

The Q-Switch Phenomenon in DPSS Green Lasers

Application Note

INTRODUCTION

Diode Pumped Solid State (DPSS) green lasers have become increasingly popular due to the significant advantages that make them effective solutions for many food industry, steel inspection, and medical applications. While the majority of non-green lasers run on Continuous Wave (CW) mode, green lasers display a phenomenon commonly known as "Q-Switching" where the output beam exhibits rapid pulses or changes in some characteristic of the ray of light. These Q-switch light pulses of extremely high peak intensities, typically within the 200 kHz to 1 MHz frequency range, are often much greater than those seen in CW mode. The light pattern consists normally of transient changes from a baseline value to a higher value, followed by rapid returns to the baseline level. The result is a "beating" pattern (also known as a pulse-periodic pattern) between longitudinal modes. In applications such as materials processing, this short but intense pulse effect is more useful than the same amount of energy distributed over a longer period of time.

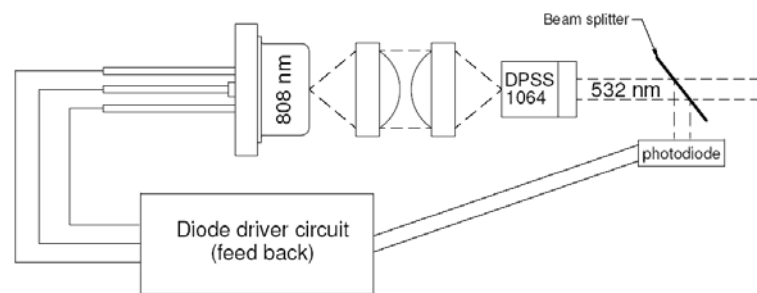


Figure 1.1 - A simplified diagram of a DPSS green laser system. The diode driver circuit, which is based on a photodiode feedback loop, provides the current to the laser diode which emits light at 808 nm (near IR). As the output beam is not circular, beam shaping optics are used to make the beam as round as possible. The Nd:YVO₄ crystal converts the 808 nm beam to 1064 nm (IR) which is then sent to the "doubler" (KTP crystal) which doubles the frequency to 532 nm (green) and the resulting green beam is then collimated.

OBSTACLES

As seen in *Figure 1.2*, a machine vision system is a combination of structured lighting, a detector, and a computer to precisely gather and analyze data. In applications where a high-shutter speed camera is used to collect the light and convert it into a digital image, the Q-switch phenomenon in green lasers can create some drawbacks with regards to accurate data acquisition. For example, the short, high-energy bursts of laser output cause low plateaus in the power intensity profile of the beam (see *Figure 1.3*), therefore making it impossible for high-shutter speed cameras to detect the beam when these "dips" are attained. At the low baseline values, the camera would not record a signal (sometimes seen as dark noise), therefore flawing the data or creating results that are difficult to interpret.

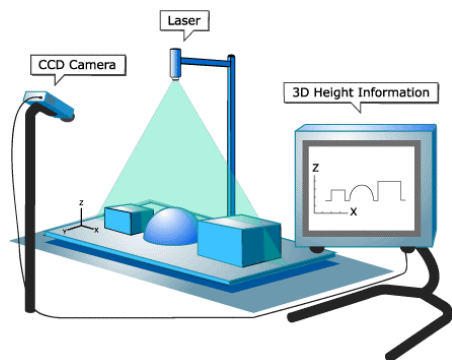


Figure 1.2 - Scanning the object with light constructs 3-D information about the shape of the object. This is the basic principle behind depth perception for machines, or 3D machine vision systems. If your green laser is used with a camera (often a Charge-Coupled Device (CCD) camera) that has a high-rate shutter, it may not acquire images at certain intervals (i.e. when the Q-switch pulses reach their baseline values.)

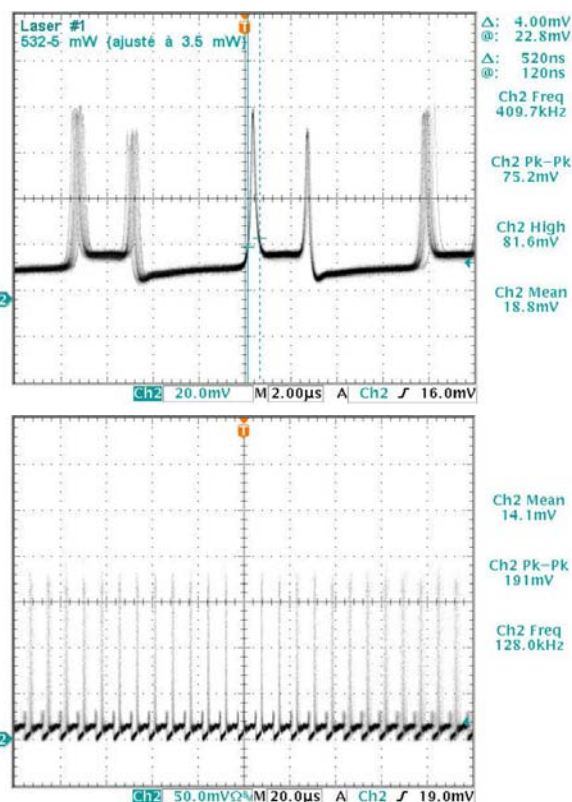


Figure 1.3 - The Q-switch phenomenon is characterized by periodic pulsed peaks as seen in the beam profile above of a Lasiris™ Green Laser (532 nm, 5 mW).

SOLUTION

In order to resolve this problem, laser system operators need to ensure that data acquisition by the camera is set to longer integration times so as to capture emissions of the green beam at their maximum power levels. This technique averages multiple Q-switch pulses during the camera's integration time in order to minimize the dark noise effect on the acquired images. Integration time varies from system to system, so it is up to the operator to optimize the laser and camera set-up. It is important to note that when you increase the number of pulses that are included in the integration time, the more accurate your data becomes as a result of the camera averaging a greater number of Q-switch pulses.

Information and specifications contained herein are deemed to be reliable and accurate. StockerYale reserves the right to change these specifications at any time without notice.



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