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LETTER TO THE EDITOR

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AHMED M. SOLIMAN

AND

MISS SANAA A. BADRE

Electronics and Communications Engineering Department, Faculty of Engineering, Cairo University, Giza, Egypt

Recently an active RC configuration for realizing a second-order allpass or a symmetrical notch responses has been given.[1] The circuit is capable of realizing a high pole Q and has the attractive feature of providing a constant gain factor of unity.

In this letter a worthy modification is added to the network[1] in order to provide any notch response. The notch frequency is controlled by a single capacitor. This modification has no effect on the poles of the transfer function, thus the frequency limitation equation of the network is the same as before.[1]

Figure 1(a) represents the basic network, which is the same as before,[1] except that the voltage controlled voltage source (VCVS) is replaced by the frequency dependent VCVS, $a(s)$.

The practical realization of $a(s)$ using an operational amplifier is shown in Figure 1(b).

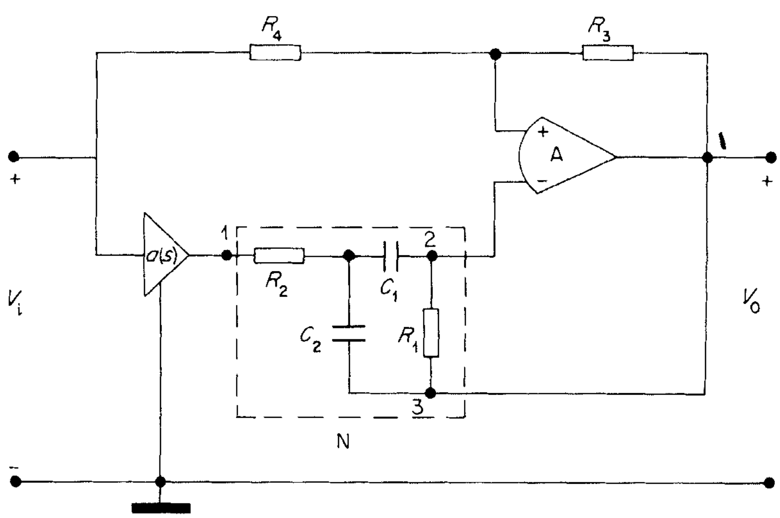

Figure 1.(a) The basic circuit. (b) The frequency dependent VCVS $a(s)$: ● o.c. for highpass notch, s.c. for notch and lowpass notch; ▲ o.c. for notch and highpass notch, s.c. for lowpass notch

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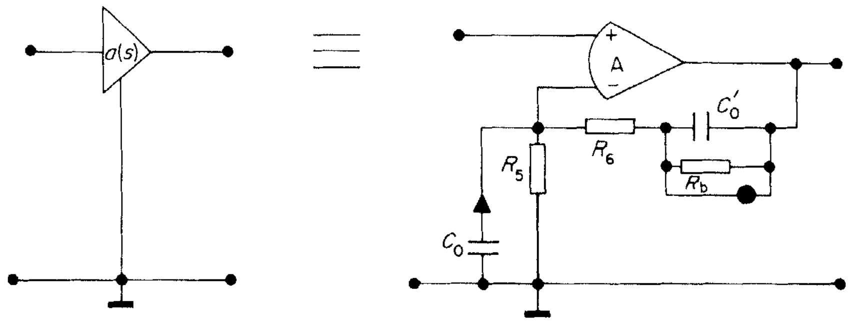

(b)

Figure 1—*continued*

Table I summarizes the results for the two cases of lowpass and highpass notch filters.

The circuit of Figure 1 was constructed in the laboratory using operational amplifiers type LM 741 (National Semiconductor Corp.) with $V_{CC} = \pm 15$ V supply voltages to realize $f_p = 533{\cdot}3$ Hz and $Q_p = 10$. The element values taken are $R = 30{\cdot}01$ kΩ and $C = 10$ nF.

For the lowpass notch, C_0 was taken as 2·2 nF and 3·4 nF to realize $f_z = 710$ Hz and 940 Hz, respectively. Figure 2 represents the theoretical and the experimental results obtained.

For the highpass notch, C_0' was taken as 33 nF and 46 nF to realize $f_z = 335$ Hz and 400 Hz, respectively, and the results are shown in Figure 3.

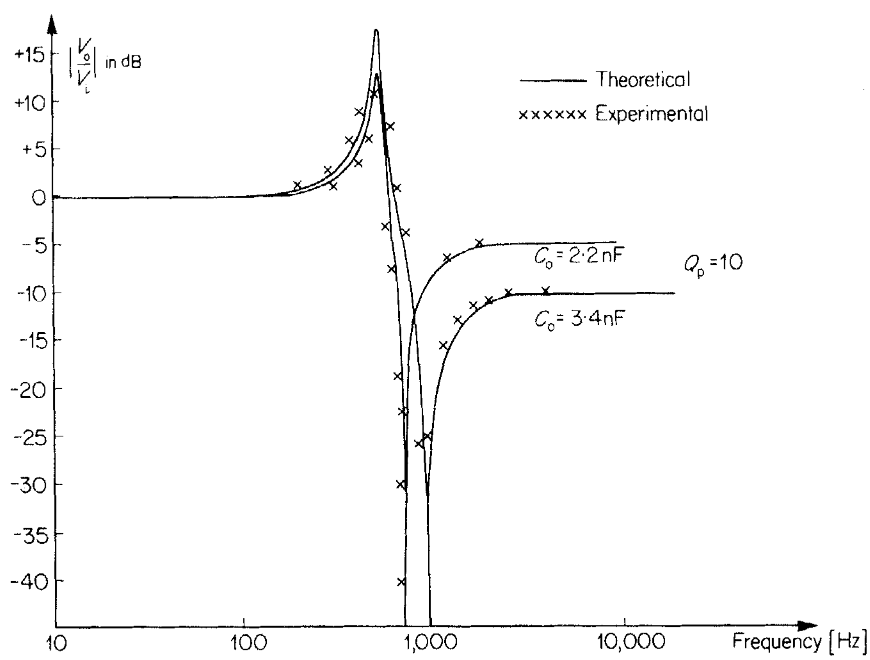

Figure 2. Frequency response of the lowpass notch filter

Table I

Network Parameters \ Network Type		Lowpass notch	Highpass notch
The transfer function of a generalized passive RC bandpass network N		$T(s)=\dfrac{K\omega_p s}{s^2+\left(\dfrac{\omega_p}{q_p}\right)s+\omega_p^2}$	$0<q_p<0{\cdot}5$ and $Kq_p\leq 1$
The gain of the frequency dependent VCVS		$a(s)=a_0+s\tau$ where $a_0=1+\dfrac{R_6}{R_5},\ \tau=C_0R_6$	$a(s)=a_0+\dfrac{1}{s\tau'}$ where $a_0=1+\dfrac{R_6}{R_5},\ \tau'=C_0'R_5$
The overall voltage transfer function V_0/V_i (assuming ideal OA's)		$G(s)=\dfrac{s^2\left(1-\dfrac{K\omega_p\tau}{m}\right)+\omega_p^2}{s^2+s\omega_p\left(\dfrac{1}{q_p}-\dfrac{K}{m}\right)+\omega_p^2}$ where $m=R_3/(R_3+R_4)$	$G(s)=\dfrac{s^2+\left(\omega_p^2-\dfrac{K\omega_p}{m\tau'}\right)}{s^2+s\omega_p\left(\dfrac{1}{q_p}-\dfrac{K}{m}\right)+\omega_p^2}$
Stability condition		$m>Kq_p$	
Notch condition		$a_0=\dfrac{m}{Kq_p}=\dfrac{1}{1-(q_p/Q_p)}$	
Notch radian frequency		$\omega_z=\dfrac{\omega_p}{\sqrt{[1-(\omega_pK\tau/m)]}}$	$\omega_z=\omega_p\sqrt{\left(1-\dfrac{K}{\omega_p\cdot m\tau'}\right)}$
Design equations	N parameters	$R_2=R,\quad C_2=C=\dfrac{1}{\omega_p\cdot R}$	$R_1=Q_p\cdot R,\quad C_1=\dfrac{C}{Q_p}$
	Potential divider parameters	$m=\frac{1}{2},\ R_3=R_4=R'$	
	Controlled source parameters	$R_6=R,\ R_5=2Q_pR$; $C_0=\dfrac{C}{2}\left[1-\left(\dfrac{\omega_p}{\omega_z}\right)^2\right]$	$R_5=R,\ R_6=\dfrac{R}{2Q_p}$; $C_0'=\dfrac{2C}{1-\left(\dfrac{\omega_z}{\omega_p}\right)^2}$
Effect of the rolloff of the OA gain[1]		$\dfrac{\Delta\omega_p}{\omega_p}\approx-\dfrac{2\omega_p}{GB}$ & $\dfrac{\Delta Q_p}{Q_p}=\dfrac{2\omega_p}{GB}$ for $Q_p\gg\frac{1}{2}$	

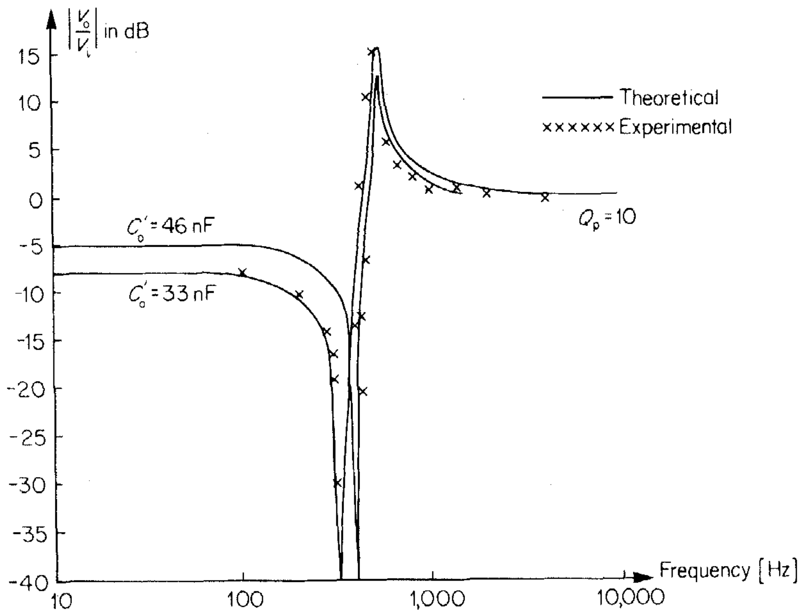

Figure 3. Frequency response of the highpass notch filter

REFERENCE

1. A. M. Soliman, 'A new active RC configuration for realizing nonminimum phase transfer functions', *Int. J. Cir. Theor. Appl.* **2**, 307–315 (1974).