Solid State

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BACK TO THE (CIRCUIT) MINES

READER response to my prospecting trip among the circuit mines of manufacturers' literature in the August issue (*A Circuit Medley*) has been so gratifying that I've decided to pay a return visit to the "diggings." The results of my latest expedition are shown in Figs. 1 through 4. Like the circuits discussed previously, these nuggets are, of course, but a minuscule sampling of the thousands of designs suggested in manufacturers' periodicals, product bulletins, catalogs, application notes, data sheets, brochures, and reference handbooks. The major sources for circuits, naturally, are the publications released by the semiconductor manufacturers, but other component manufacturers—particularly those offering more expensive components such as transducers, transformers, and relays—are excellent secondary sources of information.

Intended for use as sampling gates, the Schottky diode switching circuits in Fig. 1 were abstracted from Application Bulletin 16, published by Hewlett-Packard Components (640 Page Mill Road, Palo Alto, CA 94304). Sampling is essentially a time-stretching technique by which a high-frequency, repetitive signal is duplicated at a lower frequency to permit observation and/or measurement with standard test instruments, such as an oscilloscope or vector voltmeter. The gates sample the instantaneous amplitude of the test signal at different points on successive cycles until the original waveform can be reconstructed. Depending on the sampling rate, as compared to the frequency of the test source, the reconstructed waveform may have an equivalent frequency one-tenth or less than that of the original.

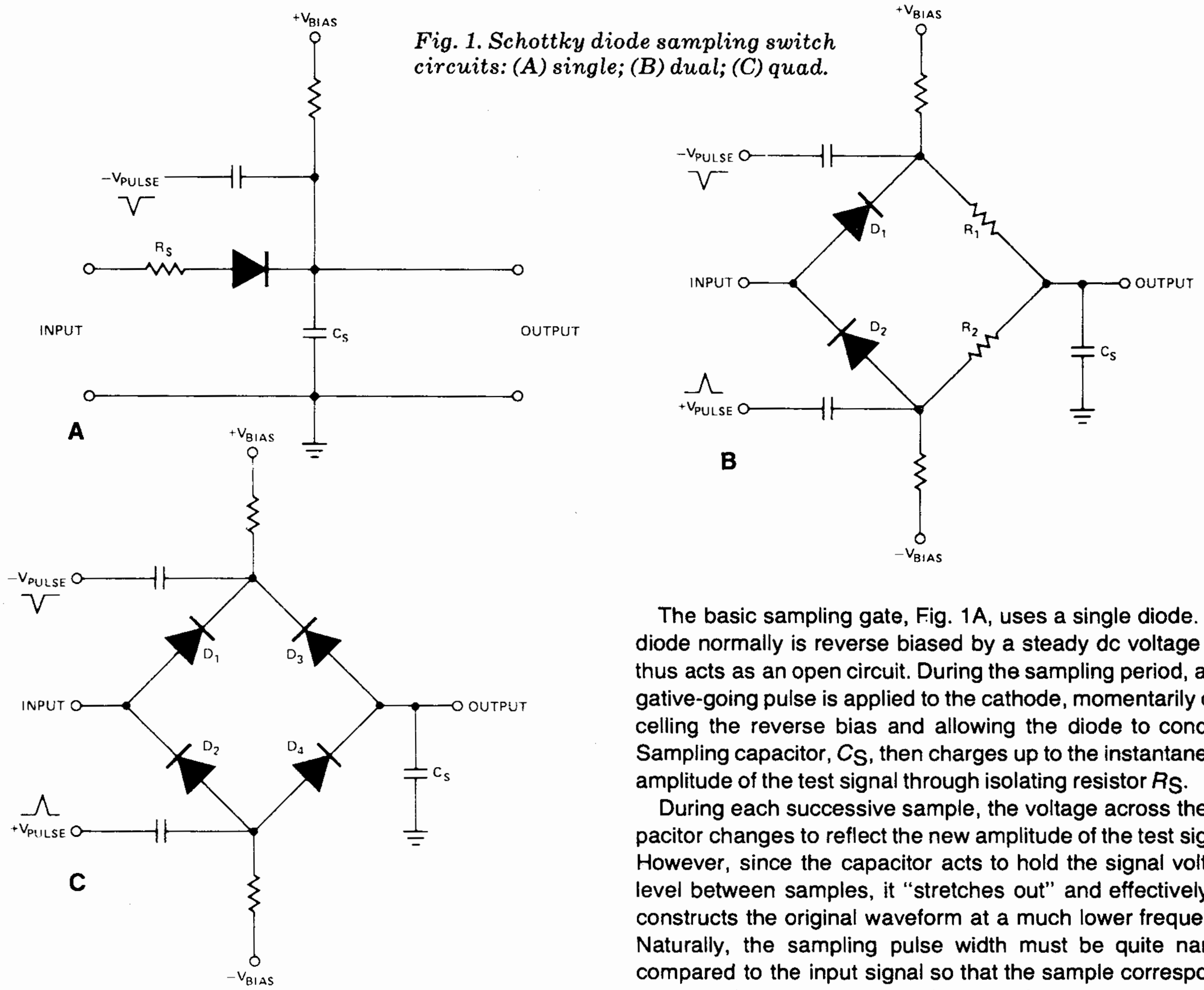

Fig. 1. Schottky diode sampling switch circuits: (A) single; (B) dual; (C) quad.

The basic sampling gate, Fig. 1A, uses a single diode. The diode normally is reverse biased by a steady dc voltage and thus acts as an open circuit. During the sampling period, a negative-going pulse is applied to the cathode, momentarily cancelling the reverse bias and allowing the diode to conduct. Sampling capacitor, C_S, then charges up to the instantaneous amplitude of the test signal through isolating resistor R_S.

During each successive sample, the voltage across the capacitor changes to reflect the new amplitude of the test signal. However, since the capacitor acts to hold the signal voltage level between samples, it "stretches out" and effectively reconstructs the original waveform at a much lower frequency. Naturally, the sampling pulse width must be quite narrow compared to the input signal so that the sample corresponds to a specific portion of the applied waveform. Also, the capacitor's charging time must be short enough to charge or discharge during this interval.

Although the basic single-diode sampling gate provides acceptable performance in some applications, it has a number of limitations. If the isolation resistor, R_S, is made too small, it is relatively ineffective. If it is too large, it reduces efficiency by introducing an excessive voltage drop and increasing the charging time constant. There is always the problem of the reverse bias developing a steady charge on the sampling capacitor. These limitations can be reduced somewhat by using a symmetrical dual diode sampling gate, as shown in Fig. 1B. Here, the diodes are arranged to form a bridge in conjunction with two fixed resistors, R_1 and R_2. Equal, but opposite, reverse bias voltage sources are required and both positive- and negative-going sampling pulses must be used to initiate operation. Superior to the single diode sampling gate, the dual diode design is also relatively inefficient due to the voltage drops across the bridge resistors.

The most efficient design as well as the most common in commercial equipment is one using four diodes arranged in a full-wave bridge, as illustrated in Fig. 1C. For optimum performance, the four diodes must have matched characteristics, the two reverse bias voltages must be equal and opposite, and the control signals must be identical in waveform except for polarity. The value of the reverse bias voltage is somewhat critical in that it must be large enough to prevent input signals from driving the diodes into conduction, yet small enough to permit the gating control pulses to forward bias the diodes during the sampling interval.

Typical Schottky diodes suitable for use in these circuits are the 1N6263 and HSCH-1001, or, for the bridge circuit, the HSCH-1004, 5082-2805, and 5082-2813 diode arrays. In practical systems, the sampling gate generally is placed between the input signal source and the following amplifier's input capacitor.