# Low-Voltage High-Frequency Gated Ring Oscillator Using Bootstrap Technique

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This paper proposes a high frequency ring oscillator with low power consumption. The proposed ring oscillator is based on Gated Ring Oscillator (GRO) by applying boot strap technique. Simulation results indicate that the FoM (Power Consumption /Oscillation Frequency) of the proposed ring oscillator is greater than that of the conventional ring oscillator.

Figure 1 shows delay element using bootstrap technique described in [1]. This delay element consists of bootstrap circuits and drivers. Since this circuit can operate under very low power supply voltage, the Figure of Merit (FoM) defined by (Power consumption) / (Oscillation Frequency) is very low. While a conventional ring oscillator taps only the previous delay stage output for its input, the GRO taps even previous delay stage in order to speed up the transition time.

Figure 2 shows the proposed ring oscillator. The proposed circuit applies a bootstrap technique to GRO in order to realize both low power consumption which is the characteristic of bootstrap technique and high frequency oscillation which is the that of GRO. The proposed ring oscillator is composed of five stages and prefetches the gate of NMOS FET. We have performed SPICE simulations to verify the validity of the proposed ring oscillator using Figs. 1 and 2: Figure 3 shows the simulation results of power supply voltage vs oscillation frequency of the typical ring oscillator, bootstrap ring oscillator, and the proposed ring oscillator. We see in Fig. 3 that the oscillation frequency of the proposed circuit is as the same as that of the bootstrap ring oscillator, and is higher than that of typical ring oscillator. Moreover, the proposed ring oscillator can oscillate under low power supply voltage as 0.2V. Figure 4 depicts power supply voltage vs FoM characteristics. Figure 4 indicates that FoM of the proposed ring oscillator is better than that of the bootstrap ring oscillator and the typical ring oscillator . The proposed ring oscillator is 12%~14% better than the bootstrap ring oscillator for all power supply voltage from 0.2V to 0.7V.

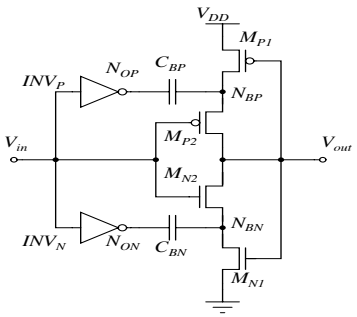


Fig.1. Delay element using bootstrap technique.

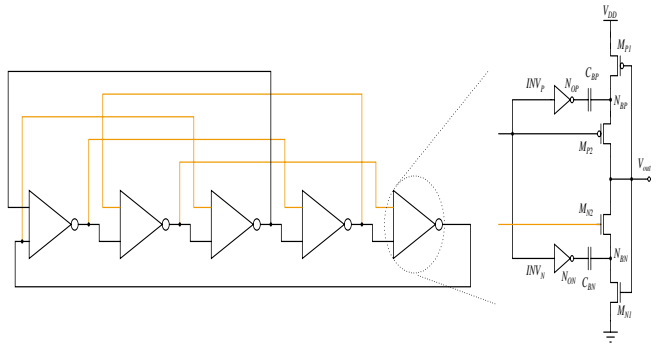

Fig.2. Proposed ring oscillator.

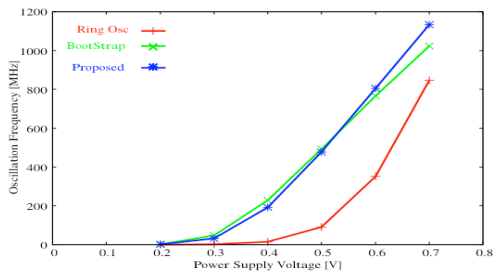


Fig.3. Power supply voltage vs oscillation frequency.

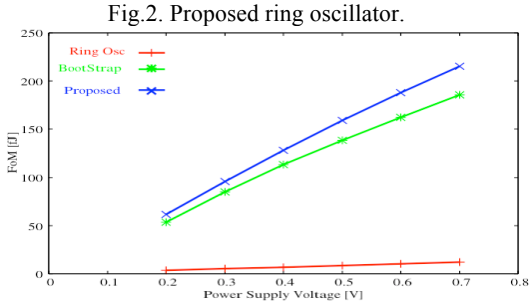


Fig.4. Power supply voltage vs FoM.

[1] Y. Ho, Y.-S. Yang, and C. Su, "A 0.2-0.6 V ring oscillator design using bootstrap technique," IEEE Asian Solid-State Circuits Conference, pp. 333–336 (Nov. 2011).
[2] M. Z. Straayer and M. H. Perrott, "A multi-path gated ring oscillator tdc with first-order noise shaping," IEEE Journal of Solid-State Circuits, vol. 44, no. 4, pp. 1089–1098 (April 2009).