

Design and Development of an Unmanned Mountain Station Supervision System using Digital Microwave Circuits in Hangyongwen, Zhejiang Province

Ma Yuchen

Computer Department, Beijing Telecommunication Equipment Factory 100016

1 Background

The system is used for supervising microwave stations in Hangzhou, Wenzhou and Ninbo, etc. The supervisor stations are generally located in urban computer rooms and the slave stations are located on mountaintops near the seaside which is often a very harsh environment. There are 6 supervisor stations. Each of them controls a slave station. Data transmission between supervisors is carried out via microwave channels (as shown by a bold black line in figure 1).

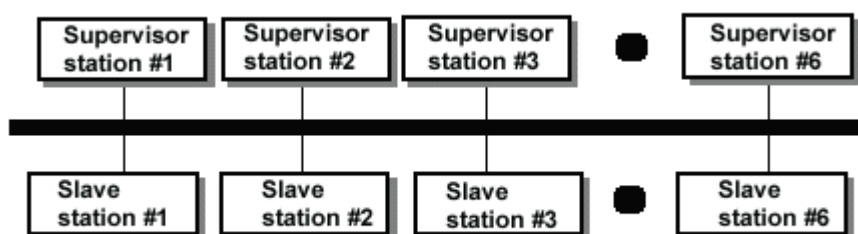


Figure 1 System architecture

However at any given time, only one supervisor can poll its slave computer; the slave computer should respond accordingly. All other supervisors must remain in listening mode. After the supervisor finishes polling its slaves, it will yield the polling privilege to the next supervisor and the polling process will continue in a manner similar to that of the first supervisor. The statuses that are monitored include the working status of the diesel generator, switch power supply, mains, storage battery etc., and environment temperature, humidity and theft protection. The system architecture is shown in figure 1.

2 Hardware Design

The oil engine monitor with double on-line backups is specially designed for working with large diesel oil generators. 1600 and 2800 are also dedicated monitors for original facilities. The 1600 is mainly used to monitor the mains and environmental parameters and the 2800 is used to monitor two sets of storage batteries (each with 12 sections). The [I-7041](#) is used for the alarm digital signal input module, [I-7067](#) for controlling digital signals and [I-7188](#) for supervisor modules. The [I-7188](#) has four serial ports which include 2 RS-232 ports (only Rx, Tx, and GND signal lines are used), 1 RS-485 and 1 full-signal 9-pin RS-232 port which can be changed to

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RS-485 by internal jumper. [I-7188](#) provides many interfaces and can operate under harsh conditions and provides many built-in functions that can help to quickly develop reliable supervising system programs for field computers. The hardware architecture of the slave stations is shown in figure 2. Since all monitoring modules use RS-485 ports, two RS-232/RS-485 conversion ports are required. Port COM1 is a full-signal RS-232 port that is connected to a dedicated Modem to transfer data through microwave channels. The supervisor stations are connected to a dedicated modem via RS-232 port to transfer data through microwave channels.

3 System Software

3.1 Supervisor software

The supervisor software is developed with KingView 5.1 and runs under the Win98/NT platform. It features real-time multiple tasking, multi-threading, high sampling speed, high reliability, and supports a distributed history database and dial-up network and many ActiveX controls. The software has been extensively used in steel and chemical industries, environment protection, national defense and the aeronautical and astronomical fields.

It is easy and convenient to develop real-time computer supervising system using the KingView software. First, it is required to define devices and load communication drivers. The system, for example, communicates with slave computers through a RS-232 port. The facilities are defined in following sequence: Smart module--[I-7000](#) series, [I-7188](#)--Modbus RTU Extension. Second, to specify working parameters of the RS-232. After that we need to define the data dictionary and variable names, data type and relationship between registers. For the variables in the data dictionary, the corresponding linear target values can be calculated automatically based on the original values. Finally one can design user interfaces with primitive controls provided by KingView software. "Animate link" can be built for both string and primitive types so as to integrate data variables and data display. Data can be displayed in two ways: text format and animation displays such as alarms, with green indicating normal and red indicating alarm.

3.2 Slave computer software

3.2.1 Slave computer main program design scheme

The I-7188 provides extensive library functions which include watchdog, related data sending

and receiving functions and a time clock interrupt function, etc.. In addition, it also provides many example programs. All of these make it easy and convenient to develop slave computer software and to integrate the technology with modules provided by other companies. Each serial port of the [I-7188](#) can control two smart devices that can be distinguished by their addresses. The working parameters and module addresses for the ICP [I-7000](#) series are adjustable and can be set before system installation, while working parameters and addresses for smart modules from other manufacturers have been preset and can't be changed.

Since the [I-7188](#) has a built-in DOS environment, the slave computer program can be written in TC2.0. The main program should first initialize the system, including serial port initialization and operating parameters initialization, and install the user timer interrupt. Because the interrupt interval is preset at 1ms, the data receiving and sending routines should not be used within the interrupt service function. The reason for this is that transmitting 1 byte at 9600 bps (typical of a supervision system) will take about 1ms. If the speed is too high, the data transmission will become unreliable. And typically in this case at least 2 bytes will be transmitted one time which will result in a DOS re-entry error and makes the system unreliable. Therefore, the time clock interrupt program should be as sparingly used as possible and only

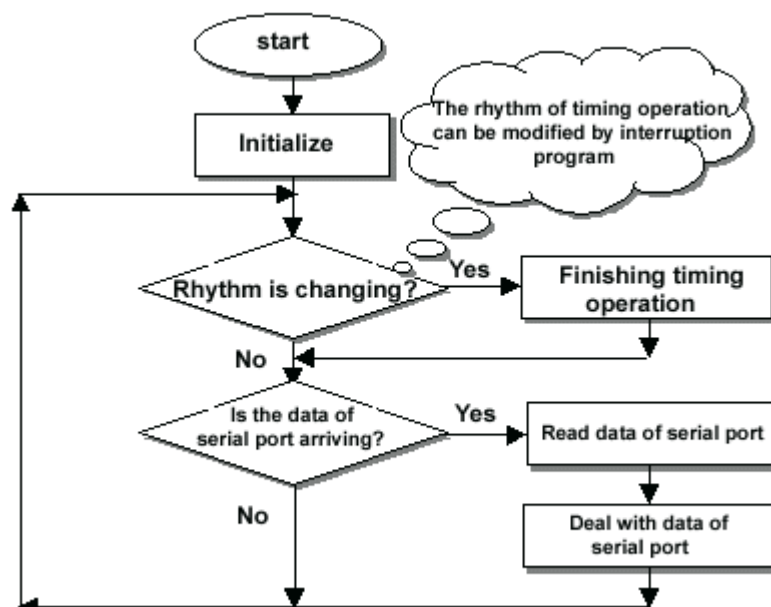


Figure 3 Slave computer main program block diagram

handle the coordination of different jobs. The main task can be implemented in the main routine. When it's time for polling, it will send an inquiry command to the smart modules or devices, and when the data is ready, the program will read data and deal with it. The software

system diagram is shown in figure 3.

3.2.2 Communication problems and solutions

Data communication reliability is most important for the computer supervising system. Industrial computer I/O devices provided by ICP can transmit data steadily and connect reliably with the [I-7188](#). However, data transmission between modules provided by other companies is not always as smooth as would be expected, and the lag time differs by the module type. Too short a time will result in data loss and too long of one may lead to system failure or mixed connections in the data exchange. The data receiving program can be found in the subroutine ReadDataDelay of program 1. After debugging many times, the delay time for the system should be greater than 0X140. If it is less than 0X130, data error rate will be about 1/4 and 1 to 2 bytes will be lost each time. The delay time between 0X130 and 0X140 is a critical value. Data sending is implemented in a subprogram shown in SendData subprogram of program 1. The first byte of data in the group is used to store the number of bytes received and following that is the data content.

```

/*****/
/*  ReadDataDelay:read data in serial port nPort and place in  */
/*      in bData , nDealy is waiting time      */
/*****/
void ReadDataDelay(int nPort, unsigned char *bData, int nDelay)
{
    int nData=0; /*received bytes*/
    int iCount=0; /*wait timing*/
    while(iCount < nDelay)
    {
        if(IsCom(nPort)==QueueIsNotEmpty) /*nPort need to transmit data*/
        {
            nData++;
            bData[nData] = ReadCom(nPort); /*read one byte of data*/
            iCount = 0; /*has data, timer is reset*/
        }
        else iCount++; /*hasn't data, wait timing*/
    }
}

```

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/*first byte of *bData data is placed the number of received bytes and other bytes are data content*/

```
    bData[0] = nData;
    ClearCom(nPort); /*clean data in serial port for the next receiving */
}

/*****/
/*  SendData : nPort is serial port number, ComData is data need to send  */
/*****/
void SendData(int nPort, unsigned char *ComData)
{
    int nlength, i;
    nlength = ComData[0];
    if(2 == nPort)    Set485DirToTransmit(nPort);
    for(i=0; i<nlength; i++)
    {
        ToCom(nPort, ComData[i+1]);
        if(2 == nPort) WaitTransmitOver(nPort);
    }
    /*Com2 is 485 port, should adjust the direction of data transmission.*/
    if(2 == nPort) Set485DirToReceive(nPort);
    return;
}
```

Program 1 Data receiving and sending

4 Comparison with Panasonic PLC system

The large-scale pump station supervising system for the Qiantang river, Zhejiang province is a national irrigation

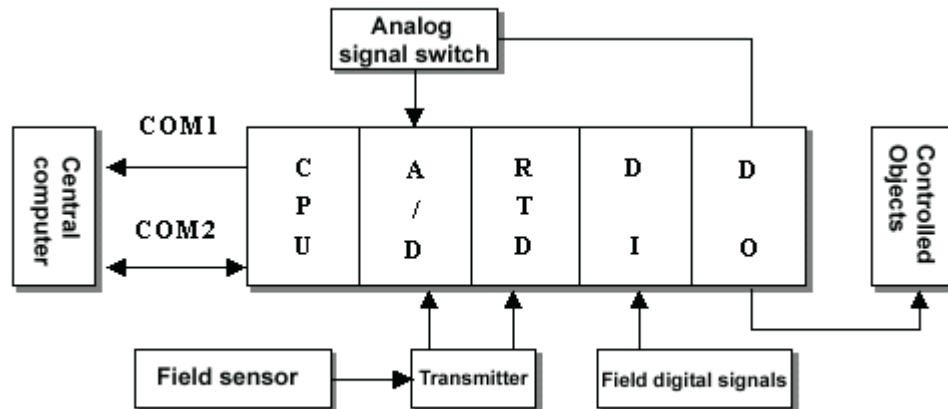


Figure 4 Panasonic PLC hardware architecture

works created using a loan from the World Bank. The central computer uses an industrial computer, and the front-end computer uses the Panasonic PLC, model FP10SH. The hardware architecture is shown in figure 4. The central computer communicates with front-end computers via two RS-232C serial ports: COM1 is used for sending interrupt signals such as real-time alarms to the central computer; COM2 is a programmable port with which the central computer can send PLC programs to the front-end computer and read/write data. In figure 4, from left to right are displayed: CPU module, A/D converter, temperature module, digital input module and digital output module.

All modules are inserted in the motherboard of the system. The main CPU module only has two RS-232 serial ports, which are so expensive that the price of the FP10SH CPU module is up to RMB10,000 in 1997. With respect to software, the central computer doesn't provide configuration software and the front-end computer software is implemented by "ladder diagram." It is difficult for developers without electrical knowledge to understand ladder diagrams. In addition, there is no sample program provided with diskette. The PLC operating system automatically scans the "ladder diagram" program repeatedly. But a problem occurred during numeral conversion. After attempts at debugging, it was found that only one piece of data can be converted during each loop of the system scan; multiple-byte conversion can not be implemented with this system. I consulted the technical support from Panasonic and gave written descriptions of this problem at the Shanghai automation technology international exhibition. But we still haven't received any of the solutions they had promised.

On the other hand, it is very easy to integrate using [I-7000](#) series modules. [I-7188](#) has four RS-232/485 serial ports and its price is about as low as RMB2000. Moreover, it can also work reliably in harsh environment; for example when its surface temperature increased to above

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50°C. The central computer program can be developed quickly and reliably with the configuration software provided by the central computer; the front-end computer software features a simple logic and watchdog resetting system which uses many library functions and example programs. In addition, the ICP technical support department provides convenient services for customers and answers many questions about programming.

5 Debugging and Conclusion

"General multifunctional computer supervising system test software" is designed especially for testing supervising systems or related smart devices through RS-232 or RS-485 (published in *Industry Automation Electronics* 1999-48). The software can be used not only as a slave computer to test supervisor programs but also as a supervisor computer to test slave computer programs, which has been verified in many supervising systems. The [I-7000](#) series modules can transmit data steadily during the debugging of the system. Supervisors provided by other company had 25 data transmission errors and the [I-7000](#) series modules had no errors when they were tested continuously for 48 hours (testing at a rate of one time per 5 seconds). There was no error during the test of the supervisor computer (configuration software) with the test software as slave computer. Now the system has passed the debugging stage in the laboratory and can operate successfully. Using the ICP configuration software and the [I-7000](#) series modules makes it possible to reduce development time and improve operations in a reliable manner. In a word, it deserves to be used extensively.

References:

- 1 Ma Yuchen and Zhao Yuehua ·Panasonic PLC Applied in Large-scale Pump Station System·Microcomputer Information , 1998 . 3 , P29~30
- 2 Ma Yuchen ·Computer Supervising System Communication Issues Solutions and Debugging·Industry Control Electronics , 1999 . 48 , P23~25