

Design of fluid pipeline leakage signal acquisition system

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Abstract: Fluid, namely liquid and gas, is a necessary resource in national production and life, so fluid plays a pivotal role in the progress of the whole society and the development of human civilization. If the fluid leaks, and is not found and treated in time, it will cause huge material losses and waste of resources, what is more, it will cause irreversible environmental damage. This paper takes fluid pipeline leakage detection as the main research object, the main research is as follows: According to the steady-state pipeline as the main analysis goal, C8051F040 single chip microcomputer as the main processor, DS18B20 temperature sensor, CEMPX221 pressure sensor, LWGY-C model turbine flowmeter for data acquisition, and the collected data through the CAN interface, RS485 interface to the host computer.

Key words: fluid; Leakage detection; Communication networks

1. System design requirements

Collect the three parameters of temperature, pressure and flow, and accept the three parameters of temperature, pressure and flow that are uploaded together under the system. The system measures multiple sets of data each time (can be adjusted), and the measured data is uploaded to the upper computer. Due to the actual operation, the surface or underground environment is harsh, so there are the following requirements:

- 1) The system must have high or low temperature resistance and good sealing to ensure that the system works on the surface or underground
- 2) The system works underground, so consider battery power. Consider system power consumption versus battery capacity
- 3) The system components need to have a good seal

So the overall design of the system

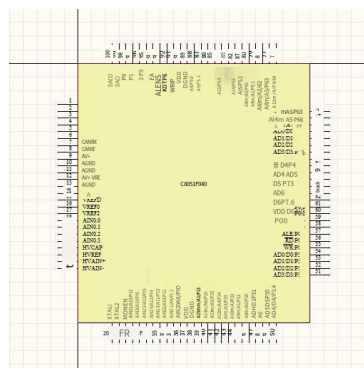
The fluid pipeline data collector is mainly designed to collect and accept data at the port of the fluid, that is, the water pipeline, the oil pipeline and the gas pipeline. The minimum diameter of the common tap water pipeline is 1cm, the minimum diameter of the oil pipeline is 5cm, the minimum diameter of the gas pipeline is 2CM, the water pipeline and the gas pipeline are in the normal temperature working environment more, and the ambient temperature of the oil pipeline is relatively high, under the premise of ensuring the normal work of the system, the need for high temperature resistance, corrosion resistance and small size. Therefore, to choose the right single chip microcomputer, the C8051F040 single chip microcomputer used in this paper, in the case of power, the single chip microcomputer can work normally from -55 ° C to 125 ° C, fully competent for the collection of fluid data requirements.

2. Processor selection

2.1 C8051F040 MCU system overview

In the fluid data acquisition system, C8051F040 single chip microcomputer not only needs to coordinate the processing of each module in the whole system, but also is responsible for sending the sampled data to the host computer through the serial port and display. C8051F040 MCU is a fully integrated mixed signal on-chip systematic microcontrol unit, is a high-speed 8051 microprocessor core, the processing speed is greatly improved, and the execution efficiency can be compared with some 16-bit MCU. Therefore, the use of 8051F040 microcontroller can simplify the circuit design and reduce power consumption. C8051F040 supports C language programming. As we all know, C language is highly practical, compact, flexible and convenient, rich data organization, wide application range and strong portability.

From the above characteristics, we can see that C8051F040 single chip microcomputer has great advantages compared with similar single chip microcomputer in terms of operation speed, or in the inherent hardware and external interface resources. It can not only provide a solid foundation for the realization of complex control operations, but also greatly provide great resource convenience for different systems. Improve system reliability and cost performance.



2.2 C8051F040 MCU clock circuit and reset circuit

MCU clock circuit

C8051F040 has a high gain reverse amplifier inside, input chip pin XTAL1, output chip pin XTAL2, in the oscillator input and output pin external connection is a component, the system uses internal oscillation mode, the specific circuit diagram is as follows

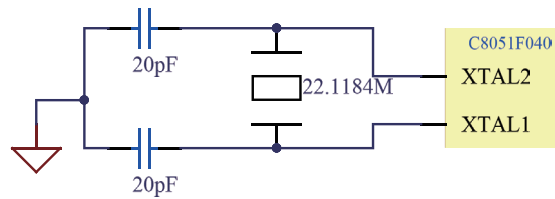


Figure 2 C8051F040 MCU clock circuit diagram

MCU reset circuit

C8051F040 is connected to the external circuit at the reset end. When the single chip microcomputer is powered on, the internal circuit starts to work from the initial state, or it needs to manually let the single chip microcomputer start to work from the initial state when working. To avoid problems such as system crash or program disorder, the reset circuit of the system is as follows

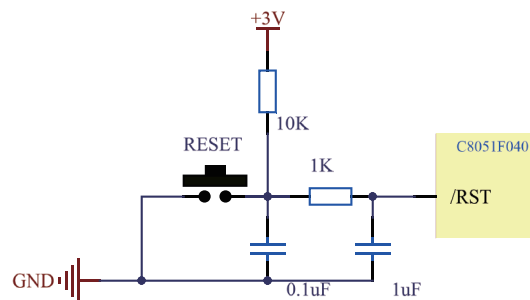


Figure 3 C8051F040 MCU reset circuit diagram

3 Design of sensor module

3.1 Temperature acquisition scheme

The temperature sensor adopts DS18B20 digital thermometer.

Pin Instructions

- 1)DQ is the input/output end of the digital signal;
- 2)GND is the power source;
- 3)VDD is the external power supply input (grounded in parasitic power connection mode)

Hardware design of DS18B20

DS18B20 can carry out normal temperature collection, and it needs to be powered during the I/O port line conversion. Therefore, if multiple DS18B20 are required to work in parallel on an I/O line at the same time, it is far from enough to provide power close to the pull-up resistor. Therefore, in order to obtain enough current for DS18B20 to work, it is necessary to supply power closely to the pull-up resistor. You need to provide an external power supply. An external power supply is connected from the VDD pin, in this case the GND pin needs to be connected to the ground of the controller and cannot be suspended.

DS18B20 software design

Access DS18B20 process: 1, first DS18B20 initialization, and then try the ROM command operation, and finally achieve the operation of the storage, operation data. The operation of each stage of accessing DS18B20 needs to be in accordance with strict and strict communication protocols and working timing. For example: when the host accesses the DS18B20 control temperature conversion, it must first follow the communication protocol of DS18B20, and then go through three steps to check: 1. In the enzymatic read and write operation, DS18B20 must be carried out once, after the reset is completed, send an instruction to ROM (memory), and then send an instruction to RAM.

3.2 Pressure acquisition scheme

The pressure sensor adopts CEMPX221 high precision pressure transmitter. The fluid pressure is affected by the resistance of the pipeline, the import and export pressure test needs a more accurate sensor, CEMPX221 pressure sensor uses a high-performance amplifier circuit, by converting the measured pressure into a potential electrical signal, to get an accurate value. And because the pressure sensor is closed and high-precision design, and is slightly affected by external vibration and temperature, it can be suitable for long-term high-intensity test environment.

CEMPX221 is mainly used in liquid or gas environment, and its measuring medium can not have corrosion, dust and other environments, so it conforms to the working environment of this paper. The measuring range of CEMPX221 is 0 to 30kPa, and the overload pressure is 1.5 times of the measuring range, so it can meet the high-strength pressure detection at the factory, and the detection accuracy is

5% static detection accuracy, so the edge pipe can also obtain high-precision data detection. CEMPX221 can work normally within -20 to +85°C, but also has a good compensation temperature.

Hardware design of pressure sensor.

CEMPX221 pressure transmitter transmits the collected pressure value to C8051F040 microcontroller.

3.3 Flow collection scheme

In the flow sensor part, LWGY-C model turbine flowmeter is used, which is characterized by relatively simple structure, high precision, sensitive response, lightweight, good reproducibility, easy installation, maintenance and use, etc. Is widely used in stainless steel 1Cr18Ni9Ti, 2Cr13, cemented carbide and no fiber, particles and other impurities, corundum Al₂O₃ and closed pipe measurement, the use of 24DC C-type power supply, the two-line current signal is: 4-20mA, and can increase HART or RS485 communication according to different needs.

4. Design of power module

The working voltage of C8051F040 MCU is 2.7V to 3.6V, the working voltage of CAN interface needs 5V, and the working voltage of pressure sensor CEMPX221 needs 24V, so the necessary voltage generated by the voltage converter is required.

4.1 Generation of 5V voltage

LM2596 is a step-down power supply device. First of all, it can produce 3A output current. At the same time, it has better load regulation characteristics and linear relationship center. And its internal integration of a fixed frequency generator, its switching frequency is 150KHz, compared with other frequency is relatively low switching power supply, it can use smaller specifications of filtering elements.

In addition, this device does not need too many external components, can use common standardized components, here not only optimize the use of LM2596, and use the method at the same time, to a large extent make the design of the power supply more simple.

4.2 Generation of 3.3V voltage

Select TPS79333, the 3.3V voltage. One that uses LDO (low voltage drop) linear voltage regulator, in SOT-23-5 package. The working parameters of TPS79333 are: maximum input voltage: 2.7 to 5.5V, output voltage: 3.3V, maximum output current :200MA, maximum operating temperature: +150°C. This calculation can meet the needs of the work.

5 Design of system CAN communication module

5.1 Hardware design of CAN bus communication

C8051F040 comes with a CAN bus protocol controller compatible with CAN technical specification 2.0A and 2.0B, so only a CAN bus driver chip from the outside CAN bus communication can be completed. This paper uses SN65HVD230CAN bus transceiver.

5.2 Software design of CAN bus communication

System CAN bus communication includes system initialization, sending and receiving procedures.

First, reset the system and enter the initialization state. The initialization of CAN bus communication system includes the initialization of CAN communication port and the initialization of CAN related parameters. The CAN controller sends the message automatically. The controller transfers the data to the send cache register according to the received instruction, and then sends the data to the encoding of the message object according to the command request. The CAN controller automatically accepts the message. The controller reads the received data from the register and processes it accordingly.

6 Design of RS485 communication module of the system

6.1 Hardware design of RS485

The TTL level of C8051F040 does not match the level signal specified by RS485, so a new communication protocol should be set between them. This paper uses MAX3485 as the communication transceiver chip.

6.2 Design of communication between RS485 and host computer

In this paper, PC is used in the upper computer, and PC is an RS232 interface, so it is necessary to convert the RS485 level to RS232 level before conversion. The actual conversion scheme can use active converter and passive converter, this paper uses RS485 half-duplex passive converter BBT485D, the converter does not need power supply, can work directly, complete the remote multi-computer communication between PC port and C8051F040 single chip microcomputer.

BBT485D has two mutual non-intervention RS485 port, the two ports do not interfere with each other, relatively independent; The converter can use RXD, TXD, GND, there are 128 nodes work; It has a high anti-static, anti-interference protector to ensure the stable transmission of signals; Because it has its own transceiver conversion technology, it can be suitable for all software. BBT485D adapter socket is DB9, DB9 is directly connected to RS232.

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