# Waves on Coupled Lines of Resonant Metamaterial Elements: Theory and Experiments

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The coupling and the resulting power transfer between two parallel magnetoinductive waveguides consisting of resonant metamaterial elements were first discussed by Shamonina and Solymar [1]. It was shown that in the lossless case full power transfer is possible between the two waveguides. A particularly interesting case arises when the two waveguides are shifted relative to each other parallel to their axes. At its most general the theory is formulated in terms of five mutual inductances, i.e., each element is coupled to its nearest neighbour in the same waveguide and to the three nearest elements in the parallel waveguide. The resulting dispersion curves have two branches with a stop band between them. The pass band and the power transfer are shown to be fast varying functions of the shift. It is shown further that the power transfer between the two waveguides may vary as much as 40 dB (minimum transmission when the frequency of operation appears to be in the stop band) so that the effect can serve as an efficient switch.

The experiments are performed in the frequency range of 0.3–0.9 GHz using two waveguides parallel to each other consisting of spiral resonant elements in the planar configuration. The first element of waveguide 1 was excited from below by a small loop protruding at the end of a coaxial cable. The receiver consisting of a similar loop was scanned above waveguide 2 measuring the magnetic field at positions corresponding to the centres of the elements. The measured values of the current distribution in waveguide 2 and the measured power transfer between the waveguides are shown to be in good agreement with the theoretical predictions.

## REFERENCES

1. Shamonina, E. and L. Solymar, *J. Phys. D: Appl. Phys.*, Vol. 37, 362, 2004.