# Studies on a Waveguide Optical Switch and a Waveguide SHG Device with Kerr-like Nonlinear Media

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A nonlinear directional coupler (NLDC) has been widely studied as a promising all-optical switch. First, an improved coupled-mode theory based on a reciprocity relation is proposed to analyse properties of NLDCs. The theory is valid for cases of weak and moderately strong nonlinearity, because the field in the NLDC is expanded using that of each isolated nonlinear waveguide. The coupling coefficient depends on the power. The switching power is smaller than that of the previous theories.

Next, the Galerkin finite element method accompanied by a predictor-corrector algorithm is proposed to analyze a strongly-coupled NLDC with a strongly-nonlinear lossy coupling region. The error of power conservation is very small and not accumulated with propagation. The propagation attenuation along a practical MQW-sandwich coupler is considerably smaller than that in the bulk MQW. The losses lower the nonlinear effects, and hence the coupling length decreases and the switching power increases. The extinction ratio of switching is the largest in the case of moderate losses.

Lastly, a new waveguide SHG (second harmonic generation) device having self-focusing Kerr-like nonlinear cladding is proposed. The refractive index of the cladding changes with the input power and so does the film thickness of phase matching. Hence, for a given thickness the phase matching is realized by adjusting the input power. The fundamental field pattern moves toward the cladding with the input power and then the overlap integral increases. Hence, the conversion efficiency increases with the input power.