BTS2048-VL

https://www.gigahertz-optik.com/en-us/product/bts2048-vl/

Product tags: VIS , NIR ,

Description

Requirements of a modern, versatile array spectroradiometer

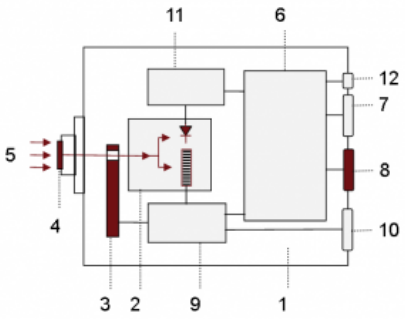
There are many factors to be considered when assessing the suitability of array spectrometer systems for the absolute measurement of optical radiation parameters. For instance, the measurement of lamps that have different power ratings is only possible using array detectors that have a wide dynamic range. Precise, absolute measurements require the entire dynamic range of the spectroradiometer to be completely linearized and also require an accurate, traceable calibration. If the electronically controlled dynamic range (set by the integration time) is not sufficient, additional attenuating filters are needed. The filter selector must be mechanically robust to ensure long-term stability of the measurement system. For time-critical applications such as LED binning in pulsed mode, the electronically controlled dynamic range must be large enough to avoid the need for a time-consuming filter change during the measurement. For absolute measurements, an automated dark signal adjustment of the CCD is most beneficial. Spectroradiometers that are used for binning of front-end and back-end LEDs must accommodate precise synchronization of the measurement with the test LEDs operated in pulsed mode requiring suitable trigger interface and fast data readout. Flash measurements, i.e. measurements within a light pulse, require an electronic shutter for instantaneous (ns) zero setting of all pixels before a measurement is triggered. The measurement of the luminous flux, luminous intensity, and luminous intensity distribution requires additional accessory components e.g., integrating spheres, luminous intensity lenses, and goniometers. Reproducible interfacing to these entrance optic accessories is essential. Direct mounting of the spectroradiometer onto the accessory equipment helps avoid influences of flexible light guide connections. Among the requirements of color measurements are precise calculations in accordance with CIE 13.3, CIE 15, and TM-30-20 (in older versions TM-30-18 and TM-30-15), CIE224. For applications in the LED and semiconductor industries, the systems must also conform to the CIE S025 and LM-79-08 standards.

High-end array spectroradiometerwith wide dynamic range,

BTS2048-VL, diode array spectroradiometer with BiTec detector

The BTS2048-VL meets all the requirements of a high-end array spectroradiometer as well as being favourably priced despite its cutting-edge design.

*One of its unique features is the from Gigahertz-Optik developed innovative **BiTec sensor** that consists of a V(lambda) filtered Si photodiode and a spectroradiometer unit. This makes it extremely linear, stable, and fastand is therefore a guarantee for higher measurement accuracy which is not accompanied by any disadvantages. Both sensors can be used independently and the mutual correction of the sensors is advantageous for accuracy, speed and versatility (see article on BTS technology).



1) BTS2048-VL 2) BiTec sensor with Si photodiode, CCD array spectrometer 3) Filter wheel with OD1, OD2 and shutter 4) Precise cosine diffuser 5) Light incident 6) Microprocessor for data procesing and communication 7) USB 2.0 Interface 8) High Speed ethernet Interface 9) Microprocessor CCD sensor control 10) Trigger In/Out 11) Microprocessor photodiode 12) DC voltage supply

From a formal point of view with the CIE 231:2019 and DIN 5032-7:2024 photometers with built-in spectral mismatch correction by spectral measurements are treated the same way as classic photometers. Resulting parameters such as f_1' can be determined in accordance with DIN EN 13032-1, provided that the spectral and integral measurements are performed with the same input optics, which is always the case with our BTS devices. The BTS were already ahead of their time, and standardization has now caught up.

The fully linearized 2048 pixel CCD detector with an electronic shutter allows for integration times ranging between 2 µs and 4 s and offers an extremely broad dynamic range without the need for additional attenuating filters. This is three orders of magnitude more than the common millisecond integration times provided by lesser instruments. An even wider dynamic range is provided by the TEC-cooled spectroradiometer (BTS2048-VL-TEC).This variant has integration times ranging from 2 µs to 60 s. The 2 nm optical bandwidth ensures accurate spectral measurement values in the range between 280 nm and 1050 nm (0.4 nm/pixel).Mathematical bandwidth correction in accordance with CIE 214 has also been implemented for auto- correction of the measurement values. Si photodiodes exhibit exceptionally high linearity across their dynamic range. This makes them ideal for linearization of the CCD within the BiTec detector (see article on BTS technology). The constantly measuring diode can also be used to synchronize the measurement of PWM signals. This enables automatic recording of absolute spectral data using the BTS2048-VL, which is very difficult for conventional spectroradiometers without a BiTec sensor due to the integration time. In addition, the Si photodiode, which is fitted with a photometric filter (CIE V-lambda), can be used independent of the CCD. The device can therefore be used to perform fast measurements on very weak signals, something that makes the BTS2048-VL ideal for integration in goniometers and other systems. Another advantage of the BiTec technology in this context is the ability to integrate online correction of the spectral mismatch (f1') of the diode using spectral data. Despite its compact dimensions of 103 mm x 107 mm x 52 mm (l x

Direct mounting of the measurement device and accessory components

w x h), the BTS2048-VL spectroradiometer has a remote-controlled filter wheel with an OD1 and OD2 attenuation filter as well as a shutter for dark measurement.

Applications in front-end and back-end LED binning

The BTS2048-VL is perfectly suited for industrial front-end and back-end LED binning applications. Its back-thinned CCD based spectrometer, incorporates an electronic zero setting feature of all pixels before a measurement is triggered. The electronic shutter and triggering of the measurement can be synchronized with the power supply via a trigger port when the test LED is operated in pulsed current mode. The powerful microprocessor only requires 7 ms to transfer a complete dataset to the system computer via the fast LAN interface.

Direct mounting instead of using a light guide

The BTS2048-VL spectroradiometer has a diffusor window and can therefore be used to measure the irradiance/illuminance, incl. spectrum, color, and color rendering index, without any accessory equipment. With the diffusor window, the BTS2048-VL can also be mounted directly onto accessories such as integrating spheres, luminance lenses (according to CIE 127), and goniometers in order to measure the luminous flux, luminous intensity, and luminous intensity distribution. Gigahertz-Optik also offers the BTS2048-VL-F for applications with light guides.

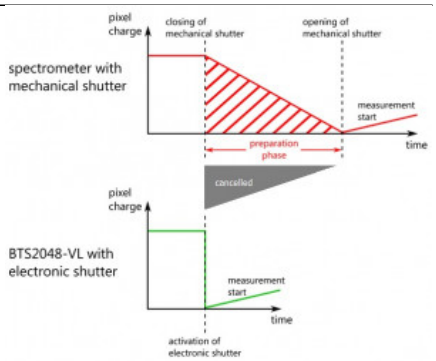
User software and developer software

The standard S-BTS2048 user software has a customizable user interface and is extremely easy to use. It has a large number of display and function modules which can be activated when configuring the BTS2048-VL with the respective accessories from Gigahertz-Optik GmbH.

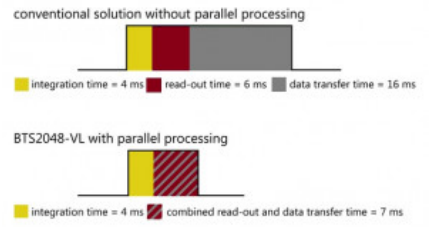
The S-SDK-BTS2048 developer software is recommended for integration of the BTS2048-VL in the customer's own software.

Calibration

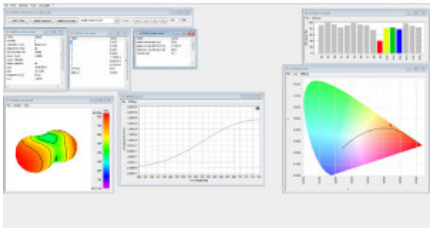
One essential quality feature of photometric devices is their precise and traceable calibration. The BTS2048-VL is calibrated by Gigahertz-Optik's calibration laboratory that was accredited by DAkkS (D-K-15047-01-00) for the *spectral responsivity* and *spectral irradiance* according to ISO/IEC 17025. The calibration also included the corresponding accessory components. Every device is delivered with its respective calibration certificate.



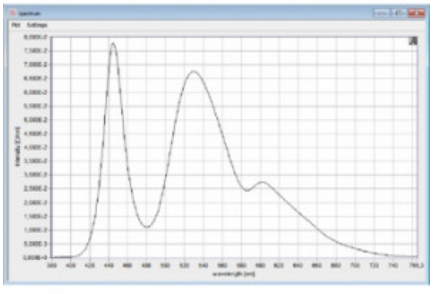
Electronic Shutter reduces the measurement time



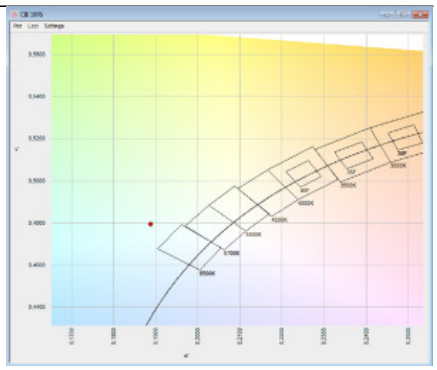
Ethernet interface reduces the datatransfer time



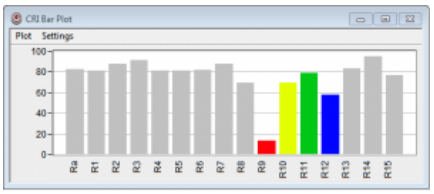
S-BTS2048 User software interface



Graphical view of the spectrum



CIE 1976 Chromaticity diagram



CRI Bar Plot

Specifications

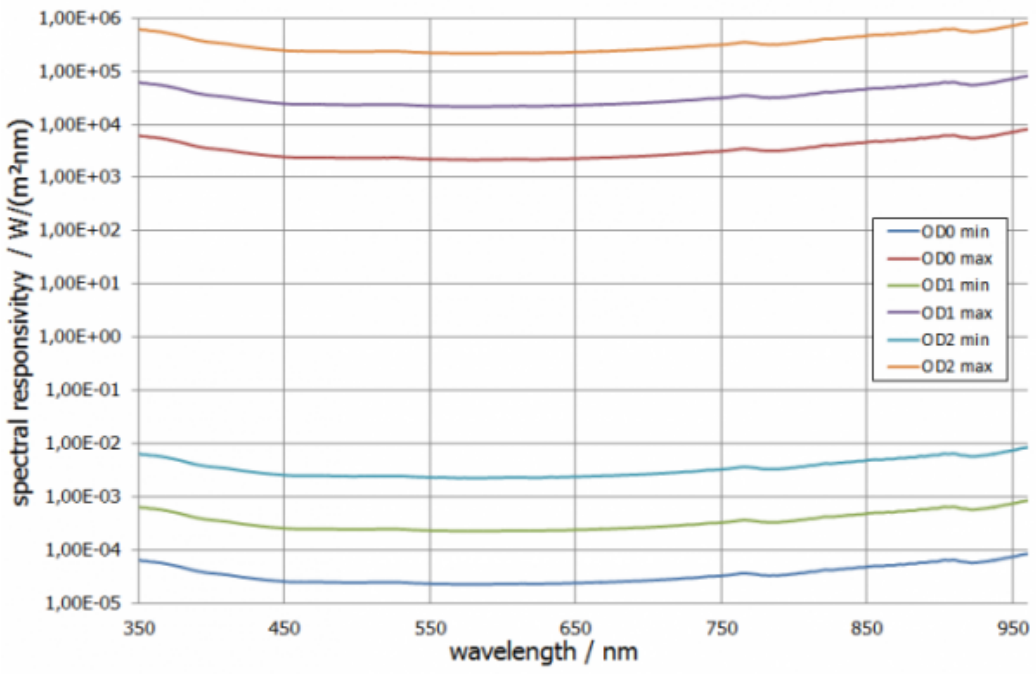
General	
Short description	High speed spectroradiometer with a wide dynamic range for CW and pulsed measurements of irradiance/illuminance, spectrum, luminous color, and color rendering index. Accessories for measurement of other parameters
Main features	Compact device. BiTec detector with back-thinned CCD (2048 pixels, 2 nm optical bandwidth, 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. Automatic PWM synchronization
Measurement range	Spectral: 300 nm to 1050 nm, 1 lx to 3E8 lx (min. level by white LED with low saturation) Integral: photometric 360 nm to 830 nm, 0.1 lx Noise signal up to 3E8 lx
Typical applications	CCD spectroradiometer for design applications. Module for integration in test systems for front-end and back-end LED binning.
Calibration	Factory calibration. Traceable to international calibration standards
Product	
Measured Quantity	Spectral irradiance (W/(m² nm)), irradiance (W/m²), illuminance (lx), spectral radiant intensity (W/(sr nm)), radiant Intensity (W/sr), luminous intensity (cd), dominant wavelength, peak wavelength, center wavelength, centroid wavelength, x, y, u´, v´, X,Y,Z, delta uv, color temperature, color rendering index (CRI) Ra, R1-R15, TM-30-20, CIE224, CQS, CIE170, etc.. Option integrating sphere: in addition spectral flux (W/nm) and luminous flux (lm) Option goniometer: in addition radiant intensity (W/sr) distribution and luminous intensity (cd) distribution
Sensor	class B DIN 5032 part 7 or AA according to JIS C 1609-1:2006 class A DIN 5032 part 7 for f_4, or general precision class according to JIS C 1609-1:2006 class L DIN 5032 part 7 for f_1' and UV response, IR response, f_3, f_6 and f_7
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*($s_z(\lambda)$) respectively F*($s_z(\lambda)$).
Spectral Detector	
Calibration uncertainty	Spectral irradiance λ u(*k*=2) (300 - 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 recommended calibration (300 - 1050) nm. Full range possible for BTS2048-VL-TEC.
Spectral range	(280 -1050) nm, see limitation for calibration
Optical Bandwidth	2 nm
Pixel resolution	~0.4 nm/Pixel
Number of pixels	2048
Chip	Highly sensitive back-thinned CCD chip
ADC	16bit (25 ns instruction cycle time)
Peak wavelength	±0.2 nm
Dominant wavelength	±0.5 nm *2
Δy Δx uncertainty	±0.0015 (Standard illuminant A, white LED) ±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	>9 Magnitudes
Spectral irradiance responsivity range	(2E-5 - 2E5) W/(m²nm) *6*7
CRI (color rendering index)	Ra and R1 to R15
Typical measurement time	10lx 2,5s *10 100lx 250ms *10 1000lx 25ms *10
Integration Time	2 µs - 4 s *1
Integral Detector	
Filter	Spectral responsivity with fine CIE photometric matching. Online correction of the photometric matching through spectral measurement data (spectral missmatch factor correction).

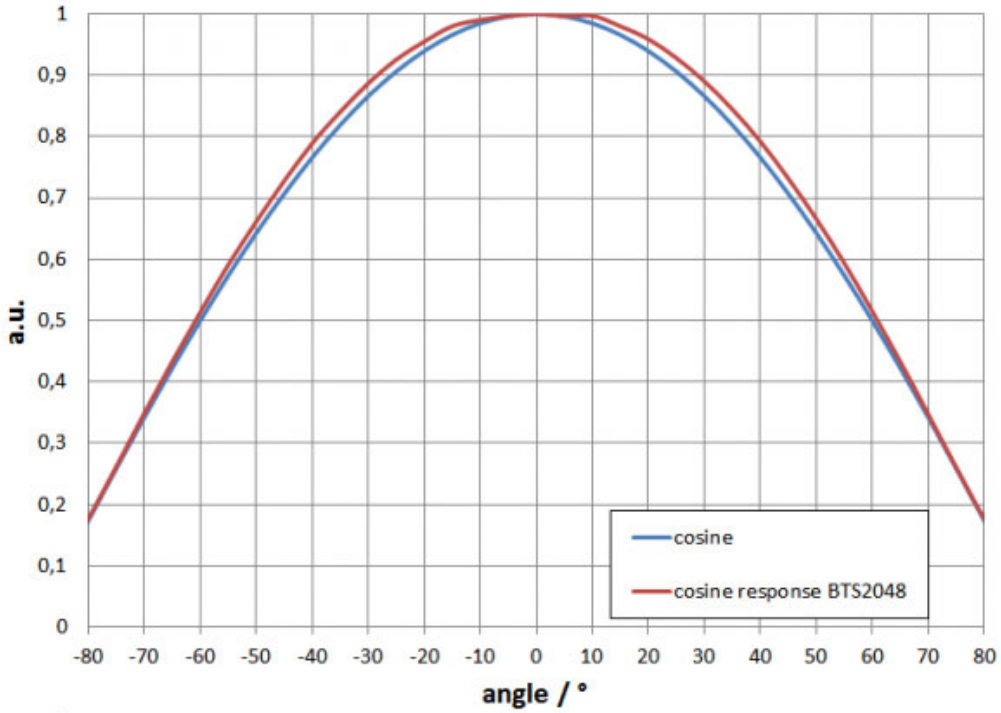
Measurement time	20 µs - 6000 ms range rise time (10 – 90) % 0,1,2 50 µs 3,4,5 65 µs 6,7,8 1.5 ms
Measurement range	nine (9) measurement ranges with transcendent offset correction
Measurement range	min. measurable illuminance value (diode): 0.1 lx *11 max. measurable illuminance value(diode): 3E8 lx *12
Calibration	Illuminance ± 2,2 %
f1' (spectral mismatch)	≤6% (uncorrected) ≤1,5% (f1' a*($s_z(\lambda)$) respectively F*($s_z(\lambda)$) corrected by spectral data, done automatically by BTS technology)
ADC	16bit

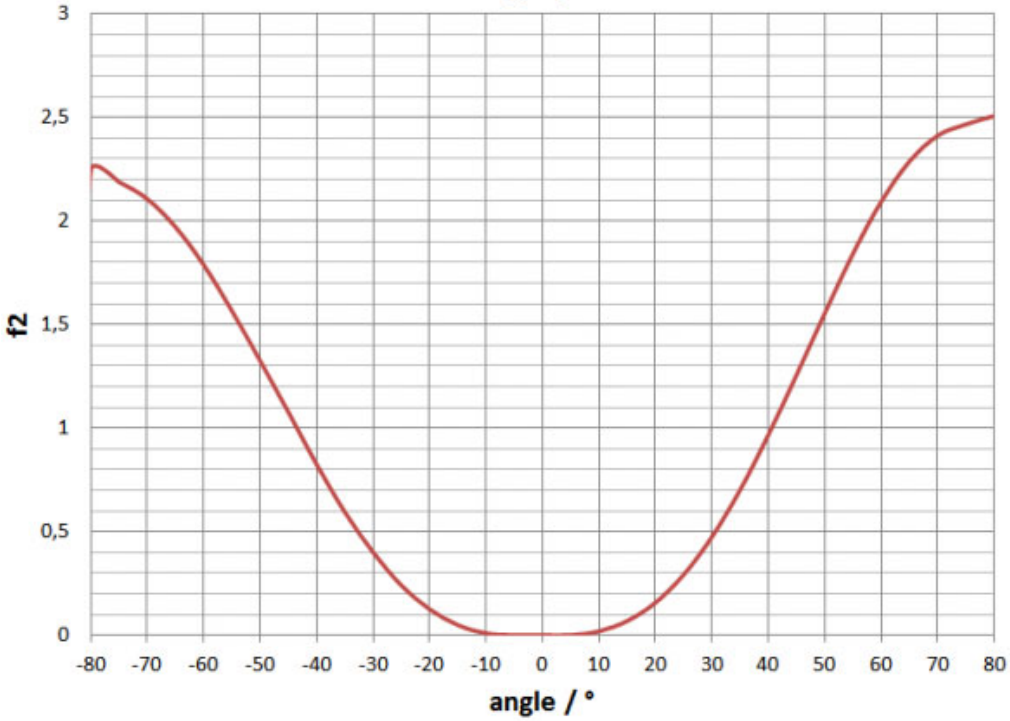
Graphs

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 (±10 %) at 700 mA With USB bus (500mA) *8
Dimensions	103 mm x 107 mm x 52 mm (Length x Width x Height)
Weight	500g
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: (10 to 30) °C *9
Info	**1 It is recommended to perform a new dark signal measurement for every change in the integration time* **2 typical value, the uncertainty of the dominant wavelength depends on the spectral distribution of the LED* **3 typical value, measured 100nm left of the peak of a cold white broadband LED* **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.e. quadratic fall of the base noise e.g. averaging to a factor 100 improves the S/N by a factor 10* **6 Minimum 500/1 S/N. Maximum at full scale control.* **7 Irradiation only allowed for a short time so as to avoid thermal damage* **8 during USB connection, not all functions are available due to the limited current supply e.g. no Ethernet* **9 Device requires for temperature stabilization approx. 25min. If a measurement is performed in the warm-up phase, or if measurements are performed under varying temperatures, dark signal measurement is required for each measurement. At high temperatures and at the maximum integration time a decreased dynamic can be used.* **10 measurement of a white LED and 20000 counts (signal-dark) saturation<* **11 Standard deviation of the noise in the most sensitive measuring range at 2s measuring time typical 1E-2 lx* **12 With OD2 filter, illumination only for very short time allowed due to thermal damage* **The typical uncertainty considerations in the data sheet refer to the calibration conditions (temperature, humidity, warm-up, modulation, etc.) and, as this is not possible, do not include user effects such as aging, contamination, etc.*

Option: 150mm Integrating Sphere (UMBB-150)

Spectral radiant flux responsivity range (spectral measurement)	(5E-8 - 5E2) W/nm
Luminous flux measurement range (integral measurement)	(3E-5 - 1E5) lm
Sphere diameter	150 mm
Typical measurement time	measurement with 20000 cts: 1 lm 80 ms 10 lm 8 ms 100 lm 800 µs optimized measurement time with 5000 cts and noise reduction: 10 lm 2 ms
Calibration	Luminous flux: ± 4 % Spectral radiant power: (350 - 399) nm: OD0: ± 8 % OD1: ± 10 % OD2: ± 10 % (400 - 800) nm: OD0: ± 4,5 % OD1: ± 4,5 % OD2: ± 4,5 % (801 - 1000) nm: OD0: ± 6,5 % OD1: ± 6,5 % OD2: ± 6,5 % (1001 - 1050) nm: OD0: ± 8 % OD1: ± 10 % OD2: ± 10 % Spectral radiant power responsivity (350 - 1050) nm

Option: 210mm Integrating Sphere (UMBB-210)

Spectral radiant flux responsivity range (spectral measurement)	(1E-7 - 1E3) W/nm
Luminous flux measurement range (integral measurement)	(7E-5 - 2E5) lm
Sphere diameter	210 mm
Typical measurement time	measurement with 20000 cts: 1 lm 160 ms 10 lm 16 ms 100 lm 1600 µs optimized measurement time with 5000 cts and noise reduction: 10 lm 4 ms
Calibration	Luminous flux: ± 4 % Spectral radiant power: (350 - 399) nm: OD0: ± 8 % OD1: ± 10 % OD2: ± 10 % (400 - 800) nm: OD0: ± 4,5 % OD1: ± 4,5 % OD2: ± 4,5 % (801 - 1000) nm: OD0: ± 6,5 % OD1: ± 6,5 % OD2: ± 6,5 % (1001 - 1050) nm: OD0: ± 8 % OD1: ± 10 % OD2: ± 10 % Spectral radiant power responsivity (350 - 1050) nm

Option: 1000mm Integrating Sphere (UMTB-1000-HFT)

Spectral radiant flux responsivity range (spectral measurement)	(2E-6 - 2E4) W/nm
Luminous flux measurement range (integral measurement)	(1E-3 - 4E6) lm
Sphere diameter	1000 mm
Typical measurement time	measurement with 20000 cts: 10 lm 450 ms 100 lm 45 ms 1000 lm 4,5 s optimized measurement time with 5000 cts and noise reduction: 10 lm 112 ms
Calibration	Luminous flux: ± 4 % Spectral radiant power: (350 - 399) nm: OD0: ± 8 % OD1: ± 11 % OD2: ± 11 % (400 - 800) nm: OD0: ± 4,5 % OD1: ± 5 % OD2: ± 5 % (801 - 1000) nm: OD0: ± 6,5 % OD1: ± 7 % OD2: ± 7 % (1001 - 1050) nm: OD0: ± 8 % OD1: ± 11 % OD2: ± 11 % Spectral radiant power responsivity (350 - 1050) nm

Option: Goniometer (GB-GD-360-RB40)

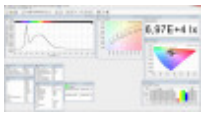
Spectral radiant intensity responsivity range	(1E-5 - 1E5) W/(sr nm) ; by 1m measurement distance
Luminous intensity measurement range (integral measurement)	(1E-1 - 3E8) cd ; by 1m measurement distance

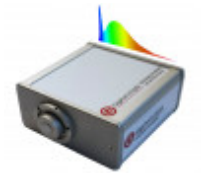
Calibration	Luminous intensity: ± 4 % Spectral Radiant intensity: (350 - 399) nm: OD0: ± 7 % OD1: ± 8 % OD2: ± 9 % (400 - 800) nm: OD0: ± 4 % OD1: ± 4 % OD2: ± 4 % (801 - 1000) nm: OD0: ± 6 % OD1: ± 6 % OD2: ± 6 % (1001 - 1050) nm: OD0: ± 7 % OD1: ± 8 % OD2: ±9 % Spectral radiant intensity responsivity (350 - 1050) nm
Option: ILED-B (CP-ILED-B-IS-1.0-HL)	
Spectral radiant intensity (ILED-B) responsivity range (spectral measurement)	(5E-7 - 5E3) W/nm
Measurment range ILED-B (integral measurement)	(3E-4 - 1E6) cd
Calibration	Luminous intensity ILED-B: ± 4 % Spectral Radiant intensity ILED-B: (350 - 399) nm: OD0: ± 7 % OD1: ± 8 % OD2: ± 9 % (400 - 800) nm: OD0: ± 4 % OD1: ± 4 % OD2: ± 4 % (801 - 1000) nm: OD0: ± 6 % OD1: ± 6 % OD2: ± 6 % (1001 - 1050) nm: OD0: ± 7 % OD1: ± 8 % OD2: ± 9 % Spectral radiant intensity responsivity (350 - 1050) nm

Downloads

Type	Description	File-Type	Download
Drawing	Dimensions BTS2048-VL	pdf	https://www.gigahertz-optik.com/assets/Uploads/102827-BTS-2048-VL.pdf
BTS2048-VL Technical datasheet	BTS2048-VL Brochure	pdf	https://www.gigahertz-optik.com/assets/Uploads/Technical-Datasheet-BTS2048-VL-210x297-EN-sheets.pdf
Brochure	Light measurement solutions for general and specialized lighting	pdf	https://www.gigahertz-optik.com/assets/Uploads-v2/generallighting-broschuere-DINA4-hoch-v2.pdf
BTS2048 Brochure	Not Just Another Spectrometer	pdf	https://www.gigahertz-optik.com/assets/BTS2048_broschuere_DINA4_hoch_V2_2022.pdf

Configurable with

Product Name	Product Image	Description	Go to product
S-BTS2048		Application software for BTS2048 variants.	https://www.gigahertz-optik.com/en-us/product/s-bts2048/

Product Name	Product Image	Description	Go to product
S-SDK-BTS2048		Software Development Kit for BTS2048 variants.	https://www.gigahertz-optik.com/en-us/product/s-sdk-bts2048/
GB-GD-360-RB40		Goniometer for the measurement of 2π sources	https://www.gigahertz-optik.com/en-us/product/gb-gd-360-rb40/
UMTB-1000-HFT		Sphere for the luminous flux measurement of 2π and 4π light fixtures inside a sphere. Features: Turnable Integrating sphere with a 1000 mm diameter, extra measurement ports for 2π luminaires with diameters of up to 254mm and auxiliary lamp.	https://www.gigahertz-optik.com/en-us/product/umtb-1000-hft/
UMTB-500-HF		Preconfigured hollow sphere of the UM series modular construction integrating spheres	https://www.gigahertz-optik.com/en-us/product/umtb-500-hf/
UMTB-1000-HF		Preconfigured 1m Integrating Sphere Detector	https://www.gigahertz-optik.com/en-us/product/umtb-1000-hf/
UMDP		Detector ports for the hollow spheres of the UM series modular construction integrating spheres. Features: Mounts for attaching detectors, fiber optic connectors and fiber pipes.	https://www.gigahertz-optik.com/en-us/product/umdp/
CP-ILED-B-IS-1.0-HL		Measurement Adapter for ILED-B. Features: High uniformity, CIE 127, UMPA-1.0-HL mount.	https://www.gigahertz-optik.com/en-us/product/cp-iled-b-is-1.0-hl/
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/
LDM-C50		Spectral radiance optic for BTS2048 series with integrated camera. Focus-able achromatic objective, for the usage with BTS2048 series. Different apertures and measurement distances including calibration are possible.	https://www.gigahertz-optik.com/en-us/product/ldm-c50/

Purchasing information

Article-Nr	Modell	Description
Product		
15298281	BTS2048-VL	Measuring device, hard cover box, users guide, S-BTS2048 software, calibration certificate.
Calibration		
15314795	K-BTS2048-XX-SLMC	Determination and implementation of stray light correction matrix.
15312709	K-BTS2048VL-E-S-V02	Calibration of the BTS2048-VL from 300 nm to 1050 nm in ND0 setting with calibration certificate.
15312051	K-BTS2048VL-E-S-V03	Calibration of the BTS2048-VL from 300 nm to 1050 nm while applying the stray light correction matrix in ND0 setting with calibration certificate.
15314332	KP-BTS2048VLTEC-E-S-V01	Factory Calibration Certificate with DIN EN ISO/IEC 17025:2018 Test Certificate. Spectral range 350 nm - 1050 nm. Testing conducted in ND0 setting.
Re-calibration		
15300769	K-BTS2048VL-E-S-V01	Re-calibration of the BTS2048-VL from 350 nm to 1050 nm in ND0 setting with calibration certificate.
Software		
15298470	S-SDK-BTS2048	Software development kit with users guide.
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.
Accessories		
15312474	BTS2048-Z03	Triggering cable for BTS2048 series measuring devices.
15308779	CP-SRT-E	Tube for stray light reduction.
15316085	BTS2048-XX-Z08	Tube for stray light reduction. 11.5° field of view.
15309137	BTS2048-UV-S-Z01	Front tube with 80° field of view.
15309109	BTS2048-VL-Z09	Front tube with 11 mrad and 100 mrad field of view (i.e. ICNIRP, EN 62471, etc.). Material: Plastic.
15309268	BTS2048-VL-Z10	Front tube with 11 mrad and 100 mrad field of view (i.e. ICNIRP, EN 62471, etc.). Material: Aluminum.
15298714	BTS2048-VL-Z07	Adapter for mounting an SRT-M37-L accessory. Required for radiance measurements.
15298717	BTS2048-VL-Z08	Filter holder for attaching filters in front of COS diffuser of BTS2048 devices. Filter size: 18 mm x 18 mm.
15298718	BTS2048-VL-Z08S	UV transmissive protection screen for mounting in BTS2048-VL-Z08.

Contact, Calibration, Service & Support

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