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Quantum bit error rate performance test for a quantum cryptography system

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Abstract

Quantum cryptography is a science that depends on the laws of quantum mechanics so as to provide absolute security in a communication scheme.

The goal of this work is to scale the performance of the receiver side in a quantum cryptography system based on BB84 protocol to get the better performance of the system. This is done by calculating the Quantum Bit Error Rate (QBER) of the receiver. To apply this performance test, an optical setup was arranged and an electronic circuit was designed and implemented to calculate the QBER.

This electronic circuit is used to calculate the number of counts per second generated by the avalanche photodiodes operating in the Geiger mode. The calculated counts per second are used to calculate the QBER for the receiver that gives an indication for the performance of the receiver.

The designed electronic circuit consists of four identical parts, each part is dedicated to one avalanche photodiode so that the number of counts per second for each avalanche photodiode is calculated separately from the others. The operation of the designed circuit is directly controlled and synchronized using personal computer that is connected to the circuit using a PC parallel port. All the signals that are to be sent from the PC to the circuit through the parallel port are controlled using a program written in MATLAB 6.5.

The four individual output signals from the four parts of the circuit are fed to the PC through the parallel port in order to be simultaneously plotted for every one second using MATLAB program so that the performance of the receiver can be observed.

The performance test was applied many times while changing one of the parameters that are related to the avalanche photodiodes performance to reach the best performance of the receiver. These parameters are:

The excess voltage of the avalanche photodiode.

The avalanche photodiode temperature.

The output power of the laser diode.

Minimum QBER, 6%, was obtained with excess voltage equals to 2V and laser diode power of 3.16 nW at avalanche photodiode temperature of -10$_{o}$C.