrial stapler.
- Step 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.

Setup

Follow this sequence when you set up the J17 Photometer:

- Step 1:** Check that a nine-volt alkaline battery is installed in the battery compartment (see page 1-8), or use the optional AC adapter to connect the J17 to an external power source (see page 1-9).
- Step 2:** Cover or shield the J1800 Series sensor head from ambient light. The photometer self-test period will be significantly shorter if the sensor is kept in the dark.
- Step 3:** Connect a J1800 Series sensor head to the J17.

Always connect the sensor head to the J17 before turning on the power. The J17 loads data from the sensor head at power-on. If you connect a new sensor head to the J17 while the power is on, any measurements you take may be inaccurate.

NOTE

The J1810 sensor will not work with the J17.

- Step 4:** Move the J17 **POWER** switch to the **ON** position.

When you turn the power on, the J17 performs the following actions:

1. The J17 performs a brief self-test. During the self-test, the J17 activates all elements of the display, checks the battery voltage, and performs the auto-zero and auto-range functions.

NOTE

If no sensor head is connected to the J17, the J17 will not proceed past the self-test display.

*Low battery voltage is indicated by a flashing **BAT** indicator. If this icon appears, replace the battery with a fresh one before taking any measurements.*

2. The J17 will display the default measurement units for the type of sensor head attached. If measurements are continuously updated, as with the J1803 Luminance Head, the J17 begins displaying measurement readings automatically. With the J1820 Chromaticity Head, the J17 will complete one measurement cycle and stop. (Pressing the **START** button initiates a new measurement cycle.)

Battery and Power Information

The J17 Photometer may be powered by either of the following sources:

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

Using Battery Power

The J17 Photometer provides a low battery warning to help prevent incorrect readings due to low battery power. Refer to *Specifications* for details on expected battery life and environmental concerns.

Use the Correct Battery

Use only a nine-volt alkaline battery, IEC type 6LR61, NEDA type 1604. (A carbon-zinc nine-volt battery may be used safely, but the operating life will be one-third to one-half that of an alkaline battery.)

Do not use rechargeable NiCd (nickel-cadmium) batteries. Their low power capacity and cell voltage will not support the J17.

Low Battery Warning

BAT

When battery voltage is below 7.2 volts, the J17 Photometer displays the flashing warning **BAT** in the upper left corner of its display. At this point, you should replace the alkaline battery (see below).

If the battery voltage is below 7.2 volts at initial power-on, the J17 will not proceed past the self-test.

Replacing the Alkaline Battery

To replace the alkaline battery, refer to Figure 1-2.

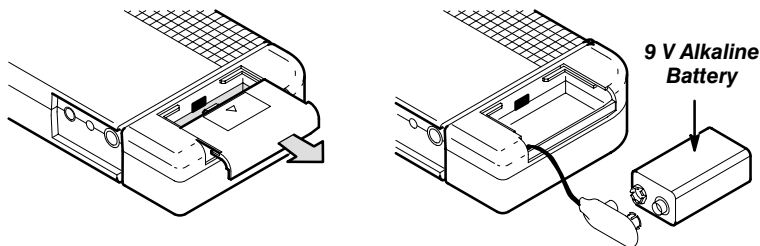


Figure 1-2: Replacing the Battery

- Step 1:** Turn off the J17 Photometer.
- Step 2:** Open the battery compartment located on the back cover of the J17.
- Step 3:** Remove the used battery, and replace it with a fresh one, arranging the wires so that they will not interfere with the battery cover.
- Step 4:** Close the battery compartment.
- Step 5:** Turn on the J17 and make sure that the low-battery (**BAT**) warning is no longer flashing.

Using the Optional AC Power Adapter

The J17 Photometer may be powered indefinitely by using the external AC power adapter, available as an optional accessory. The power adapter will override the alkaline battery, if one is installed.

To use this adapter, plug the adapter's pin connector into the **EXT. POWER** connector on the side of the J17 (see Figure 1-3). Plug the power adapter into an external AC power outlet providing 120 VAC at 60 Hz.

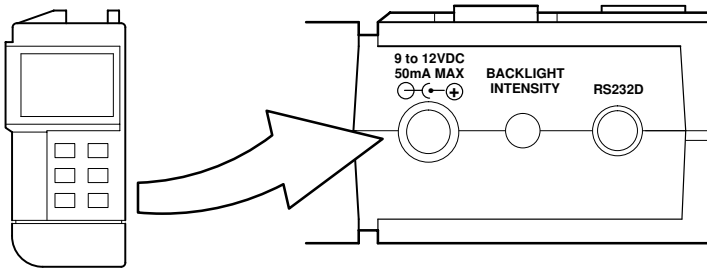


Figure 1-3: Location of J17 Power Adapter Connector

The AC power adapter supplies approximately 12 VDC at a minimum of 50 mA.



Be sure that any power supply you use with the J17 provides power within the range of 9 to 12 VDC, and that the center contact polarity of the adapter is positive. A power supply that does not meet these requirements may damage the J17.

Battery and Power Information

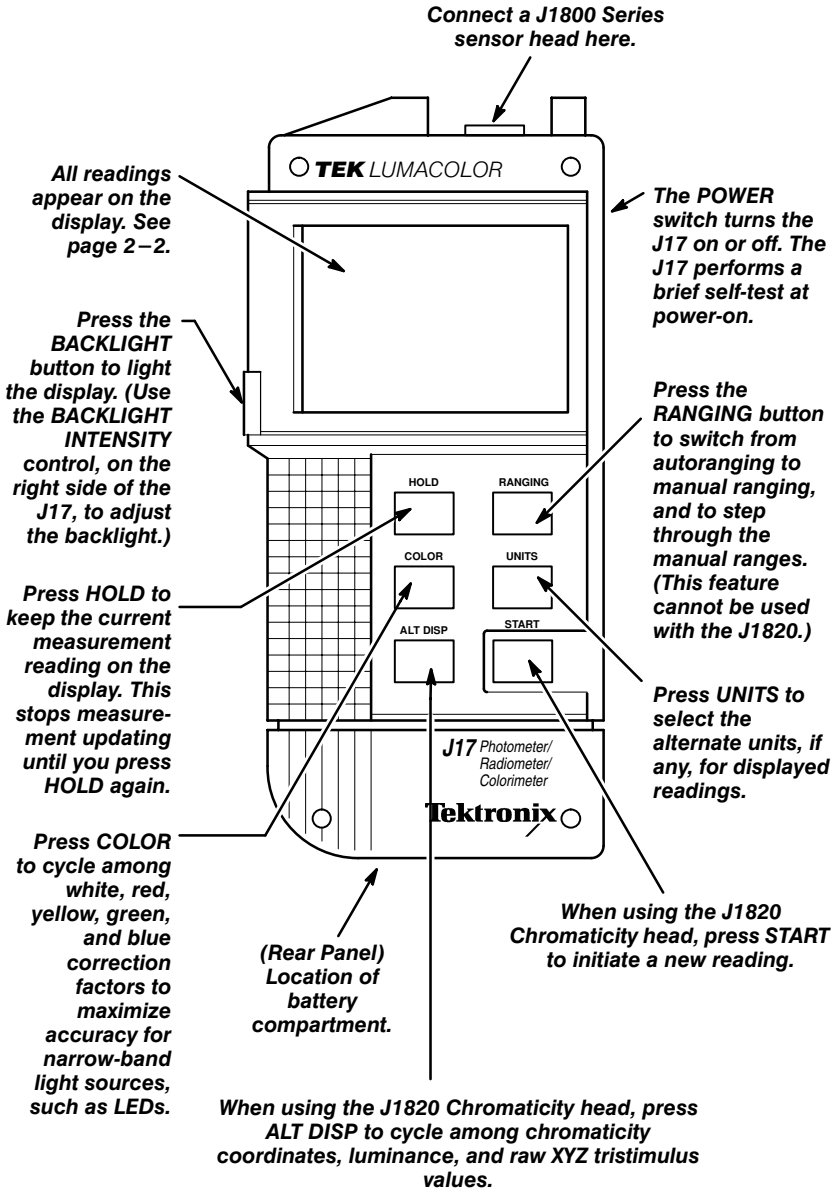
The backlight will be illuminated at power-on when the J17 is powered by the AC power adapter. The backlight may be turned off, if desired, by pressing the **BACK-LIGHT** button.

NOTE

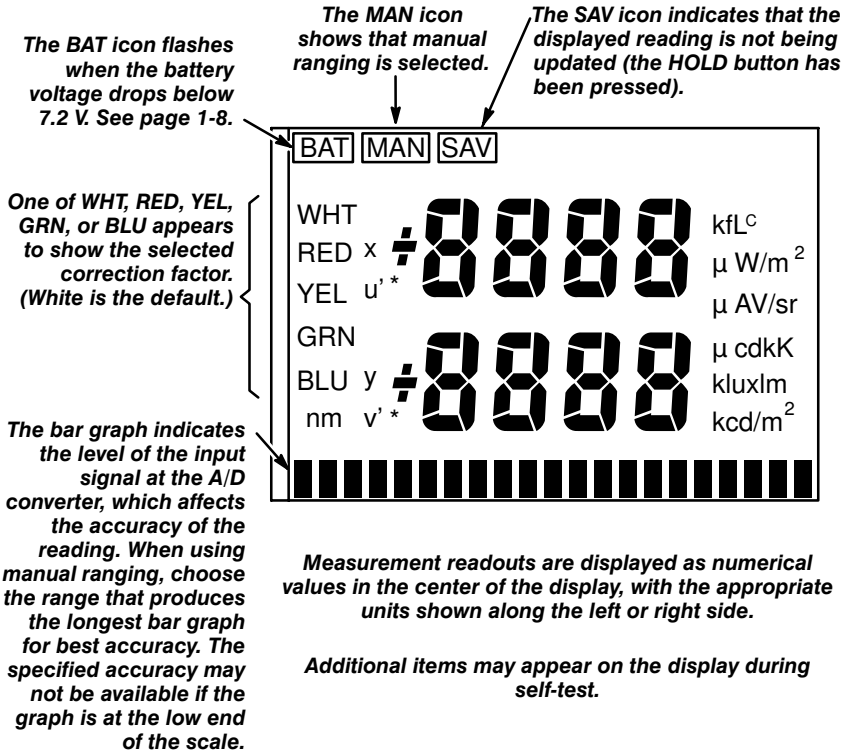
Power supplies that provide less than 12 volts DC may not automatically turn on the backlight.

Operating Basics

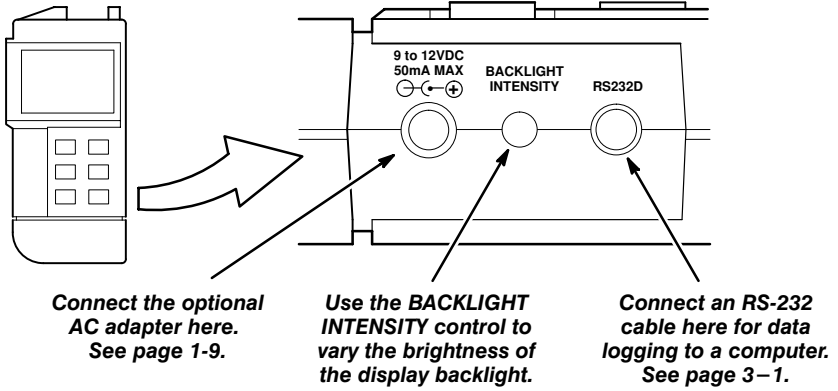
Functional Overview



The J17 Display



The J17 Side Panel



Reference

RS-232D Interface

You can use the J17 Photometer's RS-232D port to read measurements to a remote terminal, or to save measurement readings to a file on a computer. Any ASCII terminal or communications software may communicate with the J17 via the RS-232D port.

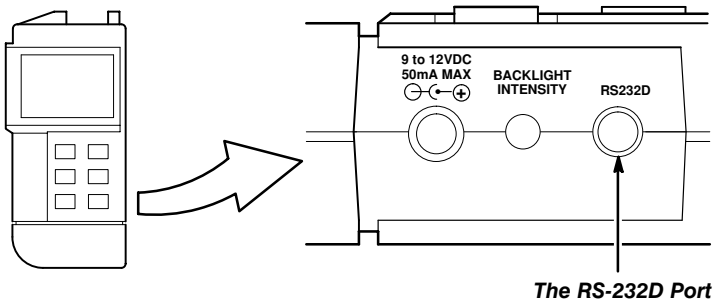


Figure 3-1: Location of the RS-232D Port

An RS-232 cable is available as an optional accessory to the J17 (refer to *Appendix A, Accessories*, for ordering information). This cable has a 3.5 mm connector for the J17, and a DB-9 female connector for connection to the computer. (Another common RS-232 connector on computers and terminals is the DB-25 connector. Adapters are commercially available to convert from the DB-9 connector to a DB-25 connector.)

The RS-232 interface is connected to a VT100 or VT102 terminal, or a personal computer with a terminal emulator installed. Typical examples of VT100 and VT102 emulators are Kermit, ProComm, and the Windows Terminal communications software.

The J17 operates with the RS-232 parameters shown in Table 3-1. The terminal must also be in the local echo mode to see text as it is entered.

Table 3-1: RS-232 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

Figure 3-2 shows the pin connections of the J17 RS-232 port and the optional RS-232 cable. The RS-232D port is a 3.5 mm stereo phone plug.

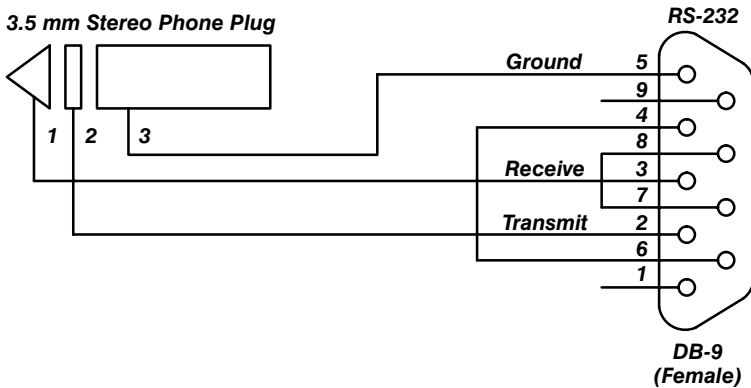


Figure 3-2: RS-232 Pin Connections

Command Set

The J17 Photometer recognizes a single command, !NEW, which causes it to report a measurement or a series of measurements. The J17 is case sensitive, so the command must be in all capital (upper case) letters.

Table 3-2 summarizes the syntax conventions of the command set.

Table 3-2: Elements of J17 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)	A space act as a parameter delimiter within commands. The J17 also recognizes a comma (,) as a parameter delimiter; these two characters may be used interchangeably. Use only one space or comma as a delimiter; multiple delimiters will result in a null statement.
<i>italics</i>	Items in italics are names of parameters. Specify the appropriate value when entering the command.

!NEW — causes the J17 to report a measurement, or a series of measurements:

!NEW{CR} causes the J17 to transmit the a single reading (the one currently displayed).

!NEW n{CR} causes the J17 to transmit multiple readings as they are taken.

Any value for *n* greater than 128 causes the J17 to report measurements continuously, until another command is sent.

To interrupt the reporting, a single **!** will hold reports.

To stop reporting, a **!NEW{CR}** will stop and suspend the continuous reports.

NOTE

*When using the J1820 color head, the values delivered by the report will only be the value of the last measurement. The **START** button must be pressed each time a new measurement is taken.*

If an off scale (999.9) reading is taken, the J17 will suspend RS-232D reporting until the reading is within the measurement range of the instrument.

Report Format

The data format for measurements consists of two major fields: the measurement units and the measurement value(s). See Figure 3-3.

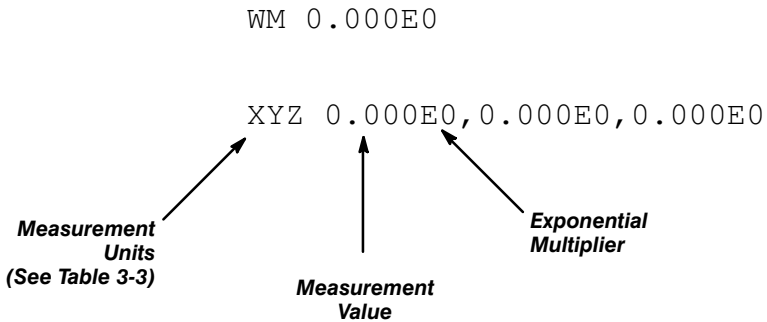


Figure 3-3: RS-232D Report Format

Measurement unit abbreviations are listed in Table 3-3.

Values are displayed with four significant digits, and a one-digit exponential multiplier with an optional minus sign. For multiple values (for example, the three values reported for an XYZ reading), commas separate the values.

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

Table 3-3: Measurement Units

Abbreviation Used	Meaning
C	candelas
CM	candelas/meter ²
FC	foot-candles
FL	foot-lamberts
K	Kelvin
LUM	lumens
LUX	lux
W	watts
WM	watts/meter ²
WMS	watts/meter ² /steradian
XYZ	tristimulus values

Color Measurements

This section is included to clarify the function of the COLOR and START buttons.

COLOR Button

The J17 has a button labeled COLOR for use with certain heads. Pressing this button and toggling through the separate colors does not give a readout of the color component of that source. The button is used when measuring pure color sources to fine adjust the sensor calibration to that specific color. For example: the RED mode should be selected when measuring the output of a red LED.

When using heads for a broad spectrum of light sources, use the WHITE setting. Use the color settings only if you are measuring narrow spectrum light sources such as lasers and LEDs.

J1820 Measurements

The J1820 is a true color head. Set the COLOR button to WHITE and then press the START button to get an accurate reading of the composition of the source.

The default color coordinate system is the x,y system. To change to the u'v' system, press the UNITS button.

To display the luminance value, press the ALT DISP button. The default luminance units are cd/m^2 (NITs). To change to fL (footlamberts), press the UNITS button.

Color Measurements

To display measurements in the XYZ color coordinate system, press the ALT DISP button. The display will show the X and Y values. To display the Z value, press the UNITS button.

Specifications

Specifications

These characteristics are valid under the following conditions:

- The J17 and sensor head must have been calibrated at an ambient temperature between +20° C and +30° C.
- The J17 and sensor head must be used in an environment within the limits described in Table 4-5, Warranted Environmental Characteristics.
- The J17 and sensor head must have had a warmup period of at least 10 minutes.

Optical measurements are referred to photometric, radiometric, and colorimetric standards traceable to NIST.

Table 4-1: Warranted Electrical Characteristics

Characteristic	Standard
Accuracy (Excluding sensor-head, including nonlinearity)	1% of reading \pm 2 Counts

Table 4-2: Warranted Sensor Ranges

Sensor	Units	Max Reading	Min. Reading
J1803	fL	500,000	0.01
	cd/m ² (Nits)	1,500,000	0.03
J1805	cd	100	0.00001
J1806	W/m ² /sr	1000	0.001
J1811	fc	5000	0.001
	lux (lm/m ²)	50,000	0.01
J1812	mW/m ²	20,000	0.01
	W	2 mW	1 nW
J1820 (Y)	fL	100,000	0.1
	cd/m ² (Nits)	300,000	0.3
J1820 u'v', xy		0.999	0.001
J1823	fL	10,000	0.1
	cd/m ² (Nits)	30,000	0.3
J1823 Opt. 01	fL	10,000	1
	cd/m ² (Nits)	30,000	3

Refer to sensor-head documentation for detailed specifications.

Table 4-3: Typical Electrical Characteristics

Characteristic	Standard
Power Requirements	
Alkaline battery IEC type 6LR61, NEDA type 1604	7 V to 10 V
External Power Supply	9 V to 12 VDC
Battery Life	30 hours
IEC 6LR61 battery with backlight off and RS-232 unplugged.	
Battery Low Indication	7.2 V

Table 4-4: Typical Mechanical Characteristics

Characteristic	Standard
Height (Without sensor.)	198 mm (7.8 inches)
Width	93 mm (3.7 inches)
Depth	34 mm (1.3 inches)
Shipping Weight (Includes battery, manual, and packaging.)	1.4 kg (3 lbs)

Table 4-5: Warranted Environmental Characteristics

Characteristic	Standard
Temperature	
Nonoperating	−55° C to +85° C
Operating	−15° C to +55° C
Humidity, operating and nonoperating	J17 Meets MIL Std 28800E Class 3 Refer to the Environmental Characteristics for each J1800 Series sensor head.

Table 4-6: Certifications and compliances

EC Declaration of Conformity	Meets 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 55011 Class B Radiated and Conducted Emissions EN 50081-1 Emissions: EN 60555-2 AC Power Line Harmonic Emissions EN 50082-1 Immunity: IEC 801-2 Electrostatic Discharge Immunity IEC 801-3 RF Electromagnetic Field Immunity IEC 801-4 Electrical Fast Transient/Burst Immunity IEC 801-5 Power Line Surge Immunity
FCC Compliance	Emissions comply with FCC Code of Federal Regulations 47, Part 15, Subpart B, Class A Limits



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.

NOTE

The J1810 chromaticity sensor will not work with the J17. The J1810 sensor will only work with the J18 LumaColor™ II photometer.

If the sensor and photometer do not pass the performance verification, contact your local Tektronix representative for support.

Maintenance

Maintenance

The J17 Photometer and J1800 Series heads do not require periodic maintenance. Clean the instrument case and sensors as directed in the *Cleaning* section.

If the J17 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 lists some operating conditions to check for if you believe the J17 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 J17. Use these procedures if you want to repair the J17 yourself.

Cleaning

Instrument Cleaning

Clean the instrument case by wiping it with a damp cloth. Follow these important guidelines:

- Dampen a soft cloth and wipe the dirt off. Do not spray cleaner directly onto the photometer.
- Use a mild detergent or isopropyl alcohol. Do not clean the case with strong solvents that may etch the plastic or remove the lettering.

Sensor Cleaning

Clean the sensor case by wiping it with a soft damp cloth. Do not attempt to cleaning the internal optics. Follow these important guidelines:

- Follow the guidelines for cleaning the photometer case.
- Clean external lenses using a lens cloth dampened with lens cleaning solution. Do not apply lens cleaning solution directly to the lens.
- Use clean compressed air to blow dust out of sensors.

Calibration

An annual recalibration of the heads will ensure best accuracy. The *Performance Verification* section in the manual that is shipped with the sensor-head details the procedures for checking the sensor-heads.

There are no calibration adjustments within the photometer or sensors. Calibration values are stored in an EEPROM circuit located in the sensor-head. Contact you local Tektronix representative for assistance if either product does not pass a performance verification check.

Basic Troubleshooting

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

The J17 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 J17 to a power source.

The Display Shows Err

The word **Err** (error) appears on the display when you press a button that is not appropriate with the sensor-head attached to the J17, or not appropriate in the chosen operating mode.

Measurements are Inaccurate

If measurements taken with the J17 are inaccurate or inconsistent, check the operating setup:

- Connect the sensor-head to the J17 *before* powering on. If not, turn the J17 off, then turn it back on. The J17 will load data from a sensor-head at power-on.
- Make sure that the sensor-head is positioned so that the measurement field is entirely filled. This is important for luminance, radiance, and chromaticity measurements.
- Make sure that the area being viewed by the sensor-head is uniformly illuminated. This is important for luminance, radiance, and chromaticity measurements.

- Position the sensor-head so that it does not shadow the surface being measured. Shadowing will occur if the surface is being measured from direction of the illumination.
- Do not operate the head in contact with the surface. Placing the head too close to the surface may cause shadowing. Reflections may also occur between the front surface of the head and the surface to be measured.

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

- Check for cable damage where the cable enters the photometer plug and sensor-head. Be careful not to stress the sensor cable and damage it.
- Do not flex the sensor-head cable when taking low-light measurements. The high sensitivity of the photometer will detect charges generated in the cable when used at high sensitivity ranges.

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

RS-232 Port Does Not Work

Check the following to make sure that you are properly connected to the RS-232 port:

- Check the terminal software to make sure it is addressing the correct COM port.
- Check the communication protocols to make sure they agree with those in the *Specifications* section.

- Turn on the backlight and see if it goes out when entering a command via the RS-232 port. The backlight will come back on when the command is ended or if it is invalid.
- Make sure that any adapters that you are using are correctly wired.

Board-level Troubleshooting

The two circuit boards in the J17 may be replaced. If the J17 does not function, you can use these procedures to isolate the problem to one of the boards. Refer to *Replaceable Parts* for ordering information.



Static electricity can damage the circuit boards of the J17. Observe static precautions when the covers of the J17 are removed. Servicing should be performed by qualified personnel only.

Most functions of the J17 are located on the A1 board. The A2 Display board controls the display, backlight, and keyboard. The general troubleshooting sequence for the J17 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 typically due to the A1 board. If a power supply problem is suspected, perform the procedure in *Checking the Power Supply* on page 6–6 to verify that the power supply, and not the battery, is at fault.

The A1 Board

Most functions of the J17 are located on the A1 board. *Checking the Power Supply* on page 6–6 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 J17 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:

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

- Step 1:** Remove the battery from the battery compartment.



To avoid equipment damage, do not apply power to the J17 while disassembling it.



Static electricity can damage the circuit boards of the J17. Observe static precautions when the covers of the J17 are removed.

- Step 2:** Using the hex wrench, remove the four screws from the J17 front panel.
- Step 3:** Remove the back cover of the J17.
- Step 4:** Remove the five screws that attach the A1 board to the A2 board.
- Step 5:** Gently pull the two boards apart, taking care not to bend the connector pins on the A1 board.
- Step 6:** Connect the battery to the A1 board and turn on the power switch.
- Step 7:** Connect the voltmeter to test point 90 and test point 32 (ground). Check test point 90 for a voltage of +7.2 V or higher. Refer to Figure 6-1 for test point locations.

If the voltage at test point 90 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.

- Step 8:** Hold the connection to test point 32 (ground) and check for a voltage of +5.75 V \pm 0.05 V at test point 30.
- Step 9:** While still connected to test point 32 (ground), check test point 31 for a voltage of +5.000 V \pm 0.025 V.

If the voltages at test points 30 and 31 are correct, the problem is not the power supply. If these voltages are not correct, the A1 board must be replaced.

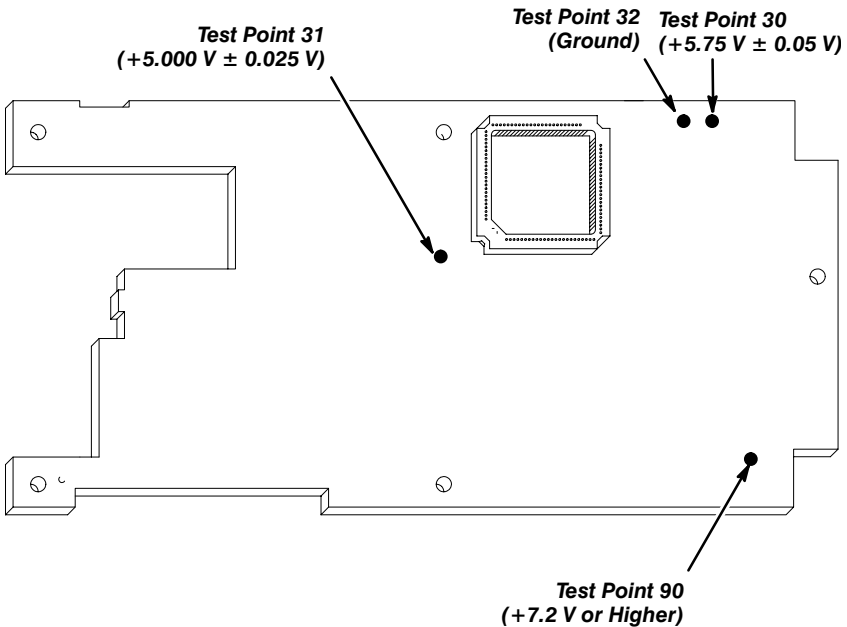


Figure 6-1: Test Point Locations on the A1 Board

Replaceable Parts

Replaceable Parts

This section contains a list of the modules that are replaceable for the J17 Photometer and the J1800 Series sensor heads. 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:

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

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

Replaceable Parts

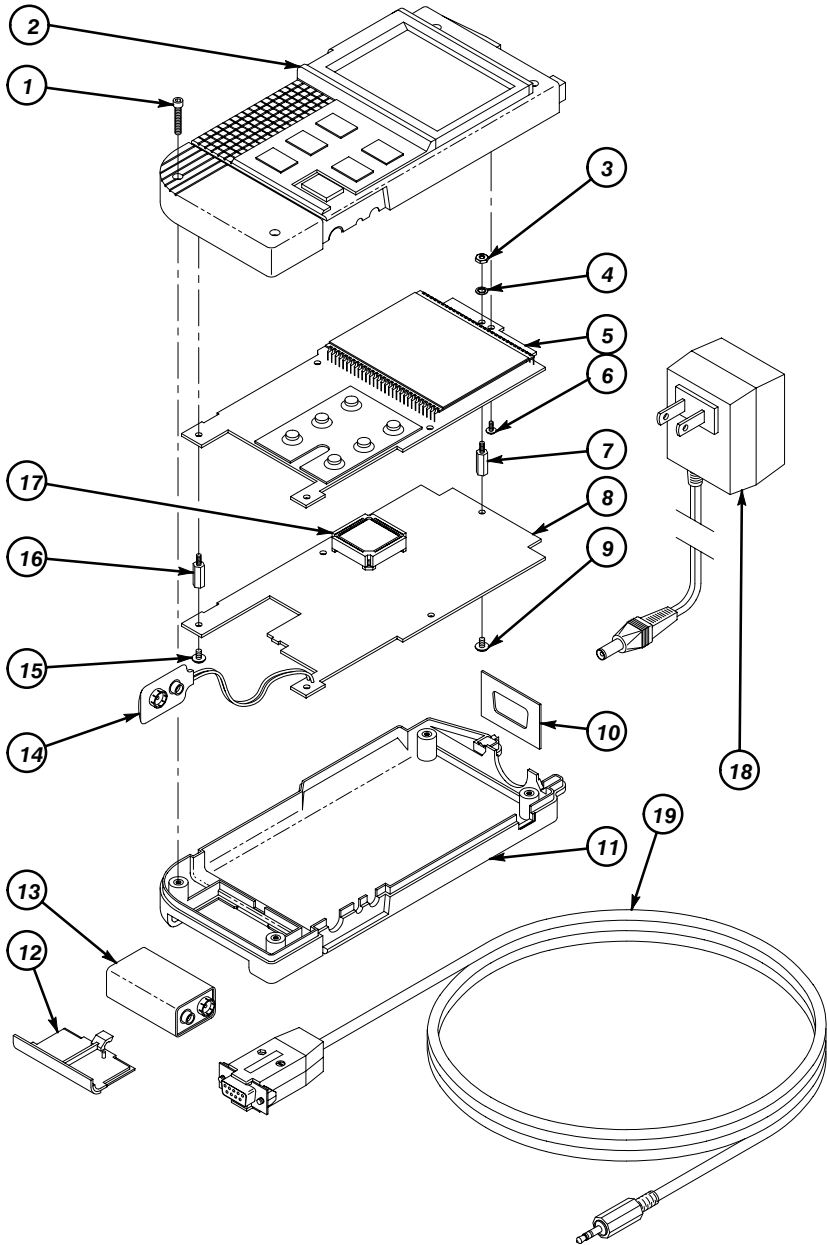


Figure 7-1: J17 Replaceable Parts

Fig. &

Fig. & Index No.	Tektronix Part No.	Serial No. Effective Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
7-1-	-----		1	J17,PHOTOMETER:		
-1	211-0789-00		4	SCREW,CAP:4-40,0.625 L, HEX SKT,STL,BLK OXIDE	0KB01	211-0789-00
-2	380-1032-00	B019999	1	HOUSING, TOP AS:W/KEYCAPS & GASKET	80009	380103200
	380-1032-01	B020000	1	HOUSING ASSY:TOP HOUSING ASSY,X KEY CAPS & GASKET	80009	380103201
-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	671-2439-00		1	CIRCUIT BD ASSY:DISPLAY	80009	671243900
-6	211-0180-00		1	SCR,ASSEM WSHR:2-56 X 0.25, PNH,BRS,NP,POZ	TK0435	ORDER BY DESC
-7	129-1361-00		3	SPACER,POST:0.460 L,W/4-40 THD ONE END,#2-5.6 OTHER END,AL,0.188 HEX	TK0588	PER TEK DOCUMENT
-8	671-2061-00		1	CIRCUIT BD ASSY:PROCESSOR	80009	671206100
-9	211-0007-00		3	SCREW,MACHINE:4-40 X 0.188,PNH,STL	TK0435	ORDER BY DESC
-10	386-0045-00		1	PLATE,MTG:CONNECTOR,BLACK ANODIZE	5Y400	386-0045-00
-11	380-1039-00	B019999	1	HOUSING,HALF:BOTTOM,ABS	7X318	380-1039-00
	380-1039-01	B020000	1	HOUSING,HALF:BOTTOM,ABS	80009	380103901
-12	200-3896-00	B019999	1	DOOR,ACCESS:BATTERY LID	80009	200389600
	200-3896-01	B020000	1	DOOR,ACCESS:BATTERY LID,PLASTIC	80009	200389601
-13	146-0017-00		1	BATTERY,DRY:9V,0.4AH @ 8MA	TK1060	MN1604BK

Replaceable Parts

Fig. & Index No.	Tektronix Part No.	Serial No. Effective Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
-14	131-1160-00		1	CLIP/ELECTRICAL: BATTERY	0DWW6	ORDER BY DESC
-15	211-0007-00		2	SCREW, MACHINE: 4-40 X 0.188, PNH, STL	TK0435	ORDER BY DESC
-16	129-1361-00		2	SPACER, POST: 0.460 L, W/4-40 THD ONE END, #2-5.6 OTHER END, AL, 0.188 HEX	TK0588	PER TEK DOCUMENT
-17	160-8856-00		1	IC, DIGITAL: 6208 X 8 MICROPROCESSOR, PRGM, MC68HC705B6F.N	80009	160885600
STANDARD ACCESSORIES						
	070-8531-03		1	MANUAL, TECH: INSTRUCTION, J17	80009	070853103
OPTIONAL ACCESSORIES						
-18	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
-19	012-1411-00		1	CABLE, INTCON: RS232 CABLE, 72.0 L	80009	012141100

CROSS INDEX – MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip Code
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
TK1060	DURACELL INTERNATIONAL INC BATTERY TECHNOLOGY CO	S BROADWAY	TARRYTOWN NY 10591
TK1325	LZR ELECTRONICS	8174 BEACHCRAFT AVENUE	GAITHERSBURG MD 20879
0DWW6	MICRO POWER ELECTRONICS	7973 SW CIRRUS DRIVE BLDG. #22	BEAVERTON OR 97005
0KB01	STAUFFER SUPPLY	810 SE SHERMAN	PORTLAND OR 97214
5Y400	TRIAx METAL PRODUCTS INC DIV OF BEAVERTON PARTS MFG CO	1800 216TH AVE NW	HILLSBORO OR 97124 – 6629
7X318	KASO PLASTICS INC	11015 A NE 39th	VANCOUVER WA 98662
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

Replaceable Parts

Appendices

Appendix A: Optional Accessories

In addition to the J1800 Series sensor heads, the following items are available for use with the J17 Photometer:

- External DC power supply (120 VAC North American)
- External DC power supply (220 VAC European)
- RS-232D cable

For part number information, refer to the *Replaceable Parts* section.

For detailed information and prices, or to obtain replacements, see a Tektronix products catalog or contact your local Tektronix field representative.

Appendix A: Optional Accessories

Appendix B: 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 $\frac{1}{4}$ footcandle.
- A perfectly white, diffuse surface illuminated by 1 footcandle has a surface luminance of 1 footlambert.

Appendix B: Photometry and Radiometry Reference

- 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

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

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

$$\text{footcandles} \cdot \text{distance}^2 \quad (\text{in feet}) = \text{candelas}$$

$$\text{lux} \cdot \text{distance}^2 \quad (\text{in meters}) = \text{candelas}$$

$$\text{footcandles} \cdot \text{surface reflectance factor} = \text{footlamberts}$$

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/meter².
- 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 ¼ watt/meter².
- A perfectly white, diffuse surface illuminated by an irradiance of 1 watt/meter² has a surface radiance of .318 watt/meter²/steradian (irradiance divided by π).
- A diffuse surface that has a reflectance of less than 100% will have a surface radiance, in watts/meter²/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

$$\text{watt/cm}^2 \cdot 10000 = \text{watt/meter}^2$$

$$\text{watt/meter}^2 \cdot \text{distance}^2 \text{ (in meters)} = \text{watt/steradian}$$

A Note on the Relation of Photometric and Radiometric Data

Note that 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 C-1). Broader sources must be converted using mathematical integrations of their intensity and the photopic curve at each wavelength.

CIE Photopic Curve

The CIE photopic curve is an international standard for the color response of the average human eye. By definition, footcandles, footlamberts, lux, and nits are based on a detector having a color response identical to the CIE photopic curve. Tektronix photopic sensors have response curves that match the CIE photopic curve. Refer to Figure B-1.

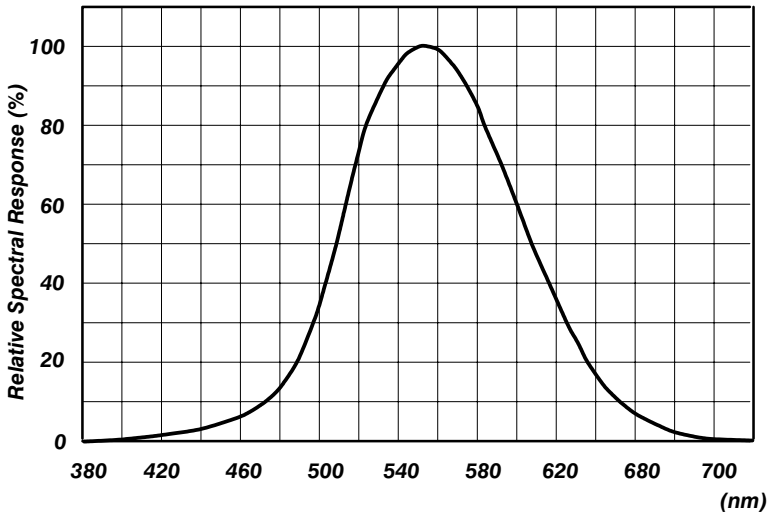


Figure B-1: CIE Photopic Curve

Appendix C: Chromaticity Reference

The reference material in this appendix can help you categorize and understand chromaticity measurements taken using the J1820 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 C-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.

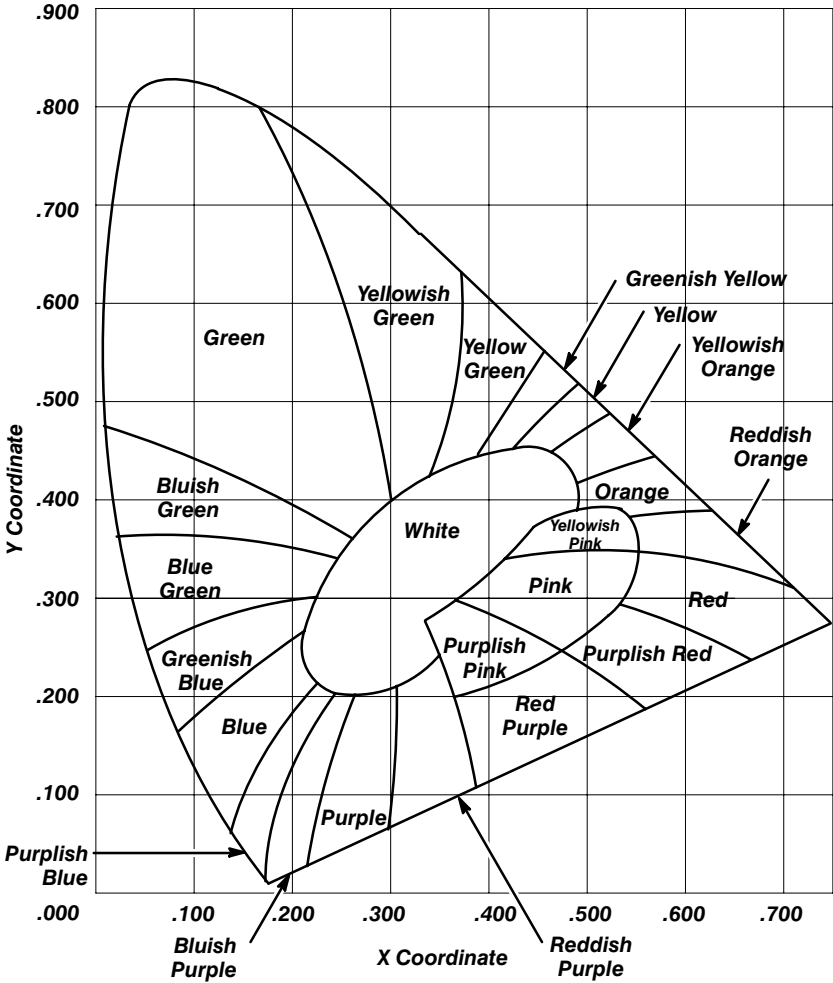


Figure C-1: The 1931 CIE Chromaticity Diagram

Appendix C: Chromaticity Reference

Figure C-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.

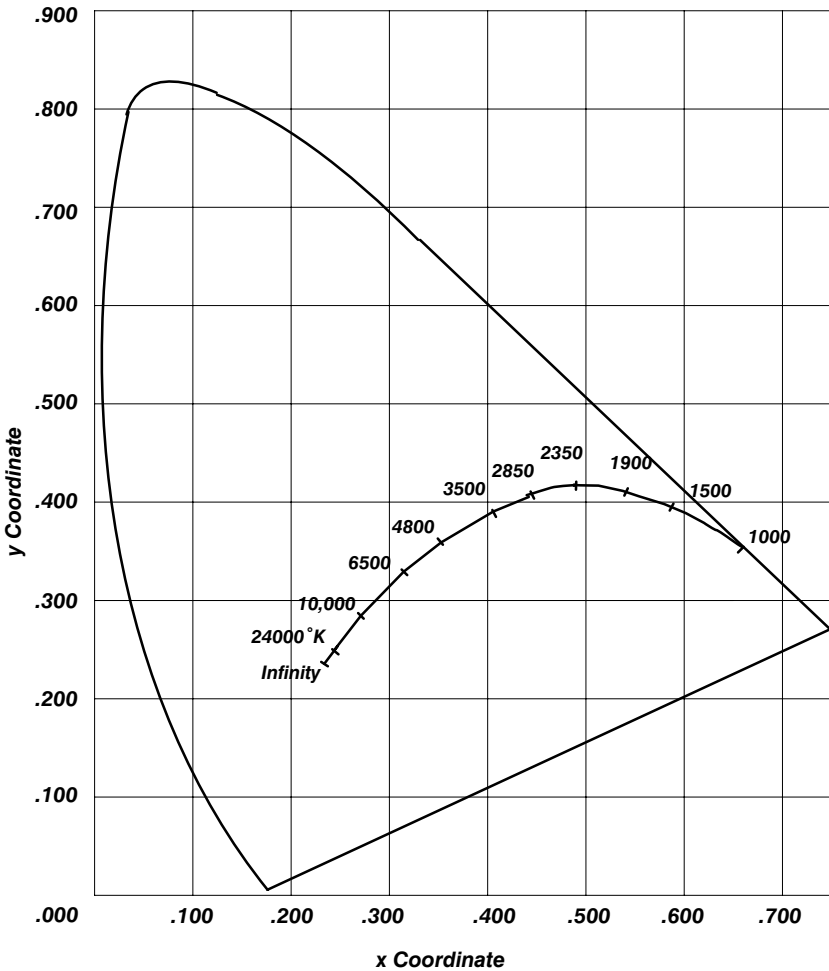


Figure C-2: 1931 CIE Chromaticity Diagram Showing Color Temperature

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

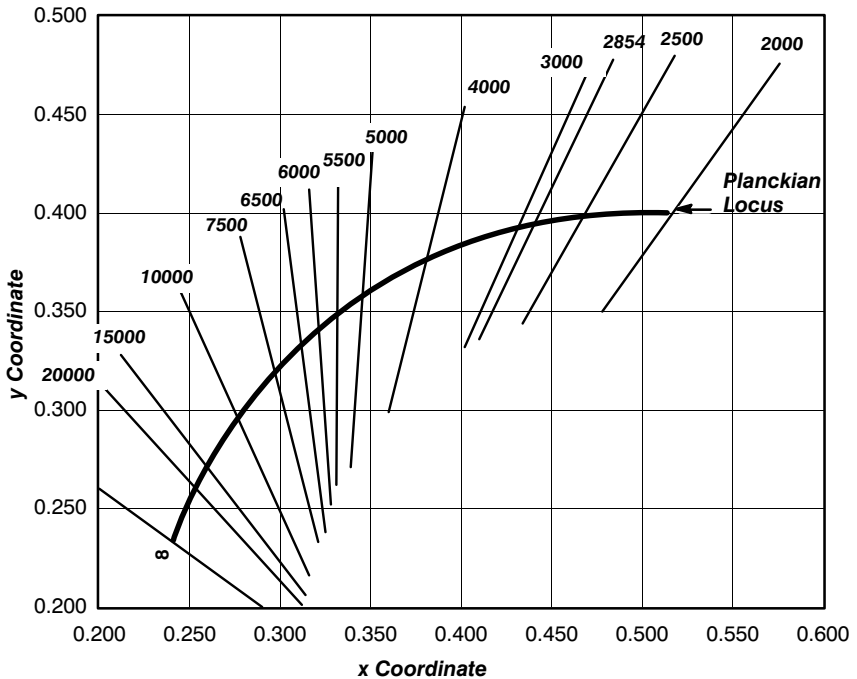


Figure C-3: Correlated Color Temperature Diagram

Although the colors displayed along an isothermperature line will appear similar, there will be noticeable differences. For the best results when setting display color balance, use the precise color coordinates of the crossing of the Planckian Locus by the desired color temperature. For example, $x = 0.318$ and $Y = 0.332$ is the location of D65 (6500 K). Do not use correlated color temperature alone.

The 1976 CIE-UCS Chromaticity Diagram

The 1976 CIE-UCS (Uniform Chromaticity Scale) diagram, shown in Figure C-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 $u' = 0.210$, $v' = 0.473$.

The primary disadvantage of the 1976 CIE-UCS diagram is that color mixtures cannot be determined easily from the coordinates and intensities of their components.

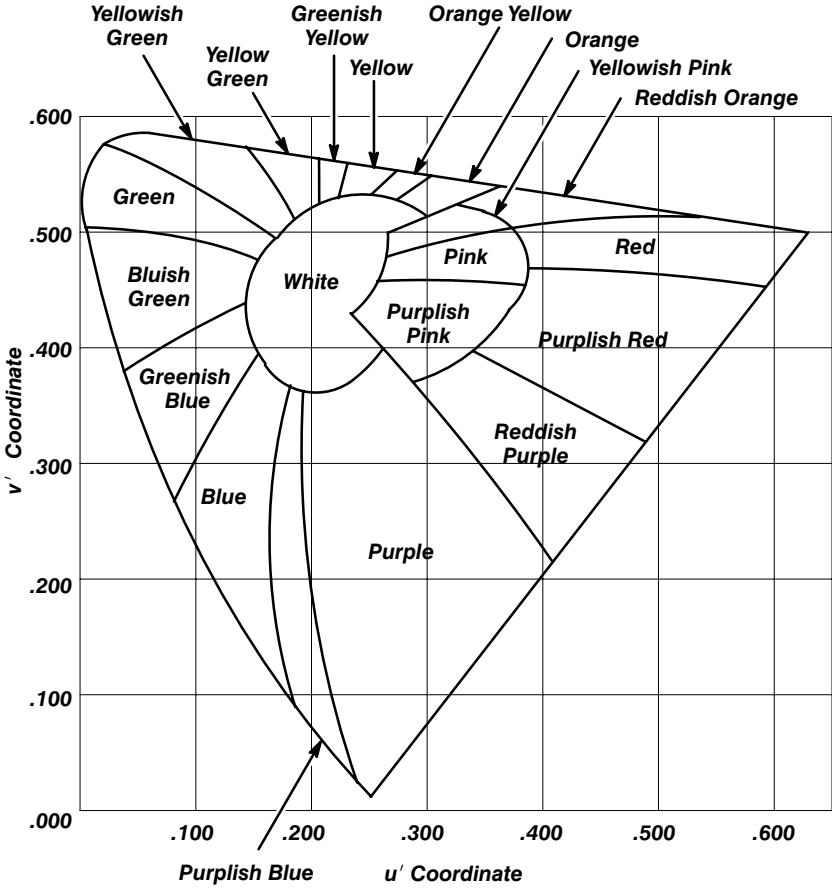


Figure C-4: 1976 CIE-UCS Chromaticity Diagram

Spectral Tristimulus Values

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

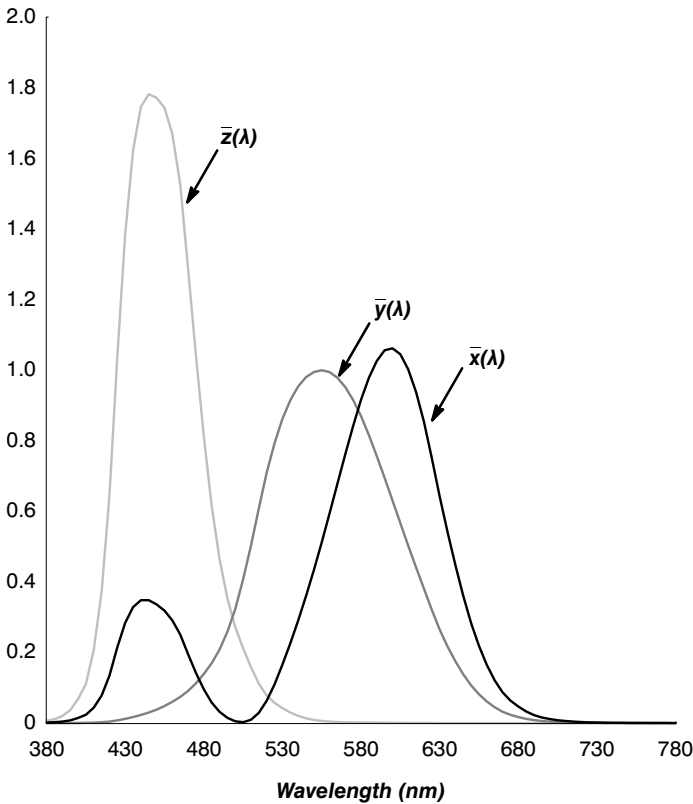


Figure C-5: Spectral Tristimulus Values for Equal Spectral Power Source (CIE 1931 Standard 2° Observer)

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

**Table C-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
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

Appendix C: Chromaticity Reference

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

Wavelength (nm)	$\bar{x}(\lambda)$	$\bar{y}(\lambda)$	$\bar{z}(\lambda)$
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
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

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

Wavelength (nm)	$\bar{x}(\lambda)$	$\bar{y}(\lambda)$	$\bar{z}(\lambda)$
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
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

Appendix C: Chromaticity Reference

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/meter²) 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/meter² or watts/cm² 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/meter² (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/meter²/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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