Design of Communication Function Test System for Intelligent Low Voltage Electrical Apparatus Based on LabVIEW and Modbus RTU Protocol

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ABSTRACT

On the brief introduction of the characteristics of Modbus RTU communication protocol commonly used in intelligent low voltage electrical apparatus and analyze test requirements of intelligent low voltage electrical apparatus communication function, a design of communication function test system based on LabVIEW and Modbus RTU protocol for intelligent low voltage electrical apparatus is introduced. The system hardware is made up of industrial computer and RS232 / RS485 converter. Introduces in detail the The design and realization of read, write and CRC check software for Modbus RTU protocol communication based on LabVIEW virtual instrument technology development platform is discussed in detail. Practical application results shows that the test system could conduct a comprehensive, safe, reliable detection for intelligent low voltage apparatus communication function, have the advantages of strong anti-interference ability and low cost.

INTRODUCTION

With the rapid development of 3C technology represented as computer, communication and control technology and the automation of power industry, the new requirements of the connotation for the intelligent electrical apparatus is put forward by people, who hope the intelligent electrical apparatus can be connected into a network, to realize the functions of remote control, remote diagnosis, fault remote recovery and remote data collection. Communication-capable has become one of the main technical characteristics of intelligent low voltage electrical products[1,2]. A number of intelligent low voltage electrical apparatus with communication interface can be connected to form a network of intelligent power distribution system by the different field bus of Modbus, Profibus or DeviceNet.
Intelligent low voltage electrical apparatus communication function is directly related to the safety, stable and reliable operation of low voltage distribution and control system, so communication function test is a key of intelligent low voltage electrical apparatus function detection[3,4]. In order to realize the communication function test for intelligent low voltage electrical products, which is called "four remote" function (remote control, remote communication, remote measurement, remote adjustment), the design and realization of the highly reliable communication software by LabVIEW virtual instrument software platform based on the Modbus RTU communication protocol commonly used in intelligent low voltage electrical apparatus communication, to realize the communication between the testing equipment and the tested products is introduced in this paper.

**CONTENT OF INTELLIGENT LOW VOLTAGE ELECTRICAL APPARATUS COMMUNICATION FUNCTION TESTING**

Intelligent low voltage electrical apparatus communication function detection is equal to the detection of "four remote" function, so the following 4 main test content should be included in the communication function detection for intelligent low voltage electrical apparatus.

1. Remote adjustment: The upper computer sends remote setting parameters command (such as open phase protection operating parameters, overload protection operating parameters, etc.), intelligent low-voltage electrical apparatus can change corresponding operating parameters in accordance with the requirements, in order to realize the PC remote to adjust power distribution circuit parameters Settings.

2. Remote measurement: The upper computer could read the real-time working parameters and all kinds of fault parameters submitted by the intelligent low voltage electrical apparatus such as the applied voltage and the main circuit current of the intelligent low voltage electrical apparatus, etc.

3. Remote control: When the upper computer send control information (such as breaking, switching signal of relay, contactor, etc.) intelligent low-voltage electrical appliances can execute correctly.

4. Remote communication: The upper computer could correctly read the information of intelligent low voltage electrical apparatus, such as products information, fault information, starting times, running time and open/close state.

**SYSTEM DESIGN**

Intelligent low voltage electrical apparatus communication function test system is mainly composed of two parts of hardware and software. Communication function testing hardware part is relatively simple; only need a computer and a communication conversion interface. The IPC610 industrial computer with the ability to work continuously for a long time and strong anti-interference ability is chosen as the upper computer, which can better guarantee the safety, stable and accuracy for intelligent low voltage electrical apparatus communication function test. The RS232/485 Communication converter is used as the communication conversion interface. The RS485 serial port with the advantage of good anti-noise jamming, long transmission distance and more standing ability is generally chosen as the communication interface of intelligent low voltage electrical apparatus, but the computer's serial port is generally for RS232 serial port, so the RS232/485
communication converter is used to realize the communication between the intelligent low voltage apparatus and the computer. The intelligent low voltage electrical apparatus communication function test system structure is shown in Figure 1. The IPC is the main equipment of the communication detection system, and the slave equipment is the measured low voltage electrical apparatus product. Communication function testing software is realized by currently the most successful and most widely used software development platform LabVIEW 7.

**REALIZATION OF THE COMMUNICATION SOFTWARE**

Intelligent low-voltage electrical communication function detection is mainly through the serial port to receive and send data, which could determine the quality of its communication function. Therefore, the realization of communication function detection involves the main program of serial initialization, read and write data, CRC check and serial port close. Read and write data, CRC check program is the key. The writing data is involved in read data process, so the implementation of the read data and the CRC check program is mainly introduced as follows.

**Design of Data Read Software**

Before reading data, set the serial port number, baud rate, number of data bits, stop bits, parity, data flow control and other parameters according to the requirements. When reading the data, it is necessary to find out the starting address of the data and the amount of data to be read clearly. At the same time, also need to check the CRC code. The master request message format of data read is shown in Table 2. If the master station request is correct, the slave station will respond. The slave response message format of data read is shown in table 3. The communication data read block diagram is shown in Figure 2.

<table>
<thead>
<tr>
<th>Slave address</th>
<th>Function code</th>
<th>Start address</th>
<th>Data</th>
<th>CRC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1Byte</td>
<td>1Byte</td>
<td>MSB LSB</td>
<td>MSB LSB</td>
<td>LSB MSB</td>
</tr>
</tbody>
</table>

Note: MSB indicates the high byte of the double byte; LSB indicates the low byte of the double byte.
Realization of the CRC Check Software

As the communication bus there will always be some interference, information in the transmission process may be wrong, which will result in the loss of information. Therefore, when using Modbus RTU mode to read and write data, it is necessary to use CRC (cyclic redundancy check) check code to check whether the received information frame is correct, in order to prevent the wrong communication process from happening, to ensure the safe, accurate and reliable communication. CRC check code is a 16-bit binary value, divided into high and low two bytes. It is calculated by the sending device and then added to the message. After receiving the message, the receiving device recalculates the CRC code and compares it with the CRC code in the received message. If they are the same, the received message is correct. On the contrary, that is not correct. Only 8 data bits, start bit, stop bit and parity bit are used in CRC calculation. The generation flow of the CRC check code is shown in Figure 3. The CRC check block diagram is shown in Figure 4.

![Figure 3. The generation flow of the CRC check code.](image)

![Figure 4. The CRC check block diagram.](image)

APPLICATION EXAMPLE

The communication function test technology researched in this paper has been applied in CPS measurement function test. Regulate the CPS main circuit current to the rated current, read the actual measurement current Ia, Ib, Ic on the LCD screen of the measured CPS by communication, and compare with the set current to determine the CPS measurement function is qualified. The front panel of CPS measurement function test is shown in Figure 5.

The communication parameter for reading CPS real-time measurement values is shown in Table 4.

<table>
<thead>
<tr>
<th>Data address</th>
<th>Number of registers</th>
<th>Rules</th>
<th>Unit</th>
<th>Format</th>
<th>Range</th>
<th>Directions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1205H</td>
<td>1</td>
<td>read</td>
<td>0.01A</td>
<td>UINT</td>
<td>0-65535</td>
<td>Current of phase A</td>
</tr>
<tr>
<td>1206H</td>
<td>1</td>
<td>read</td>
<td>0.01A</td>
<td>UINT</td>
<td>0-65535</td>
<td>Current of phase B</td>
</tr>
<tr>
<td>1207H</td>
<td>1</td>
<td>read</td>
<td>0.01A</td>
<td>UINT</td>
<td>0-65535</td>
<td>Current of phase C</td>
</tr>
</tbody>
</table>
According to the factory setting of CPS, under the Modbus RTU communication protocol mode the read data communication function code is 03H. Regulate the CPS main circuit current to 12A, the read data is shown in Table 5.

Table 5. The read data.

<table>
<thead>
<tr>
<th>Slave address</th>
<th>Function code</th>
<th>Number of bytes</th>
<th>Data 1</th>
<th>Data 2</th>
<th>Data 3</th>
<th>CRC</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>03H E0</td>
<td>3</td>
<td>MSB</td>
<td>MSB</td>
<td>MSB</td>
<td>LSB</td>
</tr>
<tr>
<td>1</td>
<td>03H E0</td>
<td>3</td>
<td>4 B3</td>
<td>4 AE</td>
<td>4 BC</td>
<td>Calculated</td>
</tr>
</tbody>
</table>

According to the read data, the actual current value can be calculated as follows:

\[ I_a = \text{Data 1 (convert to decimal)} \times 0.01 \text{(A)} \]  
\[ I_a = 1203 \times 0.01 = 12.03 \text{(A)} \]  
\[ I_b = \text{Data 2 (convert to decimal)} \times 0.01 \text{(A)} \]  
\[ I_b = 1198 \times 0.01 = 11.98 \text{(A)} \]  
\[ I_c = \text{Data 3 (convert to decimal)} \times 0.01 \text{(A)} \]  
\[ I_c = 1212 \times 0.01 = 12.12 \text{(A)} \]  

![Figure 5. The front panel of CPS measurement function test.](image)

CONCLUSION

The communication function test system for intelligent low voltage electrical apparatus based on LabVIEW and Modbus RTU protocol discussed in this paper has been put into use in related producer. Practical application results shows that the test system could conduct a comprehensive, safe, reliable detection for intelligent low voltage apparatus communication function, have the advantages of strong anti-interference ability and low cost.

ACKNOWLEDGEMENTS

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REFERENCES


[5] International Conference on Computer, Mechatronics, Control and Electronic Engineering,