

The Airfield Lights Addressing and Controlling System Design Based on PON Communication Technology

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Traditional airfield lights addressing and controlling system is realized through power carrier communication technology, and is characterized by low transmission efficiency, inaccurate testing and poor unsatisfying reliability. This paper introduces an airfield lights addressing and controlling system design based on PON communication which effectively solves the problems of traditional airfield lights addressing and controlling system.

Keywords: PON Communication Technology; Power Line Communication; Addressing and Control.

1. Introduction

Airfield lights addressing and controlling system refers to airfield lights detection system which plays an important role in guaranteeing the proper operation of the airport [1]. It is visual aids for navigation of aircraft taking-off, landing and taxing at night or in complex weather conditions. With the rise of airport volume of business and the consistent expansion of airport scale, the existing airfield lights detection system based on power line communication technology can hardly meet the operation demand of the airport [2].

This paper illustrates the development of airfield lights detection system based on PON communication technology, taking the place of traditional power carrier communication technology.

2. The Structure Design of the System

The system introduced in this paper adopts the distributing work pattern of centralized computer control and distributive data collection, and communication method with optical fiber PON structure. The system structure is shown in Figure 1.

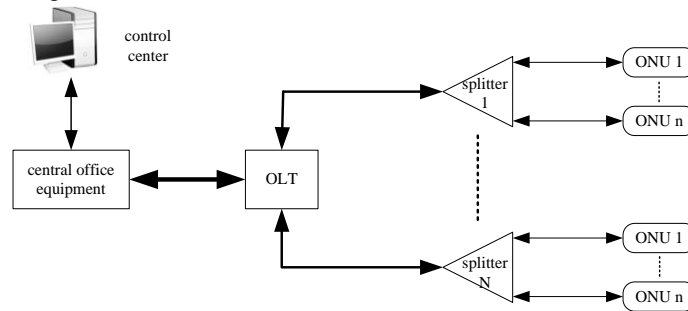


Fig. 1 System structure

PON structure mainly consists of 3 parts: OLT, optical splitter, and ONU.

Remote-controlled computer is connected to OLT of PON communication through network equipment. Major optical fiber connects OLT and splitters, and branch fibers connect splitters and ONU, realizing the network communication function of the entire system [3].

3. Addressing Function Design

To realize data-collection terminal addressing access through IP address, PON communication system needs to implant a PON communication-supporting module. The design introduced in this paper adopts EPON module to realize the communication access function [4] [5].

3.1. Problem

When EPON module is implanted to the data collection terminal, OLT of PON cannot realize addressing access. After analysis, it is found that the access failure is caused by the mismatch of communication rate of EPON module with that of data collection terminal. How to solve the problem?

3.2. Solution

To solve the problem of communication rate mismatch, the data collection terminal should be technologically modified. MCU of data collection terminal

remains unchanged. Replace PHY chip with switch chip [6], realizing the transfer of communication rate from 100M to 1000M. Switch chip is then connected to EPON module. In this way, system remote addressing function is realized. Perfect solution to the problem of mismatch of communication rate is provided, see Figure 2.

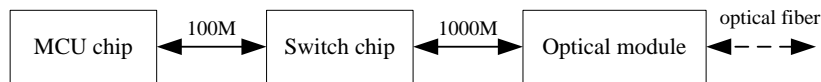


Fig. 2 Terminal hardware connection diagram

4. Design of Controlling Function

This function requires the remote computer to send control order to system data collection terminal and data collection terminal to act in time accordingly and to provide feedback, i.e. the result of the action, to the remote computer. When communication remains normal, connect the controlling pin of MCU of the system data collection terminal to the drive circuit of the load relay so that drive circuit is connected to controlling coil while relay contact is in parallel connection with airfield lights. When MCU responds to controlling order, controller will output from the controlling pin controlling signal which enables drive circuit conduction, drive electric relay coil thereupon, and then control the relay to turn or break off, realizing eventually the on-and-off operation of data collection terminal of the entire system [7]. The schematic diagram of data collection terminal control is shown in Figure 3.

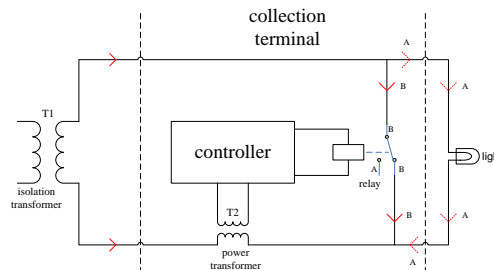


Fig. 3 Schematic diagram of data collection terminal control

5. Test Results

Testing system consists of 100 set airfield lights, 100 data collection terminals, 1 OLT equipment, 1 optical splitter, 1 server, and 1 remote-controlling computer, all of which set up a testing environment for airfield lights detection system based on PON communication technology, as is shown in Figure 4. In order to

test accurately the performance index of the airfield lights detection system based on PON communication technology, a series of tests are conducted regarding the accuracy of system dressing, reliability of control, response sensitivity and so on.

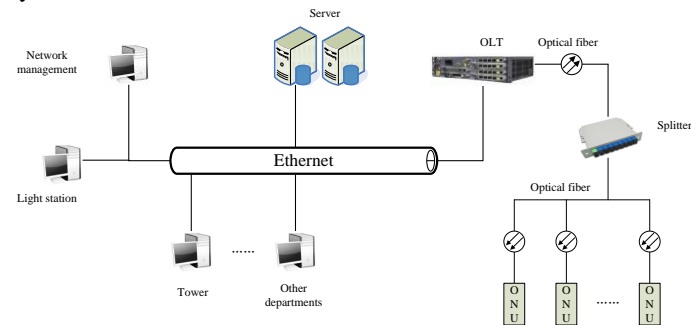


Fig. 4 Diagram of airfield lights detection environment system based on PON communication technology

5.1. Accuracy rate of addressing

5.1.1. Test content

Addressing access accuracy rate test is conducted as follows: firstly, label the 100 data collection terminals as 1-100, and set up IP address for each of them according to their labels; secondly, send PING order subsequently to the 100 data collection terminals using remote-controlling computer to testify whether the equipment is properly connected to the network; thirdly, when the computer PING orders successfully get through, data collection terminals send local IP address to the testing computer through the port.

5.1.2. Criterion

- 1) Has remote-controlling computer successfully sent PING to the IP addresses of the 100 data collection terminals labeled from 1 to 100?
- 2) Does the IP address output by the terminal identify with its label when remote-controlling computer successfully has sent PING to the IP address?

5.1.3. Test results

- 1) The addressing access accuracy rate of the 100 data collection terminals for a single test is shown in Figure 5.

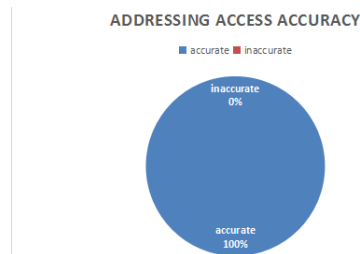


Fig. 5 Addressing access accuracy rate for single test

2) When test 1 is repeated 10 times, the results is as table 1 below.

Tab. 1 Addressing access accuracy rate for multiple tests

Serial number	All terminals PING successfully?	All terminals output correct IP address?
1	Yes	Yes
2	Yes	Yes
3	Yes	Yes
4	Yes	Yes
5	Yes	Yes
6	Yes	Yes
7	Yes	Yes
8	Yes	Yes
9	Yes	Yes
10	Yes	Yes

5.1.4. Test conclusion

Table 1 indicates considerably high addressing access accuracy rate of this system.

5.2. Single light control and response time

5.2.1. Test content

Response period: 1) remote computer sends single light controlling order; 2) data collection terminal responds to the processing order and complete turn-on and turn-off; 3) data collection terminal upload processing result of the received order.

Record the above response period after 10 tests.

5.2.2. Test results

1) With single test, the single light control response time of 100 lights is seen in Figure 6.

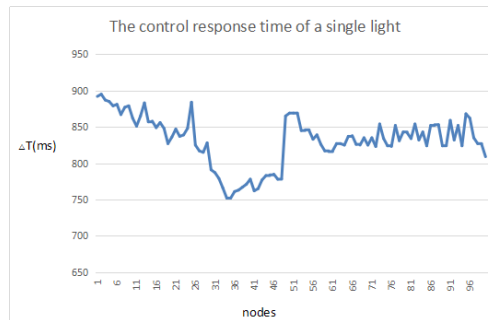


Fig. 6 Single light control response time diagram

The average response time of the system is 831ms, according to the test above.

2) After 10 tests, the single light control response time of 100 lights is as Table 2.

Tab. 2 Single light control response time after multiple tests

Test serial No.	Average response time(ms)	power line system response time(s)
1	827	<3
2	839	<3
3	820	<3
4	843	<3
5	807	<3
6	823	<3
7	815	<3
8	811	<3
9	798	<3
10	805	<3

It is concluded from Table 2 that the average response time for the airfield lights addressing and controlling system design based on PON communication technology is less than 1s, far superior to the existing power line system.

5.2.3. Test conclusion

The above tests indicate that the average single light control response time of the system introduced in this paper is less than 1s, far superior to that of the traditional system, verifying the high real-time rate.

5.3. Multiple lights control reliability

5.3.1. Test content

Multiple lights control reliability tests are conducted as follows: 10 groups of variety number of data collection terminals are chosen randomly from the 100 data collection terminals for the test. The number of data collection terminals is respectively as follows: 9, 21, 30, 41, 50, 59, and 100. The groups of lights are turned on and off to test multiple lights control reliability.

5.3.2. Criterion

Has multiple lights control been completed as is demanded?

5.3.3. Test results

The multiple lights control reliability of 10 groups of various number of data collection terminals after single test is seen in Table 3.

Tab. 3 Multiple lights control reliability

Test group No.	Number of test lights	Order completed as demanded?
1	9	YES
2	21	YES
3	30	YES
4	41	YES
5	50	YES
6	59	YES
7	69	YES
8	81	YES
9	90	YES
10	100	YES

5.3.4. Test conclusion

The tests above indicate that the system has successfully performed what is demanded, verifying the high reliability of multiple lights control.

Based on the analysis of the tests results of this system, it is safe to concluded that the airfield lights addressing and controlling system design based on PON communication technology can solve the problem of the traditional system as low accuracy rate, retarded real feature and low reliability, and improve the system reliability, real-time and accuracy.

6. Conclusion

This paper has successfully verified that the airfield lights addressing and controlling system based on PON communication technology introduced here can effectively solve the problems of traditional system based on power carrier communication technology such as low transmission efficiency, low detection accuracy rate and low reliability. It is also proved that the airfield lights addressing and controlling system design based on PON communication technology is featured by high real-time and low disruption with the communication circuit.

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