AN-16 LASER DIODE DAMAGE FROM THERMAL OVERSHOOT

Some laser diodes are very temperature sensitive (more efficient at lower temperatures). This is particularly true for many red laser diodes, as well as some far-IR diodes (wavelength >1.6µm). Under normal CW operation, the laser diode heats up so that the laser junction is 10-20 degrees C above the heatsink temperature. However, if the laser is suddenly turned on (from zero current to full current), it does take some time (0.1 to 1.0 seconds) for the laser to heat itself up to its steady state temperature. So, for the first fraction of a second after sudden laser turn-on, the laser junction is still much colder than in steady state. A temperature-sensitive laser may be super-efficient at first, but its efficiency drops as the junction temperature approaches its steady-state value. Thus, the "normal" CW operating current may drive the laser well above its rated power during this warm-up time. This could damage or destroy the laser diode.

The solution to the problem is to limit the rate of current rise when turning the laser on. This is done by introducing a time lag, or "soft start," into the circuit that drives the laser diode. The rise time of the current to the laser must be slow enough that the laser has time to heat up, thereby preventing the peak power from ever exceeding the rated power. The pictures on the following page illustrate this effect.

The soft start can be achieved using a capacitor or a time constant in the driving circuit to limit the rise time of the current waveform. Most commercial high-power laser diode drivers include this feature. You should confirm that sufficient rise time has been introduced by monitoring the laser output with a fast-response photodiode and displaying the signal on an oscilloscope. When modulating the current to a temperature-sensitive laser diode, verify that the peak laser power at turn-on does not exceed the rated CW power, even for a very short time.

This same principle can apply when a temperature-sensitive laser diode is modulated at a low duty cycle. The laser junction will be much cooler when the laser is pulse-modulated at a low duty cycle than in CW operation. The same current that is safe under CW conditions could drive the laser to a damaging power level under pulse conditions.

CASE A: NO SOFT-START

CASE B: WITH SOFT-START