Pulse Curent Controller

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Abstract - **In this paper is to introduce portable impulse controller, which controls all parameters of the current pulse.**

Keywords - **electro-detonator, impulse controller, detonation devices.**

One of the basic coal and ore underground mining is the detonation method. It is based on the electro-detonator net [1]. Some of the main net parameters are: net resistance R_m, internal detonator resistance R_{det}, line resistance R_l, reliable current i_{sig}, safe current i_{bt}, detonation energy on 1Ω resistance $E_{1\Omega}$ and impulse continuance ϑ_i. In the detonation devices are often used condensers with capacitance from 10 to 20 :F. The maximum charge voltage can vary from 500V to some thousand voltage which depends on the parameters of the detonator net.

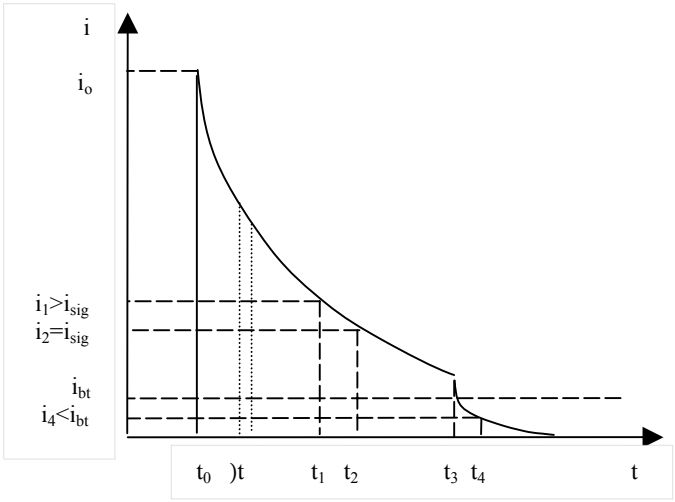

Fig.1 The time diagrame

The safety during the explosion work must be controlled too [2], so the current pulse amplitude must be limited to safety value for the time after 4ms.This safety value depends on the nature of the explosive gas.

The waveform and parameters of the current pulse are shown in fig. 1. The detonation net scheme and detonation device are shown in fig. 2.

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The charging and control scheme [3] charges the condenser C1. In the time t_0 the thyristor V2 turns on by a control pulse and the condenser C1 starts to discharge through the detonator net by exponential law. In the time t_3 the thyristor V1 turns on and thyristor V2 turns off by control pulses. In this way the current pulse is terminated through the detonator net and the condenser C1 trickle discharges through the resistor R1 and thyristor V1.

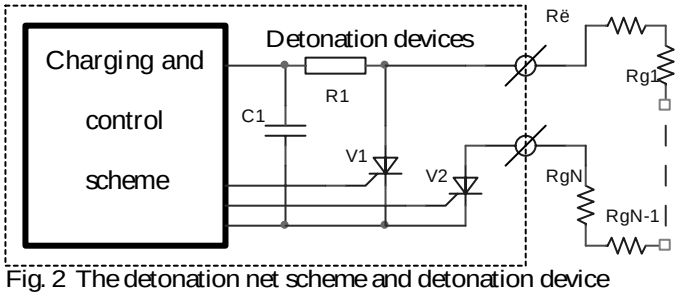

Fig. 2 The detonation net scheme and detonation device

One of the basic requirements for technical safety regulation is the control of the current pulse parameters. This pulse is generated by the detonation device when the resistance of the detonation net has the maximum surmountable value.

These parameters are checked in two levels:

- licensed laboratories, where the pulse parameters are checked by special device;
- permanent preventive check in the work place by security monitor.

The purpose of this paper is to introduce portable and cheap impulse controller, which controls all parameters of the current pulse.

The current pulse must satisfy the next three conditions for a secure work:

- $E_{1\Sigma} > E_{nom}$;
- $i_1 > i_{sig}$ by $t = t_1 = 2ms$;
- $i_4 < i_{bt}$ by $t = t_4 = 4ms$.

The fulfilment of these conditions is indicated by three green light-emitting diodes.

The impulse controller block diagram is shown in fig. 3. The impulse controller turns off and turns on by one button. Three green light-emitting diodes and one red light-emitting diode begin to flash for a short time when the button is pressed. That indicates that the device

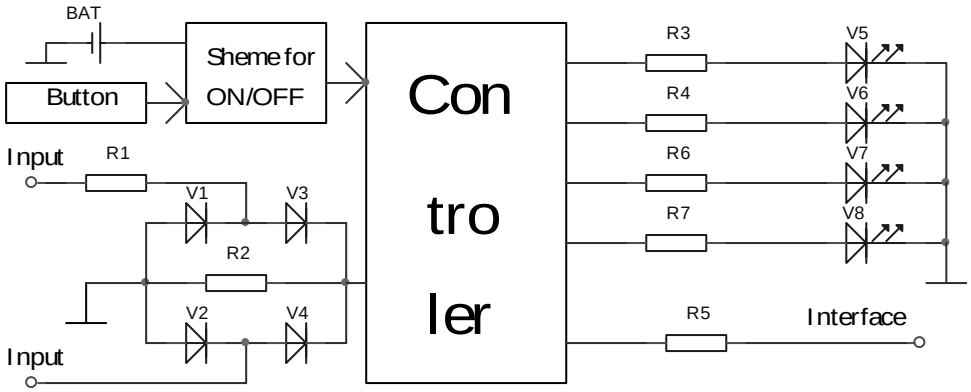

Fig. 3 The impulse controller block diagram

is trouble-free and it is ready for the measurement. If the input signal with $i>0.5i_{sig}$ is missing for 30 sec the device automatic ally turns off.

There is a resistor R1 in the input of the impulse controller. This resistor is equivalent to the net resistance R_m in real work state.

$R_m=R_l+R_{det1}+R_{det2}+ \theta\ \theta +R_{det(n-1)}+R_{det(n)}$ (1)

The resistor can be connected externally to the impulse controller. So if we use resistors with different resistance then we can simulate different detonation net types and we can test different detonation devices. The current circuit loops trough the integrated reference resistor R2=1Ω. The resistance voltage drops into the analogue-to-digital converter (ADC). The measurement interval is equal of Δt. The result is equal to $u_{R2}=i_{R2}$, because R2=1Ω.

When we turn on the impulse controller it starts to sample the input signal and periodically to save the data in the memory. When the current pulse exceeds the fixed reference value (for example $i>0.5i_{sig}$) the impulse controller starts to measure i and t. The energy is calculated after each measurement and all the values are summarised (2). The scheme monitors for the term observance $i_1 > i_{sig}$ при $t=t_1=2$ms.

$$E_{1\Omega}=\int_{t_0}^{t_2}\left(\frac{U}{R}\cdot e^{-\frac{t}{R.C}}\right)^2 dt \approx (i_0^{\,2}+\cdots+i_2^{\,2}).\Delta t\,, \quad (2)$$

where: i - is the detonation net current;

U - the condenser charge voltage;

R=R1+R_m; t - time; e=2,718;

C - capacitance of condenser C1.

The energy is measured and summarised while $i_1\geq i_{sig}$. After that the scheme samples again i and t to t4 and verifies whether the last condition is followed $i_4<i_{bt}$ by $t=t_4=4$ms. Then the measurement is finished. The results are processed and displayed through the light-emitting diode indication.

When all the requirements are fulfilled, the three green light-emitting diodes become to flash. This fact indicates that the test detonation device observes the work and safety requirements. If one of the requirements isn't true a red light-emitting diode become to flash. The green light-emitting diodes flash if the corresponding parameters conform to the standard.

The measurement results are saved in the pulse controller memory. If necessary these data can be moved and graphically presented in PC.

The suggested pulse controller allows during the exploitation the measurement of the parameters of the current pulse with the necessary accuracy.

It is easy and convenient to work with this controller.

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