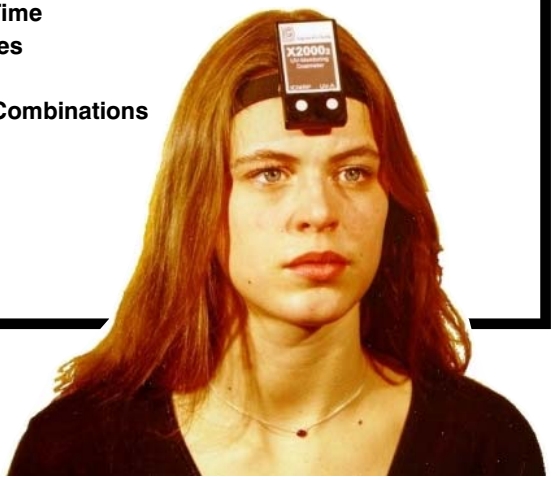
X-2000 Personal Dosimeter

- © **Personal Dosimeter for Phototherapy and UV/Light Hazard Applications**
- © **Data-logger to Document Irradiation as Variable of Measurement Time**
- © **Free Programming, High-speed and Long-term Measurement Modes**
- © **Large Data Storage Capacity of 129,000 samples**
- © **ACGIH/ICNIRP, Erythema, UV-A, UV-B, UV-C Detectors and other Combinations**
- © **Cosine Corrected Field-of-View**
- © **Compact and Lightweight (60 g / 0.13 lb)**
- © **Low Power Consumption Electronics for Long Battery Life Time**
- © **RS232 Interface for Initialization and Data Read Out**
- © **Windows XP Compatible Software**



Incoherent Optical Radiation
In simple terms incoherent optical radiation refers to radiation, other than that emitted by lasers, in the wavelength range between 100 nm and 1 mm.

Health Risks from Incoherent Optical Radiation
Shallow penetration depth restricts the health risk primarily to the eye and skin.

- Acute effects to skin
  - ©Erythema
  - ©Burning
- Chronic effects to skin
  - ©Skin cancer
  - ©Skin ageing
- Acute effects to eye
  - ©Photochemical and thermal retinal damage
  - ©Photokeratitis
- Chronic effects to eye
  - ©Cataract development
  - ©Degeneration of the retina

Light Protection
The cumulative effects of incoherent optical radiation on the skin and eye are under ever increasing scrutiny. Longer exposures to higher levels of solar radiation plus artificial UV sources account for this.
Dose levels are on the rise due to:

- reduced atmospheric UV shielding
- longer leisure time
- longer lifetime
- growing occupational use of high powered UV sources

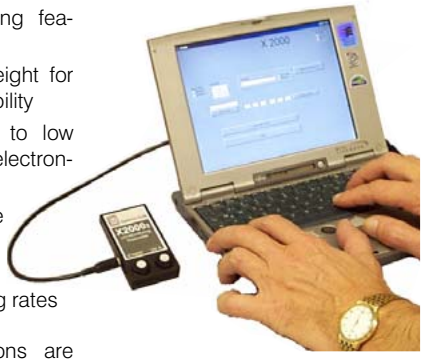
As a result professional associations, institutes of health, radiation protection bureaus, dermatological institutes, responsible lighting manufacturers, insurance companies and others are interested in understanding the risks posed by natural and any artificial light sources used in industry and limit additional exposure dose during the work period.

Light Dose
When evaluating potential occupational harm from incoherent optical radiation, it is the effective radiance (or the time integral of the radiance) that is a concern for the retina, whereas for the skin, cornea and lens of the eye the critical quantity is effective irradiance (or the exposure or dose).

Light Dose Measurement
Photobiological sensors are available which allow detection of the exposure dose. Response time issues and missing information about peak exposure and exposure interruptions are a concern with these sensors.
Personal data-logging radiometers that can be worn by the subject enable recording and documenting of measured irradiation as it varies of the measurement time to allow a more precise evaluation of the exposure profile.

X-2000 Personal Dosimeter
The X-2000 meter series was developed as a personal UV monitoring dosimeter, which enables a point-by-point measurement of individual exposure tracked chronologically over a specific time period. A complete continuous profile of the measured signals is logged.
To fulfill the need of a personal dosimeter the X-2000 series offers several outstanding features:

- small size and low weight for better subject acceptability
- long battery life due to low power consumption electronics with flash buffer
- large data sample memory
- free programming, fast and long-term sampling rates

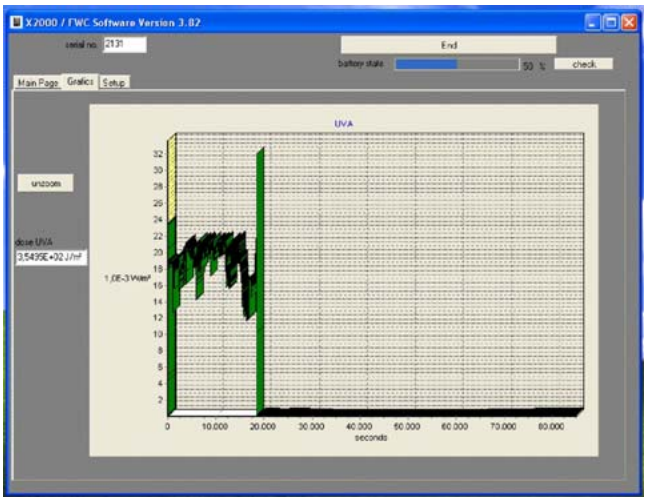


Spectral Sensitivity
Various spectral functions are offered to fulfill different health hazard assessment requirements (see following page).

Cosine Corrected F.O.V.
Each detector is supplied with a cosine corrected field-of-view for precise, effective irradiance measurements.

Software
Initialization and data read-out via the RS232 interface is made easy with optional windows compatible OSDL software. Data storage in CSV file type allows export to programs like Excel.

Traceable Calibration
Calibration is traceable to the ISO EN 17025 accredited part of Gigahertz-Optik's Calibration Laboratory for Optical Radiation Quantities and NIST standards.
Calibration of the detector(s) irradiance sensitivity plus an individually measured plot of its spectral sensitivity is part of the calibration certificate.



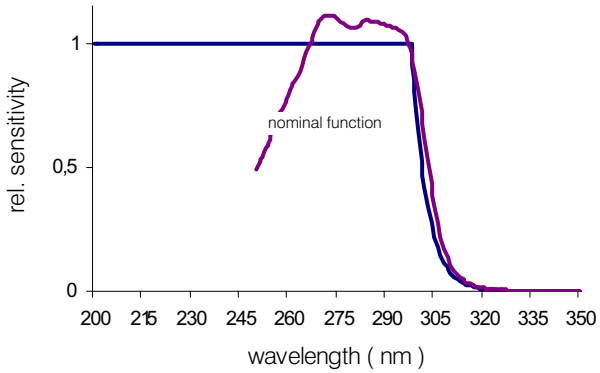
Gigahertz-Optik

X-2000 Applications

The X-2000 series can be used in different health hazard applications because it can be configured with various detectors with different spectral sensitivity characteristics. This page describes those detectors.
Our **Light Measurements Guide** shown in our catalog and website offers additional tutorial and application notes concerning UV / light hazard measurements. Please contact the factory to discuss custom design X-2000 series instruments.

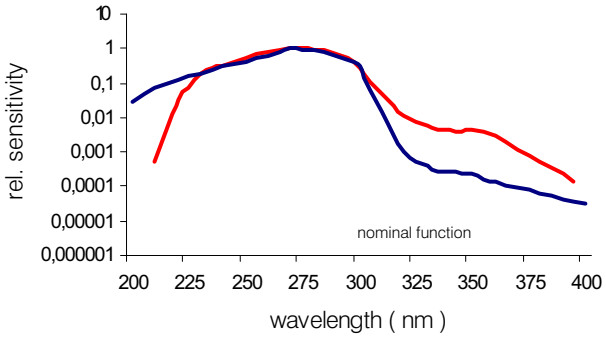
Erythema

The typical symptom of erythema (sunburn) is acute skin inflammation caused primarily by over exposure to the UV-B component of solar radiation. Present opinion is that UV-A also plays a part in causing erythema because there is so much of it present in sunlight. Photobiological investigations have shown that intensive exposure to UV during leisure time and at work increases the risk of skin cancer. Children in particular should be protected from strong UV radiation as the damage is cumulative the dose received in the first years of life can be an important factor in the development of skin problems in later years.
By definition Erythema is measured in effective irradiance and dose.



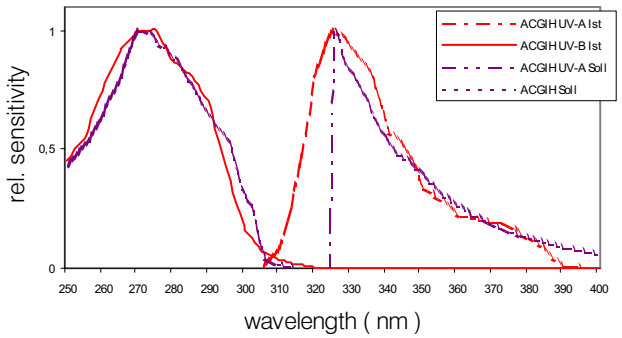
ACGIH/ICNIRP

The spectral weighting function for the acutely harmful effects of UV radiation, was developed by the *American Conference of Governmental Industrial Hygienists (ACGIH) and* the *International Commission on Non-Ionising Radiation Protection (ICNIRP).*
Upon examination of the spectral curve describing this function, it is important to note that the spectral effectiveness in the UV-C and UV-B ranges is very high as compared to the UV-A range.
ACGIH-ICNIRP Threshold Limit Values for the maximum permissible exposure of the skin are defined over the wavelengths from 200 to 400 nm. The limits of maximum permissible exposure for the eye in the range 200 (180) to 400 nm and 315 to 400 nm (UV-A) are defined separately. ACGIH-ICNIRP TLVs are specified in effective irradiance and dose.



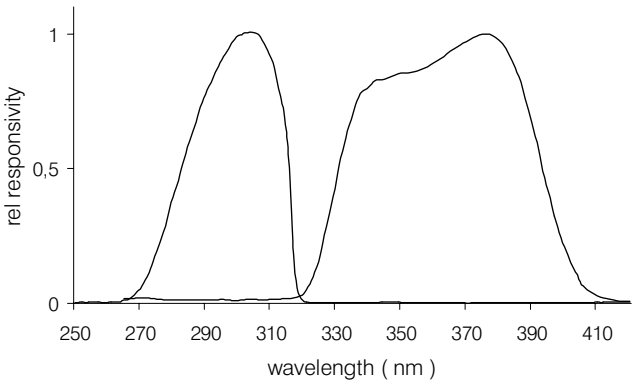
ACGIH/ICNIRP$_{Skin}$ for UV-A Rich Sources

Measurement of UV radiation for the purpose of UV hazard assessment is the subject of the new **DGZfP-Merkblatt EM6** regulation. EM6 specifies that all UV sources used in fluorescent penetration test applications must be classified and regularly tested. Protective measures must be taken for the operators depending on the safety class.
The classification criteria is the E_{eff} UV hazard effective irradiation based on the ACGIH/ICNIRP guideline. The built-in eye protection devices mounted on stationary testers enable EM6 to state a possible risk to the skin only. Stray light risk to the eye is low because of the radiation's diffuse character. **Because of the UV-A rich spectral source characteristic** a two cell (ACGIH-UV-B 250 to 325 nm and ACGIH-UV-A$_{skin}$ 325 to 400 nm) design is needed to completely isolate UV-A from UV-B&UV-C radiation.

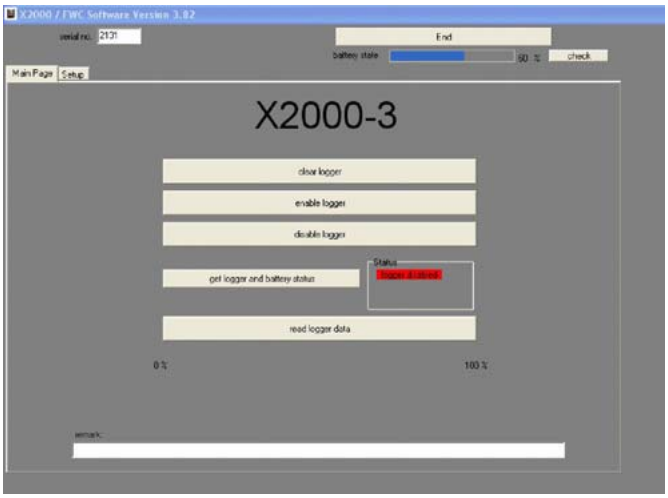


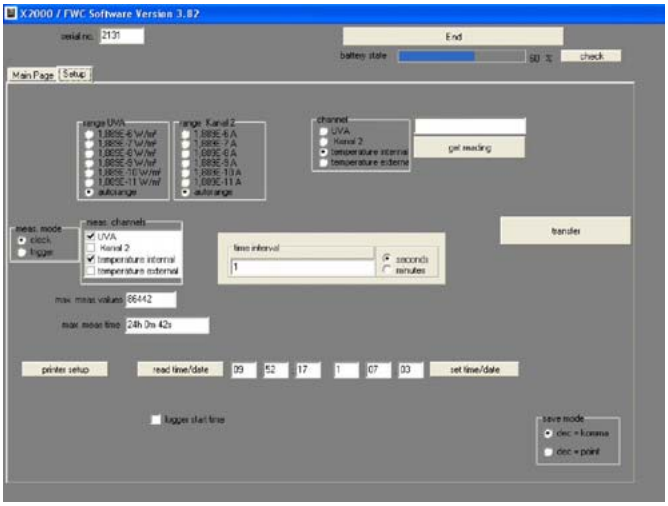
UV-A & UV-B

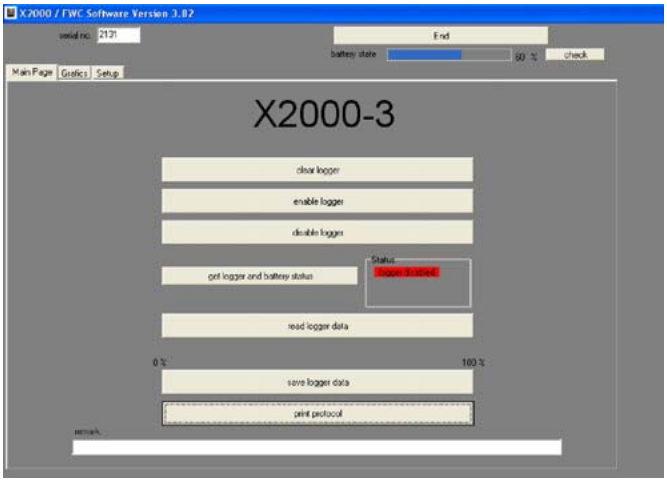
UV is widely used by dermatologists in the treatment of certain skin diseases like Psoriasis and Vitiligo. Whole body exposure booths and hand and foot units employing light sources which emit broadband UV-A, UV-B and combinations of UV-A and UV-B are used to irradiate the patient.
In PUVA photo therapy, also called photo chemotherapy, UV-A is applied in combination with a photosensitizing agent which is taken in pill form or applied topically to the skin. This medication called psoralen, giving rise to the acronym PUVA, makes the skin more sensitive and responsive to the UV-A (315-400 nm) wavelengths.
Due to the risks of premature skin ageing and skin cancer from prolonged exposures, also with consideration to skin type, PUVA is only recommended for moderate to severe cases of Psoriasis.
UV-B broadband treatment is normally administered without a photosensitizing agent. It is considered safer than UV-A for wavelengths between approx. 290 to 315 nm, since it does not penetrate as deeply into the skin and is more energetic allowing shorter overall exposure times. However, it is generally accepted that wavelengths below 290 nm produce more erythema which can actually inhibit the therapeutic effects of the longer wavelengths.



The wireless X-2000 personal dosimeter is a self contained device. A computer is needed to initialize the measurement mode and the start/stop time of the measurement and also the data read-out transfer via the RS232 interface. The following descriptions are based on the current version of the X-2000 and optionally supplied Gigahertz-Optik software. A complete description of the interface and command list is supplied with the meter which allows skilled operators to write their own software as well.







Measurement Mode Initialization

Before the measurement is started, the user has to initialize the measurement mode and the start and stop time. Initialization is done via the RS232 interface.

Irradiance and Temperature Measurement

In a two detector configuration sampling by one or two detectors can be selected. All X-2000 versions are supplied with an internal temperature sensor which allows sampling of the operating temperature condition in field service applications. The measurement range is –30 to +85°.

High-speed Data-logger Mode

This mode is selected if light flashes or light sources with fast intensity changes are to be measured. The sampling rate can be selected between 5 ms and 1,984 s. The integrating time must be set to a shorter time than the sampling rate. The gain dependent slew rate of the signal amplifier must be considered as well as the gain switching time.
If a maximum sampling rate is required, manual range setting and using one detector only is recommended.

Variable Integrating Time

As with most Gigahertz-Optik meters, all X-2000 versions offer selectable integrating times. This is achieved by the averaging of multiple measurements with the shortest integrating time at 1 ms. This function allows an adjustable selection of long integrating times for low (noisy) signals or short integrating times for fast measurements. Besides the integrating time, the slew-rate of the signal amplifier must be considered. Slew-rate is gain dependent, specified from 3 ms to 30 ms.

Manual and Auto-ranging

The X-2000 offers six gain ranges that can be selected manually or automatically. In fast measurement applications the gain switching time must be considered. This depends on the integrating time selected and number of gain ranges switched. In automatic gain mode the sampling rate should not be shorter than the max. gain range switching time!

Long Term Data-logger Mode

This mode is selected if data over a long measurement period must be sampled. The sampling rate can be set between 1 s and 127 min. To optimize battery life the meter can be set to “sleep-mode” between the measurements which reduces power consumption to only 5 μA.

Calculating Maximum Measurement time

To calculate the max. measurement time, first the memory requirement for one sample must be calculated (see specs.). Then the max. data storage capacitance of 518,656 Bytes must be divided by the calculated memory requirements. The battery capacity should be checked against the current consumption expected for the different operation modes (see specs.).

Programmable logger Start time

The data-logger can be activated by unplugging the RS232 connector from the meter, by a signal higher than the trigger level or by a start date and time. On disconnection from the computer a LED flashes and confirms the set-up is active.

RS232 Interface

Because of the large amount of power consumed by the RS232 interface, remote control operation of the X-2000 is not recommended. RS232 connection should only be made for initialization or data read-out and disconnected when not in use.

X-2000 Specifications & Ordering Information

Specifications:

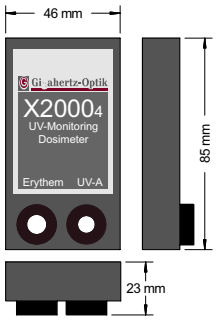
Measurement Ranges (typ. Values)		
UV-A Irradiance	50 nW/cm² to 180 mW/cm² with max. 1 nW/cm² resolution	
UV-B Irradiance	165 nW/cm² to 670 mW/cm² with max. 3.3 nW/cm² resolution	
ACGIH Irradiance	500 nW/cm² to 2000 mW/cm² with max. 10 nW/cm² resolution	
Erythema Irradiance	165 nW/cm² to 670 mW/cm² with max. 3.3 nW/cm² resolution	
ACGIHskin Irradiance	UV-A : 25 µW/cm² eff. to 0,1 mW/cm² eff. with max. 0,5 µW/cm² eff. resolution UV-B/C: 50 µW/cm² eff. to 0,2 W/cm² eff. with max. 1nW/cm² eff. resolution	
Internal Temperature	-30°C to +85°C, (-22 to 185°F), max. resolution 1/10°C	
Data-Logger		
Logger Storage Capacity	518,656 Bytes	
Memory Requirements for Logger Data:	Status	1 Byte
	One detector	3 Byte
	Two detectors	6 Byte
	Internal temperature	2 Byte
	Voltage input*	2 Byte
Logger Data Sample Rate	sleep mode off	5 ms to 1.984 s
	sleep mode on	1 s to 127 min
Power Consumption	In Operation	5 mA (at 1.3 V)
	Flash Writing	200 mA for 20 ms
	Sleep Mode	5 µA
	RS232 Connected	16 mA
General Technical Data:		
Max. Number of Detectors	2	
Measurement Ranges	6 (max. values 200 pA – 20 µA)	
Integration Time	1ms - 2s (current signal only, see slew-rate in gain range specification)	
Calibration Data	Max. 255 data sets for each current input	
Voltage Measurement	1 input (default gain setting: 100). Not activated in standard models.	
Interface	RS232, 8D, 1S, N; Baud rate: 57600 or 9600	
Operating Voltage	1.0 to 1.6 V (optional input 1.8 to 3.2 V, not activated in standard version)	
Operation Temperature	5 to 45°C (41 to 113°F) recommended, -20 to 70°C (-4 to 158°F) with reduced battery life time and accuracy	
Size / Weight	85 mm x 46 mm x 23 mm / 60 g (3.4 x 1.8 x 0.8 in / 0.13 lb)	
Battery	type N (model "Lady")	
Software Functions	Windows 9x / NT4.0 / XP; programmable data-logger, programmable start time; logger data in "CSV" format for readable file (e.g. by Excel).	

Range Specifications

Range* (A/V)	Max. Input Value* max.	Slew-Rate* (10 - 90%)	Error* (with offset compensation) 1 year, 23°C ±5°C ±(% of reading + % of range),
1x10-5	20.00 µA	3 ms	0.2 % + 0.05 %
1x10-6	2.000 µA	3 ms	0.2 % + 0.05 %
1x10-7	200.0 nA	3 ms	0.2 % + 0.05 %
1x10-8	20.00 nA	3 ms	0.2% + 0.05 %
1x10-9	2.000 nA	30 ms	0.2 % + 0.05 %
1x10-10	200.0 pA	30 ms	0.2 % + 0.05 %

*electronic specifications

Dimensions:



Ordering Information	
OS-X2000	Software for initialization and data read-out of the X-2000 via RS232.
X-2000-1	UV-Erythema instrument including BHO-06 hard case, battery, RS232 interface cable and handbook
X-2000-2	ACGIH and UV-A instrument including BHO-06 hard case, battery, RS232 interface cable and handbook
X-2000-3	UV-A instrument including BHO-06 hard case, battery, RS232 interface cable and handbook
X-2000-4	UV-Erythema and UV-A instrument including BHO-06 hard case, battery, RS232 interface cable and handbook
X-2000-5	UV-A and UV-B instrument including BHO-06 hard case, battery, RS232 interface cable and handbook
X-2000-6	UV-C (254 nm) instrument including BHO-06 hand case, battery, RS232 interface cable and handbook
X-2000-7	$ACGIH_{Skin}$ (250 to 325 nm & 325 to 400 nm cell) instrument with hard-case, battery, RS232 interface cable and handbook