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Communication Technology of Digital Remote Explosion System for Geophysical Mountain Exploration

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Abstract

At present, the digital remote explosion system is the main synchronous source remote explosion system used in mountain geophysical exploration in China. Its unique communication technology not only guarantees the authenticity and reliability of seismic data transmission, but also ensures the reliability of data transmission in complex mountain conditions. This paper explains the reason why the remote detonation system is the main synchronous source remote detonation system in China by describing the composition and communication characteristics of the remote detonation system. Then, it introduces the communication process and timing rules of the system in detail by the conventional communication mode of the remote detonation system. It also explains the characteristic relay mode of the remote detonation system in detail. Finally, it shows the development direction of the remote detonation system Hope. These contents help researchers to understand the existing communication technology application and working sequence characteristics of the remote explosion system, so as to further improve and upgrade the communication technology of the system.

Keywords

Digital Remote Explosion System; Encoder; Decoder; Repeater.

1. Introduction

Remote explosion system is the main equipment used in geophysical mountain exploration project. The main functions of remote explosion system include controlling the source excitation and ensuring the synchronization of data acquisition. Among them, ensuring the synchronization of data acquisition is the basis to ensure that the seismic data can truly reflect the geological structure, and it is also the core of remote explosion system communication technology. With the development of modern seismic exploration towards digitization, high precision and high density, the traditional analog remote blasting systems, such as remote control blaster 300 and Macha series, which were used in the early stage, are limited by time precision, communication mode and so on, and are easy to be interfered by the outside world, so they can not meet the needs of modern digital exploration and high precision exploration. At present, the mountain seismic exploration instrument system has been equipped with new digital remote explosion system, such as shotpro, Boombox, SGD and so on. The digital remote explosion system ensures the authenticity and reliability of seismic data with a unique communication mode.

2. Composition and communication characteristics of digital remote explosion system

The digital remote explosion system applied in mountain seismic exploration project is mainly composed of remote explosion communication unit, analog radio unit, antenna part and related

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peripherals (including power supply, external cable and bracket). Teleexplosion communication unit is the core unit of the whole teleexplosion system, which is responsible for the communication control and clock synchronization calibration of the whole teleexplosion system. The analog radio unit is responsible for the external communication and signal transmission of the system, usually using GM338 radio produced by Motorola. The antenna part is responsible for the signal gain of the system and amplifies the received and transmitted signals. The peripheral part is responsible for the physical support frame of the whole system, internal transmission of circuit signal and power supply. When the system works, at least two devices should work together, one as encoder system and the other as decoder system. In the complex mountainous area, the master-slave mode is selected, and a remote explosion system is added as a repeater for signal relay.

The communication mode of digital remote explosion system has the following three characteristics. (1) High signal accuracy. The signal accuracy of the system directly determines the reliability of seismic data. During the construction process, the synchronization accuracy of the system should meet the following requirements, that is, the time difference between the pre time break signal obtained by the time break signal line of the encoder and repeater and the real time break signal generated by the high voltage discharge line of the decoder should not exceed 100 μ s. The synchronization verification accuracy of the system needs to meet the following requirements, that is, the time difference between the reference pulse interface of encoder and repeater and the analog uphole interface is less than or equal to 250 μ s. (2) Good adaptability. The system needs to be applied to complex construction areas, including mountains, hills and complex electromagnetic environment. When the signal from the encoder station cannot be received directly, the relay mode is needed. Relay mode, that is, the master encoder controls the decoder to synchronize the clock of the excitation signal through the relay set in advance. (3) Good stability. The system requires the communication station to provide stable signal transmission, especially in the relay mode. The difference between the maximum delay time and the minimum delay time of the relay station is required to be less than or equal to 20 μ s.

3. Conventional communication mode of digital remote explosion system

The digital remote explosion system works in two modes: encoder and decoder. The total work flow of the system is as follows: first, after the decoder is ready, the preparation signal is sent through the radio station; Secondly, the encoder sends the initiation signal after receiving the preparation signal through the radio, and triggers to generate the pre time break signal; Then, after receiving the signal through the radio, the decoder generates the high-voltage trigger detonator, at the same time, it also generates the real time break signal and wellhead signal, and returns to the encoder through the radio; Finally, the encoder receives and records the real time break signal and wellhead signal through the radio to complete the whole operation. The clock synchronization in the system, that is, the time difference between the pre time break signal generated and the real time break signal generated by the high voltage trigger detonator at the same time should be less than or equal to 100 μ s. The decoder provides two accurate and reliable data, i.e. verification time break and wellhead time, which are used as verification signals to verify whether the operation meets the synchronization requirements.

The encoder system is mainly composed of encoder, radio and DC power supply. When working, the encoder host is responsible for generating the pre time break signal and controlling the communication with the decoder; Seismograph is responsible for controlling encoder and receiving signals from encoder and decoder through serial port line; The computer is responsible for changing the relevant parameters of the encoder; The radio station is responsible for sending and receiving signals; DC power supply is responsible for power supply of the whole system. The main communication process is shown in Figure 1. Firstly, the encoder radio receives the pre start signal generated by the decoder, receives it through the encoder and transmits it to the seismic instrument through RS232 port; Secondly, the seismograph sends the fire order to the encoder; Then the encoder sends the blaster command to the radio station and sends out the pre time break signal, which is then sent back to the seismograph; Finally, the encoder receives the seismic data returned by the decoder,

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that is, the real time break signal and wellhead signal, and transmits them to the seismic instrument through the auxiliary channel.

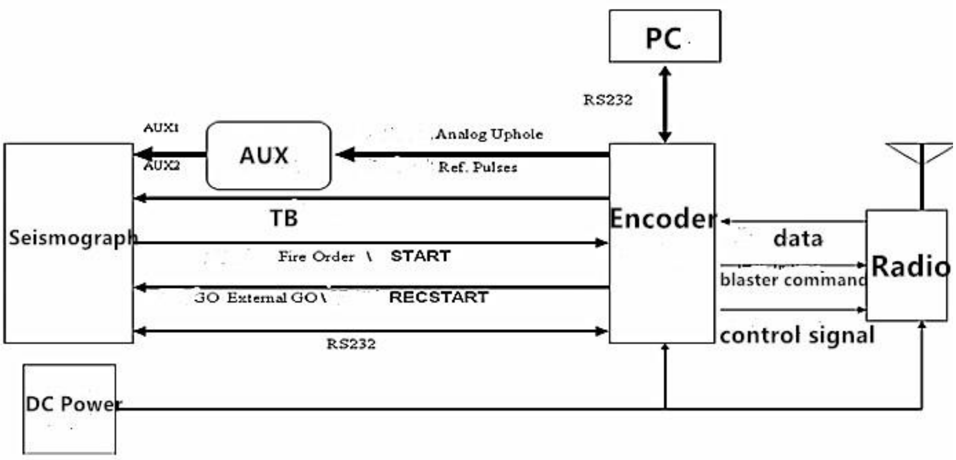

Figure 1. Encoder communication flow char

The decoder system is mainly composed of decoder, radio and battery. When working, the decoder host is responsible for generating the pre start signal, releasing the high-voltage detonator and collecting the wellhead signal through the wellhead detector (sensor); The radio station is responsible for sending and receiving signals; The battery is responsible for the power supply of the whole system. The main communication flow is shown in Figure 2. Firstly, after the decoder is ready, the pre start signal is generated and sent to the encoder through the radio; Secondly, the ignition command generated by the encoder is sent to the decoder through the radio, and the decoder releases the high voltage trigger detonator and generates the real time break signal at the same time; Finally, the decoder receives the wellhead seismic signal and sends it back to the encoder through the radio.

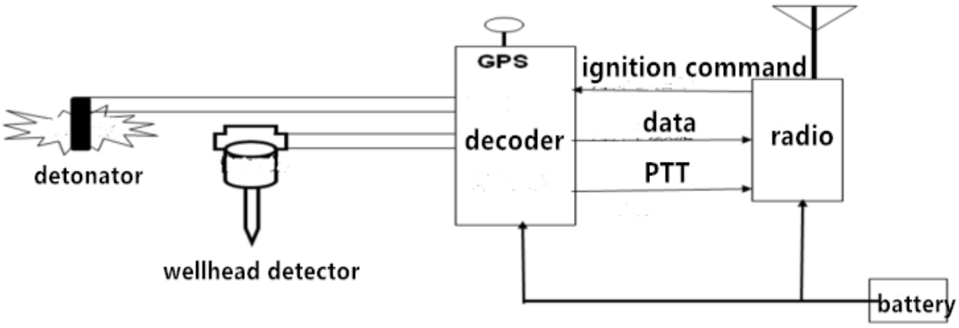

Figure 2. Decoder communication flow chart

The working sequence of digital remote explosion system is shown in Figure 3. The system starts the fire order command remotely to generate a rising edge pulse, and then starts the whole system. When the encoder transmits the ignition command, it predicts the time break through the relevant algorithm and generates the pre time break signal, which is recorded as the time break signal output by the encoder. Because of the delay of radio communication and line transmission, the reference pulse interface of encoder generates three rising edge pulse reference signals at three continuous fixed intervals after the pre time break signal. Corresponding to the three reference signals, the analog uphole interface returns the clock time break signal after the first fixed delay, that is, the rising edge pulse signal generated after the decoder receives the shooting instruction; After the second fixed delay, the rising edge pulse of the real time break signal is returned; The real wellhead signal record is returned after the third fixed delay. Among them, pre time break signal, three reference signals generated by reference pulse and clock time break signal, real time break signal and real wellhead

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signal returned by analog uphole interface will be recorded in the log of seismic instrument as the basis of data validity.

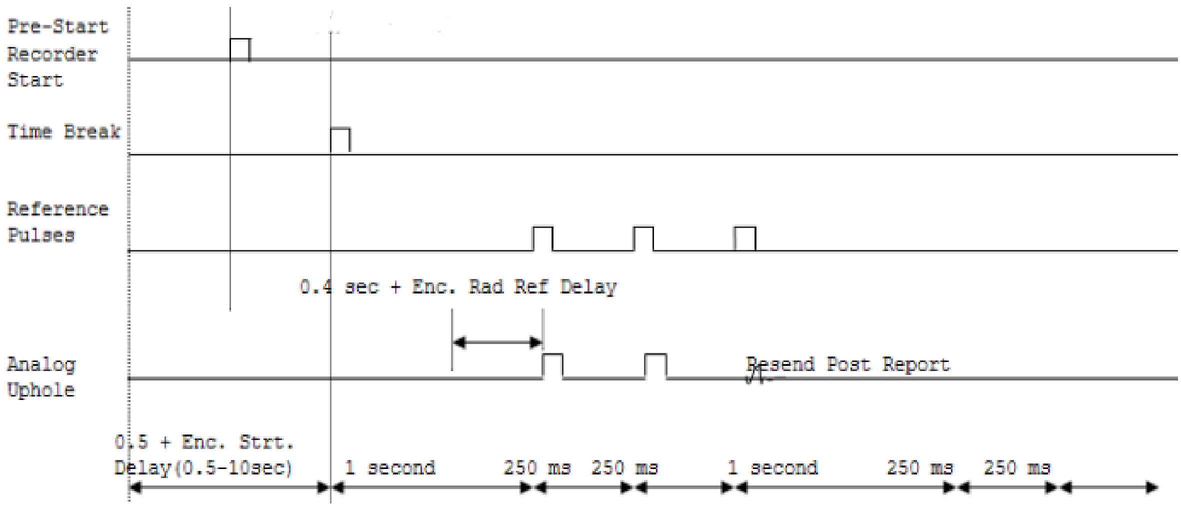

Figure 3. Working sequence diagram of digital teledetonation system

4. Relay communication of digital remote explosion system

When the communication of digital remote explosion system is not smooth, the signal loss will occur, which leads to the situation that the preparation signal sent by the decoder can not be delivered to the encoder or the ignition instruction sent by the encoder can not be delivered to the decoder. The system usually adds repeater between encoder and decoder to solve the above problems. At this time, the whole remote explosion system includes encoder system, repeater system and decoder system. The repeater system consists of repeater, radio station and battery. When working, the repeater host is responsible for transferring the signals between encoder and decoder; The radio station is responsible for sending and receiving signals; The battery is responsible for the power supply of the whole system. The main communication process is as follows: firstly, the prepared signal generated by the decoder is transmitted to the encoder through the repeater; Secondly, the seismograph command encoder sends the ignition start command and the pre time break signal at the same time, and the ignition command must be transmitted to the decoder through the repeater; Then, after receiving the ignition command, the decoder releases the high-pressure detonator and generates the real time break signal, and uses the wellhead sensor to obtain the wellhead signal; Finally, clock time break signal, real time break signal and wellhead signal can be sent back to encoder through repeater or directly. When the system uses the relay function, the repeater cannot shoot independently.

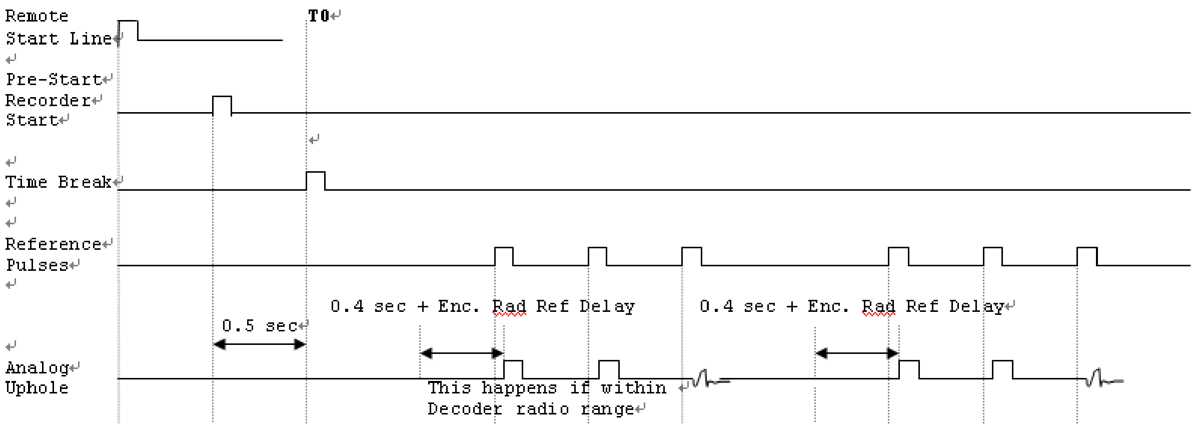

Figure 4. Repeater Working Sequence Diagram

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The working sequence of relay mode of digital remote explosion system is shown in Figure 4. The system starts the fire order command remotely to generate a rising edge pulse, and then starts the whole system. When the encoder transmits the ignition command, it predicts the time break through the relevant algorithm and generates the pre time break signal, which is recorded as the time break signal output by the encoder. Because there are delays in radio communication and line transmission, and there are also delays in transmission through repeater, the reference pulse interface of encoder has three reference signals with time interval in conventional mode and three reference signals with large time interval in pre time break signal. If the signal is returned through the repeater, the analog uphole interface will generate clock time break signal, real time break signal and real wellhead signal successively at the interval of large delay. If the signal is returned directly, the corresponding reference signal analog uphole interface in three conventional modes returns clock time break signal, real time break signal and real wellhead signal in turn. This ensures that at least one valid set of signals can be transmitted to the encoder. Compared with the conventional mode, the relay mode fully considers the delay of the relay station, and adopts two sets of different clock intervals to solve the delay problem. When using the relay mode, the delay time generated by the relay station transmitting the signal shall not be greater than 2 ms, and the difference between the maximum and minimum delay time shall not be greater than 20 μ s.

5. Conclusion

Digital remote explosion system is the core equipment to ensure the reliability of seismic data in the field of mountain geophysical exploration. The communication technology of the system is the key of clock synchronization. The current communication method can ensure the authenticity and reliability of clock synchronization. However, the efficiency of the system can not fully meet the needs of high-speed and efficient modern high-density exploration projects due to radio delay and other factors. It is believed that with the further development of communication technology, how to improve the communication efficiency of the system on the premise of authenticity and reliability will become the direction of the development of geophysical equipment technology.

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