What is a Photocunductive Semiconductor Switch (PCSS)

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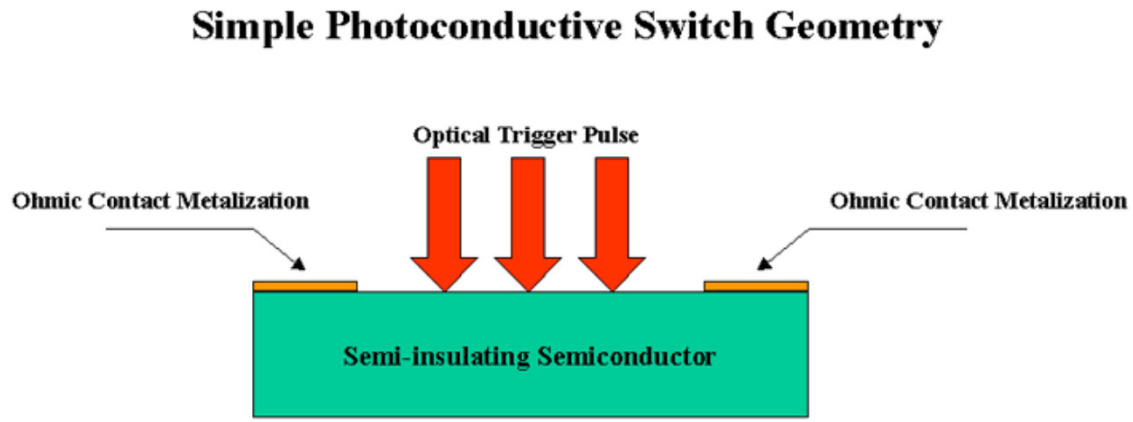
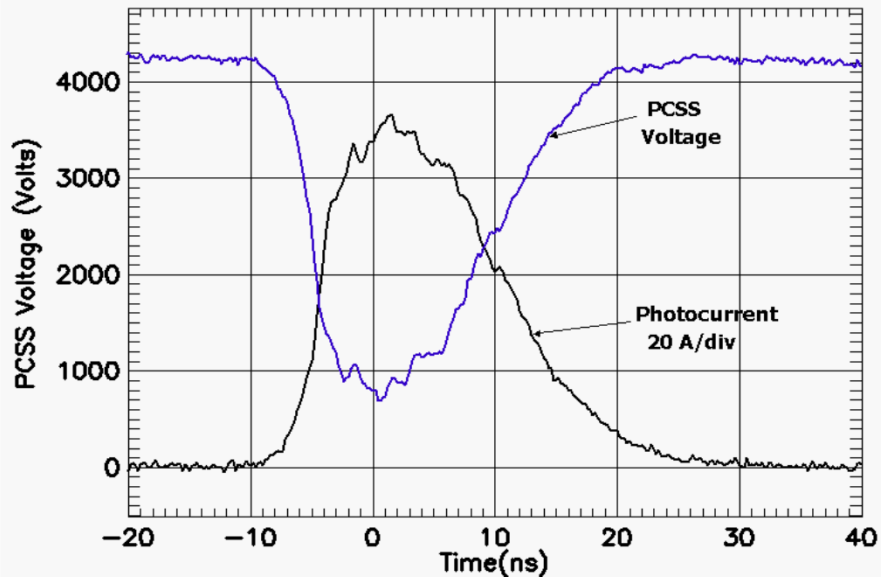
Definition

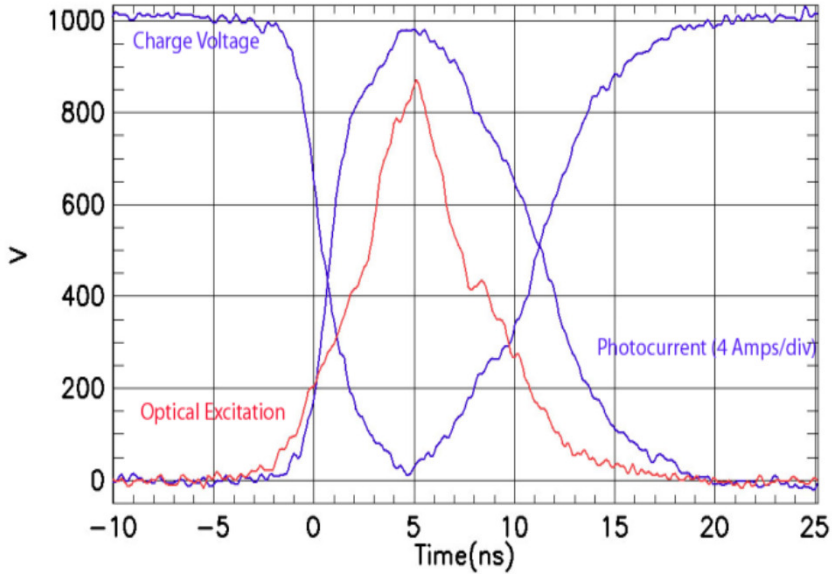
A photoconductive switch, or PCSS is an electrical switch which is based on the photoconductivity of a material, i.e. an increase in its electrical conductance as a consequence of irradiation with light. In nearly all cases, one uses a semiconductor material, where the absorbed light (with a photon energy above the bandgap energy) generates free carriers, which then contribute to the conductivity. Before the light turns it on, it does not conduct electricity. In most types of PCSS devices, the electrical conduction ceases or rapidly decays once the light source is turned off. In other cases the electrical conduction might continue, which is called a "latch-on" effect.

Many more details about PCSS devices are described in the article called **"Wide Bandgap Extrinsic Photoconductive Switches"** by J.S. Sullivan of Lawrence Livermore National Laboratory (LLNL) - that report is publicly available and can be downloaded at https://e-reports ext.llnl.gov/pdf/759551.pdf.

From LLNL report.







Kyma Tech, KO-Switch™

This high speed, high power, bulk GaN based photoconductive semiconductor switch (PCSS) combines high breakdown voltage, low on-resistance with fast switching speed.

The KO-Switch uses a specially tailored form of Kyma's crystalline semi-insulating bulk GaN, and is designed to block up to **2,000V and to drive 40A** into a **50 Ω** load at 80,000W in power when turned on with an appropriate optical beam.

The KO-Switch is claimed to respond to all wavelengths in the visible region of the electromagnetic spectrum.

Kyma's tests show rapid response of the KO-Switch to their laser, providing an upper limit of ~1 ns response time. Indeed, the switch may be significantly faster.

The results independent investigations were in close agreement and showed an average photoexcited carrier lifetime of **90 picoseconds**, with the fastest and longest measured values being **18 and 200 picoseconds**, respectively.

Microwave switches samples

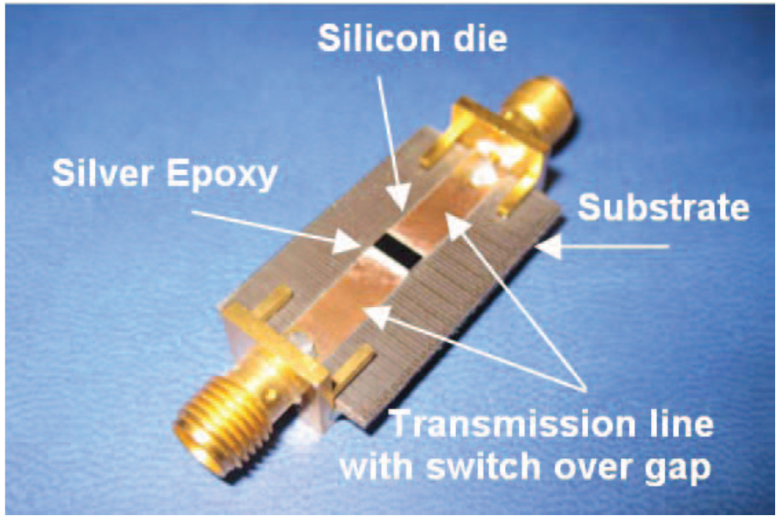


Fig. 1
This is a very simple design, the Si die glued with a conductive epoxy.

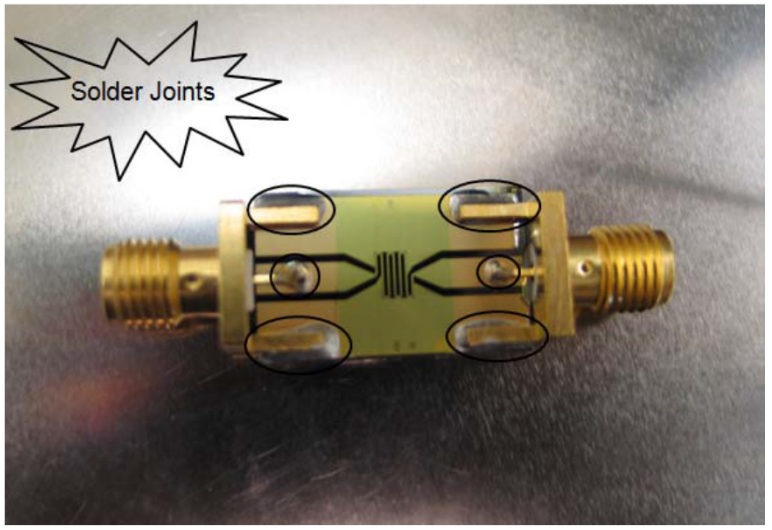
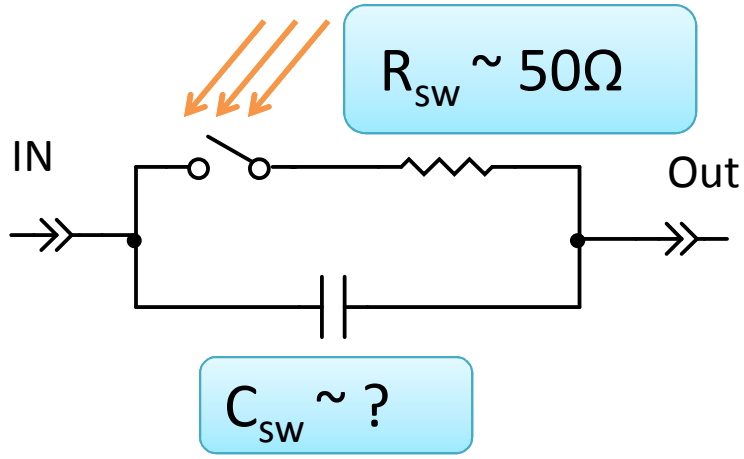


Fig. 2

Both were tested up to 10 GHz. The On/Off ratio at 2GHz is about 10db for the left and close to 45db for the right one.

Equivalent circuit of the PCSS switch :



The exact microwave control circuit depends of PCSS specs. A series resistance is about 50Ω for *Kyma Tech* switches and it cannot be very low. The cross capacitance depends from the switch geometry layout. For ON/OFF ratio above 10, two or more switches may requires.

Discussion

The PCSS switch is a very fast photo-electrical switch-device with a lot of potential application.

Use of the light pulse for triggering is a very robust way to operate PCSS with precision timing and minimum interference with other electronic devices.

It could be used in the microwave or RF control circuits or in microwave generators with sub nanosecond timing capability.

However, the confirmation of suitability, long term operation with desired repetition rate, and the exact circuit design may require an extra R&D.