

# BTS2048-VL-TEC-WP

<https://www.gigahertz-optik.com/en-us/product/bts2048-vl-tec-wp/>

**Product tags:** VIS , NIR



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## Description

### BTS2048-VL-TEC-WP BiTec sensor spectroradiometer for high-quality outdoor VIS measurements

The BTS2048-VL-TEC-WP is a high-quality spectralradiometer whose compact design and elaborate optical, electronic and mechanical interfaces make it ideal for high precision outdoor VIS measurements. Due to its spectrometer design and optional stray light reduction by the well know Zong or Nevas matrix methods it is able to measure solar radiation with a good straylight reduction performance. With the included S-BTS2048 application software precise measurements and data analysis can be intuitive performed. In addition for the UV spectral range with the complementary BTS2048-UV-S-WP a high resolution and even better device in terms of stray light reduction is available.



*Entrance optic is blow-dried by warm air to prevent dirt, rain or snow*

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### BiTec sensor for high-end light measurement

One of the outstanding features of this exceptional spectroradiometer is its BiTec sensor. This combines the special properties of a photodiode with those of a back-thinned CCD diode array. Through bilateral correction of measurement signals from both sensors, the BiTec sensor ensures precise radiometric and spectral-radiometric measurement values over a large dynamic range (see technical article [BiTec Sensor](#)).



*Side View of the BTS2048-VL-TEC-WP*

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### Spectrometer based on a high-quality back-thinned CCD detector

The spectrometer unit is based on a diode array with a utilizable spectral responsivity range between 190 nm and 430 nm. It has a 0.7 nm optical bandwidth and a pixel resolution of 0.13 nm/pixel. Due to the back-thinned technology, this CCD chip is substantially more sensitive as compared to conventional front-illuminated CCD chips. Furthermore the CCD is one stage cooled (1TEC) to reduce the dark current and increased thereby the SNR.



*The WP version in a winter measurement campaign*

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### Precise spectral radiometry (high dynamic and low straylight)

To facilitate optimum use of the CCD sensor's dynamic range and to overcome the problems of most array spectroradiometers in the UV range, the option to characterize and apply the Zong or Nevas straylight reduction methods is possible. For a high dynamic range a remote controlled filter wheel (Open, Closed, OD1 and OD2) is located in the optical beam path, this additional to the high dynamic of the integration times (2  $\mu$ s to 60 s).

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## Accuracy for spectral AOD (Aerosol Optical Depth)

The BTS2048-VL-TEC-WP showed its high accuracy in a peer-reviewed paper in terms of high [accuracy spectral AOD measurements traceable calibrated](#).

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## WP means weather proofed

The housing of the BTS2048-VL-TEC-WP is designed for outdoor measurements. The cooled backthinned CCD and the spectrometer unit are temperature controlled in a second housing. In this housing humidity is removed by a exchangeable cartridge. To avoid dust, rain or snow on the entrance optics the quartz dome is blow-dried by warm air.

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## Diffuser window directly connected instead of light guide

As for the input optics, the BTS2048-VL-TEC-WP has an incorporated diffuser window with a cosine corrected field of view. The fact that a light guide has not been used improves sensitivity and calibration stability which is an large advantage for outdoor use. Especially in terms of size of the device. The f2 adjustment of the cosine corrected field of view to less than 3% makes it possible to use the BTS2048-VL-TEC-WP for direct measurement in absolute radiometric measurands

- Irradiance ( $\text{W}/\text{m}^2$ )
- Spectral irradiance ( $\text{W}/(\text{m}^2 \text{ nm})$ )

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## State of the art interface

The BTS2048-VL-TEC-WP is controlled via a USB 2.0 or Ethernet interface. With regards to the communication speed and cable length the Ethernet port is superior to the USB2.0 interface. Furthermore, the data preparation occurs in the BTS2048-VL-TEC-WP to optimize the data-transfer speed. For this purpose, an independent, high-performance microprocessor is incorporated. Data and power interface are of course weatherproof designed as well.

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## User software with flexible desktop structure

Among the BTS2048-VL-TEC-WP delivery contents is the S-BTS2048 user software. One of the characteristic features it has to offer is the flexible desktop that can be individually configured by the user. This entails a potpourri from which the user can choose graphical and numerical display windows:

- Freely definable numerical displays in decimal or scientific representation. Zoom function.
- Numerical display fields for radiometric, spectral and other measurands.
- Measurement protocol of the selected measurement parameters.
- Spectrum. Zoom function.
- Data logger. Zoom function.
- etc.

## Traceable calibration

Calibration of the BTS2048-VL-TEC-WP, including its accessories, is performed by Gigahertz-Optik [ISO/IEC 17025 calibration laboratory](#) for optical measurands with reference to national and international calibration standards. Due to the small dimensions of the device it can be shipped easily for re-calibration purposes.

## Scientific Measurement Campaign

The BTS2048-VL-TEC-WP has took part in an [scientific intercomparison](#), to prove the quality of the measurement data in the scientific framework.

## Specifications

### General

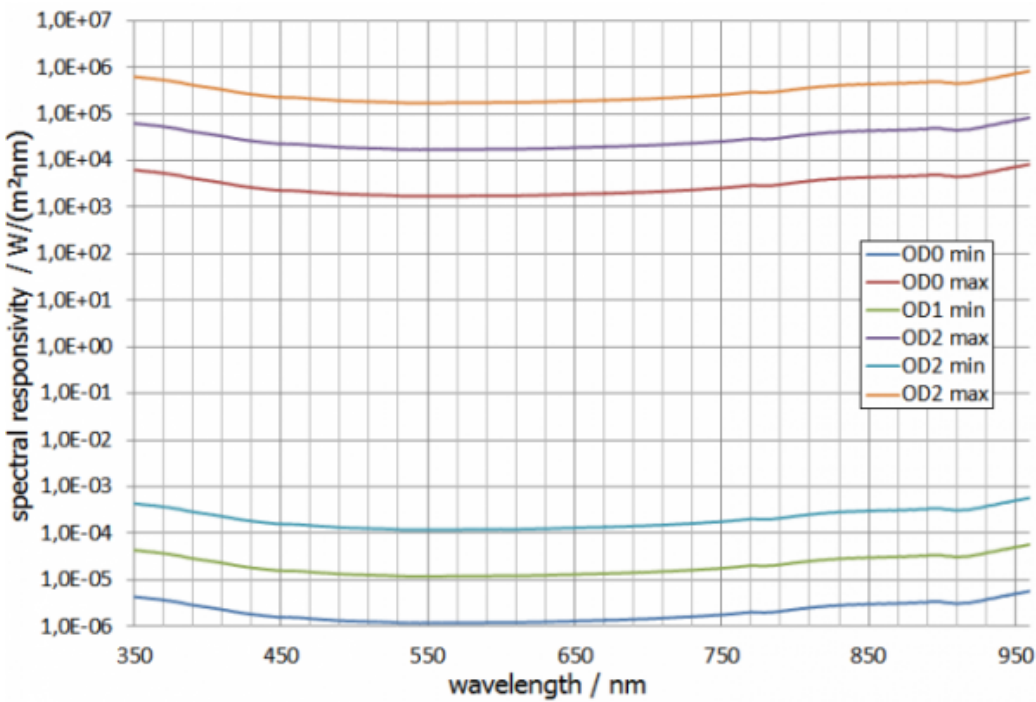
Short description	High speed TE cooled CCD spectroradiometer with a wide dynamic range for CW and pulsed measurements of irradiance/illuminance, spectrum in the VIS region for outdoor measurements.
Main features	Compact device. BiTec detector with back-thinned TE cooled CCD (2048 pixels, 2 nm optical resolution, electronic shutter) and Si-photodiode with V(lambda) filter. Optical bandwidth correction (CIE214). Filter wheel with shutter and attenuation filters. Input lens with a diffusor window that has a cosine field of view. Housing for outdoor use.
Measurement range	Spectral: 0.5 lx to 1,000,000 lx 280 nm to 1050 nm. Integral: 0.1 lx Noise signal up to 3E8 lx, photometric 360 nm to 830 nm
Typical applications	CCD spectroradiometer for scientific measurements, solar cells, outdoor measurements, development tasks.
Calibration	Factory calibration. Traceable to international calibration standards
<b>Product</b>	
Measured Quantity	Spectral irradiance (W/(m <sup>2</sup> nm)), illuminance (lx), peak wavelength, calculated quantities of the spectral power distribution, etc.
Sensor	Accuracy class B according to DIN 5032 and CIE No. 69 Accuracy class A for f1`, u, f3 and f4 according to DIN 5032 and CIE No. 69
Input optics	Diffusor, cosine corrected field of view (f2 ≤ 3 %)
Filter wheel	4 positions (open, closed, OD1, OD2). Use for remote dark current measurement and dynamic range extension.

BiTec	Parallel measurement with diode and array is possible, thereby linearity correction of the array through the diode and online correction of the spectral mismatch of the diode through $a^*(s_2(\lambda))$ respectively $F^*(s_2(\lambda))$ .		
Calibration	Spectral irradiance		
	$\lambda$	$u(k=2)$	
	(280 - 304) nm:	$\pm 7 \%$	
	(305 - 349) nm:	$\pm 5 \%$	
	(350 - 399) nm:	$\pm 4.5 \%$	
	(400 - 780) nm:	$\pm 4 \%$	
	(781 - 1030) nm:	$\pm 4.5 \%$	
	(1031 - 1050) nm:	$\pm 5.5 \%$	
	Spectral irradiance responsivity (280 - 1050) nm. Standard calibration (350 - 1050) nm. Optional calibration (280 - 1050) nm.		
<b>Spectral Detector</b>			
Integration Time	2 $\mu$ s - 60 s	*1	
Spectral range	(280 -1050) nm		
Optical Bandwidth	2 nm		
Pixel resolution	~0.4 nm/Pixel		
Number of pixels	2048		
Chip	One stage cooled highly sensitive back-thinned CCD chip		
ADC	16bit (25 ns instruction cycle time)		
Peak wavelength	$\pm 0.2$ nm		
Dominant wavelength	$\pm 0.5$ nm	*2	
	$\pm 0.0015$ (Standard illuminant A) $\pm 0.0020$ (common LED)		
Repeatability $\Delta x$ and $\Delta y$	$\pm 0.0001$		
$\Delta$ CCT	Standard illuminant A 30K; LED up to +/- 1.5 % depending of the LED spectrum		
Band-pass correction	mathematical online band-pass correction is supported		
Linearity	completely linearized chip >99.6%		
Stray Light	2E-4	*3	
Base line noise	5 cts	*4	
SNR	5000	*5	
Dynamic range	>10 Magnitudes		
Spectral irradiance responsivity range	(1E-6 - 1E5) W/(m²nm)	*6*7	
CRI (color rendering index)	Ra and R1 to R15		
Typical measurement time	10 lx	2,5 s	*10
	100 lx	250 ms	*10
	1000 lx	25 ms	*10
ADC	16bit		
<b>Integral Detector</b>			
Filter	Spectral responsivity with fine CIE photometric matching. Online correction of the photometric matching through spectral measurement data (spectral mismatch factor correction).		

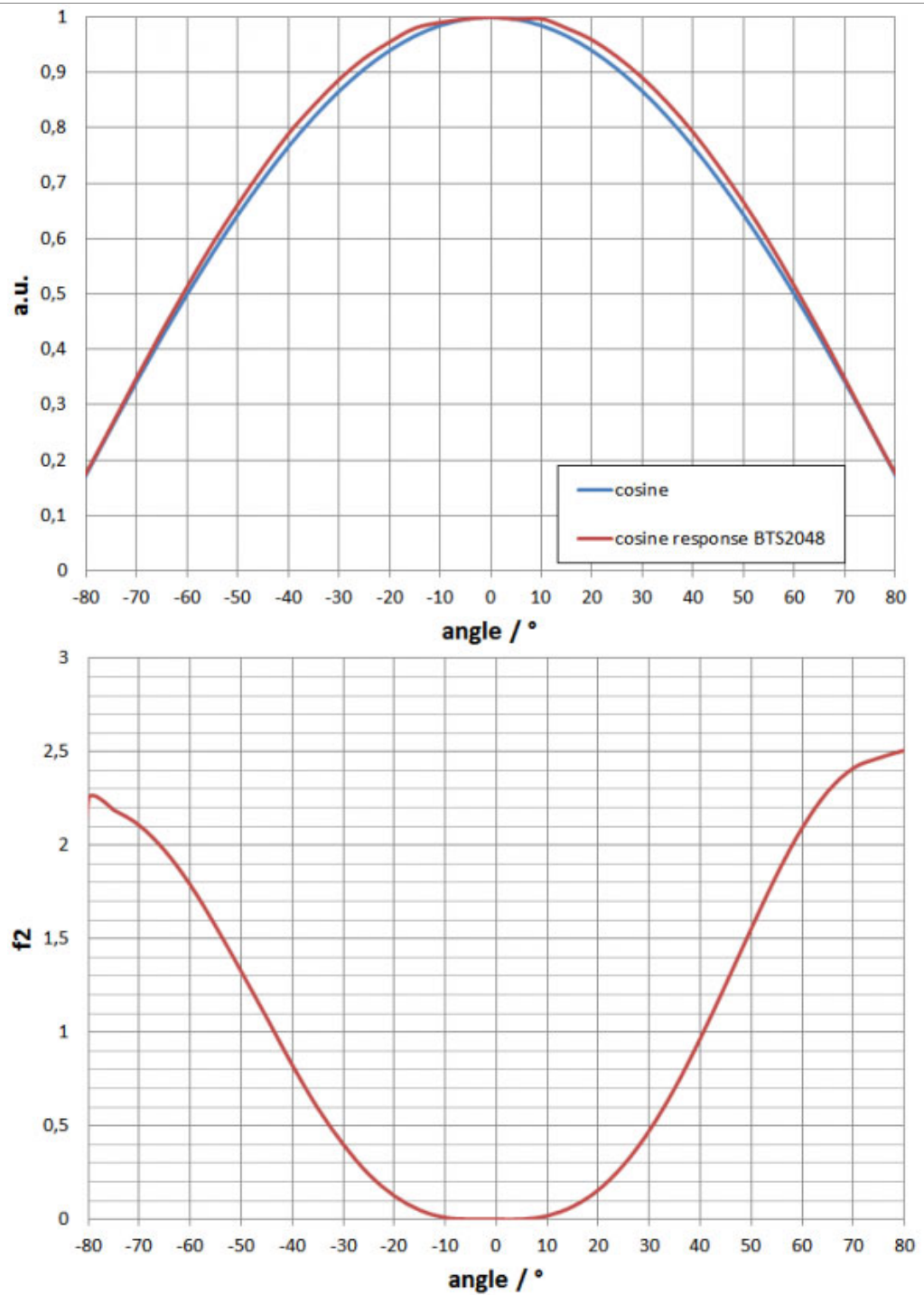
Measurement time	(0.1 - 6000) ms
Measurement range	seven (7) measurement ranges with transcendent offset correction
Measurement range	Max measureable illuminance value 3E8lx <sup>*7</sup> Noise equivalent illuminance value 1E-1lx
Calibration	Illuminance +/- 2,2 %
f1' (spectral mismatch)	≤ 6 % (uncorrected)  ≤ 3 % (f1' a*(s <sub>z</sub> (λ)) respectively F*(s <sub>z</sub> (λ)) corrected by spectral data, done automatically by BTS technology)

**Graphs**

Spectral responsivity



f2 (directional response/cosine error)



#### Miscellaneous


Microprocessor	32bit for device control, 16bit for CCD array control, 8bit for photodiode control
Interface	USB V2.0, Ethernet (LAN UDP protocol), RS232, RS485
Data transfer	Standard for 2048 float array values via ethernet 7ms, via USB 2.0 140 ms
Input Interfaces	2x (0 - 25) VDC, 1x optocoupler isolated 5 V / 5 mA
Output Interfaces	2x open collector, max. 25 V, max. 500 mA
Trigger	Trigger input incorporated (different options, rising/falling edge, delayed, etc.)
Software	User software S-BTS2048 Optional software development kit S-SDK-BTS2048 for user software set-ups based on .dll's in C, C++, C# or in LabView.

Power Supply	With power supply: DC Input 5V ( $\pm 10\%$ ) at 700 mA With USB bus (500mA) <sup>*8</sup>
Dimensions	diameter: 160 mm  height: 222 mm  (see drawing)
Weight	2.85 kg
Mounting	Tripod and M6 screw threads  Front adapter UMPA-1.0-HL for use with integrating sphere port-frame UMPF-1.0-HL
Temperature range	Storage: (-10 to 50) °C  Operation: (-25 to 50) °C <sup>*9</sup>
Stability	inside WP housing (electronics): $\leq \pm 1$ °C  CCD Chip: $\leq \pm 0.25$ °C
Housing	Spectroradiometer unit: IP67  Outdoor housing itself: IPx5
Info	<p><i>*1 It is recommended to perform a new dark signal measurement for every change in the integration time</i></p> <p><i>*2 typical value, the uncertainty of the dominant wavelength depends on the spectral distribution of the LED</i></p> <p><i>*3 typical value, measured 100nm left of the peak of a cold white broadband LED</i></p> <p><i>*4 *5 typical value measured without averaging for a 4ms measurement time and full scale control of the array. Averaging results in quadratic rise of the S/N</i></p> <p><i>i.e. quadratic fall of the base noise e.g. averaging to a factor 100 improves the S/N by a factor 10</i></p> <p><i>*6 Minimum 500/1 S/N. Maximum at full scale control.</i></p> <p><i>*7 Irradiation only allowed for a short time so as to avoid thermal damage</i></p> <p><i>*8 during USB connection, not all functions are available due to the limited current supply e.g. no Ethernet and TEC cooling</i></p> <p><i>*9 Device required for temperature stabilization in approx. 25min. In measurement is performed in the warm-up phase, or if measurements are performed under varying temperatures, dark signal measurement is required for each measurement</i></p> <p><i>*10 measurement of a white LED and 20000 counts (signal-dark) saturation</i></p>




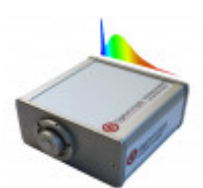
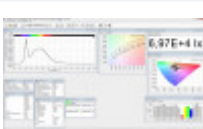

## Downloads

Type	Description	File-Type	Download
BTS2048-Series	BTS2048 'Not just another spectrometer' brochure	pdf	<a href="https://www.gigahertz-optik.com/assets/BTS2048_broschuere_DI_NA4_hoch_V2_2022.pdf">https://www.gigahertz-optik.com/assets/BTS2048_broschuere_DI_NA4_hoch_V2_2022.pdf</a>

## Configurable with

Product Name	Product Image	Description	Go to product
BTS2048-UV-S-WP		Spectroradiometer ideal for high precision outdoor UV measurements	<a href="https://www.gigahertz-optik.com/en-us/product/bts2048-uv-s-wp/">https://www.gigahertz-optik.com/en-us/product/bts2048-uv-s-wp/</a>



Product Name	Product Image	Description	Go to product
S-SDK-BTS2048		Software Development Kit for BTS2048 variants.	<a href="https://www.gigahertz-optik.com/en-us/product/s-sdk-bts2048/">https://www.gigahertz-optik.com/en-us/product/s-sdk-bts2048/</a>
SUT-1711		Sun tracker for use with e.g. BTS2048-xx-WP series meter for direct solar irradiance measurement.	<a href="https://www.gigahertz-optik.com/en-us/product/sut-1711/">https://www.gigahertz-optik.com/en-us/product/sut-1711/</a>
BTS-Solar		UV Spectroradiometer on Sun tracker for direct solar irradiance measurement and TOC determination	<a href="https://www.gigahertz-optik.com/en-us/product/bts-solar/">https://www.gigahertz-optik.com/en-us/product/bts-solar/</a>
BTS2048 Series		Compact spectroradiometers with excellent optical performance and BiTec technology for precise measurements for lab and field use.	<a href="https://www.gigahertz-optik.com/en-us/product/bts2048-series/">https://www.gigahertz-optik.com/en-us/product/bts2048-series/</a>
S-BTS2048		Application software for BTS2048 variants.	<a href="https://www.gigahertz-optik.com/en-us/product/s-bts2048/">https://www.gigahertz-optik.com/en-us/product/s-bts2048/</a>
BN-LHSI-WP		Calibration Lamp for Spectral Irradiance and Illuminance for Outdoor -WP devices	<a href="https://www.gigahertz-optik.com/en-us/product/bn-lhsi-wp/">https://www.gigahertz-optik.com/en-us/product/bn-lhsi-wp/</a>

## Purchasing information

Article-Nr	Modell	Description
<b>Product</b>		
15305846	BTS2048-VL-TEC-WP	Measuring device, hard cover box, users guide, S-BTS2048 software, calibration certificate.
<b>Calibration</b>		
15311103	KP-BTS2048VLTECWP-E-S-V01	Option: DIN EN ISO/IEC 17025:2018 Test Certificate (DAkKS).  Spectral irradiance measurement and illuminance measurement in wavelength range 280 nm to 1050 nm.
<b>Re-calibration</b>		
15306166	K-BTS2048VLTEC-E-S-V03	Re-calibration of the BTS2048-VL-TEC-WP from 280 nm to 1050 nm while applying the stray light correction matrix in ND0 setting. Calibration certificate.
<b>Software</b>		
15298470	S-SDK-BTS2048	Software development kit with users guide.

Article-Nr	Modell	Description
15307925	S-T-RECAL-BTS2048	Software module for functional enhancement of S-BTS2048 software. Support of BTS2048 series light meter re-calibration via the user.
<b>Accessories</b>		
15306934	BTS2048-XX-WP-Z01	Desiccant cartridge for BTS2048-XX-WP housing.
15307929	BTS2048-XX-WP-Z02	Front tube for direct irradiance measurements.
15308476	BTS2048-XX-WP-Z03	5 m power supply cable.
15308477	BTS2048-XX-WP-Z04	10 m power supply cable.
15308478	BTS2048-XX-WP-Z05	20 m power supply cable.
15308479	BTS2048-XX-WP-Z06	5 m Ethernet cable.
15308480	BTS2048-XX-WP-Z07	10 m Ethernet cable.
15308481	BTS2048-XX-WP-Z08	20 m Ethernet cable.
15312053	BTS2048-XX-WP-Z12	Building kit for 5 m power supply cable.
15312054	BTS2048-XX-WP-Z13	Building kit for 10 m power supply cable.
15312055	BTS2048-XX-WP-Z14	Building kit for 20 m power supply cable.

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