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roll out the bandit

This oscillator was designed for driving electronic games of chance, such as the 'three-eyed bandit' (Elektor No. 2 page 238) or an electronic 'roulette wheel'. The disadvantage of the 'three-eyed bandit' is that a stop button must be pressed to stop the three oscillators and obtain the final display. Thus the tension and anticipation obtained with a real one-armed bandit as the number drums slowly grind to a halt is missing. The voltage-controlled oscillator overcomes this by providing an output whose frequency slowly reduces until it finally stops. This can also be used to simulate the 'rolling out' of the ball in a roulette wheel.

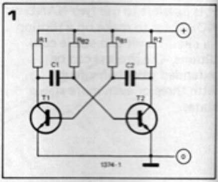
The circuit is based on the well-known astable multivibrator (figure 1). The frequency of oscillation of this circuit is determined by the charging current into C1 and C2 through R_{B2} and R_{B1} when either of the transistors is in the cutoff state. The multivibrator can be turned into a simple VCO by connecting R_{B1} and R_{B2} to a seperate supply instead of to $+V_b$. Increasing the voltage applied to the base resistors will increase the charging current through them into C1 and C2, and will hence increase the frequency of oscillation. Reducing the voltage has the opposite effect.

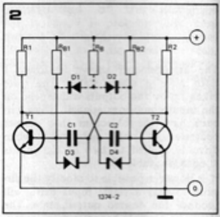
There are however, certain limitations to this simple approach. The base resistors perform two functions. When (for example) T1 is turned on R_{B1} supplies its base current. The minimum current must be such that the transistor remains in saturation. This places a restriction on the minimum voltage that may be applied for a given base resistor. When T1 is turned off and T2 is turned on, R_{B1} supplies the discharge current for C2 whilst R1 supplies the charging current for C1. For correct operation C1 must have charged up to almost $+V_b$ before T1 turns on again. This means that C2 must discharge more slowly than C1 charges, and this limits the maximum control voltage that may be applied to the base resistors. In practice frequency changes of between 10 : 1 and 50 :1 can be achieved, depending on the gain of the transistors. This is insufficient for this application.

Base current feed through zener diodes

The limited frequency range can be extended by the circuit of figure 2. Normally the coupling capacitors supply a portion of the base current whilst they are charging from the collector resistors, but this ceases as soon as the capacitors are charged. The zener diodes perform two functions:

1. they limit the voltage to which the coupling capacitors charge, and hence the time required for charging.
2. they provide a D.C. path for the transistor base current, even when the capacitors have charged. This means that the base resistors only provide the discharge current for the capacitors with the transistors in a cutoff condition. They can thus be much larger. Also, since one transistor is always cut off, only one base resistor is required (shown dotted in figure 2) provided the transistor bases are isolated by diodes. When this circuit is used as a VCO by connecting R_B to a control voltage a





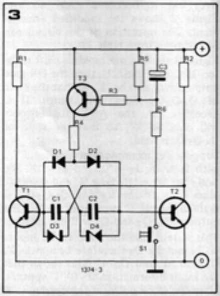
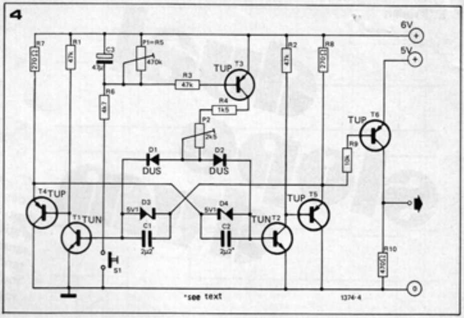


Figure 1. A basic astable multivibrator. This may be voltage-controlled by connecting the base resistors to a variable voltage instead of $+V_b$.

Figure 2. Addition of zener diodes makes transistor base current almost independent of base resistors. The two base resistors can be replaced by a single resistor and two diodes.

Figure 3. Base resistor replaced by a voltage-controlled current source.

Figure 4. Addition of emitter followers improves risetime without sacrificing loop gain. T6 further improves risetime and drives TTL.



frequency range of between 200 : 1 and 500 : 1 is obtainable.

Decaying frequency characteristic

The next step is to achieve the gradual decay of frequency required. This is accomplished in the circuit of figure 3. When the pushbutton is pressed C3 is charged rapidly. The voltage on C3 turns on T3 which causes the oscillator to start. As C3 slowly discharges the collector current of T3 decreases and the oscillator frequency reduces until the voltage across C3 is less than about 0.6 V, when T3 cuts off and the oscillator stops.

The final circuit

Figure 4 shows the final circuit. Emitter followers T4 and T5 are incorporated to provide a low impedance charging path for the coupling capacitors, thus improving the rise time of the waveform without reducing R1 and R2, which would reduce the loop gain. T6 converts the output to a level suitable for driving TTL circuits.

The discharge rate of C3, and hence the 'rolling out' time, is adjusted by P1. The initial frequency of oscillation is adjusted by P2. Note that C1 and C2 should be non-electrolytic types.

With the component values shown the results obtained were as follows:

Starting frequency 100 to 300 Hz.

Final frequency about 0.3 Hz.

'Rolling out' time 25 s maximum.

light dimmer

This simple triac dimmer can be used to control incandescent filament lamps up to 1500 W. The circuit operates on the phase-control principle. The main control is provided by P2. This determines the rate at which C2 charges and hence the point along the mains waveform at which the voltage on C2 reaches the breakdown voltage of the diac, which is when the triac is triggered. P1, in conjunction with R1 and C1 determines the minimum brightness level, or alternatively may be used as a fine brightness control. Interference suppression is provided by R2 and C3.

Construction

The printed circuit board is very compact and can easily be accommodated inside the modern, square type of flush-mounting switch panel, or in a small box for portable applications. The following safety points should be noted. No part of the circuit should be accessible from the outside. The case should preferably be made of plastic or other insulating material, and fixing screws for the board should be nylon. If a metal case is used the board must be adequately insulated from it and the case should be earthed. The potentiometer should have a plastic spindle.