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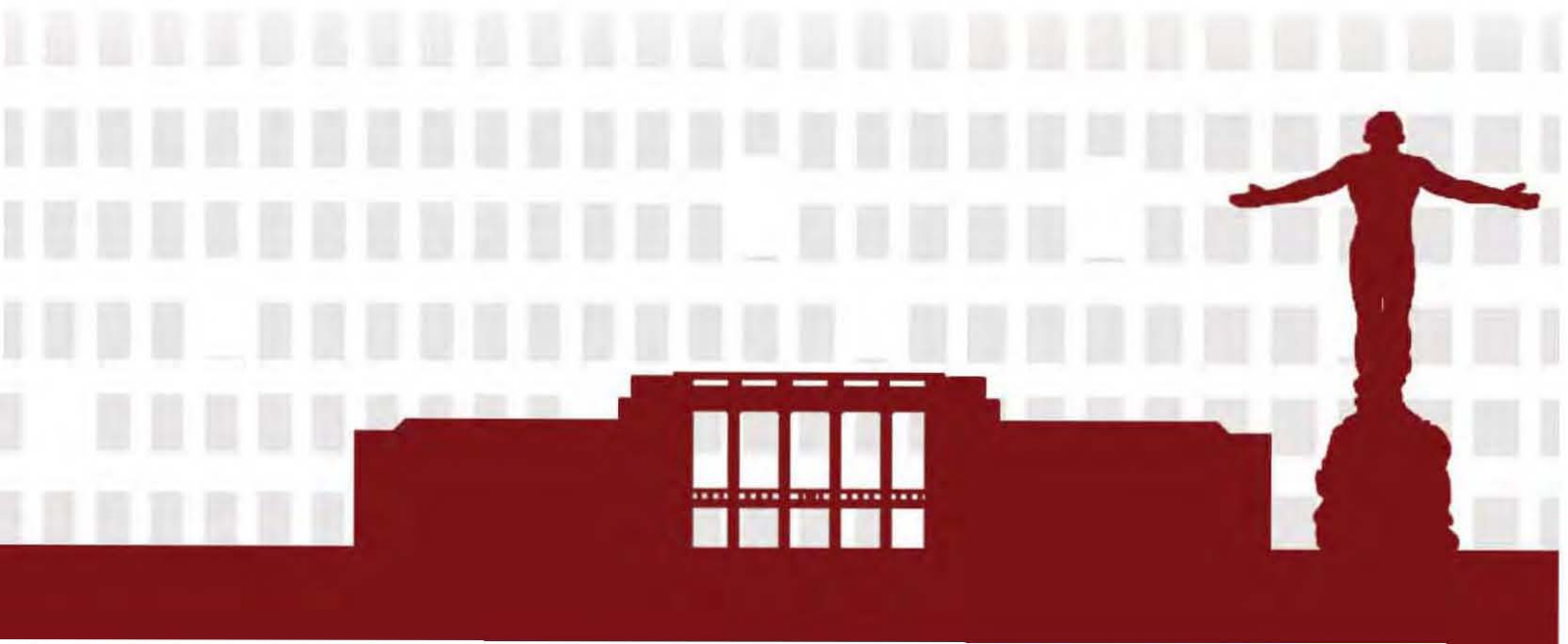
Metro Manila, Philippines



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A NOVEL POWER-EFFICIENT HD3 CANCELLATION FOR HIGH LINEARITY, PSEUDO-DIFFERENTIAL OTA

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ABSTRACT

The openloop nature of Gm-C filters demands high linearity in OTAs, with the filter linearity highly-dependent on the Gm-cell linearity. Therefore, it is important for the total harmonic distortion typically dominated by its 3rd order term and caused by mobility degradation to be kept low. The paper presents a pseudo-differential OTA with a novel low-power HD3 cancellation. The HD3 cancellation is done by adding the drain currents in saturated and subthreshold transistors with no added power overhead, presenting a low-power approach in HD3 cancellation. The HD3 cancellation resulted to an 18.2 dB and 10dB improvement in the HD3 and HD5, respectively. The OTA designed in a 65nm CMOS process achieved a -50dB HD3 for a 0.1Vpp 50MHz input, consuming 2.7 mW at a 1V voltage supply, while achieving a superior gm/power efficiency over most state of the art work.

As observed in modern CMOS processes, the actual current equation deviates from the ideal square-law model in saturation region. In short channel devices, the mobility is a strong function of the longitudinal and traversal electric fields causing mobility degradation. This effect causes non-linearity in our transistors. In an ideal differential structure, the even-order harmonic distortion terms are cancelled. This even-order harmonic distortion cancellation can also be seen in pseudo-differential structures, wherein the tail current is omitted for a larger swing. Therefore, the third harmonic distortion (HD3) dominates the total harmonic distortion (THD).

Common methods of HD3 cancellation involves HD3 feedforward branches [1]. However, the technique adds significant area and power overhead. In [3], an HD3 cancellation that takes advantage of the opposing signs of the 3rd harmonic terms of transistors in saturation and subthreshold is used. For a large input swing, the source follower gain is decreased for it to work as a voltage attenuator, effectively increasing the maximum input swing. However, the attenuation decreases the compensation capability of the subthreshold transistor. To get rid of the degradation factor and an extra current branch due to the source follower, a high-Vth device is used to bias the transistor in subthreshold and facilitate a more power-efficient HD3 cancellation.

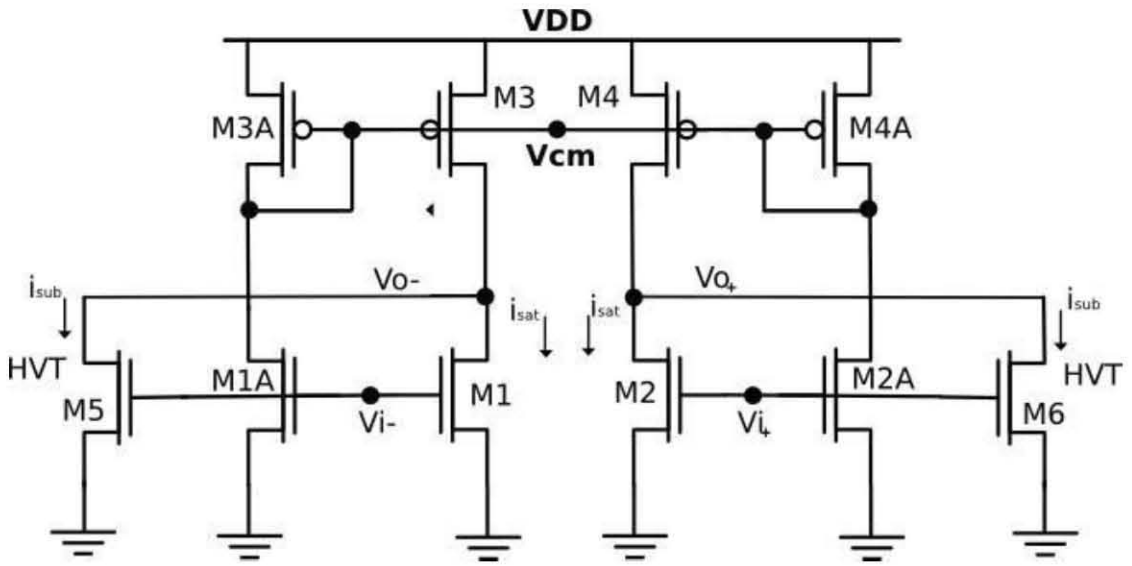

Figure 1. Subthreshold HD3 cancellation without a source follower. M5 and M6 are forced to operate in the subthreshold region by using a high-Vth device.

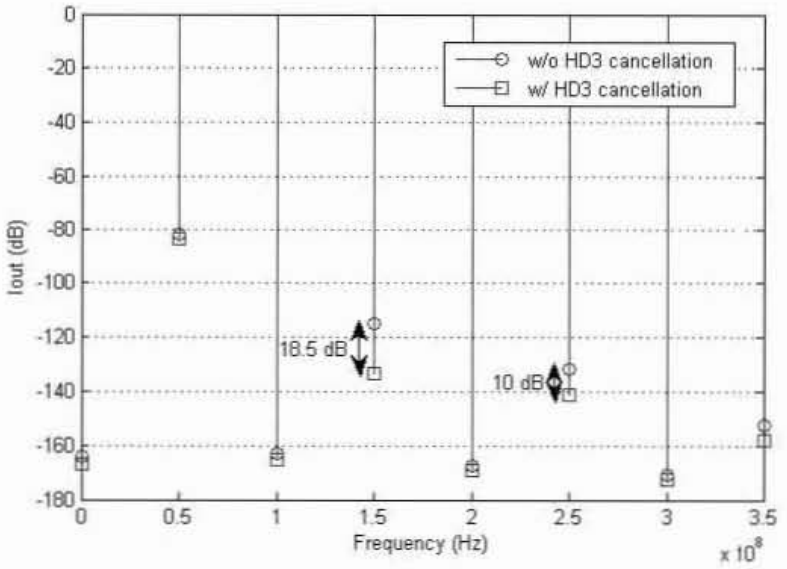

Figure 2. Periodic steady state response of the linear OTA for a Vid = 100mV at 50MHz. An 18.5 dB and a 10 dB improvement in the HD3 and HD5, respectively, is achieved by using the proposed HD3 cancellation.

Keywords: high linearity, pseudo-differential, HD3, low power

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