



Fast CW Beam Power Level Control via Q-switch Modulation

The Q-switch is a device that is used in a continuously-pumped Nd:YAG laser to generate a pulsed output. Normal Q-switched operation produces very short (100-400 ns) pulses, typically at a rate in the range of 1-10 kHz (although higher pulse rates are possible for some lasers).

However, a unique function of the Lee Laser Q-switching system allows very fast and precise control of laser CW beam power by an external source (computer or microprocessor). By applying a DC signal voltage to the Q-switch power supply, the CW beam power level may be controlled from maximum output down to total extinction, and maintained at any power level in between. The function is similar to that used to control the Q-switch as a high-speed shutter (see *technical bulletin* on this subject).

For example, this technique can be used to maintain a constant temperature of a metal sample that is being heated by the laser beam. By using an output signal from a pyrometer or other temperature sensing device, a control DC voltage may be fed into the Q-switch power supply to control the laser beam power level and maintain a constant sample temperature.

Advantages over Pump-Source Power Modulation

This approach is superior to control of laser power by modulation of pump-source (arc lamp or laser diode) power for several reasons:

1. very fast response time: 100 % modulation changes in less than 1 ms
2. excellent power stability even near zero beam power output; with pump-source power modulation, beam power at low output levels will become very unstable.
3. uniform, round beam mode structure can be maintained even near zero beam power output; with pump-source power modulation, beam mode structure can become highly non-uniform at low power output.

This is especially useful for lasers that are configured for TEM₀₀-mode generation. Nd:YAG lasers rely on the thermal focus of the YAG rod to achieve a stable TEM₀₀ output. The heat is generated by the high-power optical source that is used to optically "pump" the YAG rod. Changes in pump source power will alter the thermal focus of the YAG rod, and therefore the mode quality of the beam. In addition, the optical resonator will require up to 1 second to thermally stabilize to the point where a stable TEM₀₀ mode is being generated at the new power level. Q-switch modulation of CW beam power avoids all of these problems.

For this purpose, Lee Laser provides a BNC connector on the rear panel of the Q-switch Driver. This BNC is labeled ANALOG. Drawing No. 13000049, Q-switch Driver outline, shows its location. By applying a DC voltage (0-5 vdc) to the ANALOG BNC, the laser CW beam power output level may be controlled from full output power down to total extinction. The beam power output level will vary with the voltage.

Stable, Low-Power Q-switching

This same function also may be used for normal Q-switched operation of a laser at a low average power level. Reduction of pump source power to reduce Q-switched average power results in poor pulse stability at low power levels. However, by using nominal 10- μ s input signal pulses into the ANALOG BNC, normal Q-switched pulses may be produced. The energy contained in each laser pulse may then be controlled by the voltage level of each input signal pulse. In this manner, laser pump source power may be operated at a level that will produce a stable beam output level, and yet the laser may be made to operate stably at a much reduced beam output power level.