Ultraviolet (UV) TOCONS

- **SiC based UV sensors with 0 to 5 V voltage output**
- **measures intensities from 1.8pW/cm² up to 18W/cm²**
- **Broadband UV sensitivity or filtered for UVA, UVB, UVC or UV-Index spectral response**
- **GaP-chip based series for blue light hazard measurement**

sglux
The UV Experts

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TOCON

Catalog

TOCONS

Content of this Catalog

GENERAL INFORMATION ABOUT THE SGLUX TOCONS

What is a TOCON?

A TOCON is a UV photodetector that contains a SiC or a GaP detector chip and an amplifier circuit that outputs a voltage of 0 to 5V. This output voltage is linear in proportion to the UV radiation intensity reaching the SiC chip. Compared with a bare UV photodiode the TOCON's big advantage is the amplifier's position inside the TO5 metal housing and its close proximity to the detector. This construction protects the usually very low current levels generated by the detector chip from electromagnetic interference and also from moisture and pollution induced disturbances. A point to be considered of the TOCON is the lower dynamic range (approx. 3 orders of magnitude) compared with a SiC UV photodiode (10 orders of magnitude). To overdome this disadvantage we offer each TOCON type in many different amplification levels to avoid saturation and too low voltage output levels for nearly all applications. Please consult the selection guide on page 2 for assistance selecting the best suited TOCON.

About the material SiC

Most of the TOCONs are based on Silicon Carbide (SiC). Applications that require UV photodiodes differ widely in both required detector properties as well as spectral and absolute sensitivity. In the field of flame detection very low radiation intensity must be reliably detected. The monitoring of UV purification lamps needs UV photodiodes without degradation for many years under high UV flux. Monitoring very powerful UV radiation emitted by UV curing lamps or LED arrays require UV photodiodes that endure extreme UV radiation. Monitoring the sun's UV, in particular the erythemal intensity of the sunlight requires photodiodes with a near-perfect visible blindness and carefully tailored spectral response in the UV region. Customers that apply Silicon Carbide UV photodiodes do the best selection within all fields of applicaton. They profit from very low dark current, near perfect visible blindness and "bullet proof" radiation hardness.

Our own SiC wafer production since 2009

Since 2009 sglux produces SiC photodiodes, SiC spectrometer arrays and SiC 4-quadrant chips. The sglux R&D team has almost 20 years of experience in producing UV sensitive semiconductor chips. This skill powered the SiC R&D work focusing on extreme radiation hardness. The German PTB in 2011 measured that the radiation hardness of the sglux SiC UV chips has improved by factor of two compared to UV sensing chips produced by Cree, Inc. until 2007. Furthermore the visible blindness of the sglux chips could be improved by five orders of magnitude compared with Cree SiC chips now totaling to more than ten orders of magnitude of visible blindness. Please also refer to our list of publications (p. 10) of this catalog.

SELECTION GUIDE

Nomenclature

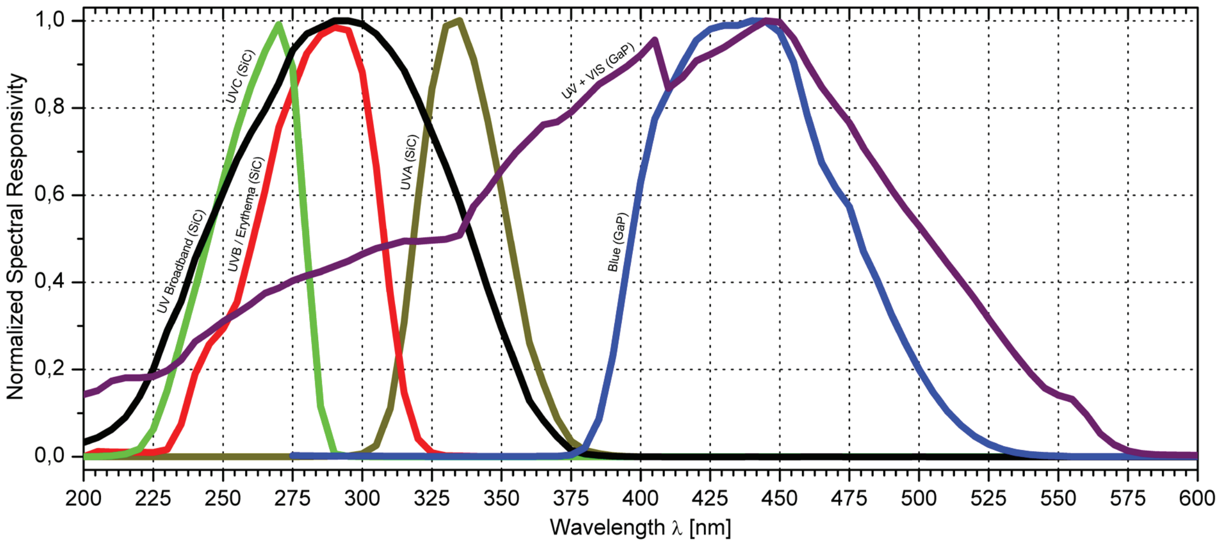
TOCON	ABC, A, B, C, E, blue or GaP	1 ... 10
	Spectral response	**Irradiance limits (V_{supply}=5V, $\lambda = \lambda_{peak}$)**
	ABC = broadband λ_{max} = 290 nm $\lambda_{s10\%}$ = 227 nm ... 360 nm	1 = 1.8 pW/cm² ... 1.8 nW/ cm²
		2 = 18 pW/cm² ... 180 nW/ cm²
	A = UVA λ_{max} = 331 nm $\lambda_{s10\%}$ = 309 nm ... 367 nm	3 = 180 pW/cm² ... 1.8 µW/ cm²
		4 = 1.8 nW/cm² ... 18 µW/ cm²
	B = UVB λ_{max} = 280 nm $\lambda_{s10\%}$ = 243 nm ... 303 nm	5 = 18 nW/cm² ... 180 µW/ cm²
		6 = 180 nW/cm² ... 1.8 mW/ cm²
	C = UVC λ_{max} = 275 nm $\lambda_{s10\%}$ = 225 nm ... 287 nm	7 = 1.8 µW/cm² ... 18 mW/ cm²
		8 = 18 µW/cm² ... 180 mW/ cm²
	Blue λ_{max} = 445 nm $\lambda_{s10\%}$ = 390 nm ... 515 nm	9 = 180 µW/cm² ... 1.8 W/ cm²
	Gap λ_{max} = 445 nm $\lambda_{s10\%}$ = 190 nm ... 570 nm	10 = 1.8 mW/cm² ... 18 W/ cm²
	E = UV-Index spectral response according to CIE087	2 = 0 UVI ... 30 UVI

Some examples for different applications:

TOCON_ABC1	for flame detection
TOCON_C7	for water purification control
TOCON_E2	for UV-Index measurements

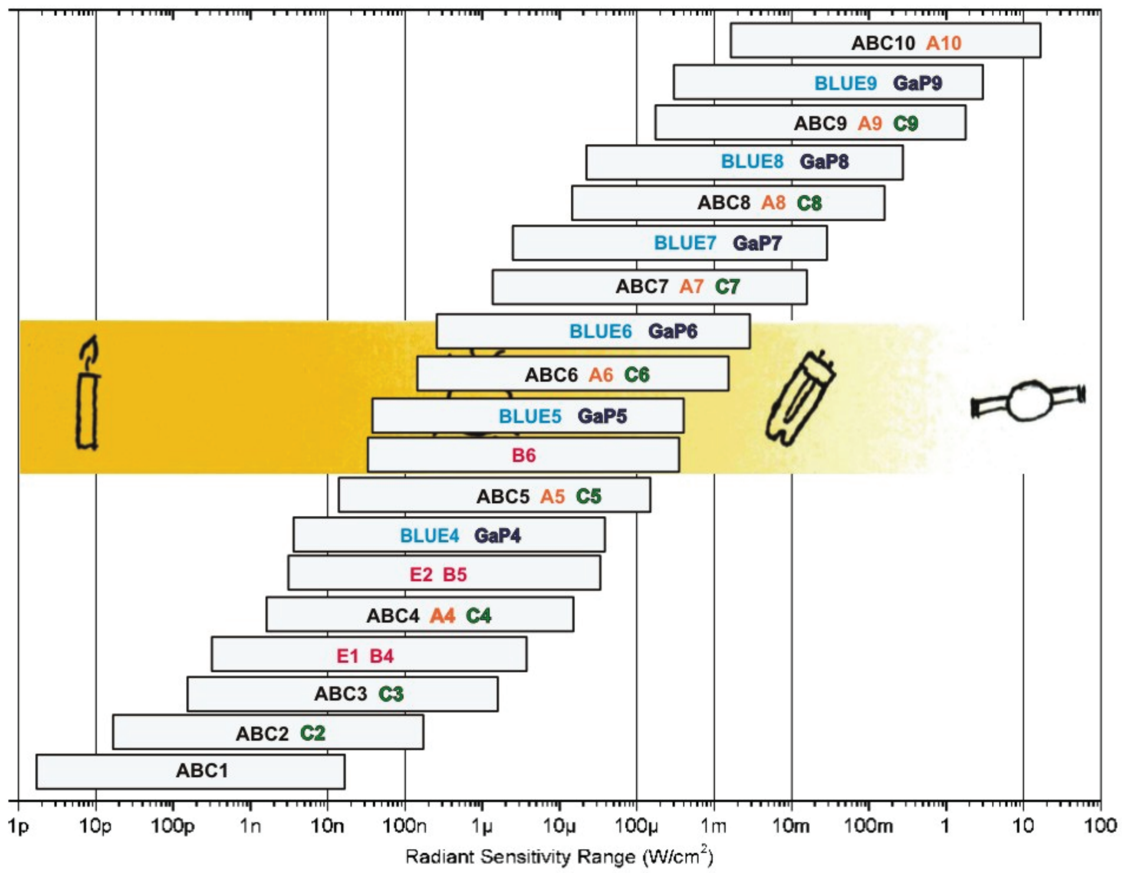
Selection of spectral response

The TOCONs are available with six different spectral responses, Broadband UV “**ABC**”, UVA **“A”** , UVB **“B”**, UVC **“C”** and Erythema Curve **“E”** (also useful for other selective UVB/UVC measurements) and blue light **“BLUE”** and **“GaP”** for near UV (UVA+blue+VIS). The below table shows the spectral response of the different TOCONs. For detailed specification please refer to our model overview (page 6) and the datasheet.



Selection of sensitivity range

The selection of the sensitivity range must be thorough. If the TOCON is too sensitive it will saturate below the upper limit of the radiation range to be measured. Conversely, a TOCON that is too insensitive gives no or a too low voltage output. Thus, for dynamic range selection, please estimate, it is best to calculate what is the max. radiation your TOCON must measure without getting saturated (the sensor will not be damaged if saturated). If not possible, we recommend to procure two samples with different sensitivities and have an experiment. The related min. radiation is lower by approx. factor 5000 – if the TOCON is powered with 5V. It is possible to power the TOCON with lower voltages down to 2.5V. However, this will reduce the dynamic range by factor $5V/V_{supply}$. The graph below shows the sglux TOCONs offered spread out over a radiant intensity range of 13 orders of magnitude. The dynamic range is determined by the numeric suffix from “1” = very sensitive for very low UV radiation (e.g. a flame) to “10” = very unsensitive for very strong radiation (e.g curing source). For detailed specification please refer to our model overview (page 6) and the datasheet.

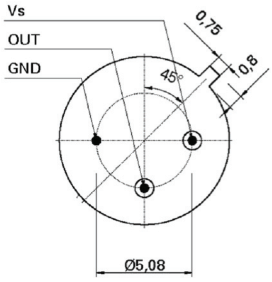


TOCON

Catalog

HOW TO USE A TOCON?

The 0 to 5V output voltage can be directly connected to a voltmeter or a controller. The TOCON is to be supplied with a voltage of V_{supply} = 2.5 - 5 V_{DC} between pin V_s and pin *GND*. The voltage output signal is measured between pin *OUT* und pin *GND*.



PRODUCT DETAILS OF ALL TOCONs

General specifications

	SYMBOL	VALUE	UNIT
Maximum Ratings			
Operating Temperature Range	T_{opt}	-25 ... +85	°C
Storage Temperature Range	T_{stor}	-40 ... +100	°C
Solding Temperature (3s)	T_{sold}	300	°C
General Characteristics			
Supply voltage	V_{supply}	-2.5 ... +5.0	V
Saturation voltage	V_{sat}	V_{supply} -5%	V
Dark offset voltage	V_{offset}	50	µV
Temperature coefficient	Tc	<-0.3	%/K
Current consumption	I	150	µA
Bandwith (-3 dB)	Q	15	Hz
Risetime (10–90%)	t_{rise}	0.058 – 0.182	s
(other risetimes on request)			
Spectral Characteristics (T = 25°C, V_{supply} = +5V)			
Typical respons. at peak wavelength	S_{max}	see next pages	nm
Wavelength of max. spectral responsivity	l_{max}	see next pages	nm
Responsivity range (S = 0.1*S_{max})	–	see next pages	nm
SiC Visible blindness (S_{max} / $S_{>405nm}$)	VB	>10^{10} (SiC)	–

TOCON model overview

Model	Approx. min. irradiance (mW/cm²)	Approx. max. irradiance (V_{supply} = 5V) (mW/cm²)	Applications
Broadband UV (SiC) Peak wavelength = 290 nm / sensivity range (S = 0.1*S_{max}) = 227 nm–360 nm			
TOCON ABC 1	1.80 E–09	1.80 E–05	Very low UV radiation detection, flame detection
TOCON ABC 2	1.80 E–08	1.80 E–04	Low UV radiation detection, occupational safety
TOCON ABC 3	1.80 E–07	1.80 E–03	UV radiation detection, occupational safety
TOCON ABC 4	1.80 E–06	1.80 E–02	UV irradiation measurement
TOCON ABC 5	1.80 E–05	1.80 E–01	UV irradiation measurement
TOCON ABC 6	1.80 E–04	1.80 E + 00	Optimized for total sun UV measurements (not Erythema curve)
TOCON ABC 7	1.80 E–03	1.80 E + 01	UV irradiation measurement, industrial standard UV radiation
TOCON ABC 8	1.80 E–02	1.80 E + 02	Curing lamp control
TOCON ABC 9	1.80 E–01	1.80 E + 03	Curing lamp control
TOCON ABC 10	1.80 E + 00	1.80 E + 04	UV hardening control and other very high radiation sources
UVA selective (SiC) Peak wavelength = 331 nm / sensivity range (S = 0.1*S_{max}) = 309 nm–367 nm			
TOCON A 4	1.80 E–06	1.80 E–02	UVA radiation detection
TOCON A 5	1.80 E–05	1.80 E–01	UVA irradiation measurement
TOCON A 6	1.80 E–04	1.80 E + 00	UVA irradiation measurement
TOCON A 7	1.80 E–03	1.80 E + 01	UVA irradiation measurement
TOCON A 8	1.80 E–02	1.80 E + 02	Measurement of high UVA irradiation, curing lamp control
TOCON A 9	1.80 E–01	1.80 E + 03	Measurement of very high UVA irradiation, curing lamp control
UVB + UVC selective (SiC) Peak wavelength = 280 nm / sensivity range (S = 0.1*S_{max}) = 243 nm–303 nm for UVB + UVC measurements and for Erythema Curve, complies with CIE087 and DIN5050			
TOCON B 4	7.50 E–07	7.50 E–03	UVB irradiation measurement
TOCON B 5	7.50 E–06	7.50 E–02	UVB irradiation measurement
TOCON B 6	7.50 E–05	7.50 E–01	UVB irradiation measurement
1 UVI input produces electrical output			
TOCON E 1	0.01 UVI	3 UVI	UV-Index measurements, if an attenuating diffusor is used
TOCON E 2	0.1 UVI	30 UVI	UV-Index measurements

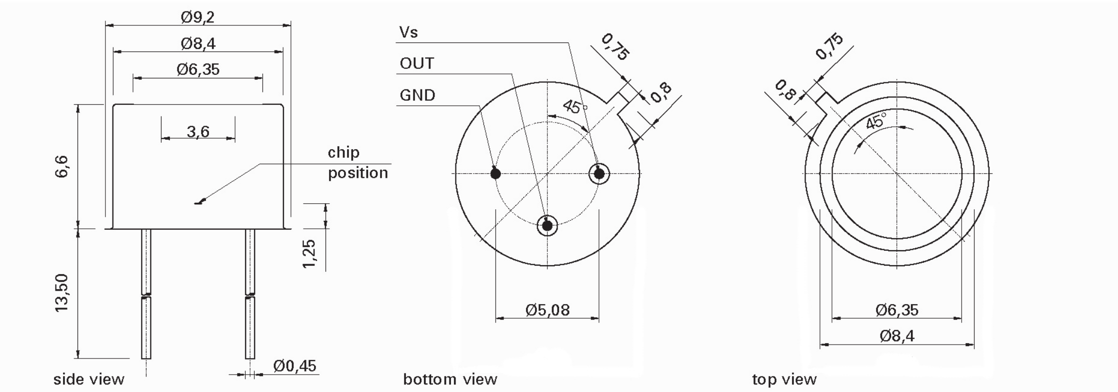
TOCON model overview

Model	Approx. min. irradiance (mW/cm²)	Approx. max. irradiance (V_{supply} = 5V) (mW/cm²)	Applications
UVC selective (SiC) Peak wavelength = 275 nm / sensivity range (S = 0.1*S_{max}) = 225 nm–287 nm; complies with DVGW W294(3) and ÖNorm			
TOCON C2	1.80 E–08	1.80 E–04	Low UVC radiation detection, occupational safety
TOCON C3	1.80 E–07	1.80 E–03	UVC radiation detection, occupational safety
TOCON C4	1.80 E–06	1.80 E–02	UVC irradiation measurement
TOCON C5	1.80 E–05	1.80 E–01	Purification lamp control
TOCON C6	1.80 E–04	1.80 E+00	Purification lamp control
TOCON C7	1.80 E–03	1.80 E+01	Purification lamp control
TOCON C8	1.80 E–02	1.80 E+02	Curing lamp control
TOCON C9	1.80 E–01	1.80 E+03	Curing lamp control
Blue Light (GaP) Peak wavelength = 445 nm / sensivity range (S = 0.1*S_{max}) = 390 nm–515 nm; complies with 2006/25/EG			
TOCON BLUE4	4.20 E–06	4.30 E–02	Measurement of very low blue light irradiation, occupational safety
TOCON BLUE5	4.20 E–05	4.30 E–01	Measurement of low blue light irradiation, occupational safety
TOCON BLUE6	4.20 E–04	4.30 E+00	Measurement of blue light irradiation, occupational safety
TOCON BLUE7	4.20 E–03	4.30 E+01	Measurement of blue light irradiation, occupational safety
TOCON BLUE8	4.20 E–02	4.30 E+02	Measurement of high blue light irradiation, occupational safety
TOCON BLUE9	4.20 E–01	4.30 E+03	Measurement of very high blue light irradiation, occupational safety
UV + VIS (GaP) Peak wavelength = 445 nm / sensivity range (S = 0.1*S_{max}) = 190 nm–570 nm			
TOCON GaP4	4.20 E–06	4.30 E–02	Measurement of very low UV & VIS light irradiation, occupational safety
TOCON GaP5	4.20 E–05	4.30 E–01	Measurement of low UV & VIS light irradiation, occupational safety
TOCON GaP6	4.20 E–04	4.30 E+00	Measurement of blue UV & VIS light irradiation, occupational safety
TOCON GaP7	4.20 E–03	4.30 E+01	Measurement of blue UV & VIS light irradiation, occupational safety
TOCON GaP8	4.20 E–02	4.30 E+02	Measurement of high UV & VIS light irradiation, occupational safety
TOCON GaP9	4.20 E–01	4.30 E+03	Measurement of very high UV & VIS light irradiation, occupational safety

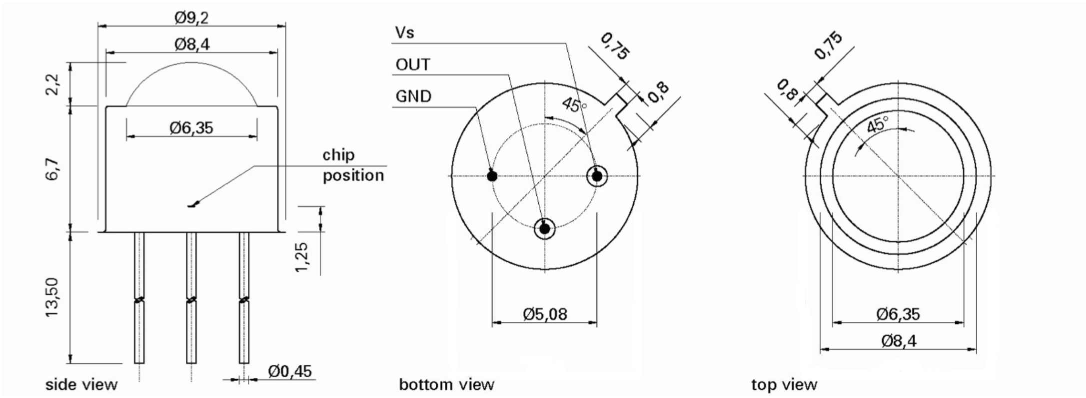
Accessories

TOCON housing	miniature stainless steel housing (M12x1) with TOCON installed and removable 5-pin connector with 2m cable, easy to mount and connect, robust thread body, suitable for all TOCONs
TOCON PTFE housing	miniature PTFE housing (M12x1) with TOCON installed and removable 5-pin connector with 2m cable, easy to mount and connect, dirt repellent
TOCON Water housing	miniature water pressure proof (10 bar) housing with G1/4“ thread with TOCON installed and removable 5-pin connector with 2m cable, easy to mount and connect, dirt repellent
TOCON Starter Kit	Kit for initial testing setup, includes a TOCON socket, two banana plugs to connect with a voltmeter and a 9V block battery

Drawings



TOCON in TO5 housing with filter, diffusor and / or attenuator



TOCON in TO5 housing with lens cap

Application note for TOCONs

The TOCONs need a supply voltage of V_{supply} = 2.5 to 5VDC and can be directly connected to a controller or voltmeter. Please note that the theoretic maximum signal output is always a little less (approx. 5%) than the supply voltage. To learn more about perfect use of the TOCONs please refer to the TOCON FAQ list published at www.sglux.com. CAUTION! Wrong wiring leads to destruction of the device. For easy setup of the device please ask for a TOCON starter kit that contains a ready to use wired socket, a connector to a 9V battery, 2 banana plugs for V_{out}.

Accessories

TOCON steel housing 24 V

- Small housing for the TOCON series
- Supply voltage 5 to 24 V
- Robust stainless steel M12x1 thread body
- Integrated sensor connector (Binder 4-Pin plug) with 2m connector cable
- Easy to mount and connect

TOCON PTFE housing 24 V

- Small housing for the TOCON series
- Supply voltage 5 to 24 V
- Material teflon (PTFE) M12x1 thread body, dirt-repellent, water proof at wetside (IP68), wide cosine field of view
- Integrated sensor connector (Binder 4-Pin plug) with 2m connector cable
- Easy to mount and connect, cleanable

TOCON water 24 V

- Miniature housing for the TOCON series
- Supply voltage 5 to 24 V
- G1/4” thread, material Teflon (PTFE)
- 10 bar water pressure proof
- Integrated sensor connector (Binder 4-Pin plug) with 2m connector cable
- Easy to mount and connect

Plastic probes for TOCON series

- UV probes in small plastic housings with a TOCON inside
- Customized housings available
- Easy to mount and to connect
- Integrated sensor connector (Binder 4-Pin plug)
- Connector cable available

TOCON Starter kit

- Optional feature for all TOCON detectors
- kit for easy initial testing setup
- output voltage 0 to 5 V
- 9 V block battey included, easy connection via banana plug ground

LIST OF PUBLICATIONS

P. Sperfeld[1], B. Barton[1], S. Pape[1], A. Towara[1], J. Eggers[2], G. Hopfenmueller[3]
[1]Physikalisch-Technische Bundesanstalt Braunschweig und Berlin (PTB), Germany, [2]DVGW-Technologiezentrum Wasser, Karlsruhe, Germany, [3]sglux GmbH, Berlin, Germany
„Spectral irradiance measurement and actinic radiometer calibration for UV water disinfection“
Metrologia, Issue 51 (2014), *p. 282-288*.

P. Sperfeld[1], B. Barton[1], S. Pape[1], A. Towara[1], J. Eggers[2], G. Hopfenmueller[3]
[1]Physikalisch-Technische Bundesanstalt Braunschweig and Berlin (PTB), Germany, [2]DVGW-Technologiezentrum Wasser, Karlsruhe, Germany, [3]sglux GmbH, Berlin, Germany
*„Spectral Irradiance Measurement and Actinic Radiometer Calibration for UV Water Disinfection*Proceedings of NE-WRAD 2014, edited by S. Park, P. Kaerhae and E. Ikonen. (Aalto University, Espoo, Finland 2014) *p. 128*.

B. Barton[1], P. Sperfeld[1], A. Towara[1], G. Hopfenmueller[2]
[1]Physikalisch-Technische Bundesanstalt Braunschweig und Berlin (PTB), 4.1 Photometry and Applied Radiometry, Braunschweig, Germany, [2]sglux GmbH, Berlin, Germany
*„Developing and setting up a calibration facility for UV sensors at high irradiance rates*EMEA Regional Conference, Karlsruhe, Germany (2013)

P. Sperfeld[1], B. Barton[1], S. Pape[1], G. Hopfenmueller[2]
[1]Physikalisch-Technische Bundesanstalt Braunschweig und Berlin (PTB), 4.1 Photometry and Applied Radiometry, Braunschweig, Germany, [2]sglux GmbH, Berlin, Germany
*„Traceable spectral irradiance measurements at UV water disinfection facilities*EMEA Regional Conference, Karlsruhe, Germany (2013)

G. Hopfenmueller[1], T.Weiss[1], B. Barton[2], P. Sperfeld[2], S. Nowy[2], S. Pape[2], D. Friedrich[2], S. Winter[2], A. Towara[2], A. Hoepe[2], S. Teichert[2]
[1]sglux GmbH, Berlin, Germany, [2]Physikalisch-Technische Bundesanstalt Braunschweig und Berlin (PTB), 4.1 Photometry and Applied Radiometry, Braunschweig, Germany
*„PTB traceable calibrated reference UV radiometer for measurements at high irradiance medium pressure mercury discharge lamps*EMEA Regional Conference, Karlsruhe, Germany (2013)

D. Prasai[1], W. John[1], L. Weixelbaum[1], O. Krueger[1] G. Wagner[2], P. Sperfeld[3], S. Nowy[3], D. Friedrich[3], S. Winter[3] and T. Weiss[4]
[1]Ferdinand-Braun-Institut, Leibniz-Institut fuer Hoechstfrequenztechnik, Berlin, Germany,
[2]Leibniz-Institut fuer Kristallzuechtung, Berlin, Germany, [3]Physikalisch-Technische Bundesanstalt Braunschweig und Berlin (PTB), 4.1 Photometry and Applied Radiometry, Braunschweig, Germany, [4]sglux GmbH, Berlin, Germany
„Highly reliable silicon carbide photodiodes for visible-blind ultraviolet detector applications J. Mater. Res., first view (2012)

S. Nowy[1], B. Barton[1], S. Pape[1], P. Sperfeld[1], D. Friedrich[1], S. Winter[1], G. Hopfenmueller[2], and T. Weiss[2]
[1]Physikalisch-Technische Bundesanstalt Braunschweig und Berlin (PTB), 4.1 Photometry and Applied Radiometry, Braunschweig, Germany, [2]sglux GmbH, Berlin, Germany
*„Characterization of SiC photodiodes for high irradiance UV radiometers*Proceedings of NEWRAD2011, edited by S. Park and E. Ikonen. (Aalto University, Espoo, Finland, 2011) *p. 203*.

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[1]Physikalisch-Technische Bundesanstalt Braunschweig und Berlin (PTB), 4.1 Photometry and Applied Radiometry, Braunschweig, Germany, [2]sglux GmbH, Berlin, Germany, [3]SGIL Silicaglas GmbH, Langewiesen, Germany
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