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Finite element and boundary element modeling of multimodal arrays

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Modern active sonar arrays exhibit the following characteristics: low operating frequency, large number of transducers, small transducer spacing compared to wavelength, and in some cases, multimodal transducers. This results in strong, complex acoustic interaction phenomena which can involve both a large number of array elements and multiple transducer modes. To predict the performance of such arrays, this paper presents a modeling approach which is both accurate and computationally economical. First, the generic equivalent circuit for an array of multimodal transducers is described. The field of application of such a model, the definition of the parameters, and the characteristics which can be calculated from it are provided. Second, the computation of the equivalent circuit parameters is performed using commercial finite element and boundary element codes. Specifically, a method is described to compute the mechanical, electrical, self and mutual radiation parameters of the various transducer modes. Finally, the methodology is applied to a 12 element volumetric array of flextensional transducers, with both $\lambda/2$ and $\lambda/4$ spacings.