Distributed RC Sinusoidal Oscillator Control Frequency by One Pole Amplifier

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Abstract: This paper present a distributed RC lines $(U\overline{RCs})$ oscillator with sinusoidal output. The frequency of oscillator can be controlled and adjustable by varying an one pole amplifier. The circuit incorporated an gain controller loop for amplitude stabilization with low distortion. The realization of simulation and experimental results are in reasonably good agreement with the theoretical , and very low harmonic distortion. In this circuit can be suitable for LSI process fabrication and the circuit application in electronic communications system.

Keywords: Amplifier , Sinusoidal oscillator , RC circuit ,

1. INTRODUCTION

Oscillators play an important role in instrumentation , measurement , communication , and control system. The literature contains a large number of oscillator design and analysis based on different principles [1]-[4]. In most of these oscillators , design methods for sinusoidal oscillators are based on the assumptions that the active elements are operating in their linear range and the circuits reach their steady state, Some circuits designed with this technique present an undesirable steady state behaviour. This behaviour has been reported for sinusoidal oscillators with a single op-amp. The active element is driven into saturation and held there permanently.

In this paper a different approach is presented we shown new structure have been proposed to overcome the frequency limitations associated with Uniformly Distributed Active RC $(U\overline{RCs})$ network and one pole amplifier based adjustable stability oscillators may be also improved, extending their range of operation and reducing the harmonic distortion. This improvement is easily achieved without introducing either active or passive additional elements. Appropriate scaling of passive components is only required. The simulation and experimental results are in reasonably good agreement with the theoretical , and very low harmonic distortion.

2. THE OSCILLATION CONDITION

The basic oscillator configuration shown in Fig. 1, A represents the gain and phase shift of the maintaining amplifier, and $\beta(j\omega)$ the frequency selective passive network. The loop transfer function $A\beta$ is such that positive feedback occurs at the frequency of oscillation. A constant amplitude oscillation exists at frequency ω_0 when .

$$A\beta_{(j\omega_0)} = 1.0\angle 0° \qquad (1)$$

Zero or 180 degrees are those phase angle that can be most easily obtained and held stable in the amplifier. For this reason the angle condition implied .

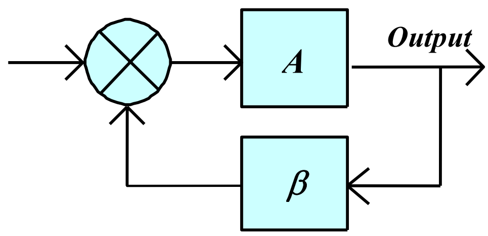


Fig. 1: A basic oscillator configuration circuit

by (1) is invariably satisfied by designing the network $\beta(j\omega)$ to have a phase angle of zero or 180 degrees at the desired frequency of oscillation ω_0. In this paper the amplifier gain (K) A is used one pole amplifier and $\beta(j\omega)$ is network structure of Distributed RC elements passive additional elements. Appropriate scaling of passive components is only required .The simulation and experimental results are in reasonably good agreement with the theoretical , and very low harmonic distortion.

3. ACTIVE DISTRIBUTED RC CIRCUIT

It is know that the Uniformly Distributed RC elements $(U\overline{RCs})$ have several advantages over lumped RC network. The structure of distributed RC elements in thin-film or LSI technology is built using smaller substrate area, less isolation and parasitic problem at high frequency. Distributed RC elements may have many form structures.[5,6] The structure and circuit symbol of uniformly distributed RC elements $(U\overline{RCs})$ is illustrated in Fig. 2.

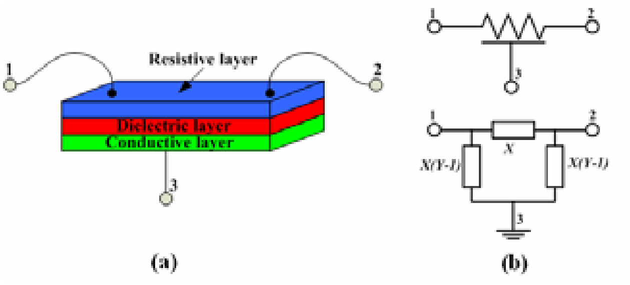


Fig. 2: (a) A Uniformly Distributed RC section, (b) are symbolic and its equivalent lumped π network

The admittance parameter [*Yij*] of the two port network $\overline{URCs}$ in Fig 2 is given as follows:

$$\begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = X \begin{bmatrix} Y & -1 \\ -1 & Y \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \end{bmatrix} \quad (2)$$

when $X = \dfrac{P}{R \sinh P}$, $Y = \cosh P$ and $P = \sqrt{sRC}$

R and *C* are the values of the total resistance and capacitance of the $\overline{URCs}$ respectively and *s* is the complex frequency.

This paper propose a method for the design consideration of sinusoidal oscillator using from active distributed uniformly *RC* [6] and an amplifier circuit shown in Fig. 3.

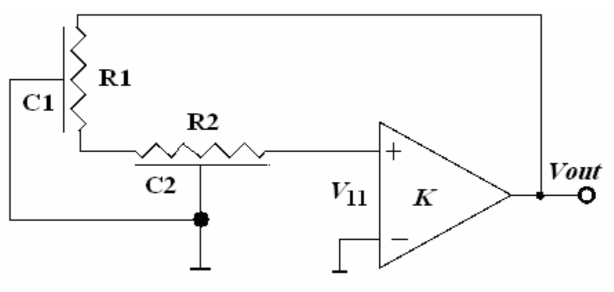


Fig. 3: An Active $\overline{URCs}$ oscillator circuit

The transfer function of this open loop circuit is shown in equation (3)

$$T(P) = \frac{V_o}{V_i} = \frac{K(\cosh P - 1)}{(1+\alpha)\cosh^2 P - (K+\alpha)} \quad (3)$$

where, *K* is voltage gain of the amplifier, $P = \sqrt{sRC}$,

$\alpha = \dfrac{R_1}{R_2} = \dfrac{C_2}{C_1}$, and $RC = R1C1 = R2C2$

In eq. (3) let α = 1 , eq. (3) reduces to equation (4).

$$T(P) = \frac{V_o}{V_i} = \frac{K(\cosh P - 1)}{\cosh 2P - K} \quad (4)$$

and *K* is the DC voltage gain amplifier. We replace a one pole amplifier instead of a DC gain amplifier. The transfer function of the amplifier is given as follows.

$$K = \frac{Vout}{V_{11}} = \frac{K_0}{1 + \dfrac{s}{\omega_1}} = \frac{K_0}{1 + j\dfrac{\omega}{\omega_1}} \quad (5)$$

When *Ko* is Constance gain and $\omega_1 = \dfrac{1}{Rk1Ck1}$

The proposed circuit with one pole voltage is shown in Fig .4 .The resonant characteristics in active distributed uniformly RC band pass filter are shown in The Fig. 5 for various value of $\omega_1(\omega_1 = 0.5, 1, 2.5, 10, \infty)$ .Then the normalized resonant frequency .

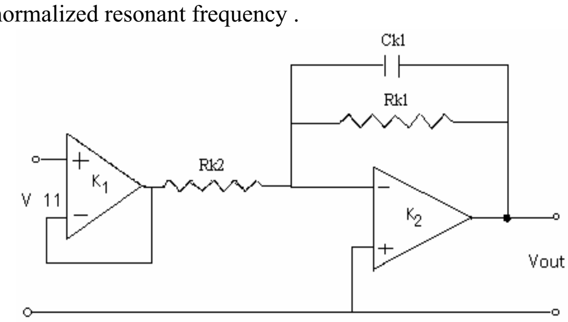


Fig. 4 The practical one pole amplifier

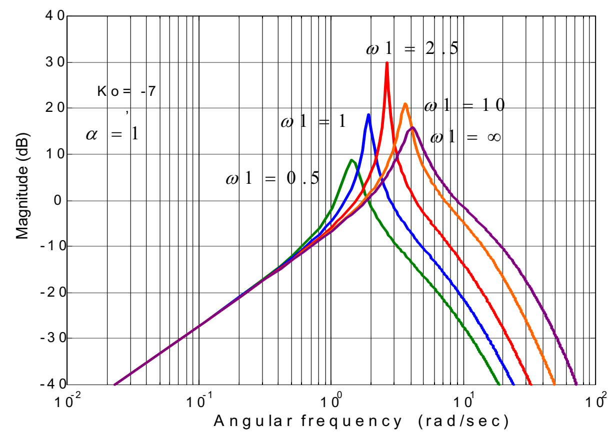


Fig. 5 The resonant characteristics for various values of ω_1

4. STABILITY REGION

In equation (4) we put

$$\cosh 2P\big|_{\substack{P=\sqrt{j\omega CR} \\ RC=1}} = \cosh(\sqrt{2\omega} + j\sqrt{2\omega}) = \mathrm{Re}(U) + j\,\mathrm{Im}(U) \quad (6)$$

Stability region of denomination in eq.(4) is shown in Fig. 6

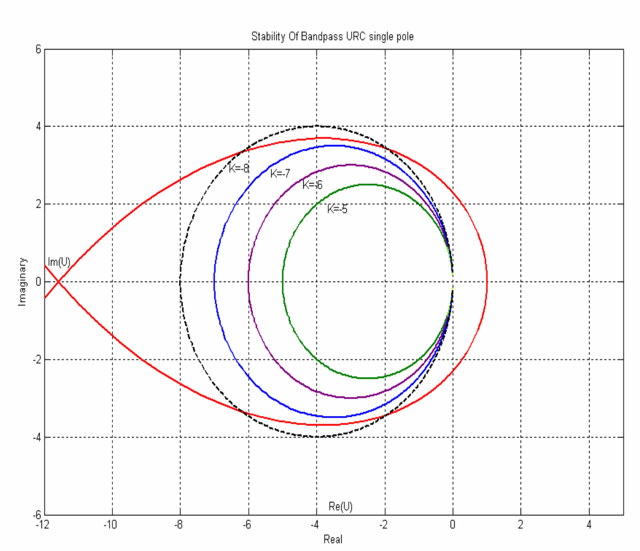
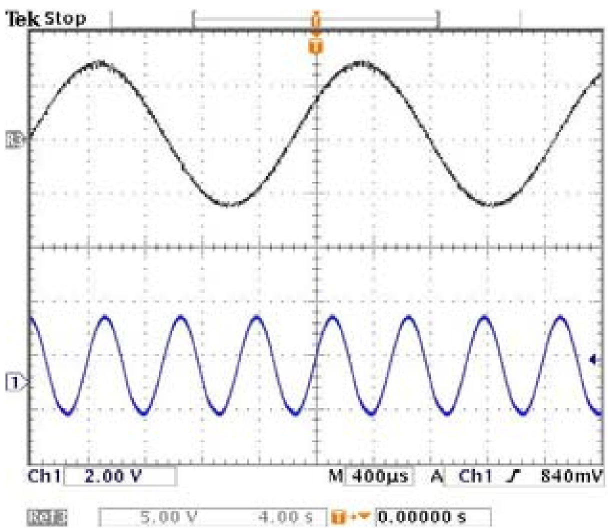


Fig. 6 Stability region for oscillation

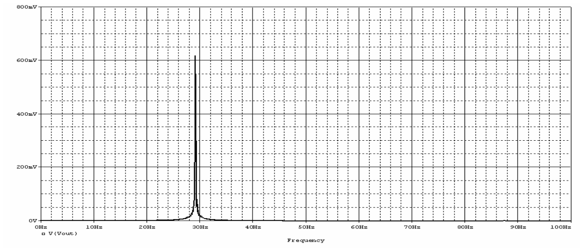
The vector *K* in eq. (5) move to the clock wise when *ω* increases. The vector *U* in eq. (6) moves to counter clock wise when *ω* increases. Therefore, the vector *K* and the vector U move to the opposite direction each other. In the case of considering one pole approximation, a resonance occurs when the difference between the smallest. From Fig. 6.

5. EXPERIMENTAL RESULTS

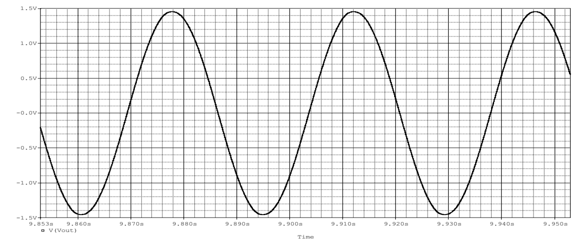
In the experiment of circuit Fig. 3, the used of Distributed RC elements by thin film process in any integrated circuit are immense complication compare to well established lump RC circuits. Herein, are choose the lumped RC elements of 10 section and one pole circuits is LF353 Op-Amp . Output signal experimental and simulation results in proposed oscillator circuit is shown Fig. 7 to Fig. 8 .



(a)

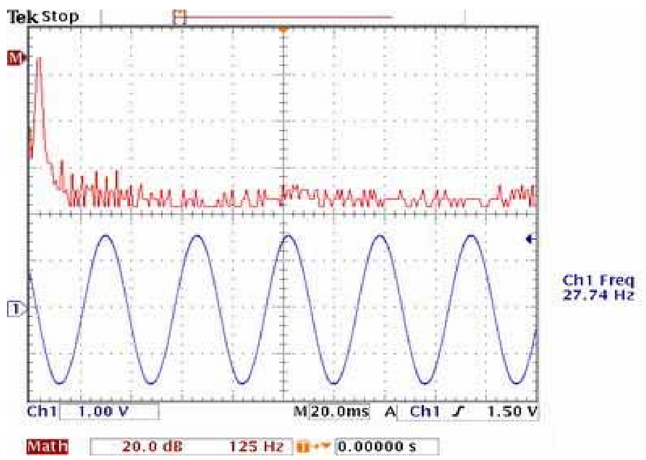


(b)

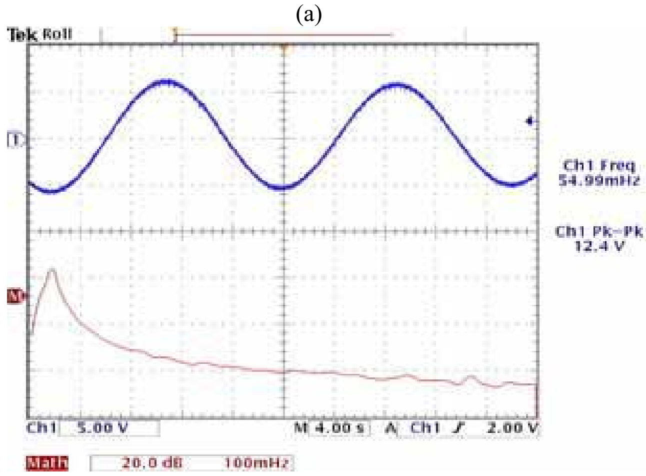


(c)

Fig. 7 (a) Experimental output signal results of adjustable frequency with appropriated parameters of gain amplifier (*K*) control , (b) Circuit simulation results output signal spectrum frequency and (c) waveform of output signal (with OrCAD PSpice)



(a)



(b)

Fig. 8 Waveform signal output proposed oscillator circuit

From active Distributed RC Sinusoidal oscillator propose circuit . The output signal we have wide range sinusoidal oscillator and less than harmonic content .

6. CONCLUSIONS

A new proposed oscillator circuit using one pole amplifier circuit is adjustable frequency and amplitude stability .The experimental results of the Active $U\overline{RCs}$ sinusoidal oscillator at relatively wide variable range frequency by proper selection of the $U\overline{RCs}$ element The simulation and experimental results are in reasonably good agreement with the theoretical , and very low harmonic distortion .The proposed circuit can be suitable for fabrication by LSI process. It will be useful for sinusoidal signal circuit oscillator. An application in electronic communication and modulation circuits or instrumentation , measurement system.

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