

Optical chaos based on a laser diode with positive feedback

Eskoskin D., Khoruzhii K., Primak E.

05.03.2021

Goals

Globally we would like to transmit a high-frequency signal in encrypted form.

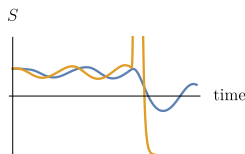
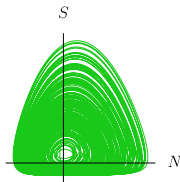
Here, we will consider the following steps towards this goal:

- dynamical chaos and synchronization (to encrypt and decrypt signal);
- theory of the laser evolution and its adaptation under our needs;
- realization of the positive feedback in laser: theory, modeling and practice.

Definition of dynamic chaos and applications

Map¹ f is **chaotic**, if

- periodic orbits are dense everywhere;
- orbits are mixed;
- f sensitive to the initial conditions.



Possible applications:

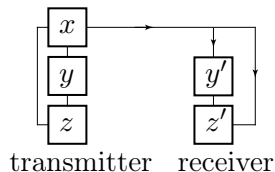
- random numbers generation;
- signal encryption.

¹W. Hirsch, S. Smale, Introduction to Chaos.

Synchronization

Possible² synchronization of chaotic systems:

enough to transmit
part of the signal;
configure system parameters.



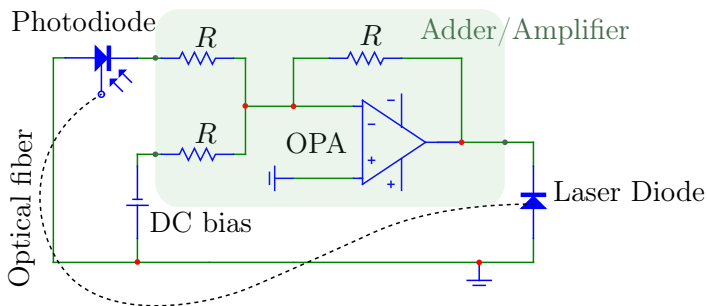
The use of optics to transmit the signal allows to achieve a greater bandwidth of the channel.

UHFO (ultrahight frequency oscillations) is a characteristic to optic systems.

²M. Pecora, L. Carroll, Synchronization in Chaotic Systems, 1990.

Scheme

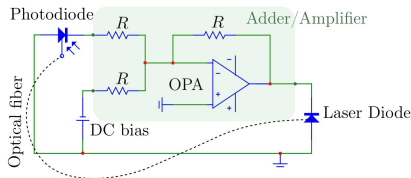
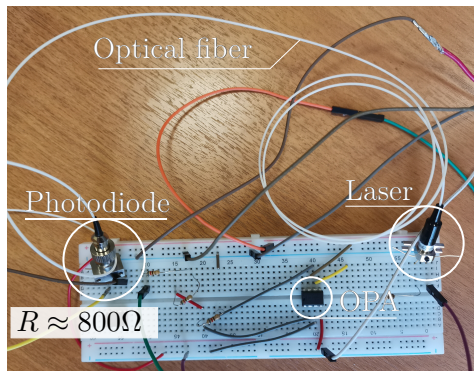
After several experiments came to this scheme with the summing amplifier:



Photodiode power is enough to not use an additional amplifier.

Realization

For testing, the assembly was carried out on the dumping board.

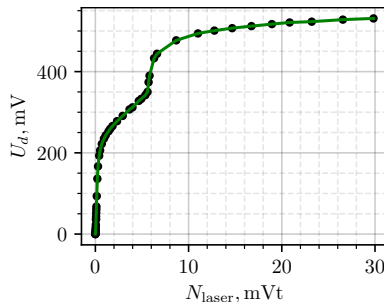
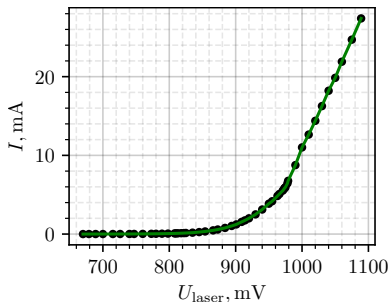


Thus, a scheme with positive feedback was implemented.
However, no desired oscillations were observed.

I-V curve

Makes sense to be in the most sensitive range, it was measured:

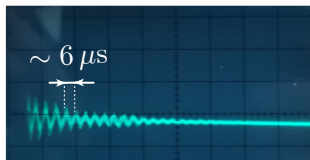
- I - V curve for a laser
- the dependence of the ph. diode voltage on the laser power.



So, laser voltage range of 0.95 – 1.00 mV selected.

Problems

With used amplifiers, the following oscillations at the amplifier output with DC power can be observed:



This is due to the instability of the amplifier.

The main problem is that desired oscillations ~ 10 ns.

We proceeded to experiments with faster amplifiers, but it is usefull to understnd results of such delays.