

Frequency tuning and alignment of the ECDL-7820R (#090857 – August 2014)

The following experimental data specify the operation of the ECDL-7820R and might serve as references for its alignment.

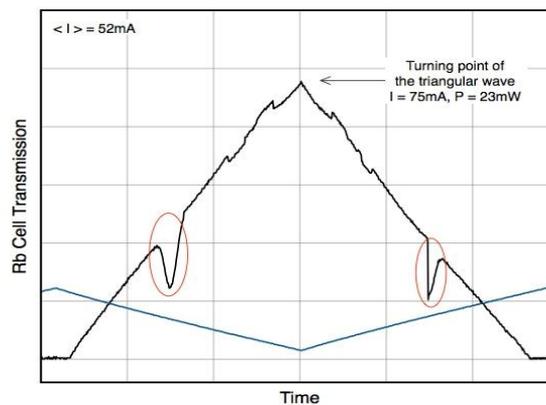


Fig.1. The dependence of the output power on the LD current. The LD current is changed by the symmetrical triangular wave. The red ellipses show the zones of the Rb absorption.

Fig.1 shows the output power of the ECDL-7820R when the internal triangular-wave generator modulates the laser current around its average value of 52 mA. Almost horizontal sections in the basis of oscillogram correspond to subthreshold regime of the ECDL. Above the threshold the linear change of the current induces the nonlinear response of the output power due to the mode structure of the laser. This is manifested in the form of mode-hops and slope changes on the power-on-current dependence. The Rb absorption is revealed at some certain zones in Fig.1 (the regions surrounded by the red ellipses). This dependence is recorded at alternate PZT voltage set to zero. The constant PZT voltage is set so to make the absorption more evident. The frequency of the extended cavity mode is out of resonance with the atomic transition at another DC voltage applied to the piezo.

The next oscillograms (Fig.2) are recorded at constant LD current and linearly changing PZT voltage. The scan amplitude is set to the maximum. On the upper curve, which reflects the laser output power at the exit of Rb cell, the extended-cavity mode-hops are visible. The laser frequency changes by a few GHz from one to another mode-hop (the value matched with the free spectrum range of the ECDL). In the regions of the continuous frequency tuning the lines of linear absorption are visible. They correspond to $F_g=3 - F_e=2,3,4$ transitions in ^{85}Rb and $F_g=2 - F_e=1,2,3$ in ^{87}Rb . The cell of 5 cm long is warmed up to $30\div 40\text{ }^\circ\text{C}$ to increase the registered signal.

The change of injection current causes the change of the LD cavity optical length due to thermal expansion of the LD chip and variation of the refractive index of active media. This allows in principal to synchronize in a certain range the tuning of eigenmodes of a laser diode and

of a compound extended cavity, and as a result to expand the continuous tuning range of ECDL-7820R.

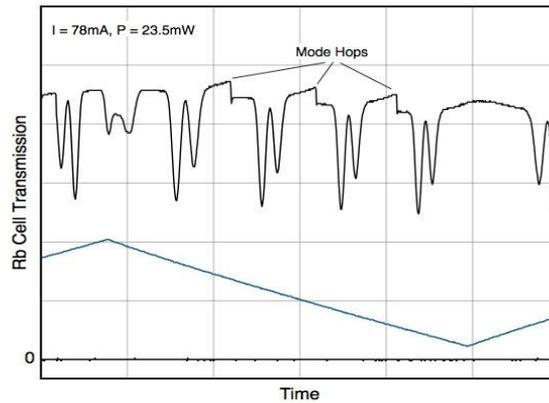


Fig.2. The transmission of a Rb cell on the PZT voltage sweeping (upper curve). The LD current is constant. The lower blue curve displays the output of the internal generator.

Fig.3 displays the transmissions of a Rb cell at the synchronous scan of PZT voltage and LD current. The span of the piezoelement scan is set to the maximum while the amplitude of the current scan and the DC levels of the LD current and the PZT voltage are determined empirically till complete vanishing of mode-hops in a whole tuning range.

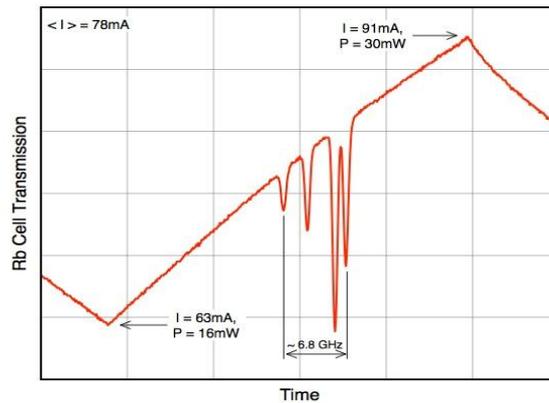


Fig.3. The transmission of the cell containing vapor of ⁸⁷Rb at the synchronous scan of the piezo and the LD current.

It should be noted that a certain delay exists in response to a control signal between the piezoelectric element and the LD current, which depends on the frequency and amplitude of the scanning. Therefore it is not always possible to get synchronous tuning of eigenmodes of a laser diode and of a compound extended cavity on both slopes of the control signal simultaneously and thus the ECDL frequency tuning might differ for different slopes of the control signal.

Readjustment of the ECDL-7820R

Follow the way below, if the laser realignment is necessary.

- 1) Insert the fork-shaped lever into the slot of the horizontal axle of the grating.
- 2) Find the direction in which the lever decreases the LD threshold. Gently press the lever up and down for this.
- 3) The clockwise rotation of the lock screw (M2) is applied if the motion of the lever down (i.e. the laser beam reflected from the grating goes up) reduces the threshold. The counter clockwise rotation is needed at the up-level position. Typically a few degree rotation of the screw is enough to restore the operation of ECDL-7820R.
- 4) When the minimum of the threshold current is achieved, set if necessary the operation wavelength by tuning the horizontal screw which is accessible even in fully assembled optical unit.

Common recommendations of the ECDL-7820R maintenance

1. Do not try to change the laser beam collimation. In the case of laser diode degradation the module has to be replaced as a whole by a manufacturer.
2. Do not violate the procedures of the laser activation and disabling.
3. Do not reduce the LD temperature below the dew point. The LD temperature can be estimated using the TCR (temperature coefficient of resistance) of the thermistor: $TCR = -4\%/^{\circ}C$.
4. Use an optical isolator to avoid unwanted reflections back into the laser.
5. Follow **the golden rule**: an ECDL as a part of an experimental setup must be switched on the last and switched off the first.

Specifications.

1. Wavelength	780.0 nm
2. Output power @ 78 mA	23 mW
3. Continuous tuning range by PZT only	7 GHz
by PZT+LD current	38 GHz
4. Coarse tuning range	± 2 nm
5. Polarization	linear vertical
6. Beam shape	elliptical 5×1.5 mm ²
7. Threshold current	32 mA
8. Operating current (D₂Rb)	78 mA
9. Maximum current	100 mA
10. Thermistor	17.0 kOhm