Advance Journal of Food Science and Technology 10(3): 185-188, 2016
DOI: 10.19026/ajfst.10.2049
ISSN: 2042-4868; e-ISSN: 2042-4876

Submitted: May 5, 2015 Accepted: June 22, 2015 Published: January 25, 2016

Research Article

Single-phase Energy Metering Circuit Applied in Food System Based on ADE7755 Chip

[1]Yu Qiong-Fang, [2]Shi Zhina, [3]Dong Yangmei and [1]Dong Ai-Hua
[1]School of Electrical Engineering and Automation, Henan Polytechnic University, Jiaozuo 454000, China
[2]Sippr Engineering Group Co., Ltd., Zhengzhou 450000, Henan, China
[3]Document Micro. Duplication Center, National Library of China, Beijing, 100081, China

Abstract: This study designs a single-phase food measurement circuit for food system users. The circuit adopts a high-precision single-phase energy metering chip ADE7755 produced by the United States ADI company for the acquisition of the electrical energy and uses the high-performance SCM AT89C51 as a whole control center of electrical acquisition circuits. The working principle schematic of the single-phase energy metering chip circuit, the diagram of the components of the entire energy metering circuit and the software flow chart are introduced in study. At last, the test situations is introduced, the test results are analyzed and compared, the test showed that the energy metering circuit has the high precision.

Keywords: ADE7755 chip, electrical energy acquisition, food system

INTRODUCTION

Because the reform of food system in food system and the rational use of the electronic, appear a variety of watt hour meter with electronic type, broke the situation of there has only watt hour meter with induction type in the past. Watt hour meter with electronic type has some advantages, such as low food consumption, high accuracy, high work efficiency, etc. But at the present stage, the technology of the watt hour meter with electronic type is not fully mature, it has some disadvantages, such as complex line, the not stable of system and the limited application occasions, etc.

In view of the above situation, a simple and practical electric energy metering circuit with single-phase electronic type is designed in this study to the food system user. A high precision single-phase electric energy metering chip ADE7755 is adopted in this circuit to collect the food system by users and a high performance MCU AT89C51 is adopted to as the control center of the whole electric energy collection circuit. The current and voltage Holzer sensor with high precision, good stable performance are used to replace the current and voltage transformer which is always used in circuit to collect current and voltage (Dong *et al*., 2009). In addition, the working principle of single-phase electric energy metering chip ADE7755, the whole electric energy metering circuit composition and the software flow chart are also introduced in the study.

The electric energy metering device is a kind of weighing and measuring equipment which records how many electrical energy are used by food system customers, is the "measurement instrument" of trade settlement to the sale of electric energy for food systems. It is accurate or not, will directly affect the normal recovery funds of food systems and has a very important significance for the promotion of reducing consumption, the saving of electric energy, the strengthen economic accounting, the improvement of management and the increase of economic benefit, etc., (Zhao *et al*., 1999; Yang *et al*., 2001).

MATERIALS AND METHODS

The basic components of the electric energy metering circuit: The electric energy metering circuit is mainly composed by detection circuit, electric energy metering chip ADE7755, AT89C51 microcontroller, LCD display circuit, memory, remote communication interface and food supply in the study. Among them, the voltage detection circuit, current detection circuit and ADE7755 food measurement chip is composed the electric energy acquisition module. The characteristics of this circuit is there has an examination link in electric energy acquisition part, it can improve the precision and stability of the whole circuit. The single-chip computer AT89C51 is adopted in energy metering circuit as the central control circuit to control the acquisition, food measurement, transmission to the host computer and the electric energy display work in the electric (Fig. 1).

Firstly, the load current is converted into suitable voltage signals through the current sensor and through

Corresponding Author: Yu Qiong-Fang, School of Electrical Engineering and Automation, Henan Polytechnic University, Jiaozuo 454000, China

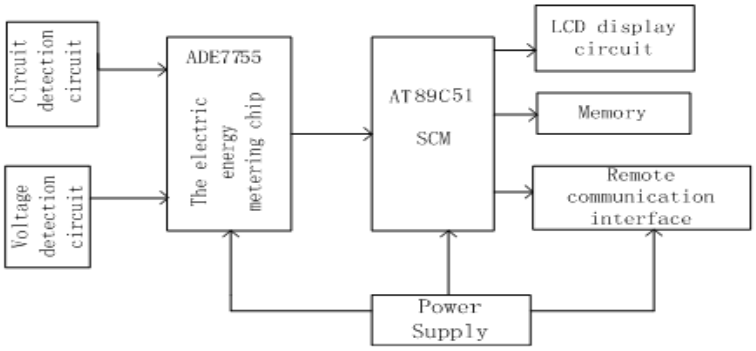

Fig. 1: The principle diagram of energy measurement circuit

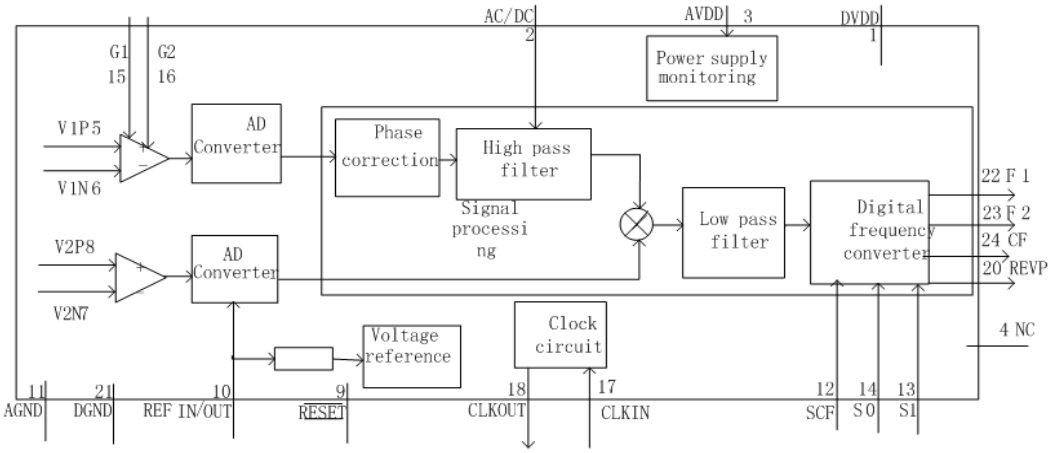

Fig. 2: The functional block diagram of ADE7755

the filter circuit, then the suitable voltage signals is carried into current channel of electrical energy measurement chip ADE7755, that is the V1P and V1N terminal; While the 220 V phase voltage is decompressed through the voltage sensor and then through the filter circuit is carried into voltage channel of electrical energy measurement chip ADE7755, that is the V2P and V2N terminal. Through the electric energy metering chip, the two volumes are converted into active food with the form of high frequency pulse and output from the CF terminal and into the external interrupt signal input terminal by AT89C51. That is, the MCU control circuit collect pulse from CF terminal of ADE7755, the data after processed be transmitted to the LCD display circuit and through the remote communication circuit transmitted to the host computer.

The introduction of electric energy metering IC ADE7755: Functional block diagram of ADE7755 is shown in Fig. 2. ADE7755 has two channels of current and voltage, which has two analog inputs, respectively are the current channel V1P and V1N and the voltage channel V2P and V2N. The two ADC digitized the signals from the voltage and current sensors, the two ADC is 16 bits, two order ∑-ΔADC, the sampling rate up to 900 kHz. The analog input structure of ADC7755 has a wide dynamic range, which greatly simplified the sensor interface. Among them, PGA (Programmable Gain Amplifier) of channel 1/current channel makes the shunt resistance with small resistance can be used in instrument, so the sensor interface can be simplified. HPF (High Pass Filter) filter out the DC component of current signal, thereby eliminated the calculate errors of active food due the offset by voltage or current.

The instantaneous value of active food output from the CF pin with the higher frequency mode, which can be used for instrument calibration. Active food is calculated from the instantaneous food signal. ADE7755 directly multiplied the digitized current and voltage signals, gain the instantaneous food signal. As long as low-pass filtering the instantaneous food signal, the active food component (i.e., DC component) can be obtained. All signal processing is done by digital circuit, so it has excellent temperature and time stability (Wang *et al*., 2007).

Active food average value output from the ADE7755 pin F1 and F2 with low frequency mode, the output can direct drive electromechanical meter and two-phase stepping motor. The low frequency output of ADE7755 is produced by total the information of active food, that is accumulated the two output pulses with a long time, so the output frequency is proportional to the

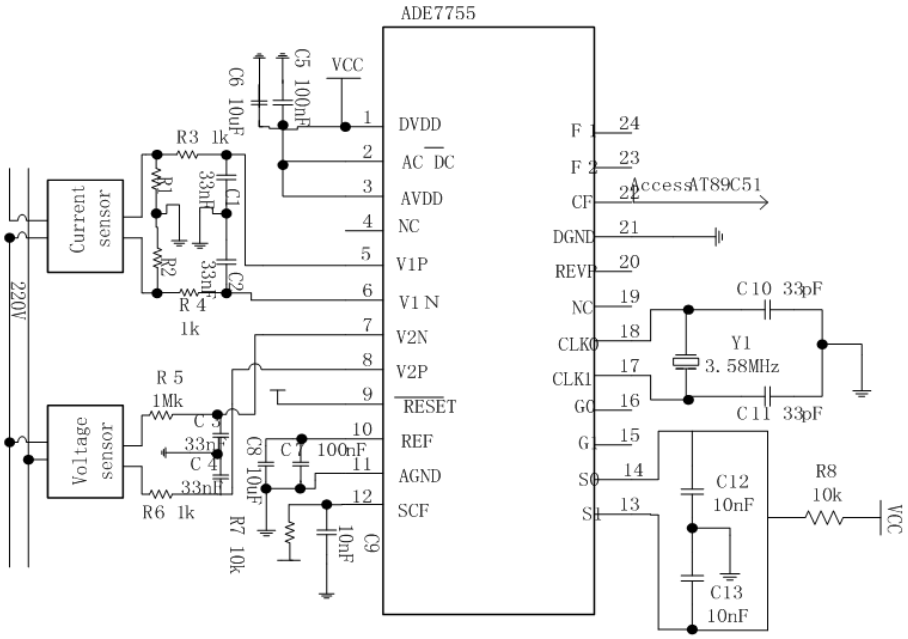

Fig. 3: Electric energy measurement circuit

average active food. When the average active food information is further accumulation (e.g., by counter or counters accumulated), can obtain the electric energy metering.

The ADE7755 includes a control circuit for AVDD food supply pin. When AVDD is less than 4 V, the ADE7755 remains a reset state. At this time, F1, F2 and CF are not output.

The measurement circuit of electric energy: Electric energy measurement circuit is shown in Fig. 3, it is mainly composed with voltage detection circuit, current detection circuit and the electric energy metering chip ADE7755 and the peripheral circuit with ADE7755. Because the current channel of ADE7755 using the fully differential input mode and the maximum differential peak voltage should be less than 470 mV, a filter circuit is added after the load current through the current sensor, which can make the voltage value reduce to the appropriate size and input it into the current channel of ADE7755. Voltage is carried to the voltage channel of ADE7755, after hypotension and the divider circuit and filter circuit, the voltage channel also uses fully differential method.

The voltage Holzer sensor and the current Holzer sensor are used in the study. Holzer sensor can realize the magnetoelectric conversion through use the Holzer effect and the se.

In this electric energy measurement circuit, the peripheral circuit of ADE7755 is also shown.

In this study, the system control of the whole electric energy metering circuit is completed by AT89C51. The AT89C51 is a kind of 8 bit single chip microcomputer, with the advantages of low food/low voltage, strong function, high flexibility and reasonable price. It has 128 KB RAM data memory, 4 KB ROM program memory, 4 I/O ports, a serial port, 2 timer/counter, 5 interrupt sources, without built-in watchdog, has no A/D converter (Yu, 2003).

AT89C51 MCU control the normal operation of the whole electric energy metering circuit: monitor the working state of ADE7755; read active, reactive food, apparent food and current, voltage value from ADE7755 register and output them to digital display circuit; save the data into the memory to prevent data loss during the blackout; realize the response to keyboard operation and process the data communication with remote computer, etc.

Software design: The software flow chart of electric energy metering circuit is shown in Fig. 4. First of all, carry on the electric energy measurement circuit initialization: Such as single chip initialization, electric energy metering chip ADE7755 initialization and display circuit and remote communication initialization and then electric energy pulse reset and the system parameters initialization, then the interrupt system of MCU AT89C51 judge whether there has the reading order. If there has the reading command, began to read the electric energy data and calculate the food, then transmit the electric energy data and LCD display processing; if there has not the reading command, waiting until the command come. After the execution of each step, return to the start to re-execute the command. This is the main flow chart of the single-phase electric energy metering circuit in the study. Measurement of electric energy is mainly depends on the interrupt system of MCU to complete, due to limited space, the details do not.

Table 1: The data table of test and calculation

				Electric energy metering (kW/h)	
Voltage (V)	Current (A)	Food factor	Measurement time (h)	Calculated value	Measured value
220	0.51	0.4	0.5	0.225	0.227
220	0.51	0.4	1.0	0.450	0.455
220	0.51	0.4	1.5	0.675	0.680
220	0.51	0.4	2.0	0.900	0.904

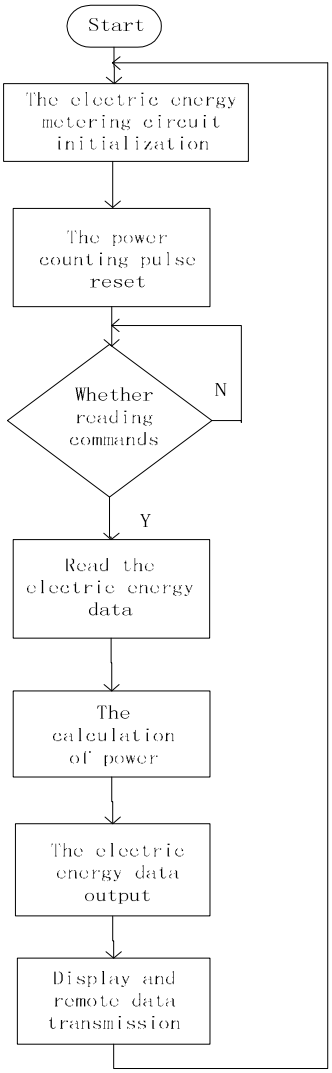

Fig. 4: Software flow chart

RESULTS AND DISCUSSION

Test results and conclusion: In order to validate the performance of the single-phase electric energy metering circuit, a test platform for the test is set up and the electric fan which is commonly used as the measuring object. The test platform is mainly composed with a regulated food supply, voltage meter, current meter and food meter etc., the specific electric energy metering test platform is shown in Fig. 5.

The regulated food supply is to ensure that the voltage of test circuit stability in 220 V, voltage meter, ammeter and the food factor represent the actual food

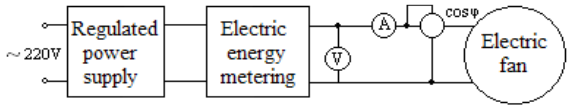

Fig. 5: The test platform of energy measurement

used by electric fan, electric fan food consumption in that time period can be calculated according to the measuring time, compare this calculation value with measurement value of electrical energy metering circuit, the test data and the calculated data are shown in Table 1.

From Table 1 it can be seen that although there has some error between the calculated value and the electric energy measurement, but the error is relatively small, less than 1% and considering the own consumption of voltage meter, current meter and food meter, it is reasonable for electric energy measurement values slightly higher than the calculated value, so it can be seen that it is relatively high of measurement accuracy for the energy metering circuit.

CONCLUSION

With the special measure chip ADE7755 as the core and combine AT89C51 MCU technology, the paper designed an electronic single-phase electrical energy measurement circuit. The circuit has a series of characteristics, such as simple circuit, low food consumption, high precision, strong anti-interference ability, good stability, etc. And the circuit has the advantages of small volume, low cost, easy for food system users, so the electric energy metering circuit has better application prospect.

REFERENCES

Dong, A., L. Li *et al*., 2009. Detection and Conversion Technology. Chinese Food Press, China.

Wang, Z., G.H. Zeng and Y.B. Zhang, 2007. Design of single-phase multi-rate Watt-hour meter based on LPC9401 CPU. Electr. Meas. Instrum., 44(495): 30-33.

Yang, H., Y. Zhang and F. Lv 2001. The status and prospect of communication schemes in AMRS. Electr. Meas. Instrum., 38(8): 8-11, 34.

Yu, F., 2003. Principle and Application of SCM. China University of Mining and Technology Press, China.

Zhao, W., H. Pang and C. Liu, 1999. The course development of electric energy meter technology. Electr. Meas. Instrum., 36(42): 4-7, 55.