Skew Dependence of Nanophotonic Devices Based on Optical Near-Field Interactions

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We examine the timing dependence of nanophotonic devices based on optical excitation transfer via optical near-field interactions at the nanometer scale. We theoretically analyze the dynamic behavior of a two-input nanophotonic switch composed of three quantum dots based on a density matrix formalism while assuming arrival-time differences, or skew, between the inputs. The analysis reveals that the nanophotonic switch is resistant to a skew longer than the input signal duration, and the tolerance to skew is asymmetric with respect to the two inputs. The skew dependence is also experimentally examined based on near-field spectroscopy of InGaAs quantum dots, showing good agreement with the theory. Elucidating the dynamic properties of nanophotonics, together with the associated spatial and energy dissipation attributes at the nanometer scale, will provide critical insights for novel system architectures.

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1. INTRODUCTION

For information and communications technologies, nanoscale devices, systems, and architectures that are not based on conventional electronic means have been attracting increasing interest even though they have not yet reached the stage of mass production [Collier et al. 1999; Dai et al. 2010; Naruse et al. 2005; Peper et al. 2004;

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