

Study on the Distribution Automation System Terminal Automatic Test Method

Peng Li, Yimin Qian and Wei Li

Abstract With the widespread use of DAS, higher requirements for distribution automation terminal on-site testing have been put forward on account of limitations of field working conditions. Based on the requirement of relevant standards, this paper discusses automatic testing exploratory research, by analyzing the principal experimental objects and information transmission mode of the distribution automation terminal, which adopts IEC-60870-5-104 protocol. On this basis, this paper brings forward a set of feasible distribution automation terminal test method based on automatic information acquisition and predefined rules, by scheme design, process design, and building test environment. Finally, based on the test environment which divides into online and offline modes, the relevant automatic testing system has been studied and applied, achieves a fully automated power distribution terminal test process, and improves the efficiency of this test to ensure safe and stable running of power distribution automation terminal.

Keywords Distribution automation system (DAS) · Remote terminal unit of distribution automation · Automatic test · 104 protocol

1 Introduction

With the widespread use of distribution automation system (DAS) in China, higher requirements for detecting DAS have been put forward. Terminal unit is an important part of DAS [1]. Taking into account the working environment of distribution terminals, the power performance requirements of distribution terminal is more stringent than main station of DAS [2, 3]. The distribution automation terminal which accesses to DAS must be safe, stable, and reliable in order to meet the need of safe and stable operation of the power system. Because of limitations of field working conditions, the installation, debugging, and testing of distribution

P. Li · Y. Qian (✉) · W. Li
State Grid Hubei Electric Power Research Institute, Wuhan, China
e-mail: 61893790@qq.com

automation terminal must be completed in a short time, which puts forward higher demand to the efficiency of the distribution terminal test [4–6]. This paper studies the main test objects of distribution automation terminal and information transmission mode, puts forward a set of feasible automatically test method of distribution automation terminal to improve test efficiency, accurately and quickly complete the terminal device test, and ensure the safe and stable operation of distribution network terminal.

2 The Main Test Object and Information Transmission Mode

Study of distribution automation terminal test first needs to determine the main test object and information transmission mode. The test objects include several aspects of the response time, the measuring accuracy, the switching input and output, which directly affect performance. In addition, the information transmission mode of distribution automation terminal is selected 104 protocol for communications statute.

2.1 Overview of Test Objects

According to several aspects of the response time, measuring accuracy, switching input and output, this paper brings forward the test objects of distribution automation terminal.

2.1.1 Response Time

The main testing objects of response time include the telemetry response time, the response time of remote communication, and the response time of remote control.

2.1.2 Measuring Accuracy

The measuring accuracy involves the current and voltage basic error, the reactive and active power basic error, the power factor basic error, and the basic error of harmonic component.

2.1.3 Switching Input and Output

The switching input involves the remote communication change, the SOE resolution, the remote communication storm, and the avalanche situation. On the other hand, the switching output involves the action accuracy of switching action signal.

2.2 Information Transmission Mode

In DAS, data communication between terminal and master station of DAS is used by communication network. And the main communication protocol of the communication network adopts IEC60870-5-104.

All information interactive contents between distribution automation terminal and master station use the standard 104 protocol to encode data. Therefore, it can be considered that any 104 packets between the distribution automation terminal and the master station contain the main information of transmission, such as telemetry values, remote status and remote control commands, and so on.

2.2.1 Introduction of IEC60870-5-104

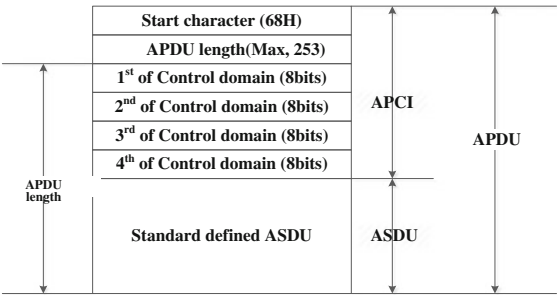
IEC60870-5-104 standard protocol applies to telecontrol equipment and systems with data transmission of serial bits encoding to monitor and control geographic wide process. Specific packet information of the 104 protocol is defined by the application protocol data unit (APDU), which includes the application protocol control information (APCI) and application service data unit (ASDU), as shown in Fig. 1.

The APCI defines the data stream starting point, length, and control information of APDU (such as packets no missing, no repeat, the transmission start/stop transmission connection monitoring, etc.). The ASDU consists of information unit and data unit identifier. Data unit identifier specifies the data type, ASDU length (optional), variable structure qualifier (optional), and ASDU public address (optional). Information unit is the main information carrier of information communication, provides information unit type, address, element set, and the time-scale.

2.2.2 The 104 Message Parsing of Distribution Automation Terminal

Data communication packet of distribution automation terminal contains its main information with collection and receiving. And it is parsed to get critical data of

Fig. 1 Definition of APDU in companion standard for telecontrol



distribution automation terminal. For the use of 104 protocol, the transmission packet parsing focuses on the APDU. The APDU structure itself must meet the standard requirements, so it can easily use to describe the standard design of the corresponding parsing rules (Fig. 2).

3 Distribution Automation Terminal Automatic Test Method Design

3.1 Design of Testing Scheme

According to main test contents and information transmission mode of the distribution automation terminal, an automatic testing method is designed based on the automatic information acquisition and predefined rules. According to tested distribution automation terminal type, this scheme predefines test cases and evaluation rules. In an automatic test, test system directly injects testing energizing quantity to tested distribution automation terminal based on predefined test case. Meanwhile, the testing system obtains real-time response of distribution terminal. And test data is obtained from the 104 packet parsing module and computationally analyzed. Then this test system completes specified test project according to the test cases. After the test project is completed, the testing system forms a report according to test results and predefined evaluation rules. In this method, besides test cases and evaluation rules with artificial selection, all test procedures are done automatically.

Depending on whether the distribution automation terminal communicates with the main station by real-time data, automatic test process can be divided into online and offline modes. In online automatic test pattern, distribution automation terminals communicate with master station of DAS. The terminal test platform simulates the actual amount of electrical excitation to the distribution terminal, and acquires real-time response of distribution automation terminal through a network communication device with mirroring function, and completes the scheduled testing and evaluation of the project. In offline automatic test pattern, distribution automation terminal directly communicates with master station by disconnecting data to establish communication test platform. The terminal test platform simulates the actual amount of electrical excitation to the distribution terminal, and directly acquires real-time response of distribution automation terminal through network communication, and completes the scheduled testing and evaluation of the project.

3.2 Design of Testing Process

According to the design features of testing scheme, automatic testing process of distribution automation terminal is shown in Fig. 3. Among them, the test

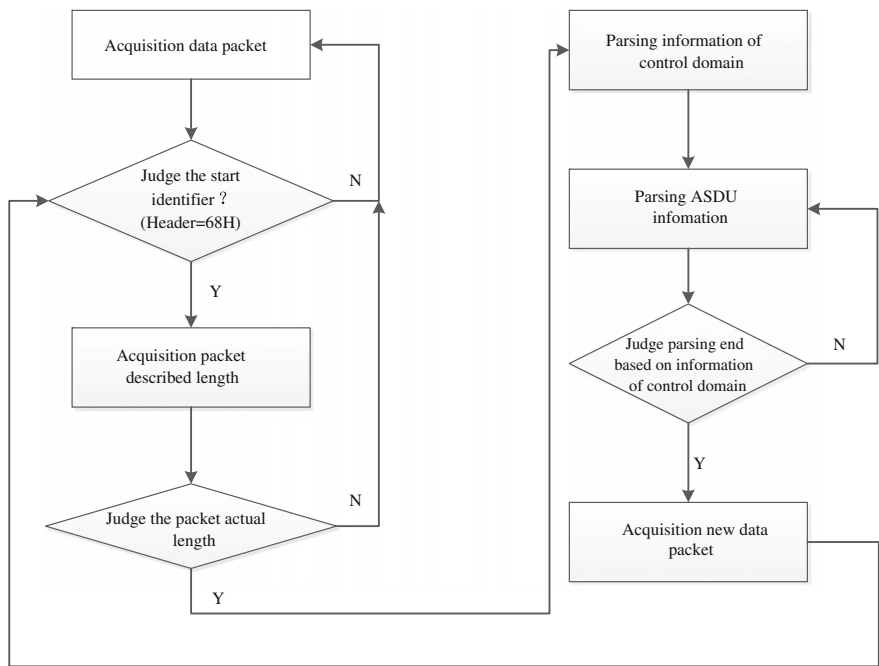


Fig. 2 Communication data parsing rule of distribution automation terminal based on 104 protocol

configuration section needs to manually complete the basic test parameters (such as the tested distribution automation terminal type and specification, rated electrical quantities, communication parameters, etc.), test cases and evaluation rules configuration. Automatic test section itemizes automatic testing and calculations based on the configuration information. After all project specified by the test case is completed, the test system automatically completes evaluation and generates test reports.

3.3 Construction of Testing Condition

According to the test methods and test process design, testing system consists test console and test interface worktable. Among them, the test console completes several capabilities, including the basic configuration, testing project control, test results evaluation, and test report generation. The test interface performs two functions, including receiving test console control instructions and encouragement amount according to the control command of distribution automation terminal. Online and offline test environment of automatic test pattern are shown in Figs. 4 and 5.

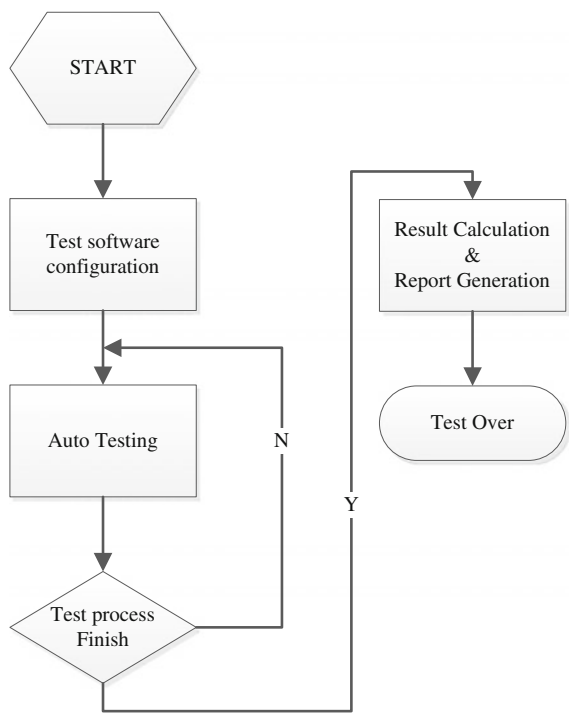


Fig. 3 Automatic test flow chat of distribution automation terminal

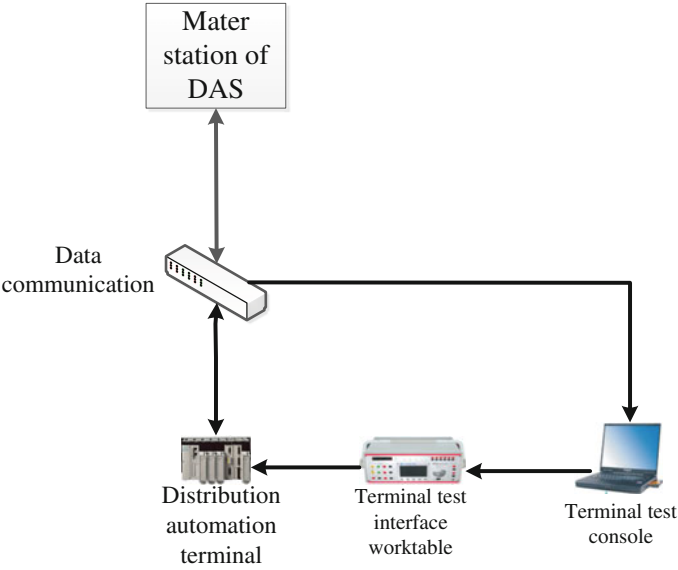
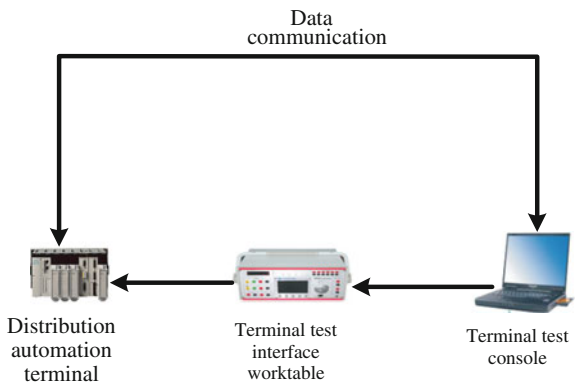


Fig. 4 Automatic online test pattern of distribution automation terminal

Fig. 5 Automatic offline test pattern of distribution automation terminal



4 Research of Automation Testing System

According to the design ideas of distribution terminal automatic testing methods, a power distribution terminal automated test system based on information extraction can be designed and developed, which is shown in Fig. 6. The test system consists of three parts, Terminal Information Collector, Terminal Test Console, and Terminal Test Interface Worktable.

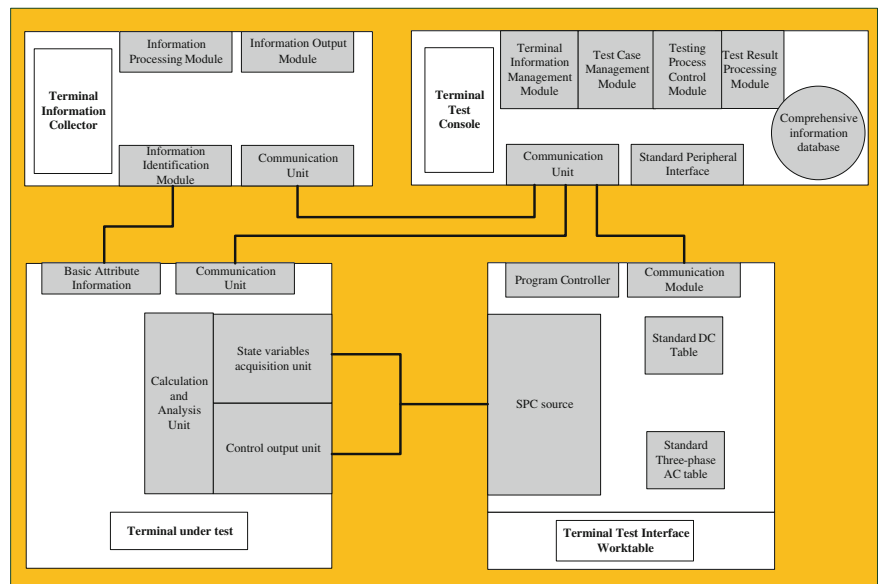


Fig. 6 Power distribution terminal automated test system based on information extraction

4.1 Terminal Information Collector

Terminal Information Collector is used to automatically identify the basic attribute information of terminal under test, and complete the data collection, form a standard format to provide to Terminal Test Console.

4.2 Terminal Test Console

According to the basic attribute information terminal, Terminal Test Console finish test case matching, matching methods including standard cases and custom cases. After completion of test case configuration, console form control instruction according to the control rules, automatically implement test content, and complete the collection, calculation, analysis, and evaluation of test results. Terminal basic attribute information, test cases, test results, and the test evaluation are automatically saved in the test console database, and can be automatically exported in the form of general external interface and data format.

4.3 Terminal Test Interface Worktable

Test Interface Worktable receives control signals from Terminal Test Console, which is converted into real-time identifiable test excitation signal. The signal is automatically injected to the measured power distribution terminal. In the meantime, Test Interface Worktable automatically collected the response signal from terminal according to test cases, and automatically transferred to Terminal Test Console.

5 Conclusion

According to the detailed analysis of the main test contents and information transmission mode of distribution automation terminal, this paper studies the feasibility of distribution terminal automatic testing methods, and process design of distribution automation terminal is designed. Additionally, the establishment of test environment about two automatic test mode is completed. At last, automatic test method of distribution automation terminal designed in this paper can effectively improve test efficiency, accurately and quickly completes the test terminal device, to ensure safe and stable running of power distribution automation terminal, with a high application value.

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