A Study of Dual-band Frequency Synthesizer for DAB

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Abstract

A frequency synthesizer for DAB(Eureka-147) applications is designed using 0.18 ㎛ CMOS process with 1.8V supply. PMOS core type is chosen for VCO core in L-Band to reduce phase noise. Differential ring oscillator is chosen for VCO core in Band-III to have small chip area and low power dissipation. The proposed VCO consumes 267 ㎂ (Band-III) and 3.69 mA(L-Band) current and phase noise is lower than -99.6 dBc/Hz and -109.8 dBc/Hz at 1 MHz offset for 185.6 MHz and 1436 MHz output frequency each.

Keywords: DAB, Frequency Synthesizer, VCO

1. Introduction

DAB(Digital Audio Broadcasting) is one of broadcasting services supported by many countries including Korea, which has started in the mid of 90's. DAB provides CD quality audio through AM/FM radio, various data services, and bi-directional functions[1][2][3][4][5].

Table 1. Specification for DAB

Bandwidth[MHz]		1.536
Audio coding method		MPEG Audio Layer II
Frequency range [MHz]	Band- III	174 ~ 240
	L-Band	1452 ~ 1492

In this paper, the frequency synthesizer optimized for Band-III and L-Band DAB system is proposed. The VCO, divider for VCO output frequency scaling and other blocks are designed and verified using CADENCE SPECTRE.

2. The design of the frequency synthesizer

The block diagram of the proposed the frequency synthesizer is illustrated in Figure 1. The PLL loop has two VCO's for different bands. One of VCO's is turned on according to the selected band.

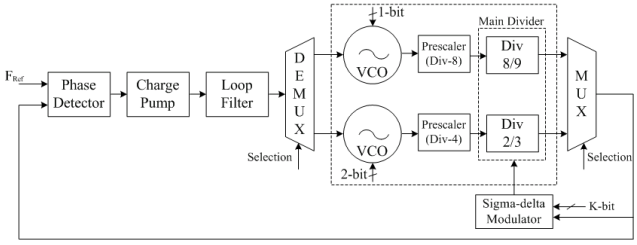


Fig. 1. Block diagram of the Frequency Synthesizer

Figure 2 shows the block diagram of VCO used to generate the oscillation frequency in L-Band. LC tank architecture by PMOS core is selected to minimize the phase noise of VCO. We also minimize capacitor bank while supporting the desired frequency specification for L-Band.

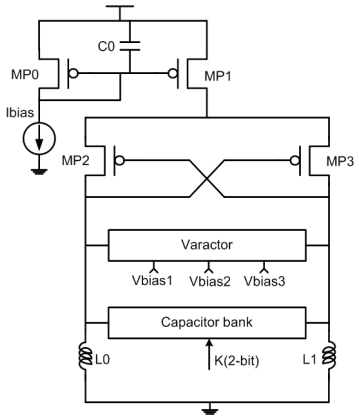
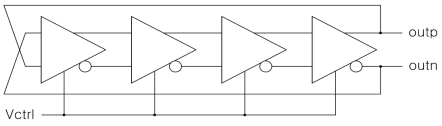
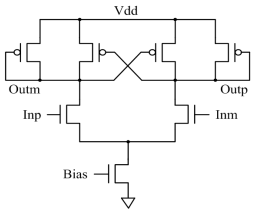


Fig. 2. The structure of LC-VCO

Figure 3 shows the block diagram of VCO to synthesize frequencies in Band-III. VCO is made of the ring oscillator of 4-stage differential type. Ring type oscillator is not good for phase noise characteristic than LC oscillator, but has the advantages in small chip area and low power dissipation. So ring type is selected in this work.



(a) Differential VCO



(b) Delay cell

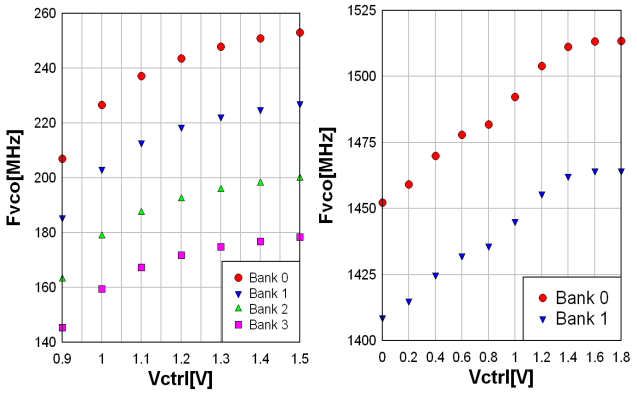
Fig. 3. The structure of differential VCO and delay cell

3. Simulation result

Simulations are carried out using 0.18 ㎛ CMOS technology. SPECTRE is used to verify the proposed frequency synthesizer.

A. VCO gain characteristics

Figure 4 shows the VCO gain characteristics according to VCO control voltage. We verified the output frequency of 145.32 MHz ~ 253.09 MHz for Band-III in (a). We also verified the output frequency of 1408.8 MHz ~ 1513.3 MHz for L-Band in (b).



(a) Band-III (b) L-Band

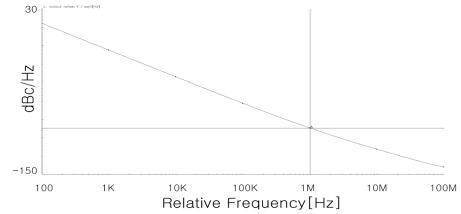
Fig. 4. VCO gain characteristics

B. VCO phase noise characteristics

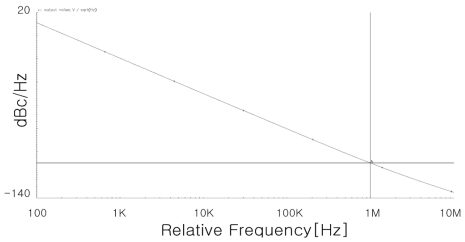
Figure 5 shows the simulation result of the phase noise according to selected channel in each band.

Figure 5.(a) shows the simulation result of the phase noise characteristic in Band-III and phase noise is -99.6 dBc/Hz at 1 MHz offset for 185.6 MHz output frequency.

Figure 5.(b) shows the simulation result of the phase noise characteristic in L-Band and phase noise is -109.8 dBc/Hz at 1 MHz offset for 1436 MHz output frequency.



(a) Phase Noise characteristic(Band-III)



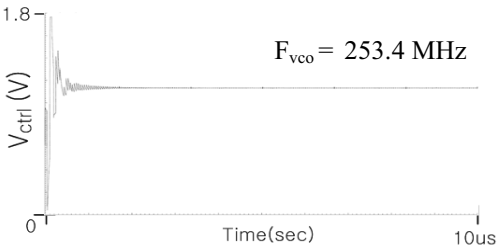
(b) Phase Noise characteristic(L-Band)

Fig. 5. Simulation Result of Phase Noise

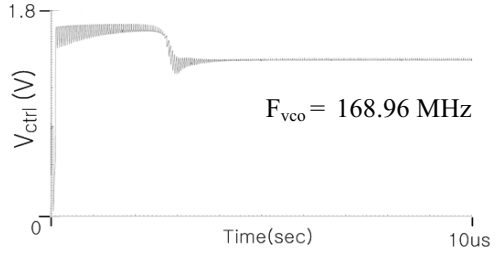
C. The frequency synthesizer

Figure 6 shows the VCO control voltage when the frequency synthesizer completed frequency generation in Band-III. Figure 6.(a) shows the VCO control voltage when “Bank 0” is selected. Figure 6.(b) shows the VCO control voltage when “Bank 3” is selected.

At these conditions, the output frequencies of VCO are 253.4 MHz and 168.96 MHz.



(a) Bank 0



(b) Bank 3

Fig. 6. Simulation Result of the V_{ctrl}(Band-III)

Figure 7 shows the VCO control voltage when the frequency synthesizer completed operation in L-Band. At this condition, the output frequency of VCO is 1495.8 MHz.

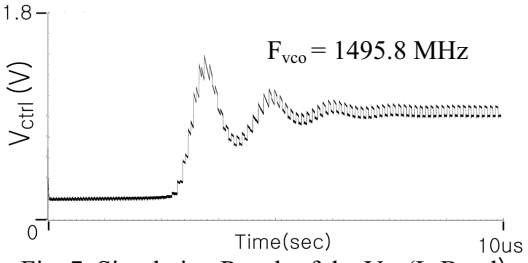


Fig. 7. Simulation Result of the V_{ctrl}(L-Band)

4. Conclusion

A frequency synthesizer for DAB(Eureka-147) applications is designed using 0.18 ㎛ CMOS process with 1.8V supply. The VCO used in L-Band is designed using PMOS core LC-VCO and shows the feasibility of frequency synthesizer by switching capacitors in capacitor bank. The VCO used in Band-III is designed using differential ring oscillator and has advantages in small chip area and low power dissipation. Though two VCO's are used in this frequency synthesizer, the total chip area of frequency synthesizer is not larger than the frequency synthesizer of using one LC-VCO for wide range. The designed VCO consumes 267 ㎂ (Band-III) and 3.69 mA(L-Band) current, phase noise are lower than -99.6 dBc/Hz and -109.8 dBc/Hz at 1 MHz offset for 185.6 MHz and 1436 MHz output frequency. The proposed frequency synthesizer consumes 1.45 mW for Band-III and 17.9 mW for L-Band. This work could be useful to implement DAB system for dual-band support.

Acknowledgment

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