

Design of Electronic Circuit for Mining Explosive Detonator

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Abstract

Designing of mining explosive electronic circuit, safety for work environment is vital and important. The system devices contained transmitter block, which are containing computer monitoring software and Internet modem. The other one is receiver block which is included explosive circuit and their components (i.e., a digital component mobile phone, ICs, and detector). To control the operation steps process used software program written with C++ language. The system was successfully built and designed. Besides that, it could capabilities of components set in the designed circuit. Moreover, the circuit and their components were operated carefully according to program sequence. The results are achieved the general objectives of the research. Also, it was match standards, specified in national standards for performances and appearances of such devices.

Key words- *Computer Numerical Control; Disk Video Drive; Scalable Vector Graphics*

I. INTRODUCTION

An explosive is a chemical compound, or a mixture of compounds, initiated by heat shock, impact friction, or a combination of these conditions [1]–[3]. This, to crush natural resources rocks, which is one of the most accessible and a major basic raw materials [3]. Once explosive material initiated, it decomposes very rapidly in a detonation which could produce a rapid release of heat and large quantities of high-pressure gases [4], [5]. The gases produced expand rapidly with sufficient force to overcome confining forces, i.e., the rock surrounding a borehole [6]. The explosives and blasting agents sold are used in mining [5]. Generally, there are two classifications of explosives and blasting agents. The permissible explosives that are uses in Mine Safety and Health Administration Approved [6], [7]. Miners are lost their lives due to a methane and coal dust explosion. An explosion or a mine collapse will result in immediate traumatic injuries or fatalities, whereas a prolonged exposure to coal or silica dust can result in debilitating and fatal consequences for miners over the years in the form of lung diseases. In mining as well as in other hazardous industries, various safety levers exist and can be acted upon to modify the exposure to the inherent risks involved in industries, and promote safety [7]. Various safety factors are considered in installing an explosion proof equipment (also called Ex-equipment) in a hazardous area because of presence of flammable materials like various gases or vapors, dust particle, or fibers which causes ignition and thus hampering the safety [6], [8]. Accordingly, it is very important to protect operators mining areas by install new electrical circuit to ensure safety in development of mineral fields. The prime source of energy initiating devices (detonators), are falling into three basic types (i.e., electric, electronic, and non-electric). In comparison with electric and electronic detonators systems. Electric detonators are traditional system have been in use in the mining industry for many decades and it's come in several types with the most common being

the low firing current variety [4]. In this method used more than 2Km long of copper wires to initiate the detonators. Although, copper wires have excellent electrical and thermal conductivity. But, it difficult to use the sequential process of explosive detonator in this method, which is very complicated. Their difficulty is come from costing, risking, and increasing the operation time of the work in the mining place. While, electronic detonators systems are new and continually advancing digital technology for the initiation of blasts in mining operations [9]–[12]. Of these, it is better designed mining explosive circuit, by used electronic components to initiate the explosive detonator. Recently, used wireless communication to control signal and explode the detonators [11]. The wireless communication is used to protect mineral operators in mining fields. Accordingly, in installed mining electronic circuit, it better to use wireless communication to control signal, and ensure safety in development of mineral fields. The designed circuit have some benefits compared with others methods. Such as: control the mining process more safety, saving time, and reducing money because it is cheaper compared to the price of 2Km copper wires. Also, by used designed circuit, can control and initiate more than one detonator in a different position at same time. It can also, use in future as a remote-control system, which can lead to new promotions, especially in the military applications (missiles and UAVs).

II. METHODOLOGY

The mining explosive circuit has been constructed and practically tested in electron lab of Sudan University of Science and Technology. Figure 1 illustrated the schematic diagram of the system with all component of mining explosive circuit.

A. Transmitter

The transmitter was including two components or devices as:

- The first part of the system is a computer (TOSHIBA, processor Intel Pentium dual core and have RAM 2 giga bite.), which was programmed by used C++ language.
- The computer was connected with internet modem (3G SIM card) from Sudani Company which use to send accurate (code) as SMS to the exclusive circuit (mobile).

B. Receiver

The receiver is containing as following bellow:

- Mobile phone (with SIM card), electronic circuit. This part is used to receive the SMS from the modem, and send it as tone with head set to digital component integrated circuit (MT8870-D1-DTMF decoder) [13].
- Dual Time Multi Frequency MT-8870D1- (DTMF) decoder: The type of IC is MT 8870-D1, its dual time multi frequency has 18 pins and 4 Q - bit code as output. This part is use to decoding the mobile signal, (SMS) and send it as an output signal to the IC (ULN 2003A/L) component inside interface block with any of four pins Q1, Q2, Q3, and Q4. The IC MT8870D is a complete dual time multi frequency DTMF receiver integrating both the band split filter and digital decoder functions. The filter section uses switched capacitor techniques for high and low group filters; the decoder uses digital counting techniques to detect and decode all 16 DTMF tone-pairs into a 4-bit code show.
- IC ULN 2003A/L: The IC type is ULN 2003 A/L, have 16 pin and series input resistors selected for operation directly with 5 V TTL or CMOS. The designing comprises major components are shown in Figure (2). The IC (ULN 2003 A/L), the part is used as an amplifier for MT8870-D1 -DTMF signals and send the new signal immediately to the fuse or detonator. The output signal is capable of sinking 500 mA and will withstand at least 50V in the OFF state. Output signal may be paralleled for higher load current capability. The ULN2003A/L is high voltage, high current Darlington arrays each containing seven open collectors Darlington pairs with common emitters. Each channel rated at 500 mA and can withstand peak currents of 600 mA. Suppression diodes are included for inductive load driving, and the input is pinned opposite the output to simplify board layout. The four versions interface to all common logic families.

C. Detonator

The final part is the detonator which is used to initiate the explosive material. Instead of the real detonator we used 5 V lamb to indicate and achieved that the singles were received and amplified.

Finally, the software program was written with C++ language the software program sublimated, Figure. (2), demonstrated software flow chart.

III. RESULTS AND DISCUSSION

As mentioned earlier, this study intends to design of mining explosive system, thats applied in blasting, and their performance in minerals field, considering the operators safety,

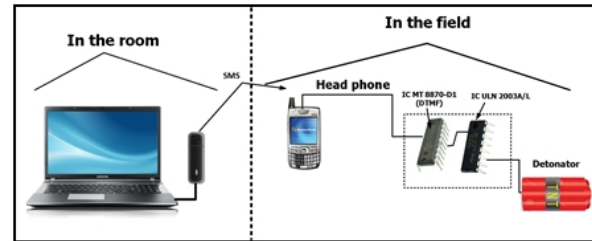


Fig. 1. Schematic diagram illustrated the idea of mining explosive circuits..

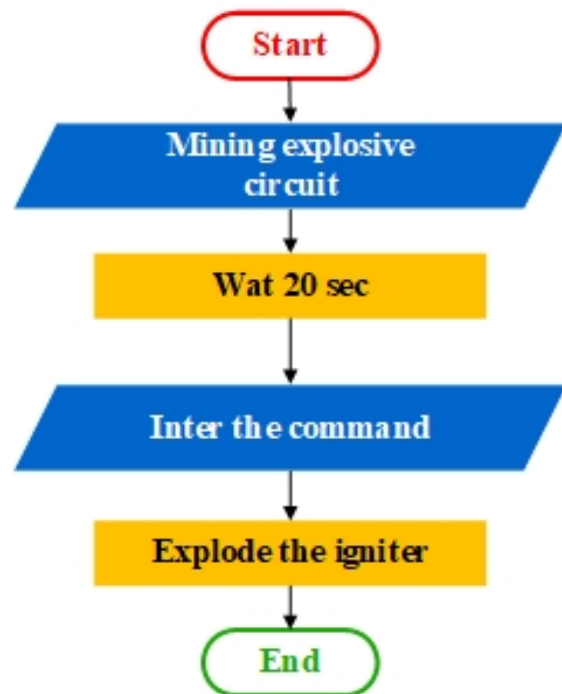


Fig. 2. Software flowchart.

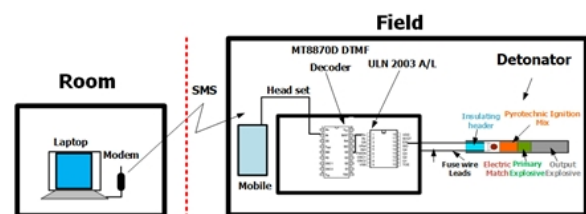


Fig. 3. Schematic diagram illustrated the designing of major component Mining Explosive Circuit.

circuit cheapness, and simplicity.

When the system is run by sending the code from PC through the components (MODEM, MOBILE, MT 8870-D1, and ULN2003 A/L), they are all operating run properly according to the program sequence. Figure 3 showed designing of major component Mining Explosive Circuit. The system process is consisting of four steps through five items which are used to create and control SMS signal, sent by wireless communication from PC (transmitter) to mobile phone (receiver). That after running the software written with C++ language code. After the SMS sent to the mobile, the signal was changed to

tune in the mobile head set. After a while, the signal trace the circuit wire to IC MT 8870-D1 and reached pin number (2). The signal is obtained was weak, then, it sent to decoder built in the IC. As we know the MT-8870D-1 is a full DTMF Receiver that integrates both bands splits filter and decoder functions into a single 18-pin. Moreover, the filter section of IC MT-8870D-1 uses switch capacitor technology for both the high and low group filters and dial tone rejection. IC MT-8870D-1 decoder uses digital counting techniques to detect and decode all 16 DTMF tone pairs into a 4-bit code.

Consequently, the coded signal was transferred through MT-8870-D1 pin (Q4) to the fourth item in the electronic circuit, which is IC (ULN 2003 A L) at pin number (1). This IC are used as amplifier item to treat and amplify the signal that is come from IC MT-8870-D1 pin Q4, and send the treated signal (output signal) through in (16) to the last component (fuse/detonator). Furthermore, the output signal voltage is capable of sinking 500 mA, and will withstand at least 5 V in the OFF state. Beside that, the output signal current may be paralleled for higher load current capability. Finally, the detonator are ignited and initiated the explosive material. All process were and started controlled used a software programmed and written with C++ language. Which is used to guide and determine the number of pin in (IC MT-8870-D1), should be uses (such as: Q1, Q2, Q3, and Q4. or uses all in one step).

Test results show application of mining explosive circuit can effectively enhance the safety over the mining areas and provide reliable guarantee to ensure orderly development of mineral resources and to protect human and property safety of citizens in these areas. These simple results were obtained (because we are concentrating on the small part of the research), which can be taken as practical evidence making us able to controlling in mining explosions. This project is similar to many another project successfully applied in MINING INDUSTRIAL.

IV. CONCLUSION

Designing of electronic circuit for mining explosives was favor and important, the circuit has capabilities of all components set. Moreover, it could successfully operated as remote control system, to igniting the explosive materials (detonator). This circuit could represented a simple designed method, which it is necessary for mining fields, as well as any others related fields, such as igniting ground to ground missiles, or controlling drones (UAVs) missiles.

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