Instituto Federal de Educação, Ciência e Tecnologia de São Paulo
Laboratório Maxwell de Micro-ondas e Eletromagnetismo Aplicado
Anais do Workshop de Micro-ondas ISSN 2675-4460

COMPARISON OF CABLE HARNESSES SIMULATIONS FOR ELECTROMAGNETIC COMPATIBILITY

Marco Antonio Bernardino Pinto[1,2,3], C.J. Reddy[1,3,4], Heitor Giatte da Costa[1,2], Gustavo Ferreira Vicentine[1,2], Lucas Paraventi Gomes Cardim de Medeiros[1,2], Alexandre Maniçoba de Oliveira[1,2]

[1]Maxwell Laboratory of Micro-waves and Applied Electromagnetism (LABMAX), [2]Federal Institute of Education, Science and Technology of São Paulo (IFSP), [3]Altair Engineering,[4]Indian Institute of Technology, Kharagpur

{m.antonio; heitor; gustavo; paraventi; amanicoba} @labmax.org; {marco; cjreddy} @altair.com

Abstract – This paper aims to explore Computational Electromagnetics (CEM) solutions to verify the electromagnetic disturbance intensity of cable harnesses, comparing the VSWR and reflection coefficient for four different cable types, which are commonly present in vehicles, with the intention to evidence which of them presents more efficient shielding to avoid electromagnetic interference (EMI).

Keywords: Electromagnetic Compatibility; Computational Electromagnetics; cable harness; twisted pair; CISPR.

INTRODUCTION

Since the creation of internal combustion vehicles until today, throughout the industrial revolutions, vehicles have gone through modernization processes, in which the presence of electrical/electronic devices has been increasingly seen. Consequently, this implied the emergence of problems such as electromagnetic disturbance in the operation of any electrical devices, both in the form of interference radiated from one device to another in the vehicle itself (CISPR 25) [1], as well as from one vehicle to another (CISPR 12) [2] and also from devices close to the vehicle and vice versa (CISPR 12) [2]. For this, the CISPR, whose acronym means Comité International Spécial des Perturbations Radioélectriques compile a set of standards to ensure that these disturbances are below a threshold defined as safe for the operation of these electrical devices in question. Until then, this regulation becomes even more necessary when focused on electric vehicles and autonomous vehicles, since there are even more electronic devices on board than in a combustion vehicle, in addition to the need for massive transmission/reception of environmental information around and trajectory (for autonomous vehicles.

GENERAL PURPOSE

The general objective of the developed research is an initial theoretical study of the excitation behavior of cables exposed to an electromagnetic disturbance, to compare the efficiency of the presence or absence of shielding along the cable harness.

SPECIFIC PURPOSE

This article compares the disturbance suffered in four types of cables, unshielded, shielded, and twisted pair, as described in table 1. Examples of studies like this one are carried out by COLIN et al [3], and ELFGRANI, REDDY [4]. In these articles, the research carried out has the purpose of presenting electromagnetic computational solutions to aid in decision-making of electrical projects present in vehicles.

TABLE 1 – Compared cables informations

Cable Type	Conducting Material	Radius [mm]	shielding	Radius [mm]
Single conductor	PEC	1	-	-
Shielded	Copper	1	Teflon	1
Shielded	Copper	1	Teflon;Copper	2;1
Twisted Pair	Copper	1	Teflon;Copper	2;1

DEVELOPMENT

The scenario for evaluating the cable consists of a wooden surface whose upper face has a PEC layer, a cable harness with a length of 1.5m, which types are shown at table 1, and those cables are exposed to a disturbance of a vertically polarized Log Periodic Dipole Antenna (LPDA) at 1m from the evaluated cable (fig.1); the frequency range emitted by the LPDA is 200 to 500 MHz. The Voltage Standing Wave Ratio (VSWR) is shown in fig.3 and reflection coefficients could be seen in fig. 4.

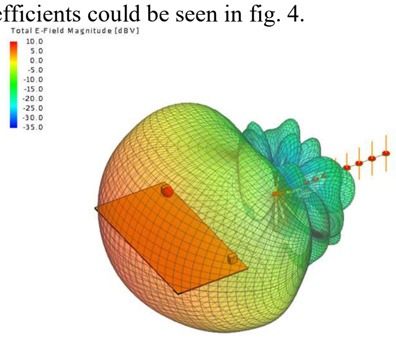

Figure 1 – Evaluated Scenario (Own Authorship – 2021).

Instituto Federal de Educação, Ciência e Tecnologia de São Paulo
Laboratório Maxwell de Micro-ondas e Eletromagnetismo Aplicado
Anais do Workshop de Micro-ondas ISSN 2675-4460

RESULTS AND DISCUSSIONS

Figure 2 shows the far field magnitude pattern, and figures 3 and 4 show the behavior of the cable harness when exposed to a 1V disturbance, in the frequency range of 200 to 500 MHz, with figure 2 being the reflection coefficient magnitude, and figure 3 the VSWR, for the four types of cable harness shown in table 1.

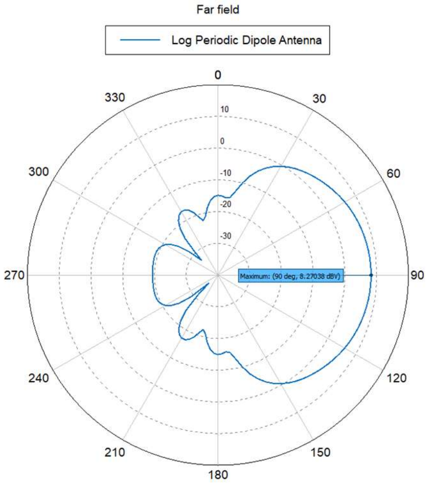

Figure 2 – Far-field LPDA at center frequency (350 MHz) (Own Authorship – 2021).

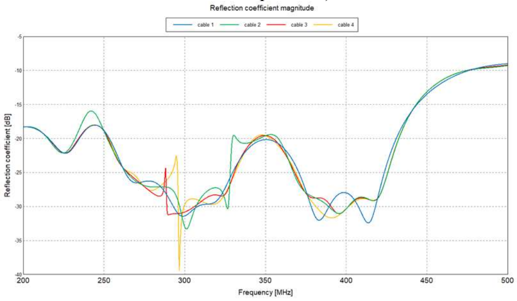

Figure 3 – Reflection Coefficient (Own Authorship – 2021).

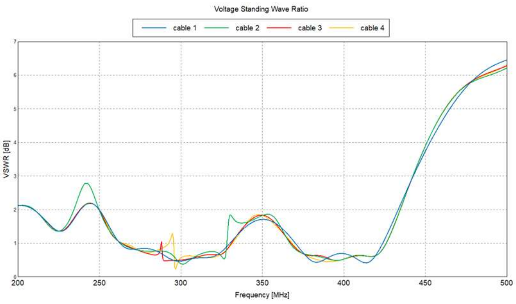

Figure 4 – VSWR (Own Authorship – 2021).

In possession of the result obtained through the simulations carried out, the authors outline as next steps the realization of physical models of the simulated systems, to validate the results obtained in the simulations carried out. Furthermore, the authors consider it convenient to go deeper into the reading of CISPR 12 and 25 standards, since these standards offer specifications for the setup of electromagnetic disturbance assessment scenarios.

REFERENCES

[1] IEC-INTERNATIONAL ELECTROTECHNICAL COMMISSION et al. IEC CISPR 25 CORR 1. 2009.

[2] IEC, CISPR. Ed. 7 (CDV), 2017,". **Vehicles, boats and internal combustion engines-Radio disturbance characteristics-Limits and methods of measurement for the protection of off-board receivers**, 12.

[3] Colin, Arnaud & Nogueira, Artur & Menezes, Magno & Perotoni, Marcelo & Marconi, Kenedy & Mologni, Juliano & Roza, Arthur. (2017). **A Feature Selective Validation-Based Comparison of Commercial Electromagnetic Simulation Software for Antenna Standing Wave Ratio and Radiated Immunity Analysis**. GEMCCON 2017 The IEEE Global Electromagnetic Compatibility Conference.

[4] Das, D., Elfrgani, A., and Reddy, C.J., **Simulation of Conductive and Radiated Emission for Off and On-Board Radio Receivers according to CISPR 12 and 25**, SAE Technical Paper 2020-01-1371, 2020, doi:10.4271/2020-01-1371.