

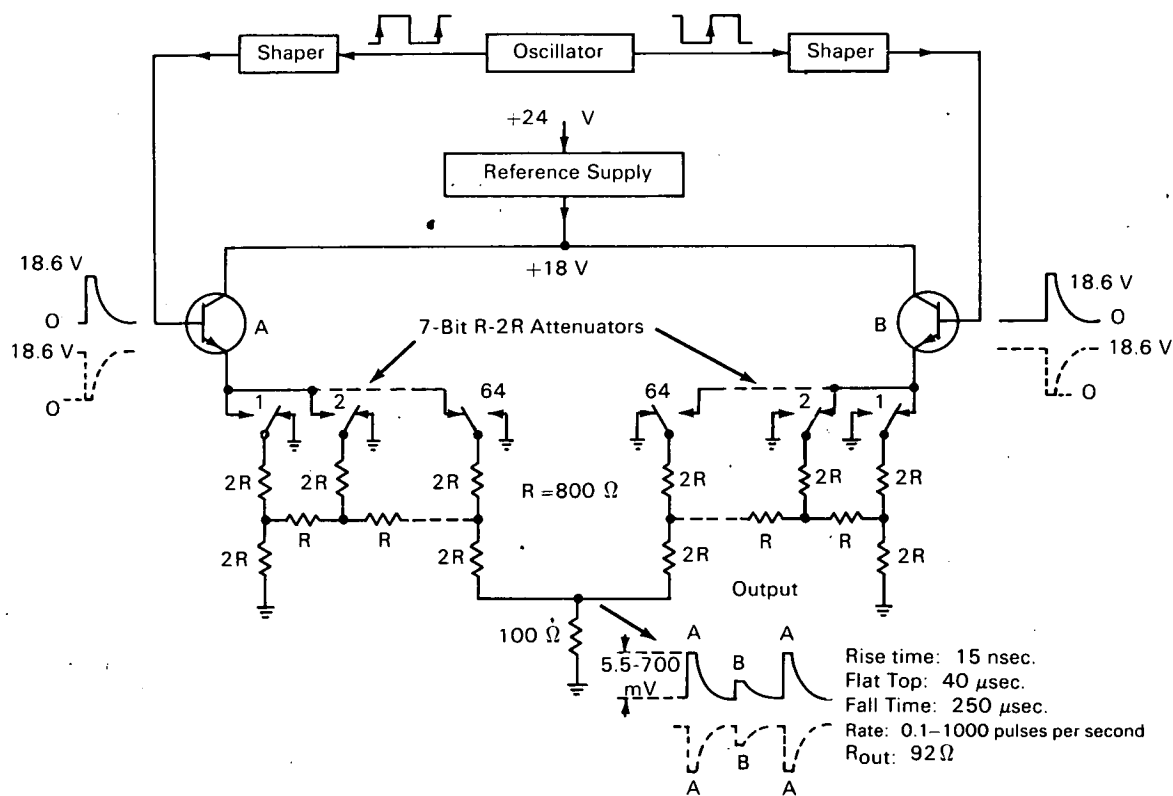


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Ultrastable Reference Pulser for High-Resolution Spectrometers



Simplified Schematic Showing Basic Features of the Pulse-Generator

The problem:

To develop an ultrastable pulse-height-analysis system for a high-resolution semiconductor detector. Specific requirements for resolution (0.05%), amplitude range (0.1-13 MeV), and repetition rate (0.1-1000 pulses per second) had to be met. In addition, a method for tagging the reference pulses was desired.

The solution:

A solid-state double-pulse generator with a pulse amplitude-temperature coefficient of 0-8 ppm/°C was developed. When a servo-stabilized spectrometer is locked on the pulser peaks, the gain and zero-intercept of the system drift only ± 20 ppm/day, or less than 1/10 of the optimum resolution of Ge(Li) detectors.

(continued overleaf)

The pulser generates signals that rise in 15 nsec, remain flat-topped for 40 μ sec, and then fall exponentially to the base line in 250 μ sec. The pulse rate can be varied from 0.1 to 1000 pulses per second in nine steps. The amplitude of the two pulses can be set independently from 5.5 to 700 mV by use of a seven-bit, precision, R-2R attenuator. When the pulser is used in conjunction with a preamplifier test capacitor of 1 pF, this amplitude range corresponds to an energy range from 0.1 to 12.8 MeV for particles detected in germanium. A "tag" pulse, generated in coincidence with each reference pulse, may be used for gating of a multichannel analyzer, a coincidence system, or a stabilizer.

The performance of the pulser was measured with a computer-based, servo-stabilized, multichannel analyzer in which the two ^{60}Co lines, recorded by a Ge(Li) detector, were used as the stabilizer-reference peaks. The shift of the pulser's peak relative to the ^{60}Co peaks is a measure of the pulser's stability.

How it's done:

An oscillator (see figure) followed by a flip-flop generates two square waves, 180° out of phase, that are applied to two pulse-shapers. For positive output pulses, the outputs of the shapers are applied to emitter followers that are normally "off." (For negative outputs they are normally "on.") The emitter followers alternately saturate and then return exponentially to their initial condition. The 18-V emitter signals are attenuated by a seven-bit R-2R ladder and mixed at the output across a 100-ohm resistor to produce the wave form shown.

The stability of the output pulses may be influenced by the 18-V reference supply, the R-2R attenuators, and the transistor switches. The supply has good resolution against variations in the applied + 24 V. Since the temperature coefficient also is small, only 2 ppm/°C, the 18-V supply has no appreciable effect on the stability of the output pulses. The attenuator also has only a second-order effect on the stability of the output pulses.

The saturation voltage of a transistor varies as a function of emitter and base current as well as of

temperature. Since in the pulser the emitter current is constant with a given attenuator setting, it does not affect the stability of the output, but only its linearity. However, the base current is subject to variations induced by instability in the +24-V supply, which in turn results in fluctuations of the saturation voltage.

The variations in saturation voltage due to fluctuations of temperature and base drive are by no means negligible relative to the output level of the pulser (5.5 to 700 mV), but are quite small compared with 18 V. Thus, instead of producing the low-level signals directly, the 18-V pulses are generated and subsequently attenuated to the desired millivolt level, thereby reducing the instability of the output signals by a factor which ranges from 25 (18/0.7) to 3300 (18/0.0055). This reduction is the basic concept underlying the stability of this pulser.

Notes:

1. This innovation may interest designers and manufacturers of nuclear instrumentation.
2. Inquiries concerning this innovation may be directed to:

Office of Industrial Cooperation
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439
Reference: B70-10216

Source: M. G. Strauss, L. L. Sifter,
F. R. Lenkszus, and R. Brenner
Electronics Division
(ARG-10364)

Patent status:

Inquiries concerning rights for commercial use of this innovation may be made to:

Mr. George H. Lee, Chief
Chicago Patent Group
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Chicago Operations Office
9800 South Cass Avenue
Argonne, Illinois 60439