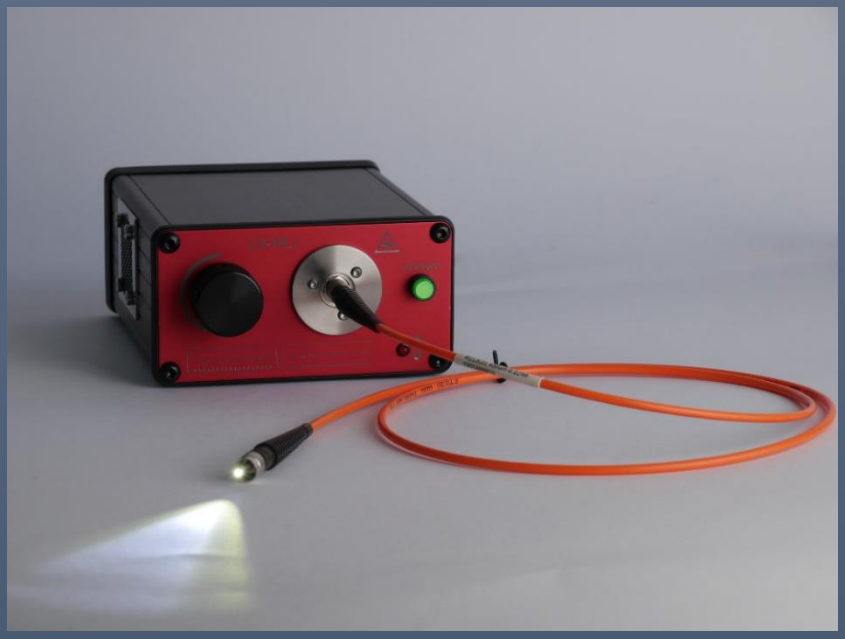
lightsource.tech



LS-WL1 high brightness fiber light source

Content

General description

The LS-WL1 is a compact high power, ultra-high brightness fiber light source. It outputs brilliant white light from optical multimode fibers with small core diameters.

This is achieved by fluorescent conversion of focused laser light (450nm) on a special converter phosphor. The total optical power emitted from the source is greater than 1 Watt from an area of ca. 0.1mm^2. The aperture of the relay optics, although efficient, limits the fractions of the emitted light finally coupled into the optical fiber to approximately 40%.

The LS-WL1 is the right choice were high directional quality, low étendue, yet high-power lighting is required. The smaller the light source, the better it is suited for collimation, beam shaping or focusing.

Advanced current driver electronics allows for fast on/off switching of the source, enabling stroboscope or pulse trigger applications up to at least 100kHz. Thus, you may synchronize the LS-WL1 with external high-speed events, synchronize a camera or spectrometer or even concatenate multiple LS-WL1 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. 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-WL1 dissipates up to 20 watts of power in a very compact housing, thus thermal control is required. Therefore, the device is equipped with dual high-performance, yet agreeably quiet air fans and temperature sensor for protection.

Safety - read carefully before use -

The LS-WL1 is an ultra-high brightness point light source. The light emitted from it may reach very high and harmful intensity levels.

The LS-WL1 is **NOT A TOY** and must only be used by technically educated persons. If the LS-WL1 or its optical engine is built into devices or instruments or attached to these as a sub-system, appropriate safety precautions must be maintained. If the LS-WL1 is operated stand-alone, make sure that you switch off emission before you leave it unattended.

Risk of eye injury:

Avoid direct observation with the eye

- **of the aperture without fiber**
- **or the fiber end**
- **or tightly collimated or focused spots.**

Use safety glasses to reduce the light intensity to comfortable levels. For the LS-WL1, most of the power is emitted below 600nm, so many laser safety glasses for blue and green lasers will work (OD>2 for UV-Yellow. Suitable glasses are also available at lightsource.tech).

Many applications include collimation or focusing of the beam. Depending on the optics employed, hazardous power levels may be present even in large distance from the source. In particular, coupling the light source to a microscope or other device with direct human observation may cause a focus in user-accessible spaces with very high power levels. Careful layout of the optical system avoiding such dangerous exposure conditions is mandatory for such use cases.

Advice for neurologically photosensitive persons: the LS-WL1 may be operated in pulsed or strobe-scopic operation modes. Avoid exposure to intense low frequency flickering light.

Risk of skin burn: avoid exposure of skin to focused or highly collimated light.

Risk of fire: do not place inflammable objects at the focus.

For users of the try-out kit: adhere to the safety notes above and follow special precautions for individual experiments! Use the safety glasses included!

The core light emitting device has independent UL certification for the solid-state lighting safety standard ANSI/UL 8750. It is rated a “Class 1 Laser Product” under IEC 60825-1 standard and rated “Risk Group 1” for IEC 62778 photo-biological safety.

The laser emitter is sealed and not directly visible. Only diffuse scattering of the laser and diffuse white light from the phosphor converter is visible and focussed onto the aperture (SMA connector) which may hold an optical fiber.

Contact your local laser safety officer if you are insecure about appropriate safety measures or contact lightsource.tech for support.

Modes of operation

The LS-WL1 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.

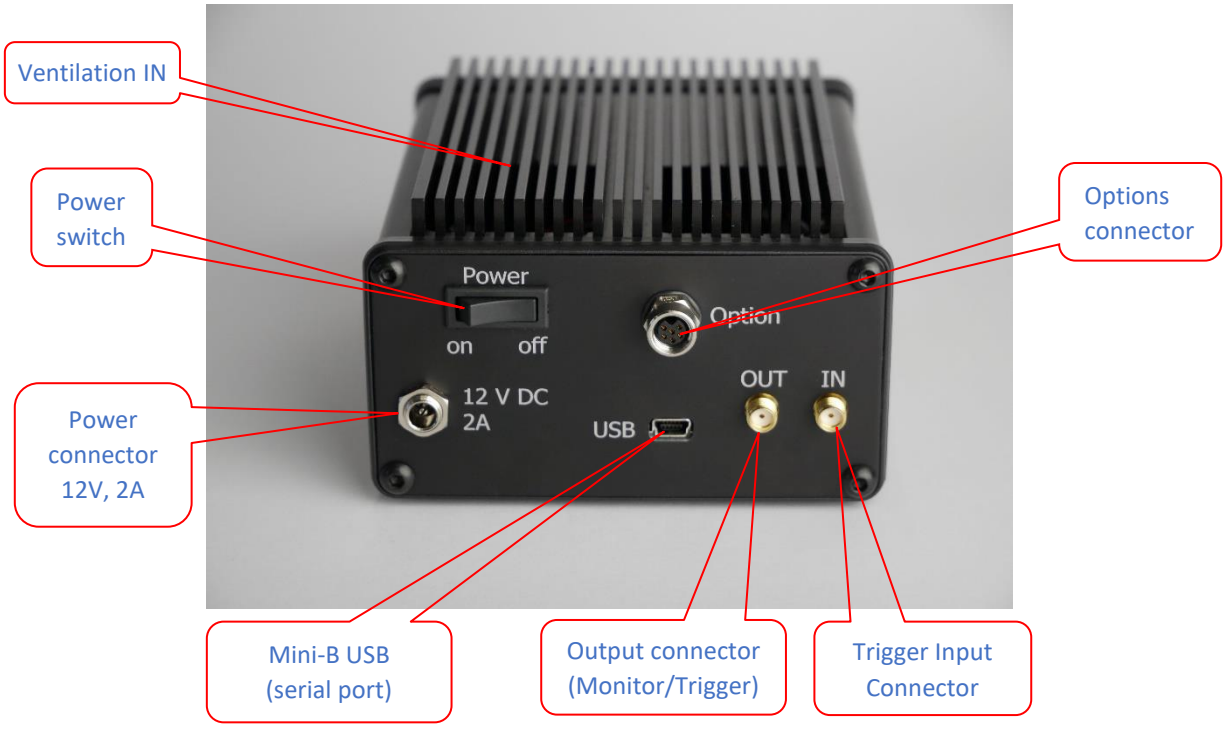
Mode 3, Pulse trigger mode: outputs a pulse of light with selectable duration and delay after a trigger signal edge has been detected on the input (TTL, positive or negative edge selectable). This mode is useful if a (short) pulse of light shall be generated synchronized to an external event, e.g. a 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 view

Backside view



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 2.5A.

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)

Input/Output

The LS-WL1 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_WL1.

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-WL1 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_WL1 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-WL1, make sure that possible emission of bright light will not be harmful to yourself or others (for example, do not look 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, 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. Because ca. 20 watts of heat are being generated at full power operation, 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.

Please note that also the laser driver of the light source may produce a chirping sound, depending on power and pulse frequency.

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. Before doing so, make sure that operation is safe (see

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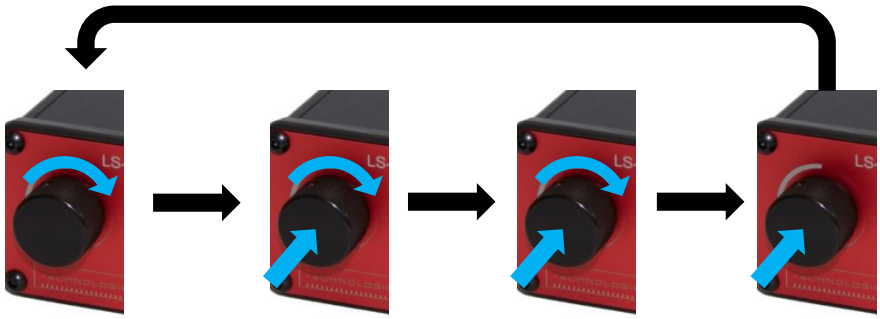
Monitoring the set values of power, frequency, etc. is possible via the serial interface (see “Serial Interface”) or by attaching an oscilloscope to the output (see “Input & Output”).

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 to start
pulse	power	pulse width	delay	

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*).

Connections

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)

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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_WL1 on a single signal source.

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

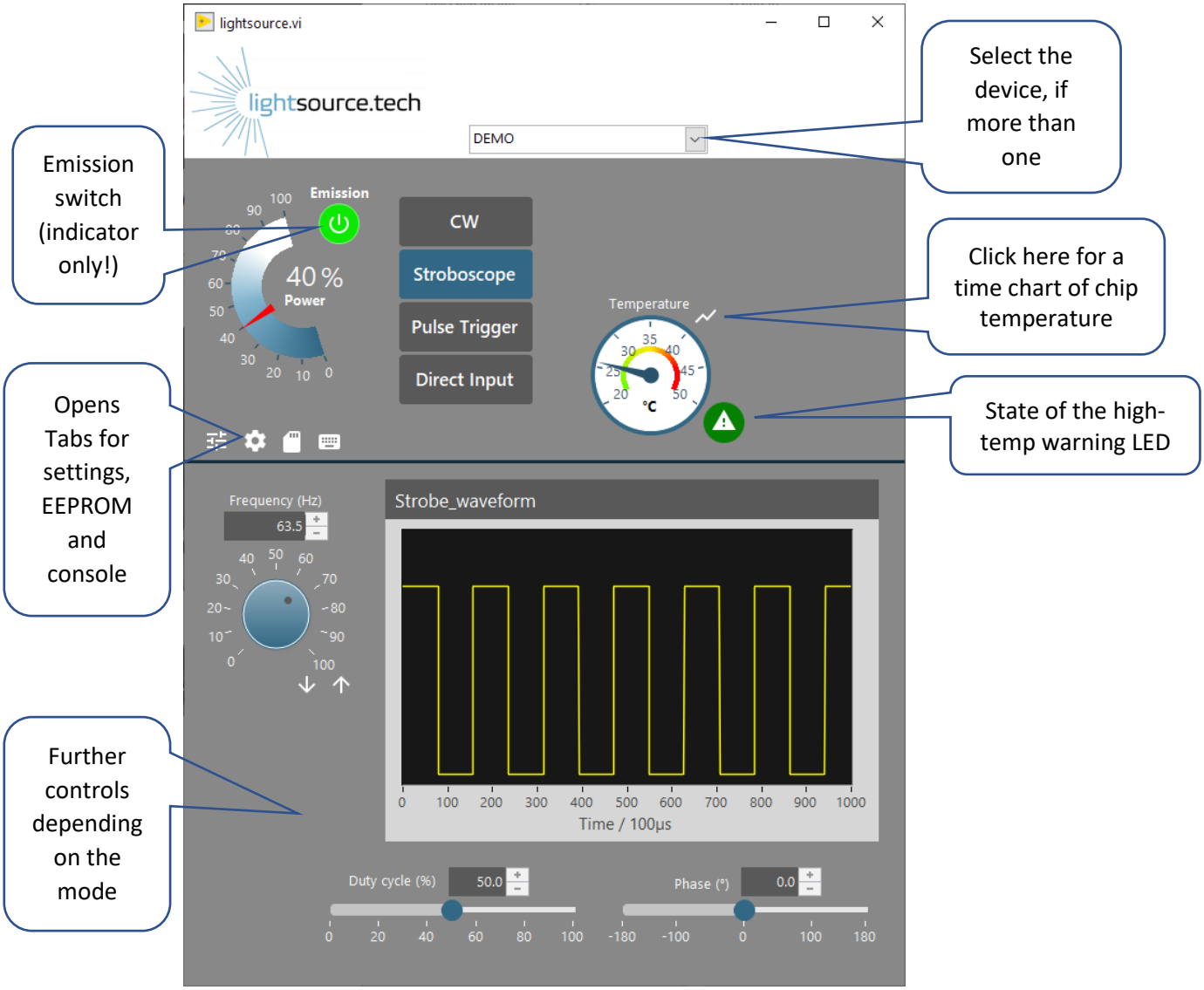
You may attach an oscilloscope to the output (if needed, use an SMA-to-BNC adapter).

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.

Software (GUI)

The LS-WL1 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_WL1 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-WL1 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-WL1. 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 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-WL1 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-WL1 produces up to 20 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-WL1 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.

Timing Details

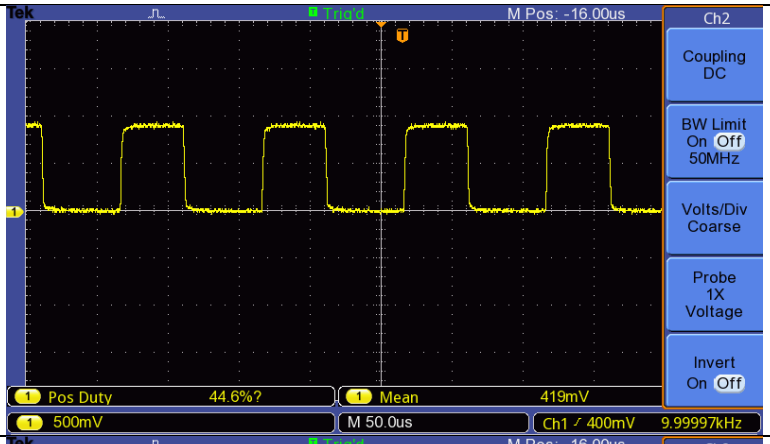
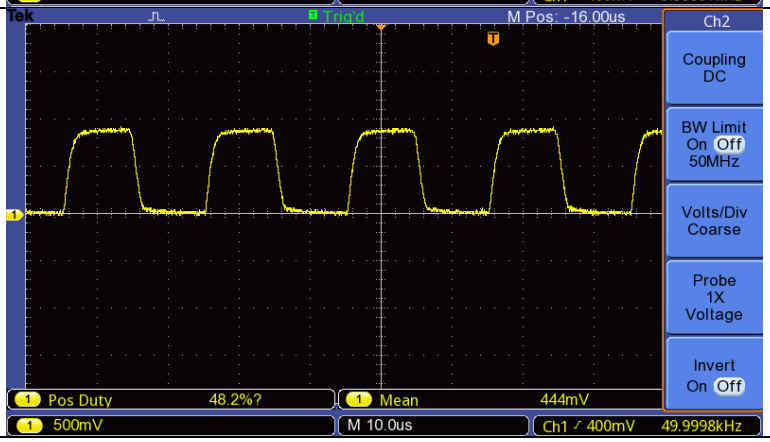
The precision of setting frequence, pulse widths or other parameters depends on the frequency/time regime you are working in. For low frequencies or long pulses, the smallest programmable increment -in absolute frequency or time- is larger than for very high frequencies or much shorter pulses. If you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

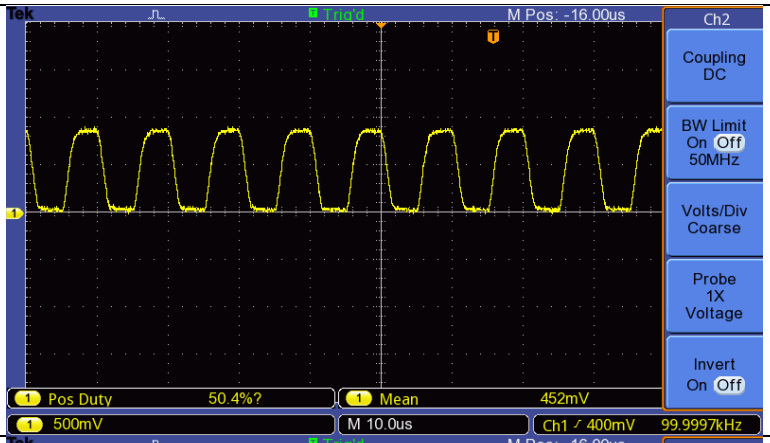
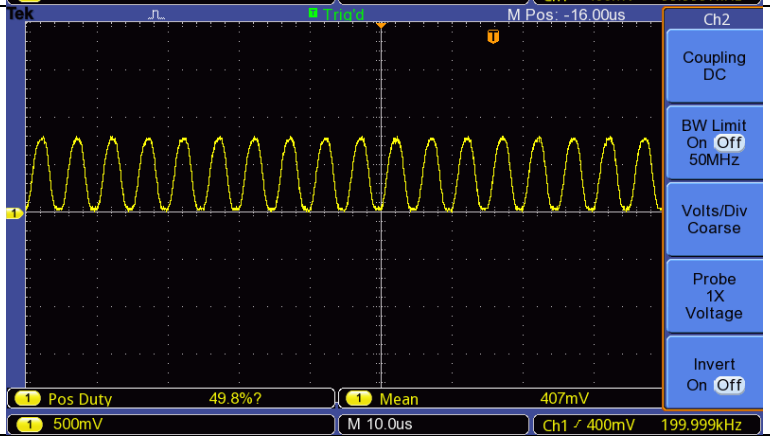
For triggering, there is a minimum delay of 4µs between the original trigger edge and the beginning of the rising slope of the light pulse. This is due to the internal processing times of the signal input.

Pulse shapes

To obtain good modulation and rectangular pulse shape at high frequencies >1kHz in stroboscope and pulse trigger mode, it is important to drive the LS-WL1 at high or maximum power levels. Especially at very high frequencies > 10kHz it will usually be necessary to drive it at 100% power. Additionally, the actual duty cycle in terms of optical signal may require some adjustment and - because of finite rise&fall times, smaller duty cycles may not be achievable. It is recommended to use a separate optical monitor (e.g. fast photo diode) and an oscilloscope to optimize the pulse shape at high frequencies.

See the following examples of some optical signal traces at very high frequencies:

f=10 kHz duty cycle =50% power= 100% full signal modulation	
f=50 kHz duty cycle =65% (nominal) power=100% beginning signal rounding	

f=100 kHz duty cycle =68% (nominal) power=100% significant signal round off, but still fair signal shape	
f=200 kHz duty cycle =63% (nominal) power=100% signal round off to ca. 80% of max amplitude	

(Measured with Thorlabs PDA36A2 Si Amplified Photodetector).

Appendix A: Brightness & Étendue

If one would compare the output of a very strong torch light with the LS-WL1 (with the fiber removed) on a room wall a few meters away, the torch light may seem to shine more light, while the LS-WL1 seems to be inferior.

So what is the benefit, what makes the LS-WL1 different from other high power light sources?

To conserve the power of light when it passes through an optical system, the light at the entrance needs to be "squeezed through" through all the components towards the output. The property of a light field being "spread out" in area and angle distribution is called *étendue*. In an optical system that ideally shall transmit all the light, *the étendue cannot be decreased* by any means. The component with the smallest etendue will thus limit the light transmission or collecting property of the entire system.

A small area optical fiber with a limited numerical aperture has a small étendue. On the other hand, a large area LED with its Lambertian wide angle emission has a large étendue. When you plug the optical fiber to this LED emitter, the amount of light collected is limited by the fiber's étendue, even with the most sophisticated, over-specified optics for the coupling.

The peculiarity of the LS-WL1 is that its light is coming from a very small emitting area. Because of that, *and only because of that*, it is possible to couple the light into a small diameter optical fiber with a high efficiency. A larger high-power LED emitter as in the torch light example -while emitting a much higher total power- would only allow to couple into the fiber a very small fraction of its light. For example, a 50µm fiber may be useful for certain measuring applications, but from an extended source it collects only 1/400 compared to a 1mm fiber of the same numerical aperture.

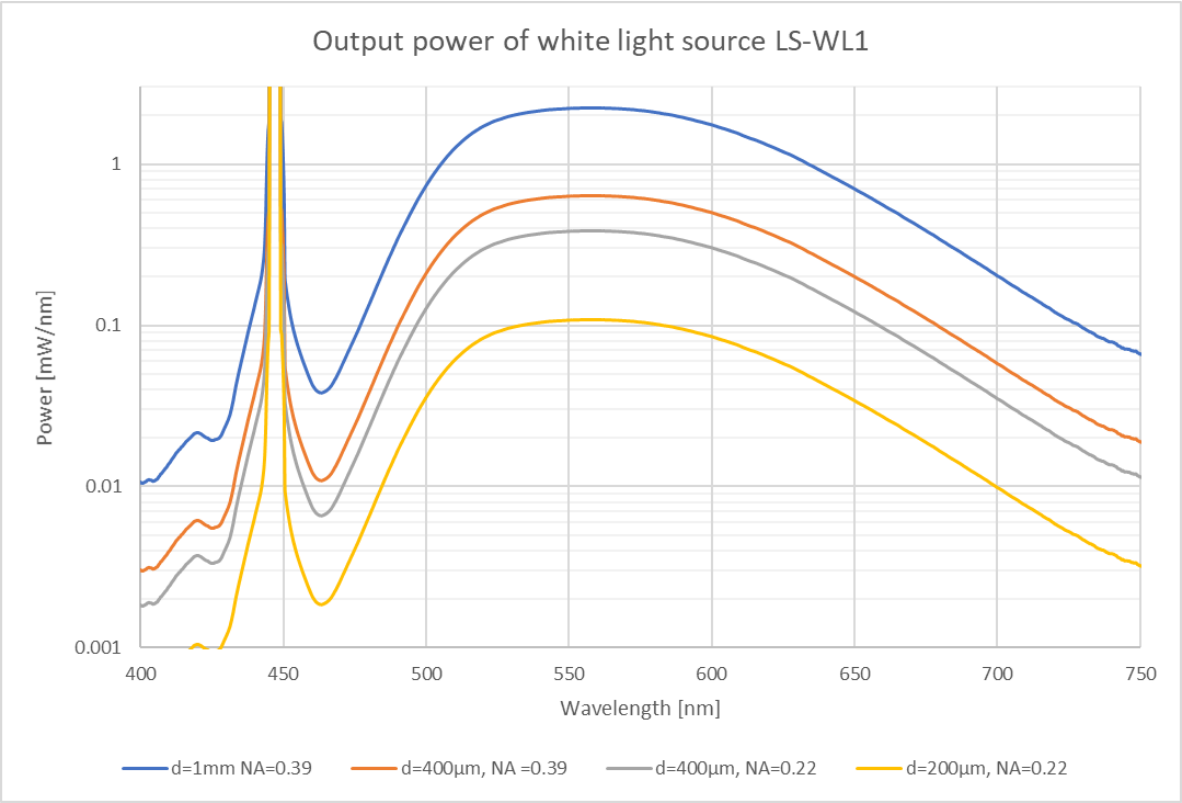
The output of the optical fiber attached to LS-WL1 again may serve as a point light source, which may then be coupled into the application without much loss. Or it may be collimated to a highly parallel light beam or focussed to a small spot over a large distance. The high brightness of the fiber output thus produces light of high quality, providing more light throughput, faster measurement times and more flexibility in designing your application.

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>Laser-pumped, phosphor converter, white light source (450nm lasers)</td></tr>
<tr><td>Spectral range</td><td>440 – 700 nm (see spectrum graph)</td></tr>
<tr><td>Optical power</td><td>Total emission (half sphere): 1 Watt
1mm core optical fiber, NA 0.39: 300mW
400µm core optical fiber, NA 0.39: 85mW
200µm core optical fiber, NA 0.22: 50mW
variable power 5...100% via jog wheel or software</td></tr>
<tr><td>Optical connector</td><td>SMA connector for multimode fibers up to 1mm core</td></tr>
<tr><td>Manual control</td><td>by software-configurable jog wheel, e.g. power/frequency/duty cycle (depending on mode of operation)
emission butt</td></tr>
<tr><td>Modes of operation</td><td>
<table>
<tr><td>Constant output</td><td>cw</td></tr>
<tr><td>Stroboscope</td><td>frequency 0.12Hz..200.000 Hz
duty cycle 0..100%</td></tr>
<tr><td>Pulse trigger</td><td>pulse duration: 10µs…4000ms
delay: 4µs..4000ms
(delay + duration <= 4000ms)</td></tr>
<tr><td>Direct input</td><td>analog or digital modulation up to 200 kHz</td></tr>
</table>
</td></tr>
<tr><td>Signal In</td><td>TTL level for trigger input or digital modulation, analog input (0..5V, biased input) for analoq modulation (via SMA connector)</td></tr>
<tr><td>Signal Out</td><td>Selectable output signals (via SMA connector)
Signal Reference out (TTL), Laser Driver Input (0..5V), Laser current monitor (165mV/A), Signal In pass-through</td></tr>
<tr><td>Thermal management</td><td>Emitter on fan-cooled copper heatsink, on-board temperature sensor with high temperature warning LED, temperature read-out via software
Operating temperature: 5-30°C (higher temperature range on request)</td></tr>
<tr><td>Power supply</td><td>wall plug 12V DC, 2.5A (included), power jack 2.1X5.5mm ID/OD
power consumption ca 20 W @ full output</td></tr>
<tr><td>Dimensions</td><td>130mm(L) x 106mm(W) x 56mm(H) excl. controls & electrical connectors</td></tr>
<tr><td>Options connector</td><td>Customizable 4 signal lines for external sensors, interlock, signalling, etc. (DIO/analog/I2C, +5V, GND)</td></tr>
<tr><td>Control interface</td><td>USB-C connector (RS-232), LabVIEW™-based GUI, various external control options</td></tr>
</table>

Specification may change without notice



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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