

The Multi-energy High precision Data Processor Based on AD7606

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Abstract. This paper designs an information collector based on AD7606 to realize the high-precision simultaneous acquisition of multi-source information of multi-energy systems to form the information platform of the energy Internet at Laogang with electricity as its major energy source. Combined with information fusion technologies, this paper analyzes the data to improve the overall energy system scheduling capability and reliability.

1. Introduction

The fusion of energy network and the Internet is based on the comprehensive integration and rational use of electricity, heating, cooling, gas, water and other resources ^[1]. Energy Internet has a variety of real-time data such as electricity monitoring, thermal monitoring, natural gas monitoring and water supply monitoring, as well as complex load such as electricity, heat, gas and traffic. The amount of data acquired is huge ^[2]. The existing energy testing installation such as electricity meter, gas meter, thermometer are all single information gathering. Lack of comprehensive analysis of multiple information, efficient information collection and primary functional applications can hardly be achieved ^[3-5]. Therefore, a multi-energy data processor is urgently needed for different forms of energy.

With rapid economic development, urban waste production is also increasing at an annual average rate of 9% ^[6]. Shanghai, as the largest comprehensive financial center in China, produces a large amount of household waste and a higher proportion of landfill. In order to reduce the amount of landfill, waste disposal will gradually change to incineration-based methods. The Laogang solid waste comprehensive utilization base can handle 70% of Shanghai's domestic garbage and achieve the re-usage of waste, achieving the integration of a number of renewable energy ^[7-8]. In order to solve the issues of energy distribution and low utilization, there is an urgent need to design a unified energy dispatch system, i.e. the energy Internet.

Building an energy Internet in a solid waste base requires a data processor of multi-data collector, especially for specific plant sites such as leachate, landfill gas, electricity and thermal part, all of which are mixed together. Therefore, the collection of multiple source information is really necessary. This necessity is also reflected in the need for measuring these energy at the same time so as to schedule them at a whole scale.

In this paper, a high-precision multi-energy data processor is designed based on the AD7606. This data processor is used to monitor the current, voltage, power, harmonic and other power of Laogang. This paper presents a method of information fusion, which combines fast data, such as electricity, air



intake, pressure, velocity, volume and other data in the steam volume with slow information, such as temperature. By calculating the enthalpy of the intake air volume, energy and other parameters, the open interconnection of different forms of energy can be realized.

The main contributions of this paper is as follows:

1. The production process of landfill gas, energy interconnection and functional composition in the base are introduced. The energy grid structure of Laogang is constructed by considering the electricity, heating and gas networks.

2. The multi-energy high precision data processor based on AD7606 is designed, and the control principle of DSP on AD is illustrated. The information acquisition method and uploading process are given and the real-time waveform of acquisition current is drawn.

3. Combining information fusion technologies, the Laogang energy network information fusion model is built. The collected real time data will be uploaded to the cloud platform for use by Laogang base and other customers.

During storing the historical data on the cloud platforms, the paper continue analyzing the equipment active and reactive power and other indicators that users concerned about. Besides, the cloud platform also has analysis function, helping realize demand-side response in Laogang energy Internet construction.

2. The functional composition and the energy interconnection of Laogang base

2.1. The functional composition of LaoGang Solid Waste Base

Laogang base is the largest living garbage disposal base in Shanghai. Its function includes waste incineration power plant, landfill and leachate treatment plant. Waste incineration power plant handles 1 million tons of garbage a year. It generates more than 300 million kWh a year, by incineration power generation to maximize the recycling of the waste resources. The fourth phase base of the landfill converts garbage directly into methane. Through the fermentation, it produces biogas generated from landfill waste, and then generates power. The annual power generated can provide nearly 100,000 households living electricity. Figure 1 is a flow chart of the landfill gas cogeneration.

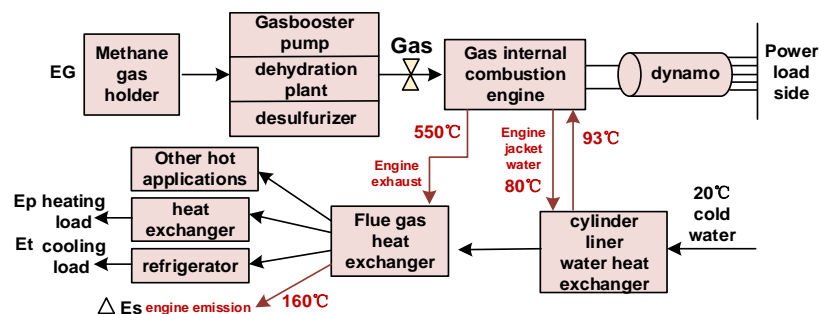


Figure 1. Combined heat and power generation flow chart

In view of the different production capacity of different plant energy with different ways, the following paragraph describes the energy interconnection at Laogang.

2.2. Energy interconnection in Laogang base

In the base, waste incineration and landfill gas produce heat while generating electricity which is an important thermal unit. Combined heat and power (CHP) system produces both electricity and heat by consuming natural gas. CHP is the coupling equipment of natural gas system and thermal system, making thermal energy electricity and gas networks more connected, achieving interconnection at the level of transmission and distribution networks. This paper designs a comprehensive processor based on AD7606, which includes sampling, signal conditioning, A / D, calculation, timing, switch input, display and other functions. Various data such as gas, heat and electricity are collected at the same time for

combining analysis of the concept of energy Internet, improving energy efficiency and making the monitoring device to achieve digital, integrated and intelligent monitoring system. Figure 2 shows the coupling diagram of the grid - gas network - heat network.

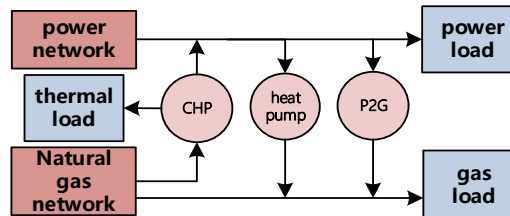


Figure 2. The grid - gas network - heat network coupling diagram

2.3. The production of landfill gas

The production of landfill gas is divided into five processes. Aerobic microorganisms convert oxygen and organic matter from rubbish to carbohydrates. With the consumption of oxygen, anaerobic microorganisms will further decompose carbohydrates into carbon dioxide, ammonia and organic acids, and temperature drop. Carbon dioxide, hydrogen and carbohydrates are converted to acetic acid under the action of microorganisms. The decline in hydrogen content is good for the growth of methanogens. The methane production phase is the main stage of landfill gas production, which can last for decades. Organic acids are converted to methane and carbon dioxide under the action of methanogens. The typical composition of landfill gas is 60% methane and 40% carbon dioxide. The organic acids are gradually depleted in the process of producing methane and carbon dioxide. The new aerobic microorganisms will establish a new aerobic environment, began another cycle. The composition of each stage of landfill degradation is shown in Fig 3.

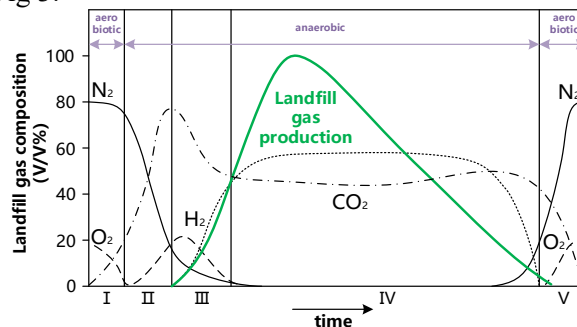


Figure 3. Composition of each stage of landfill degradation

3. Design of data processor device

3.1. The main chips

AD7606 in this device is a 16-bit synchronous sampling chip with 200k sampling rate and 8-channel. The data is retrieved by level switch. A complete sampling and calculation cycle is 200ms. The device performs sampling, storage, and conversion data 256 times in 20ms period. The frequency of sampling and calculation is 145times in 30 seconds, then waiting for the IPC command and stop the next sampling. IPC sets up instructions for uploading data every 30 seconds with CANET, loads the current data and sends them. If the interrupt occurs during the sampling period, the data collected before the interruption is removed and the sample program is re-executed when interrupt is executed. Figure 4 for the AD main program and interrupt flow-process diagram

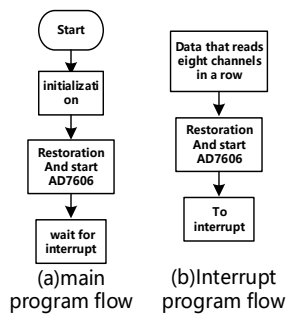


Fig.4 AD main and interrupt program diagram

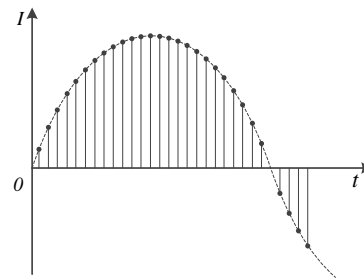


Fig.5 Real-time current waveform

The data collected by this device are eight analog quantities, including A,B,C phase voltage and two auxiliary analogs. Its conversion results reflected on DB0-DB15 data lines. DSP connects to AD with XD0-XD15 common interfaces. The instantaneous voltage and the instantaneous current are sampled in every phase. The approximate waveforms of the single-phase voltage and current are fitted by these sampling points. Figure 5 for a real-time current waveform.

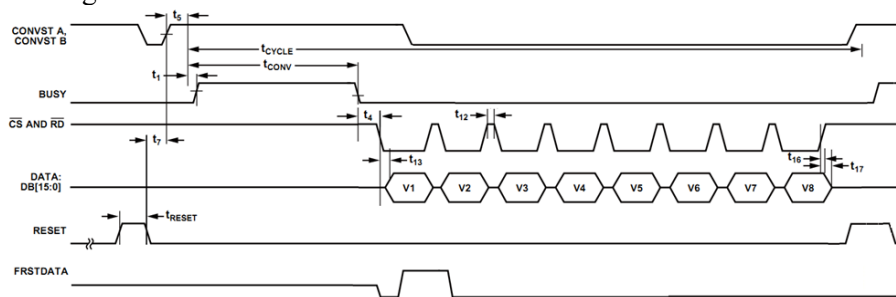


Fig.6 Data sequence diagram

Data sequence shown in Figure 6. The data acquisition system performs AD conversion when AD7606 in parallel mode. First, a high signal with width of 50ns pulses the RESET pin, AD7606 reset. Then a low signal pulses the CONVSTA / B pin to start the conversion, BUSY pin turns high and start the AD conversion process. The BUSY pin automatically turns low when AD ends the transformation. Finally, the data on the parallel data bus is read.

TMS320F28335 has a strong control and signal processing capability to solve complex control algorithms. It integrates Flash memory, fast AD converter, CAN module, event manager and other peripherals. It can compile software with C/C++. There are nine corresponding control pins between AD7606 and DSP, 3 oversampling rate set pins, 2 channel conversion pins, restart pin, read data pin, chip enable pin and A / D busy pin.

The DSP28335 contains two independent CAN interfaces, CAN-A and CAN-B. The CAN protocol specifies four types of data frames, remote frames, error frames and overload frames. eCAN is a CAN controller with 32-bit internal architecture. It consists of the CAN protocol kernel and the message controller. It can store 32 messages of mailboxes. The communication is carried out by operating 25 communication registers. the data collected by A/D is transmitted to the host via communication interface in the DSP

3.2.Design of data processor device

Real-time voltage and current can be collected through the monitoring of multi-energy information device in each power equipment. By computing active power, reactive power, frequency, harmonics and other related electrical parameters, data acquisition can be realised. The real-time production of the factory is presented according to the information from the data processor.

Main control board of the device is designed as a four-layer circuit board. The main chips are DSP28335 and AD7606. They are connected with power supply and communication board through 20

pins, sampling, signal conditioning, A/D, calculation, timing switch and multi-controller cascade etc. functions are performed. The power and communication board is designed as two sided circuit boards, where main chips include DS1307, CTM1050, 6N137 and MAX1487. Communication between CAN and 485 is achieved through signal inputted into main control panel. Compared with the AD conversion results of 28335, AD the conversion results of AD7606 is more accurate, which is suitable for high-precision AD conversion circuit. AD and DSP structure is shown in Figure 7.

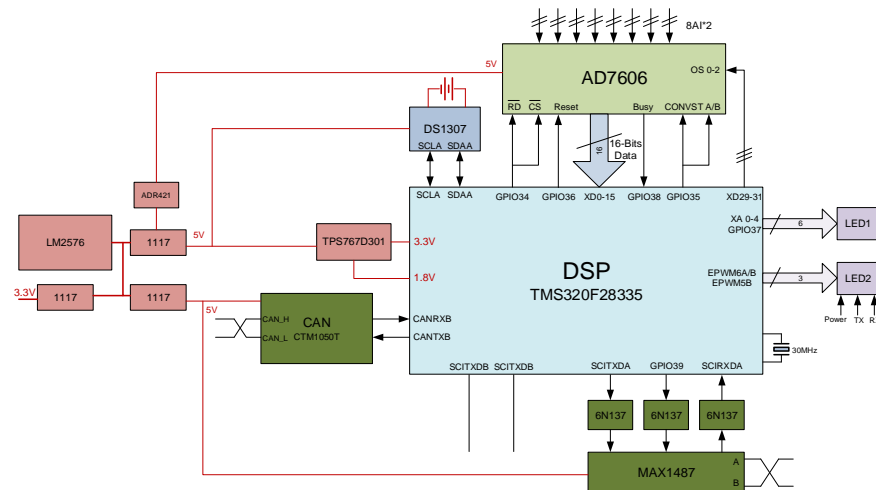


Fig.7 A/D and DSP structure chart

4. Information Allocation and Information Fusion of Data Acquisition Equipment

Information fusion is an information processing process which analyzes automatically and completes the required decision-making and evaluation by the multi-sensor under certain criteria. Laogang base contains thermal power, biogas, waste heat, wind power, photoelectric and other energy forms. There are complex loads such as electricity, natural gas and heat in this base too. The connection between different energy is weak and the application is single. The phenomenon of energy waste is outstanding. Information fusion provides a good way to Laogang with a variety of data processing.

The biggest advantage of information fusion technology is that it can coordinate data. There are a wide variety of information in Laogang, the system components are different and there are many environmental effects such as the composition of the garbage. The historical data, real-time data and forecast data are needed to be analyzed synthetically. It can transform inaccurate, incomplete, unreliable information into the phenomenon of consistency interpretation. It is applicable to different levels of fusion algorithms and solutions. While improving system reliability, it is able to expand the time and space on observation range and reduce system investment too. Figure 8 for Laogang energy network information fusion framework model.

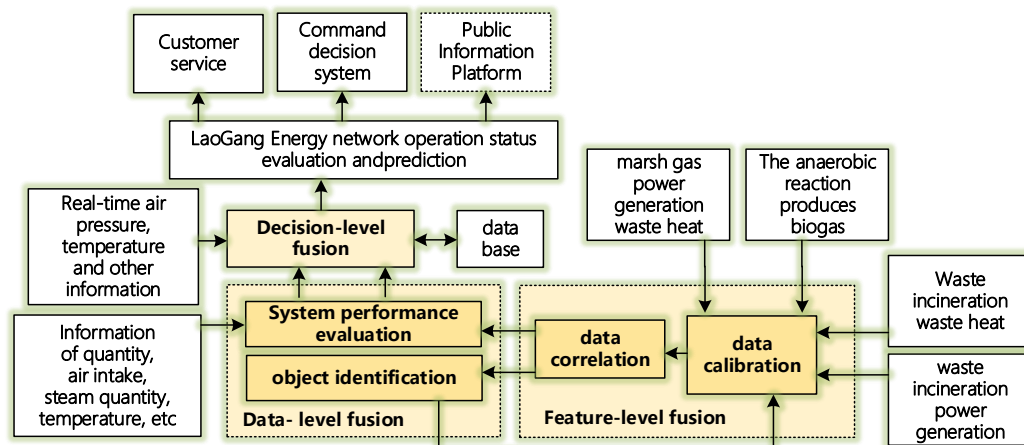


Fig.8 Laogang energy network information fusion framework model

5. Summary

This paper analyzes the recycling of garbage and establishes the energy interconnection based on base's functional classification. The design of the processor realizes the combination of automation technology and computer network technology to monitor power quality. It obtains information of the detected object more quickly, reliably and accurately. Combining with information fusion technology, the command decision system will make better judgment.

Acknowledgments

This paper is supported by the Shanghai Committee of Science and Technology, China, under Grant 16DZ1202800.

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