

I-7000 Series Applied in Small Hydroelectric Power Stations

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Abstract: This paper gives a brief introduction to the application of I-7000 series in the management of small hydroelectric power stations via telephone network.

Keyword: RTU, dial-up network, background

In the Jinhua Prefecture of Zhejiang province, the number of small hydroelectric power stations is more than 30, in some area it can be up to 100. During the season of low water, the power output is insufficient and electricity is supplied by power network. In the rainy season, the power output has a surplus, and electricity is supplied by hydroelectric power stations. Because too many power stations are connected to the network, it's very easy for the power energy to flow in reverse direction, resulting in the waste of energy. Therefore the management of power stations is very important. Since most of the power stations are located near rivers and mountains, and the number of I/O nodes and measurement circuits are very small, in addition, no special communication facilities are used exclusively, it's very difficult for the power supply bureau to manage these stations. Compared to the RTU used in other transformer stations, the real-time characteristics of RTU in the small hydroelectric power stations is not acceptable. Therefore we created a low-cost system based on the I-7000 series to manage the small hydroelectric power stations via dial-up network. Because this system is still in the experimental phase, only a brief introduction is put forward in this paper.

1. Introduction to the system architecture

2. System performance requirement:

a. AC sampling (1-2 channels)

Voltage input 0 - 120V, Current output 0 - 5A.

Digital output from one channel: U_a , U_b , U_c , U_o , I_a , I_b , I_c , I_n , U_{ab} , U_{bc} , U_{ac} , P ,

Q , Wh , F , $\cos \phi$

Total AC sampling conversion error: 0.5%

b. Pulse signal (2 channels)

photoelectric isolation is used for the input loop

pulse width $> 10ms$

interface electric level: 0 - (5-30V)

The data records can be hold permanently (without power supply)

c. Synchronizing port with other system

Transmission speed: 300、600、1200、2400、4800、9600 (Adjustable);

Working mode: half-duplex, full duplex

d. Digital signals (8-16 channels)

Status signal input 0 - (5 - 30V)

Resolution in the station for important event record $\leq 20\text{ms}$

e. Remote control (2 channels)

f. Remote control protocol for synchronization with other system

CDT Telecontrol Protocol issued by the Ministry of Power Industry

Protocol 1801 and other communication protocols

3. System software

1) Introduction to I-7188 software used in small hydroelectric power stations

I-7188 modules can exchange information with I-7052, I-7067 and AC sampling devices, and create a dynamic database. On the other hand, it can send data to the upper level system via dial-up telephone network..

I-7188 polls for the status change of field switch signals from I-7052 at very high frequency to ensure the resolution of the status change of the field switch signals are less than or equal to 20ms. To ensure the accuracy of the status signal of the field switches, I-7188 uses software filtering against the field switch signals to filter out the switch interference signals. I-7188 also polls for the AC sampling data periodically. If the upper level PC has downward remote control commands, I-7188 executes the commands by controlling the switches via I-7067.

When the status signal of the field switch changes, I-7188 should dial the upper level PC automatically and requires sending the switch signals. If the upper level system doesn't respond, I-7188 will try 3 times. In the case of failure, the network may be busy or there is a problem, the data will be stored for the query from the upper level machine. The modem of I-7188 will be set to automatic reply mode for the upper PC to query data.

2) Introduction to the I-7188 software for the upper level machine

There is one dial-up port, one network port for connection with other system, and one background monitoring port.

I-7188 queries for the data of small hydroelectric power stations actively and receives SOE data from the hydroelectric power stations passively. These data are exchanged with other systems or background processes via Protocol 1801 and other communication

protocols.

3) Introduction to the background monitoring

IPC is used for background monitoring. It has the following functions:

Analog signal processing includes measurement and calculation of power (active, reactive, apparent power, power factor), measurement of voltage and current. Analog processing also includes signal anti-interference, digital filtering, error compensation, data validity judgment, scale conversion, out-of-range alarm processing, etc.

The acquisition and processing of status information indicate the accident/malfunction, position signal of breaker and isolator switch, action signal of replay protection etc. The acquisition of this information is via fast polling method. The signal processing also includes photoelectric isolation, anti-dithering processing for the contact points, hardware and software filtering, base time compensation, data validity judgment, etc., and the necessary response and action or enabling the related processing utilities (i. e., enable the event log, issue accident alarming, automatic screen pop up etc.).

The acquisition and processing for accumulated pulse value can be frozen, read and unfrozen at fixed time interval (1 minute, 5 minutes, 10 minutes or at specified interval). The acquisition and processing of pulse information includes data validity and rationality judgment, scale conversion, error detect and correction, processing for the overflow of the accumulated value etc. During the processing of pulse information, no other functions should be affected.

Background monitoring modules were written in Visual Basic 6.0. It has all the functions of the system. The details are as follows:

Main wiring graph: displays the wiring graph of primary equipment of the station and the related enumerating graph. It shows the actual state of the breakers and switches, the flow direction, and the main electrical information (active, reactive, current, voltage). Users can perform remote control via this graph, includes the choice of remote control devices and the execution. Before any commands are executed, the system requires the user to input the correct password. After the commands are sent out, it requires a response from the remote site. If the command is not executed successfully within the specified time interval, the remote command is canceled and an alert message will pop up.

Bar graph: displays the running voltage curve and frequency curve of each station.

Real-time information: displays the real time remote analog data, real time digital data and pulse data of the station, including equipment type, name, measurement point name, the analog value, switch status, times of action, times of switch jump, impulse electrical degree value.

Database interface: maintains all the databases in the system, including data query,

addition, modification and deletion.

System commands: the user can set the operation mode and the password for the operator to prevent the user from performing operations that exceeds the user's privilege, or operations made by mistake. The user can also set the system clock, the alarming message. In the case of important operation or accident, the system can make voice alert to notice the operator to handle the situation accordingly. It can also dial the phone number as required by the system. In addition, the user can setup the printers to print the related information (based on the specified time or on-demand).

4. Some issues that need to pay attention to during programming:

- 1) The high speed polling of I-7188 to query data from the change-of-status signals of the I-7052 should not be interrupted by dialing of the mode, which is essential to ensure the resolution of data acquisition is not less than 20ms. Therefore the dialing process should only be implemented by an interrupt routine.
- 2) If the dial port is busy for a long time, it should be forced to quit to ensure smooth of dial-up network.
- 3) Because the dial-up network exchanges data at very high speed, it is very important to implement a complete verification facility.