Available online at www.sciencedirect.com

SciVerse ScienceDirect

Energy Procedia 17 (2012) 450 – 455

Energy Procedia

2012 International Conference on Future Electrical Power and Energy Systems

Design and Simulation of Voltage Fluctuation Rate Monitor System Based on Virtual Instrument Technology*

Wen Xinling[1,a], Zhao Cheng[2,b]

[1]*Department of Electronic and Communication Engineering*
Zhengzhou Institute of Aeronautical Industry Management
Zhengzhou,Henan 450015, China
[2]*School of Mechatronics Engineering*
Zhengzhou Institute of Aeronautical Industry Managem ent
Zhengzhou,Henan 450015, China
[a]*wenxinling@zzia.edu.cn,* [b]*zhaocheng@zzia.edu.cn*

Abstract

Electronic power is the most widely used energy, and its application degree has been a mark of country development level. This paper introduces a method of voltage fluctuation rate monitor by using virtual instrument technology. Because virtual instrument technology uses computer own hardware and design graphics procedure frame diagram software to complete, which has many advantages of the simple algorithm and fast speed, etc. Through simulating three-phase voltage of electronic power system, this paper completes voltage fluctuation rate monitor of electronic power system and electronic power quality judgment, as well as verifies accuracy of algorithm diagram procedure.

Keywords-voltage fluctuation rate; virtual instrument; electronic power quallity; system simulation; LabVIEW; electronic power system

1. Introduction

With the development of microelectronic and electronic power technology and widely application, user has higher demand of electronic power quality little by little. But because of existing of disturbance load, such as nonlinear, impact or imbalance electronic load. As well as other disturbance source, such as

* This work is partially supported by Henan Nature Science Grant #2009A510014

.

 doi:10.1016/j.egypro.2012.02.119

system short circuit, etc. which causing amount of electronic power quality problem, and affecting electronic power network as well as users' equipment safe.

Electronic power quality problem's production, not only related to power plant, but also electronic power users. Such as voltage fluctuation, which causing by user disturbance. Ideal three-phase AC power system should be a kind of sine wave voltage providing to electronic power user in constant frequency and standard voltage. Each phase voltage magnitude and electronic currency magnitude is equal and different of phase is 120º. But because of electronic power system has generator, transformer, etc equipment and semiconductor rectifier, thyristor and frequency adjusting equipment, as well as including nonlinear or household appliances, asymmetric load introduced, and so, ideal state does not exist, which producing electronic power quality problem. Power electronic quality decreased will make electronic equipment running in abnormal, producing equipment damage, and production reject rate increased. So, electronic power affect normal industry producing and electronic network running, which causing huge economic damage.

Now, electronic power quality problem has caused each country electronic power workers' high treatment. Improving electronic power quality technology has become electronic power system research field new hot-pot. So, collecting and analyzing original measurement data is very important, which has very important significant to whole electronic power system electronic power quality management and improvement. [1]

2. System Composition and Principle

System uses computer hardware and software to design. Software system used virtual instrument LabVIEW8.5 to design, virtual instrument is a measurement instrument, which realizing many more function that other normal instrument cannot to realization. In fact, virtual instrument adopts computer's indicator to display as traditional instrument LED or LCD displayer. We use data collection module hardware equipment, and adopt some process circuit to complete computer strong software function, such as data operating, analyzing, and processing. [2]

Comparing with traditional instrument and equipment, Software of virtual instrument technology uses computer's strong source, which realizing low cost spend in maximum degree. So, virtual instrument is by means of computer technology, it has more different comparing with traditional instrument, which different is shown as Table I. [3]

Table 1. Different between Virtual And conventional instrument

Visual instrument	**Conventional instrument**
Development and maintenance reduce into lowest	Development and maintenance cost is high
Technology renew period is short	Technology renew period is long
Software is most important	Hardware is most important
Low cost spend and strong configure character	Cost spend is expensive
Open, flexible and synchronous development	Closed and fixation
Easy to connection with network and other equipment	Single function, connecting in limited equipment

LabVIEW8.5 is most widely use virtual instrument development software, which is presented by American company of NI. LabVIEW8.5 includes lots of function module and completely bus equipments driving procedure. LabVIEW8.5's character according to method of graphics: LabVIEW8.5 adopts frame diagram rather than the traditional text program mode. Program method emphasizes actual process of the signal process, program has simple character, and modifying is convenient. Virtual instrument software

of LabVIEW8.5 is a most spread to world nowadays, which can complete system monitor or measurement. In domestic and international, many designers in designing measurement system or control system are using it to carry out program designing, which is the development tendency.

3. Monitor Principle

Voltage fluctuation is a kind of timely changing in a series of voltage changing or work frequency voltage wave line, which causing by impact character power load, [4] such as active power and reactive active power's greatly changing of furnace, rolling mill, electric locomotive, arc welding, etc running. Its essence is act voltage fluctuation sub-component as amplitude modulation wave, and modulate voltage's square mean value (or peak value).

Voltage fluctuation is act envelope of voltage's square mean value or peak value as time function wave. When analyzing, we act work frequency voltage u as carry wave, and make fluctuation voltage v as amplitude wave, which is shown as Fig.1. [5]

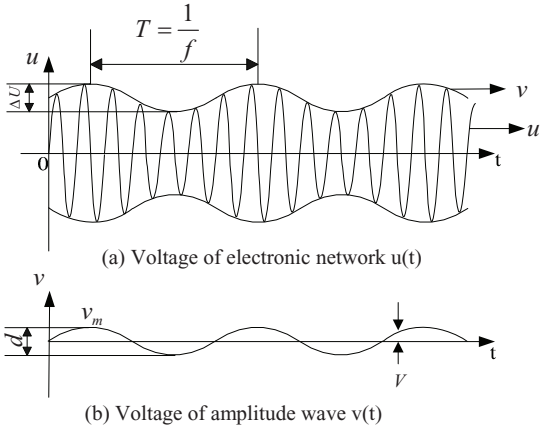


Fig.1 Fluctuation voltage v modulate to work frequency voltage.

In Figure 1. (a), u is electronic network frequency 50Hz instantaneous voltage, acting as carry wave, v is sine fluctuation voltage. v is 10 Hz sine amplitude wave, when using it to modulate 50Hz work frequency carry wave voltage u's peak value. In Figure 1. (b), vm is sine amplitude wave maximum value or peak value, d is v peak-valley different value (p-p value). V is v square mean value in its period T, and express in UN's percentage.

Normally, voltage fluctuation measurement adopts as style as below: measuring each period wave effect value in a fixed period, then compare its, use maximum value different ΔU (Umax-Umin) plus standard voltage UN, its percentage expresses relative value, which is voltage fluctuation rate *d.*

Voltage fluctuation rate is shown as below formula (1):

$$d = \frac{\Delta U}{U_N} \times 100\% = \frac{U_{max} - U_{min}}{U_N} \times 100\% \quad (1)$$

4. System Software Design

According to formula (1), we carry out each phase voltage fluctuation monitor and fluctuation rate monitor. Among them, A phase voltage simulation signal adding pulse fluctuation sub-component, voltage fluctuation monitor procedure frame diagram is shown as Fig.2.

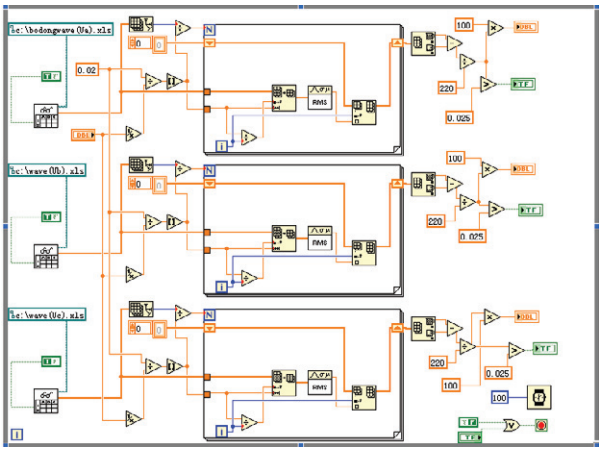


Fig. 2 Voltage fluctuation monitor procesure frame diagram.

To calculate voltage effect value peak value *U*max and *U*min, procedure uses for circle structure [6], procedure uses (array size function) to return array's elements number, and judges circle times *N*. Circle times *N* is input voltage sampling period numbers *n*. *n* can get in work frequency voltage's period 0.02s (50Hz) plus sampling period (sampling frequency is 10000Hz, sampling period is 0.0001s). So, we obtain every period has 0.02/0.0001=2000 number sampling pots. We can use input array size of simulation signal sampling point number 30000 plus 2000, which is *n*=150 numbers period.

We make input voltage every sampling period using array sub-collection function calculate 150 number period elements by using mean square function. And use array insert function to get new array, which adopting array maximum and array minimum function to calculate maximum value and minimum value, and then using mathematics function to compare reference voltage effect value 220V, which completing voltage fluctuation rate calculation.

5. Experiment and Conclusion

In order to prove procedure accuracy, system uses simulation data to complete. We suggest each phase simulation wave is shown as below:

Voltage of A phase wave is:

$u\mathrm{A}(t)=U\mathrm{m}\sin wt+0.25U\mathrm{m}\sin(3wt+5^{\circ})+0.13U\mathrm{m}\sin(5wt+9^{\circ})+0.1U\mathrm{m}\sin(7wt+13^{\circ})+p+$white noise;

Voltage of B phase wave is:

$u\mathrm{B}(t)=U\mathrm{m}\sin(wt-120^{\circ})+0.19U\mathrm{m}\sin(3wt-118^{\circ})+0.13U\mathrm{m}\sin(5wt-115^{\circ})+0.07U\mathrm{m}\sin(7wt-110^{\circ})+$white noise;

and Voltage of C phase wave is:

$u\mathrm{C}(t)=U\mathrm{m}\sin(wt+120^{\circ})+0.31U\mathrm{m}\sin(3wt+123^{\circ})+0.17U\mathrm{m}\sin(5wt+125^{\circ})+0.13U\mathrm{m}\sin(7wt+129^{\circ})+$white noise;

Among them, angle frequency $\omega=2\pi f_0$, and $f_0=50\mathrm{Hz}$, $U\mathrm{m}=\sqrt{2}\,U\mathrm{N}$, $U\mathrm{N}=220\mathrm{V}$. $I\mathrm{m}=\sqrt{2}\,I\mathrm{N}$, $I\mathrm{N}=5\mathrm{A}$. In order to make each phase voltage simulation data approximate to fact electronic network data, so, let each phase basic wave value different, and all have white noise disturbance signal, and its standard deviation value is 10. In addition, A phase voltage adds a reverse pulse fluctuation signal *p*. And by using of LabVIEW to producing A phase voltage simulation data producing procedure frame diagram is shown as Fig.3.

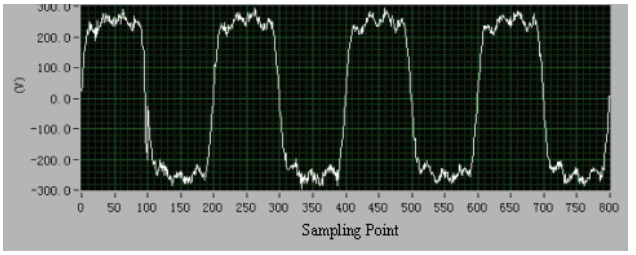
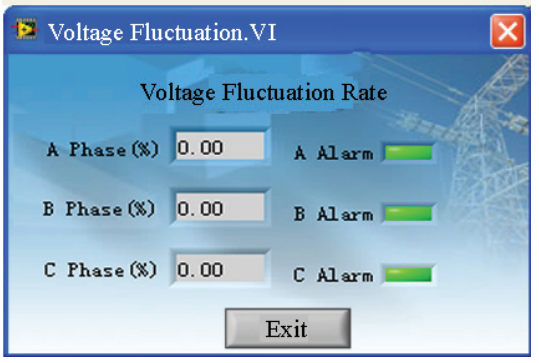
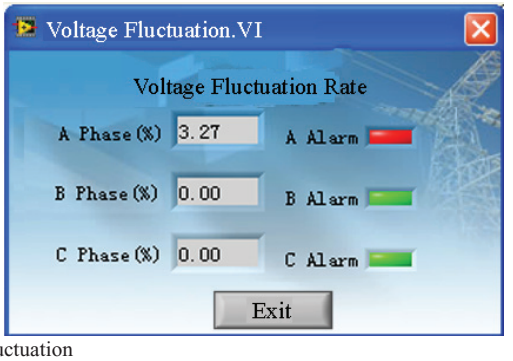


Fig. 3 A phase voltage simulation data producing front panel.

Other phase voltage producing method is same as upon method. Running front panel of voltage flucation rate monitor is shown as Fig.4.



(a) No alarming condition of voltage fluctuation



(b) Alarming condition of voltage fluctuation

Fig. 4 Voltage fluctuation monitor front panel.

Voltage fluctuation monitor result is shown as front panel display control file, A phase voltage fluctuation rate is 1.03%, according to standard <Voltage fluctuation and flicker> (GB-12326-2000), below 10kV, it is not more than 2.5%, so A phase fluctuation does not beyond alarming limit value, A phase alarming green lamp is light. When we define A phase simulation fluctuation delay width 10, which fluctuation rate monitor value is 3.27%, alarming lamp become red. B and C phase simulation wave does not add fluctuation signal. So, fluctuation rate is 0, which is consist to suggestion, and proving procedure frame diagram's accuracy.

By using VI technology, we simulate three phase voltage, and design fluctuation rate monitor procedure. Through system simulation, we get voltage fluctuation rate value, and result is consistent with suggest value.

References

[1]Zhu Yongqiang, Yin Zhongdong, Xiao Xiangning, Shen Zhan, "Comprehensive Summarization For Power Quality Monitoring Technology," *Elecctric Age*, 2007(5), p.66.

[2]Chen Yu. "Research and Design of Electronic Power Quality Monitor System Based on VI", *Northwestern Polytechnical University*, 2009.

[3]Li Ningxin, Zhang Xiaodong, "Design of signal generation and analyzing system based on LabVIEW," *Electronic Measurement Technology*, 2007(5), p.48.

[4]Montanari G C,Loggini M,Cavallini A,Pitti L,Za-ninelli D. "Arc Furnace Model for the Study of Flicker Compensation in Electrical Networks," *IEEE Trans on Power Delivery*, 1994,9(4), pp. 2026-2036.

[5] Hao Ke. "Flicker Detecting Algorithm Based on Fast Wavelet Transformation.," *Sichuan Electronic Power Technology*, 2006,2 (29), p44.

[6]Xu Qian. "Development of Network Electronic Power Quality Monitor System Based on VI," *Zhejiang University*. 2007.5.