A Dual-band Image-reject Mixer for GPS with 64dB Image Rejection

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Abstract - A dual-band image-reject mixer is designed for a GPS L1/L2 dual-band receiver with an extension of the conventional Weaver architecture. The quadrature mixer with phase error compensation capability in the quadrature LO signal without calibration and tuning is reported. The measurement of the dual-band image-reject mixer demonstrated 64dB image reject ratio (IMRR).

I. Introduction

GPS (Global Positioning System) has been widely used as a system which performs position information reception for car navigation, the cellular phone, etc. Positioning by GPS is performed using the RF signals transmitted from the satellites. The RF signals are sent on two frequencies, L1(1.57GHz) and L2(1.23GHz) from the GPS satellites, where L2 is limited in military use now. However, L2 will be available for private use in the near future, leading to huge demand for the dual-band receiver which receives two frequencies, both L1 and L2.

Figure 1 shows a block diagram of the dual-band image reject mixer. The mixer consists of 1st and 2nd quadrature mixers and on-chip polyphase filters for 1st LO and 2nd LO. The 1st quadrature mixer converts the input signal into 1st intermediate frequency (1st IF) of 170MHz.

To meet such demand, we designed a dual band image reject mixer with L1/L2 dual band data outputs using 0.25μm CMOS technology[2,3] based on the Weaver architecture[1]. In the Weaver-type image reject mixer, the phase mismatch of LO is compensated by the use of a quadrature mixer including communalized transconductor stage, as 1st mixer.

II. Methodology and Experimental Results

Figure 1 shows a block diagram of the dual-band image reject mixer. The mixer consists of 1st and 2nd quadrature mixers and on-chip polyphase filters for 1st LO and 2nd LO. The 1st quadrature mixer converts the input signal into 1st intermediate frequency (1st IF) of 170MHz.

The 1st quadrature mixer shown in Fig. 2 is basically a pair of Gilbert mixers whose transistors in transconductor stages have been shorted at the drain terminal [4]. The quadrature mixer compensates phase error in the quadrature LO signal because of its switching characteristic. Figure 3 shows the measured results, IF phase error vs. LO phase error as a parameter of LO amplitude.
In the case of small LO phase error, IF phase error is suppressed by 60% at the LO amplitude of 0.90V\textsubscript{p-p} after the downconversion, while no IF phase error is compensated at the LO amplitude of 0.28V\textsubscript{p-p}.

Figure 4 shows the measured IMRR of dual-band image reject mixer vs. LO amplitude. The IMRR increases with increasing the amplitude of LO up to 64dB.

Figure 5 shows the dual-band image reject mixer fabricated with 0.25μm CMOS technology, the chip size of 0.6 x 0.6 mm\textsuperscript{2}. The fabricated image-rejection mixer consumes 4mA at 2.5V supply and demonstrates the input 1dB compression of >0dBm.

III. Summary and Conclusions

We demonstrated that the phase compensation effect was achieved by using a quadrature mixer which includes communialized transconductor stages. This technique can improve IMRR up to 64dB in the Weaver-type image reject mixer.

Acknowledgements

Support for the present study was provided by the JSPS (Japan Society for the Promotion of Science) research for future program. This work is also supported by VLSI Design and Education Center (VDEC), the University of Tokyo in collaboration with Cadence Design Systems, Inc. and Synopsys, Inc.

References