RIN Transfer Induced Signal Degradation in Fiber Optical Communication Links

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It is well known that degradation of an information signal during its propagation along the fiber optical communication link can significantly restrict bit rate. In practice, any real transmission link introduces distortions into the signal that can be either recoverable (e.g., dispersive broadening) or not fully removable (e.g., noise). The sources of such unremovable distortions leading to loss of information are double Rayleigh scattering (DRS), amplified spontaneous emission (ASE), RIN (Relative Intensity noise transfer) and nonlinear interactions such as four-wave mixing FWM [1].

Recently many works investigated RIN Transfer from pump to signal in Raman fiber lasers and amplifiers both numerically [2,3] and analytically [4]. However, analytical models work only in the case of undepleted pump approximation, which is not always satisfied in the real communication links. Moreover, the most common analytical and numerical models are based on balance (average-power) equations and do not describe evolution of phase modulated signals along the fiber under influence of dispersive and nonlinear effects. To investigate RIN transfer in the real Raman fiber amplification systems we perform a numerical modelling based on a generalized nonlinear Schrödinger equation taking into account dispersion, Kerr nonlinearity and Raman gain. We develop a method of RIN transfer calculation in the amplitude models and use this method to study signal degradation. We numerically investigate phase-modulated signal degradation due to RIN transfer in the real optical communication link and show that not only Raman scattering but also FWM can initiate pump to signal intensity noise transfer.

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References

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