FLICKERMETER DESIGN IN LABVIEW

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ABSTRACT

This paper deals with the description of flickering light sources and flicker measurements. It describes the standard flicker meter and its implementation in Lab View. It shows some of the disadvantages and drawbacks of the standard flicker-meter.

1. INTRODUCTION

Fast voltage fluctuations can cause flickering light sources. Voltage fluctuations can be caused by amplitude voltage modulation, but also by the presence of interharmonics which are produced by some modern appliance or serve as control signals.

However, standard flicker meter is unable to record voltage fluctuations caused by the interharmonics.

2. FLICKER

2.1. Definition of flicker

Flicker is defined as the discomfort impression experienced by the human vision resulting from the variations of the luminous flow in the electric lamps fed by a fluctuating voltage.

Flicker significantly distorts vision, and generally causes discomfort and fatigue. The blinking light sources may create discomfort and impaired quality of work - in some cases can cause accidents in the workplace [2]

Voltage fluctuations of low amplitude (< 10%) and within a spectral bandwidth from 0,5 to 35 Hz usually cause flicker. Flicker emission is a power quality problem which utilities and customers are confronted with. In spite of its subjective character, it is nowadays a well defined, analyzed and measurable phenomenon, for which standard profiles and mitigation measures exist.

It is unpleasant for the human psyche. Research has shown that the human eye response has the broadband filter characteristic with maximum sensitivity to light flux at a frequency of around 8-9 Hz (Figure 1). Brain response to visual stimulus has the inertia time constant at about 300 ms, which means that slow flux change is monitored and rapid changes are "smoothed".[1]

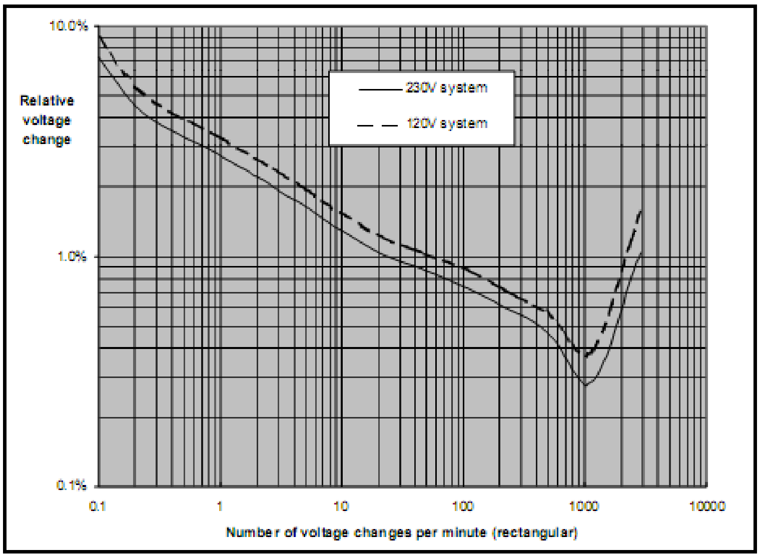

Figure 1: Curve of equal severity (Pst = 1) for rectangular voltage changes on LV power supply systems [2].

2.2. Flicker origin

Ideal voltage fluctuations can be described as amplitude modulation. The simplest case is the sinusoidal voltage fluctuations, described by the equation in the standard form.

$$u(t) = U \cdot \sin(2\pi f_1 t) \cdot \left[1 + \left(\frac{\Delta U}{U}\right)\frac{1}{2}\sin(2\pi f_M t + \varphi)\right] \quad (1)$$

Where $\frac{\Delta U}{U}$ is the depth of modulation, f_M frequency of modulation, φ is initial modulation phase

Fluctuations in voltage can be caused by summation harmonic voltage components with the interharmonic and subharmonic components with frequencies: $f_{IH} = \left| f_1 \pm f_M \right|$

Interharmonic components with high frequency (above 100 Hz) can cause voltage fluctuations and flicker light sources [1]. This applies to all types of light sources, except light bulbs. It would be appropriate for the flicker-meter to be able adequately reflect the effect of interharmonics with a frequency greater than 100 Hz.

These interharmonics and harmonics are generated by appliances such as power converters, arc furnaces, etc., or directly injected into the supply network as electronic ripple control signal.

3. FLICKER MEASUREMENT

3.1. UIE/IEC FLICKERMETER

The flicker meter design is based on studies of human brain responses to flickering light sources. The flicker-meter functional and design specification are described by the international standard IEC IEC 61000-4-15. The scope of the flicker meter is based on two main approaches: the simulation of the chain lamp-eye-brain and real time statistic analysis of the flicker signal.

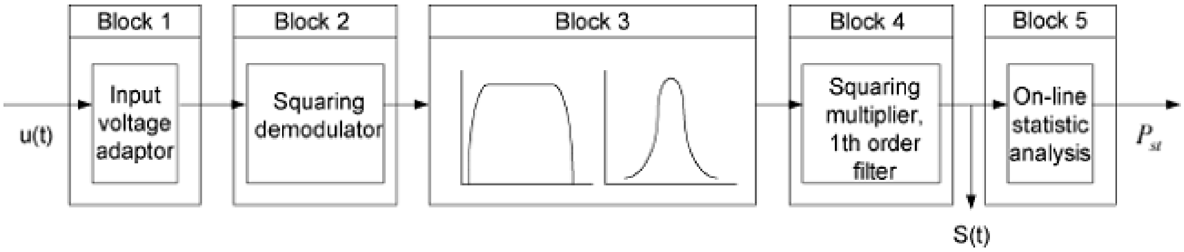

Figure 2: Functional block diagram of IEC Flicker-meter [2]

Block 1 scales the input voltage down to an internal reference level. In this way flicker measurements can be made independently of the actual input carrier voltage level.

Block 2 recovers the voltage fluctuation by squaring the input voltage, thus simulating the behavior of an incandescent lamp.

Block 3 is composed of a cascade of two filters. The first filter eliminates the d.c. and double mains frequency ripple components of the demodulator (Block 2) output. The filter incorporates a first order high-pass (recommended 3 dB cut-off frequency at about 0.05 Hz) and a low-pass section, for which a 6th order Butterworth filter with a 3 dB cut-off frequency of 35 Hz system is recommended.

The second filter is a weighting filter (Figure 3) that simulates the frequency response to sinusoidal voltage fluctuations of a coiled filament gas-filled amp (60 W, 230 V) combined with the human visual system. The response function is based on the perceptibility threshold found at each frequency by 50 % of the persons tested. Fig. 2 shows the weighting filter response which attains its maximum at 8,8 Hz since at this frequency the flicker perception is higher.

Block 4 is composed of a squaring multiplier and a first order low-pass filter with a time constant of 300ms. The output from Block 4 represents the instantaneous flicker level. This output is mandatory according to the standard. It measures how intensely the effect can be noticed by the average human being.

Block 5 performs an on-line analysis of the flicker level deriving measurements of flicker severity by statistical analysis. The statistical analysis is made by subdividing the amplitude of the flicker level signal into a suitable number of classes. The IEC standard requires at least 64 classes for the classifier. From this the cumulative probability function of the flicker levels can be calculated the short-term flicker severity.

3.2. UIE/IEC FLICKERMETER DISADVANTAGES

The disadvantage of UIE / IEC flicker meter is the only response to the voltage fluctuations related to the amplitude modulation, i.e. the frequency up to 100 Hz. However, flickering of fluorescent light sources is caused by frequency components up to 2.5 kHz.

A standard Flicker-meter prevents any response to high-frequency interharmonics, even if voltage envelope fluctuates and fluorescent light sources can flicker. [1]. Alone harmonics cannot cause a nuisance flickering flux, but in combination with interharmonics creates voltage fluctuations, which may lead to Flicker. [3]

These interharmonics and harmonic frequencies are generated with appliances such as power converters, arc furnaces, etc., or directly injected into the supply network as electronic ripple control signal.

4. FLICKERMETER IN LABVIEW

4.1. LABVIEW

LabVIEW is a platform and development environment for a visual programming language from National Instruments. The graphical language is named "G". LabVIEW is commonly used for data acquisition, instrument control, and industrial automation on a variety of platforms.

4.2. FLICKERMETER MODEL

UIE / IEC flicker-meter model was implemented in Lab VIEW. This model does not contain Block 5, thus only provides information on the immediate flicker-meter response to voltage fluctuations with the frequency and depth modulation.

This model contain internal voltage generator. This generator simulates input voltage with sinusoidal and square voltage fluctuation.

This model was created for the research disadvantages of the standard UIE/IEC flicker-meter. It serves primarily to simulate the standard flicker-meter response of subharmonic, interharmonic and harmonic frequencies up to 3 kHz.

Another feature of this model is to research the possibility of Lab VIEW environment for development of a new type of flicker meter, which will be based on an analysis of voltage in frequency domain.

A flicker-meter meeting standards is an analogue measuring device. Digital measuring instruments used a modified version of the standard flicker meter. S-transfer functions of analog filters are transferred using the bilinear Z-transformation to digital form.

4.3. VALIDATION

Standard EN 61000-4-15 rules total flicker-meter response on the Block 4 output. Unit output equals human perception threshold for flicker. If the input value is in range +-5% for the unit output, then the desired accuracy is obtained.

Tests were carried out for sinusoidal and square flickering. Results of both tests comply with standard.

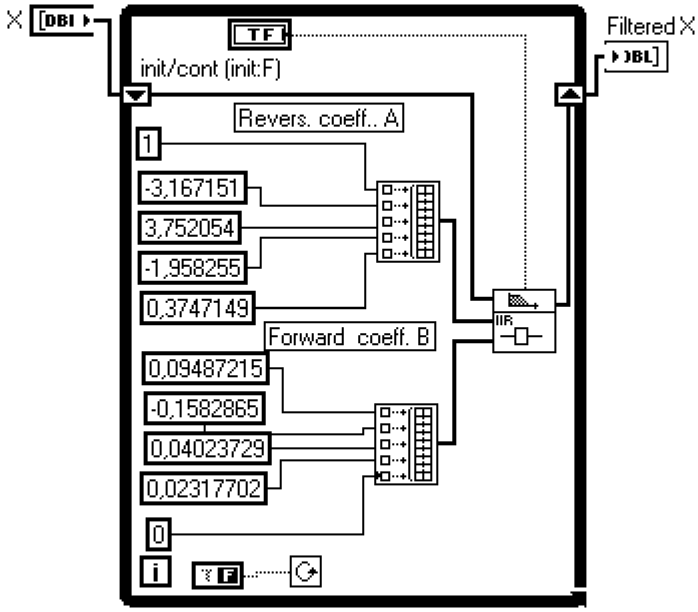

Figure 3: Weighting filter (block 4) functional block diagram

5. CONCLUSION

A flicker-meter model has been developed in Lab VIEW. Its functionality has been verified. The results of the tests coincided with the results from the MATLAB Simulink, developed in [1].

The flicker-meter will be tested for response at frequency up to 2.5 kHz. The ideally flicker-meter should be able to reflect the effect of interharmonics with a frequency greater than 100 Hz. It is clear that the standard flicker-meter will not be successful in these tests. Therefore possibility of modifications will be sought that lead to the expected capabilities.

It will be possible to apply the results of this work directly to quality monitors electricity as a new type of flicker-meter with response to the frequency range DC-2500 Hz.

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