Waveform Adjustments on Radiated Immunity Standards over the 210-216 MHz Frequency Range

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Electromagnetic Compatibility tests are part of electro-electronic equipment validation processes. Checking the immunity of such devices to electromagnetic fields is one important step in this context. Nevertheless, if the standards that define this type of test do not faithfully represent real scenarios, wrong statements about the component performance are likely to occur. Recent experimental and computational results indicate that Radiated Immunity test standards do not faithfully represent real scenarios in the 210-216 MHz frequency range regarding the electromagnetic fields waveforms. The present contribution has the aim of proposing a simple solution for the mentioned misalignment, with basis on adjustments applied to the traditional standardized waveforms. The results showed good agreement between a digital television signal and an adjusted pulse modulated waveform.

Index Terms—**Digital TV, Electromagnetic Compatibility, Immunity Testing, Pulse Modulation.**

I. Introduction

Electromagnetic Compatibility (EMC) consists in a set of requirements for the design of electro-electronic devices, regarding their Radiofrequency (RF) emissions and immunity levels. In such context, Radiated Immunity (RI) tests are necessary to ensure that equipment will not malfunction even under the presence of RF disturbances [1]. In an attempt to check the reliability of EMC requirements and standards, as well as proposing adjustments, studies have continuously been made [2]-[3].

The present study is part of an investigation about the RI standards representativeness, considering real scenarios as the reference. Among the many parameters of such standards, the electromagnetic fields waveforms have been chosen for the analyses. The proposed investigation is focused on understanding if the standardized waveforms faithfully represent the effect of real disturbances, caused by the Telecommunication services, over a Device Under Test (DUT). This type of questioning can be found in [4]-[5], with results based on some DUTs. In [6], a similar investigation that does not consider the DUT particularities has been proposed, considering the 210-216 MHz frequency range. Computational and experimental results indicate that the RI standards are not representative in this frequency range. In the present contribution, a solution for this issue is proposed, with basis on adjustments applied to a standardized wave.

II. Development

A. Description of the Problem

A test setup, based on the RI standard ISO 11452-2 and illustrated in Fig. 1, has been used as a reference for the investigation. It basically comprises a transmitting antenna and a pair of conductors, used as an electric field sensitive element, over a bench and inside a semi-anechoic chamber.

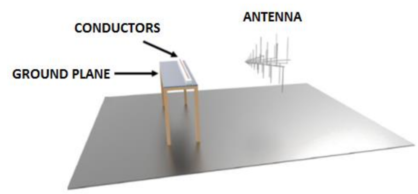


Fig. 1. Test setup.

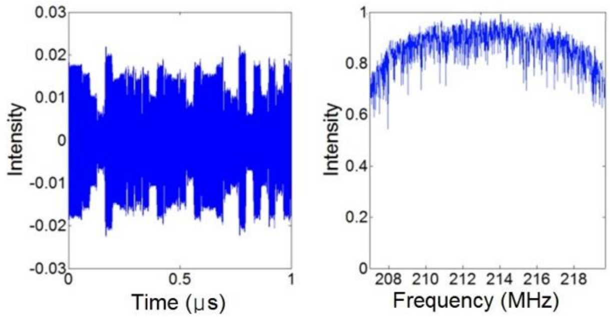
The proposed methodology consists in finding the induced voltage over the pair of conductors from Fig. 1, considering the two following situations:

- When the antenna is excited by an adjusted Pulse Modulated (PM) voltage signal, representing a typical RI standard recommendation.
- When the antenna is excited by a digital television Integrated Services Digital Broadcasting-Terrestrial (ISDB-T) signal, representing a Telecommunication service typically allocated in the 210-216 MHz range.

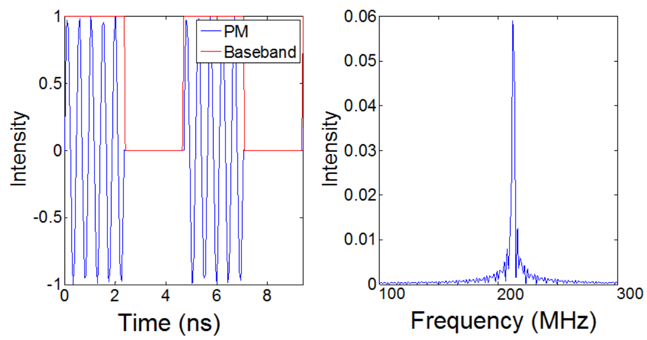
Once the induced voltage levels are known, it is possible to understand if they are influenced or not by the differences between the actual signals and their standardized representations. The choice of a PM signal instead of other waveforms proposed by the RI standards is a consequence of the results obtained in [6], which have showed that Continuous Waves (CW) are not a good approximation.

B. Adjusting the Pulse Modulated Signals

Time and frequency domains ISDB-T and PM waveforms are shown in Fig. 2. The first one has an approximate planar spectrum with a 6 MHz bandwidth centered at 213 MHz. The PM spectrum, on the other hand, is composed by a sinusoidal component and a series of harmonics with a sinc-shaped decay, related to the square wave baseband signal.



(a)



(b)

Fig. 2. Waveforms in time and frequency domains. (a) ISDB-T. (b) PM.

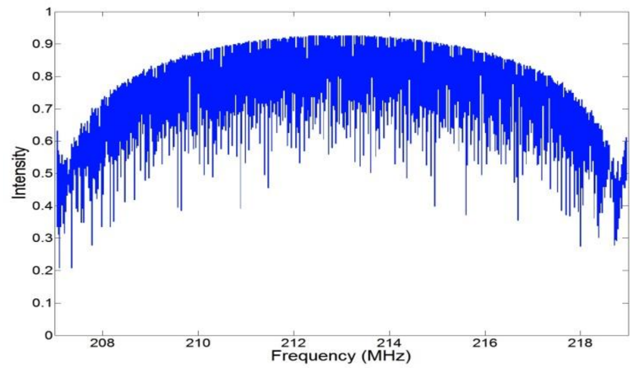
A Fourier analysis of the PM signal shows that the spacing between its frequency components is related to its fundamental period through an inversely proportional relation. Besides that, the harmonics amplitudes decay can be associated with the relation between the pulse width and the fundamental period, i.e. with the duty cycle of the signal [7]. Hence, by changing the baseband signal properties, it becomes possible to reach a good correlation with the ISDB-T waveform. The aim of this work is to find the characteristics of the PM signal that maximize the mentioned correlation.

C. Experiments and Simulations

Once an adjusted PM signal is obtained, it can be used in both the simulations and experiments, in an attempt to verify its electromagnetic effects. The goal is to compare the induced voltage levels due to the CW and adjusted PM fields effects in such a way that it is possible to understand which waveform better represents the effects of the ISDB-T wave. During the simulation process, a three-dimensional model based on the test setup from Fig. 1 is constructed with the ANSYS HFSS® software. Once the electromagnetic field calculations are performed, signal analyzes can be done with the ANSYS Designer® software.

III. Results and Conclusions

Fig. 3 exhibits the adjusted PM signal in the frequency domain, in which it is clear the similarity with the ISDB-T spectrum. The corresponding time domain signal has a 12 μs fundamental period and a 0.18 μs pulse width. On the other hand, Tables I and II specifies the measured and simulated induced voltage levels under both a typical standardized electric field level (100 V/m) and a more realistic strength (6 V/m). It shall be emphasized that these results are valid for the 210-216 MHz range only. Other studies are required to understand the standard representativeness outside this range. More details about the PM signal adjustment, simulations and experiments will be found in the full version of this paper.



(b)

Fig. 3. Adjusted PM signal.

TABLE I
Induced Voltage Levels (Measurements)

Electric field amplitude	Modulation		
	CW	PM	ISDB-T
6 V/m	39.80 mV	65.21 mV	66.91 mV
100 V/m	683.46 mV	649.37 mV	653.36 mV

TABLE II
Induced Voltage Levels (Simulations)

Electric field amplitude	Modulation		
	CW	PM	ISDB-T
6 V/m	39 mV	65 mV	69 mV
100 V/m	640 mV	661 mV	810 mV

Acknowledgement

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