

# BTS2048-VL-TEC-WP

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

**Product tags:** VIS , NIR



## 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 known 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.



*BTS2048-VL-TEC-WP*

### 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 [BTS Technologie](#)).



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

### 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.

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



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

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).

## 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.

## 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 a 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 (W/m<sup>2</sup>)
- Spectral irradiance (W/(m<sup>2</sup> nm))

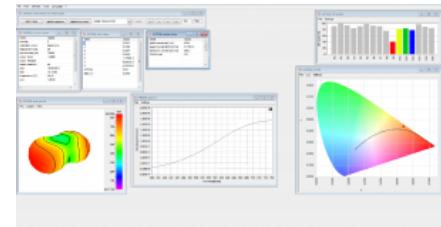
## State of the art interface

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.

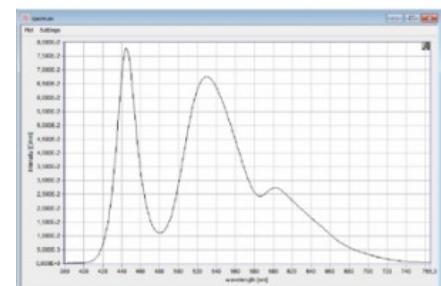
## User software with flexible desktop structure

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.



*S-BTS2048 User software interface*



*Graphical view of the spectrum*



*The WP version in a winter measurement campaign*

# Traceable calibration

Calibration of the BTS2048-VL-TEC-WP, including its accessories, is performed by Gigahertz-Optik 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.

## Specifications

### General

Short description	High speed TE cooled CCD spectroradiometer with a wide dynamic range for CW and pulsed measurements of irradiance/illuminance, specturm in the VIS region for outdoor measurements.
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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.
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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
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typical applications	CCD spectroradiometer for scientific measurements, solar cells, outdoor measurements, development tasks.
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Calibration	Factory calibration. Traceable to international calibration standards
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### Product

Measured Quantity	Spectral irradiance (W/(m <sup>2</sup> nm)), illuminance (lx), peak wavelength, calculated quantities of the spectral power distribution, etc.
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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
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Input optics	Diffusor, cosine corrected field of view (f2 ≤ 3 %)
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Filter wheel	4 positions (open, closed, OD1, OD2). Use for remote dark current measurement and dynamic range extension.
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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 <sub>z</sub> (λ)) respectively F*(s <sub>z</sub> (λ)).
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Calibration	Spectral irradiance	
	(280 - 304) nm:	± 7 %
	(305 - 349) nm:	± 5 %
	(350 - 399) nm:	± 4.5 %
	(400 - 780) nm:	± 4 %
	(781 - 1030) nm:	± 4.5 %
	(1031 - 1050) nm:	± 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 µs - 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	± 0.2 nm	
Dominant wavelength	± 0.5 nm	*2
	± 0.0015 (Standard illuminant A) ± 0.0020 (common LED)	
Repeatability Δx and Δy	± 0.0001	
ΔCCT	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/(m <sup>2</sup> nm)	*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
<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 transcient offset correction	
Measurement range	Max measureable illuminance value 3E8lx *7 Noise equivalent illuminance value 1E-1lx	

Calibration	Illuminance +/- 2,2 %
f1' (spectral mismatch)	<p>≤ 6 % (uncorrected)</p> <p>≤ 3 % (f1' a*(s<sub>z</sub>(λ)) respectively F*(s<sub>z</sub>(λ)) corrected by spectral data, done automatically by BTS technology)</p>
<b>Graphs</b>	
spectral responsivity	[image src="/var/www/html/web/assets/responsivity-BTS2048-VL-TEC2.png" id="6367" width="600" height="404" class="leftAlone ss-htmleditorfield-file image" title="responsivity BTS2048 VL TEC2"]
f2 (directional response/cosine error)	[image src="/var/www/html/web/assets/cos-BTS2048-VL2.png" id="6366" width="600" height="849" class="leftAlone ss-htmleditorfield-file image" title="cos BTS2048 VL2"]
<b>Miscellaneous</b>	
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	<p>User software S-BTS2048</p> <p>Optional software development kit S-SDK-BTS2048 for user software set-ups based on .dll's in C, C++, C# or in LabView.</p>
Power Supply	<p>With power supply: DC Input 5V (±10 %) at 700 mA</p> <p>With USB bus (500mA)<sup>*8</sup></p>
Dimensions	<p>diameter: 160 mm</p> <p>height: 222 mm</p> <p>(see drawing)</p>
Weight	2.85 kg
Mounting	<p>Tripod and M6 screw threads</p> <p>Front adapter UMPA-1.0-HL for use with integrating sphere port-frame UMPF-1.0-HL</p>
temperature range	<p>Storage: (-10 to 50) °C</p> <p>Operation: (-25 to 50) °C      <sup>*9</sup></p>
Info	<p><sup>*1</sup> It is recommended to perform a new dark signal measurement for every change in the integration time</p> <p><sup>*2</sup> typical value, the uncertainty of the dominant wavelength depends on the spectral distribution of the LED</p> <p><sup>*3</sup> typical value, measured 100nm left of the peak of a cold white broadband LED</p> <p><sup>*4</sup> <sup>*5</sup> 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</p> <p>i.e. quadratic fall of the base noise e.g. averaging to a factor 100 improves the S/N by a factor 10</p> <p><sup>*6</sup> Minimum 500/1 S/N. Maximum at full scale control.</p> <p><sup>*7</sup> Irradiation only allowed for a short time so as to avoid thermal damage</p> <p><sup>*8</sup> during USB connection, not all functions are available due to the limited current supply e.g. no Ethernet and TEC cooling</p> <p><sup>*9</sup> 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</p> <p><sup>*10</sup> measurement of a white LED and 20000 counts (signal-dark) saturation</p>
Stability	<p>inside WP housing (electronics): ≤ ± 1 °C</p> <p>CCD Chip: ≤ ± 0.25 °C</p>
Housing	<p>Spectroradiometer unit: IP67</p> <p>Outdoor housing itself: IPx5</p>

## Downloads

Type	Description	File-Type	Download
BTS2048-Series	BTS2048 'Not just another spectrometer' brochure	pdf	<a href="https://www.gigahertz-optik.com/assets/Uploads/BTS2048-broschuere-DINA4-hoch-V1-final-web12.pdf">https://www.gigahertz-optik.com/assets/Uploads/BTS2048-broschuere-DINA4-hoch-V1-final-web12.pdf</a>

## Configurable with

Product Name	Product Image	Description	Show product
BTS2048-UV-S-WP		Bi-technology sensor light meter for high quality solar UV measurements. Features: Weatherproofed, high stray light reduction (comparable double monochromator), high spectral resolution, short measurement time, entrance optic with diffusor for irradiance and spectral irradiance, etc.	<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>
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. Features: Tubular level, compact size, weather proof, included software	<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		Sun tracker for the use with e.g. BTS2048-xx-WP series meter in direct solar irradiance measurement. Features: Tubular level, compact size, weather proof, included software	<a href="https://www.gigahertz-optik.com/en-us/product/bts-solar">https://www.gigahertz-optik.com/en-us/product/bts-solar</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	Option: DIN EN ISO/IEC 17025:2018 Test Certificate (DAkkS).  Spectral irradiance measurement and illuminance measurement in wavelength range 280 nm to 1050 nm.

Article-Nr	Modell	Description
<b>Re-calibration</b>		
15300499	K-BTS2048-VL-I	Recalibration of the BTS2048-VL with calibration certificate
<b>Software</b>		
15298470	S-SDK-BTS2048	Software development kit with users guide.
<b>Accessories</b>		
15310402	BHO-27	Carry case for BTS2048-XX-WP and accessories.
15307929	BTS2048-XX-WP-Z02	tube for the measurement of the direct solar irradiance
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.