Intelligent Monitoring Device for Agricultural Irrigation

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Abstract: With the continuous progress of science and technology, the application of electric power system in agriculture is becoming more and more extensive and complicated. In this paper, an intelligent monitoring device for agricultural irrigation power consumption is designed. The system consists of voltage regulation module, wireless transmission module and metering module. The main control unit module uses MCU-32S as the core processor to process the data transmitted by each sensor in real time. The function of 220V voltage regulation to 5V, power off and recovery is realized by using a photo-coupler relay. The data processing and transmission module uses SUI-101A AC transmitter as CPU to process and control the data transmitted from several centralized monitoring unit modules and monitor the voltage, current and power values in real time. A serial communication interface can be installed at the periphery of the system for remote communication with the upper computer.

1. Introduction

China is a world population country and an agricultural country with a large demand for agricultural products. The electricity consumption of agricultural irrigation deserves our attention. The intelligent monitoring device is mainly based on the voltage, current, power measured by AC transmitter and compared with the set value. When the power used exceeds the given power value, it will immediately conduct power-off protection and give a delayed alarm (10s). When the power is less than the given power, it can automatically return to normal operation.

2. General layout of system design

Because the optical coupler isolation relay is simple and convenient to use, stable in performance and high in cost performance, the system uses the optical coupler relay to control the 220V power supply to be switched off, the SUI-101A AC transmitter measures the voltage and current of the electrical appliance and transmits the measured data to the single chip microcomputer, which plays a protective role when exceeding the given power and immediately cuts off the power. When the power falls within the allowable range and the delay is 10s, normal operation is resumed. The data is sent to the mobile phone by the single chip computer through wireless WiFi to meet the design requirements. System block diagram is shown in the Fig. 1.

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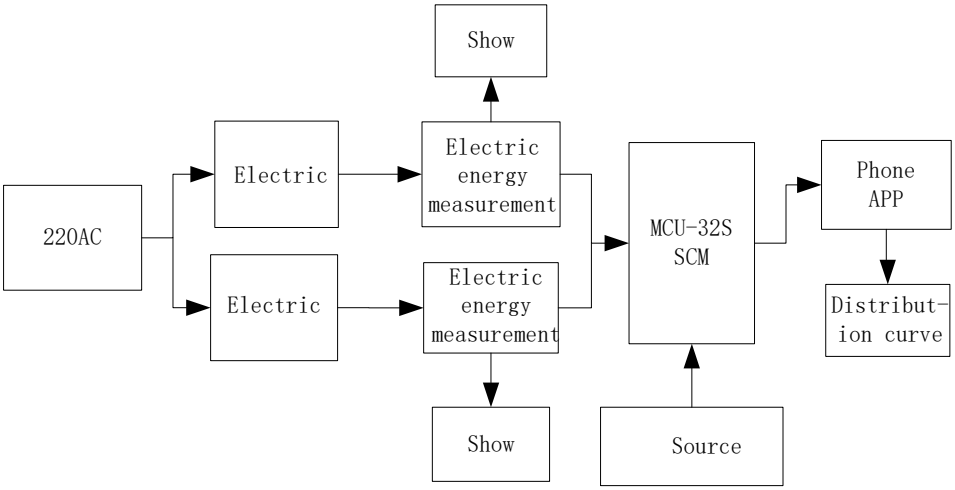

Fig. 1. System block diagram.

3. Selection of control system

Using NodeMCU-32S as a system control scheme this system provides WiFi and Bluetooth functions. Small 32S volume, easy to insert into any product, Lua programming, simple development, High cost performance. Support three modes: AP, STA, AP+STA coexistence mode. Powerful function, Support LWIP protocol freertos. It includes antenna switches. Radio frequency balun, Power amplifier, low noise amplifier, filter and power management module. The entire solution takes up the smallest PCB area. Power consumption and RF performance are the best. It is safe, reliable and easy to extend various applications.

4. Device selection and parameters

4.1 Functions and parameters of optical coupling isolation relay

One optocoupler isolation relay has the function of isolation, such as signal isolation or photoelectric isolation; the driving power is higher than the ordinary optical coupler. It can be used to control various loads. Such as electromagnetic relay, light emitting diode and so on; at present, the relay module has two trigger modes of high and low level. Optocoupler isolation is used on every road. Auxiliary freewheeling diode protects the former circuit.

Table 1. Functions and parameters of isolation relay.

working voltage	5V/12V/24V	**Trigger current**	5mA
Patch optocoupler isolation	Open interface maximum load	**Direct current 30V/10A**	alternating current 250V/10A
High and low level trigger	Fault-tolerant design	**Performance stability**	Strong driving ability

4.2 Functions and parameters of SUI-101A

SUI-101A is a high-precision multi-function AC transmitter with transformer isolation. It isolates the measuring power supply from the working power supply through the transformer and can measure parameters such as AC current, voltage, active power, accumulated power, frequency and power factor in real time. It can also provide standard communication interface (TTL asynchronous serial port) and support standard protocol (Modbus protocol) and custom protocol.

Table 2. Functions and parameters of SUI-101A.

Product name	Ultra-high precision fully isolated power transmitter	**Product grade**	Industrial grade
working temperature	-40～85℃	**Power supply voltage**	DC5V±0.2V
current range	0～5A	**Current precision**	0.2level
Voltage range	0～400V	**Voltage precision**	0.2level
Power range	0～2000W	**Power precision**	0.2level
sampling frequency	1Hz	**power factor**	-1＜cosϕ＜1
Minimum precision	0.1μA	**maximum power**	≤0.1W
Interface support	3.3V TTL	**Extension interface**	2.2 Color screen
Product weight	30g±2g	**Warranty time**	2 years
communication protocol	Modbus-RTU Or simple custom protocol intelligent recognition		

5. Circuit design

5.1 Buzzer circuit design

Buzzer is an electronic alarm device with extremely high integration level. When the electric appliance is powered off, the buzzer will alarm for 10s continuously to realize the power limiting function of this design. The circuit diagram is shown in Fig. 2.

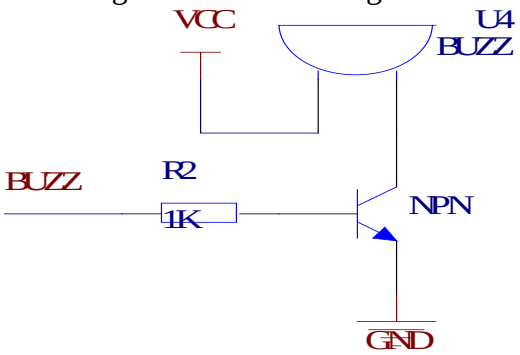

Fig. 2. Buzzer circuit diagram.

5.2 Control system circuit

MCU-32S microcontroller as control system. Most of the I/O to bilateral needles are drawn. You can link peripherals according to your needs. When bread board is used for development and debugging, The standard needle on both sides can make the operation simpler and more convenient. The circuit diagram is shown in Fig. 3.

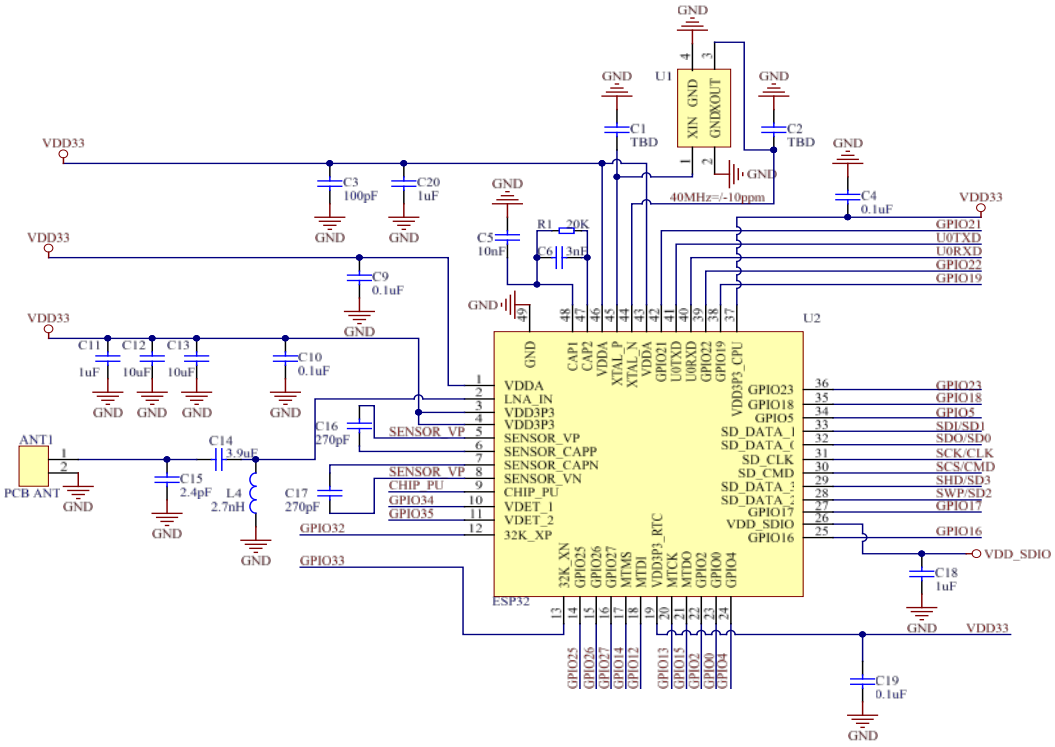

Fig. 3. Control system circuit.

5.3 Colour illustrations

A low-voltage 5V control high-voltage 220V circuit is carried out by using an optocoupler isolation relay. The SUI-101A AC transmitter isolates the measuring power supply from the working power supply through a transformer, and measures parameters such as AC current, voltage, power factor and the like in real time. When the measured value of the transmitter is higher than the set value, the MCU completes the driving control of the relay to disconnect it, thus playing the role of timely power - off. A delay is set in the MCU to enable it to automatically return to normal working state, and then the measured data is transmitted to the mobile phone by wireless transmission for real-time monitoring. The system software flow chart is shown in Fig. 4.

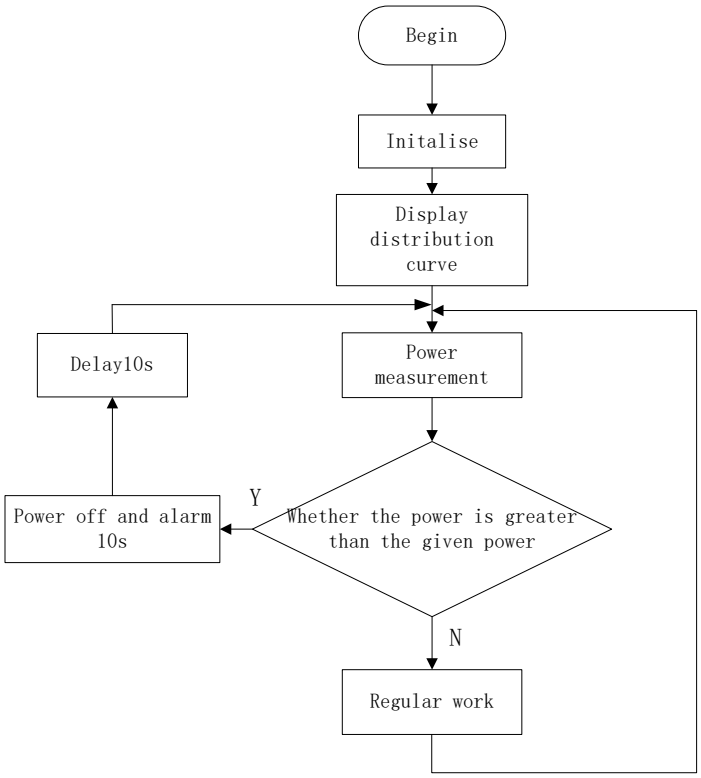

Fig. 4. Control system circuit.

6. Conclusion

This design is aimed at detecting the amount of electricity used in agricultural irrigation and can monitor whether the electricity used in agriculture exceeds the standard. When the electric power used for agricultural irrigation is less than the set value, the device can visually display the electricity consumption and parameter information through the mobile phone app with an accuracy of 0.01. When the electric power used for agricultural irrigation is greater than the set value, the device will automatically power off and give an alarm for 10s. After the alarm for 10s, if the electric power used is less than the set value, it will automatically return to the normal working state. The device has the advantages of low power consumption and high cost performance, can always detect the electricity consumption of agricultural irrigation, and fully guarantees the safety of agriculture.

References

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