EMC investigations on light sources

PhD theses

(thesis brochure)

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Introduction

Electronic devices populate almost all parts of our life, starting from the normal houses to the most modern office sites. Among those electronic devices, modern lighting technologies are especially emerging. The fast rise of the price of electric power offers demand to researchers for the development of more and more economic solutions in the field of lighting as well. On the other hand utilization of modern lamps creates new problems like EMC.

Disturbance emissions in 0,15MHz – 30MHz frequency range are well known. Above 30MHz the investigations on mechanism of modern lamps disturbances emissions are incomplete. With my research results I tried to fill up a part of these lacks. That is the reason why I tried to understand the mechanism of disturbance emissions above 30MHz and to try to find solutions for reducing the disturbance emissions.

I proved that for compact lamps and induction lamps the electronic ballast is the only part responsible for producing disturbances. The power supply cable determines the frequency of the radiated emission of compact and induction lamp in low frequencies.

In contrast with induction lamp where I did measurements up to 1GHz, for compact lamp I did measurements only up to 300MHz, because in 300MHz – 1GHz frequency range the compact lamp does not produce any disturbances. In 300MHz – 1GHz frequency range the disturbance emission of induction lamp is higher than in 30MHz – 300MHz .

Theses

1. **Thesis**

The CISPR 15 standard B amendment (2007-01) give the option that in 30MHz – 300MHz frequency range the measurements could be done in unshielded rooms as well.

The SAE J1113-41 (2000-05) standard is ambiguous that the conducted emission should be done or not in shielded rooms.

The GTEM cell is recommended by the manufacturers for two kinds of measurements: for disturbance emission, and immunity measurements.

I prove that the above mentioned measurement systems should be done only in shielded rooms, otherwise the external disturbances in radiated FM radio and televisions bands may falsify the measurement results. For the measurement system from above mentioned two standards (CISPR 15 and SAE J1113-41) I used GTEM cell as shielding enclosure. That is means that the set of available functions of GTEM cells extend far beyond its original intended usage area.

The high frequency measurement system is very sensitive to external disturbances (natural or industrial). The frequency range for compact lamps and induction lamps are 30MHz – 300MHz, for HID auto lamp is 0,15MHz – 108MHz. The conductors used for measurement system is acting like a good receiver antenna.

According to the measurements made by Magyar Elektrotechnikai Ellenőrző Intézet, all over Hungary the existence of electromagnetic disturbances is a general issue. In concordance with that and with my researches, my opinion is that all the high frequency measurements must be done in shielded enclosure (however standards don’t require it). The measurements in unshielded enclosures are false and invalid results. In conformity with my measurement results the GTEM cell can be successfully used as a shielded enclosure.

The cables used in measurement system constructions are not only receiver antenna they are good transmitter antenna too. During the measurement the radiated disturbances from device under test are absorbed by high frequency absorbing material which is in cell interior.

2. Thesis

Through measurements I prove that in the 30MHz – 300MHz frequency range the discharge lamp does not take part in compact lamp high frequency disturbances production. The only part that produces high frequency disturbances is the electronic ballast.

In the 9kHz – 30MHz frequency range the discharge lamp has an important role in disturbance production. During the operation near the lamp electrodes the discharges process are instable. That produce broad band disturbances. The narrow band disturbances are generated by harmonics, which are produced by electronic ballast.

In the 30MHz – 300MHz frequency range the mechanism generating the disturbance is changed. The discharge lamp in this frequency band does not produce disturbances. To prove that I substituted the discharge lamp by an adequate resistor. The disturbance emission of the artificial compact lamp is the same as the disturbance emission of the compact lamp. That means the discharge lamp does not produce disturbances. The electronic ballast is the only part which produce disturbances. Compared to low frequency range in high frequency range the disturbances are broad band which appear on supply cables as common mode current. The half bridge inverter are the most important disturbance generator part of the electronic ballast.

3. Thesis

It is a general fact that the compact lamps in 9kHz – 30MHz frequency range radiated disturbances trough the power supply cable and discharge lamp. In my dissertation I prove that this phenomenon is not real for 30MHz – 300MHz frequency range too. In this frequency range the compact lamp radiated disturbance emission propagates only trough power supply cable. The compact lamp together with the power supply cable form a resonant circuit, where the resonance frequency is determined mainly by the power supply cable. Frequency of the radiated disturbance signals depends totally on the frequency of the resonant circuit.

In the 30MHz – 300MHz frequency range the compact lamp radiated disturbance signals propagate only trough the power supply cable. To prove this assumption I did the following measurements:

From high frequency point of view I eliminated the power supply cable from circuit. That means in this case the electronic ballast provides only the discharge lamp with disturbances. It would not be possible to measure radiated disturbances from this circuit.

When I substituted the discharge lamp with a resistor the measured radiated disturbance signal was the same with the measured radiated disturbance signal from normal compact lamp. The compact lamp and the power supply cable form a resonant circuit, where the resonance frequency is determined mainly by the power supply cable. The compact lamp influences somewhat the resonance frequencies namely trough impedance of the electronic ballast, which is located close to one of the ends of the power supply cable. The frequency band of the radiated disturbance signals are determined by the power supply cable. The discharge lamps do not influence the resonant circuit in spite of during the operation the discharge lamp has negative resistance. The wavelength of the disturbance signals is close to the dimension of the resonant circuit.

4. Thesis

I proved by measurements that the induction lamp in the 30MHz – 1GHz frequency range radiated disturbances signals propagate trough the power supply cable and induction coil. The lower frequency band of the radiated disturbance signal is determined by the power supply cable while the upper frequency band is determined by induction lamp.

In case of Genura lamp the dependence of the disturbance signals on the power supply lines is a matter of the given frequency band. Here a resonant circuit is formed again. The induction lamp radiated in high frequency too and the radiated signal does not depend on the resonant frequencies of the power supply cable.

The radiated disturbance signal produce near field in the low frequency domain. In upper frequencies far field appears too.

With the produced disturbance signal, the electronic ballast loads both the power supply cable and the lamp’s coil. A part of electromagnetic field lines get closed inside of the power supply wires which increase the level of disturbance.

Dissemination of results

EN 55015 standard requires measurements in the 30MHz – 300MHz frequency range for not too long time, hence the developer engineers do not have to much experiences. My dissertation try to fill a part of these lacks.

My research results have practical advantage for lighting manufacturers. I showed which part of compact lamp produce high frequency disturbances. The developer engineers find explanations for disturbances production, radiations mechanism and disturbance suppression methods.

Papers

1. Schmidt Gábor, Istók Róbert: Fluorescent Lighting Systems Causing Electromagnetic Interference in Office and Household Appliances, City of Tomorrow and the Electricity, Prague, 2003.

2. B. Novák, G. Schmidt, R Istok: Electromagnetic Interference on Instabus EIB Systems Caused by Continuous Noise Sources such as Fluorescent Lighting Systems, 3-RD International Conference on Electrical and power Engineering, Romania, 2004.

3. Istók Róbert: Testarea lampilor auto HID din punctul de vedere al CEM. In: Electricianul, Romania, No. 1, 2006.

4. Istók Róbert, Schmidt Gábor: Imbunatatirea metodei de masurare a perturbatiilor emise prin conductie de catre lampile auto HÍD. In: Electricianul, Romania, No. 2, 2006.

5. Istók Róbert, Schmidt Gábor: Fénycsövek nagyfrekvenciás zavaremisszió vizsgálatának eszközei és rendszere. In: Elektrotechnika, No.4, 2006.

6. Istoc Robert: Metode de masurare a perturbatiilor emise prin radiatie de catre corpurile de iluminat moderne. In: Electricianul, Romania, No. 4, 2006.

7. Robert Istok: A new method for lamp's radiated disturbances emission measurement in 30 MHz – 300 MHz bandwidth. In: Advances in Electrical and Computer Engineering, Romania, Vol. 6, No. 1, 2006.

8. Istók Róbert, Bagoly Zsolt, Schmidt Gábor: A modern autólámpa EMC-vizsgálata. In: ELEKTROnet, No. 8, 2006 december.

9. Robert Istok: Relation between disturbance radiation of CFL and resonant frequency of power supply cable. In: Advances in Electrical and Computer Engineering, Romania, Volume 7, Number 1, 2007.

10. Robert Istoc: Reducerea perturbațiilor emise de câtre lămpile fluorescente compacte în banda de frecvență 30MHz – 300MHz. In: Electricianul, Romania, No. 4, 2007.

11. Istók Róbert: Az indukciós lámpa zavar emissziói 30MHz fölött. In: Elektrotechnika, No.11, 2007.