Waveform Averaging and EMP Extrapolation

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***Abstract*—The final step in processing measured EMP data on a test object is to extrapolate it to an EMP standard as described in [1]. The extrapolation corrects for simulator inadequacies in amplitude, spectral density, and planarity. Many test programs have used only Type 2 (single point) extrapolation. However, it will be shown in this paper that the use of Type 3A extrapolation, where the data is spatially averaged over the working volume, offers significant improvements in the results.**

Keywords-EMP, CW, waveform averaging, extrapolation

I. Introduction

To estimate the coupling of EMP to an aircraft or other test object, the measured data must be extrapolated to a standard EMP waveform as described in [1]. This is done to correct for simulator inadequacies in field amplitude, spectrum, and uniformity. Many test programs have used only Type 2 (single point) extrapolation. However, it will be shown in this paper that Type 3A extrapolation (where the data is spatially averaged over the working volume) offers significant improvements in the results for both horizontally and vertically polarized simulations.

There are several steps in the extrapolation process.

1. Measure the principal components of E and H across the working volume, with phase.
2. Remove the ground reflection from each measurement using (E + H)/2.
3. Average the results across the working volume.
4. Normalize the cable current measurements to the averaged field value and multiply by the EMP standard.

If the field pattern in the CW and pulse illuminations are uniform, and the CW radiated spectrum is flat, the final CW and pulse results will compare very well. Examples are shown in the paper.

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II. Waveform Averaging

A. Horizontal Polarization. For an overhead incident, horizontally polarized wave, there will be a large ground reflection that must be removed.

B. Vertical Polarization. Vertically polarized fields also reflect off of support poles and trailers, causing notches in the field map spectra at every test point. However, these notches are spatially dispersed – they occur at a different frequency at each point in space due to differences in travel time between the arrival of the incident and reflected fields. Therefore, when the measurements are averaged, they will disappear. These notches do not appear in the internal cable current measurements, because the test object responds only to the average field.

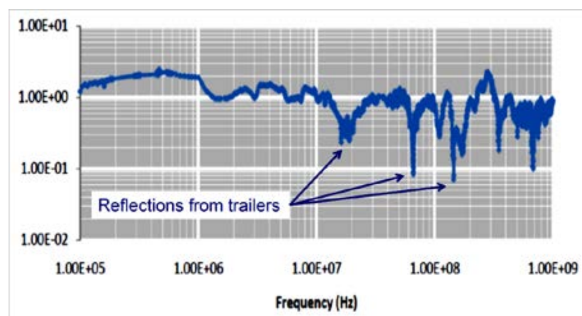

Fig. 1. Measured electric field at one point in space showing the appearance of the spatially dispersed notches.

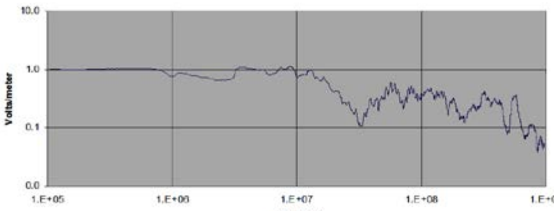

Fig. 2. Averaging 5 TP reduces or eliminates these notches.

References

[1] C.E. Baum, "Extrapolation Techniques for Interpreting the Results of Tests in EMP Simulators in Terms of EMP Criteria," Sensor & Simulation Note 222, AFWL, Kirtland AFB NM, March 1977.