博士論文 (要約)

The University of Tokyo

PhD Thesis

Pulse Generation Methods based on CMOS and Transmission Line Resonator for Impulse Radio

(伝送線路型共振器を用いたインパルス無線用ＣＭＯＳパルス発生手法)

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論文の内容の要旨

Thesis Summary

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In this thesis, novel pulse generation methods based on CMOS and transmission line resonator are proposed. The proposed architectures aim at efficient pulse generation with high center frequency. Conventional techniques are limited at the frequency near CMOS's F_{max} because of diminishing CMOS's gain. As opposed to the conventional pulse generation techniques which employs feedback oscillator, direct pulse generation methods using excitation-based architectures are explored. Since the CMOS's gain is not required in the excitation type, pulse's center frequency higher than CMOS's F_{max} is theoretically possible to be generated. In addition, the proposed techniques feature zero standby power, and quick starting time. The proposed circuit architectures are divided into two main categories; voltage-mode, and current-mode circuit. The voltage-mode circuit utilizes a fast step voltage generated by a CMOS transistor to trigger the resonator while the current-mode circuit utilizes a short current impulse generated by a CMOS transistor as a trigger signal. The voltage-mode pulse generator is first successfully demonstrated by T-shape resonator on FR-4 substrate and on a quartz substrate. Then the voltage-mode pulse generator based on quarter-wavelength resonator is analyzed in details, followed by design and implementation using a flipped-chip-on-quartz process. The measurement results show very good agreement with analysis and simulation results. The efficiency of 2.37 % at 11.5 GHz is obtained, which is the best for the excitation type, allowed by high Q factor of the transmission line resonator. To further increase the efficiency, a current-mode pulse generator based on a quarter-wavelength resonator is proposed, analyzed and designed. The measurement shows increasing efficiency to 3.1 % at 12 GHz. The proposed techniques are suitable for high frequency impulse radio applications which has stringent constraint on power consumption.