HIGH-SPEED, HIGH-ACCURACY METHOD FOR MUTUAL INDUCTANCE CALCULATIONS

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ABSTRACT

Three methods for calculating the mutual inductance of coils are examined and compared: a finite-element field code analysis method, theoretical analysis method, and F. W. Grover's tabular method. These methods are applied in this research to coaxial single-layer coils. When compared to finite-element field code results, theoretical analysis is found to be highly accurate, within at least 4 or 5 significant digits, but suffers from long calculation times and the inability to calculate accurately by hand without the use of series equivalent formulations. Grover's tabular method is thoroughly examined. Grover's method, as published, does not have the claimed accuracy of 4 to 5 significant digits for highly coupled coils and 3 significant digits for loosely coupled coils. In an effort to improve the tabular method's accuracy, interpolation methods are examined and, surprisingly, are found to significantly impact the accuracy. Cubic spline interpolation proves to be the best method and while the accuracy was improved the desired accuracy is still not achieved. Using theoretical formulas, this investigation derives the elliptic integral formula used to generate Grover's look-up tables. This formula is used to derive new look-up tables for the purpose of further reducing errors. A process of adding and refining tables is used to improve the tabular method's minimum accuracy by an order of magnitude to the desired accuracy. The tabular method is also the fastest to calculate and the only method that is reasonably computed by hand.