IED내 Trace층 다중 전송선로상의 신호간섭 특성 분석

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Analysis of Interference on the Signal over the Multiple TX-Lines of a Trace Layer in an IED

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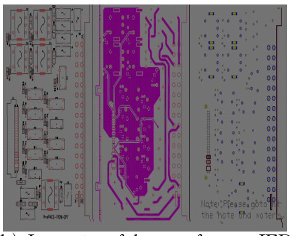
Abstract - In this article, we deal with the IED(Intelligent Electronic Device) on the EMC aspect. Recognizing how expensive the thorough EMC work will be regarding the entire IED, we focus on the characteristics of RF signals moving along multiple TX-lines in one specified example of the typical IED structure, say, the layer of trace lines. Simplifying the real structure, we run a 3D EM program and analyze the properties of signals on the lines and interference due to the coupling between the neighboring lines

1. Introduction

The IED is made to monitor the quality of electric power, accommodating power lines on the purpose of smart power grid implementation[1-2]. A commercially available IED is shown as follows with imaginary input and output power lines.

(a) Photo of an IED on the market



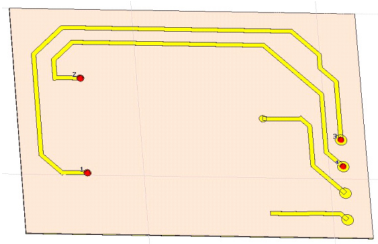
(b) Layouts of layers for an IED

<Fig. 1> A real IED and the layouts of its important layers

As shown above, layers have a number of TX-lines as signal traces and can cause the degradation of the RF signal of a line possibly affected by the interference between unintentionally coupled lines. So we will see the unwanted linkage of two adjacent TX-lines.

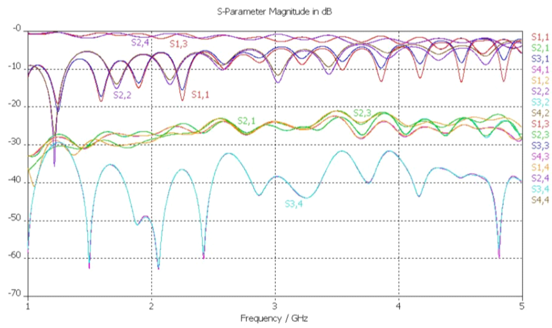
2. Prediction of Coupling between TX-Lines

Here comes a simplified but fundamental example of a trace layer.



<Fig. 2> A simplified ground-backed trace-line layer of an IED

In the figure, the upper and outer TX-line starts from port 1 to port 3. Concurrently, the lower inner line has ports 2 and 4 as its ends. Close to ports 3 and 4, there is a part of a TX-line which comes up and goes down through vias to another layer. Though this picture appears simple and apart from the actual geometry, it consists of layers which renders the choice of the simple TX-line theory failing in predicting EM interference with accuracy, since the TX-line theory is derived from the assumption of the dominant mode with the plane-wave propagation and its considering the coupling between lines relies upon only the cross-sections. Therefore, we use the FIT-based program to simulate the given structure. In detail, the 8 PMLs are used as the absorbing pad surrounding the analysis region including Fig. 2. The electromagnetic fields distributions can be plotted with no trouble, but here in this article, we present the scattering parameters as the relations of all the ports.



<Fig. 3> Scattering parameters of ports 1 through 4

When port 1 is excited, the signal going to port 3 is strong. On the contrary, S21 is weaker than the reflection observed at port 1, since port 2 and port 1 have very weak coupling. What draws our attention is the level of S34 that is the lowest in the family of plotted curves. It can be explained that ports 3 and 4 have a part of extra line which is interpreted as short-circuiting, in their vicinity. This is helpful to lowering the unwanted coupling level.

3. Conclusion

We picked up an example of the IED and its trace line layer and run a numerical analysis program to characterize the electromagnetic fields between the TX-lines on the grounded slab, when specified ports are fed an RF signal. The scattering parameters as the relations between the ports have shown the TX-lines are coupled and vary with the changing frequency

[References]

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