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Published by
ams OSRAM Group

Application Note No. AN105

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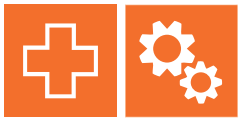
Operating the pulsed laser diode SPL LL90_3

Application Note



Valid for:
SPL LL90_3

Abstract

The SPL LL90_3 is a hybrid laser module. 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 emission wavelength is 905 nm. The specified optical peak power is 70 W.

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A. Principal of operation

The capacitors are charged using a constant DC voltage. Each time the gate of the MOSFET is triggered, the capacitors are discharged 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 (at charge voltage of 18.5 V a current pulse of up to 30 A is possible).

The pin configuration of the SPL LL90_3 laser diode is as follows:

Pin 1: Trigger signal for the MOSFET gate

Pin 2: Charge voltage

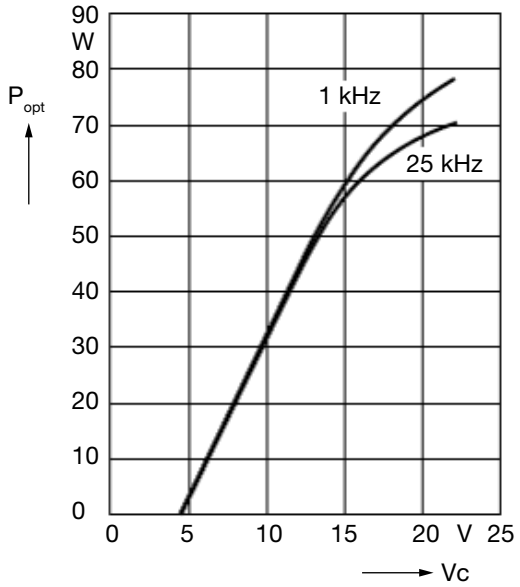
Pin 3: Ground

Figure 1: Hybrid pulsed laser diode SPL LL90_3 with integrated driver stage.

B. 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 LL90_3 typically delivers 70 W at 18.5 V (30 ns, 1 kHz). The maximum rating of peak power is 80 W. By increasing of pulse repetition frequency the peak optical power will be slightly decreased (as shown in Figure 2).

Figure 2: Variation of optical peak power P_{opt} with charge voltage V_c (pulse width t_p = 30 ns, PRF 1 kHz and 25 kHz, gate voltage 15 V) for SPL LL90_3 using the MOSFET driver Renesas EL7104C



C. 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 Figure 4 an additional tuning (5 to 30 ns FWHM) can be achieved by adjusting the pulse width of the MOSFET trigger (gate) signal.

Figure 3: Optical pulse form for different trigger pulse widths of SPL LL90_3 (left) and variation of optical pulse width (FWHM) and peak power with trigger pulse width (right). Operating conditions are 15 V gate voltage, 18.5 V charge voltage and 1 kHz PRF, using the MOSFET driver Renesas EL7104C

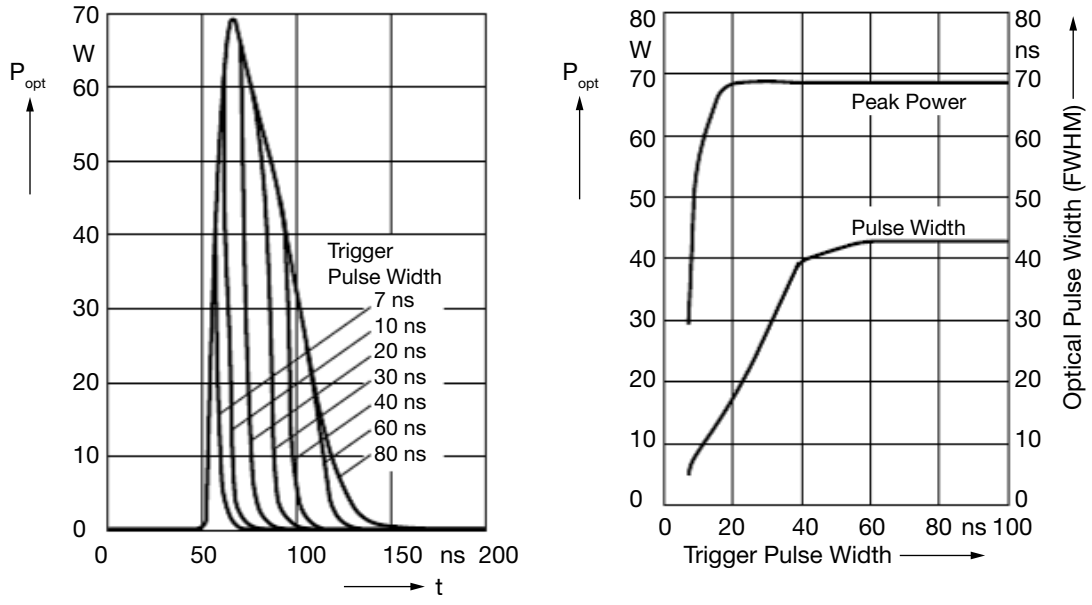
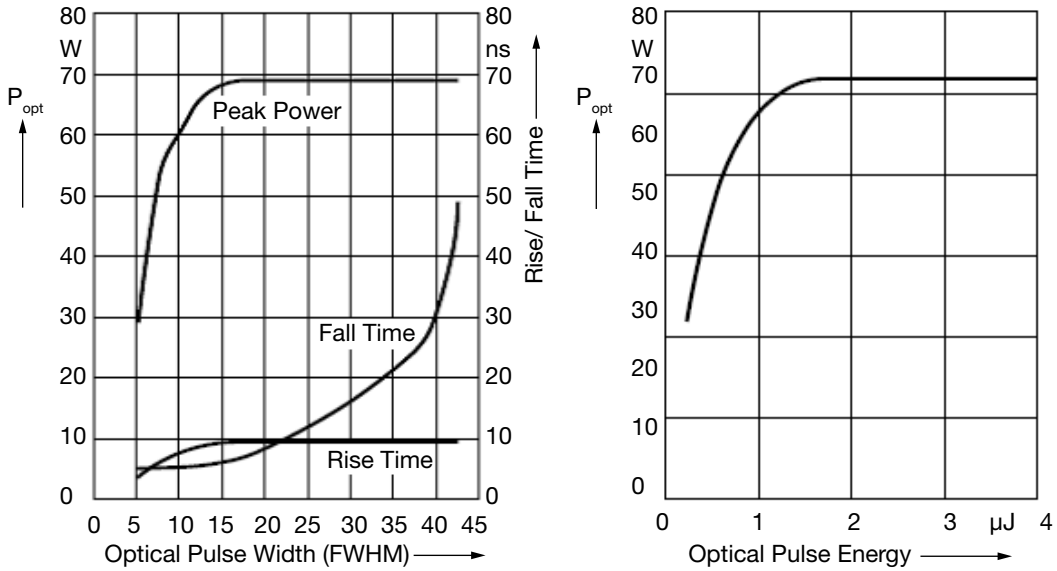


Figure 4: Variation of peak power and rise/ fall time with pulse width of SPL LL90_3 (left). Optical peak power vs. pulse energy (right). Operating conditions are 15 V gate voltage, 18.5 V charge voltage and 1 kHz PRF, using the MOSFET driver Renesas EL7104C



Please note that the peak output power decreases for optical pulse widths shorter than 20 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.

D. 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.

E. 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

- Renesas EL7104C [1]
- Micrel MIC4452 [2]

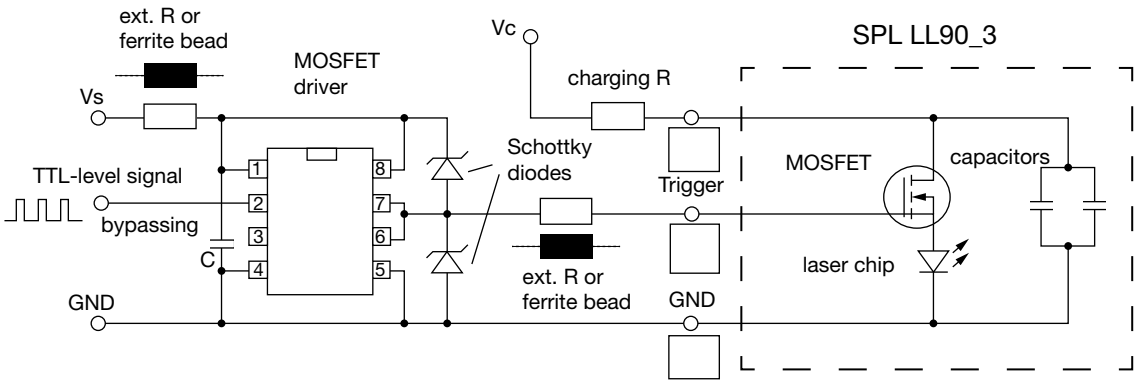
Figure 5 shows the block diagram of the SPL LL90_3 together with the MOSFET driver IC. Both MOSFET driver ICs mentioned above have the same pinning.

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

To operate the SPL LL90_3 two DC voltages are needed namely the supply voltage Vs (e.g. 15 V) for the MOSFET driver IC and the charge voltage Vc (e.g. 18.5 V) 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 Renesas application note AN1108 “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 5: Schematic of the internal and external driver electronics for the SPL LL90_3



F. References

[1] Renesas Electronics, data sheet of EL7104C, https://www.intersil.com/content/dam/Intersil/documents/el71/el7104.pdf

[2] Micrel Inc., data sheet of MIC4452 http://ww1.microchip.com/downloads/en/DeviceDoc/mic4451.pdf

[3] Infineon Technologies, data sheet of BSP318S, https://www.infineon.com/cms/de/product/power/mosfet/20v-800v-n-channel-small-signal-mosfet/bsp318s/

[4] Renesas Electronics, application note AN1108 “Applying Power MOSFET Drivers”, https://www.intersil.com/content/dam/Intersil/documents/an11/an1108.pdf

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