Analog synthesizer

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***Abstract*: music is an art that is widely practiced. One of the most common musical instruments is the keyboard. The synthesizer is essential component of the keyboard. There are two types of synthesizers, digital and analog. In this project we will design an analog synthesizer and form a sound file.**

I. Introduction

Analog synthesizer a device that use different component to create and mix different frequencies which will produce sounds. There are two main parts, oscillators and adder. The oscillators are unstable circuit that use positive feedback to produce a sinusoidal wave with different frequencies depending on its internal circuit. The adder, next, will synthase the frequencies from the oscillators giving us the desired output. In this project three different configurations of oscillator and single adder had been used.

II. Design

The oscillators are phase shift, quadrature, and wine-bridge

A. Proposed circuit: (as shown in Fig.4)

- Phase shift

It consists of an op-amp amplifier with negative feedback network and three capacitors in each will yield a 60° phase shift.

- Wie-Bridge

A Wien-bridge is an oscillator which has single op-amp with bridge circuit in the non-inverting side of op-amp.

- Quadrature

A two-stage circuit that produce two sinusoidal output 90° out of phase. It consists of two op-amps, one of them constructing an integrator.

Finally, three switches were used to control synthesizing the signal for the inverting adder.

B. Thoeritcal analysis

From the Barkhausen's criterion for each oscillation there are frequency of oscillation and condition of oscillation have to be met in order to oscillate.

Phase shift:

$$\omega_0 = \frac{1}{\sqrt{6}\,CR} \quad (1)$$

$$R_2 \geq 29\,R \quad (2)$$

Wien-bridge

$$\omega_0 = \frac{1}{RC} \quad (3)$$

$$R_2 \geq 2R_1 \quad (4)$$

Quadrature

$$\omega_0 = \frac{1}{RC} \quad (5)$$

$$R_f = 2R \quad (6)$$

Inverting -Adder

$$v_0 = -\left(\frac{R_f}{R_1}v_1 + \frac{R_f}{R_2}v_2 + \frac{R_f}{R_3}v_3\right) \quad (7)$$

III. Simulation Results

Usin LT-spice, an analog electronic circuit simulator, The design was simulated giving a sound file based on the frequency of the oscillators. The frequencies of the oscillation are based upon the musical tone and the availability of the component.

Oscillators frequencies:

- Phase shift : 1035 Hz
- Wien-bridge : 284 Hz
- Quadrature : 432 Hz

The avrage power consumed in the circuit is 152.64mW

IV. Discussion

The output is not perfectly sinusoidal because of the capacitors and resistors availability. The frequencies in the sound file were controlled utilizing voltage switch. It has been observed that the amplitude of each oscillator is not the same which might be clear at the sound volume. That is because of the building blocks for each type of oscillator.

A. Figures

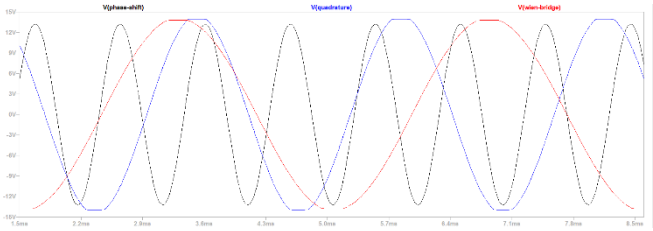

Figure 1. oscillators output

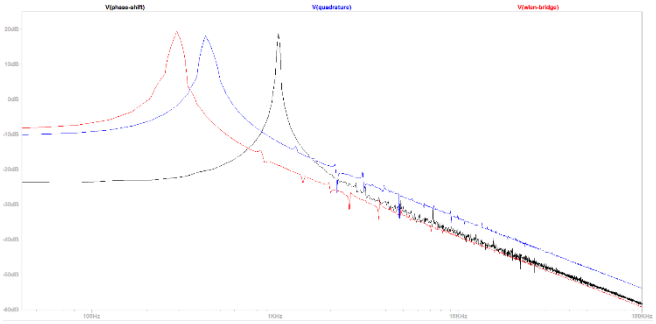

Figure 2. oscillators FFT graph

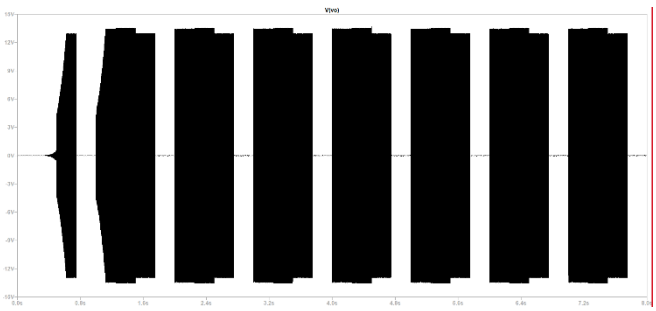

Figure 3.synthesizer output

Figure Labels: for figure (1 & 3) the x-axis is the time in seconds and y-axis is the voltage after the oscillation stabilized. For figure 2 the x-axis is frequency in hertz and y-axis is the amplitude in dB

V. Conclusion

An analog synthesizer design was presented and simulated using LT-spice. Oscillators were used to generate a sinusoidal wave with different desired frequencies. it has been mixed with a single adder and controlled with switch for each oscillator. Thus, a sound file, as attached, was generated with controlled sequence of tones.

REFERENCES

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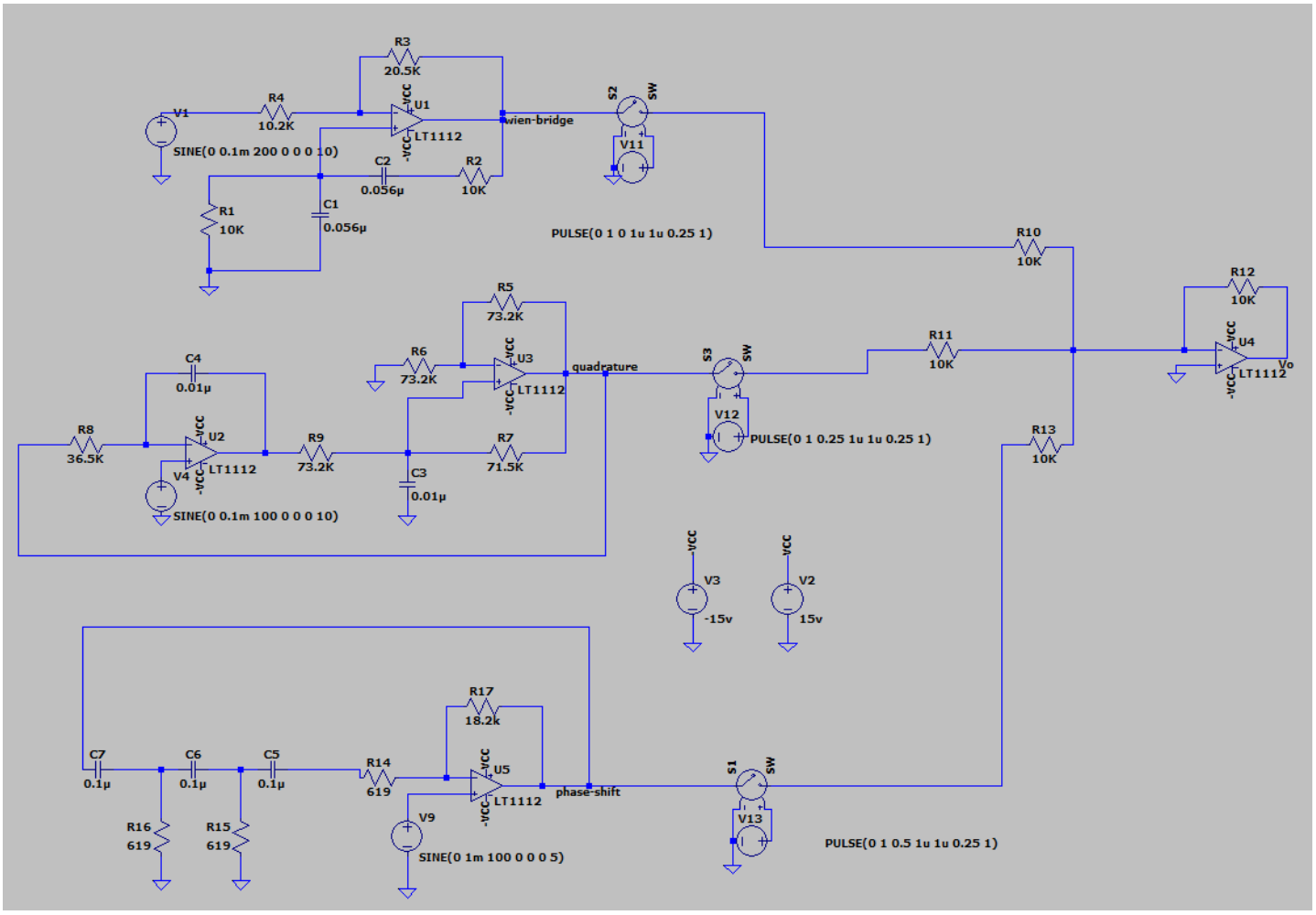

Figure 4 analog synthesizer design