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Noise Elimination Method in Automatic Fire Detection Equipment in Accordance with the Communication Distance

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Abstract

This research focused on the communication noise level depending on the distance for conventional fire detection systems (RS-485 code-transmitter) in comparison to the newly developed optical cable automatic fire detection system (optical communication code-transmitter. The noise levels of the RS-485 code-transmitter were respectively 10, 200, 1200, and 2400 mV for the communication distances of 0, 1, 40, and 80 m and showed a correlation between the increase of the communication noise with the increase of the communication distance. However, the optical communication code-transmitter did not show any sign of communication noise at these four different distances. Therefore, the newly developed optical communication system is an ideal system to avoid false alarms in automatic fire detection system.

Keywords: *automatic fire detection system, code-transmitter, false alarm, noise*

1. Introduction

The automatic fire detection system is an important fire-fighting tool that warns the residents of a fire occurrence at an early stage, preventing fire from spreading and minimizing the damage [1]. The repeater, which is one of the elements of the automatic fire detection system, receives a signal from the detector, transmitter, or electrical contact and sends the signal to the control panel [2]. However the frequent occurrence of nuisance and false alarms made people doubting the reliability of the system. This is why the origin of nuisance alarms became an important subject to the researchers in this field in order to eliminate the problem. Researches about false alarms have been made by the following researchers; Min-Yong Lee, Geon-Ho Lee, Si-Guk Kim, Pil-Young Kim, Chun-Ha Lee (2014) [3] - development of address type repeater searching position of the operated fire detector; Keun-Ho Ryu (2012) [4] - possibility of the connection between communication network and alarm equipment network including code-transmitter; Young-Jae Kim (2009) [5] - a study on the intelligent integrated disaster prevention system using communication technology in fire receiver and code-transmitter; Gong-Hui Kim (2008) [6] - a study on the surge damage protection method by lightning for the fire alarm system including repeaters. The application of a CO_2 Dial System for Infrared Detection of Forest Fire is believed to reduce false Alarm [7]. Wireless fire alarm system also considered to improve safety critical real-time system [8].

False alarms are more often caused by code-transmitter than detectors or receivers. However it has not been proved yet that improving the signal waveform of the code-transmitter reduces the occurrence of false alarms. Since false alarms can be generated by the noise of the code-transmitters this needs to be investigated. This paper compares the

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generation of noise between conventional RS-485 code-transmitter and optical communication code-transmitter developed for preventing the noise caused by communication distance.

2. Experiment

2.1. Design and Fabrication of the System

Figure 1 shows the optical communication code-transmitter comprised of control panel, input/output panel, power panel and communication port. The control panel was fabricated with 8 bit micro-controller ATmega64 model; the input panel uses a PNP type transistor 2N2907 and a NPN type transistor 2N2222A with an addressing setting switch, sensor, and input port; the output panel was constructed with 3 output channel and dry contact type non-voltage output 1 channel; power panel was composed with LM2576-5 (5 V) switching regulator and LM1117 (3.3 V) linear regular and designed with minimum heat generation; the communication port uses OLKDX Optical transceiver and communicates with the control panel through the Low Voltage Differential Signaling (LVDS).

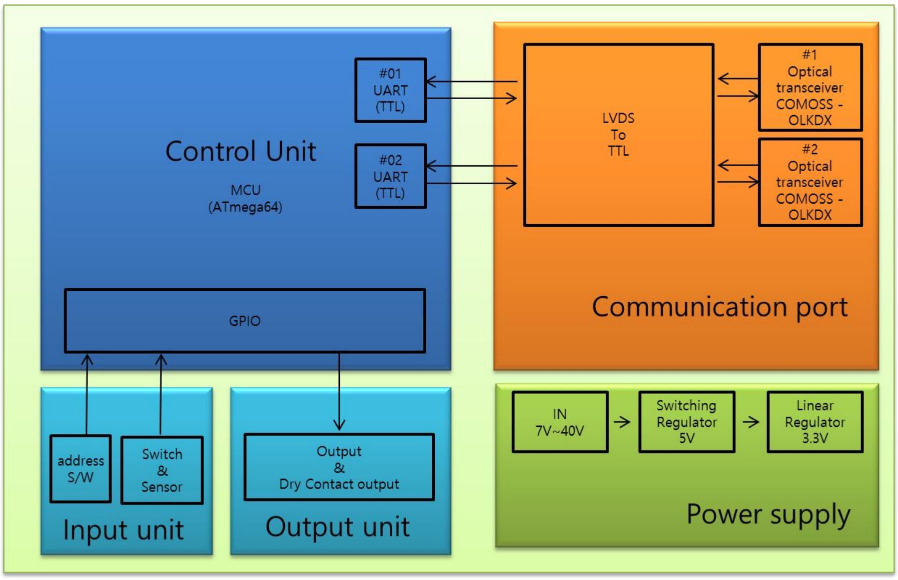
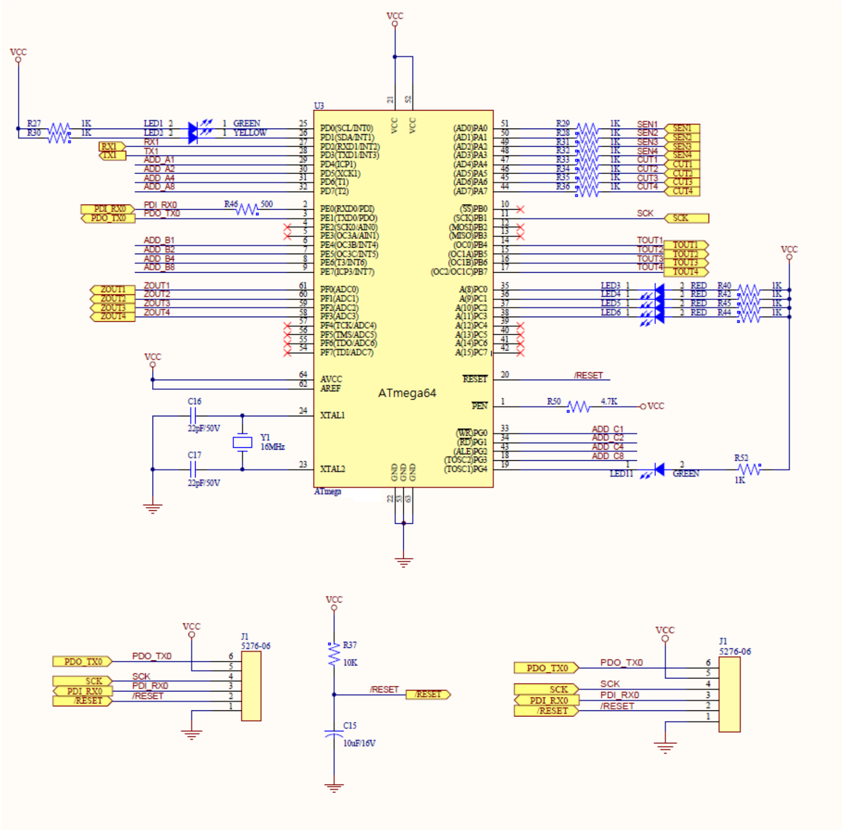
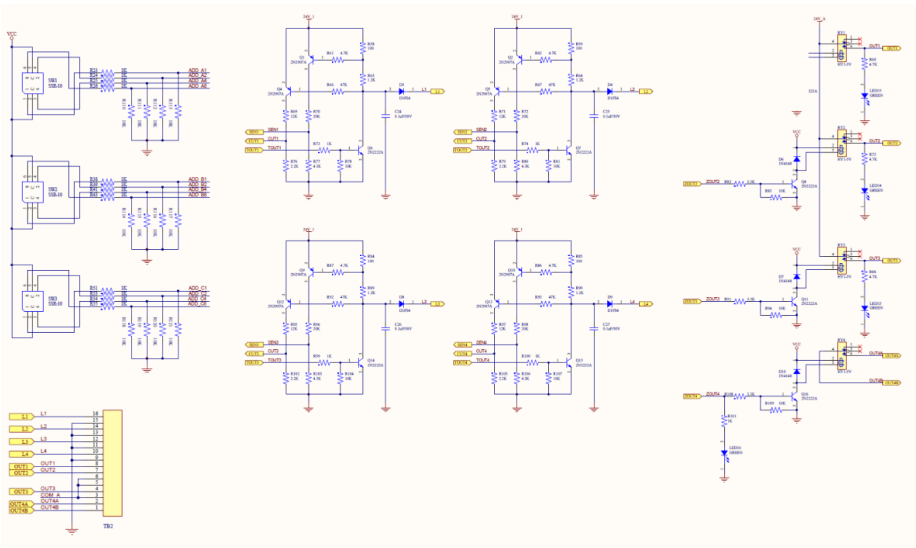


Figure 1. Block Diagram of Optical Communication Code-Transmitter

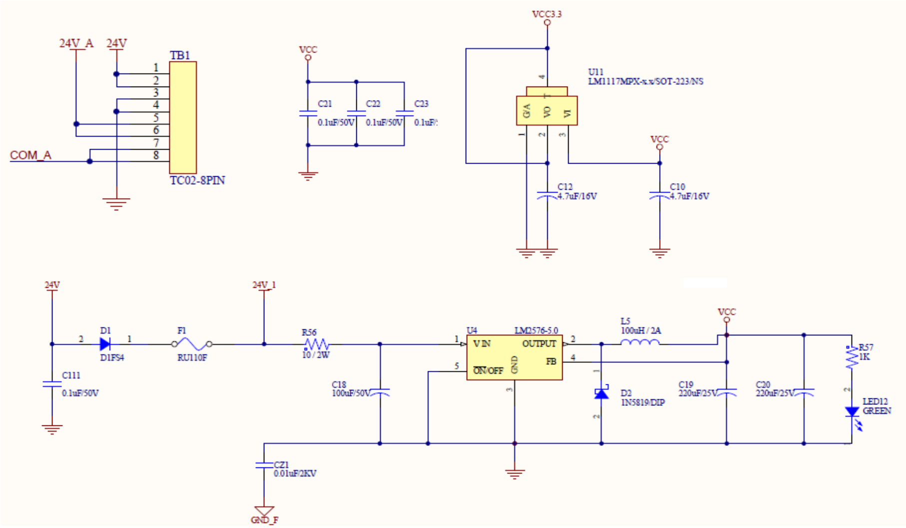
Optical data received from the host are transformed into electrical signal through OLKDX transceiver and sent to the control panel. The control panel sends the data requested by the host or executes the requested operation through the input/output port. The control panel also sends the data to the lower code-transmitter when the data is not related to the panel. Therefore, the communication port uses two channels to communicate with the higher host, code-transmitter, or lower code-transmitter. Although the maximum communication speed is 100 Mbps, 115,200 bps was used in this experiment. Figure 2 shows the circuit diagram and the picture of the optical code-transmitter.



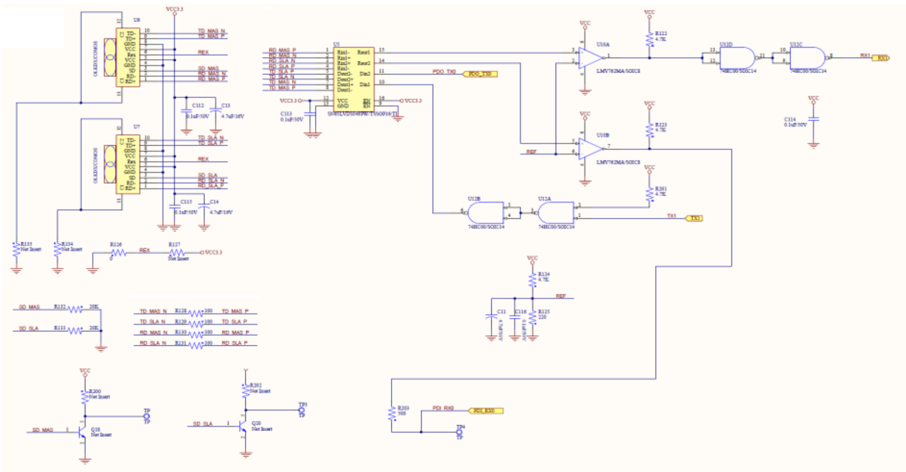
(a) Diagram of the controller



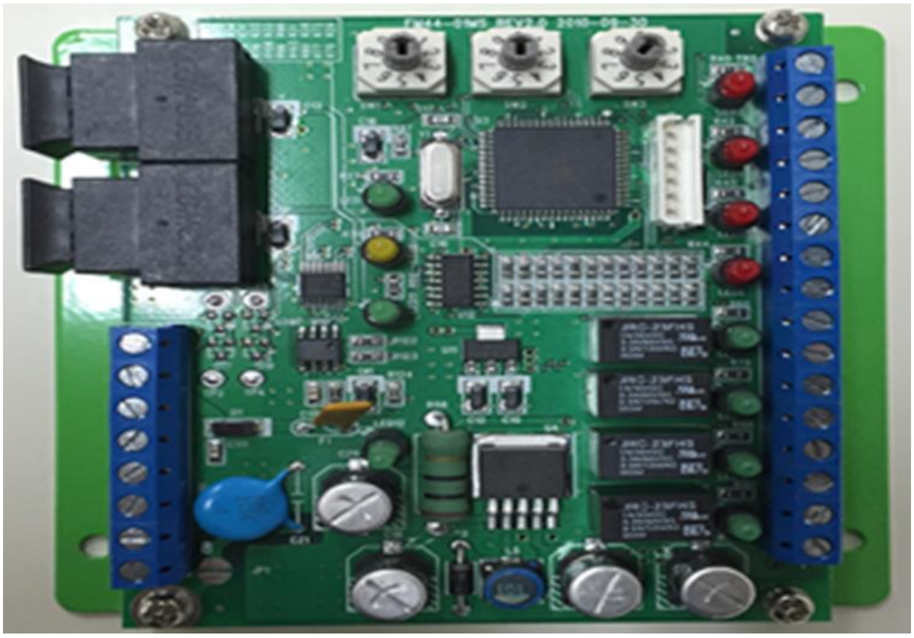
(b) Diagram of the input port



(c) Diagram of the Power Supply



(d) Diagram of the Communication



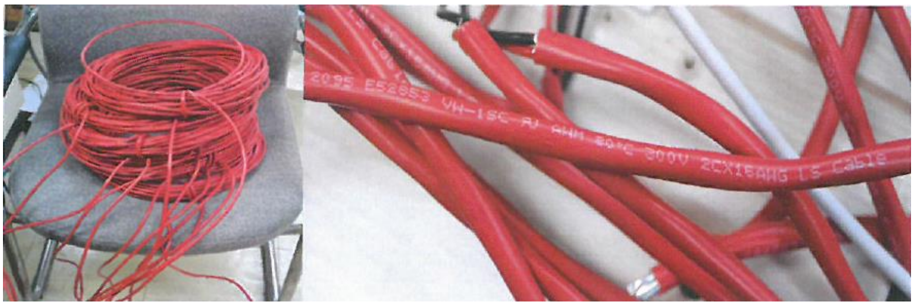
(d) Real Size Picture

Figure 2. The Newly Developed Optical Communication Transmitter

2.2. Experiment Setup

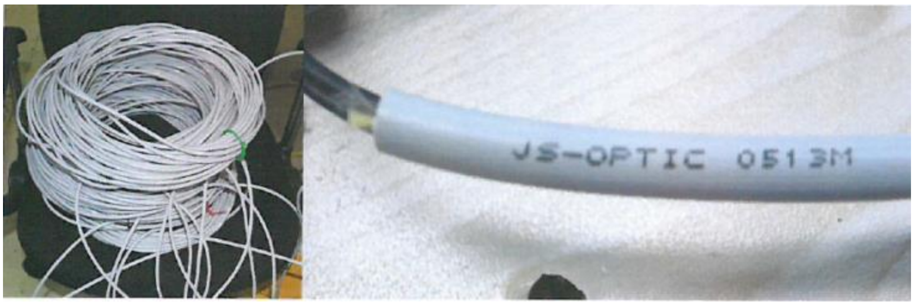
Figure 3 shows conventional RS-485 code-transmitter and cable, optical communication code-transmitter and communication cable. Table 1 shows the specifications of the conventional RS-485 and optical communication.

(a) RS-485 Code-Transmitter



(b) RS-485 Code-Transmitter Communication Cable

(c) Optical Communication Code-Transmitter



(d) Optical Communication Cable

Figure 3. Conventional RS-485 Code-Transmitter and Cable and Optical Communication Code-Transmitter and Cable

Table 1. Specifications of the Test Equipment

Items	RS-485 code-transmitter	Optical communication code-transmitter
Rated voltage	DC 24V	DC 24V
Number	1	1
Cable length between the code-transmitters	0m, 1m, 40m, 80m	0m, 1m, 40m, 80m
Company	Hyundai Infra Core, Inc.	Hyundai Infra Core, Inc.

Figure 4 and Table 2 show the shape and specifications of the oscilloscope, to measure communication noises of conventional RS-485 system and optical communication code-transmitter system. The experiment setup is comprised of a code-transmitter, a communication cable, and an oscilloscope.

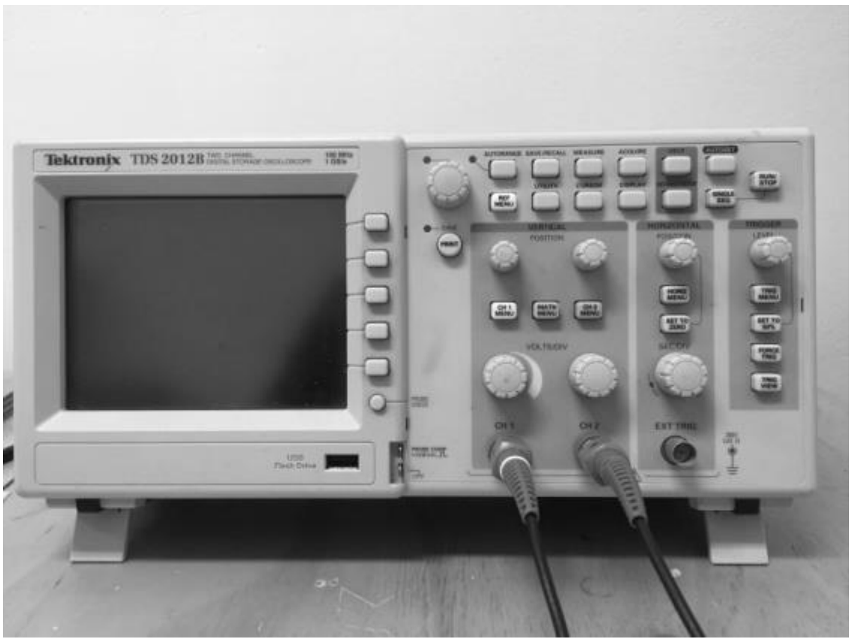


Figure 4. The Oscilloscope

Table 2. Specifications of the Oscilloscope

Items	Description
Name	Digital Oscilloscope
Model name	TDS 2012B
Analog	2Channels
Max. sampling rate	1.0GS/s Real time
Analog Frequency Bandwidth	100MHz Bandwidths
Max. Record length	2.5kW/Ch.
Company	Tektronix

2.3. Experiment Method

The method of noise assay according to the communication distance is as follows; ① preparation of RS-485 communication cable, ② preparation of optical communication cable for optical communication code-transmitter, ③ connection of power cable to the each code-transmitter, ④ connection the communication cable to the communication line, ⑤ supply the DC 24V power to the master unit, ⑥ supply DC 24 V to the RS-485 code-transmitter and optical communication code-transmitter, ⑦ measuring the noise by connecting code-transmitter and oscilloscope with the distance 0, 1, 40, and 80 m. Table 3 shows the oscilloscope setting.

Table 3. Oscilloscope Setting

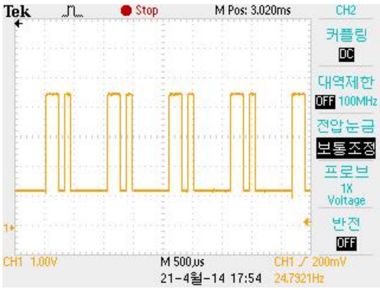
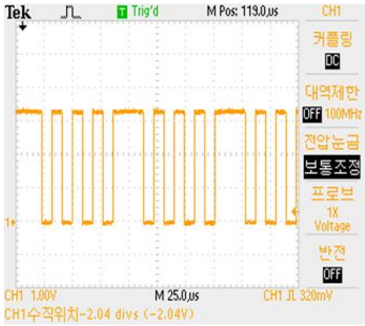
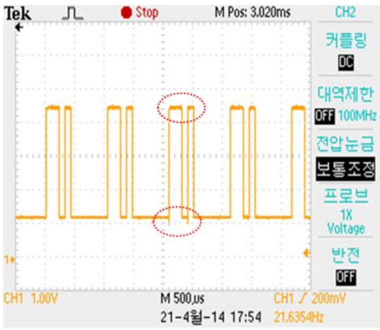
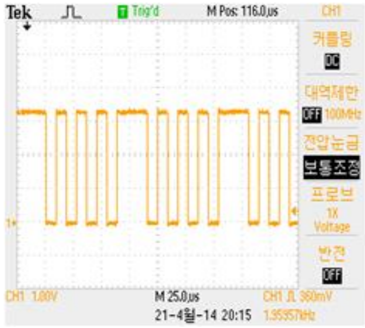
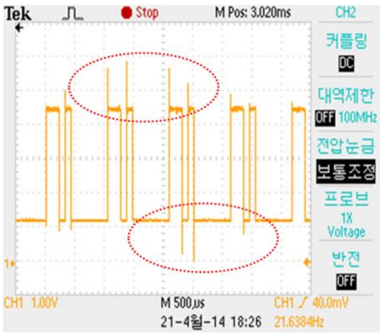
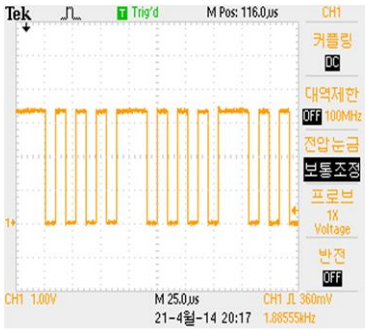
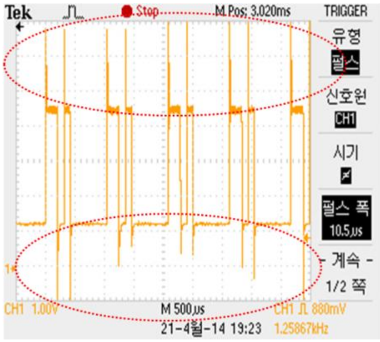
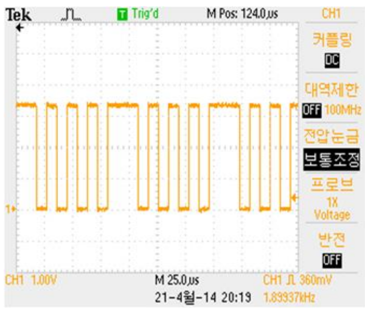
Type of code-transmitter	Horizontal axis (speed)	Vertical axis (V)
RS-485 code-transmitter	500us/div	1V/div
Optical communication code-transmitter	25us/div	1V/div

3. Results and Discussion

3.1. Signal Waveform According to the Communication Distance

The noise was almost not inexistent when the communication distance was 0 m for the RS-485. The width and frequency of noise increased with the increase of the communication distance for the RS-485. However, the noise was completely inexistent at all communication distances for the optical communication code-transmitter as shown in Table 4.

Table 4. Measurement of the Noise According to the Communication Distance

Distance	RS-485 code-transmitter system	Optical communication code-transmitter system
Tx 0m		
Tx-Rx 1m		
Tx-Rx 40m		
Tx-Rx 80m		

Note) Tx: communication input, primary signal
Rx: communication output signal obtained by primary signal according to the different communication distance

3.2. The Measurement Value

The noises of the RS-485 code-transmitter were 10, 200, 1200, and 2400 mV for the communication distances at 0, 1, 40, and 80 m, respectively. However, the noise was inexistent for the optical communication code-transmitter system with all 4 different distances as shown in Table 5.

Table 5. The Measurement Results for RS-485 Repeater and Optical Communication Repeater

Distance	RS-485 code-transmitter system	Optical communication code-transmitter system
Tx 0m	- TX level 3.3V - Noise level; within 10 mV	No noise
Tx-Rx 1m	- Noise level; 200mV	
Tx-Rx 40m	- Noise level; 1,200 mV	
Tx-Rx 80m	- Noise level 2,400 mV	

4. Conclusions

This research performed the comparison of noise levels depending on the communication distance between the conventional automatic fire detection system (RS-485 code-transmitter system) and newly developed automatic fire detection system (optical communication code-transmitter system) in order to eliminate false fire alarms. The results are the following:

1) The conventional automatic fire detection system (RS-485 code-transmitter system) generated the 10, 200, 1200, and 2400 mV of noise level for the communication distances at 0, 1, 40, and 80 m, respectively and increased noise level with the increase of the communication distance.

2) However, the newly developed optical communication code-transmitter system did not generate any noise at all four different distances.

Therefore, the optical communication code-transmitter system is the ideal system to remove the false fire alarm in the automatic fire detection system.

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