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EMI Model Validation and Standard Challenge Problems

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Introduction
There are a number of numerical techniques available for modeling EMI problems, including various commercial software. Each of the different modeling techniques have areas where they match the problem quite well, and can provide accurate and reliable results. Also, each of the different modeling techniques have areas where they do not match the problem well, and can create questionable results. A potential user must be able to evaluate the various options against their style problems in order to better understand which method is most suitable, and possibly evaluate commercial software.

In addition to applying a specific modeling technique or software package to an appropriate problem, it is desirable to be able to validate the results against previous modeling efforts or measured data. While many technical papers have shown results from models, and many include measurements or other validations, the details of the models and measurements are often not sufficiently reported to allow someone to repeat the model and directly compare results.

A joint IEEE/EMC Society TC-9 Committee and the Applied Computational Electromagnetic Society (ACES) effort has resulted in a central web location for contributors to provide model and measurement data to share and compare with others. In addition to the data repository, a set of standard challenge problems have been proposed over the past few years, and they are also located at this web site.

Validation Data
A committee has been established to review all submittals to this storage location. The submittal must include sufficient detail about how the modeling was accomplished (if any), and how the measurements were conducted (if any) so that the modeling and/or experiments can be easily repeated. The results from these models and/or measurements must be clearly presented, and a simple ASCII text file with the data must be available for downloading. The submittal will be posted on the web once accepted by the review committee and will be available for downloading by interested engineers.

All submittals are expected to contain sufficient information that the user can reproduce the reported results. Model and measurement data or multiple modeling techniques (showing the same results) are preferred so that there is validation within the submittal. Engineers using this data are encouraged to provide their results as further validation of the specific model and results.

Challenge and Specific Standard Problems
The second major purpose of this web location is to provide a central location where interested researchers and engineers can download the details of the IEEE/EMC Society TC-9 Challenge and Specific Standard Modeling Problems. These problems have been designed to allow users to highlight strengths and weaknesses of various modeling techniques and tools.
The Challenge problems are difficult problems that may require an EM modeling expert. These problems include shielding problems, PC boards with long wires attached, PC boards with microstrips, system-level shielded enclosures connected to remote PC boards via long wires, and others. Many of these problems can not be solved by certain modeling techniques, or require limiting assumptions, while those same problems can be solved in a straightforward manner by other modeling techniques. Some problems may require multiple modeling stages (where the output of one model becomes the input to a second model), or hybrid modeling techniques.

These challenging problems were created specifically to highlight how certain techniques are well suited to some problems, but not well suited to other problems. Since there is no simple modeling technique that can do all the various types of modeling required by the typical EMC engineer, a variety of tools are often required.

In 1998, two challenge problems were proposed. Problem 98-01 (Figure 1) consisted of a shielded metal box with an aperture. The source was a common mode voltage between an internal motherboard-daughter card combination. A second daughter card provided partial shielding between the source and the aperture. Problem 98-02 consisted of a PC board with traces, and long wires running off the PC board. A split in the board's reference plane was included.

In 1999, four challenge problems were proposed. Problem 99-01 (Figure 3) concerned the emissions along the edge of a PC Board, due to a trace on that board. Problem 99-02 (Figure 4) was to find the difference in shielding performance of a number of different seam shapes. Problem 99-03 (Figure 5) was a system level problem, with an enclosed shielded box, and a PC board connected by a long cable. Problem 99-04 (Figure 6) was to find the crosstalk between active and passive pins in a complex high speed connector.

The Specific Standard Problems are more limited in scope, and intended to be 'simpler' to solve. They are more useful for evaluating a commercial software by a potential user, since they are more limited and can be solved by a non-expert, and in a reasonable amount of time. These problems are again selected to highlight the strengths and weaknesses of the various modeling techniques.

These Specific Standard Problems include a heatsink emissions problem, a PC board decoupling problem, a microstrip problem, and a shielding problem. The dimensions are selected so that these problems can be converted into reasonable sized models, and solved in a short amount of time. Examples of results for each of these problems are posted along with the problems, so that potential tool purchasers can compare their evaluation results to the posted results. As additional results become available, they will be added to the web location.

Summary
A central location has been developed to allow interested persons to use previous results as a source for numerical modeling validation. This site will be carefully monitored by a review committee to insure only high quality information is posted on this site.

Also available from this site will be the IEEE/EMC Society TC-9 Challenge and Specific Standard Modeling problems. The problems are specified in sufficient detail so that users can easily create models which allow direct comparison to data from other contributors, and allow evaluation of commercial software as well.

This site has been developed as a joint ACES and IEEE/EMC TC-9 effort.
Figure 1 Problem #98-01

Challenge Problem #1
Overall View (sheet 1/3)

Shielded Enclosure
Aperture
Source Daughter Card
Mother board
Source Area
Grounding Pins
Partial Shield Daughter Card

Figure 2 Problem 98-02

PROBLEM 2 SHEET 1

15 cm

1 2 3 4

88
Figure 3 Problem 99-01 Emissions Along Edge of PC Board due to Trace

Figure 4 Problem 99-02 Shielding of Various Seam Shapes
Figure 5 Problem 99-03 Emissions from a Interconnected System

Figure 6 Problem 99-04 Crosstalk within High Speed Connector