1. INTRODUCTION

The uniformly distributed RC line with a single amplifier have been published in many case [1], [2], [3], [4]. Herein, the paper proposed an active high pass filters using two lumped URC and two amplifiers. The lumped URC (R1C1) behavior as a high pass filter in conjunction with amplifier K1 and active notch filter circuits with amplifier K2 respectively.

2. UNIFORMLY DISTRIBUTED RC LINE (URC)

A crossed sectional structure of the URC is illustrated in Fig. (a) The circuit symbol of Fig. 1(a) is illustrated in Fig. 1(b)

The 3-ports floating admittance parameters matrix \([Y_{ij}]\) of the URC in Fig. 1(a) is given as follows:

\[
\begin{bmatrix}
Y_{11} & -1 & -(Y-1) \\
Y_{21} & Y & -(Y-1) \\
-(Y-1) & -(Y-1) & 2(Y-1)
\end{bmatrix} \quad (1)
\]

Where \(X = \frac{P}{R \sinh P}\) and \(Y = \cosh P\),

\[P = \sqrt{sRC}\], R and C are the values of total resistance and capacitance of the URC respectively. And \(s\) is the complex angular frequency variable.

3. HPF USING URC

3.1 HPF WITH NOTCH CHARACTERISTICS

The proposed active distributed RC HPF circuit is shown in Fig. 2. The voltage transfer function \(T(p) = V_2/V_1\) of the circuit is given as follow:

\[
\frac{V_2}{V_1} = \frac{-(Y-1)(sC_0 + X_0)K_2}{(sC_0 + X_0)K_2 - Y[-X_2(Y-1)K_2 + (sC_0 + X_2)Y]} \quad (2)
\]

Abstract: This paper describes the high pass filter with notch characteristics. The proposed circuits configuration consists of two uniformly distributed RC line (herein after is called URC) and two gain amplifiers (K1 and K2). With the appropriate K1 and K2, the circuit has a steeper slope of magnitude response at pass band steeper than using a single gain amplifier.

Keywords: High Pass Filter, URC
Where
\[ Y_1 = \cosh P_1, \quad Y_2 = \cosh P_2, \]
\[ X_1 = \frac{P_1}{R_1 \sinh P_1}, \quad X_2 = \frac{P_2}{R_2 \sinh P_2}, \]
\[ P_1 = \sqrt{s R_1 C_1}, \quad P_2 = \sqrt{s R_2 C_2}, \]
\[ \frac{P_2}{s C_0 R_2} = \frac{1}{P_2} \beta, \quad \beta = \frac{C_2}{C_0} \]
\[ \text{Eq. (2)} \]
\[ \text{Eq. (3)} \]
\[ K_1, K_2 \text{ are positive gain amplifier.} \]

From Fig. 3(a), 3(b) it is seen that for \( K_2 = 0.9, \beta = 17.786 \) and \( K_1 = 1 \) will give a high pass filter with steeper slope at the pass band without producing pass band peak.

### 3.3 Example

Herein, we consider a high pass transfer function. Let \( K_1 = 1, K_2 = 0.9 \) for an experiment, we choose the values of the circuit parameters as follows:

\[ R_1 = 10 \Omega, \quad R_2 = 100 \Omega, \]
\[ C_1 = 10 \mu F, \quad C_2 = 100 \mu F, \]
\[ C_0 = 5.622 \mu F \]
\[ \text{Eq. (5)} \]

The experimental results for the frequency characteristics is shown in Fig. 4. The results gives good agreement with theoretical values.

### 3.4 Sensitivity

The sensitivity \( S_{K_i}^{T} \) is defined as the ration of the normalized incremental change of the transfer function \( T(p) \), due to the normalized change of the circuit parameter \( X_j \):

\[ S_{X_j}^{T} = \frac{T(p)}{dX_j} \frac{X_j}{T(p)} \]
\[ \text{Eq. (6)} \]

Magnitude sensitivity is defined as follow:

\[ S_{X_j}^{|T|} = \text{Re} S_{X_j}^{T} \]
\[ \text{Eq. (7)} \]

We can calculation the magnitude sensitivity for the change of \( K_1, K_2 \). The sensitivity \( S_{K_i}^{|T|} \) for the voltage gain \( K_1 \) is shown as follow:
\[ S_{k_1}^{\text{P}} = \frac{\cosh P_1 \left[ \chi - \beta K_2 - \beta P_2 \sinh P_2 \right]}{(P_2 \sinh P_2 + \beta)K_1 K_2 + \cosh P_1 \left[ \chi - \beta K_2 - \beta P_2 \sinh P_2 \right]} \]

Where \[ \chi = \beta \cosh P_2 (K_2 - 1) \]

The sensitivity \[ S_{k_2}^{\text{T}} \] for the voltage gain \[ K_2 \] is shown as follow:

\[ S_{k_2}^{\text{T}} = \frac{-\cosh P_1 \left[ \beta \cosh P_2 + P_2 \sinh P_2 \right]}{(P_2 \sinh P_2 + \beta)K_1 K_2 + \cosh P_1 \left[ \chi - \beta K_2 - \beta P_2 \sinh P_2 \right]} \]

Where \[ \chi = \beta \cosh P_2 (K_2 - 1) \]

Fig. 5(a), (b) shown magnitude sensitivity of \[ T(j\omega) \] for amplifier \[ K_1, K_2 \].

From Fig. 5(a) and 5(b), it is seen that the sensitivities of positive gain \[ K_1 \] are sensible than does the positive gain \[ K_2 \] at the pass band.

4. CONCLUSIONS

The novel active distributed RC HPF using URC elements are proposed and discussed. The experimental results of the frequency characteristics and the simulation by H-SPICE showed good agreements with theoretical.

REFERENCES