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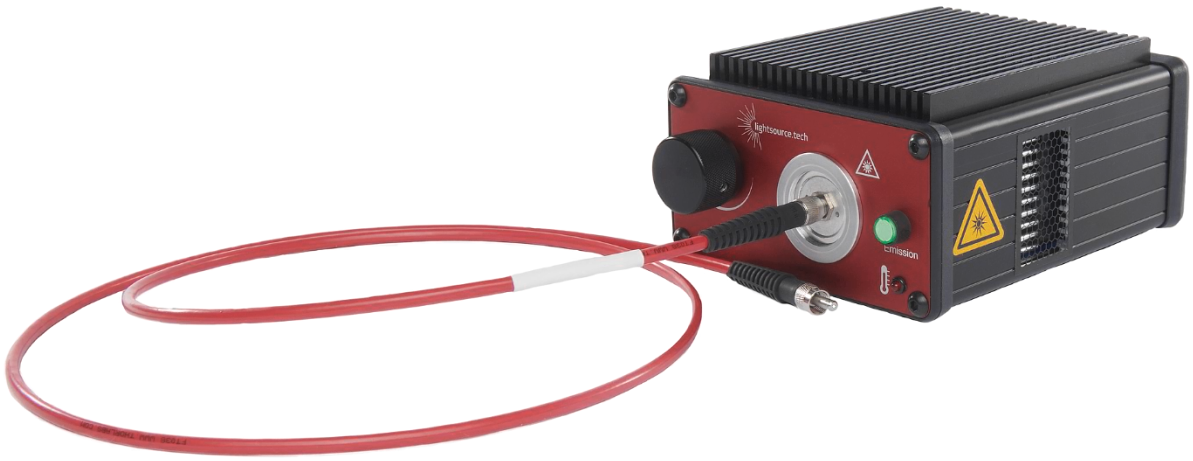

LS-BB1

Broadband LED light source
VIS/NIR

Manual

rev. 1.1

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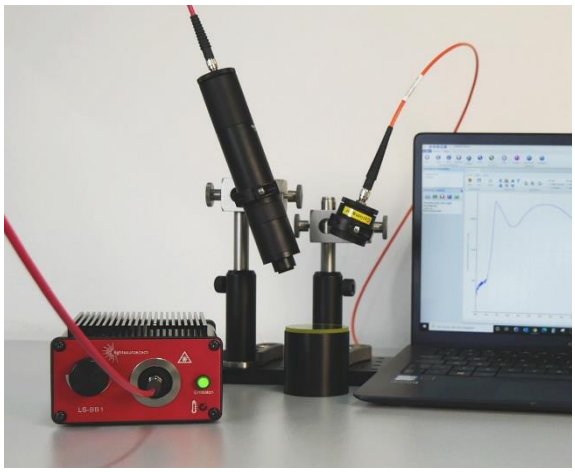
General description

A broadband LED light source



The LS-BB1 is a compact, fiber-coupled powerful **light source for spectroscopic applications**.

Technology: A special VIS / NIR phosphor converter converts the primary light of a high-performance LED at 450nm into a very broad, line-free spectrum up to the NIR range. This results in a point light source that is especially suitable for spectroscopy. The LS-BB1 efficiently couples this light into a multimode fiber with core diameters between 50 µm and 1 mm. This provides the user with a point light source that can be used flexibly with high luminance and very broadband spectral radiation.

Advanced current driver electronics allows for fast on/off switching of the source, enabling stroboscope or pulse trigger applications up to 1kHz (limited by the source in case of the LS-BB1). Thus, you may synchronize the LS-BB1 with external high-speed events, synchronize a camera or spectrometer or even concatenate multiple LS-BB1 to create chase lights or controlled multi-angle illumination. Input and output connectors are provided for trigger in/out or signal monitoring and synchronisation.

The onboard microprocessor controls several modes of operation (CW, stroboscope, pulse trigger, external modulation) and provides a serial interface to a host PC via USB. An easy-to-use GUI is provided, as well as LabVIEW VIs and a Window 64bit DLL (on request). Besides these, the simple RS232 communication protocol allows easy integration into existing setups and in all programming environments.

Parameters like power, pulse frequency or duration may also be conveniently controlled via a user-programmable jog wheel on the front panel.

The LS-BB1 dissipates up to 5 watts of power in a very compact housing. For thermal control, the device is equipped with dual high-performance, yet agreeably quiet air fans and temperature sensor for protection.

Safety Instructions – Please read before use –

The light source LS-BB1 is a bright point light source. Emitted light output and luminance can reach very high, potentially dangerous levels!

The LS-BB1 is **not a toy** and may only be used by technically trained personnel. If the LS-BB1 or the underlying optics module is built into devices or instruments, or is connected to such devices or instruments via an optical fiber, appropriate protective measures must be taken to ensure the safe operation of the entire system. If the LS-BB1 is operated as a stand-alone device, please ensure that emission is switched off when the device is not being supervised.

Risk of eye damage: avoid direct observation of:

- the outlet opening if no fiber is inserted, or

- the glowing fiber end, or

- narrow, collimated beams or focal points.

Use protective glasses to reduce light intensity to a safe and comfortable level. Please check whether the protective glasses you use – e.g. laser safety glasses – are suitable for the emission range of the LS-BB1. In particular, we recommend the use of safety glasses that suppress the primary LED at 450 nm. Suitable protective glasses are also available from lightsource.tech.

Many applications require the beam to be collimated or focused. Depending on the optical technology used, dangerous luminance levels can arise even far from the source.

Particularly when coupling into optical microscopes or similar visual observation devices, light may be focused in areas that result in direct exposure to the user (eyes, hands, etc.). It is imperative that optical systems of this kind are professionally designed to avoid dangerous exposure.

Neurologically photo-sensitive persons should note: The LS-BB1 provides pulsed or stroboscopic modes. Avoid visual observation of intense, low-frequency flickering illumination conditions.

Risk of burns arises in the range of focused or narrow, collimated beams.

Fire risk: Do not place flammable substances in focus.

For users of the Try Out Box: Please note the general safety instructions above and the special information on the individual experiments! Use the safety glasses enclosed!

If you feel unsure about whether safety measures are sufficient, speak to the Laser Safety Officer or contact us on lightsource.tech.

Modes of operation

The LS-BB1 supports four modes of operation. In all modes the output power may be controlled between 1..100%. In some modes, additional parameters may be set. Modes may be switched by software or with the jog wheel on the front panel.

Mode 1, CW-mode: constant emission of light. In this mode, only the power can be controlled with the jog wheel or via PC.

Mode 2, Stroboscope mode: outputs a continuous train of light pulse with selectable power, frequency and duty cycle. This mode is useful for example to visualize fast recurring movements or processes. Check out lightsource.tech for examples and videos. The stroboscope mode operates up to 100kHz and above.

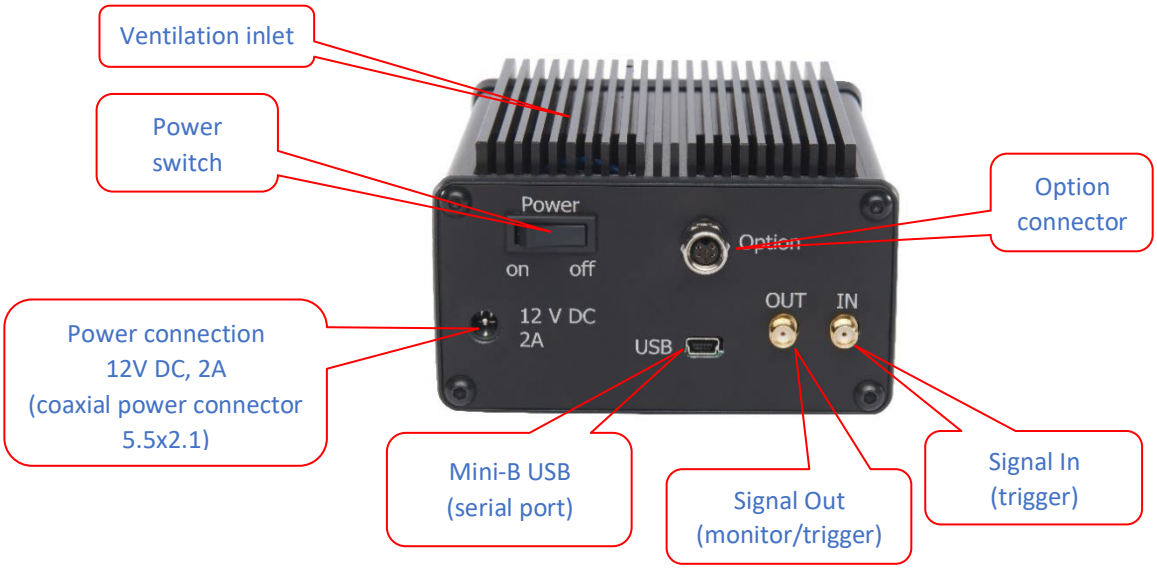
Mode 3, Pulse trigger mode: outputs a pulse of light with selectable duration and delay after a trigger signal edge has been detected on the input (TTL, positive or negative edge selectable). This mode is useful if a (short) pulse of light shall be generated synchronized to an external event, e.g. a camera exposure strobe signal. Pulses can be up to 4s long and as short as 10µs. The programmable delay between trigger and pulse goes down to 4µs.

Mode 4, Direct input mode: use a TTL or analog input signal to directly modulate the output of the light source. This mode can be used if the reference or sync signal is provided completely by the application.

Housing and Controls

Front panel with controls:

Back panel with connections:



Connections

Connect the wall-plug DC adapter (12V) to the power connector input. If you want to use your own power supply, note that it should at least be specified to 1A.

USB port

The USB port allows remote control of the light source from a computer. *While the device may also be operated without computer connection*, it is required if the supplied control software is being used, to change non-standard parameters, to customize the device or if very precise control of timing is required.

Use a USB Mini-B cable to connect the device to a USB port. After switching ON, the device should be recognized as COM port and appear in the ports section (COM & LPT) of the Windows device manager. If the light source is recognized only as “unknown USB device”, the appropriate device drivers for the USB port may be missing. Try to update the USB driver automatically or install the latest *virtual COM port* drivers from FTDI (search for: FDTI USB driver COM)
If you install the provided GUI software, a suitable USB driver is automatically installed.

Occasionally, proper COM port assignment creates problems. This may be especially true if a larger number of serial devices are attached to the PC or have been attached in the past. In this case, cleanup of the COM port history may be needed. Contact lightsource.com for support, if required.

Input/Output

The LS-BB1 may be triggered or modulated via the input connector (type SMA, back panel). Depending on the mode of operation, the signal may by a rising or falling edge trigger signal (software-selectable) for pulse mode, or a direct modulation TTL signal.

The output connector (type SMA, back panel) offers a choice of output signals, which may be selected via software. The outputs can be used for monitoring purposes, or to trigger external devices (camera or else) or to trigger another LS-BB1.

SignalDigital	The digital TTL signal that drives the laser source, except for Direct Input mode	e.g. to trigger a camera/detector or to drive subsequent LS-BB1 for timed follow-up flashes
DriverIn	The signal into the laser source driver, after attenuation by power control, but before the emission switch*	(p command) *allows to “prepare” the light source with an oscilloscope while emission is OFF
Monitor	The current signal of the laser drivers is provided scaled by 165mV/A	Mainly for advanced pulse monitoring and servicing.

Input	Input signal pass-through to the output	e.g. for using multiple LS-BB1 on a single signal source.

Changes to the output function may be stored permanently as default (*Customizing).*

You may attach an oscilloscope to the output (if needed, use an SMA-to-BNC adapter).

Option connector

The option connector gives access to some digital TTL input and output lines (GPIO) as well as external analog input signals. It is intended for specific customization purposes, e.g. connection of external photodiodes, shutters, switches, indicator lamps etc. Contact lightsource.tech if you have a requirement for such an extension.

Operation

Before switching on the LS-BB1, make sure that possible emission of bright light will not be harmful to yourself or others (for example, do not look directly into the fiber output or connector). The emission button on the front panel should be switched off, i.e. the button is in its “out” position. If no fiber is connected, the fiber connector opening should be closed with its cover or pointing away from your line of sight.

After pushing the power ON button on the backpanel, the device will default to its startup configuration. This means it will be resetted to the last saved configuration in terms of mode of operation, power and other parameters, if applicable (see chapter *Customizing* for details on how to change the startup configuration).

At this time, you should be hearing the air fan. To avoid overheating, make sure that the in- and outlets of the ventilation are not blocked. A temperature sensor is placed close to the emitter to monitor temperature. If the temperature is exceeding a (programmable) maximum value, a warning lamp is lit on the front panel and the emission is eventually reduced.

Inserting the optical fiber: it is possible to plug-in an optical fiber into the SMA connector at the front panel at any time. However, it is recommended to disable emission to avoid exposure to bright reflected light from the end of the fiber.

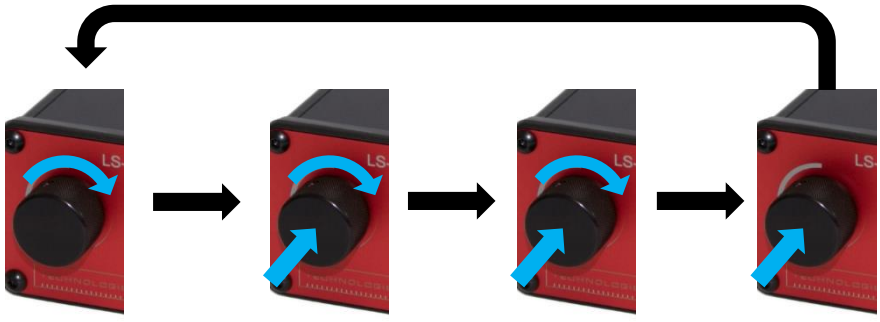
Pressing the emission button starts emission.

Monitoring the set values of power, frequency, etc. is possible via the serial interface (see “Serial Interface”) or by attaching an oscilloscope to the output (see “Input & Output”).

Jog Wheel

Use the jog wheel on the front panel to change the output power from 0..100%. The jog wheel has a non-linear response on the speed of rotation to allow fine tuning at low speed and fast tuning at higher speeds.

Depending on the mode, you may also use it to change other parameters. For example, it may be used to change the frequency in stroboscope mode. To toggle from one parameter to the other, push the jog wheel button inwards once.



cw/direct	power	-	-	-
strobe	power	frequency	duty cycle	cycle back
pulse	power	pulse width	delay	to start

Mode change via jog wheel

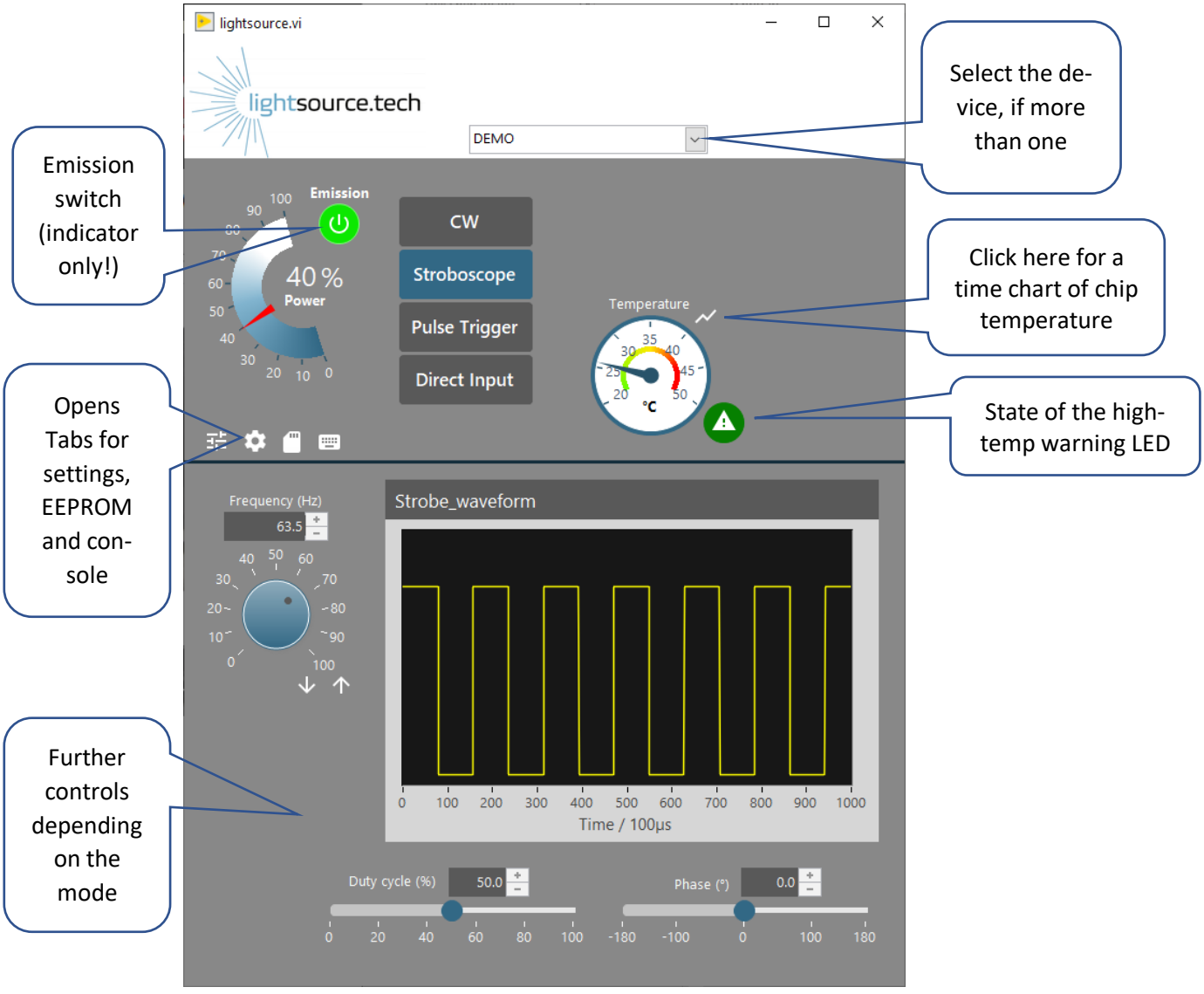
The jog wheel also allows to change the mode of operation:

1. Press the jog wheel until the temp warning LED starts flashing (after 1s). Do not press the jog wheel longer than 5s, because this would overwrite the default values! (see *Customizing*)
2. Select the mode by stepwise rotation of the jog wheel. The new mode is indicated by the number of flashes of the temp warning LED (1..4 times).
3. Press the jog wheel once more for a second until the LED flashes.

Note: if you don't see any change in the output, e.g. in frequency, it may be because you are working on the wrong parameter, exceeding the range limit (e.g. 100% power) or the limit of human perception (e.g. >50 Hz frequency). It may also be the case that the jog wheel button mode had been customized. You may enable or disable the available parameters or disable the jog wheel completely (see *Customizing*).

Software (GUI)

The LS-BB1 comes with an easy-to-use, mostly self-explanatory graphical software. Use the provided installer for installation of the executable and the required LabVIEW runtime engine (minor increment software updates of the executable may not require re-install of the runtime engine, but simply copy/paste of the exe file).



Computer Interface

The LS-BB1 may be controlled via the supplied USB interface, which presents itself as a virtual RS232 COM port. A very simple language that uses ASCII strings allows to access all functions of the hardware.

Serial Interface Connection

The device communicates via a virtual RS232 com port. Make the connection via the supplied USB mini B cable. The COM port settings are baud rate 115200, 8 data bits, no parity, 1 stop bit.

By sending simple ASCII strings, the LS-BB1 can be accessed from within all programming environments. See below for details.

After establishing a RS232 connection to the device, it will restart and provide some lines of information. In particular, it will provide the string lightsource.tech as the first line.

GUI, DLL, LabVIEW and else…

The provided GUI allows an easy, user-friendly access to the LS-BB1. It requires installation of the LabVIEW run-time engine (included). A library of LabVIEW VIs may also be provided on request.

A Windows DLL is provided on request as a higher-level layer, which is encapsulating the ASCII commands. It may be used to conveniently access the device from arbitrary programming languages.

A basic Python interface may also be provided on request as a starting point for your own Python programming.

Communication Protocol

Each command consists of a single character token, followed by a numeric (integer or fractional number) if required, and a termination character (0x0A = \n =line feed):

Example: p50\n sets the output power to 50%.

You must comply with upper or lower case of the token. Some commands are mode sensitive, i.e. they are only available in their associated mode (e.g. frequency command f is only available in stroboscope mode).

If a command is successfully received, it is bounced back. By this, you may check successful transmission. Note that the returned parameters may have a slightly different formatting. For example, sending an integer value of power like p50 will bounce back p50.00. For some commands, a comment is also being returned. This is following the bounced-back command in the same line after a space character and given in brackets. The data line returned is also ended by the termination character 0x0A.

To query a parameter without changing it, use the ? token followed by the requested parameter.

Example: ?p\n returns the power level as p50.00\n

Generic commands

These commands are available independent from the mode of operation

COMMAND	TOKEN	NUMERIC/PARAMETER		EXAMPLE	COMMENT
mode	m	1	CW constant output mode	m2\n Hex: 6D 32 0A	Sets the mode of operation
		2	Stroboscope mode		
		3	Pulse trigger mode		
		4	Direct trigger mode		
		…	n/a		
power	p	1..100 (p < 1 is coerced to 0 = no output)		P10.5\n	Sets the output power in %. Note that due to discrete steps and non-linearity, the power setting is only approximately.
emission	e	0 (OFF) /1 (ON)		?e\n	Read-only to query the state of the emission button
tmax	tm	value		tm40\n	Sets the maximum temperature to ligth the high temp warning LED and reduce the output power. ?t returns the *actual temperature*
query	?	p, f, t… i.e. any cmd token of other parameters		?p\n	Returns the parameter value, e.g. the power, frequency, temperature, …
FWprogON	XY	-		XY\n	enable firmware programming mode
FWprogOFF	YX	-		YX\n	disable firmware programming mode
store	s	-		s\n	Stores the current parameters including the current mode to EEPROM, to be used as default at next startup. You must enable firmware programming mode before using it.

				Use this command to prepare the device for your typical use case, see *Customizing*
read	r	-	r\n	Reads the defaults from EEPROM, but does not change most of the actual settings unless you switch the mode
buttonmode	b	Binary code, each bit enables one parameter in the toggling sequence.	b1\n (enable only power) b0\n (disable all)	Depending on the operation mode, sets the toggling of the jog wheel's push button. See function for individual modes. Setting buttonmode to zero disables the jog wheel !
output	o	0 SignalDigital 1 DriverIn 2 Monitor 3 Input 4… SignalDigital	o2\n	Sets the signal presented at the output connector
increment	i	p, f, d, j, w, D for the parameter followed by the numeric value	if10\n (sets the frequency increment to 10Hz)	The increment value of a parameter for the jog wheel, e.g. the power or frequency

CW mode commands

CW continuous out mode supports only the power command, which is a generic commands (see above).

Stroboscope mode commands

In stroboscope mode, one would like to set power (generic command), the pulse frequency and the duty cycle (i.e. the fraction of the ON state with respect to the overall pulse lengths). Additionally, it may be required to shift the phase of the signal.

COMMAND	TOKEN	NUMERIC/PARAMETER	EXAMPLE	COMMENT
frequency	f	0.12 .. >200000 (Hz)	f24.5\n	Sets the pulse frequency in Hz. The actually achievable optical light emission frequency and pulse shape may be lower than the internally settable frequency and depends on power level and other hardware parameters. See *TIMING* Details
duty cycle	d	0..100 (%)	d10.1\n	Sets the duty cycle in %. Note that the real duty cycle has a certain granularity, see *Timing* Details
width	w	>1 (µs) (w > 1/f -> duty cycle = 100%)	w1000\n	Instead of using duty cycle, you may also set the ON time width (in µs) directly. This command returns the duty cycle.
phase shift	j	+/- 360 (°)	j90\n	Shifts the phase of the pulse train.
buttonmode (strobe mode specific)	b	B1 Power B10 Frequency B100 Duty cycle B1000 Phase (B=binary!)	b3\n (enable power&frequency only) b15\n (enable all)	Jog wheel push button: control bits enable/disable toggling power->frequency->dutycycle->phase->power…

Pulse trigger mode commands

In pulse trigger mode, one would like to set power (generic command), the pulse width and the pulse delay with respect to the input trigger signal. Additionally, one would like to be able to set the polarity of the input trigger to active-high or active-low state.

COMMAND	TOKEN	NUMERIC/PARAMETER	EXAMPLE	COMMENT
pulse width	w	1..(4000000-pulse delay) The maximum allowed is given by the sum of width and delay.	w1200\n	Sets the pulse width in microseconds with some granularity. The actually achievable light emission pulse width and shape depends on the power level. See *TIMING* Details
pulse delay	D (upper case!)	4..(4000000-pulse width) The maximum allowed is given by the sum of width and delay.	D200\n	Sets the pulse delay with respect to the trigger input in microseconds with some granularity. Note that there is an internal minimum delay of a few µs even if you set it to zero. See *TIMING* Details.
pulse picker	k	1..65535	k4\n	Pick only every n-th pulse and reject the others
pulse add	+	+/- 1..65535	+2\n +-2\n	Increment or decrement the pulse counter to shift the "phase" of the pulse generation
edge	E (upper case)	r or f	Ef\n	Sets the trigger edge to either following or rising
buttonmode (pulse mode specific)	b	B1 Power B10 Pulse width B100 Delay (B=binary!)	b3\n (enable power&width only) B7\n (enable all)	Jog wheel push button: control bits enable/disable toggling power->pulsewidth->delay->power…

Direct input mode commands

In pulse trigger mode, one directly supplies the input signal, which may be a digital (TTL) or analog signal to modulate the optical output. However, the generic power command is still available.

Customizing

On startup, default parameter values like power, frequency etc. as well as the default mode of operation are loaded from EEPROM. For convenience, you may change these default values. This is useful, for example, if the LS-BB1 is integrated into a stationary setup and you want it to start up in pulse trigger mode at a given pulse width every time. Note that also the default function of the output connector may be altered.

Storing the current values to EEPROM is possible in 3 ways:

- by sending the "s" command via RS232
- by using the respective GUI function (which also sends "s")
- by pressing the jog wheel button for longer than 5s. This will be indicated by a faster flickering of the "temperature warning" LED.

Additionally, you may change the behaviour of the jog wheel with the GUI or via the "b" (which parameters are accessible) and the "i" (increment of each parameter) commands (see above), followed by "s" to store it to EEPROM. Note that jog wheel settings are stored separately for all modes.

Switching between modes is also possible with the jog wheel (see above).

Thermal management

The light source and driver of the LS-BB1 produces up to 5 watts of heat. At the same time, the base plate temperature of the core emitting device needs to be maintained at not too high temperature to avoid power drop and reduced lifetime. Therefore, the LS-BB1 has a special thermal design to enable efficient dissipation of excess heat. It consists of 5 elements:

- special cooler design with controlled air flow for active and passive convection
- two high performance, yet low noise fans
- temperature sensor close to chip base, which may be read-out at any time
- over-temperature warning LED on front panel
- power-down logic with programmable Tmax

Make sure that the in and out openings for the ventilation are not blocked. Note that there are ventilation holes also on the bottom. If using multiple LS-BB1 or other LS-type devices placed alongside or on top of each other, ensure unimpeded air circulation.

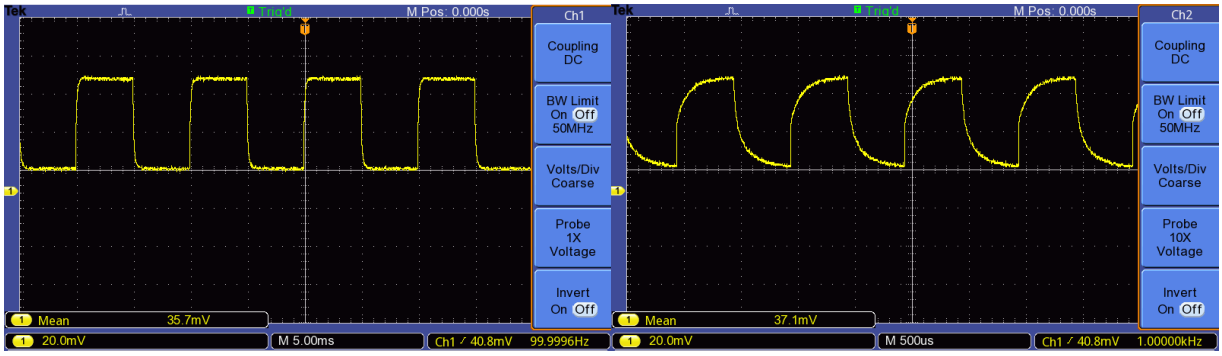
Timing Details

The precision of setting frequence, pulse widths or other parameters depends on the frequency/time regime you are working in. For low frequencies or long pulses, the smallest programmable increment -in absolute frequency or time- is larger than for very high frequencies or much shorter pulses. If you need details on this granularity, please contact lightsource.tech.

For triggering, there is a minimum delay of 4µs between the original trigger edge and the beginning of the rising slope of the light pulse. This is due to the internal processing times of the signal input.

Pulse shapes

The light of the LS-BB1 can be switched on and off quickly, but the afterglow of the VIS / NIR phosphor converter results in lower frequencies compared to our other light sources. Switching frequencies of up to 1 kHz with full modulation are easily possible, as for example for synchronization with spectrometers. An external trigger input with an adjustable delay is available for this. The minimum delay is approx. 4 µs, jitter is less than 1 µs. Thanks to the built-in microprocessor, the LS-BB1 can also be operated as a free-running stroboscope with an adjustable frequency and duty cycle.



Optical pulse shape at 100% output power in stroboscopic operation with 100Hz (left) or 1kHz (right), measured with Thorlabs PDA36A2 Si Amplified Photodetector

Specifications

Specifications are provided to our best knowledge and are not guaranteed to be complete or free from errors. Specifications may change without notice.

<table>
<tr><td>Emitter</td><td>LED at 450nm with special VIS/NIR phosphor converter</td></tr>
<tr><td>Optical output</td><td>SMA optical fiber connection for multimode fibers with a core diameter of 50-1000µm (maximum fiber aperture NA=0.5)</td></tr>
<tr><td>Optical output power

(typical)</td><td>Core diameter of optical fiber 1mm NA 0.5: >33mW

400µm, NA 0.39: >3.3mW

Output power for other core diameters d or NA approx. $P_{out} \geq P_{tab}$* $NA^2/0.25 * d^2$ [mm]. Output adjustable via jogwheel or software 1-100%</td></tr>
<tr><td>Wavelength range</td><td>420-900 nm, see spectrum above</td></tr>
<tr><td>Manual operation</td><td>Software controlled configurable jogwheel (output, frequency, switch-on duration) depending on selected mode.</td></tr>
<tr><td>Operating modes</td><td><table>
<tr><td>Constant output</td><td>CW</td></tr>
<tr><td>Stroboscope</td><td>Frequency 0.12Hz – approx. 1kHz

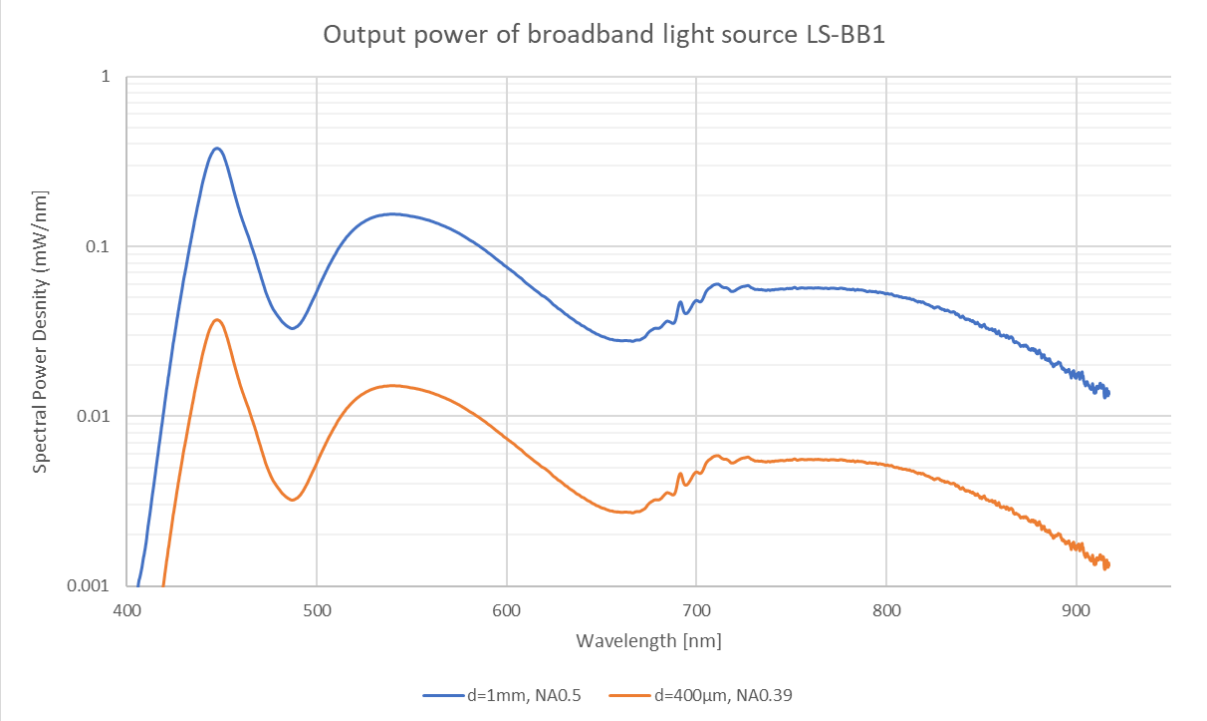
Duty cycle 0–100%</td></tr>
<tr><td>Pulse trigger</td><td>Pulse width: approx. 500µs–4000ms

Delay: 4µs–4000ms

(Width + Delay <= 4000ms)</td></tr>
<tr><td>Direct mode</td><td>Analog/digital modulation to 2 kHz</td></tr>
</table>All modes allow output setting of 1–100%</td></tr>
<tr><td>Interface</td><td>Mini-USB type B connection, RS-232 via USB (COM interface, FTDI chipset, 115200 baud)</td></tr>
<tr><td>Software</td><td>LabVIEW™-based GUI or control with commands via RS-232, therefore able to be integrated into all programmable environments or direct terminal input.</td></tr>
<tr><td>Signal In</td><td>TTL level for trigger or digital modulation, analog input (0-5V, biased) for analog modulation (via SMA connection)</td></tr>
</table>

Signal Out	Selectable output signals (via SMA connection); Signal reference (TTL), Laser driver input (0-5V), Current monitor (500mV/A), Signal In looped through
Option output	4 via firmware adaptable inputs/outputs for external sensors, interlocks, etc. (DIO/analog/I2C, +5V, GND)
Thermal management	2 miniature high-performance fans, low-noise, air inlet on top, air outlet on both sides and underneath. Temperature sensor (readable using software), overheating protection, LED signal. Environmental temperature 5-30 °C. (Other temperature ranges possible on request.)
Power supply	Plug-in power supply 12V DC, 2.5A (included with delivery), connection: coaxial power connector 5.5x2.1, power input approx. 5W max.
Dimensions	130mm (L) x 106mm (W) x 56mm (H) without user controls and connections

Spectrum (typical)



Scope of delivery

- Light source LS-BB1

- Plug-in power supply

- Operating instructions

- USB cable (A to Mini-B, 2m)

- Software (as download or USB stick)

An optical fiber is not included in the standard delivery scope. Suitable optical fibers for your application with various core diameters, numerical apertures and of various materials are available from us or other suppliers. We recommend using quartz optical fibers.

Certifcates

The LS series of light sources has been tested according to the following guidelines:
CE 2014/35/EU Low Voltage Directive, LVD
2014/30/EU EMC directive, EMC test standard DIN-EN 61326-1 2018-09 [VDE 08433-20-1]
Electrical measuring, control, regulating and laboratory equipment – General EMC requirements

Test certificate available on request.

Any other plug-in power supply with suitable connection (coaxial power connector 5.5x2.1) and output may be used in place of the plug-in power supply provided.

Disclaimer

This manual is provided with no guarantee on correctness and completeness of the information within. Specs and data may change without notice.

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