The design of monitoring communication system Based on Power line carrier

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***Abstract* — The design of the power line carrier communication system was introduced in this paper, DSP was adopted as the hardware platform to complete the core task. DSP sending terminal delivered the collecting data to the DSP receiving terminal through the power line carrier, and the DSP receiving terminal send the data to PC through a serial port. The design improved the power line carrier communication system and the data transmission became faster and more reliable. The experiment results showed that the PER of the receiving data is less than 0.4%, which satisfied the power line carrier communication requirement. Our design is feasible and effective.**

***Keywords*—DSP, Power line carrier, D/A, A/D**

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1 Introduction

The power line carrier (PLC) communication is a special method of communication with the function of transmitting data using the high voltage power lines with voltage of 35kV and above, medium voltage power lines with voltage of 10kV or low voltage wire which is 380/220v subscriber line as the information transmission medium. Power line carrier communication can transmit high speed using existing lines through the carrier for analog or digital signal after modulation. Power line carrier is the characteristic communication in electric power system. In recent years, the power line carrier technology has entered into the digital age. So it has objective theoretical basis and reality to apply the power line carrier communication technology to the control communication system.

In the power communication system planning and construction, as one of the basic means which can transmit information in electric power system, power line carrier has been widely used in communication systems in the power system ,experienced from analog to digital, from a single function to the intelligent control, from the division to the development of integrated process[1]. Power Line Communication is transmitted the modulation data after coupled to power line In the early development of power line carrier, power line carrier communication is mainly applied to distance transmission at the high voltage power lines above 11kV,also the working frequency is 150kHz below, and now the band has become the formal band of power line communication of European electric power communication technology standardization commission at the 1950s,Low voltage electric communication technology has been quite mature[2]. All kinds of high power line carrier machine arise, which is widely used for remote monitoring and voice transmission and equipment protection, etc [3] [4]. From the 1950s to the early 1990s, power line carrier communication technology has been applied in the medium and low voltage distribution network, mainly it is concentrated in the network load control, electric automatic meter reading and supply management[5][6], etc. In this period, application technology for medium and low voltage power distribution line is not mature, so that did not result in low-voltage electric communication products and services.

2 The design principle

In typical power line carrier communication systems, data signals load into power network by the signal coupling network, through the carrier communication equipment, after modulation and power amplifier. And on the other side of the power network, also the modulated signal of the power network is sent to the corresponding power line carrier communication equipment, through the same signal coupling network, the original signal is restored after the demodulation. Due to the existence of 50HZ harmonic frequency interference of serious power frequency .The working frequency range in general is 40-500kHz[7][8].It utilizes the power lines for data transmission so it have many advantages which

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includes Transmission channel, less investment, high reliability and so on.

In this system the core task is completed using DSP as the hardware platform, meanwhile the sender collect the various parameters through DSP, Data processed by D/A transformation chip completes the analog-to-digital conversion, Then the signal is processed by the simulation front-end circuit, after that the signal will be sent to the power line signal channel through the coupled circuits, later the receiver receives analog signals by coupling circuit, first the signal filtering is completed, then the A/D transformation is done through the A/D Chip, afterwards the signal is sent to PC after DSP processing, and the data monitoring is realized through the PC.

3 The hardware design of the system

In order to realize the function of power line carrier communication, the system should complete a series of signal system process, In the design process, this system is based on the modular design method, Considering the separation of strong electricity and weak electricity and electromagnetic interference, system can be divided into two parts including the sensor signal acquisition and processing module and power line carrier communication module simply. At the same time, the whole system can be divided into three modules which includes the signal acquisition, processing and transmission, the signal processing mainly completes noise filtering for signal and analog digital conversion in order to facilitate the processing of the DSP. Peripheral hardware circuit for Power line carrier module mainly consisted of power supply circuit, A/D, D/A transformation circuit, coupled circuits, filter circuits, automatic gain former amplifier circuit, power amplifier circuit etc. The general block diagram of system is shown in fig.1.

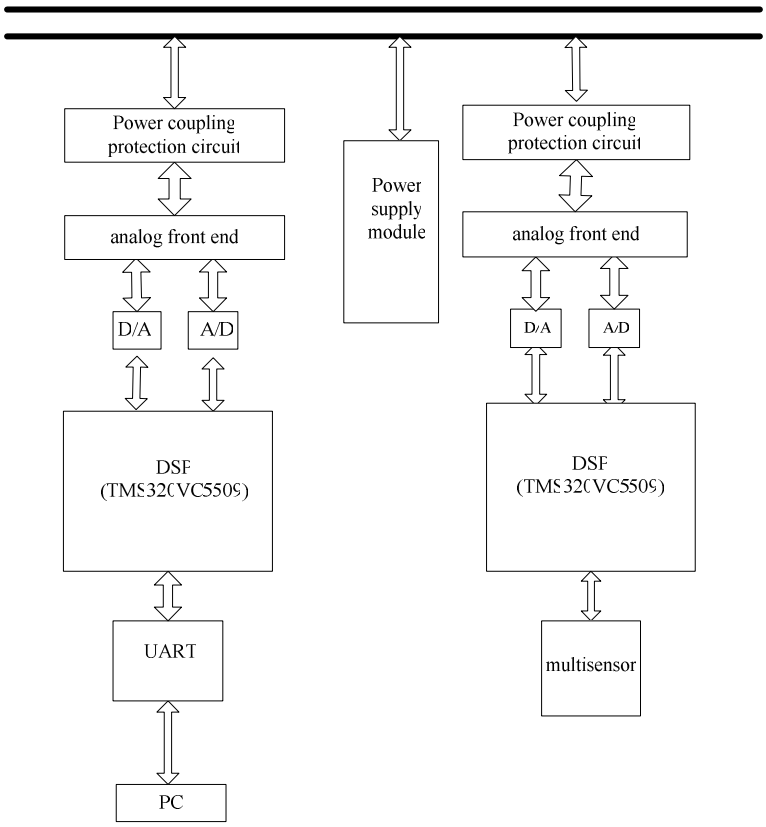

Fig.1 The general block diagram of monitoring system based Power Line Carrier

3.1 The DSP minimal systems

The DSP minimal system includes power management circuits, crystal oscillator circuit, reset circuit, JTAG interface, memory expansion circuit, etc. In this design, the system uses TMS320VC5509 of TI company, while it adopts +3.3V and1.6 V power supply, among these the I/O supply voltage is 3.3V, and chip kernel voltage is 1.6 V. This system works in 144M clock[9], the clock signal of TMS320VC5509 adopts external vibration mode, External clock inputs from CLKIN pin, crystal oscillator of external oscillating circuits provides the system clock by 20M passive crystal[10]. The clock expected frequency was produced through digital phase lock loop(DPLL)Of clock generator and the clock mode

registers by frequency doubling inside, JTAG(Joint-Test-Action-Group) , namely boundary scan system, which can scan and test the logic values of each pin, various resources can be accessed within JTAG interface ,also it includes the registers, RAM, ROM, various peripheral on chip, etc, also we can download a program through JTAG in order to compete the system debugging. The addressable storage space of TMS320VC5509 is large, also interface is rich. It can be connected to the synchronization SDRAM, also it can connect the asynchronous FLASH.TMS320VC5509 has four parts also; it can be expanded space CE0~CE3[11].The SDRAM is mapped in CE0 space and CE1 space. The FLASH is mapped in CE1 space .SDRAM and FLASH can realize the address multiplexing in CE1 space.

3.2 Simulation Front end AFE1230

The A/D、D/A Chip in DSP platform used in this paper is AFE1230 of TI company, also the AFE1230 connected with DSP through multi-channel cache synchronous serial port. At the sender, the digital signal is converted into analog signals and then sent out, in the receiver, the analog signals received is converted into digital signals in order to complete signal demodulation by DSP. The hardware circuit between DSP and AFE1230 is as shown in fig.2. BFSXO pin is frame control clock pin, also BCLKRO pin is sampling control clock pin of DSP, BDXO pin while BDRO pin is the serial data pin of DSP.

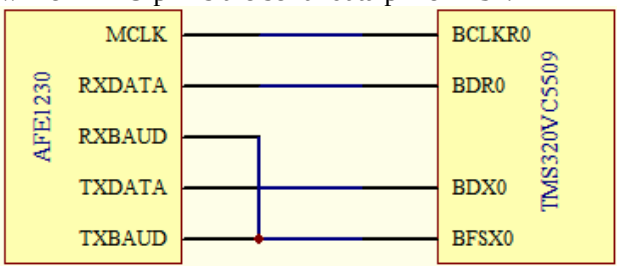

Fig.2 The communication interface between AFE1230 and DSP

3.3 Coupled circuits

Coupled circuits are shown in fig.3.Coupled circuits are output and input pathway of carrier signal. Also it can insulate power frequency in 380V/50Hz, in practical designing circuits, Impedance characteristics at the side of 380V should be considered, T1 is signal coupling transformer, generally impedance is 3 ~ 30Ω at the side of 380V. Then we should determine ratio or impedance ratio of coil primary and secondary, Finally the output matching resistance of power amplifier is designed, Input channel the Surge protection for diode is necessary, After the isolation of resistance, the signal is sent to ground-clamp diode circuits, then it is sent to former filter circuits.

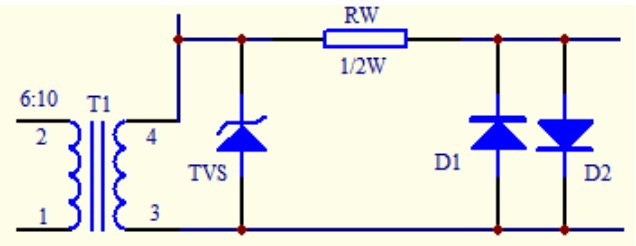

Fig.3 The Coupled circuit

3.4 AMP circuit

The amplifiers (AMP) module purpose is enlarge signal for75 times after filtering without distortion. In order to get an expected corresponding gain of 30dB or more, the no distortion of Small signal should be pay particular attention. Because the purpose of this module is mainly complete the amplifier of small signal and also the circuit noise can not be too big.

3.5 PAMP circuit

Power amplifier (PAMP) works in soft switch condition itself, because the Launch time is very short. When choosing the triode parameters we should pay attention to its power parameter, also the work time cannot be too long when testing. In order to avoid the damage to the power amplifier especially the output triode a resistor can be connected in series when testing the whole board manual sculpture. But the output waveform and power will be affected at this time.

4 The testing and analysis of the System

At the sender and the receiver, we observe each point of signal use spectrum analyzer and oscilloscope and test performance of the system, when this system is installed, The sensor data which is collected will be transmitted through power line carrier, we can make a careful observation of signals use the spectrum analyzer and oscilloscope and test system performance. also we can test Error rate and Packet loss rate using the PC test software, DSP receiver and PC communicate with serial RS232, the test software is written in c #, BER and packet loss rate is tested using CRC checksum.

Tab.1 The experimental results of 20 meters away

Type number	Baud rate	Distance	Quantity originated	Quantity received	Successful receiving number	Error rate	**Packet loss rate**
1	1kbps	20m	3280	3275	3262	0.396%	**0.152%**
2	1kbps	20m	3282	3276	3265	0.335%	**0.183%**
3	1kbps	20m	3270	3267	3255	0.365%	**0.092%**
4	1kbps	20m	3276	3271	3260	0.336%	**0.153%**
5	1kbps	20m	3285	3279	3267	0.365%	**0.182%**
6	**1kbps**	**20m**	**3275**	**3268**	**3257**	**0.334%**	**0.214%**

Based on the analysis of data of the tests, the accuracy and reliability of the system is good, and receiving circuit for signal requirement is very low, at the same time Packet loss rate and BER are very low, also these results have shown the strong anti-interference ability. Test results show that this is such a system with effective design, low cost, high reliability, and wide application prospects.

5 Conclusion

Power line carrier communication system is their unique way of power system. Its information routing is reasonable, and information transmission is stable and reliable, also the system can reuse remote signal. In the meantime the system is the only wired communication mode without line investment. Therefore realizing data communication technical has considerable economic benefit and application prospect. It is a good market to apply the power line carrier communication to control communication system. Due to the limited time, the paper only makes the design of the basic function, There are still many problems need to be further discussed. This system has a certain line attenuation and anti-jamming ability, But the performance also need further improvement. Due to the electric circuit impedance variations, power amplifier of DSP send board can not coupled to the line well, we can improve system performance Transmission power can be increased and improve the turn ratio of the coupler in order to realizing the impedance matching with line.

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