The Art of Tuning Lasers

Controlling light often means controlling very small and precise mechanical movements. This for certain holds true for Radians Innova's compact tunable laser sources used in fiber optic test and measurement instruments from leading companies all over the world. The products are made possible by a unique combination of skills in optics, electronics and fine mechanics together with 25 years experiences of building tunable lasers. And, of course, customized PSDs from SiTek.

A tunable laser plays the same role for testing a fiber optic component as a function generator plays for testing electrical components: To stimulate a response that can be detected and analyzed. The demands on the output signal are also similar: both have to be very accurate and stable in terms of power and frequency. The difference? Light is much, much harder to control.The core of Radians PICO™ family of products is an external cavity laser in which one end of a laser diode is "opened up" and replaced by a grating relatively far from the diode. This means that most of the cavity where the lasing takes place is outside the diode, hence the word external cavity. A laser diode usually emits light at a very distinct and fixed wavelength corresponding to the length of the cavity. By opening up the cavity and letting the light bounce at a well defined grating placed on a movable arm, the wavelength of the light can be tuned by just tilting the arm. Depending on the angle, the grating will allow just one specific wavelength to live at a time.

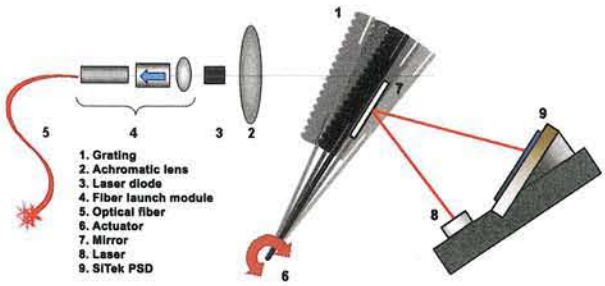

Figure 1 The principle of an external cavity based tunable laser

A tunable laser used for testing and measuring can span more than 100 nanometers (nm, or millionths of millimeters), typically centered at 1550 nm (infrared). This is where most fiber based telecommunication takes place. The wavelength of the laser could be either swept continuously (up to 200 nm/s) or randomly accessed, both with a very high precision. To achieve a wavelength resolution of 0.001 nm, one has to know the exact

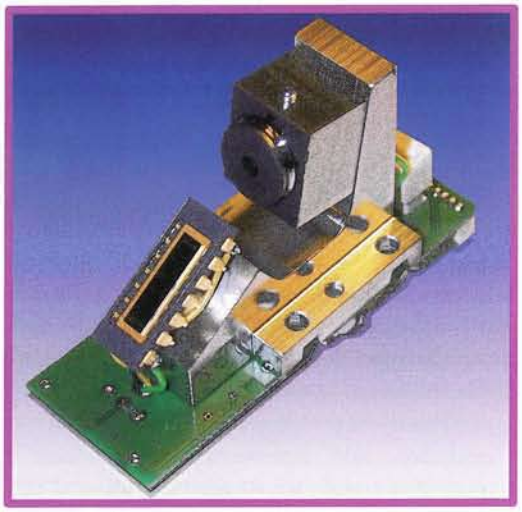

Figure 2. The triangulation unit consists of a laser unit (mounted in the "cubic" housing) and a one-dimensional position-sensing detector from SiTek. The detector is mounted directly on the mechanical support structure in order to obtain maximum stability.

position of the arm. This particular product specification can only be met by a complex control system, sensing both the angular speed of the arm carrying the grating and sensing the exact angular position of the arm. An angular displacement of the order 8 degrees, between angles corresponding to maximum and minimum wavelengths respectively, yields a wavelength tuning range of about 120 nm. The wavelength resolution of 0.001 nm can thus be expressed as a required angular resolution of about 0.00007 degrees!

The system used for measuring the position is a classical triangulation system built around a laser diode, a position-sensing detector from SiTek, and a mirror mounted on the arm, see figure 1.

Obtaining the high resolution was a demanding task. During the development phase Radians Innova have had numerous in depth discussions with SiTek concerning the physics and the processing of the PSD devices. These discussions, combined with our skills concerning clever design of the electronic circuitry and selection of the laser diode made it possible to achieve the high angular resolution. The Radians PICO™ family of tunable lasers now offers the market's best combination of wavelength and dynamic range, tuning speed, accuracy and resolution, all in compact modules.