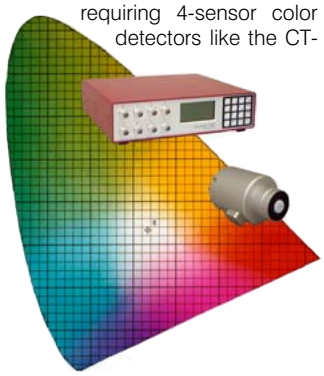
P-9801 8-Channel Synchronous Optometer

- © **8-channel Bench-top Meter for Laboratory Use and Application Integration**
- © **Universal Use in any Light & Color Measurement Application**
- © **Synchronized Operation of up to 8 Detectors or two CT-37 Color Detectors**
- © **Measurement of DC and AC Signals**
- © **Wide Detector Signal Dynamic Range from 0.1 pA to 2 mA**
- © **100 µs Fast Sampling Rate**
- © **Adjustable Integrating Time from 1 ms to 10 s**
- © **CW, Dose, Data-Logger, Color, ext. Trigger RS232, IEEE488 Operation Mode**
- © **Optional Windows Software**

Associated Parts / Service:
Chapter Detector Heads
Chapter Integrating Spheres
Chapter Calibration

There are many applications for ***multiple detector head arrangements*** in light measurement. Examples include luminous color measurements of light sources requiring 4-sensor color detectors like the CT-



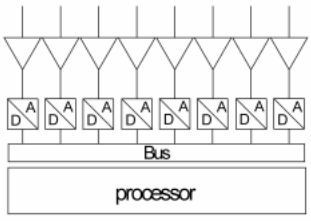
3701, profiling or monitoring of irradiance dose for process control at various locations in UV curing or for multi-wavelength radiometry for UV-A, UV-B, VIS and NIR irradiance measurements.

Desirable features of multi-channel light meters used for these jobs would include:

- simultaneous measurement of all detector channels
- wide detector signal dynamic range
- short and variable measurement time
- fast, multi-channel data-logging
- remote control operation

The P-9801 offers all of these features. It is a highly efficient eight-channel optometer designed for multipurpose use in any photometric, radiometric and colorimetric application.

Eight Identical A/D Channels
Eight identically built photocurrent-to-voltage amplifiers and eight 12 bit highly linear analog-to-digital converters (ADC) enable signal digitization of the 8



signal amplifiers at exactly the same time.

Wide Dynamic Range:
Each channel's wide 0.1 pA to 2 mA signal range covers the dynamic range of most current semiconductor photodiodes for nearly unrestricted use in any light measurement application.

Fast Measurements:
Each channel offers a slew rate of 2 to 10 ms (gain dependent) allowing fast signal detection of events like the switch-on characteristic of light sources or the pulse energy in UV polymerization processes. A quick 100 µs sample rate enables the P-9801 to work as a fast eight channel data logger with >5k sample storage capacity for each channel. In low light level applications the measurement process time can be increased up to 6 s through multi-sampling and calculated averaging of signal.

Precise Measurements:
The 8 manually or automatically selected amplifier gain ranges are calibrated using a traceable current source for a maximum linearity error of 0.2 %. The 12 bit ADC (resolution increases to 14 bit for longer measurement times) offers optimum linearity.

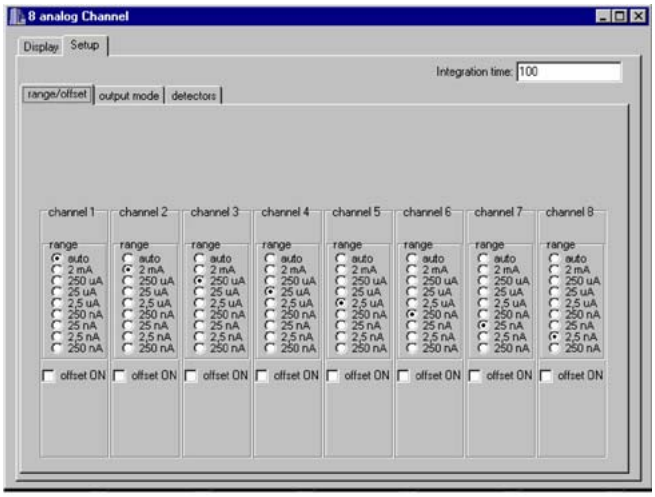
Remote Control:
A bi-directional RS232 serial and IEEE488 interface allows external remote control.
Optional Windows based software is available for a quick turn-key solution or user generated programming is possible using the complete command set supplied. Adjustment of the factory programmed calibration factors can be accomplished using OS-CAL software (optional).

System Integration:
The P-9801 is suitable for integration into other equipment with features like 19" rack mounts.

Metal-shielded Housing
A high quality metal housing offers best EMV shielding for applications in sensitive ambient environments.

Multiple Applications:
The P-9801 is compatible with most of GO's detectors covering any photometric, radiometric and colorimetric measurement quantity.

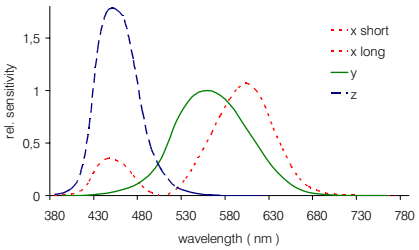
Numerous Functions:
The unit's many modes of operation include CW, dose, data-log and external trigger.



P-9801 Applications

Featuring simultaneous operation of up to eight detectors, the P-9801 is one of the most powerful optometers available today. Additional high end specifications such us large and linear signal dynamic ranging, fast measurement and sampling time makes the P-9801 the right tool for any photometric, radiometric and colorimetric application. All single and multi-cell Gigahertz-Optik detectors can be used with the P-9801. Plus RS232 and IEEE488 interfaces enable integration of the P-9801 in process control applications. This page describes a few typical P-9801 applications.
Our **Light Measurement Guide** available in our catalog and website offers additional tutorial and application notes for the Measurement of Light and Measurement with Light.

Luminous Color Measurements



Color sensations are human sensory impressions and color measurement technology must express them in descriptive and comprehensible quantities.
Colorimetry is the study of the dimensional relations between colors. It assumes that colors can be described by dimensional figures and that these dimensional figures can be measured. In this context, color measurement is a comparison of one color with another, since colors, as sensory impressions, cannot be traced back to other physical quantities such as current or temperature. The comparative instrument used is the human eye. In 1931 the Commission Internationale de l' Eclairage (CIE) recommended, for the unambiguous determination of colorimetric measures, the use of 3 spectral evaluation functions x (λ), y(λ) and z(λ), derived from the measurements made by Guild and Wright for a 2° field of view in humans with normal color vision. For many color measurement tasks it is important to determine the color temperature of luminous objects. According to DIN 5031-P.5, the color temperature t_c of a radiator requiring characterization is the temperature of a Planck's radiator at which it emits radiation of the same color type as that of the radiator being characterized. The P-9801 in use with one or two CT-3701 luminous color detector heads allows the measurement of color (x/y and u'/v' values) and color temperature of self emitting light sources. The CT-3701's four cell detector head design accurately measures high color temperatures or predominantly blue light sources. A small diameter cosine corrected measurement aperture avoids errors caused by non uniform illumination. Simultaneous operation of the four cells allows fast, remote controlled color measurements in production processes or fast sampling rate data-logging to measure the switch-on characteristic of lamps and other events.

Luminous Color Measurements Combined with Photometric & Radiometric Quantities

Along with measuring the luminous color and color temperature of light sources, photometric & radiometric information may be required such as:

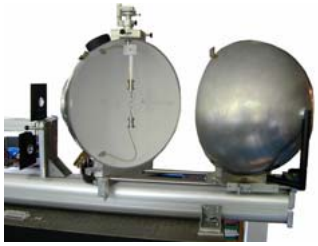
- illuminance & irradiance
- luminance & radiance

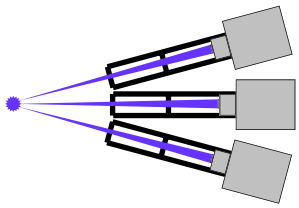
- luminous flux & radiant power
- luminous intensity & radiant intensity

The wavelength range of interest for typical radiometric quantities spans the UV to the NIR. A common radiometric application involves checking the blocking efficiency of UV and IR (heat) blocking filters.
Multi-wavelength range measurements are easily performed using multiple and/or different kinds of detector heads connected to the P-9801. Using the 4-cell design CT-3701 color detector head as the base unit, other input components can be attached to it to fulfill the measurement geometries for different applications :

- standard diffuser (illuminance)
- front lens (luminance)
- integrating sphere (luminous flux)
- steradian tube (luminous intensity)

Integrating sphere based measurement systems can be built for both directional (spot) and non-directional (flood) lamps. Several P-9801s, each with (2) CT-3701 plus steradian front tubes can be operated in parallel via the IEEE488 bus to control the luminous color and luminous intensity distribution of light sources.

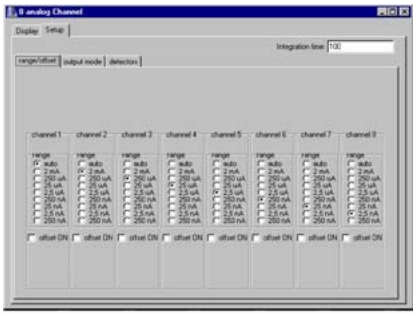




Commonly used radiometric detectors are the UV-3717 (UV-A) & RW-3704 (800-1100 nm).

High-speed Eight-channel Irradiance Data-logger

If the design of a radiation source ensures a uniform irradiation of a surface area, the irradiance only needs to be measured at one point to control intensity. If the source uniformity is not known, the irradiance must be measured at several points to ensure uniform irradiance over the surface area. Also, if the irradiation exposure is very short and if the distance from the surface area to the light source is not constant multi-point irradiation is needed. In three-dimensional UV curing applications the irradiance dose depends on the sample to UV source distance and the irradiation time. To measure the irradiance dose uniformity in these applications a multi-channel simultaneous sampling of signal with data-logging capability is needed to document the irradiation-time profile.
The P-9801 can operate up to eight RCH-type detectors to measure the irradiance of high-power UV-sources used in UV curing processes. This model detector offers a low profile for close to the sample surface measurements. The P-9801's built-in data-logger allows stand alone use or it can be used with the P-9801-RP software (optional) for remote control operation.



Accessories for P-9801 >> Chapters: Detector Heads, Integrating Spheres

P-9801 Operation Modes & OS-P9801 Software

Operation Modes

Because of it's fast and precise eight-channel amplifier electronics and 16 bit microprocessor the P-9801 optometer is one of the most powerful optometers available. Several useful functions and user adjustable measurement parameter set-up makes the P-9801 one of the most flexible as well.
Multiple functions, features plus IEEE and RS232 interfaces make the P-9801 ideal for remote control operation in process control, high-speed multi-channel data-logging, R&D and many more applications.
This page describes the various functions of the unit. Contact the factory to discuss customized units with other user specified operational modes or complete custom application solutions.

CW Measurement

CW mode is used to measure continuous DC or AC signals at a user selected integration time from 1 ms to 10 s. Readings and measurement units of all eight channels are displayed. User selectable manual or auto-ranging operation.

CW Offset

A constant offset value, such as an ambient light level, can be measured and subtracted from the CW measurement value.

Ratio Relative (%), Relative log. (dB), Relative factor

Measurement of the ratio between a reference value and the actual measurement value. Displayed as relative ratio (%) or logarithm ratio/attenuation (dB or dBm) or ratio factor.

Reference

The reference value is used for ratio measurements and can be set to 1 with the selected unit such us 1 W, 1 A for example.
A CW measurement value can be stored as reference value.
A manually entered value can be used as reference.
The measurement value of an other channel can be used as reference (dynamic reference).

Dose (Integrated Energy)

Measurement values are accumulated and displayed as dose. The measurement can be manually started and stopped or be automatically stopped at a max. dose measurement time or a max. dose value. The actual measurement status can be displayed

Data Logger

Up to 5,957 measurement values per channel can be stored at a sampling rate of 0.1 to 6000 s.

Fast Data Logger

Up to 5,957 measurement values per channel can be stored at a sampling rate of 2 to 100 ms in manual range mode.

Default Initialization

Allows re-set of meter to the standard parameter and mode set-up as supplied by the factory.

Color Measurement

Up to two color detector heads can be simultaneously operated with the P-9801 (channel 1 to 4 and 5 to 8). Color temperature, chromaticity values x/y or u'/v'' and photometric quantity (illuminance, luminance, luminous intensity or luminous flux) are displayed at one time.
Adjustment of factory calibration factors by the end-user is possible. The trigger input of the P-9801 can be used to check the operating temperature of one or two CT-3701 detector heads. The display flashes if temp. drops out of operating range.
If only one color detector is used, the other four channels are available for other detectors. These four readings are displayed together with the color values.

Manual & Auto ranging

Manual or auto ranging operation can be user selected. Manual ranging is recommended for fast measurements or to monitor readings at some constant level.

Self Calibration

Calibration data for a user detector can be adjusted against a known calibration or in-house standard. The measured values of the standard are used to calculate new calibration data.

Analog Output

The P-9801 offers one analog output. One of the 8 channels can be switched to the analog output.

Display Digits

With longer integrating times the ADC resolution will increase up to 14 bits. In this case the displayed measurement value resolution can be increased to maximum of 5 digits.

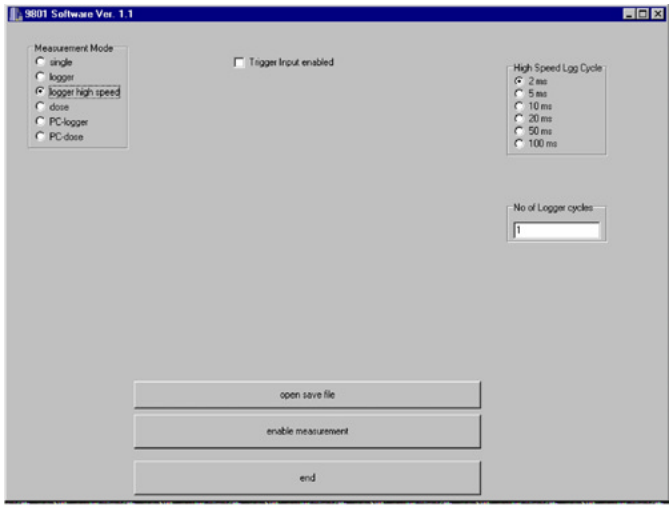
Remote Control

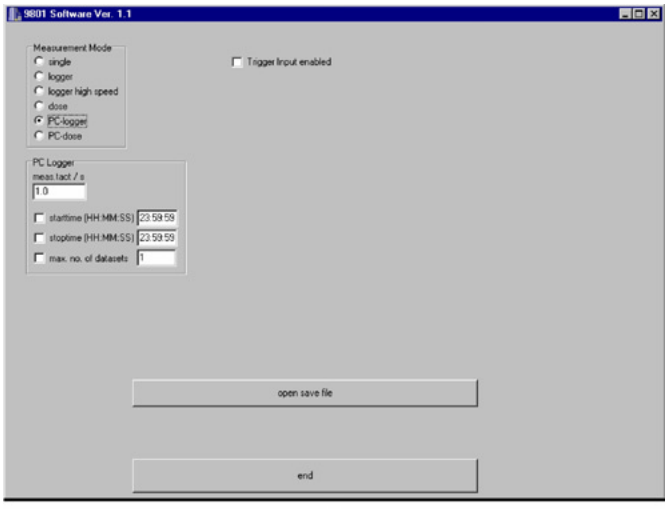
Instrument can be set-up for remote control operation using either RS232 or IEEE488 interface.

IEEE488 Address

Sets the address for the IEEE488 communication.

OS-P9801 Software





P 9801 Specifications & Ordering Information

Specifications:

Range and Uncertainty Specifications				
Range (A/V)	**Range max.**	**Slew-Rate (10 - 90%)**	**Error (with offset compensation) 1 year, 23°C ±5°C ±(% of reading + % of range),**	**Gain (A/V) Analog Output**
$1x10^{-3}$	2.000 mA	2 ms	0.2% + 0.05%	$1x10^{-3}$
$1x10^{-4}$	250.0 µA	2 ms	0.2% + 0.05%	$1x10^{-4}$
$1x10^{-5}$	25.00 µA	3 ms	0.2% + 0.05%	$1x10^{-5}$
$1x10^{-6}$	2.500 µA	3 ms	0.2% + 0.05%	$1x10^{-6}$
$1x10^{-7}$	250.0 nA	4 ms	0.2% + 0.05%	$1x10^{-7}$
$1x10^{-8}$	25.00 nA	4 ms	0.2% + 0.05%	$1x10^{-8}$
$1x10^{-9}$	2.500 nA	10 ms	0.2% + 0.05%	$1x10^{-9}$
$1x10^{-10}$	250.0 pA	10 ms	0.2% + 0.05%	$1x10^{-10}$

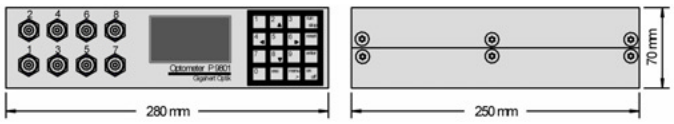
Signal Input	
Detector Input	Eight photocurrent to voltage converter amplifiers with following voltage to voltage amplifiers (x10). 8 decade stepped gain ranges with max. gain signal values from 2.000 mA to 200.0 pA . Manual or automatic range switching. Eight 12 bit ADC with up to 14 bits at longer integration times.
Signal Processing	A/D converter with 100 µs time interval. Longer integration (1 ms to 10 s) through averaging of multiple measurements.
Frequency Range	Signal conversion from 0.166 Hz (6s integration time setting) to >300 MHz. .
Zero Setting	Gain independent offset subtraction of unwanted ambient light signal.
Detector Connector	8 BNC sockets . Detector heads with BNC connector (type –1).

Functions	
Parameter Settings	Menu controlled parameter set-up. Retention of the last settings in continuous memory. 10 function buttons.
Measurement Quantity	Amperes calibrated with DKD calibrated current source. Current signal multiplied by calibration correction factor to display absolute photometric or radiometric quantities. Calibration data stored in calibration data connector of the detector heads manually entered into the meter memory.
Dose Measurement	Setting of the max. integration time for all channels, or the max. dose that will end the dose measurement. Start/stop function. Information request of the current status of the dose measurement
Data Logger	Sampling rate 0.1 s to 6000.0 s or fast sampling in steps between 2 ms to 100 ms; max. 5957 stored values / channel.
Color Measurement	Signal inputs 1-4 and 5-8 for detectors A and B. Calculation of the color values x/y or u'/v', illuminance E or luminous flux phi and the color temperature T_c. "lamp selection" for adaptation to different types of lamps, up to 8 of which can be stored; calibration routine for automatic compensation of the stored and measured calibration data of a standard lamp; temperature monitoring via trigger input
Trigger Input	Measurements can be triggered (started) by external event using Trigger Input
Analog Output	BNC socket; output signal from the assigned input amplifier

General	
Display	LCD display, LED background illumination (switchable), 160x80 pixels
Operating Temperature	+5 to +40 °C (+41 to +104°F)
Dimensions/Weight	280 mm x 250 mm x 70 mm; 1 kg (11 in x 9.8 in x 2.8 in; 2.2 lb)
Serial Port Settings	RS232 (9600 baud, 8 data bits, 1 stop bit, no parity) 5 pin cylindrical TRIAD01 connector..
Power supply	6.5 - 7.5 VDC / 1A; cavity plug 5.5/2.5 mm, Plug-in AC power supply unit 230 V/50 Hz; 7.5 VDC/1 A; cavity plug 5.5/2.5 mm, inner conductor positive.
Electromagnetic Compatibility	Electromagnetic compatibility is assessed in accordance with EN 61326-1 Class B (noise emission for "living areas", noise immunity for "continuous supervised operation"

Interface	
RS232	RS232, adjustable baudrate 600 - 57600.
IEEE488	IEEE488 with settable device address; optional checksum calculation; for debugging purposes, received commands (Hexadecimal/ASCII) or measurement results can be displayed in parallel to remote operation

Dimensions



Detector Head / Measurement Output	
Detector Heads	All detector heads with –1 type BNC connectors. See chapter 'detector heads' to select the detector head for your application.

Ordering Information	
P-9801	Optometer with handbook and plug-in power supply
Detectors	All Gigahertz-Optik detecctor heads with BNC-type (-1) connector
OS-P9801-RP	Software for photo- & radiometric application
OS-P9801-RPC	Software for colorimetric application
BHO-02	Carrying case for P-9801 with CT-3701 color detector head and accessories
P-98Z-01	Rack-Mount