XR-2206 IC Function Generator Circuits

Part II. The XR-2206, IC is a versatile function-generator with many applications. Here are some of the more interesting circuits you can try.

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LAST MONTH, WE LOOKED AT THE PERFORMANCE characteristics of the XR-2206 IC and its application in sine, triangle and squarewave applications.

This month, we'll look at pulse, ramp, AM and FM applications.

Function generators

The circuits shown in Figs. 2 thru 8 can be combined in a variety of ways to make different types of waveform generators. Figure 9, for example, shows how some of the circuits can be combined to make a simple fixed-amplitude function generator that provides sine, triangular and square waveforms. Here, the squarewave output is taken directly from pin 11 of the IC, and is produced simultaneously with the sine or triangular waveform at pin 2, which are selected by switch S1.

Alternatively, Fig. 10 shows how some of the circuits can be put together to help make a low-cost high-performance function generator that covers 1 Hz to 200 kHz in five switched ranges. Frequencies are selected by RANGE switch S1 and FREQUENCY control R1. Each range of S1 covers a full decade plus 100% overrange at its upper frequency. The circuit has THD adjustment of the sinewave, and produces a typical distortion of 0.5%.

The sine/triangular output of the IC is taken from pin 2, and all outputs are fed to a simple variable attenuator network via the Q1–Q2–Q3 buffer stage. The sine/triangular output can be centered on precisely zero volts using OFFSET control R8, and R3 sets the maximum sinewave output level, which should be set at 2 volts RMS.

The procedure for initially setting up the circuit when it is first built is as follows. First, set the attenuator controls to give maximum output, set the circuit to the sinewave mode at about 1 kHz, and then adjust R8 to give zero offset of the output signal. To do this, connect a 0–2.5 volt DC meter to the output of the circuit, and then adjust R8 for zero reading. Next, connect a 0–2.5 volt AC meter to the output of the circuit, and adjust R3 to give a sinewave output of approximately 2 volts RMS. Finally, adjust R4 and R6 to give minimum distortion of the sinewave, as previously described, and then recheck the DC offset and output amplitude. The setting up procedure is then complete and the circuit is ready for use.

Pulse and ramp waveforms

Figure 11 shows the practical connections for using the XR-2206 as a variable-slope ramp generator circuit. Here, the squarewave output (pin-11) is connected to the FSK input (pin 9) of the IC. The circuit action is such that, when pin 11 is high, timing capacitor C1 charges via R1 until a threshold voltage is reached, at which point pins 11 and 9 switch abruptly to the low state. When this happens, the timing capacitor recharges in the reverse direction via R2 until pins 11 and 9 go high again. The process then repeats. The circuit, therefore, automatically switches between timing resistors on alternate half cycles, and produces a linear ramp output waveform at pin 2. The risetime and falltime are independently controlled by R1 and R2. The operating frequency of the circuit is given as:

$$f = \frac{2}{C1\ (R1+R2)}$$

The circuit shown in Fig. 11 develops a variable duty-cycle squarewave at pin

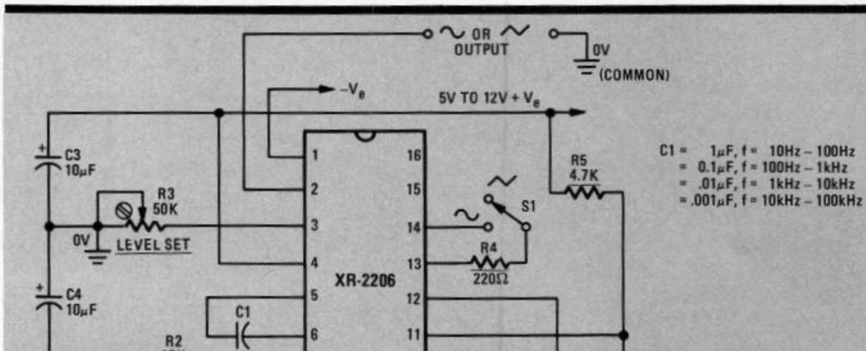

FIG. 9—SIMPLE FUNCTION GENERATOR provides sinusoidal, triangular and square waveforms.

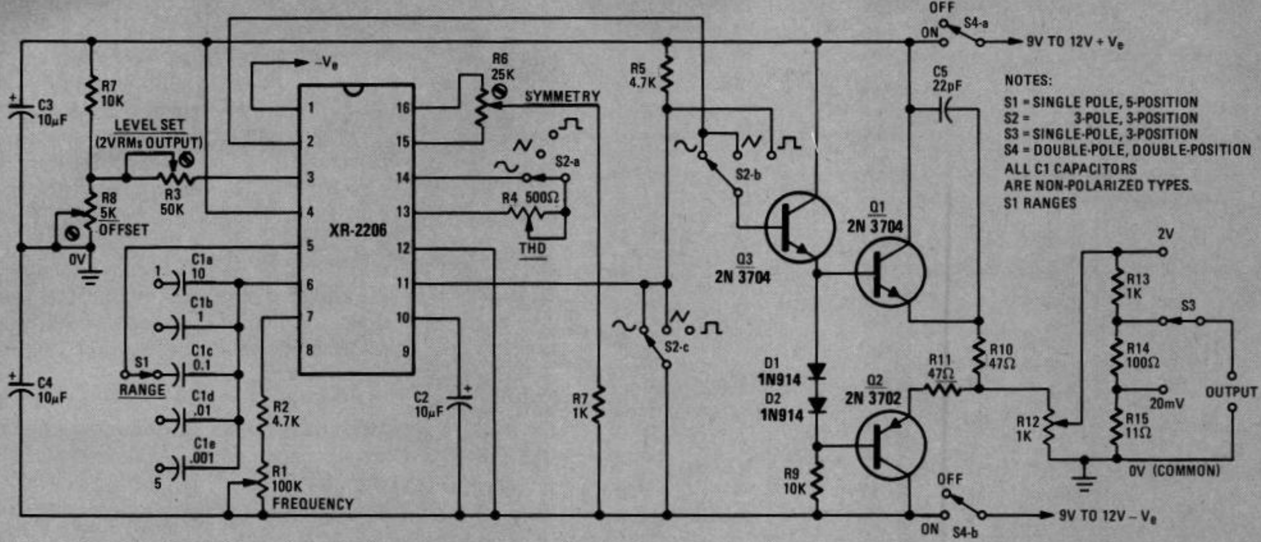

FIG. 10—HIGH-PERFORMANCE FUNCTION GENERATOR has a frequency range of 1 Hz to 200 kHz. The sinewave output has a distortion of 0.5 percent and an amplitude of 5.6-volts P-P maximum. The triangular waveform has a linearity of 1 percent and a maximum peak-to-peak amplitude of 12 volts. The squarewave output has a risetime of 200 ns, a falltime of 100 ns, and a maximum output of 16 volts P-P.

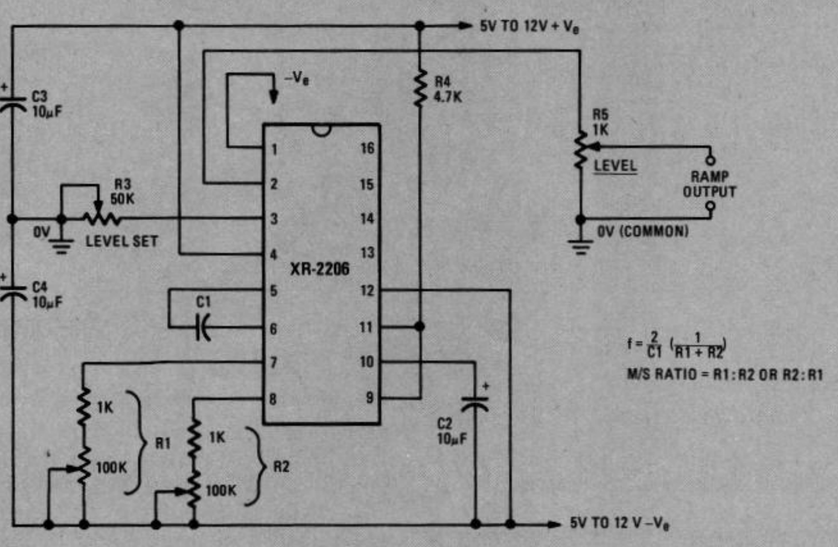

FIG. 11—RAMP GENERATOR provides variable-slope output signal.

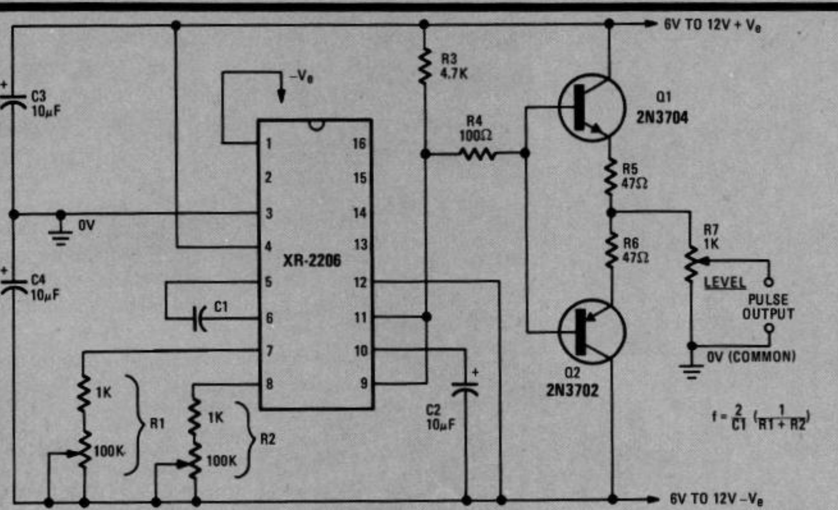

FIG. 12—PULSE GENERATOR provides variable duty-cycle output signal and has an output buffer.

11 simultaneously with the ramp waveform. The squarewave, however, is of fixed amplitude and is not suitable for directly driving low-impedance external loads. If required, the XR-2206 can be used specifically as a pulse or variable duty-cycle squarewave generator as shown in Fig. 12. Here, the SET-LEVEL control is eliminated from the pin–3 terminal of the IC, and the pulse signal at pin 11 is made available to external loads by the Q1–Q2 emitter-follower stage and LEVEL control R7.

Alternatively, the circuits shown in Figs. 11 and 12 can be combined to form a practical variable pulse or ramp generator by using the connections shown in Fig. 13. Here, the desired waveform can be selected by S1, the waveform shapes are varied by R1 and R2, and the waveform amplitudes are controlled by R8.

The versatility of the Fig. 13 circuit can be increased, if desired, by replacing the existing pulse output stage with the one shown in Fig. 14. This circuit enables either positive, negative or symmetrical output pulses to be selected by S2, a 2-pole 3-position switch. Here, load resistor R4 is replaced by a pair of 2.7K, 5%, resistors. With switch S2 in position 1, the pulse output of the circuit is effectively taken from the junction of these two resistors, so the output switches between the fully positive and the half-supply or zero voltage levels. The circuit, therefore, provides positive output pulses. In position 2 of S2, the output is effectively taken from pin 11 of the IC and symmetrical output pulses are available. In position 3, the output is again taken from pin 11 of the IC but the top end of R4 is connected to the zero-voltage line. The output switches between the zero and negative supply voltage, and negative output pulses are available from the circuit.

FSK modulation

When the FSK input terminal of the XR-2206 IC (pin 9) is open circuit or externally biased above 2 volts with respect to the negative supply voltage, the pin-7 timing resistor is automatically selected and the circuit operates at a frequency determined by the timing capacitor and the pin-7 timing resistor. When pin 9 is connected to the negative supply voltage or is biased 1-volt below the negative supply voltage rail, the pin-8 timing resistor is automatically selected and the circuit operates at a frequency determined by the timing capacitor and the pin-8 timing resistor. The XR-2206 IC can thus be frequency-shift keyed (FSK) by simply applying a suitable keying or pulsing signal between pin 9 and the negative supply. Figure 15 shows the practical connections for making a simple FSK modulated sinewave generator or 'warble-tone' generator.

If required, the keying signal can be referenced to the ground or zero-volt line by using the 3-transistor add-on circuit shown in Fig. 16. Here, with the keying signal at the zero-volt level, all three transistors are cut off. When this occurs, pin 9 of the IC is effectively open circuit, and the output frequency is controlled by timing resistor R1. When the FSK input keying signal is high, transistors Q1 and Q2 conduct, causing Q3 to saturate. When Q3 saturates, pin 9 shorts to the negative supply and the output frequency is controlled by R2. The FSK facility controls both signals appearing at the pin 2 and pin 11 output terminals.

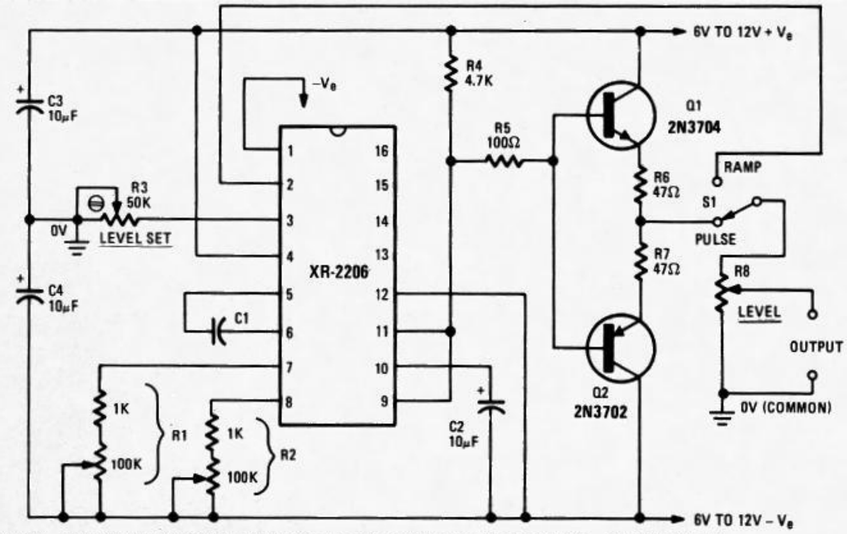

FIG. 13—PULSE AND RAMP WAVEFORM generator provides variable output signals.

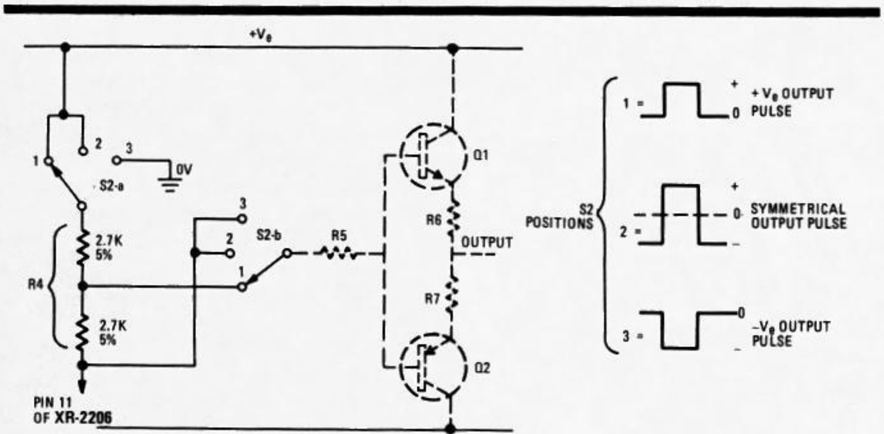

FIG. 14—MODIFIED OUTPUT STAGE for circuit shown in Fig. 13 provides either positive, negative or symmetrical output pulses.

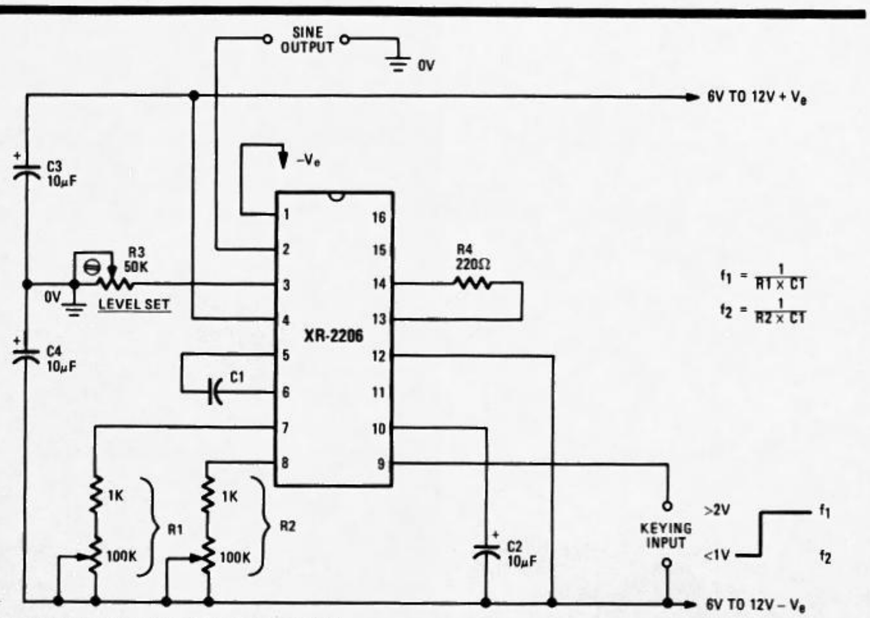

FIG. 15—BASIC FSK sinewave generator.

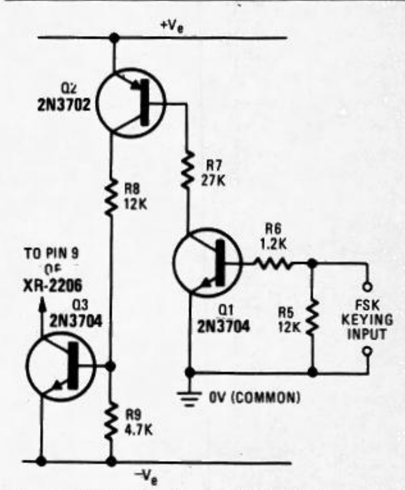

FIG. 16—FSK MODIFICATION to the circuit shown in Fig. 15 references the FSK input to the common or ground line.

Amplitude modulation

The output-signal amplitude at pin 2 of the XR-2206 can be modulated by applying a DC bias and a modulating signal to pin 1, as shown in Fig. 17. The internal impedance at pin 1 is approximately 200K ohms, so this pin should be connected to the negative supply to prevent unwanted pick-up when the AM facility is not in use.

The signal amplitude varies linearly with the applied voltage at pin 1 when this voltage is within 4 volts of the half-supply value. In split-supply circuits, of course, the half-supply value equals zero volts. When pin 1 is at the half-supply value, the amplitude of the signal at pin 2 is approximately zero. When the pin-1 voltage is increased above the half-supply value, the signal at pin 2 rises in direct proportion. When the pin-1 voltage is reduced below the half-supply value, the pin-2 signal again rises in direct proportion, but the phase of the output signal is reversed. This last-mentioned feature can be used for phase-shift keyed (PSK) and suppressed-carrier AM generation.

The pin-1 terminal can also be used to facilitate gate-keying or pulsing of the output signal at pin 2. This can be achieved by biasing pin 1 at approximately half-supply voltage to give zero output at pin 2, and then imposing the gate or pulse signal on pin 1 to raise the pin 2–signal to the required turn-on amplitude. The total dynamic range of amplitude modulation is approximately 55 dB.

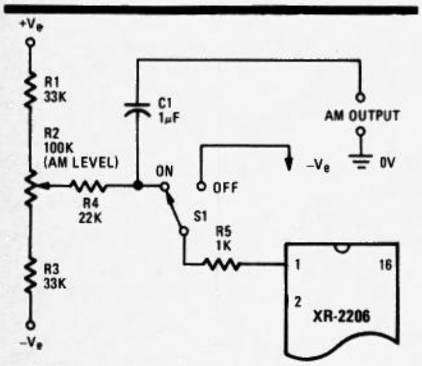

FIG. 17—AMPLITUDE MODULATION is accomplished with this add-on circuit.

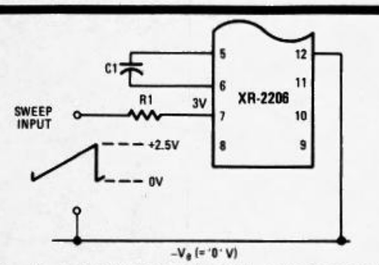

FIG. 18—FREQUENCY-SWEEP CONNECTION provides a 6:1 frequency range.

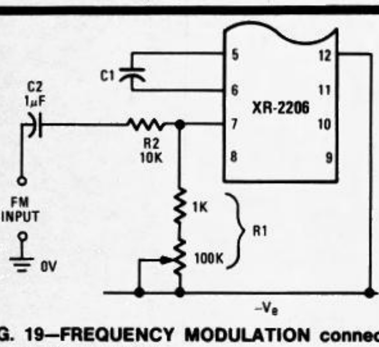

FIG. 19—FREQUENCY MODULATION connection for the XR-2206.

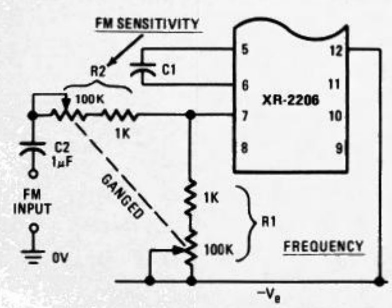

FIG. 20—CONSTANT-SENSITIVITY FM connection.

Frequency modulation

The output frequency of the XR-2206 is proportional to the total timing current (I_T) drawn from pin 7 or 8, and is given by:

$$f = \frac{320 \times I_T}{C}\ \text{Hz}$$

where I_T is in milliamperes and C, the timing capacitor, is in microfarads. Pins 7 and 8 are low–impedance terminals and are internally biased at +3 volts with respect to pin 12. The frequency varies linearly with I_T over the range of 1 µA to 3 mA. The frequency can be varied either by wiring a variable current-determining resistor between pin 12 and the timing terminal, or by applying a variable voltage in the range 0 to +3 volts between pin 12 and the timing terminal using a current-limiting resistor, or by a combination of these two techniques.

Figure 18 shows the basic connections of a simple frequency-sweep circuit with a 6:1 frequency range. Here, a sawtooth frequency-sweep signal that has a peak amplitude of 2.5 volts is applied between pin–12 and pin–7 timing terminal. When the instantaneous peak value of the sawtooth voltage is zero, 3 volts is developed across R1, and the frequency is the same as in the case of a simple resistance-controlled XR-2206 oscillator. When, on the other hand, the instantaneous peak value of the sawtooth voltage is 2.5 volts, only 0.5 volt is developed across R1, and the R1 current and, therefore, the frequency is reduced to only 1/6th of that of the case we have just looked at.

Figure 19 shows the essential connections of a simple FM generator. Here, in the absence of a modulating signal, the output frequency is determined by R1 and C1, as in the case of a conventional XR-2206 oscillator. When the modulating signal is connected to the FM input, the timing currents and, therefore, the output frequency of the circuit are modulated.

A weakness of the simple circuit shown in Fig. 19 is that, for a given amplitude of the modulating signal, the percentage of frequency deviation varies with the setting of the R1 FREQUENCY control. This snag is overcome in the constant-sensitivity circuit of Fig. 20. A dual-ganged potentiometer is used with one arm used as the R1 frequency-determining control and the other arm as the R2 FM-SENSITIVITY control, so that the sensitivity is automatically adjusted to track with the frequency setting.

It should be noted that the frequency-sweep and frequency-modulated signals appear at both pins 2 and 11.

Power supplies

Finally, a few notes on choosing power supplies for the XR-2206 IC. It should be noted that the XR-2206 has built-in voltage regulation circuitry controlling the VCO, and that the amplitude of the output signal at pin 2 is not significantly influenced by variations in circuit supply voltage. Consequently, there is little advantage in using higher supply-voltages than are absolutely necessary for correct operation. In most cases, single-ended or split 12-volt supplies are adequate.

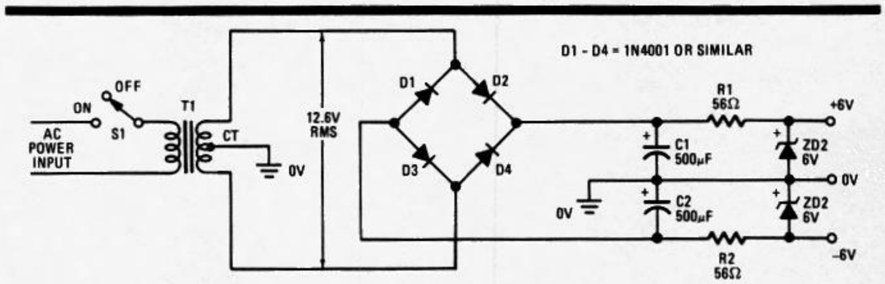

FIG. 21—REGULATED SPLIT-VOLTAGE power supply provides a 6V-0-6V output.

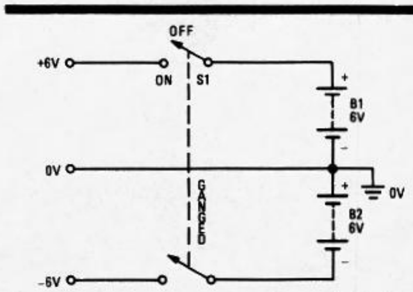

FIG. 22—BATTERY SUPPLY with split 6V-0-6V output.

Figure 21 shows the practical circuit of a line powered Zener-regulated 12-volt split-supply (6V–0–6V) circuit. Figure 22 shows the alternative connections for using a battery power supply. The XR-2206 draws a typical current of about 15 mA when used with these supplies. R-E