INSTRUMENTATION & TECHNIQUES

An inexpensive electronic switch with adjustable gain

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A simple electronic switch, based on the Motorola MFC 6040 electronic attenuator integrated circuit, is described. The circuit is useful in the slow-speed switching of audio signals where key click and switch bounce cannot be tolerated.

The electronic switch described here was adapted from circuits shown in Gray (1974) and elsewhere (Note 1) to program bilevel tapes for use in an experiment on the auditory von Restorff effect (Winters & Ward, 1975).

The device served so well in its original application that it has been further adapted for use where switch bounce (Gray, 1975) or key click (De Maw, 1971, p. 209; Lancaster, 1966) might be a problem in audio applications. The simplicity of the circuit makes it unsuitable for use in highly critical applications, e.g., in psychophysical studies where rapidly alternating on-off periods, with specifiable attack and decay slopes, are required; however, in less critical applications, where switch click and bounce can introduce spurious stimulus information (e.g., in operant conditioning experiments), the circuit may be of some use.

Figure 1 shows the circuit both in its original

configuration and with simplified alternative switching circuitry (lower right) to replace R1, R2, and SW1 in less stringent applications.

Integrated circuit IC1 regulates the power supply, producing a steady 12 V to insure that output volume will not vary with changes in line voltage. IC2 is a voltage-controlled amplifier, the frequency response of which is essentially flat (± 2 dB, re: .707 V rms input voltage) from 32 Hz to 16 kHz. Potentiometers R1 through RN set the level of attenuation of the signal passing through IC2. With the switches open, Pin 2 of IC2 is at ca. +5 V, producing an attenuation of ca. 90 B (0-dB reference = 13 dB gain @ 1 kHz) of the signal through IC2. When any switch is closed, Pin 2 goes less positive by an amount determined by the setting of its associated potentiometer, in a time period determined by the RC time constant (De Maw, 1971, p. 30) of the potentiometer's resistance and the value of C6. The less positive Pin 2 becomes (to a minimum of ca. 2.9 V), the higher is the gain of IC2. The exponentially graduated discharge of C6 through the potentiometer "shapes" the onset envelope of the switched signal (De Maw, 1971, pp. 209, 214) to "absorb" click and bounce (Lancaster, 1966). The offset envelope is controlled by the RC time constant of R1 and C6 in the original configuration; in the alternative configuration, it is controlled chiefly by C6. This being the case, the value shown for C6 should be considered the minimum necessary to prevent noise at signal offset when using the alternative switching configuration.

Since the potentiometers have the dual function of determining the discharge time of C6 and also of setting final output volume, there is an inverse relationship between attenuation and onset time (also offset time in the original configuration) of the output signal. In applications where such a relationship might cause problems (e.g., in a situation where high attenuation is coupled with the need for fast onset), the original configuration should be used, with the value of C6 reduced and the value of R1 increased to the point at which the output signal is below auditory threshold with SW1 in the normally closed position.

Figure 1. Device wired for use in original application and (lower right) with alternative switching circuitry.

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