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SIGNAL SWING NORM AS A MEASURE OF ELECTRICAL ENERGY QUALITY

A. Bien
Department of Measurement and Instrumentation
University of Mining and Metallurgy, Cracow, Poland

Abstract: Stability of root mean square (rms) voltage is one of more important parameters of electrical energy quality. To evaluate the stability - rather unstability of rms voltage- we use a flickermeter which determine the flickering severity factor P_{ST}. Flickermeter is such an instrument in which reaction of electrical power is modelled by source of light onto human psychophysical features. The obtained signal is statistically analysed. As a result we obtain value P_{st} which is a measure of electrical energy quality. After statistical treatment of the signal we obtain the value of parameter P_{ST} which is a measure of electrical energy quality.
Functional of signal swing instead of statistical treatment is suggested to measure unstability of model signal. Functional of signal swing can be used for determined signals e.g. test signals, changes appearing in isolated cases (unit number of appearances in a certain time interval) and signals with statistical properties.The feature enables better interpretation of measuring results. The results obtained by a signal swing functional have properties similar to P_{ST}.
Keywords: Flickermeter, swing norm

1 INTRODUCTION

Power networks are nowadays the basic sources of energy used in the newest technologies as well as for operating of advanced electronic equipment.

Turbulent or nonlinear energy receivers produce disturbances appearing as transient changes of voltage amplitude and for shape as well as of the period duration. Such changes affect the action of power receivers and show the tendency to intensify in consequence of reverse receivers action upon the network.

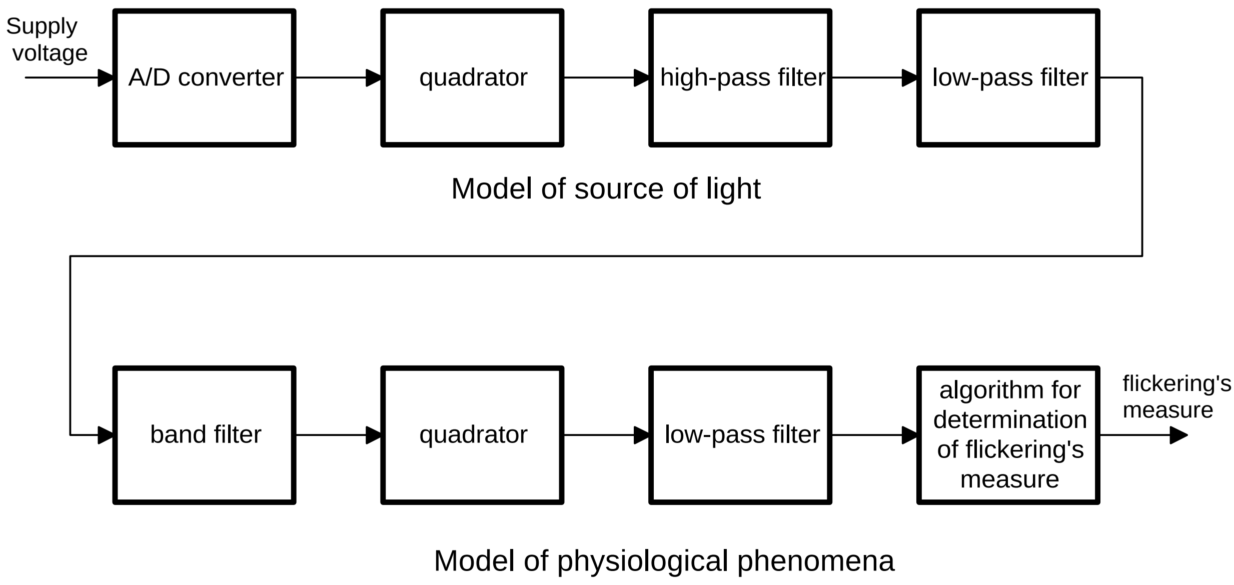

Figure 1. Block scheme of a basic functional structure of a flickermeter.

Nowadays it is accepted that for the power network voltage there exist two areas of perturbances: for the frequencies greater than the basic frequency $f_0 = 50\,Hz$, defined by THD parameter, and for frequencies smaller than f_0, defined with P_{ST} parameter, connected with flicker signal. Currently used P_{ST} meter is flickermeter [4], whose digital version structure is showed in the Figure 1.

Users of these systems complainof ambiguity of obtained results. The confirmation of these problems lies in changing complection of the matter in the normative documents (CD in revision to 61000-4-15, IEC 1999). The author of this paper is of opinion that the sources od these problems should be seeked in the following areas:

1. Construction description is given for analog accomplishment and its approximate digital and analog accomplishments, with errors of amplitude vs frequency characteristic of order of 1% is not correct, i.e. the requirements concerning technical realization of instrument are too high.
2. Calibration of instrument is performed with sinusoidal or rectangular signals while in reality the instrument works with nonstationary signals.
3. The procedure of determining P_{ST} and on its basis P_{LT} is based upon cumulated probability curve determined for the flickering signal and on the relationships synthesizing properties of this curve. It is very problematical to treat this procedure as reliable norm of flicker signal.

The first point is obvious and addressed to constructors so that they carefully reflect parameters given in normalization documents. Remaining points are connected with declaration of such flicker signal processing algorithm, that its properties would be the same for determined and nonstationary signals, and moreover, that it would possess atributes of a standard.

2 FUNCTIONAL OF SIGNAL SWING

It is proposed to introduce as algorithm of the block called in quoted documents „algorithm for determination of flickering measure" – the algorithm determining the measurement result on the ground of the norm of flicker signal swing according [1]:

$$\underset{[0,T]}{Var}\, h = \sum_{i=0}^{n-1} \left| h_{i+1} - h_i \right| \tag{1}$$

where: $[0,T]$ – the time of observation of the *h* signal, possessing *n* local extrema,

h_i – values of corresponding local extrema.

The result $\underset{[0,T]}{Var}\, h$ is counted over to P_{ST} and further P_{LT} values in order of preservation of hitherto existing coefficients of power network quality. In may be noticed that for test signals published in standards – i.e. determined ones – the counting will be based upon simple algebraic relationship.

The use of suggested algorithm makes possible to analyse the instrument functioning by means of simulation investigations. These investigations show that such solution is technologically realizable, and for test signals i.e for the testing of instrument according to [4] the results are adequate for classical solution.

Therefore, the application of swing (1) leads to a simpler algorithm, called „algorithm for determination of flickering's measure".

3 RESULTS OF THE EXPERIMENTS

Construction of the instrument structure presented in Fig. 1 should be build using Wiener's and Hammerstein's models. [2,3]. The usage of the proposed solutions enables the analysis of instrument operating by modelling research.

A digital model of flickermeter in which all blocks (Fig. 1) are realised in a digital way by use of 32 bits floating point. Error for a flickering signal made by flickermeter according to [4] is smaller than 5%.

The results obtained in modelling for test signals recommended by [4] are showed in Fig 2,3,4. They deal with sinusoidal type of modulating signals.

In order to compare results presented in Fig. 1 a basic relation approximating the results of classical flickermeter P_{ST} and flickermeter with functional of signal swing $P_{ST}*$ is introduced.

$$P_{ST}* = a \cdot \sqrt{\underset{[0,10\min]}{Var}\, f_S} \tag{2}$$

where a -calibration parameter,

f_S - signal of flickering severity.

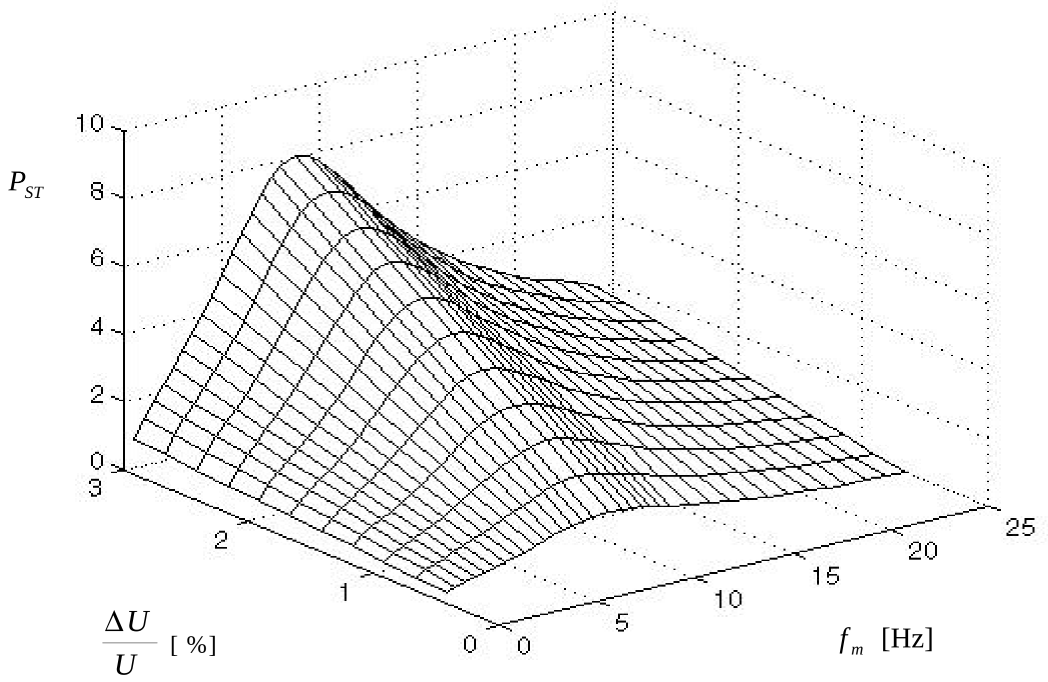

Figure 2. The dependence of P_{ST} on both frequency and relative amplitude of modulating sinusoidal signal

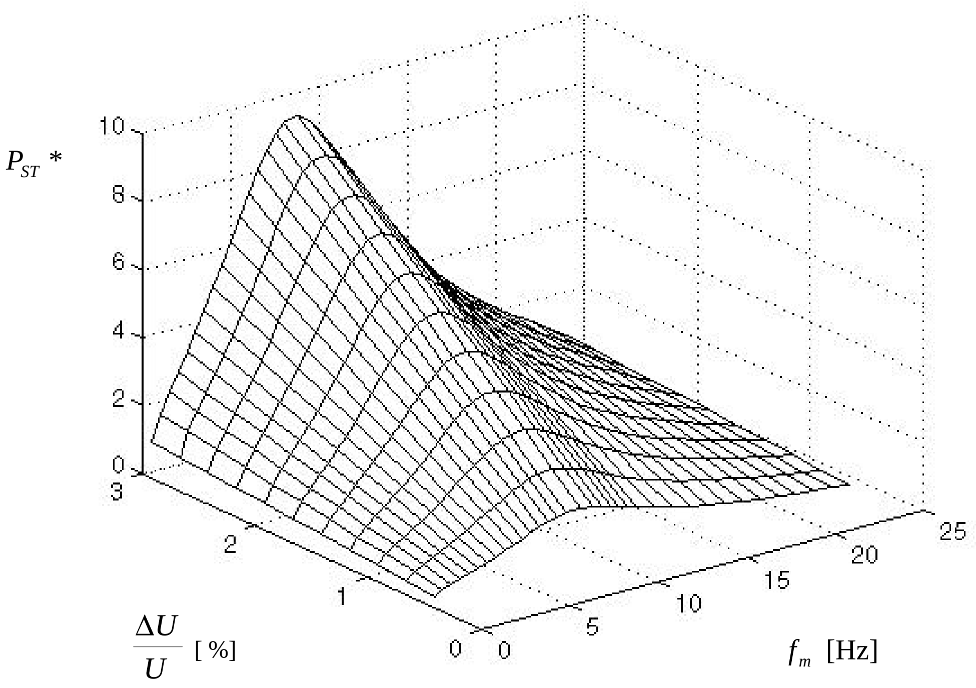

Figure 3. The dependence of P_{ST} * on both frequency and relative amplitude of modulating sinusoidal signal

Making a comparison between Fig. 1 and Fig 2. It can be observed that they have the similar character, which results from the identical part, which modulates a lamp and physiological reactions. The difference between P_{ST} and P_{ST} * is shown in Fig 1.

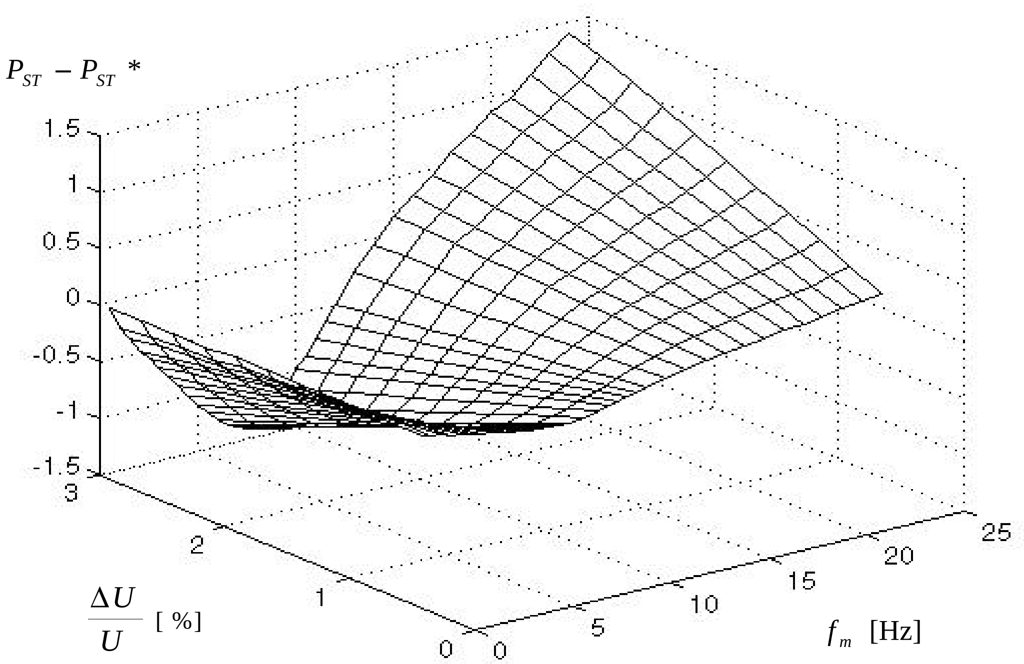

Figure 4. A difference between P_{ST} * and P_{ST} for experiments from Fig. 2 and Fig. 3,

A surface of difference (Fig. 3) is ranged out for a minimizing the maximal distance between the surfaces in Fig. 1 and Fig. 2. We have found that P_{ST} * reaches higher values than P_{ST} for frequency smaller than 14 Hz and lower values for higher frequencies.

4 CONCLUSION

Presented results confirm that the solution based on a functional of signal swing can be technically/practically realised. For test signals i.e. for a procedure of checking instrument by requirement [4] the obtained results are closed to the classical solution. Differences between P_{ST} and P_{ST} * results from different behaviour of processing algorithms for changeable signals particularly for oscillating components of these signals. For signals, which cause oscillations inside a structure of flickermeter, bigger differences can be expected. Application of swing (1) leads to the easier algorithm for determination of flickering's measure.

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AUTHOR: Ass. Prof. Andrzej BIEN, Department of Measurement and Instrumentation, Faculty of Electrical Eng., Automatics, Computer Science and Electronics, University of Mining and Metallurgy, al. Mickiewicza 30, 30-059 Cracow, Poland, Phone: ++48 12 6172873, Fax: ++48 12 6338565, E-mail: abien@uci.agh.edu.pl