CURRENT-CONTROLLED SAWTOOTH GENERATOR

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A simple current-controlled sawtooth generator is presented. Both the amplitude and the frequency of the generated sawtooth can be current-controlled. The circuit uses off-the-shelf components. Experimental results are included.

Keywords: Function generators

1 INTRODUCTION

Sawtooth and pulse generators find numerous applications in many diverse fields, for example, in instrumentation, measurement and control. In most of the existing sawtooth generators, a grounded capacitor is charged at a pre-specified rate using a constant-current source, and then rapidly discharged through a transistor switch [1–5]. However, while electronic control of the frequency is available in some of the circuits, none of the available circuits can simultaneously provide electronic control of the frequency and the amplitude. The purpose of this article is therefore to present a simple sawtooth generator with electronic control of the frequency and the amplitude.

2 PROPOSED CIRCUIT

The proposed circuit is shown in Figure 1. The operation of this circuit can be described as follows:

1. When the voltage at pin 3 is high, that is V_{CC} the output current of the operational transconductance (OTA1) equals the input auxiliary bias current I_{b1} . This is attributed to the fact that when the differential input voltage of the OTA is greater than a few millivolts, then all the bias current will be pushed into the output of the OTA. In the meantime, a high voltage at pin 3 will switch off the switch S_1 . Thus, the capacitor C will charge at a constant rate equals I_{b1}/C .

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FIGURE 2 Variation of the sawtooth frequency with the control current I_{b1} . $V_{CC} = 5$ V, $C = 30$ nF, $I_{b2} = 0.7$ mA.

$30\ \Omega$. Thus, by connecting the four SPST switches in parallel an on-resistance as low as $7.5\ \Omega$ can be achieved and high accuracies can be achieved. The sawtooth output is taken from the voltage across the capacitor via a buffer to isolate the load. By inverting the output at pin 3, a pulse with very narrow width, that is a sync, can be obtained.

FIGURE 3 Variation of the sawtooth frequency with the control current I_{b2} . $V_{CC} = 5$ V, $C = 30$ nF, $I_{b1} = 0.7$ mA.

FIGURE 4 Variation of the sawtooth amplitude with the control current I_{b2} . $V_{CC} = 5$ V, $C = 30$ nF, $I_{b1} = 0.7$ mA.

Figures 2 and 3 show the variations of the frequency of oscillation with the bias currents I_{b1} and I_{b2} . These results were obtained with $C = 30$ nF and $V_{CC} = 5.0$ V. Figure 4 shows the variation of the sawtooth amplitude with the bias current I_{b2} . Figure 5 shows typical output waveforms. It appears from Figures 2–5 that the agreement between the measurements and

FIGURE 5 Typical output waveforms obtained with $V_{CC} = 5$ V, $C = 30$ nF, $I_{b1} = 1.4$ mA, $I_{b2} = 0.7$ mA.

the presented theory is fairly good. Discrepancies can be attributed to violations of the approximations leading to Eqs. (1) and (2).

4 CONCLUSION

A simple current-controlled sawtooth generator has been presented. The circuit is built around the 555 timer and uses a grounded capacitor and two operational transconductance amplifiers to achieve current control of the amplitude and the frequency of the sawtooth waveform. It is worth mentioning here that since the sawtooth output is taken from the capacitor, then any load resistance connected across the capacitor would take its current from the charging current of the capacitor. This may result in distorting the sawtooth output voltage. Such distortion can be avoided by inserting a unity-gain buffer between the capacitor and the load.

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