# BTS2048-UV-S-WP

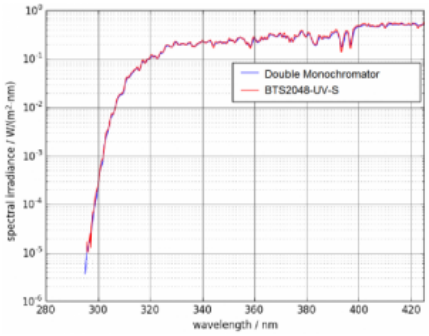
https://www.gigahertz-optik.com/en-us/product/bts2048-uv-s-wp/

**Product tags: UV**

# Description

## BTS2048-UV-S-WP BiTec sensor spectroradiometer for high-quality outdoor UV measurements

The BTS2048-UV-S-WP is a high-quality spectroradiometer whose compact design and elaborate optical, electronic and mechanical interfaces make it ideal for high precision outdoor UV measurements. Due to its innovative filter and spectrometer design it is able to measure solar radiation with a very good straylight reduction performance. Accordingly, even the edge of the sun below 300 nm can be resolved for some orders of magnitude (see figure 2). With the included S-BTS2048 application software, precise measurements and data analysis (Erythema, ICNRIP, etc.) can be performed intuitively. In addition, the spectral range can be extended from the UV to the NIR with the complementary BTS2048-VL-TEC-WP. Applications in the whole Si spectral region (e.g. solar-cells) are possible.




*Comparison of a solar measurement of the BTS2048-UV-S and a standard double monochromator. The BTS2048-UV-S achieves about the same quality in a measurement time of a few s compared to about 1.5 min of the double monochromator.*

**BiTec sensor for high-end light measurement**

One of the outstanding features of this exceptional spectroradiometer is its BiTec sensor (see **technical article about BiTec sensor**). It 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.

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

The spectrometer unit is based on a CCD with usable 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, the CCD 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 and thereby increase the signal to noise ratio.

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

## Precise spectral radiometry (low straylight)

To facilitate optimal use of the CCD sensor's dynamic range and to overcome the problems of most array spectoradiometers in the UV range, a remote-controlled filter wheel (open, closed, optical filters) is located in the optical beam path. This filters combined with smart measurement and stray light correction routines enables high quality measurements of the BTS2048-UV-S. Results are comparable with double monochromator results (see figure). However, the measurement duration is significantly lower.

The BTS2048-UV-S-WP is equipped with a particular set of filters optimized for solar irradiance measurements. Those allow a superior stray light suppression compared to other spectroradiometers that puts the device's performance on the same level as double monochomators. The results of a direct intercomparison study are presented here.

However, the BTS2048-UV-S-WP cannot only be used for solar irradiance measurements but for the measurement of other UV sources as well. Usually, no WP (weather proof version) is required for that particular purpose (see the models BTS2048-UV and BTS2048-UV-S). In some applications e.g. when measuring extraterrestrial solar simulators, a good

Side View of the BTS2048-UV-S-WP

stray light suppression is key to precise measuring results. Gigahertz-Optik's stray light calibration technique can be used in combination with further smart measurement routines to enable the superior stray light suppression. See also our technical article about stray light reduction for spectroradiometers. The calibration of a BTS2048-UV-S-WP's additional stray light correction matrix is available optionally on request.

The WP version in a winter measurement campaign

## WP means weather proofed

The housing of the BTS2048-UV-S-WP is designed for outdoor measurements. The cooled back-thinned CCD and the spectrometer unit are temperature controlled in a second housing. In this housing, humidity is removed by an exchangeable cartridge. In order to avoid deposits of dust, rain or snow on the entrance optics 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-UV-S-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 big advantage for outdoor use. The device's compact size is also of significant benefit. The f2 error of the cosine corrected field of view to less than 3% makes it possible to use the BTS2048-UV-S-WP for direct measurement in absolute radiometric quantities:

- Irradiance (W/m²)
- Spectral irradiance (W/(m² nm))

## State of the art interface

The BTS2048-UV-S-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, data preparation occurs in the BTS2048-UV-S-WP to optimize the data-transfer speed. For this purpose, an independent, high-performance microprocessor is incorporated. Data and power interface are of course of weather-proof design as well.

## User software with flexible desktop structure

The BTS2048-UV-S-WP's scope of delivery includes 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 of graphical and numerical display windows from which the user can choose:

- 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.

## Traceable calibration

Calibration of the BTS2048-UV-S-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.

## International Measurement Campaign

Additional to the above mentioned scientific campaign the BTS2048-UV-S-WP has took part in an international intercomparision (ATMOZ) in Tenerifa, to prove the quality of the measurement data in the scientific framework in TOC measurements.

A scientific publication by INTA showed a very good agreement in a three comparison campaigns of global UV spectral irradiance measurements: **Comparison of global UV spectral irradiance measurements between a BTS CCD-array and a Brewer spectroradiometer.**

# Specifications

| | |
|---|---|
| **General** | |
| Short description | CCD based spectroradiometer with large dynamic for CW-, Datalogger- and Single measurements of spectral irradiance and derivative quantities (spectrum, erythema, ICNIRP, etc.) in the UV spectral region for outdoor use. |
| Main features | Compact measurement device. Bi-Tec detector with back-thinned CCD-diodearray spectrometer (0.7 nm optical bandwidth, electronic Shutter, high dynamic) and SiC-Fotodiode. High stray light reduction. Filter wheel with aperture and optical filters. Entrance optic with diffuser which is cosine FOV. Weatherproof housing for outdoor use. Ethernet and USB interface. |
| Measurement range | Spectral: 3E-5 W/(m²nm) to 3E4 W/(m²nm) @325 nm. Responsivity from 190 nm to 430 nm. |
| Typical applications | Diodearray spectrometer for scientific outdoor measurement tasks. Erythema, ICNIRP, solar-cells, etc. |
| Calibration | Factory calibrations traceable to PTB calibration standards. |
| **Product** | |
| Measured Quantity | Spectral irradiance (W/(m² nm)), irradiance (W/m²), peak wavelength, center wavelength, centroid wavelength, Erythema, ICNIRP. |
| Input optics | Diffusor, cosine corrected field of view (f2 ≤ 3 %) |
| Filter wheel | 8 positions (open, closed, optical filters). Use for remote dark current measurement and stray light reduction. |
| 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 $a^*(s_z(\lambda))$ respectively $F^*(s_z(\lambda))$. |

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| Calibration uncertainty | Spectral irradiance<br><br>λ u(*k*=2)<br>(200 - 239) nm ± 9 %<br>(240 - 339) nm ± 6.8 %<br>(340 - 359) nm ± 5 %<br>(360 - 399) nm ± 4.3 %<br>(400 - 430) nm ± 4 %<br>Spectral irradiance responsivity (200 - 430) nm |
| **Spectral Detector** | |
| Integration Time | 2 µs - 60 s *1 |
| Spectral range | (190 - 430) nm |
| Optical Bandwidth | 0.8 nm |
| Pixel resolution | ~0.13 nm/Pixel |
| Number of pixels | 2048 |
| Chip | Highly sensitive back-thinned CCD chip, one stage cooled (1TEC) |
| ADC | 16bit (25 ns instruction cycle time) |
| Peak wavelength | ± 0.05 nm |
| Band-pass correction | mathematical online band-pass correction is supported |
| Linearity | completely linearized chip >99.6% |
| Stray Light | Out of Bound method < 1E-4 *3<br><br>Bandpass method < 1E-5 *3 |
| Base line noise | 5 cts *4 |
| SNR | 5000 *5 |
| Dynamic range | >9 Magnitudes |
| Spectral irradiance responsivity range | (3E-5 - 3E4) W/(m²nm) @325nm *6*7 |
| Typical measurement time | W/m² of a Halogen lampe from (250 - 400) nm<br><br>1 4,4 s<br>10 440 ms<br>100 44 ms |
| Measurement modes | Standard measurement mode: 200 nm to 430 nm<br><br>Out of Range stray light corrected measurement mode (OoR SLC): 200 nm to 430 nm<br><br>Stray light corrected bandpass mode for solar measurements (solar BP SLC): 285 nm to 420 nm<br><br>Universal stray light corrected bandpass measurement mode (BP SLC): 245 nm to 420 nm |
| **Integral Detector** | |
| Measurement time | (0.1 - 6000) ms |
| Measurement range | seven (7) measurement ranges with transcendent offset correction |
| Calibration | Irradiance ± 6 % *10 |
| Measurement range | (5E-3 - 2E5) W/m² *11 |

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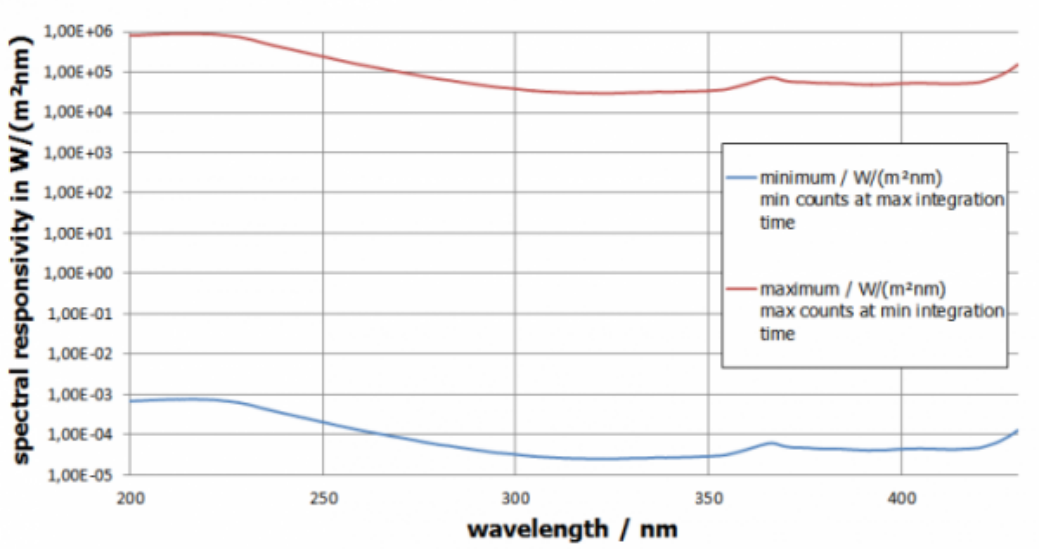
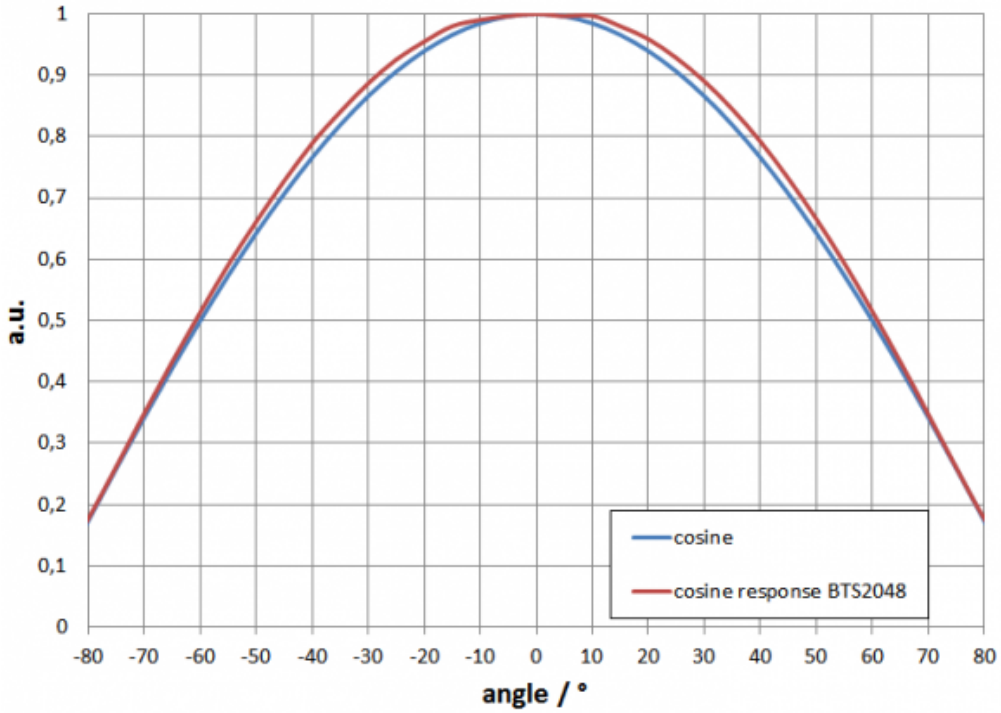
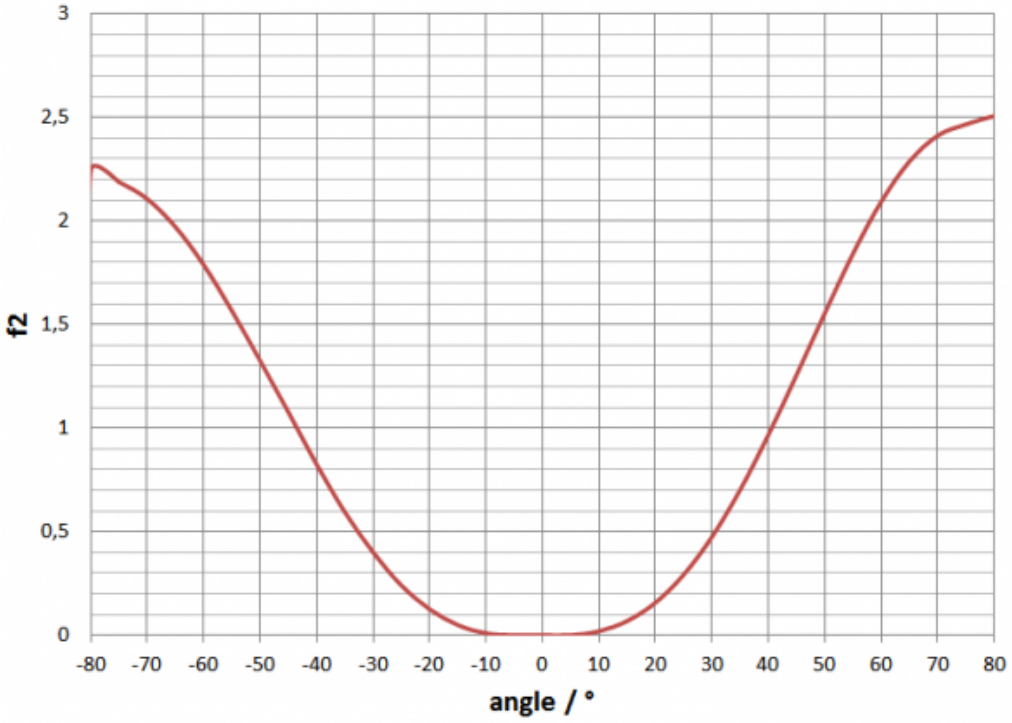
| ADC | 16bit |
| Filter | Optional: Mathematical adjustment of the responsivity to a rectangular function from 220 nm to 360 nm (SMCF on-line correction to the radiometric function with the measured spectral data).*<br><br>** The spectral responsitivity of the diode does not correspond to a rectangular function (not possible with optical filters). When measuring light sources with a spectrum that deviates from the calibration spectrum of the integral detector (UV LED, peak at 405 nm), the measurement result is corrected using SMCF. The uncertainty of this correction depends on the quality of the measured spectrum (noise) and the size of the correction factor (spectral range).* |
| **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<br>Optional software development kit S-SDK-BTS2048 for user software set-ups based on .dll's in C, C++,C# or in LabView. |

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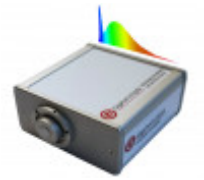
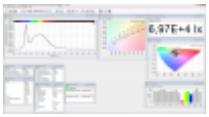
|---|---|
| Power Supply | With power supply: (90-295) V 150 W |
| Dimensions | Diameter: 160 mm<br>Height: 222 mm<br>(see detailed drawing) |
| Weight | 2.85 kg |
| Mounting | 3x M6 screw threads |
| Temperature range | Storage: (-10 to 50) °C<br>Operation: (-25 to 50) °C *9 |
| Housing | Spectroradiometer unit: IP67<br>Outdoor housing itself: IPx5 |
| Stability | inside WP housing (electronics): ≤ ± 1 °C<br>CCD Chip: ≤ ± 0.25 °C |
| Info | **1 It is recommended to perform a new dark signal measurement for every change in the integration time*<br>**2 typical value, the uncertainty of the dominant wavelength depends on the spectral distribution of the LED*<br>**3 typical value, measured 100nm left of the peak of a cold white broadband LED with and deep blue LED peak. The dynamic which can be resolved within one measurement depends on the number of averages and the light source. Typical for a solar measurement is a dynamic of 4.5 orders of magnitude resolution within one measurement.*<br>**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<br>i.e. quadratic fall of the base noise e.g. averaging to a factor 100 improves the S/N by a factor 10*<br>**6 Minimum 500/1 S/N. Maximum at full scale control.*<br>**7 Irradiation only allowed for a short time so as to avoid thermal damage*<br>**8 during USB connection, not all functions are available due to the limited current supply e.g. no Ethernet and TEC cooling*<br>**9 Device requires for temperature stabilization approx. 25min (power supply is needed for outdoor use). In measurement is performed in the warm-up phase, or if measurements are performed<br>under varying temperatures, dark signal measurement is required for each measurement.*<br>**10 With a(Z) correction by a Deuterium lamp*<br>**11 By a spectral power distribution of a deuterium lamp, maximum radiation only allowed for a short time so as to avoid thermal damage* |

# Downloads

| Type | Description | File-Type | Download |
|---|---|---|---|
| BTS2048-UV-S-WP Technical datasheet | BTS2048-UV-S-WP Brochure | pdf | https://www.gigahertz-optik.com/assets/Uploads/Technical-Datasheet-BTS2048-UV-S-WP-210x297-EN-RZ-web.pdf |
| BTS2048-Series | BTS2048 'Not just another spectrometer' brochure | pdf | https://www.gigahertz-optik.com/assets/BTS2048_broschuere_DIN A4_hoch_V2_2022.pdf |

| Type | Description | File-Type | Download |
|---|---|---|---|

## Configurable with

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

## Purchasing information

| Article-Nr | Modell | Description |
|---|---|---|
| **Product** | | |
| 15298728 | BTS2048-UV-S-WP | Measuring device, users guide, software CD, calibration certificate. |
| **Calibration** | | |

| Article-Nr | Modell | Description |
|---|---|---|
| 15300809 | K-BTS2048UVS-E-S-V01 | Extended calibration of a BTS2048-UV-S from 200 nm to 430 nm. Calibration certificate. |
| **Re-calibration** | | |
| 15314246 | K-BTS2048UVS-E-S-V02 | Re-calibration of a BTS2048-UV-S from 280 nm to 430 nm. Calibration certificate. |
| **Software** | | |
| 15298470 | S-SDK-BTS2048 | Software development kit, software CD with users guide. |
| **Accessories** | | |
| 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. |
| 15310402 | BHO-27 | Carry case for BTS2048-XX-WP and accessories. |
| 15306934 | BTS2048-XX-WP-Z01 | Desiccant cartridge for BTS2048-XX-WP housing. |
| 15307929 | BTS2048-XX-WP-Z02 | Front tube for direct solar 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. |
| 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. |
| 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. |

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- Repairs & Updates
- OEM & Feasibility Consulting of Customized Solutions

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