SAWTOOTH GENERATOR

Sawtooth signals can be useful for test purposes in audio and other circuits, but few signal generators (except expensive ones) provide a sawtooth output. This simple circuit will generate a sawtooth over the range 50 mHz to 50 kHz.

The simple generator described in this article will generate a linear repetitive ramp (sawtooth) waveform from subsonic to ultrasonic frequencies. The circuit, shown in figure 1, uses only five transistors and few other components.

T1 is connected as a constant current source and since T5/T4 present a high input impedance almost all this current flows into C_X, charging it so that the voltage across C_X rises linearly. The base voltage of T2 is set to about 9.9 volts by R3 and R4, so T2 and T3 are normally turned off. When the voltage across C_X (and hence on the emitter of T2) rises to about 10.5 V T2 turns on. Positive feedback from the collector of T2 to the base of T3 turns on T3 and positive feedback from the collector of T3 keeps T2 turned on. C_X rapidly discharges through T2 and T3, these transistors turn off and the cycle repeats. The compound emitter follower T5/T4 buffers the output and the output voltage may be adjusted by P2. P1 varies the charging current into C_X and hence provides fine control of the repetition frequency.

Since R3 and R4 determine the voltage at which T2 turns on they may be altered to set the maximum output voltage of the generator. The maximum output is given by:

$$V_{out\ max} = \frac{V_{supply} \times R_4}{R_3 + R_4}$$

From this it is apparent that the output voltage is also dependent on supply voltage, so this should be stabilised to avoid output voltage variations.

The repetition frequency of the sawtooth is given by:

$$f \approx \frac{I_{C_X}}{V_{C_X max} \cdot C_X}$$

$$\approx \frac{\frac{V_f}{R_1 + P_1}}{\left(\frac{V_{supply} \cdot R_4}{R_3 + R_4} + V_f\right) C_X}$$

Where V_f is a diode forward voltage drop (about 600 mV).

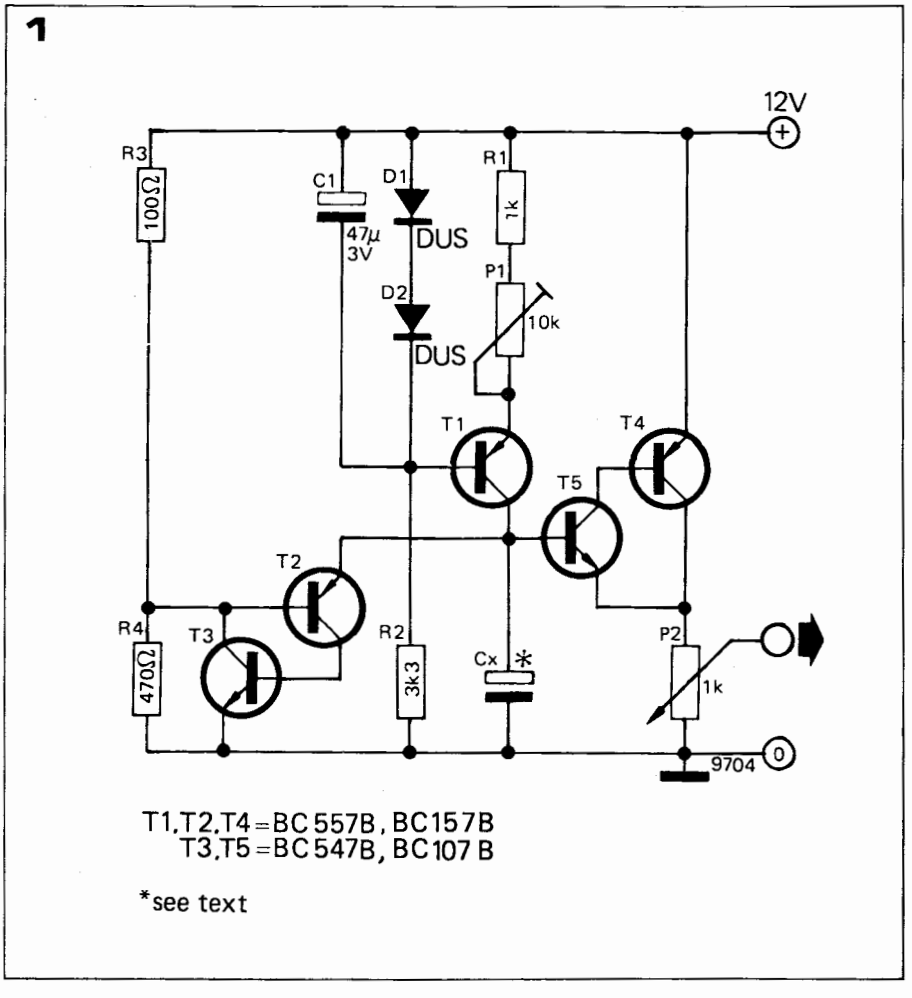
The value of P1 may, of course, be varied between zero and 10 k. P1 can, however, vary the frequency only over a 10:1 range, so to obtain a wider range different values of C_X must be switched in. Table 1 gives values of C_X for six decade frequency ranges from 50 mHz to 50 kHz. However it should be noted that on the lowest frequency range (where C_X must be an electrolytic) the frequency range covered may deviate from that given due to the large tolerance of electrolytic capacitors.

Table 1

C_X	Frequency Range
100 µ/16 V	50 mHz to 500 mHz
10 µ/16 V	500 mHz to 5 Hz
1 µ/16 V	5 Hz to 50 Hz
100 n	50 Hz to 500 Hz
10 n	500 Hz to 5 kHz
1 n	5 kHz to 50 kHz

Figure 1. Circuit of the sawtooth generator.

Table 1. Values of C_X for six frequency ranges.



T1,T2,T4 = BC 557B, BC157B
T3,T5 = BC 547B, BC107 B

*see text