Title
A 10Mc/sec PULSE-AMPLITUDE DISCRIMINATOR

Author
Mey, Jacques.

Publication Date
1958-11-10

UCRL 8540

UNIVERSITY OF CALIFORNIA

Radiation Laboratory

BERKELEY, CALIFORNIA

UCRL-8540

UNIVERSITY OF CALIFORNIA
Radiation Laboratory
Berkeley, California

Contract No. W-7405-eng-48

A 10 Mc/sec PULSE-AMPLITUDE DISCRIMINATOR

Jacques Mey

November 10, 1958

Printed for the U.S. Atomic Energy Commission

A 10-Mc/sec PULSE-AMPLITUDE DISCRIMINATOR

Jacques Mey

Radiation Laboratory
University of California
Berkeley, California

November 10, 1958

ABSTRACT

A pulse-height discriminator has been developed which is capable of operating at repetition rates up to 10 Mc/sec. It accepts positive input pulses with a threshold adjustable from 1 to 11v. The output signal is of constant shape and amplitude. The circuit is described and test results are given.

A 10 Mc/sec PULSE-AMPLITUDE DISCRIMINATOR*

Jacques Mey†

Radiation Laboratory
University of California
Berkeley, California

November 10, 1958

INTRODUCTION

In counting experiments with high-energy particle accelerators, the requirement has arisen for circuits capable of high repetition rates. In the use of pulse-amplitude discriminators it is important that the circuit maintains a constant input threshold and output pulse shape for wide variations of the input duty factor. The circuit described here is primarily intended to embody these features and to operate from the signals of coincidence circuits. The discriminator uses reliable long-life tubes; it has been designed to achieve good threshold stability for long periods and for repetition-rate variations from 0 to 10 Mc/sec. The complete circuit is shown in Fig. 1. It consists of a threshold amplifier (V1A, V1B, V2), a trigger circuit (V4A, V4B) and a cathode-follower output circuit (V5A, V5B).

THRESHOLD AMPLIFIER

The threshold amplifier is derived from the conventional difference amplifier. The diode D1 which introduces a nonlinear coupling between cathodes improves the discriminator linearity by sharpening the lower knee of the transfer characteristic. It also increases the speed and the stability, because the tubes are

*This work was done under the auspices of the U.S. Atomic Energy Commission.

†On leave from the Centre d'Etudes Nucléaires de Saclay (France).

both conducting in the quiescient state and the circuit is highly degenerative. The feedthrough due to the diode capacitance and to stray capacitances between cathodes is neutralized by the circuit employing tube V2. The signal threshold is adjusted by varying the grid bias on tube V1A.

TRIGGER CIRCUIT

The trigger circuit is a two-stage amplifier with a positive-feedback loop through a capacitance (C8) and a nonlinear device (semiconductor diode D5) presenting a high impedance in the quiescient state in order to insure stability. The output signal is shaped by means of a resonant circuit. The tubes V4A and V4B are in series for the direct-current path. This arrangement[1] allows one to use direct-current coupling through the diode D5 and increases the stability. At rest, the tubes are both conducting in a region of high transconductance. The positive pulse coming from the threshold amplifier is fed through diode D2 to the grid of V4B and increases the current in this tube. When the anode potential of V4B is lowered enough to get D5 to conduct, the gain of the feedback loop becomes greater than 1, and the circuit is regenerative. Tube V4A is then driven to cut-off, while V4B becomes highly conductive. The cathode follower, V6, supplies the current to V4B and maintains the cathode potential of V4A at a constant value. The positive half wave of the resonant circuit is critically damped through diode D7, which is required to offer fast switching capabilities. The grid bias of tube V4A is stabilized by using the forward characteristic of silicon diodes D8 and D9. The recovery speed of the circuit is helped by the use of crystals with low forward impedance.

The positive output signal at the plate of V4B is applied to a cathode follower (V5A, V5B), which provides a low output impedance (120 ohms) and avoids any loading effect of external circuitry on the trigger.

The waveforms at different points of the circuit are represented in Fig. 2.

---

[1] W. C. Davidon and R. B. Frank, Rev. Sci. Instr. 27, 15 (1956).

PERFORMANCE

Linearity of the Threshold

The threshold linearity in the useful range of 1 to 11 volts is better than 1% for pulses longer than 50 nsec (1 nsec = 10^{-9} sec). With 25-nsec pulses the linearity is at least 2%, but the absolute value increases by 0.1 volt. With 10-nsec rectangular pulses, the error in linearity is 20% at the lowest value, decreases continuously to 1% at 0.2 of the range, and remains lower than 1% for the rest. However the absolute value is increased by 1.25 volts.

Resolution Time

The resolution time for two input pulses is characterised by the curves of Fig. 3, which gives the variation of the threshold for the second of two input pulses versus the separation between these pulses. The test has been made in the two cases in which the amplitude of the first pulse exceeds the threshold by 0.1 volt and 1 volt.

The circuit is capable of being triggered at a continuous rate as high as 11 Mc/sec. It responds to pulses 0.1 μsec apart occuring in bursts having a duration of several μsec and a repetition rate of 100 cps without threshold variations higher than 100 mv.

Delay Time

The delay between corresponding input and output pulses taken at 50% of the front edge varies by the amount by which the amplitude of the input signal exceeds the threshold, as represented in Fig. 4. For example the delay time for a pulse exceeding the threshold by 0.04 volt is 40 nsec.

Threshold Stability

The threshold stability has been tested continually for 165 hr. After an aging period of 35 hr the drift of the average value of the threshold has been less than 2 mv per hour, while the rapid variations never exceeded 25 mv. During this test the circuit was supplied with 1%-regulated filament- and anode-supply voltages.

ACKNOWLEDGMENTS

The author acknowledges the hospitality of the Electronics Department and the Counting-Development Group at the University of California, Radiation Laboratory and wishes to thank Mr. Dick Mack and Mr. Michiyuki Nakamura for their helpful discussions and encouragement.

LEGENDS

Fig. 1. Circuit for 10 Mc/sec pulse-amplitude discriminator.

Fig. 2. Waveforms at (a) input, (b) plate of V4B, (c) grid of V4B, and (d) output. Horizontal calibration is 20 nsec/division.

Fig. 3. Double-pulse resolution curves showing threshold variation vs. separation θ between pulses.

Fig. 4. Delay time for various increments of input-pulse amplitude above threshold.

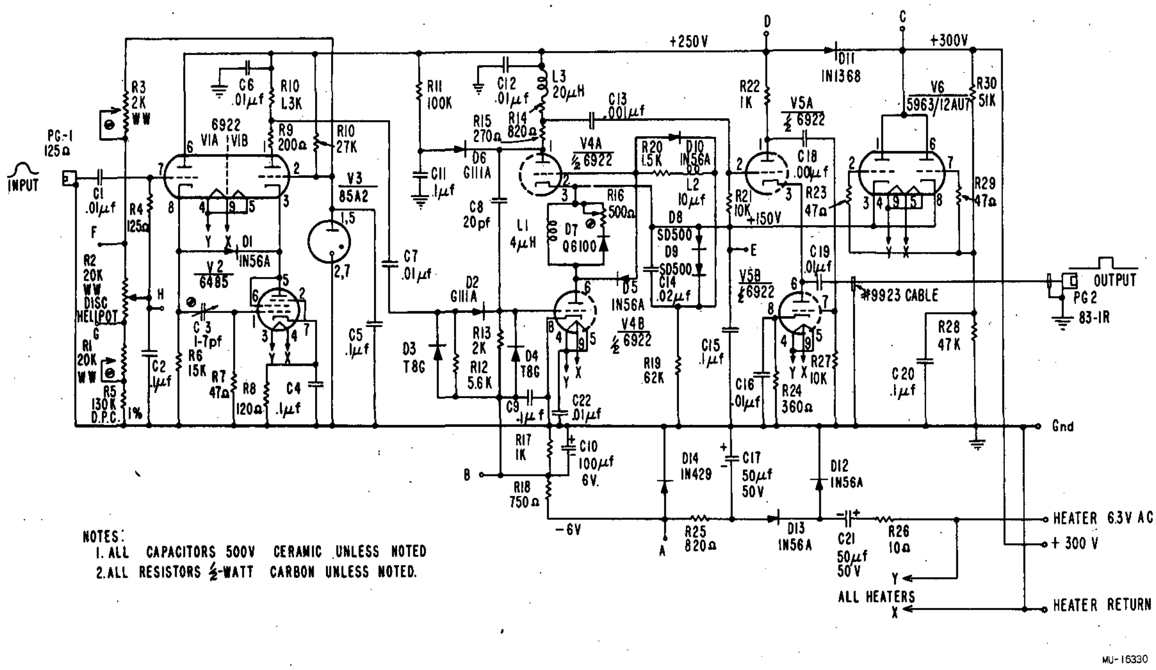
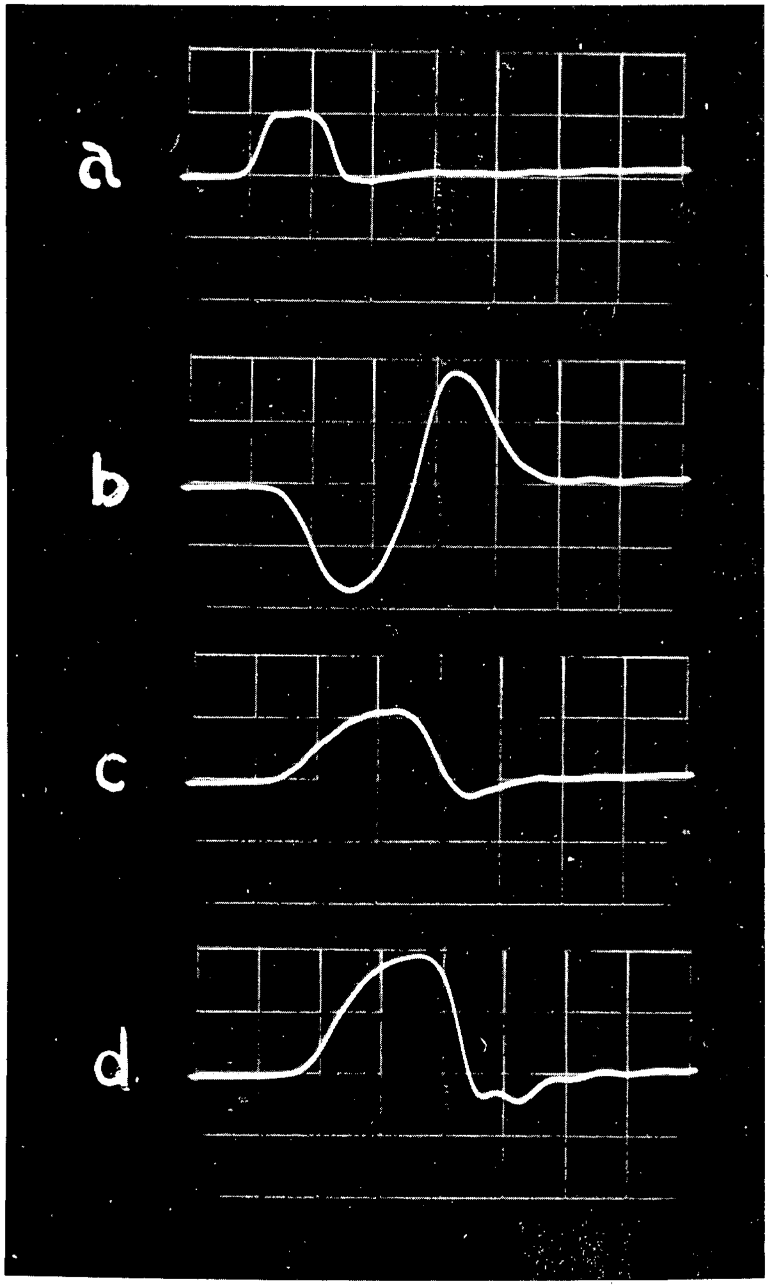


Fig. 1. Circuit for 10 Mc/sec pulse-amplitude discriminator.



ZN-2073

Fig. 2. Waveforms of (a) input, (b) plate of V4B, (c) grid of V4B, and (d) output. Horizontal calibration is 20 nsec/division.

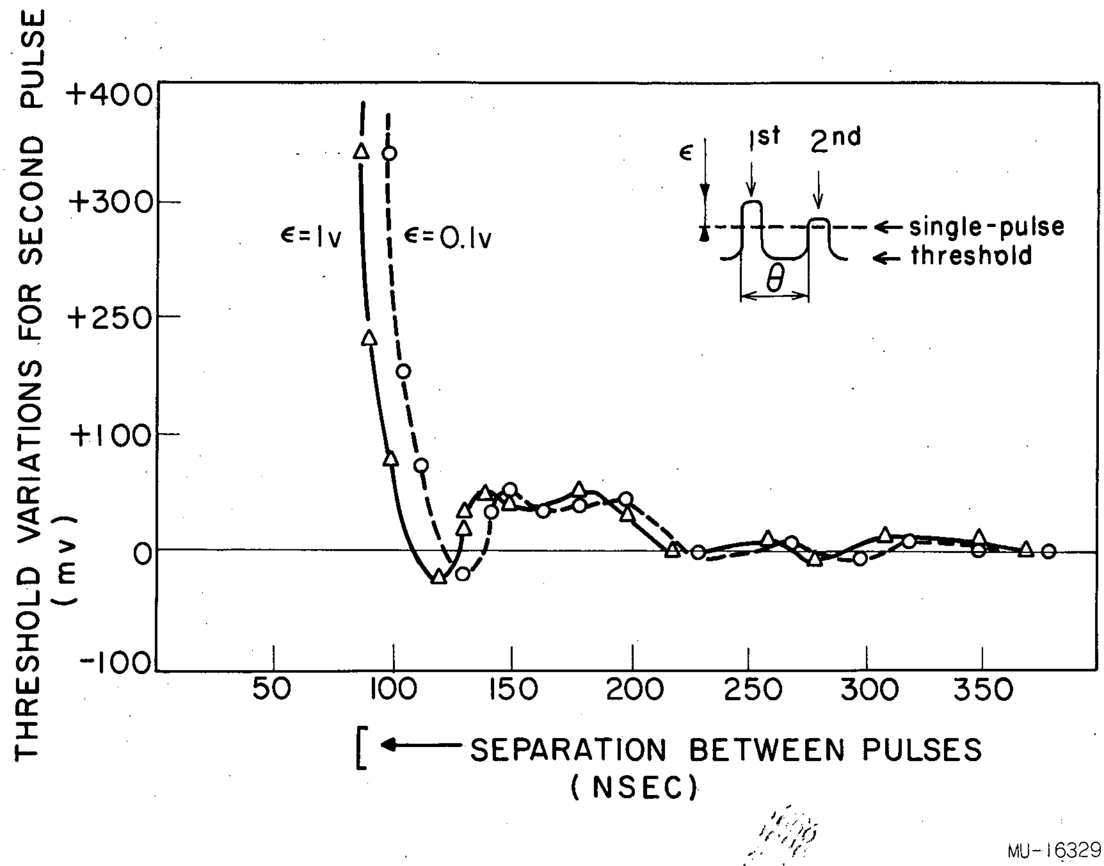


Fig. 3. Double-pulse resolution curves showing threshold variation vs. separation θ between pulses.

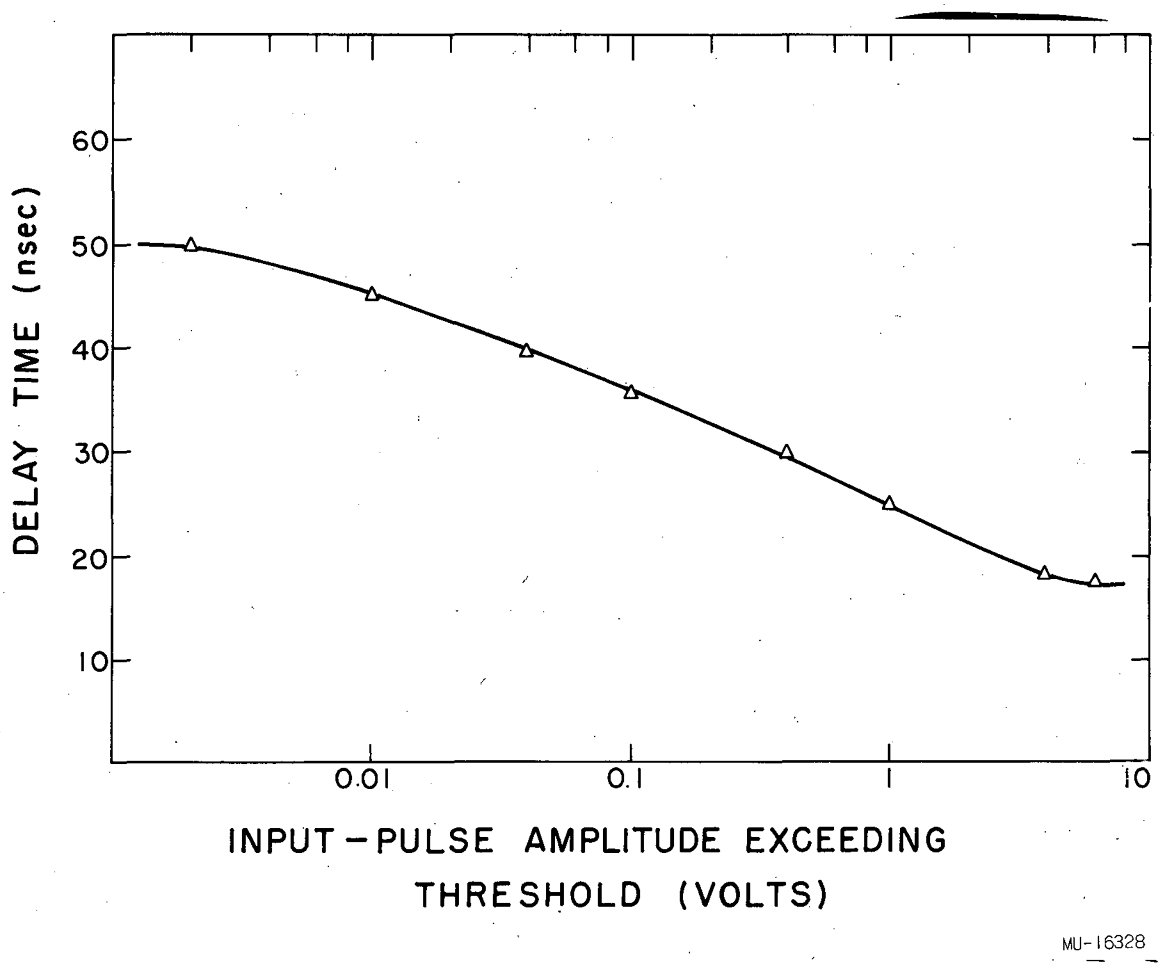


Fig. 4. Delay time for various increments of input-pulse amplitude above threshold.