



BDS-MM Family Picosecond Diode Lasers

Optical power up to 60 mW at 50 MHz

Wavelengths 405, 445, 525, 640, 685, 785, 915 nm

Power up to 60mW, multi-mode

Small-size laser module, 40 mm x 40 mm x 120 mm

Free-beam or multi-mode fibre output

Pulse repetition rate 20 MHz and 50 MHz, selectable

Fast on / off / multiplexing capability

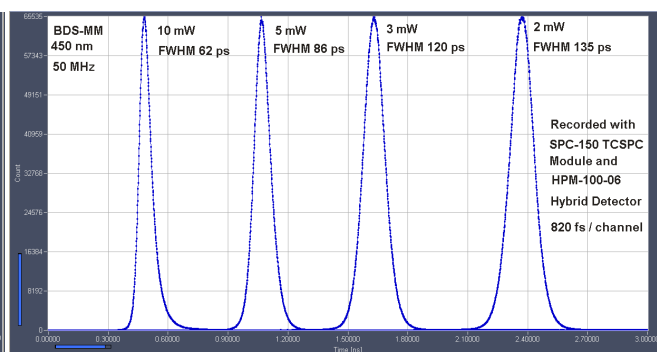
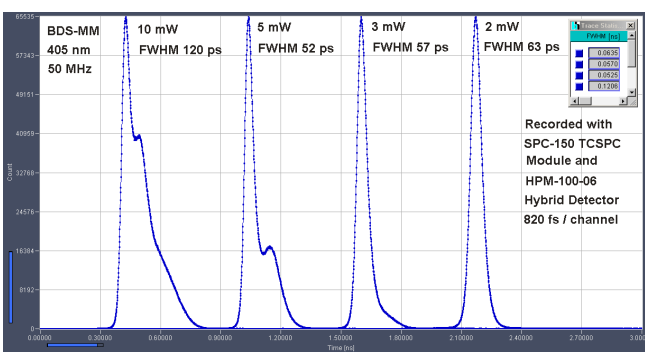
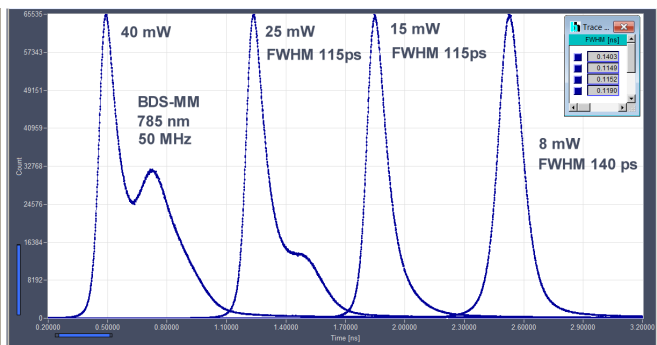
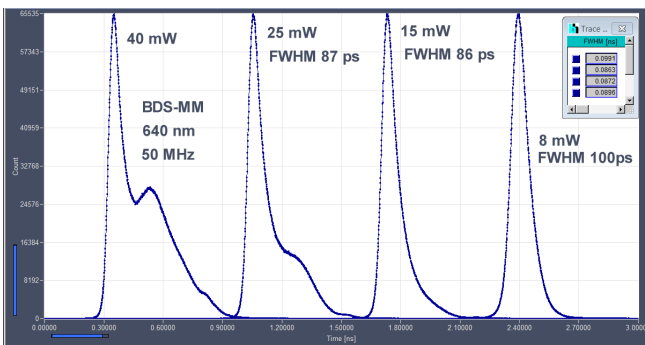
Internal power regulation loop

All electronics integrated

No external driver unit

Simple +12 V power supply

Compatible with all bh TCSPC devices



Pulse shapes may change due to development in laser diode performance. Power measured in free beam. Coupling efficiency into optical fibres is 60 to 90%, depending on fibre diameter

Designed and manufactured by



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BDS-MM

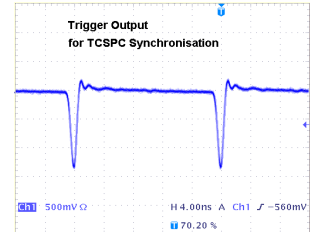
Optical

Repetition Rate, switchable by TTL signal
 Wavelengths
 Max. optical power
 Coupling efficiency into fibres (multi-mode, typical values)
 Pulse width (FWHM, at medium power)
 Pulse width (FWHM, at maximum power)
 Warm-up time for power and pulse shape stabilisation after power on

20 MHz and 50 MHz, other combinations on request
 405, 450, 525, 640, 685, 785, 915 nm, other on request
 10 to 60 mW at 50 MHz, depends on wavelength version
 100µm: 60% 200µm: 80% 500µm: 90%
 65 to 120 ps
 120 to 300 ps
 1 min¹⁾

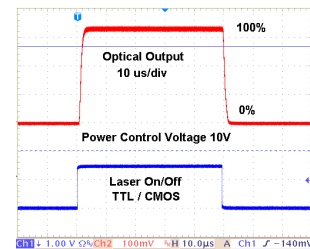
Trigger Output, to TCSPC Modules

Pulse Amplitude -1V (peak) into 50 Ω
 Pulse Width 1 ns, see figure right
 Output Impedance 50 Ω
 Connector SMA
 Jitter between Trigger and Optical Pulse < 10 ps



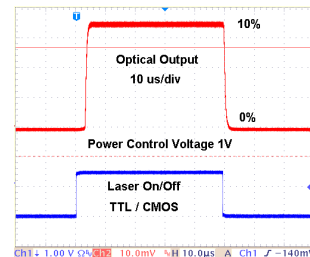
Synchronisation Input

Input amplitude +3.3 to +5V into 50 Ω
 Duty cycle 10 to 30 %. DC equivalent must be < 2.5V
 Input frequency 20 to 60 MHz
 Connector SMA
 Switch between internal clock and sync input automatic, by average voltage at trigger connector



Control Inputs

Laser ON / Off
 Response of optical output to on/off signal < 4 us for power 10 to 100%, see figures right
 External Power Control analog input, 0 to + 10V
 Response time of optical output to power control < 4 us for power 10 to 100%, see figure right
 Frequency 50 MHz active H, internal pull-up resistor
 Frequency 20 MHz active H, internal pull-down resistor
 Laser runs at 50 MHz with Frequency inputs unconnected



Power Supply

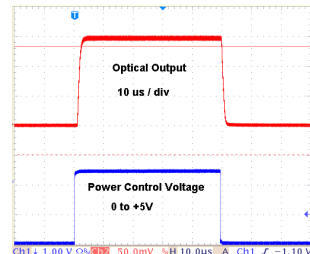
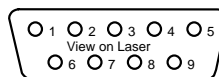
Power Supply Voltage +9 V to +15 V
 Power Supply Current at 12V 200 mA to 500 mA 2)

Mechanical Data

Dimensions 40 mm x 44 mm x 120 mm
 Mounting holes four holes for M3 screws
 Heat sink requirements < 2°C / W 3)

Connector Pin Assignment

Connector version Mini Sub-D
 Power supply +12V 1, 2
 GND 4, 5, 9, and case
 Power control voltage 8
 Laser On/OFF (active H) 6
 Frequency 50 MHz (active H, internal pull-up resistor) 7
 Frequency 20 MHz (active H, internal pull-down resistor) 3



Maximum Values

Power Supply Voltage 0 V to +15 V
 Voltage at 'Laser On/Off' and 'Frequency' inputs -2 V to +7 V
 Voltage at 'Laser Power' input -12 V to + 12 V
 Ambient Temperature 0 °C to 40 °C 3)

- 1) Operation below 13 °C ambient temperature may result in extended warm-up time.
- 2) Depends on case temperature due to laser diode cooling. Cooling current changes with case temperature
- 3) Laser must be mounted on heat sink. Case temperature must remain below 40°C

Related Products

BDS-SM picosecond diode lasers, BDL-SMN picosecond and CW diode lasers, 375nm, 405nm, 445nm, 473nm, 488nm, 515nm, 640nm, 685nm, 785nm



Caution: Class 3B laser product. Avoid direct eye exposure. Light emitted by the device may be harmful to the human eye. Please obey laser safety rules when operating the devices. Complies with US federal laser product performance standards.

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Application Information

Frequency Selection

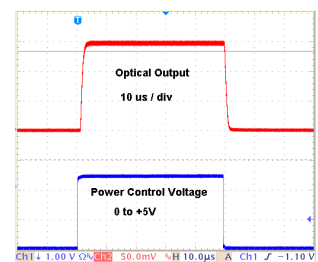
The BDS laser can be operated at two internal clock frequencies, normally 50 MHz and 20 MHz. The frequency is selected by two TTL input lines, F1, and F2:

Signal	Pin at 9-pin laser connector	Frequency	Logic Level
F1	7	50 MHz	active H, internal pull-up resistor
F2	3	20 MHz	active H, internal pull-down resistor

F1	F2	Function
H	L	50 MHz
L	H	20 MHz
L	L	No output. Don't use to turn off the laser - use Laser ON/Off instead.
H	H	Both frequencies active. Don't use.
not connected	not connected	50 MHz

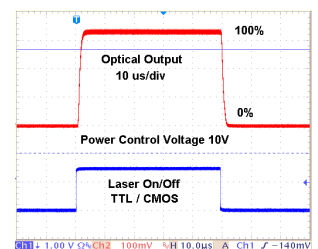
Power Control

The optical power is controlled via a 0 to 10 V analog signal. The signal is connected to pin 8 of the 15-pin connector of the laser. The source of the signal should have less to 100 Ω source impedance. If the input is left open the laser runs at approximately 20% of its maximum power. The reaction to a change in the power control voltage occurs within a time of about 2 μ s, see diagram on the right.



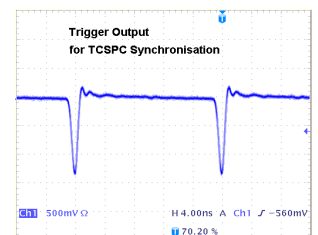
ON / OFF / Multiplexing Control

The optical output of the laser can be switched on and off by a 'Laser ON/OFF' signal at pin 7 of the 15-pin connector of the laser. The logic level is TTL /CMOS, H means 'Laser ON', L means 'Laser OFF'. The laser is 'ON' if the input is left open. The reaction time to the Laser ON/OFF signal is in the range of 1 to 5 μ s, see figure on the right. The SYNC output of the laser becomes inactive when the Laser is in the 'OFF' state. When several lasers are multiplexed their SYNC signals can be combined into a single SYNC line to a TCSPC module by a simple resistive power combiner.



Synchronisation Output

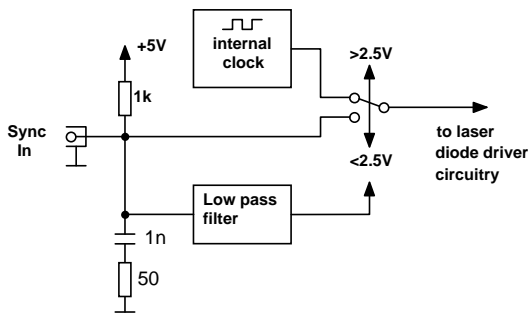
The laser delivers a synchronisation (SYNC) output for TCSPC modules. The pulse polarity is negative, the amplitude is about -1.2V. The pulse duration is about 1ns. The SYNC output is inactive when the laser is in the 'OFF' state (Laser On/Off = L). When lasers are multiplexed their SYNC Out signals can be combined by a simple resistive power combiner.



Synchronisation Input

The synchronisation input is used to synchronise a BDS laser to an external clock source. The input signal must be TTL/CMOS compatible, and DC coupled into the synchronisation input from a 50 Ω source. The pulses must be positive, with a duty cycle of no more than 30%. With a signal like that, the laser automatically recognises that a synchronisation signal is connected, and switches its clock path from the internal clock generator to the synchronisation input.

The principle of clock source switching is shown in Fig. 1. The average voltage at the Sync input connector is sensed via a low-pass filter. The output voltage from the filter sets a switch. If the average voltage is >3 V the clock comes from the internal clock generator, if the voltage is <3 V it comes from the Sync input connector. The active edge of the input signal is the rising edge.



Sync Input:	open	TTL High	TTL Low		
Average voltage:	>3V	>3V	<3V	<3V	>3V
Clock source:	internal	internal	external, but no clock. Don't use	external	internal Don't use

Fig. 1: Principle of switching between the internal clock generator and an external clock source

Power Regulation Loop

Light generation in a laser diode is a highly nonlinear process. The slightest changes in the driving conditions or junction temperature, or mode fluctuations and back-reflection of light into the laser diode can result in large changes in the optical power. Therefore, the BDL-SMN lasers have an internal power regulation loop, see Fig. 2. The laser power is monitored by a photodiode, and the photodiode current, I_{pd} , compared with a reference current, I_{ref} . The difference of both is amplified, and used to control the electrical driving power to the laser diode. Thus, the difference between the photodiode current and the power control signal is regulated down to zero. That means the optical power is linearly related to the power control signal. Changes in the optical power due to temperature variation, variation in the supply voltages, or mode fluctuations in the laser diode are largely suppressed.

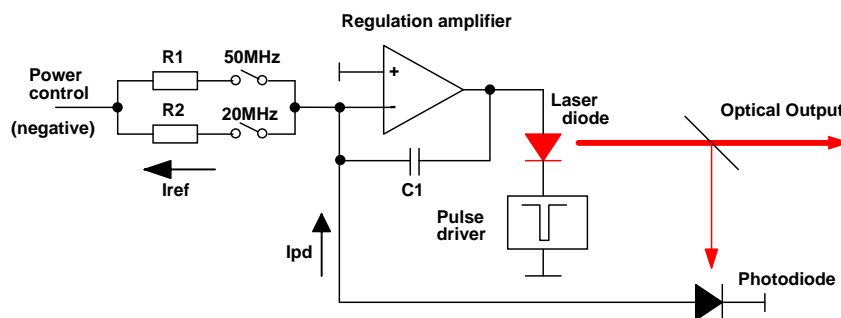


Fig. 2: Principle of power regulation loop

The regulation loop reacts to the average intensity of the optical output, not to the peak intensity of the laser pulses. For constant average power the peak power changes with the pulse repetition rate. When the lasers are running with the internal clock oscillators the variation with the repetition rate is taken into account by switching the resistors, R1 and R2, in proportion to repetition rate selected. For operation with external clock frequencies the peak power changes with the pulse period. To obtain a reasonable power regulation range with an external clock we recommend to chose the F1 an F2 signals for an internal clock frequency closest to the external clock frequency.

Dependence of Pulse Shape on Laser Power

When a laser diode is sharply driven from the off state into the on state it emits a short pulse of light before it settles into its steady-state intensity. In a picosecond diode laser, driving conditions are chosen which result in short duration and high peak intensity of the initial pulse. The pulse shape depends on the amplitude of the current pulse that drives the diode. At low pulse current light pulses of near Gaussian shape are emitted. The pulses get narrower with increasing pulse current. If the pulse current through the diode is increased further emission by the normal light generation mechanism occurs. It more or less follows the current flowing through the diode junction, and forms a bump or tail following the initial peak. At very high power, the amplitude of the bump can reach or exceed the

amplitude of the initial peak, and, eventually, become the dominating part of the pulse profile. Please see pulse shapes at Page 1 of this data sheet. The change of the pulse profile versus the laser power makes it recommendable to keep the laser power at a constant level within one series of experiments.

Operation of the BDS Laser with the LSB Laser Switch Box

For stand-alone use the BDS laser modules come with the LSB Laser switch box and a AC/DC +12 V power adapter. The box contains the key switch and the emission indicator that it is mandatory for class 3b laser products, see Fig. 3, left.



Fig. 3: LSB laser Switch box for operating the BDS lasers as a stand-alone device

The repetition rate can be changed by a switch. The 'Power' control signal and a Laser 'On/Off' signal can be connected to the box via SMA connectors. The control signals can also be fed into a 15-pin sub-D connector, see Fig. 3, right. The pin assignment of this connector is

1	not connected	9	not connected
2	Frequency 20 MHz*	10	not connected
3	Frequency 50 MHz*	11	not connected
4	not connected	12	Power, 0 to +10 V, parallel to SMA connector
5	GND	13	not connected
6	not connected	14	not connected
7	On/Off, parallel to SMA connector	15	GND
8	not connected		

* Put frequency switch in 'EXT' position to use the F1 and F2 inputs

The lasers are, however, fully operable without the switch box, e.g for integration into other instruments. These must then have their own their own laser safety provisions incorporated.

Application Examples

Controlling the BDS Lasers from a DCC-100 Card

The BDS series lasers can be controlled via the bh DCC-100 detector / laser controller card. One of the outputs, Con1, is connected to the control input connector of the laser switch box. The laser power can then be controlled via the ‘Gain’ slider, and the laser output be turned on and off via the +5V button. The other output, Con3, can be used to control a detector or a second laser. Con2 is reserved for controlling shutters.

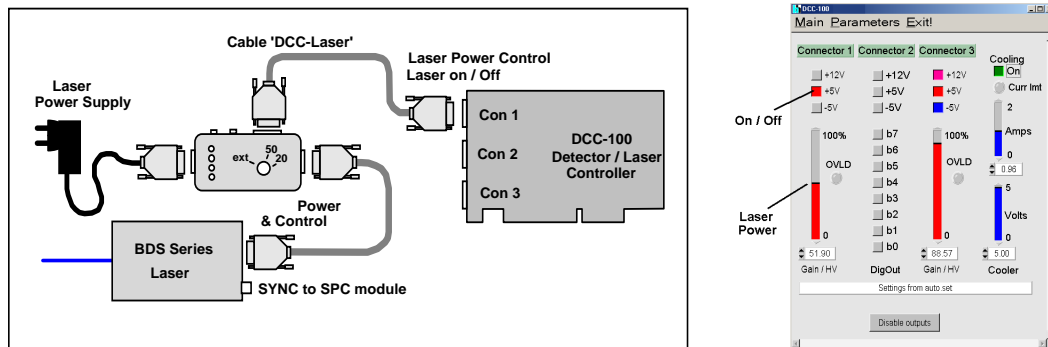


Fig. 4: Controlling the BDL-SMN from a DCC Detector / Laser Controller card

Simple Fluorescence-Decay Experiment

The setup shown in Fig. 5 uses a BDS-MM or BDS-SM laser for a simple fluorescence lifetime experiment. The sample is excited by the picosecond pulses from the laser. The fluorescence photons are detected by a bh HPM-100 or PMC-100 detector, and recorded by an SPC-150, SPC-130, or SPC-130EM TCSPC module (any bh TCSPC module will work). The timing synchronisation signal for the TCSPC module comes from the Sync output of the laser. Both the laser and the detector are controlled by a DCC-100 detector / laser controller card. The entire setup is operated via the bh SPCM TCSPC operating software, see Fig. 5, right.

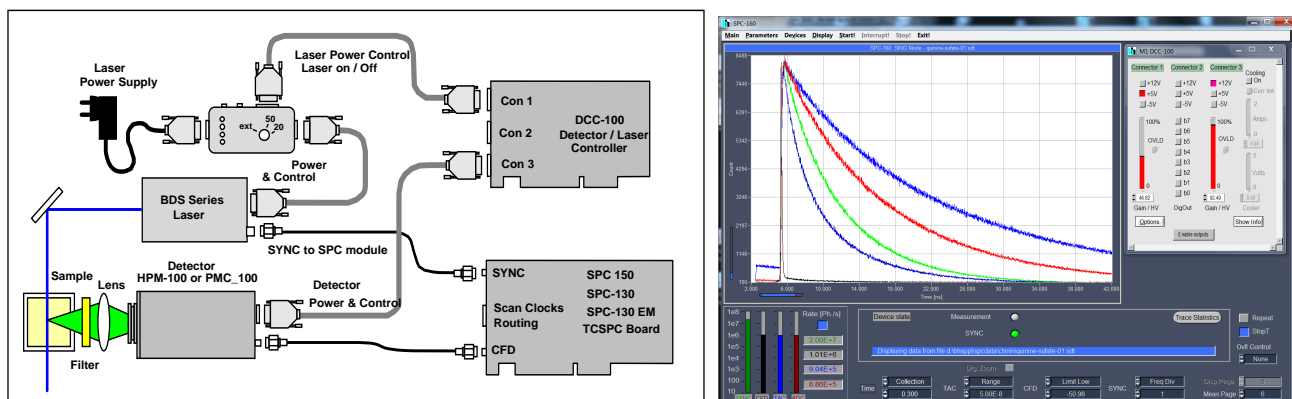


Fig. 5: Simple fluorescence-lifetime experiment. Left: System setup. Right: SPCM panel.

Laser Multiplexing

Two or more lasers are switched on/off alternately at a period in the microsecond or millisecond range. Simultaneously with the switching of the lasers, the memory block address in the SPC module is switched. Thus, photons excited by each laser are stored in separate memory blocks in the SPC module [1, 2].

A connection diagram is shown in Fig. 6. The laser on/off signals are generated in a DDG-210 pulse generator card. Switching of the lasers is achieved via the ‘Laser on/off’ inputs of the lasers. The DDG-210 card also generates the routing signal for the SPC module. It is applied to the lowest routing bit, R0, via the 15-pin control connector of the SPC module. Please see [2] for details.

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