

Application of Computer Control System in Ground Lightning Protection

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Abstract: Computer control system has the advantage of fast and efficient, which can be applied to the ground lightning protection to greatly improve the anti-lightning effect. This paper studies the application of computer control system in ground lightning protection. The principle of the application and the application system diagram are provided. The application effect of the computer control system is discussed by experiments. The experimental results show that the application of computer control system into the ground lightning protection may achieve long-range control, and it may have better control efficiency, which is worthy to promote the application.

Keywords: computer system; control system; ground lightning protection; application research

1. Introduction

Due to the presence of a large number of atmospheric water droplets, ice crystals and gas dust in thunderclouds, and due to the continuous movement in the air flow, a huge opaque clouds will be formed, which is black and has a lot of charges. Thunderclouds will continuously accumulate in the sky, and then lead to lightning, thunder and other phenomena, which is called thunderstorm by people. Thunderstorms include frontal thunderstorms and thermal thunderstorms, which threaten the safety of human life. Frontal thunderstorms can occur anywhere. While thermal thunderstorms occur more often in mountainous zones, and based on the charge-absorbing effect, the freezing effect of water droplets and the effect of water droplet rupture these three theories it can be found that the cumulonimbus cloud can produce a large number of charges at high altitude. Cumulonimbus cloud contains uneven distribution charges, forming many charge centers. In contact with the earth there will be induced by a variety of charges of different polarity, thus thunderclouds and the earth will produce huge field strength. Once the field strength reaches 25-30kV/cm, there will be discharge lead to the ground by the thunderclouds (in rare cases, there will be discharge upward)^[1]. When the pilot arrives on the ground or meets the ground pilot, a lightning strike occurs due to a strong discharge generated by charge neutralization. It usually happens that the discharge is repeated several times, but the current generated for the first time is the largest, and the current generated thereafter continues to decrease until it disappears^[2].

Computer control system, referred to as CCS, can use the computer to control a variety of auxiliary software to achieve a certain purpose. The hardware facilities of computer control system include: word computer, input and output interfaces, detection devices and actuators, etc., connection methods including wired connection and wireless connection. The introduction of computer control system in ground lightning protection can greatly improve the lightning protection effect. Therefore, this paper studies the application of computer control system in ground lightning protection, and verifies the effectiveness of the computer control system through experiments^[3].

2. Application Composition of Computer Control System in Ground Lightning Protection

The electric field strength inside the cloud is weak, but the electric field strength of the cloud to the ground is very strong. When it reaches the ground and the electric field reaches the maximum, it will discharge. The highest point is a certain critical value. Most of the discharge occurs inside and between the clouds^[4]. Based on the principle of electrostatic induction efficiency, great field strength appears in the clouds and forms huge lightning impulse voltage wave, as shown in Figure 1:

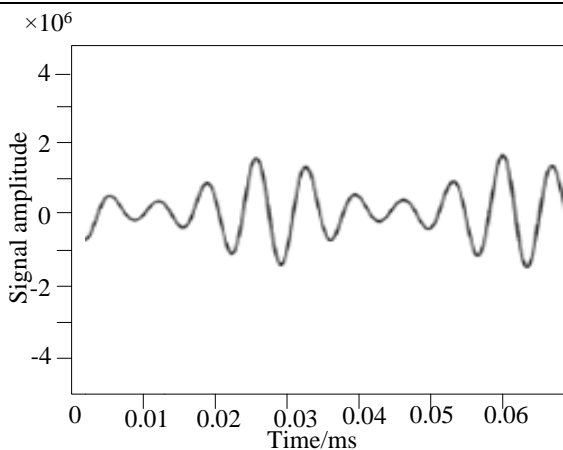


Figure 1. Lightning impulse voltage waveform

Analysis of Figure 1 shows that the main parameters of lightning impulse include A and B point before wave, as well as the C and D point after wave. The lightning impulse point before wave is at 30% of the peak voltage, the lightning impulse point after wave is at 90% of the peak voltage and the impact time is T. Observing the graph it can be known that the first time the current generated before wave may damage the ground objects the most and the strongest.

Computer control system simulates lightning impulse to carry out certain lightning protection measures; the system structure is shown in Figure 2 below:

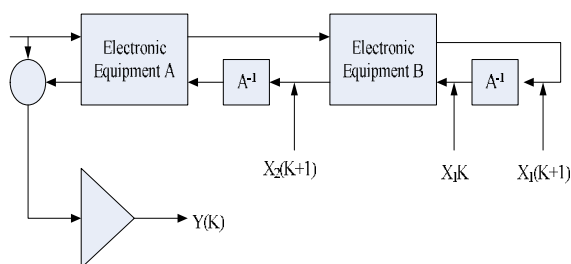


Figure 2. Control system of ground lightning protection

Through the power lines and signal lines, the point and signal at the same position will be introduced into the protected space LPZ1 zone, and set LPZOA zone and LPZ1 zone. Select the line into the room ground and make an allelic connection in the potential connection, then make a shield zone at LPZ1 zone and LPZ2 zone for equipotential bonding. Connect the shield 1 outside the building to the equipotential bonding strip 1 and the inner shield 2 to the equipotential bonding strip 2^[5]. Therefore the formed LPZ2 may prevent lightning current passing into the space, so as to achieve the purpose of control. The wireless connection guides the analog signal, and the connection methods are the infrared connection, the mi-

crowave connection, the radio wave connection, the light wave connection and so on^[6].

The devices connected to the lightning protection by computer system include: lightning receiving devices, downline, ground wire, grounding (pole), grounding grid and grounding resistance. By increasing the cross-sectional zone of cable connected by anode, lightning protection and grounding measures may meet the requirements. Computer control system can not only prevent indoor thunderstorm, but also can effectively prevent outdoor thunderstorm. Alarm system is set up on top of hills, ridges or buildings; once someone approached it will sound to remind the attention of people passing by. Feedback signal will be passed to the implementing agencies, and then passed to model converter by the digital converter. The computer control system divides lightning thunders into lightning protection zones, thunderstorms days, thunderstorms activity zones and ground lightning density. Lightning protection zones are vulnerable to get lightning strikes to access into protected zones, which will be recorded in the form. The control system divides lightning activity zones into fewer minefields, mid-minefields, multi-minefields and strong minefields: fewer minefields refer to zones that the thunderstorms are less than 25 days in each year, zones that produce thunderstorms within 25 to 40 days are mid-minefields, zones that the thunderstorms occur within 40 to 90 days each year are multi-minefields, and zones that the thunderstorms occur over 90 days are strong minefields^[7]. The operation process of computer control system in ground lightning measures is as below:

$$R_j = d(t) + l(t)P \tag{1}$$

In equation (1): R_j is the grounding resistance of the vertical grounding electrode, which unit is Ω , P is the soil resistivity, which unit is Ω/m , l is the length of the vertical grounding electrode, which unit is m, d is the diameter of the round bar for grounding, which unit is m. Through the formula (1), the grounding resistance of different shapes of the vertical grounding electrode can be calculated.

$$R_i = L(t) + h(t)p \tag{2}$$

In equation (2), R_i is the grounding resistance of the horizontal grounding electrode, which unit is Ω , L is the total length of the horizontal grounding electrode, which unit is m, h is the buried depth of the horizontal grounding electrode, which unit is m, and A is shape factor of the horizontal grounding electrode. Through the formula (2), the grounding resistance of different shapes of the grounding electrode can be calculated, so as to complete the lightning protection process.

Complete lightning protection application of the computer control system according to the above processes. The

grounding lightning protection mainly refers to different protection measures according to different zones. The lightning protection zones (LPZ) are divided into four parts: (1) LPZOA zone, which is the exposed zone outside the building, and usually accept the strongest lightning current, all objects in this zone may suffer direct lightning strike and lead all the lightning current, lightning electromagnetic field is difficult to decay. (2) LPZOB zone, which has the same charge amount as the LPZOA zone, does not suffer from lightning strikes due to the nature of the objects in the zone. (3) LPZ1 zone, the charge is relatively small, will not have a direct lightning effect, and has good shielding measures. (4) LPZ2 zone, follow-up lightning protection zone, which is an effective lightning protection zone, through the reduction of lightning current and electromagnetic fields, and other shielding measures to achieve the effect of the protection of the internal objects within the region^[8].

3. Application Comparison Experiment of Computer Control System in Ground Lightning Protection

In order to study the validity of the computer control system in ground lightning protection, the comparison experiment is carried out. Two identical lightning protection systems are selected. One system is under manual control and the other system is under computer control. Experimental parameters are as follows: origin O1, time T, wavefront time T1, half-peak time T2. Experiment is carried out according to the above parameters, and the results obtained are shown in Figure 3:

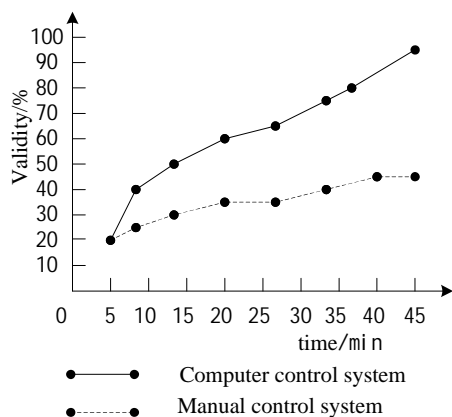


Figure 3. Experimental results

Analysis of Figure 3 shows that, although both the manual control system and computer control system can improve the lightning protection effect, with the joining

of computer control system, the lightning protection effect is better, and the time spent less, the cost is lower. Computer control system prevents the loss due to lightning and static electricity through electrostatic grounding. Based on the effect of cathodic protection, people pay more attention to the specifications of grounding lightning protection. Computer control system has the characteristics of high precision and accurate grasp of every detail transformation. When a fault occurs, the computer control system can judge the fault type at the first time, and provide solutions to strengthen the lightning protection effect, so as to provide the most reliable protection for people's lives and property.

4. Conclusion

In recent years, lightning protection technology is more and more advanced. The introduction of computer control system into ground lightning protection can not only applied to indoor control, but also can achieve outdoor long-distance control. Through this study it can be found that the computer control system using remote sensing technology and the wireless technology to operate the alarm structure, thereby reducing the probability of the occurrence of the risk. Hopefully, this article will provide positive and beneficial help for future researchers to explore related issues.

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