CHARACTERIZATION OF A TRANSCONDUCTOR FOR LOW – VOLTAGE APPLICATIONS

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ABSTRACT: The characterization of a transconductor to be used in a GM-C bump equalizer is presented. This transconductor is programmable by means of either a DC voltage or a digitally controlled current divider. The transconductor is intended to be used in a battery-operated hearing aid device and it was designed with a 0.35μm CMOS fabrication process for a power supply of 1.4V. The transconductor performance is supported by a set of simulation and experiment results, which indicates a –3dB cutoff frequency around 10 kHz.

I – INTRODUCTION

Graphic equalizers are filters aimed to change the amount of equalization without altering the shape of the transfer characteristic. Particularly, bump-equalizers are applied in audio systems to provide hearing-impaired people with improved sound quality by equalization of the frequency response.

This work focuses on the characterization of the prototype of a transconductor used in a GM-C bump equalizer intended for hearing aid applications initially presented in [1].

The test of the circuit of the isolated basic structure of the transconductor used a low noise current pre-amplifier (SR-570) to analyze the frequency response.

II – TRANSCONDUCTOR TOPOLOGY

The main building block is a transconductor whose transconductance depends linearly on the drain-to-source voltage of a MOSFET operating in triode region. One of the most appealing features of our filter is that all building blocks such as current sources were derived from the basic transconductor topology. Moreover, the tuning strategy is very simple the center frequency of the bump equalizer can be changed (tuned) by varying a DC voltage (Vtune), where V_{TUNE} = Vdd -V_Y, and V_Y is indicated in figure(1), while two digital words control the quality factor and the boost/dip coefficient of the bump equalizer.

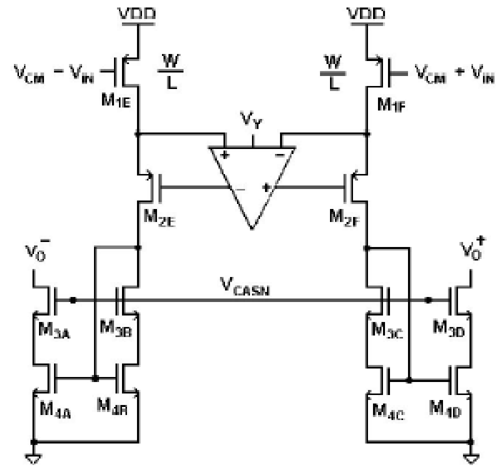

Figure 1 – Transconductor circuit

III – TEST METHODOLOGY AND RESULTS

The transconductor was characterized for a power supply of 1.4V, a bias current of 1μA and common-mode voltage (VCM) of 0.6V. There is, as well, another pin called V_{TUNE} that controls the transconductance. Expression (1) gives the relation between the transconductance g_m with V_{TUNE}

$$g_m = \frac{\partial I_D}{\delta V_{in}} = \frac{W_1}{L_1} \mu_p C_{ox} V_{TUNE} \qquad (1)$$

For the DC test of the transconductor, the input voltage (Vin) was swept from 0.4 to 0.8V, and four values of Vtune were used, namely 50, 100, 150 and 200mV.

The transconductance has been measured from figure (2) by taking the derivative of the current with respect to the support voltage for each value of V_{TUNE}. In figure (3) we summarize the variation of transconductance with V_{TUNE}.

To analyze the frequency response of the transconductor a low noise current pre-amplifier (SR 570) was used. To take the measurements a single to differential signal converter with DC of 0.6V was employed.

The transconductor was implemented in the TSMC 0.35µm process.

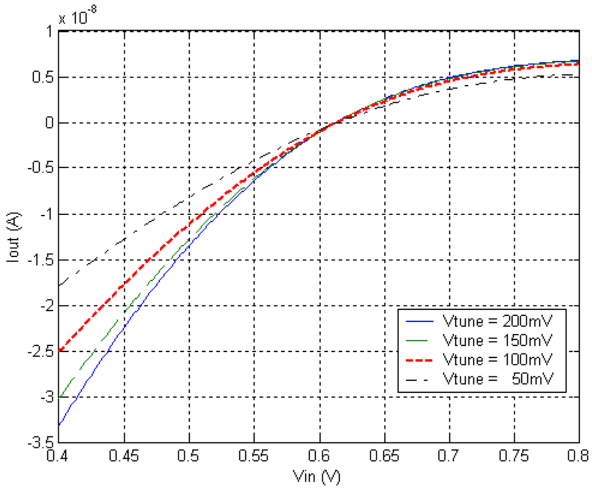

Figure (2) – DC Characterization

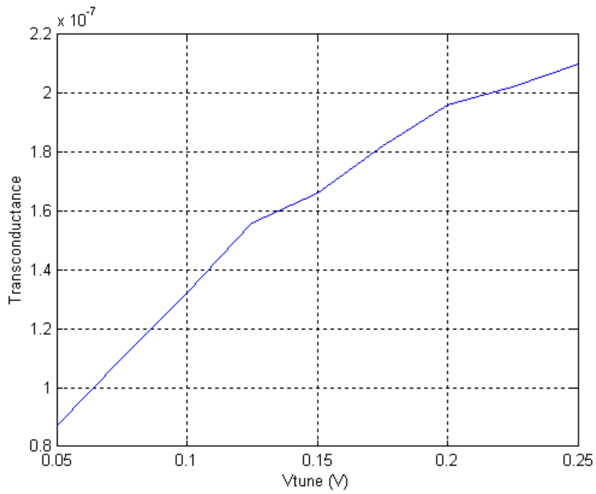

Figure (3) – Transconductance

The frequency response for a single transconductor, determined with V_{TUNE} = 100mV and using a sensitivity of 50nA/V in SR-570, is show in figure (4).

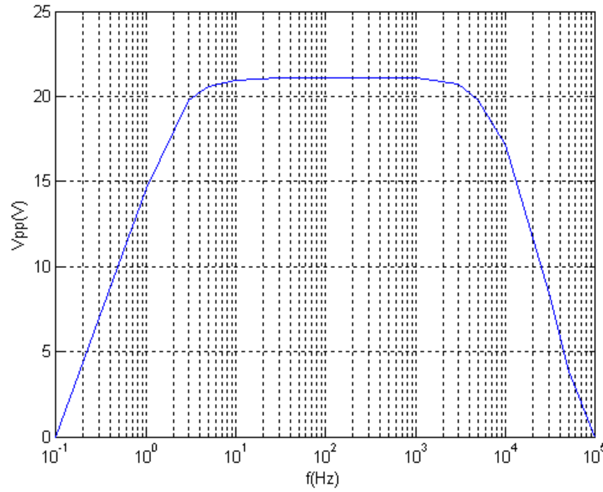

Figure (4) – Frequency response of the isolated transconductor

IV - CONCLUSIONS

The transconductance plot in figure (3) shows that the transconductance depends almost linearly on V_{TUNE}.

The frequency response of the isolated transconductor worked as predicted, and the bump equalizer is being already tested.

V – REFERENCE

[1] - R. Galembeck, J. A. de Lima and M. C. Schneider, "A Gm-C bump equalizer for low-voltage-power applications",International Symposium on Circuits and Systems (ISCAS), Vancouver, Canada, vol. 1, pp.797-800, May 2004.