On the Capacity of Bandlimited Optical Intensity Channels With Gaussian Noise

Abstract:

We determine the lower and upper bounds on the capacity of bandlimited optical intensity channels (BLOIC) with white Gaussian noise. Three types of input power constraints are considered: 1) only an average power constraint; 2) only a peak power constraint; and 3) an average and a peak power constraint. Capacity lower bounds are derived by a two-step process including: 1) for each type of constraint, designing admissible pulse amplitude modulated input waveform ensembles and 2) lower bounding the maximum achievable information rates of the designed input ensembles. Capacity upper bounds are derived by exercising constraint relaxations and utilizing known results on discrete-time optical intensity channels. We obtain degrees-of-freedom-optimal (DOF-optimal) lower bounds which have the same pre-log factor as the upper bounds, thereby characterizing the high SNR capacity of BLOIC to within a finite gap. We further derive intersymbol-interference-free (ISI-free) signaling-based lower bounds, which perform well for all practical SNR values. In particular, the ISI-free signaling-based lower bounds outperform the DOF-optimal lower bound when the SNR is below 10 dB.