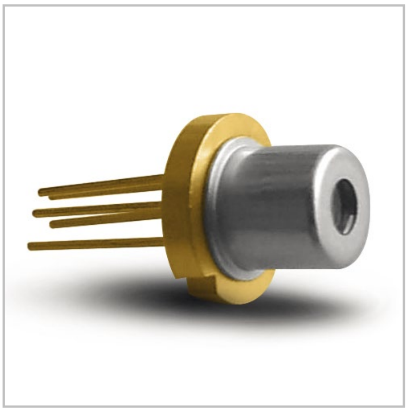
Laser
Diodes

Operating the QS (QuickSwitch®) Laser Application

Introduction



The QS-905 is a compact hybrid TO-56 size which contains a 905 nm laser diode and a fast switching FET capable of sub nanosecond rise time of the laser current. The QS-905 used with a triple junction laser, will deliver optical pulses of 2.5 ns with optical power in excess of 80 W with the QS905D1S3JT09U variant.

Principle of Operation

The fast switching FET discharges an internal capacitor into the laser to form the pulse typically less than 2.5 ns FWHM (Full Width Half Max).

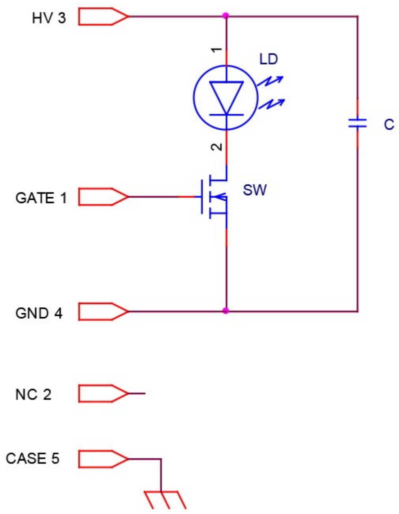


Figure 1: Equivalent circuit

The FET switch can be as fast as an avalanche transistor, but with a lower power dissipation, which enables sustained operation at several 10's of kHz, and burst mode up to a few 100 kHz in free air. Higher repetition rate will require heat sinking of the QS case.

Using a lower capacitance storage capacitor can lead to shorter pulse and a reduced peak power. Inversely, higher capacitance will allow higher peak power, but with a larger FWHM. Please consult factory for special request.

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EMI Shielding and Recharge Element

As high current is switched inside the TO-56 can, the isolated case, pin 5, shall be connected to ground to reduce external EMI (Electro Magnetic Interference).

An external series resistor (R15) of 1 kΩ between HV and PIN 3 is recommended for operation up to 100 kHz repetition rate. This series resistor may also be combined with a small inductance value to reduce the peak current value on the HV line. If inductance value is too large, an HV overshoot may be created when firing is interrupted. For operation above 100 KHz, R15 will need to be reduced proportionally. The higher power QS version may also have higher internal capacitance, in which case a lower value of R15 may be required.

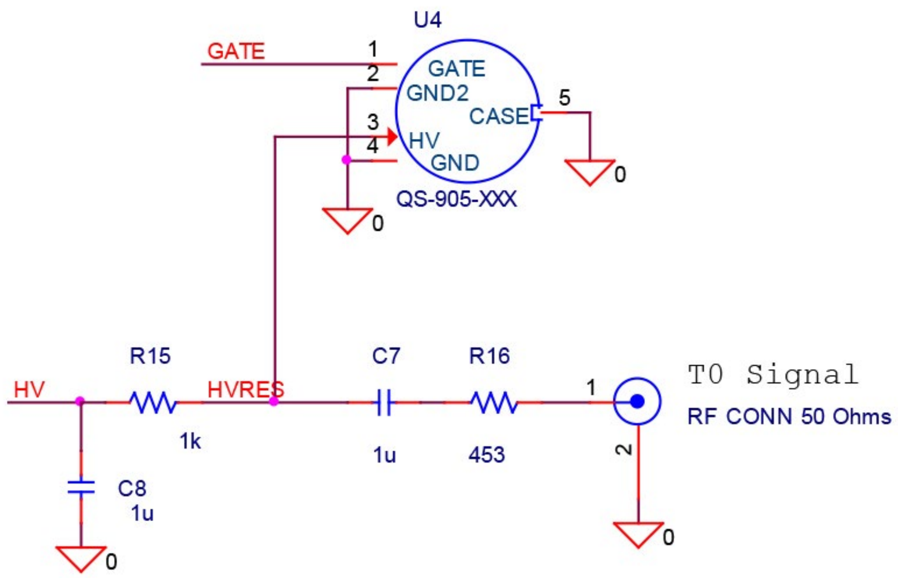

Figure 2: HV recharge and monitor.

Having a good timing signal to indicate when the laser is fired is important in most LIDAR systems. The trigger signal is usually not a good timing reference due to the latency of the gate driver. The capacitor discharge is rapid and may be used as a To (laser firing) time reference. The HV discharge needs to be attenuated by a series resistance such as R16. R16 value may need to be adjusted such that the pulse amplitude matches the logic level of the timing electronics such as the TDC (Time to Digital Converter). Both R15 and R16 shall be kept close to the QS package to maintain optimum performance and reduced EMI. Loading the To into 50 Ω is acceptable for repetition rate up to 25 kHz. For higher repetition rate a much higher impedance driver is required in order not to affect the recharge circuit.

Gate Driver and Gate Pulse Width

The QuickSwitch® behaves as a linear device, so the rise time of the signal applied to the gate of the switch must have a fast rise time to achieve the specified peak power and FWHM (Full Width Half Max) of a few nanoseconds. Slower driver rise time will lead to a lower peak power and a wider FWHM.

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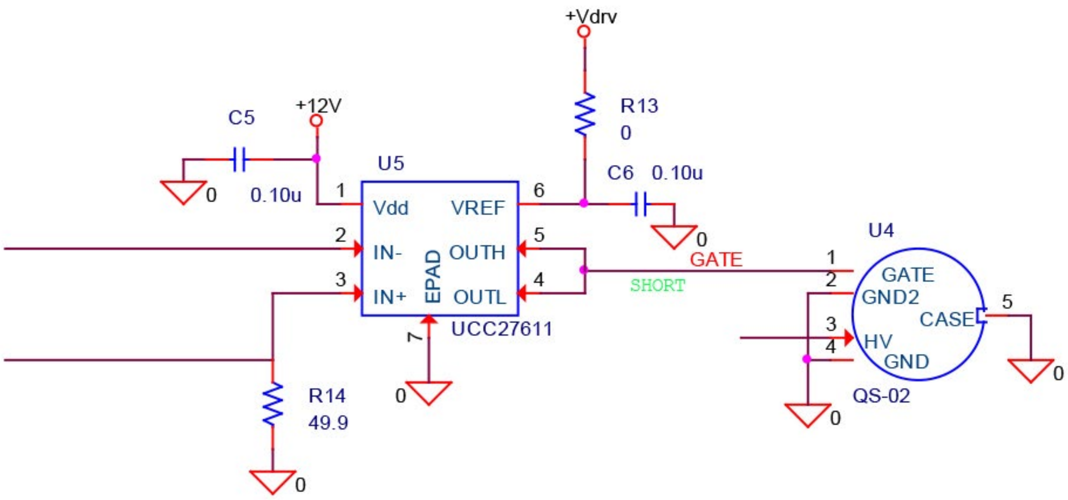

Figure 3: QS recommended driver

It is recommended to use a driver such as the TI UCC27611. The recommended +Vdrv shall be 5.4 V for the fastest optical rise time and narrowest FWHM. Higher +Vdrv may damage the QS device. The driver shall be located close to the gate pin of the QS device to minimize gate ringing which may damage the QS internal gate.

The signal applied at the input of the UCC27611 coming from a FPGA or other logic circuitry should typically have a pulse width of 40 ns. Although the laser pulse may be on only 3 ns, it is recommended to hold the gate ON for 40 ns, until internal ringing stops. Longer hold ON time may be used, but would lead to higher power dissipation into R15 (Fig. 2) and to a reduced recharge time.

Power Modulation

Optical power may be reduced by lowering the applied HV, from 80 V down to 20 V. Lower HV leads to reduction of both the optical rise time and the FWHM of the pulse. Below 20 V, follows a rapid degradation of the optical power and of the FWHM. For more details, please refer to the QS datasheet.

References:

[1] Laser Components, datasheet of the QS-905
https://www.lasercomponents.com/fileadmin/user_upload/home/Datasheets/lc-pld/qs-905-series.pdf

[2] Texas Instruments, datasheet of the UCC27611 www.ti.com/lit/pdf/slusba5

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