LEYSOP LTD

Manufacturers and suppliers of electro-optic components

Pulse Slicing with Pockels Cells

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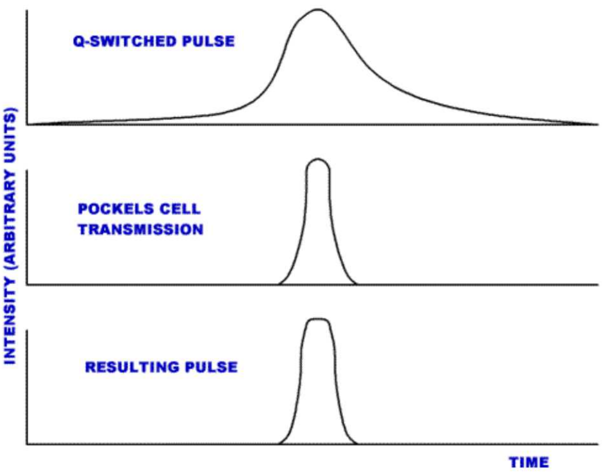
It is well known that the generation of short duration, intense optical pulses may be achieved by the technique of laser Q-switching. The laser's circulating stored energy field is kept from building up to any appreciable output level by introduction of an intra-cavity loss mechanism which lowers the round trip gain below unity and laser output is suppressed. If the laser medium is continually pumped with energy during this process, the absorbed pump energy is stored in the excited atomic field until a significant population inversion is obtained. The loss mechanism is then rapidly removed and the cavity gain increases to a high state. A pulse of energy soon builds up from the optical noise and all the stored energy is (hopefully) released as one giant "Q-switched" pulse.

What then you ask is the problem? Well, the characteristics of the pulse produced by this process are determined by a number of interrelated factors, including the cavity round trip time and gain. In practice, it may not be possible to achieve the desired combination of factors in a practical laser. For example, say that one desires a pulse of duration ~1ns. One Q-switching technology often used is acousto-optic (Bragg cell) based. However, the relatively slow Q-switching obtainable and the high insertion loss prevent the very rapid build up of the pulse required and AO Q-switched lasers typically generate pulses of durations of 10's of ns. Apart from the rather unique products offered by Advanced Optical Technology Ltd. the much faster electro-optically Q-switched lasers do not usually operate at prf's above a few kHz. Even then, with the noted exception of the offerings from AOT the pulses are usually of 3 to 5ns duration. What then can one do to obtain this elusive short pulse capability in the context of an existing laser system?

The answer is to use an external Pockels cell to slice the section of the pulse containing the peak of the envelope from the optical pulse, leaving the longer build up and decay portions behind. This way, most of the peak intensity of the pulse is retained and the final pulse duration is shortened.



It all sounds simple, but of course there's a catch (you knew there would be)! The Pockels cell needed for this operation is not the usual run of the mill type used for Q-switching, but has to be rather special. It must be remembered that as pulses enter the sub-ns regime, the effective electrical bandwidth over which the Pockels cell must operate rises above 1GHz. Special constructions of devices are needed to avoid difficulties when driving with short electrical pulses.

One such device is the Ultra Fast Pockels cell or UPC. This device has been especially designed to offer the cleanest electrical interface to the pulse generating circuit to reduce distortions of the driving signal. The moderate 6mm aperture size is practical for most applications and yet offers rise-times of around 150ps when driven with an appropriate signal. This device is thus ideally suited to pulse slicing applications, particularly when driven by an ultra-fast source such as a high pressure spark gap. Such sources are however very highly specialised and do not provide flexibility in pulse length selection. In applications such as pulse picking where an individual pulse is selected from a pulse train (often to reduce the effective pulse rate of a model locked laser source running at typically 80MHz prf) the rise-time itself is not so important because the optical pulse is already extremely short (ps or even fs). What is important is that the pulse is selected cleanly from the pulse train so the switch on and off times must be fast (~ns) and symmetrical. This is difficult to achieve using conventional pulse driver technology. Switching a voltage to ground is much easier to achieve in the required time, but the return to the high voltage state is usually much slower as the circuit capacitance charging conditions are different to the discharging conditions. What is needed therefore is a device which can produce an effect similar to a pulsed operation device, but when driven from a step function generator.