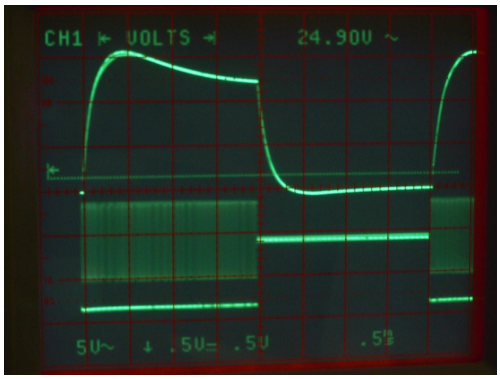
ACCESS LASER

Application Note: Power Control for RF excited CO2 Lasers

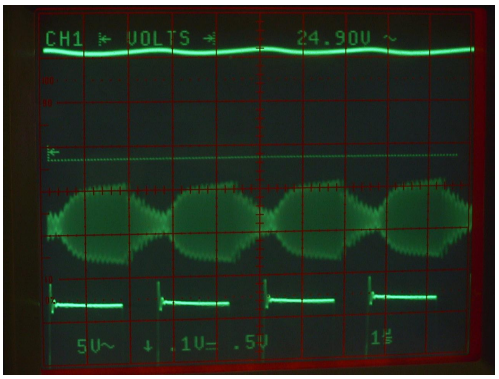
All RF excited CO2 lasers use pulse-width modulation (PWM) to control their output power. The laser discharge is a dynamic and non-linear load to its RF driver. While the load impedance changes with the input RF power the matching network between the RF driver and the laser (load) can only match to a fixed impedance. A mismatch between the RF driver and the laser would overstress the RF driver, causing it to fail prematurely, or/and inconsistent laser performance. Therefore it is essential to maintain the input RF power constant to avoid mismatch. This is achieved with PWM where the RF power is either on or off without intermediate level.

When the frequency is high enough the practical result of PWM is the same as changes in power level. Two factors contribute to this fact:

1. *Laser output response is slower than the PWM electric signal.* As can be seen in the following two scope traces. In both of these photos the upper trace is the laser power, the faint straight line below the upper trace designates zero power, the second trace is the envelop of RF power, and the bottom trace (half shown) is the TTL (0/5 volt) modulation signal.



A) PWM 50% at 250 Hz



B) PWM 64% at 400 kHz

It is clear from these traces that at low frequency the laser output power follows the modulation signal, but at high frequencies it does not respond to the modulation signal. Therefore at high frequencies the adjustment of the duty cycle in the control PWM signal translates into the adjustment of the level of laser power. This behavior is similar to the output of an RC circuit driven by a square wave with much longer (A) or shorter (B) period than the RC time constant.

2. *Material response is slower than the rate at which the laser power changes.* If the material has a low thermal conductivity and the laser beam changes relatively slowly the laser power will be averaged on the material. Therefore the effect of the PWM is the same as a continuous wave with the same average power. Materials with low thermal conductivity include paper, plastic, wood, glass, fabric, etc.

PWM is achieved with a TTL signal (0 or 5 Volts)

For all the Access Laser products there is a BNC port on the RF driver where the customer can supply a pulse signal at a wide range of frequencies and duty cycles. 0 volt turns off the laser and 5 volts turns on the laser. Please consult with the factory if you plan to use a PWM frequency of 100 kHz or higher. Laser controllers from Access Laser provide a knob for PWM control at a fixed frequency, 15 kHz for lasers using model RF3 RF driver, and 2.5 kHz for lasers using other RF drivers. The customer can adjust the average power using this knob. Typically a CW-capable laser can be adjusted to down to 10% duty cycle and still maintain a good stability.

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