Table 1. Summary of the QKD results for a BB84 transmission, implementing the decoy state protocol

Parameter	Value	Parameter	Value
Attenuation	6 dB	Q_μ	1.18×10^{-1}
μ	0.5	Q_{ν_1}	1.8×10^{-2}
ν_1	6.6×10^{-2}	Q_{ν_2}	3×10^{-3}
ν_2	2×10^{-3}	e_μ	1.14×10^{-2}
R_{secure}	3.64 Mbps	$f\left(E_\mu\right)$	1.16

The obtained values are for a 6 dB attenuation, where μ, ν_1 and ν_2 are the signal, decoy 1 and decoy 2 (ideally vacuum) states. The computed values are the gains for the signal Q_μ, decoy 1 Q_{ν_1}, decoy 2 Q_{ν_2} states and the QBER for the signal states e_μ. Finally the lower bound of the secure key rate R_{secure}, for the presented source, is 3.64 Mbps with a QBER as low as 1.14×10^{-2} while a R_{secure} of 187 bps for an attenuation as high as 35 dB.

7. Conclusions

We have shown that a single photon source based on an attenuated laser diode for QKD applications can be built based on a novel scheme including semiconductor optical amplifiers. The source is capable of generating pulses of random polarization distributed over four states and three intensity levels required for decoy state BB84 protocol. A lower bound secure key rate of 3.64 Mbps with a quantum bit error ratio as low as 1.14×10^{-2} for an attenuation of 6 dB. To our knowledge, this is the fastest polarization encoded QKD system which has been reported so far. Given the relatively low driving voltages of the SOAs, the laser diode and the other integrated optical components, the proposed transmitter is potentially low power consumption, highly integrable and stable. The experimental demonstration has been carried out at 850 nm, for the implementation in free-space links, with 100 MHz generation rates. However, taking into consideration that the SOA's bandwidth can go well beyond 10 GHz and operate also at other wavelengths (e.g. 1310 nm and 1550 nm for fiber transmission), the source can be easily scalable to higher bit rates, the upper limit probably being set by the laser diode itself.

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