Digital Auto-Tuning for Center Frequency and Q-Factor of Analog Band-Pass Filter

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In recent years, wireless communication technology has evolved dramatically due to the rapid advancement of LSI technology, and analog bandpass Gm-C filters play a crucial rule in mobile phone, wireless LANs, and Bluetooth transceivers[1-6]. This paper describes a digitally-controlled Gm-C bandpass filter which is suitable for several communication standards and fine CMOS implementation. The expected advantages of fine CMOS digitally control are as follows:

(1) Low voltage operation. (2) Stable operation. (2) Design easiness. (4) Small chip area.

We consider the structure of the band-pass Gm-C filters that are suitable for implementation in fine CMOS process. Since Gm-C band-pass filters require automatic adjustment of the property, we propose here digital auto-tuning schemes for second-order Gm-C bandpass filters which are suitable for fine CMOS implementation. We use a switched Gm-C analog filter [7] and two digital tuning schemes: a center frequency tuning scheme using the phase information (Fig.1) and a Q-factor tuning scheme using the magnitude information (Fig.3) . Simulation results show their effectiveness (Figs. 2, 4).

Note that the tansfer function of the second bandpass filter is given by

$$H(s) = \frac{K\omega_0 s}{s^2 + \omega_0 s / Q + \omega_0^2}$$

where ω_0 is the center frequency and Q is the Q-factor.

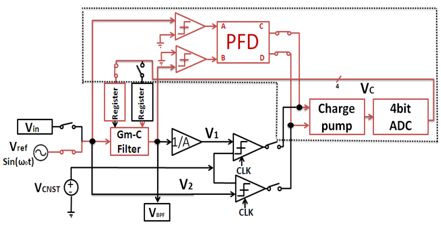

Fig. 1 Center frequency tuning scheme.

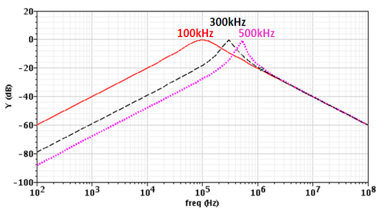

Fig.2 Simulation results of the bandpass filter magnitude response for varying reference frequency.

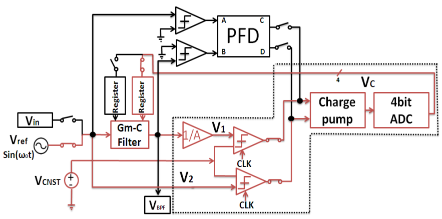

Fig. 3 Q factor tuning circuit.

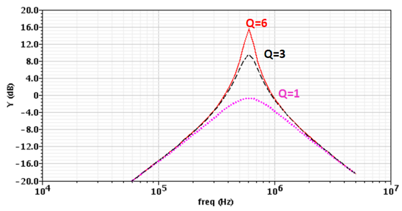

Fig. 4 Simulation results of the bandpass filter magnitude response for a fixed desired center frequency and varying Q.

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