Operating the Pulsed Laser Diode SPL PLxx

Application Note

Introduction

The SPL PLxx type pulsed laser diode is operated by directly applying the forward current pulses to the anode and cathode pins. The cathode pin is the short one. To generate short (up to 100 ns) and high-amp (up to 75 A) current pulses a suited laser diode driver is necessary.

Figure 1: *Pulsed laser diode SPL PLxx in plastic package*

Electrical operation: laser diode drivers

The important criterion concerning the driver electronics is the combination of amplitude, width and repetition frequency (or rep rate) of the current pulses.

In principal two different types of suited laser diode driver are offered:

- cost-effective driver boards for OEM application
- housed tabletop devices

With these boards very short pulses with high currents and high rep rates can be achieved:

- pulse widths from 4 ns to 100 ns.
- peak currents up to 120 A
- rep rates up to 50 kHz

The pulsed laser driver circuit consists of a capacitor with capacitance C and a switch which discharges the charge of the capacitors to the laser. The charging of the capacitor is done between two laser pulses. As switch a MOSFET or an avalanche transistor can be used. Figure 2 shows a schematic pulser circuit using an avalanche transistor as switch.

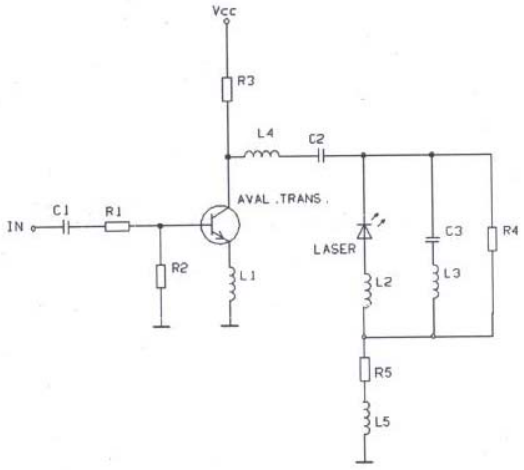

Figure 2: *Schematic pulsed laser driver circuit with a capacitor C2 for storing the electrical energy and an avalanche transistor as switch [1].*

A simple approximation for the value of the storage capacitance C is:

$$C \times U = I_p \times t_p \qquad (1)$$

Increasing the value of C increases both the width of the current pulse t_p and the peak amplitude of the current I_p. By increasing the operating voltage U the amplitude of the current pulse increases (and in practice, at the same time the width of the current pulse decreases slightly, because the on state resistance of the transistor decreases) [1], [2]. Please note that it is very important to minimize the inductance of the circuit.

Therefore low loss RF capacitors (ceramic chip capacitors) have to be used. Current carrying conductors have to keep to the bare minimum. Also the leads of the laser diode have to be cut as short as possible. To separate the laser diode from the circuit board a transmission line has be used to minimize the inductance. Note that each inch of length adds approximately 20 nH of inductance. This means that a di/dt of 20A/10ns generates a transient Ldi/dt voltage of 40 V per inch of wire length. The real effect will be a significant increase in rise time. Please note that the operating voltage is in the range of some tens or hundreds volts.

A supplier of specially manufactured avalanche transistors is the company Zetex [3]. Figure 3 shows the avalanche current vs. supply voltage for the Zetex ZTX413 avalanche transistor.

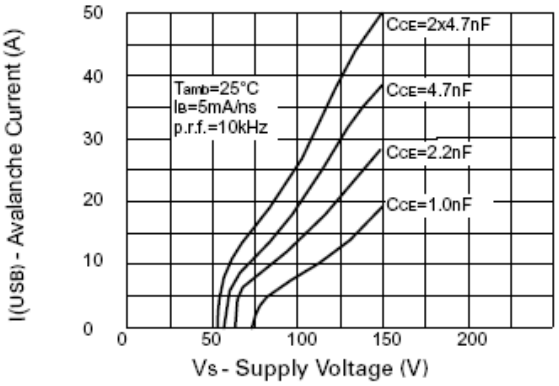

Figure 3: *Avalanche current against supply voltage for the ZTX413 avalanche transistor.*

Please note that the operating voltage is a high voltage in the range of several 10 to several 100V. The charge capacitors have values of several nF.

For example an OEM board from the company DEI delivers 50 Amp high and 15 ns wide 15 ns current pulses. The charge capacitors have values of 4 nF and the operating i.e. charge voltage is 195 V. This corresponds in good approximation to equation (1): 4nF x 195V ≈ 50 A x 15 ns

Suppliers of pulsed laser drivers boards and accessories

There are several suppliers of pulsed laser drivers with different combinations of current pulse amplitude, width and rep rate.

- EO-Devices Inc. [4]

The product line of OEM pulsed laser diode driver boards is called ETX [5].
These driver boards have fixed pulse widths determined by the capacitors. The peak current is adjustable by the operating high voltage. As switch a MOSFET is used. Maximum current pulse amplitudes and pulse widths vary from 35 to 75 Amps and from 5 to 30 ns, respectively.
The 75 Amp board is equipped with an on-board DC-DC-converter to supply the high voltage directly on the board.

Also available from EO-Devices are DC-converters to convert low DC voltage (12V) into high DC voltage, adjustable by a trim potentiometer.

EO-Devices also offers optical receivers, laser ranging subsystems and time-of-flight chronometers for OEM applications.

- Directed Energy Inc. [6]

The product line of OEM pulsed laser diode driver boards is called PCO-7110 [7] and uses MOSFETs as power switch.
These driver boards have fixed pulse widths determined by the capacitors. The peak current is adjustable by the operating high voltage. Maximum current pulse amplitudes and pulse widths vary from 40 to 120 Amps and from 4 to 65 ns, respectively.
Figure 4 shows the detector signal of a SPL PL90_3 driven by the PCO-7110 model 100-7. The optical peak power is 70 W at 250 V operating voltage of driver board (see figure 5).

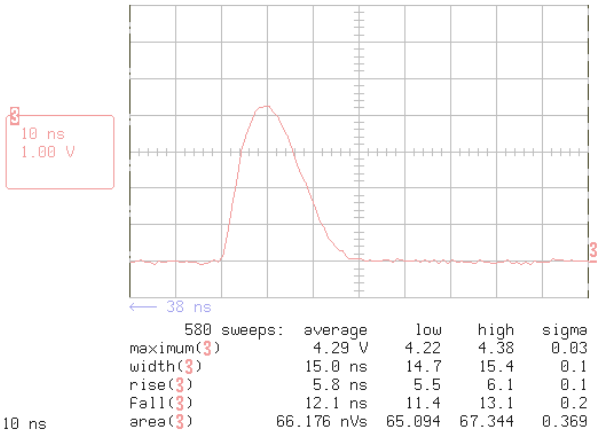

Figure 4: *PIN photo diode signal of SPL PL90_3 driven by the board PCO-7110 model 100-7 from Directed Energy Inc. Peak power is 70 W, pulse width is 15 ns (FWHM) and rise/fall times are 6 and 12 ns respectively.*

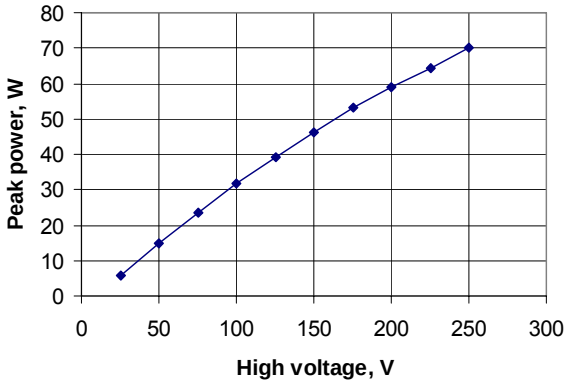

Figure 5: *Peak power vs. pulser voltage for SPL PL90_3 with pulser PCO-7110 model 100-7 from Directed Energy Inc.*

Also available is a driver board called PCO-7120 [8] with variable pulse width from 12 ns to 1 µs and variable peak current from 5 to 50A. Maximum rep rate varies with pulse width and amplitude. The absolute maximum is 1MHz at moderate pulse width and amplitude.

- Dr. Heller Elektronik KG [9]

Dr. Heller Elektronik offers an OEM driver board with variable peak current (0 to 50 A), pulse width (25 to 100 ns) and repetition rate (up to 10 kHz). Because the principal of operation is based on charging a delay line the driver delivers roughly rectangular shaped pulses (see figure 6). This driver board is custom made for OSRAM Opto Semiconductors for testing the laser diodes in the lab and production line.

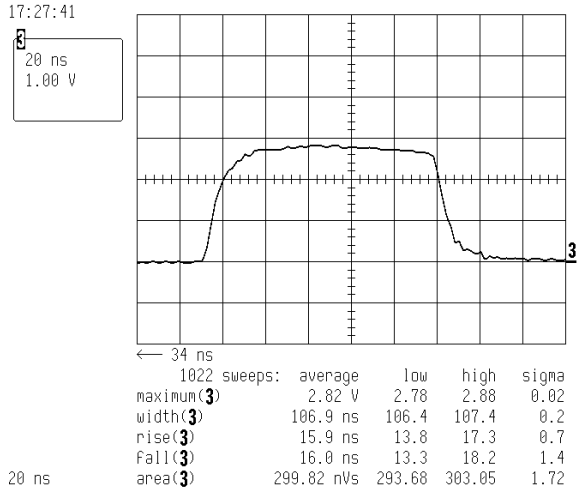

Figure 6: *PIN photo diode signal of SPL PL90_3 driven by a 30 A high and 100 ns wide current pulse using a pulser from Dr. Heller Elektronik.*

Another type of driver board the HS-LD25.0 operates at fixed pulse width of 4 ns and peak currents from 4 to 25 A. Figure 7 shows the detector signal of a SPL PL85 pulse laser (850 nm) driven by the HS-LD25.0 laser pulser from Dr. Heller Elektronik KG.

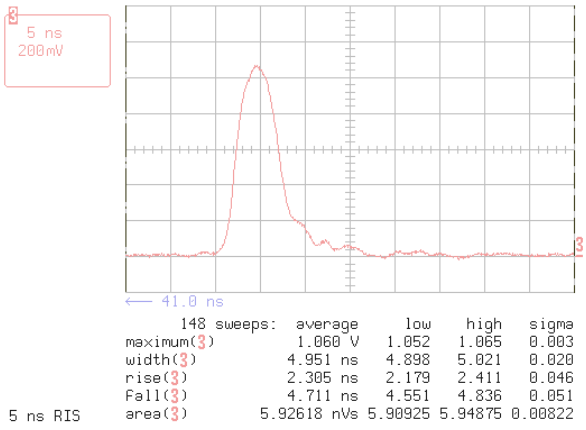

Figure 7: *PIN photo diode signal of SPL PL85 driven by a fast MOSFET laser pulser (laser diode driver HS-LD25.0 from Dr. Heller Elektronik KG). Peak power is 17 W, pulse width is 5 ns (FWHM) and rise/fall times are 2.3 and 4.7 ns respectively.*

- Avtech Electrosytems Ltd. [10]

Avtech Electrosystems Ltd. is a supplier of housed tabletop laser diode drivers with front panel, display, interfaces etc.
The parameters like pulse current, width and repetition rate are adjustable by front panel knobs or via IEEE or RS232 interface.
There are two types of laser diode driver series operating in pulsed voltage or pulsed constant current mode. The type of choice depends on the operating conditions of the laser diode.
Please see the Avtech website to select the suited laser driver out of the large product range. As an example the model AVO-5A-C (20 to 200 ns, max. 5 kHz, max. 40 A) should be mentioned here.

- Current Probes

For measuring high-amp current pulses so called current probes can be used. These inductive probes transform the current pulses into voltage pulses which can be displayed on an oscilloscope.
A supplier of suited current probes is Channel Island Circuits [11].

References:

[1] A. Kilpelä, J. Kostamovaara, A laser pulser for a TOF laser radar, Review of Scientific Instruments Vol 68(6) pp. 2253-2258, June 1997

[2] A. Kilpelä, Pulsed time-of-flight laser ranfe finder techniques for fast, high precision measurement applications, University of Oulu, Finland, 2004,http://herkules.oulu.fi/isbn9514272625/isbn9514272625.pdf

[3] Zetex Semiconductors
http://www.zetex.com

[4] EO Devices Inc.
http://www.eodevices.com
mailto:sales@eodevices.com

[5] Application note of EO-Devices ETX pulsed laser driver series:
http://www.eodevices.com/pdf/an_1.pdf

[6] Directed Energy Inc.
http://www.directedenergy.com
mailto:deiinfo@directedenergy.com

[7] Application note of Directed Energy PCO-7120 pulsed laser driver series:
http://www.directedenergy.com/Products/specs/pdfdocs/sppco-7110.pdf

[8] Application note of Directed Energy PCO-7110 pulsed laser driver series:
http://www.directedenergy.com/Products/specs/pdfdocs/sppco-7120.pdf

[9] Dr. Heller Elektronik KG, Germany, -
www.dr-heller-elektronik.de
mailto:info@dr-heller-elektronik.de

[10] Avtech Electrosystems Ltd.
http://www.avtechpulse.com
mailto:info@avtechpulse.com

[11] Channel Island Circuits
http://www.channelislandcircuits.com/
mailto:cic@impulse.net

Author: Stefan Morgott

About Osram Opto Semiconductors

Osram Opto Semiconductors GmbH, Regensburg, is a wholly owned subsidiary of Osram GmbH, one of the world's three largest lamp manufacturers, and offers its customers a range of solutions based on semiconductor technology for lighting, sensor and visualisation applications. The company operates facilities in Regensburg (Germany), San José (USA) and Penang (Malaysia). Further information is available at www.osram-os.com.