Research and Analysis of Single-Phase Electrical Appliance Analysis and Detection Device

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Abstract

In this paper, a high-precision meter integrated circuit CS5463 is used as the core metering and 16-bit MC9S12XS128 MCU as the core controller, which implements the monitoring device for the analysis of electrical appliances category and working status. The system is mainly composed of five modules: ACDC power supply module, voltage acquisition module, signal conditioning module, metering module, and CPU module. The voltage acquisition module converts the load current into a 2.5V output voltage from the Hall current sensor CS010GT. The signal conditioning module is composed of OP07 and CD4051 and can achieve a 30dB gain adjustment range. The measurement module is based on the CS5463 power chip. The analog voltage signal is converted into a digital signal and sent to the microcontroller; the CPU module is controlled by xs128 monitoring process and display CS5463, through the 12864 liquid crystal display and terminal host computer real-time monitoring of electrical appliances. The entire system is reliable, stable, low-cost, and highly efficient. It fulfills all the requirements of the basic part and fulfills part of the requirements.

Keywords

Energy measurement chip CS5463, XS128 microcontroller, Monitor display.

1. Introduction

This paper designs and builds a device that can analyze the electrical appliance category and operating status based on the electrical parameter information of the power cord. The device has two working modes of learning and analysis monitoring. In the learning mode, the characteristic parameters of each single piece of electric appliance used to identify the electric appliance and its working state under various conditions are tested and stored; in the analysis and monitoring mode, the category and working state of the electric appliance are indicated in real time.

2. Plan Selection

(1) Power module selection

Solution 1: Self-designed bridge rectifier circuit, composed of main circuit, filter and transformer, converts AC power into DC power. This method can theoretically achieve 220V AC to 5V DC functionality.

Solution 2: Using AC-DC power supply module to achieve stable power conversion, but in the process of practice, it is found that its peripheral circuits are too complex and the hardware requirements are too high, and it is difficult to stably output a 5V DC voltage.

Solution 3: Use the power adapter on the mobile phone charger to output the stable 5V DC voltage required by the monitoring circuit through the USB to TTL interface. This scheme is simple and reliable, and the reliability is strong while the output DC voltage fully meets the requirements of the post-stage circuit.

Comparing scheme 1, scheme 2 and scheme 3, taking into account that monitoring the electrical characteristics of the load for the circuit measurement requirements are relatively high, the first two

programs can not output a stable circuit of the DC voltage stability, therefore, the creative proposal to use the power adapter three, The title circuit requirements can be fully realized.

(2) Signal conditioning module selection

Solution 1: Using relays to switch the channels of the signal, but due to the excessive change of the current through the relay and the large number of signal clutter, the temperature characteristics and the anti-interference ability of the electronic circuit are poor, and the radiation resistance is also poor. Slow, if not take effective measures, the work reliability is low.

Solution 2: Using the analog switch CD4051 integrated chip, its selection channels are more than relays, it can more easily achieve signal gain selection, and has low on-resistance and very low off-leakage current, which has little effect on the signal and is stable.

In comparison between scheme 1 and scheme 2, for the AC signal circuit, the switching mode of the analog switch is more stable and more channels are selected, so scheme 2 is selected.

(3) Core measurement module selection

Solution 1: Uses the one-chip computer sampling signal to carry on the internal AD conversion computation to obtain each electrical appliance parameter. This scheme is simple in principle and easy to operate, but it is difficult to achieve most of the functions required by the problem, and it is impossible to measure power factor parameters, etc., and the operation of the microcontroller program is too complicated and difficult to implement.

Solution 2: CS5463 is used for parameter calculation. The CS5463 is a meter integrated circuit with two converters and high-speed energy calculations. It can accurately measure voltage, current, active power, power factor, etc., and comes with a timer and a digital filter to automatically calibrate the gain. After conditioning, the electrical signal is directly input into the CS5463 integrated chip. By operating the CS5463, xs128 can easily complete the measurement of the required parameters.

Comparing scheme 1 and scheme 2, the CS5463 energy chip can monitor parameter information more comprehensively, the peripheral circuit is simpler, and the measurement method is more scientific. Therefore, scheme 2 is selected.

3. System Scheme Description

This design uses the MC9S12XS128 microcontroller as the core control chip, and measures the voltage, current, and power rms value of the electrical instrument through the energy measurement chip CS5463. The voltage of the electrical appliance is converted by the voltage transformer and input to the voltage channel input pin of the CS5463. The electrical current is converted by the current transformer and input to the current channel input pin of the CS5463. After the CS5463 converts the signal obtained by the conversion and calculates, the voltage, Current, power, and other data are communicated to the microcontroller through a SPI port. After the data is processed by the microcontroller, the number of the device, its operating status, and electrical characteristics are displayed on the LCD display of the 12864 LCD.

When passing the hot or neutral wire of the socket through the center of the Hall current sensor, the sensor will output an AC voltage referenced to 2.5V. As the load side changes, the current through the center will also change, causing the output voltage amplitude changes, that is, the CS010GT can convert the current value to the voltage value Vo, and its voltage value is one-tenth of the original value.

After that, the voltage Vo is sent to the differential mode voltage input channel of the CS5463 chip. By measuring the voltage, the current, active power, power factor, and other circuit parameters that can be used for identification are obtained. The typical maximum differential input voltage (full-scale) of the CS5463 voltage channel (PGA is set to 10X gain) is 250mv.

However, for any one channel, it is not practical to input a sine wave with an effective value of 250mv. At this time, the sine wave will exceed the maximum differential mode voltage input range. The maximum unsaturated sine wave voltage input signal is typically about full scale. Through testing, when the voltage is less than 50mv, the measurement effect is not good. Therefore, for a large current

converted voltage, attenuation is needed, and a small current conversion needs to be amplified. After the voltage is processed, it can be identified very well, so the circuit voltage and current can be directly measured, and then the active power of the load can be obtained through calculation. Since there is a certain difference in the power between the electrical appliances, the electrical appliances with similar power have their voltages. There is also a difference between the current and the current, so it is decided to use the voltage and current active power as characteristic parameters for the detection.

4. Circuits and Programming

(1) Voltage acquisition module

This part of the circuit is to pass the center of the Hall current sensor CS010GT through the hot wire of the socket, so that the 220V AC power passes through, and a voltage signal based on 2.5V is output at the output pin 3 for the subsequent circuit conditioning.

(2) Signal conditioning module

OP07 as the core of the op amp differential amplifier circuit, the input negative terminal connected to a potentiometer adjustable 2.5V reference voltage to eliminate the output from the Hall sensor 2.5V DC component; then connected to a Π-type attenuation circuit, The CD4051 is controlled by the single-chip microcomputer program and then the channel selection is performed. The high and low signals of the input terminal are processed differently and are again received by the single-chip microcomputer.

(3) Measurement module

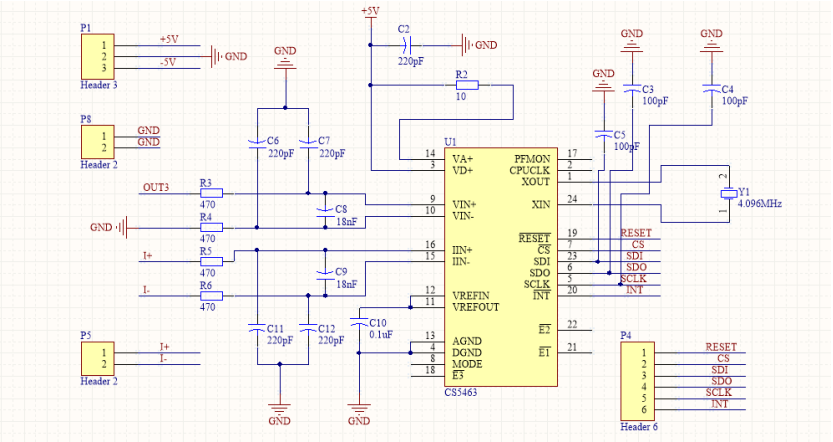

Figure 1. Core Measurement Module

CS5463 as the core of the measurement module, as an intermediate system, receives the voltage analog signal and current analog signal, through the chip's internal circuit output into an effective digital input to the microcontroller, and finally get the electrical operating characteristics of the parameters, in 12864 Displayed on the LCD screen and host computer terminal.

5. Analysis of Test Results

After the appliance monitoring system is connected in series to the mains input, the electrical appliances with different rated powers are sequentially connected to or disconnected from the load circuit, and the three power parameters are measured when the different appliances are connected to the circuit in the steady state: voltage, current, Active power, and match them with the electrical code, record to the structure array, and write the array to the EEPROM address bit sequentially.

Tab. 1 Test data

Number	Name	Current	Voltage /mV	Active power
1	load 1	5	0.5	1.202
2	load 2	15	1.5	4.211

3	LED	22	2.2	10.092
4	Small fan	39	3.9	22.634
5	Electric iron	47	4.7	40.231
6	Incandescent	196	19.6	37.820
7	mobile phone	330	33	13.270
8	computer	2480	248	483.234
9	Hair dryer 1	3620	362	667.374
10	Hair dryer 2	8800	880	1467.482

Here, the current and the voltage are signals generated by the input of the Hall current sensor, and the power is the calculated actual value, that is, the judgment of the power value determines the operating status and electrical parameters of the electrical appliance.

When an electrical appliance is used to access a circuit load, a large starting current is generated, but this current is a transient amount, and it is only through this judgment that the useful appliance is connected to the circuit. Further, it is determined by the stable voltage and current after accessing the circuit which one of the appliances accesses.

6. Conclusion

Different electrical appliances have different electrical characteristics in the access circuit. The current, voltage, active power, and reactive power can be used as the judgment basis. Therefore, the electrical status of each electrical appliance can be detected by judging the electrical characteristics of the electrical circuit. .

References

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