AQTR 2004 (THETA 14)
2004 IEEE-TTTC - International Conference on Automation, Quality and Testing, Robotics
May 13 – 15, 2004, Cluj-Napoca, Romania

THE INFLUENCE OF DIGITAL SAMPLING IN THE ELECTRICAL METROLOGY

Costin Cepişcă[*], Horia Andrei[**], Cornelia Cepişcă[***], Stergios Ganatsios[****], George Seritan*

[*] *POLITEHNICA University*
313, Spl.Indep., Bucharest, Romania
Tel: +40-0745180439, fax: +40-0214116290 costin@electro.masuri.pub.ro
[**] *VALAHIA University*
Tirgoviste, jud.Dimbovita, handrei@valahia.ro
[***]*Gr.Sc. Electronica Industriala*
254, sos.Pantelimon, s.2, Bucharest
Tel: +40-0212506734, fax: +40-0212506734 costin@wing.ro
[***]*Technological Educational Institute of West Macedonia*
Kila, 501 00 Kozani, Greece
Tel: +30-02461021811, fax: +30-0246139682 ganatsio@kozani.teikoz.gr

Abstract: The paper presents the results of a study of the errors caused from digital sampling in the measurement of active power and energy with digital meters. The presence of non-sinusoidal regimes makes the use of the Shannon theorem more difficult. The models of digital sampling operations and Matlab applications show which the sampling frequency for a minimum of errors is.

Key words: digital meters, energy, errors, sampling, frequency.

1. INTRODUCTION

The amount of sampling rate is very important for the measurement incertitude of electrical power and energy. In energy metering ANSI and IEC specifications call for accurate measurement up to the 20th harmonic (1 kHz), but in the electrical systems, the order of harmonics is greater. This paper presents a study for the accurate choice of sampling frequency to digital meters use in the electrical systems with non-sinusoidal signals. The sampling rate f_s will determine the highest frequency that can be measured, f_s /2, while the total measurement time T' will determine the lowest frequency that can be resolved and the frequency resolution will be 1/T.

2. THE DIGITAL MEASUREMENT OF ENERGY

The conditions for minimizing the error are:

$$\frac{4\pi}{k}N = 2m\pi, \quad m \in Z \quad \Rightarrow \quad 2T' = mT$$

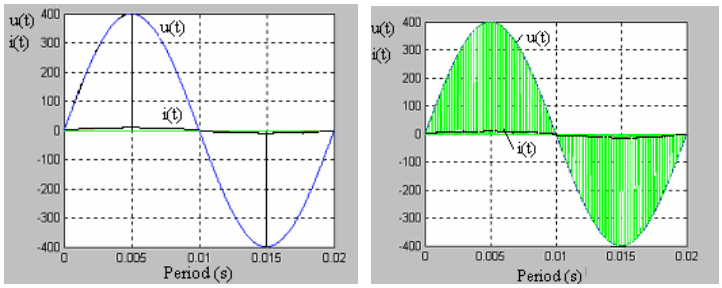
$$\sin\left(\frac{2N}{k}\pi\right)=0 \Rightarrow \frac{2N}{k}\pi = m\pi \qquad 2T' = mT, \quad m \in Z \tag{1}$$

$$\cos\left(\frac{2(N-1)}{k}\pi+\varphi\right)=0 \Rightarrow \frac{2(N-1)}{k}\pi+\varphi=(2p+1)\frac{\pi}{2}, \qquad p \in Z$$

$$\frac{4\pi}{k}i \neq 2\mu\pi \Rightarrow \frac{2}{k}i \neq \mu \Rightarrow T_e \neq \frac{\mu}{2i}T, \quad \mu \in Z$$

3. MODELS AND SIMULATIONS

The results based on a MATLAB model of digital sampling are presented in Figure 1, where the signals are: $u(t)=400\sin 314t$, $i(t)=10\sin 314t$



a) $f_s = 3f_1$ b) $f_s = 199f_1$

Figure 1. Digital sampling, $T'= T$

For the fundamental frequency f_1= 50 Hz, the error due to frequency sampling f_s is presented in Figure 2.

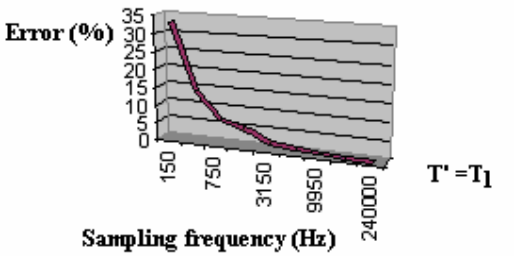


Figure 2. Error due to frequency sampling, $T'= T_1$

4. CONCLUSIONS

The error decreases with the number of samples taken, however just by a factor ~ $1/\sqrt{n}$. Therefore, with shorter conversion times and higher computer efficiency given by the modern technology it is possible to get a reasonable accuracy with this method, even if it takes more than one million samples to get an uncertainty of less than 0.1%.

5. REFERENCES

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