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Understanding UV Detection: The Power of UVTRON® Technology

The demand for advanced sensors has surged, particularly in applications requiring accurate measurements in extreme environments. Among the various sensor types, optical sensors face significant challenges when operating under intense ambient light, such as sunlight. Researchers and engineers have explored innovative solutions that minimize interference and maximize performance to address this issue. One promising approach is to utilize wavelengths that are less affected by sunlight, particularly in the infrared and ultraviolet (UV) spectrum.

The Importance of Ultraviolet Detection

A major challenge in optical sensing is achieving reliable measurements in bright ambient light. One of the most common techniques to reduce the interference of sunlight is to apply optical filters on the sensor surface. However, these filters often lack high efficiency and complicate both manufacturing and usage. To overcome these challenges, researchers have begun to explore wavelengths with reduced impact from sunlight. For example, LiDAR (Light Detection and Ranging) sytems typically use infrared wavelengths, which are less influenced by sunlight compared to visible light, enabling effective photon detection.

Another significant spectral region is that of ultraviolet (UV), where the intensity of the solar spectrum is considerably lower than in the visible spectrum.

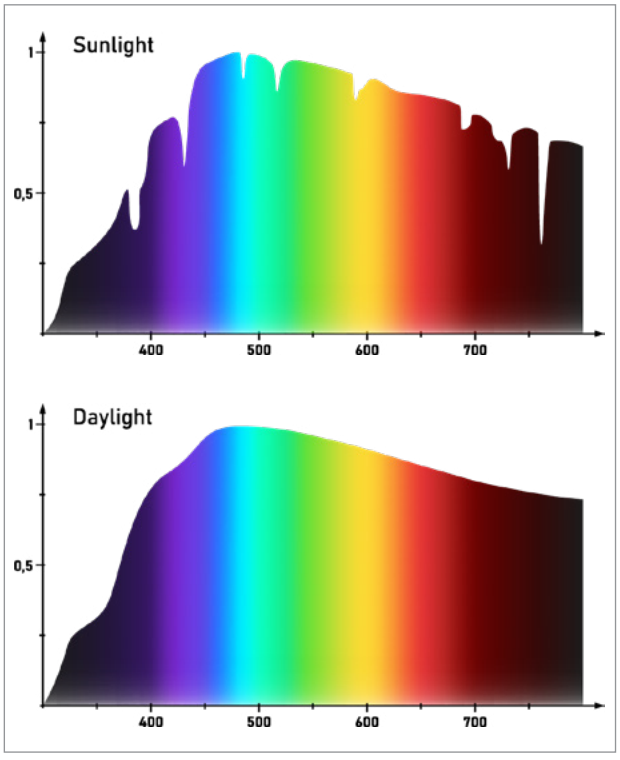


Figure 1 : Spectrum of daylight and in general, of solar light emission.

Applications of UV Detection

Discharge Sensing

High voltage cables and their towers can generate shocks or fires, or produce an audible buzz, particularly under cloudy conditions. While such phenomena may be familiar to many from popular movies, the often-overlooked electrical discharges emitted from corona discharges are invisible to the naked eye.

Hydrogen Flame Detection

The use of Hydrogen as an energy source is one of today's critical challenges for environmental protection. Unlike methane, hydrogen's flame is not visible; it emits primarily in the ultraviolet spectrum, a potential matter of concern.

Fire Detection

Early identification of small flames is critical for preventing large-scale fires, whether in forests, grasslands, or indoor facilities such as warehouses. UV sensors can detect the ultraviolet emissions of flames at their inception, ensuring rapid response.

Understanding UVTRON®: Features and Capabilities for UV Detection

Hamamatsu Photonics has taken up the challenge and developed a sensor specifically for UV detection called UVTRON®.

UVTRON® Flame / Discharge sensors.

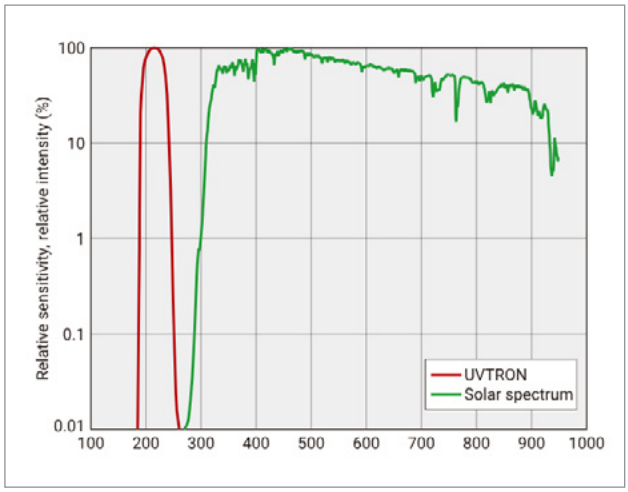
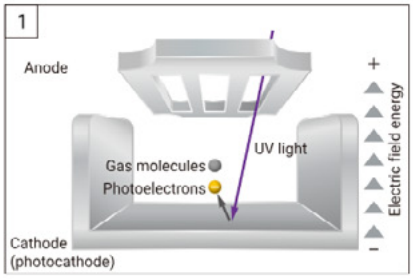
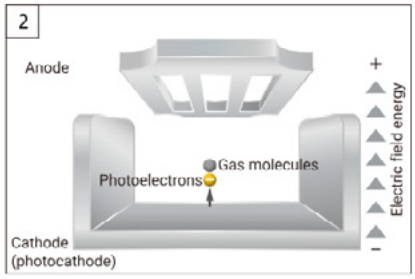


Figure 2: Spectrum comparison between UV-Tron and solar light.

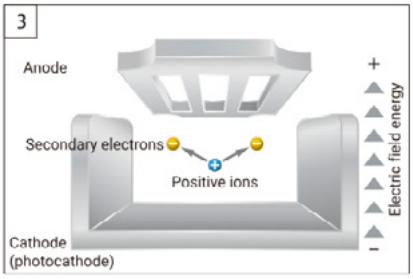
Operating principle



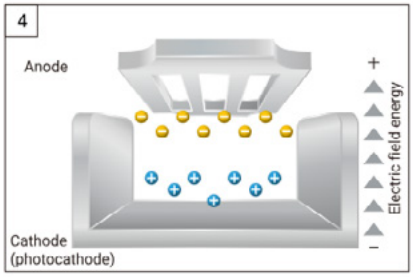
When more than a certain amount of UV light enters the cathode (photocathode) through the UV transmitting glass, photoelectrons (electrons) are emitted from the cathode surface due to photoelectric effect of the electrode material.



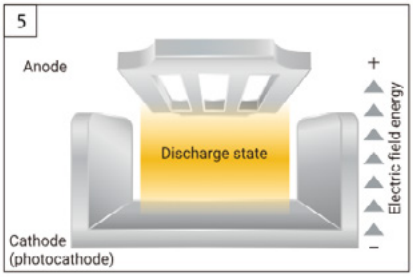
The photoelectrons are attracted to the anode side by the electric field energy and collide with glas molecules in the tube as they accelerate, resulting in ionization of the gas molecules.



Electrons and positive ions are generated by the ionization.



The number of electrons and positive ions increases at an accelerated rate as they repeatedly collide with other gas molecules.



When the UVTRON®-specific discharge conditions are met, a large current flows drastically between the anode and cathode, producing a discharge state.

Figure 3: UVTRON® operating principle.

As depicted in Figure 3, when UV light enters and impacts the cathode, photoelectrons are emitted due to the photoelectric effect. These photoelectrons accelerate toward the anode, colliding with gas molecules and triggering ionization. This ionization produces additional electrons and positive ions, resulting in a significant current flow between the anode and cathode, creating the discharge state.

Thanks to its ability to detect events at long distances and within large spaces, UVTRON® can be used in various conditions, including drone applications or storage monitoring.

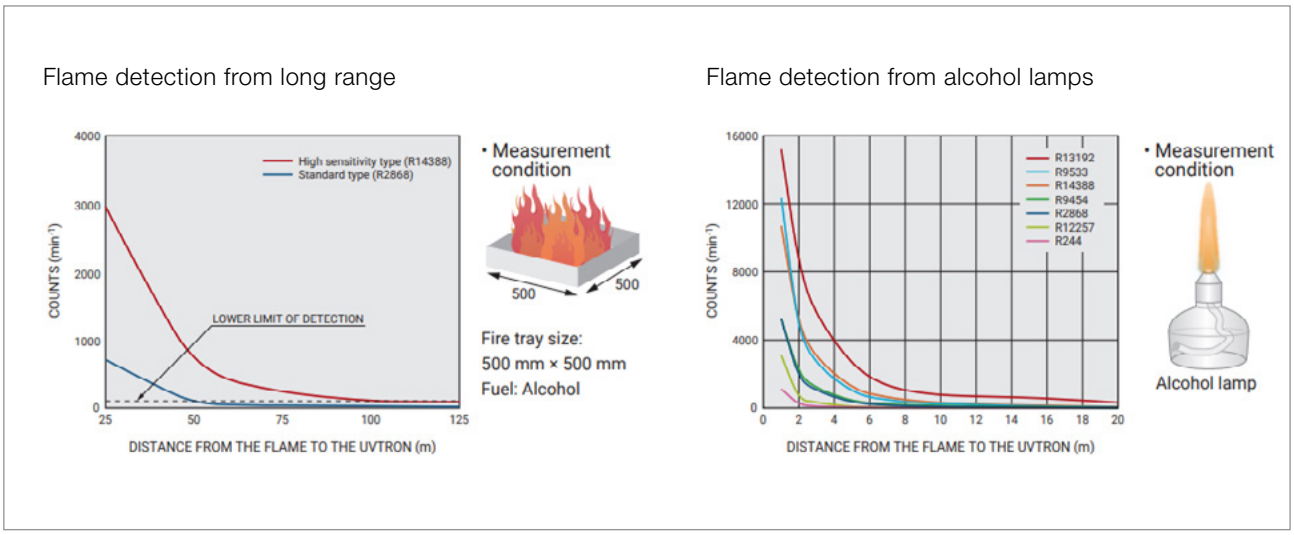


Figure 4: Flame detection - sensitivity vs distance

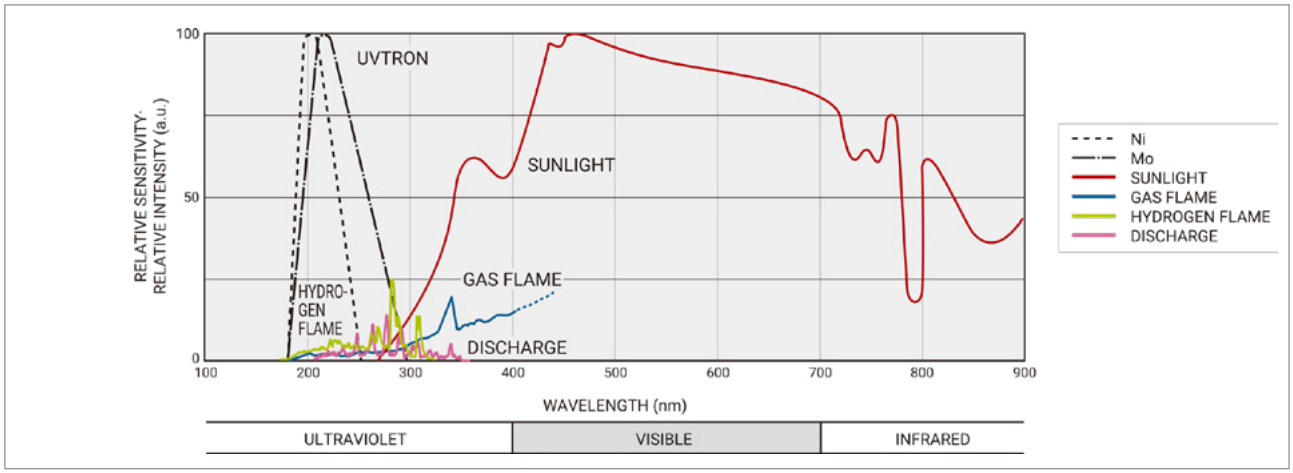
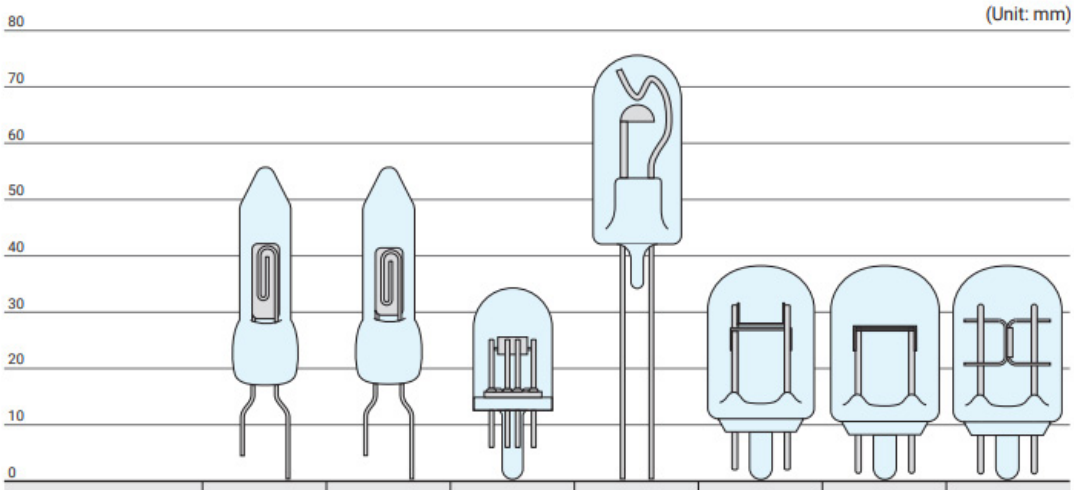


Figure 5: UVTRON® detection in the UV range

Hamamatsu offers a range of UVTRON® configurations tailored to specific requirements. Ready-to-use modules are available to facilitate sensor testing and integration into your system.

UVTRON® series quick reference



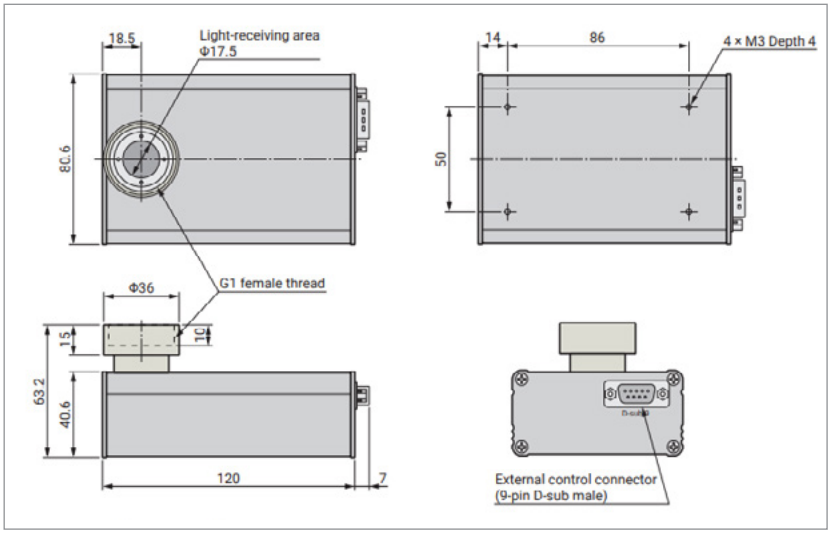
Type No.	R2868	R9454	R9533	R244	R14388	R13192	R12257
Spectral response range (nm)	185 to 260	185 to 260	185 to 260	185 to 260	185 to 260	185 to 260	185 to 300
Sensitivity (min^{-1}) at 25 °C	5000	4000	10 000	480	10 000	15 000	1200
Supply voltage (V DC)	325 ± 25	400 ± 25	350 ± 25	500 ± 50	325 ± 25	325 ± 25	310 ± 25
Quenching time (ms)	2	2	1	3	2	2	1
Estimated life (h) at 25°C	25 000	25 000	25 000	25 000	25 000	25 000	10 000
[Maximum ratings] Operation ambient temperature (°C)	-40 / +125	-40 / +125	-40 / +125	-40 / +125	-40 / +125	-40 / +125	-40 / +125
Purpose: Arson surveillance	●	●					
Purpose: Indoor fire detection	●	●					
Purpose: Fire detection in large spaces					●	●	
Purpose: Fire detection for public transportation and facilities			●				
Purpose: Boiler combustion monitoring			●	●			●
Purpose: Hydrogen flame monitoring			●		●	●	

Flame sensor module C16956-02

Dimensional outlines:

External control connector (9-pin D-sub) connection

Pin No.	Signal	
1	Input voltage (12 V to 24 V)	Input
2	Sensitivity (detection count)	Output
3	UV detection signal	Output
4	Internal UV-LED control signal	Input
5	RS-485 (B+)	–
6	Ground	–
7	Ready signal	Output
8	Temperature alarm signal	Output
9	RS-485 (A-)	–



Specifications:

Parameter		Description / Value	Unit
Installed UVTRON®		R14388	–
Spectral response range		185 to 260	nm
Sensitivity *1	Typ.	10 000	min⁻¹ *4
Background noise *2	Max.	5	min⁻¹ *4
Quenching time		2 to 20	ms
Estimated life *3		25 000	h
Input voltage (DC)		12 to 24	V
Power consumption	Max.	1.2	W
Cooling method		Not required	–
Operating temperature range		-10 °C to +60 °C	–
Storage temperature range		-10 °C to +80 °C (no freezing)	–
Operating humidity range		20 % to 80 % (no condensation)	–
Storage humidity range		Below 80 % (no condensation)	–
External control		Ready signal, UV detection signal, sensitivity (detection count) output, temperature alarm signal	–
Applicable standards	EMC standards	IEC 61326-1 Emission limits: CISPR 11 Group 1 Class A Immunity requirements: Table 2	–
	Safety standards	IEC 61010-1	
	Environmental standards (RoHS)	EN 63000	
Shock resistance		1000 m/s², 11 ms	–

*1: Typical value measured with a light intensity of 10 pW/cm² at a wavelength of 200 nm. In actual use, sensitivity varies depending on the wavelength and intensity of the incident UV light.
*2: Measured under room lighting (approximately 500 lx) and recommended operating conditions.
*3: Estimated life of the R14388 operated at room temperature when UV light is continuously incident under recommended operating conditions. The life varies with the ambient temperature, etc.
*4: min⁻¹ indicates counts per minute.

UV detection is proving to be an essential tool in the drive towards safety and the UVTRON® is well-equipped to support these applications effectively. With Hamamatsu's expertise, the most suitable solutions and configurations can be identified, and new possibilities in this field can be explored.

For more information please visit our dedicated information hub[1] or contact our team[2] of UVTRON® specialists.

[1] Hamamatsu Photonics, UVTRON®: Flame / Discharge sensors [online]: https://www.hamamatsu.com/eu/en/product/optical-sensors/uv_flame-sensor/flame-sensor_uv-tron.html

[2] Hamamatsu Photonics, Inquiry, [online]: https://www.hamamatsu.com/eu/en/inquiry/input.html/content/hamamatsu-photonics/global-web/eu/en/product/optical-sensors/uv_flame-sensor/flame-sensor_uv-tron.html