

A VOLTAGE FLUCTUATION SIMULATOR

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ABSTRACT

The voltage fluctuation simulator was designed for power quality laboratory. It is a physical model of the electrical appliance connected to the electrical system with sine-voltage power supply. The appliance current-time characteristic gives rise to the voltage fluctuation, which causes luminous flux flickering. The power supply is programmable laboratory generator. The electrical system model consist stepped adjustable impedance with inductive characteristic. The appliance consists of two load impedances, first one is stationery and second is switched by Solid State Relay. The switching is controlled by PC output card. The control software allows to change frequency and pulse duty factor. The switching frequency is selected for maximize luminous flux flickering. The simulator is modular system with wide variability.

1. INTRODUCTION

The Power Quality and Low-frequency Electromagnetic Compatibility issue is closely linked to the operation of Electrical Networks. The aim of this project is to create new laboratory task for effective and simple demonstration of light flicker phenomena.

2. SOURCES OF VOLTAGE FLUCTUATIONS

The primary cause of voltage changes is the time variability of the reactive power component of fluctuating loads. Such loads include, for example, arc furnaces, rolling mill drives, main winders, etc. – in general, loads with a high rate of change of power with respect to the short-circuit capacity at the point of connection to the supply.

It is very important to note that small power loads such as starting of induction motors, welders, boilers, power regulators, electric saws and hammers, pumps and compressors, cranes, elevators etc. can also be the sources of flicker.

Other causes are capacitor switching and on-load transformer tap changers, which can change the inductive component of the source impedance.[1]

Variations in generation capacity of, for example, wind turbines can also have an effect. In some cases, voltage fluctuations can be caused by low frequency voltage interharmonics.[2]

3. LABORATORY TASK DESCRIPTION

The laboratory task is called „Light flicker caused by voltage fluctuation“, and will serve for demonstration a flicker origin and its propagation in the electrical system. The task is located in the power quality laboratory.

The task consists of the following basic parts:

- the power supply of sinusoidal voltage of 230 V 50Hz
- the electrical system model
- the appliance model with a fluctuating load
- the flickermeter
- the reference light source and other types of light sources
- the luminous flux indicator (objective flickermeter)

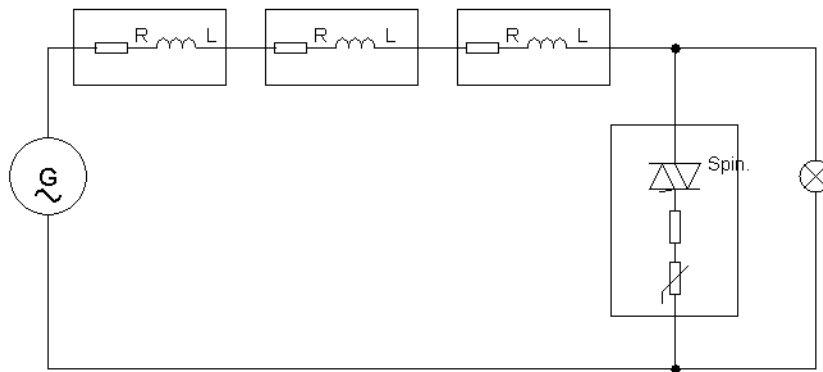


Fig. 1: Task function scheme

3.1. THE TASK PRINCIPLE

The sinusoidal voltage power supply feeds the model with a fluctuating load. The load current will flow through the electrical system model and causes the voltage drop. Students will be watching how the voltage fluctuations level depends on:

- electrical distance from the source flicker
- the size of load and switching frequency

On the connected light source can be assessed subjective flicker perception, arising from various light sources (incandescent, discharge, LED). A photocell is used for measure and analyze the generated luminous flux.

3.2. SINE – VOLTAGE POWER SUPPLY

As a source of sinusoidal voltage is applied stabilized laboratory source Pacific AMX 108 with adjustable voltage from 0 to 300 V.

3.3. ELECTRIC SYSTEM MODEL

Electric system model consists of three identical modules which can be connected in series. Total line drop can reach up to 7.7 % in nominal current 1 A.

Each module has adjustable impedance in three stages. The impedance consist of inductance 1 mH and resistance 0,1 Ohm in series.

Each modules is stored in a separate plastic box, number of stages is selected by rotary switch. Modules are interconnected by safety measuring leads.

3.4. FLUCTUATING LOAD MODEL – FLICKER ORIGIN

A resistance load fast switching leads to the current fluctuation and then to the line impedance voltage drop. It leads to the voltage fluctuation, which increase with electrical distance from the power supply.

The power supply terminal voltage is invariable, the largest voltage fluctuation is on the load terminal. The load resistor is switched by Solid State Relay, i.e. semiconductor contactless relay ERI 012 PAC.



Fig. 2: SSR ERI 012 PAC

The load resistor consists of two resistors in series, fixed 150 Ohms and rheostat 0 ... 250 Ohms. It is therefore possible to switch current in the range of 0.5 to 1.5 A. The fixed resistor do not allow cross-circuit current above 1.5 A (Maximum allowable model current).

Relay control

Solid state relay is controlled by voltage 0-10 V, which is galvanically isolated from the switching circuit. Control voltage is generated using a multi-card NI USB-6009, which will be connected to a computer via USB. At the same time, this card will serve as a flicker measuring card

3.5. FLICKER MEASUREMENT

Flickermeter use virtual measuring instruments in LabView, which will receive data from the measurement card NI USB-6009. For the purposes of task already programmed digital flickrmetr based on the IEC 61000-4-15 standard is used.

Luminous flux measurement

A simple photodiode BPW 21, adapted on eye spectral perception connected to the transimpedance amplifier LMV793, will be used for a real luminous flux measurement. Amplifier output is connected to the DAQ card NI USB-6009.

4. CONCLUSION

The laboratory task with voltage fluctuation simulator will improve the laboratory teaching in Power Quality Laboratory. Students will be able to understand flicker origin and its propagation in electrical network.

ACKNOWLEDGEMENTS

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