IMPLEMENTATION OF RECURSIVE DIGITAL SINUSOIDAL SIGNAL GENERATOR

Lingampelly Narsimhulu[1], Rajitha Aripirala[2]
[1,2]Dept of ECE
Christu Jyothi Institute of technology and Science Jangaon, Telangana, India

Abstract
The sine wave has found its usage in various applications, including factory testing for connectivity. One method of sine-wave generation is based on a positive feedback system that employs the principle of oscillation. Oscillation can only be achieved if the system satisfies the Bakhausen Criterion. Following the principles of an analog oscillator, a digital oscillator is implemented using a special two-pole band pass filter which is modeled with a recursive difference equation to generate fixed frequency sinusoidal wave.

Index Terms: sinusoidal wave generator, digital filter, positive feedback, recursive difference equation, digital oscillator

I. INTRODUCTION

The signal generator is exactly what its name implies: a generator of signals used as a stimulus for electronic measure- ments. Most circuits require some type of input signal whose amplitude varies over time. The signal may be a true bipolar AC signal (with peaks oscillating above and below a ground reference point) or it may vary over a range of DC offset voltages, either positive or negative. It may be a sine wave or other analog function, a digital pulse, a binary pattern or a purely arbitrary wave shape. The signal generator can provide ideal waveforms or it may add known, repeatable amounts and types of distortion (or errors) to the signal it delivers. This characteristic is one of the signal generators greatest virtues, since it is often impossible to create predictable distortion exactly when and where its needed using only the circuit itself.

II. DIFFERENCE EQUATION

A discrete, or difference, equation expresses a relationship between the elements of a sequence, yn, For example, the trivial difference equation

$y_{n+1}= y_n$

above has the solution

$y_n = y_0$

which means that the sequence y(n) may be any constant sequence. Many mathematical models are posed in the form of discrete equations. Discrete equations also arise when solving continuous models using numerical methods, a necessary task for all but the most simple models. Computers can only work with discrete data, so continuous equations must be discretized before they can be solved numerically.

III. RECURSIVE DIFFERENCE EQUATION BASED MODEL

The sine wave has found its usage in various applications, including factory testing for connectivity. One method of sine-wave generation is based on a positive feedback system that employs the principle of oscillation. Oscillation can only be achieved if the system satisfies the Bakhausen Criterion. Following the principles of an analog oscillator, a digital oscillator is implemented using a special two-pole band pass filter. Which is modeled with following recursive difference equation.

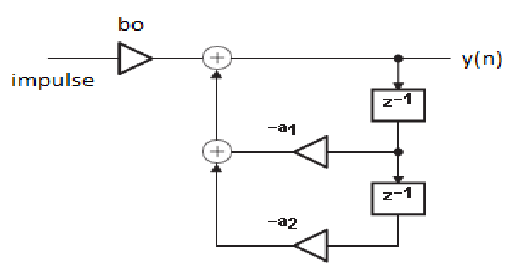

Fig.1.Realisation of Recursive difference equation

$y(n) = \delta(n) \times b_0 - a_1 \times y(n-1) - a_2 \times y(n-2)$

$y(-1) = y(-2) = 0, \ \omega o = \frac{2\pi fo}{Fs}$

$b_0 = A \times \sin(\omega_o),\ a_1 = -2 \times \cos(\omega_o),\ a_2 = 1$

IV. IMPLEMENTATION USING MATLAB SIMULINK

Using the above model designing a sinusoidal generator with frequency fo=5 hz, fs=20 hz amplitude A=5 v, we get following coefficients, assuming zero initial conditions

$b0 = 0.136,\ a1 = -1.999,\ a2 = 1,\ \omega o = 1.57,$

$A = 5$

On simulation of above Simulink model a sinusoid of 5 hz frequency and approximate peak to peak of 5v generated.

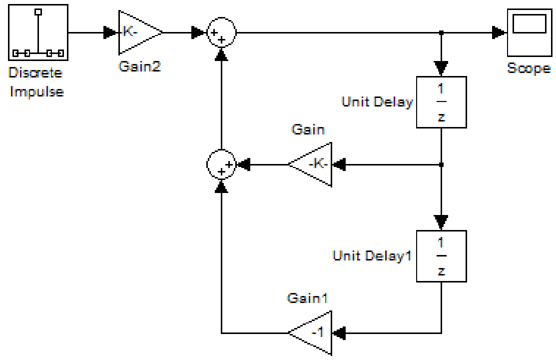

Fig.2.MATLAB Simulink Model

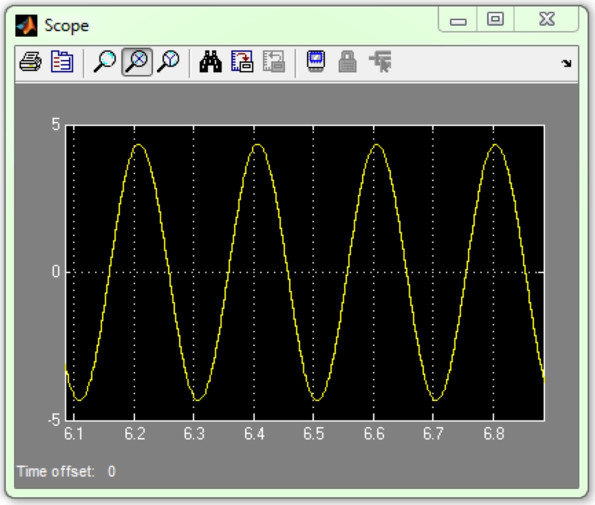

Fig.3. Generated Sinusoid of 5 hz

V. CONCLUSION

The recursive oscillator has good frequency stability, but the basic circuit has high output distortion. Nonlinear feedback offers the best performance over the mid- and upper-frequency ranges. The decreasing cost of digital devices and components has reduced the popularity analog oscillators.The drawback is the low amplitude, which can be increased using an additional gain stage, but with the penalty of greatly reduced bandwidth.

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