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Current-Switching Technique for Analog Pulse Circuits

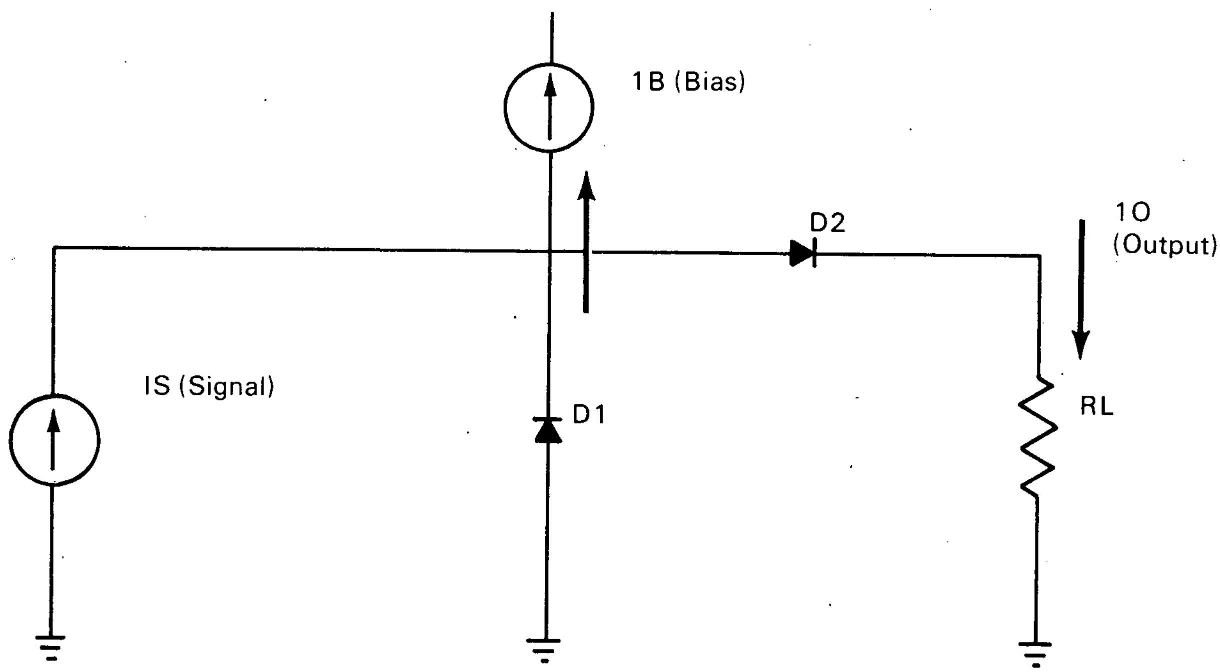

Fig. 1. Diode-current switch driven from a high-impedance source (Is). This circuit gives improved transfer-function linearity above the threshold.

A new circuit technique is analyzed both theoretically and experimentally (*1*); its principle is use of a signal diode as a series current-pass element. This technique is applied to the design of two circuits: a biased amplifier and a nanosecond-pulse stretcher.

In the design of analog pulse circuits, the transfer function of the circuit is generally of prime importance: in the design of a linear amplifier, for example, an output is desired that is truly a linear function of the output. The input parameter may be in terms of voltage, current, or charge; the output parameter need not be the same; the amplifier transfer function could, for example, be voltage output versus charge input. Whichever parameters are used they must be linearly related over the dynamic range of the circuit.

The electronic components used in design of analog circuits (vacuum tubes, transistors, diodes) do not have linear voltage-transfer functions. Circuit linearity is usually achieved by such techniques as negative feedback through linear components such as resistors

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and capacitors; this technique has proved quite satisfactory with linear amplifiers. However, negative feedback does not always give the best circuit performance with other types of analog circuits such as a biased amplifier; in this case, the transfer function is zero up to a specified input threshold and is linearly related to the input above this threshold. Such a transfer function is useful when pulses below a specified input threshold are of no interest.

An important characteristic of such a transfer function is the "sharpness" of the threshold. There are several techniques for improving this characteristic; the method investigated (*1*) utilizes the current-transfer characteristics of a junction-signal-diode switching circuit.

Since the diode is a two-terminal device, the current into the diode obviously equals the current out of it, and the current input and output are linearly related. Often a biased switching circuit is used. However, since the diode does not have ideal V-I characteristics, the output is not a linear function of the input, especially near the point where the diode begins conduction; this is so because the voltage-attenuation across the diode is a nonlinear function of the current through it.

The effect of the nonlinear V-I characteristics of the diode can be reduced by use of a simple current-switching circuit (fig. 1). In this circuit, diode D_1 is normally conductive, D_2 is nonconductive, and the output current is zero for all values of $I_s < I_b$. When I_s exceeds I_b, diode D_1 switches off, and the input-signal current flows through diode D_2. This current $(I_s - I_b)$ flows through D_2 regardless of the V-I characteristics of D_2, even when the input signal barely exceeds the bias current. The output (current) is then linearly related to the input (current) over a much greater dynamic range than the conventional biased switching circuit.

Several current-switching circuits based on this principle are investigated both theoretically and experimentally (*1*), as well as their advantages and limitations relative to conventional circuits.

Reference:

1. R. N. Larsen, "A new current switching technique for analog pulse circuits" (Argonne National Laboratory, May 1968).

Notes:

1. Designers or manufacturers of computer or process-control systems may be interested.
2. Inquiries concerning this information may be directed to:

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Patent status:

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