Operating the Pulsed Laser Diode SPL LLxx

Application Note

Introduction

The SPL LLxx (SPL LL85 and SPL LL90) are hybrid laser modules. Additional to the laser chip the module contains two capacitors and a MOSFET which act as a driver stage. The two capacitors are connected in parallel to sum their individual capacitance of 47 nF. The SPL LL85 and LL90 differ in their emission wavelength of 850 and 905 nm respectively. The specified optical peak power is 14 W for the SPL LL85 and 25 W for the SPL LL90.

Principal of operation

The capacitors are charged using a constant DC voltage. Each time the gate of the MOSFET is triggered, the capacitors are uncharged via the laser chip leading to a short and high-amp current pulse. These high-amp current pulses are required to obtain the high peak power laser emission.

The pin configuration of the SPL LLxx laser diode is as follows:

Pin 1: Trigger signal for the MOSFET gate
Pin 2: Charge voltage
Pin 3: Ground

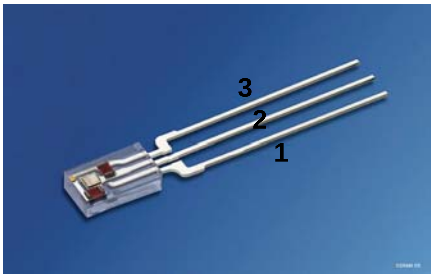


Figure 1: *Hybrid pulsed laser diode SPL LLxx with integrated driver stage.*

Optical peak power

As shown in figure 2 the peak current and therefore optical peak power is adjusted by the applied charge voltage. The SPL LL85 and LL90 typically deliver 14 W at 7 V and 25 W at 16 V respectively (30 ns, 1 kHz).
The maximum ratings of peak power are 16 and 30 W for the SPL LL85 and LL90 respectively. The lower maximum power of the SPL LL85 is due to the lower allowed level of optical power density on the facet of the laser die.

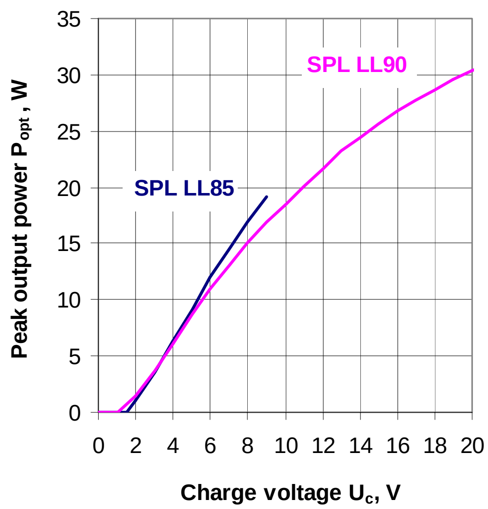


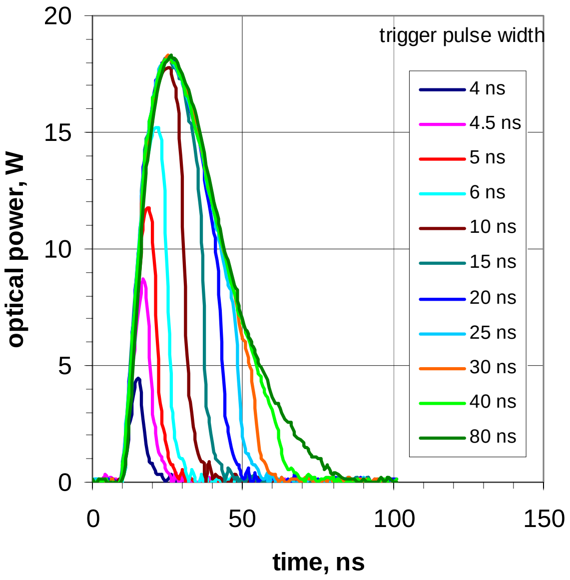
Figure 2: *Variation of optical peak power with charge voltage (pulse width 30 ns, PRF 1 kHz, gate voltage 15 V) for SPL LL85 and SPL LL90 using the MOSFET driver Elantec EL7104C.*

Optical pulse width

In principle the width of the laser pulse is determined by the value of the capacitors. As shown in figure 3 and 4 for the SPL LL85 an additional tuning (5 to 30 ns FWHM) can be achieved by adjusting the pulse width of the MOSFET trigger (gate) signal. Please note that the peak output power decreases for optical pulse widths shorter than 20 ns. The maximum pulse width is 30 ns. By increasing the trigger pulse widths beyond 30 ns the FWHM width of the optical pulse and the peak power remains constant but the pulse energy increases (within the tail of the optical pulse). As a result the fall time increases for longer pulse widths. Beyond a trigger pulse of 80 ns the pulse shape remains unchanged.

Pulse repetition frequency (PRF), duty cycle (d.c.)

The PRF of the laser pulses corresponds to the frequency of the trigger signal. Due to dissipation of heat within the laser chip, the maximum duty cycle is limited to 0.1 %. Increasing the d.c. leads to an increase of the chip and package temperature and therefore to a decrease of optical power performance. An increase of chip temperature can also lead to a permanent degradation of the chip and/or package and therefore reduction of operating lifetime.



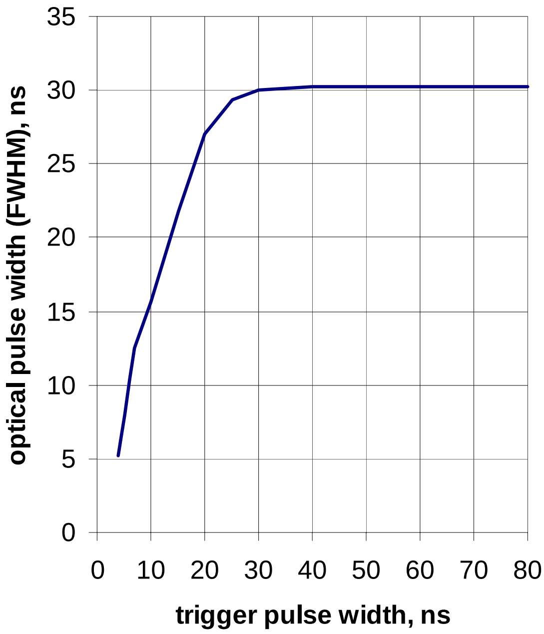
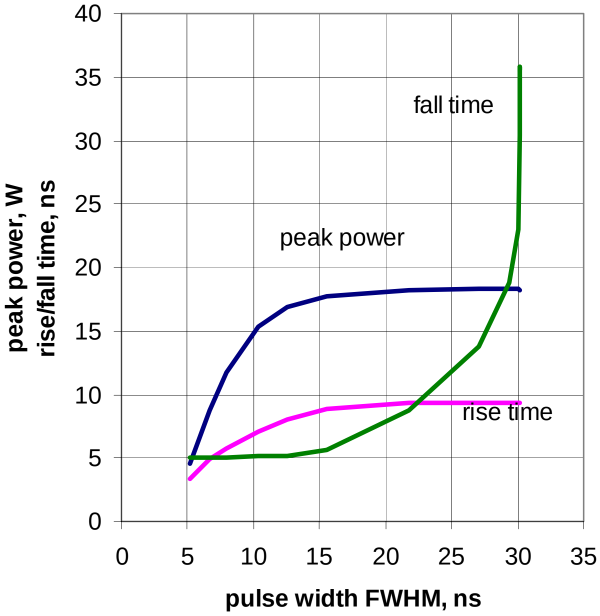


Figure 3: *Optical pulse form for different trigger pulse widths of SPL LL85 (top) and variation of optical pulse width (FWHM) with trigger pulse width (bottom). Operating conditions are 15 V gate voltage, 9 V charge voltage and 1 kHz PRF, using the MOSFET driver Elantec EL7104C.*



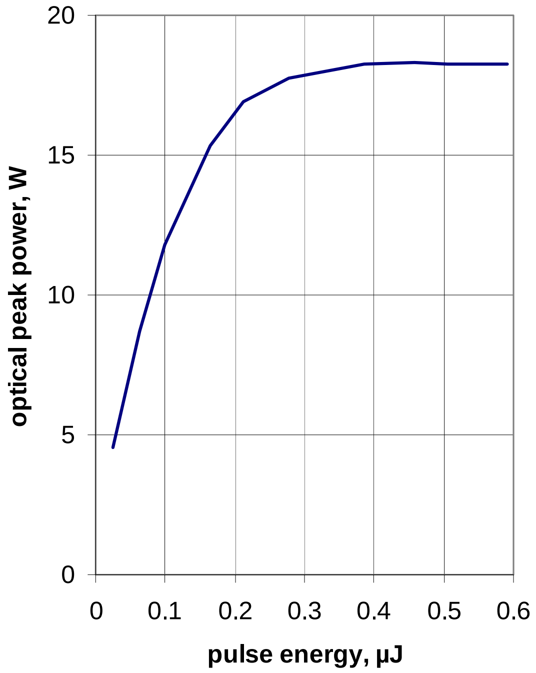


Figure 4: *Variation of peak power and rise/fall time with pulse width of SPL LL85 (top). Optical peak power vs. pulse energy (bottom). Operating conditions are 15 V gate voltage, 9 V charge voltage and 1 kHz PRF, using the MOSFET driver Elantec EL7104C.*

Laser Driver Electronics

To obtain the short optical pulses, the MOSFET gate has to be charged very fast. The MOSFET has a gate capacitance of 300 pF. To obtain the required gate-source threshold voltage of 5 V the gate must be charged with about 7 nAs within several nanoseconds. Therefore a pulsed trigger current of about 1 A is required. Such a signal can be generated by a high speed power MOSFET driver IC which itself is triggered by a TTL-level voltage signal.

As MOSFET driver we can suggest the following types
- Elantec EL7104C [1]
- Micrel MIC4452 [2]

Figure 3 shows the block diagram of the SPL LLxx together with the MOSFET driver IC. Both MOSFET driver ICs mentioned above have the same pinning.

The MOSFET inside the hybrid package is the Infineon BSP318S [3].

To operate the SPL LLxx two DC voltages are needed namely the supply voltage Vs for the MOSFET driver IC and the charge voltage Vc for charging the capacitors. Please note that the charging resistor determines the charging current and therefore the time necessary to charge the capacitors i.e. the maximum lasing repetition rate.

To ensure proper operation of the MOSFET driver several guidelines have to be observed. Problems that can occur are CMOS latch-up, over-voltage spikes, insufficient overdrive and thermal overload. These phenomena and their prevention are described in the Elantec application note #25 ‘Applying Power MOSFET Drivers’ [4] by using bypassing capacitors, clamping Schottky diodes and external resistors. Useful application information are also given in data sheet of the Micrel MIC4452 [2].

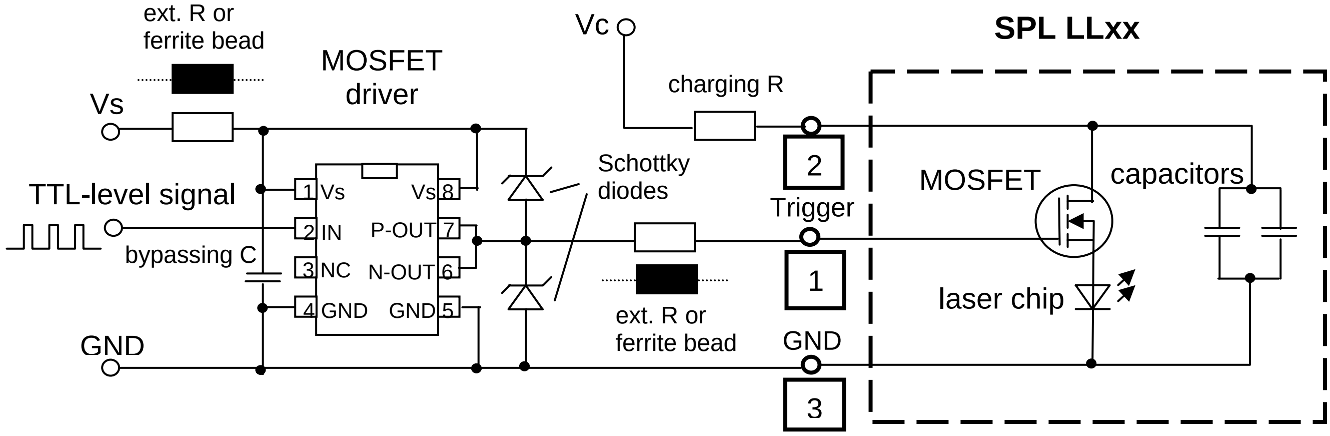


Figure 3: *Schematic of the internal and external driver electronics for the SPL LLxx.*

References:

[1] Elantec Inc., datasheet of EL7104C: http://www.elantec.com/pages/pdf/d47104.pdf

[2] Micrel Inc., datasheet of MIC4452: http://www.micrel.com/_PDF/mic4451.pdf

[3] Datasheet of Infineon BSP318S: http://www.infineon.com/cmc_upload/migrated_files/document_files/Datasheet/bsp318s.pdf

[4] Elantec application note #25 'Applying Power MOSFET Drivers': http://www.nalanda.nitc.ac.in/industry/appnotes/Elantec/d40931.pdf

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