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Impact of Noise on the Power Lossless Compression Quality in Intelligent Power System

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Based on the study of FPGA architecture and DSP power quality, the data acquisition system, analysis system works, summarize functional modules of the power quality in the data collection process noise were introduced. Its classification all kinds of noise modelling and simulation, after consideration of the noise source and data compression, the influence of various noises obtained data compression. The corresponding noise suppression measures, data processing of the data will be compression impact. The paper has also carried out some related research. These studies help to optimize all aspects of electric power data acquisition systems, which improved power lossless data compression ratio. Data processing for different noise, a mathematical model of each noise separately the effects of the law in the case of different data processing methods. Noise at each major electric power alone was lossless data compression. Pure power signal compression ratio is very high, due to the introduction of noise makes lossless compression effect decreased significantly.

1. Introduction

With the advancement of technology and the power system reform, the establishment of energy collection system is imminent (Sabarimalai et al, 2015; Pham et al, 2015). Energy collection system as the power marketing system and technical support future grid commercial operation will also play an important role (Zhu et al, 2012). Power acquisition system consists of master station side computer systems, factory station end power collection device, and information and communication network of three parts when it comes to electronics, computers, communications, networks, electric power systems and other aspects of professional knowledge (Shariatzadeh et al, 2015; Spencer et al, 2004). The main function of electric energy data acquisition system is to achieve the jurisdiction range electric energy plant, power supply Bureau, the sale of electric energy supply and a net loss of electric energy automatic acquisition and settlement. Appraisal system can not only distinguish between peaks, valleys, flat electrical energy (Sadek and Tarighat, 2007).
In today's grid, a partial failure will lead to instability in the operation of the entire power system. Even cause blackouts to power data acquisition systems, fault recorder of power, protection and control devices, power quality analysers and synchronous measurement vector unit-based smart grid dynamically in real-time monitoring of the grid power quality, transient data. Timely recording and analysis of these data can help us deal with the power and prevent power quality problems caused by the economic loss (Wong et al, 1998). It will help to improve the power grid and environment reduced the incidence of grid failure. Power grid task focuses on large-scale resource sharing and inter-organizational coordination, grid monitoring as an important part of any grid system, is the need to query the status of grid resources and match the needs of users (Sadek et al, 2007; Zhu et al, 2011). In order to ensure that the use of grid monitoring software or hardware availability and reliability, reduce the probability of failure unpredictable, monitoring and evaluation must be carried out on the grid (Raore et al, 2011).
Intelligent network power quality requirements acquisition system have high reliability, timeliness and accuracy. Power Data Acquisition System performance is mainly reflected in the stability of data collection, compression efficiency and accuracy of sampling algorithms, so the electric power data acquisition system

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research is very necessary. First, the actual power quality acquisition system structure, analysing synchronous sampling asynchronous sample relative advantage. Subsequently, the working principle of each module will analyse power quality collection system, noise sources and analyse each part. Noise power quality lossless compression quality impact is quite significant; detailed calculation noise model white noise op amp, and its modelling and simulation analysis; then will analyze the signal conditioning circuit, the transformer noise model; Acquisition System , the most important source of noise is the quantization noise of the AD converter, the quantization noise analysis the mathematical model, and presents two methods to reduce the quantization error and the quantization error calculated after reducing the signal to noise ratio improvement.

2. Noise source and its impact on the power data acquisition

2.1 The main sources of noise power system

Power system automation is required in real-time monitoring of the electricity network in an important aspect, wherein the data acquisition system plays a central role, but it is also the core of the whole design. From the recent trend of power system automation, the intelligent power system automation is the future direction of development (Tong et al, 1995). Intelligent power network collection system can help the system controller or a good measure and calculate the optimum performance of some point of time and the system is running (Rahmani et al, 2015). For the power system network automation intelligent power quality monitoring system consists of three functional modules: data acquisition, measurement and monitoring, data acquisition is where the power from the power system network via voltage and current transformers digital power monitor collection data collection. Mathematical model of asynchronous sampling in the time domain is equivalent to convolution sampling switch function and continuous function:

$$f^{'}(t)=\sum_{k=-\infty}^{+\infty} f(kT)\delta(t-kT) \tag{1}$$

Frequency domain model:

$$F^{'}(s)=\frac{1}{T}\sum_{k=-\infty}^{+\infty} F(s+jk\omega_s) \tag{2}$$

Data acquisition system in the process of collecting the signal, after attenuation, amplification, filtering, analogy to digital conversion and transfer is a useful signal, but also the interference noise signal is introduced into the data to be collected by them, these noise components in certainly affect the data collection characteristics, and thus will affect the results of our subsequent use of these data. Affecting the accuracy of the data acquisition, A / D conversion of the quantization noise is the most important component of a factor.

In the process of data acquisition systems, each module circuit noise introduced will inevitably affect the power quality performance, if subsequent studies used in the resulting energy are bound to affect the accuracy of the analysis of the state power grid. White noise impact on the system all over the entire frequency band, cause there are many white noise, its impact on the acquisition of the most obvious, but not completely eliminate the white noise only to reduce as much as possible. In the A / D conversion synchronous sampling process, AD conversion quantization noise is the entire collection process the main source of noise, so we need to AD conversion process research, analyses major source of quantization error.

2.2 The impact of noise on the power data acquisition

Broadly any noise that is unnecessary interference, such interference would affect what we want to get the signal. Sensors, detectors, amplifiers and converters are the foundation of our instruments and control and measurement industry, they are also power data acquisition system "eyes" and "ears." They must be characteristic of the actual physical world into electrical signals, and then for us to measurement and processing. Engineering problems associated with a detection system is the amplitude of the electrical noise generated by the sensor and electronic equipment. Although in recent years, new high resolution sensor and high-performance systems have been developed, but the system designer must noise of the electronic circuit have a certain understanding, in order to reduce the additional noise, which is noise amplifier case the core of designs.

Thermal noise power Nt bandwidth Δf is proportional to absolute temperature T and systems:

$$N_t=aT\int_0^{\infty} G(f)df \tag{3}$$

Where k- Boltzmann constant;
T - Kelvin;
Δf - noise bandwidth of the measurement system.
Taking into account that we compared to the noise power can be more easily measured noise voltage:

$$E_t = \sqrt{4kTr\Delta f} \tag{4}$$

Here, I would like to focus on to mention the noise bandwidth on a particular device is in terms of its output - the area under the curve of frequency, divided by the noise frequency power amplitude quotient care. You can be expressed by the following formula:

$$\Delta f = \frac{1}{G_a}\int_0^\infty G(f)df \tag{5}$$

Under normal circumstances, the system will only know the voltage gain versus frequency f of the curve, and because the power gain is proportional to the square of the voltage gain, so the equivalent noise bandwidth of the expression is as follows:

$$\Delta f = \frac{1}{A^2}\int_0^\infty |A_v(f)|^2\, df \tag{6}$$

Figure 1 is thermal noise the venin equivalent model.

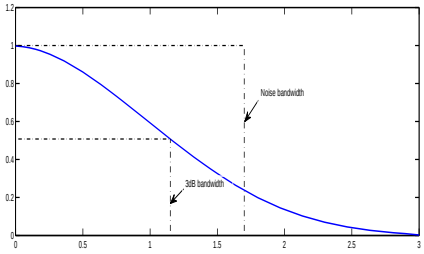

Figure 1: Thermal noise thevenin equivalent model

3. Experiments and results

3.1 Hardware of power system data acquisition system

The system data through power line voltage transformer current transformer voltage power line parameters, the current parameters into weak signal (the amount of data acquisition can be the root of a lot of the power line, as shown in Figure 2. All the way, the rest of this section and the same), and then through sophisticated detection and time division multiplier process, the processed data is sent to the high-precision AD converter into a digital signal amount supplied to the digital processor and various digital processing and digital signal the results of the classification processor will process save or transfer or displayed, and can be subjected to the man-machine interface human-computer interaction.
Of the filter circuit requirements to be able to remove the product circuit, considering the gain and filtering effect, you can use active filter "in using op amps Active filter zero should pay attention to the use of drift is smaller; and as for when small signal that the product may be very small, close to the magnitude mv, this same general drift op amp with almost zero "So in a small signal operation, should adopt a passive filter network or high-precision low zero-drift op amps.

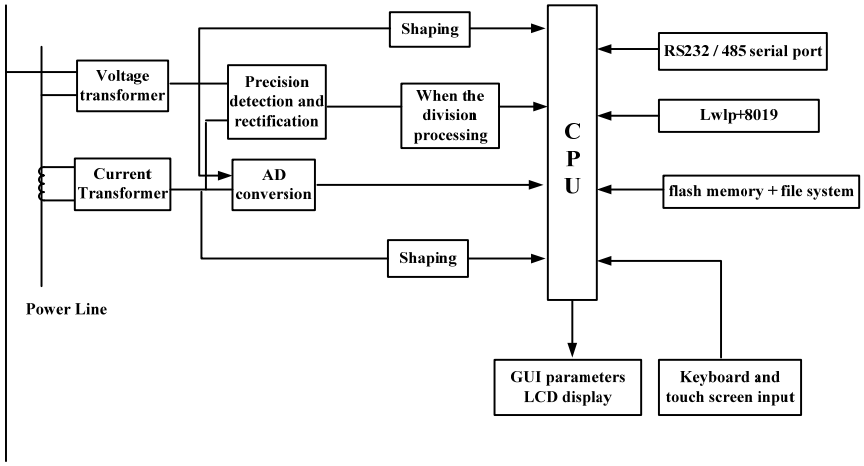

Figure 2: Block diagram of the data acquisition system

3.2 The quantization error of the AD converter

AD output can only be finite word length. Suppose we are using AD output is 8, then a unit of AD represent values are:

$$LSB = \frac{q}{2^b} \tag{7}$$

The significance of this is that the output value represents the value of the ADC LSB is an integer multiple of the lowest level since AD is not the component, the output value of AD is not continuous. In this process, the error is generated in the quantization error. FWL not represent a number or a signal AD conversion, the smaller word length calculation accuracy less accurate, the more serious problem of the quantization error with infinitely precise digital. For example, suppose that AD converter LSB is 50mV, after following the analogy signal AD conversion, quantization error in Figure 3 below:

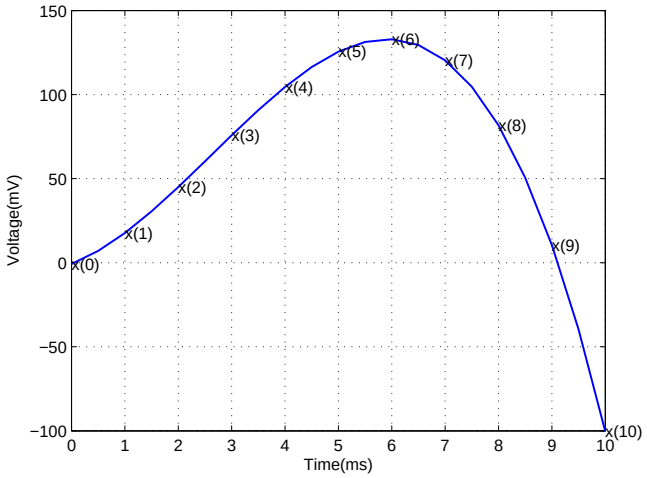

Figure 3: Random signal quantization result

AD output SNR:

$$SNR_{A/D} = 10\lg\frac{\sigma_{input}^{2}}{\sigma_{A/D\text{noise}}^{2}} \tag{8}$$

Where in σ_{input}^2– Input signal variance, $\sigma_{A/Dnoise}^2$– AD Quantizationnoise variance.

In practice, AD converter, you can easily calculate the maximum signal to noise ratio by the above formula AD conversion, which is the actual AD converter maximum SNR in the practical application of the continuous signal is not always necessary use a lot bigger than its own SNR a / DSNR, under normal circumstances, will assume AD converter SNR ratio a DSNR small 3-6dB.

3.3 Simulation analysis

Ideal PLL output signal was shown in Figure 4 below. It is composed of a single frequency, but this is only an ideal case, the actual phase-locked loop circuit includes harmonic distortion and noise and spurious components.

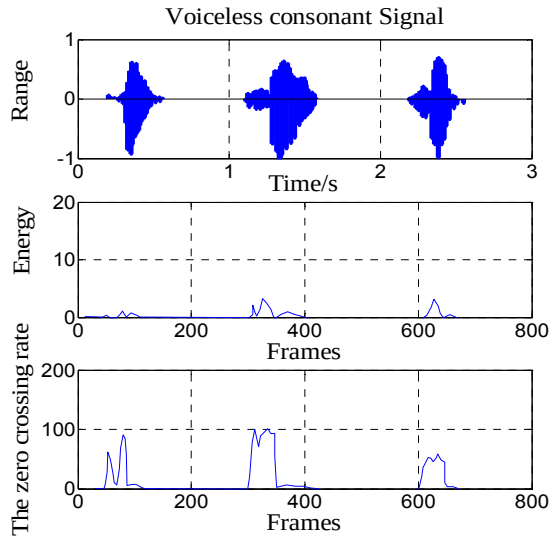

Figure 4: Ideal phase-locked loop output spectrum

Phase noise has become a PLL frequency synthesizer of the most important issues, if we use the low-pass filter to filter easily offset oscillator 2nd and 3rd harmonic, but it is difficult to filter out near the oscillation frequency the first harmonic (phase noise), so the phase noise is the main source of transmission characteristics of the output of the oscillator and a voltage controlled oscillator. PLL phase noise spectrum was shown in Figure 5.

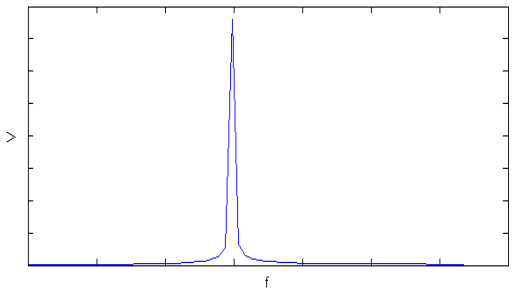

Figure 5: PLL phase noise spectrum

4. Conclusion

Power data acquisition system performance is mainly reflected in the stability of data collection, compression efficiency and accuracy of sampling algorithms, so the electric power data acquisition system research is very necessary. First, the actual power quality acquisition system structure, analyzing synchronous sampling asynchronous sample relative advantage. Based on the study on the basis of the architecture of FPGA and DSP power quality of the data acquisition system, analysis system works and summarize the various functional modules of the power quality data acquisition system in the data collection process noise introduced, and its classification all kinds of noise modeling and simulation, after consideration of the noise source and data compression, the influence of various noises obtained data compression, and the corresponding noise

suppression measures; data processing of the data will be compression impact, the paper have also carried out some research. These studies help to optimize all aspects of electric power data acquisition systems, improve power lossless data compression ratio. Data processing for different noise, a mathematical model of each noise test separately the effects of the law in the case of different data processing methods, noise at each of the major electric power alone lossless data compression.

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