Noise reduction methods of single photon detector based on InGaAs/InP avalanche photodiodes

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Abstract. This work is dedicated to the problem of noise reduction of single photon detector development based on InGaAs-InP avalanche photodiodes. Dark count probability and quantum efficiency of the detectors have been measured. We show the quantum key distribution setup parameters obtained with designed detectors.

1. Introduction

The telecommunication wavelength photodetectors are primarily made on the base of InGaAs photodiodes. Photon counting is the key part of quantum communication as the need arise to transmit single photons over long distances using optical fibers. InGaAs/InP single-photon avalanche diode detectors are favoured in a number of applications for single-photon detection at wavelengths around 1550 nm, e.g. quantum key distribution [1]. Gated quenching, in various realization, including the use of active quenching circuits [1,2], has been implemented in many of these applications to limit the charge flow per event to reduce the detrimental effects of the afterpulsing phenomenon. In this work the commercially available InGaAs avalanche diode ERM 547NT is used to designe as single-photon detector. We implement the noise reduction methods proposed and measure dark count probability and quantum efficiency of the detectors have been measured. Experimental results of quantum key distribution on the fiber setup obtained with these detectors are given.

2. Single photon detectors based on InGaAs avalanche diodes

To detect individual photons, avalanche photodiode (APD) operates in the Geiger mode [1,2]. For this purpose, the reverse supply voltage in them is raised above the threshold breakdown voltage of the diode. The higher the volt age above the threshold the higher the probability to detect a photon. However, voltage augmentation is usually accompanied by an increase in the noise clicks without any incoming signal (dark noise) and the probability of the noise due the so-called afterpulsing effect. During the passage of the avalanche current after an operation of the photodiode from a photon or thermal noise pulse, the so-called traps in the semiconductor volume can be charged and then, with a delay, they begin to discharge spontaneously and lead to a new avalanche of the charge. This causes the photodetector to operate falsely. The effect of afterpulses strongly restricts the maximal click rate