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J16 Photometer/Radiometer

- Digital LED Readout
- Eight Silicon Sensor Probes Quickly Interchange Without Recalibration
- Freedom From Saturation Effects over Entire Range
- Accurate Spectral and Cosine Corrections
- Metric and US Versions Available
- BCD/Analog Output (Option 07)
- AC or Internal Rechargeable Battery Versions
- Longer Battery Life—4-Hour Operation
- Application Notes Available

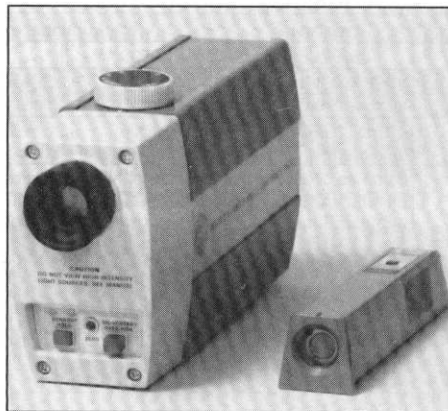
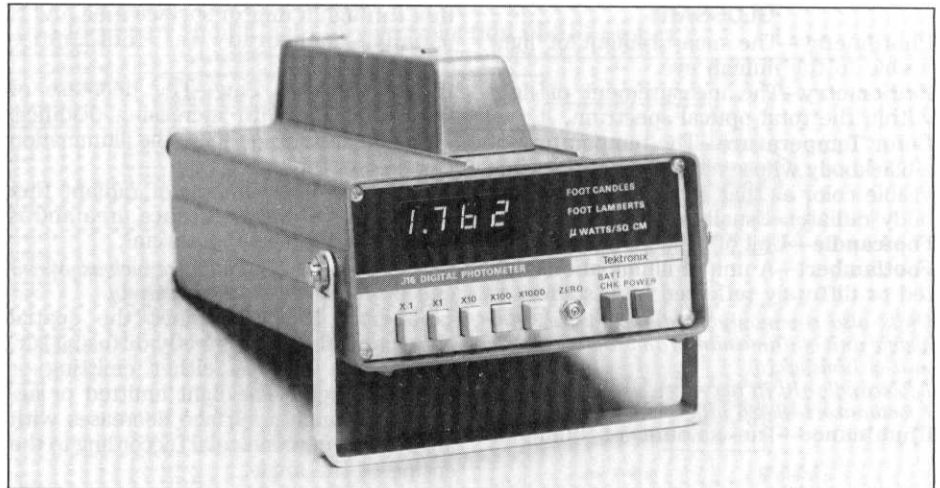
The Tektronix J16 is a portable digital photometer/radiometer capable of making a wide variety of light measurements—in the laboratory, in the field, or on the production floor. A J16 System consists of a J16 mainframe and one of eight detachable probes. Probes can be either mounted on the J16 or used on the end of an extension cable. All probes have a Hold switch to allow the reading to be held.

Eight quickly interchangeable probes are available for measuring illuminance, irradiance, luminance, light-emitting diode output, and relative intensity. Recalibration is not necessary when probes are interchanged. Connection of a probe to the J16 automatically selects the correct front panel units indicator. The 3½-digit LED display can be easily read under low ambient conditions.

All probes use silicon photodiodes and multi-element glass filters for maximum stability and accuracy.

The optional BCD/analog output feature (Option 07) allows the user either a BCD output of the displayed reading or an analog signal (level) proportional to the light falling upon the sensor. The J16 can be also used with Tek MI 5010/50M30 system for interface with a GPIB system.

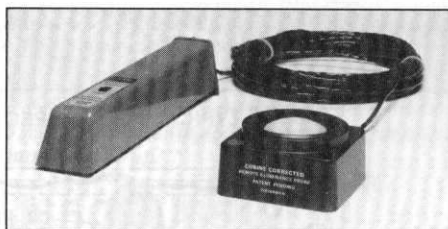
Under normal usage, the internal rechargeable nickel cadmium batteries will operate the J16 for four hours. An ac power supply is recommended for continuous operation.



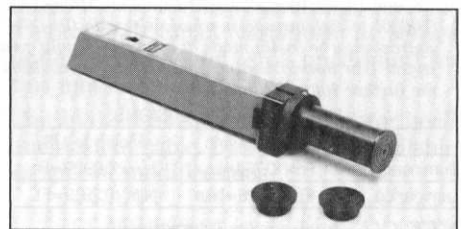
J6501 J6504 J6523
J6502 J6505
J6503



LIGHT OCCLUDER
016-0305-00



J6511 (shown)
J6512



LED ADAPTER WITH EXTRA LED HOLDER
(included with J6505)
014-0047-00

Power supplies or battery packs can be changed quickly by removing four screws on the J16's rear panel. The cabinet and probes have an internal threaded socket (¼ inch×20) for convenient mounting on a tripod or optical bench.

J16-TV Package

The J16-TV package is an excellent transfer mechanism which provides a simple, accurate method for adjustment of monitor screen color temperature. The primary colors are measured and adjusted to produce white color temperature balance.

The J16-TV with optional J6503 or J6523 measures monitor screen brightness on both color and black and white monitors. Other applications include measurement of studio lighting, camera lighting, and illumination of work areas.

The J16-TV package includes: J16 Battery-Operated Photometer, J6502 Irradiance Probe, light occluder, probe extension cable, and battery charger. See Application Note 58A-2926-1 for additional information.

GLOSSARY

Photometry—The measurement of light visible to the human eye.

Radiometry—The measurement of light within the total optical spectrum.

Color Temperature—The temperature of a blackbody whose radiation has the same visible color as that of a given nonblack-body radiator. Usually expressed in °K.

Footcandle—Unit of incident illumination.

Footlambert—A unit of illumination emitted or diffusely reflected by a source.

Units also commonly used include lux (the metric unit of illumination) and nit (the metric unit of luminance).

1 footcandle=10.76 lux

1 footlambert=3.426 nits

Illuminance—The amount of luminous

flux through a unit of surface area and is usually measured in footcandles (lumens/ft²).

Inverse Square Law—The decrease of light intensity with increasing distance. Twice the distance reduces the illumination to one-quarter.

Irradiance—The amount of radiant flux received by a unit of surface area and is usually measured in watts/cm².

Note: Other units of irradiance such as μW/cm² and W/m² are also used extensively.

Lambert's Law—Describes the spatial characteristics of a perfectly diffusing surface which may be either emitting or reflecting light. The light emitted or accepted by such a surface decreases with angle (from perpendicular) according to the cosine of the angle.

Luminance—The amount of light emitted or scattered by a surface and is usually measured in footlamberts.

Photopic—Spectral (color) sensitivity of the average human eye, predominantly peaked in the yellow-green region.

Steradian—A unit of area on the surface of a sphere equal to the radius squared. There are 12.6 steradians total area on a sphere.

Spatial—The directional characteristics of light in space.

Spectral—The distribution of light by wavelength within an electromagnetic spectrum.

Note that each radiometric unit has a photometric equivalent differing only in spectral response of the sensor. However, the units are not interchangeable.

PROBE CHARACTERISTICS

Application	Illuminance		Irradiance	Luminance		Uncorrected	Red LED
	J6501	J6511		J6503	J6523		
Probe	J6501		J6502/J6512	J6503	J6523	J6504	J6505
Range	US*2	0.001 to 1999 footcandles*1	0.001 to 1999 microwatts/cm ²	0.1 to 199,900 footlamberts*1	0.1 to 19,990 footlamberts*1	Relative response only	0.001 to 1999 footcandles*1†
	Metric (Opt. 02)	0.01 to 19,990 lumens/m ² (lux)*1†	0.01 to 19,990 lumens/m ² (lux)*1†	0.01 to 19,990 milliwatts/m ²	1 to 1,999,000 candelas/m ² (Nits)*1	1 to 199,900 candelas/m ² (Nits)*1	Relative response only
Accuracy (Including J16)	Within 5% of NBS standards and ±1 digit in last place. Calibrated with a 3100°K tungsten halogen light source traceable to NBS		Same as J6501, except calibrated with a 762 nm filter	Within 5% of NBS standards and ±1 digit in last place. Calibrated with a 3100°K tungsten halogen light source traceable to NBS		Probe-to-probe accuracy ±5% with tungsten light source	Same as J6501, except calibrated with a 656 nm filter
Spectral Response	Within 2% (integrated) of CIE photopic curve		Flat within ±7% from 450 to 950 nm	Within 2% (integrated) of CIE photopic curve		UV enhanced silicon spectral curve (250 to 1200 nm)	Within 2% (integrated) of CIE photopic curve from 600 to 710 nm
Acceptance Angle	50% sensitivity at 48° off axis	Cosine corrected (180°)	50% sensitivity at 48° off axis	8°	1°	50% sensitivity at 48° off axis	
Stability and Repeatability	Within 2% per year						
Linearity	Within 2% over entire range enabling single point calibration						

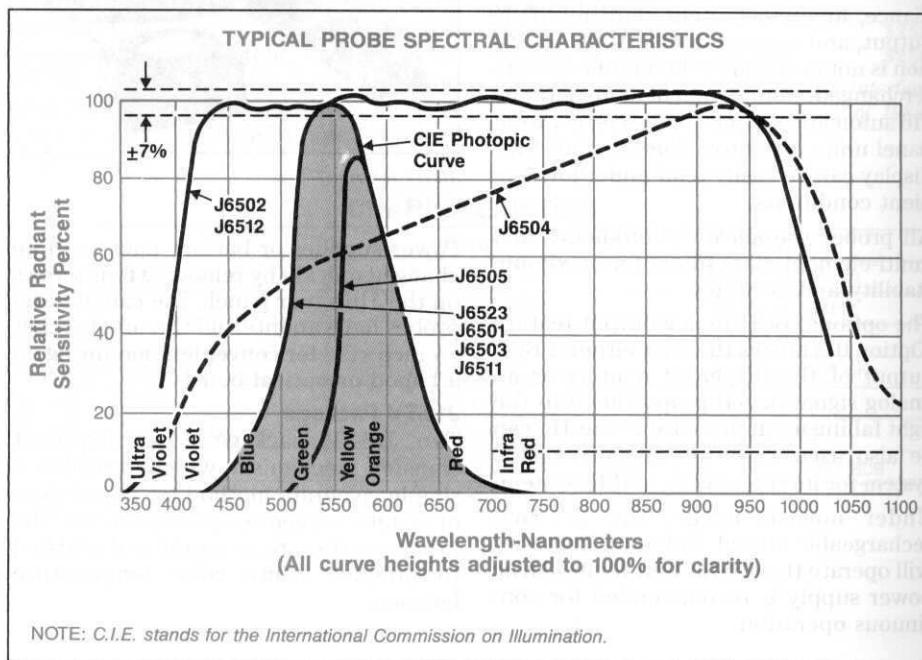
*1 An additional decade of sensitivity is included and is usable if the J16 is carefully zeroed and used at a relatively stable temperature.

† 0.00001 to 199.9 candelas when used with 014-0047-00 LED adapter or at 3.8 inches source-to-sensor spacing. Luminous intensity readings of higher intensity light sources may be easily made at correspondingly greater distances using the formula: Footcandles × d² = candelas where d is the distance from the source to the sensor in feet. (For metric readings, use lux × d² = candelas where d is distance from the source to the sensor in meters.) Request J16 Application Notes 58A-2635 and 58A-2704-1 for further information.

*2 US/METRIC CONVERSIONS

	US to Metric	Metric to US
Illuminance	Fc × 10.764 = Lux	Lux × 0.0929 = Fc
Luminance	FL × 3.426 = Nits	Nits × 0.2919 = FL

NOTE: C.I.E. stands for the International Commission on Illumination.

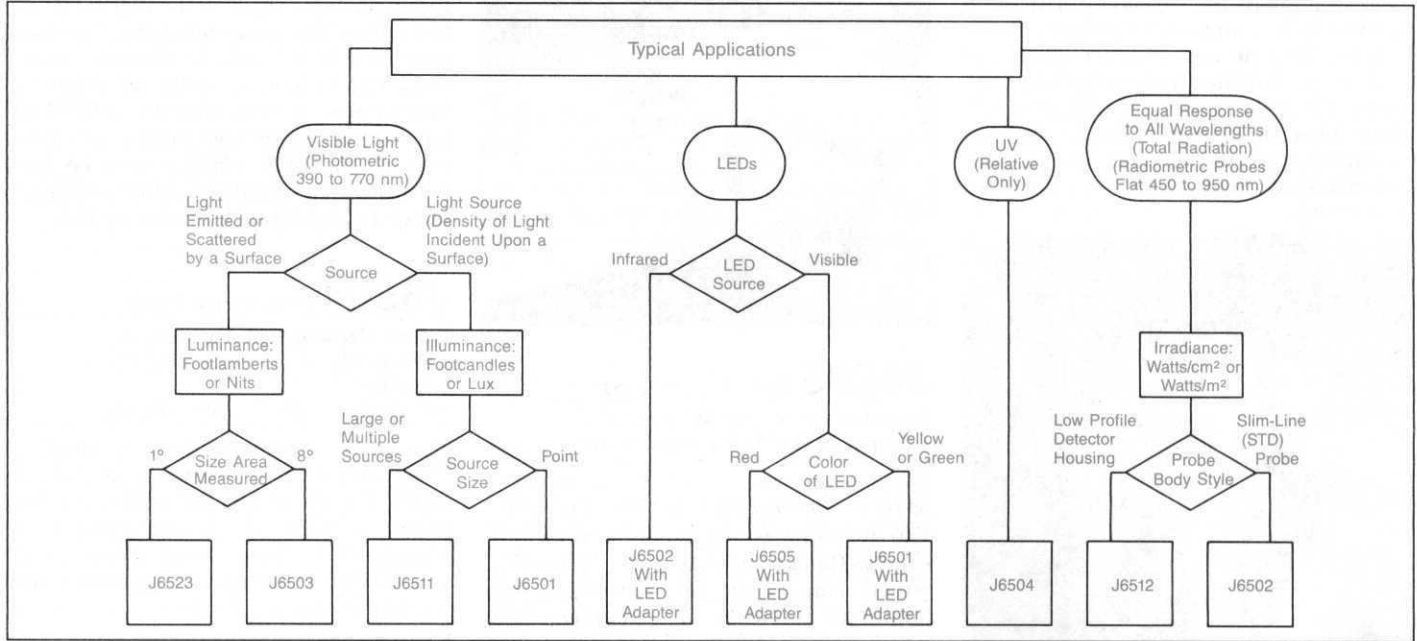


NOTE: C.I.E. stands for the International Commission on Illumination.

To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, Toll free: 1-800-426-2200, Ext. 99. In Oregon call collect: (503) 627-9000, Ext. 99.

J16 PROBE SELECTION

Applications are too numerous to list, but this flowchart should help in your selection of J16 probes.*1



J6511/J6501
Illuminance Probes

Typical Measurement Applications

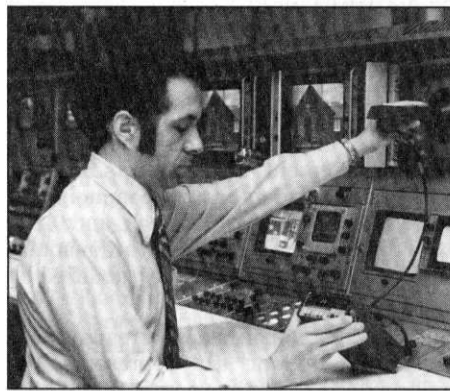
- Roadway Illumination
- Office Lighting
- Work Surface Illumination
- Studio Lighting
- Camera Setup
- Yellow/Green LED Testing

The J6511 is an illuminance probe with readout in footcandles [lumens/m² (lux) for the J6511 Option 02]. A multi-element glass filter and silicon photo-diode ensure a close match to the CIE photopic curve (color corrected). The silicon-sensor recovery time is virtually instantaneous; low-light levels can be measured immediately after exposure to bright sunlight.

The angular response is accurately cosine corrected, simulating an ideal 180° field-of-view detector. The low-profile probe has a leveling indicator to ensure accurate measurements where a significant proportion of the illumination comes from sources at low angles to the horizon.

A 25-foot cable between the probe (J6511) and J16 allows the user to be out of the field of view while making measurements. Where cosine correction is unnecessary, the standard J6501 probe is available with the same photopic correction and units as the J6511. The J6501 can be used to measure green and yellow LEDs.

*1 Refer to page 501 for available application notes.



J16-TV System with J6502 being used for color monitor set-up.

J6502/J6512
Irradiance Probes

Typical Measurement Applications

- Laser Research/Experimentation
- Radiant Efficiency
- Color CRT Setup
- Infrared LED Testing

The J6502/J6512 measure irradiance in microwatts/cm² (milliwatts/m² with Option 02). The spectral response is flat from 450 to 950 nanometers, ±7%. The response is typically down 50% at 400 and 1030 nm.

An optional filter holder is available for the J6502 to mount standard 1 inch diameter customer-supplied filters of up to 3/8 inch thickness. Where high intensity sources are

used (over 1990 μwatts/cm²), neutral density filters can be used to extend the range of the J16. (An ND 1 filter has 10% transmission, an ND 2 1%, etc.). These filters may be held with an optional filter holder.

Where the 1 sq cm sensor is not completely filled by the source, for example with a laser beam, the reading obtained represents microwatts instead of μwatts/cm² or milliwatts × 10⁻⁴ instead of milliwatts/m² (Option 02). Small variations in sensor uniformity may add ±5% uncertainty to this measurement.

The J6512 has a low-profile detector head and six-foot cable. Longer cables available as special modifications.

J6503 8° Luminance Probe

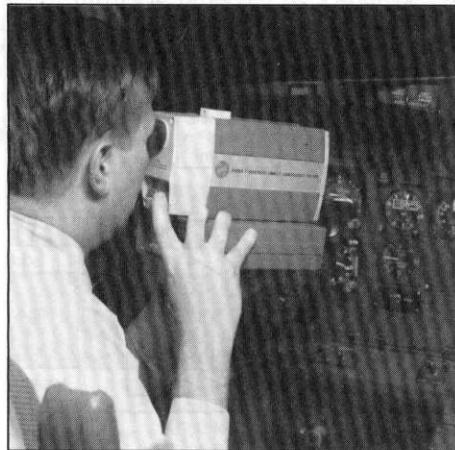
Typical Measurement Applications

- Video Screen Illumination
- Street Sign Illumination
- Work Surface Illumination
- Movie Screen Illumination

The J6503 measures luminance in footlamberts (candelas/m² (nit) with Option 02) where light scattered or emitted by a surface must be measured. The probe is pointed at the emitting surface.

The probe's response is closely matched to the CIE photopic curve, ensuring accurate results even when measuring spectrally different light sources.

The acceptance angle is approximately 8 degrees, which is determined by internal field stop apertures. Providing that the 8 degrees field is uniformly filled, the probe can be held at any distance from the source. At 21 inches from the front of the probe, the field of view is approximately three inches in diameter. The footlambert or candelas/m² (nit) (Option 02) indicator automatically lights when the J6503 is connected.



Measuring Luminance with the Tektronix J16/J6523.

J6523 1° Luminance

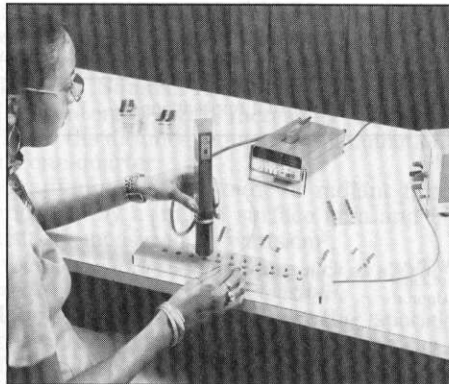
Typical Measurement Applications

- Highway Lighting
- Video Display Illumination
- Photographic Equipment Illumination
- Lighting Equipment Illumination

The J6523 will measure the luminance in footlamberts (candelas/m² with Option 02) of a spot as small as 0.32 inch in diameter. By using commercially available 55-mm stackable diopters, areas as small as 0.035 inch (+10 diopters) can be measured. These 55-mm diopters are physically similar to threaded 55 mm filters, and are available from most photography stores. (See Application Note 58-AX-3252.)

The 1-degree angle represents 0.21 inch per foot of distance from the probe to the source. Thus at 10 feet, the J6523 measures a 2.1-inch diameter spot.

The probe includes an optical sighting system with a 9-degree viewing field. The focusing range is 18 inches to infinity, closer with 55-mm close-up diopters. The spectral response is closely matched to the CIE photopic curve (color-corrected) for accurately measuring all commonly used light sources. The J6523 may be attached to the J16 or used with an optional probe extension cable. A standard 1/4 inch x 20 threaded socket allows it to be used on a tripod or an optical bench.



J6505 Red LED Test Probe

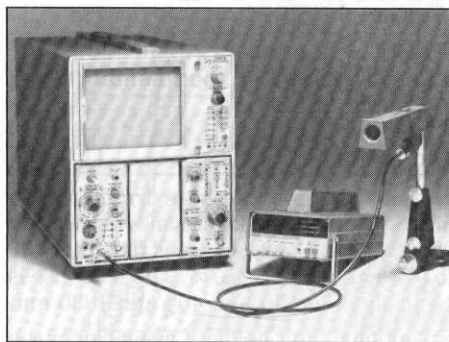
Typical Measurement Application

- Output of Red LEDs (600-710 nm)

Note: For yellow or green LEDs use the J6501 probe, for infrared LEDs use the J6502 probe. The J6505 measures illuminance in footcandles (lumens/m² (lux) with Option 02), which can easily be converted into luminous intensity in candelas. (See Application Notes 58-A-2635 and 58-A-2704-1.)

An adapter supplied with the probe provides a controlled spacing between the sensor and the LED under test. The adapter excludes ambient light, and has internal baffles to prevent stray reflections during the measurement. Three inserts are supplied with the adapter to fit common sizes of LEDs (0.080 inch, 0.125 inch, and 0.200 inch diameter). These inserts are made of soft plastic that can be easily modified by the user.

With the adapter in place, a reading of 1 footcandle on the J16 represents 100 millicandelas of luminous intensity. With a metric version of the J16/J6505 (Option 02), 1 lumen/m² represents 10 millicandelas. A 10x increase in sensitivity is available on special order.



J16 used to measure pulsed light source. Refer to Application Note 58A-2702-1.

In the J6505, the silicon photodiode-filter combination provides an excellent match to the photopic curve in the region 600 nm to 710 nm. This close match requires compromising in the 380 to 600 nm region, making this probe unsuitable for general illuminance measurements. For LED measurements in the yellow or green regions, the LED adapter must be used with the J6501, and the same conversion factor for luminous intensity applies.

J6504 Uncorrected Probe

Typical Measurement Applications

- Photoresist/Photo-Processing Light Sources
- Comparison of UV Light Sources

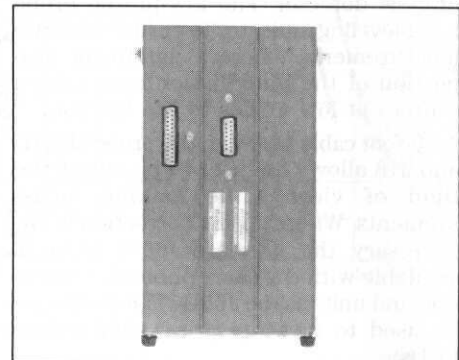
This probe is designed for applications where only relative measurements need be made. The J6504 has the widest spectral range, and is the most sensitive probe. Use is made of a UV-enhanced silicon sensor and a UV-transmitting window rather than spectral-correction filters.

No units are indicated on the three front panel indicators when using the J6504, since it provides relative readings only.

An optional filter holder may be used to mount standard 1-inch diameter filters on standard-configuration probes. Ultraviolet, visible, or near infrared filters can be used to select the wavelength of interest and exclude ambient light.

Option 07 BCD/Analog Output

The J16 is equipped with a 25-pin connector on the unit's top. This provides parallel TTL logic and BCD outputs, a "hold" input line (TTL), and a linear analog signal output 0 to -2 V or 0 to -6 V (depending upon the probe used), for a full-scale readout. The analog bandwidth is approximately 0.8 Hz. A cable-end connector and cover have been added to the accessories complement.



J16 with analog BCD output (Option 07).