BTS2048-VL

https://www.gigahertz-optik.de/en-us/product/BTS2048-VL

Product tags: VIS

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-30-15. For applications in the LED and semiconductor industries, the systems must also conform to the CIE S025 and LM-79-08 standards.

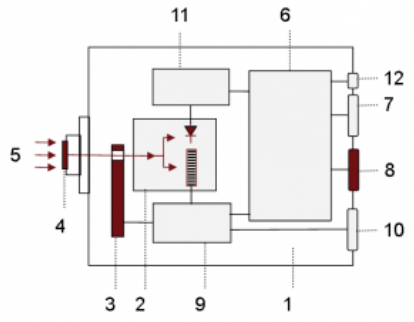
The BTS2048-VL spectroradiometer

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 innovative BiTec detector that consists of a V(lambda) filtered Si photodiode and a spectroradiometer unit based on a back-thinned CCD. This makes it extremely linear, stable, and fast. 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).

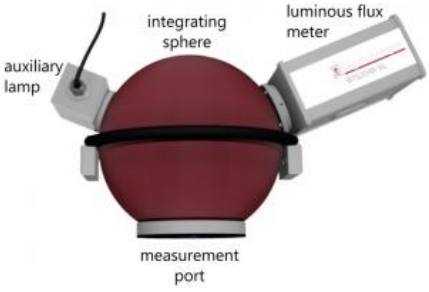
The fully linearized 2048 pixel CCD detector with an electronic shutter allows for integration times ranging between 2 µs and 4 s and offers an extremely broad dynamic range without the need for additional attenuating filters. This is three orders of magnitude more than the common millisecond integration 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 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.



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

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



Direct mounting of the measurement device and accessory components

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.

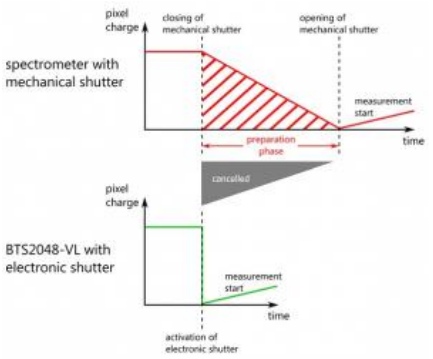
User software and developer software

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.

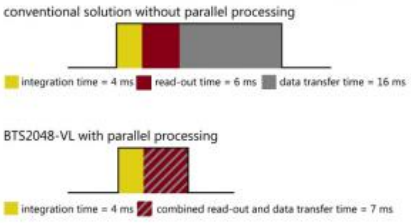
The S-SDK-BTS2048 developer software is recommended for integration of the BTS2048-VL in the customer's own software.

Calibration

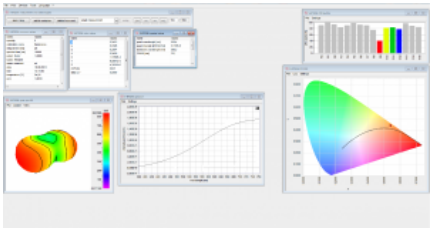
One essential quality feature of photometric devices is their precise and traceable calibration. The BTS2048-VL is calibrated by Gigahertz-Optik's calibration laboratory that was accredited by DAkkS (D-K-15047-01-00) for the *spectral responsivity* and *spectral irradiance* according to ISO/IEC 17025.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



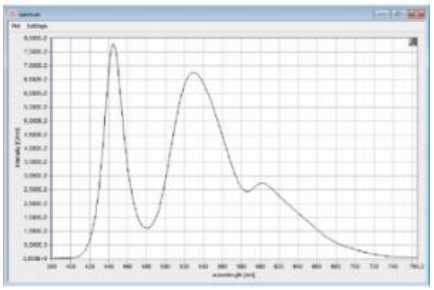
Electronic Shutter reduces the measurement time



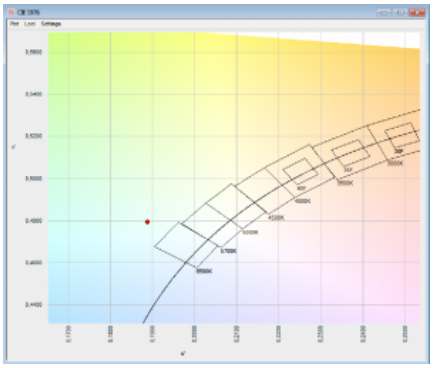
Ethernet interface reduces the datatransfer time



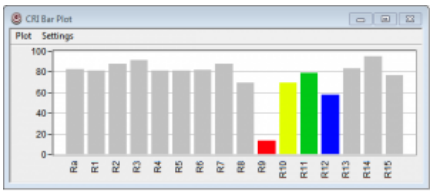
S-BTS2048 User software interface



Graphical view of the spectrum



CIE 1976 Chromaticity diagram

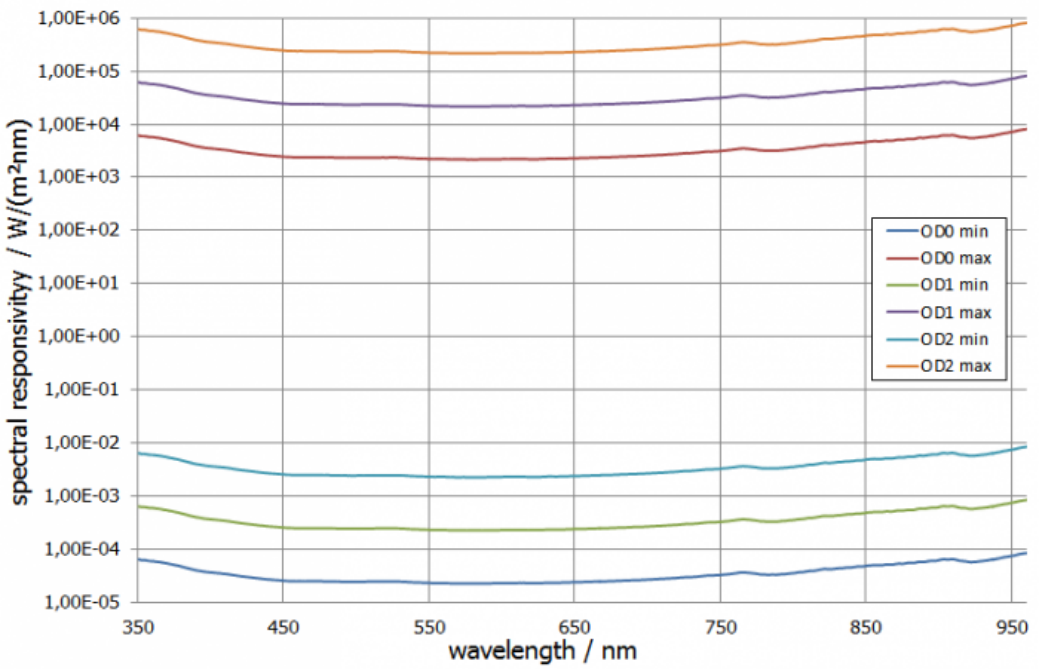


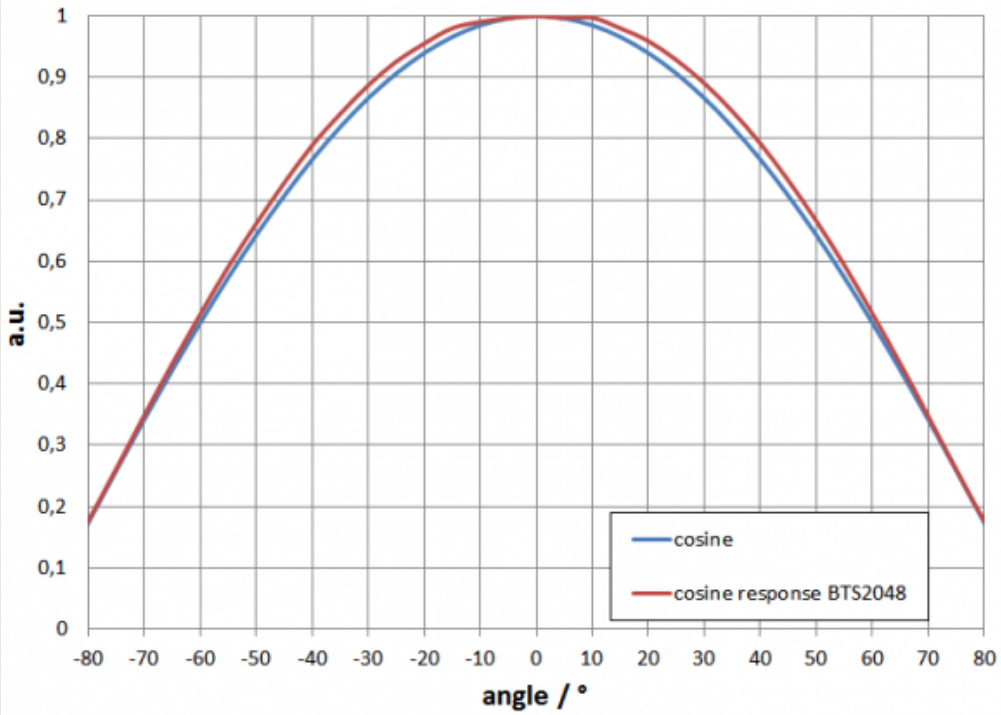
CRI Bar Plot

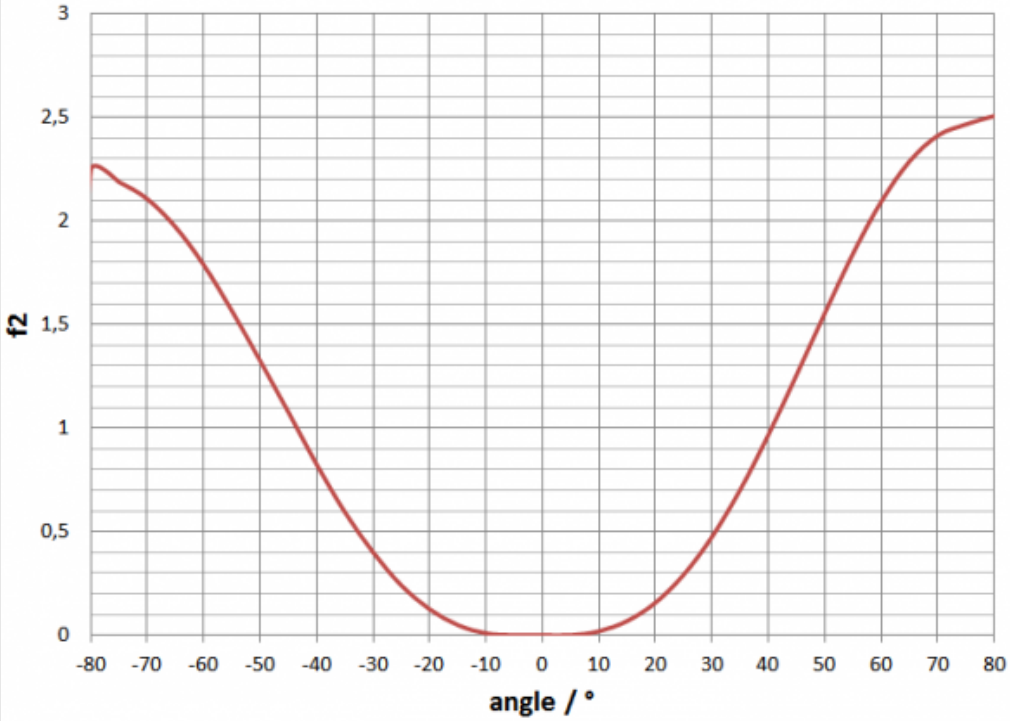
Specifications

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: 280 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-30-15, CQS, CIE-170, 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	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*($s_z(\lambda)$) respectively F*($s_z(\lambda)$).
Spectral Detector	
Calibration uncertainty	Spectral irradiance (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.
spectral range	(280 -1050) nm
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) ±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)
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*
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.de/assets/Uploads/102827-BTS-2048-VL.pdf
BTS2048-VL Technical datasheet	BTS2048-VL Brochure	pdf	https://www.gigahertz-optik.de/assets/Uploads/Technical-Datasheet-BTS2048-VL-210x297-EN-sheets.pdf
Brochure	Light measurement solutions for general and specialized lighting	pdf	https://www.gigahertz-optik.de/assets/Uploads/generallighting-broschuere-DINA4-hoch-v2.pdf
BTS2048 Brochure	Not Just Another Spectrometer	pdf	https://www.gigahertz-optik.de/assets/Uploads/BTS2048-broschuere-DINA4-hoch-V2-WEB.pdf

Configurable with

Produktname	Product Image	Description	Show product
ISD-100HFT-BTS2048-VL		System for the luminous flux and light color measurement of individual 2π and 4π light light sources. Features: Turnable Integrating sphere with 100cm diameter, auxiliary lamp and a hemispherical shell for opening and closing, compact spectral light meter with Bi-Tec sensor for acurate measurement of the luminous flux, spectral radiant power, CCT, CRI, chromaticity coordinates, etc.	https://www.gigahertz-optik.de/en-us/product/BTS2048-VL-ISD-100HFT-V03
GB-GD-360-RB40-2-BTS2048-VL		System for measurement of the luminous intensity distribution of 2π spot lamps and LEDs. Features: Goniometer bench with adjustable measurement distance of up to 2000 mm. Light meter for precise measurement of the luminous intensity distribution, spectral data, CCT, CRI, chromaticity coordinates, User software, etc.	https://www.gigahertz-optik.de/en-us/product/BTS2048-VL-GB-GD-360-V01-2

Produktname	Product Image	Description	Show product
TPI21-TH		Measurement system for the testing of LEDs and LED assemblies. Features: CIE S025 compatible, temperature control, Keithley 2400 source, BTS2048-VL spectroradiometer, automatic measurement procedure, intuitive fast DUT contacting, etc.	https://www.gigahertz-optik.de/en-us/product/tpi21-th
ISD-15-BTS2048-VL		Compact integrating sphere spectroradiometer as monolithic module for LED test system Integration in CW and pulse measurement mode. Features: Integrating sphere with 15 cm Diameter, auxiliary lamp, high-end CCD-sensor spectralradiometer with Bi-Tec detector for fast and acurate measurement of the luminous flux, spectral radiant power, CCT, CRI,	https://www.gigahertz-optik.de/en-us/product/ISD-15-BTS2048-VL
ISD-25-BTS2048-VL		System for the luminous flux and light color measurement of individual 2π LED lamps up to 76.2 mm. Features: Integrating sphere with 25cm diameter and auxiliary lamp, CCD-sensor spectralradiometer for acurate measurement of the luminous flux, spectral radiant power, CCT, CRI	https://www.gigahertz-optik.de/en-us/product/ISD-25-BTS2048-VL
BTS2048-VL-CP-ILED-B-IS-1.0-HL		CCD-sensor spectral radiometer for measurement of CIE 127B averaged LED intensity. Features: Measurement Adapter with compact integrating sphere for uniform active area. High-end CCD-sensor spectral Radiometer for CW and pulse measurements.	https://www.gigahertz-optik.de/en-us/product/BTS2048-VL-CP-ILED-B-IS-1.0-HL

Purchasing information

Article-Nr	Modell	Description
	Product	
15298281	BTS2048-VL	Measuring device, hard cover box, users guide, S-BTS2048 software, calibration certificate.
	Calibration	
15300770	K-BTS2048VL-E-S-V02	Calibration of the BTS2048-VL from 280 nm to 1050 nm with calibration certificate.
15306166	K-BTS2048VL-E-S-V03	Calibration of the BTS2048-VL from 280 nm to 1050 nm with calibration certificate. Including determination and implementation of stray light matrix.
	Re-calibration	
15300769	K-BTS2048VL-E-S-V01	Re-calibration of the BTS2048-VL from 350 nm to 1050 nm with calibration certificate.
15300770	K-BTS2048VL-E-S-V02	Re-calibration of the BTS2048-VL from 280 nm to 1050 nm with calibration certificate.
15306166	K-BTS2048VL-E-S-V03	Re-calibration of the BTS2048-VL from 280 nm to 1050 nm with calibration certificate. Including determination and implementation of stray light matrix.
	Options	

Article-Nr	Modell	Description
15309109	BTS2048-VL-Z09	Front tube to limit the field of view of spectralradiometer BTS2048-VL to 20 mm or 2.2 mm diameter in 200 mm distance. For blue light hazard applications.
15309268	BTS2048-VL-Z10	Front tube to limit the field of view of spectralradiometer BTS2048-VL to 20 mm or 2.2 mm diameter in 200 mm distance. Tube manufactured of aluminum including black inner coating. Suitable for higher temperatures at measurement location. For blue light hazard applications
Software		
15298470	S-SDK-BTS2048	Software development kit 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.