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PTD-symmetric Waveguides and Radiating Elements

I. Nadeem[(1)], E. Martini[(1)], M. Silveirinha[(2)], A. Toccafondi[(1)] and S. Maci*[(1)]
(1) University of Siena, Siena, Italy; e-mail: engineer.iram@gmail.com, {martini, albertot, macis}@dii.unisi.it
(2) University of Lisbon, Portugal; e-mail: mario.silveirinha@co.it.pt

Topological edge modes (TPEMs) enable robust propagation along arbitrarily shaped pathways thanks to their immunity to backscattering [1]. TPEMs are normally associated to non-reciprocal elements; however, recent researches have shown that they can be also supported by reciprocal structures. In this case, the edge modes are bidirectional, but largely (in the ideal case totally) immune from backscattering. In particular, in [2] it is shown that this phenomenon arises in structures invariant under the composition of the parity, time reversal, and duality operators (PTD-symmetric). This means that PTD-symmetric systems may support waves that are insensitive to any form of perturbation or discontinuity that satisfies the PTD symmetry.

A PTD-symmetric waveguide structure supporting an edge mode was recently proposed in [3]. It consists in the combination of two dual semi-infinite parallel-plate waveguides with PEC and PMC walls, and it supports a TEM mode confined to the interface line between the two semi-infinite structures, with characteristic impedance coincident with the wave impedance and with the impedance of the free space. This is the only supported mode over a frequency range depending on the distance between the two couples of surfaces. In this frequency range, this mode is immune to scattering from PTD-symmetric discontinuity. Also, it exhibits excellent decoupling with the corresponding mode in an adjacent similar waveguide. Other waveguide structures, also including vertical walls, can be devised based on the same principle and possessing similar properties.

This kind of structure can find interesting applications for protected data transmission and for the design of large scanning phased arrays. In fact, the transition to free space is a particular kind of PTD-symmetric discontinuity, thus, guaranteeing excellent matching for the isolated element. Furthermore, the port-to-port decoupling assures that this property is maintained under arbitrary scanning conditions. The practical implementation of the PMC boundary can be done with pin or mushroom type MTS. Examples will be provided at the conference.

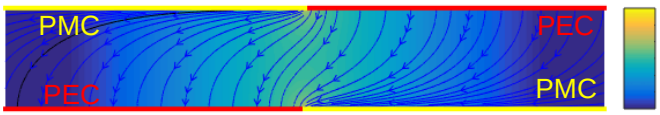

Figure 1. Electric field distribution inside a PTD-symmetric waveguide.

References

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