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# Computer-aided investigation of magnetic fields caused by electronic step down converters for low-voltage halogen lamps

***Abstract.*** *The investigation results of magnetic fields induced by electronic step down converters for low-voltage halogen lamps are presented. For the investigation the personal computer high definition audio system and software tools developed in the MATLAB® program package environment were used. The investigations of magnetic fields in the frequency range from 20 Hz to 48 KHz were performed.*

***Streszczenie.*** *Przedstawiono wyniki badania pól magnetycznych wywoływanych przez przetworniki obniżające napięcie dla lamp halogenowych niskiego napięcia. Dla badań był stosowany był system audio HD komputera PC oraz oprogramowanie z wykorzystaniem środowiska MATLAB. Wykonano badania pola magnetycznego w zakresie częstotliwości od 20 Hz do 48 kHz. (**Wspomagane komputerowo badania pól magnetycznych wytwarzanych przez przetworniki elektroniczne do obniżania napięcia lamp halogenowych niskiego napięcia**).*

**Keywords:** low-voltage halogen lamp, electronic step down converter, magnetic field, MATLAB®.
**Słowa kluczowe:** lampa halogenowa niskiego napięcia, przetwornik obniżający napięcie, pole magnetyczne, MATLAB®.

## Introduction

We are living in a rapidly changing world and technological developments play an important part in this. Also in the world of lighting, new products and applications are launched all the time in order to give the best solution for the changing demands of the customers. Issues like better color properties, lower power consumption, smaller dimensions, longer life time, lower costs and more flexibility are the basis for modern lighting systems. New or improved lamp types and luminaires can be an adequate answer to the changing demands. But the heart of any lighting system still is and will be the lamp and its control gear. The lamp circuits have to answer to numerous basic needs, including compliance with national and international safety standards, ease of installation, compatibility and, of course, price and performance ratio.

## Fundamentals

The low voltage halogen lamp is a great solution that leads to a separate, but related problem: how to step down the voltage from the power line. To solve this problem a transformer is needed in order to provide the halogen lamp with a low voltage supply from either 110 or 220 V AC mains. The transformers used in a low voltage lighting systems may be either electronic or magnetic.

The magnetic transformer represents a classical means of power conversion. An electronic transformer or more correctly electronic step down converter represents an alternative means of power conversion to the more standard iron core, 50 or 60 Hz transformer technique.

The typical electronic step down converter has the following basic components (Fig. 1) [1]:

- an electronic filter for radio interference suppression (EMI suppression);
- an AC/DC converter, converting the sine wave mains voltage 220 / 110 V, 50 / 60 Hz into a DC voltage;
- an high frequency generator, stepping up the frequency to approx. 40 KHz;
- an high frequency transformer stepping down the voltage to 12 V;
- electronic components for short circuit, overload and thermal protection.

## Measurement technique and results

At present various electric devices and equipment inducing the electromagnetic fields are used in everyday life, industry, trade, medicine and in other human activities. People spend increasingly more time both at work and at home at the personal computer, the monitor of which induces the wide spectrum electromagnetic waves [2]. Another rather intensive source of electromagnetic fields is compact fluorescent lamps [3] and low voltage halogen lighting systems, which are finding increasing use for lighting of living and other premises, i.e. in desk, wall and general purpose luminaires [4]. Let us consider magnetic fields caused by transformers for low voltage halogen lamps.

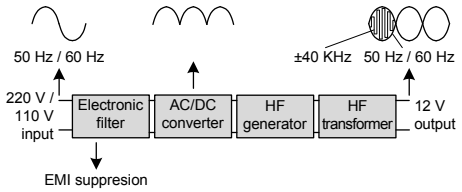


Fig.1. Block diagram of typical electronic step down converter

For the investigation of magnetic fields induced by transformers for low voltage halogen lamps the software tools in the MATLAB® program package environment were created. The personal computer high definition audio system and the magnetic field sensor were applied in the measurements.

The known scheme was used in the magnetic fields measurement (Fig. 2) [2, 3].

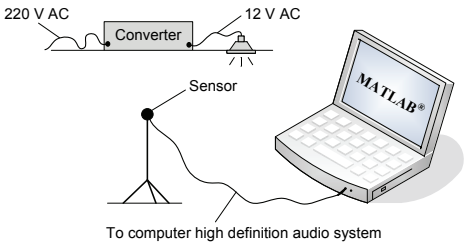


Fig.2. Measurement scheme

A desktop personal computer can be used for investigations, but the application of a portable computer has two main advantages. Firstly, it is its mobility, which facilitates the investigation at different places of the premises. Secondly, the signal recorded from the sensor by the high definition audio system will be less affected by various interferences and noises because the portable computer operating from batteries is disconnected from the electric wiring.

During the investigation the toroidal magnetic and electronic step down converter of the same power rating of 100 W were chosen. Both of them were loaded with two 35 W low voltage halogen lamps. All measurements were carried out on the same portable computer, i.e. the same high definition audio system with the same settings was used for the signal recording from the sensor.

Obtained waveforms of the voltage induced by the transformers magnetic field are of pulsed type (Fig. 3).

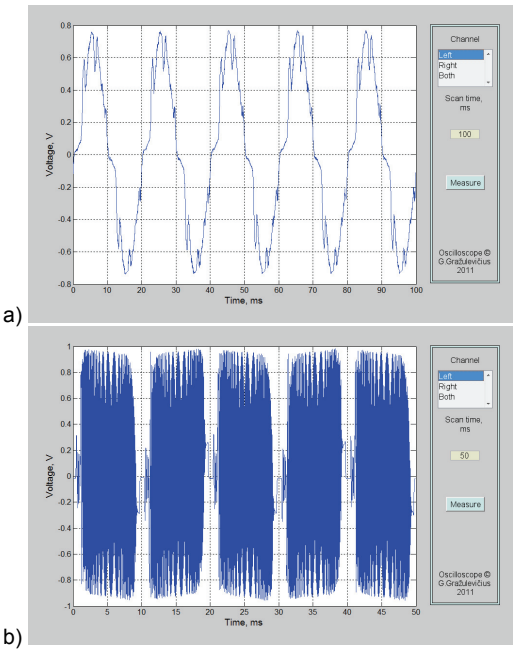


Fig.3. Waveforms of the voltage induced by the transformers magnetic field: a) – toroidal magnetic transformer; b) – electronic step down converter

The waveforms show that the voltage induced by the electronic step down converter magnetic field is higher than the voltage induced by the toroidal magnetic transformer magnetic field.

The spectral analysis of the magnetic field shows that spectrum of induced magnetic field of electronic step down converter is wide, discrete and ranges up to about 42 KHz. (Fig. 4).

It can be explained by a much more complicated construction and operation principle of electronic step down converter, because voltages of different frequencies, levels and forms are applied in them.

For the investigation of the magnetic field dependence on the distance from the transformers, measurements were performed every 5 cm up to the 50 cm distance (Fig. 5).

As it was expected, with the increase in the distance from the transformer, a fast decrease of the voltage induced by the magnetic field is observed. The presented results indicate that the intensity of magnetic field caused by the electronic transformer is higher than intensity of toroidal magnetic transformer magnetic field.

**Conclusions**

1. The software tools developed in the MATLAB® program package environment intended for the investigation of magnetic fields caused by electronic step down converters for low voltage halogen lamps have been created.

2. The investigation of electronic step down converters magnetic fields in the frequency range from 20 Hz to 48 KHz were performed by applying the high definition audio system of the portable personal computer.

3. The spectrum of induced magnetic field of electronic step down converter is wide, discrete and ranges up to about 42 KHz.

4. The intensity of magnetic field of electronic step down converter is higher than that magnetic field of toroidal magnetic transformer.

5. According to investigation data of the magnetic field dependence on the distance from the transformers, it is recommended to install electronic step down converters at a distance of at least 1 meter from frequently occupied areas.

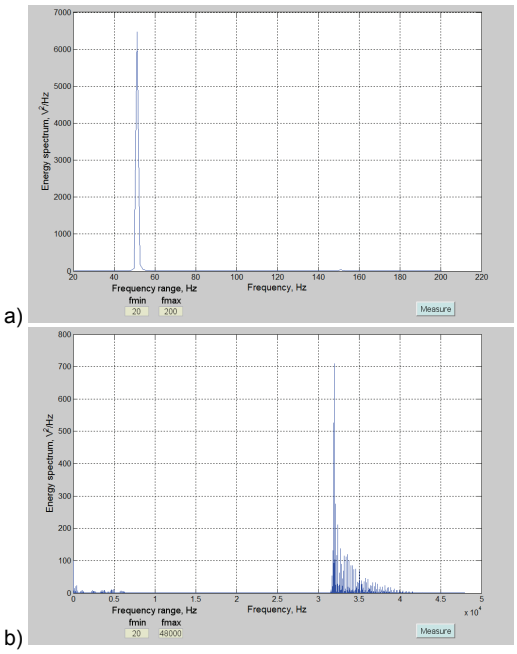


Fig.4. Spectrums of the voltage induced by the transformers magnetic field: a) – toroidal magnetic transformer; b) – electronic step down converter

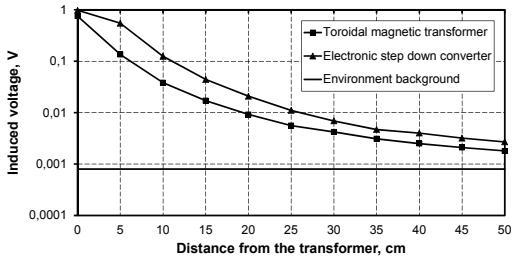


Fig.5. Dependences of the voltage induced by the transformers magnetic field on the distance from the transformer

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