May, 2005

Digital Calculation of Frequency of Periodical Signal (Sinusoidal and Triangular

Tarak Benslimane
Boukhemis Chetate

Digital Calculation of Frequency of Periodical Signal (Sinusoidal and Triangular)

T. Benslimane, B. Chetate

Research Laboratory of Electrification in Industrial Enterprises
Independance avenue, Boumerdes (35000), Algeria
Phone/Fax : +213 24 8170 50, Fax : +213 24 81 91 72
bens082002@yahoo.fr

***Abstract* — In this paper, a method of digital calculation of frequency of periodical signal (sinusoidal and triangular signals) is proposed. This method is based on calculation of time between two successive peaks of the rectified signal which constitutes it's half period. This method allows the measurement of AC current and voltage of AC electrical network. To apply this method, it is necessary to have current and voltage sensors, analogue/ digital converter (ADC) and a processor. A software C++ based program is developed which can be implemented using appropriate processor. In the end are presented the digital simulation results.**

***Index Terms* — Frequency measurement, Sinusoidal signal, Triangular signal, Data type, Digital measurement, Peak value, AC voltage and current.**

I. INTRODUCTION

AC systems (AC network, induction motor) need to be controlled continuously to avoid damages caused by faults. This control may cover peak values (or RMS values), frequency values, phase values, etc. In this paper, a digital frequency measurement method is proposed. This method based on calculation of time between two successive peaks of rectified voltage or current then doubling this value to get the period of the signal. The frequency is deduced by inversing the period value. A software C++ based program is developed which can be implemented using appropriate processor. In the end are presented the digital simulation results.

0-7803-9219-1/05/$20.00 © 2005 IEEE

II. Principle of Proposed Digital Frequency Measurement Method

This method based on calculation of time between two successive peaks of rectified signal then doubling this value to get the period of the signal. The frequency is deduced by inversing the period value (fig. 1).

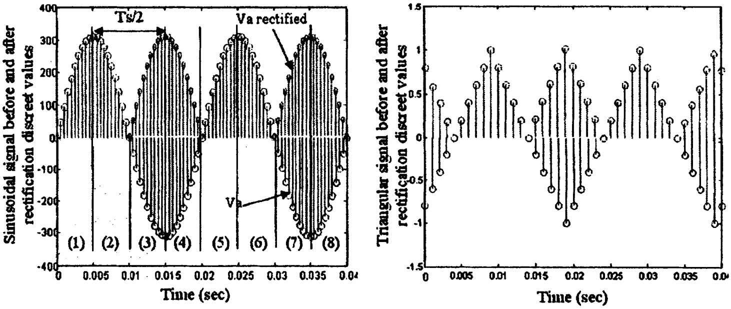
A. Rectification of sinusoidal and triangular signals

This rectification is ensured by simple software program in C++. This former algorithm is like follow:

If (Va≥0) Va rectified = Va.

If (Va<0) Va rectified = -Va.

Rectified signal result is presented in fig. 1.



a. Discreet values of Sinusoidal Signal before and after rectification

b. Discreet values of Triangular Signal before and after rectification

Fig. 1. Discreet values of Sinusoidal and Triangular Signal before and after rectification

B. Digital Calculation of Peak Value of Sinusoidal and Triangular Signals

The calculation of signal peak value is ensured by software C++ program respecting the algorithm of fig. 2. The first part of this algorithm constitutes software rectifying of the signal. The calculation of peak value (Vapmaxdef(n)), that is initially nil, is based on calculation of temporary maximal value of the signal (Vapmaxpro(k)).

Voltage Va(k) is acquisitioned and rectified to get Vap(k). Then, it will be compared to Vapmaxpro(k) that is initially nil. If Vap(k) is greater than Vapmaxpro(k) then there will be new temporary maximal value of this signal which is Vap(k) else Vapmaxpro(k) stays the same.

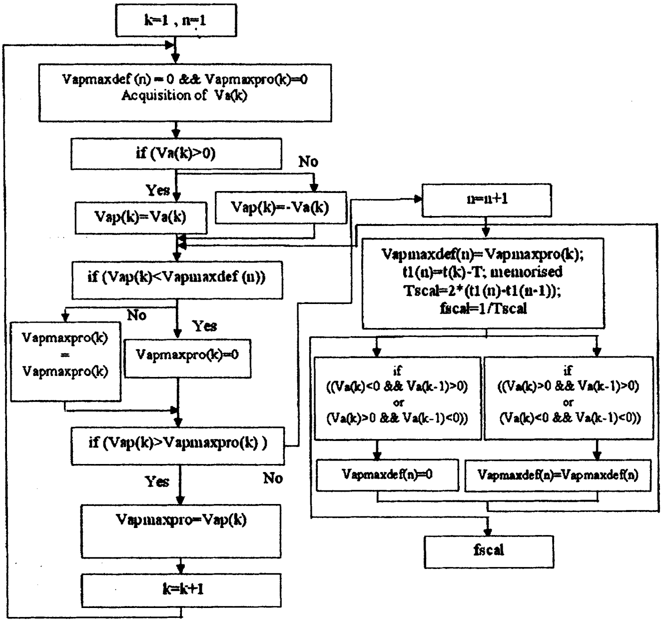


Fig. 2. Algorithm of the proposed method of the signal frequency calculation

The peak value (Vapmaxdef(n)) will be got when the acquisitioned value of the rectified signal Vap(k) becomes less than temporary maximal value of the signal Vapmaxpro(k). In this case we will have a new peak value (Vapmaxdef(n) = Vapmaxpro(k)). Time corresponding to this peak value is being (t1(n)=t(k)-T with T as sampling time). The difference between two successive peaks corresponding times (t1(n)-t1(n-1)) constitutes the half period of the sinusoidal signal. Then the period will be the double of this difference:

$$Tscal=2(t1(n)-t1(n-1)) \qquad (2)$$

The frequency will be finally deduced by taking the inverse of the calculated period:

$$fscal=1/Tscal \qquad (3)$$

Its remarkable that there is an over flow of frequency at the beginning of the signal (fig. 8). This is due in fact, to the initial value of t(n) which was taken nil. The frequency in this case is wrongly calculated by fsacl=1/Tscal=1/(2(t1(1)-0)) and will be very high. Therefore, we can limit this value to pre defined maximal value fsmax by using simple software program:

$$\begin{array}{ll} \text{If (fscal} \geq \text{fsmax)} & \text{fscal = fsmax.} \\ \text{If (fscal} < \text{fsmax)} & \text{fscal = fscal.} \end{array} \qquad (4)$$

When time belongs to the intervals (3), (5) and (7) Vapmaxdef(n) will be taken as nil to allow the calculation of next temporary peak value Vapmaxpro(k) and then next Vapmaxdef. The transfer from of Interval (2) to (3), from (4) to (5) and from (6) to (7) is detected like indicated on the (fig. 2.) by defining the signs of signal values Va(k) and Va(k-1) for example transfer from interval (2) to (3) is characterized by (Va(k)<0) and (Va(k-1)≥0) (fig. 1). Along the intervals (2), (4) and (6) Vapmaxdef(n) will stay invariable because there is no peak values to be calculated in these intervals (fig. 1).

III. Results of Digital Simulation

The simulation is done by using the software language C++ with following parameters:
For sinusoidal signal: Vrms = 220, (25 Hz, 40 Hz, 50 Hz and 60 Hz),
For triangular signal: Vmax = 1, (25 Hz, 40 Hz, 50 Hz and 60 Hz),
Sample time T=0.0001 seconds.

IV. Conclusion

In this paper, a digital new method to calculate the frequency of periodical signal (sinusoidal and triangular signals) is proposed. This method based on determination of times corresponding to two successive peak values of the signal then getting the frequency from the difference between these two times. This method can easily be implemented by using signal sensors, analogue/digital converter and processor. Simulation results confirm the high precision of this method in sinusoidal signals frequency calculation.

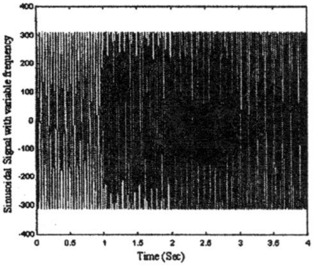


Fig. 3. Simulation result of Sinusoidal Signal with variable frequency (25 Hz, 40 Hz, 60 Hz and 50 Hz)

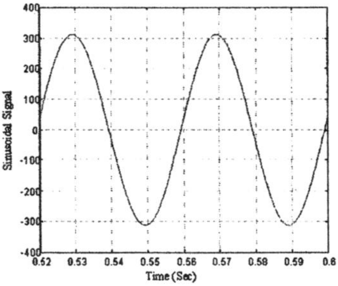


Fig. 4. Simulation result of Sinusoidal Signal (25 Hz)

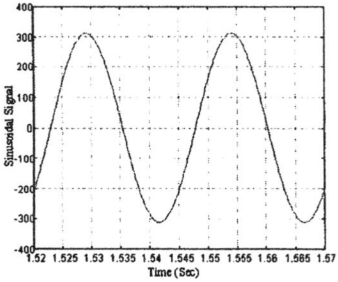


Fig. 5. Simulation result of Sinusoidal Signal (40 Hz)

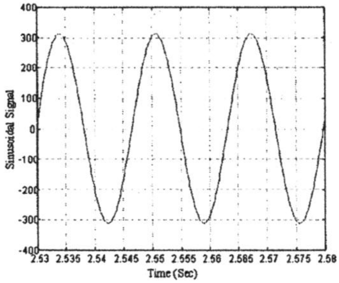


Fig. 6. Simulation result of Sinusoidal Signal (60 Hz)

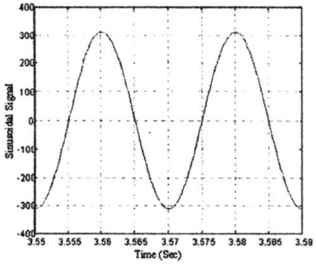


Fig. 7. Simulation result of Sinusoidal Signal (50 Hz)

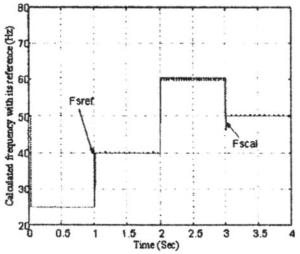


Fig.8. Simulation result of calculated frequency of Sinusoidal Signal with its reference

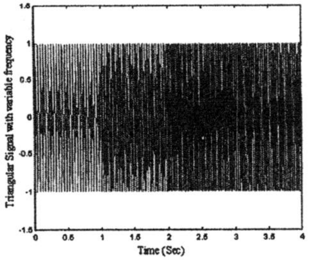


Fig. 9. Simulation result of Triangular Signal with variable frequency (25 Hz, 40 Hz, 60 Hz and 50 Hz)

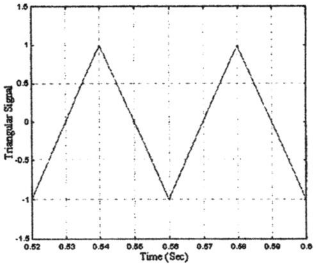


Fig. 10. Simulation result of Triangular Signal (25 Hz)

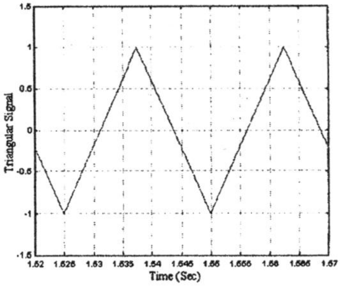


Fig. 11. Simulation result of Triangular Signal (40 Hz)

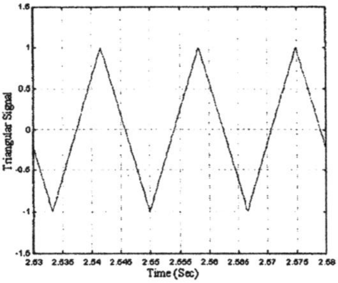


Fig. 12. Simulation result of Triangular

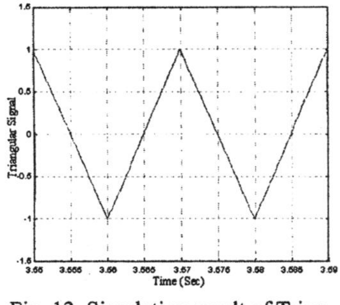


Fig. 13. Simulation result of Triangular Signal (50 Hz)

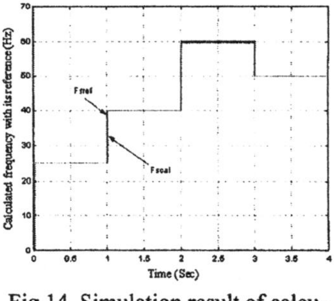


Fig.14. Simulation result of calculated frequency of Triangular Signal with its reference