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 \textmu m 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 \textmu A (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

<table>
<thead>
<tr>
<th>Bandwidth[MHz]</th>
<th>1.536</th>
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<tr>
<td>Audio coding method</td>
<td>MPEG Audio Layer II</td>
</tr>
<tr>
<td>Frequency range [MHz]</td>
<td>Band-III 174 ~ 240</td>
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<tr>
<td></td>
<td>L-Band 1452 ~ 1492</td>
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</table>

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 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.

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.

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.
3. Simulation result

Simulations are carried out using 0.18 \( \mu \)m 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 \( \sim \) 253.09 MHz for Band-III in (a). We also verified the output frequency of 1408.8 MHz \( \sim \) 1513.3 MHz for L-Band in (b).

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.

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.
4. Conclusion

A frequency synthesizer for DAB(Eureka-147) applications is designed using 0.18 μm 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 μA (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.

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References


