

Phase-Change Reconfigurable Circuits



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Reconfigurable electronics are becoming a necessity to address increasing silicon costs and the need for flexible operation. Digital and analog circuits often use CMOS switches to achieve reconfiguration for programmable logic functions and for programmable gain or bandwidth. However, due to their high capacitive parasitics and high ON state resistance (R_{ON}), CMOS switches are not well-suited to reconfiguring RF circuits in multi-standard radios. Here, we propose a new approach for reconfiguration by implementing on-chip switches using non-volatile phase-change (PC) materials that feature high dynamic range R_{OFF} and R_{ON} in the amorphous and crystalline states, with low parasitics. To prove the proposed concept, cross-coupled LC VCO's with two different PC via-reconfigurable inductors: (a) series connected and (b) coupling controlled have been designed and fabricated as demonstration vehicles, as shown in Fig. 1. The transistors, capacitors, resistors and inductor traces are fabricated in a 130 nm CMOS process, and flip-chip integrated with a PC chip fabricated in an in-house PC process (Fig. 2). The two LC VCOs can be band-switched by PC-switched reconfigurable inductors, coarsely tuned using a programmable capacitor array and finely tuned by MOS varactors. Measured results of the integrated VCOs show successful reconfiguration with wide frequency tuning. The characterized tuning ranges of the two designs are shown in Fig. 3 and Fig. 4, respectively.

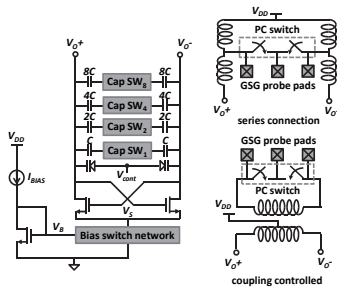


Fig. 1: Reconfigurable PC switch VCO

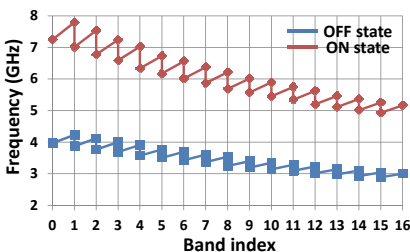


Fig. 3: Frequency tuning of series connection VCO

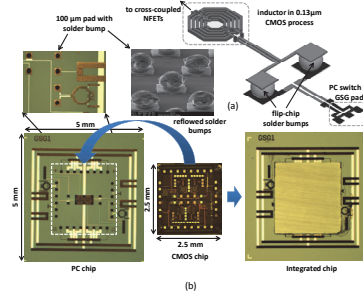


Fig. 2: Flip-chip bonded VCO

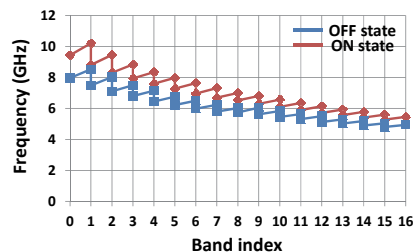


Fig. 4: Frequency tuning of coupling controlled VCO